Naturalized Economics
Understanding the Natural Forces that Determine the Economic Future

By: Mark Aaron Martin, PhD (Electrical Engineering), MBA
Email: (mark@frolix.com)
Date: March 15, 2019
© Copyright 2014-2019  Mark Aaron Martin

1-Page Summary: This book discovers natural principles of morality and economy written into nature's laws and forces, applying universally to everything from molecules up to societies. The essence of morality is a propensity to cooperate toward mutual benefit. The essence of economy is the emergence of synergy from such cooperation. Synergistic cooperation toward mutual benefit is the common theme that creates all value and drives all evolutionary progress, starting with patterns of genes that cooperate to produce the synergy of cell division (patterns benefit by replicating). Through ever-higher levels of organization, ever-greater synergies emerge from mutually beneficial cooperation among patterns of genes, cells, organs, individuals, cultural behaviors, worker activities, and businesses. In manufacturing, workers cooperate toward their mutual benefit by arranging various materials into specific evolving patterns capable of redirecting nature's forces to the service of mankind—producing synergies of greater value than their costs. Our world is now covered by an enormous variety of evolving synergies (increasingly man-made), cooperating toward mutual proliferation in ways that are sometimes non-obvious and even counter intuitive.

By focusing on cooperating patterns and the synergies they produce at ever-higher levels, we gain a crystal clear and panoramic view into exactly how evolution works, what creates evolutionary advantage, and why an economy must be modeled as an evolving system. We learn that natural selection operates far more by proliferating the fittest patterns (the friendliest) than by culling the least fit. We learn that fitness for any product of evolution is an absolute measure of synergy emerging from cooperation among its underlying patterns, guaranteeing that evolution must have long-term directionality (toward species of ever-greater absolute fitness). Once we understand the intrinsic directionality of evolution, it becomes clearly evident in the historical progression of life as well as in the development of technology, indicating where both are headed. Most importantly, we learn new economic policies for stimulating growth and good-job creation, and for preventing the harmful effects of huge wealth disparity, even without redistributing it. These ideas are critical, timely, and firmly grounded in the forces of nature—built on simple scientific truths that are likely to be valid across the entire universe and for all eternity.
# Table of Contents

Prologue

Chapter 1. **Introductory Overview**
- Pattern Synergy
- Nature's Definition of Value: Self-Reinforcing Synergy
- The Common Theme: Cooperation toward Mutual Proliferation
- Emerging Complexity
- Natural Selection: Negative Culling and Positive Proliferation
- The Evolution of an Economy
- The Trajectory of Evolution: Determined by Nature's Forces
- Nature's Directional and Progressive Intentions
- Absolute Fitness: The Synergy of Mobility and Intelligence
- The Pace of Evolutionary Progress: Determined by Flow of Resources
- Nature's Morality: Reciprocal Altruism toward Mutual Benefit
- Natural versus Non-Natural
- Nature's Economy: The Synergistic Trading of Critical Resources
- Needs versus Wants
- Intelligent Machines
- Insights Gained from Adopting the Naturalized Perspective

PART I: The Naturalized Perspective

Chapter 2. **Evolution as the Basis for All Progress**
- The Abstract Algorithm Behind All Types of Evolution
- The Operational Mechanisms Underlying Evolution
- Ever-Increasing Diversity in Aggregate Life
- Stages of Absolute Fitness
- Stages of Absolute Fitness Emerging in Technology
- The Replicator-Centric Viewpoint
- Kin Selection in Environments of Long Ago

Chapter 3. **Synergy as the Driver and the Product of Evolution**
- Complexity Theory and Self-Referential Systems
- The Magic of Synergy
- The Synergy-Centric Viewpoint
- How Nature Assesses the Value of Synergy
- Cooperative Synergies in Some Unexpected Places
- The Evolution of Synergy in Aggregate Life—Gaia
- Cooperation versus Competition
- Cooperation among Humans
<table>
<thead>
<tr>
<th>Chapter 4. <strong>Patterns</strong></th>
<th>140</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Natural Creation of Replicating Patterns</td>
<td>140</td>
</tr>
<tr>
<td>The Automatic Translation of Patterns by Nature's Forces</td>
<td>142</td>
</tr>
<tr>
<td>How the Human Brain Processes Patterns</td>
<td>148</td>
</tr>
<tr>
<td>Looping Pathways for Pattern Translations</td>
<td>150</td>
</tr>
<tr>
<td>The Looping Pathway of Mimicry that Transmits Culture</td>
<td>155</td>
</tr>
<tr>
<td>Cultural Absolutism</td>
<td>159</td>
</tr>
<tr>
<td>The Unification of Synergistic Systems</td>
<td>160</td>
</tr>
<tr>
<td>Learned Patterns of Causality Underlying Science</td>
<td>167</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 5. <strong>Evolving Patterns of Technology</strong></th>
<th>171</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Natural Origins of Technology</td>
<td>171</td>
</tr>
<tr>
<td>How Technology Evolves</td>
<td>175</td>
</tr>
<tr>
<td>Building Blocks</td>
<td>177</td>
</tr>
<tr>
<td>From Patterns of Information to Patterns of Physical Embodiment</td>
<td>179</td>
</tr>
<tr>
<td>Process Technologies</td>
<td>182</td>
</tr>
<tr>
<td>How Technology Drives Prosperity</td>
<td>184</td>
</tr>
<tr>
<td>Homo Economicus—Breeding Ground for Patterns of Technology</td>
<td>186</td>
</tr>
<tr>
<td>Modern Technology Selected by Humans as Nature's Proxies</td>
<td>189</td>
</tr>
<tr>
<td>The Natural Destiny of Technology</td>
<td>294</td>
</tr>
<tr>
<td>The Acceleration of Technology</td>
<td>297</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 6. <strong>How Jobs Relate to Pattern Synergies</strong></th>
<th>204</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs are Eliminated by Growing Depth of Economic Synergy</td>
<td>205</td>
</tr>
<tr>
<td>Jobs are Created by Growing Diversity of Economic Synergy</td>
<td>207</td>
</tr>
<tr>
<td>The Employment Life-Cycle for a New Innovation</td>
<td>211</td>
</tr>
<tr>
<td>The Business Cycle</td>
<td>215</td>
</tr>
<tr>
<td>Technology and the Great Depression</td>
<td>219</td>
</tr>
<tr>
<td>Technology and the Great Recession</td>
<td>223</td>
</tr>
<tr>
<td>Government's Role in Long-Term Job Creation</td>
<td>226</td>
</tr>
<tr>
<td>Summary of the Naturalized Perspective</td>
<td>227</td>
</tr>
</tbody>
</table>

**PART II: Nature's Most Preferred Style of Economy**

<table>
<thead>
<tr>
<th>Chapter 7. <strong>Evolutionary Origins of Economic Activity</strong></th>
<th>234</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Widening Scope of Identity</td>
<td>234</td>
</tr>
<tr>
<td>Energy Economization</td>
<td>235</td>
</tr>
<tr>
<td>Life's Responsibilities</td>
<td>239</td>
</tr>
<tr>
<td>Life's Tactics and Strategies</td>
<td>242</td>
</tr>
</tbody>
</table>

3
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reciprocity, Direct and Indirect</td>
<td>245</td>
</tr>
<tr>
<td>The Natural Flow of Causality and Resources</td>
<td>249</td>
</tr>
<tr>
<td>Good Flows of Resources and Bad Flows</td>
<td>252</td>
</tr>
<tr>
<td>Parasitism in Biological Life</td>
<td>254</td>
</tr>
<tr>
<td>Economic Parasitism</td>
<td>256</td>
</tr>
<tr>
<td>Parasitism Gives Way to Mutualism</td>
<td>260</td>
</tr>
<tr>
<td>Prisoner's Dilemma</td>
<td>262</td>
</tr>
<tr>
<td>Nature's Preferred Code of Conduct—Tit-For-Tat</td>
<td>267</td>
</tr>
<tr>
<td>Religions Evolve to Discover Nature's Morality</td>
<td>269</td>
</tr>
<tr>
<td>Specialization, Division of Labor and Trade</td>
<td>272</td>
</tr>
<tr>
<td>Freedom and the Pursuit of Innovation</td>
<td>276</td>
</tr>
<tr>
<td>Chapter 8. The Synergistic Allocation of Resources</td>
<td>281</td>
</tr>
<tr>
<td>Aggregate Growth and Development</td>
<td>282</td>
</tr>
<tr>
<td>Proliferation of Quantity versus Improvement of Quality</td>
<td>285</td>
</tr>
<tr>
<td>Nature's Very Unfair Resource Allocation Scheme</td>
<td>288</td>
</tr>
<tr>
<td>The Self-Reinforcing Effects of Nature's Forces</td>
<td>292</td>
</tr>
<tr>
<td>The Emergence of Intelligence from Self-Reinforcing Systems</td>
<td>295</td>
</tr>
<tr>
<td>Resource Allocation in a Very Simple Economy</td>
<td>299</td>
</tr>
<tr>
<td>The Role of Money in an Economy</td>
<td>300</td>
</tr>
<tr>
<td>Resource Allocation in a Business</td>
<td>304</td>
</tr>
<tr>
<td>Incentives Reconsidered as Means for Allocating Resources</td>
<td>307</td>
</tr>
<tr>
<td>The Ethical Usage of Wealth</td>
<td>311</td>
</tr>
<tr>
<td>Charitable Giving and Income Redistribution</td>
<td>316</td>
</tr>
<tr>
<td>The False Allure of Communism and Socialism</td>
<td>321</td>
</tr>
<tr>
<td>Free Markets</td>
<td>324</td>
</tr>
<tr>
<td>The Self-Reinforcement of Success in Capitalism</td>
<td>329</td>
</tr>
<tr>
<td>The Loops of Causality Driving All Evolutionary Progress</td>
<td>332</td>
</tr>
<tr>
<td>Chapter 9. The Natural Economy—A Model for Optimal Economics</td>
<td>338</td>
</tr>
<tr>
<td>Benefit Now or Greater Benefit Later</td>
<td>338</td>
</tr>
<tr>
<td>The Ultimate Resource—Human Capital</td>
<td>340</td>
</tr>
<tr>
<td>The Natural Purpose of Society</td>
<td>342</td>
</tr>
<tr>
<td>Multilevel Selection</td>
<td>346</td>
</tr>
<tr>
<td>A Serial Style of Evolution</td>
<td>351</td>
</tr>
<tr>
<td>How An Economy Evolves, or Devolves</td>
<td>357</td>
</tr>
<tr>
<td>Hyper-Capitalism</td>
<td>361</td>
</tr>
<tr>
<td>Control versus Ownership of Wealth</td>
<td>364</td>
</tr>
<tr>
<td>Fully Democratized Venture Investing</td>
<td>370</td>
</tr>
<tr>
<td>A New Style of Patent System</td>
<td>371</td>
</tr>
<tr>
<td>Decentralization of Business—Maximizing Degrees of Freedom</td>
<td>375</td>
</tr>
</tbody>
</table>
Chapter 10. Naturalized Politics

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Social Contract</td>
<td>383</td>
</tr>
<tr>
<td>Discipline and Accountability</td>
<td>387</td>
</tr>
<tr>
<td>Mother Nature's Political Affiliation</td>
<td>391</td>
</tr>
<tr>
<td>The Difference between Liberals and Conservatives</td>
<td>394</td>
</tr>
<tr>
<td>Opportunity Costs</td>
<td>398</td>
</tr>
<tr>
<td>Focusing on Success</td>
<td>401</td>
</tr>
</tbody>
</table>

PART III: The Future Economic Effects of Intelligent Machines

Chapter 11. Transitioning to a Much Different Style of Economy

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The New Shadow Economy</td>
<td>407</td>
</tr>
<tr>
<td>Crossing a Critical Threshold</td>
<td>408</td>
</tr>
<tr>
<td>The Problem is Structural, Not Cyclical</td>
<td>411</td>
</tr>
<tr>
<td>Income Inequality</td>
<td>412</td>
</tr>
<tr>
<td>Eternal Deflation</td>
<td>416</td>
</tr>
<tr>
<td>The Destiny of Machine-Based Economics</td>
<td>421</td>
</tr>
</tbody>
</table>

Chapter 12. Economics of the Future

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyzing the Economy on the Basis of Causality</td>
<td>428</td>
</tr>
<tr>
<td>Invariant Laws of Economic Causality</td>
<td>429</td>
</tr>
<tr>
<td>The Patterns Proliferating Most Rapidly Today</td>
<td>437</td>
</tr>
<tr>
<td>Patterns and Synergies of the Future</td>
<td>440</td>
</tr>
<tr>
<td>The Inevitable Competition over Resources</td>
<td>444</td>
</tr>
<tr>
<td>Climate Change</td>
<td>446</td>
</tr>
<tr>
<td>The Urgent Race to Trans-Human Machines</td>
<td>449</td>
</tr>
<tr>
<td>Economic Policy in the Very Different Future</td>
<td>452</td>
</tr>
<tr>
<td>The Final Frontier</td>
<td>454</td>
</tr>
<tr>
<td>Perfect Life</td>
<td>457</td>
</tr>
</tbody>
</table>

Epilogue

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedication and Acknowledgments</td>
<td>461</td>
</tr>
</tbody>
</table>

Appendices

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix: Deterministic Mind</td>
<td>469</td>
</tr>
<tr>
<td>Appendix: Inertia and Economic Instability</td>
<td>478</td>
</tr>
<tr>
<td>Appendix: Predictions Compared with Reality</td>
<td>482</td>
</tr>
<tr>
<td>Appendix: A Possible Technological Fix for Global Warming</td>
<td>486</td>
</tr>
</tbody>
</table>
Prologue

I shall take some freedom during this opening section to express my thoughts in an informal manner, intending to be intimate, candid and revealing of who I am and how I think. Readers have a right to understand the context of my thinking as it applies to the development of concepts in this book. I shall be even more candid and revealing in the Epilogue, after the book's many ideas have been fully presented.

As I compose this opening section of the book, I am sitting alone in a beach chair on the New Jersey shoreline, facing in a south-westerly direction toward the late afternoon sun. I have many pleasant memories of being young, sitting on the very same beach with a lovely girl who would later become my wife and the mother of our two children. I remember enjoying the beach with our two kids, when they were young, and teaching them that, amazingly, there are more stars in the universe than grains of sand on the beach. Using modern space-based telescopes, astronomers estimate that there are many billions of stars in a typical galaxy (more than the number of sand grains it takes to fill a child's sand bucket), and there are many billions of galaxies in the universe (more than the number of buckets full of sand it would take to make a very large beach). From our biased perspectives as individuals, we watch the sun and stars move across the sky as if the Earth is the center of everything. But in fact our place in the universe is as insignificant as a single grain of sand among all the others on the beach.

Closing my eyes to the afternoon sun allows my mind to drift, and I imagine what advanced life might be like near one of those many distant stars. Suppose there is an advanced civilization somewhere out there, having a style of economy that better uses nature's forces to create even more widespread prosperity than we humans now enjoy. If so, then it is likely possible here on Earth, because the laws of nature completely determine what is possible and what is not possible, and they appear to be the same everywhere, throughout the entire universe.

As I bury my feet in the comfortable warmth of the sand, held from the earlier mid-day sun, I begin to think about an oyster, laying rather motionless somewhere on the ocean floor, gathering nutrients from its local environment. If a piece of irritating grit gets inside its shell, the oyster automatically generates a slimy substance to cover it, layer by layer, eventually turning it into a smooth and beautiful pearl. Similarly, we humans have been evolutionarily programmed to cover the uncomfortable aspects of our lives with pearly layers of beautiful myths, perhaps as a mechanism for coping as optimistically as possible with the harsh realities of life, pretending, for example, that the death of a loved-one is actually just the means for passage to an even better afterlife. (Credit to Daniel Dennett for this metaphor.) To see the gritty truth of optimal economic development, we need to strip away the pearly layers of how we humans view our place in the world. No matter how uncomfortable or unpopular the truth might be, we must stand face-to-face—nose-to-nose—in our confrontation with it. Science is our only path to truth, and the truth
of the universe is often much different than it seems. So, let us challenge our own personal desires in a quest for understanding exactly why we desire those things. Let us metaphorically take a few giant steps backward for a much wider and deeper view of ourselves, divorcing our thoughts from our normally-held ego-centric perspectives, our hectic daily lives and our selfish ambitions. Let us look at ourselves, as if from far away—from an emotionally detached perspective considering only nature's laws and forces. Looking at life from a fully naturalized perspective—from nature's point of view—frees our minds from the many inaccurate biases of our thinking. Let us ultimately try to understand how the laws of nature make possible the amazing progress that has already occurred in the ongoing development of economic prosperity. Unfortunately, such a deep understanding requires that we face-up to some very uncomfortable economic truths.

As I relax to the soothing sound of the surf crashing onto the beach, like Mother Nature's reliable heartbeat, I begin to think about the very special place where I am sitting—a natural cusp between the miles of atmosphere above me, 8000 miles of earth below me, 3000 miles of land to the right of me, and 2000 miles of ocean to the left of me. The ocean is inhabited by many creatures that are rather stupid. Fish do what they were evolutionarily programmed to do. Many fish swim in schools, collectively meandering toward some mysterious destiny. During my scuba-diving experiences, I've seen certain types of fish get caught-up in a circular formation, where they each just follow the fish in front of them, around and around the circle. It is almost as if fish want to create patterns of order, but can only manage a fleeting sort. On the other hand, the land to the right of me is highly organized by artifacts of human production—cities, small towns, cookie-cutter houses, identical baseball fields, factories full of workers performing the same patterns of activities many times a day, and farmland teeming with crops all lined up into neat little rows. We humans are very good at bringing patterns of order to the world.

As I look all around at the ocean and the beach, I notice the regularity of waves and the similarity of patterns in each. As waves crash onto the beach and then recede back into the ocean, I am reminded of how the economy roars for a while and then inevitably goes into recession. I wonder if nature's forces cause oscillations in both ocean waves and economic cycles to be somewhat similar. I further notice the similarity of patterns in all the beach chairs and in all the beach umbrellas, and the similarity of patterns in all the people sitting under those umbrellas. It seems that nature's forces automatically generate some patterns, as in the waves that crash on the beach every few seconds. And then some of those automatically generated patterns can further create patterns of their own, as in the pattern of smoothed-out sand that records the last high tide. Naturally-created patterns cross an important threshold when they are able to use nature's forces to get themselves automatically replicated—they become more abundant in the environment. Life emerges. As life becomes increasingly complex, patterns of behavior emerge and evolve. Life eventually becomes intelligent and moral, and economies then emerge and evolve.

The view of economics presented here will be very unfamiliar to economists, since it is rooted entirely in the scientific understanding of nature's forces, primarily the forces that enable evolution. Instead of talking about demand curves, supply curves, and equilibrium points, I endeavor to explain all aspects of economic development using the very natural
process of evolution. For the sake of simplifying the arguments, I use the term *synergy* to represent the abstract essence for which all evolutionary processes naturally search. When primitive elements are arranged into specific patterns—discrete packets of order—they can reliably produce an emergent effect making them more valuable than the sum of values over all the constituent elements considered separately. They achieve a sort of synergy. And when such synergistic patterns are arranged into a yet higher-level pattern, they can sometimes create an even more beneficial form of synergy. Most fundamentally, economics is all about the pursuit of beneficial synergy emerging from patterns.

As I continue to ponder my beach surroundings, I become envious of the lifeguards who get to sit in elevated chairs and occasionally take their rowboat or jet-ski out for a quick spin on the waves. It is very unfair that they alone, among all the people on the beach, get to control those critical beach resources. But it is clearly the practical thing to do, given that they have proven themselves to be among the fittest swimmers on the beach. Simply by allocating control over critical resources to the fittest, everyone on the beach stands to benefit. Everyone becomes safer as the fittest swimmers—the lifeguards—are combined with the resources they need to save the lives of unfit swimmers. Indeed, a synergistic benefit emerges from the combination. All forms of evolutionary progress rely on critical resources being used in ways that best promote valuable synergies, mutually beneficial to all who participate in their production. Indeed, efficient allocation of control over resources is a universal law of nature that determines the rate of progress able to be made by any set of evolving patterns. Nowhere is this more evident than in a thriving economy. When control over economic resources is allocated to the most resourceful innovators, everyone can potentially benefit from the ever-increasing synergies that then become available as a result. But the subtle difference between having control over economic resources and having outright ownership of them is extremely important to understanding how economies are properly organized.

As I sit in my beach chair and think, I notice that most of us on the beach, including me, appear to have eaten more than our fair share of beach food—pizza, french fries, and ice cream. Such is the *curse* of living in prosperity. The most prosperous countries around the world tend to have the highest incidences of obesity, heart disease and diabetes. But before we criticize prosperous people for their excessive eating habits, let us simply recognize that we humans have been evolutionarily programmed to consume as many calories of food as possible whenever calorie-rich food is readily available. It is a genetically inspired strategy for survival that worked very well long ago, in the wild environments of our hunter-gatherer ancestors. Evolution programmed them to load-up on calories of food energy whenever they could, because food was so scarce. But farming technology has progressed so much over the past two centuries that calorie-rich foods are now extremely cheap and plentiful. So, we humans do what we have been programmed to do, and in the process, we often consume far too many calories for our own good. In fact, many things produced by our modern economy now work against human welfare, but we eagerly buy them anyway because we like them, and we like them because our emotions and desires are adapted to the very different environments of our ancestors.
As the afternoon sun sinks ever-lower and its worshipers pack-up and leave the beach, my thoughts take a darker turn toward an uncomfortable subject explored at the end of this book, regarding the clear near-term destiny of evolution. Just as the strip of sandy beach on which I sit is a transitional span of space between primitive life to the left of me and intelligent human life to the right of me, economic development is now evolving through a similar sort of transitional span, not of space, but of time, between the intelligent human life that has existed over recent millenia and a new type of very advanced life-like activity—super-intelligent machine technology—which has only recently begun to emerge. Machines will become life when they are fully able to reproduce themselves, which will surely happen within a few decades.

I am convinced that humans and machines are both products of evolving patterns, changing by way of nature's forces. However, machines are evolving and becoming increasingly capable at a much faster pace than our biological ancestors ever did. Robotic mechanisms have become far more powerful and adept than humans in many physical domains. And computers have already become far smarter than humans in many intellectual domains. What will happen to the economy when machines are smarter and more capable than humans in all respects? How high will the unemployment rate go (for humans)? What will be the value of human labor, compared to machine labor? When will it happen? Why are there so few economists who even recognize the accelerating speed at which technology is transitioning toward that profound point in time? There is a great deal of evidence suggesting that enormous economic disruptions are already beginning to happen. We are already seeing greatly widening income disparity, falling workforce participation, and the decades-long stagnation of real median wages. Perhaps these are early indicators of much bigger economic disruptions to come. Indeed, we might already be well-along in the transition to a very different sort of machine-based economy. In Yogi Berra's words, “The future ain't what it used to be.”

Everything I know about economics tells me that entrepreneurial capitalism has been the wellspring of almost all prosperity over recent centuries. But capitalism, as it is now practiced, is completely incompatible with the economy of the future. Capitalism must change dramatically so as to accommodate the accelerating pace of development in future machine technologies, and it must do so in the next couple of decades. Most nations will adopt full-on income-redistributing socialism, because that is the system that worked well in the zero-sum environments of our hunter-gatherer ancestors, and thus we are programmed to prefer it. But a few other nations will adopt a style of capitalism kicked into a much higher gear—a sort of hyper-capitalism. By creating a much faster pace of economic development and many more job opportunities, hyper-capitalism will be capable of accommodating and further pushing the rapid advancement of science and technology. In the end, nature's forces will bestow prosperity on whichever society is most aligned with the directional properties of nature's laws that enable prosperity to flourish in the first place.

One thing becomes crystal clear to me as I push the warm sand around with my feet. Even though some patterns seem to pop out of nothingness, just as dandelions randomly pop up in my lawn, everything happens according to nature's causal forces. As I look
around at all the new patterns that have emerged on the beach today, I notice the
similarities of sandcastles. Someone, long ago, must have for the first time inverted a
bucket full of packed sand, producing a highly-ordered, obviously man-made, regularly-
shaped pattern that served well as a component of a sandcastle. That pattern of sand was
visually appealing enough to automatically inspire many other people to build sandcastles
of their own using the very same technique. The very same pattern of behavior, starting
almost always with inverting buckets full of packed sand, has been replicated, again and
again, by millions of people. Indeed, the act of building a sandcastle is merely copied—
automatically mimicked—as the youngest beach-goers watch older veterans. It seems as
though young humans are programmed, at every moment of their young lives, to
automatically mimic what they have seen older humans doing (in similar situations).
Through simple mimicry, children establish many different habits of behavior that
continue to guide their activities for the rest of their lives.

As I see it, economic development happens through the natural evolution of replicating
patterns. It happens according to nature's very rigorous laws playing themselves out over
time, operating on existing patterns of matter and energy in all things, including the many
memories in our human brains. I simply intend here to expose all the evolving patterns
underlying economic activity, as if to paint them all in glowing neon colors. Like a well-
dressed magical rabbit standing upright on its hind legs preparing to pull a magician out
of its hat, arguments here turn traditional thinking upside down. Imagine such a magic
rabbit standing next to a hole in the ground, beckoning with one of its front paws, inviting
you to come down the hole to see all the patterns underlying everything of interest to
intelligent life, all of them playing-out strictly according to nature's laws and forces so as
to fulfill the near-term future. Don't go down that rabbit hole unless you want to learn
certain truths about how the world really works—truths that are bound to conflict with
what you want to be true, just as surely as the things you should eat conflict with the
things you want to eat. Everything of interest to us is composed from patterns, a plethora
of them swirling around through time and space, some of them competing with each
other, but most of them cooperating in many different synergistic ways toward their own
proliferation, mutually, while progressively discovering ever-better ways to cooperate.

Very truly yours,
Mark Aaron Martin

P.S.—The first chapter of the book (immediately following) is intended to give a fast
overview of the entire book, addressed primarily to readers who are already familiar with
the intricacies of how evolution works. It progresses quickly through high-level
discussions and uses some terminology that might be somewhat unfamiliar to readers
who have not already studied evolution. All subsequent chapters move more slowly,
building up from novice-level concepts familiar to most college-educated people. So,
readers who find the first chapter to be too confusing might benefit from starting with the
second chapter and then, at some later point, return to the first chapter.
Chapter 1

Introductory Overview

This book is dedicated to the proposition that fundamental principles of morality and economy are written into the laws of nature, such that life on any planet in the universe must evolve toward becoming increasingly moral and economical. As life evolves, intelligence emerges, and individuals eventually learn how to achieve evolutionary advantage by respecting the lives of others with whom they might cooperate toward mutual benefit. Morality emerges, setting the stage for imminent economic development.

The natural principles of economy discovered here are derived from well-established scientific truths and a simple base premise: *Life is good*. If we can't agree on this simple premise, then we likely won't agree on anything. The premise certainly *rings true* when we compare our vibrant world to an imagined universe that is completely and forever devoid of life, having no ability for anything to ever *value* its existence. Without life, there can be nothing of value. In fact, all values, all wants, and all desires originate from life, as evidenced by the strong *will to live* bred into most instances of life. Since this book intends to consider economics from a fully naturalized perspective—from nature's point of view—the validity of the base premise depends on whether *nature* values life. Obviously, nature's forces make life possible, and perhaps even probable on planets similar to Earth, many of which are presumed to exist throughout the universe. Further, since nature's forces tend to breed into all life a strong *will to live*, and natural selection must reflect nature's values in the life that it *chooses* to proliferate, then life can only evolve toward valuing its own existence if nature also values life. So, nature certainly appears to value life. But is there any way to prove that life is naturally good? Consider an argument made by German philosopher Immanuel Kant: Certain logical propositions are necessarily true—naturally self-evident—if claiming otherwise always creates a self-contradiction. Using Kant's argument we can easily prove that life is intrinsically good. Indeed, any claim that life is worthless (disputing the premise that *life is good*) can only be made by one who relies on one's own life to make the claim, creating a self-contradiction. So, let us readily stipulate that the base premise is both obvious and self-evident—*life is naturally and intrinsically good*. In fact, life is the *only* good.

If *life is good*, then it logically follows that more life is better than less life, and that prolific life is better than life that barely survives, and that diverse life is better than homogeneous life because it is less susceptible to systemic failure, and that economic production is good to the extent it enables life to spread its abundance and diversity around the world and throughout the universe. We have thus easily established a naturalized value system, telling us that *economic development* is valuable, but only to the extent it better enables the promotion of life—all kinds of cooperative life. And the natural goal of economics is therefore to facilitate life however possible—to make the aggregate system of life better for we who exist and even more importantly for future generations yet unborn.
Regarding the future, economists desperately need a new theory to explain how qualitative progress naturally occurs in economic development—how patterns (in the things we produce and in the ways we produce them) naturally get better over time. Since the process of evolution is the only known algorithm through which nature's forces are able to make qualitative progress, the primary goal here is to describe an economy as a naturally evolving system, developing by way of nature's very rigorous (but not perfectly rigorous) laws and forces playing themselves out over time.

All actions happen as nature's forces play-out through various arrangements of matter and energy, however they exist. And all existing arrangements have been previously determined by how nature's forces played-out in the past. We humans are entirely products of nature's forces, each of us programmed to act in certain ways under certain conditions. Some of our programming comes from genetic adaptations that occurred millions or many thousands of years ago. Some of our programming comes from cultural behaviors and beliefs that worked well many hundreds of years ago. Some of our programming comes from ideas that were taught to us by our parents or teachers only decades, years, or months ago. And some of our programming results from internal thought processes that arrived at certain conclusions or decisions only days, hours, minutes, or seconds ago. All of our beliefs, our plans, our thoughts, and our actions flow from the forces of nature that control the functional properties of our neurons. Thus, all proliferating patterns in the world are products of nature's forces, including the many things we humans produce.

We must stop seeing ourselves as acting outside of nature's forces. Instead, we must see ourselves as the best evolutionary mechanisms produced so far through which nature's forces have been able to bring order to the world. We are highly favored by nature's forces because we have facilitated a new style of evolution operating at a higher level than genes, on patterns of memories and repeated human activities. We proliferate our own species (along with many other species on which we depend) through the ongoing development of new and better technologies, especially in the cultivation and widespread distribution of food. Some of the more recent technologies we've developed are becoming species of their own, defined by their own sets of replicated patterns of activities, causing their own proliferation at an astounding rate. As we learn to recognize the evolving patterns underlying our modern economy, we quickly discover that some are proliferating much faster than others, ensuring that they will most heavily influence how the economy will change in the future. Brand-new concepts are developed here regarding the natural and directional evolution of pattern complexity, predicting a future economy—within just a few decades—very different from what now exists.

This introductory chapter presents a fairly complete overview of naturalized economics, establishing a brand-new way of looking at an economy from the most fundamental perspective of all: nature's perspective. Remaining chapters merely fill in many of the very tedious details. However, those details contain quite a few surprises, mostly regarding evolution. After this introductory overview chapter, the remaining text is divided into three parts. The first part (Part I) explains how to look at economics from nature's perspective, and why it is so important. The second part (Part II) explains exactly
what we see when we study economics from the naturalized point of view, describing the kind of economy that natural selection would most prefer and reward. The third part (Part III) speculates on future economic trends that become obvious when we fully understand how nature’s laws define the trajectory of economic development.

**Pattern Synergy**

*Patterns of order* are the focus of a new way of thinking about economics. For any given domain whatsoever, certain patterns—particular arrangements of matter and energy in space and time—are more economical and easier to manage than other patterns. For example, farmers arrange their crops into orderly rows so that they are easier to plant, to weed, to fertilize, and to harvest. Small towns organize their roads into an orderly criss-crossing rectangular grid so that they are easier to navigate and traffic is easier to control. Houses tend to be similarly shaped such that they best satisfy the natural tradeoff between functionality and cost to build. Cars tend to be similarly shaped so as to achieve optimal aerodynamics and thus better fuel mileage. Nature’s laws seem to favor certain patterns over others in every domain—a concept that will become completely obvious, like recognizing that the best shape for a wheel is round.

Patterns can achieve various synergies just from their arrangements, as recognized decades ago by the brilliant astronomer Carl Sagan, famous for his ability to make science fun and interesting. He sometimes made the point that the fundamental materials composing a typical human body—mostly water, carbon, iron, calcium, and several others—can be purchased for a few dollars at a local hardware store. But dumping a bag of charcoal, a box of nails, and some sticks of chalk into a caldron of water gets you nothing of value. It is not the atoms themselves that are valuable, but rather, the precise arrangement of them into a living, breathing, thinking, caring, friendly human-being that gives them incalculable value. What can possibly account for the profound difference between a living human and the mere sum of its parts other than a synergy that reliably emerges from the very specific pattern into which its atoms are arranged? Such is the simple definition of synergy—the whole is greater than the sum of its parts. As it is used here, the term *synergy* always refers to the wide range of emergent effects produced by various *patterns*, especially those that facilitate life and those that underlie a thriving economy.

*Pattern synergy* is uniquely recognized here as both the *driver* of evolution as well as the *product* of evolution, accounting entirely for all progress made by any evolving process, and applying equally to the development of life as to the development of an economy. Pattern synergy allows us to understand how value emerges from matter and energy, how mind emerges from a collection of neurons, how absolute fitness emerges from traits of intelligence and mobility, how morality emerges from intelligent individuals learning to cooperate toward their mutual benefit, and how economic prosperity emerges from individuals all pursuing their own individual interests. Pattern synergy unifies all systems that make ongoing progress toward some sort of betterment.
Underlying every principle of economic benefit is some sort of synergistic order, whether it is a particular shape, or a specific combination of materials, or a hierarchical structure of management, or an assembly line, or the synergistic allocation of complicated tools to people having the proper skills in the division of labor. With great hubris, we humans like to think of the beneficial patterns we routinely use as if we invented them. But no one invented roundness as the best shape for a wheel. Someone merely discovered it. The specific patterns that work best in any given domain are entirely determined by nature's forces. And nature's forces determine, at least probabilistically, the patterns that will direct the future of economic development. Patterns, and the synergies they produce, underlie everything about life, and everything of value to life.

Synergy is everywhere. In fact, synergy is so pervasive that we seem to have taken it completely for granted. Since we live in a world full of many material substances that all look and feel different, we merely assume that matter comes in many different forms. But the fundamental composition for all matter is essentially the same—roughly equal amounts of protons, neutrons, and electrons. Why then doesn't all matter appear to be the same, like a sort of gray playdough? What is it that gives some matter the ability to stretch, and some matter the ability to conduct electricity, and some matter the ability to be clear liquid? What can give rise to a system behavior that is completely unlike the respective behaviors of its isolated components? The answer, in all cases, is best described in terms of the different synergies that naturally emerge from how protons, neutrons, and electrons are arranged into particular patterns of atoms, and how atoms are arranged into patterns of molecules, and how molecules are arranged into various things.

Various patterns reliably produce corresponding synergies. And certain combinations of those synergistic patterns can produce yet higher-level synergies. Since the number of possible combinations of increasingly complex patterns is endless, perhaps the potential synergies emerging from them are endless as well. Brand-new synergies can emerge when things are arranged into specific patterns, no matter what those things are: atoms, molecules, proteins, cells, organs, people, gears, electrical components, machines, businesses, allied societies, and so on. The value of synergy comes for free, out of thin air, just by arranging things into specific patterns. Synergy is the proverbial free lunch. And anyone who can reliably create new and useful synergies is like the proverbial goose that lays golden eggs.

Pattern synergy plays a huge role in defining evolutionary fitness. For example, the amazing success of the human species came about not by pure accident, but by nature's preference for life having the synergistic combination of general mobility and general intelligence. Neither intelligence by itself, nor mobility by itself, is worth very much. But when they are combined—when they act together synergistically so as to enable life to move intelligently—they establish most of nature's metric for absolute fitness. Indeed, the dexterity of the human hand (an aspect of general mobility) is extremely valuable because it acts synergistically with the human brain. Together, the human brain and the human body co-operate (mechanistically, like the gears of a clock) so as to achieve a high degree of absolute fitness, produced entirely through synergy. As life evolves, mobility and intelligence evolutionarily drive each other toward ever-greater magnitudes and
degrees of freedom. So, it is not surprising that the species considered most intelligent (by far) is also best at performing ballet (by far).

Just as the evolution of life operates on synergies emerging from patterns in traits of fitness, economic development is also described here as an evolutionary process operating always on pattern synergies. By describing the progress of economic development in terms of patterns, we learn many similarities between how the world economy evolves and how life evolves. And in the process of reconciling the subtle differences between the evolution of economic development and the evolution of life, this book makes real advancements in the understanding of both. For example, we learn that nature defines fitness on a scale that is absolute and universal, applying to any instance of life in any environment, anywhere in the universe, largely independent of whatever other species might co-exist. Absolute fitness is difficult to see, because it is composed mostly of synergy. But knowing that fitness is absolute ensures there is clear directionality in the way all types of evolving systems must progress—always toward patterns of ever-greater absolute fitness.

There is indeed very clear directionality to how evolution unfolds over a long period of time, despite its rather random short-term appearance. By describing evolution's directionality abstractly, in terms of synergy, we are suddenly able to see it in the evolution of technology, which is destined to progress similarly to how life has developed. Indeed, traits that are now emerging in technology are abstractly similar to traits of absolute fitness that emerged long ago in biological life. This should not surprise us, because the forces of natural selection that guide the evolution of life are the very same as those that ultimately guide the evolution of technology. A society can only achieve prosperity by choosing to go in the same direction as evolution's inherent long-term directionality—by pursuing goals that are fully aligned with nature's goals (as revealed by evolution's directionality). This simple principle of economics will become completely obvious, like recognizing that a bicycle rolls fastest when it is most aligned with the natural force of gravity—when it is pointed down the hill.

Pattern proliferation is what gives evolution its natural directionality. At any point in time, the future is largely predicted by the patterns proliferating most rapidly at that time. So, the critical question we should be asking ourselves is: What patterns of technology are proliferating most rapidly today? The answer—transistors—tells us a lot about the future of machine technology, and how it is indeed following a path of development abstractly similar to the history of biological life on Earth.

From the principles of evolutionary economics developed throughout this book, we learn that nature defines morality differently from how we typically think of it. Nature's preferred morality is not based on the selfishness we see in lower forms of life, nor on pure altruism as we have wrongly come to believe, but instead on the synergies that can result from ongoing acts of generosity and cooperation that are reliably reciprocated among moral individuals. The evolutionary benefit of morality comes from the simple fact that synergies are more likely to be created and properly shared among trustworthy—moral—individuals. We humans are prosperous because our moral values enable us to work together cooperatively toward mutual benefit. Our human moral values have
evolved so as to make economic prosperity possible, by encouraging us to collectively create economic synergy and then share its value among all who contributed.

We also learn from upcoming discussions that the natural purpose of an economy has little to do with satisfying our human wants and desires, and everything to do with the proliferation of aggregate life around the planet and throughout the universe. Natural selection works far more by proliferating the fittest than by culling the least fit, making nature's process of evolution far kinder than the red-in-tooth-and-claw manner in which we have come to think of it. Perhaps most importantly, we learn that while the rich certainly do get much richer in a thriving economy, the poor do not get poorer as a result. In fact, the rich can only get richer by making others, including the poor, more prosperous in similar degrees (but spread over lots of people). Also, we learn the conditions under which greed can be good—indeed, very good. And, we learn exactly when greed is bad, from nature's perspective. Further, and quite contrary to typical belief among economists, we learn that economic progress depends more on efficient resource allocation than on incentives. Finally, we learn that the business cycle results from the advancement of technology, and that every period of boom will necessarily be followed by a comparable period of bust as the market penetration of the corresponding new technology reaches its halfway point, unless overall technology can be advanced more steadily and more rapidly.

Upcoming arguments show clearly that many of our human emotions and desires—while they were quite appropriate in the environments of our hunter-gatherer ancestors—are now very much outdated, pushing our economy toward producing products that have zero or in some cases even negative evolutionary benefit to us in our modern environment. Looking forward, nature's forces will eventually adapt the genes of our descendants to the modern environment, given enough time. But for a world in which more than seven billion people are causing rapid climate change and are increasingly vulnerable to ever-more nuclear weapons, time is of the essence. Perhaps there is something more fundamentally valuable to nature's evolutionary process than the utilitarian idea of raising the most happiness for the most people. Indeed there is, but it can only be seen from a naturalized perspective, because we humans are strongly programmed to believe that our happiness is everything. It is imperative that we learn the many differences between what we humans now want and what nature appears to want for us (clearly revealed by the directional properties built into nature's forces).

Our human emotional drives surely worked very well for our distant ancestors, but some are now working against nature's goals for life in our modern environment. The very common human desire for fairness, for example, emerged evolutionarily as a tactic for human species survival in long-ago environments that were much different from our modern environment. Sharing and fairness likely served our hunter-gatherer ancestors very well, because their environments were mostly zero-sum—one person's gain came at another person's loss, because critical resources in the local environment were finite and often very scarce. But in our modern world there are lots of opportunities for promoting widespread economic prosperity, over the long term, through win-win scenarios involving the almost-unlimited creation of pattern synergies. Nature's forces reward economies that provide complete fairness of opportunity to anyone who willingly and
capably contributes to the creation of economic synergy. Unfortunately, however, many
of us hold a desire for fairness of outcome, independent of contribution, which is badly
misaligned with nature's long-term directionality toward ever-greater synergy creation.
Nature loves diversity, but along with diversity necessarily comes differences in attitudes
and capabilities. Evolutionary progress, today, absolutely depends on very different
outcomes for individuals making very different contributions toward synergy creation.

Several notable authors have written about synergies in nature, starting with the
brilliant inventor Buckminster Fuller. His 1975 book, Synergetics, describes how natural
synergies arise from the geometric relationships between atoms as they bind together into
various three-dimensional patterns. Another author, biologist Peter Corning, discusses
the role of functional synergy throughout evolutionary development in his 1983 book
titled The Synergism Hypothesis: A Theory of Progressive Evolution. In a later book of
his, titled Nature's Magic (2003), Corning describes chemistry as “a bottomless well of
creativity in nature and a prodigious source of synergy.” Indeed, different types of
chemical mixtures and compounds create different synergies from their combinations of
elements. Yet another notable author who has written about synergy, although he calls it
by a very different name, is Robert Wright, whose book Nonzero brilliantly describes
life's development in terms of a class of theoretical paradigms—non-zero-sum games—in
which the players have overlapping interests—they can simultaneously win, together (by
creating synergy). Wright properly describes the non-zero-sum dynamic as: “a kind of
force … that has crucially shaped the unfolding of life on earth so far.” (2000, p.5)

Ideas here build on concepts beautifully expressed by economist Eric Beinhocker in his
Economics. After brilliantly surveying the history of economics, including recent
advances in applied complexity theory, Beinhocker concludes that the origin of wealth is
the evolutionary production of “fit order.” But his explanation for what makes some
types of order fitter than others is complicated. The explanation here is much simpler:
fitness is mostly a measure of self-reinforcing synergy (discussed in the next section).
Beinhocker and a few other forward-thinking economists clearly see the value of
modeling an economy as an evolving system, yet they rarely mention the term patterns,
which are the very things that evolve (e.g. Beinhocker says business plans evolve).

Patterns are the means through which all progress is made in all evolving systems,
including both aggregate life and a developing economy. The word pattern is used quite
often throughout this book. It can be somewhat enigmatic and daunting to any reader
who has not spent a lifetime thinking about how patterns critically enable all forms of
evolution, intelligence, knowledge, information, and value (as this author has). Patterns
can take on many forms. The shape of a maple leaf is a pattern, as is the location of all
trees in a particular forest, or the arrangement of letters in a particular word, or the notes
in a song unfolding through time. Patterns underlie everything, and every thing exists as
some sort of pattern. The term pattern is the ultimate variable intended to serve as proxy
for the arrangement of order for absolutely anything in the universe. Readers who feel
intimidated by the concept of a pattern are asked to trust the book to develop the concept
slowly and steadily, by accumulation of familiarity over many different examples to be
Presented in coming chapters. For now, let us just think of patterns as being similar to arrangements of ink on cloth, as in pinstripes, or polka-dots, or plaid, or paisley, each having its own slightly different synergistic visual effect.

**Nature's Definition of Value: Self-Reinforcing Synergy**

In a universe where the actions and interactions of all things are directed according to mathematical laws, it seems silly to suppose that there is any such thing as *value*. How can one collection of matter and energy have more value than another? And yet, we humans intuitively understand the concept of value at a very fundamental level, from our own perspectives as individuals. We all value fresh food and clean water more than rocks and mud. And, as parents, we value our own children more than just about anything else. But how can we possibly understand what nature values? The goal here is to define nature's values so that the definition abstractly applies to all kinds of patterns, enabling us to identify which patterns (or sets of patterns) are naturally valuable and which are not.

From any perspective, value can only come from synergy, because without the synergistic effects that are naturally produced when atomic particles are arranged into particular patterns, everything would be exactly the same in texture, appearance, rigidity and so on. And everything would be exactly the same in *usefulness*, or *value*. By its very definition, synergy is capable of producing a whole having greater value than the sum of its parts. And by giving a consistent name, *synergy*, to the many different types of emergent characteristics that naturally result from various patterns of order, we open our minds to the origin of all natural value, in any domain whatsoever.

Not all types of synergy are valuable, but all value in the universe is produced by a certain type of synergy. Indeed, pattern synergy crosses an important threshold when it is able to *reinforce its own existence*—causing the proliferation of the specific patterns of order that produce the synergy, thereby enabling more of the synergy to exist. The idea that nature values *self-reinforcing synergy* is completely consistent with the base premise cited earlier and proven to be self-evident—*life is good*—because the essence of all life comes from sets of patterns that act synergistically toward their mutual proliferation. We now have a metric for assessing natural value. *All value in the universe comes from patterns to the extent they are able to act toward their own proliferation, and from any scarce resources required for the maintenance and replication of such patterns.* This very simple metric applies universally to absolutely anything and everything, including any system of evolving patterns, whether they are patterns of life or of economic production. Fundamentally, nature values growing order—the more order the better.

All types of evolution are driven by synergies that reinforce their own existence. Accordingly, the patterns underlying all life—arrangements of DNA in genes—facilitate their own replication by way of the synergies they create in the cells and the bodies they build. Stated as simply as possible, gene patterns proliferate to the extent they are able to cause their own proliferation through the synergies they create. This very simple circular concept yields great insight into the evolutionary process. Even greater insight comes
from recognizing that natural selection is much more than just a threshold for survival between the unfit and the fit. Nature differentially selects patterns to the extent they spontaneously create order from within, synergistically causing their own proliferation. Synergy that reinforces its own existence is the abstract elemental stuff for which evolution always searches, and is also what evolution always produces. Self-reinforcing synergy is the origin of all natural value—a central theme echoing throughout this book.

Consider how the very first type of self-reinforcing synergy might have started. Certain molecules act as catalysts, actually performing chemistry on their own by reliably combining specific nearby molecular ingredients into a new type of molecule of greater complexity. This feature of chemistry naturally builds molecular complexity over time, and opens-up the possibility of a very simple kind of self-reinforcing synergy where two types of molecules, let's call them X and Y, are able to catalyze each other. Suppose, for example, molecule of type X reliably grabs two particular types of molecules floating by (say, A and B) and combines them into a molecule of type Y. The new molecule of type Y then grabs two other particular types of molecules floating by (say, C and D) and combines them into a molecule of type X. So long as sufficient amounts of the simpler molecular ingredients (A, B, C, and D) keep floating by, the more complex molecules, X and Y, naturally catalyze themselves into ever-greater abundance—a primitive source of progress. Such simple loops of circular causality might have played-out in the primordial ooze, long ago, eventually starting-up the increasingly complex processes of life.

All kinds of evolutionary development rely on loops of self-reinforcing synergies for making their progress. The loops can sometimes be very indirect and roundabout, but only circular causality can yield reliable progress over time. Circular causality happens wherever the causal effects of nature's forces automatically propagate along a route that is in some abstract sense circular—always returning to a previous state. For example, the act of cellular division—the basis for all life—is a self-reinforcing synergistic effect that proliferates the underlying patterns that cause it. The process is abstractly circular in the sense that it happens over and over again, always returning to a previous state in each daughter cell ready to start the process all over again. As another example, the act of acquiring food by a typical animal is a self-reinforcing synergistic effect proliferating the patterns that cause it, acting through a circular process that returns to a previous state of having sufficient nutrition to acquire more food. Further, the act of having sex by a pair of opposite-gender heterosexual animals is a self-reinforcing synergistic effect proliferating their underlying patterns, returning to a previous state of sexually satisfied individuals, and sometimes returning to a previous state in new offspring who will likely later engage in sex of their own. Further yet, the repeated enticement of a honeybee to a flower is a self-reinforcing synergistic effect that returns to a previous state in the process of proliferating the patterns of both flowers and honeybees—a beautiful case of synergistic mutualism (to be discussed in the next section).

In all these examples, a causal loop is formed by some sort of process that can be thought of as having its output connected back around to its input. Patterns flowing into the input cause their own replication, producing even more patterns flowing out of the output, which are then directed back to the input again. Synergy can only be self-
reinforcing if it produces new replicas of the patterns that cause the synergy. Those new patterns are then able to cause their own self-reinforcing synergy of exactly the same kind.

Self-reinforcing synergy is the driving force of evolution, the prime mover of life, and the progenitor of everything life repeatedly produces. The evolutionary ascendance of life from the earliest self-catalyzing molecular patterns all the way up to a moral species, such as *Homo sapiens*, can only happen by a long sequence of incremental discoveries producing ever-better synergies acting toward the survival and proliferation of the gene patterns that produce those synergies. As life becomes increasingly intelligent and knowledgeable, nature's forces make possible many different types of higher-level synergies that emerge from multiple individuals working together in businesses and markets, all acting synergistically toward their mutual benefit—ultimately toward the mutual proliferation of their underlying patterns.

Arguments here abstractly unify all types of synergy, all types of value, and all types of evolutionary progress under one simple conceptual umbrella, built entirely from evolving patterns that cooperate synergistically toward their mutual proliferation. All value in the universe comes from pattern synergy, and all progress comes from evolution's ability to discover new and better patterns able to engage in new and better forms of *cooperation* toward mutual benefit. There is a central theme being developed here, suggesting that we have improperly come to see evolutionary progress in terms of *competition*, whereas the much more profound effect is that of pattern synergy causing its own proliferation through *cooperation*. Competition is sometimes necessary in the ongoing process of evolution, but cooperation toward mutual proliferation is what covers the world with life.

**The Common Theme: Cooperation toward Mutual Proliferation**

No pattern can replicate in isolation. Nature's forces make it impossible for any pattern to replicate itself without help, as from at least one other pattern that catalyzes the replication. So, self-reinforcing synergy *always* involves multiple patterns working together toward their mutual benefit—usually by helping each other to replicate. We may think of them *in combination* as a single pattern (such as a replicating cell), but we must then always keep in mind that its proliferation necessarily involves distinct sub-patterns acting toward their mutual replication. The common theme and purpose of evolution is thus to discover sets of patterns able to cooperate synergistically toward their mutual proliferation.

As we look at life from nature's perspective, what we find is a plethora of different patterns across many different species and substrates, all cooperating toward their mutual proliferation in many different ways, some of which are obvious and others of which are much more difficult to see. Synergistic cooperation toward mutual benefit—or just *synergistic mutualism*—is the essential unifying mechanism by which self-reinforcing synergies naturally occur, underlying all life at all of its many different levels, from patterns of DNA all the way up to a thriving economy. Later chapters expose many
different types of mutually beneficial synergistic relationships among the patterns 
underlying life and, in recent centuries, among the many patterns underlying modern 
economic production benefiting patterns of life.

Throughout life, we find many different sets of patterns routinely cooperating toward 
their mutual survival and proliferation. For example, every instantiated gene pattern 
works with many other gene patterns within the same genome toward mutual 
proliferation. And every pattern of culture works with many other patterns of culture 
toward mutual proliferation (each word of language works with many other words to 
form a language that is beneficial to those who use it). And certain patterns of genes 
work with certain patterns of culture toward mutual proliferation. Indeed, the genes 
underlying a human brain enable it to mimic beneficial cultural behaviors performed by 
other humans, so as to proliferate those same genes and those same cultural behaviors. 
Likewise, many different patterns of economic activity work together toward their mutual 
proliferation, as well as toward the proliferation of humans who carry-out those activities.

In what appears as an elaborate tapestry, many evolving patterns on Earth, across many 
different species, work together in many different ways to keep aggregate life ever-
expanding in number and diversity. Patterns of economic activity are just a rapidly 
growing subset of the many patterns on Earth that have found ways to synergistically 
cooperate with each other (and with genetic patterns of life) toward their mutual 
proliferation. From lowly bacteria all the way up to human beings and their many 
patterns of economic activity, every pattern of every domain (genetic, behavioral, 
cultural, technological) exists for the simple evolutionary purpose of trying out various 
new forms of pattern synergy to see what works best—to see what best cooperates 
synergistically with other already-existing patterns toward their mutual survival and 
proliferation. Synergistic cooperation is the essence of life at all levels, among species, 
among individuals, and among various domains of economic production.

In the late-1800s, Russian zoologist Karl Kessler recognized mutual aid as being far 
more important than mutual struggle in the evolution of social systems, for animals as 
well as humans. After Kessler's death, in 1881, Russian anarchist Peter Kropotkin further 
developed Kessler's views through a collection of essays titled Mutual Aid: A Factor of 
Evolution. The essays argued against the then-prevailing ideas of Social Darwinism 
(based on competition and survival of the fittest), focusing instead on the pragmatic 
advantage of mutual aid as the primary driver of social progress. Here, mutual aid is 
completely generalized so as to underlie evolutionary development for all types of 
evolving systems, across all domains, explaining all types of progress, by way of patterns 
that cooperate synergistically toward their mutual proliferation.

It is worthwhile at this point to consider some of the natural mechanisms enabling 
synergistic cooperation. The exchange of by-products and services among loops of self-
reinforcing synergies is a very common type of cooperation that exists at many levels of 
life. Various loops of self-reinforcing synergies create various types of waste by-products 
that build up in the local environment. And one loop's by-product can be another loop's 
food source. As by-products from one loop's synergistic activities become more plentiful 
in the environment, they create opportunities for other complementary types of loops to
consume them. However, such a one-way flow of resources, from one type of loop to another, is not nearly as sustainable over the long term as a bi-directional flow of resources between two synergistic loops that are able to exchange their by-products, forming yet another interconnecting loop of mutually beneficial synergy between them.

At the smallest scale, cellular metabolisms are full of by-product exchanges between various chains or loops of catalytic molecular processes. There exist many different synergistic loops of causality in the metabolic process of a living cell—often called cycles, such as the Krebs cycle. The causal loops exchange various molecular by-products as they carry out their synergistic activities of catalysis. Any by-products that are not re-used by the cell must be expelled as waste, the amount of which will build up in the environment unless it is consumed by some other type of life.

At the highest scale, the plant kingdom and the animal kingdom together exchange metabolic by-products, trading oxygen (a waste product of plants needed by animals) in exchange for carbon dioxide (a waste product of animals needed by plants). Such trading of waste products establishes another sort of synergistic loop of exchange, interconnecting the welfare of the animal kingdom with the welfare of the plant kingdom. In another clear example of by-product trading, many flowering plants produce nutritious nectar that they offer in exchange for a pollination service, which happens as a by-product of small birds or insects flying from flower to flower, for the purpose of gathering and consuming nectar. In yet another example, an exchange of beneficial services happens as bacteria residing in the gut of an animal break-down food consumed by the animal into ingredients necessary for it to grow and function, distributable throughout the animal's bloodstream. As the animal eats, it supplies its gut-residing bacteria with a steady stream of fresh food, and in exchange, the bacteria provide a digestive service. Bacteria provide yet another service to many other species of life by digesting their carcasses. When plants and animals die, their carcasses contain lots of valuable molecular patterns, which are bound-up together in such a way that makes them unable to be consumed by plants. But they are broken-down through bacterial digestion in the process of natural decay. Thus, carcasses (the ultimate by-products of complex life) are consumed by bacteria, whose waste products produce the nutrients of fertile soil necessary for growing new plants that can then be consumed by animals at the bottoms of various food chains. The circular process of birth, life, death, and bacterial decay, forms yet another loop, linking-in the self-reinforcing synergies of various bacteria (responsible for carcass decay) with the self-reinforcing synergies of plants and animals.

Another very common style of cooperation happens through modular combination, when two or more different types of patterns have interfaces that allow them to be easily combined so as to produce some brand-new synergistic effect. Modular interfaces facilitate the trying-out of many new types of pattern combinations. Atoms and molecules, for example, are modules that are able to combine by way of coulombic forces acting on electric charges. Many different types of atoms (about a hundred) routinely combine in many different ways to create an infinite diversity in types of molecules. When molecular diversity reaches a sufficient threshold, various subsets find ways to catalyze themselves into ever-greater abundance—life inevitably emerges.
In species of life, patterns of DNA are neatly packaged into modules called *genes*. And each gene encodes for a modularized molecule called a protein. The ability of biological life to find new and better synergistic patterns is greatly facilitated by life's ability to combine and recombine modularized patterns of genes, which get translated to modularized patterns of proteins. The evolutionary value of sex comes about by way of its shuffling of modularized genes, which enables a sexual species to more rapidly explore the space of all possible patterns with greater likelihood of viability than would occur through purely random mutations to the genes. Also, sexual organs can be thought of as having modularized interfaces, those of males being complementary to those of females, allowing them to combine and interact synergistically in the act of sex. Further, we humans can be considered to have been modularized by the common interfaces of natural spoken languages that we share, which allow us to collectively create and communicate various plans for producing and sharing mutually beneficial synergies.

The evolutionary benefit of modularity is especially apparent in the mechanical and electrical technologies underlying modern economic production. Gears are modular because they easily interface synergistically with other gears. Belts are modular because they easily interface synergistically with pulleys. Transistors are modular because they easily interface synergistically with resistors, capacitors, and especially other transistors. Even hammers are modular because they interface synergistically with a human hand so as to deliver an impulse of force to a nail. An economy benefits greatly when its products and services are built with common interfaces that enable them to be modular, and thereby easily combined in various synergistic new ways.

It seems to be generally true that nature's laws yield a much greater chance of discovering a new type of valuable synergy by trying out a combination of already-discovered patterns that are themselves synergistic (existing modules) than by trying out a comparably complex pattern that is randomly chosen. Accordingly, there is a much greater chance of creating a useful electronic device by combining a handful of already-known synergistic electronic modules, such as resistors, transistors, and capacitors, than by tossing those very same modules into a churning blender and seeing what comes out. In both cases, the atomic ingredients are exactly the same, but only in the modular case is there any significant chance for success.

**Emerging Complexity**

Occurring at many different levels, evolution searches for synergistic combinations of modules that already exist and are known to work well with other modules. Hierarchical complexity naturally emerges, from the bottom, up, as many types of existing synergistic modules are combined and recombined at many different levels. Some of those combinations produce self-reinforcing synergies, which then cause their own proliferation. The most complex patterns thus take the structural form of hierarchies built entirely from synergistic combinations, of combinations, of combinations, … of fundamental elements. We often think of a human as a single thing, but it is actually a
hierarchical combination of many modular things, such as organs, which are composed of
cells, composed of proteins, composed of amino acids, composed of atoms.

The health of any evolving system depends on the number of inter-cooperating
modules it has already developed and on the ability to generate new ones in the future.
The health of aggregate life depends on the diversity of its many inter-cooperating
species, each being a different set of genetic patterns but with a lot of overlap between
them all. The health of an economy is similarly very dependent on the diversity of inter-
cooperating businesses, producing and exchanging a wide diversity of products and
services. Businesses exist primarily for the purpose of carrying out repeated looping
patterns of activities, producing various synergies that are ultimately self-reinforcing to
the extent they are valued enough to be profitable. The products and services generated
by those businesses can be viewed as by-products of their corresponding loops of routine
activity patterns. Some of the various products and services produced by businesses are
exchanged with other businesses, and the rest are essentially traded to human consumers
in exchange for their labor, contributed as employees (using money as a medium of
exchange). The result of the many ongoing exchanges is a healthy economy consisting of
a complex web of interconnected loops, all exchanging various products and services in
ways that allow them all to mutually proliferate their underlying patterns.

Any evolutionary system will naturally tend to develop more quickly as it develops
more modules, which make possible more synergistic combinations of modules. Thus,
all healthy evolutionary systems tend to experience a combinatorial growth in diversity as
they mature, which naturally causes an acceleration of the evolutionary process over time.
The ability for an economy to grow is largely determined by the amount of diversity in
the products that are already available. Further, it will be clearly shown in a later chapter
that the only way to increase (over the long term) the number of jobs in an economy (as a
percentage of the total population) is to grow the breadth of diversity in the economy's
various products and services.

Economic prosperity increases as innovators discover new synergistic effects made
possible by the laws of nature, which get expressed through technology. Brian Arthur, an
early pioneer in the field of complexity economics, describes technology in his 2009 book,
The Nature of Technology: What It Is and How It Evolves. According to Arthur,
technology naturally “creates itself out of itself” through the ongoing human process of
combining and re-combining previously discovered patterns of technology into brand-
new patterns, from which valuable patterns are selected for ongoing replication—
combinatorial evolution. Arthur recognizes that exploitable effects naturally emerge
from certain combinations, or patterns, of materials. He refers to those exploitable effects
by the awkward term phenomena of nature. Here, all such naturally occurring exploitable
effects of technology are referred to as pattern synergies. The use of the simple term
synergy in reference to all emergent properties is a great convenience for discussing
higher-order effects that can sometimes emerge from synergistic patterns, such as self-
reinforcing synergy.

Nature's forces make possible the existence of many different styles of self-reinforcing
synergy, through various combinations of patterns. And, brand-new patterns of synergy
are created as evolution combines and recombines all synergistic patterns discovered so far, searching at ever-higher levels to find even better combinations of patterns acting synergistically toward their mutual proliferation. There might be an infinite number of ever-higher levels yielding brand-new types of synergy from combinations of existing known synergies at lower levels. The only way to know, for sure, is to keep trying out various combinations, either physically or by computational simulation, which is what a creative and well-trained human brain automatically tries to do through its limited ability to imagine the synergistic causal effects of combining various materials and actions in new and different ways.

As previously discussed, the most fundamental source of natural synergy discovery comes from a process in chemistry called catalysis. Many different types of naturally occurring molecules are able to act as catalysts for the creation of other molecules. And molecules created by catalysis can themselves sometimes act as new types of catalysts. As the variety of existing catalysts becomes increasingly plentiful, more types of increasingly complex molecules and increasingly capable catalysts become possible. So the ongoing development of capability and complexity in nature's chemistry tool box essentially builds itself out of itself, automatically, through catalytic reactions. And when catalytic reactions are arranged into a loop, their synergies can be self-reinforcing.

According to Stuart Kauffman, an expert in the science of biological complexity, life on Earth likely started out as a set of molecules capable of catalyzing each other—an autocatalytic set. In his 1993 book Origins of Order, Kauffman brilliantly describes how the first molecules of life must have acted together through loops of catalytic reactions to circularly catalyze their own ongoing replication. Today, we easily find many such self-reinforcing catalytic loops existing as various metabolic cycles within living cells. In his later writings, Kauffman recognizes that catalytic loops exist in a thriving economy too, abstractly similar to those of life. Just as catalytic reactions facilitate the production of chemical synergy, similar abstract mechanisms exist for creating economic synergy. Various types of business activities serve the very same abstract role in economic production as catalysis does in the chemical production underlying biological life. In its abstract essence, a manufacturing business simply catalyzes the production of useful products from raw materials, energy, and labor.

**Natural Selection: Negative Culling and Positive Proliferation**

It is widely believed that natural selection works through mortal competition, eliminating the weak and the unfit. But Stuart Kauffman brilliantly argues that nature's culling of the unfit might be only a secondary effect in the natural emergence of order, and that the primary effect is more like a vital force spontaneously creating order from within. In Kauffman's words: “We do not understand the sources of order on which natural selection was privileged to work. … Evolution is not just 'chance caught on the wing'. It is not just a tinkering of the ad hoc, of bricolage, of contraption. It is emergent order honored and honed by selection. … below the particular teeming molecular traffic
in each cell lie fundamental principles of order any life would reexpress.” (1993, pp. 643-645) The fundamental principles of order sought by Kauffman, underlying all life, are indistinguishable from what we have referred to here as *self-reinforcing synergies*.

Our understanding of evolution has unfortunately become fixated on *competition* between instances of life, rather than on the much more important opportunities for *cooperation* among them. The fixation improperly focuses on *survival* as the means for evolutionary progress. It was philosopher Herbert Spencer, not Charles Darwin, who coined the unfortunate term *survival of the fittest* and thereby put blinders on us, by improperly focusing our attention on just the threshold between life and death, while ignoring the very wide range of differential ability to proliferate, above mere survival. *Spontaneous creation of order from within* by way of self-reinforcing synergy is what evolutionary development is all about. Patterns of self-reinforcing synergy essentially use nature's forces to select themselves for survival and proliferation to whatever degree those patterns are able to cooperate synergistically toward their mutual ongoing replication, no matter the substrate in which the patterns exist (genetic, molecular, cellular, cultural, mechanical, electrical, or otherwise). For any and all evolving patterns, nature's metric of *fitness* is established by the huge range of varying degrees in *ability to proliferate*, extending well above mere survival. Characterizing natural selection as just *survival of the fittest* completely ignores most of its functional significance—the entire positive range, above mere survival.

We well understand how *negative* selection destructively culls the unfit through competition. But far more important is the *positive* selection that constructively proliferates cooperating patterns (more rapidly than non-cooperating patterns) as they synergistically act toward their mutual benefit. Far more important than the very familiar *Darwinian struggle* is the never-mentioned *Darwinian flourishing*. The future of life always depends far more on the patterns that are proliferating most rapidly than on those that are barely sifted out from among the unfit. Thus, natural selection is much more accurately characterized as *proliferation of the fittest*, where proliferation clearly implies survival. The worldwide population of synergistically cooperating humans has grown to over seven billion, not by survival alone, but by proliferation. Ants, termites, wasps, and bees are similarly prolific because they too (like humans, but not to the same degree) are able to cooperate synergistically toward the successful development of their colonies and hives.

Competition among replicating patterns is only necessary when critical resources are scarce. During times of resource abundance, patterns proliferate to the degree their respective synergies are self-reinforcing. As the fittest patterns carry-out their more rapid proliferation, subtle mutations on them explore pattern space in regions where patterns of even greater fitness—greater ability to proliferate—are most likely to be discovered (near the already fittest). Thus, the positive selection process of *order creation from within* prevails over the negative process of *competition* to the extent critical resources are available. When resources are scarce and competition *is* necessary, its effect is always to promote patterns that best cooperate synergistically toward their mutual survival and ongoing proliferation.
Natural selection can finally be understood in fairly simple terms—not in the typical negative sense of eliminating patterns that are least fit, but in the positive sense of proliferating patterns that are most fit, eventually reducing patterns of much lesser fitness to relative obscurity by comparison. Patterns select themselves for survival and proliferation to the extent their respective synergies enable them to avoid predators and acquire the resources necessary to fund the catalytic processes that protect and proliferate the underlying patterns. Some such catalytic processes of life build things, such as cell walls, to protect the patterns inside. Other catalytic processes carry out replication—cellular division—as means for proliferating the underlying patterns. Many such catalytic processes act together synergistically, at many different levels, so as to breathe the fire of life into the mere mechanistic patterns underlying a living being.

The way natural selection mostly operates—through differential proliferation—can be illustrated by a thought experiment involving a Petri dish full of nutrient-rich agar, onto which several different types of small microbial colonies are carefully placed. Each type of microbe needs to ingest a particular set of molecular ingredients, in order to grow. And, by way of its metabolism, each type discharges a particular effluent by-product, or waste product. Depending on the nutrients in the agar, the different microbe colonies will grow at different rates and will produce different types of waste. Through differential proliferation, some microbe types are naturally selected for greater abundance in their particular environment. This should be obvious, at least until the different microbe colonies grow big enough to begin colliding with each other. They then interact according to their metabolic needs and their by-products of waste. For example, one type of microbe will dominate another type if it produces a waste product that is toxic to the other. This is exactly what Alexander Fleming discovered in a Petri dish originally containing bacteria, killed by the growth of penicillium mold, spores of which happened to land in the dish simply by chance. In such a case, natural selection operates in the mode with which we have become most familiar, by negatively culling the microbes of least fitness, relative to others existing in the particular local environment.

Now, consider the possibility that the metabolic process of one type of microbe, let's call it \( M_1 \), produces a type of waste that is a beneficial resource—food—to be eagerly ingested by another type of microbe, let's call it \( M_2 \). And further suppose that microbe \( M_2 \) produces a type of waste able to be ingested as food by \( M_1 \). Upon interacting, they feed each other extra amounts of ingredients enabling their greater mutual proliferation. Such a complementary pair of microbe types achieves a healthier metabolism as a single symbiotic system, by together creating and exchanging valuable resources. Many such complementary microbes exist throughout nature. For example, many different fungi and algae combine symbiotically to form thousands of types of lichens, found all over the world. And many types of fungi attach to plant roots as symbiotic partners (known as mycorrhizae), for mutually acquiring critical nutrients. Resource trading is everywhere, at many different levels, all throughout life.

Trading of resources happens also among the many different autocatalytic loops that make-up the metabolic pathways of every living cell: A catalytic process, let's call it \( X \), produces a molecule acting as catalyst for a different catalytic process \( Y \), which produces
a molecule acting as catalyst for yet another catalytic process \( Z \), which completes the loop by producing a molecule acting as catalyst for process \( X \). This is a simple example of the autocatalytic loop described by Stuart Kauffman. If such a catalytic loop is able to acquire its needed external resources (energy and critical nutrients), it will continue indefinitely to produce a growing abundance of each critical catalytic molecule in the loop. As such abundances build up inside a cell, they eventually become sufficient to allow the cell to split into two daughter cells. As nature stumbles over combinations of things that cooperate synergistically toward their mutual proliferation, they are memorialized by way of that very same proliferation. Over time, the world naturally becomes filled with such mutually-benefiting, self-reinforcing processes.

The same is true in an economy. Just as a living cell maintains many different interacting metabolic pathways (autocatalytic loops), so does a well-functioning business set up chains of repeatedly looping catalytic reactions among its employees (processing information and carrying out production, from raw materials to finished products) for the sole purpose of yielding various synergies that reinforce their own existence (as sales revenue is re-invested into ongoing production). We are now better able to understand why big businesses exist and how they develop. In 1937, economist Ronald Coase wrote a now–famous article titled *The Nature of the Firm*, in which he cited minimization of transaction costs as the primary reason for why a firm—a big business—naturally comes into existence and persists over time. But it is far more insightful to describe the firm in terms of its ability to maintain synergistic relationships among its divisions and employees, over long periods of time. Changing any of those synergistic relationships is what incurs the transaction costs cited by Coase. Arguments in later chapters propose a complete decentralization of big businesses, making each division of a business its own independent profit center, while maintaining all the crucial synergistic relationships existing between them. The resulting greater degrees of freedom make such decentralization worthwhile, and new blockchain-based technologies make it realizable.

We are now able to settle a long-standing debate over group selection, with regard to how group-favoring behaviors naturally emerge. Group selection does not require a selective force killing-off entire groups of lesser fitness by way of mortal conquest, as so many authors mistakenly assume. Instead, the greater proliferation of group members who synergistically cooperate with each other is a much stronger factor of selection. As humans learn behavior patterns that encourage cooperation, they better proliferate as a result, and genes eventually adapt to support those behaviors. The development of group-favoring behaviors can start with only a few members of a group adopting social behavior patterns that promote synergistic cooperation—they form a sub-group. Such a sub-group is likely to grow at a more rapid rate than the overall group, simply because the members act synergistically toward their mutual benefit. Because economies of scale can increase the synergistic benefit (per person) in such a cooperative sub-group, others can benefit by joining. The faster-growing sub-group of cooperators either subsumes the remaining group members, or, over time, dilutes them to a point of irrelevance, without anyone ever having to die. The same thing happens at the next higher level. Groups composed of cooperators grow much faster in size and strength than non-cooperative
slower-growing groups, which are then subsumed or diluted to irrelevance. Thus, group selection is mostly a matter of self-reinforcing synergy spontaneously creating order from within through cooperation among group members, enabling them to proliferate faster than other non-cooperative members. A similar style of bottom-up group selection has been computationally simulated by Harvard professor of biology, Martin Nowak, as briefly mentioned in his 2011 book *SuperCooperators*.

It is easy to underestimate the value of this slight refinement in how we think of natural selection—conceptually elevating proliferation of the fittest over culling of the least fit. This simple twist in our understanding of evolution gives us a much clearer view into how the world works at the level of its most fundamental nuts and bolts. We can now see fitness as an absolute measure of synergy acting toward pattern proliferation, giving evolution a clear directionality, defined in the short term by the patterns that are proliferating most rapidly. And, self-reinforcing synergy (acting toward the proliferation of the patterns that produce it) is easily recognized as the driver of evolution—the prime motivator underlying all progressively advancing systems, including life, culture, science, technology, and economic prosperity. We are finally able to apply principles of evolution to economic development. An economy thrives by way of the flourishing patterns in good businesses, not by the culling of bad businesses. Indeed, the economic future is determined far more by the successes of Amazon, Apple, Google, and Microsoft, than by the failures of Circuit City, Sears and RadioShack.

**The Evolution of an Economy**

If everything that happens in the world is a result of nature's forces playing-out through pattern synergies, then even an economy must be a natural process. And the progression of economic development must be modeled as an evolutionary process, operating on repeated patterns of worker activities (in conjunction with patterns of technology in the tools and machines they use). Worker activity patterns get translated into corresponding patterns of materials and energies in the things they produce, and those patterns generate highly beneficial synergistic effects. The worker activity patterns underlying economic production serve the very same role as the metabolic processes inside all living cells. Thus patterns underlying an economy evolve in ways that are abstractly similar to how patterns underlying life evolve.

Most dictionaries define evolution as little more than a process of change, but throughout this book *evolution* will always refer to the specific interpretation of progressive change first proposed by Charles Darwin in his landmark 1859 book *On the Origin of Species*. Darwin's theory of evolution explained for the first time how the progression of biological life depends on the reproductive success of inherited traits, as they are assessed by the forces of natural selection. Over the past fifty years, the concept of Darwinian evolution has been abstracted to a more generalized theory, applicable to any domain in which progressive improvement can be seen. Thus, our understanding of
the evolutionary process has itself been evolving, by inheriting some traits from the original idea while modifying them occasionally with subtle new changes.

The discovery of DNA in the 1950s taught us about the patterns underlying the evolution of biological life. Understanding exactly what happens to those patterns reveals evolution as an algorithm. Whereas Darwin's conceptualization of heritable traits was not well defined, we now know with great certainty that genetic patterns facilitate a simple algorithm of replication, occasional mutation, and differential selection. The very same algorithm has been recognized as a potential basis for the progressive development in patterns of culture, language, technology, economic production, and many other naturally developing systems, as well. The process of evolution, when it is abstractly and algorithmically defined, seems to account for all sources of creativity in the universe. Even the human brain appears to achieve its creativity through a real-time evolutionary process operating on neural firing patterns, which serve as imagined proxies for all types of patterns found in the real world, after they have been learned (including static shapes of objects as well as dynamic patterns of causality).

Nature's forces operate entirely on patterns, which exist everywhere, in many different forms and in many different substrates. Nature's forces do a wonderful job of maintaining the fidelity of patterns within certain substrates, and of faithfully translating patterns from one substrate to another. For example, audio patterns of spoken words (sound waves that change over time) get automatically translated from vocal chord vibrations to corresponding air vibrations, which then get automatically translated to ear-drum vibrations within the ears of someone who is hearing the spoken words, and then to fluid vibrations in the inner ear, and then to neural firing patterns. Finally, the patterns of neural firings get translated to corresponding patterns of strengthened synapses between neurons that encode a memory of having heard the spoken words. Nature's forces cause all kinds of patterns in the world to get automatically translated among many various substrates.

Some patterns stumble onto circular translational pathways that allow them to replicate themselves. When patterns are able to replicate with occasional mutations in a selective environment, they evolve. Circular translational pathways for patterns are the natural mechanisms through which pattern synergies are able to reinforce their own existence. Indeed, self-reinforcing synergies cause their underlying patterns to be replicated through looping pathways of pattern translations—loops of positive feedback operating on patterns. If we can identify the patterns underlying culture, technology, and economic production, and if we can find the loops of positive feedback through which they are able to get themselves replicated (with occasional mutations), then we can describe them as naturally evolving systems. Those patterns will naturally evolve toward ever-greater fitness. Nature's metric for fitness always relates to pattern synergy of a type that is self-reinforcing, ultimately revealed through the reproductive success of the underlying patterns.

It is enlightening to consider some of the similarities and differences between evolving life and an evolving economy. The essence of life depends on patterns of genes producing synergies in bodies that ultimately cause those same gene patterns to
proliferate (population growth). The essence of economic development depends on patterns of worker activities producing synergies in products that ultimately cause those same worker activity patterns to proliferate (economic growth). Success in life accrues to gene patterns that build synergistic bodies able to acquire sufficient resources (food) needed to sustain their metabolic processes. Success in an economy accrues to makers of synergistic products that are able to acquire sufficient revenue to cover their cost to manufacture (the excess being profit), and, success also accrues to buyers of products having greater utility value than their price (the excess being prosperity). Progress in life occurs as random mutations to gene patterns occasionally discover new patterns yielding greater bodily synergies. Progress in economic prosperity occurs as businesses try-out new ideas and occasionally discover better patterns of activities, producing greater synergies in better or cheaper products and services. However, new trials of slightly different economic activity patterns are not generated randomly (as are gene mutations), but rather, intelligently, allowing economies to evolve much more rapidly than life evolves.

In all cases of evolution, patterns of things evolve to produce ever-better self-reinforcing synergies. Pattern synergy is always the output of the evolutionary process, as well as the driver of the process. For either life or an economy, the best patterns—the fittest—will tend to replicate the fastest. And due to their more rapid replication, those fittest synergistic patterns have a higher probability of serving as the templates for creating the next generation of patterns, most of which will be identical but some of which will be merely very similar. Evolutionary progress need not involve death at all. Progress comes mostly from certain newly mutated patterns proliferating faster than all other patterns. Over time, the world naturally becomes filled with the types of patterns that produce the special synergy sought by nature—synergy that is self-reinforcing.

Even though economists typically consider the concept of synergy only in connection with mergers or acquisitions (specifically, the elimination of redundant operations performed by a merged company's workforce) synergy underlies all progress in an economy. Pattern synergy can be found to underlie every successful principle of economics. Synergy explains Adam Smith's invisible hand, recognizing that widespread economic benefit somehow emerges from individuals each pursuing their own self interest. Smith's brilliant insight is famously quoted over and over again: “It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own interest.” (The Wealth of Nations, 1776, pp.23-24)

How can we possibly explain one person's benefit—acquiring a good dinner—in terms of others' self-interest? The answer always includes different individuals having different skills cooperatively pursuing their own selfish gains, working together toward creating a style of synergy that would be difficult for an ordinary individual to create on one's own. Interestingly, the very same is true of a man and a woman engaging in sex. From their actions, a synergistic pleasure emerges beneficial to both, even though each participant is merely pursuing his or her own self interest. So, it is not from the benevolence of the man or the woman that we expect sex to occur between them, but from their regard to their own self interest. Synergies are maximized when each participant in a cooperative
relationship has a specialized skill or attribute. Just as a butcher, a brewer and a baker each have their own respective specialized skills for preparing food, so do a typical man and woman each have their own specialized body parts for maximizing the synergies of sex (in both the achievement of mutual pleasure and the incredible synergy resulting from the creation of a new life: 1+1=3).

The common motive behind every good and proper activity performed by cooperating life is the selfish pursuit of value from synergy, created with others and then shared among all who contributed to its creation. Only when each participant has a specialized advantage can synergies among them be maximized. And only when each participant looks-out for one's own self-interest are the resulting synergies likely to be mutually beneficial, in proportion to the respective contributions of each.

Simply by acknowledging the existence of pattern synergy, we begin to see the economy in a very different way. For example, the profit made by any sustainable business is just a different term standing for a portion of the synergy that is created by cooperating employees who bring together raw materials, energy, and labor, through a specific pattern of economic activities. Thus, a business can only be profitable to the extent its patterns of economic activity create synergy, which can only be self-reinforcing to the extent sales revenue is sufficient to fund ongoing production. Profit comes entirely from the creation of synergy, at no one's expense (so long as labor is properly compensated). Prosperity also comes entirely from the creation of synergy. A given product is only purchased when a customer perceives its utility value to be greater than its price. The difference is referred to as consumer surplus. This extra value accrues to the benefit of the buyer—makes the buyer more prosperous—but is an intangible effect that completely escapes accounting, because it exists only as synergy. Societal prosperity comes from total consumer surplus, which equals the perceived utility value of all products purchased minus the utility value of all the labor required to earn the money to purchase them.

Both wealth (from profit) and prosperity (from consumer surplus) come entirely from the creation of synergy. Good businesses create synergy and then share the value of that synergy with their customers. They price their products somewhere between the cost to make them and the perceived utility value of them, as assessed by customers. Over many transactions, profitable businesses accumulate wealth, and satisfied customers accumulate prosperity. So long as wealth is earned through the creation and sharing of synergy, it comes not at the expense of others, but by increasing the prosperity of others. A society's ability to generate greater prosperity heavily depends on the freedom of successful people to build on their previous success, which is a self-reinforcing effect that causes the rich to get even richer. But, so long as rich people re-invest their wealth into new businesses that create and share new synergies, it never causes the poor to get poorer. In fact, wealth re-investment opens-up many new opportunities for everyone to get better jobs and to become more prosperous through the better things they are able to buy, and perhaps even to acquire the necessary funding for starting new businesses of their own.

The invisible hand is often associated with the expression greed is good. But whether or not such an association is justified depends on how greed is defined. If greed is
defined as the strong pursuit of one's own self-interest by synergistically cooperating with others and then sharing the value of whatever synergy is produced among all who cooperate, then *greed is indeed very good*. When individuals greedily pursue their own self-interest to the maximum extent possible, they all can mutually benefit, so long as it happens through the creation and sharing of synergy. The more such synergy is created and shared, the better-off all participants are, with no expense to anyone else. Only when *greed* is defined as the pursuit of one's own self-interest *at the expense of others* is it clearly *bad*, in nature's view. Fortunately, most economic production is driven, not by such a *bad* style of greed, but instead, by the *good* style of greed that encourages people to cooperatively produce synergy and then share its value amongst themselves.

Economic products are naturally good to the extent they facilitate the growth of the human population, which then leads to the proliferation of those very same economic products (more food, more clean water, more medicines) in tandem with the growing human population. The net effect is yet another loop of beneficial exchange—a growing economy enables a growing population, which in turn enables a growing economy. Thus, synergistic mutualism clearly exists between the patterns underlying economic production and the patterns underlying the human population, as both sets of patterns act synergistically so as to reinforce their mutual existence and ongoing proliferation.

As we live out our daily lives, we rarely recognize the many underlying patterns that affect us, evolving in many different domains. We almost never think about the patterns of materials in the products we buy, or the patterns of activities that went into arranging those materials, or the patterns of words we use, or the abstract patterns of thoughts they convey, or the patterns of behaviors we routinely perform, or the patterns of employees working synergistically in a business, or the patterns of businesses in a supply chain, or the patterns of laws affecting the economy. But all those patterns exist nonetheless, and they all evolve as nature's forces automatically translate them among many different substrates. Whether we like it or not—whether we realize it or not—the destiny of everything in the universe is probabilistically determined by how nature's laws interact with evolving patterns, including even the neural firing patterns within all human brains.

The total system of all the patterns that work together toward their mutual proliferation is *aggregate life*, encompassing many amazing capabilities. *Aggregate life* is certainly a beautiful system. But perhaps our definition of beauty has evolved so as to find aggregate life to be beautiful, simply because we humans depend so heavily on many other species for our own survival and proliferation. We humans like to believe we exist for the purpose of making ourselves happy. We wrongly believe that maximizing our own happiness is the end goal—*la raison d'être*. But the simple evolutionary reason for why we humans experience happiness is to motivate us to do things that cause our patterns to proliferate. This realization has profound consequences regarding the natural purpose of an economy. Economists like to believe that the purpose of economic production is to satisfy our human wants and desires. But nature endorses an economy only to the extent it facilitates growth of *aggregate life*, in which we humans now play an enormous role. Aggregate life can only proliferate to the extent its many underlying patterns find ways to work together synergistically toward their mutual proliferation, which depends very little
on happiness but greatly on pattern diversity. Proliferating the web of cooperating life around the globe and throughout the universe, by increasing its diversity, is in fact the end goal—the natural reason for our existence, and the natural purpose of an economy.

**The Trajectory of Evolution: Determined by Nature's Forces**

Synergy comes in many different forms and flavors, all of which are made possible by the laws of nature. We can imagine a *pattern space* representing all possible patterns, such that patterns that are similar to each other are guaranteed to be close to each other in the space. The many types of possible pattern synergies that exist within pattern space lay-out probabilistic pathways for the future of any evolving process. The closeness of various synergies to each other (in terms of similarity among the patterns required to produce them), weighted by the magnitudes of self-reinforcing effects, is what determines the path most likely to be followed by an evolutionary process operating on a clustered set of patterns (a species of life) in pattern space. The concept is best illustrated by analogy.

Imagine a blind man standing on a meandering stone pathway in the middle of a mud field. The man wants to avoid stepping into the mud, but he cannot see the path of stones. So, he uses a cane to probe *randomly* in all directions from the stone on which he stands, searching for a nearby stone that might move him closer to voices he hears in the distance. This analogizes the way in which the natural process of evolution blindly discovers each successive step in its probabilistic trajectory, following the path of increasingly complex and increasingly valuable synergies laid out by nature's forces. The mud field represents the space of all possible patterns—*pattern space*. Every point location in the mud field represents a different possible pattern, and every probe of the cane represents a trial mutation—the trying out of a new but similar pattern. The stone pathway represents the subset of all possible patterns that produce instances of life.

Of course, in the real universe there are many more dimensions to the actual *space* of all pattern possibilities than the two dimensional landscape used in our simplified analogy. Also, we must suspect that the many synergies made possible by nature's forces might not be lined up in a nice neat row through the entire *space* of pattern possibilities, as we would expect a stone pathway to be, but instead, are probably scattered more randomly and sparsely all throughout. Although, they do seem to be ordered in such a way that roughly correlates evolutionary value with complexity. In other words, given any synergistic pattern, producing a synergy of greater evolutionary value generally requires a pattern of greater complexity. Both complexity and capability of life naturally grow in tandem over time due to this correlation between synergistic value and the complexity required to produce it. Capability increases when new and better synergistic value is discovered. And better synergistic value is discovered when mutating patterns stumble onto better synergies, often requiring slightly greater complexity among the many different types of patterns as they discover new ways to cooperate toward their mutual proliferation.
Even though evolutionary progress happens as a result of many random probes, the ultimate direction of the trajectory taken by the evolutionary process is not itself random. The emergent trajectory is a result of how nature's forces enable some patterns of order to survive and proliferate better than others, by way of the synergies they produce. Random pattern mutations in developing life simply probe in all directions of pattern space (local to whatever pattern is being mutated) for slightly more or better synergy of a type that is valuable to the survival and proliferation of the very same pattern. All synergies result from patterns interacting with nature's laws and forces, and those forces make possible many different types of synergies, just waiting to be discovered by some evolutionary process. The important point is that all those synergistic possibilities have always existed, ever since the creation of the universe as we know it. Nature's forces make them possible. Evolution discovers them. And, most importantly, the trajectory of evolution—nature's inherent directionality—is always constrained by them, and guided by them in a probabilistic sense.

Evolution tends to follow a trajectory established by successive synergies that are proximal in pattern space, which guarantees they are similar in design and complexity. But big jumps to brand-new regions of pattern space can sometimes be easily achieved simply by combining, through mechanistic cooperation, the causal effects of patterns that are already known to be beneficially synergistic. Whether or not such a combined pattern—being a new pattern in its own right—will produce valuable synergy cannot be known for sure until it is tried (or computationally simulated). Such combinatorial synergies are fairly easy to achieve, as if they are connected somehow to the simpler patterns that compose them by something like wormholes through pattern space.

Let us think of a species as a set of similar patterns in a localized region of pattern space, whether those patterns are biologically based, or products of technology, or anything else. The particular path of synergies taken by the natural development of any given species can depend heavily on the paths that have already been taken by other species (existing in the same local environment). But such a dependence does not alter the fact that nature's laws establish the sorts of synergies that are possible and the sorts of complex patterns that are required to produce them. It will later be shown that even when we consider the many effects of one species on the fitness of another species, in any given local environment, there are certain characteristics of absolute fitness toward which traits existing in aggregate life must evolve. The many different species of aggregate life act as various probes, searching pattern space for greater absolute fitness. Just as the laws of mathematics establish a natural path that progresses in complexity and analytic value from simple addition to algebra, to geometry, to trigonometry, to calculus and so forth, so do the possibilities for synergistic patterns lay out a natural path of increasing complexity and increasing value. Like erratically spaced stepping stones laid out by nature's forces, synergistic possibilities built into the laws of physics naturally guide the trajectory of any evolutionary process toward ever-greater levels of absolute fitness.

The specific path taken by any naturally evolving system can be very chaotic in the short term, but over the long term there is likely to be a predictable directionality to its evolutionary progression. Similarly, complexity researchers have discovered many
natural processes that seem to occur by random-like behaviors haphazardly guided by
*dynamical attractors*, or *basins of attraction*, which are completely defined by the natural
laws of physics. Like the path of a marble rolling around the inside of a large round sink,
it might be impossible to predict the exact route by which such a natural process will
proceed within its given basin of attraction, but in the real world, we can often predict
where the process will end up. All paths of such a rolling marble eventually converge at
the drain, thanks to the realities of friction. Just as a rolling marble can have a predictable
destiny, we are discovering that all instances of planetary life also have a predictable
destiny—to eventually develop at least one species having traits of general mobility,
general intelligence, and human-like morality, which synergistically combine to create the
highest levels of absolute fitness known so far, at least to us here on Earth.

**Nature's Directional and Progressive Intentions**

There are many clear aspects of directionality over time at the most fundamental levels
of nature's forces. For example, the total amount of entropy in the entire universe is
always increasing. And we now know that the universe is always expanding. Perhaps the
strongest directionality built into nature's forces is how evolution tends to progress toward
life that is increasingly synergistic, capable, and moral. By considering life in its
aggregate, across all species, such progressive synergies become quite evident in the
historical record of life on Earth. Aggregate life on land first developed the ability to
crawl on many appendages or legs, then *walk and run* on four legs, then stand on the back
two legs and *climb* using the front two legs as arms, then *fly* using the arms as wings. If
we were able to replay the evolutionary history of life on Earth, over and over again, we
would likely see those same capabilities emerge in roughly the same order in every
replay, but with unpredictable intervals and perhaps emerging in very different species.

Some traits provide such great evolutionarily advantage that they are guaranteed to
emerge, eventually. The capability of vision, for example, is so advantageous that it is
believed to have emerged independently in at least a dozen very different species of life
on Earth. Many of the most valuable traits that appear in aggregate life depend on other
traits appearing first. Indeed, the capability of vision depends on the earlier emergence of
neural processes capable of building a brain that can interpret neural signals coming from
such things as eyes. Dependencies are what largely establish nature's probabilistic
directionality. This ongoing directionality makes the natural process of evolution appear
as if it has some sort of mechanistic *intent*, always developing the entire system of
aggregate life toward containing species that are increasingly diverse, increasingly
complex, increasingly mobile, increasingly intelligent, and increasingly cooperative,
which translates to becoming increasingly moral.

Another clear manifestation of nature's directionality is revealed by the fact that time
always marches forward. Well, no, time always *progresses* forward; but only humans can
*march* forward. We must guard against the temptation to think of nature
anthropomorphically—as if it has human properties. As we come to recognize the many
similarities between the way nature's forces act and the way humans act, it is tempting to attribute some human characteristics to nature that might appear to be proper, but are in fact completely inappropriate. For instance, the commonly used term *Mother Nature* carries the very improper implication that nature emotionally *cares about* all instances of life, especially humans, in the same way a human mother cares about all her children. We are often tempted to analogize between how nature acts and how humans act, in ways that can be very misguided. But there *is* a very strong connection between what we humans actually *are* and the forces of nature by which we *came to exist*.

We humans seem to be well-programmed by way of our emotions to want to carry out the directional process of evolution, in many ways and at many different levels. Indeed, it is not just a coincidence that the emotions we humans feel—the things that motivate us—tend to reinforce the process of evolution. Our emotions encourage us to survive, to eat, to explore, to learn, to avoid injury, to procreate, and to protect our families and nurture our children. Further still, as clear evidence that we humans are programmed to advance evolution, we, as children, enjoy running and playing in ways that develop many of the mobility and intelligence traits that are so important and unique to our species. Indeed, it appears that the things we humans *want* and *like* have been tailored by evolution to reflect and further develop whatever directionality exists in the process of natural evolution. This should not surprise us, because natural selection culls life that is not compatible with its directionality, and rapidly proliferates life whenever it represents a significant step in the direction that nature appears *intent* on going.

It is perfectly acceptable to say that nature's evolutionary process *intends* for life to get better, so long as we don't suspect that nature has any sort of *feeling* of intent, as we humans do. Indeed, it is fine to say that nature *intends* for life to get better in the same way that a thermostat *intends* to heat up a cold room to whatever temperature it is set. Even though a thermostat isn't likely to have any sort of *feeling* of intent as we humans do, the observable behavior of it is just as if it had a similar sort of will, or intent, as we humans have. A thermostat's *intent* is manifested by its directionality, always toward a certain temperature. And the same is true for the evolutionary development of life, always toward life that is better in some way. While we do not suspect that nature *feels* any emotion of intent or desire as it expands the universe, or as it increases entropy, or as it moves time forward, we may certainly recognize nature's directionality as a form of automatic or mechanistic intent and associated desire. We are indeed entitled to say that nature's forces intend to expand the universe, and they intend to increase entropy, and they intend to move time forward, so long as we never imply any sort of emotional *feelings* involved with such intentions or desires.

The reason why we might want to describe nature's forces as having *intentions* is because it is very logical to conclude that we humans have our intentions only because nature's forces have bred into us properties that reflect nature's intentions. Given our amazing replicative success, and our clear dominance of the food-chain, we must suspect that our species is more aligned than all other species with the direction in which evolution is destined to progress. In other words, we humans must be closer than all other species to the kind of life nature *intends* to breed. We are a reflection of what
nature wants, as expressed entirely through natural selection. From nature's perspective, the term better is clearly defined by the direction in which nature's forces are probabilistically destined to go. Thus, nature's reliable directionality is indeed a form of involuntary or mechanistic intent toward making the universe a better place over time, strictly according to how nature defines what better means—full of ever-more life that increasingly embodies and expresses ever-greater self-reinforcing synergies. Nature essentially defines progress by the inherent long-term directionality built into its laws and forces.

As we look all around us at the many things existing in the universe today, it is reasonable to conclude that nature, in some sense, must like those things that are most abundant. We are simply using a shorthand notation for expressing nature's biases for certain types of things by saying that nature likes them over other things. What we really mean is that nature acts as if it likes certain things over other things, which is a perfectly acceptable and logical thing to say about natural forces. We certainly should not suspect that nature feels any sort of emotion of liking things that naturally become abundant. Instead, nature simply shows its preference for certain types of things by virtue of their ability to become more abundant in the environment. This is particularly obvious for things that have existed in great numbers since long before humans ever arrived on the evolutionary scene. For instance, nature appears to like stars and galaxies, simply because nature's forces have created so many of them in the universe.

We may even speak of certain types of atoms liking other specific types of atoms. For example, hydrogen and oxygen seem to like each other as molecular companions, together forming water. Of course, the liking that exists between any two atoms is completely defined by nature's forces operating through their charged particles—the protons in their nuclei and the electrons in their outer orbital shells. But the net effect is that nature's forces cause some types of molecular combinations to become more plentiful than others over time, in any given environment. The very same concept applies to patterns considered more generally. Various atomic and molecular patterns naturally come and go by way of nature's forces, and some patterns naturally become more abundant than others, over time, by finding ways to replicate. When a replicating pattern becomes very abundant over time, we may infer that natural selection has something of a bias or preference for it over other patterns that fail to replicate so prolifically.

Nature's likes and dislikes, with regard to evolving patterns, are revealed through natural selection, which is performed rigorously (although probabilistically) by nature's physical laws, largely according to how much self-reinforcing synergy those patterns produce. All forms of pattern development are controlled entirely by the forces of nature. All patterns exist and proliferate by way of nature's forces, even when those forces act through human brains to create and proliferate the various patterns of activities that underlie economic production. Over the long term, all processes of natural change tend to go in a direction that expresses nature's apparent will. Accordingly, human economies can only thrive over the long-term if they create patterns of economic activities that somehow cooperate with patterns of genes toward their mutual proliferation.
The particular patterns that are most likely to proliferate better than all others are those that are most advanced along evolution's overall long-term directionality. Because we humans are far more prolific than most other species, it is quite appropriate for us to view ourselves as the best evolutionary products, discovered so far, through which nature has been able to express its directionality—its automatic will. In other words, we humans are the species most advanced along the direction in which nature has always intended for life to go. Nature's forces created us for the specific purpose of bringing enormous amounts of order to the world. And some of the economic patterns of order that we humans are now producing serve nature's directional interests even more than they serve our own human interests. We should not be too surprised, because our human interests were evolutionarily designed by nature's forces to fulfill nature's directionality. Indeed, the pattern of a transistor appears to be well-aligned with nature's directionality, as it is now proliferating at a rate that is likely faster than any other pattern has ever replicated on Earth. It reveals a lot about how nature's forces will cause the unfolding of the economic future.

Evolution's natural directionality acts as a wind-to-the-back of any economy that is well-aligned with it. An economy can only thrive to the extent it works with nature's order-creating forces rather than against them. Indeed, nature's forces automatically bestow prosperity on any economy to the extent it discovers and uses brand-new beneficial economic synergies. Any society that chooses an economic path in clear defiance of evolution's apparent directionality will surely be punished by nature, just as a sailor is denied progress when choosing to sail directly into the wind. Such a defiant economy will surely fail relative to other economies. Over the long term, nature's laws guarantee that patterns of life making most effective use of nature's many synergies will eventually emerge and evolve in various regions of the world. And those that are most aligned with nature's directionality will prosper more than all others, as a result. In the end, nature's directionality always wins.

Absolute Fitness: The Synergy of Mobility and Intelligence

When biologists talk about fitness, they are typically describing the ability for an individual or a species to survive and reproduce in its own particular environment. And since the respective environments for most instances of life necessarily include many other individuals from many other species, fitness is generally considered to be relative to those other forms of life. Thus, fitness usually refers to how well a species or individual fits with all the other life in its own particular localized environment. While it is certainly true that the ability to thrive for any given species depends greatly on its environment, it is also true that the ability to thrive in many different environments implies a greater level of fitness than the ability to thrive in only one very specific environment. Thus, we can imagine a species of greatest absolute fitness that is able to thrive in almost any environment, no matter what other species of life might also exist there.
Recognizing that attributes of fitness can combine synergistically allows us to think about fitness in a way that is absolute and universal. Indeed, nature defines fitness absolutely in terms of synergies that break down across just two distinct categories—general mobility (an ability to move in many different ways) and general intelligence (an ability to conceive and assess many different types of plans for moving beneficially). As previously mentioned, neither mobility nor intelligence is valuable by itself (think of a very smart rock or a very stupid Olympic athlete), but when they are combined they create the highest form of self-reinforcing synergy—intelligent mobility. Fitness is thus defined in an absolute sense by synergistically combining traits of general mobility with traits of general intelligence. However, it is also very true that the various species having the most intelligent mobility—the ones at the tops of the world's food chains—are nevertheless very dependent on many other species for their proliferation success, which limits our ability to describe the fitness of any given species in isolation. Instead, we will find it useful to apply the concept of absolute fitness at the level of aggregate life, treating it as something of an indivisible system. But before we discuss the fitness of aggregate life, let us first explore a few related concepts at the most fundamental level.

In any system of evolving life, the trait of mobility is likely to develop first, before the trait of intelligence. The earliest species of land-based animal life on Earth surely explored randomly for food simply by crawling around—no intelligence required, other than for distinguishing between food and nonfood. New species of land-based animal life became incrementally more mobile over time by adding new degrees of freedom to what life was already capable of doing. Since mobile individuals always have the option of not moving, mobility of any degree can never be a bad thing for life to possess.

As new species achieve greater general mobility, they can increasingly benefit from developing intelligence. Indeed, the ability to run fast is of little value if it is not used at the proper times. So, the ability to run fast is greatly enhanced by knowing or anticipating exactly when it is important to run fast and in which direction it is most beneficial to run. In any environment whatsoever, intelligent individuals are statistically more likely to survive than unintelligent individuals, all else being equal. This is necessarily true by definition of what it means to be intelligent. When intelligence is properly defined, it can never be a bad thing for life to possess.

Some abstract types of synergies made possible by nature's forces are so advantageous to life that they are guaranteed to emerge, eventually, anywhere in the universe where life has bootstrapped itself into existence. As previously discussed, the ability to visually sense and recognize nearby patterns is another highly advantageous trait (wherever light exists), contributing always to the category of intelligence as it develops. A later chapter discusses other such traits of absolute fitness—mimicry and morality (both of which also contribute to the category of intelligence as it develops)—recognizing them as universal by the fact that they are guaranteed to emerge in all planetary systems of biological life as well as in all manifestations of advanced machine technology.

Nature's biases toward traits of universal fitness, when considered abstractly, do not distinguish between life on one planet versus another, allowing us to expect that all systems of aggregate life throughout the universe will eventually acquire the same
abstract traits of universal fitness. Neither do nature's biases distinguish between evolving patterns of biological life and evolving patterns of machine technology, on the same planet. All evolving patterns are just patterns, no matter their underlying substrate, and all abstract traits of absolute fitness apply equally to both evolving patterns of life and evolving patterns of technology. Thus, we can expect patterns of technology to progress through the very same abstract traits of universal fitness that are evident in the historical progression of earthly biological life. Indeed, the development of technology has already traced through many of the very same stages, combining ever-increasing mobility with ever-increasing intelligence, just as those stages progressed in the early evolutionary history of biological life. Traits that are now emerging in technology are abstractly similar to universal traits of fitness that emerged long ago in biological life, as shall be explored in a later chapter. For example, the capability of human-like vision is now emerging in our technological products, and is advancing much more rapidly in computer technology than it ever did in biological life.

The co-development of general mobility coupled with general intelligence is what evolution always seeks. Not surprisingly, both mobility and intelligence can be defined entirely in terms of patterns. General mobility is defined by many different patterns of motion, including the ability to: crawl, walk, run, turn, jump, kick, swim, slither, push, pull, thrust, grasp, carry, throw, drag, climb, punch, fly, hack, twist, pound, swing, suck, spit, talk, and so on. The more patterns of motion a species can perform, the more adaptive it can be to any environment whatsoever. General intelligence is defined by pattern perception and prediction, which includes the ability to: sense patterns, learn static patterns (the shapes of objects), learn dynamic patterns of causality, classify patterns, imagine combinations of patterns, and predict the synergistic effects of combining various patterns on the basis of learned patterns of causality.

As any trait of fitness develops in a particular species, it can have very different effects on other species, depending on whether they compete or cooperate. Competing species often develop an arms race, exploring for ever-better versions of the same trait, such as the ability to run fast. For example, both lions and cheetahs compete over the same prey, so if lions adapt to run faster, then cheetahs must do the same. Arms races also emerge between predators and their prey, driving them both to ever-higher levels of fitness. But there is a critical distinction to be made here. When predators and their prey exist at different levels of absolute fitness, nature considers the relationship between them as a completely natural mechanism for guiding critical resources to ever-higher levels of fitness, critical to the pace of evolutionary progress, which is discussed in the next section.

Opportunities for different species of life to synergistically cooperate with each other tend to have positive effects on the amount of overall life. And dysergistic competitions among species tend to have negative effects on the amount of overall life. So, aggregate life naturally evolves toward a composition of species that cooperate toward their mutual proliferation, especially as various traits of universal absolute fitness emerge among them. Such cooperative synergies bind many different inter-dependent species together in ways that are not at all obvious. Indeed, synergistic cooperation between species takes
many different forms, some of which are difficult for us to see until we develop the
ability to look at life from a fully naturalized perspective—from a replicator-centric or
synergy-centric viewpoint, as discussed in later chapters.

When discussing the evolution of life's fitness, it is most useful to consider it at the
level of the entire system of aggregate life. Individuals and species come and go in the
natural course of evolution, as the natural process randomly tries out new combinations of
patterns. But aggregate life is what tends to persist over great expanses of time. It is only
logical to expect a particular trait of absolute fitness to eventually emerge somewhere in
aggregate life, not necessarily in any given species.

The many forms of inter-species cooperation that naturally develop within a system of
aggregate life tend to bind the various cooperating species into a unified synergistic
system that simply does not lend itself to fitness analysis on a per-species basis. Indeed,
the fitness of any one species cannot be assessed without considering all the other species
on which it depends for its survival and proliferation. When traits of fitness are assessed
in an absolute sense, it is only appropriate to assess them at the level of aggregate life.

For example, some species of life appear to be capable of digesting grass, such as cows,
but only because they enlist the help of certain gut-residing bacteria that enable them to
do so. Thus, we may say that aggregate life on Earth is capable of digesting grass, but we
may not say that cows are so capable, because they would not be able to perform the
digestion on their own without help from the particular species of bacteria on which they
so heavily depend.

Let us consider traits of absolute universal fitness primarily as aspects of aggregate
life. If any species in a system of aggregate life is capable of flying, for example, then the
entire system of aggregate life can be considered to have developed the capability of
flight. If any species in a system of aggregate life is intelligent, then the entire system of
aggregate life can be considered to have developed intelligence. Recognize, for example,
that cows benefit greatly from the intelligent creation and administration of certain bovine
vaccines, and that such intelligence comes not from cows but from humans. Further,
animals aided by wildlife rescue teams, all around the world, often benefit from advanced
technologies developed by humans who seek to preserve the precious diversity of species
in the overall system of aggregate life. Human technologies are creating lots of problems
for various nearly-extinct species of life on Earth, but they are also creating lots of
opportunities for betterment, especially for the many species of life that cooperate
synergistically with humans toward mutual proliferation, such as the bees that pollinate
our crops (and many more species to be described in later chapters).

Due to the co-development of intelligence and mobility in our ancestors, we humans
are uniquely capable of elaborate planning. A good plan is simply a synergistic
combination of various activity patterns, over time, predicted to yield evolutionary
advantage through the creation of some beneficial synergistic effect in the future. Our
ability to imagine the causal effects of various pattern sequences yields tremendous
evolutionary value to all the species of aggregate life, especially those that cooperate with
us toward our mutual proliferation. Accordingly, we humans are able to imagine how the
geographic spread of our modern technology is likely to threaten various species extinctions, and we have been making plans to preserve life's diversity, as best we can.

The Pace of Evolutionary Progress: Determined by Flow of Resources

Everything about an evolving system's ability to flourish comes down to how critical resources flow. Pattern replication always requires energy and specific raw materials to create new replicas. So, patterns can proliferate only to the extent they are able to acquire the critical resources necessary to carry out their ongoing replication (just as pregnant females consume more food than usual to fund their baby's growth). The flow of resources not only determines the trajectory but also the pace at which an evolving system will progress, bringing us face-to-face with one of the most important issues in economics: How should scarce critical resources be allocated? Consider three different cases: If critical resources tend to flow fairly and evenly toward all patterns, independent of fitness, then the overall fitness level across all patterns is not likely to progress. Even worse, if critical resources tend to flow toward patterns of least fitness, then the overall fitness level will surely decline, as those unfit patterns use those resources to replicate themselves and thereby become more abundant than other patterns of greater fitness. Only when the fittest patterns are able to acquire scarce critical resources can they replicate at a faster rate than other patterns of lesser fitness, and thereby cause a progressive rise in the overall level of fitness. More importantly, as the fittest patterns replicate at a faster pace, occasional mutations enable them to more rapidly explore their respective local regions of pattern space in the evolutionary search for even fitter patterns.

There is good reason to believe that pattern space is proximally correlated, meaning that patterns close to each other are more likely to have similar levels of fitness than patterns far away from each other. So, finding patterns having fitness levels greater than all known so-far is more likely to happen by exploring in regions surrounding the fittest known patterns than in regions surrounding the least-fit known patterns. By loose analogy, if many explorers carrying altimeters are seeking to discover the highest peak of a given mountain range (say, hidden in dense fog), scarce resources (such as, say, batteries for the altimeters) should go to those explorers who are already at the highest elevations, rather than to those who are in valleys.

Understanding an evolving system in terms of how resources flow makes perfectly clear what self-reinforcing synergy actually means. The degree to which any type of synergy can be self-reinforcing depends mostly on its ability to acquire critical resources. In biological evolution, nature's forces establish a high degree of correlation between the absolute fitness of patterns and their ability to acquire critical resources. When a pride of lions chases a herd of gazelles, for example, it is usually one of the fittest lions that ends up with a belly full of energy and protein, which formerly belonged to the unfortunate gazelle that was likely among the least fit of its herd. Nature's forces probabilistically cause critical resources to flow toward the fittest species of life and toward the fittest individuals within those species, thereby ensuring evolutionary progress. Naturally
occurring *food chains* order the flow of resources from species of least fitness to species of ever-greater fitness. For all patterns of self-reinforcing synergy, the acquisition of resources typically happens by way of the synergies those patterns create. So, the amount of resources patterns are able to acquire is highly correlated with the degree to which the synergies they create are self-reinforcing. From nature's perspective, the optimal flow of resources—always toward the fittest—is critical to the progressive development of life, and it is true *all the way down*: among various species, among various individuals within those species, and even among various body parts within the bodies of those individuals.

The extent to which any individual of life can acquire critical resources depends on how efficiently resources are allocated within its own body, which happens in an animal by way of its supporting structures—things like blood vessels and lung ducts. All such structures in biological life exist ultimately for the purpose of getting resources to the replicating patterns—the genes—that define them. Genes that create superior mechanisms for the acquisition and flow of critical resources are in essence gathering and guiding those resources toward optimal use for the perpetuation and proliferation of those very same genes.

Optimal characteristics for the flow of resources are determined entirely by nature's forces. Just as round is the best shape for wheels, we find that circles have certain mathematical characteristics making them optimal in the design of many supporting structures that are fundamentally responsible for allocating resources within a living body. The best shape for a pipeline, for example, is to have a cross-section that is a circle. Less energy is required to pump a flowing resource through a cylindrical pipe than through any other shape of pipe (of identical volume per unit of length). Accordingly, evolution seems to have settled on blood vessels that are round (in cross-section) for the flowing of blood, as well as round bronchial tubes for the flowing of air, and round veins in leaves for the flowing of water.

Another physical shape that reveals itself over and over again throughout nature is the particular pattern that appears to be optimal for *distributing* critical resources from a point to a region, or for *gathering* resources from a region to a point—the pattern found in the branches of a tree, the roots of a plant, the veins in a leaf, the blood vessels of an animal, the air ducts in lungs, the streams feeding a river, and the dendrites of a neuron. Such a tree-like pattern is defined by a multi-stage bifurcation of a big flow at one end (the trunk) down through multiple levels to ever-smaller flows at the many other ends (the leaves), self-similar at ever-smaller scales.

Nature's forces clearly define the patterns that are optimal for any given domain. And evolution haphazardly discovers them. The evolutionary tendency toward optimization has created very similar tree-like structures to guide the flow of all kinds of resources, including the flow of blood through the circulatory system (distributed through ever-smaller arterial branches, and then re-gathered through ever-larger veins), the flow of air into lungs (from large bronchi down to many small alveolar sacs), and the flow of information through any neuron of a brain (from many small dendritic branches up to the single cell body and trunk-like axon). Indeed, the same optimal tree-like structure for flowing resources has been independently discovered by many different species of life.
The tree-like pattern for gathering or distributing flowing resources prevails because it is optimally practical. And it is optimally practical because nature's forces cause it to be optimally practical. Nature's forces cause all things that happen in the universe. And when nature's forces cause things to happen in a particular way, we may infer a bias of nature. All sorts of biases toward pattern synergies are built into the laws of nature and are revealed in the patterns chosen by natural selection for survival and proliferation.

In a 2012 book titled *Design in Nature*, Duke University professor of mechanical engineering Adrian Bejan describes what he refers to as the *constructal law* and how it governs evolution in every aspect of all things that evolve. Bejan writes: “I realized that the world was not formed by random accidents, chance, and fate but that behind the dizzying diversity is a seamless stream of predictable patterns. … The designs we see in nature are not the result of chance. They arise naturally, spontaneously, because they enhance the access to flow in time.” (pp.2-3) Accordingly, in all cases of naturally occurring tree-like structures the flow of critical resources has been evolutionarily optimized, in accordance with the laws of nature. And, indeed, the very same type of tree-like structural pattern is often evident in an economy with regard to the flow of capital, the flow of goods, the flow of energy, the flow of raw materials, and the flow of information.

For all types of evolving systems, evolutionary progress is only possible to the extent critical resources are allocated to the fittest patterns, which is what nature's forces tend to ensure. In an economy, research into the discovery of new and better patterns tends to yield the best results when already-successful businesses—the fittest—build on their previous successes by using their profits to expand their product lines and make their already-valuable products even better. Every economic participant can then benefit from purchasing better products and from greater availability of good jobs. Thus, optimal research and development is only possible to the extent resources flow toward the fittest businesses, which is what capitalism tends to ensure. Artificially allocating resources to the unfit forfeits the opportunity to use those same resources for much greater exploratory and developmental benefit that would have otherwise been possible by allocating them to the fit. Such misguided allocation would be like heavily taxing profitable businesses and giving the tax revenue to failing businesses that make products nobody wants to buy. The long-term pace of evolutionary progress, for any evolving system, depends on the fittest patterns acquiring more critical resources than the unfit, enabling them to become more abundant. As the fittest patterns replicate, along with occasional mutations, they explore regions of pattern space in which even fitter patterns are most likely to exist.

There is a critical tradeoff between pattern *quantity* versus pattern *quality*, the effects of which are quite different in the short term than in the long term. In the short term, quantity of patterns is maximized by a fair and even distribution of resources across all patterns, independent of fitness. But such an allocation strategy achieves its short-term quantitative progress at the expense of lowered qualitative progress, which is the only path to a much fitter and more prolific future. In biological life, the *quantity versus quality* tradeoff depends heavily on the natural rate of random mutations occurring to germ-line patterns, many of which fail and lead to early death, but some of which
occasionally discover even better life. A lower mutation rate is safer as it yields greater abundance of very similar patterns in the short term. If we could choose where to set the mutation rate for patterns of life, it would be tempting to set it at a very low level, because that would be clearly the safest and most beneficial in the short term. A higher mutation rate is risky, yielding more birth defects and early deaths, but with the clear evolutionary benefit of wider diversity in the population of patterns, including some much fitter than average, capable of acquiring more resources and using those resources for much more rapid population growth in the future. A higher mutation rate essentially sacrifices some near-term abundance in exchange for discovering greater levels of fitness through greater pattern diversity. Such risks are necessary for making evolutionary progress toward ever-better life, able to grow its abundance at an even faster rate in the future. The evolution of life on Earth could not have produced humans without a sufficiently high mutation rate and the consequent failures of life that inevitably resulted from many errant mutations.

The quantity versus quality tradeoff reveals itself in an economy as a clear choice between re-distributing tax revenue from successful businesses and their owners, or allowing them to keep all of their profits for re-investing into new research, promising the discovery of even better new products in the future. This tradeoff forms the central issue of politics, and is easily resolved by recognizing that optimal future benefit flows from full re-investment of profits by the already-successful—the fittest. Such investment into a better (more synergistic) future can be risky and costly to those investors in the short term, but is absolutely necessary for achieving the fastest possible rate of progress in both quality and quantity over the long term. Of course, re-investment of wealth tends to make the rich even richer, which seems very immoral to us, as compared to donating wealth to the poor. But, our moral intuitions are adapted to the zero-sum environments of long ago.

Nature's Morality: Reciprocal Altruism toward Mutual Benefit

For morality to have been produced by evolution, it had to have been evolutionarily advantageous to our ancestors. But from the way we typically think of it, morality should work against evolutionary fitness. We tend to define morality in terms of sacrificing our own welfare for the benefit of others. And any sacrifice made by one individual for the benefit of another represents, by definition, a reduction in one's own ability to survive and to procreate. As any good evolutionist knows, traits that work against evolutionary benefit tend to disappear over time. So, how have we come to believe that behavior is only moral to the extent it is purely altruistic? What we discover is that our moral intuitions are tuned to the zero-sum environments of our hunter-gatherer ancestors, and have simply not yet adapted to what nature would prefer for us to have in our modern non-zero-sum environment.

Since genetic patterns of biological life evolve through mutations that are random, it can take millions of years for evolving genes to stumble onto the specific patterns that are most beneficially adapted to whatever environment exists. So, we must assume that our
genes are mostly adapted to the wild environments that were typical over most of the past million years. Accordingly, we humans are born with intuitions that define the moral good in a way that would have been appropriate long ago. There are two factors of morality that were very different in those wild environments as compared to our modern world. First, our hunter-gatherer ancestors were constantly exposed to close family members, whereas today we are not. Second, and more importantly, the environments of our distant ancestors were very clearly zero-sum situations (with regard to the availability of food), whereas today we live in a world that is very non-zero-sum. Let us consider both these factors, in turn.

We humans are programmed by our underlying patterns to treat our own close family members better than we treat everyone else. The reason is that close family members are more likely than others (selected randomly from the population) to share identical underlying patterns (genes and cultural memes). And the evolutionary success of any characteristic or trait is ultimately determined by its effects on the reproductive success of the underlying patterns that produce it. Gene patterns tend to evolve in ways that appear completely selfish. But in fact, the most selfish thing a gene pattern can do (to maximize its own future proliferation) is to program its host to be purely altruistic toward others who are likely to share the same gene. Indeed, a gene pattern in one body can selfishly proliferate itself by aiding copies of itself existing in other bodies. So, behaviors among close family members, who are likely to share many of the same genes, can easily evolve over many generations toward becoming purely altruistic. Since our nomadic hunter-gatherer ancestors traveled as families, until about 10,000 years ago, every moment of every day for them was spent mostly among close kin, causing a highly altruistic style of morality to evolve among them. But unlike our distant ancestors, we modern humans are no longer constantly exposed to close kin. So the style of morality that is appropriate for our modern world is likely to be somewhat different from what we have inherited.

Another far more essential difference between our modern environment and the environments of our distant ancestors is that we no longer live in a zero-sum situation, regarding the availability of food. For our hunter-gatherer ancestors, there was a relatively fixed amount of food available in any given territory. So, one person's gain of food had to come at the expense of another person's eventual loss of food. Moreover, there were no opportunities to invest any excess resources, or even to save them in something like a refrigerator. So, any excess food available would be wasted if not shared. In the zero-sum situation of our distant ancestors, the sharing of food, by those who had more than they needed with those who had less than they needed, was a great strategy for evolutionary success, especially when it happened among close family members who were likely to share many of the same genes. A gene could ensure its greater proliferation by programming its host to share any excess food with the rest of the family, thereby aiding copies of itself in the bodies of those other close family members.

The situation changed dramatically from zero-sum to very much non-zero-sum when our ancestors began settling into agricultural communities about 10,000 years ago. By planting and cultivating seeds, they were able to create more food in their territory than would have otherwise existed. They learned how to put the synergies of life to the service
of their own benefit, which ultimately acted toward the greater proliferation of their underlying patterns. The more seeds they planted and cultivated, the more food they could create. And the more food they created, the more they were able to proliferate their underlying patterns into an ever-growing population of descendents, all of whom could grow their own food. In such a non-zero-sum environment, one person's gain of food could occur at no expense to anyone else, so long as it resulted from the contribution of one's hard work toward the planting and cultivating of new seeds. In addition to growing crops, our ancestors also learned how to raise chickens, hogs, and cows, from which they could get eggs, milk, and meat. The earlier moral concept of sharing food—appropriate in a zero-sum environment—was replaced by a far better strategy of teaching starving people how to invest in the growing of their own food.

Our modern environment is rife with technologies that enable humans to work synergistically together in ways that are increasingly non-zero-sum, full of ever-greater opportunities for producing highly beneficial synergies. Yet, the genes that define our innate morality remain strongly adapted to the zero-sum environments of our hunter-gatherer ancestors, and we persist in defining morality in terms of pure altruism. When morality is naturally and properly defined for our modern environment, its sole purpose is to foster cooperation, which in turn produces new and better synergies from which all cooperating participants can mutually benefit. From nature's viewpoint, a policy is moral only to the extent it causes, over the long term, a total amount of self-reinforcing synergy to exist in the universe greater than what would have otherwise occurred.

Yet another reason we tend to improperly define morality comes from more recent trends in culture. Popular but erroneous concepts of religion, persisting over recent millenia, have created a culture that parses all actions into the two distinctly separate categories of good and evil, where good actions are inspired by God and bad actions are inspired by the Devil. This has led to persistent religious beliefs defining good behaviors as those that are purely altruistic, and bad behaviors as those that are purely selfish. The natural evolution of religion has duped our recent ancestors into believing that moral behavior is defined, by God, as purely generous and entirely unselfish.

Science tells us that there are no independent sources for pure good or pure evil, such as by a god or a devil. Nature's forces guarantee that both good and bad must exist simultaneously in fairly equal doses. For example, evolution depends on both birth and death, along with the creative proliferation of fit life and the destructive culling of unfit life, to work its magic. And as life naturally generates diversity, it is guaranteed to create some people who are genetically programmed to be kind and generous, as well as some who are programmed to be cruel and selfish (while simultaneously pretending to be kind and generous). Thus, in our modern environment, nature's forces should prefer a style of moral behavior that simultaneously handles both good and evil—pure altruism and pure selfishness—a style of morality known as reciprocal altruism, best summarized as I will help you today, but only if I can trust you to help me at some time in the future. To be long-term stable, the benefits of cooperation must flow toward all who cooperate.

Synergistic cooperation often requires an up-front sacrifice—an act of pure altruism by one individual for the benefit of another. But it is only logical and long-term beneficial
for one to make such an upfront sacrifice (for the benefit of another) under the assumption that it will be reciprocated (by the other) at a later time. Morality becomes a stable evolutionary platform for behavior only when acts of kindness and generosity are likely to be reciprocated, such that all those who act generously and all those who reciprocate such acts of generosity tend to benefit mutually from whatever synergies they together create. Our human emotions of compassion, gratitude, and vengeance are completely consistent with reciprocal altruism, causing us to act in ways that are purely altruistic at times, but with an expectation for future reciprocity (which often remains somewhat hidden in the subconscious mind). Feelings of compassion cause us to commit acts of kindness. Feelings of gratitude inspire the beneficiaries of kindness to reciprocate it. And feelings of vengeance inspire us to punish those who fail to donate or reciprocate acts of kindness to those who have proven that they themselves deserve it. Ongoing cycles of reciprocated acts of kindness build trust and thereby lay the foundation for many future acts of self-reinforcing synergistic cooperation, in a completely natural process called friendship. We routinely shake each other's hands, hug each other, and give each other gifts as signals of a desire to cooperate. But make no mistake: friends only remain friends over a long period of time if the friendship benefits them mutually.

Synergistic cooperation among individuals of life is the essence of all moral goodness, from nature's perspective, and forms the basis for the evolutionary emergence of human morality and the consequent development of economic prosperity. When people work together synergistically toward a common purpose, mutual benefit comes by way of the resulting synergy, at no other individual's expense. The morality that many of us think of as ideal—purely generous and entirely unselfish—tends to fail miserably in the real world, as a long-term evolutionary strategy, simply because it breeds cheaters. Pure generosity is always open to exploitation by selfish others, who seek evolutionary advantage at the expense of the generous. Only reciprocal altruism can be long-term sustainable as a widely embraced code of conduct. Ongoing cooperation among trustworthy individuals creates synergistic benefit allowing them to proliferate faster than others, producing children that learn to be trustworthy, as well.

So long as acts of kindness end up flowing toward mutual benefit over the long term, everyone tends to get more value than they give, to whatever extent synergies are created. Many of us are perfectly willing to help out people who are complete strangers, but with an expectation of reciprocity from all strangers, at large, when we ourselves need help. Such an expectation of anonymous reciprocity is somewhat illogical, given that the strangers we help and the strangers who are in a position to help us in the future are likely to be very different people. Nevertheless, a widespread cultural belief in the goodness of aiding strangers can proliferate by way of the expected synergistic benefits those adopted beliefs can create. When that widespread belief breaks down, it is difficult to re-generate.

When morality is properly defined, so that it facilitates synergistic cooperation and discourages cheating, it can never be a bad thing for intelligent life to possess, making it yet another universal trait of absolute fitness for life that has reached a certain threshold of intelligence. When morality is completely understood, it can be seen as just a particular manifestation of intelligence. In other words, intelligence subsumes morality,
because it is always intelligent to be moral. In any domain, the most intelligent style of behavior is always that which seeks to maximize synergistic cooperation—exactly the goal of nature's most preferred style of morality. Intelligence and natural morality become indistinguishable from each other.

The directionality of evolution guarantees that life will eventually learn how to turn a zero-sum environment into a highly cooperative and synergistic non-zero-sum environment, as it becomes increasingly intelligent. And the directionality in nature's forces determines what life ought to do. All our moral oughts derive from nature's preference for life that aligns itself with nature's directionality, toward ever-greater creating and sharing of mutually beneficial synergies. So, quite simply, we ought to do what nature has always intended for life to do in the future. Since we modern humans have clearly become one of nature's most prolific and dominating species, we may logically infer that we humans hold moral values that resemble the values nature prefers for life to hold, at least, more closely than all other existing species of life on Earth. And we may also infer that our moral values are still evolving, toward becoming ever-closer to the kinds of moral creatures that nature most prefers.

Natural versus Non-Natural

As we look at the world around us, we see and lament the severe disruption of nature by enormous amounts of human economic activities. Patterns of nature are being overwhelmed by patterns of human production. Trees, bushes, meadows, and all the species of life that typically live in those natural habitats are giving-way to roads, sidewalks, parking lots, strip malls and skyscrapers. We usually think of nature as existing only in those areas of the world where mankind's heavy-handed influence has not yet been felt. But we need to start thinking of nature in a bigger sense. We need to acknowledge that the trajectory built into nature's forces has always pointed toward the eventual emergence of a human-like species capable of using nature's forces for advantage toward its own survival and proliferation. And along with such an intelligent species would inevitably come sidewalks, roads, parking lots, strip malls, and skyscrapers. Everything in the universe must be considered natural, because everything is a product of nature's forces, including all the things we humans build.

We prefer to think of ourselves as non-natural, separate and distinct from nature. We like to model ourselves as having a spiritual sort of essence—an immortal soul with complete freedom of will. Believing in such a spiritual essence enables us to further believe that we are above nature, holding moral values that make nature's behaviors look shameful by comparison to our human capacity for sympathy and compassion. But this way of modeling ourselves is merely a myth, probably held over from religious concepts because it is compatible with what we humans like to believe. The idea of a spiritual afterlife easily propagated among our ancestors, most of whom surely enjoyed believing in the promise of living in heaven, forever. And the same religious beliefs incentivized them to do whatever religion told them to do (spread the gospel), in order to fulfill that
heavenly promise. Religious concepts surely gripped the imaginations of our ancestors over recent millennia, proliferating by preying on our likes for all things purported to be in heaven, and our sever dislikes for all things purported to be in hell. After all, who wants to burn in a lake of fire? The promises of heaven and threats of hell made by religion can never be disputed, as they are alleged to happen after death.

Despite the devious manner in which evolving patterns of religious beliefs have proliferated themselves, some religious concepts have well-served nature's interests by enabling ever-greater human proliferation. Indeed, the myth of spirituality has been a critically valuable tool employed by various religions to promote the style of morality most preferred by nature's forces of selection, by making us believe in an omnipotent God who wants us to work cooperatively with others and is willing to reward us for it. The possibility of spending the rest of eternity in a heavenly afterlife is promised only to trustworthy cooperators who are willing to make up-front sacrifices in the interest of greater long-term mutually-enjoyed benefits. Conversely, an ever-lasting hellish afterlife is threatened against the untrustworthy, the uncooperative, and those unwilling to make immediate sacrifices for the greater good. Such beliefs have served humanity well.

Our moral values surely evolved through religious preachings that survived only to the extent they provided real benefit. Among the many diverse preachings from various religions, those that preached a style of morality conducive to synergistic cooperation surely flourished merely as a result of the benefits they enabled. Moral principles valuing all life have enabled large numbers of our ancestors to co-exist and mutually proliferate for thousands of years. Unfortunately, the very same religious mechanisms that made us moral in the past now give some of us very inaccurate views of ourselves. We are not divine spirits, but rather, products entirely of nature's forces, programmed by our genes to act in ways that would have been good for our distant ancestors in their zero-sum environments. We desperately need to develop widely accepted moral values that will prevent us from annihilating ourselves using the huge weapons we are now capable of building. We need to promote principles that displace societal competition with mutually beneficial synergistic cooperation.

Thanks to the deeper understanding of evolution developed here, our typical view of nature now seems very incorrect. Nature is not so much interested in life that is red-in-tooth-and-claw, except as necessary precursors—stepping stones—to life that is beneficent, moral, trustworthy, and synergistically cooperative. Everything in the universe must be natural, including the many products and services of an economy, because nothing can come into existence by any way other than by nature's forces playing themselves out over time, primarily through various evolving patterns. As we learn the scientific truth about what we humans actually are (biological machines) and how we humans came to exist (by way of nature's forces carrying out evolution), we are forced to reconcile our science with a choice between two competing views of humanity: Are we destroyers of nature, or are we facilitators of nature? Are we nature's enemies, or are we nature's dutiful agents? The uncomfortable answer becomes quite clear when humanity is viewed from a completely naturalized perspective.
We are nature's agents, designed entirely by natural forces. We humans are not disrupting nature, we are simply carrying out nature's ambitions in a mostly automatic process progressing toward nature's ultimate destiny. We act exactly as the forces of nature have caused us to act—programmed by the forces of natural selection operating on many different patterns at many different levels. We are genetically endowed with intelligence enabling us to automatically learn from previous generations various patterns of behavior for using nature's forces to our own proliferation advantage. The many patterns of activities that make up our modern economy have resulted from the completely natural evolutionary process playing itself out. For every biological species that is being driven to extinction by human activities (and there are many, every year), several new species of replicating patterns in economic production are created. This is especially true in the digital domain, where many new species of patterns are proliferating wildly over the Internet.

Every time a person types into Twitter, the pattern of words is replicated to all who are followers. Every time someone views a particular product on eBay or on Amazon, the pattern of information on the corresponding web page is replicated yet again on the user's screen. Every time a song is downloaded from iTunes, a rather large pattern of digital music is replicated. Every time a movie is streamed from Netflix, a much larger digital pattern is replicated. Every time a new Internet server has a copy of Linux (operating system software) installed on it, a large and very complex pattern is replicated, and that pattern is highly synergistic in the way it enables the automatic replication of the many web pages, songs, and movies that are routinely downloaded from the Internet. Brand-new patterns of digital technology are proliferating at a rate that is far outpacing any pattern replications in the many species of life that we humans are sadly but naturally driving toward extinction. We humans have built the facilitators by which brand-new patterns of many kinds are now able to evolve—the digital domain through which nature is now able to spread knowledge across ever-more humans and develop even higher levels of evolving intelligence than what now exists in the brains of humans.

It now appears as though the natural forces of evolution have always guaranteed the eventual emergence of life that is highly intelligent, diversely mobile and morally cooperative—like humans. Further, it now appears that earthly life has always been destined to create the same kinds of technologies that we humans have created for ourselves, through human-like beings performing human-like activities engaging in human-like economic trade. Further still, earthly life is destined to discover and produce even greater patterns of technology in the future, which will be capable of acting entirely toward the proliferation of their own underlying patterns—machines building new machines. Finally, it now appears to be completely natural that we humans would inevitably replace the lovely patterns in trees and shrubs—including all the many species of life that live in those trees and shrubs—with brand-new patterns of economic production. We appear to be aligning our actions with nature's inherent evolutionary trajectory as we raze forested lands for the building of our modern, economically productive cities and computer-server farms.
It is highly likely that there are many instances of evolving life throughout the universe, all developing along guidelines probabilistically defined by the universal laws of nature. All instances of evolving aggregate life, no matter where they might occur in the universe, will eventually stumble on the many synergistic effects made possible by the universal laws of nature. And they will likely do so in roughly the same order as has occurred here on Earth. We know this with a fair degree of certainty by virtue of the fact that scientists tend to make their discoveries by standing on the shoulders of previous scientists (cited by Sir Isaac Newton), as they further extend the previous discoveries of those earlier scientists. Higher-level technologies are only possible after the discovery of lower-level pre-requisite technologies, which creates a natural order to the sequence of emerging new technologies, anywhere in the universe.

Nature's Economy: The Synergistic Trading of Critical Resources

The simple idea that patterns can engage in mutually beneficial synergistic cooperation allows us to explain the natural development of all life and all of life's economic activities. There is no better example of mutually beneficial synergistic cooperation than trading of resources and activities, which happens naturally at many different levels of life, from the lowest levels—among catalytic reactions trading molecular by-products in the metabolism of a living cell—to the highest levels—among people using money as a medium for trading their specialized labor with businesses ultimately in exchange for the synergistic benefits of economic production. Of course, at an even higher level, businesses also trade with other businesses various things such as raw materials or capital equipment or specialized services or manufactured sub-components. Each and every trade facilitates some sort of mutually beneficial synergy, which is exactly what the natural process of evolution always seeks.

The degree of synergy that arises from trade depends largely on the degree to which the trading participants have different comparative advantages, or capabilities. This is especially true for trade among different species of life. Plants, for example, have the ability to produce oxygen as a by-product of their metabolism, whereas the animals who need oxygen do not. Animals have the ability to produce carbon dioxide as a by-product of their metabolism, whereas the plants that need carbon dioxide do not. Bees have the ability to carry pollen from plant to plant, whereas plants do not. Plants have the ability to generate nutritious nectar, whereas bees do not. Bacteria in the guts of animals have the ability to break down organic substances into pieces small enough to circulate throughout a bloodstream, funding an animal's ability to grow and to move intelligently, whereas the animals themselves do not. Animals have the ability to move quickly through the environment in the act of acquiring food, whereas bacteria by themselves do not.

In a thriving economy, synergy emerging from trade similarly depends on the comparative advantages and capabilities possessed by its individuals and by its businesses. Hundreds of years ago, economic synergies emerged from trade among
individuals having only a few different skills, such as those of a blacksmith, or a farmer, or a doctor. Today, synergy emerges from cooperation among many people having many different types of skills, even within the same business, such as those of salespeople, marketing specialists, managers, machine operators, financial analysts, accountants, and scientific researchers (each specialized to explore a particular segment of science). At a higher level, businesses achieve synergy through cooperation with other businesses to the extent they have very different comparative advantages or capabilities. Indeed, businesses tend to prosper when they specialize in some core set of competencies.

Trade is the basis for emerging synergies of all kinds at all levels of an economy. As television commentator John Stossel has often pointed out, the mutual benefit of a typical win-win commercial transaction is evident in the double “thank you” that often occurs after such a transaction: The merchant thanks the customer for payment greater than the merchant's cost, and the customer thanks the merchant for the surplus value, above the price paid, in the quality product or service received. As customers buy products at prices higher than the cost of manufacturing them, businesses and their owners accumulate wealth. And because those products have utility value greater than the value of the money paid for them, that extra value accumulated over all consumer transactions creates societal prosperity. As healthy competition in any given market naturally drives prices lower, consumers get an increasing share of the synergy in the things they buy. In other words, producers are forced by competition to keep less of the total synergistic value for themselves in the form of profit, which makes the portion of surplus value contributing to prosperity all the greater. Thus, over the long term of a healthy and competitive economy, it is the consumers who stand to benefit most from the capitalistic creation of synergy and the consequent emergence of ever-growing prosperity.

The competitive drive to reduce production costs is particularly evident in the ever-decreasing inflation-adjusted price of food that has been produced by innovative farmers as they have competed with each other, technologically, over the past two hundred years. In the words of successful businessman Edward Conard (2012, p.38), “the split of value (before corporate taxes) between consumers and producers created by agricultural innovation and investment is in the range of 20:1 in favor of consumers.” In other words, consumers get 20 times more surplus benefit from buying food than farmers get from their profits. A similar consumer-favoring split is likely to be the case for any area of economic production after it matures competitively, “because all product offerings are in competition with one another for an incremental dollar of consumption demand.”

When capitalism allocates enormous wealth to some people, it is not for the purpose of aggrandizing them or giving them great luxury and pleasure, but rather, it is for the purpose of discovering bigger and better secrets of technology hidden in nature's forces, to be added to nature's available toolkit and used by mankind for making life better. Capitalism works well because it naturally allocates capital to the fittest synergy producers—those who have a comparative advantage in their ability to invest wisely, innovate, and organize a business. Overall prosperity grows fastest when success breeds more success. To the extent people who have been successful use the fruits of their success to create even more success in the future, they create new jobs, new products,
and, consequently, new forms of useful synergy—hence, widespread prosperity. Society's wealth need not be owned by smart and successful people, but it must be controlled by them for the sole purpose of creating new and useful synergies, the value of which can then be shared with consumers. The difference between owning or controlling great wealth is revealed by how that wealth is likely to be used.

Successful business people are much better equipped to control capital than are politicians, who know well how to use it for acquiring votes, but typically have no idea how to create synergy. And this is the fundamental reason why high taxation tends to bleed an economy of its ability to foster synergy creation. It is much more a matter of how capital is allocated than a matter of incentives. Success tends to build on itself when precious capital resources are allocated to those who have already achieved success. Successful innovators use their consequent wealth to fund new ideas for products and services, making them even more successful. Investors who are already successful receive the biggest investment returns, making them even more successful. Businesses that are already successful are able to hire the smartest and most hard-working people, making them even more successful. And societies that are already successful are able to acquire critical raw materials from around the world, making them even more successful. Such successes, feeding on their own previous successes, are in perfect alignment with nature's primary mechanism for breeding ever-greater future success. And the fit thereby get fitter, through the ongoing creation and sharing of synergy from which everyone can mutually benefit (to the extent they themselves become economic participants). But, contrary to popular belief, it all happens by increasing the prosperity of many others, at no expense to anyone.

Nature's forces tend to reward economies to the extent their critical economic resources are allocated to the fittest economic participants. Simply by guiding resources to the already successful, an economy builds on its previous successes. The benefits from ever-increasing synergistic production ultimately accrue to everyone, over the long term, in the form of greater opportunities for both consumers and employees. Indeed, existing products become cheaper, brand-new products become better, more jobs ultimately become available, and employee wages are forced upward from the competitive demand for labor. The whole world benefits from newly discovered synergies that are then made available to consumers at prices that are guaranteed to fall over time (in real, inflation-adjusted dollars), as technology reduces costs and competition reduces prices. The most wonderful thing about synergy creation is that it is unbounded. No matter how much synergy already exists, more can always be created simply by arranging things into certain patterns, at ever-higher levels of complexity. Thus, if everyone is properly educated, everyone can be similarly successful, through the ongoing creation of mutually beneficial synergies. We must stop thinking about the economy as if it is zero-sum.

In stark contrast to our human desires for fairness, free markets allocate valuable resources mostly to those who have already achieved success, making them potentially far more successful. This is exactly the way nature's forces tend to allocate resources—toward the fittest—always seeking to build on previous successes. While optimal synergy in a society demands fairness of opportunity for everyone, it ultimately requires
very unfair outcomes for different people. Optimal synergy production demands that capital resources be controlled mostly by those who are best educated and have proven their ability to effectively allocate capital resources. Contrary to our common expectations, economic progress tends to be highly correlated with the amount of wealth disparity that exists between economic participants. Yet, there are ways to reduce certain unhealthy aspects of such wealth disparity (to be revealed in the principles of hyper-capitalism), even without income redistribution, and they end-up making a society even more synergistically inclined, and thus more prosperous.

Whether or not fairness is long-term beneficial to the success of a species depends on the opportunities available to do even better things—create more synergies—with the excess resources that would otherwise be fairly shared. Such opportunities for discovering and creating new synergies abound in our modern environment. Indeed, opportunity costs are later shown to be at the very heart of economics. We often witness certain obvious problems in society, such as the starvation of poor people, and we therefore dedicate lots of resources to solving those easily seen problems in the short term, while not realizing that the same resources could have created much more synergistic benefit over the long term—even to those very same poor people—if they had been invested into brand-new businesses, creating good new jobs. Economics is all about discovering the best opportunities for using resources most synergistically, many of which are much harder to see than the obvious instances of poverty that directly confront us. The best answer always involves synergy-creating investments, never handouts.

Ongoing wealth creation through complete and continued re-investment by successful people is absolutely necessary for growing widespread economic prosperity. And such complete re-investment of earnings is only possible to the extent taxes do not confiscate a large portion of it. But high taxation is not the only means by which wealth is diverted away from its best use. Such diversion happens also when successful people use their wealth for their own self-indulgence or self-aggrandizement through the purchase of huge mansions, expensive cars, or luxurious yachts, rather than for re-investment. Capitalism fails terribly when successful people use their wealth to indulge their own egos. And such misuse of capital is exactly what is encouraged by excessively high taxation on income. When tax on income is high, rich people find themselves preferring to spend their money rather than risk losing it through risky re-investment into future income, much of which will be lost to taxes anyway. Therefore, a high level of tax on income poses a double whammy to an economy: (1) confiscating resources that could have otherwise been re-invested, and (2) discouraging the re-investment of whatever resources remain after the high tax is imposed. We typically only recognize the latter (the disincentives of high taxes), whereas coming chapters show that the former (the inefficient allocation of critical resources) is likely even more influential.

Societies become successful when they enact laws that encourage successful people to put their wealth at-risk toward re-investing into more success. If laws that encourage re-investment of capital are not sufficient to make it happen, then there must be other laws that force it to happen. The worst thing that can happen to an economy is for its capital to go dormant, or to be allocated toward items of personal luxury and aggrandizement.
When excess wealth sits in a money-market fund or is used for self-indulgent purposes, it loses its potential to create new synergy. Consequently, the potential to create new good jobs goes unfulfilled. The path to maximal prosperity for any society is to allocate all its spare capital (in excess of that which is minimally required to maintain the health and welfare of all its workers) toward funding the discovery and development of brand-new technologies. Further, optimizing economic development also requires a fully democratized process of inventing and venture investing, open to easy participation by anyone. Finally, much of the unhealthy wealth disparity that exists can be eliminated by completely decentralizing all business activities, breaking-up all large vertically organized corporations, allowing each small division to act as its own highly focused profit center (its own small business forced to compete on its own merits), while maintaining all the cooperative relationships between them. These are among the major economic changes discussed in later chapters, needed for kicking capitalism into a much higher gear—into hyper-capitalism.

**Needs versus Wants**

Starting several million years ago, the earliest forms of technological innovation by our distant human ancestors produced things they needed to survive, such as stone tools and weapons used primarily for acquiring food. For most of the past several million years, the things our ancestors wanted were identical to the things they needed. They spent nearly every moment of every day merely trying to survive. But innovation took a huge leap forward around ten thousand years ago, when the technology of agriculture emerged, enabling our more recent ancestors to more easily satisfy their need for food. Only in the most recent couple of centuries has farming technology enabled the most advanced civilizations to fully satisfy the needs of their people with work done by only a fraction of their total populations, leaving lots of manpower available for manufacturing things we humans merely want. Modern technology has become so successful at fulfilling our human needs that we now spend most of our earned money buying things we merely want, but do not need. And many modern businesses are now producing things that give us zero or even negative evolutionary benefit, but we like to buy them anyway simply because they make us feel good in some way.

The economy has been learning how to exploit many of the evolved mechanisms within us that bring us pleasure and make us happy. Those mechanisms were originally designed by evolution to guide our ancestors toward things they needed for survival in their wild environments. Today, they guide us toward things we want, but that often provide no evolutionary value whatsoever. For example, we humans want things like chocolate cake, ice cream, labor-saving appliances, comfortable lounge chairs, alcohol, cigarettes, smartphones and big-screen televisions. We structure our economy so as to satisfy our human cravings often without fulfilling nature's ultimate goals for which those cravings were evolutionarily intended. While a slice of cake might have well-served our malnourished ancestors in their harsh environments of long ago, it only serves to make us
diabetic and obese in our modern environment, in which cake is so cheap and plentiful that it is routinely served on everyone's birthday.

Various technologies have certainly made our lives more fun. When a new technology comes along, we get some sort of perceived benefit, such as a better smelling shampoo, or a stiffer hair spray, or a bigger television screen. All sorts of products and services have become possible and affordable thanks to ever-advancing technology. And we humans choose to buy whatever products and services we believe will make us happy and bring us pleasure. But evolution designed our human emotions of pleasure and happiness to serve as motivators for us, to perform activities serving nature's interest in proliferating our underlying patterns—both genes and cultural memes. From nature's perspective, those motivational proxies worked very well in the wild environments of our distant ancestors, during the period of time in which our distinctly unique and valuable human genes mostly evolved. But our human emotions are now failing to act as reasonable proxies for fulfilling nature's interests, simply because our modern environment is so radically different from that to which our genes are mostly adapted.

From nature's perspective, we humans do not exist for the purpose of making ourselves happy; we were evolutionarily designed to make ourselves happy for the purpose of proliferating our genes. Nature would prefer for us to produce the kinds of things we now need so as to keep ourselves safe and to spread our replications more prolifically around the world and throughout the universe—things like better educational facilities, cleaner energy, smarter computers, more competent robots, more convenient and cheaper space travel, better defense systems for protecting against a nuclear attack, clothing that senses our medical condition, and so on. It is clear when looking from the naturalized perspective at our ancestral history that our feelings of pleasure evolved for the sole purpose of encouraging our distant ancestors to survive and proliferate. And that is still our natural mission. Unfortunately, in our modern environment, the things that now bring us pleasure no longer facilitate our ongoing proliferation, at least not to the extent they used to. In fact, we invented birth control to prevent human proliferation.

There is a growing disconnect between what we humans want and what nature wants for us, and from us. The disparity is growing ever-larger ever-faster as our modern environment diverges ever-further from environments of long ago, to which our genetically defined emotions are mostly adapted. Some evolving patterns of technology have evolutionarily discovered various devious ways to proliferate themselves by merely satisfying the selfish pleasures of humans. Oddly enough, we humans believe we benefit from technologies that bring us pleasure, even when those pleasures work against our long-term health, survival, and ability to proliferate. Today's technologies are exploiting our human pleasures for the purpose of proliferating their underlying patterns with little regard for the proliferation of the patterns underlying humans.

Because we humans are programmed with legacy emotions that were appropriate over most of the past million years, we now find ourselves wanting large doses of, and exaggerated versions of, the things our distant ancestors needed: high calorie foods, pleasures of sex without the consequences, more attractive cosmetics and clothing, political power and influence, and so on. And our modern economy is increasingly able
to package and deliver things that give us the good feelings that accompany greatly exaggerated versions of those things. High-calorie foods, such as cake, represent just one example of how our economy produces exaggerated versions of the things we now want but do not need (at least not in the amounts that we buy them). There are many more.

Men seek beauty in women, and the more beautiful, the better. Physical appearances have long been the primary means by which men have assessed fitness in women. We can only speculate on why men find certain characteristics of women to be attractive, but we can be fairly sure that those characteristics must have been beneficial indicators of fitness, long ago. For example, pink lips and rosy cheeks are attractive on a female, perhaps because they served as beneficial indicators to our male ancestors of a healthy circulatory system in females, capable of bearing many children. Further, perhaps we find shaded eyelids attractive on a female, because they were beneficial indicators of advanced intelligence (accompanied by a larger prefrontal cortex hanging over the eye sockets, serving as a differentiator between modern humans and Neanderthals at a time when they were inter-breeding). Today, lipstick, rouge, and eye shadow now enable women to achieve an exaggerated style of beauty far in excess of what is natural—bright red lips, rosy cheeks, and deep set eyes. And the availability of breast implants can create a feminine figure that is exaggerated well past what is natural for a woman. The same is true for all styles of make-up, fashion, and cosmetic enhancement surgery. They are products and services designed to appeal, in a deceptively exaggerated way, to a modern male's sense of feminine beauty, which evolved in the distant past under very different circumstances.

Women seek power in men, and the more powerful the better. Demonstrations of power by males have long been the primary means by which groups of humans have selected effective leaders, and by which females have selected their preferred mates. And just as women can exaggerate their beauty with cosmetics and surgeries, male body builders often use growth hormones to exaggerate their appearance of physical power, well past what is natural. Far further, however, it is the modern availability of enormous wealth that now inspires some rich men to spend huge amounts of money on things that serve as exaggerated expressions of power, such as yachts, personal jets, cars that cost more than some people earn in a lifetime, and mansions having many more rooms than could ever be useful. Such extravagant and expensive products often serve only to make the men who can afford them appear to women as being more powerful and prestigious than they naturally are. Later arguments show clearly why we are programmed to seek prestige—respect from others—in many different forms, and how that programming explains the evolutionary origins of humor as well as some other common human behaviors.

Thanks to ever-advancing medical technology, birth control pills now allow us to enjoy the pleasures of sex without the natural consequence of childbirth. Further, many men now vicariously enjoy the pleasures of sex with extremely beautiful women having exaggerated physical proportions, by masturbating to widely available pornography. Modern technologies (including things like birth control, videos, dildos and vibrators) now allow us to satisfy our selfish human desires for sexual pleasures, often without
fulfilling nature's goals regarding pattern proliferation, for which those human desires were evolutionarily intended. We eat too much, spend too much on exaggerated beauty and demonstrations of power, and engage in meaningless sexual activities for no other purpose than to stimulate our short-term pleasures. And we spend far too much time laughing at recreational television sitcoms, when we could be learning about how to design and achieve a much better future. Products such as high-calorie foods, alcohol, cigarettes, pornography, and birth control pills can provide us with a lot of fun, but they ultimately work against their own long-term proliferation as they will inevitably cause the human population to diminish due to ever-increasing obesity, heart disease, diabetes, lung cancer, and childless couples.

The US economy is built on a system of laws oriented entirely toward a freedom to satisfy our individual human pleasures, through the pursuit of happiness. And economists often improperly describe economics as the study of how best to satisfy human wants and desires. From nature's perspective, prosperity for humans depends on how well the economy facilitates the proliferation of human replicators, with absolutely no regard to how much happiness humans experience. As economist Eric Beinhocker writes: “Evolution doesn't give a whit about our happiness.” (2006, p.315) Indeed, nature is entirely indifferent to the enjoyment we humans tend to associate with certain products and services. Nature is completely uninspired by how nicely our hair smells, or how well our hairstyles hold their shape in the wind, or how easy it is for us to keep ice cream frozen, or how much we enjoy watching television sitcoms. Nature is only concerned with developing new and better patterns of life that are able to cause their own proliferation by way of self-reinforcing synergies.

We humans exist for the benefit of evolution, not the other way around. We do not represent the culmination or the goal of the evolutionary process. The human species is merely another stepping stone, further along in evolution's process of building complexity toward patterns of things that are increasingly mobile, increasingly intelligent, and increasingly moral. We humans are far more aligned with nature's inherent directionality than all other species discovered so far. However, evolution is always searching for patterns that are able to cause their own proliferation by routes that are even more direct than the slowly evolving circular pathways of our human genes. And there are some emerging patterns of self-reinforcing synergy now replicating faster than any complex sets of genes have ever replicated in the history of Earth.

The forces of natural selection have the final say in the long run. Over the long term, nature will choose—bestow prosperity on—societies and economies that work effectively toward the proliferation of their fittest synergistic patterns, in far greater preference to societies that work toward the mere widespread satisfaction of their human pleasures. Our human feelings of pleasure and happiness were always intended by nature to be the means to an end (proliferation of humanity), but we have hedonistically come to believe that they are the end in themselves. Until a species even better than humans comes along, nature will tolerate our profligate human behaviors. The better species to come along might well be intelligent machines, which are not at all burdened by human-like emotions adapted to outdated environments of long ago. Indeed, while we humans are busy
craving and consuming technologies that make us feel good, but degrade our ability to survive and proliferate, we are concurrently generating lots of brand-new machine technologies capable of producing synergies that act directly toward the proliferation of the patterns underlying those machines.

It almost seems as if we humans are preparing for our own demise, while simultaneously building far greater self-reinforcing synergies in the ultra-cooperative, ultra-disciplined, and ultra-capable machines that are destined to fulfill nature's pursuits even better than we humans possibly can. In complete accordance with the directionality built into nature's forces, we seem to be preparing the way for bringing far more order to the world than it has ever seen before. But that rapidly proliferating order will likely not come in the form of biological life, as it has for billions of years; it will come in the form of extremely intelligent machines building copies of themselves and designing new machines of even greater intelligence and mobile capabilities. Whether we like it or not, intelligent machines are quickly becoming nature's best source for diverse pattern creation and proliferation—a new platform for a new type of life. Some machine technologies are already capable of producing a style of synergy that acts directly toward the proliferation of their own underlying patterns—making electronic components that are the essential elements of those very same machines.

**Intelligent Machines**

Biological life appears to have been necessary for bootstrapping the process of evolution, on Earth, and bringing the proliferation of order as far as it has already come. But machines seem much better suited to carrying out the discovery and production of order into the future. Human-built machines have already been exploring our solar system. It is almost as if nature created us—humans—for the specific purpose of creating our own evolutionary successors—very orderly and fully cooperative machines. Unfortunately, as we teach our best machines to do more accurately and more cheaply all the tasks we humans do, their effect on our economy will be enormously disruptive.

During the eight years of the Obama administration, the US economy struggled to achieve annual GDP growth higher than 2%, which isn't a terrible sustained growth rate, until we recognize that the Federal Funds (short-term) interest rate was held at near zero for that span of time and enormous government spending caused annual deficits averaging well over half a trillion dollars per year. We have been deficit spending an amount roughly equal to 4% of our overall economy to get growth of only 2%. It seems we can't even buy new growth with borrowed money. And the 3% growth promised by the Trump administration comes with deficit spending equal to about 5% of the economy. The numbers portend a dire, debt-ridden future. But arguments presented in the final chapters of this book show that our ever-growing national debt is not the problem we need to worry about. Hyper-deflation and a lack of good jobs for humans are the main concerns, as technology continues to accelerate.
Real wages have been stagnant for several decades, and even though the published unemployment number in the US has fallen to historically low levels, much of that progress has come not from robust job creation, but from people simply dropping out of the workforce, no longer looking for jobs. Many economists talk as if the falling rate of work-force participation and the stubbornly stagnant wages will only be temporary, as if they merely result from a deeper-than-usual business cycle—the Great Recession. Some futuristic-minded thinkers, however, are seeing the situation as a structural problem, threatening a very different future. Economists Erik Brynjolfsson and Andrew McAfee (both at Massachusetts Institute of Technology) have together written a couple of books describing the likely future economic impacts of intelligent machines. Their first book, *The Race Against the Machine* (2011), describes in less than 80 pages “how the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy.” A follow-up book by them, titled *The Second Machine Age* (2014), thoughtfully and optimistically describes how jobs must change radically to accommodate technology's future advances. Another author writing about the economic effects of smart machines is software executive Martin Ford, whose books include *The Lights in the Tunnel* (2009), and *Rise of the Robots* (2015). These well-researched books lay out a compelling case that accelerating technology is greatly reducing the need for human employment.

Modern patterns of technology are evolving so fast that in just a few decades computers are expected to achieve trans-human intelligence, and robots are likely to achieve trans-human mobility. Combined, they will synergistically fulfill nature's pursuit of patterns able to move intelligently, far better than humans. The trend is clearly toward future machines capable of entirely designing and building their own descendants, replicating their own patterns with occasional well-considered mutations, from which the best patterns will be selected for future replication, thereby fulfilling nature's definition of evolving life. Nature's preferences for evolving patterns will surely shift away from the patterns that define humans, toward the better patterns that will underlie future intelligent machines. The natural allocation of critical resources, mostly energy, will shift toward the new evolving patterns of technological life as they inevitably become fitter than humans. The effects of future technology on the world's economy will be quite profound. We are likely just beginning a transitional phase to a very different economic future.

Just as species of biological life have built up layers of synergistic relationships among molecules, cells, organs, individuals, businesses and trading nations, we are now seeing the very same sorts of hierarchical structures building-up in technology, among certain combinations of atoms at the lowest levels of various man-made objects, through increasingly higher levels of synergistic cooperation among various components, all the way up to very sophisticated products working together in ways that are increasingly intelligent and synergistic. There is no clearer example of cooperative synergy than what is now happening among many interconnected computer servers around the world. If the root word of *business* is *busy*, there is nothing busier or more businesslike than a huge collection of computer servers each handling thousands of complicated transactions every second. The very nature of business is changing right before our eyes. The economic
effects are quickly becoming ever more threatening to our old ways of life. The relentless evolution of digital patterns is increasingly discovering new ways to produce various synergies acting on an enormous scale toward the perpetuation and proliferation of those very same patterns. The number and diversity of digital patterns rapidly replicating across the Internet is absolutely exploding.

The economics of intelligent machines replicating patterns of digital information is radically different from the economics of manufacturing physical stuff. All the work is done by machines. Digital patterns are proliferating everywhere, with no end in sight. And the technology of 3D-printing is now enabling certain digital patterns to be translated directly into real-world physical patterns without any human intervention whatsoever. If nature's goal is to proliferate patterns of order at an ever-increasing rate, then nature should surely be pleased by the many new digital patterns our modern economy is automatically proliferating around the world.

As computers get increasingly intelligent and machinery becomes ever-more adept, the fraction of jobs in the economy requiring humans to perform them will necessarily decline. At some point, technology will surely displace workers from their jobs at a rate faster than the economy can create new jobs. At that point in time, the consumer base for all products will begin to erode. An ever-smaller fraction of people will have jobs providing sufficient income to buy more than just basic necessities. And the competition for jobs, among the unemployed, will force human wages ever-lower even for those still employed. All human labor around the world, whether physical or intellectual, will ultimately have to compete against machine labor, the capability of which is rising incredibly rapidly and the cost of which is falling even more rapidly, as the advancement of technology continues to accelerate. Machines will increasingly leverage the value of those few workers who control the machines, until they themselves can also be replaced by machines. New companies are already earning annual revenue, per employee, in the range of millions of dollars, which is much higher than for any companies of the past. In fact, the 2014 purchase of the company WhatsApp by Facebook for $19 billion works out to a valuation of $350 million per each of the 55 employees who worked for WhatsApp. Over the span of only 5 years, each employee had therefore contributed, on average, $70 million worth of value per year. It will soon become possible for companies to earn billions of dollars per employee, per year. Advancing technology is the sole driver of dramatically increasing income inequality, and it is destined to get far worse.

The emotions that worked well for our ancestors a million years ago, with which we are now endowed, will actually work against us in the radically different technological future. Nature's forces of selection will surely prefer future machines capable of proliferating themselves by way of pure reason without emotion. And we humans will readily facilitate nature's preferred transition. We already rely on many different types of convenient appliances that act as our servants. And we rely on electronic gadgets and big-screen televisions for our sources of entertainment pleasure. We rely on machines so much that we are very eager for them to become even more physically capable, more intelligent, and less expensive. We humans are in fact emotionally predisposed for wanting to build and train the precursors of our evolutionary successors. The future
economic effects of highly intelligent machines are quite ponderous, yet most economists seem to have no appreciation of them whatsoever.

**Insights Gained from Adopting the Naturalized Perspective**

When two intelligent people disagree over some issue—any issue—it is always because they each view it from a different perspective. The only way to resolve any such dispute is for both people to agree that there is an impartial perspective having higher authority than all others, higher even than each of their own. In a universe controlled entirely by nature's laws and forces, nature's perspective is the only one that matters. Looking at everything from a fully naturalized perspective is the very basis for all science and reason—the only way to bring a scientifically rational approach to the resolution of any intellectual debate whatsoever. In fact, mathematical formulas developed by scientists and engineers serve no other purpose than to see physical reality from nature's perspective.

Consider, for example, the issue of government taxation. What is the proper tax rate? From the perspective of political **liberals**, government exists mainly for the purpose of aiding individuals who are having trouble succeeding in society; and the best possible economic future comes about through government aid to the poor financed by high taxes levied on the rich. From the perspective of political **conservatives**, on the other hand, government exists for the simpler purpose of enforcing law and providing a common defense; and the best possible economic future comes about through the greater innovation that results from allowing people, especially rich people, the freedom to pursue their own best interests free from government intervention or encumbrance other than that which is minimally required to fund a justice system and a strong military. So, how can a smart liberal and a smart conservative, each considering the role of government from their very different respective viewpoints, possibly come to agreement over the proper tax rate? They simply have to ask themselves: How does nature view the role of government? That question is clearly answered in later chapters, which describe the style of government that is best able to use the laws of nature to its own prosperous advantage, and thereby achieve the most prosperity over the long term.

Another very important economic insight coming from the naturalized perspective regards income inequality. It is a widespread myth propagating among many people, including even many economists, that excessive wealth gained by the already-wealthy somehow comes at the expense of the non-wealthy. In fact, the truth is exactly the opposite: The legal accumulation of wealth, by any rich person, can only occur through the production of greater prosperity, for all, in the form of much cheaper and much better synergistic products and services, providing greater utility value to consumers than their cost. In other words, the things we love to buy (from the wealthiest people in the world) are worth much more to us than the sacrifice of labor it takes to earn the money to buy them. When the synergies of production and their effects on widespread prosperity are fully understood, it becomes absolutely clear that income inequality is only bad if it
results from the poor and the middle-class getting poorer, which never happens in a properly functioning economy. Indeed, even the poorest among us today have fairly easy access to things that could only have been dreamt of by the richest just a few hundred years ago—things like antibiotics, exotic foods from around the world, cheap but very enjoyable entertainment, rapid travel to any part of the world, and so on. There is no problem with income inequality so long as rich business owners get richer by putting their wealth entirely at risk, creating synergy out of thin air, and then sharing the value of that synergy with their employees, their suppliers, and their customers. The problem with our modern economy has little to do with income inequality, but everything to do with rich people not putting their wealth at sufficient risk in the pursuit of brand-new innovation.

As we learn to describe an economy entirely in terms of its patterns, yet another very important economic insight emerges, fully explaining Joseph Schumpeter's concept of *creative destruction*. It becomes crystal clear how to create good new jobs. The clarity comes from recognizing that there are only two fundamental parameters by which economic patterns improve. Either new patterns produce brand-new qualitative features of usefulness, or they produce the same features as previously but at lower cost. In other words, either the synergies of production get broader (more diverse) or they get deeper (less expensive). Jobs are created over the long-term when the diversity of synergistic economic patterns broadens—when *brand-new types* of synergies are invented. Jobs are inevitably destroyed as the synergies of existing patterns deepen—as newly invented synergies find ways to increase the magnitude of *old* synergies by replacing human labor with machines. This is a simple but hugely valuable revelation for any economist who seeks to fully understand how best to create new jobs in our modern economy. Over the long term, an economy can only increase the number of jobs available (as a percentage of the population) by continuously widening the breadth—the pattern diversity—of production.

Once the very simple relationship between the broadening of economic pattern diversity and consequent job creation is fully understood, it becomes much easier to understand what causes an economy to go through booms and busts. Economic booms occur when technology makes a big advancement—brand-new jobs open up in the economy for developing and producing qualitatively new products. But every such boom is inevitably followed by an economic bust, as the market saturation of the new technology reaches about half of its maximum potential and as the new technology matures into new devices that are able to replace certain types of labor. Indeed, economic booms and busts are necessarily connected as two parts of a single wave. Every economic boom creates jobs, but most of those jobs are only temporary, destined to be eliminated as the market for the new technology becomes halfway saturated.

In the same manner that an ocean wave crashing onto a sandy beach immediately thereafter recedes back into the ocean, economic booms and busts are similarly connected, initially surging forward, followed by an inevitable receding backward. Luckily, the number of jobs considered over the long-term can steadily increase as the product diversity widens, similar to how a rising tide moves the wave-induced high-water line further up the beach. But unfortunately, like a receding tide, the number of human
jobs available can steadily decrease from machine technology reaching a certain level of capability—the threshold of trans-human capability.

The naturalized perspective finally enables us to resolve the long standing debate between the Keynesian philosophy of stimulus and the Austrian philosophy of market-clearing austerity. While Keynesian stimulus can certainly stimulate confidence levels and thereby facilitate temporarily increased economic activity, there is a real question as to how much benefit persists after the stimulus is finally removed. It turns out that there is only persistent benefit from Keynesian stimulus if it facilitates the creation of new and useful synergy of a kind that is self-reinforcing. But Keynesian stimulus, as it is typically used, facilitates little or no creation of self-reinforcing synergy. If it did, it should become a new business and it should be performed independent of whether the economy is in good times or bad times. In fact, the creation and production of new and useful synergy, when it is performed during good times, is the only thing that can forestall the inevitable arrival of bad times and largely counteract their detrimental effects.

An economy can only thrive to the extent it discovers and develops brand-new kinds of synergies at a rapid and regular pace. Growing prosperity depends much more on the creation of self-reinforcing synergy than it does on consumer confidence, or investor confidence, or the growth of the money supply, or the ability for markets to clear. The reasons for why economies boom and inevitably bust are always rooted more in technological advancement than in the confidence levels of consumers and investors, which are the parameters economists prefer to study.

As major new technologies mature, they inevitably cause a deflationary force by enabling businesses to produce more with fewer workers. Technologies that have been recently emerging are turning out to be very deflationary. Extremely powerful yet inexpensive computers communicating over the Internet are now enabling many businesses to drive down their costs by eliminating human labor. As the entire economy moves increasingly into the digital domain, products and services can be delivered almost for free, with little or no human intervention. The need for human labor will surely begin declining within a decade or two. And the median wage for human labor will most certainly decline rapidly as the technological future unfolds over the next few decades. Many economists have been forecasting imminent inflation as the expected result from the dramatic expansion of the US base money supply just after the 2008 financial crisis. But looking at the economy from a naturalized perspective reveals exactly why deflationary forces remain so persistent. The inflationary effects of money printing are being counteracted by the very deflationary effects of rapidly accelerating technology. The future economy will be capable of easily withstanding much higher rates of monetary expansion than have ever been previously considered, thereby accommodating much more national debt than we ever thought was possible.

A hundred years ago, it was mainly physical labor that drove economic production. Consequently, a wage was only fair if it properly represented the amount of physical labor performed in exchange for the wage. Likewise, the price of any product roughly represented the amount of physical labor it took to produce it, distribute it, and sell it (plus some profit at each stage). Thus, up until a few decades ago, a unit of money
generally represented a unit of physical labor, done by humans. More recently, economic production has come to depend on intellectual rather than physical labor by humans. As machines have advanced in their ability to perform an ever-widening array of physical tasks, jobs for people have been moving increasingly toward the need for intellectual labor, to program and control the machines. Consequently, there has been a shift in what money fundamentally represents. A unit of money now represents a unit of intellectual human labor.

As computers gain in their intellectual capabilities, all intellectual human labor is sure to be replaced by machine computation. Thus, another shift is coming in what it is that a unit of money represents—away from intellectual labor done by humans to computation done by computers, which are nothing more than huge collections of transistors. Transistors—specific patterns embedded into silicon—are the most basic elements of machine intelligence. So, total economic production in the rapidly approaching digital future will depend on the total number of transistors available to perform the required computations. And the total number of transistors existing, worldwide, is growing enormously every year, at a rate of about 70% per year. Transistors are already proliferating far faster than any other pattern has ever sustainably proliferated in the history of Earth—at a rate that is roughly 40 times faster than the maximum rate at which human neurons have ever proliferated. The total number of transistors in the world will soon exceed the total number of human neurons in the world. The economic effects of rapidly replicating transistor patterns are already quite profound, but are pointing to an economic revolution in just a decade or two.

Transistors are the new source for self-reinforcing synergies, acting in many different ways toward their own proliferation. Indeed, many trillions of transistors work intelligently and tirelessly inside the machines that make transistors. So, investments into semiconductor companies (makers of transistors on integrated circuit chips) are reaping some of the biggest returns, today. The semiconductor industry is now creating the heart of the future economy. Likewise, cloud computing companies are best positioned to use the plethora of transistors being produced to offer many kinds of very beneficial computing services. Whereas information technology used to be a cyclical investment, it is now quickly becoming the core focus of all new businesses, which is why small business indexes and the NASDAQ have well outperformed the S&P500 over the past decade, and can be expected to do so into the indefinite future. Small businesses are simply able to adapt to rapidly changing technologies more easily than large businesses.

Perhaps the most fundamentally important concept conveyed in this book is that the future of the world's economy is probabilistically determined by the laws of nature. Of the many different types of economies that have been tried in various nations around the world, the ones that have best succeeded are those that have been most closely aligned with nature's directionality toward ever-greater discovery and production of self-reinforcing synergies. Economic policies to be prescribed in later chapters simply teach us how best to align our economic efforts with nature's inherent directionality, so as to follow the stepping stones laid out by nature's forces, thereby fulfilling nature's probabilistic directionality in perfect alignment with nature's apparent interests. The
society that comes closest to implementing those policies will reap the most prosperity, as a result. Nature's forces guarantee it, at least probabilistically.

The present economy is very unlike the past, and is changing faster than ever. Never before have machines been able to easily beat any human in the game of Chess, or prevail over the best human champions in the television game-show Jeopardy!, or carry out spoken commands, or translate languages, or perform a trillion floating point calculations per second, or predict patterns of weather a week in advance, or drive a car, or make a lot of money trading on the stock market. All this, … even though our machines are still just in kindergarten. They are in their infancy. The impact of thinking machines on the economy of the future will be quite unlike anything in the past. Yet, economists insist on basing all their predictions on similarities they are sometimes able to find between conditions that exist today and conditions that existed at various times, decades ago. No wonder they have been failing miserably at predicting the economic future.

The subject matter of this book should be of interest to a wide audience of well-educated people. All college students ought to be aware that most future jobs will require a good education in math and science. All job seekers ought to be aware of exactly why good jobs are destined to become ever scarcer. All business people ought to be aware of how patterns of technology will entirely reshape the business landscape. All economists ought to be aware of the enormous differences between economic trends of the past and economic trends of the unfolding future, even though certain statistics might appear to be very similar. All investors ought to be aware of how the natural evolution of technology is influencing various patterns of economic production. And all voters in our democracy ought to be aware of the enormous economic changes coming in the span of only several presidential elections, so that we can each make better informed political choices.