Wandering Toward our Goals and How We May Get There a Lot Faster than You Think

At first glance it seems that the unthinking mechanical laws of physics could never give rise to such a complex and mysterious thing as our consciousness. But Charles Darwin solved this riddle over 150 years ago. He showed how chemically mediated processes of variability, reproduction and selection can create the seemingly purposeful structures and behaviors of life.

The personal experience we call consciousness and the aims and intentions that go with it may be the most mysterious thing that evolution created, but it is not hard to see why natural selection would favor its path into existence. Consciousness is just the tool that complex mobile organisms need to place themselves in the world and decide what actions to take next. Consciousness is a useful companion to mobility because awareness of one's surroundings and the ability to sense events and circumstances, a sense of self and an understanding of one's body and the capabilities of the body, the ability to analyze and make predictions about your surroundings, and all the other things associated with consciousness are just the things that are useful and necessary for a mobile organism to function. Consciousness arose because of the requirements of mobility and then became more and more sophisticated as bigger and more complex mobile organisms evolved. Consciousness is a purposeful adaptation created by natural selection in the same way and under the same pressures as all the other mechanisms of life. Because of this, we should be able to assume that it is an efficient mechanism that wastes little energy on unneeded intricacy or elaboration. Our reasoning power, emotional responses, motivations, desires, attitudes, and perceptions must reflect just what we need to know in order to survive. In fact consciousness is just the logical extension of information creation. Information is an ongoing simulation of the past, present, and future of the world embedded into the world, and this is what consciousness embodies.

Although Darwin solved the basic problem how life generates information there is still a lot to be debated concerning related philosophical and engineering issues. Initial emphasis on genetics led to a view that life works to maximize that propagation of genes. Then why would an individual go through the complicated process of sexual reproduction only to mix his genes with others? Life is really a more holistic process where all components work together for maintenance and growth. Life is a process whereby selection generates stored information that allows the organization to use energy extracted from the environment to carry out activities that promote its welfare. All the parts work together and are equally important in accomplishing this goal. Life is an energy dissipating system like many others in nature except that unlike anything else it creates information.

Information is a defining quality that separates living processes from the nonliving. But like life, experts have a hard time pinning down what exactly information is. The word seems to have first appeared in the literature of the English language in the 1300s and was apparently derived by adding the "noun of action" ending to the verb "inform" to make the noun "information." The earliest meaning of information was the act of informing or giving form to

the mind through education and training. The word “inform” itself came from the verb “to form” and implied giving form to an idea through instruction and education.

In modern English the word “information” has many meanings depending on context. In general the word is associated with the words “knowledge,” “instruction,” “communication,” “records,” and “data.” Usually there is a source or sender involved as well as a receiver of information. Information is often stored and transmitted in coded form, and the code must be understood or translated by the receiver. Information can be a representation of something in a different medium, such as a picture, or a set of statistics about something or a written description. Information can be the contents of a message, sensory input, or the contents of stored records. In physics, information can be just the state of things, and a system contains a certain amount of information in the sense that it takes a fixed amount of code to describe its state completely. But whether information comes from a description of a system’s state, from records or stored knowledge, or from the senses, there is always an implied transfer of a message from place to place. Also it can be assumed that the message has some sort of effect on the receiver.

In 1948 Shannon and Weaver published a paper with a mathematical analysis of information that quantified the amount of information that could be transmitted by any specified code. Shannon had been involved in studies that helped break the code of encrypted enemy communications during World War II. This was the beginning of information theory, and it developed into an important field that greatly contributed to the development of computers and electronic communications. Information theory allows the theoretical quantity of information within any particular string of symbols to be calculated. But information is really a relationship between an organism or consciousness, its information system, and the environment. This relationship cannot be quantified with information theory alone, which only supplies engineering data on the efficiency of the coding and communication systems. Information theory is about storing and transmitting information, but not about the usefulness or the effect the transmission of information has on the relationship between the sender and receiver.

Information is what gives life its unique qualities of self-organization, purposefulness, awareness, and intelligence. “Information” is used here as a word that describes relationships between the functioning parts of living beings and their environments. These relationships involve the way that various symbolically coded representations of the world interact with a living system to affect its actions. The word usually involves a sender and a receiver but often the sender and receiver are parts of the same entity. An organism receives information from other parts of its body, from its DNA, from the knowledge stored in its memory, and from its sensory organs. But always the concept of information would have no meaning without a living system to use it and interpret it. Humans are unique in that they deposit and store information externally in all sorts of manmade structures and then retrieve messages from this external body of records routinely.

“Information” could be defined as a symbolically embedded awareness or understanding of an organism’s self and its environment that is accumulated through natural selection. Biological evolution and life cannot really be separated from the concept of information because each of these concepts requires the other to fully understand their meaning. The essence of life is that life develops a record of the past that enables it to continue in the future. A living system

uses this record of past events to make predictions about future events and conditions. Through this process, the organism receives directions on how to cope with the future and use materials in its environment to grow and survive. The information system of an organism tracks conditions in the external world through signals received from the environment and then, by running a limited model or simulation of the world, the information mechanism predicts likely conditions that will develop in the future and supplies a plan to prosper under these conditions. This description of the overall information process applies as well to a highly intelligent engineer designing a modern factory as to the way trees lose their leaves in the fall anticipating cold weather and then re-grow them in the spring because summer will follow. The engineer may use all sorts of sophisticated economic and physical surveying to collect data and advanced engineering software and mathematics to try to plan and construct a factory that will pay off in the future, but, fundamentally this is no different than the way a tree unthinkingly uses signals from its environment and its stored information to predict the best time to lose and re-grow its leaves. Even the simplest organisms exhibit an awareness of themselves and the workings of their environment by taking actions that are proved by events in the future to be in their best interests.

Information involves a simulation of the world and the organism's relationship to it that can predict the future. This is possible because the universe itself seems to be a large calculating mechanism that continuously computes its next state from the last one according to a fixed set of rules. Modern physics envisions the world as made up of units or quanta of space or matter that all interact with one another according to natural laws. At each moment of time, these interactions result in changes that create the state of the universe in the next moment. In this way the universe continuously calculates its future. Since the entire universe is an interconnected system, any part of the world can potentially influence any other part, and a complete calculation of the next state must involve every unit of the present state. This means that everything is connected, but it also means that there can never be a perfect simulation or complete knowledge of future events. A complete simulation would require the entire universe to be represented in the calculation, but this is the universe itself.

The strange thing about the way life creates information is that this information is at the same time a simulation of the universe and part of the universe being simulated. The mechanism of the simulation of the future must also be a part of the universal calculation of the immediate next state. Information embodies a memory of the past, a prediction of the future, and an immediate computation of the present all rolled into one. This is the magic of information and how it creates and embodies life and consciousness. The nonliving world has no past or future, only the present state that leads to the next state. Information superimposes a memory of the past and a simulation of the future onto the present, creating an awareness of self and a purposefulness of action.

The engineering aspects of how life stores information has been central to how it has developed. The invention of DNA to provide a stable method of encoding information was essential. The development of chromosomes and sexual reproduction made information search and processing more efficient. This worked well for single cells but posed a problem when life progressed to multicellular organization. Multicellular animals and plants are constructed by cloning a single eukaryotic cell. Then, these cellular building blocks are modified for specialized tasks and integrated into a cooperative, higher level organism. But with cloning, millions of

identical genomes are created, none of which can coordinate the operation of the whole structure. One of the central problems of multicellular organization was how to coordinate all these formally self-contained, independent units.

What first developed was a system of interactive control in which every cell had a complete set of instructions in its DNA, but these instructions were turned on and off in each cell as needed through programmed interactions between cells. Essentially each cell has the information to do everything, but what it actually does is determined by its location within the organism and signals it receives from surrounding cells. This is how plants grow and operate and how animals develop from a single egg cell.

Plants are stationary and only need to react relatively slowly to a restricted environment, and so the mature structure can be regulated along these same lines. But animals are mobile and must react much faster to a much more complex environment. They developed their higher level control system, made up of their brain, senses, and neural network, to give them rapid-response centralized operational control.

But, the problem with this line of development is that the cellular level hereditary and developmental control system based on DNA information could never be adequately connected to the organism level information and control structures of the nervous system. Information inherited through DNA can only be directly transferred to the nervous system through the limited range of instinctual behavior, and information gathered by the brain during a lifetime is lost between each generation.

Compare this dysfunctional divided control system to the simple and elegant system of single-celled organisms where the information is stored in the nucleus, which is the same structure that handles the control of daily operations and the duplicating and passing on of the genome to the offspring. When single-celled species reproduce, they simply make duplicates of their internal structures, including the nucleus and its stored information, and then they divide themselves in half. The whole process is centrally controlled, no information is lost, and each daughter cell is immediately a fully functioning individual.

If an individual of a single-celled species was conscious, it would have a very different perception of the reproductive process from humans. Each time it divided there might be a brief period of unconsciousness as its chromosomes were duplicated and reconstituted into new nuclei, but then each daughter cell would reawaken to a world that contained a clone of itself with all its memories and personality traits, but also to find its own memories and consciousness intact. For a single-cell organism, death comes only from the environment and is not at all connected with reproduction. It is potentially immortal and, in fact, any individual cell alive today has been continuously alive for the last 3.5 billion years.

Unfortunately, cloned multicellular animals are locked into a dead end that limits the development of a completely centralized information center because there is no way to connect hereditary DNA information with the learned information of the brain. The ongoing accumulation of knowledge through natural selection eventually is blocked because each

individual must start as a single cell and therefore only limited amount of information can be passed on through a single set of DNA chromosomes.

It only requires a few relatively simple changes in our DNA to produce a larger brain. The question is why, in all the different permutations of animals that came before us, none ever developed a larger brain like ours? The answer may be partly that there was no real advantage because any small amount of new knowledge that a more intelligent mind might discover during a lifetime would just be lost anyway. A larger brain had to be developed in conjunction with language so the greater capacity to accumulate and store new knowledge was accompanied by a way to pass it on to the next generation. But once language was invented, it was a simple step to invent writing, and then suddenly there was a solution to the 600-million-year-old problem of the fractured multicellular information system. The importance of this recent invention of language and then writing cannot be overstated.

For over 3 billion years DNA was the only way for life to store information. Now for the first time, a new far superior method has been created. Language is the key to our expanded intelligence and survival. Animals can only think emotionally or spatially but because we have words to name things and sentences to organize the world we have a tremendously greater ability to create and understand information. And with the invention of writing we now have a new way to permanently store, copy and process information that is vastly more efficient than DNA.

The two necessary ingredients of life are energy availability and information capacity. If we focus on these we can get a better idea of the power of our externally stored information. For 3.5 billion years life has had only photosynthesis as its one significant source of energy. But with language and writing way have accessed nuclear power, solar cells, hydro and wind power and also unlocked fossil fuels. DNA can only access the functionality of RNA and proteins but through people, the information in writing can connect to any material in any environment. In spite of the amazing variety of life that has evolved, the universe of DNA information is extremely limited. On the other hand the universe of information that writing can access is enormously large and what could evolved from this platform in the next few million years is unimaginable.

Information generation has created our consciousness and language has amplified our intellectual capacity immensely, but we still only really exist step by step in the mechanical world with no past or future. We live in a complex world of ambition and laziness, love and hate, pain and happiness, curiosity and willful closed mindedness, and we could add to this an endless list of other emotions desires, perceptions and motivations. But all of this reality that we operate in has no physical counterpart other than the chemical processes going on in our brain and body. None of it is real outside of the workings of our own consciousness. The most enduring, all-encompassing love or the most unbearable pain is nothing more than electrical activity and chemical processes that are fundamentally no different than how a battery operates a clock.

So, really aims and ambitions were non- existent until we had language to reify these concepts in our conscious world. Animals have no aims or ambitions, only emotions and instincts that are their operating system. Technically speaking aims and ambitions came into

existence with language and then our ambitions led to the invention of mathematics. These things come into being only when our consciousness creates them.

But mathematics seems to have an uncanny ability to reveal truths about reality. Language is well suited to explaining our world of objects, emotions and our related actions, but math seems to tap into the fundamentals of reality. Language may not ultimately be the best way to describe reality and our word based intellect may simply not be capable of fully understanding it. Mathematics may be just as important as writing to unlocking future information. It may be the preferred language of a computer based consciousness that leads life into a realm of awareness that we can only dream of.

The only trouble is that we, as human beings, are probably not completely in control of our own destiny and can't consciously plan our future. Writing allows us to discover and store vast amounts of new information, but as we will see, discovering and implementing new information is an evolutionary process. Our future is determined by how this process of evolution unfolds, but unfortunately a species can't consciously plan the direction of its own evolution. We can decide what we do with our individual lives, but the direction we take collectively as a species is beyond our control. This is a fundamental and indisputable fact of evolution and we are just as constrained by the forces of evolution as any other living beings.

As Darwin pointed out, evolution is a process where all individuals struggle to survive and reproduce, but it is fitness that determines the outcome. All the different characteristics of individuals of a species and the choices that they make merely provide the raw material of variability that evolution works on. An essential trait for any individual is the belief that his way is the best and that he deserves to prosper. People provide different options through their abilities and choices in the belief that they are right. They do their best to fulfill their dreams, but it is some higher authority embodied in the structure of physical reality that makes the final determination of what will survive and prosper and what won't. All life is subject to this basic law of nature.

Individuals by themselves can't control the future, but they are still the agents of change. Evolution is a lot like voting. No national election has ever been decided by one vote. So, an individual could rightly say that his vote will never really make a difference. But if everybody said that there could be no elections. With voting it seems that one person can't make a difference, but together we actually make all the difference. It's the same with evolution. It operates only on what we do collectively, but we still need to make all our individual decisions for it to work However, unlike voting, evolution is non-linear, so a tiny individual action or decision can also sometimes mushroom into a historical, world-changing event. Though we may not ever even realize it, a single individual choice can possibly have a huge impact on the future. We may not be able to consciously plan and control our future but still what we do is the determining factor in creating it.

Most people think that our future is guided by what we decide to do or maybe decisions or plans that our leaders make. Actually, our future will be determined by an autonomous evolutionary process. But both are really true. We cannot plan evolution but evolution cannot operate without our plans. The trick for us is to find the right answers that turn out to be the

successful evolutionary path. We will conquer the galaxy but only if we learn to harness the power of evolution and incorporate it into our plans instead of trying to thwart it or ignoring its effect.

In fact we seldom consider evolution at all in our daily decisions. Humans are still instinctual animals in this sense. Evolution shapes our emotions, drives and attitudes that determine our actions. Then our actions lead to success or failure in reproduction which determines what characteristics future people will have. But this trail of causation seldom enters our thoughts. Like all animals we just live according to how our emotions and attitudes tell us to.

Since the advent of writing humans have been able to commandeer 1 to 2 % more energy every year to further their aims and ambitions. This may not seem like a lot, but a sustained expansion by one species of this magnitude is unprecedented in the entire history of life. If we continue to expand in this manner for only a few hundred thousand years we will have access to a substantial portion of the energy of the entire galaxy. And given the potential of our new information systems there seems to be no reason why we can't do this.

Our government, business, and social organizations are a form of evolving proto-life following a written or electronic genome. We are endo-symbionts within these entities serving to translate their written code into action. And now our DNA information is being shifted to written code in the same way that the code of the bacterial symbionts in the eukaryotic cell was eventually shifted to the chromosomes of the host. Life is undergoing a profound transformation into an enormously more powerful form. Our goals and ambitions will interact with the natural process of evolution to create a nearly unlimited future we can scarcely imagine.

Albert Einstein said "Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution." At least this essay doesn't lack imagination.

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