Analogical Engine

Mention quantum theory, the two words that follow it are **great** and **weird**: great as in the greatest scientific theory ever, and weird as in sci-fi Star Trek, Captain Kirk being teletransported across galaxies to Uranus and Alpha Centauri with stopovers in Boston and Bangkok, but with speed much much faster than you can say "Sharzam"!

There is no question that quantum theory is one of the greats, perhaps even the greatest scientific theory ever invented by Mankind, but the purity of its achievements could do very well without calling attention to stories of its weirdness.

A quantum theory without the sobriquet of weirdness can be imagined.

Metaphorically imagine quantum theory as the lighthouse tower on the edge of White Cliff of Dover. If you approach it from Calais, France, you have to scale the vertiginous face of the Cliff, but if you approach it from Brighton Beach, it is a leisurely Sunday drive over undulating downs of English countryside.

The Calais-side situation is what we get when we approach quantum mechanics from the classical traditions and mindsets of Newtonian physics. Then, everything about quantum mechanics looks weird: **wave-particle duality** (and its schizophrenic nature); **uncertainty** (and its inability to measure *exactly* the position and the momentum together); and **entanglement** (and its extraordinary ability to communicate over distances that light can not even reach). Thus quantum theory does open up all sorts of questions about the **nature of reality** we live with everyday.

Einstein, Podolsky, and Rosen had devised a thought-experiment to show that quantum **entanglement** is inconsistent with his **Special Theory of Relativity**.

If *wave-particle* duality is the heart of quantum mechanics as Richard Feynman famously said, entanglement is its soul. But for Einstein, the soul of physics is **objective reality**, the very antithesis of what entanglement is all about.

Experimental validations of **Bell's Theorem** concerning the nature of quantum and local realistic theories has however shown that quantum particles have an extraordinary ability to communicate and affect each other in a manner contrary to dictates of Einstein's Relativity theory, which famously forbids that nothing travels faster than light.

Quantum theory and Relativity theory are the two main pillars of physics, and they appear to be in conflict.

In *Quantum Non-Locality and Relativity*, philosopher Tim Maudlin writes about the conflict:[1]

"One way or another, God has played a nasty trick. The voice of Nature has always been faint, but in this case it speaks in riddles and mumbles as well. Quantum theory and Relativity theory seem not directly contradict one another, but neither can they be easily reconciled. Something has to give: either Relativity or some foundational element of our world-picture must be modified. Physicists may glory in the challenge of developing radically new theories in which non-locality and relativistic space-time structure can more happily co-exist."

Echoes of these arguments from those long-ago debates are still reverberating in today physics and philosophy forums, being discussed and talked about endlessly in popular media, and woven into the culture in the form of films and television programs. However, to get to to speed on the technical underpinnings of standard quantum theory, I recommend the following online videos:

1.   Professor Fay Dowker, theoretical physicist, Imperial College, London, Inaugural Lecture on Quantum Gravity http://wwwf.imperial.ac.uk/imedia/content/view/3134/spacetime-and-the-quantum-united-by-history

2.   NOVA - The Fabric of the Cosmos by Brian Greene -Quantum Leap https://www.youtube.com/watch?v=UYuiV6fckg8

3.   Double Slit Experiment explained! By Jim Al-Khalili, The Royal Institution presentation https://www.youtube.com/watch?v=A9tKncAdlHQ

Brighton Beach Version of Quantum Mechanics

In this version, quantum mechanics is considered "analogical" in the following sense:

"What *quantum* mechanics is to *classical* (physics) **is similar to** what *analogy* is to *reasoning* (rationality)."

Concisely, it will henceforth be represented as: *Quantum-classical ≈ analogy-reasoning*, the symbol "≈" being a short form of "is similar to" or "is analogical to." With this notation, it is easier to see that "quantum is analogical" and "classical is rational."

Let us explore the implications.

What is Analogy?

First, analogy is something that hardly needs an introduction. We – human beings -- are analogical from birth, and everything we do is also analogical from that point on.

Analogy is an indispensable part of the human mind: a search light of the mind, if you will. And without it being there *first*, there would be no chance at all for *reason* and/or *rationality* to ever exist. (Analogous situation obtains between the quantum theory and the gravity theory: here the existence and stability of atoms has to come before the force of gravity can act on the atoms.)

We start with the fact that there are *two* fundamentally different styles or kinds of thinking in our thinking as there are *two* fundamentally different kinds of physical laws in the world.

Of the two fundamental modes of human rationality, the one we most frequently use is the "analogical" modes of thought. In point of fact, you could say that the "analogical" modes are the iceberg under the waterline of our mental life. The moment we take note of their existences, we tend to put them under the labels of: *abduction*, *analogy*, *commonsense*, *induction*, *intuition*, *recognition*, *judgement* etc., etc. Because of our barely conscious relationships with these mental faculties and processes, we also tend to

forget about the economy in time and effort we invariably achieved through the use of the **mechanism of automaticity** that underlies every one of these mental processes.

For us, analogy and its close families are natural modes of thought, requiring none of the paraphernalia of logic such as transitivity, identity, and predetermined legal if-then action rules. Indigenous to this analogical character is its chameleonic nature, which possesses—at all times—a propensity to fit itself into every imaginable environments, practically instantaneously and with the slightest of hints from where it finds itself. This kind of automaticity is different from the automaticity that Turing made famous.

How crucially important to our well-being that these automatic mental processes are can be seen by trying to imagine the absence of just the commonsense and analogy-making power in our lives. Without the benefits of automaticity accompanying the commonsense and the analogy-making power of the mind, our behavior would be like a robot mindlessly following rules and instructions to do the simplest of tasks that a child of two instinctively know how to do. Commonsense and analogical power of mind— together with language—are what makes humans special, guiding us with sense and sensibility in an ever- and fast-changing scenes of human life.

In other words, it would not be too farfetched to treat commonsense and analogy-making power of our mind -- which all of us possesses in large doses or small -- as our own *private* THEORY OF EVERYTHING. TOE for short.

Like the commonsense and the analogy, the DNA is also another TOE. (DNA builds each of us—from the blue-eyes, blond-hair to the pink toe-nails—automatically without instructions and supervisions from outside other than the snippets of small encouragements from the enzymes.)

From these observations, I am going to conjecture that this mechanism of automaticity is *universal* not only in our **thoughts** but also in our **world**.

The mechanism of automaticity we are talking about here is *not* anything like the Turing-defined automaticity of computational theory.

As we know Turing-styled automaticity requires precise instructions for it to work and because of that requirement of "precision," it is neither natural nor efficient. Turing-styled algorithm is *mechanically deterministic* by construction, requiring inputs values that need to be totally *unambiguous*.

The automaticity that accompanies the use of commonsense or analogy is different, requiring neither the "precision" nor the "instructions" for its mechanism to work. What we are talking about is the kind of mechanism that works with small and tiny hints, running *effortlessly*, on its own juice so to speak!

Lucky for us some such mechanisms are found already embodied in the activities of face-recognition, early childhood language learning, analogy-making, and induction, among others: a face will be recognized instantly in poor light and under varying orientations; a child of two will form perfect and sometimes convoluted but grammatical sentences without proper grammatical instructions; inspired and surprising analogies are found without being told what to look for; and we invariably generalized after seeing sufficient number of instances of one thing or another.

On the other hand, *reasoning* is a different style of rationality from *analogy*. Reasoning requires a series of arguments that need to be checked for the consistency of time and place—and the logic of cause and effect—all requiring the memory of what comes before and what comes after among many items jostling chaotically for attention, while analogy, intuition, judgment, recognition, and some such faculties of mind can dispense with all the baggages of time, place, cause, and effect.

When we go beyond normal human reasoning into the computational mode of programmatic "reasoning," we are required to supply even more numbing details about the *addresses* of numerous items, *routines and subroutines*, and *rules* about *rules* to add, subtract, shift, queue and stacks. Such programmatic and rigidized mode of reasoning requires teams of programmers and millions lines of code to affect a simple procedure.

Today I believe that we have reached a new evolutionary plateau in the forward march of rationality, and this new rationality requires a marriage of computation and information.

"Connecting the dots" is informational-age phraseology for a style of thinking that relies on huge amount of data stored in organizations and institutions, generally separated by missions and/or functions. The stored information is digitalized and pixelated around organizational and institutional objectives. Associated with this style of thinking are the activities of "searching or mining of data," with an operating assumption that at the end of the activities, there is a nugget of invaluable information waiting to be discovered. Like finding "a silver bullet." When compared to the style of thinking that Isaiah Berlin described most lyrically in his famous essay "The Political Judgment",[2] or to the style of symmetry thinking that marks Einstein's scientific work, this data-driven institutional style of rationality is an extreme form of reasoning.

Since it is practically impossible to be perfect at the first try—or find the proverbial needle in the haystack—the most natural and surest way to "perfection", "truth" and/or "reality" is a method of successive approximations.

Successive approximation is a process similar in nature to the analogical, and in that sense we can think of ANALOGY as the faculty of mind designed to be "roughly correct" in every conceivable frames of reference, and RATIONALITY as the faculty designed to be "perfectly or precisely correct," at all times.

Analogy is about *sameness*, while rationality is about *difference*. In quantum mechanical context, *wave-particle* duality is the analogue of *sameness* and *difference*. Once such **analogical engine** is started, the dynamics of SAMENESS took over: The *mind-body* brings up the *wave-particle*, and the *wave-particle*, the *quantum-classical*, and the *quantum-classical*, the *same-difference*, and so on resulting in a transcient configuration of duals that reflects the state of one's mind. Such a group might look like the following:

Mind-Body ≈ Wave-Particle ≈ Gene-Protein ≈ Synatax-Semantic ≈ Subjective-Objective ≈ Freedom-Determinism ≈ Variation-Selection ≈ Software-Hardware ≈ Same-Difference ≈ Chance-Necessity ≈ Action-Reaction ≈ Quantum-Classical ≈ Boson-Fermion ≈ Random-Nonrandom ≈ Empiricism-Rationalism ≈ Induction-Deduction ≈ Analogical-Rational ≈ Imaginary-Real ≈ Vector-Scalar ≈ Order-Disorder ≈ Space-Time ≈ Discrete-Continuous ≈ Unconscious-Conscious ≈ Automatic-Notautomatic ≈ Computable-Notcomputable ≈ Linear-Nonlinear ≈ Rational-Irrational ≈ Supply-Demand ≈ Cooperation-Noncooperation ≈ Roughly Correct (RC)-Prisely Correct (PC) ≈ Connected-Notconnected ≈ X-Y, where as before the symbol "≈" stands for either "is similar to" or "is analogical to."

At different moments, a different configuration of duals can arise in our minds:

Wave-Particle ≈ Mind-Body ≈ Quantum-Classical ≈ Antirealism-Realism ≈ Quantum Theory-Gravity Theory ≈ Special Theory of Relativity-General Theory of Relativity ≈ Analogy-Reasoning ≈ Syntax-Semantic ≈ Inertial-Gravitational ≈ Gene-Protein ≈ Variation-Selection ≈ Chance-Necessity ≈ Connected-Separate ≈ Computable-Noncomputable ≈ Linear-Nonlinear ≈ Global-Local ≈ Unconscious-Conscious ≈ Empirical-Rational ≈ Roughly Correct-Precisely Correct ≈ Space-Time ≈ Boson-Fermion ≈ Same-Difference ≈ Schrödigner's wave mechanics-Heisenberg's matrix mechanics ≈ Complete-Incomplete ≈ Freedom-Determinism ≈ X-Y ≈ and so on.

All of our speeches, all of our conversations and all of our intellectual dialogues and discourses are composed from combinations and permutations of these duals. Great theories are built from duals: *wave-particle* is the foundational element of quantum theory; *analogy-reason* of cognition; *gene-protein* of molecular biology; *space-time* of special relativity; *variation-selection* of evolutionary theory; and the list goes on.

Nobody can deny the fact about dualities being ubiquitous, but the question is why.

A Toy Model of How Mind Works

Start with the analogy between *mind-body* and *wave-particle*, and then read it as "what *mind* is to *body* ≈ what *wave* is to *particle*."

Or, the analogy between *mind-body* and *subjective-objective*, and then read it as "what *mind* is to *body* ≈ what *subjective* is to *objective*.

Or, if the analogy is between *mind-body* and *quantum-classical*, and then read it as "what *mind* is to *body*" ≈ what *quantum* is to *classical*."

Since analogies can be freely chosen, we have potentially an infinite variety that we can work with. For examples:

"What *quantum* is to *classical* ≈ what *global* is to *local*." Or, "what *global* is to *local* ≈ what *unconscious* is to *conscious*." Or, "what *wave* is to *particle* ≈ what *gene* is to *protein*." Or, "what *quantum* is to *classical* ≈ what *analogy* is to *rational*." And so on.

From sets such as the above, we can easily derive other sets that are simpler to read, or grammatically correct.

"*Mind* is *subective*, and *body* is *objective*." (You probably don't need to pause to agree.)

"Mind is global, and body is local." (You probably had to pause to think.)

"Quantum is analogical, and classical is rational." (You probably think it doesn't make a whole lot of sense, especially the statement "Quantum is Analogical."

Is Quantum Analogical?

Based on the principle of duality ("What *quantum* is to *classical* ≈ what *analogical* is to *rational*"), the essence of the quantum mechanical is the "analogical." In other words, when we are making analogies—as we routinely and frequently do—we are in essence playing with the same rule of Nature that quantum atomic processes do.

But before we try to see quantum theory through the conceptual framework of analogical processes, I feel that we must first study the theory as seen by the physicists who developed it, with attention to its history, foibles, and concerns that are unique and internal to it, preferably in the vernacular and words of physicists themselves.

From our studies of quantum mechanics, we came to know that the two most important and defining phenomenal features of the theory are *wave-particle duality* and *entanglement*.

Double slit experiments have confirmed the wave nature of atomic entities: with two slits both open (equivalent to not trying to observe and identify which slit an electron goes through, treating different paths it took as *same* or *indistinguishable*), the electron shows its *wave* nature, obeying the *linear* mathematics of Schrödinger's equation. With one slit opened (equivalent to observing and identifying which slit the electron goes through), the electron shows its particulate or *particle* nature. Born's rule, which is mathematically *non-linear*, is used in the calculation of the positions of atomic particles.

We cannot help but notice the affinities between words such as *same*, *supperposition*, *linear*, or between words such as *particle* and *nonlinearity*.

Surely, **self-referentiality** is at work here, and it would not be too farfetched to conclude that *self-referentiality* is another name for *analogy*, as are the propeties of *linearity* and *supperposition* attending the wave nature of atomic particles. A simple model of analogy might help to delineate the nature of these terms as they apply to *mind* and *matter*.

<p style="text-align: center;">*A Model of Analogy*</p>

We start by building a simple model of analogy based on the conceptual distinction between the *figure* and the *ground*, which—as we should note—is a built-in feature of our *visual system*, a modality that connect *us* and *world*, and vice versa. The recognition of the distinction between figure and ground is thus immediate, needing no intermediaries of help from either logic or reason, as befitting all the naturally automatic—i.e., effortlessly running—systems, including our own sense of *self* and *non-self*.

However, it is important to note that the *seed* of logic and reason—naturally absent *before* the moment of recognition—is present right *after* it. The concept of *nothingness* is thus central to the concept of *figure-ground*, and vice versa.

We begin with *nothing*: The *initial state* in such a system is a state of *nothingness*, which can be imagined as the state of *figure* and *ground* when neither the figure nor the ground can be *distinguished* from each other, nor could they have been considered as *preexisting* side by side. From this initial state, let us imagine the instant when the very first figure and ground come into being, i.e. the

moment coinciding with the first appearance of *distinguishability* or *individuality* so to speak, in an otherwise sea of nothingness.

Within this picture, we can see the initial state of analogy-making to the earliest awareness of some such figure and ground. At that very moment, the figure and the ground are to all intent and purpose indistinguishable. And *simultaneously* at that moment—and importantly also at *will*—one can call a "figure" the "ground", and a "ground" the "figure" and no one will be the wiser for it. In other words, at such moments, one needs not be "precisely prescient" as to which is which, i.e. one is always "rougly correct" whichever sides of the *two-ness* one chooses to call it the "figure" or the "ground."

It is in this sense that one can define the conjoined-twin concepts of flexibility and automaticity: (1) *flexible* because which is "figure" and which is "ground" need not be specified precisely at that moment, and (2) *automatic* because the "figure" and the "ground" are the two entities that always cropped up together from a place we have called *nothingness*.

In the case of analogical processes, we can know the exact moment of "division" into a "figure" and a "ground" because we are experiencing it directly: As when a face in the crowd draws your attention even though you are not looking for that face. Here, we are making the "figure" to stand in for the face; the "ground" for the visual system integrated with the brain.

In the case of physical processes, we have no direct access to "physical reality" and the question that arises is how are we to know which physical processes—with their own hierarchy of *causes* and *effects* or with their own *figures* and *grounds* so to speak—is the one that is actually generating the *experience* of recognition.

We can choose to carve up Nature at many different points, yielding answers that differ with the scales we probe and the premises we adopted. But Nature itself is quite agnostic and mum and plays no favorites.

The lesson is clear: In the case of physical processes, we have *indirect access*, i.e. only through the *rationalism of our minds*.

Rationally, we could argue that the following statements are not illogical:

     1. The moment of "recognition" has to be contingent to and simultaneous with the moment of separation of the physical system of interest; and

     2. The physical separation into two indistinguishable states must have certain cost in terms of endogenous energy; and the corollary is: the indistinguishability of the separated states is contingent upon the smallness of the energy affecting that separation process.

Logically, we might wish to minimize the energy cost of this separation process to be as small as possible. From greed or curiosity, we might even attempt—if at all possible—to reduce it to zero.

Let's see what kind of world it would be if such a wish for zero energy cost was possible.

Zero energy cost would make the world—and our lives in it—magical, unreal and chaotic. Castles and candles, lambs and lions would not only be appearing and disappearing in our minds, but they will also

do so with equal ease in the world, making us mad or schizophrenic and the world chaotic and lawless. This is a situation where everything is unpredictable.

To avoid disorientation for both Life and World through ceaseless and meaningless activities, what is needed is some kind of connection to an anchor of *reality* as a means of taming these unnecessary activities.

But how much of a connection to reality, and how is it going to be implemented *physically*? A connection is fine, but how much stronger than from having no connection at all?

A value of zero is certain to produce a fantasy world, but we could go just as wrong by going too strongly away from zero. A too strong a dose of reality would then make everything in the world silent from inactivity and boredom, banishing minds and consciousness along with imaginations and free-will. This is a situation where everything is predictable, unchanging, or unchangeable.

How Nature does strikes a balance between the unpredictable *freedom* of too weak a hold on reality and the predictable *determinism* of too strong a hold on the same reality?

I think by gripping *both* horns of freedom and determinism, thus making too strong a hold on reality as *untenable* as too weak a hold on it. Metaphorically, by making the lion to lay down with the lamb.

The energetic requirement in this recipe of Nature is quite unforgiving—so unforgiving that its own existence is threatened if it gets bigger or smaller! The beauty of it is that the *simultaneous nature* of this determination produces a *constant* of nature that paradoxically is also the main reason for the creation of two entities that are *different* and yet a *mirror image* of one another.

I am gong to call this constant the **Mother of all Dualities**, but at the same time I am aware of the fact that its provenance has uncanny resemblances to the **Planck Constant** of 1900 derived from black-body radiation studies. In fact, it may be construed as one and the same!

EPILOGUE

One can only marvel at what a small constant can do, creating an impersonal cosmos of unimaginable dimensions out of nothing as it were, while not forgetting to populate a corner of it with conscious human beings like us, brimming with desire to know what it is all about.

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1.   Tim Maudlin, *Quantum Non-Locality and Relativity* (Blackwell Publishing, 2nd Edition 2002), p. 242.
2.   Isaiah Berlin: "On Political Judgment," *The New York Review*, October 3, 1996.