A " LAYERS OF REALITY TO A WEB OF INDUCTION " HYPOTHESIS

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ABSTRACT

It is shown that as knowledge is structured, it comes in modules. This provides different " layers of reality ". Each layer of reality has its own distinctive inductive logic which may differ from that of the others. All this is woven together to form a " web of induction " in a multidimensional space. It is the overall resilience, firmness and consistent interconnectedness of the whole web which justifies induction globally and which allows science to continue to "read" nature using the inductive logic.

Advanced knowledge of science and other disciplines is imparted through Universities. Each university has departments and each department specializes in a particular discipline. Different departments mostly work independently of each other. Most of the time they are not even aware as to what is being taught in the other departments. They continue to do so without in anyway compromising their ability to impart knowledge in their own discipline. Hence this is the most straight forward acknowledgement of the fact that scientific knowledge is structured and comes in modules. By and large each module of knowledge may exist independent of the other modules of knowledge.

Succinctly we may state that scientific knowledge, as a mapping of reality, is structured into "layers". In common usage the word layer stands for two dimensional surfaces in a three dimensional world. Let us not confine ourselves to this three dimensional world here. When talking of the dimensionality of any reality one necessarily means the dimension (or number of degrees of freedom) of the minimum number of variables needed to describe that particular aspect of nature completely. Hence here a layer would mean a surface in this "large dimensional" field of reality. Hence the layers of reality that we are talking about has multidimensionality built into it.

So, broadly speaking, scientific knowledge can be considered as not being an interrelated or interdependent compendium of facts and relationships. It is "almost" discrete and exists in different compartments which are 'almost' independent of each other. In fact it is entirely because of this feature of nature that we have been able to 'uncover' or understand nature, part by part and one at a time. In fact, had it been not so, then one may wonder as to how scientists would have ever been able to acquire any knowledge whatsoever ?

As scientists, we have gone into different layers one at a time. Once in a while one encounters a boundary between two layers and that creates unanticipated complications and difficulties. In tackling these, one often discovers other hidden layers of reality. However. if it turns out that a particular boundary is indeed unbreakable, then that too gives information about still other aspects of what reality is all about. Hence knowledge is not static. It keeps on changing and evolving.

In physical science, there is a neat way of understanding these layers of reality. Simply stated, the different layers of reality in physics have to do with different energy or length scales. Without going into mathematical details,

short length scales imply larger energies in a particular physical phenomenon and larger length scales mean smaller energies available for relevant physical processes. It has been a major achievement of the physical sciences that it has uncovered the fact that nature is built upon different length/energy scales. And that these energy scales are a few and finite in number. As long as one is working within a particular energy scale, one can by and large ignore effects arising from the other energy scales. Boundaries where the two energy scales meet require careful handling as that may create unexpected complications. A proper understanding of these has always been found to be extremely enlightening as well. However, as long as one stays away from these complicating cases, then one has a good and independent sub-discipline of physics.

Gravitational interaction is dominant at large distance scales. Coming down to smaller scale of a few Angstrom, the gravitational interaction can be completely ignored for all practical purposes and the molecular forces start to manifest themselves. The energies involved here are the ones available in ordinary combustion of wood, paper etc. A little more energy is available at say a little smaller distance of only one Angstrom or so. At this level electrons are bound to protons to form atoms. The relevant energies are approximately an electron volt (in a particular unit) or so. At this scale, one can study atomic physics without worrying about nuclear forces. Nuclear forces start becoming significant as one goes to a much smaller distance of a fermi or so. The energies are now measured in a million electron volts or so. The whole discipline of chemistry need not worry about any other scale than these two (atomic and molecular) to do its work!

One may treat these different energy scales as opening up of different layers of the "onion" of reality. In nuclear physics (which is relevant for nuclear power generation and for nuclear bombs like the ones dropped on Hiroshima and Nagasaki) the relevant energy is about a million electron volts. Still another layer of onion is known to exist at around a billion electron volt of energy. At this scale quarks start manifesting themselves explicitly in nuclei. Still another scale occurs at a much higher scale of energy and is popularly called the Planck scale. A lot of bizarre things are supposed to happen at the Planck scale and today it forms a frontier of research in physics (Callender and Nuggett (2001)). Even the difficult case of the boundary problems, wherein two scales meet, interesting things happen. For example phase transitions (like ice melting of into water) reveal still other basic

features of the mathematical reality - the significance of irrational numbers like the golden ratio etc.

It seems that the reason that so far the philosophers of science have failed to appreciate the significance of the intrinsic existence of layers of reality as presented here is because intuitively they have been believing in the existence of a global, uniform and all encompassing reality - which they have been trying to uncover, if not always through physical arguments than by using metaphysical arguments.

So far no such universal physical reality has manifested itself. The reality which has become clear in recent decades consists of almost disjoint sets woven in a structured whole. It is nature which has forced the scientists to accept the fact that it is structured and consists of different layers of reality. Once we have understood this fundamental structuring of the scientific knowledge of nature, then it will allow us to tackle the problem of induction as well.

Since the time of Hume the logical method of induction has been taking centrestage in the thoughts of mathematicians and scientists in general and philosophers in particular. There has been an onslaught against induction. It has been warding off these attacks but it has had its back to the wall. Basically the only reason it has managed to survive so far is because the sciences, wherein it is extensively used, have actually been "progressing". Whatever one may mean by the word progress, science and its associated technology is indeed changing the world almost on a daily basis at present.

The arguments for and against induction are well documented in text books (Ladyman (2002)) and other compilations (Balashov and Rosenberg (2002)). We do not intend to go into the detail of the same here. however, still to put the issues in proper context let me quote Broad (1887 - 1971) who very crisply called induction, "the glory of science and the scandal of philosophy".

In terms of the layers of reality, if one has a theory which explains the reality at a particular layer, it had better be "complete" in as much as it would give a consistent description of the physical reality manifested in that layer. This theory will involve its empirical justifications, mathematical framework and reliable predictability. Hence a particular induction shall be applicable in that regime. In simple terms, one has to agree to this induction as it actually "works". It works because in the regime under discussion, these set of physical and mathematical arguments of the relevant inductive framework

explain 'all' empirical information and make predictions which are found to be correct.

It is a common feature, that scientists working in a particular discipline (describing a particular layer of reality) would soon start finding limits to the applicability of that particular theory. They would find that there are situations wherein the particular inductive logic inherent in the description of that layer of reality actually fails. Hence the scientists are forced to define boundaries (in terms of some physical parameters like say high energy/low energy or small distance/large distance or low temperature/high temperature etc.) within which a particular inductive logic works and beyond which it fails.

But this does not mean that the particular theory describing the reality manifesting itself within that particular layer is wrong. It was correct in as far as it was applicable - empirical aspects incorporated in the theory and useful applications (if there be any), as technological spin offs arising from the particular theory, would testify to it. But it is not universally and globally correct for all the situations. In struggling with these limitations of a particular theoretical reality, one does further experimentations with different mathematical models, until one finds that he/she has reasonable understanding of another layer of reality. This forces one to appreciate and use another set of inductive logic and so on. This is the way that nature has been unfolding itself to the scientists.

As an example Newton's gravitational mechanics was useful to explain Kepler's laws of planetary motion. It was a consistent theoretical framework which was very successful. Then came along Einstein's theory of special relativity in 1905 and which shook the foundations of classical theory of gravity. Did it prove Newtons gravitational force laws wrong? If one reads the books in philosophy of science - in general the answer is that yes, Einstein's theory proved Newton's theory wrong. It is unfortunate that many philosophers of science actually think that Einstein's theory proved Newton's Theory wrong. This involves blatant misunderstanding of the physics involved. In fact, even today one can use Newtons laws of motion with great confidence to understand planetary motions up to a level of accuracy which is acceptable in most of the situations. Only when one requires an accuracy to a much higher place in decimals and when the velocities of objects involved are much higher (ie approaching the velocity of light) does one need to incorporate the corrections arising from Einstein's theory. In reality Einstein's theory defines the

limit (in terms of relative velocity etc.) on the Newton's Law of Gravitation. One should bear in mind that when a physical law has been empirically verified to work under certain conditions (like temperature, pressure, distance, energy etc) then under the same conditions it will continue to work the same way always. If at all there arises a situation that one encounters a failure of the same, then it just shows that one's initial understanding was limited as it did not take into account the situation in which it failed.

Another example, wherein one would explore different layers of reality in terms of different inductive/theoretical framework, is that of classical thermodynamics description going over to kinetic theory of gases description and thereafter to statistical mechanics description (which itself may go over from classical statistical mechanics to quantum statistical mechanics both for fermions and bosons). At each layer of reality, there were experimental and empirical statements which were translated into a suitable theoretical framework with its relevant concepts and proper mathematical language. Predictions were made and confirmed. One gained confidence in one's inductive logic when the same was used to 'control' reality by making relevant innovative technology to serve mankind and which could not have been visualized without that particular induction involved. Then as one gains control over various physical parameters like temperature, pressure and density etc one may be forced to go to another layer of reality with its own inductive logic. Today quantum statistical mechanics is trying to extend and establish its own limits of applicability.

Still another example of layers of reality each with its own inductive logic is that of geometrical optics going over to electrodynamics and thereafter to quantum optics. All inductive logic in each subdiscipline is accurate and reliable within its own limits. It is never wrong or inapplicable in these regimes. And each furnished its own technology which was applicable within the limits specified for that particular layer of reality and its corresponding inductive logic.

Understanding the boundaries between different layers is a more challenging proposition. For a few such cases one may understand it by utilizing the limiting process (for example as in the mathematical language of calculus). Hence one finds that in the limit of low density and high temperatures, quantum statistical mechanical description would go over into the classical statistical mechanical one. In other cases like those of phase transitions, like as in the early universe, as to how matter particles gained masses, ex-

otic mechanisms like the Higgs mechanism in the Standard Model of particle physics are invoked. At present these boundary situations between different layers of reality are under active investigation and one looks forward to a deeper understanding of nature arising from such endeavours.

Note that induction in "linear" within each layer of reality. By 'linearity' here I mean that inductive correlations are understood in a direct manner in terms of a straightforward interpretation of theoretical terms with the experimental reality. When one jumps to the next layer of reality then another set of inductive laws are found to be applicable. Those are 'linear' themselves. But what about the boundary of the two layers of reality? I suggest that this boundary involves a " non-linear " jump. One goes from one "linear" inductive logic of one layer of reality to another set of independent "linear" inductive logic of the other layer through a " non-linear " jump.

As an example of this non-linear jump let us look at the early universe scenario in particle physics. As we stated a little earlier, the masses of particles like electron, quarks etc arise through a mathematical technique called the Higgs Mechanism. This is a non-linear process with complicated mathematics. As such this defines the boundary between two layers of reality which themselves are linear. Above the Higgs mechanism scale, the electrons are massless and are understood in terms of a particular inductive logic and below it another inductive logic manifests itself in terms of the Standard Model of Particle Physics. So a "non-linear" reality acts as a "knot" to join together two different "linear realities".

I therefore propose " a web of induction hypothesis ". In terms of induction one may define existence of a "web" of induction. Different inductive logical systems are correlated with each other through limits to form a web of induction. This web of induction is what justifies induction. There is no universal and global inductive logic. Induction is justified because different layers of reality with their own limited but justified inductive logics hang together in the form of a "web". The linear part of the induction (at a particular layer of reality) forms the "thread" part of the web. The non-linear part of induction (for the boundary cases) forms the "knot" part of the web, So knots in the web connect the threads together. Induction is "correct" because the resilience of the web of induction gives it strength and validity.

It is because different inductive logics (which describe different layers of reality) from a consistent and solid web in a multidimentional space is that

one may use these to describe the reality of nature. Each thread of the web can only be understood in its total involvement with the rest of the threads as well as knots. You cannot cut it at a point and hope that the rest will remain intact. It is this web of induction that gives consistency to the whole scientific enterprise.

Note that "induction" gets justified as a valid means of acquiring knowledge not because induction itself forms an essentially one single global entity - as has implicitly been assumed by most of the philosophers of science. As shown here "Induction", gets a global justification because it consists of several interconnected parts which are relevant for a consistent description of the different layers of reality. The whole thing stands firm, resilient and consistently interconnected in the form of a web.

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