

Theory of Time-Affirmation

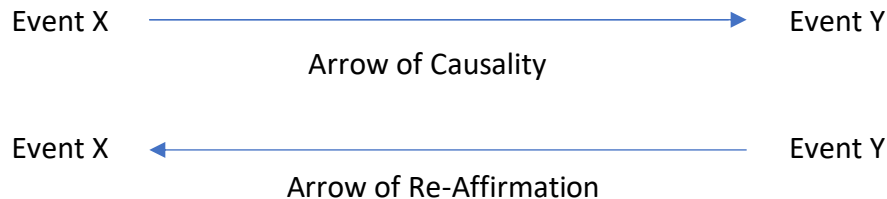
Since Einstein's theory of Relativity, concept of time has forever been made part of the basic fabric of the universe as the conjoined entity of space-time. It's treatment as the fourth dimension in addition to the three spatial axes has revolutionized physics and our overall understanding of laws on nature. The two areas most deeply influenced by it are general relativity and quantum mechanics. In the purview of general relativity, space-time is seen as the theatre where all events in the universe take place. In this theory, gravity contorts space-time leading to fascinating phenomena like time-dilation and Length-contraction¹. This treatment provides the entity of space-time a physical meaning and binds it tightly with the notion of causality. On the other hand, relationship between quantum mechanics and time is a bit more complex. Double Slit experiments², Einstein-Podolsky-Rosen paradox³ and its apparent resolution by quantum entanglement ask for a different approach towards the concept of time, one that is not usually bound with the notion of causality.

In the last 10 years, there is a huge push towards determining whether time is physical and real or emergent. On one side of the table, we have supporters of emergent time. This camp believes that time is not a physical entity but emergent due to more fundamental laws of nature. Work of physicists John Wheeler and Bryce DeWitt exposed a 'problem of time'⁴ and in 2013 a group of researchers in INRIM Turin confirmed their ideas and emergent nature of time under certain conditions within the framework of quantum mechanics⁵. An attempt to show the emergent nature of time at cosmological scale is recently been laid out in a paper by Arkani Hamed et. Al. by their use of a concept called "The Cosmological Bootstrap"^{6,7}.

However, there is also a camp of scientists and philosophers who believe in the reality of time. Lee Smolin of Perimeter Institute of Theoretical Physics in Canada is one such advocate and through his books Time Reborn and The Singular Universe and The Reality of Time: A Proposal in Natural Philosophy^{8,9} proposes that time is so real that even the supposedly timeless laws of physics – are subject to it. The idea of time-affirmation I want to put forth in this paper is on the side of the reality of time but presents a novel approach in thinking towards the arrow of time, causality and overall knowability of our universe.

The most fundamental nature of time is its incessant march towards the future. In classical mechanics, we are always presented with a unitary direction of time from past to present to future. It doesn't loop, goes backward or branches in different directions. This fundamental nature is seen as a result of the second law of thermodynamics which in layman terms states that the entropy of the universe always increases. We always move towards a state of higher disorder from order. However, this explanation hides more than it reveals about the nature of time. In more scientific terms, the phenomenon of increase in entropy deals with the increase in number of microstates leading to same macro-state¹⁰. This macro-state can be the general state of a system in observation or the universe itself. Basically, what it talks about is the arrangement of constituent particles (molecules, atoms or sub-atomic entities) in the observed system at a particular time (event Y) evolving from a previous state of the system when the particles were in

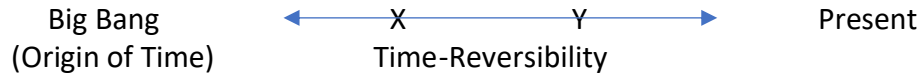
a different configuration in time (event X). So, this movement from event X to event Y is viewed as the chain of causality leading to the forward movement of time. However, there is another approach to look at the same events but from a point of view of affirmation. If we are presented with the event Y in conjunction with event X, we can very well say that event Y actually re-affirms the happening of event X. The exact reason for the use of the word 're-affirm' is presented later in the paper.



At a superficial level both views of causality and re-affirmation look the same but fundamentally re-affirmation presents a very different view in our intuition towards time and how events unfold. In fact, logically both the concepts are very different due to the nature of future.

Though some theories believe in the notion of a set, deterministic future as described in the "block -universe" theory of time, many believe it to be non-existent as put-forth in "growing block-universe theory". In philosophy too such views are presented as eternalism and presentism¹¹. In fact, the idea of future directly follows from our belief in causality and the general intuition of Event X giving rise to Event Y. The concept of causality and future necessitates the occurrence of Event Y due to the fact that event X occurs. However, in all fundamental laws of nature, time is completely reversible and doesn't have a set direction. If we now believe that future is non-existent and we can only know the outcome of an event when it happens, causality need not be invoked and the whole phenomenon can instead be explained via Time-Affirmation. The concept of Time-Affirmation states that the correct way of looking at the direction of time is not forward but backward. In other words, it's not the past that causes present or necessitates future but instead, it's the present that re-affirms that past happened. The idea of affirmation rises directly from observable and known events X and Y without invoking any need for the concept of future. This also encompasses all the sub-events that happens between X and Y as a chain of re-affirmation. Due to our knowledge of all events starting from Event Y to X, we can form an affirmation history and know the root cause of all sub-events. This can also be argued that this view of the direction of time is our real way of understanding physical phenomenon whether it is the evolution of species or evolution of the universe itself.

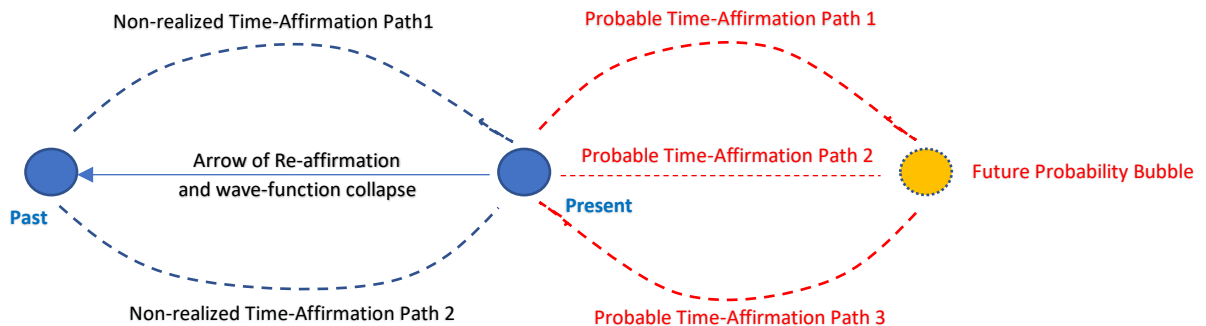
The notion of direction of time is also not necessary in this view but is rather used as a tool to easily explain the relationship between two events X and Y. Time remains reversible within the purview of event X and Y and by the same extension between the Big-Bang to the present moment.



In this view, the sequence of events between X and Y can either be seen as a causal chain or reaffirmation history with time being reversible in itself and not bound by the concept of future. This provides a working framework to think about time without violating any time-reversibility as mathematically encoded into Newtonian mechanics or in the macroscopic world.

However, a skeptic's view into this can be that time-reaffirmation is nothing but pre-destination. We know that future is out there somewhere and when it happens, we know why it happened and can trace the sequence of events leading to it. Though it feels that the argument of pre-destination essentially views time backward as re-affirmation, it still hinges on the concept of future. Philosophically as well as logically, it necessitates the occurrence of future to determine the past. On the other hand, Time-Affirmation only needs the present and past, both observable and traceable between them eliminating any need for future.

In the purview of Time-Affirmation future can be thought of, for any philosophical or explanatory purposes, as probability bubbles without any physical interpretation.



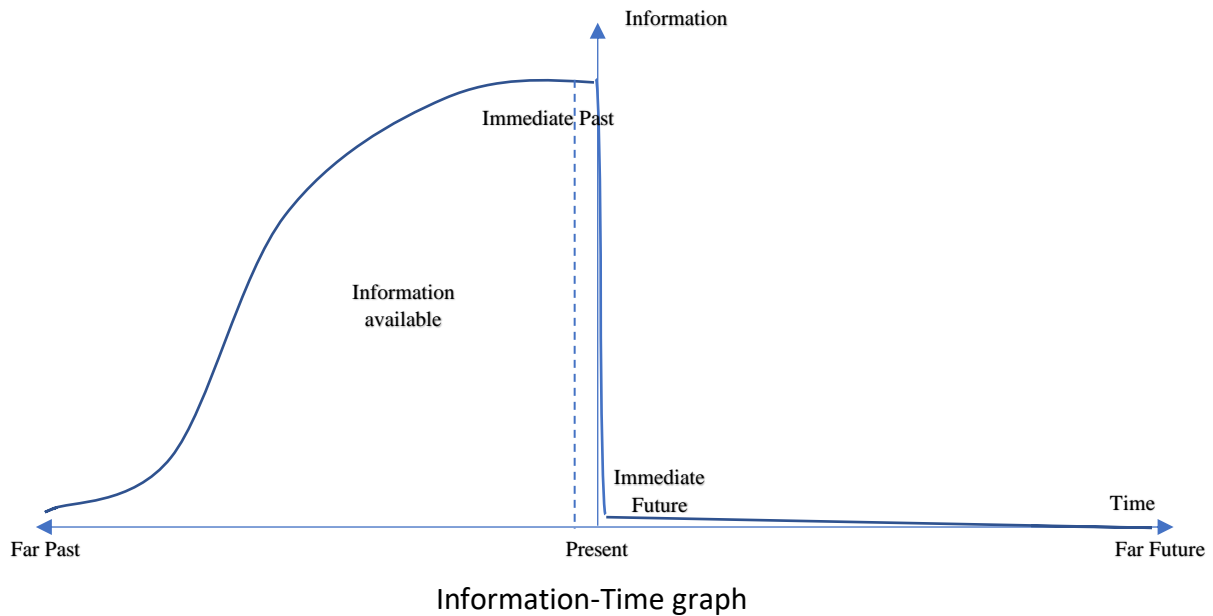
This understanding of future is internally consistent with quantum mechanics where future doesn't exist as a concrete fact. Wave function of a particle contains all the super-positioned states and an event occurs in the present when the wave function collapses to a single state. To explain time, the concept of multiple histories collapsing to a single one is already given by Richard Feynman¹². His Feynman Path Integral which is integrated over the set of all possible histories can be viewed as the observed event re-affirmation path. In this view, future is nothing but a probable state associated with probable time-affirmation paths. Whether we believe that the wave-function collapse happens due to observation by an observer as postulated by Copenhagen Interpretation¹³ or due to some axiomatic nature encoded in space-time as in Orchestrated Objective Reduction¹⁴, Time-Affirmation converts any probable future event to a present observed event with the help of wave-function collapse and Feynman's Path Integral. This will be explained in detail with reference to actual experiments later in the paper. To help us understand the experimental inferences from Time-Affirmation, another feature of this idea needs to be discussed.

The concept of Time-Affirmation also contains in itself the limits on the knowability of our universe. The only way we can be sure of our past is to know about the present. Our present contains (I) amount of information from which we understand its features and characteristics. However, this (I) amount of information is nothing but (I') amount of information from the past which goes through some transformative process. For immediate events on an infinitesimally small interval of time, (I') \rightarrow (I).

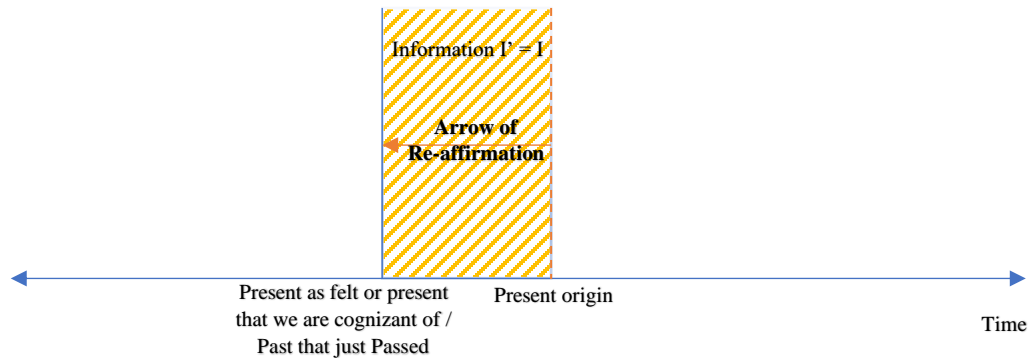
$$\lim_{n \rightarrow \infty} \sum_{i=1}^n f_i(t) = \int_X^Y f_i(t) dt = I$$

$f_i(t)$ = information contained in a time-affirmation path history as a function of time

For a complete knowability of past, (I') should be equal to (I). But this situation is limited by our recording and retrieval mechanisms. We know to a high degree of certainty about our immediate past due to high fidelity mechanisms for information retrieval. These mechanisms minimize data loss and make re-affirmation of past possible. These mechanisms are not only physical like recording media but also theoretical as in mathematical equations describing a natural phenomenon. However, as we move away from the present, the information available to us to know about the past reduces. This loss of information is not a physical destruction of information which was proposed in the Black-Hole Information Paradox and subsequently disproved¹⁵ but a limit in our retrieval methods and tools. We can describe what happened a year earlier in our life because we have been there to witness it but to ask what happened before our birth is subjected to information we can receive from parents, society or science in general. And because that information is also subjected to what has been retrieved earlier, there is a subsequent loss of information as we look backward in time. This loss of information in physical processes can be envisioned in terms of increasing entropy. Since the current macro-state can be formed due to many microstates, knowing the exact microstate becomes dependent on the knowledge of the previous microstate which in turn is dependent on its predecessor. So even though theoretically, it is possible to have this information, for any practical purpose, it is impossible to retrieve the information in its entirety. This practically places a limit on our knowledge of the past. Hence knowing about the origin of the universe and the early conditions leading to the birth of dark energy, cosmic inflation, matter-antimatter dis-symmetry, etc. becomes more of a question of theoretical models than actual physical knowability of the process. This leads to a very intuitive understanding of our universe as shown in the graph below.



This graph brings forth a few interesting points. We have some level of certainty in knowing our immediate future, as we have the information of present entropic states. But Time-Affirmation does not require the existence of a concrete future, which leads to the only logical conclusion that as the present shifts from one moment to the next, it is the process of re-affirmation that makes us cognizant of the present and what immediately preceded it. We do not require a physical, real presence of future to know the present and hence what we think is cause and effect is event and affirmation. Present is an ever-changing point within the information-time graph which has the information as $(I') \rightarrow (I)$. This doesn't mean that present moves forward towards future but that the past solidifies as the present which just passed. This can be visualized as two presents. One present is from where the arrow of re-affirmation originates and the other which the arrow of re-affirmation touches with $(I') = (I)$. The act of becoming cognizant of the present results it in becoming the past that just passed. This is the reason for the use of the word "re-affirm" as one present occurred, but we only become cognizant of it when the arrow of re-affirmation touches it from the other present. As the information contained in both presents is the same on an infinitesimally small interval of time, this could be thought of as the second present re-affirming the presence of first, where both the events are actually the same. Hence present continuously originates the arrow of re-affirmation and re-affirms itself. However, the act of re-affirmation of itself immediately turns the present into past. This is the exact way our own understanding of time and being in present feels like. Hence Time-Affirmation successfully encodes our intuition of time. It is interesting to note here that such a characteristic of time cannot be envisioned without thinking of it as a real entity rather than emergent.

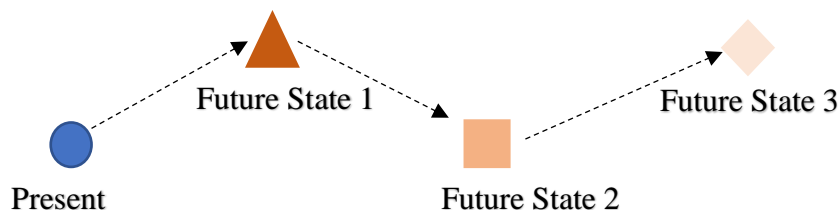


Another point that can be inferred from the graph is the lack of general non-existence of information in the forward direction. This can be interpreted as our inability to know the future at a cosmological scale which is exactly the current state of affairs or a general rejection of any physical presence of the concept of future as proposed by Time-Affirmation.

A final point as inferred from the graph is a lack of information on the far-past events or the origin of the universe. This is the appropriate juncture to address one criticism that could arise for Time-Affirmation. How could we ever know what sequence of events could have led to the present? In the language of causality, this could be argued that different causes could result in the same effect. So how could we ever know what was the root cause of a particular effect? The answer to this question lies in the information-time graph itself. We don't! Our knowledge of an 'effect' is only known when looked backwards towards the sequence of events causing it. In the purview of Time-Affirmation, we only affirm the apparent 'cause'. Any predictability of future is just probabilistic in nature, a view which is very much in sync with quantum mechanics and may become the worldview with the development of quantum theory of gravity¹⁶. Within the confines of present and past in Time-Affirmation, time itself remains completely reversible and the use of mathematical models to define nature gives us the same advantage of predictability. Coupled with the information available, this predictability leads to a high level of certainty when the observed phenomenon is close to the present. But as the information we can use to know the past reduces as we move away from present, our predictability for the far-past events reduces. This is the exact reason we cannot know with absolute certainty how the universe came to be. Was there a big-bang that created time and space? Was the bang result of Big-Bounce from an earlier universe or is this cosmos a grand design of an all-powerful entity?

As described above, dependency on information is one of the central features of Time-Affirmation. Recording and data retrieval methods are strongly tied to the action of probing our past. All this could be clubbed together into a single action dubbed as "observation-reaffirmation". We have observations about past and standing in present we can re-affirm our observations with the help of recording and data retrieval methods (whether physical or mathematical). Especially in science, this is viewed as the ability of a mathematical equation to predict the future given the initial states. Since physical experiments conducted in the past

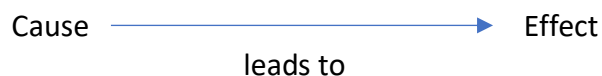
beautifully line up with theoretical results, scientists make predictions for future based on the observational data available to them in the present.



In Time-Affirmation also, without making future a real entity, we need a model to talk about it. Taking the help of "observation-reaffirmation", the matter of knowing anything can be boiled down to reaffirming entropic states present at any event under observation. If future can be thought of as a series of entropic states, we can observe them from a vantage point of present with our mathematical models. The models confirm these states when they actually occur because we predicted them in the first place. The use of the word confirm is done intentionally as re-affirmation of anything is only possible when the event has occurred in the past. So the problem is, how can we re-affirm our future and make it fit in Time-Affirmation when it doesn't exist?

The first step in solving the question lies in realizing the fact that our understanding of the concept of future is completely causal. This view is the root cause of non-intuitive experimental results, especially in quantum mechanics. A causal view of time in quantum mechanics necessitates a physical and real presence of future state for wave function collapse to happen. Such a physical interpretation of future is inconsistent with basic mathematical tenants of quantum mechanics and the tension can be best seen in delayed choice quantum eraser group of experiments¹⁷.

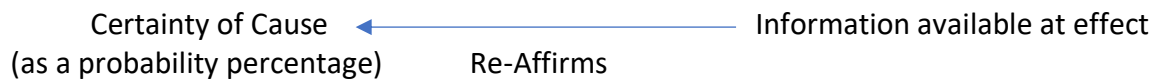
The results of these experiments are sometimes explained by invoking a principle called retrocausality^{18,19} where signals from future are said to be influencing the events in present. Though there have been oppositions to this view^{20,21}, the basic confusion arises from our de-facto belief in causality and our understanding of the second law of thermodynamics which we interpret as present states evolving into a future state of higher entropy. Why we can't observe future is because in reality, it doesn't exist. The statement stems from our belief/intuition that



Time-Affirmation doesn't violate the second law of thermodynamics but shifts the focus from a present-future point of view to present-past outlook. If present is thought of as a higher entropic state evolving from the past, you do not necessarily need a future state to define any experimental results. It provides for a new way of looking at the causal nature of the universe by proposing



or better still



Higher the amount of information available at present, better is our knowledge of past events. The degree of reaffirmation is directly proportional to the amount of information available. Imagine this as light been shined on an object. Brighter the light, more revealing would be the features of the object in question. Re-affirmation carries with it this light of information. Higher the amount of information, more is the knowledge of the past event disclosed.

Percentage of reaffirmation \propto amount of information

In delayed-choice quantum eraser experiments, we can talk about the interference pattern observed, in terms of erasure of which-path information in present. This re-affirms our observation in the past at the initial signal detector where we did not know the exact slit signal photon emerged from. For the results where there is no interference pattern, the detection of idler photon reaffirms our observation that its entangled photon exists and was detected in the initial signal detector. Even if we did not have the information about its 'which-path' at the time of signal photon detection in the past, we have the affirmation of its existence. The availability of new information of 'which-path' at idler photon detection in present provides for the disappearance of interference pattern. This is because the observation of the 'which-path' property of the photon causes the wave function to collapse in present. This collapse causes the wave of reaffirmation to propagate into past as new information determining the slit, signal photon originated from. Unlike retro-causality, this is not some exotic effect-influencing-cause action but a filling of a gap in our information about the past with new data available to us in the present. This is not unlike many experiments where new results often evolve our understanding of the past phenomenon by providing information that was hitherto undiscovered.

The concept of Time-Affirmation provides for a novel approach in our day today's understanding of time without sacrificing intuition or violating any scientific principles. Instead of viewing it as an exotic methodology, the right way of looking at it is in terms of changing our vantage point. From this new view, we can re-examine the past with the help of information available to us in the present. In philosophy, this is very close to the Nietzschean concept of 'will-to-power' and 'eternal recurrence' where we own up to all the things we have done in the past and our present situation is a direct result of willing our past in the way it happened. Scientifically, this framework is a cleaner way of looking at time with time-reversibility built in to support all physical theories describing nature.

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