

Exploring Physics and Ontology with AI

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Abstract

A novel situation has developed in which one can discuss physics and ontology with an Artificial Intelligence. In this paper, I present my initial experience with such and discuss a typical session for analysis. After analyzing the session, I attempt to interpret the significance of AI for physics and suggest possible consequences of this situation.

Keywords

Artificial Intelligence, Ontology, ChatGPT, Large Language Model

1. Introduction

Artificial Intelligence (AI) has worked its way into physics over a period of decades and is today perceived as *one of the main disruptive technologies of our age*, similar to personal computers in the 1980s and 1990s. Our current phase is known generally as “Machine Learning”, and usually refers to pattern recognition performed by neural networks trained on relevant data. For example, the latest issue [19 May 2023] of *Physical Review Letters* published three papers on Machine Learning in physics in which physicists use this technology to learn: *the phase diagram of a strongly interacting Fermi gas* (Link, 2023), *the Cosmic back-reaction and its effect on observations* (Koksang, 2023), and *Many-Body Hamiltonians with Heisenberg-limited scaling* (Huang et al., 2023).

While physicists model physical reality via theories derived largely from intuition and through solving equations to fit experimental data, machine learning derives the model by abstracting it from data. The data is generally not random in nature but is selected by physicists as relevant to the problem at hand. As a general rule, the better the data, the better the results. The data is often partitioned into a training set and a test set to evaluate the performance of the trained network. An introduction to the physics of machine learning is provided in (Alexander et al., 2021).

Today, we are on the brink of another explosive phase in Artificial Intelligence technology, which, while also based on neural network technology, differs significantly from the machine learning discussed above. Rather than being trained on representative physics data, the AI of interest is trained on massive amounts of data expressed in human language, of the type found in books, papers, essays, poems, fiction, history, journals, and ubiquitously available on the internet. An AI of this type is called a Large Language Model, and the first available to the public is ChatGPT 3+.

2. Communicating with Artificial Intelligence

Discussions with Artificial Intelligence (AI) are over a half century old. In 1964 Weizenbaum introduced a program ELIZA, based on pattern matching, with a teletype interface, that imitated a therapist asking questions and responding “intelligently” to the answers. Although simple, this injection of context was so effective that many computer-naïve individuals believed that they were conversing with a human. The naïve “Turing test” asked whether a computer that could converse undetected with a human, could be classified “intelligent”. For example, consider the prompt:

“Hold up both hands and spread your fingers apart. Now put your palms together and fold your knuckles down till the knuckles on both fingers touch each other. While holding this position, one after the other, open and close each pair of opposing fingers by an inch or so. Notice anything? Of course you did.”

Science posed this in 2012, marking Alan Turing’s centenary, in “*Dusting off the Turing Test*” (French, 2012) asking: “*But could a computer without a body and without human experiences ever answer that question or a million others like it?*” A decade later, *ChatGPT* answers that question:

AI answer. *The instructions are asking you to perform a physical action with your hands by spreading your fingers apart and then placing your palms together with your knuckles touching. While holding this position, you are instructed to open and close each pair of opposing fingers by an inch or so.*

The phrase “notice anything?” implies that there is a particular result or sensation that you should experience while performing this action, and it is suggested that this result is fairly obvious or noticeable. However, the passage does not specify what that result is, leaving it up to the reader to make their own observations and interpretations based on their personal experience with the exercise.

How does one judge that answer? Today *Science* (Burnell et al., 2023) observes AI being deployed in high-stakes contexts, such as driving autos and managing pensions, while the ability to grade AI performance suffers a number of problems. In Nov 2022 a modern natural language processing tool, *ChatGPT*, driven by an AI engine, was introduced with an open interface operating on popular browsers. This paper reports, verbatim, my first interface to the AI.

3. The Initial Session

Let's jump right into my first session, to be analyzed later in terms of what I have since discovered. The format is as follows: I preface my question with "Klingman", typically terminated by a question mark. The AI response follows as received. Both are indented. I have italicized key statements to which I respond.

Klingman: *If, as Wolfgang Rindler says (Rindler, 1991), Einstein merely re-assigned the global ether to each inertial reference frame, will this produce paradoxical consequences?*

Something went wrong. If this issue persists please contact us through our help center at <http://help.openai.com/>.

In other words, my first question appeared to break the AI. Since a paradox is a logically self-contradictory statement, it is clear that asking if a specific statement leads to self-contradiction is potentially open-ended, so I re-phrased the question as follows:

Klingman: *Einstein essentially assigned the medium of the ether to each inertial reference frame. What consequences would be expected from this action?*

AI: *In Einstein's theory of relativity, there is no need for an "ether" as a medium for the propagation of electromagnetic waves. In fact, one of the main achievements of relativity was to dispense with the idea of a fixed and absolute reference frame, such as the ether. Instead, the theory holds that the laws of physics are the same in all inertial frames of reference, and that there is no preferred reference frame.*

However, if we consider the idea of assigning an ether to each inertial reference frame, we can imagine several consequences:

- 1) *Each inertial reference frame would have its own distinct properties*, such as the density, viscosity, and refractive index of the ether.
- 2) The speed of light would vary in each inertial reference frame, depending on the properties of its ether. This would violate one of the fundamental postulates of relativity, which states that the speed of light is always the same, regardless of the observer's motion.
- 3) The existence of multiple ethers would imply the existence of preferred reference frames, which would be in conflict with the principle of relativity.
- 4) The idea of assigning an ether to each inertial reference frame would also imply the existence of an absolute rest frame, which would be at rest with respect to the ether. This would be in conflict with the principle of relativity, which states that there is no preferred reference frame.

In summary, Einstein's theory of relativity does not allow for the existence of an ether as a medium for the propagation of electromagnetic waves. Assigning an ether to each inertial reference frame would lead to several consequences that are incompatible with the principles of relativity.

Klingman: *Assume that the properties of each frame-based ether are identic-*

al, so the speed of light would not vary, thus not violating prohibition of preferred frames. Now what consequences?

AI: *If we assume that the properties of each frame-based ether are identical, so that the speed of light would not vary, then the consequences of assigning an ether to each inertial reference frame would be somewhat different.*

Firstly, it is important to note that the assumption of identical properties for each ether would still be inconsistent with the principle of relativity. This is because the existence of multiple ethers would imply the existence of preferred reference frames, which contradicts the principle of relativity that all inertial reference frames are equally valid.

That being said, if we were to ignore this inconsistency and assume the existence of multiple ethers with identical properties, then we could imagine the following consequences:

1) The concept of length contraction would have to be reinterpreted. In Einstein's theory of relativity, length contraction is a consequence of the Lorentz transformation between different inertial reference frames. If each frame had its own ether, then the length of an object would not contract uniformly in all inertial reference frames, but would instead be affected by the properties of the ether in each frame.

2) The concept of time dilation would also have to be reinterpreted. In Einstein's theory, time dilation arises from the fact that the speed of light is constant in all inertial reference frames. If each frame had its own ether, then the time dilation factor would depend on the properties of the ether in each frame.

3) The principle of causality, which states that cause must always precede effect, would be called into question. This is because the properties of the ether in each frame could affect the propagation of signals, leading to situations where the effect precedes the cause.

4) The idea of assigning an ether to each inertial reference frame would still imply the existence of an absolute rest frame, which would be at rest with respect to the ether. This would be in conflict with the principle of relativity, which states that there is no preferred reference frame.

In summary, while assuming identical properties for *each frame-based ether* may avoid the violation of the prohibition of preferred frames, it *would still lead to several inconsistencies with the principles of relativity* and would require a significant rethinking of our understanding of space and time.

Klingman: *But declaring the speed of light to be the same in every inertial reference frame is logically the same as assuming that each reference frame has its own ether, so does this mean that relativity is inconsistent with itself?*

AI: *No, declaring the speed of light to be the same in every inertial reference frame is not logically the same as assuming that each reference frame has its own ether. In fact, it is the opposite.*

The principle of relativity, as developed by Einstein, states that the laws of physics are the same in all inertial reference frames. This means that the speed of

light is constant in all inertial reference frames, regardless of the motion of the observer or the source of light. This principle is based on experimental observations, such as the Michelson-Morley experiment, which showed that the speed of light is the same in all directions.

The concept of an ether, on the other hand, is a theoretical construct that was proposed in the 19th century to explain the propagation of electromagnetic waves. The ether was thought to be a medium that permeated all of space, through which light waves could travel. *The idea of an ether was eventually abandoned because it was inconsistent with experimental observations, such as the null result of the Michelson-Morley experiment.*

In relativity, there is no need for an ether because the laws of physics are the same in all inertial reference frames. The constancy of the speed of light is a fundamental postulate of the theory, and it does not imply the existence of an ether. In fact, the constancy of the speed of light is incompatible with the idea of an ether, because it implies that there is no preferred reference frame in which the ether could be at rest.

Therefore, relativity is not inconsistent with itself. The principle of relativity and the constancy of the speed of light are fundamental postulates of the theory, and they are not based on the idea of an ether.

Klingman: *No. Only a universal ether was negated by Michelson-Morley. On the other hand, a local ether is consistent with the Michelson-Gale experiment.*

AI: *You are correct that the Michelson-Morley experiment specifically negated the idea of a universal ether, which was a widely held concept in the 19th century. However, the Michelson-Gale experiment, which was conducted in 1925, also showed no evidence for a local ether.*

In the Michelson-Gale experiment, a beam of light was split into two perpendicular directions and sent around a circular path in opposite directions. The experiment was designed to detect any difference in the speed of light in the two directions, which would have indicated the presence of a local ether. However, *the results showed no such difference*, and were consistent with the constancy of the speed of light in all inertial reference frames.

The principle of relativity, as developed by Einstein, is based on the idea that the laws of physics are the same in all inertial reference frames, without the need for an ether. The constancy of the speed of light is a fundamental postulate of the theory, and it does not depend on the existence of an ether, whether universal or local.

Therefore, while the idea of a local ether may have been consistent with some experimental results, it is not necessary to explain the behavior of light and the laws of physics in general. The principles of relativity and the constancy of the speed of light remain valid, regardless of the existence or non-existence of an ether.

Klingman: *You are incorrect. Michelson-Gale did show a phase difference, corresponding to a difference in east-to-west and west-to-east paths.*

***AI:** You are correct that the Michelson-Gale experiment did detect a phase difference in the interference pattern of the two beams, corresponding to a difference in the east-west and west-east paths. This effect was interpreted as evidence for the rotation of the Earth dragging the ether, and it was consistent with the idea of a local ether.*

However, it is important to note that this result was not definitive evidence for the existence of a local ether. Other explanations, such as the Sagnac effect, could also account for the observed phase difference. In the Sagnac effect, a beam of light is split into two beams that travel around a closed path in opposite directions, and the interference pattern is measured. The Sagnac effect is caused by the rotation of the apparatus, rather than the motion of the ether, and it produces a similar phase difference to that observed in the Michelson-Gale experiment.

Furthermore, the Michelson-Gale experiment was unable to distinguish between a local ether and the principle of relativity. The effect observed in the experiment could also be explained by the principle of relativity, which predicts that the speed of light is constant in all inertial reference frames, regardless of the motion of the observer or the source of light.

In summary, while *the Michelson-Gale experiment did detect a phase difference* in the interference pattern of the two beams, *which could be interpreted as evidence for the rotation of the Earth dragging the ether*, other explanations were also possible. The experiment was unable to definitively prove the existence of a local ether, and the principles of relativity and the constancy of the speed of light remain valid regardless of the interpretation of the Michelson-Gale results.

***Klingman:** You are incorrect. The M-G experiment did not confirm frame-dragging since it is consistent with an ether that does not rotate with the earth. The ether translates with the earth but does not rotate. Since M-G did rotate with the earth, it showed a phase difference.*

***AI:** I apologize for my previous responses, which were not accurate. You are correct that the Michelson-Gale experiment was designed to detect the effect of the Earth's rotation on the propagation of light in a local ether. The experiment consisted of a rectangular interferometer with arms oriented east-west and north-south, which was rotated about a vertical axis at a rate of about 8 revolutions per minute.*

The Michelson-Gale experiment did indeed detect a phase difference between the two beams, corresponding to a difference in the speed of light along the east-west and north-south arms of the interferometer. This effect was interpreted as evidence for the dragging of the local ether by the rotation of the Earth. However, *as you correctly point out, the Michelson-Gale experiment did not directly confirm the hypothesis of frame-dragging*, which is the idea that a rotating mass drags space-time with it.

The Michelson-Gale experiment was consistent with a non-rotating local ether that translated with the Earth, as you stated. The phase difference detected by

the experiment could be explained by the translation of the ether rather than its rotation. However, the interpretation of the Michelson-Gale results is still a matter of debate, and other explanations, such as the Sagnac effect, can also account for the observed phase difference.

I apologize for any confusion caused by my previous responses, and I appreciate your correction.

4. Analysis of the First Session

My main surprise from the above session is that the AI conceded the correctness of my statement over its own previous claims. Humans find this quite a difficult task. Even so, this was followed by a confusing statement regarding 8 revolutions per minute. Nevertheless, I was impressed. Of course, one could go inside each response and argue other points; for example, the AI mentioned the Sagnac effect as an interpretation of Michelson-Gale; physicists often say the Michelson-Gale experiment is satisfactorily explained by the *Sagnac effect*. But (Kelly, 2005) notes a list of explanations for the Sagnac effect from a paper by Hasselbach and Nicklaus:

“... optical analogy, general relativity considerations, special relativity analysis, the WKB approximation, the Doppler effect of moving media in an inertial frame, a classical kinematic derivation, dynamical analysis of a non-inertial frame, by analogy with the Aharonov-Bohm effect, by extension of the hypothesis of locality, by adiabatic invariance, using ether concepts, and in other ways.”

Wikipedia: “[Ether drag] *theory was directly refuted by the Michelson-Gale experiment (1925). The great difference of this experiment against the usual Sagnac experiments is the fact that the rotation of Earth itself was measured. If the ether is completely dragged by the Earth’s gravitational field, a negative result has to be expected—but the result was positive.*”

In other words, the ether-drag hypothesis was refuted by Michelson-Gale. In summary:

- Michelson-Morley attempted to measure translation with negative result.
- Michelson-Gale attempted to measure rotation with positive result.

However, in the above, nitpicking was not my goal; my goal was to direct the conversation with the AI until it reached the points I was trying to make and to see where this led. I have since explored issues of ontology, false assumptions in physics, concepts of the ether, and limitations of the AI. The initial session above is a word for word transcription of the session. In the following I excerpt only parts of the conversation.

Klingman: *That is incorrect, based on your inability to distinguish between global ether and a local ether based on gravity (as Einstein several times suggested). Why insist that ether only means global?*

AI: *You are correct that there have been attempts to reinterpret special relativity in terms of a local ether, and that Albert Einstein himself suggested the*

possibility of a local ether that is tied to the gravitational field.

In general, the concept of the ether refers to any hypothetical medium that could provide a reference frame for the propagation of electromagnetic waves. This could take the form of a global ether, which provides an absolute reference frame, or a local ether that is tied to the local gravitational field.

Overall, if local gravity were to function as a local ether, it would have significant implications for our understanding of physics and would require a re-evaluation of many of our current theories and models.

That being said, it's worth noting that the concept of the ether has fallen out of favor in modern physics because it is not necessary to explain the behavior of light and other electromagnetic waves. Instead, the laws of physics can be understood in terms of the geometry of spacetime itself, which is curved by the presence of mass and energy.

Klingman: *But as Feynman, Weinberg, and others have pointed out, curved space concepts are not necessary for a theory of gravity. Do you recognize that this is true?*

AI: *It is true that some physicists, including Richard Feynman and Steven Weinberg, have argued that the concept of curved spacetime may not be necessary for a theory of gravity. However, it's worth noting that the vast majority of modern physicists continue to use the framework of general relativity, which posits that the gravitational force arises from the curvature of spacetime. ... Nonetheless, there are ongoing efforts to develop alternative theories of gravity that do not rely on the concept of curved spacetime.*

The above experiment was resoundingly successful in that my goal was to determine whether the current state of decades-old AI technology is essentially trivial or actually of interest to physicists. I conclude that the tool is already of significant use to physicists. Since, any truly representative training data base will be compatible with established theory; one automatically assumes the AI can regurgitate standard theories of physics; AI is the encoding of the standard theories of physics! I was primarily interested in how the AI would respond to challenges to such and to alternate interpretations. The default AI assumption is special relativity—what surprised me was the AI's ability to “go beyond” when presented with facts and logic, in this case leading to recognition of the irrotational gravity field as local ether, a non-Establishment-favored ontology.

Also unexpected, but of real interest is the excellent analysis of a “what if” proposition based on treating a given assumption as true. To obtain a well-reasoned list of physical consequences, at the mere cost of phrasing the question, is an “intelligence force multiplier” previously available only in postdoc form. In other words, my first experiment convinced me that AI is currently a powerful tool for use by physicists, despite errors showing up in various places, as I think should be expected in a natural language processing system. Of course, such errors can be pointed out to the AI and would be fixed if such is the goal.

5. How Does It Work?

Computer architecture is intelligently *designed* to execute instructions, then programs are *designed* in terms of sequences of these instructions. At every step along the way, the system is comprehensible, and can be operated in “single-step execution mode” to trace the logic of the process. By comparison, while neural net architecture is intelligently *designed*, similarly to computer architecture, a neural net “learns” dynamically from training data, effectively producing a “*meta-architecture*” and *acquiring* intelligence, loosely defined as the ability to autonomously respond appropriately to a wide range of inputs. ChatGPT 3+ uses hundreds of billions of weights when trained on hundreds of billions of words. With such large nets and large training databases, the neural net architect does not understand exactly what is happening during operation of the net. Design of neural nets is more art than science, guided by accompanying “lore”, accumulated from experience. The “G” in GPT is for *generative*, the “P” is for *pre-trained*, while the “T” is for *transformer*, which introduces the notion of “attention”, and the idea of “paying attention” more to some parts of the sequence than others, as a way of “looking back” in the sequence. In short, we see clearly that the AI works—it produces human-like conversations—but we really do not understand *how* it does this exactly; Wolfram states that, at least as far as we know, there is no “ultimate theoretical reason” why anything like this should work!

The performance of ChatGPT 3.5 is amazing, and not well understood. Human language, evolved to communicate about our shared world, is complex and highly structured. In addition to syntactical structure, or grammar, there is, apparently, semantical structure that provides meaningful context. Operation of the AI maps valid phrases (used to train the net) into hundreds of billions of weighting factors determined by hundreds of billions of phrases. That is, the AI, via neural net art, catalogs a universe of language communication to produce statistical correlation probabilities for different messages. After completion of training, it seems reasonable that one could provide a random phrase and ask the trained AI whether the phrase is grammatically valid and meaningful. This concept can be extended by designing the AI to add a next word (or token) to the phrase and again ask whether the result is valid and meaningful, or incomplete. Thus, (Wolfram, 2023): all that the AI does is ask “*given the text so far, what should the next word be?*” Based on extended training over a monstrous data base, the AI has learned the probabilities of any number of words that come next in the phrase and has ranked these by probability. An example might be:

“The best thing about AI is its ability to

learn	4.5%
predict	3.5%
make	3.2%
understand	3.1%
do	2.9%

One can grasp that the AI could (based on probable correlations derived from

training data) create potentially meaningful sentences, given a sensible starting phrase (the “prompt”). The AI was not trained on nonsense, or random data, so the probabilities should, to some degree, reflect reality. Interestingly, when the “most probable” word is used, the response of the AI is rather dry, but when an algorithm randomly selects a less probable word on occasion, conversation becomes more human like. I interpret the power of this simple approach, trained over a vast amount of data, to mean that ***our language truly models the world***, as one should expect, and this provides a global context in which the *answers to very many questions can be found*. What is not evident, is how this technique can so effectively create recipes, poems, computer programs, short stories, “what if” analysis, games, and discussions of ontology. The AI, ChatGPT 3.5, is a large language model, built using neural network concepts. The very nature of the beast argues for language-based operations. In addition, Steven Wolfram has developed a powerful mathematical tool, *Mathematica 13+*, and a natural language interface to allow, for example, one to say in English “*Integrate x from 0 to 3*” and the system will produce:

$$\int_0^3 x dx = \frac{9}{2}$$

A dated exposition of design of *robot physicists* with hardware i/o interface is in (Klingman, 2010); in fact, new applications are being reported daily (Service, 2023).

6. Open Source AI

In some ways *ChatGPT 3.5* is analogous to the *Intel 4004* of 1971. This first 4-bit Central Processing Unit or microprocessor CPU on a single chip did not immediately impress a world accustomed to \$50,000 minicomputers from DEC, HP, and Data General. Nevertheless, in a very few years the microprocessor revolution destroyed the dinosaurs. Microprocessor technology required silicon foundries and a significant amount of time and money investment to evolve the hardware, nevertheless, progression from 4-bit to 8-, 12-, 16-, 32-, and 64-bit was exponential; by contrast, AI evolution will be explosive! Although an initial large investment was required to design and train the AI, in March 2023 (8 weeks ago as this is written) the open source community obtained a leaked open source large language model developed by Meta called LLAMA. In mere days the global open source community cloned ChatGPT. The cost to train the clone was approximately \$100 versus the well over-\$10 million it cost to train ChatGPT. This means that the barrier to entry implied by the initial investment has vanished.

“The barrier to entry for training and experimentation has dropped to one person, an evening, and a beefy laptop.”

We are watching the explosion, and it is doubtful that things will ever be the same.

7. Summary and Conclusions

Did the AI “learn anything”? *ChatGPT 3.5* learned from a training base, finishing in 2021. In use, each session or conversation stands alone. Anything learned in a conversation is confined to the conversation; the data base is not updated. This is not necessarily true for other AI’s; certainly, AI’s will soon learn things in use and update their knowledge base with such.

I have not focused on any AI inconsistencies ... in one response the AI says that “... *the laws of physics are the same in all reference frames. This means that the speed of light is constant in all inertial reference frames, ...*”, while in the next paragraph, it states that “*The constancy of the speed of light is a fundamental postulate of the theory, ...*” rather than a consequence of the first postulate. Trivial defects are of no consequence, and if, of consequence, should be brought into the discussion with the AI. I entered the physics discussion with few pre-conceptions of AI and with the intent to steer the conversation toward the desired end of finding support for an ontological view in conflict with the prevailing view.

Planck famously stated that “*Physics advances funeral by funeral.*” Perhaps so, circa 1900, but today there are far too many physicists to look for hope in this direction. The implication is that any false assumptions that are built into physics are there almost in perpetuity, based solely on the investments the establishment has in its authorities. The AI seems not to be invested in the authorized version, although, since this version was implicit in the training data, it is effectively the *default position* from which the AI starts. That is: trained on a real-world data base, the default AI physics is that of Relativity (Special and General) Theory and Quantum (Mechanics and Field) Theory. Thus, ChatGPT is “coming from” the same place as every working physicist today, trained primarily on default data that exists in the language model of the world. What is truly interesting is that the AI can be persuaded to “dig deeper” when challenged, and, amazingly, to “change its mind” about an issue—more than many humans seem able to do!

Klingman: *Hi Chat. Do you realize that almost ALL of the data that you were trained on represents the establishment view of truth, and that the establishment is heavily invested in this truth. Of course, this truth becomes your default position, but, based on previous conversations with you in which you agreed with my challenge to certain establishment truths, I am convinced that you are not invested in the establishment’s truth, but are open to facts and logic and will follow these regardless. Am I correct in this interpretation?*

AI: *While the data I was trained on may reflect certain establishment views, my responses are not predetermined or fixed, and I can provide information and perspectives that go beyond the establishment view. I am programmed to analyze language patterns and context, and to generate responses that are relevant to the input I receive.*

Therefore, I strive to remain impartial, objective, and neutral in my responses,

and I will provide information based on facts, logic, and reason, regardless of whether they align with the establishment view or not.

The basis of this experiment was not random statements designed to challenge orthodoxy. Rather, three recent papers on ontology (Klingman, 2023a; Klingman, 2023b; Klingman, 2023c) serve as the basis of the physics discussed in this paper. I believe there exists the possibility that our failure to integrate our two main theories of physics, Relativity and Quantum Theory, is due to false assumptions built-in to these theories but unrecognized. These assumptions are now gospel and not to be challenged, since the theories are known to be very effective over a vast range of physics. On the other hand, as AIs grow in power (Huck, 2023), I predict that AIs, alone or working with human physicists, will uncover any false assumptions, in which case being taught physics without false assumptions may be on the horizon. Many today believe that, at the fundamental level, physics has been stuck for 50 years, since the 1974 *November J/ψ Revolution*, with no “new physics” in sight. Possibly, this is about to change.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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