How can we distinguish between good and bad interpretations in the Natural Sciences?

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The fundamental idea behind the natural sciences has long been to understand the physical world that surrounds us based on factual observations. Their empirical nature is, however, challenged by the fact that observations have no intrinsic meaning. In most cases, it is possible to observe *what* is happening, but not *why* it is happening.

However, in order to be able to understand and predict our world, we need to be able to infer that *why*, which is why we are compelled to build interpretations from our observations. For the purpose of this essay, I will define *interpretations* as our understanding of observed phenomenons. Sadly, as there is no strict and deterministic process for bridging the gap between evidence and understanding, there is no guarantee that someone's interpretation will be right. Therefore, if we want to keep the rigour of the scientific method intact, while being able to use interpretations, we need a way to more objectively classify an interpretation as good or bad.

But what makes an interpretation good or bad? I believe that the answer to this question is twofold: a good interpretation should (1) be able to match past observations and predict future ones and (2) it should be representative of what is actually happening.

However, I believe that this good / bad distinction is a false dichotomy, as the validity of an interpretation is often impossible to permanently establish and is almost always dependent on context.

My goal throughout this essay is to explore the validity of those criteria as well as the limitations of the good / bad dichotomy by looking at the historical development of the Lamarckian theory of evolution and of the Newtonian theory of gravitation.

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Jean-Baptiste Lamarck was a French biologist who theorized at the start of the 19^{th} century that species evolved through the "inheritance of acquired characters". In short, he believed that animals would see some of their characteristics change throughout their life in order to adapt to their ever-changing environment and that those changes would be transferred to their offspring. Over time,

characteristics of species as a whole would change through this process.[1] Those conclusions were based on a lifetime of observations on many animals. To the best of his knowledge, his theory (1) matched past observations and (2) was representative of what was actually happening, his theory being about what he believed to be the cause of evolution. At that time, we probably would have said that his interpretation of the phenomenon of evolution was good.

Yet, we now know that species evolve not through changes that happen during the life of specimens, but rather through the natural selection of random variations throughout the specie, as outlined by Darwin's theory of evolution, who arrived to this conclusion after conducting much more extensive research throughout the world. Lamarck's theory couldn't justify all of the observed evolutionary behaviours anymore, or at least, not as well as Darwin's theory.

This example highlights how an interpretation's goodness can vary through time, a consequence of the fact that proving something true in the natural sciences is next to impossible, as no finite number of observations could ever lead to absolute certainty about a fact or trend. This is not to say that we should consider all interpretations to be bad and unprovable, as that would imply that there is no point in even observing our world. It is simply a reminder that we must always be cognizant that new observations can overthrow past interpretations and that no interpretation should be held too high to be requestioned.

In the case of Lamarckism, experts initially found it to be a good interpretation, as it was a sensible theory matching real-world evidence, but changed their minds once more observations and a new theory that was even closer to the real world appeared. Lamarck's theory is now simply a perfect example of the provisional nature of the natural sciences.

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Moving out of biology and into the field of physics, the Newtonian theory of gravitation also proves to be a rich example of what makes an interpretation good or bad.

In 1687, Isaac Newton, an English mathematician and physicist, constructed a mathematical model for the gravitational interaction of objects, based on many empirical observations. The formula $F_g = Gm_1m_2R^{-2}$ could essentially be considered to be his interpretation of the phenomenon of gravity.[2]

However, this interpretation was not without its flaws, notably that (1) it failed to correctly predict Mercury's orbit and that (2) it couldn't justify why the mass of the objects was linked to their gravitational pull.[3]

Based on our above two criteria, we would have to say that this is a rather bad interpretation, as these two failures clearly show that it doesn't match actual

[1] Richard W. Burkhardt. *Jean-Baptiste Lamarck*. Dec. 14, 2022. URL: `https://www.britannica.com/biography/Jean-Baptiste-Lamarck` (visited on 03/09/2023).

[2] Richard S. Westfall. *Isaac Newton*. Feb. 21, 2023. URL: `https://www.britannica.com/biography/Isaac-Newton` (visited on 03/09/2023); The Editors of Encyclopaedia Britannica. *Newton's law of gravitation*. Nov. 11, 2022. URL: `https://www.britannica.com/science/Newtons-law-of-gravitation` (visited on 03/09/2023).

[3] Randy Kobes. *Gravity as Curved Space: Einstein's Theory of General Relativity*. Sept. 29, 1999. URL: `https://theory.uwinnipeg.ca/mod_tech/node60.html` (visited on 03/09/2023).

observations and that it doesn't fully explain why things happen in the way that they do.

Yet, it is still widely used to this day and taught in roughly all high school curriculums. How can this be?

In practice, our lack of a grand unified understanding of the universe implies that no interpretation can be purely good in the natural sciences, at least based on the criteria of accurate predictions and justification. However, as long as we state the assumptions under which a model can predict truthful results and that its justification is close enough to what is really happening, the interpretation is probably just fine. This comes back to the idea that we should simply always keep in mind that interpretations are meant to be requestioned as we deepen our knowledge.

In most cases, Newton's theory of gravitation is a perfectly fine interpretation and almost matches the two criteria, we simply must be aware of its limitations.

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In conclusion, while a good interpretation should generally match past observations and be representative of what is truly happening, it must be kept in mind that the passage of time may always invalidate past interpretations, that no interpretation can really be truly universal and that it is therefore quite impossible to definitively classify an interpretation as being either good or bad.

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