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To Explain or To Predict: Which one is mandatory?

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Abstract

Recently, Luk mentioned that scientific knowledge both explains and predicts. Do these two functions of scientific knowledge have equal significance, or is one of the two functions more important than the other? This commentary explains why prediction may be mandatory but (natural language) explanation may be only desirable and optional.

Keywords: philosophy of science, scientific knowledge, explanation, prediction.

1. Introduction

Luk (2016) mentioned that scientific knowledge explains and predicts (Shmueli, 2010), but it is left unclear whether these two functions are equally important or whether one function is more important than the other. In here, we argue which function is fundamental that is mandatorily required and which function is only optionally desirable.

2. Quest for Scientific Knowledge

As Luk (2010) defined science as a body of scientific knowledge, it is natural to consider that the aim of scientific knowledge is to achieve some understanding (Kosso, 2007) of the subject. In our experience, some reviewers or editors of scientific journals/conferences may require scientific papers to be qualitative instead of quantitative because they see scientific papers as the dissemination of scientific knowledge with the ultimate aim of achieving understanding or gaining insight of the particular topic. Their view of science is that scientific knowledge is mainly concerned with (natural language) explanations and insights, rather than predictions. In fact, philosophers of science (e.g., Salmon, 1971; 1984; Kitcher, 1989; Schurz, 1995) have been researching in what sense science provides explanations because explanations are thought to be central in science (as science has explanatory power).

According to Luk (2015), (prediction) accuracy is one of the basic qualities of scientific knowledge. Luk (2015) has even formulated a basic principle that requires scientific models to achieve prediction accuracy at least better than random on average. Although Luk (2015) formulated an assumption that eventually theories and models (i.e., some form of scientific knowledge) can explain the phenomena, it is only an assumption and not a basic principle (unlike prediction accuracy) that is applicable all the time. Therefore, Luk (2015) considers predictions to be of central importance instead of explanation as he put (prediction) accuracy as part of the aim of scientific study by Luk (2015) instead of explanation or understanding.

3. To Explain or to Predict

With these two opposing views, how can we decide whether explanation or prediction is important, or indeed whether both are important? Explanations and predictions are two functions of scientific knowledge and these functions are related to each other as explanations lead to predictions and poor predictions can eliminate explanations. This interlocking relationship makes it difficult to discern. So, we consider the extreme situation like string theory in physics where there is an elaborate mathematical theory to explain the different phenomena or solve theoretical problems, but it has not provided novel predictions that match reality. While we think of string theory still belongs to science as working scientific knowledge (Luk, 2015), we do not consider it to be established scientific knowledge like a scientific theory (Luk, 2016). Because it is possible to work out the explanations given the results, we attribute more confidence to the theory if it can make a correct novel prediction as the theory does not know the result during the prediction. One may argue to use a statistical procedure (like scientific realism in Luk, 2016) to decide to accept such a theory only by making successful explanations (given the results). However, all these tests are of the same type which may imply that the tests are not independent trials. Therefore, there is a need to include novel predictions in the tests. This suggests that just by having explanations does not override the need to have (novel) predictions.

Can predictions override the need for explanations? In the past, there are instances where prediction accuracy overrides the need for explanations or understanding. For example, quantum mechanics (Kosso, 2000; Santos, 2015) achieved its current status because of its prediction accuracy, and a satisfactory explanation of it is still needed today in order to understand it. It may be argued that it was accepted at the time in the hope that a good explanation will be provided later, which explains why there are so many papers recently on interpreting quantum mechanics (e.g., Santos, 2015). However, there is no reason to believe that nature guarantee us to be able to understand it in terms of human natural language. There is, however, a reason to believe that nature facilitates us to understand it in terms of rule-like explanations because nature must have sufficient regularities for us to observe. Otherwise, we will just be random noise if there are no such regularities. When we observe these regularities, they may become patterns or rules that we discover in science. Therefore, we believe that natural language explanations may not be possible for some topics in science even though there are rule-like explanations.

4. **Counter Intuitive?**

If (natural language) explanation is only desirable but optional, then one might argue that it is counter intuitive that we do not need to understand scientific knowledge which is why it was discovered for in the first place. Our argument is that nature does not guarantee us scientific knowledge in natural language that can be understood by human. The scientific knowledge is discovered from the regularities in nature, in order to predict the outcome reliably conforming to the aim of scientific study by Luk (2015). If we understand in natural language how the scientific knowledge leads to the outcome (intuitively), that is a bonus. If we do not understand in terms of natural language, then we lack the reasons to believe that the predicted outcome will follow although it does not mean that that predicted outcome will necessarily not follow. Therefore, we can conclude that insights and (natural language) explanations are only highly desirable in the scientific papers but they are not mandatory.

Furthermore, (rule-like) explanations may be counter intuitive. In science, this has happened before. For example, our common understanding in mechanics of exerting a force on some object requires the force to be in contact with the object. However, in nature like gravity, the force may act on a particle in free space without being in contact according to Newton's law of universal gravitation (which is replaced by general relativity). This is counter intuitive to our everyday experience in mechanics. Similarly, in general relativity, space can be bent due to gravity but empty space has nothing to be bent suggesting that there is an ether even though no such ether is established in science suggesting that this is a counter-intuitive explanation. In order to explain gravity, researcher comes up with the idea of a particle or a string mediating this force. For example, some may conjecture that there is a graviton (particle or string) so that gravity can be mediated to the objects to exert some force to the object. However, it may be that in nature no such graviton exists (for the sake of argument) and we just have to accept that gravity can propagate through free space without any intermediaries or space can be bent unlike our everyday experience of mechanics or intuition. Based on accepting this property that gravity can propagate through free space or space can be bent, we may deduce how much force is exerted on the object. So, for the sake of argument the explanation requires us to accept some properties (like axioms) that are found in nature as they are (which may be counter-intuitive), and use these properties to explain other phenomena. Therefore, there is no guarantee that the explanation conforms to our intuition even though intuition may be a good source of hypothesis generation for deeper understanding. So, reviewers and editors of scientific journals/conferences who keep asking the authors to provide (intuitive or natural language) explanations (for communication) may be too demanding for some phenomena although rule-like explanations can be provided. Note that we are not arguing that we should stop deep inquiry by not generating hypothesis that leads to deep understanding, and this kind of deep inquiry has been very successful in the past. Instead, we are arguing that nature does not guarantee us with regularities or properties that necessarily conform to our intuition. So, we should not be surprised that there may not be any natural language explanations coming from the scientific knowledge. However, we believe that rule-like explanations can be provided by scientific knowledge, consistent with our assumption in Luk (2015) that theory and model can (eventually) explain phenomena.

Note that we are not arguing whether explanatory modeling is more important than predictive modeling as in Shmueli (2010). We believe perhaps both types of modeling are important as descriptive accuracy and predictive accuracy are qualities of the scientific knowledge. However, explanatory modeling can hold out a small amount of its data for estimating the predictive accuracy of the explanatory models so that they can be assessed in terms of prediction accuracy as well (since goodness-of-fit does not necessarily imply description accuracy). To know whether the ultimate model or theory is describing accurately, the model or the theory needs to be applied to many different situations demonstrating it can predict accurately for these different situations which are tested to establish the statistical significance in our decision to accept the model or theory as the accurate model or theory of the phenomena according to the argument by Luk (2016) about scientific realism.

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