

## CHAPTER 1

### INTRODUCTION AND TERMINOLOGY

The approach-to-the-truth project started with the publication of Popper's *Conjectures and Refutations* in 1963, which contains the first formal explication of the "verisimilitude" notion. Eleven years after this publication, the twenty-fifth volume of the *British Journal for the Philosophy of Science* gave the project a significant incentive. In their contributions, Miller, Tichý, and Harris, proved the inadequacy of Popper's definition. In this chapter the rise and fall of Popper's proposal is sketched, and a technical framework is developed to compare the alternatives to Popper's proposal. I deal with the general philosophical background of the verisimilitude notion, Popper's definition and its failure in Sections 1.1–1.2. An explanation of how I shall compare the various proposals presented in Chapters 2–3 is given in Section 1.3. I shall base this comparison on the most elementary mathematical applications of the definitions: propositional languages. The two different ways to paraphrase theories and data in the algebra foreshadow the paramount distinction between two kinds of approach-to-the-truth proposals: the content and likeness definitions. This distinction is reconstructed in Section 1.4 in terms of two different strategies to revise Popper's original explication. It leads to a formal definition of the contrast between content and likeness definitions. Finally, in the fifth section, I introduce further metatheoretical properties used in later chapters.

#### 1.1. PHILOSOPHICAL BACKGROUND

The basic philosophical ideas related to the verisimilitude notion are sketched in this section. My ambition is a modest one. I do not want to give a thorough account of all the advantages and drawbacks of the various points of view involved. That would require a separate publication of more than one volume. It is my intention to give a rough map as to where to find the verisimilitude notion in the landscape of philosophical ideas about developments in scientific knowledge.

##### *1.1.1. Scientific Progress*

I want to mention two prescientific or philosophical intuitions underlying the idea of *scientific progress*. The first is that knowledge in various scientific disciplines

becomes increasingly exact. I shall call this feature *growth in depth*. Scientists manage to answer more and more why questions about a particular area of investigation. For instance, scientists became acquainted with chemical reactions that caused phenomenological changes, next, they discovered the importance of chemical bonds in chemical substances, and today, chemists use quantum mechanical insights to study these bonds. In the same manner, scientists first thought that atoms were the smallest particles in the universe; subsequently they discovered that atoms consisted of protons, neutrons and electrons, and today, quarks are thought to be the smallest building blocks of all substances. Smaller steps, such as concretizations also exemplify this growth in depth. The Van der Waals's refinement of the Boyle-Gay Lussac law serves as an example. These are not unique examples of the growth in depth phenomenon. On the contrary, the scientific community has produced such examples in large numbers. C.S. Peirce compared the improvement of our scientific understanding with the increasing knowledge about the numerical value of  $\pi$  in digits.<sup>1</sup> Just as our knowledge about  $\pi$ 's decimals increases, our knowledge of physical phenomena becomes more and more exact. The idea that this increase of exactness must be interpreted as *accumulation* has been severely scrutinized in the past, since no scientific theory is strictly speaking true.<sup>2</sup> Scientific progress interpreted as approaching the truth differs from progress as accumulation of truths.

The second intuition related to scientific progress is the idea that the *number of scientific subjects*, about which scientists make warranted claims, *increases steadily*: I shall call this phenomenon *growth in breadth*. Not long ago, people believed that earthquakes, the plague, lightning, and deformed babies were all examples of divine punishments. Now we know that plate-tectonics, the bacterium *Yersinia pestis*, electromagnetism, and DNA provide scientific explanations for these phenomena. Our knowledge about the different subjects is also becoming mutually compatible.<sup>3</sup> This fosters the idea that our knowledge is not an arbitrary way to put phenomena together, but indeed reflects some relevant part of reality. In short, the growth in number of answered questions and the profound increase of detail nurture our philosophical intuitions about improvement of scientific knowledge and advancement that scientists make in unravelling the mysteries of nature. Combining content and a likeness strategies, my proposal of *Refined Verisimilitude* mirrors both forms of progress.

In our era, after the publications of Thomas Kuhn, the distinction between normal science and scientific revolutions has gained importance. The growth in breadth and depth are not incompatible with the distinction between normal and revolutionary science. The ideas about paradigmatic changes only qualify the notion of constant scientific growth. The distinction between normal science and scientific revolutions pertains to the two forms of scientific progress. For instance, the enhancement our specific knowledge about the chemical properties of chemical

compounds (*growth in depth*) is a paradigmatic example of normal science; however, it might lead to unexpected results that can end in revolutionary insights.

The debate between realists and instrumentalists, also affects the discussion about scientific progress. The success of science has been used as a weapon against the antirealists: witness the following, often cited quotation of Putnam: “The positive argument for realism is that it is the only philosophy that does not make the success of science a miracle (Putnam (1975))”. Realists roughly argue that, if scientific theories bear no similarity to some parts of reality, then the successes of science would be inexplicable. The anti-realists, like Van Fraassen and Laudan, have defended themselves along various lines. Laudan, for instance, denies that the actual history of the sciences shows a course of progress. He scrutinizes Putnam’s argument, and constructs “a confutation of convergent realism.”<sup>4</sup> Laudan challenges realists to come up with a definition of convergent realism according to which the better (false) theory guarantees more lasting success. Following Kuipers, I shall refer to this adequacy condition with the term *Laudan’s challenge*.<sup>5</sup> Despite the force of Putnam’s argument, and despite the realistic origin of my formal work in the following chapters, I do not straightforwardly favour realism, and the present work is not relevant for realists only. Anti-realists also use partial orderings of theories, although they rather call a better theory more *empirically adequate* than closer to the truth.

History teaches that quarrelling about philosophical intuitions is an unsuccessful philosophical method. Comparison of (formal) results often provides a more important contribution to a philosophical debate. The approach-to-the-truth project is no exception. After the collapse of Popper’s definition the discussions about verisimilitude intuitions have brought us a plethora of approach-to-the-truth definitions. In this multitude of proposals the content likeness distinction turns out to be the most important one. The comparison of the formal proposals in Chapters 2–3, eventually shows that there are at least two different intuitions hiding behind Popper’s informal discussion of verisimilitude; a fact difficult to discover without the formal explanations.

In sum, the approach-to-the-truth project falls within the attempts of realists to define scientific progress, and some authors use verisimilitude to explain lasting empirical success. This does not mean, however, that the results of their endeavours are of no concern for anti-realists.

### 1.1.2. Popper

Popper’s ideas about verisimilitude can be interpreted to be a possible version of convergent realism. Popper tries to formulate an answer to a combination of the following questions which have vexed philosophers for a long time.

How can it be that, on the basis of singular observation, scientists are able to formulate abstract hypotheses that successfully explain and predict phenomena? How do the non-observable terms function in those hypotheses?

We shall come to Popper's proposal in the next section. Here, we only need an outline of his answer. Inspired by Tarski's truth definition, Popper proposes that successful theories are in a way *similar to Tarski's truth* relative to some language. When some relatively successful theory is replaced by a successor, there are indications that this successor is *more similar* to the truth and, hence, to some aspect of reality; thus, it will remain more successful. Popper's answer refers to at least three issues that need further explanation.

The first issue concerns the *concept of truth*. Popper is convinced that Tarski's definition of truth can be extended to the natural language of scientists. Such an extension would avoid the metaphysical bias that accompanied older truth definitions which ascribed truth to ideas instead of sentences. Popper considers Tarski's truth concept perfectly fit to serve as an explicans in his theory of verisimilitude. Consequently, his verisimilitude definition depends on some conceptual framework  $\mathcal{L}$  used to specify the theory and the problems to which it is an answer.<sup>6</sup> In the verisimilitude discussion, the truth corresponds to the strongest  $\mathcal{L}$ -proposition that is true.<sup>7</sup> For those who maintain that this notion of truth implies that there must be in some way "theories in nature", perhaps the following description is more acceptable. First, a language  $\mathcal{L}$  is *semantically determinate* (Niiniluoto's term) if all empirical sentences are to receive a definite truth-value.<sup>8</sup> Then, the true theory correctly divides these  $\mathcal{L}$ -sentences into a set of (Tarski) true sentences and a set of (Tarski) false ones.<sup>9</sup> Verisimilitude is a relation between linguistic (conceptual) elements, and Popper's strategy is an indirect, and sophisticated form of convergent realism. It does not directly claim that successive theories are more like some aspect of *reality* than other theories, but they are more like reality *as described by some language  $\mathcal{L}$* , and the relevant background knowledge.

The explanation of the property "being more like the truth" is the second part of Popper's answer that needs elaboration. In other words, the basic idea of one theory being more like the truth than another one, must be defined explicitly. This is the problem of the *definition of verisimilitude*. Popper has given an intuitive description and a formal definition of the concept. Unfortunately, the latter failed to capture Popper's intuitions. This will be the subject of the next subsection. In Chapters 2–3 I deal with several alternative proposals to define verisimilitude which can be reconstructed as adaptations of Popper's original definition. The problem of the definition must emphatically be distinguished from the *epistemic problem* of verisimilitude; and this distinction is the third element of Popper's answer that needs elaboration.

The definition of verisimilitude gives an answer to the question about what *we mean* if we claim that a theory is more verisimilar than another one. The epistemic

problem of verisimilitude, instead, reads, *how do we know* that a theory is more verisimilar than another one; or on what indications are we to conclude that a theory is closer to the truth than its predecessor.<sup>10</sup> The fourth chapter contains an evaluation of two important solutions to this epistemic problem of verisimilitude found in the literature. Obviously, Popper's own proposal must be connected with his ideas about falsification and corroboration, although, curiously enough, Popper introduced his methodological recommendations decades before he formulated his ideas about verisimilitude.

### 1.1.3. *Related Concepts*

This subsection concerns the difference between verisimilitude and many-valued logic, or even approximate truth. Although the latter concept is related to the idea of verisimilitude, Popper claims that his proposal differs from, and even in some respects improves many-valued logic.<sup>11</sup>

Kleene's introduction to three-valued logic is based on the following idea.<sup>12</sup> It often happens that we have to reason in a situation in which not all sentences have a fixed truth-value for us. A system of three-valued logic prescribes how we are to reason in such a situation. For instance, if  $\phi$  is true and  $\psi$  is unknown, we can safely infer that  $\phi \vee \psi$  is true, and that the truth-value of  $\neg\psi$  is unknown. A third truth-value  $I$  for "unknown", must be added to the system, and the truth-tables of the logical connectives have to be extended. These extensions depend on the interpretation of  $I$ . J. Łukasiewicz, and D. A. Bochvar give other interpretations to  $I$  than Kleene, viz. "possible but not necessary", and "meaningless", respectively. Although their truth-tables for the negation are identical, the truth-tables of the other connectives diverge. For instance, according to Łukasiewicz and Kleene, if  $\psi$  is false and  $\phi$  is  $I$ , then their conjunction is also false, whereas according to Bochvar the conjunction is meaningless. When a three-valued system is defined, there is no need to stick to only one extra truth-value. We can introduce a whole sequence of linearly ordered truth-values, and the higher the truth-value, the more a sentence is apt to be true.

Popper claimed that his ideas about verisimilitude differ from many-valued logic. Even in a two-valued system, two sentences with the same truth-value can be more or less similar to the truth. More specifically, if we know by falsification that two theories are false, one of them can definitely be more like the truth than the other. For instance, the mechanics of Descartes and those of Newton are both false, but we have strong indications that the second is more similar to the truth than the former. Verisimilitude has nothing to do with many-valued logic as "various degrees of truth".

The distinction between approximate truth and verisimilitude is less clear. Both concepts are used in attempts to vindicate some form of convergent realism.<sup>13</sup> The



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