Occam's razor (sometimes spelled **Ockham's razor**) is a principle attributed to the 14th-century English logician and Franciscan friar, William of Ockham. The principle states that the explanation of any phenomenon should make as few assumptions as possible, eliminating those that make no difference in the observable predictions of the explanatory hypothesis or theory. The principle is often expressed in Latin as the **lex parsimoniae** ("law of parsimony" or "law of succinctness"): *"entia non sunt multiplicanda praeter necessitatem"*, roughly translated as "entities must not be multiplied beyond necessity".

This is often paraphrased as "All other things being equal, the simplest solution is the best." In other words, when multiple competing theories are equal in other respects, the principle recommends selecting the theory that introduces the fewest assumptions and postulates the fewest entities. It is in this sense that Occam's razor is usually understood.

Originally a tenet of the reductionist philosophy of nominalism, it is more often taken today as an heuristic maxim (rule of thumb) that advises economy, parsimony, or simplicity, often or especially in scientific theories.

The origins of what has come to be known as Occam's razor are traceable to the works of earlier philosophers such as Alhazen (965-1039),[2] Maimonides (1138-1204), John Duns Scotus (1265–1308), Thomas Aquinas (c. 1225–1274), and even Aristotle (384–322 BC) (Charlesworth 1956). The term "Ockham's razor" first appeared in 1852 in the works of Sir William Rowan Hamilton (1805–1865), centuries after Ockham's death. Ockham did not invent this "razor," so its association with him may be due to the frequency and effectiveness with which he used it (Ariew 1976). Though Ockham stated the principle in various ways, the most popular version was written not by himself but by John Ponce of Cork in 1639 (Thorburn 1918).

The version of the Razor most often found in Ockham's work is *Numquam ponenda est pluralitas sine necessitate* [Plurality ought never be posited without necessity.]

Science and the scientific method

The aforementioned problem of underdetermination poses a serious obstacle to applications of the scientific method. Formulating theories and selecting the most promising ones is impossible without a way of choosing among an arbitrarily large number of theories, all of which fit with the evidence equally well. If any one principle could single-handedly reduce all these infinite possibilities to find the one *best* theory, at first glance one might deduce that the whole of scientific method simply follows from it, and thus that it alone would be sufficient to power the whole process of hypothesis formulation and rejection scientists undertake.

However, while the necessity of some method or another to determine a working hypothesis in spite of the problem of underdetermination is by and large undisputed, the progression of actual science and actual scientific consensus is far removed from some simple formula which accepts "the evidence" and outputs "the best theory". Axioms may be taken for granted that are not at all true; theories might exist that are better supported by the evidence but will be overlooked because scientists were collecting data from the wrong places or asking the wrong questions to begin with (this was emphasized by Thomas Kuhn, who outright rejected induction as the main driving force of scientific progress altogether in favor of paradigm shifts). Resorting to the importance of Occam's Razor within the limits of inductive arguments still leaves open problems of formulation; "the simplest explanation tends to be the best" is hardly a formally precise statement and it may be difficult to use it, as is, to rigorously compare two competing hypotheses. This leaves open the possibility of rigorous modern formulations, and indeed such formulations have been derived which- while being outside the scope of Occam's original razor- are true to its spirit and yield useful results (see below, "probability theory"). As a matter of fact, the razor's first known appearance, in Maimonides "The Guide for the Perplexed" was indeed done in the context of choosing between two competing scientific (cosmological) theories.

In physics, for example, one measurement of the simplicity of a theory is the number of free parameters. A theory with adjustable free parameters is considered to be less desirable than one with fewer free parameters, and a desirable goal of physics is to provide a theory with the minimum number of parameters required to explain the observations.

Occam's razor is *not* equivalent to the idea that "perfection is simplicity". Albert Einstein probably had this in mind when he wrote in 1933 that "The supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience" often paraphrased as "Theories should be as simple as possible, *but no simpler*." Or even put more simply *"make it simple, not simpler"*. It often happens that the best explanation is much more complicated than the simplest possible explanation because its postulations amount to less of an improbability. Thus the popular rephrasing of the razor - that "the simplest explanation is the best one" - fails to capture the gist of the reason behind it, in that it conflates a rigorous notion of simplicity and ease of human comprehension. The two are obviously correlated, but hardly equivalent.

There are two senses in which Occam's razor can be seen at work in the history of science. One is ontological reduction by elimination and the other is by intertheoretic competition.

In the former case the following are examples of reduction by elimination: The impetus of Aristotelian Physics, the angelic motors of medieval celestial mechanics, the four humors of ancient and medieval medicine, demonic possession as an explanation of mental illness, phlogiston theory from premodern chemistry, and vital spirits of premodern biology.

In the latter case there are three examples from the history of science where the simpler of two competing theories each of which explains all the observed phenomena has been chosen over its ontologically bloated competitor: the Copernican heliocentric model of celestial mechanics over the Ptolemaic geocentric model, the mechanical theory of heat over the Caloric theory, and the Einsteinian theory of electromagnetism over the luminiferous aether theory.

- In the first example, the Copernican model is said to have been chosen over the Ptolemaic due to its greater simplicity. The Ptolemaic model, in order to explain the apparent retrograde motion of Mercury relative to Venus, posited the existence of epicycles within the orbit of Mercury. The Copernican model (as expanded by Kepler) was able to account for this motion by displacing the Earth from the center of the solar system and replacing it with the sun as the orbital focus of planetary motions while simultaneously replacing the circular orbits of the Ptolemaic model with elliptical ones. In addition the Copernican model excluded any mention of the crystalline spheres that the planets were thought to be embedded in according the Ptolemaic model. In a single stroke the Copernican model reduced by a factor of two the ontology of Astronomy.
- According to the Caloric theory of heat, heat is a weightless substance that can travel from one object to another. This theory arose from the study of cannon boring and the invention of the steam engine. It was while studying cannon boring that Count Rumford made observations that conflicted with the Caloric theory and he formulated his mechanical theory to replace it. The Mechanical theory eliminated the Caloric and was ontologically simpler than its predecessor.
- During the 19th century, physicists believed that light required a medium of transmission much as sound waves do. It was hypothesized that a universal aether was such a medium and much effort was expended to detect it. In one of the most famous negative experiments in the history of science, the Michelson-Morley experiment failed to find any evidence of its existence. Then when Einstein constructed his theory of special relativity without any reference to the Aether this subsequently became the accepted view, thus providing another example of a theory chosen in part for its greater ontological simplicity.