Ockham's Razor (also Ocam's Razor or any of several other spellings), is a principle attributed to the 14th century English logician and Franciscan friar, William of Ockham that forms the basis of methodological reductionism, also called the principle of parsimony.

In its simplest form, Ockham's Razor states that one should not make more assumptions than needed. When multiple explanations are available for a phenomenon, the simplest version is preferred. A charred tree on the ground could be caused by a landing alien ship or a lightning strike. According to Ockham's Razor, the lightning strike is the preferred explanation as it requires the fewest assumptions.

Variations:
The principle is most often expressed as *Entia non sunt multiplicanda praeter necessitatem*, or "Entities should not be multiplied beyond necessity", but this sentence was written by later authors and is not found in Ockham's surviving writings. William wrote, in Latin, *Pluralitas non est ponenda sine necessitate*, which translates literally into English as "Plurality should not be posited without necessity".

Dave Beckett of the University of Kent at Canterbury writes: "The medieval rule of parsimony, or principle of economy, frequently used by Ockham came to be known as Ockham's razor."

The principle of Ockham's Razor has inspired numerous expressions including: "parsimony of postulates", the "principle of simplicity", the "KISS principle" (keep it simple, stupid), and in some medical schools "When you hear hoofbeats, think horses, not zebras".

A re-statement of Ockham's Razor, in more formal terms, is provided by information theory in the form of minimum message length.

Another variant of this law is *Thargola's Sword* from Nightfall, (originally a short story by Isaac Asimov and later expanded to a novel in conjunction with Robert Silverberg):

*We must drive a sword through any hypothesis that is not strictly necessary.*

Leonardo da Vinci (1452–1519) lived after Ockham's time and has a variant of Ockham's razor. His variant short-circuits the need for sophistication by equating it to simplicity.

*Simplicity is the ultimate sophistication.*

Ockham's Razor is now usually stated as follows:

*Of two equivalent theories or explanations, all other things being equal, the simpler one is to be preferred.*

As this is ambiguous, Isaac Newton's version may be better:

*We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.*

History:
William of Ockham (1287-1347) is usually credited with formulating the razor that bears his name, which is typically phrased "entities are not to be multiplied beyond necessity." In Latin, "entia non sunt multiplicanda praeter necessitatem". However this phrase does not appear in any of his extant writings. It is not until 1639 that this phrasing was coined by John Ponce of Cork. There are a variety of similar phrases such as "frustra fit per plura quod potest fieri per pauciora", "non est ponenda pluritas sine necessitate", and "si duae res sufficient ad ejus veritatem, superfuum est ponere altam (tertiam) rem". These translate as "in vain we do by many which can be done by means of fewer", "pluralities ought not be supposed without necessity", and "if two things are sufficient for the purpose of truth, it is superfluous to suppose another", respectively. The origins of what has come to be known as Ockham's razor is traceable to the works of earlier philosophers such as John Duns Scotus (1265-1308) and even as early as Aristotle (384-322 BC) (Charlesworth, 1956). Even the name 'Ockham's Razor' was unknown to William. This phrase does not appear until the 19th century in the works of Sir William Hamilton (1805-1865). It is perhaps how often and effectively he used it that accounts for its association with Ockham. See Roger Ariew's dissertation of 1976, *Ockham's Razor: A Historical and Philosophical Analysis of Ockham's Principle of Parsimony* and W. M. Thornburn's *The Myth of Occam's Razor*.

Historical significance:
Ockham's Razor was essentially a conviction that natural science (as seen in the works of Aristotle) and theology must split and go in different directions. The 12th and 13th century saw great efforts to unify theology and reason which cumulated with the works of Thomas Aquinas. Ockham rejected Thomas's "unnecessary" entities such as the active intellect, intelligible species and final causes that Thomas had created to construct a system of thought linking the operations of the natural world with the creativity of God. Ockham said such a construct was impossible and that the study of the natural world, and the study of theology must split. The former is knowable;
the latter will forever be a mystery. The divorce of reason and faith is a major turn in Western thought and significant in the development of scientific thinking.

**Justifications:**

Ockham's Razor is known by several different names including the Principle of Parsimony, The Principle of Simplicity, and The Principle of Economy. The reason for these alternate names can be explained by the association of simplicity and parsimony with Ockham's Razor. Prior to the 20th century it was believed that the metaphysical justification for Ockham's Razor was simplicity. It was thought that nature was in some sense simple and that our theories about nature should reflect that simplicity. With such a metaphysical justification came the implication that Ockham's Razor is a metaphysical principle. From the beginning of the 20th century, these views fell out of favor as scientists presented an increasingly complex world view. In response, philosophers turned away from metaphysical justifications for Ockham's Razor to epistemological ones including inductive, pragmatic, likelihood and probabilistic justifications, which is where things stand today. Thus, Ockham's Razor is currently conceived of as a methodological principle. Elliott Sober has expressed dissatisfaction with epistemological justifications for Ockham's Razor. He thinks that there must be a metaphysical presupposition for Ockham's Razor, but offers no possibilities (Sober, 1990). For a summary of epistemological justifications for Ockham's Razor see Roger Ariew's dissertation of 1976 "Ockham's Razor: A Historical and Philosophical Analysis of Ockham's Principle of Parsimony".

**Chatton's Anti-razor:**

Walter of Chatton was a contemporary of William of Ockham (1287-1347) who took exception to Ockham's Razor and Ockham's use of it. In response he devised his own anti-razor: "If three things are not enough to verify an affirmative proposition about things, a fourth must be added, and so on". Although there have been a number of philosophers who have formulated similar anti-razors since Chatton's time, Chatton's anti-razor has not known anything like the success of Ockham's Razor. Among those who have coined their own anti-razors are Gottfried Wilhelm Leibniz (1646-1716), Immanuel Kant (1724-1804), and Karl Menger (20th century). 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 thus 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. Einstein capitalized on this finding and constructed his theory without any reference to the Aether, thus providing another example of a theory chosen in part for its greater ontological simplicity.

**In biology:**

Biologists or philosophers of biology use Ockham's Razor in either of two contexts both in evolutionary biology: the units of selection controversy and Systematics. George C. Williams in his book *Adaptation and Natural Selection* (1966) argues that the best way to explain altruism among animals is based on low level, i.e. individual, selection as opposed to high level group selection. Altruism is defined as behavior that is beneficial to the group but not to the individual, and group selection is thought by some to be the evolutionary mechanism that selects for altruistic traits. Others posit individual selection as the mechanism which explains altruism solely in terms of the behaviors of individual organisms acting in their own self interest without regard to the group. The basis for Williams' contention is that of the two, individual selection is the more parsimonious theory. In doing so he is invoking a variant of Ockham's Razor known as Lloyd Morgan's Cannon. However, more recent work by biologists have revealed that Williams' view is not the simplest and most basic. The way evolution works is that the genes that are propagated in most copies will end up determining the development of that particular species, i.e., natural selection acts to select specific genes, and this is really the
fundamental underlying principle, that automatically gives individual and group selection as emergent features of evolution.

Zoology provides an example. Musk oxen, when threatened by wolves, will form a circle with the males on the outside and the females and young on the inside. This as an example of a behavior by the males that seems to be altruistic. The behavior is disadvantageous to them individually but beneficial to the group as a whole and was thus seen by some to support the group selection theory.

However, a much simpler explanation immediately offers itself, once you realise that natural selection works on genes. If the male musk ox runs off, leaving his offspring to the wolves, his genes will not be propagated. If however he takes up the fight his genes will live on in his offspring. And thus the "stay-and-fight" gene prevails. This an example of kin selection. An underlying general principle thus offers a much simpler explanation, without resorting to special principles as group selection.

Systematics is the branch of biology that attempts to establish genealogical relationships among organisms. It is also concerned with their classification. There are three primary camps in systematics; cladists, pheneticists, and evolutionary taxonomists. The cladists hold that genealogy alone should determine classification and pheneticists contend that similarity over propinquity of descent is the determining criterion while evolutionary taxonomists claim that both genealogy and similarity count in classification.

It is among the cladists that Ockham's razor is to be found, although their term for it is cladistic parsimony. Cladistic parsimony (or maximum parsimony) is a method of phylogenetic inference in the construction of cladograms. Cladograms are branching tree like structures used to represent lines of descent based on one or more evolutionary change(s). Cladistic parsimony is used to support the hypothesis(es) that require the fewest evolutionary changes. It should be noted that for some types of tree, it will consistently produce the wrong results regardless of how much data is collected (This is called long-branch attraction). For a full treatment of cladistic parsimony see Elliott Sober's *Reconstructing the Past: Parsimony, Evolution, and Inference* (1988). For a discussion of both uses of Ockham's Razor in Biology see Elliott Sober's article *Let's Razor Occam's Razor* (1990).

**In medicine:**

When discussing Ockham's Razor in contemporary medicine, doctors and philosophers of medicine speak of diagnostic parsimony. Diagnostic parsimony advocates that when diagnosing a given injury, ailment, illness, or disease a doctor should strive to look for the fewest possible causes that will account for all the symptoms.

**In philosophy of mind:**

Probably the first person to make use of the principle was Ockham himself. He writes "The source of many errors in philosophy is the claim that a distinct signified thing always corresponds to a distinct word in such a way that there are as many distinct entities being signified as there are distinct names or words doing the signifying. (Summula Philosophiae Naturalis III, chap. 7, see also Summa Totus Logicae Bk I, C.51). We are apt to suppose that a word like "paternity" signifies some "distinct entity", because we suppose that each distinct word signifies a distinct entity. This leads to all sorts of absurdities, such as "a column is to the right by to-the-rightness", "God is creating by creation, is good by goodness, is just by justice, is powerful by power", "an accident inheres by inherence", "a subject is subjected by subjection", "a suitable thing is suitable by suitability", "a chimera is nothing by nothingness", "a blind thing is blind by blindness", "a body is mobile by mobility". We should say instead that a man is a father because he has a son (Summa C.51).

Another application of the principle is to be found in the work of George Berkeley(1685-1753). Berkeley was an idealist believing that all of reality could be explained in terms of the mind alone. He famously invoked Ockham's Razor against Idealism's metaphysical competitor materialism claiming that matter was not required by his metaphysic and was thus eliminable. Idealism has few adherents today and Berkeley's arguments find few sympathetic ears.

In the 20th century Philosophy of Mind, Ockham's Razor found a champion in J.J.C. Smart who in his article "Sensations and Brain Processes"(1959) claimed Ockham's Razor as the basis for his preference of the mind-brain identity theory over mind body dualism. Dualists claim that there are two kinds of substances in the universe: physical (including the body) and mental, which is nonphysical. In contrast identity theorists claim that everything is physical, including consciousness, and that there is nothing nonphysical. The basis for the materialist claim is that of the two competing theories, dualism and mind-brain identity, the identity theory is the simpler since it commits to fewer entities. Smart was criticized for his use of the razor and ultimately retracted his advocacy of it in this context.

Paul Churchland (1984) cites Ockham's Razor as the first line of attack against dualism but that by itself it is inconclusive. The deciding factor for Churchland is the greater explanatory prowess of a materialist position in the Philosophy of Mind as informed by findings in Neurobiology.
Dale Jacquette (1994) claims that Ockham's Razor is the rationale behind eliminativism and reductionism in the Philosophy of Mind. Eliminativism is the thesis that the ontology of folk Psychology including such entities as "pain", "joy", "desire", "fear" etc. are eliminable in favor of an ontology of a completed neuroscience.

In religion:
In the philosophy of religion Ockham's Razor is sometimes used to challenge arguments for the existence of God. None of these applications has been considered definitive because the competing assumptions are not (and perhaps cannot be) precisely defined. Also, it should be added that the principle is only a guide to the best theory based on current knowledge, not the "truth."
William may have been inspired by earlier thinkers. For example, Book V of Aristotle's Physics has the statement "Nature operates in the shortest way possible."
Galileo Galilei lampooned the misuse of Ockham's Razor in his Dialogue. The principle is represented in the dialogue by Simplicio.
The telling point that Galileo presented ironically was that if you really wanted to start from a small number of entities, you could always consider the letters of the alphabet as the fundamental entities, since you could certainly construct the whole of human knowledge out of them. (A view that Abraham Abulafia held much more expansively.)
Adding another layer of irony, many modern scientists and mathematicians seriously propose that the basic "entities" of reality may be "bits of information", i.e. the digits of binary code, in which case the entities of William of Ockham might be seen as foreshadowing the logic of George Boole and modern computing.
Perhaps due to the abstruse nature of medieval logic and the obscure goals of William of Ockham as a theologian and logician, discussion and application of Ockham's Razor is frequently full of ironies.
It is argued that Ockham was an intellectual forefather of the Scientific Method because he argued for a degree of intellectual freedom in a time of dogmatic belief. He can also, however, be seen as an apologist for Divine Omnipotence, since he was concerned to demonstrate that creation was contingent and the Creator free to change the rules at will. Thus, if God is free to make an infinity of worlds with completely different rules from those which prevail in our world, then we are free to imagine such worlds and their logical and practical consequences (within the bounds set by the Church's infallible Dogma).
Perhaps the best formulation of Ockham's Razor is the one which states that, of equally good explanations for a phenomenon, the best one is the simplest explanation which accounts for all the facts.
Ockham's Razor could also be said to apply to the elimination of the soul as a superfluous entity.
Creationists sometimes employ Ockham's Razor in defense of their theory of Cosmogenesis and Geogenesis claiming that theirs is the simpler theory as compared with evolution. However, because this is an attempt to apply Ockham's Razor to the past, where observation to verify or falsify its use is not possible, this use of Ockham's Razor is disputed. The disputation continues on question of whether the postulation of a Creator with cogniscence and forethought is "simpler" than one in which complexity spontaneously generates over geological timescales.

In statistics:
There are various papers in scholarly journals deriving versions of Ockham's Razor from probability theory and applying it in statistical inference, and also of various criteria for penalizing complexity in statistical inference. Recent papers have suggested a connection between Ockham's Razor and Kolmogorov complexity.
One of the problems with the original formulation of the principle is that it only applies to models with the same explanatory power (i.e. prefer the simplest of equally good models). A more general form of Ockham's Razor can be derived from Bayesian model comparison and Bayes factors, which can be used to compare models that don't fit the data equally well. These methods can sometimes optimally balance the complexity and power of a model.
Many artificial intelligence researchers are now employing strongly probabilistic Bayesian techniques.

Related quotes:
- The longer the explanation, the greater the lie

References: