

# Heuristic

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November 19, 2022

## RECOMMENDED CITATION

mohammad looti (2022). *Heuristic*. PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=38392>

Heuristic refers to experience-based techniques for problem solving, learning, and discovery. Heuristic methods are used to speed up the process of finding a good enough solution, where an exhaustive search is impractical. Examples of this method include using a "rule of thumb", an educated guess, an intuitive judgment, or common sense.

In more precise terms, heuristics are strategies using readily accessible, though loosely applicable, information to control problem solving in human beings and machines.

### **Example**

The most fundamental heuristic is trial and error, which can be used in everything from matching bolts to bicycles to finding the values of variables in algebra problems.

Here are a few other commonly used heuristics, from George Pólya's 1945 book, *How to Solve It*:

If you are having difficulty understanding a problem, try drawing a picture.

If you can't find a solution, try assuming that you have a solution and seeing what you can derive from that ("working backward").

If the problem is abstract, try examining a concrete example.

Try solving a more general problem first (the "inventor's paradox": the more ambitious plan may have more chances of success).

### **Psychology**

In psychology, heuristics are simple, efficient rules, hard-coded by evolutionary processes or learned, which have been proposed to explain how people make decisions, come to judgments, and solve problems, typically when facing complex problems or incomplete information. These rules work well under most circumstances, but in certain cases lead to systematic errors or cognitive biases.

Although much of the work of discovering heuristics in human decision-makers was done by Amos Tversky and Daniel Kahneman, the concept was originally introduced by Nobel laureate Herbert Simon. Gerd Gigerenzer focuses on how heuristics can be used to make judgments that are in principle accurate, rather than producing cognitive biases - heuristics that are "fast and frugal".

In 2002, Daniel Kahneman and Shane Frederick proposed that cognitive heuristics work by a process called attribute substitution which happens without conscious awareness. According to this theory, when somebody makes a judgment (of a target attribute) which is computationally complex, a rather easier calculated heuristic attribute is substituted. In effect, a cognitively difficult problem is dealt with by answering a rather simpler problem, without being aware of this happening. This theory explains cases where judgments fail to show regression toward the mean. Heuristics can be considered to reduce the complexity of clinical judgements in healthcare.

## Theorized psychological heuristics

### Well known

Anchoring and adjustment  
Availability heuristic  
Representativeness heuristic  
Naïve diversification  
Escalation of commitment

### Less well known

Affect heuristic  
Contagion heuristic  
Effort heuristic  
Familiarity heuristic  
Fluency heuristic  
Gaze heuristic  
Peak-end rule  
Recognition heuristic  
Scarcity heuristic  
Similarity heuristic  
Simulation heuristic  
Social proof  
Take-the-best heuristic

### Philosophy

In philosophy, especially in Continental European philosophy, the adjective "heuristic" (or the designation "heuristic device") is used when an entity X exists to enable understanding of, or knowledge concerning, some other entity Y. A good example is a model which, as it is never identical with what it models, is a heuristic device to enable understanding of what it models. Stories, metaphors, etc., can also be termed heuristic in that sense. A classic example is the notion of utopia as described in Plato's best-known work, *The Republic*. This means that the "ideal city" as depicted in *The Republic* is not given as something to be pursued, or to present an orientation-point for development; rather, it shows how things would have to be connected, and how one thing would lead to another (often with highly problematic results), if one would opt for certain principles and carry them through rigorously.

"Heuristic" is also often commonly used as a noun to describe a rule-of-thumb, procedure, or method. Philosophers of science have emphasized the importance of heuristics in creative thought

and constructing scientific theories. (See *The Logic of Scientific Discovery*, and philosophers such as Imre Lakatos, Lindley Darden, and others.)

## **Law**

In legal theory, especially in the theory of law and economics, heuristics are used in the law when case-by-case analysis would be impractical, insofar as "practicality" is defined by the interests of a governing body.

For instance, in all states in the United States the legal drinking age is 21, because it is argued that people need to be mature enough to make decisions involving the risks of alcohol consumption. However, assuming people mature at different rates, the specific age of 21 would be too late for some and too early for others. In this case, the somewhat arbitrary deadline is used because it is impossible or impractical to tell whether an individual is sufficiently mature for society to trust them with that kind of responsibility. Some proposed changes, however, have included the completion of an alcohol education course rather than the attainment of 21 years of age as the criterion for legal alcohol possession. This would put youth alcohol policy more on a case-by-case basis and less on a heuristic one, since the completion of such a course would presumably be voluntary and not uniform across the population.

The same reasoning applies to patent law. Patents are justified on the grounds that inventors need to be protected in order to have incentive to invent. It is therefore argued that, in society's best interest, inventors should be issued with a temporary government-granted monopoly on their product, so that they can recoup their investment costs and make economic profit for a limited period. In the United States the length of this temporary monopoly is 20 years from the date the application for patent was filed, though the monopoly does not actually begin until the application has matured into a patent. However, like the drinking-age problem above, the specific length of time would need to be different for every product in order to be efficient; a 20-year term is used because it is difficult to tell what the number should be for any individual patent. More recently, some, including University of North Dakota law professor Eric E. Johnson, have argued that patents in different kinds of industries - such as software patents - should be protected for different lengths of time.

## **Computer science**

In computer science, a heuristic is a technique designed to solve a problem that ignores whether the solution can be proven to be correct, but which usually produces a good solution or solves a simpler problem that contains or intersects with the solution of the more complex problem. Most real-time, and even some on-demand, anti-virus scanners use heuristic signatures to look for specific attributes and characteristics for detecting viruses and other forms of malware.

Heuristics are intended to gain computational performance or conceptual simplicity, potentially at the cost of accuracy or precision.

In their Turing Award acceptance speech, Herbert Simon and Allen Newell discuss the Heuristic Search Hypothesis: a physical symbol system will repeatedly generate and modify known symbol structures until the created structure matches the solution structure.

That is, each successive iteration depends upon the step before it, thus the heuristic search learns what avenues to pursue and which ones to disregard by measuring how close the current iteration is to the solution. Therefore, some possibilities will never be generated as they are measured to be less likely to complete the solution.

A heuristic method can accomplish its task by using search trees. However, instead of generating all possible solution branches, a heuristic selects branches more likely to produce outcomes than other branches. It is selective at each decision point, picking branches that are more likely to produce solutions.

In human-computer interaction, heuristic evaluation is a usability-testing technique devised by expert usability consultants. In heuristic evaluation, the user interface is reviewed by experts and its compliance to usability heuristics (broadly stated characteristics of a good user interface, based on prior experience) is assessed, and any violating aspects are recorded.

### **Software interface design**

In software development, the use of a heuristic approach can facilitate a well-designed user interface, enabling users to navigate complex systems intuitively and without difficulty. The interface may guide the user when necessary using tooltips, help buttons, invitations to chat with support, etc., providing help when needed. However, in practice, the designer of the user interface may not find it easy to strike the optimum balance for assistance of the user.

Software developers and targeted end-users alike disregard heuristics at their own peril. End users often need to increase their understanding of the basic framework that a project entails (so that their expectations are realistic), and developers often need to push to learn more about their target audience (so that their learning styles can be judged). Business rules crucial to the organization are often so obvious to the end-user that they are not conveyed to the developer, who may lack domain knowledge in the particular field of endeavor the application is meant to serve.

A proper Software Requirements Specification (SRS) models the heuristics of how a user will process the information being rendered on-screen. An SRS is ideally shared with the end-user well before the actual Software Design Specification (SDS) is written and the application is developed, so users' feedback about their experience can be used to adapt the design of the application. This

saves much time in the Software Development Life Cycle (SDLC). Unless heuristics are adequately considered, the project will likely suffer many implementation problems and setbacks.

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