heuristic

Contents

English

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Etymology

Irregular formation from Ancient Greek εὑρίσκω (*heurískō*, “I find, discover”) (compare the proper Greek term εὑρετικός (*heuretikós*)).

Pronunciation

- IPA(key): /hjuˈɹɪstɪk/, /hjʊˈɹɪstɪk/
- Audio (US) (file)
- Hyphenation: heu·ris·tic
- Rhymes: -ɪstɪk

Adjective

heuristic (*comparative* **more heuristic**, *superlative* **most heuristic**)

1. (*of an approach to problem solving, learning, or discovery*) That employs a practical method not guaranteed to be optimal or perfect; not following or derived from any theory. [from 1821]

    - **2015**, Ippoliti, Emiliano; Thomas Nickles, *Heuristic Reasoning*[1] (https://www.scribd.com/doc/290648904/):

        "The **heuristic** appraisal is the 'identification and evaluation of hints and clues that can provide direction to inquiry in the sometimes large gap between the extremes of complete knowledge and complete ignorance'".

2. (*computing*, *of a method or algorithm*) That solves a problem more quickly but is not certain to arrive at an optimal solution.

    - **2002**, Te Chiang Hu, Man-tak Shing, *Combinatorial Algorithms*[2] (http://books.google.com/books?id=BF5_bCN72EUC):

        If a **heuristic** algorithm works for most of the input data or its maximum percentage error is tolerable, we may prefer the **heuristic** algorithm to an optimum algorithm that requires a long time.

3. (*of an argument*) That reasons from the value of a method or principle that has been shown by experimental investigation to be a useful aid in learning, discovery and problem-solving.

Derived terms

- heuristically
- heuristical

Translations

relating to general strategies or methods for solving problems

- Arabic: إرشادي *m*
- Bulgarian: евристичен (evrističen)
- Catalan: heurístic (ca)
- Czech: heuristický (cs) *m*
- Danish: heuristisk
- Dutch: heuristisch (nl)
- Esperanto: heŭristika, problemsolvila
- Finnish: heuristinen (fi)
- French: heuristique (fr)
- Georgian: ევრისტიკული (evristiḳuli)
- German: heuristisch (de)
- Greek: ευρετικός (el) *m* (evretikós)
- Hungarian: heurisztikus (hu)
- Italian: euristico (it)
- Occitan: euristic
- Polish: heurystyczny (pl) *m*
- Portuguese: heurístico (pt)
- Romanian: euristic (ro)
- Russian: эвристи́ческий (ru) (evristíčeskij)
- Spanish: heurístico (es)
- Swedish: heuristisk

in computing, that is not certain to arrive at an optimal solution

- Greek: ευρετικός (el) *m* (evretikós)
- Occitan: euristic
- Portuguese: heurístico (pt)
- Swedish: heuristisk

Noun

heuristic (*plural* **heuristics**)

1. A heuristic method. [from 1860]
2. The art of applying heuristic methods.
3. (*computing*) A technique designed for solving a problem when classic methods are too slow or fail to find any exact solution.

Translations

heuristic method, heuristics

- Catalan: heurística (ca) *f*
- Chinese:
  - Mandarin: 啟發法 (zh), 启发法 (zh) (qǐfāfǎ)
- Czech: heuristika *f*
- Danish: heuristik
- Dutch: heuristiek (nl) *f*
- Esperanto: heŭristiko, problemsolvilo (eo)
- Estonian: heuristika
- Finnish: heuristiikka (fi)
- French: heuristique (fr) *f*
- Georgian: ევრისტიკა (evristiḳa)
- German: Heuristik (de) *f*
- Greek: ευρετική (el) *f* (evretikí)
- Hebrew: יורסיטיקה
- Hungarian: heurisztika (hu)
- Italian: euristica (it) *f*
- Japanese: ヒューリスティックス (hyūrisutikkusu)
- Khmer: អធិគតវិជ្ជា (ak thi got vij jea)
- Lithuanian: euristika
- Occitan: euristica *f*
- Polish: heurystyka (pl) *f*
- Portuguese: heurística (pt) *f*
- Russian: эври́стика (ru) *f* (evrístika)
- Serbo-Croatian:
  - Cyrillic: хеуристика *f*
  - Roman: heuristika (sh) *f*
- Slovak: heuristika *f*
- Spanish: heurística (es) *f*

References

- **Heuristic (computer science)** on Wikipedia.
- **Heuristic argument** on Wikipedia.

Heuristic

A **heuristic technique**, or a **heuristic** (/hjʊəˈrɪstɪk/; Ancient Greek: εὑρίσκω, *heurískō*, 'I find, discover'), is any approach to problem solving or self-discovery that employs a practical method that is not guaranteed to be optimal, perfect, or rational, but is nevertheless sufficient for reaching an immediate, short-term goal or approximation. Where finding an optimal solution is impossible or impractical, heuristic methods can be used to speed up the process of finding a satisfactory solution. Heuristics can be mental shortcuts that ease the cognitive load of making a decision.[1]:94[2]

Examples that employ heuristics include using trial and error, a rule of thumb or an educated guess.

Contents

Overview

Heuristics are the strategies derived from previous experiences with similar problems. These strategies depend on using readily accessible, though loosely applicable, information to control problem solving in human beings, machines and abstract issues.[3][4]

The most fundamental heuristic is trial and error, which can be used in everything from matching nuts and bolts to finding the values of variables in algebra problems. In mathematics, some common heuristics involve the use of visual representations, additional assumptions, forward/backward reasoning and simplification.[5] Here are a few commonly used heuristics from George Pólya's 1945 book, *How to Solve It*:[6]

- 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).

In psychology, heuristics are simple, efficient rules, learned or inculcated by evolutionary processes, that have been proposed to explain how people make decisions, come to judgments, and solve problems typically when facing complex problems or incomplete information. Researchers test if people use those rules with various methods. These rules work well under most circumstances, but in certain cases can lead to systematic errors or cognitive biases.[7]

History

The study of heuristics in human decision-making was developed in the 1970s and the 1980s by the psychologists Amos Tversky and Daniel Kahneman[8] although the concept had been originally introduced by the Nobel laureate Herbert A. Simon, whose original, primary object of research was problem solving that showed that we operate within what he calls *bounded rationality*. He coined the term *satisficing*, which denotes a situation in which people seek solutions, or accept choices or judgments, that are "good enough" for their purposes although they could be optimized.[9]

Rudolf Groner analyzed the history of heuristics from its roots in ancient Greece up to contemporary work in cognitive psychology and artificial intelligence,[10] proposing a cognitive style "heuristic versus algorithmic thinking," which can be assessed by means of a validated questionnaire.[11]

Adaptive toolbox

Gerd Gigerenzer and his research group argued that models of heuristics need to be formal to allow for predictions of behavior that can be tested.[12] They study the fast and frugal heuristics in the "adaptive toolbox" of individuals or institutions, and the ecological rationality of these heuristics; that is, the conditions under which a given heuristic is likely to be successful.[13] The descriptive study of the "adaptive toolbox" is done by observation and experiment, the prescriptive study of the ecological rationality requires mathematical analysis and computer simulation. Heuristics – such as the recognition heuristic, the take-the-best heuristic, and fast-and-frugal trees – have been shown to be effective in predictions, particularly in situations of uncertainty. It is often said that heuristics trade accuracy for effort but this is only the case in situations of risk. Risk refers to situations where all possible actions, their outcomes and probabilities are known. In the absence of this information, that is under uncertainty, heuristics can achieve higher accuracy with lower effort.[14] This finding, known as a less-is-more effect, would not have been found without formal models. The valuable insight of this program is that heuristics are effective not despite of their simplicity — but because of it. Furthermore, Gigerenzer and Wolfgang Gaissmaier found that both individuals and organizations rely on heuristics in an adaptive way.[15]

Cognitive-experiential self-theory

Heuristics, through greater refinement and research, have begun to be applied to other theories, or be explained by them. For example, the cognitive-experiential self-theory (CEST) also is an adaptive view of heuristic processing. CEST breaks down two systems that process information. At some times, roughly speaking, individuals consider issues rationally, systematically, logically, deliberately, effortfully, and verbally. On other

occasions, individuals consider issues intuitively, effortlessly, globally, and emotionally.[16] From this perspective, heuristics are part of a larger experiential processing system that is often adaptive, but vulnerable to error in situations that require logical analysis.[17]

Attribute substitution

In 2002, Daniel Kahneman and Shane Frederick proposed that cognitive heuristics work by a process called *attribute substitution*, which happens without conscious awareness.[18] According to this theory, when somebody makes a judgment (of a "target attribute") that is computationally complex, a more easily 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.[18] This theory explains cases where judgments fail to show regression toward the mean.[19] Heuristics can be considered to reduce the complexity of clinical judgments in health care.[20]

Psychology

Informal models of heuristics

- Affect heuristic — Mental shortcut which uses emotion to influence the decision. Emotion is the effect that plays the lead role that makes the decision or solves the problem quickly or efficiently. Is used while judging the risks and benefits of something, depending on the positive or negative feelings that people associate with a stimulus. Can also be considered the gut decision since if the gut feeling is right, then the benefits are high and the risks are low.[21]
- Anchoring and adjustment — Describes the common human tendency to rely more heavily on the first piece of information offered (the "anchor") when making decisions. For example, in a study done with children, the children were told to estimate the number of jellybeans in a jar. Groups of children were given either a high or low "base" number (anchor). Children estimated the number of jellybeans to be closer to the anchor number that they were given.[22]
- Availability heuristic — A mental shortcut that occurs when people make judgments about the probability of events by the ease with which examples come to mind. For example, in a 1973 Tversky & Kahneman experiment, the majority of participants reported that there were more words in the English language that start with the letter K than for which K was the third letter. There are actually twice as many words in the English Language that have K as the third letter as those that start with K, but words that start with K are much easier to recall and bring to mind.[23]
- Contagion heuristic — follows the Law of Contagion or Similarity. This leads people to avoid others that are viewed as “contaminated” to the observer. This happens due to the fact of the observer viewing something that is seen as bad or to seek objects that have been associated with what seems good. Somethings one can view as harmful can tend not to really be. This sometimes leads to irrational thinking on behalf of the observer.[24]
- Effort heuristic — the worth of an object is determined by the amount of effort put into the production of the object. Objects that took longer to produce are more valuable while the objects that took less time are deemed not as valuable. Also applies to how much effort is put into achieving the product. This can be seen as the difference of working and earning the object versus finding the object on the side of the street. It can be the same object but the one found will not be deemed as valuable as the one that we earned.
- Escalation of commitment — Describes the phenomenon where people justify increased investment in a decision, based on the cumulative prior investment, despite new evidence suggesting that the cost, starting today, of continuing the decision outweighs the expected benefit. This is related to the sunk cost fallacy.

- Familiarity heuristic — A mental shortcut applied to various situations in which individuals assume that the circumstances underlying the past behavior still hold true for the present situation and that the past behavior thus can be correctly applied to the new situation. Especially prevalent when the individual experiences a high cognitive load.[25]
- Naïve diversification — When asked to make several choices at once, people tend to diversify more than when making the same type of decision sequentially.
- Peak–end rule — experience of an event is judged by the feelings of the peak of the event and nothing more. Usually not every event is seen as complete but what was felt at the climax whether the event was pleasant or unpleasant to the observer. All other feelings is not lost but is not used. This can also include how long the event happened.
- Representativeness heuristic — A mental shortcut used when making judgments about the probability of an event under uncertainty. Or, judging a situation based on how similar the prospects are to the prototypes the person holds in his or her mind. For example, in a 1982 Tversky and Kahneman experiment,[26] participants were given a description of a woman named Linda. Based on the description, it was likely that Linda was a feminist. Eighty to ninety percent of participants, choosing from two options, chose that it was more likely for Linda to be a feminist *and* a bank teller than only a bank teller. The likelihood of two events cannot be greater than that of either of the two events individually. For this reason, the representativeness heuristic is exemplary of the conjunction fallacy.[23]
- Scarcity heuristic — works as the same as the economy. The scarcer an object or event is, the more value that thing holds. The abundance is the indicator of the value and is a mental shortcut that places a value on an item based on how easily it might be lost, especially to competitors. The scarcity heuristic stems from the idea that the more difficult it is to acquire an item the more value that item has. In many situations we use an item's availability, its perceived abundance, to quickly estimate quality and/or utility. This can lead to systemic errors or cognitive bias.[27]
- Simulation heuristic — simplified mental strategy in which people determine the likelihood of an event happening based on how easy it is to mentally picture the event happening. People regret the events that are easier to image over the ones that would be harder to. It is also thought that people will use this heuristic to predict the likelihood of another's behavior happening. This shows that people are constantly simulating everything around them in order to be able to predict the likelihood of events around them. It is believe that people do this by mentally undoing events that they have experienced and then running mental simulations of the events with the corresponding input values of the altered model.[28]
- Social proof - also known as the informational social influence which was given its name by Robert Cialdini in his book called **Influence** written in 1984. It is where people copy the actions of others in order to attempt to undertake the behavior in a given situation. It is more prominent in situations were people are unable to determine the appropriate mode of behavior and are driven to the assumption that the surrounding people have more knowledge about the current situation. This can be see more dominantly in ambiguous social situations.[29]

Formal models of heuristics

- Fast-and-frugal trees
- Fluency heuristic
- Gaze heuristic
- Recognition heuristic
- Satisficing
- Similarity heuristic
- Take-the-best heuristic

Cognitive maps

Heuristics were also found to be used in the manipulation and creation of cognitive maps.[30] *Cognitive maps* are internal representations of our physical environment, particularly associated with spatial relationships. These internal representations are used by our memory as a guide in our external environment. It was found that when questioned about maps imaging, distancing, etc., people commonly made distortions to images. These distortions took shape in the regularization of images (i.e., images are represented as more like pure abstract geometric images, though they are irregular in shape).

There are several ways that humans form and use cognitive maps, with visual intake being an especially key part of mapping: the first is by using **landmarks**, whereby a person uses a mental image to estimate a relationship, usually distance, between two objects. The second is **route-road** knowledge, and is generally developed after a person has performed a task and is relaying the information of that task to another person. The third is a **survey**, whereby a person estimates a distance based on a mental image that, to them, might appear like an actual map. This image is generally created when a person's brain begins making image corrections. These are presented in five ways:

1. **Right-angle bias**: when a person straightens out an image, like mapping an intersection, and begins to give everything 90-degree angles, when in reality it may not be that way.
2. **Symmetry heuristic**: when people tend to think of shapes, or buildings, as being more symmetrical than they really are.
3. **Rotation heuristic**: when a person takes a naturally (realistically) distorted image and straightens it out for their mental image.
4. **Alignment heuristic**: similar to the previous, where people align objects mentally to make them straighter than they really are.
5. **Relative-position heuristic**: people do not accurately distance landmarks in their mental image based on how well they remember that particular item.

Another method of creating cognitive maps is by means of auditory intake based on verbal descriptions. Using the mapping based from a person's visual intake, another person can create a mental image, such as directions to a certain location.[31]

Philosophy

A **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 that, 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 this 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 opted for certain principles and carried them through rigorously.

Heuristic is also often used as a noun to describe a rule-of-thumb, procedure, or method.[32] Philosophers of science have emphasized the importance of heuristics in creative thought and the construction of scientific theories.[33] (See *The Logic of Scientific Discovery* by Karl Popper; and philosophers such as Imre Lakatos,[34] Lindley Darden, William C. Wimsatt, 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.[35]

The present securities regulation regime largely assumes that all investors act as perfectly rational persons. In truth, actual investors face cognitive limitations from biases, heuristics, and framing effects.

For instance, in all states in the United States the legal drinking age for unsupervised persons is 21 years, 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 must be protected so they have incentive to invent. It is therefore argued that it is in society's best interest that inventors receive a temporary government-granted monopoly on their idea, so that they can recoup 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 patent application 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 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.[36]

Stereotyping

Stereotyping is a type of heuristic that people use to form opinions or make judgments about things they have never seen or experienced.[37] They work as a mental shortcut to assess everything from the social status of a person (based on their actions),[2] to whether a plant is a tree based on the assumption that it is tall, has a trunk, and has leaves (even though the person making the evaluation might never have seen that particular type of tree before).

Stereotypes, as first described by journalist Walter Lippmann in his book *Public Opinion* (1922), are the pictures we have in our heads that are built around experiences as well as what we are told about the world.[38][39]

Artificial intelligence

A heuristic can be used in artificial intelligence systems while searching a solution space. The heuristic is derived by using some function that is put into the system by the designer, or by adjusting the weight of branches based on how likely each branch is to lead to a goal node.

Critiques and controversies

The concept of heuristics has critiques and controversies. The "We Cannot Be That Dumb" critique argues that the average person has low ability to make sound and effective judgments.[40]

See also

- Algorithm
- Behavioral economics
- Erudition
- Failure mode and effects analysis
- Heuristics in judgment and decision-making
- List of biases in judgment and decision making
- Neuroheuristics
- Priority heuristic
- Social heuristics

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