Block 5.
Thinking & Reasoning
Artificial Intelligence

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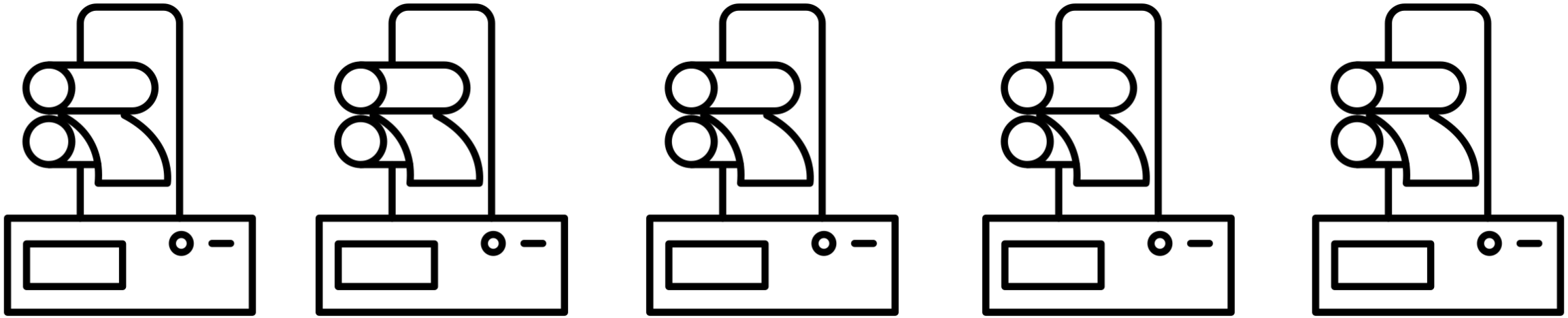
The cognitive reflection test

- A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? ___ cents

Frederick (2005)

The cognitive reflection test

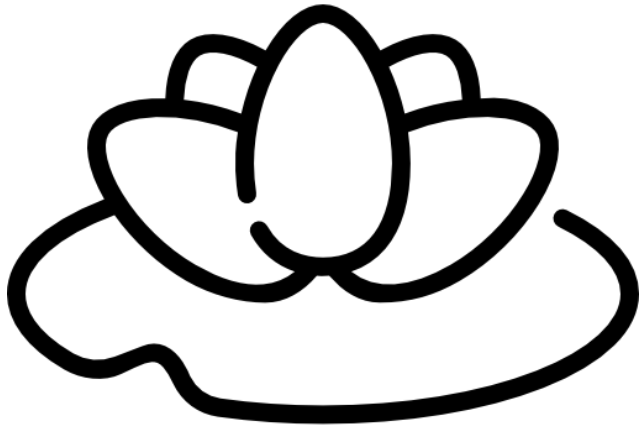
- If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

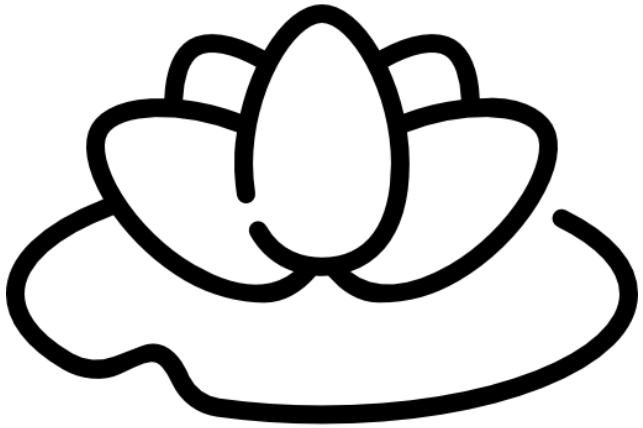


Frederick (2005)

The cognitive reflection test

- In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?





Frederick (2005)

Thinking and reasoning

1. Fast thinking (System 1)
2. Judgement (heuristics and biases)
3. Decision Making (expected utility and prospect theories)
4. Slow thinking (System 2)
5. Deductive Reasoning
6. Categorical Reasoning
7. Propositional reasoning (conditional and disjunctive)

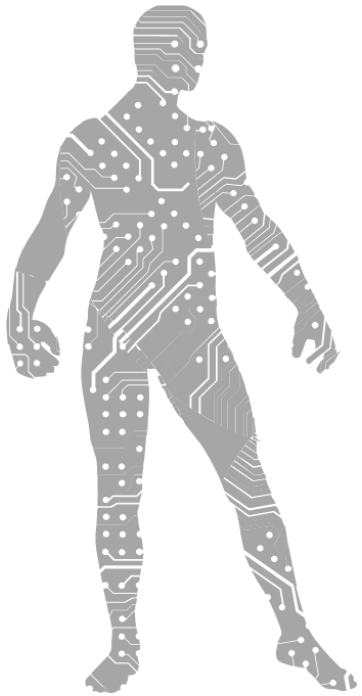
2 Systems of thinking: Fast and Slow

Characteristics	System 1	System 2
Knowledge	Implicit	Explicit
	Beliefs, pragmatism	Logic
	Contextual	Abstract
Mode of functioning	intuitive	Reflexive
	unconscious, preconscious	Conscious
	Automatic	Controlled
	Fast, parallel	Sequential, slow
Cognitive load	High capacity, low load	Low capacity, high load
	Independent of working memory	Dependent of working memory
Ontogeny	Evolutionarily old	Evolutionarily new
	Independent of language	Dependent of language
	Shared with animals	Specifically human
	Not related to intelligence	Related to intelligence

System 1

Normative models and descriptive models of human thinking

Human thinking	Normative model
Judgements (plausibility)	Probability theory (Mathematics)
Reason	Logic (Philosophy/mathematics)
Decision making	Utility theory (Branch of the economy that deals with decisions based on costs and benefits)
Hypothesis testing	Scientific method
Problem solving	Computational theory



Fast thinking: Intuition, impressions & Decision Making

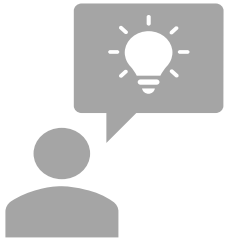
1. Judgement

Impressions and judgments

Accessibility

Prediction of uncertain events

Heuristics and Biases



2. Decision making

Rational theories in decision making (EUT and MAUT)

Problems with rational theories in decision making

Prospect theory

Framing of decisions

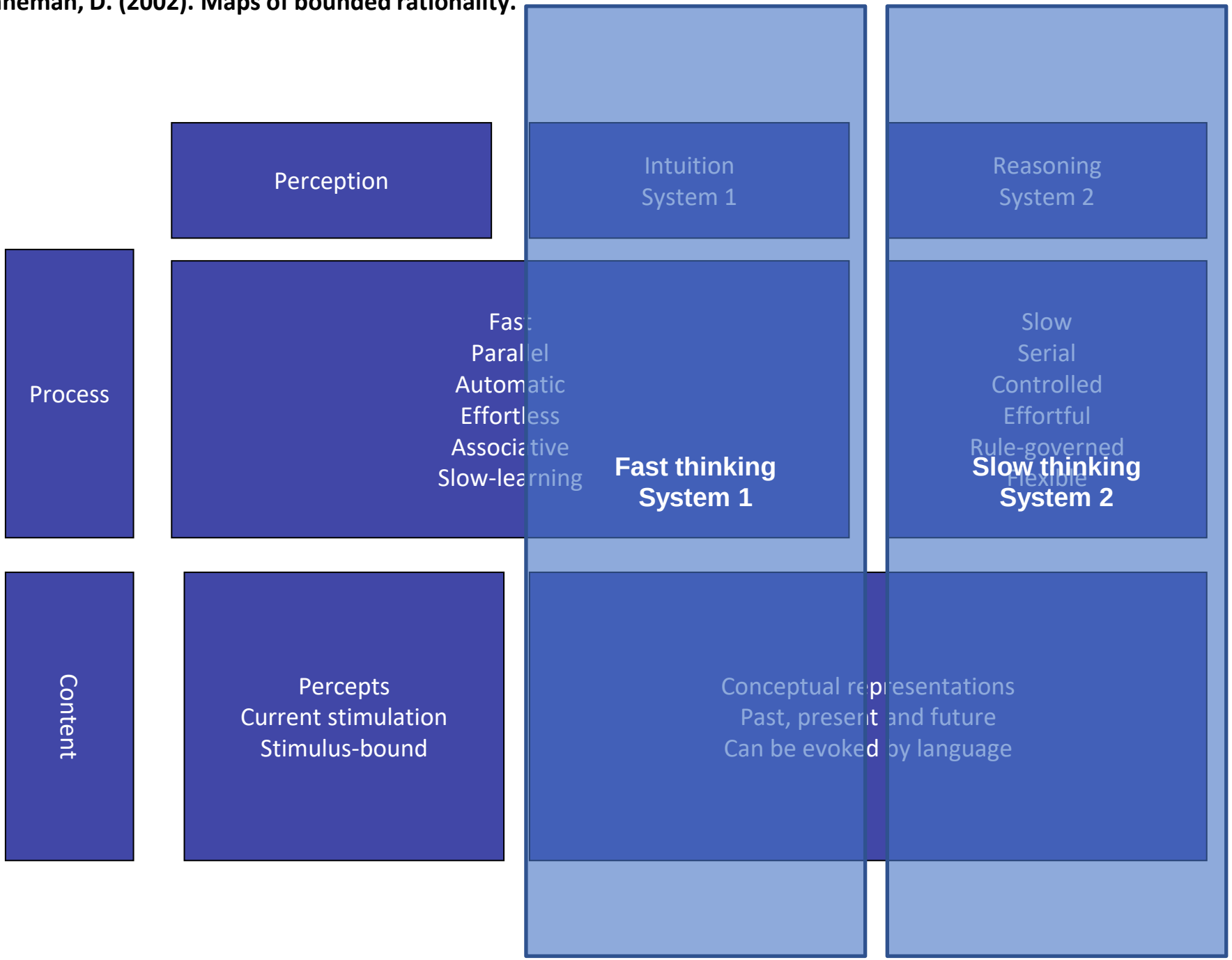
Limits of rationality

There are limits to rational behavior. Some of these limits are:

- The **bias of knowledge**, since humans have a fractional knowledge of the conditions of reality.
- The **impossibility to anticipate** the consequences of the desired acts.

- The limited capacity of imagination since it also fails to conceive all the probable models that humans can put into practice.
- Life is a constant decision making: https://www.youtube.com/watch?v=hJZ0pAoxksE

Kahneman, D. (2002). Maps of bounded rationality.

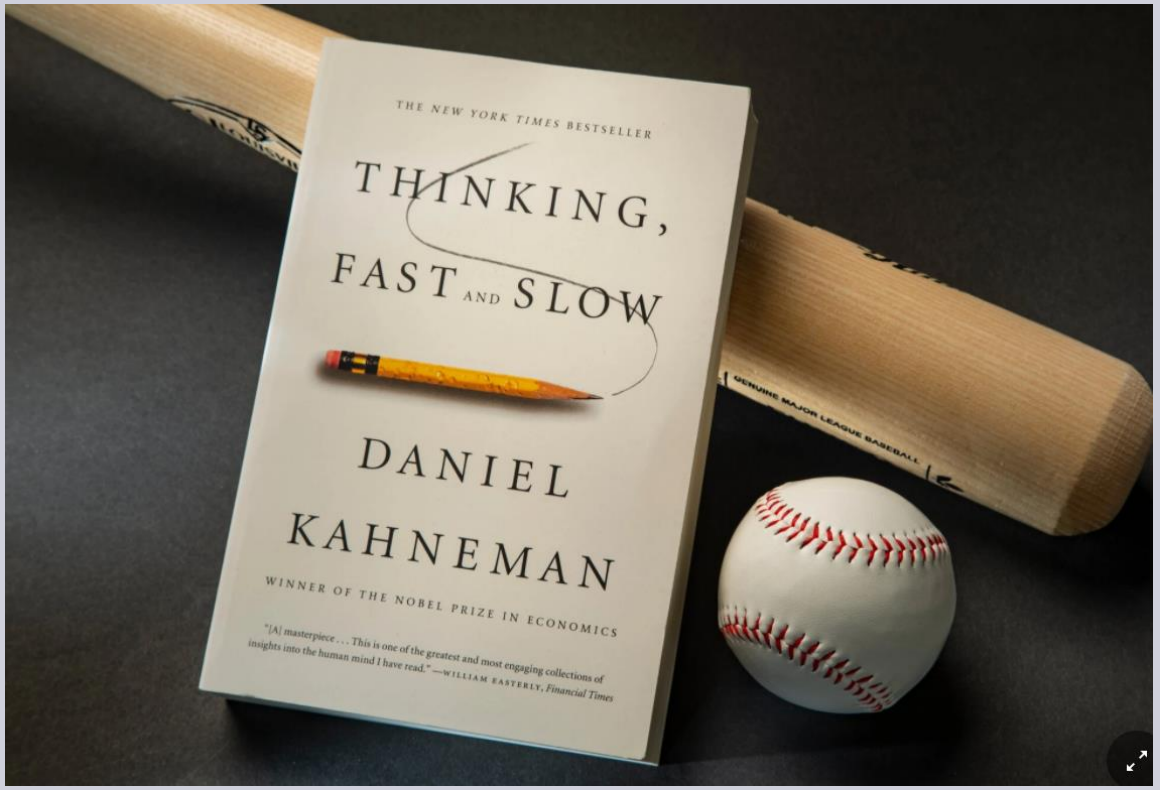


COURSE EVALUATION

Impressions and judgements

- Impressions are generated of perceptions and intuitions from System 1
- Judgments are formed from System 2 reasoning
- Both systems have no ontological existence. They are an analogy to explain how our thinking works
- They are not all-or-nothing systems, but ways of functioning that often interact.
- To clarify how System 1 and System 2 work, (Daniel Kahneman:'Thinking fast and slow'): https://www.youtube.com/watch?v=uqXVAo7dVRU

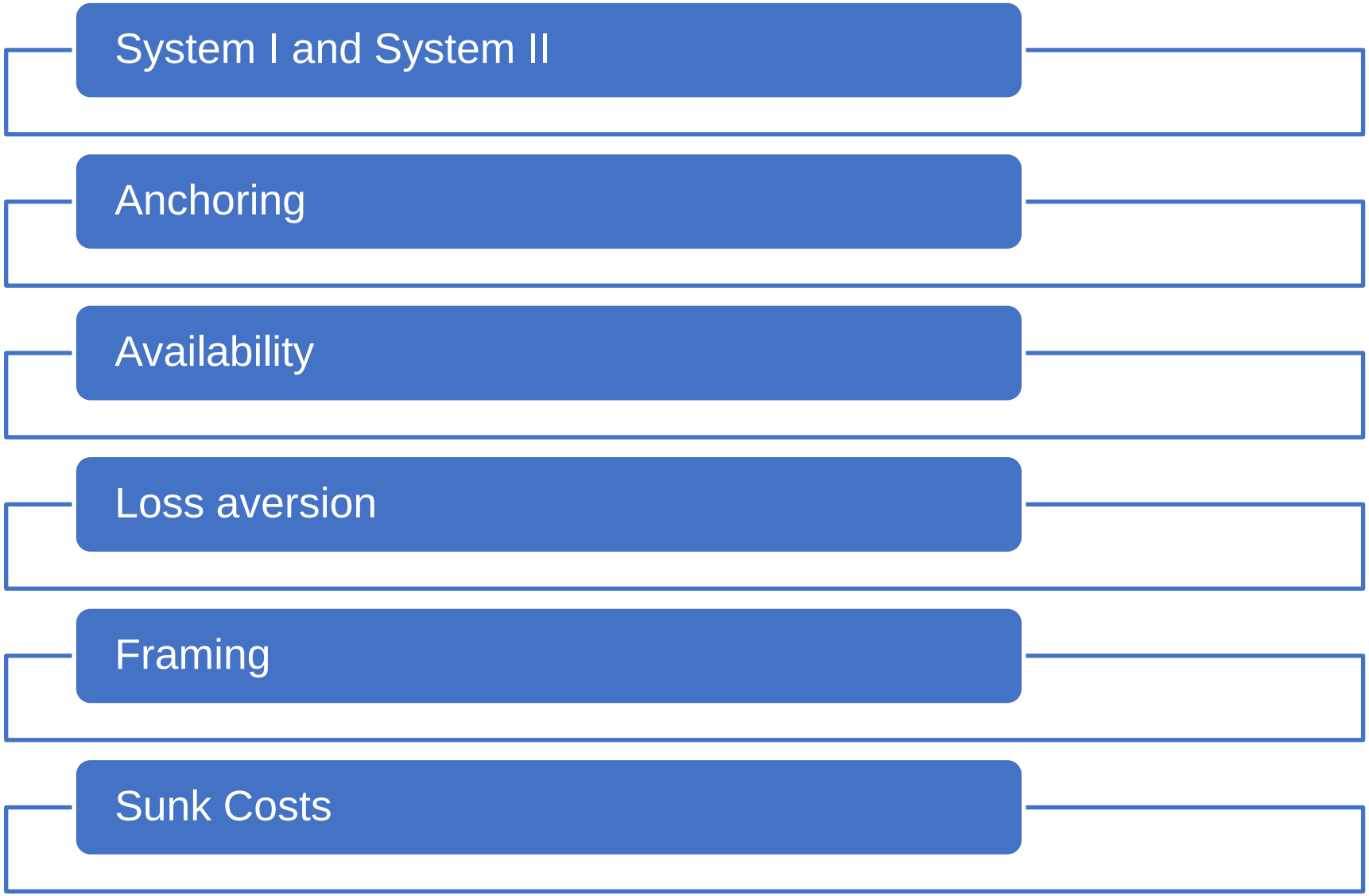
This Book Is Not About Baseball. But Baseball Teams swear by It. A psychology book by a Nobel Prize-winning author has become a must-read in front offices. It is changing the sport. (24/2/21)



https://www.nytimes.com/2021/02/24/sports/baseball/thinking-fast-and-slow-book.html

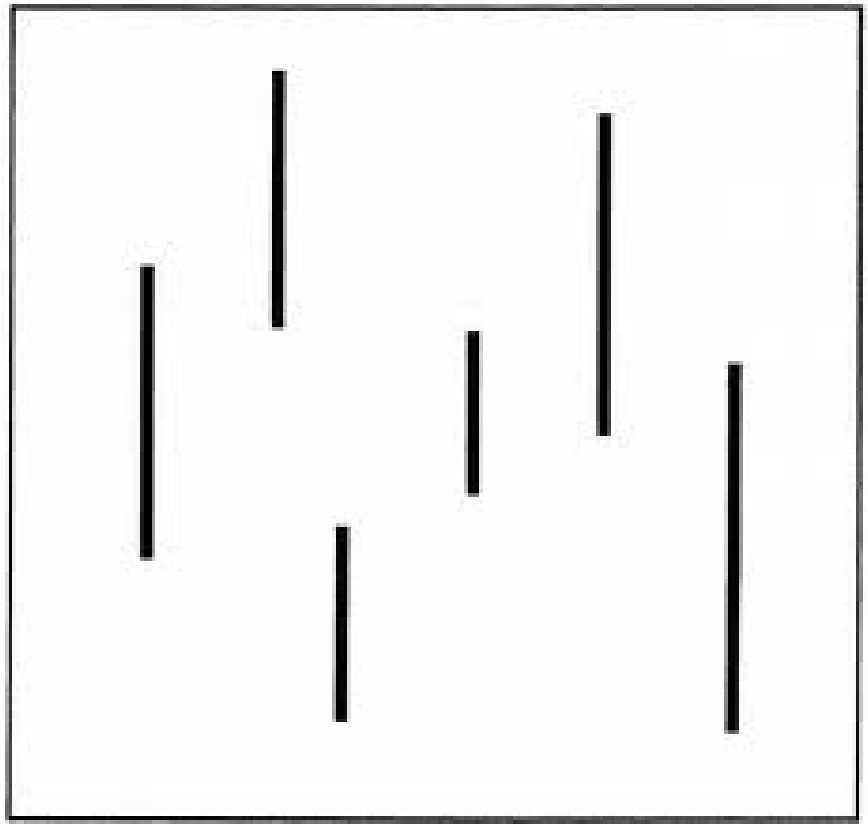
The probability of uncertain events intuited

Intuition, how is it generated?


System I and System II
Anchoring
Availability
Loss aversion
Framing
Sunk Costs

Accessibility

What is the average length of the lines in the figure?



What is the total length of the lines in the figure?

Determinants of accessibility

- Accessibility is related to the salience of the stimulus, the selective attention and the activation of the response or *priming*.
- Some attributes are more accessible than others and have been called natural assessments (Tversky & Kahneman, 1983)
  - Physical properties (volume, distance, etc.)
  - Similarity
  - Causal propensity
  - Surprise
  - Affective value

When we talk about intuitive thinking it is that not all things 'come to our mind' with the same speed or with the same ease, and 'what comes to us' depends on different factors.

How does intuition works?

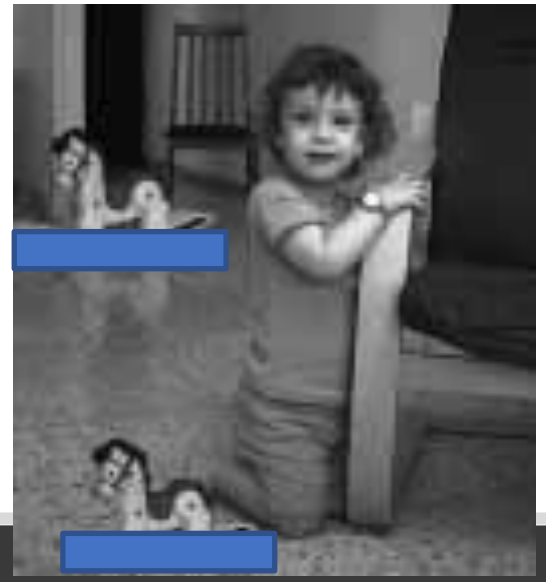
- "People rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors" (Tversky & Kahneman, 1974)
- The most classic ones were already described in the 1974 article:
  1. Representativeness
  2. Availability
  3. Anchoring
- Other examples of heuristics that have been researched and demonstrated are:
  4. The affect heuristic (Slovic et al., 2002/2007)
  5. Prototypic heuristics (Kahneman, 2002)

Attribute Substitution

- A judgment is said to be mediated by a heuristic when the individual evaluates the specified objective attribute of an object's judgment, replacing it with a related heuristic attribute that comes to mind most quickly (Kahneman & Frederick, 2002).

What are the sizes of the two horses in the photo?

The two horses are the same. The illusion occurs because although the question is a two-dimensional question, we automatically transfer it to the three-dimensional (heuristic) estimate.



Which team will win the match, A or B?

The question cannot be answered. What we done is to answer a different question based on the information that comes to mind most quickly (ranking, available players, etc.).

1. Representativeness heuristic

- The more similar a fact, object, or situation is to the typical examples of a category, the more likely they are to fall into that category

Manel is very shy and not very talkative. He is always helpful but not very interested in people or the real world. Manel is disciplined and methodical and needs to order and organize everything. He has an obsession with detail. What is the probability that Manel works as?

Construction worker

Librarian

Waiter

1. Representativeness heuristic

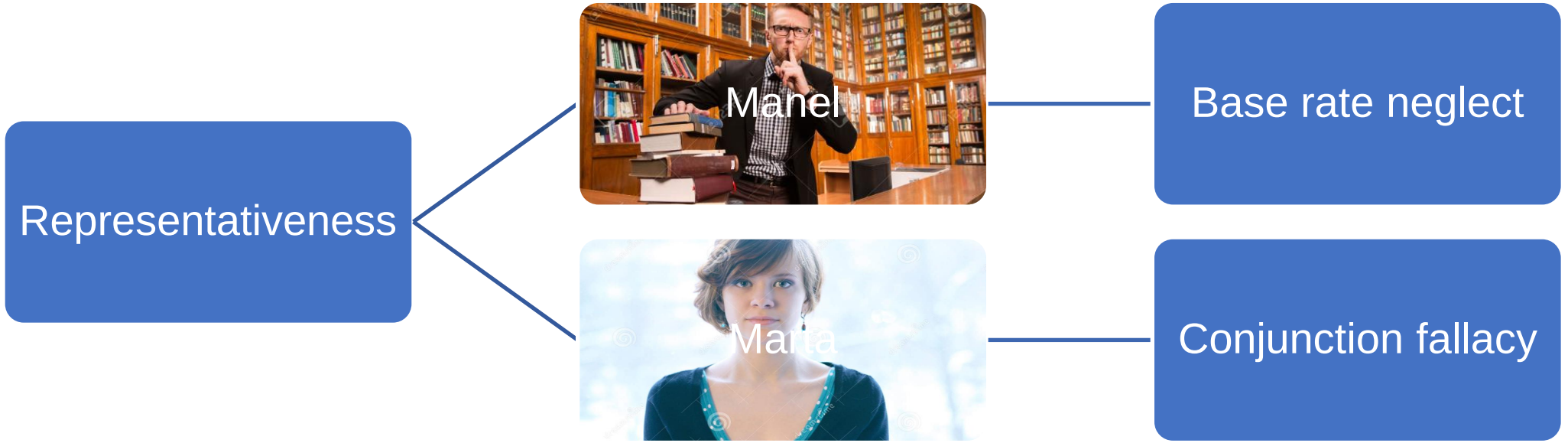
Marta is 31 years old, single, open and very intelligent. She graduated in philosophy. As a student, she was very concerned about issues of discrimination and social justice, and also participated in anti-nuclear protests.

What is the probability that Marta is:

(a) La Caixa employee

(b) La Caixa employee and feminist activist

From heuristic to bias...



2. availability heuristic

- Impressions and judgments based on the ease with which certain information comes to mind

What percentage of deaths occur in Spain caused by…?

Natural causes (diseases)

Non-natural causes (suicides, car accidents, homicides, drug abuse, drownings, falls,…)

From heuristic to bias...


IDENTIFICACIONS POLICIALS
MOSSOS D'ESQUADRA
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3. Anchoring

- The first information received acts as a reference point that then must be adjusted considering other factors.

Imagine these three situations:

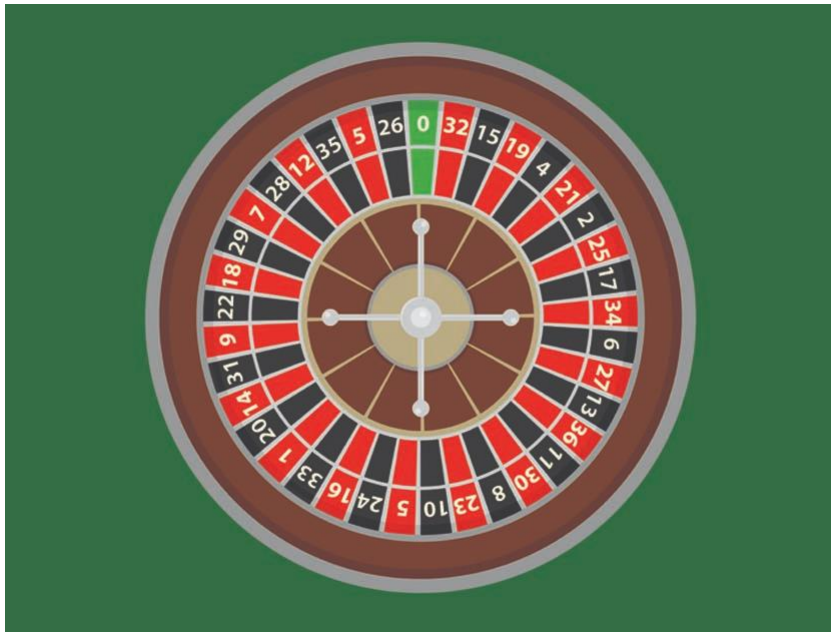
Vox makes an estimate of those attending the 8M protest ... X

The representative of the ministry gives a number of Covid-infected people... Y

You travel to Marrakech and you want to buy a carpet. The seller offers you a price ... Z

3. Anchoring

- Research has shown that the anchoring effect occurs even in the case of randomly provided numbers that have nothing to do with the amount to be estimated.



4. The affect heuristic

- Impressions and judgments based on the sensations (positive or negative) provided by the stimuli.

Manipulation of affect in everyday life:

Series and movies use music to induce the desired affect in the viewer.

Advertising models smile to associate positive affect with the clothes they are selling

Product brands use affective labels that increase the likelihood of being bought

4. The affect heuristic

- Affection is understood as the quality of 'good' or 'bad' experienced as a sensation (conscious or not), and which demarcates the positive or negative quality of the stimuli.
- Affective responses happen quickly and automatically.
- Confidence in these sensations can be characterized as a heuristic of affect

To learn more about this heuristic you can read the article:

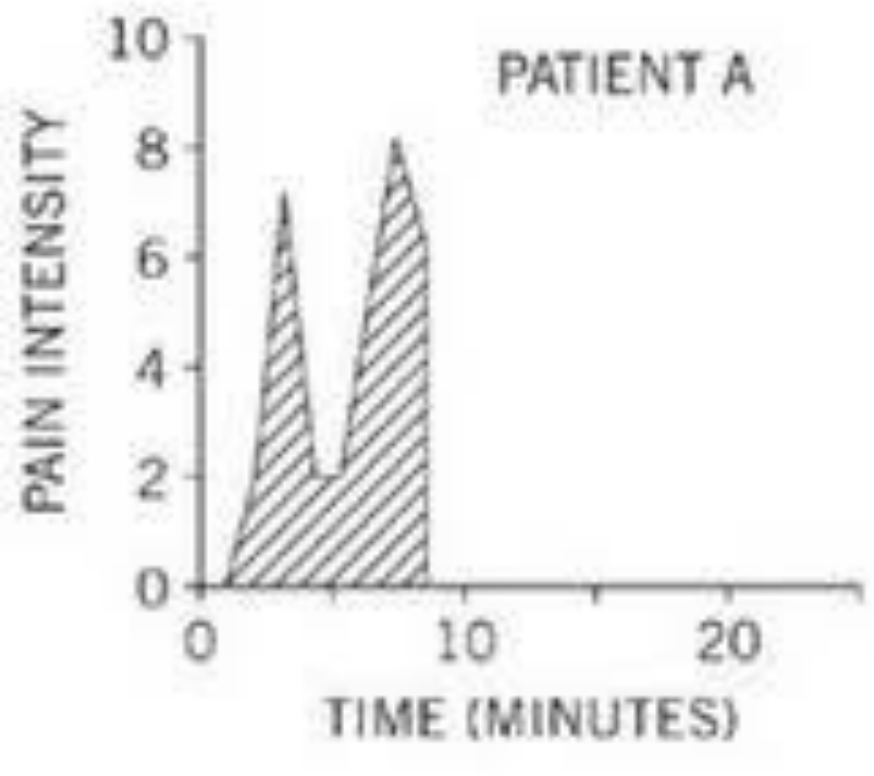
Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research*, *177*(3), 1333–1352. https://doi.org/10.1016/j.ejor.2005.04.006

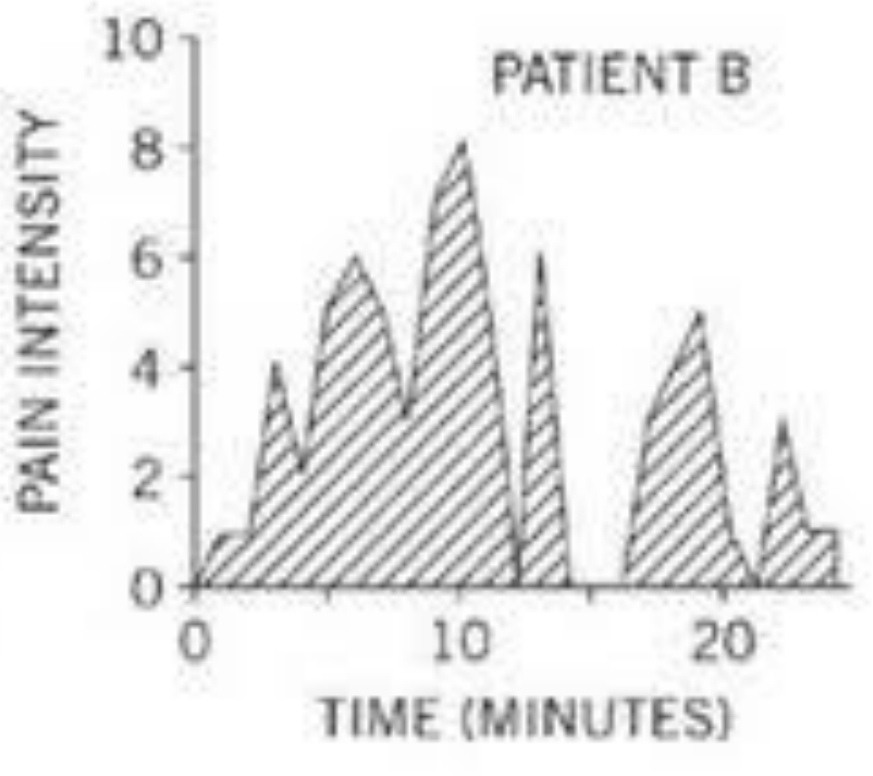
"This heuristic appears at once both wondrous and frightening: wondrous in its speed, and subtlety, and sophistication, and its ability to ''lubricate reason''; frightening in its dependency upon context and experience, allowing us to be led astray or manipulated—inadvertently or intentionally— silently and invisibly." (p.1349)

5. Prototypic heuristics

- A family of heuristics that share a common mechanism and a consistent pattern of cognitive illusions (analogous to the Marta problem).
- They can be described as the substitution of an average instead of the sum.
- As an illustrative example we have the data of a study with the intensity of pain reported by patients undergoing colonoscopy (Rederlmeier & Kahneman, 1996).
  - They reported the intensity of the pain every 60 seconds and at the end a global assessment of the pain suffered.
  - The correlation of pain suffered with duration (Range 6 to 66 minutes) was .03
  - The correlation between the overall assessment and the two-point assessment (maximum pain and before the end) was .67

Which patient reported the most pain overall? A





Which patient actually suffered the most pain? B

Can the effect of heuristics be avoided?

- A heuristic comes into operation from System 1 and intuitive judgments, and implies a certain error of System 2 in detecting and not correcting it.
- It can be avoided through corrective thinking
- If the rule reaches the subject's mind quickly enough, an intuitive judgment that violates a rule that the subject accepts will be replaced.

In Marta' example:
It may not be more likely to be two things at once than only one

Representation (heuristic) leads us to bias (participating in the fallacy of conjunction)

106508.
Cognitive Processes

Artificial Intelligence

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