Neuro-Symbolic Modeling

The Two Systems of Thinking

This lecture

- The Two Systems of Thinking
- Learning & Reasoning
- History: Statistical relation learning
- Some examples of neural-symbolic integration
- Technical challenges for neural-symbolic integration
- A taxonomy of approaches

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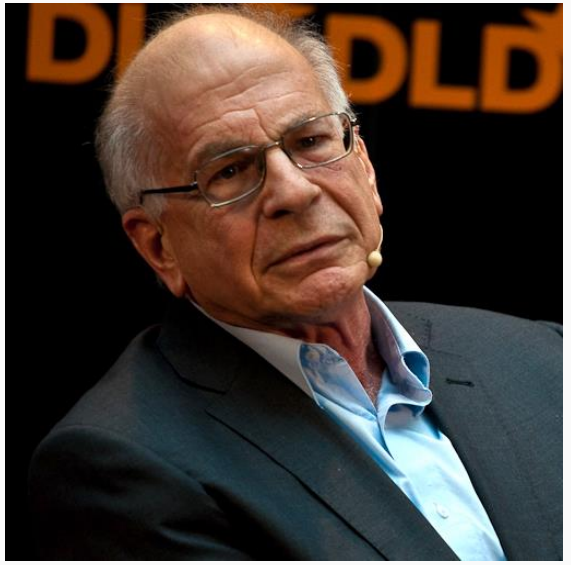
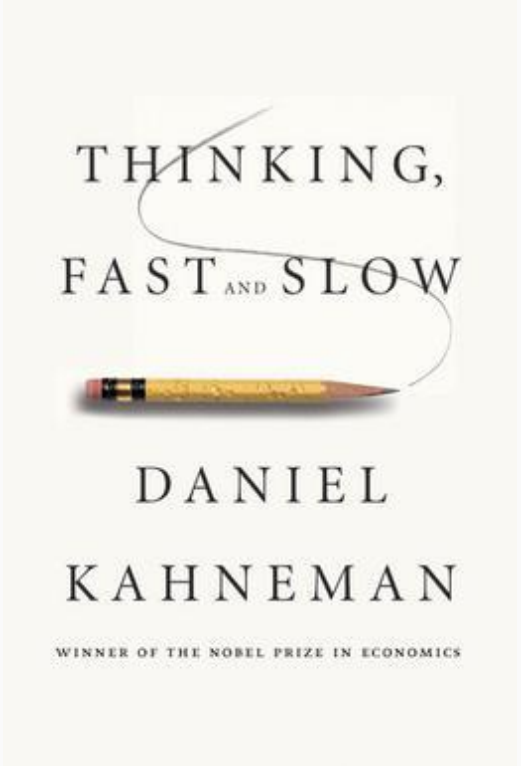
System 1 and System 2

Daniel Kahneman: We have two different ***conceptual*** mental systems that shape our decisions





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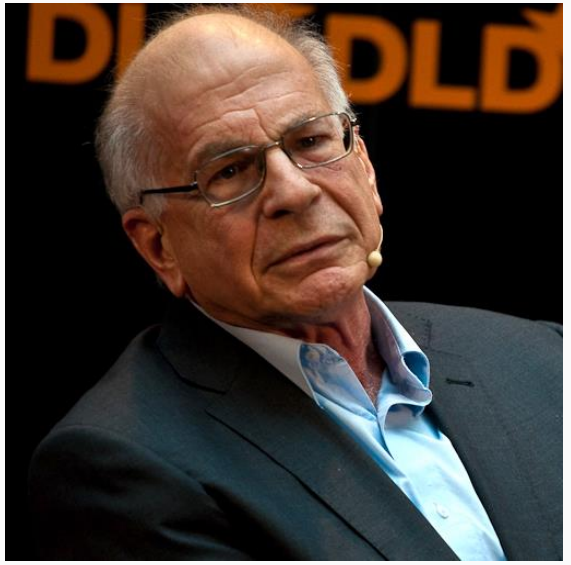
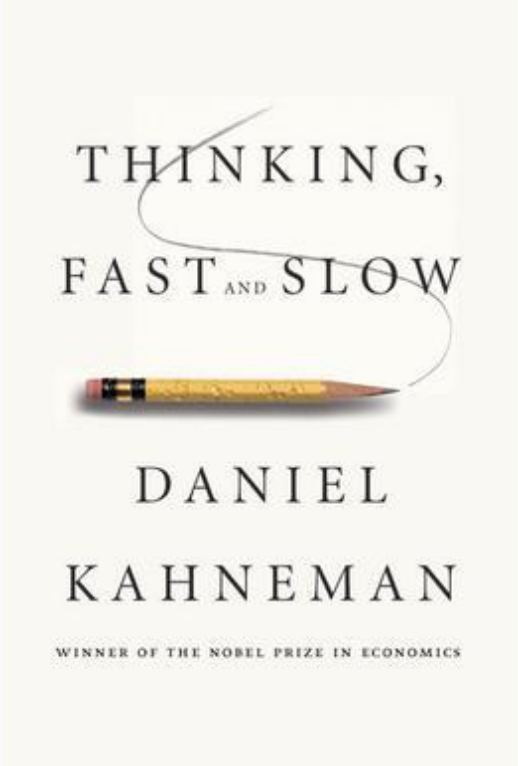
System 1: Quick thinking that happens automatically and effortlessly





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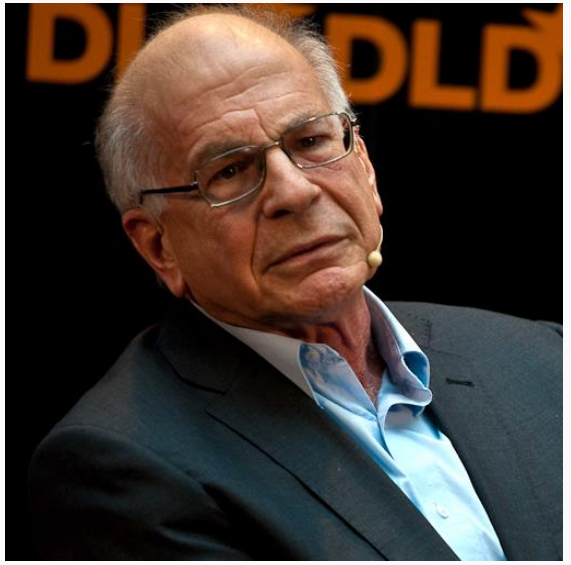
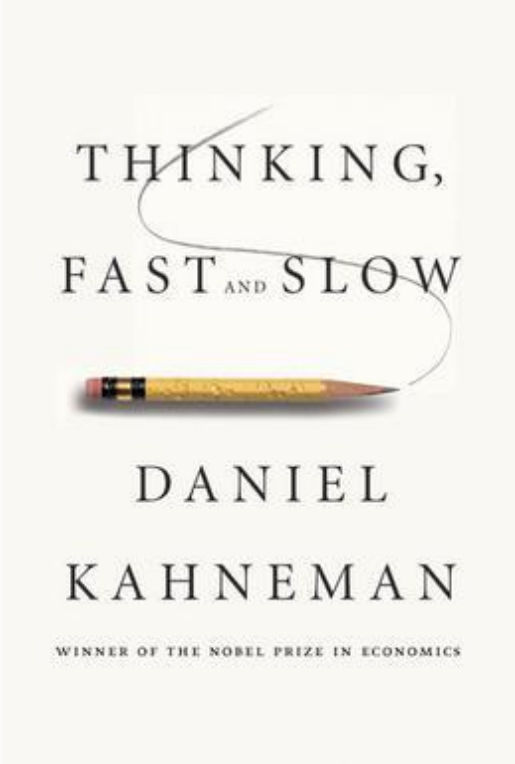
System 1: Quick thinking that happens automatically and effortlessly

System 2: Deliberate thinking requiring attention and concentration





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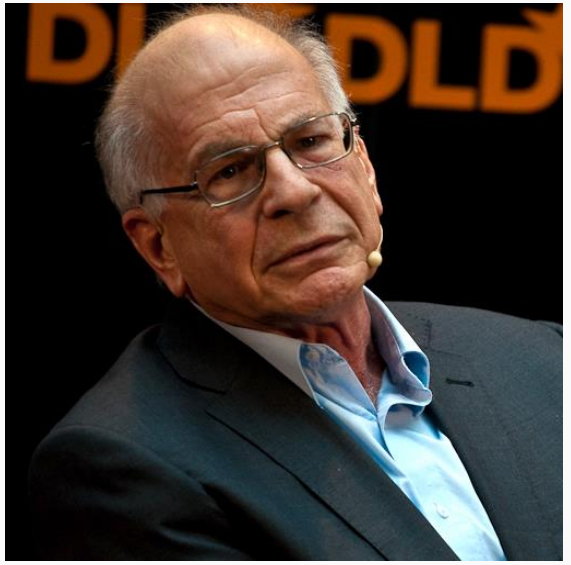

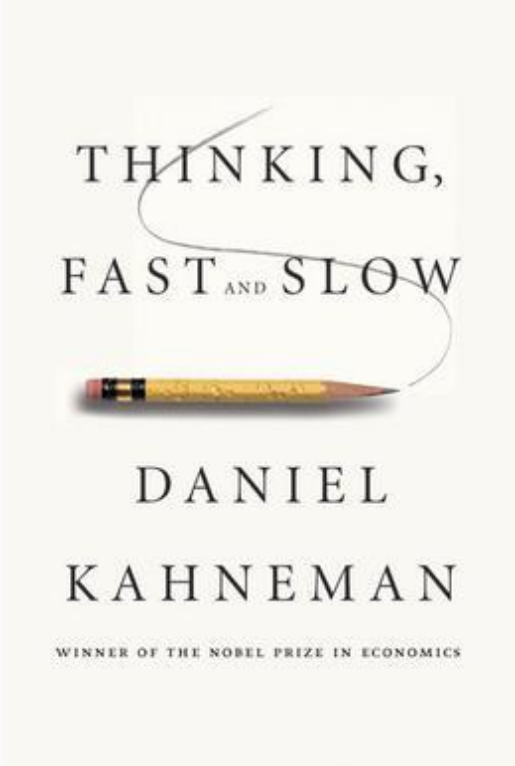

The terms System 1 and System 2 were not coined by Kahneman. They have a long history in psychology research. But his book popularized them.

System 1 versus System 2

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System 2: Slow, logical

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- Reflective: Responsibe for conscious thoughts and deliberate decision-making

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- Automatic: Responsible for initial impressions, gut feelings, hunches
- Less effort: Uses emotion, past experience and biases
- Heuristic-driven: Uses mental shortcuts & rules-of-thumb

System 2: Slow, logical

- Slow: Operates with controlled thought processes
- Reflective: Responsibe for conscious thoughts and deliberate decision-making
- Effortful: Requires attention, effort and control
- Reasoning-driven: Uses reasoning and analysis to make decisions

Some examples

Let us try to guesstimate which actions are controlled by systems 1 & 2

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Recognize a familiar face in a crowd		
	System 1	System 2
	Which system does this?	

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Some examples

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Recognize a familiar face in a crowd — System 1 — System 2

Double-check your math homework — System 1 — System 2

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Our decision making

An *interplay* between these two systems

System 1 generates initial impressions quickly

System 2 can modify them through conscious deliberation

Understanding how these two conceptual systems work with each other may help us gain a better understanding of human decision making processes

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Our decision making

An *interplay* between these two systems

System 1 generates initial impressions quickly

… but can be prone to systematic biases, errors and irrational decisions

System 2 can modify them through conscious deliberation

…but overuse can lead to mental exhaustion and decreased performance

Understanding how these two conceptual systems work with each other may help us gain a better understanding of human decision making processes