

Artificial Intelligence: Search Methods for Problem Solving

Prologue

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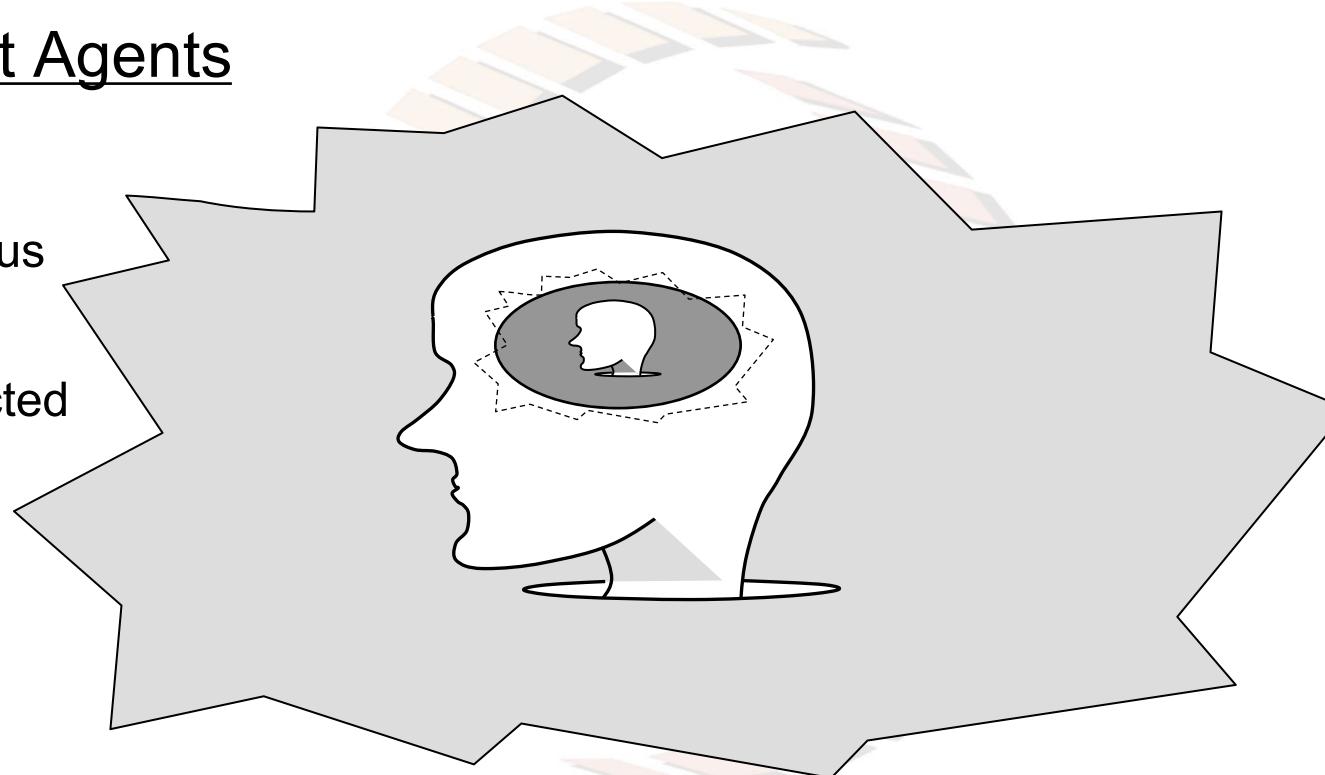
Intelligent Agents

Persistent

Autonomous

Proactive

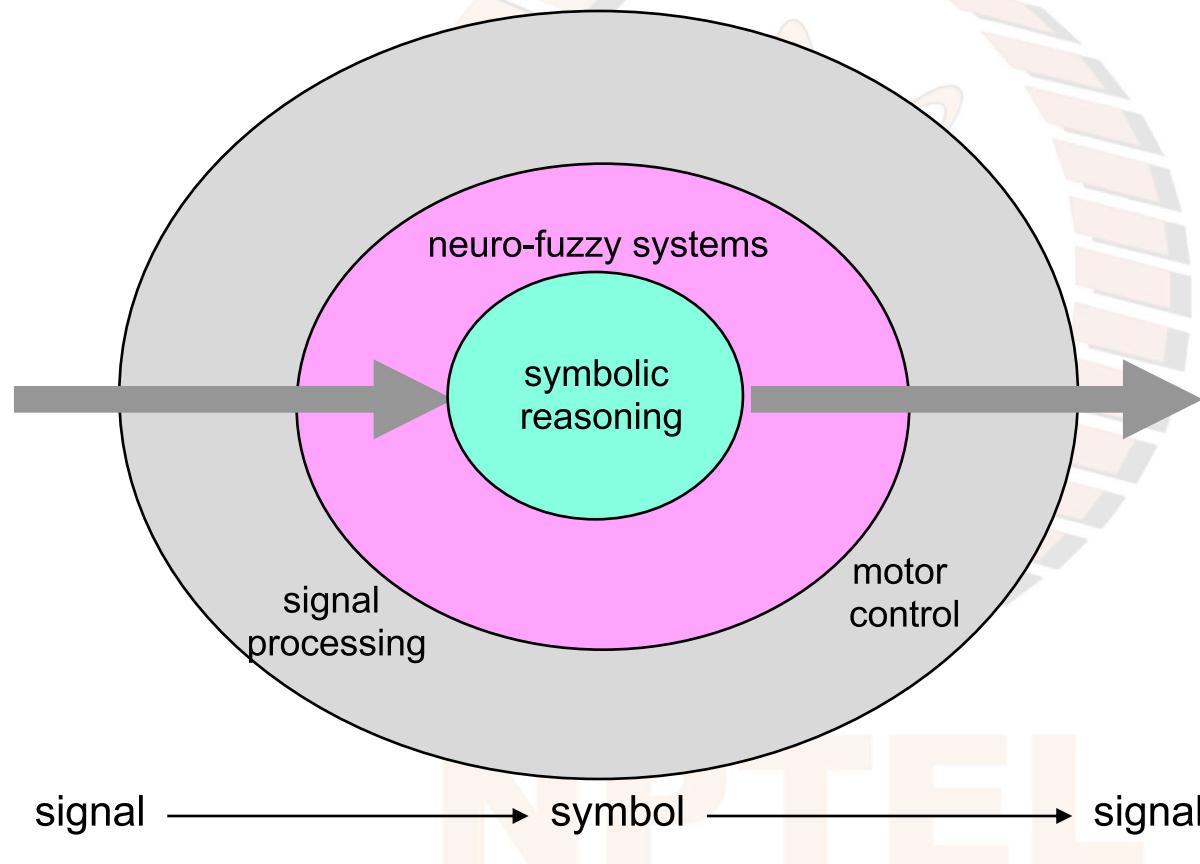
Goal Directed



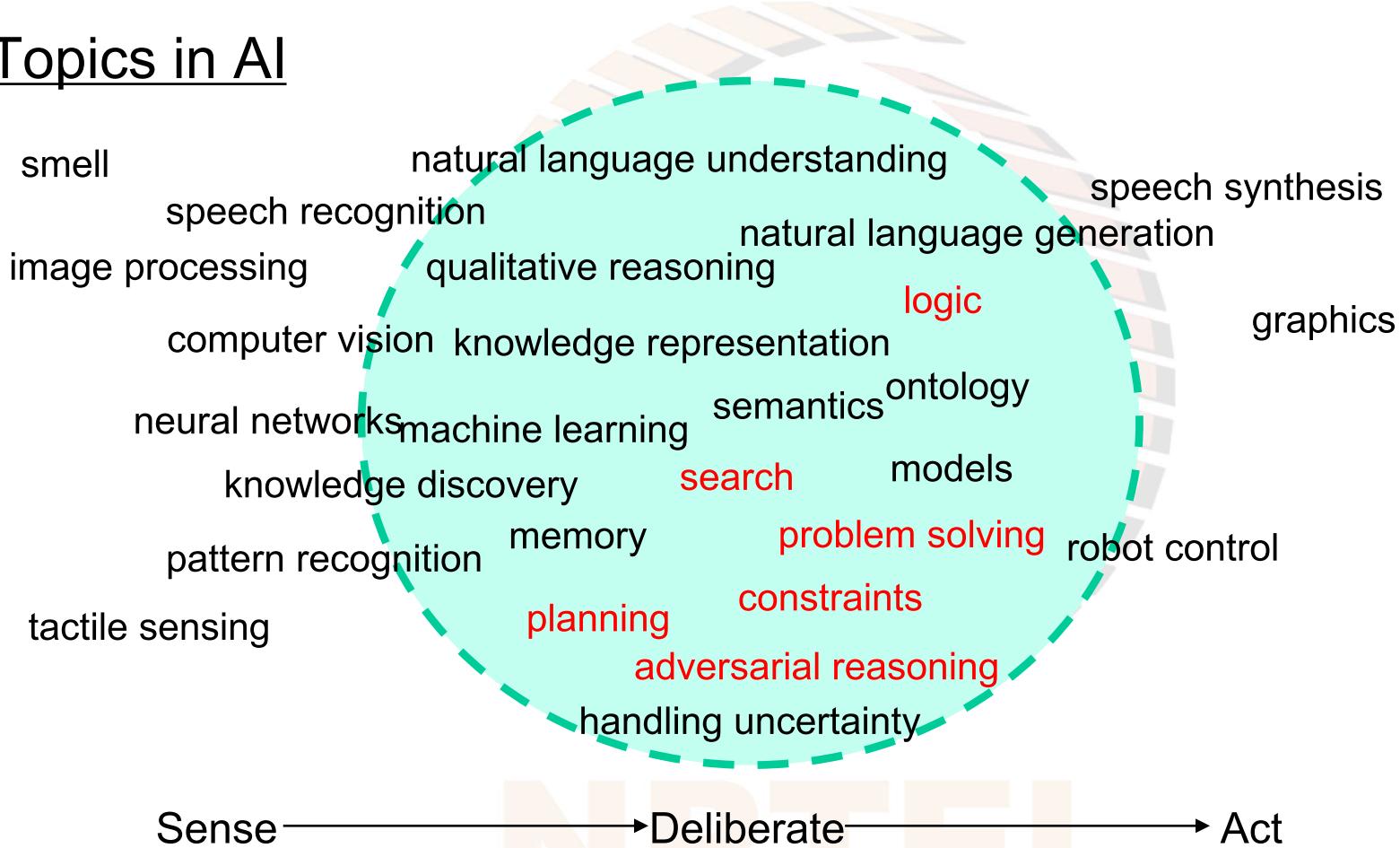
An intelligent agent in a world carries a model of the world in its “head”.
The model maybe an abstraction. A self aware agent would model itself
in the world model.

(From A First Course in AI – Deepak Khemani)

Information Processing view of AI



Topics in AI



Source: Deepak Khemani, A First Course in Artificial Intelligence

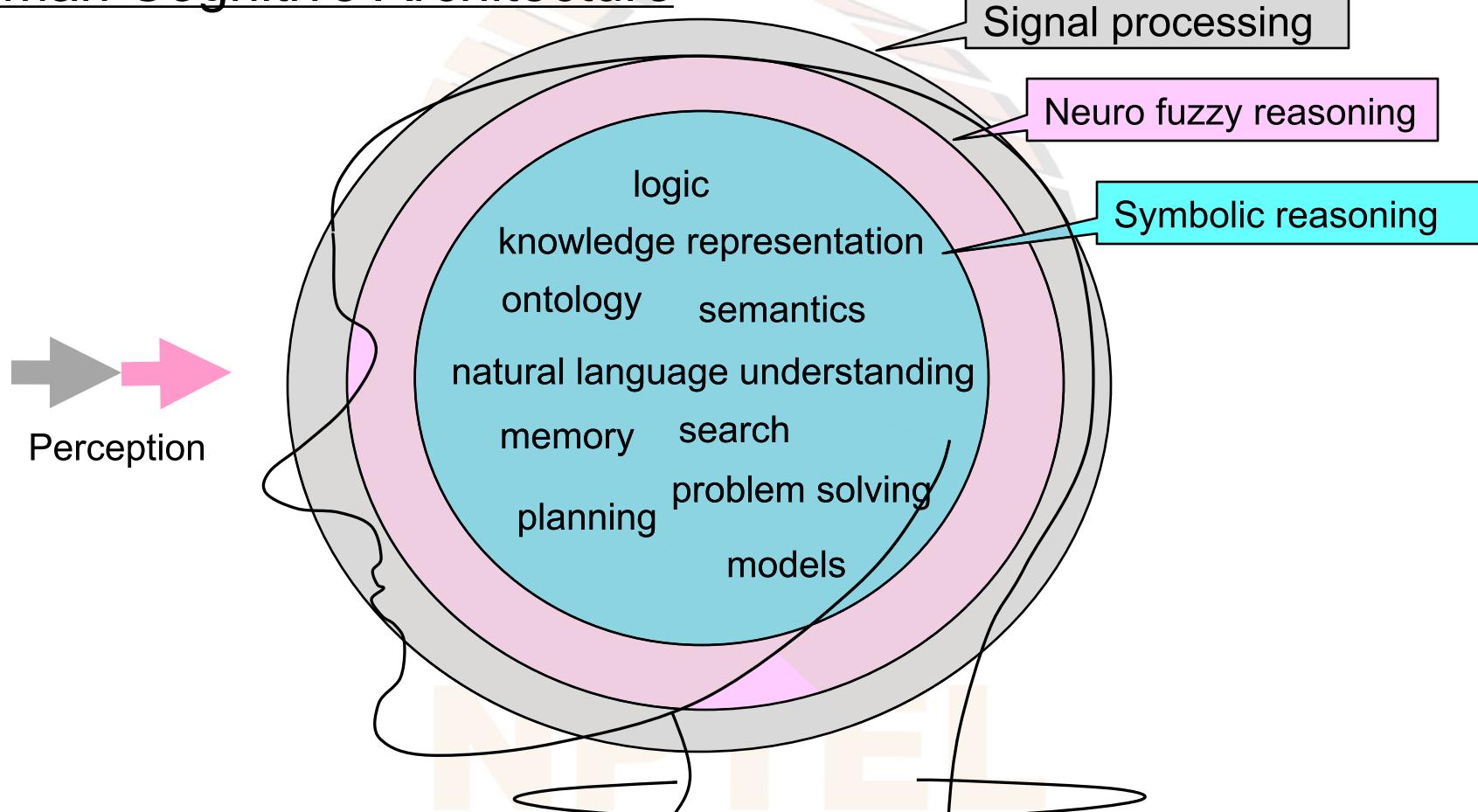
Introduction to the 2nd edition of the course

The last decade has seen an **explosion**
in the amount of data available
and
advancements in neural network training algorithms

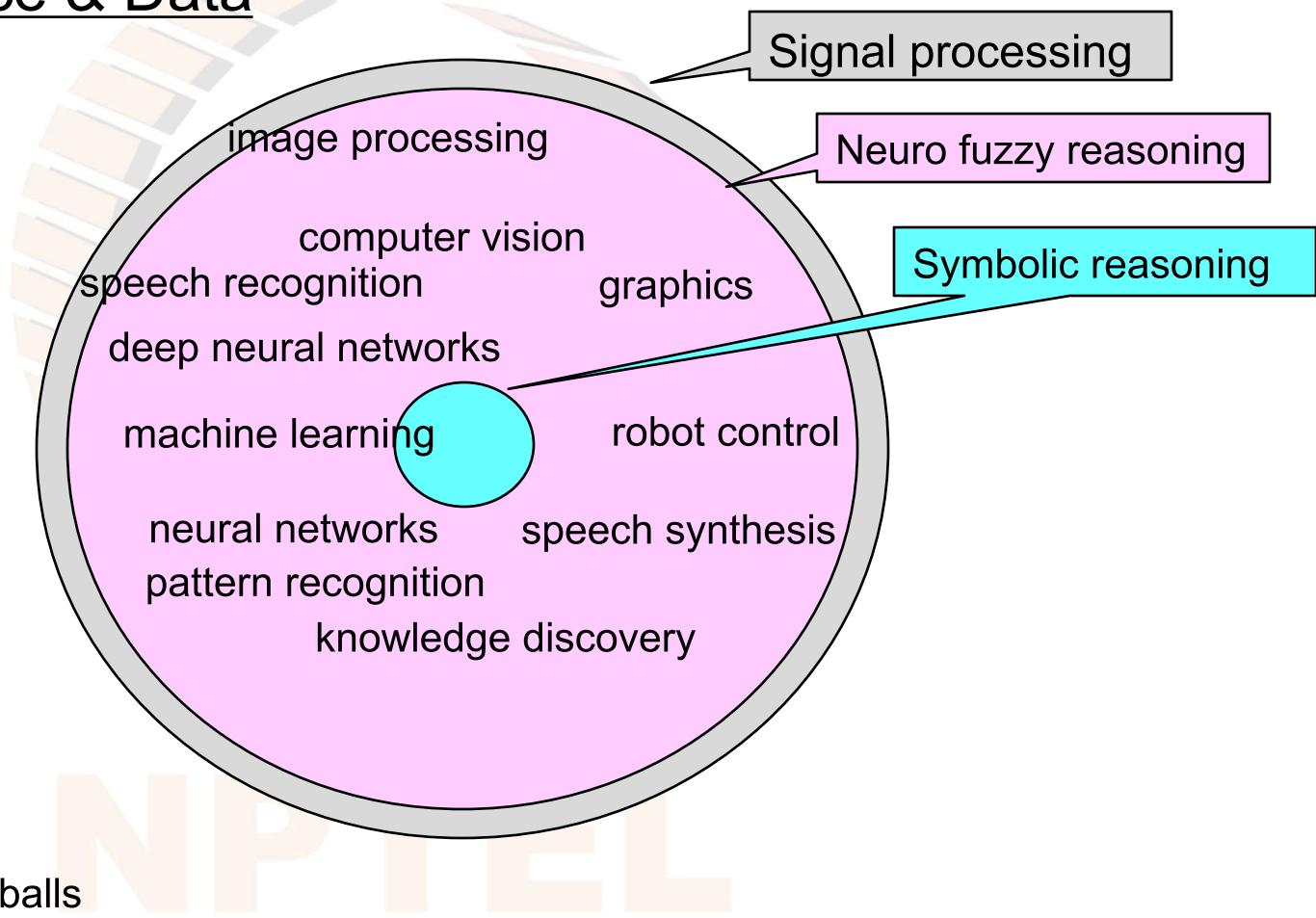
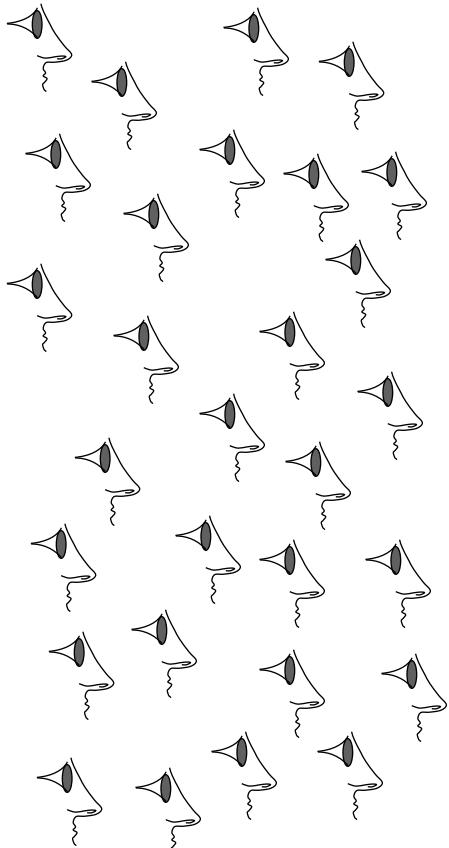
leading to the impression
that
that is all AI is about!

We briefly look at this phenomenon
before proceeding to our syllabus
on problem solving using search...

Human Cognitive Architecture



Machine Intelligence & Data



Artificial Intelligence & Machine Learning

- AI – symbolic knowledge representation and problem solving
- ML – making sense of data
 - Data → Information
(big data, recommender systems, predictive analytics....)
 - Data → Classification
(deep learning, images and language....)

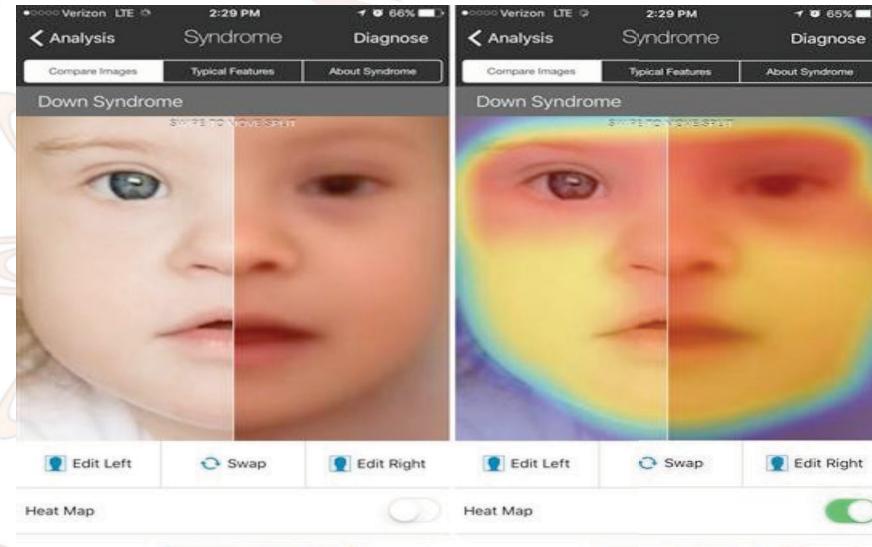
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How Machine Learning Is Revolutionizing the Diagnosis of Rare Diseases

Facial recognition app Face2Gene is being used by doctors to diagnose rare diseases.

Within a matter of seconds, the app generated a list of potential diagnoses — and corroborated his hunch. “Sure enough, Mowat-Wilson syndrome came up on the list,” Abdul-Rahman recalls.

Courtesy FDNA



Jane C. Hu

<http://www.nbcnews.com/storyline/the-big-questions/how-machine-learning-revolutionizing-diagnosis-rare-diseases-n700901>

Animal-Like Abilities

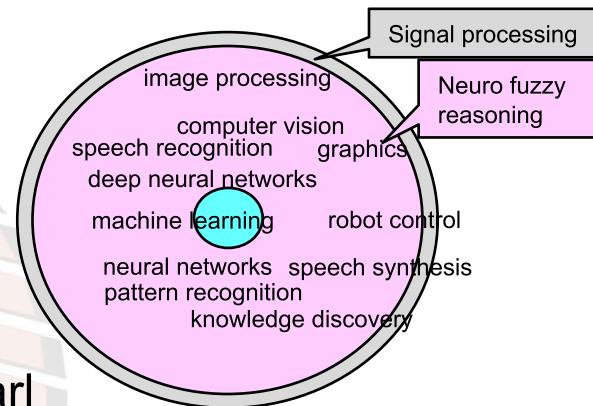
“Everything ML does now,
humans do in the blink of an eye”

- “Eagles and snakes have better vision systems”

- Judea Pearl

- Cats have superior navigation abilities
- Dogs recognize and react to human speech
- African grey parrots can mimic human speech

Yet, none of these animals have
the cognitive abilities and the intelligence
typically attributed to humans.



Adnan Darwiche, Human-Level Intelligence or Animal-Like Abilities,
CACM, Vol. 61, No. 10, Oct 2018.

Performance vs. Competence

Now suppose a person tells us that a particular photo shows people playing Frisbee in the park. We naturally assume that this person can answer questions like *What is the shape of a Frisbee? Roughly how far can a person throw a Frisbee? Can a person eat a Frisbee? ...*

Computers that can label images like “people playing Frisbee in a park” have no chance of answering those questions...

...they have *no idea* what a person is, that parks are usually outside, that people have ages, that weather is anything more than how it makes a photo look, etc.

Rodney Brook, [The Seven Deadly Sins of AI Predictions](#).
MIT Technology Review

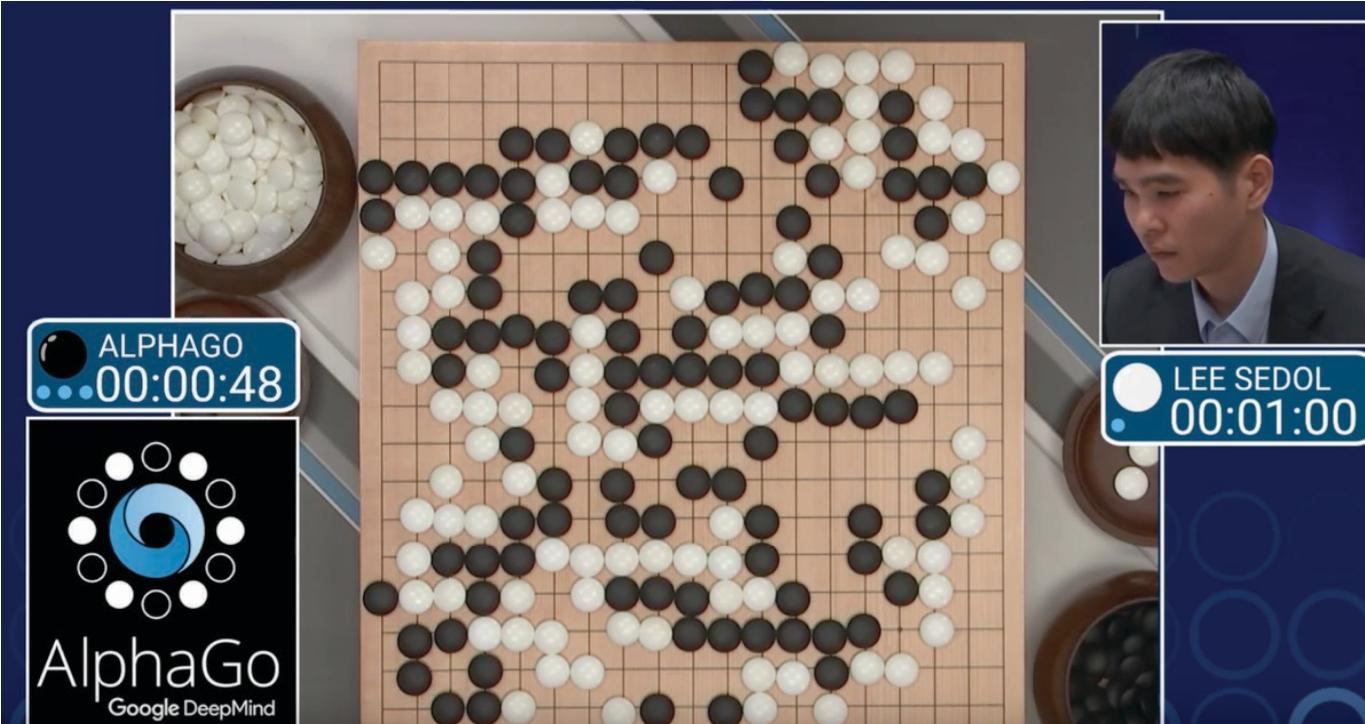
Suitcase Words

Marvin Minsky called words that carry a variety of meanings “suitcase words.” “Learning” is a powerful suitcase word; it can refer to so many different types of experience...

When people hear that machine learning is making great strides in some new domain, they tend to use as a mental model the way in which a person would learn that new domain. However, machine learning is very brittle, and it requires lots of preparation by human researchers or engineers, special-purpose coding, special-purpose sets of training data, and a custom learning structure for each new problem domain.

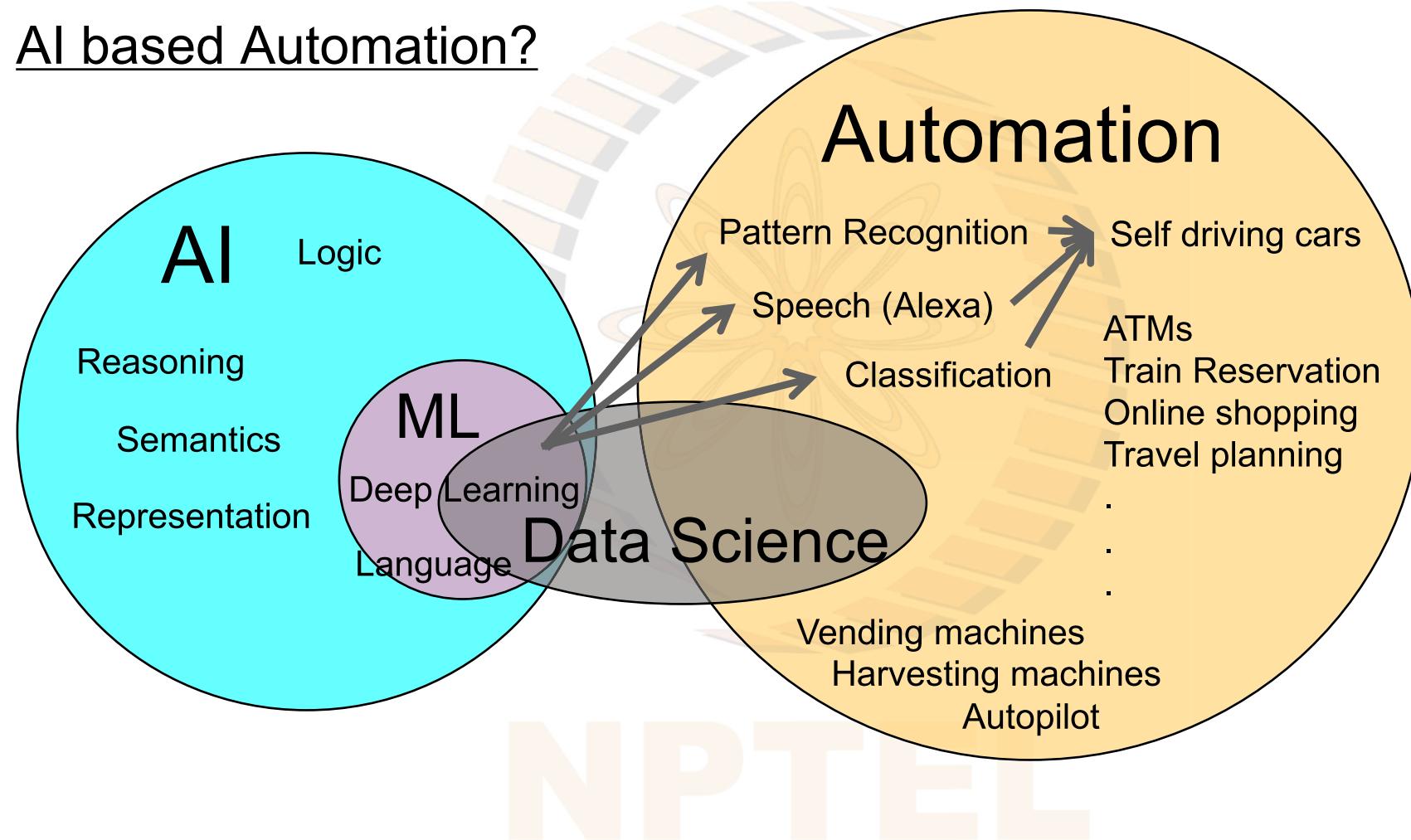
Rodney Brook, [The Seven Deadly Sins of AI Predictions](#).
MIT Technology Review

AlphaGo beats World Champion at Go in 2016



from [this Popular Mechanics article](#)

AI based Automation?



Nadine the Robot Is Your New Social Companion

After the Coronavirus epidemic there has been an increased demand for robots for various activities like serving food in hospitals...

.....even as companions



from

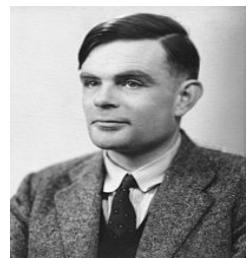
https://motherboard.vice.com/en_us/article/pgkgzv/nadine-the-robot-is-your-new-social-companion-Nadia-Thallman

Kirobo: A Companion in Space



Kirobo - <https://www.cnet.com/news/japans-iss-kirobo-robot-is-lonely-in-space/>

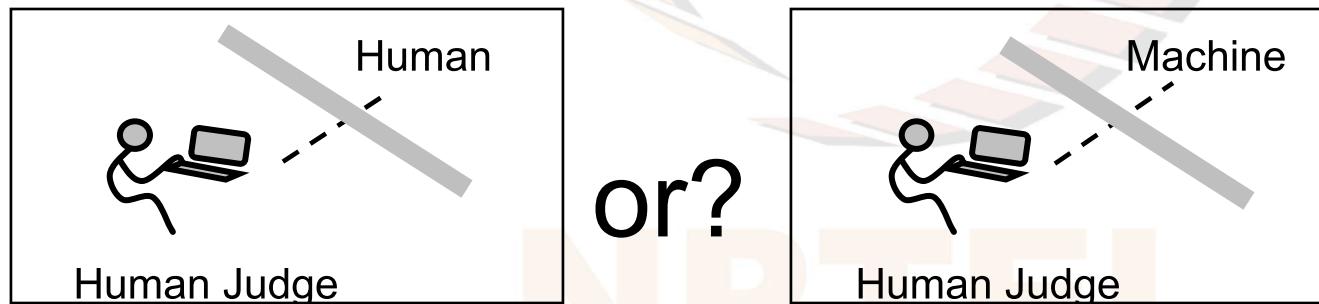
Alan Turing's Imitation Game



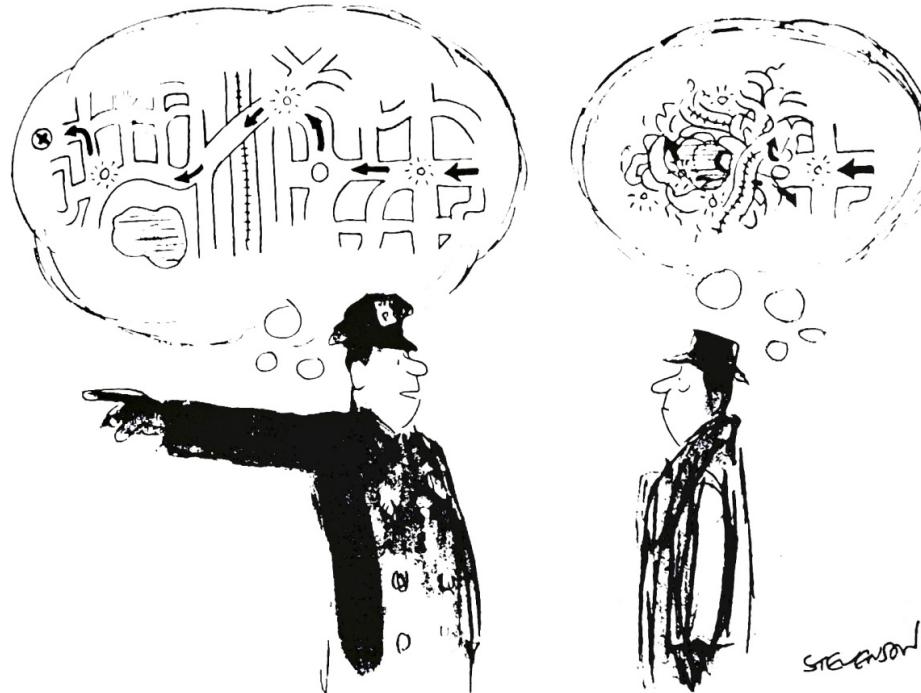
Alan Turing (1912 – 1954)

- The question whether machines can think itself “too meaningless”
- Prescribed a test which he called the *Imitation Game* which is now known as *The Turing Test*
 - Turing, A.M. (1950). Computing machinery and intelligence. *Mind*, 59, 433-460.
<http://www.loebner.net/Prizef/TuringArticle.html>

http://en.wikipedia.org/wiki/Alan_Turing



Natural Language

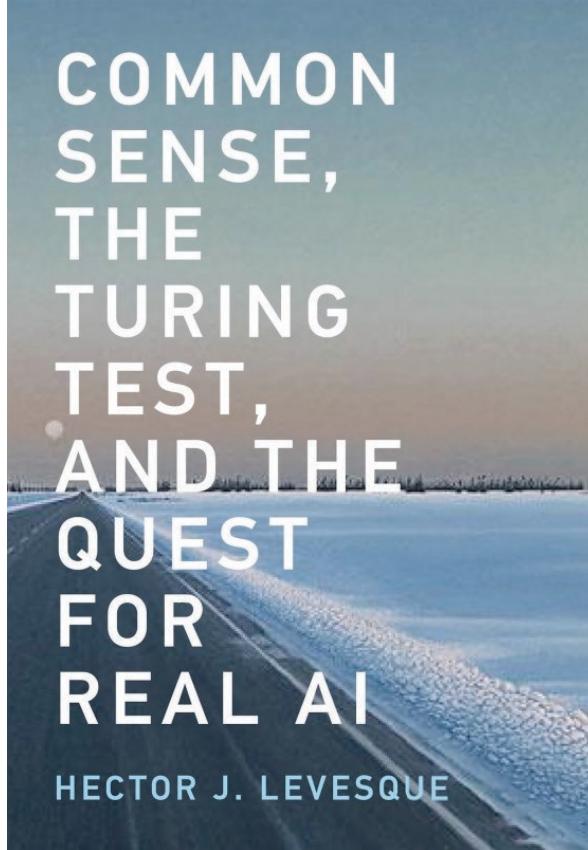


Drawing by Stevenson; © 1976 The New Yorker Magazine, Inc.

Book: John Sowa: Conceptual Structures

Richness
Ambiguity
Verbosity
Imprecision

Conversations with machines



Given the advances in web data processing, corpus based natural language processing, and clever distracting techniques - it has become easy to build conversational chat bots that are impressive but lack intelligence.

Hector J. Levesque has recently proposed a new test.

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Winograd Schemas – an alternate “Turing Test”

- Winograd schemas ask a pointed multiple choice question that requires knowledge of the subject matter.
- For example, contexts where “give” can appear are statistically quite similar to those where “receive” can appear, and yet the answer must change depending on which one is used.
- This helps make the test *Google-proof*: having access to a large corpus of English text would likely not help much.
- The claim is that doing better than guessing requires subjects to figure out what is going on.



Winograd Schemas: Anaphora Resolution

- A Winograd Schema Challenge question consists of three parts:
- A sentence or brief discourse that contains the following:
 - Two noun phrases of the same semantic class (male, female, inanimate, or group of objects or people),
 - An ambiguous pronoun that may refer to either of the above noun phrases, and
 - A special word and alternate word, such that if the special word is replaced with the alternate word, the natural resolution of the pronoun changes.
- A question asking the identity of the ambiguous pronoun, and
- Two answer choices corresponding to the noun phrases in question.
- A machine will be given the problem in a standardized form which includes the answer choices, thus making it a binary decision problem.

https://en.wikipedia.org/wiki/Winograd_Schema_Challenge

Winograd schema: Example 1

The first schema was given by Terry Winograd himself in 1972.
Such sentences are now named after him.

- The city councilmen refused the demonstrators a permit because they *feared* violence.
- The city councilmen refused the demonstrators a permit because they *advocated* violence.

Who does “they” refer to?

Answer 0: The demonstrators

Answer 1: The councilmen

Winograd schema: Example 2 (IJCAI 2016 challenge)

- John took the water bottle out of the backpack so that it would be *lighter*.
- John took the water bottle out of the backpack so that it would be *handy*.

What does “it” refer to?

1. The backpack
2. The bottle



Winograd schema: Example 3

- The trophy would not fit in the brown suitcase because it was too *small*.
- The trophy would not fit in the brown suitcase because it was too *big*.

What does “it” refer to?

1. The trophy
2. The suitcase

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Winograd schema: Example 4

- The lawyer asked the witness a question, but he was reluctant to *repeat* it.
- The lawyer asked the witness a question, but he was reluctant to *answer* it.

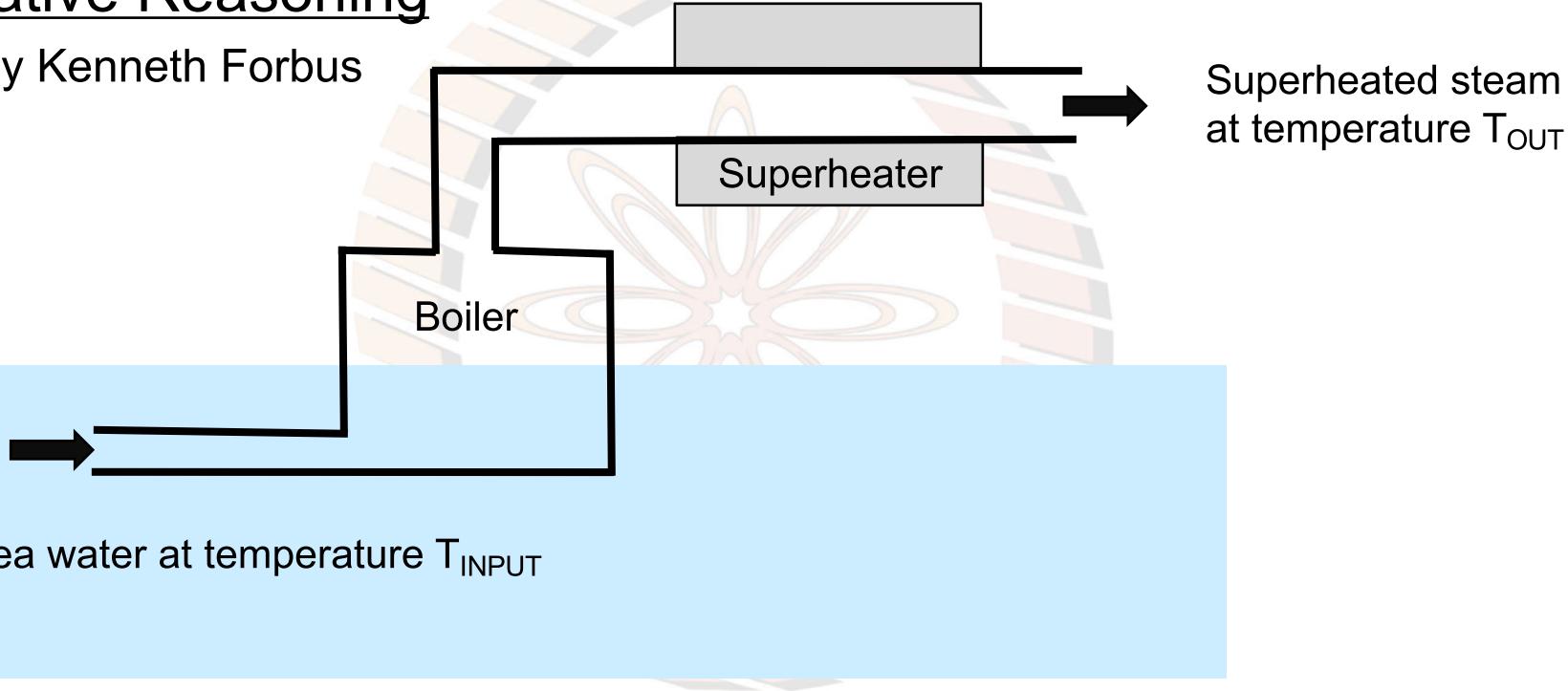
Who was reluctant?

1. The lawyer
2. The witness



Qualitative Reasoning

Courtesy Kenneth Forbus



Sea water at temperature T_{INPUT}

What happens to T_{OUT}
when the ship moves to warmer waters,
and T_{INPUT} increases?

Problem solving

An autonomous agent

in some world

has a **goal** to achieve

and

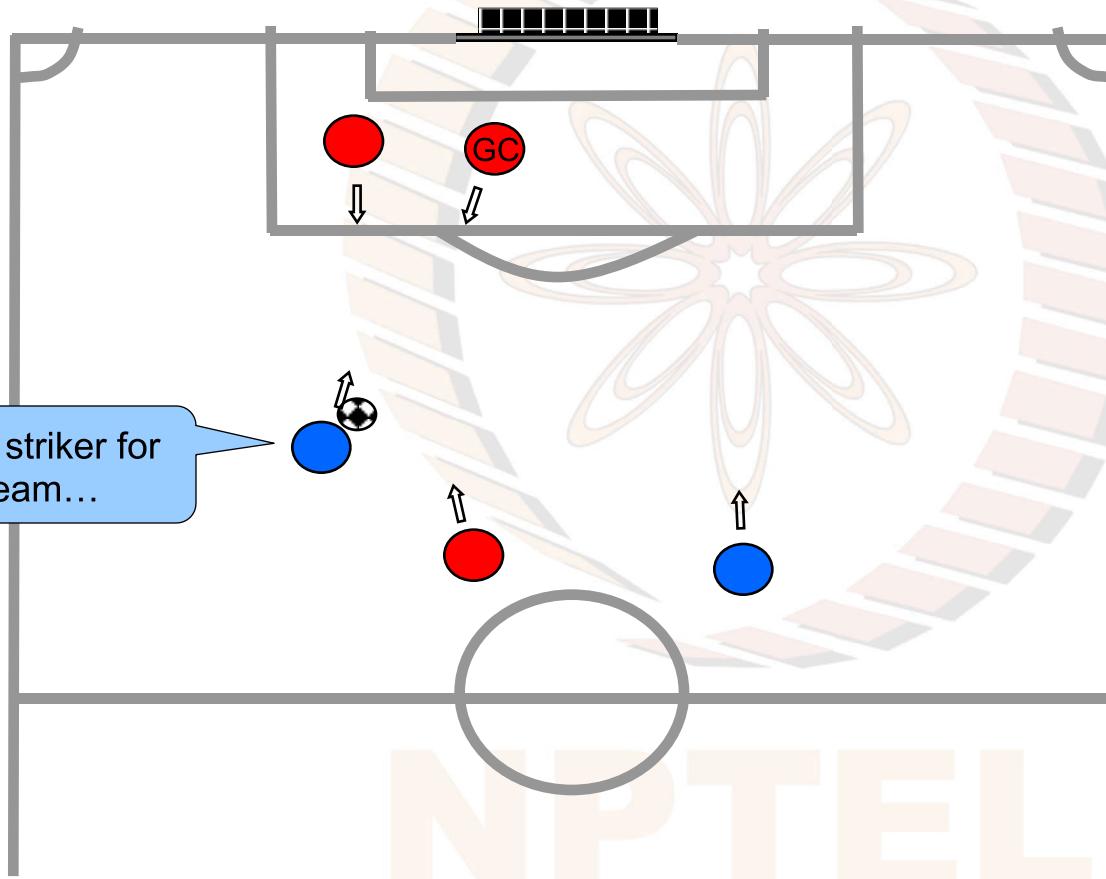
a set of **actions** to choose from

to strive for the goal

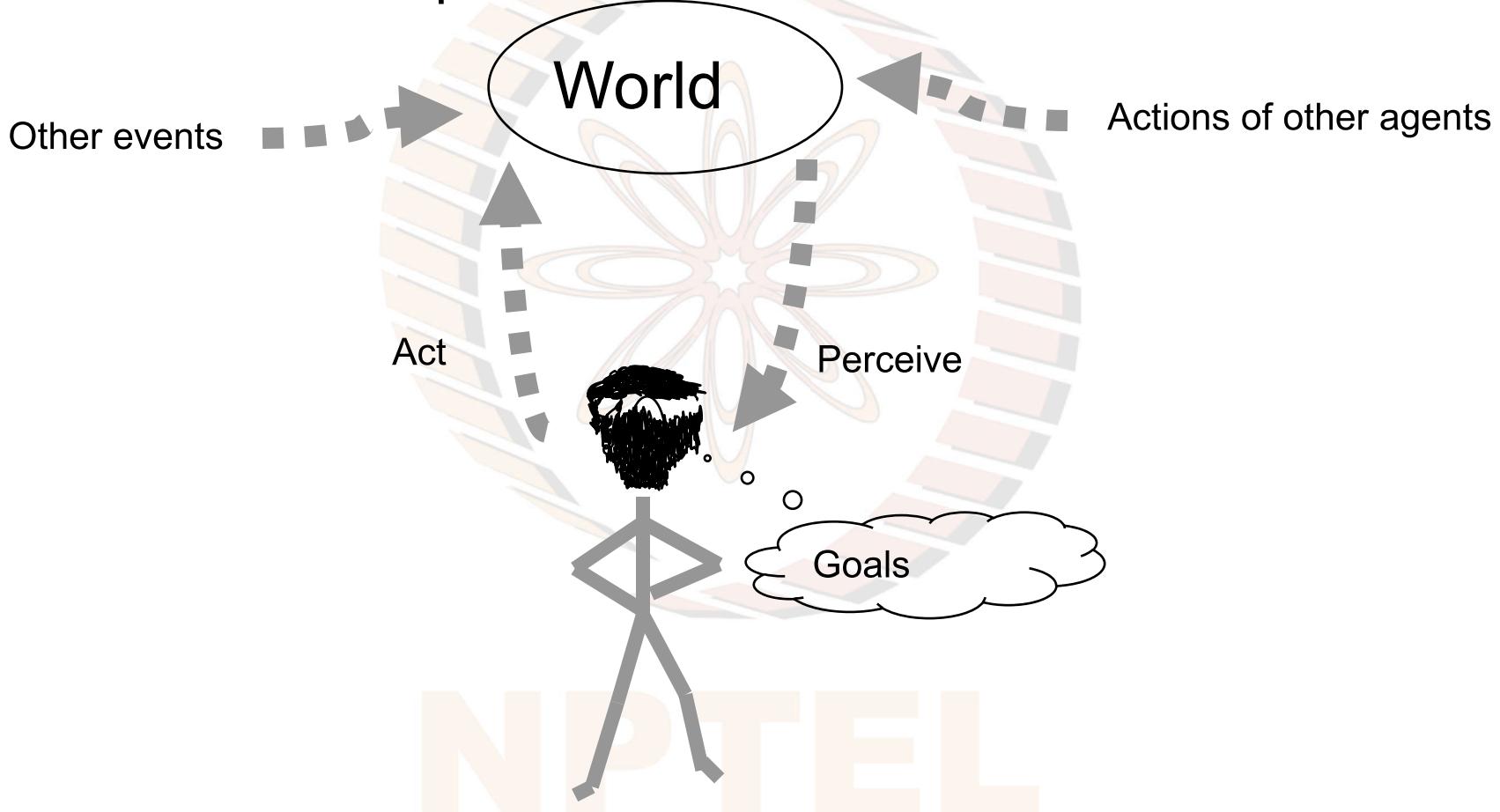
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On a football field...

from NPTEL introduction video



The real world is complex!



Must learn to walk before one can run

Deal with simple problems first

- The world is static
- The world is completely known
- Only one agent changes the world
- Actions never fail
- Representation of the world is taken care of
(to start with at least)



Humankind is a problem solving species

This course
Search Methods

Problem Solving

Companion course
Knowledge Representation & Reasoning

First
Principles

Knowledge

Ontology +
Domain Semantics

Experience

Model Based Reasoning

Memory Based Reasoning

Next

Artificial Intelligence: History and Philosophy

+

AI: Search Methods for Problem Solving Syllabus and reference material

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