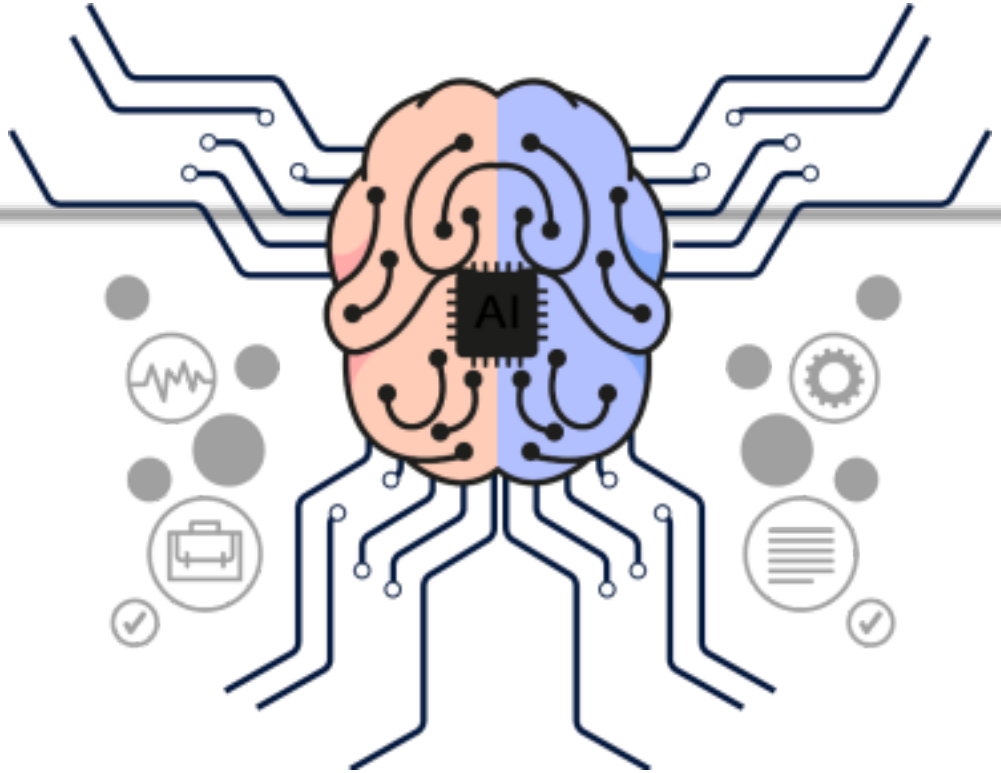
INTRODUCTION TO

ARTIFICIAL INTELLIGENCE

Outline

- What is Artificial Intelligence (AI)?

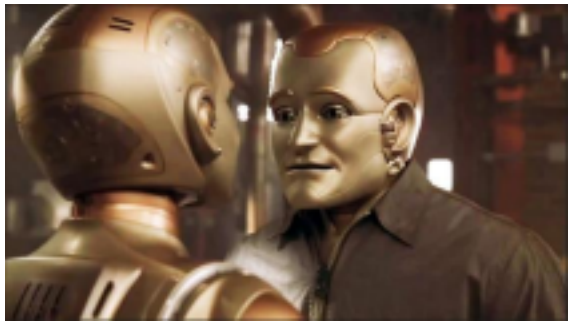
- The foundations of AI
- A brief history of AI
- AI applications in various fields
- What are we going to learn?



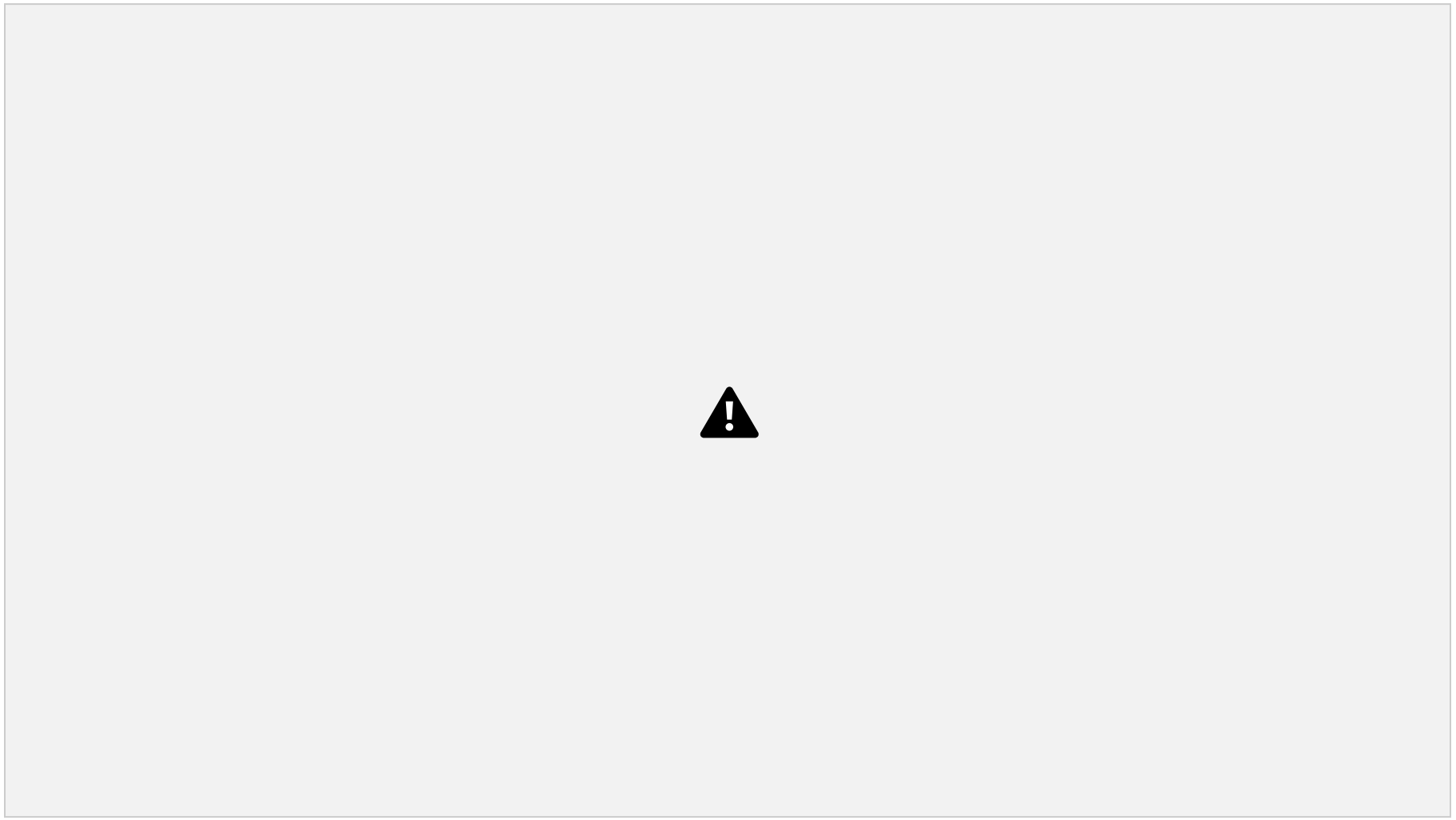
What is AI?

AI: Dreams for everyone


JUNE 21
TRANSFORMERS
THE LAST KNIGHT

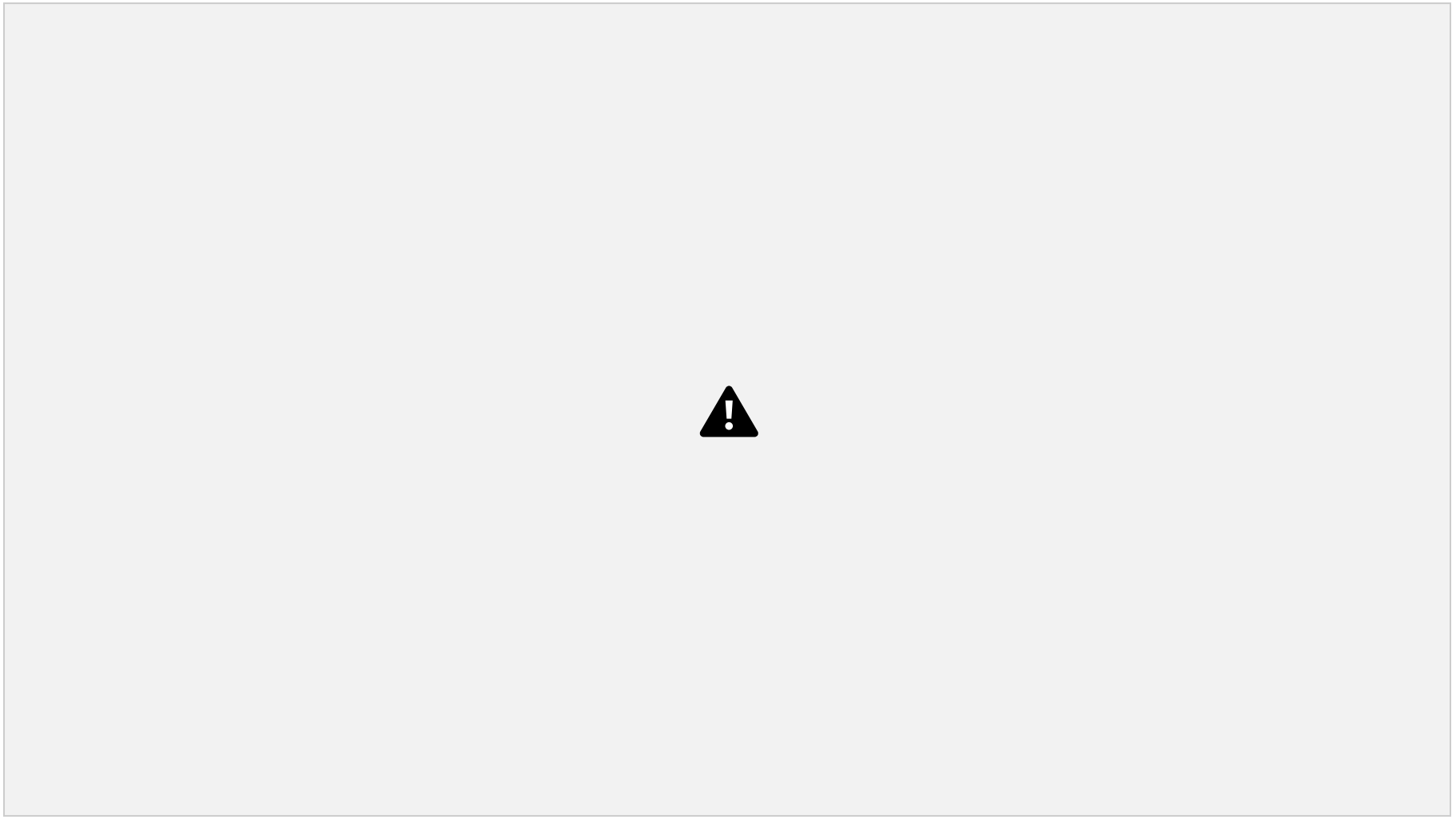


AI Innovations: Personal robots



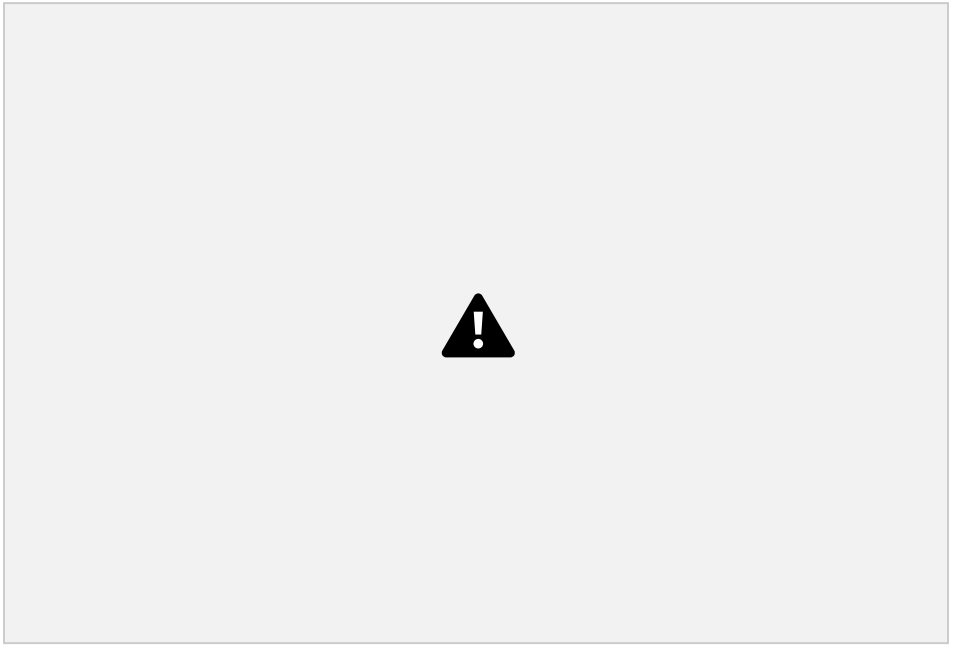
Source: https://www.youtube.com/watch?v=QdQL11uWWcI

AI Innovations: Humanoid robots



Source: https://www.youtube.com/watch?v=9DaTZQxg21U

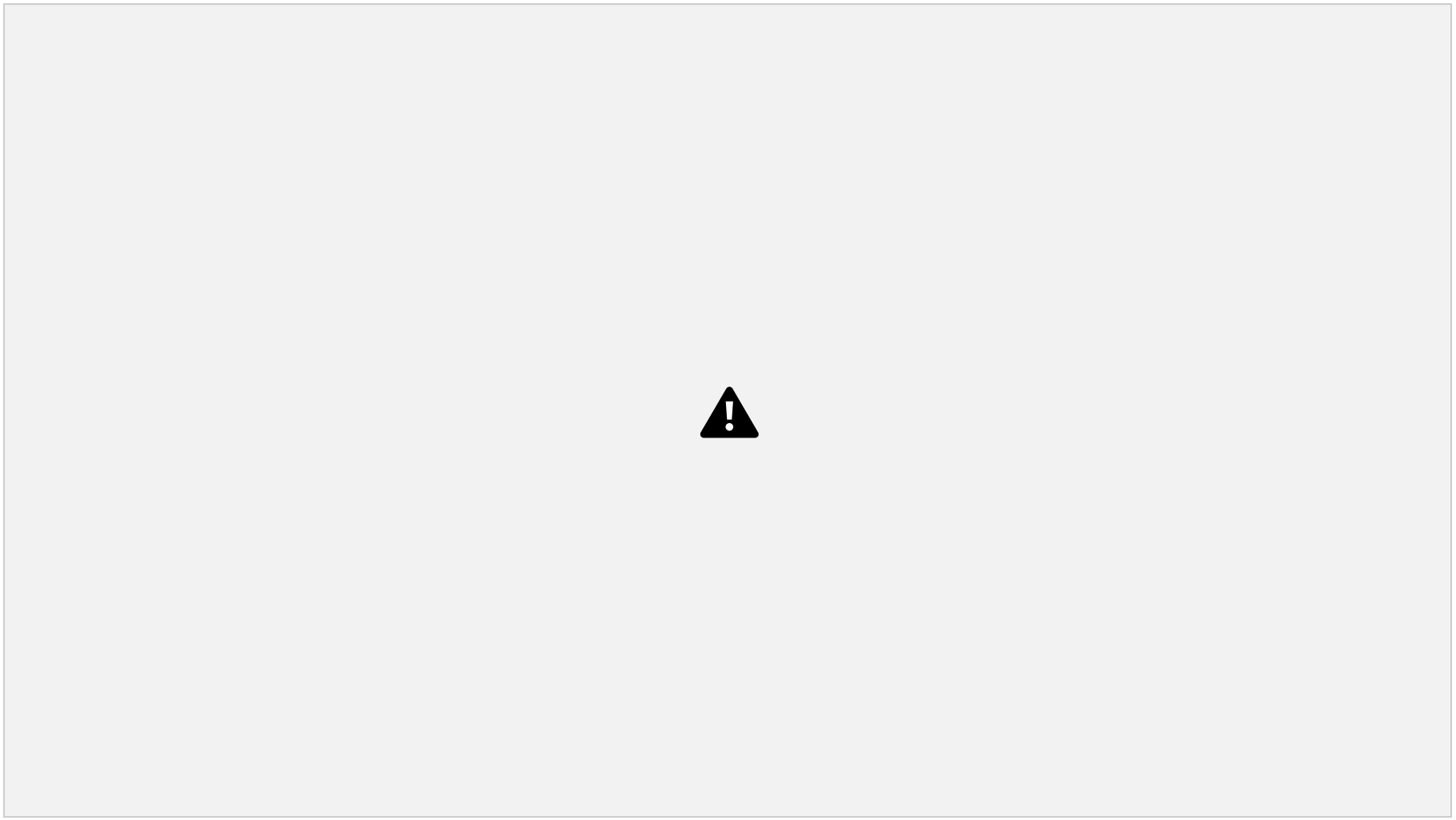
AI Innovations: Deep Blue – AlphaGo



AlphaGo vs. Lee Sedol
(03/2016)

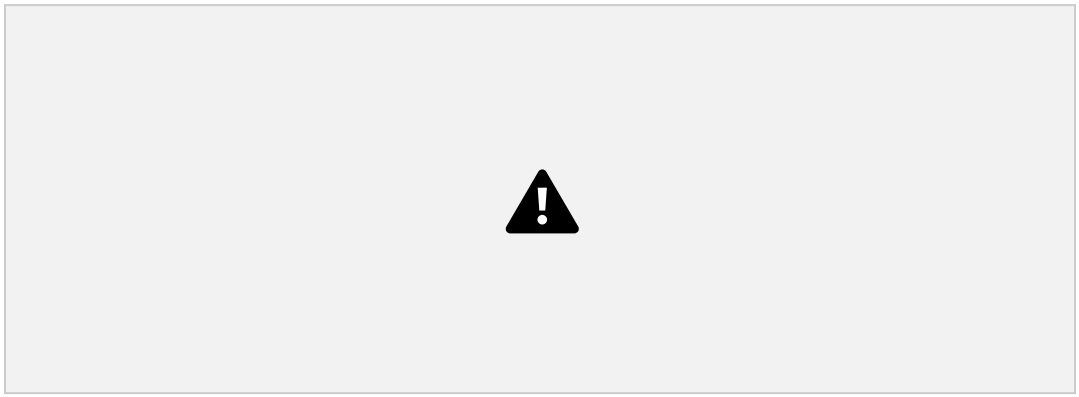
Deep Blue vs. Kasparov
(02/1996 and 05/1997)

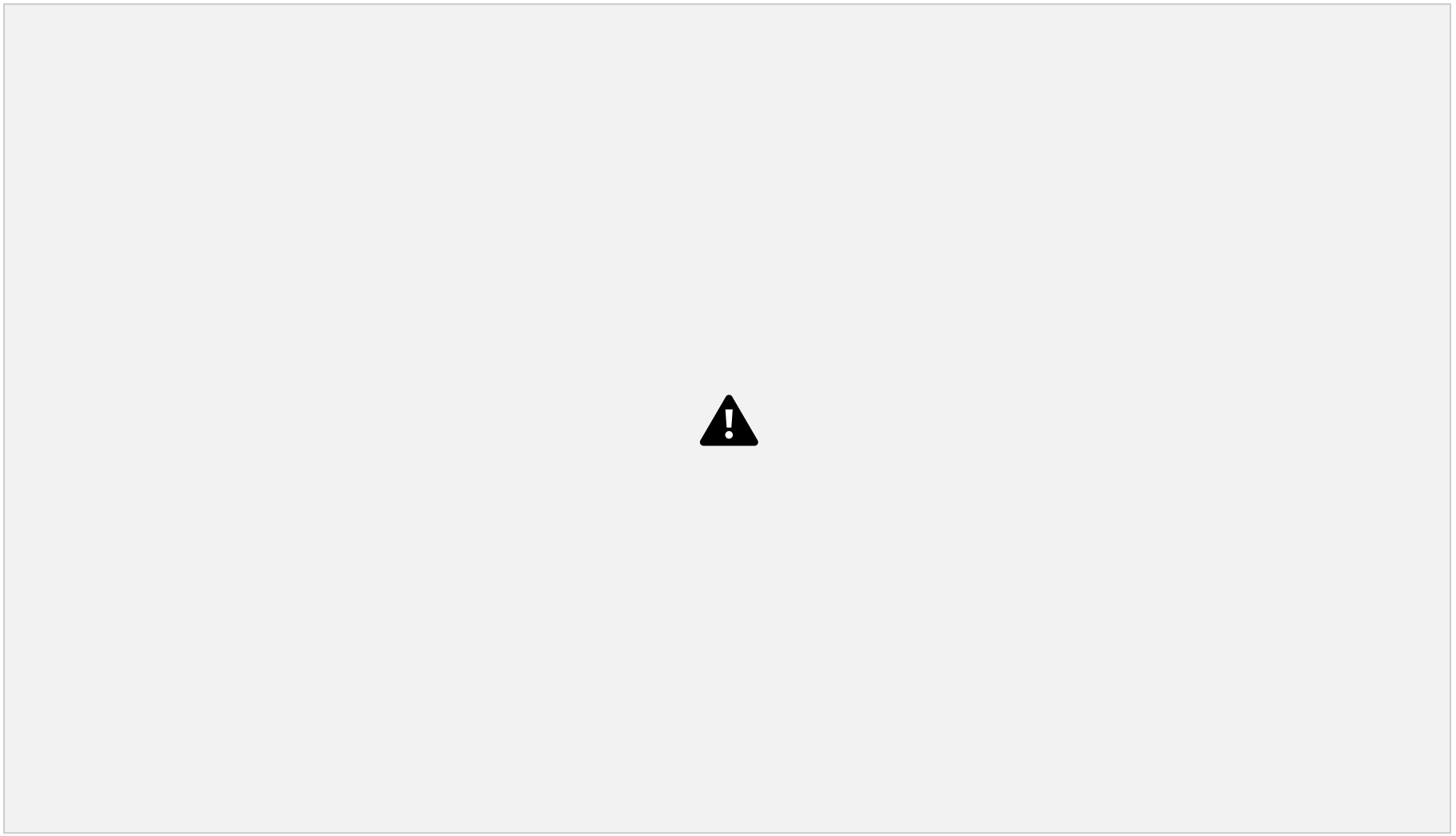
The complexity of Chess and GO



Source: https://www.youtube.com/watch?v=SUbqykXVx0A

AI Innovations: OpenAI Five

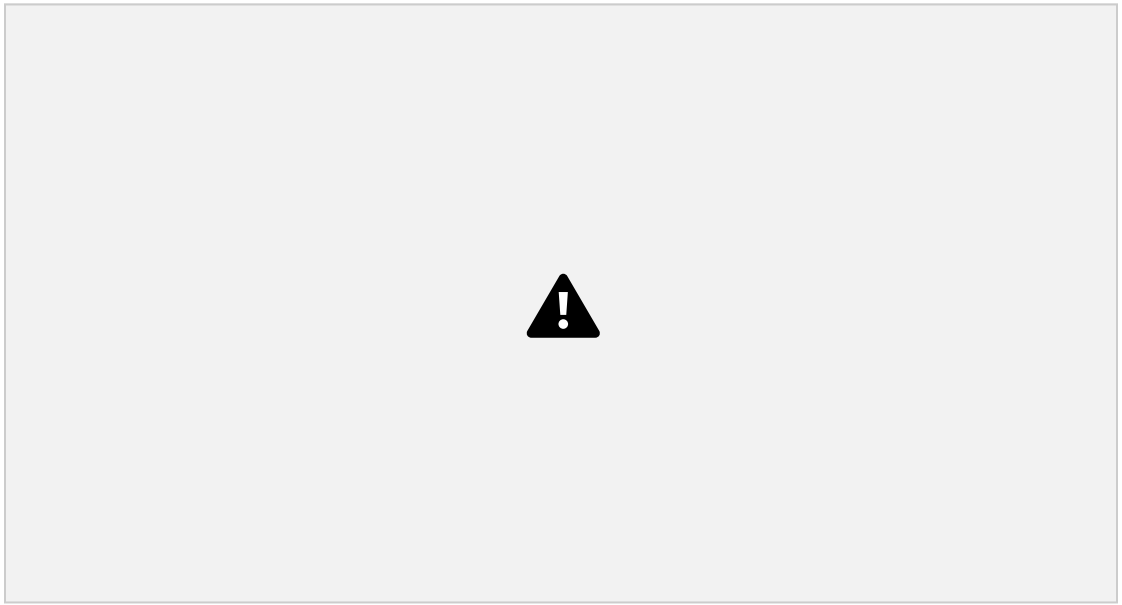




Source: https://openai.com/projects/five/

Intelligence vs. Artificial Intelligence

Intelligence includes the capacity for logic, understanding, learning, reasoning, creativity, and problem solving, etc.

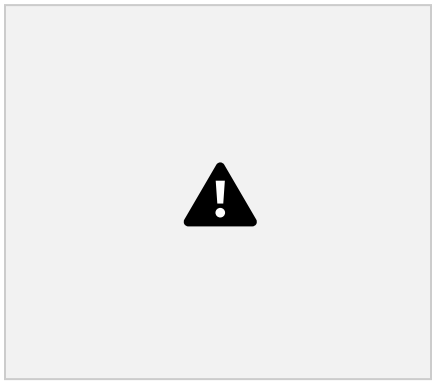
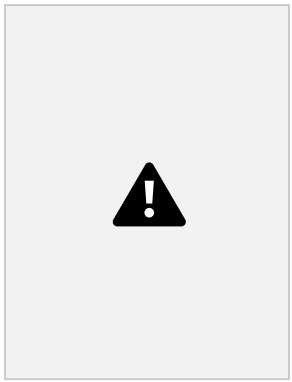


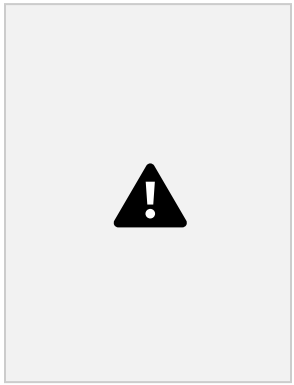
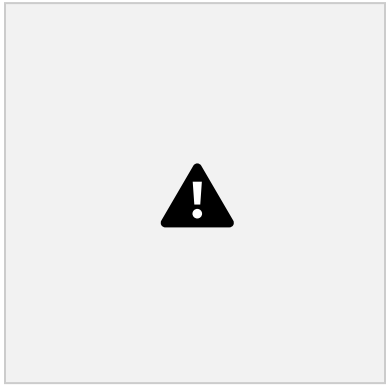
Artificial intelligence (AI) attempts not just to **understand** but also to **build intelligent entities**.

The field of Artificial Intelligence

• AI is one of the newest fields in science and engineering. • Work started in earnest soon after World War II

• The name was coined at a conference at Dartmouth College in 1956.

John McCarthy **(1927 – 2011)** Marvin Minsky (1927 –

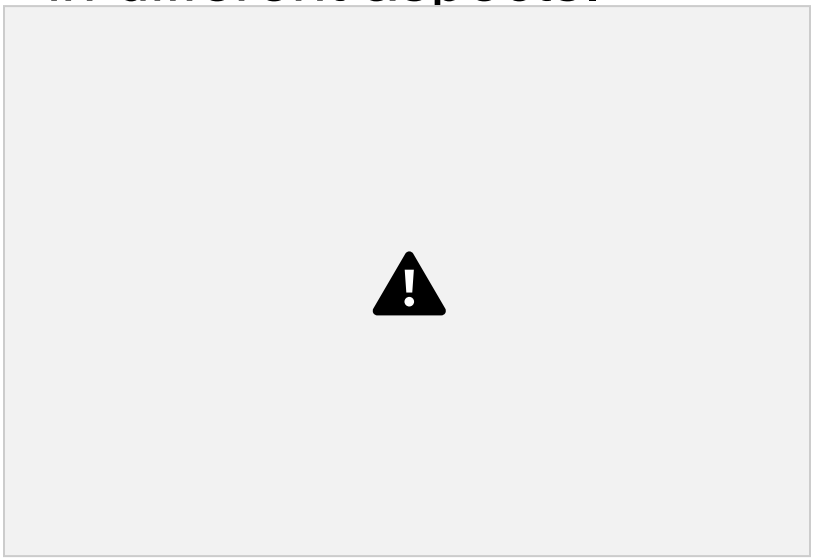
2016) Allen Newell (1927 –

1992) Arthur Samuel (1901 –

1990) Herbert Simon (1916 – 2001)

The field of Artificial Intelligence

- AI research builds **intelligent entities** that **simulate humans** in different aspects.



✓ Thinking: learning, planning, and refining knowledge

✓ Perception: see, hear, feel, etc. ✓

Communication in natural languages✓

What is Artificial Intelligence?

What is Artificial Intelligence?

Thought processes and reasoning

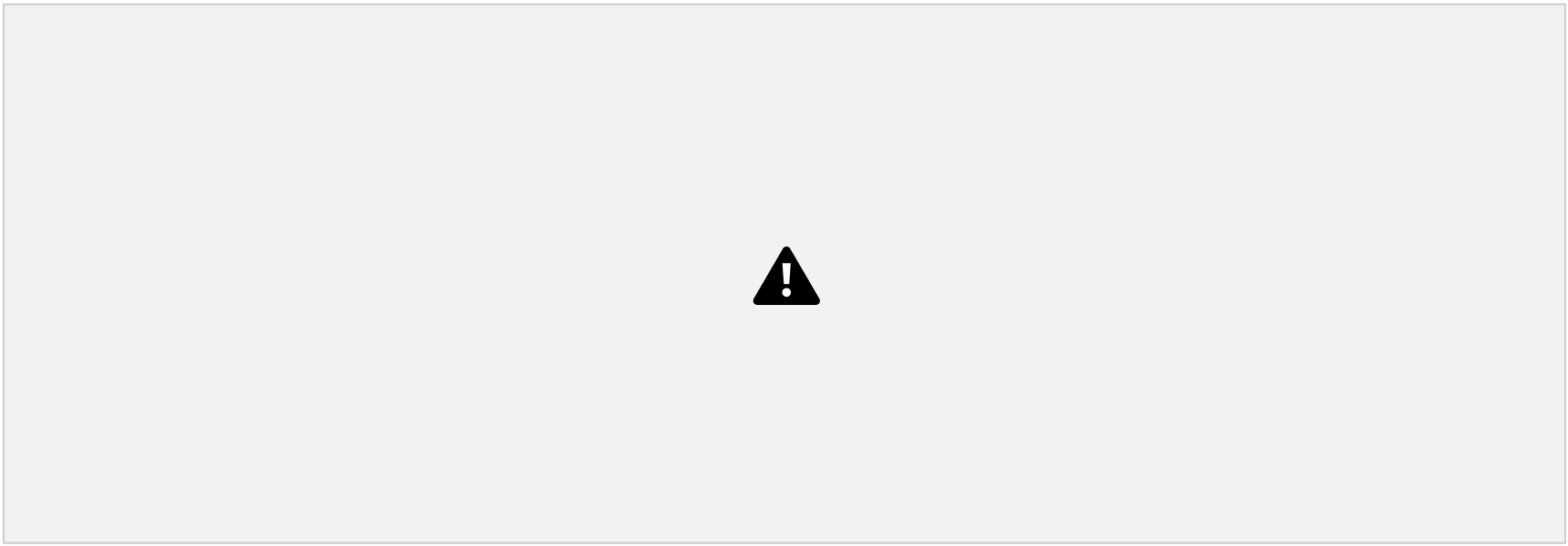
Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally

Rationality

Humans

Systems that act like humans

- **The Turing Test approach** (Alan Turing, 1950)



A computer passes the test if a human interrogator, after posing several written questions, cannot tell whether the written responses come from a person or from a computer.

Systems that act like humans

- Problems with the Turing Test

nin ig n hu n
h io

n ig n h io hu n on
o

- Variations

  - Reverse Turing Test: CAPTCHA

    - Total Turing Test: additionally examine the perceptual (computer vision) and the objects manipulation (robotics) abilities of the subject.

A better Turing Test?

• AI researchers have devoted little effort to pass the test. • It is more im elligence than to

Sheep
dog
or mop?

Systems that think like humans

• General Problem Solver – GPS (Newell and Simon, 1961) • Not merely solve problems correctly

  • Compare the trace of its reasoning steps to traces of human subjects while solving the same problems

• Cognitive Science

• Computer models from AI

• Experimental techniques from psychology • These approaches

are now distinct from AI

the human mind

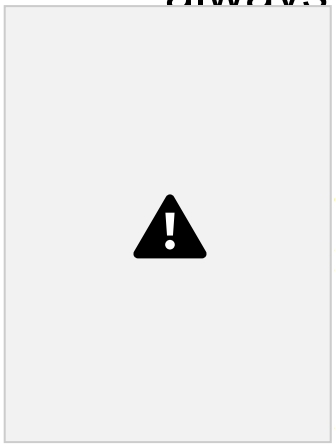
precise and testable theories of

- Share the available theories but do not explain anything resembling human intelligence
- All share a principal direction

Systems that think rationally

- The laws of thought approach
  - “Righ hinking” = irrefutable reasoning processes

- E.g., A i o ’ syllogisms provided patterns for argument structures that always yielded correct conclusions when given correct premises.



All men are mortal.

Socrates is a man.

Therefore,

Socrates is mortal.

Aristotle
(381BC – 322BC)

$\forall x.man(x) \Rightarrow mortal(x)$

$man(Socrates)$

$mortal(Socrates)$

Systems that think rationally

- Problems with the logicist approach
  - Not all intelligence is mediated by logic behavior
  - Solving a problem “in p incip ” is different from doing in practice •

Both obstacles apply to any attempt to build computational reasoning systems

Systems that act rationally

- The rational agent approach
- Rational behavior = “ oing the right thing”,
  - “Right thing”: what is expected to maximize goal achievement given the available information
- An agent is just something that perceives and then acts

$$f: P \rightarrow A$$

- A rational agent acts to achieve the best outcome or, when there is uncertainty, the best expected outcome.
  - Include thinking, inference as a part of being rational agent

- Include more: action without thinking, e.g., reflexes

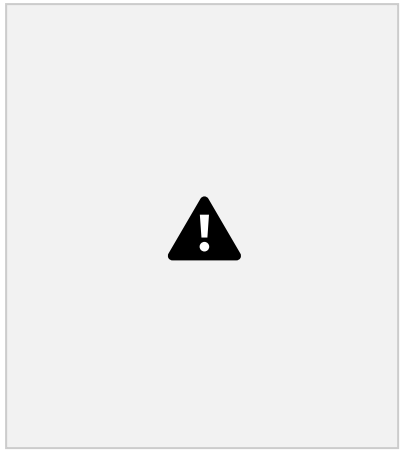
Systems that act rationally

More general than the “ w of hough ” approach • Correct inference is not all of rationality.

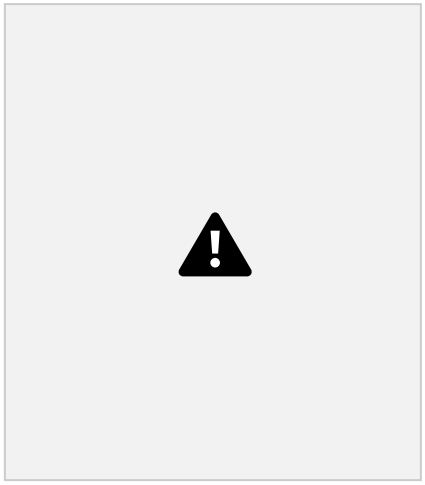
- In some situations, there is no provably correct thing to do, but something must still be done.

- Amenable to scientific development than those based on human behavior or human thought

Major roles and Goals of AI

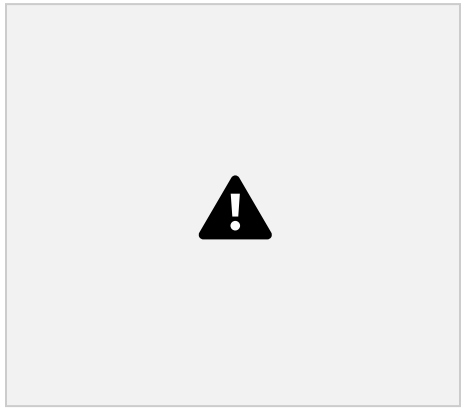


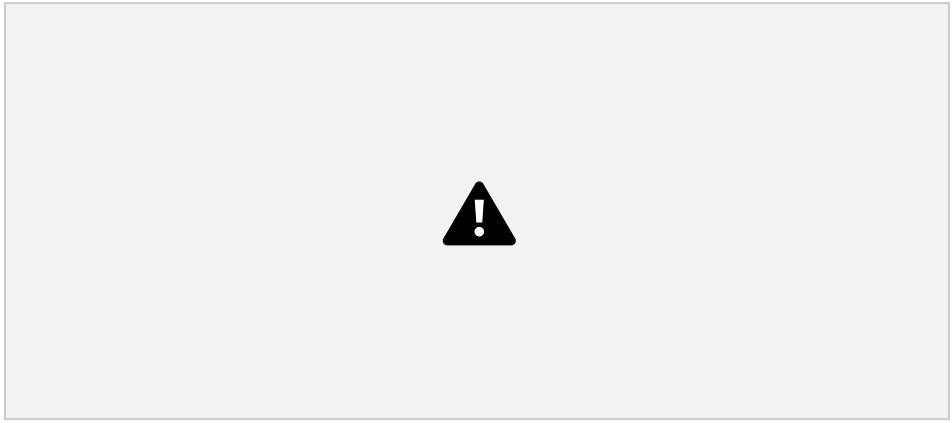
Goals of AI



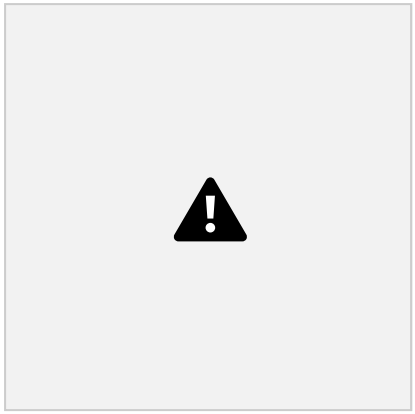
AI studies the intelligent part concerned with humans and represents those actions using computers.

Rational? Intelligence?



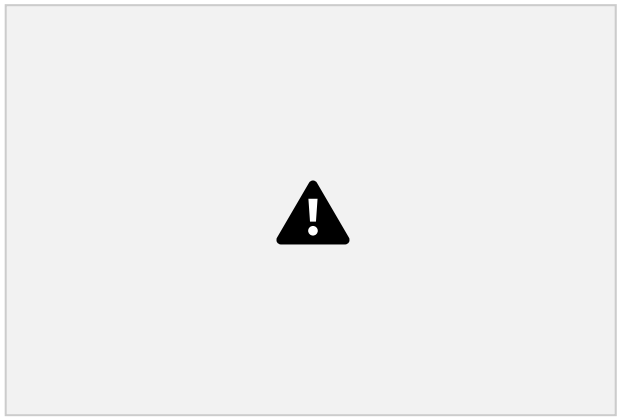


A man withdraws his fingers from a hot

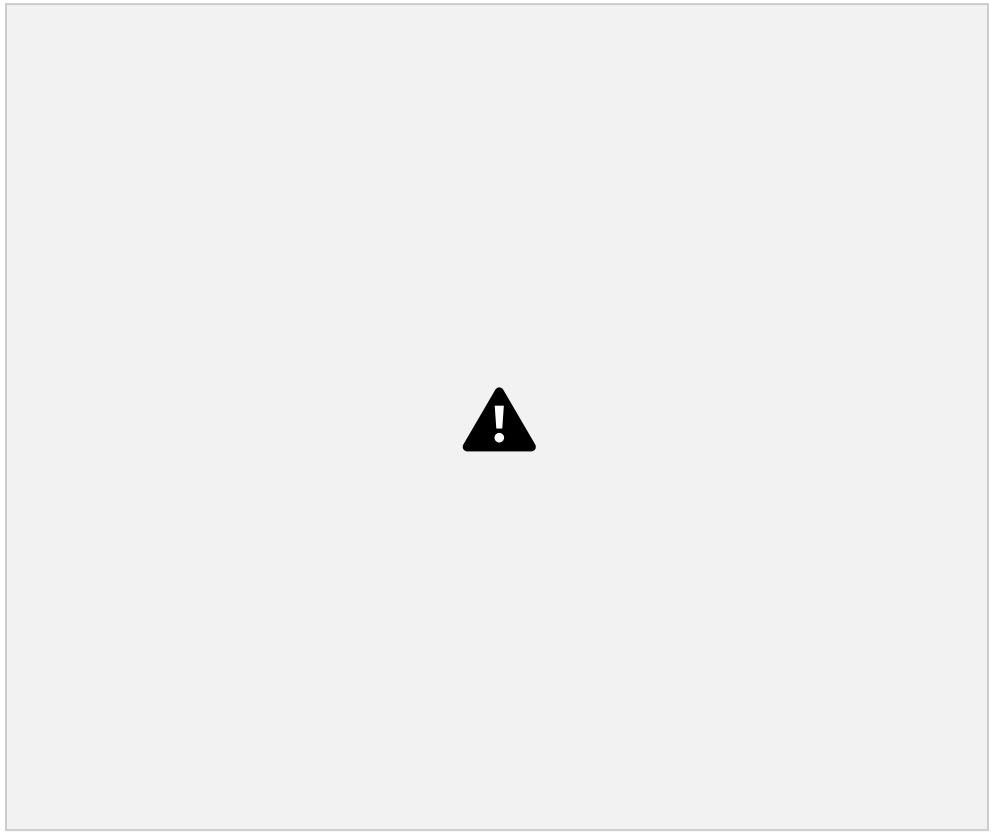


stove.

A girl wears a mask to avoid
Two people cross the street at the zebra crossing.

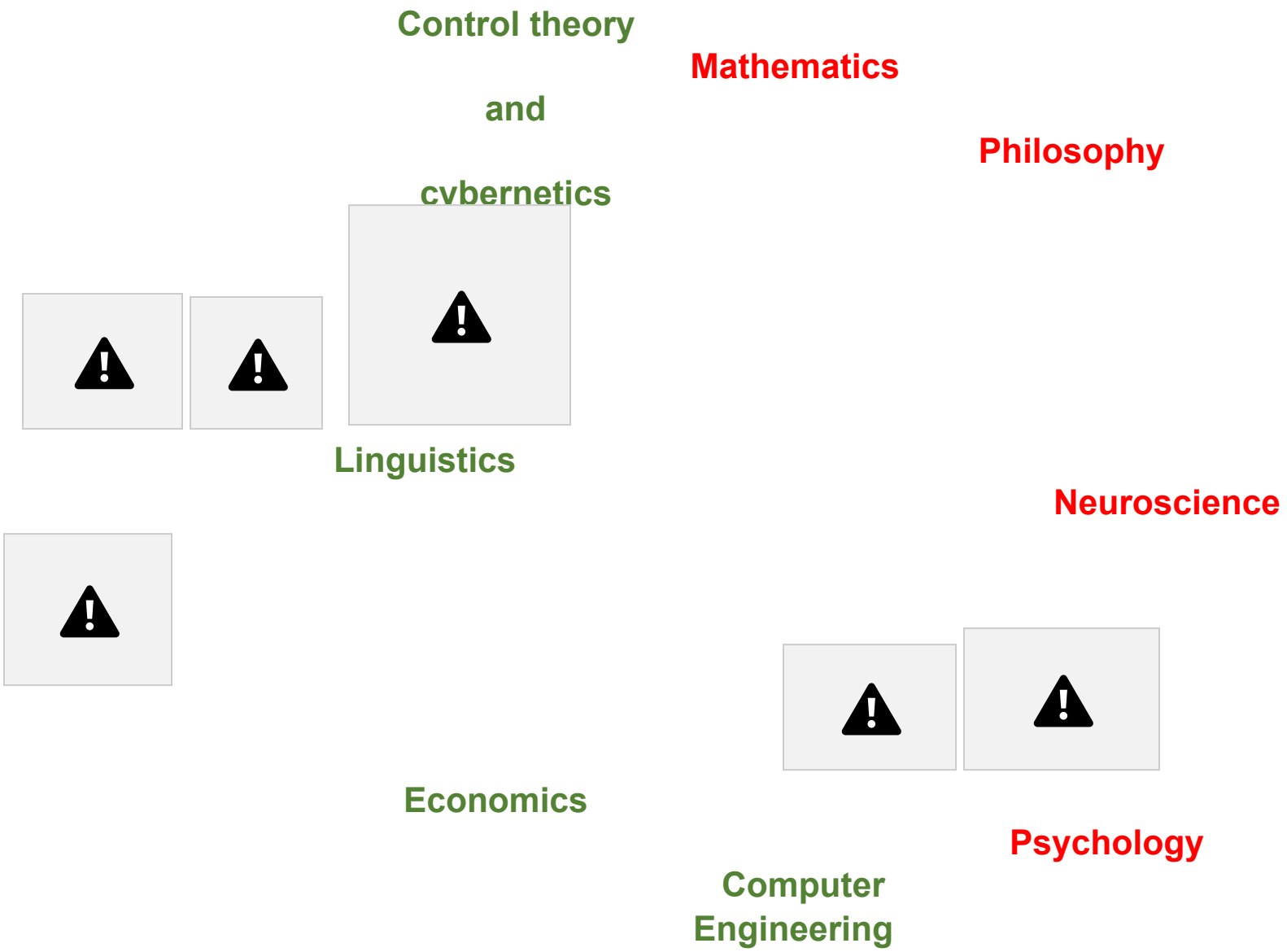


spreading flu to others.
A newborn baby grasps his/her o h ’ finger.



Foundations of AI

Research fields related to AI



Research fields related to AI

Philosophy	Logic, methods of reasoning, mind as physical system, foundations of learning, language, rationality.
Mathematics	Formal representation and proof, algorithms, computation, (un)decidability, (in)tractability, probability.
Economics Utility, decision theory, rational economic agents	
Neuroscience Neurons as information processing units.	
Psychology/ Cognitive Science	How do people behave, perceive, process information, represent knowledge.
Computer Engineering Building fast computers	

Control Theory	Design systems that maximize an objective function over time
Linguistic Knowledge representation, grammar	

Research fields related to AI

AI and related concepts

Source: https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning deep-learning-ai/

Pros and Cons of AI

- More powerful and more useful computers
- New and improved interfaces
- Solve new problems
- Better handling of information
- Relieve information overload
- Conversion of information into knowledge

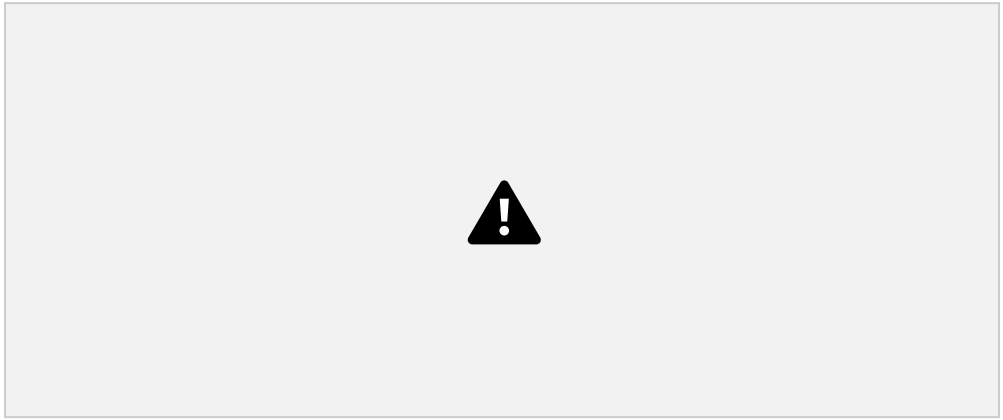
- Increased costs
- Difficulty with software development - slow and expensive
- Few experienced programmers

A brief history of AI

A brief history of AI

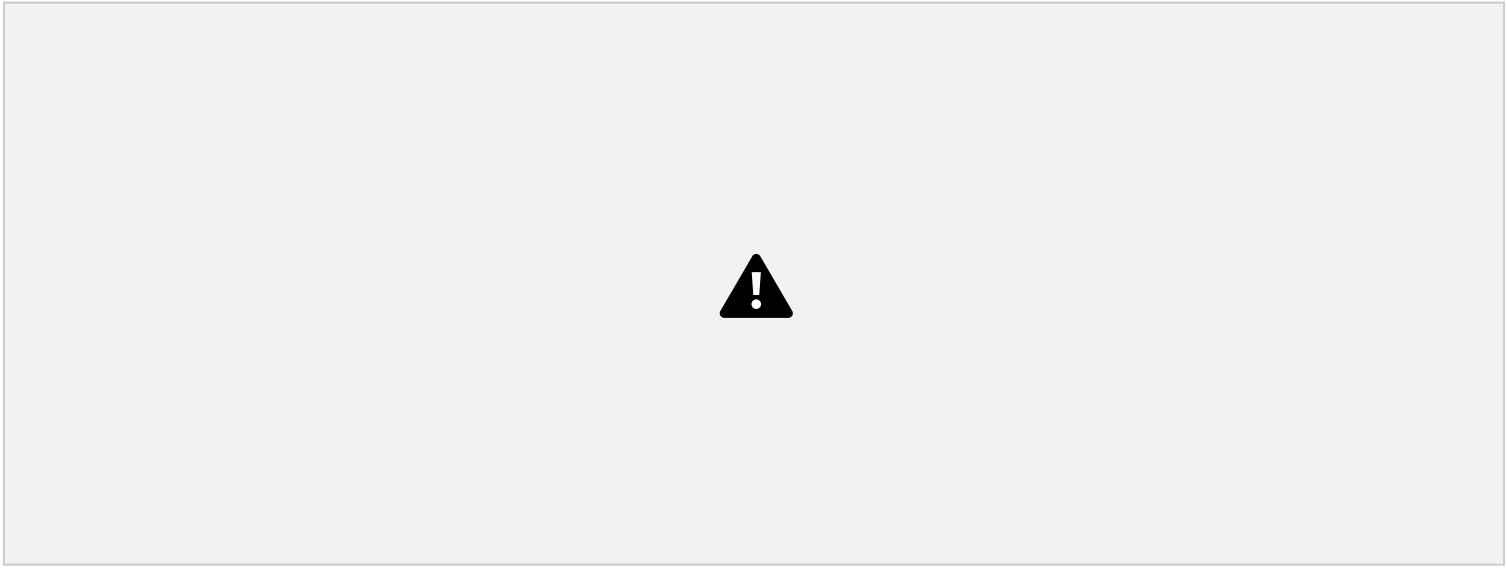
- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Co pu ing Machinery and n ig nc ”

- 1950—70: Excitement: Look, Ma, no hands!
  - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
  - 1956: Dartmouth meeting: “A ifici n ig nc ” adopted
  - 1965: Robinson's complete algorithm for logical reasoning
- 1970—90: Knowledge-based approaches
  - 1969—79: Early development of knowledge-based systems
  - 1980—88: Expert systems industry booms
  - 1988—93: Expert systems industry busts: “A Win ”

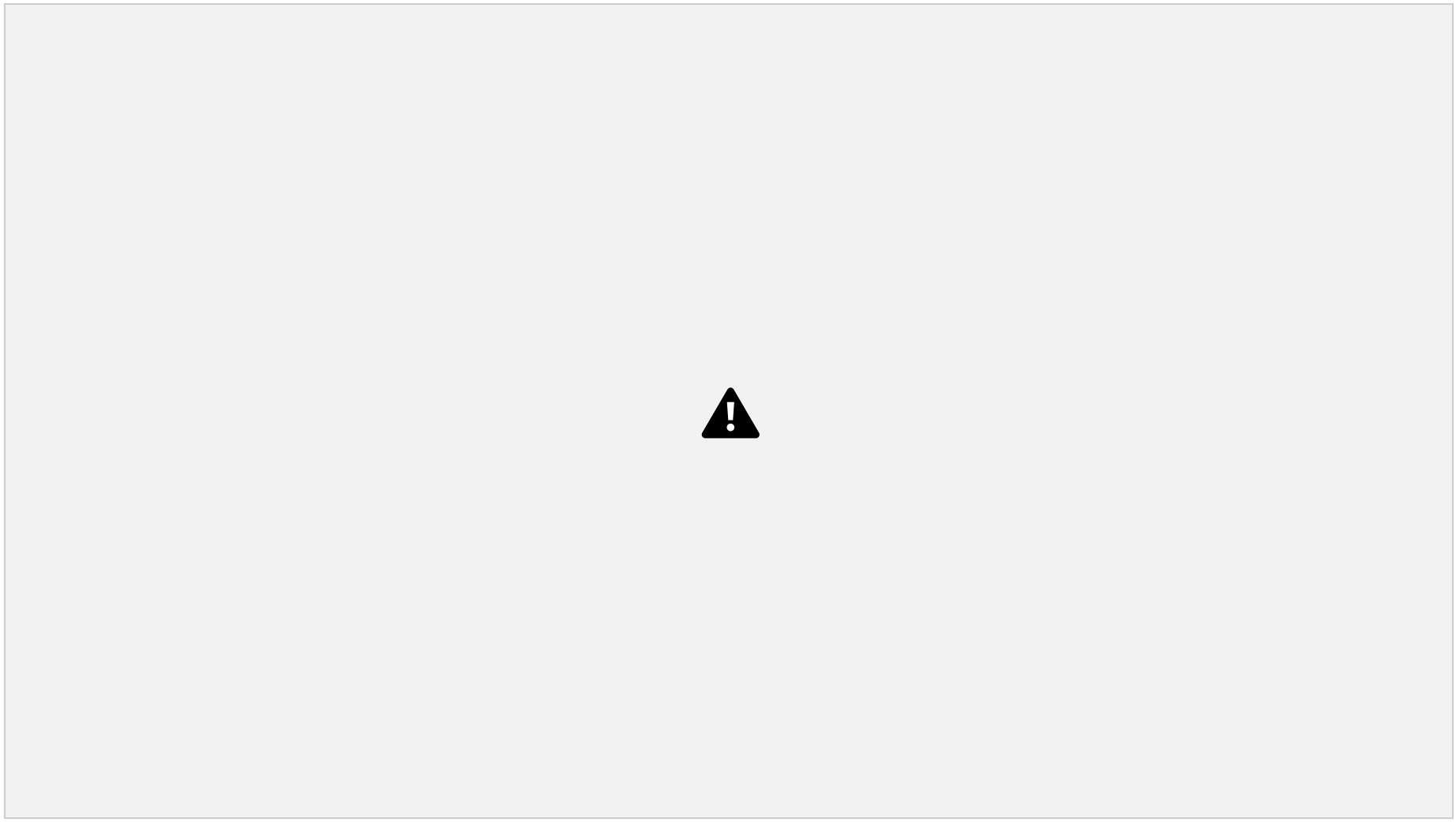


A brief history of AI

- 1990—: Statistical approaches
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems… “A Sp ing”?
- 2000—: Where are we now?



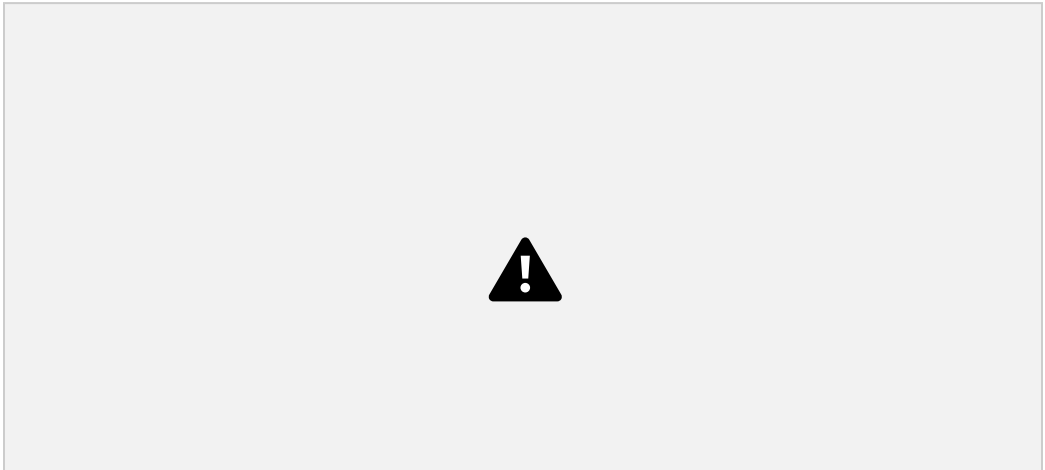
A demo of artificial neural network

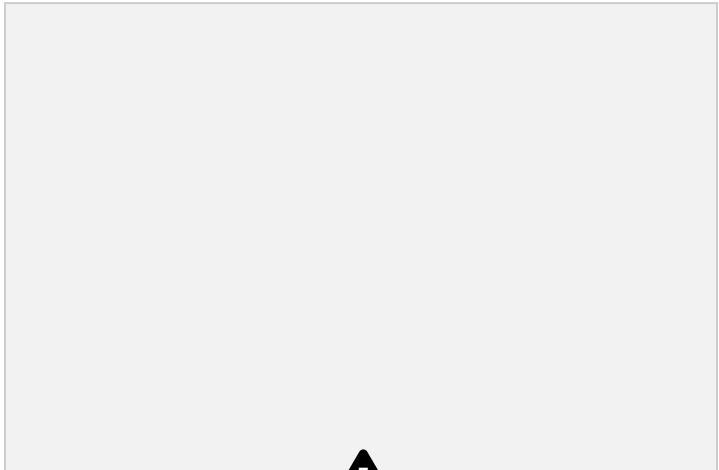


Source: https://www.youtube.com/watch?v=3JQ3hYko51Y

AI Applications

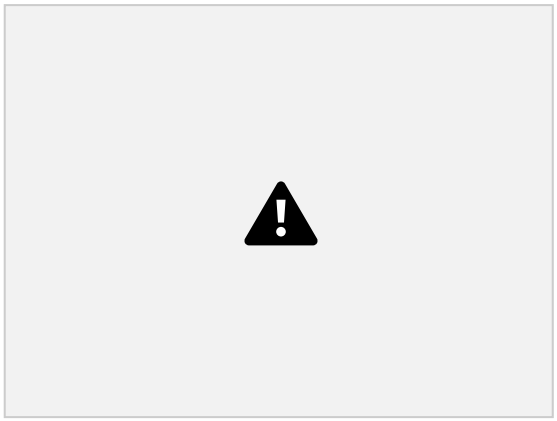
Autonomous Planning and Scheduling







Autonomous rovers

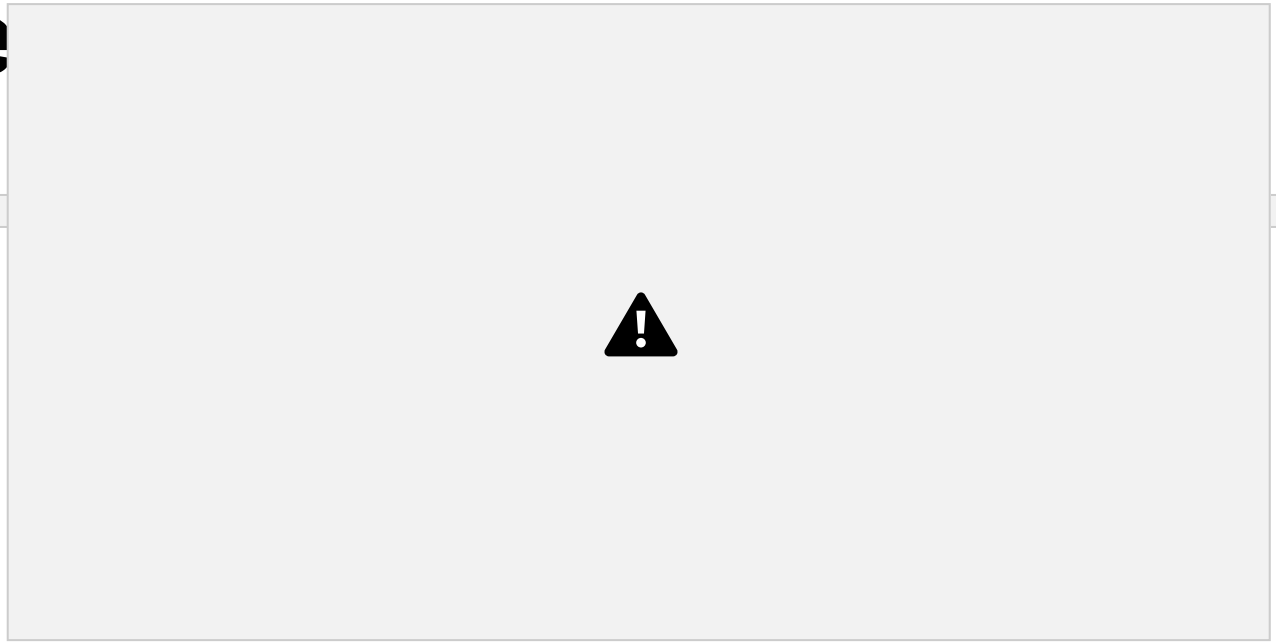


Autonomous rovers

Telescope scheduling

Analysis of data

Medicine



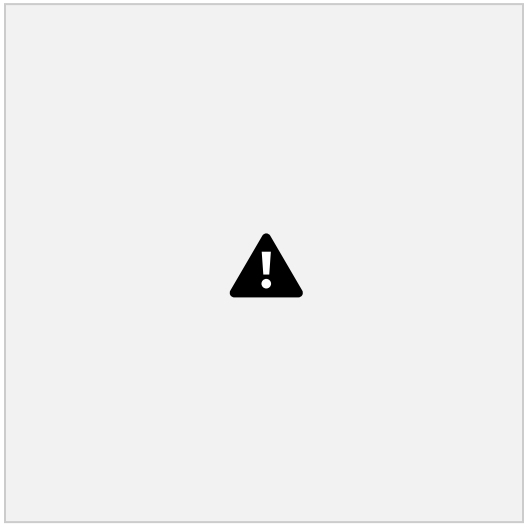
Classification on medical images

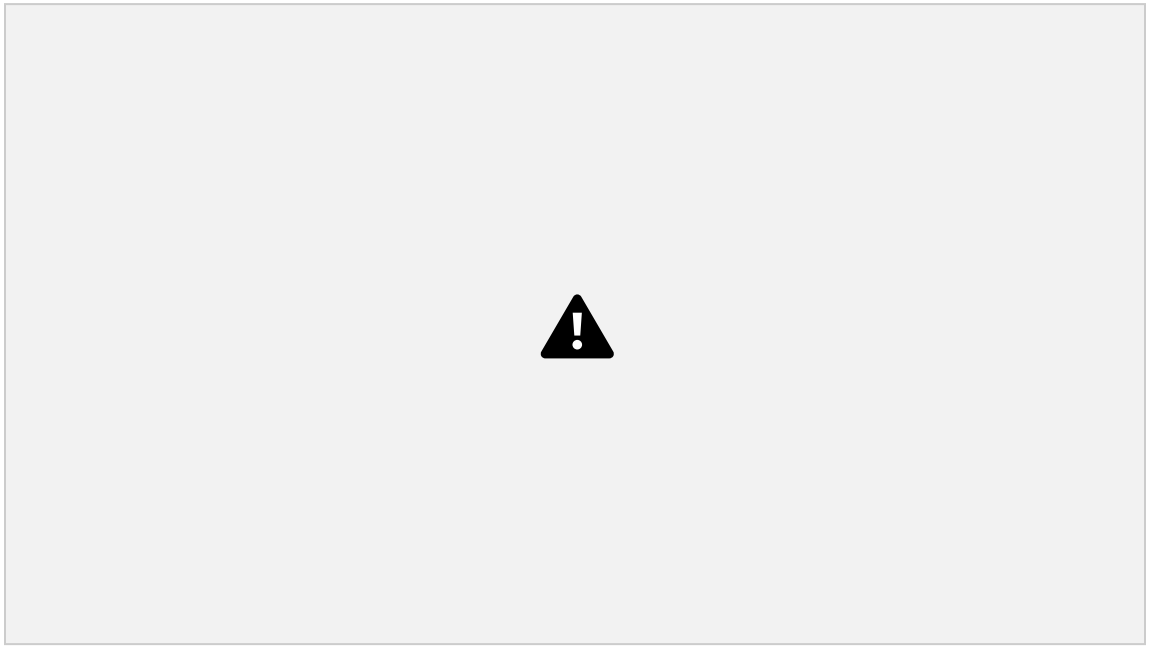
I recommend gentamycin using a doze of ...

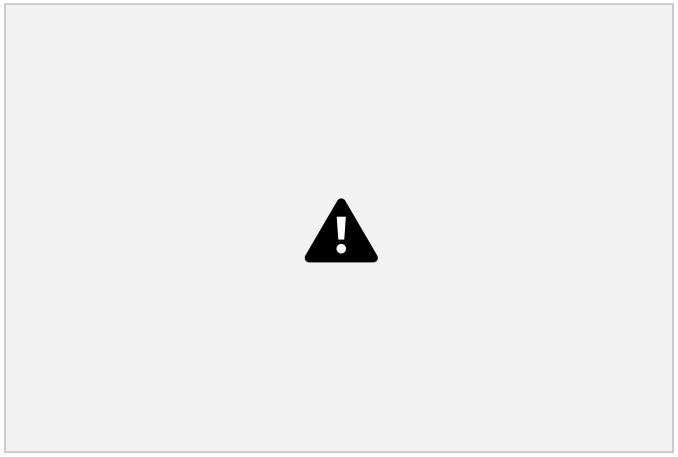
Have you obtained positive cultures?
Yes.
What type of infection is it?
Primary bacteremia.
When did the symptoms first appear?
May 5

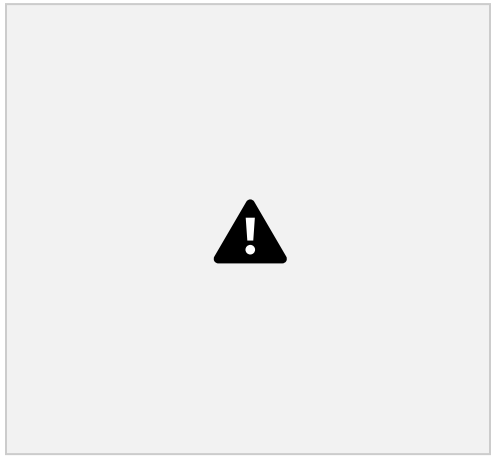
Diagnosis system (e.g. MYCIN)

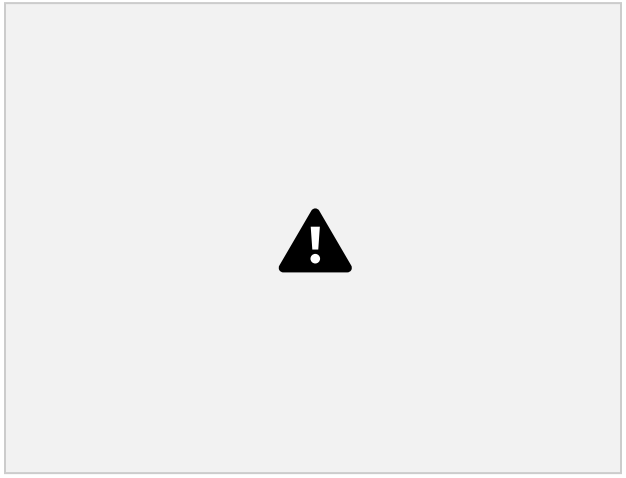
Games and Entertainment

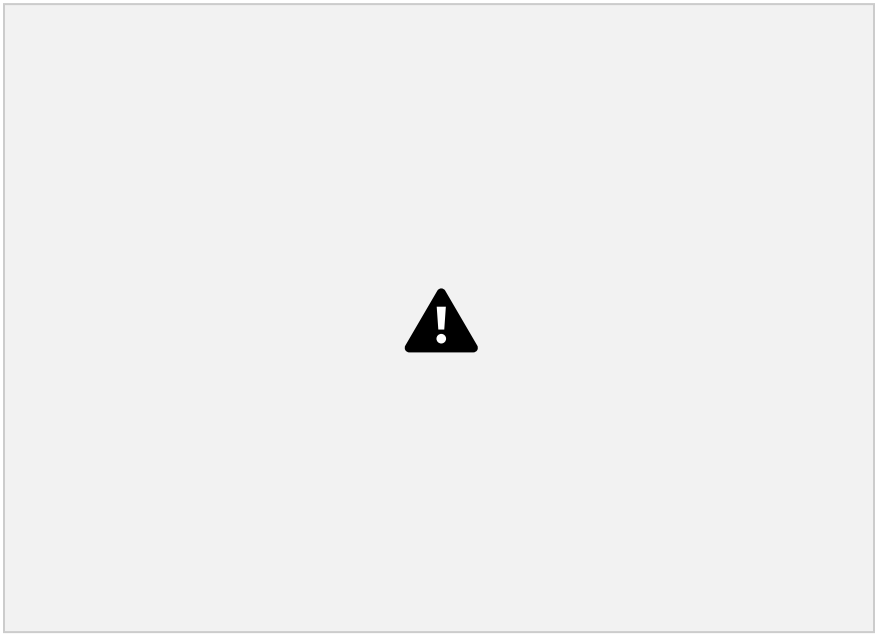












What are we going to learn?

Main topics in AI

- Search (includes Game Playing)
- Representing knowledge and reasoning with it

- Planning
- Learning
- Natural language processing
- Expert systems
- Interacting with the Environment
    - E.g. Vision, Speech recognition, Robotics, etc.
- An o …

We won't have time in this course to consider all of these.

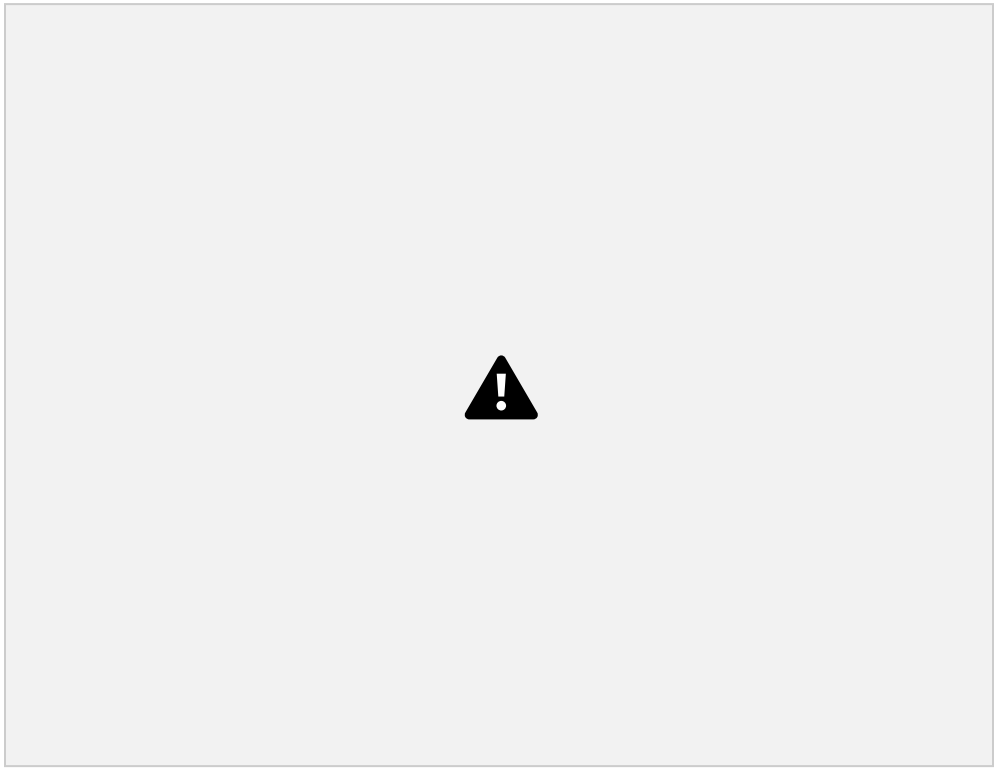
Solving problems by searching

- **Search** is the fundamental technique of AI.
  - Possible answers, decisions or courses of action are structured into an abstract space, which we then search.
- Search is either "uninfo " or "info "
  - Uninformed: we move through the space without worrying about what is coming next, but recognizing the answer if we see it • Informed: we guess what is ahead and use that information to decide where to look next.
- We may want to search for the first answer that satisfies our goal or keep searching until we find the best answer.

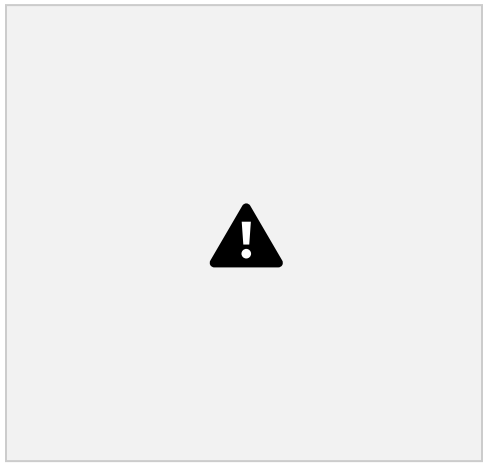
Solving problems by

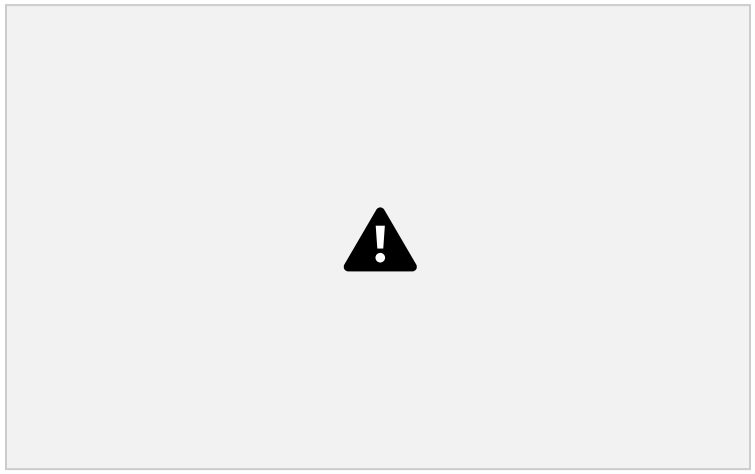
searching

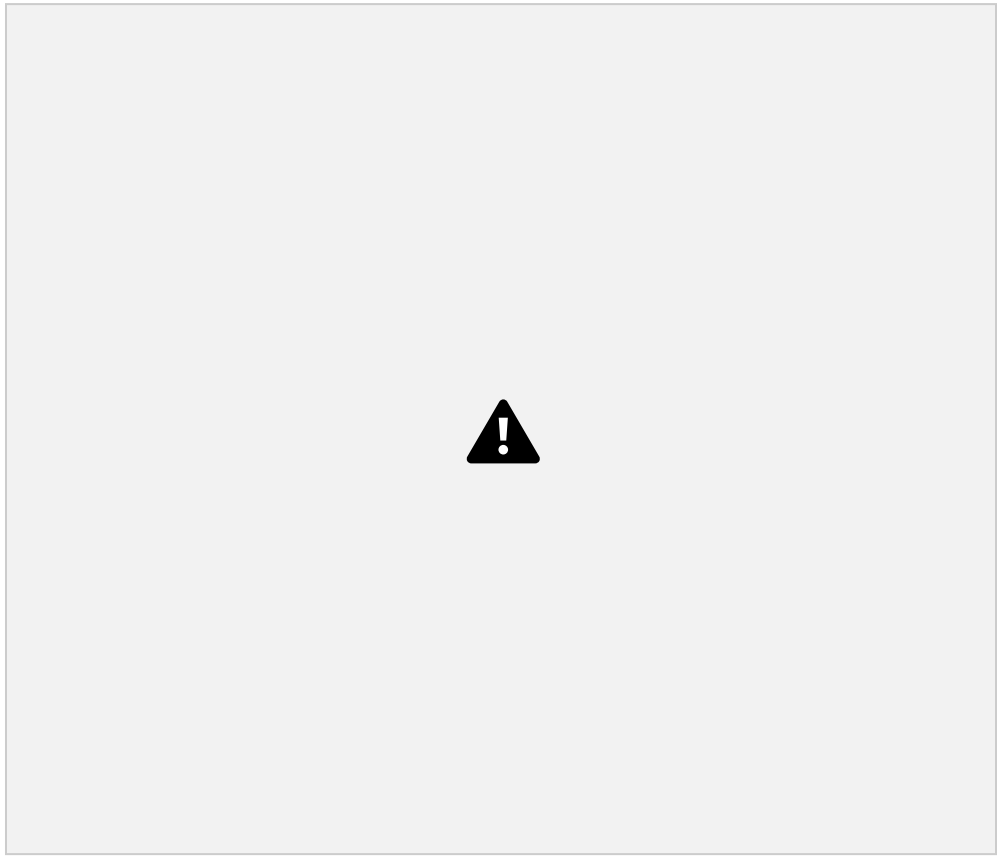
- Uninformed and informed strategies
- Global vs. local search



Solving problems by searching







- Adversarial search
- Constraint satisfaction problems

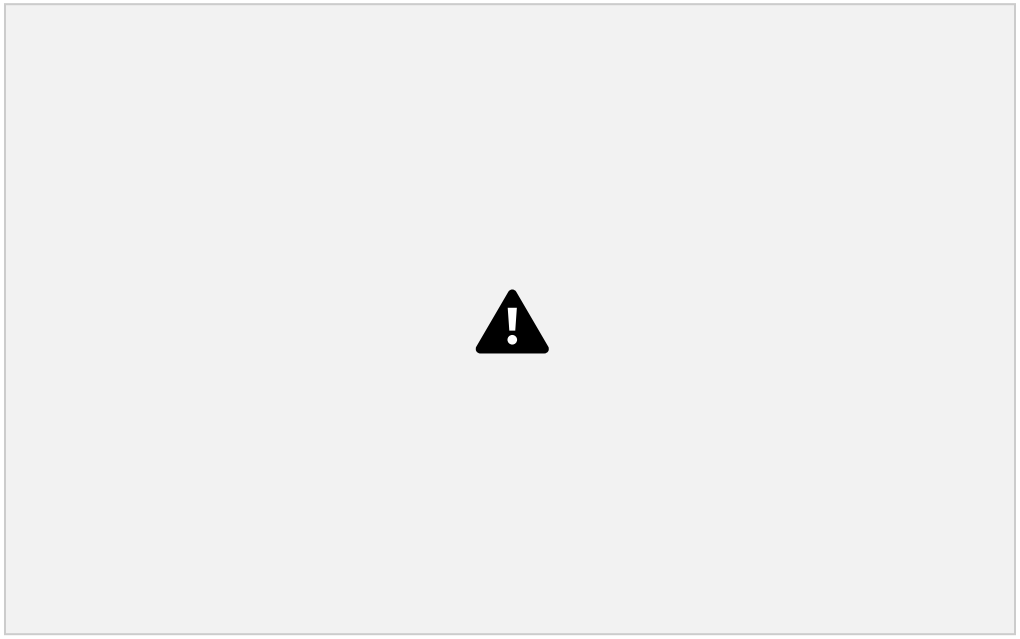
Knowledge and reasoning

- The second most important concept in AI

- If we are going to act rationally in our environment, then we must have some way to describe the given environment and draw inferences from that representation.
  - How do we describe what we know about the world ?
  - How do we describe it concisely ?
  - How do we describe it so that we can get hold of the right piece of knowledge when we need it ?
  - How do we generate new pieces of knowledge ?
  - How do we deal with uncertain knowledge ?

Knowledge and reasoning

- Propositional logic and predicate logic
- Inference techniques: forward chaining, backward chaining, and **resolution**
- Uncertain knowledge and reasoning



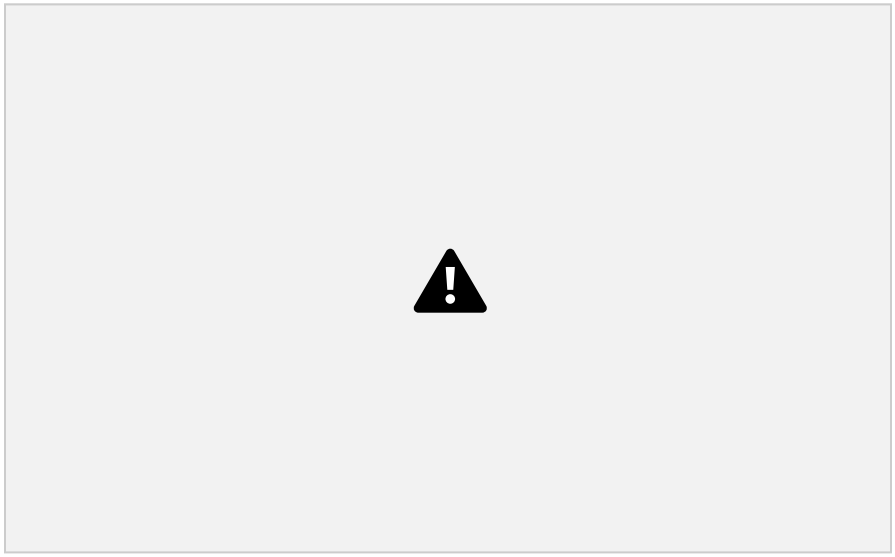
Machine learning

- If a system is going to act truly appropriately, then it must be able to change its actions in the light of

experience. • How do we generate new facts from old ?

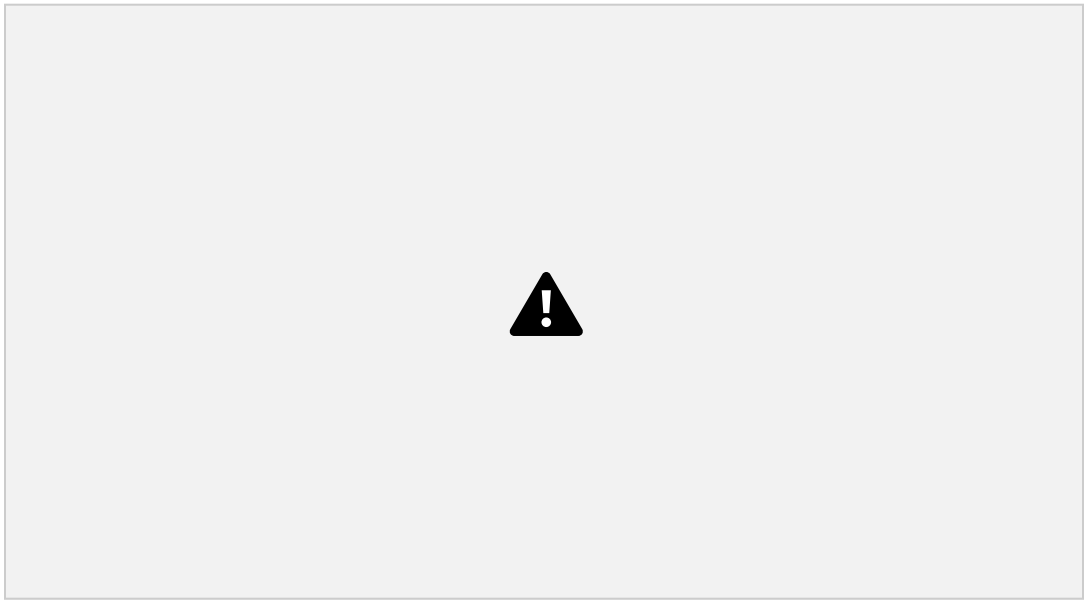
• How do we generate new concepts ?

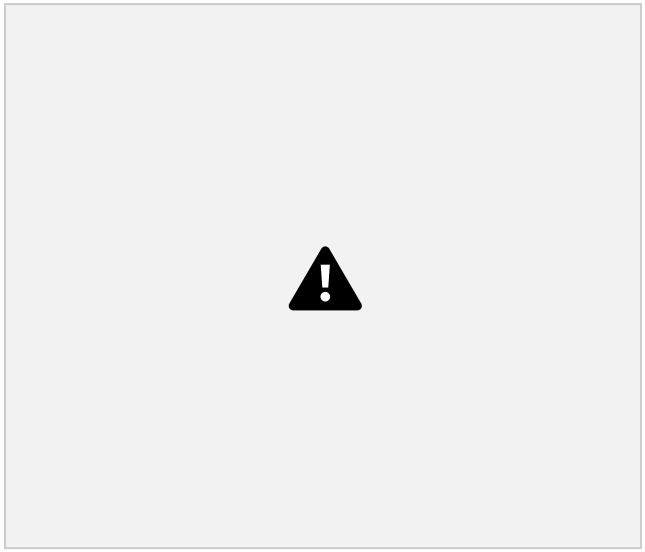
• How do we learn to distinguish different situations in new environments ?

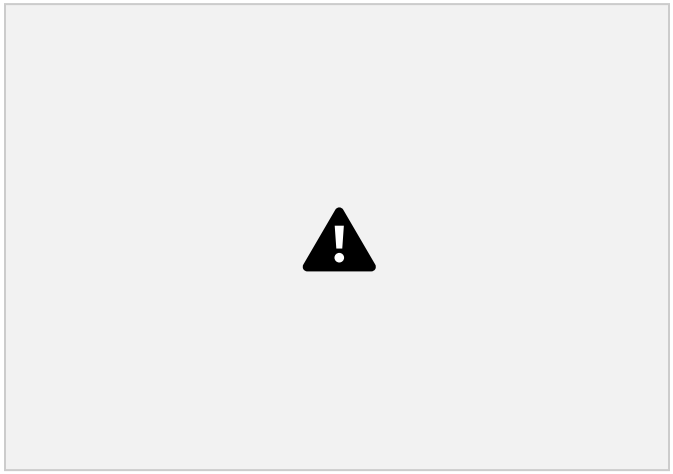


Machine learning

- Classification with ID3 Decision tree and Naïve Bayes
- Artificial neural networks







THE END