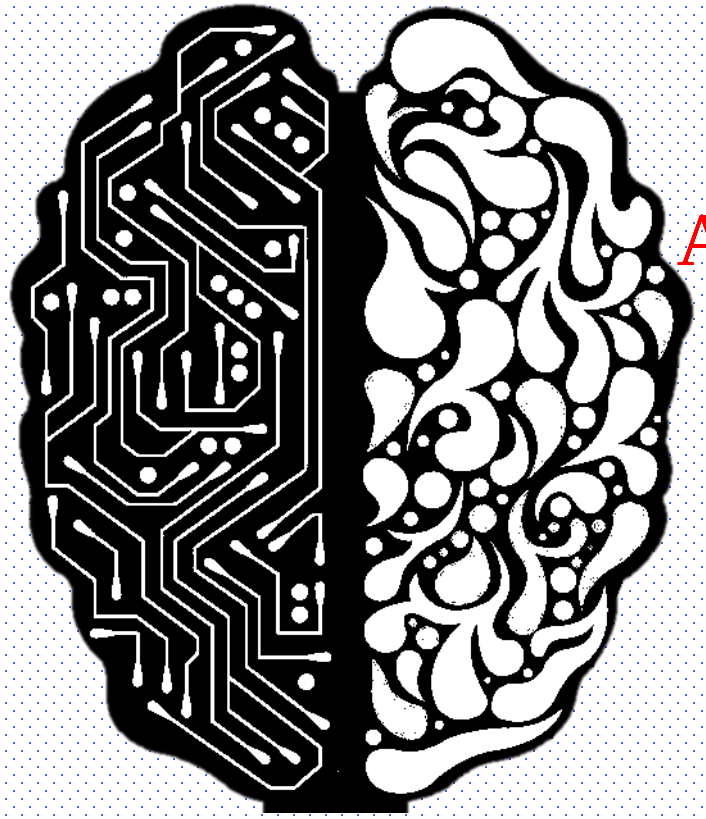

Multi-Agent Systems

Lecture 1

Dr. Nestor eo,

- Researcher CONSUS (Crop OptimisatioN through Sensing, Understanding & viSualisation),
- School of Computer Science
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Origi ory of Artificial In nce

Generate & Test 1

The simplest form of state space search is that of **Generate & Test**.

Such an approach involv ges, those of ...

(a) Generating a possible solution m of a new state.

(b) Ascertaining whether the new state is indeed the final state.

(c) If new state is the final state terminate, otherwise repeat steps a, b and c.

Generate & Test 2

- Two forms of generate and test exist: Depth-first Search & Breadth-first Search.

- Both fall foul of the ‘combinatorial explosion’, caused by the exponential growth of the nodes irres generation.

- Consequently exhaustive search is onl when the search space is very small.

- For larger spaces the search needs to be guided.

- Guided searches are normally referred to as **Heuristic Searches**.
- Searches of this nature utilise domain specific knowledge called heuristics.

Exercise 1

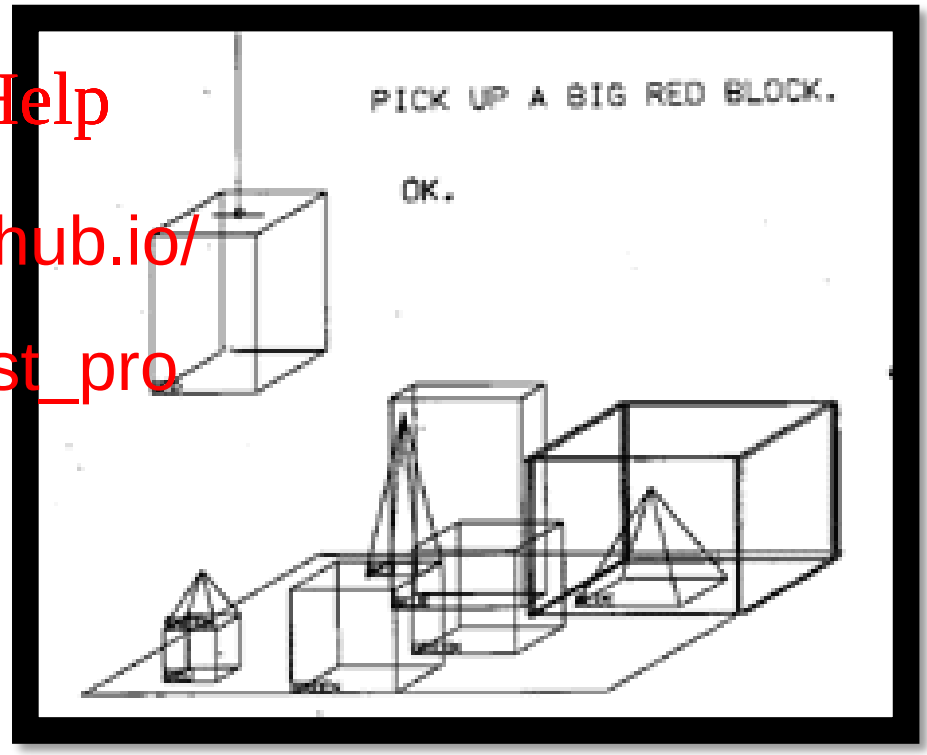
Attempt to draw a state space for the famous Missionaries and Cannibals problem

On one bank of a river are three **missionaries** ▲ and **three cannibals** ●
There is **one boat** available that can hold up to **two people** and that they would like to use to cross the river. If the cannibals ever outnumber the missionaries on either of the river's banks, the missionaries will get eaten.
How can the boat be used to safely carry all the missionaries and cannibals across the river?

State Space

The Development of Expert Systems

- Stanford Professor, Terry Winograd developed the **Shrdlu** expert system which was able to understand a subset of English an manipulate wooden blocks.
- Soon after came numerous a diversity of domains.
- Researchers became aware that the repre of knowledge was central to achieving a truly intelligent system.
- Thereafter numerous formalisms were proposed.



The History of AI Research

- In 1973 a report by Sir James Lighthill concluded that AI work within the UK was unproductive. There ensued a removal of government funding. Referred to as the AI Winter.

- Consequently the US and esearch for a period gaining predominance .

- In later years expert systems emerged r a high level of performance in complex domains.

  Examples include XCON & MECHO.

- R1/XCON delivered the first commercial return on AI by 1986 delivering circa $40 Million per annum.

The History of AI Research

- **In 1987 Deep Blue defeats Gary Kasparov world chess champion.**

- **IBM shares soar in value. Regarded as a coming of age for AI.**

- **In 2011 IBM's Watson* on a Quiz show entitled Jeopardy. But not any best all time performers on the show.**

- **IBM Watson, has consumed "*600,000 pieces of medical evidence, more than two million pages from medical journals and the further ability to search through up to 1.5 million patient records*"**

AI Timeline

Can Computers Think?

- Throughout the evolution of artificial intelligence there have been many opponents to the whole concept of machines generating anything original.
- Turing identified man ns:
  - **Mathematical obje** odel's theorem claims limitations to the powe d artificial
  - **Lady Lovelace's objection**: claims that a computer can only do what it is told and thus it cannot have pretentions to originate
  - **Theological objection**: suggests only the possession of a soul permits thought, hence machine nor animals can think anything (derived intentionality).

Can Computers Think?

Other Objections:

- **Arithmetic Machine objection**: a computer is little more than a fast arithmetic machine. Of course a computer can achieve more than merely arithmet FT, READ, COMPARE, LOAD etc.
- **Informality of Behaviour objec** ossible to detail set of rules which indicate how a per uld act in all possible situations.
- **Sensory Perception objection**: humans have senses not available to machines sight, touch, smell, ESP.
- **Head in the Sand objection**: too horrendous even to contemplate that computers could think.

Contradicting the Objections

Numerous examples, however, may be cited to contradict this.

- **Samuels checker program**, primitive learning capacity
- **Lenat's Automate** which identified new maximally divisible nu d by most mathematicians.
- **Prospector** , which was claimed to be in error in certain circumstances, but was eventually proven to be right.

Thought, origin of new knowledge.

Consider a computer is given the following pieces of knowledge:

Elephants are large and grey…

Clyde is an elephant.

Conceptually we can think of this knowledge as a graph. If in addition we armed the computer with the technique:

properties may **the directed arcs.**

Hence it could conclude a new item of knowled

Clyde is La **rey**

Is this equivalent to thought? The computer only used techniques **we** equipped it with, but after all we only use skills we acquire from our environment.

Can a computer exhibit **emotions** or indeed have **morals**?

Isaac Asimov: The Three Laws of Robotics

The Trolley Problem

Self Driving cars 

Things to Do!

- Watch Marvin Minsky Interview:

INFINITE HISTORY PROJECT MIT

Marvin Minsky Interviewed by John Hockenberry

https://youtu.be/EI0NXTrS5Pw

- Read Franklin, S., & Graesser, A. (1996, August). **Is it an Agent, or just a Program?**: A Taxonomy for Autonomous Agents. In *International Workshop on Agent Theories, Architectures, and Languages* (pp. 21-35). Springer, Berlin, Heidelberg.

Things to Do!

- Johnson-Laird, P.N. (1983). ***Mental Models: Towards a Cognitive Science of Language***, Inference, and Consciousness. Cambridge: Cambridge University Press.4

- Johnson-Laird, P.N. (2006) ***How We Reason***. Oxford University Pres

- Watch **The Social Dilemma Of Driverless Cars** https://youtu.be/nhCh1pBsS80

Lecture I Learning Objectives (recap)

- ❑ To understand the linage of AI:
- ❑ To understand within this journey;
- ❑ To understand the principles around AI;
- ❑ To understand how MAS differentiates itself from traditional AI;

Additional Resources

- SHRDLU
  - https://hci.stanford.edu/winograd/shrdlu/
  - https://www.youtube.com/watch?v=bo4RvYJYOzI
- History of AI
  - http://sitn.hms.harvard.edu/flash/history-artificial-intelligence/
  - https://www.bbc.com/timelines/zq376fr
- Joseph Weizenbaum's ELIZA
  - https://www.masswerk.at/elizabot/
  - https://www.youtube.com/watch?v=RMK9AphfLco
- A.L.I.C.E. (Artificial Linguistic Internet Computer Entity)
  - https://www.pandorabots.com/pandora/talk?botid=b8d616e35e36e881
- AIVA (Artificial Intelligence Virtual Artist)
  - https://www.youtube.com/watch?v=gzGkC_o9hXI
- IBM Watson for Oncology
  - https://www.ibm.com/us-etplace/clinical-decision-support-y
- T l Art
  rtists.org/ai-timeline-art
- Self-driving cars and the trolley problem
  - https://www.youtube.com/watch?v=9nV3kQRP5eg
- Ex-Machina (2014)