



HUMAN PERFORMANCE

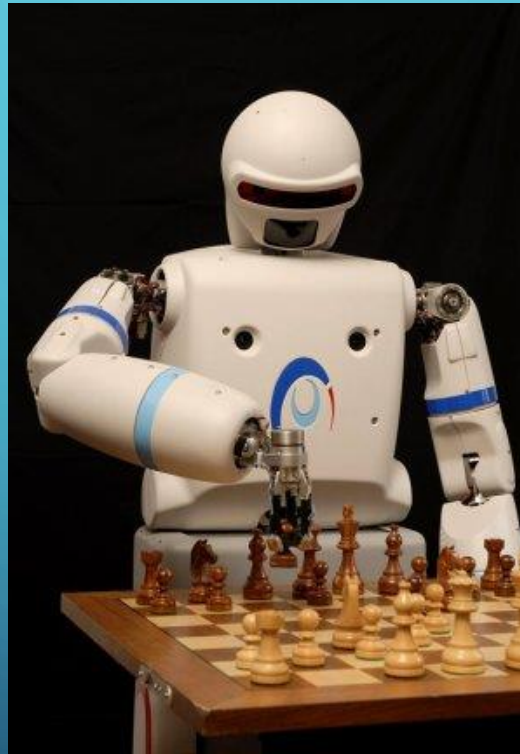
LECTURE 3: ARTIFICIAL INTELLIGENCE (AI)

DR KATE WILLIAMS

ARTIFICIAL INTELLIGENCE

- Can research into artificial intelligence tell us anything about human performance?

**Robots: Perform
like humans.....
.....only better.**



**Computer beats
human at game
of chess**

AI: Predicting you

AI

- Cognitive modelling can be simple box-&-arrow diagrams derived from behaviour.
- It can be equations and software programmes derived from a computer.
 - From this computational modelling, the idea arises of using artificial intelligence to help better understand us as humans.
- AI is the “intelligence” shown by machines and computers.
 - It can range from a computer running a programme to a robot that looks and seems to behave like a human.

AI

- An ideal "intelligent" machine is a flexible rational agent that perceives its environment and takes actions that maximize its chance of success at some goal.
 - Sound familiar?
- Founded on idea that human intelligence can be so precisely described that a machine can be made to simulate it.
- Cold Fusion – What is artificial intelligence exactly?
<https://www.youtube.com/watch?v=kWmX3pd1f10>

AI – Background

1600s: Descartes: most human behaviour susceptible to simple mechanistic explanation - *Automata*: machine that can simulate body movement.

- However, no matter how human-like a machine could appear in form or operations, it would always be possible to distinguish from a human being by functional criteria.
 - “Humans are capable of a greater variety of different activities than what could be performed by anything lacking a soul.”

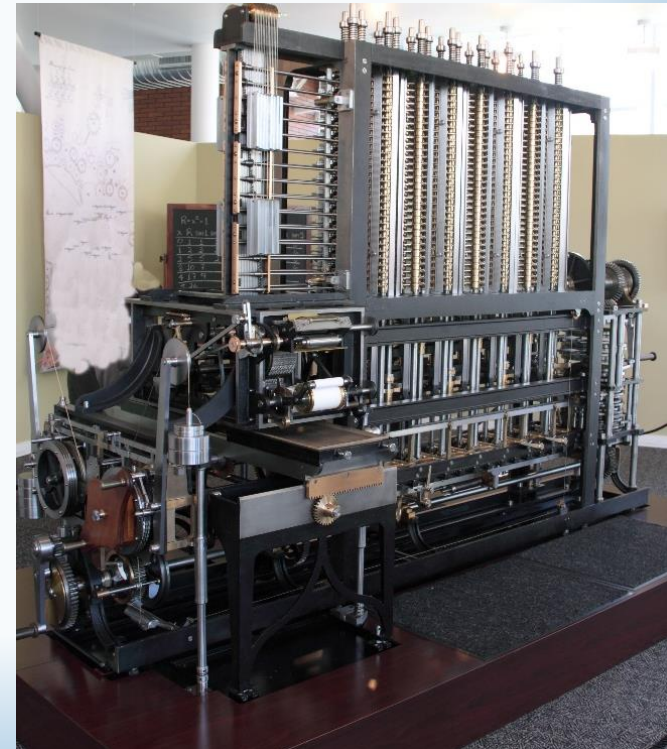
AI – Background

1700s: development of mechanical toys.

- De la Mettrie: the human body is like a machine that winds up its own strings.

19th century: Babbage designed the **difference engine**.

- An automatic mechanical calculator designed to tabulate various functions.
- Some think of it as the first type of computer
 - Especially to make the argument that computers don't necessarily have to be made with electrical components only mechanical components.

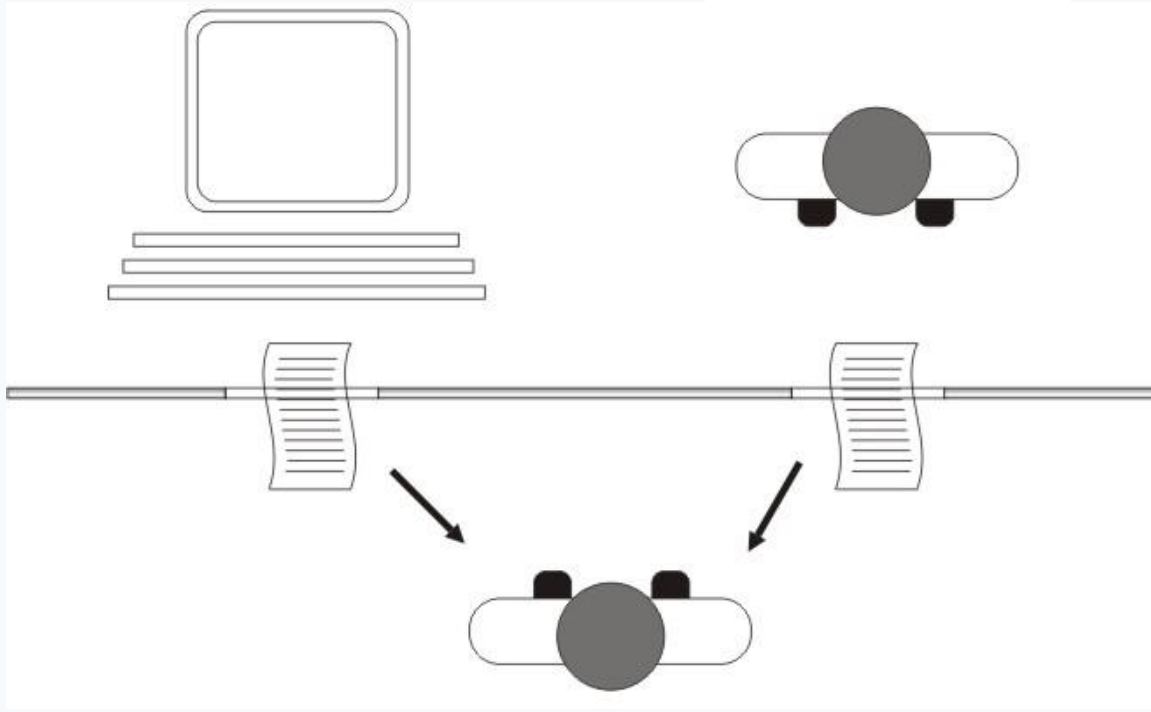


AI – Background

Turing Test/Imitation Game

- Alan Turing: Mathematical & computer scientist.
 - The way in which we carry out a computation (i.e., work something out), a computer could also do in the same way by following a series of rules in a step-by-step manner and manipulate symbols according to these rules.
- To examine this he devised the imitation game...
 - Person types a question in to a computer and receives the answers on the screen.
 - The answer can either be sent from another human or the computer answers the question.
 - If person asking questions could not tell whether responses came from a human or a computer after a prolonged period of time then we could say computers think like humans.

AI – Background



- Thinking defined in terms of output (verbal behaviour)
- If human and machine perform the same in the Imitation Game then the material is irrelevant; only the function matters.

AI – Background

- Although the predictions did not transpire, it made people question how thinking should be defined.
- Hixon symposium (US): discussion about the correspondence between cognition & types of things computers were doing.
 - Karl Lashley: computers are basically models of human thinking.

AI – Background

- Along with concurrent discoveries in neurology, information theory, & cybernetics, researchers considered building an electronic brain.
- 1943: first work that is now generally recognized as AI achieved by McCulloch & Pitts who showed that operations of a nerve cell can be modelled in terms of logical cybernetics.

AI – Background

1950s: Field of AI research founded at a conference in Dartmouth, US.

- In attendance: John McCarthy (coined the term AI), Allen Newall and Herbert Simon.
- By now electrical computers were developed.
 - So, AI researchers went on to write programmes and code.
- Computers were becoming so advanced they were winning chess games, solving word problems in algebra, proving logical theorems and even speaking.

AI – Background

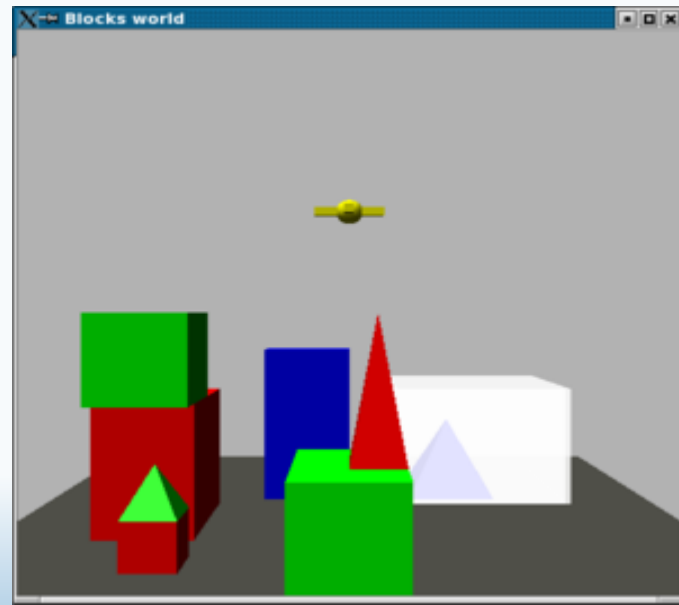
- Newell and Simon: developed a “Logic theorist”
 - Early computer program that could manipulate symbols to work out problems: 32 problems in under a minute.
 - They claimed this was an example of a thinking program that could work backwards from what it already knew and also had insight.
- Substantial funding from government departments (in the US and the UK) were really helping in building purpose built labs purely for AI research.

AI

- Other notable feats of AI research = SHRDLU programme
- A natural language understanding computer program developed by Winograd at MIT.
 - In it, the user carries on a conversation with the computer, moving objects, naming collections and querying the state of a simplified blocks world, which was basically a virtual box filled with different blocks.

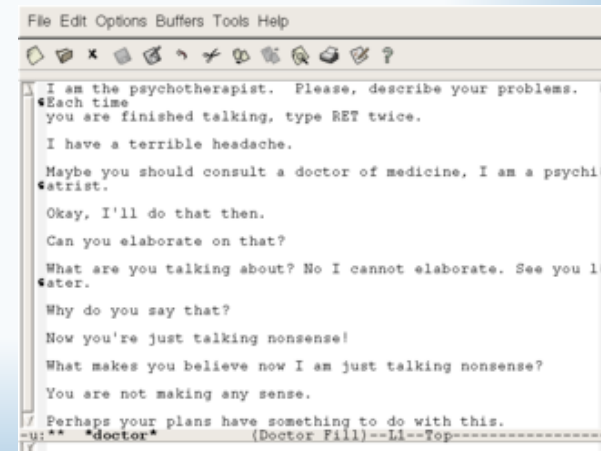
“Blocks world” in SHRDLU

<https://hci.stanford.edu/winograd/shrdlu/>



AI

- ELIZA program: natural language processing computer, also created at MIT by Weizenbaum.
 - Simulated conversation by using pattern matching and substitution methodology that gave an illusion of understanding, but had no built in framework for understanding the context of events.
 - ELIZA would process user inputs & engage in discourse following rules & directions of pre-programmed script.
- Most famous script, called DOCTOR, simulated psychotherapist: used rules, dictated in the script to respond with non-directional questions to user inputs.



```
File Edit Options Buffers Tools Help
I am the psychotherapist. Please, describe your problems.
*Each time
you are finished talking, type RET twice.
I have a terrible headache.
Maybe you should consult a doctor of medicine, I am a psychi
*atrist.
Okay, I'll do that then.
Can you elaborate on that?
What are you talking about? No I cannot elaborate. See you l
*ater.
Why do you say that?
Now you're just talking nonsense!
What makes you believe now I am just talking nonsense?
You are not making any sense.
Perhaps your plans have something to do with this.
-ur:* *doctor* (Doctor Fill)--Li--Top-----
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AI

- ELIZA considered as one of the first chatterbots & thought by some as being capable of passing the Turing Test.
- Some also believed it would positively influence the lives of people, particularly those suffering from psychological issues and that it could aid doctors with treatment.
- Can you see any major issues with this?
 - Although ELIZA was capable of engaging in discourse, it did not have true understanding.
 - What elements are seriously lacking?

AI – Background

1960s – 1970s: Some of the issues faced by AI researchers not being solved - funding dried up and progress slowed.

1980s: AI research revived by commercial success of “expert systems”- form of AI that simulated knowledge and analytical skills of human experts.

- By 1985 market for AI reached over a billion \$ and Japan's 5th generation computer project inspired US and UK governments to restore funding for academic research.

1990s - 21st century: AI being used for practical things like logistics, data mining, & medical diagnosis.

- Success due to increasing computational power, emphasis on solving specific problems, new ties between AI & other fields, & commitment by researchers to mathematical methods and scientific standards.

AI – Background

- Deep Blue: first computer chess-playing system to beat a reigning world chess champion, Garry Kasparov in 1997.
 - Changed the way people saw AI:
 - For some: beginning of new & exciting adventure,
 - For others: seen as dangerous times - thoughts of a computer revolution where machines would be taking our jobs (& over the world??).
- Advanced statistical techniques (loosely known as deep learning), access to large amounts of data and faster computers enabled advances in machine learning.
- By now machine learning applications are used throughout the world in a variety of aspects of our lives – e.g., smart phone, Google, Human robotics.

AI

- The term "artificial intelligence" is applied when a machine mimics "cognitive" functions associated with what a human mind can achieve – what type of cognitive functions?.....
- The main aims of AI research include being able to mimic problem-solving, reasoning, knowledge, planning, learning, natural language processing, & ability to move objects.
- Long-term goal of some AI researchers is to mimic “general intelligence”.
- All this raises a number of issues, which can be divided into philosophical and practical arguments.

AI

Philosophical arguments:

- Raises questions about the nature of the mind & ethics of creating artificial beings endowed with human-like intelligence – thoughts?
- Has resulted in most challenging/important questions in AI research: can a computer experience conscious awareness?

AI

- Typically AI is divided into **strong** AI and **weak** AI.
 - Strong AI: all thinking is computational, so the more carrying out of computations a machine does the outcome will eventually evoke conscious awareness.
 - Weak AI: what's simply being expressed is that we can only model our intelligent processes to create a different type of intelligence – e.g., pocket calculator.
 - Andrew Keever – Strong and Weak AI
<https://www.youtube.com/watch?v=5nwUJnlvjCc>

AI

- The leap from weak to strong AI is being seriously considered by some – how does something that copies us become a mind itself.

Practical arguments:

- Say we created machines to mimic how our mind reasons – what are the problems with attempting to do this?.....
 - We don't know how this works in our own mind to begin with: Cognitive psychologists are still trying to work out how higher level cognitive functioning works, so how could we build/program a machine/computer to do it?
- What do you think the counterargument to this would be based on the most basic assumptions of why we attempt cognitive modelling in the first place?.....

AI

- Build/programme something so that we can work out how it worked it out through reverse engineering to then apply that to our thought processes.
 - But, how would you know where to even start?
- Other criticism: we are not made of metal and cables we're made of blood and tissue.
 - Surely the type of material that makes us and that makes computers are too different to be compared?
 - In concurrence with this argument, French proposed a list of questions that an entity could only answer if it had a body in a Turing type test – this naturally makes it impossible for a computer to pass.

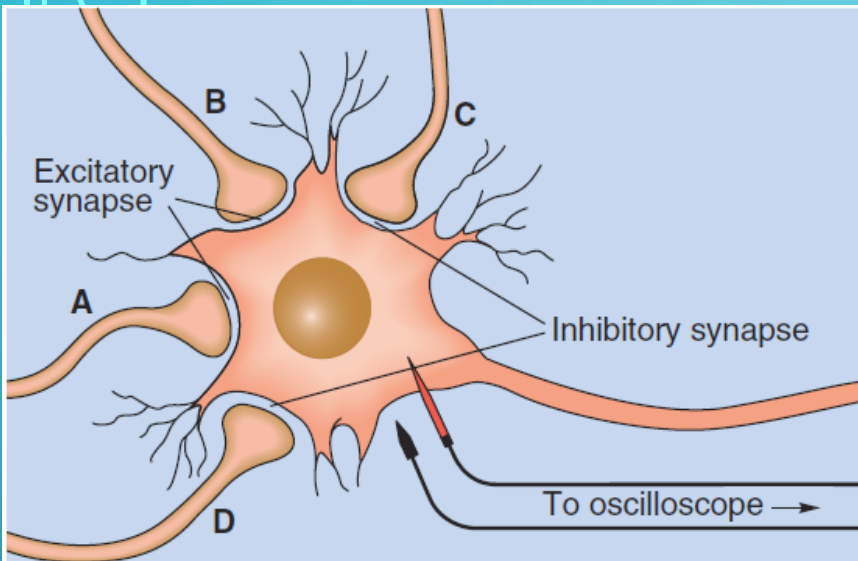
Brains and Computers compared

- However, (if the mind is situated in the brain), what do we now know about the connections in the brain?
 - Wired connections of electrical activity.

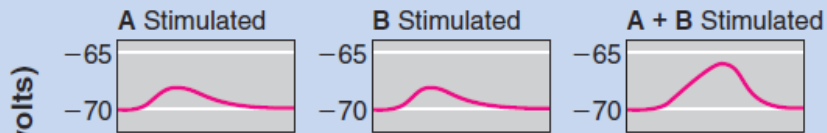
Digital vs. Analogue

- Is the human brain digital or analogue?
 - Both
 - A neuron either fires or not – to this extent it is digital.
 - Yet the rate of firing is a continuous variable.
 - Another analogue process is spatial summation.

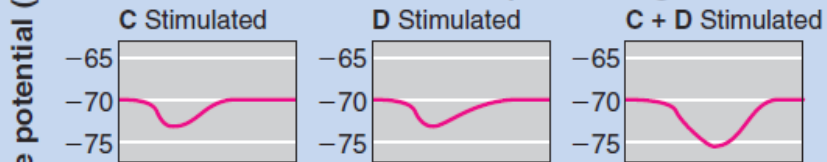
BRAINS AND COMPUTERS COMPARED



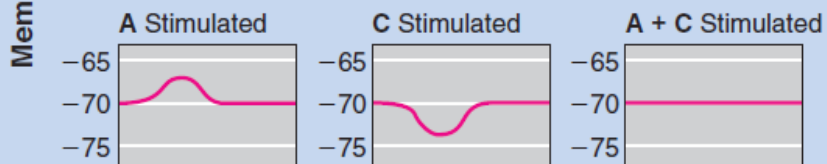
Two simultaneous EPSPs sum to produce a greater EPSP



Two simultaneous IPSPs sum to produce a greater IPSP



A simultaneous IPSP and EPSP cancel each other out



- When the 1st cell fires, neurotransmitters cross the synapse & change state of polarisation of postsynaptic membrane briefly & for a short distance around the synapse.
- When effects of lots of synapses on the same cell at different times and distances add up, if polarisation at the cell reaches a critical threshold, the second cell fires.
- The process of summation is analogue.
- The final output (fire or not) is digital.

Brains and Computers compared

Serial vs. Parallel

- Digital computers process information quickly but serially.
- They have a single central processing unit.
 - They can work simultaneously on different tasks
 - But only by dividing the tasks up and switching between them.
 - By doing this a serial machine can simulate a parallel machine.

Brains and Computers compared

Serial vs. Parallel

- In comparison, neurons operate to a slower degree
- However, the brain is parallel in nature with no central processor.
- Instead it has millions of simultaneously operating cells.
- This parallelism compensates for slower speed.
- The latest super computers are estimated to be four times as fast as the human brain.

Brains and Computers compared

Serial vs. Parallel

- Brains have different areas for vision, hearing, etc.
- All operate in parallel all the time.
- Patterns of information in the brain move in complex networks with no serial organisation.
- But, can argue that the brain has bottlenecks (e.g., in STM and attention).
- Also, some outputs (e.g., spoken/written language) are serial.
- Thus, the brain is a parallel machine simulating a serial machine.

Brains and Computers compared

Computable vs. Non computable

- A computable procedure can be described explicitly (a procedure done by a computer).
- ***Computational functionalism***: the brain is a Turing machine & its operations are computations.
- If true, it should be possible to reproduce all human abilities (making strong AI feasible).
- However, such computations would only simulate human function - There is more to consciousness than “running the right programme”.

Brains and Computers compared

Deterministic vs. Nondeterministic

- A machine that always produces the same output from the same input & internal state is *deterministic*.
- One that can produce different outcomes is *nondeterministic*.
- Digital computers are deterministic while brains are nondeterministic.
- Neurons are living entities whose electrical properties change as their dendrites grow or move.
- Synapses form and decay and their strength changes in response to use.

AI - Issues

- Another problem for AI comes from the question as to whether knowledge is declarative (based on facts) or whether it is procedural (based on actions).
- Can also argue that computers don't possess what we call common sense.
- These issues can be seen as minor criticisms but there is also a major criticism.....

AI - Issues

- Do computers understand input and produce outputs in the same way as humans?
- Searle (1980): criticised cognitivism and AI with what is called 'The Chinese room argument'.



AI - Issues

- Dreyfus: as humans we do not find ourselves in situations where we are incidental to cognition.
- We are involved in many open-ended task where there are an infinite number of ways to perform.
 - Much of our behaviour is not driven by knowledge that can be encoded explicitly from rules, but from practical knowledge.
- Machines are disembodied and only interact with the world through humans.
 - Most would carry out simple, well-specified tasks, in controlled environments (e.g., block world).

AI - Issues

- Building machines such as this seemed sensible at the time because the basis was on an implicit model of the mind.
- It assumed the need for accurate representation of the world manipulated by rules without the messiness of a body and physical considerations.
- However, it is thought that the mind can only be created by interacting in real time within a real environment.

AI – Issues

- For skilled actions, such as riding a bike, the role of the situation is critical.

EMBODIED COGNITION



- Clark (1997): The brain, body, and world interact causally and computationally.
 - Profound embodiment = every aspect of our mental function depends on our connection with the world we live in.

AI – Issues

- Rather than viewing the world humans live in as complicated and messy.....
 - It provides the constraints and feedback that make our perception, intelligence, and consciousness possible.
- What about creativity: can be unexpected & sometimes unconscious in humans.
- Can machines be creative?
 - If a robot draws a brilliant piece of art, can we say its been creative?



AI – Future developments

- Create machines that also move around in the real world.
 - E.g., driverless car not just recognising a collection of pixels as a white van slowing down quickly, it also assess the situation and takes evasive action.
 - Known as ‘Situated Robotics’ or ‘Behavioural-based Robotics’.
 - Implication = intelligent behaviour will emerge from simple systems

AI – Future developments

- An example can already be seen from biology...
 - Termites build impressive structures
 - They look planned but only emerge from simple rules about where & when to add/remove mud.
 - Emergent intelligence in social insects has inspired swarm robotics (Brambilla et al., 2013).
 - Large number of simple robots follow simple rules to produce complex swarm behaviour.
 - Can be used in medicine, disaster rescue, and autonomous warfare.
- <https://www.youtube.com/watch?v=G1t4M2Xnlhl>

Consciousness

- Can a machine be conscious?
- If so, can we even test for consciousness?
 - If we agree consciousness is subjective, then the only one who can know whether a machine is conscious is the machine itself.
- Does the following provide evidence for machine consciousness?
<https://www.youtube.com/watch?v=jx6kg0ZfhAI>
- Cold Fusion: Are we approaching robot consciousness?
<https://www.youtube.com/watch?v=JTOMNkZJRao>

AI - Group Task

- Can you tell the difference between a human and a machine?
- In groups, find a variety of works.
 - Some created by a real human
 - Some created by an AI system.
 - Group One: Paintings
 - Group Two: Jokes
 - Group Three: Poems
- Present your pieces of work to the rest of the class
- Everyone will then try to work out which of the works presented was created by a human and which were created by AI.

KEY AI PAPERS

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- Searle, J. (1990). Is the brain's mind a computer program. *Science*, 262(1), *Science*, 1990, Vol.262(1).
- Stuart, S. (2010). Conscious machines: Memory, melody and muscular imagination. *Phenomenology and the Cognitive Sciences*, 9(1), 37-51.
- Turing, A.M. (1950). Computing machinery and intelligence. *Mind*, 59, 433-460.

AI Films

- AI films relating to machines/robots designed to imitate human behaviour potential consequences:
 - AI Artificial Intelligence,
 - iRobot,
 - Eagle Eye,
 - Her,
 - Transcendence,
 - Ex Machina,
 - Any of the Terminator or Matrix films.
 - Be careful as some are a bit gory or include violence!!!

NEXT WEEK

- Lecture: Signal detection.
- Seminar: Applications of Signal Detection Theory.
- ESSENTIAL READING: See module handbook