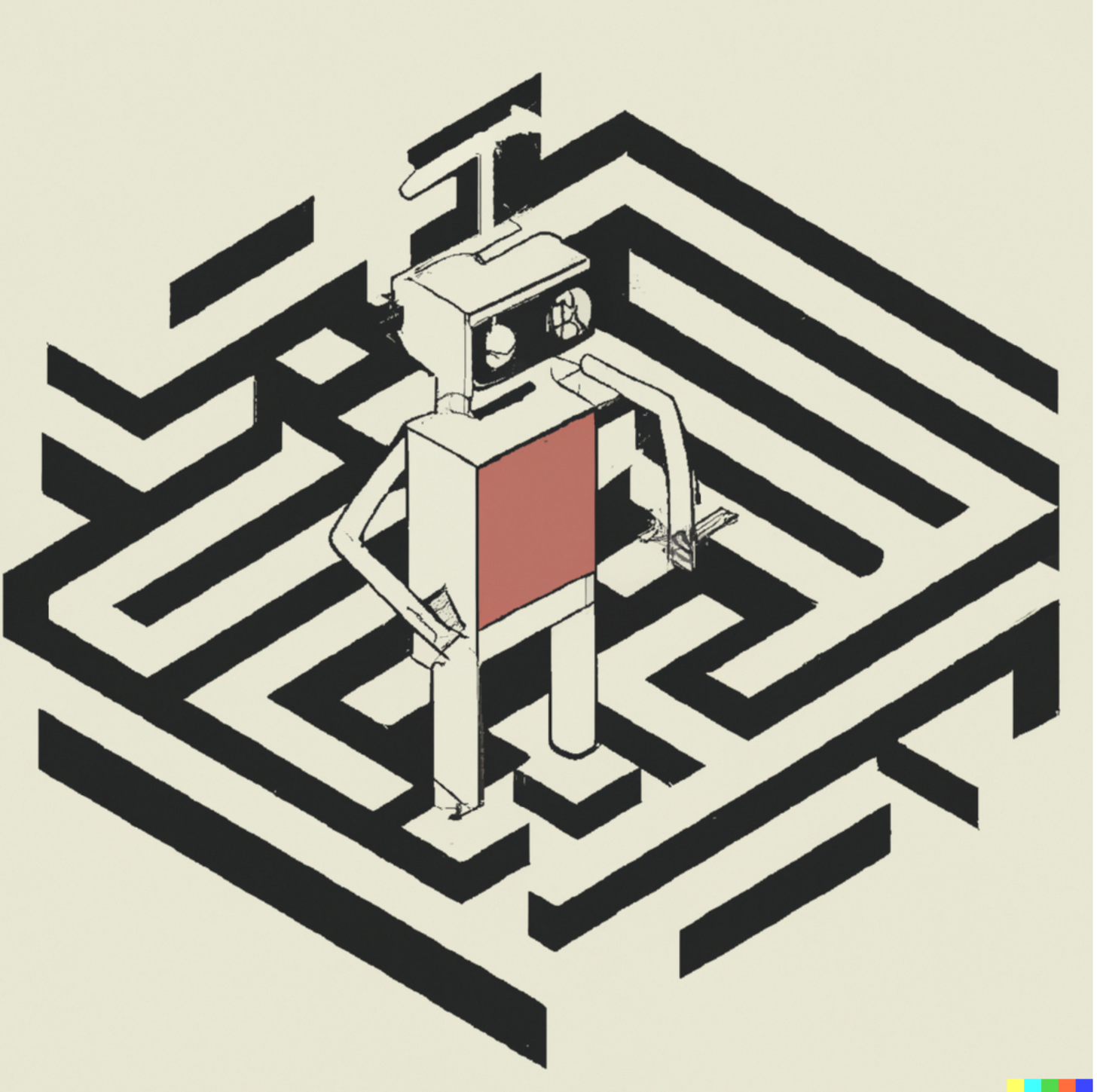


Seminar in Cognitive Modelling

Lecture 1 - Welcome, Introduction, Preliminaries,

10-11am — 19th September 2023

Neil Bramley

Your course lecturers

Neil Bramley
(Course organiser this year)

https://bramleylab.ppls.ed.ac.uk/

Maithilee Kunda
(Lecturer Semester 2)

https://engineering.vanderbilt.edu/bio/maithilee-kunda-

Frank Mollica
(Lecturer Semester 1; creator of this course)

https://mollicaf.github.io/

Max Taylor-Davis
(Teaching assistant)

https://www.edinburgh-robotics.org/students/max-taylor-davies

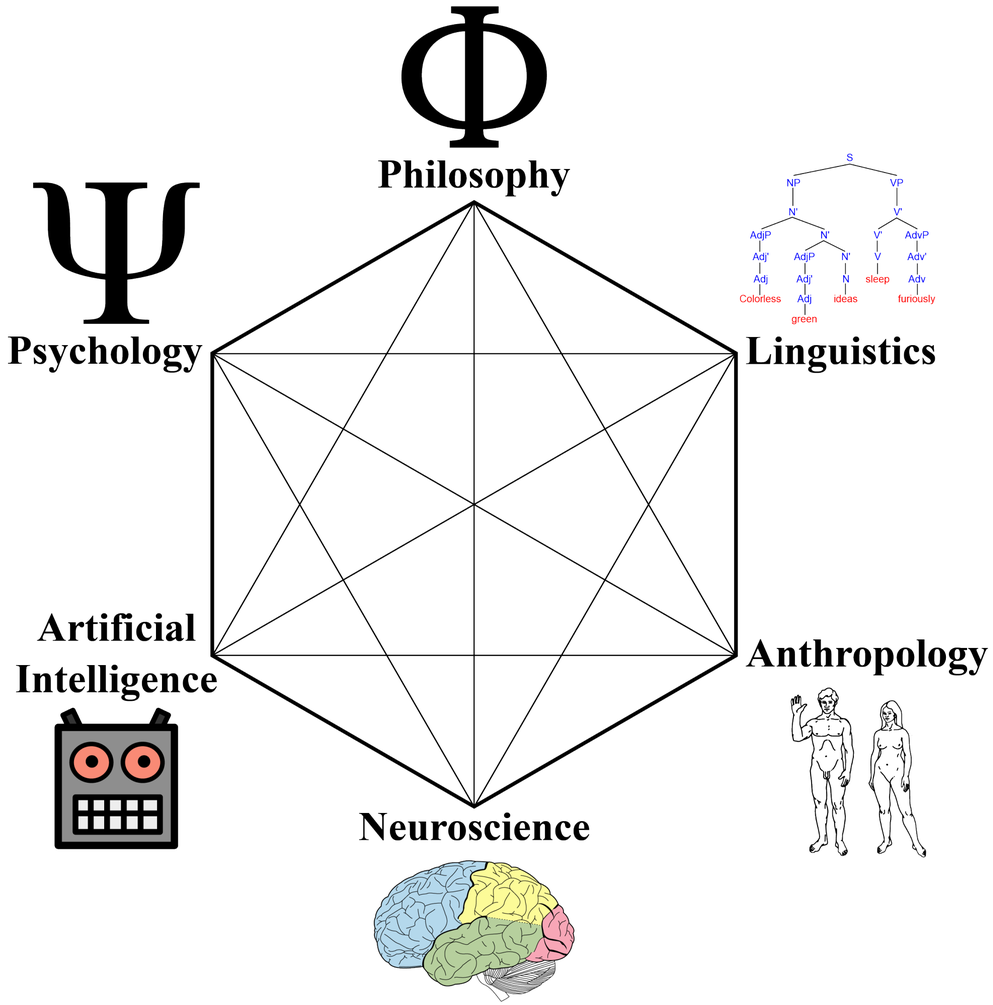
What is a seminar?

A Discussion

Learning Objectives:

- Demonstrate understanding of a range of classic and current articles in cognitive science by summarising and critiquing their central ideas & results
- Search the literature, synthesise info from several papers on same topic & create a coherent presentation on that topic
- Communicate key findings in CogSci to inter-disciplinary audiences

What is cognitive science?



What is cognitive science?

- The study of **mental representations** and **processes**
  - A mental representation is a description of information in the mind
  - A mental process is a procedure for translating:
    - sensory information into representations
    - representations into other representations
    - representations into actions / behaviour
- Loosely speaking… **content** and **computation**

Required background

- This course is suitable for outside students. But:
  - Assumes knowledge of cognitive science
  - By semester 2, knowledge of:
    - Linear algebra (vectors / matrix multiplication, orthogonality, eigenvectors);
    - Probability theory (discrete and continuous univariate random variables, expectations, Bayes rule);
    - Statistics (linear / logistic regression); and model evaluation.
  - Data visualisation and programming experience will be useful
  - But there is no required programming.

Logistics

Pay attention, it's a bit complicated!

- In **Semester 1**, half of you will be assigned to '**earlies**' (10-11), half to '**lates**' (11-12)
  - So you have two 1-hour sessions per week
  - You should always attend your assigned session but are also welcome to attend other session (space permitting*)
  - No-one should have a clash for both earlies and lates, but some people will have a clash for lates (let me know and you'll be an 'early'!)

	Monday	Tuesday	Wednesday	Thursday	Friday
9-10					
10-11		Early group		Early group	
11-12		Late group		Late group	
12-13					

Logistics

Pay attention, it's a bit complicated!

- In **Semester 2:** Half will be assigned to **Tuesdays** and half to **Thursdays**
  - So you will attend one 2-hour session per week in Semester 2
  - You may also attend the other session if you like
  - These are not the same groups as semester 1, i.e. we will try and mix things up so you have different group mates in each semester
- **In both semesters you will be giving a presentation!**
  - In semester 1, these will be on topics/readings assigned by us
  - In semester 2, these will be on a topic/readings chosen by you

	Monday	Tuesday	Wednesday	Thursday	Friday
9-10					
10-11		**Tuesday group**		**Thursday group**	
11-12					
12-13					

Course Roadmap

- **Semester 1:** Tour of cognitive modelling topics approaches themes and perspectives
    - Emphasis on ‘important’, ‘famous’, ‘classic’, ‘foundational’, ‘representative’ papers (but also recent high profile papers for contrast)
    - Each one hour session will centre on 1 (or sometimes 2) student presentation(s), followed by group discussion
- **Semester 2:** Your turn. Present on topic of your choice (same as essay), focusing on a modelling approach used in 1-2 paper(s) of your choice
    - Each two hour session will involve 2-3 student presentations with breaks between

Nominally emphasising representations vs processes vs perspectives

Course roadmap: Semester 1

Week	Tuesday Topic	Date	Guide	Thursday Topic	Date	Guide
1	Intro to course	19/09/23		How to present	21/09/23	

Course roadmap: Semester 1

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3	Concepts	3/10/2		Categorization	5/10/23	
4	Objects & Events	10/10/23		Inductive Reasoning	12/10/23	
5	Causality	17/10/23		Physical Reasoning	19/10/23	
6	Rationality	24/10/23		Learning & Development	26/10/23	
7	Time	31/10/23		Decision Making	2/11/23	
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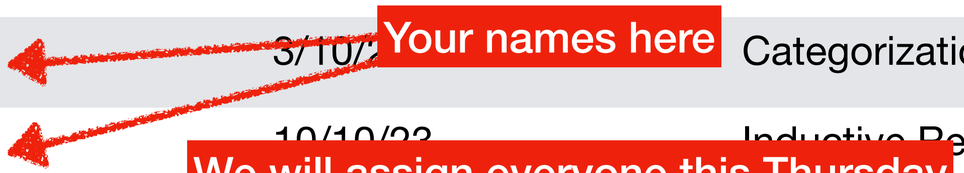


Course roadmap: Semester 2

Week	Tuesday Topics	Date	Guide	Thursday Topics	Date	Guide
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						

We will assign everyone over Christmas break

Topic allocation

- On Thursday, I will go through topics in a random order, and you'll put your hand up if you'd like to present on that topic
- We need minimum two presenters for each (one early, one late)
- We will use a random number generator to tiebreak, and random allocation if you don't put your hand up or don't win a tiebreak
- Then I'll randomly assign early/late (accommodating clashes and with some sensitivity to preferences)
- Tonnes of overlap, so many topics can be spun to angle of choice
    - There's also no perfect taxonomy of cognitive science topics
        - E.g. no session on language but language permeates many of the topics
        - No session on "generalization" or "similarity" but very central principles to many (e.g. induction, causality, rationality, ecology, development)

Portfolios

- Over the course of each semester, you will build a portfolio of reflections on required papers. Each week, you need to submit two (100-200 word) entries. One for the Tuesday class, one for the Thursday class

- Handwrite or print, and bring to class. Include name and student number.

- An entry should:

  - Pick a discussion role (can’t use the same role consecutively)

  - Briefly summarise the main idea of the article (2-3 sentences); comment on whether or not you believe the conclusions (1-2 sentences); justify your belief (2-5 sentences).

Portfolios

- Goal of the weekly entries is to ensure that you are prepared to participate in class discussions
- In class, you will may also be asked to comment on the discussion and state if you revised your belief and why.
- Portfolios will be marked at the end of the semester
- 4 of the 20 entries can be missing, no questions asked and no detriment to the marks. Otherwise, no extensions.

Reviewer roles

All credit to: https://colinraffel.com/blog/role-playing-seminar.html

1. 👩🏽‍🔬 **Scientific Peer Reviewer:** The paper has not been published yet and is currently submitted to a top conference where you've been assigned as a peer reviewer. This includes recommending whether to accept or reject the paper.

2. 🏺 **Archaeologist:** This paper was found buried under ground in the desert. You're an archeologist who must determine where this paper sits in the context of previous and subsequent work. Find and report on one *older* paper cited within the current paper that substantially influenced the current paper and one *newer* paper that cites this current paper.

3. 🍜 **Academic Researcher:** You are a researcher who is working on a new project in this area. Propose an imaginary follow-up project *not just* based on the current but only possible due to the existence and success of the current paper.

Reviewer roles

All credit to: https://colinraffel.com/blog/role-playing-seminar.html

4. 💰 **Industry Practitioner:** You work at a company or organisation developing an application or product of your choice. Pitch for why someone should be paid to implement the method in the paper, and discuss at least one positive and negative impact of this application.

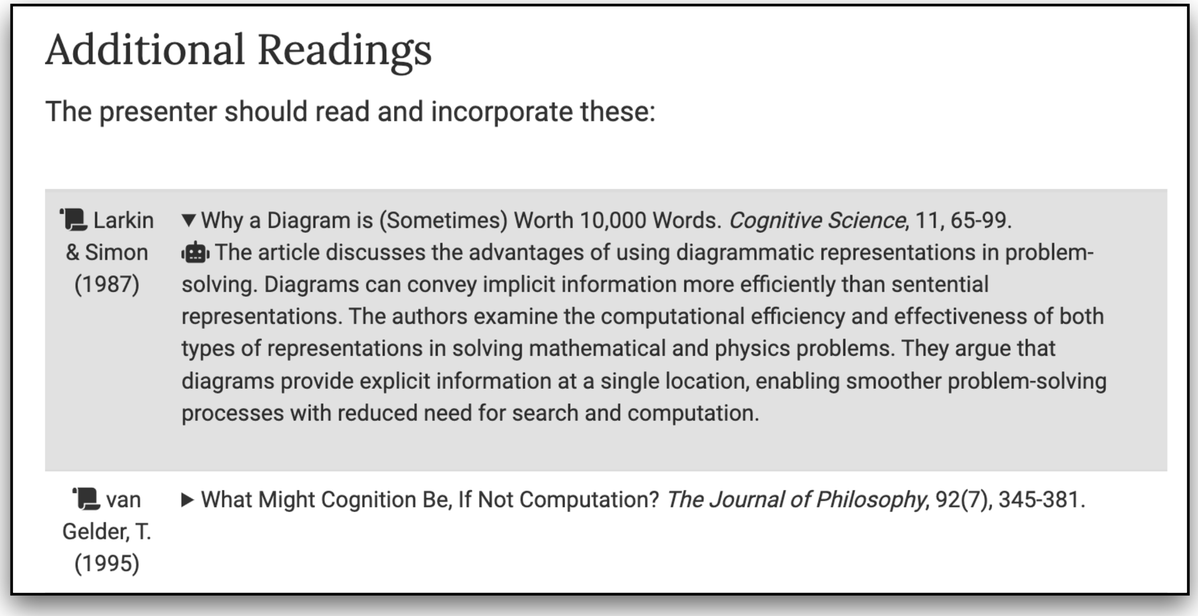
5. 👾 **Hacker:** You're a hacker who needs a demo of this paper ASAP. Describe, with pseudocode, how you will implement a small part or simplified version of the paper on a small dataset or toy problem.

6. 🕵️ **Private Investigator:** You are a detective who needs to run a background check on one of the paper's authors. Where have they worked? What did they study? What previous projects might have led to working on this one? What motivated them to work on this project?

7. 🌎 **Social Impact Assessor:** Identify how this paper self-assesses its (likely positive) impact on the world. Have any additional positive social impacts left out? What are possible negative social impacts that were overlooked or omitted?

ChatGPT summaries

- This year's course website includes short chatGPT-generated summaries for all Additional readings
- Partly in response to feedback last year, that it can be hard to appreciate connections with additional readings for non-presenter.
- There is not enough time to read all the additional readings (except for the topic you are presenting on)



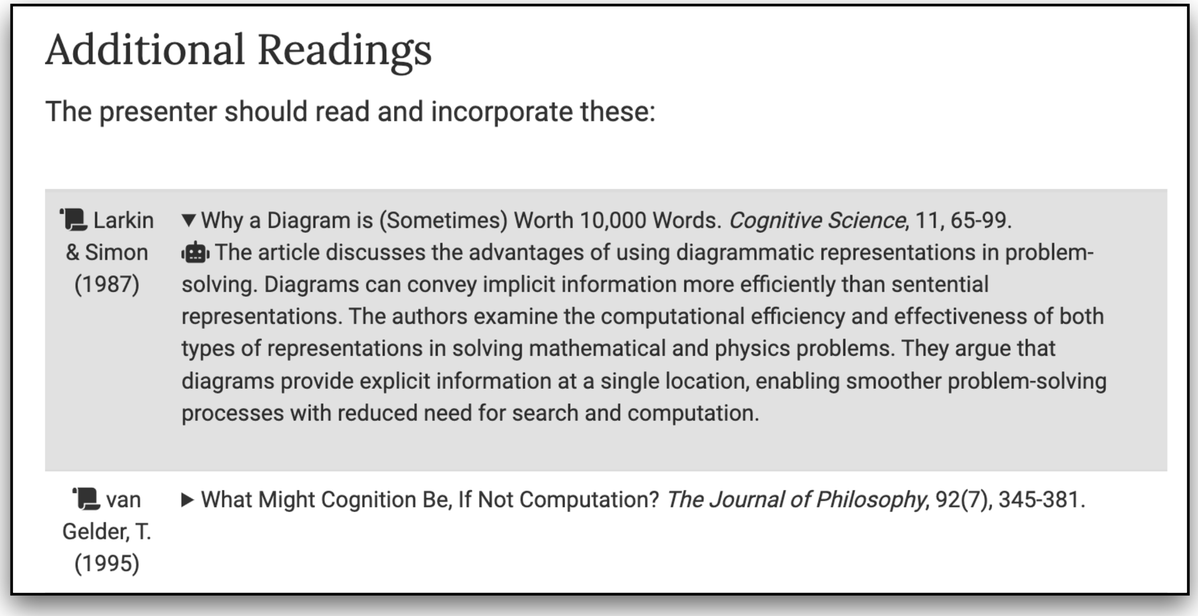
Additional Readings

The presenter should read and incorporate these:

Larkin & Simon (1987)	▼ Why a Diagram is (Sometimes) Worth 10,000 Words. *Cognitive Science*, 11, 65-99. The article discusses the advantages of using diagrammatic representations in problem-solving. Diagrams can convey implicit information more efficiently than sentential representations. The authors examine the computational efficiency and effectiveness of both types of representations in solving mathematical and physics problems. They argue that diagrams provide explicit information at a single location, enabling smoother problem-solving processes with reduced need for search and computation.
van Gelder, T. (1995)	▶ What Might Cognition Be, If Not Computation? *The Journal of Philosophy*, 92(7), 345-381.

ChatGPT (3.5) summaries

- It is also an experiment in pedagogy
  - Generative AI will increasingly be part of academic workflow
  - We can’t really stop you using it
  - Feels unfair if tech-savvey students do this but not others
  - Undeniable for a pure summary of a paper’s content, GPT3.5 starting to do a reasonable job
- Obviously, these summaries do not substitute for actually reading the paper…



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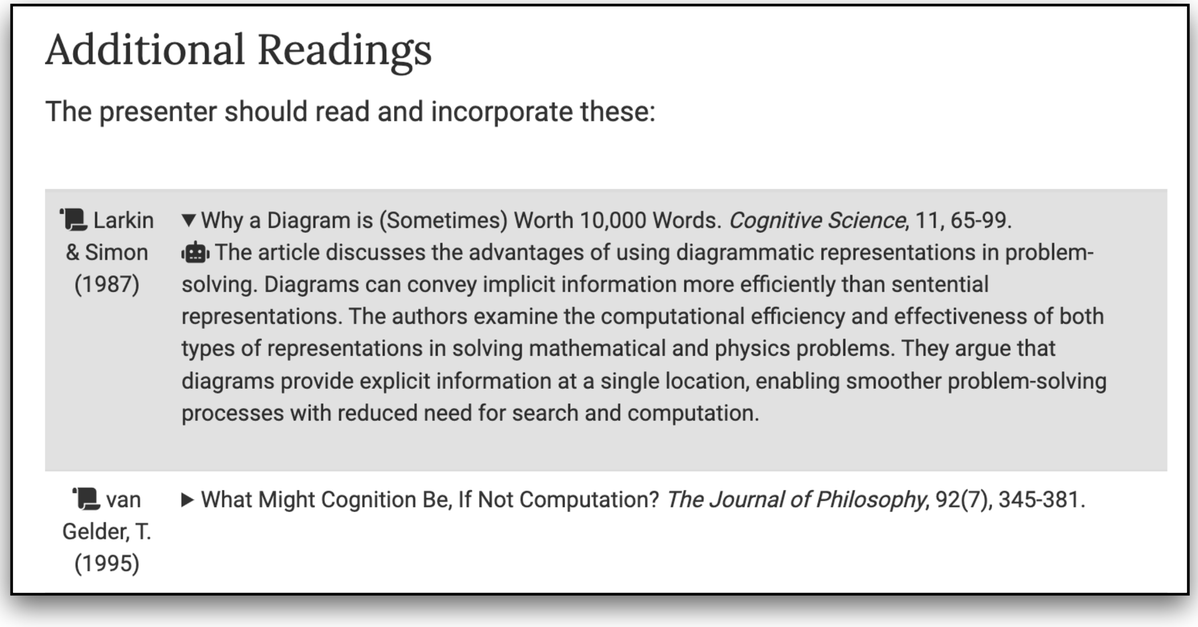
ChatGPT (3.5) summaries

- But perhaps raises bar for the portfolio entries, we want to see evaluative content beyond mere summarisation

- Reviewer roles challenge you to form your own opinion & go beyond text— Strive to make your entries distinct from these generic generative AI outputs!



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van Gelder, T. (1995)	▶ What Might Cognition Be, If Not Computation? *The Journal of Philosophy*, 92(7), 345-381.

One more reviewer role:

8. **LLM Debugger:** Identify what ChatGPT got wrong about one of the Additional readings. Speculate as to why.

How you will be marked

Semester 1

- Presentation — Formative but required; Arranged
- Portfolio — Worth 15%; 2 Weekly (Best 16/20)
- Essay — Worth 40%; Due Jan 2024

Semester 2

- Presentation — Worth 30%; Arranged.
- Portfolio — Worth 15%; Weekly (Best 16/20)

Extended common marking scheme

Mark (%)	Grade	Description
90-100	A1	An excellent performance, satisfactory for a distinction
80-89	A2	An excellent performance, satisfactory for a distinction
70-79	A3	An excellent performance, satisfactory for a distinction
60-69	B	A very good performance
50-59	C	A good performance, satisfactory for a masters degree
40-49	D	A satisfactory performance for the diploma and certificate
30-39	E	Marginal Fail
20-29	F	Clear Fail
10-19	G	Bad Fail
0-9	H	Bad Fail

https://www.ed.ac.uk/timetabling-examinations/exams/regulations/common-marking-scheme

About the essay

- Based on 1-2 papers of your choice on a topic in cognitive modelling
- Should discuss empirical findings in context of a computational model or models, to a non-specialist audience
- Easiest: Find a single paper including both empirical and modelling results. Paper in question should be substantial, i.e., include several experiments or a systematic comparison with other approaches
- Alternatively, find 2 shorter papers covering:
  - Different models of a single phenomenon
  - Or additional experiments testing the same model

About the essay

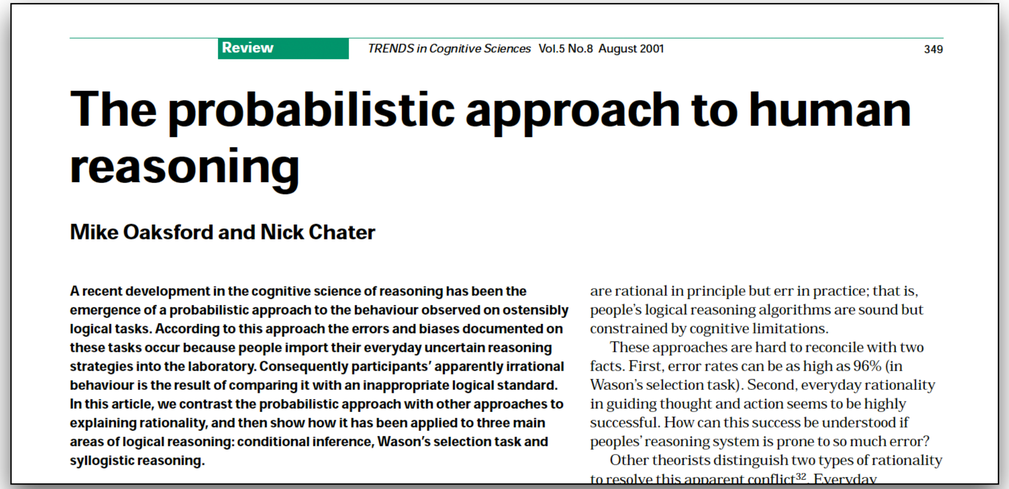
- Marking will take into account the difficulty of the chosen article(s)/theme(s)
- It’s fine to choose an old paper, but should explain how it relates to more recent work
- Post your intended paper(s) on the Piazza note for essay topics before **11 November 2023**
- For help choosing papers, see the tips on the website
    - If you are still having trouble, feel free to contact one of the instructors well before the deadline
- Essays may not focus on papers that are already the subject of other student presentations. So make sure to look at Piazza to avoid overlapping topics

About the essay

- Essay should:
    1. Discuss the context of the work (i.e., behavioural findings or philosophical questions addressed)
    2. Summarise the model(s) and experiment(s)
    3. Critically evaluate the work
- A good essay will include some material you get from “reading around” the topic.
- You may also wish to address one or more of the following questions:
    4. How does this work relate to other models/approaches we have studied in class?
    5. What questions are raised by this work?
    6. What further experimental or modelling work might help to address these questions?

About the essay

- Goal: Demonstrate that you can read a cognitive modelling paper, understand its methods, evaluate its claims and place it in context in the field
- Essays should be between 2000 and 2500 words, including headers and figure captions but not the bibliography
- Should be written at a level that an interested but non-specialist reader would understand – someone who has some background in cognitive science but not necessarily in the specific area you are discussing
- Do not include an abstract
- Articles in the journal *Trends in Cognitive Science*, such as those included as readings in this course, are good examples of this level of writing (although the format/content of these articles is different from what you will write)



Review *TRENDS in Cognitive Sciences* Vol.5 No.8 August 2001 349

The probabilistic approach to human reasoning

Mike Oaksford and Nick Chater

A recent development in the cognitive science of reasoning has been the emergence of a probabilistic approach to the behaviour observed on ostensibly logical tasks. According to this approach the errors and biases documented on these tasks occur because people import their everyday uncertain reasoning strategies into the laboratory. Consequently participants' apparently irrational behaviour is the result of comparing it with an inappropriate logical standard. In this article, we contrast the probabilistic approach with other approaches to explaining rationality, and then show how it has been applied to three main areas of logical reasoning: conditional inference, Wason's selection task and syllogistic reasoning.

are rational in principle but err in practice; that is, people's logical reasoning algorithms are sound but constrained by cognitive limitations.

These approaches are hard to reconcile with two facts. First, error rates can be as high as 96% (in Wason's selection task). Second, everyday rationality in guiding thought and action seems to be highly successful. How can this success be understood if peoples' reasoning system is prone to so much error?

Other theorists distinguish two types of rationality to resolve this apparent conflict[32]. Everyday

Essay marking criteria

Basic Criteria

1. Provides a clear description of the phenomena motivating the work and relevant empirical data from this and/or previous works.
2. Clearly states hypotheses being tested by the model(s) and their relevance to the field of cognitive science.
3. Clearly summarises the model(s), including any key technical details and assumptions that are made.
4. Summarises key experiments and results obtained in the chosen paper(s) and explains how these bear on the hypotheses being tested.
5. Demonstrates a detailed understanding of the chosen paper(s).
6. Discusses strengths and weaknesses of individual model(s) and evaluation(s).
7. Well written

Essay marking criteria

Additional Criteria (beyond chosen papers)

1. Includes original discussion.
2. Explicitly compares alternative approaches or competing hypotheses.
3. Reviews additional behavioural evidence.
4. Reviews other uses of the model.
5. Relates the topic/model to broader issues and themes from the course/ cognitive science or society.
6. Proposes useful extensions to the model or further ways to test them

How we communicate

When you sign up for the course, you will have access to:

- The Learn page of the course (“Seminar in Cognitive Modelling (2023-2024)[YR]”) containing links to course website, forum, copies of any copyrighted literature and portal for submitting assessments
- The Course Website which contains **all course materials** (https://eco.ppls.ed.ac.uk/~nbramley/msc/scm23/)
- The course mailing list, used for all essential communication
- The course Piazza forum:
  - Use it to post questions about the course content;
  - The main purpose is peer support: students discuss course material and help each other;
  - Lecturers will lightly moderate the discussion and contribute

How to find the readings

- 📜📄📚📘📖📗📚📄📜
- No textbook 📔
- Readings are listed on the website (https://eco.ppls.ed.ac.uk/~nbramley/msc/scm23/)
- If the reading is behind a copyright wall, it's on Learn
- Otherwise, you should be able to use university resources (e.g., the library) to find them
- I was able to find all these texts online for free

Nominally emphasising representations vs processes vs perspectives

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10	Theory of Mind	21/11/23		Analogical Reasoning	23/11/23	
11	Ecology	28/11/23		Expertise	30/11/23	

Nominally emphasising representations vs processes vs perspectives

Representation

Jul 1, 2023

Cognitive Science is the science of mental representations and processes. But what *are* representations?

Processes

Jul 1, 2023

Cognitive Science is the science of mental representations and processes. What are processes?

Concepts

Jul 1, 2023

"*Concepts are the glue that holds our mental world together*" (Murphy, 2002, p1).

This session will explore recent attempts to model the structure of human concepts. This will involve engaging with a historical debate and distinction between more "statistical" and more "rule-based" models and their implications but also thinking about how our concepts relate to how we categorize things but also how we think and generate new ideas.

Categorization

Jul 1, 2023

Plato famously characterised humans as seeking to 'carve nature at its joints' (Phaedrus). The rough idea is that we find ways to classify and group the things in our experience in ways that somehow respect their natural clustering and separation.

This topic looks at cognitive models that have tried to capture how and why we partition the world in the ways we do.

Objects & Events

Jul 1, 2023

Light hits our eyes and somehow we perceive 3 dimensional 'objects'. What is an object? In representational systems like programming languages, objects are core structure. Is the same true for our cognitive system? Are objects learned or innate?

Similar to object, events seem like a great candidate for an ontological type. Formal semanticists have illustrated time and time again that they are important for explaining language. But are events core conceptual knowledge?

Inductive Reasoning

Jul 1, 2023

While Sherlock's over there blogging *The Science of Deduction*, I'd argue most of human reasoning is **inductive**. We see lot's of examples (e.g., 10 million white swans) and then try to explain them (swans are white). Checks out, right?

Nominally emphasising representations vs processes vs perspectives

Causality

Jul 1, 2023

The search for a causal understanding of the world is at the heart of human cognition. It In this session, we will think about how to model the cognition involved in learning, representing and exploiting a causal model of the world.

Physical Reasoning

Jul 1, 2023

From pouring a cup of coffee to playing frogger through the streets, physical reasoning is ubiquitous in human behavior. Arguably these goals have been stable throughout the evolution of our species, so are we optimal physical reasoners?

Rationality

Jul 1, 2023

In popular culture, we often think of *rationality* as in tension with *intuition*. We see this in caricatures of hyper-rational agents like Spock in Star Trek. The probabilistic revolution in cognitive science has changed this notion. It is not rational to treat every task as logical deduction when the world itself is underdetermined and radically uncertain. This session will explore the notion of being rational in an uncertain world.

Development & Learning

Jul 1, 2023

Compared to other animals, humans are flexible generalists. We are born "half baked", with relatively little in the way of initial skills or "core knowledge". We spend decades growing and maturing and even once mature can continue to be able to learn new things. This session will explore a zoomed out perspective on how the human mind achieves this impressive flexibility. This touches on how the ability to learn and change shifts over our lifespans and the benefits and costs of childlike cognition.

Expertise

Jul 1, 2023

On the other hand, these models struggle far more than people to *generalize* this expertis to even slightly different tasks, or indeed to master more than one thing at all. What is expertise in cognition? This session will explore how we can model expertise, how expertise changes our how a cognizer approaches a task, and what trade-offs this can come with.

Time

Jul 1, 2023

Unlike most computational systems, humans experience and must respond to their environment through time. One of the most basic forms of human and animal learning is to associate things that happen close together. Everyday activities like speech, music, dance demand precise time control, while imagination, mental simulation, and memory ("mental time travel") seem to require encoding of (and ability to regenerate events) in the right temporal sequence. What then is the role of time in the various cognitive processes and representations we have been discussing throughout this course?

Nominally emphasising representations vs processes vs perspectives

Decision Making

Jul 1, 2023

Humans are said to be 'predictably irrational', departing from the ways that economists would like to think they will behave. Businesses, policy makers, marketers and consultants and increasingly economists would all like to understand how and why people make the decisions they do. The judgment and decision making topic focuses on these questions

Attention

Jul 1, 2023

The world isn't neatly carved into units aligned with our mental representations. Instead it's presumably a "blooming, buzzing confusion." Presumably the goal of attention is to filter this confusion such that we can better process signals in the environment.

Memory

Jul 1, 2023

Memory is the process of encoding, storing, and retrieving information when it is needed. This topic will explore the structure and function of memory in cognitive systems and relate it to the other themes of the course.

Ecology

Jul 1, 2023

Agents operate in an environment but most experiments construct sterile, artificial environments to exert epistemic control. So is looking at the environment worthwhile or can we understand cognition by looking at agents in fixed environments?

Number

Jul 1, 2023

Of all the terrifying things humans have created, perhaps maths are a fairly tame, although remarkable, invention. While we clearly created maths, did we create numbers?

Space

Jul 1, 2023

Space. The final frontier. How do we move in space? Vectors, scalars, navigation? Is spacial reasoning a cognitive instinct or a cognitive technology?

Theory of Mind

Jul 1, 2023

This session will think about how people reason about others and how we might make machines that can do the same.

Analogy

Jul 1, 2023

Analogies help highlight similarities between different situations. Sometimes they just help us make pretty prose and literary points; however, they can also help us with problem solving. Is analogical reasoning responsible for creative solutions and "aha!" moments of insight?