cog sci lecture 2

#yale/coursework/sophomore/CGSCI 110#

Slides


2-CogSci-Foundations+Architect…
Sep 1, 2017

Book: golden braid

Readings:

(Optional) Highly Recommended Book: An Eternal Golden Braid

They're made out of meat


Bisson-1991.pdf
Sep 1, 2017

How to study the brain


Marcus-EtAl-2014.pdf
Sep 1, 2017

From circuits to behavior


Carandini-2012.pdf
Sep 1, 2017

Lecture

Will be exploring themes for first few weeks

Cog sci is a mix of disciplines. Why?

- at boundary of physics and chem, people asking the same question but using different methods. Cognitive science is willing to study how the mind works using whatever tools are available, no matter the discipline they came from
  - William James started experimental psych: principles of psychology. He said if I want to study something, I can do it however I like

- **Shortcuts to the truth**: mixing strengths of disciplines brings us to the truth faster
- **instinct blindness/intuitions** about our cognition can lead us astray when trying to study the mind, so we need to bring in other disciplines. This can help us cure instinct blindness.
    - We will appreciate the common place in this class.
    - The brain takes a lot of shortcuts/has instinct blindness, so we can't trust it to tell the shapes of objects, colors, brightness etc.
    - The ambulance cutout example
    - The checkerboard square colors example
        - the brain rapidly analyses subtle patterns of light and dark and overcompensates to meet our expectations, regardless of the reality
- **Curing instinct blindness:**
    - In computer science, when you have to implement a process, then you realize how difficult it is
        - minsky thought computer vision would be easier than cognition. But until he sat down and tried to replicate it, then he realized it was so hard
        - computer science forces us to realize the failures of our intuitions
    - In neuropsychology:
        - healthy brains operate too seamlessly to recognize its parts
        - brain damage rudely tears different processes apart
        - **disassociations**: e.g. when normal visual processing of objects is divorced from face recognition / face blindness. This shows us that faces and objects are processed separately.

Wednesday's Readings: About brain damage by Sacks. About varying perceptions of time. Balint's syndrome: subjects that can only see one object at a time.

- **Intrinsic scientific reasons:** just neuroscience is not enough to make you understand how the mind works. Just psychology or CS is not enough either. You need to bring them all together
    - *What's on the exam? Slides we linger on or spend time on, like Marr's 3 Levels.*
    - Marr's 3 levels:
        - computational: what is the problem being solved?
        - algorithmic: what are the steps used to solve it?
        - Implementation: how are those steps implemented in underlying hardware (biological or otherwise?)
        - e.g. multiplication 9 * 13.
            - At the computational level, the only thing/answer is 117.
            - At the algorithmic level, there are multiple algorithms or steps you could go through to implement the exact same computation. E.g. add 9 to itself 13

times, add 13 to itself 9 times, do the piece of paper stuff, multiply 13 * 10 and subtract 13
    - At the implementation level, you could implement in a meat machine / human, a silicon machine / computer, a mechanical machines made of levers or lego blocks, a binary adder and so on…
- **Is each level critical?**
    - **implementation corresponds to neuroscience, algorithmic level to applied psychology, computation corresponds to computer science**
    - some critics say neuroscience can't help you explain how the mind works. Others say the neuroanatomy has correspondence between structure and function. Still others take it even farther and say, let's only study neurons and deep structure instead of higher level generalizations
        - **you can't get by with only computation** (only higher level generalization)
            - **Color in the retina / why do we see after images example:** this has nothing to do with higher level computation or psychology, it is just a consequence of how neurons are wired together
        - **you can't get by with only implementation** (only neurons). You need to be able to capture some generalizations (explanation rather than physical description)
            - suppose Microsoft word crashes across implementations on macOS and Windows. But you could do a bug fix by using a shared vocabulary / programming language, rather than wasting time talking about physical stuff like circuitry

Readings

1. From circuits to behavior, a bridge too far?
2. Similar network activity from disparate circuit

Computations can be transferred across implementations, but the underlying biophysics can change. **We need an appropriate level of abstraction**

Researchers were able to map out all the neural connections in a nematode worm, but knowing what "stuff" there is does not always help finding about how computations are done.

Is it all just neurons in the end?

- True, but then you could just go further and say: it's all just molecules and atoms in the end. Should we find out everything about molecules first?
- **Marr**: "can we study bird flight by studying only feathers?"

All of this necessitates cognitive science.

Why not cognitive science**S**?

- what we learn in neuroscience can constrain psychology. What we learn in computer science can constrain neuroscience. These disciplines are intertwined, and no longer independent of each other. Hence a single cognitive science.
    - e.g. of constraint from **below**: a single neuron takes 5 ms to fire (neuroscience), so this imposes limits on how quickly we can understand speech (psychology). There can now only be a 100 steps in understanding speech, so that we understand speech in the empirically observed 500 ms.
    - constraint from **above**: the "rigidity assumption" made by the brain allows us to see objects in 3D, even though only dots on an image may be moving.

The ability of cog sci to bring together constraints from disciplines is very valuable.