Cognitive Computing

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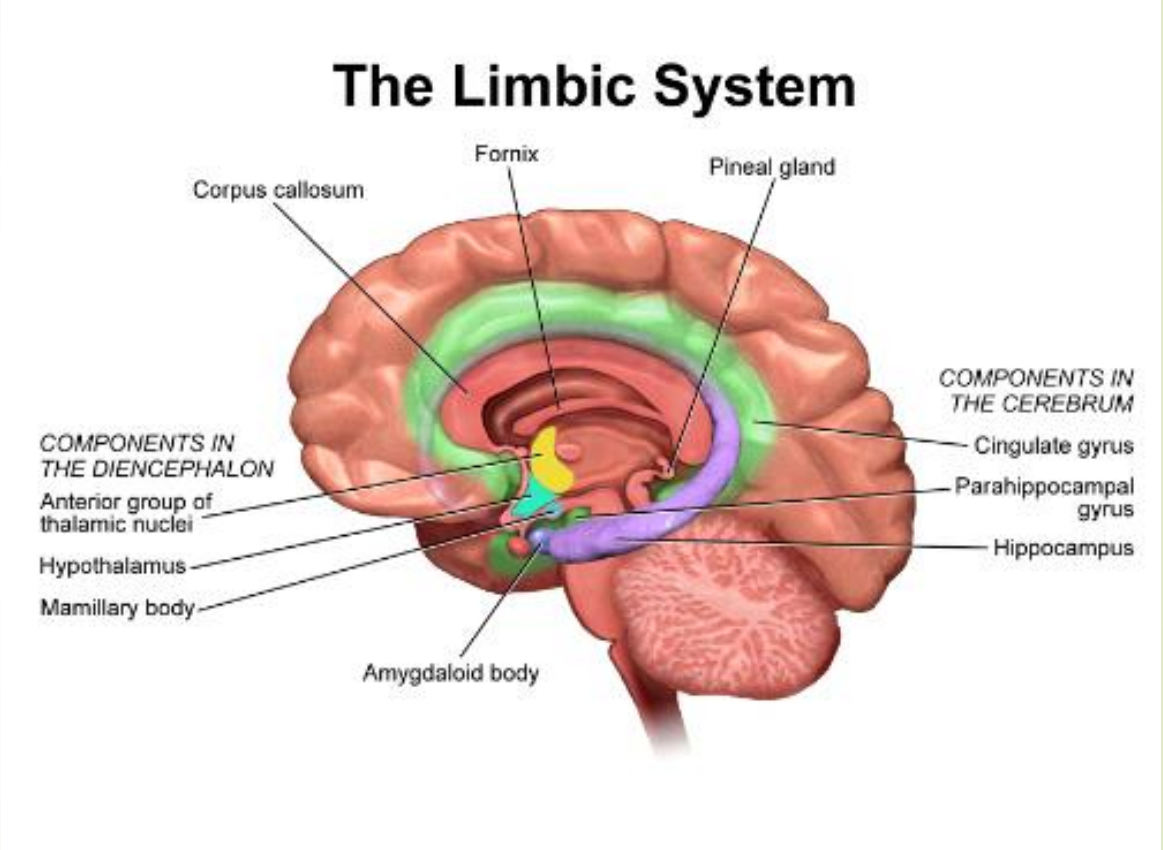
The Amazing Brain

Navigation and Making new Memories
New memories and remembering past experiences.

- Infection in parahippocampal
- Navigation
- House map



Why Should we Study the Human Brain in the first place?

"Decade" refers to a period of ten years. The "Decade of the Brain" refers to the period of time from 1990 to 2000, during which there was a focused effort to increase public awareness of neuroscience research and to promote funding for such research.

- To know thyself.

your mind/brain is who you are; understand yourself!

many other fine organs, but the brain is special

you would die without a heart,

but your brain is your *identity*.

that's why heart transplants not brain transplants

that's why decade of the brain not pancreas or kidney or liver.

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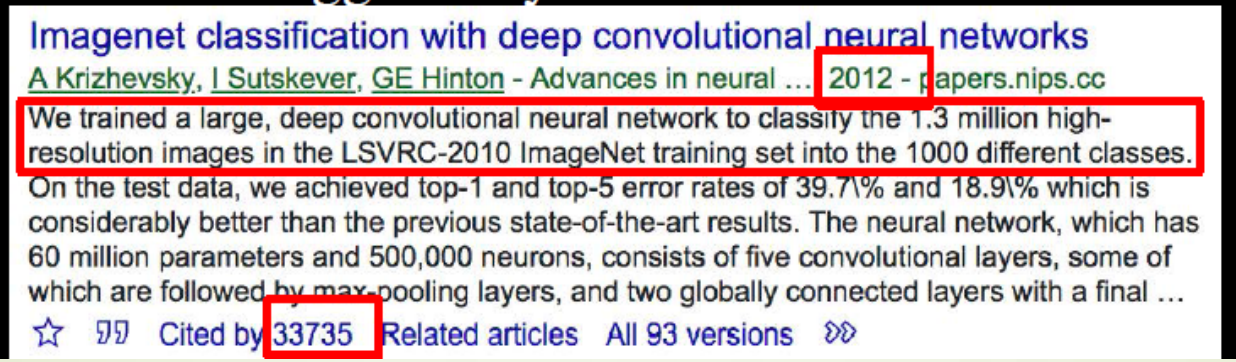
- To understand the origins and limitations of human knowledge (empirical epistemology)
  (how) does the structure of our brain shape the structure of our thought?

- To advance AI.
  For example visual object recognition.
  Machines lagged very far behind humans until….



MUCH more accurate than anything before. Approaching humans.

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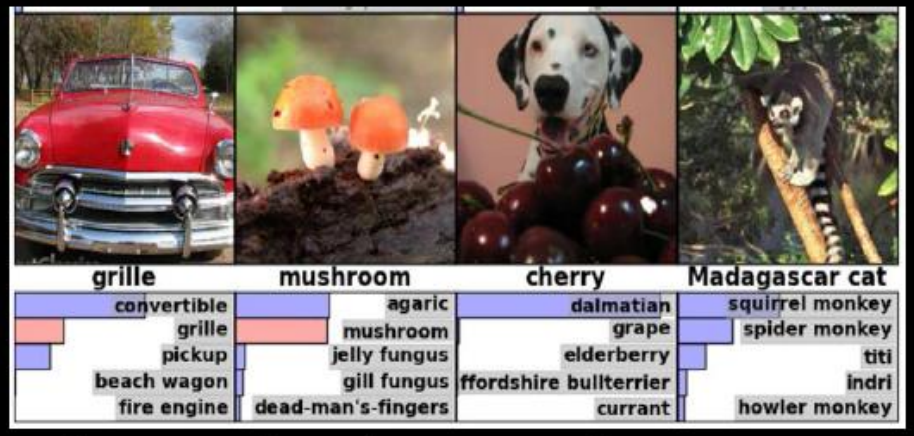

Amazing, and transformative for CS and cog sci and neuroscience.

These networks can be taken as computationally precise models of obj rec.

But do they really perform as well as humans?

What if tested on images not in ImageNet?

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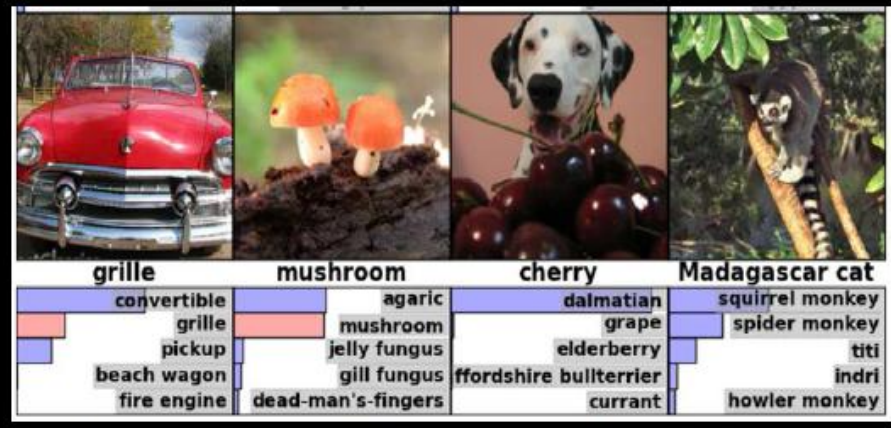

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But do they really perform like humans?

What if tested on images not in ImageNet?

Katz & Barbu:

More variable locs/orientations than Imagenet.

Human performance is still good, but...

Accuracy of ResNet-200 drops from 71% correct (ImageNet) to 25% correct (Katz/Barbu imgs).

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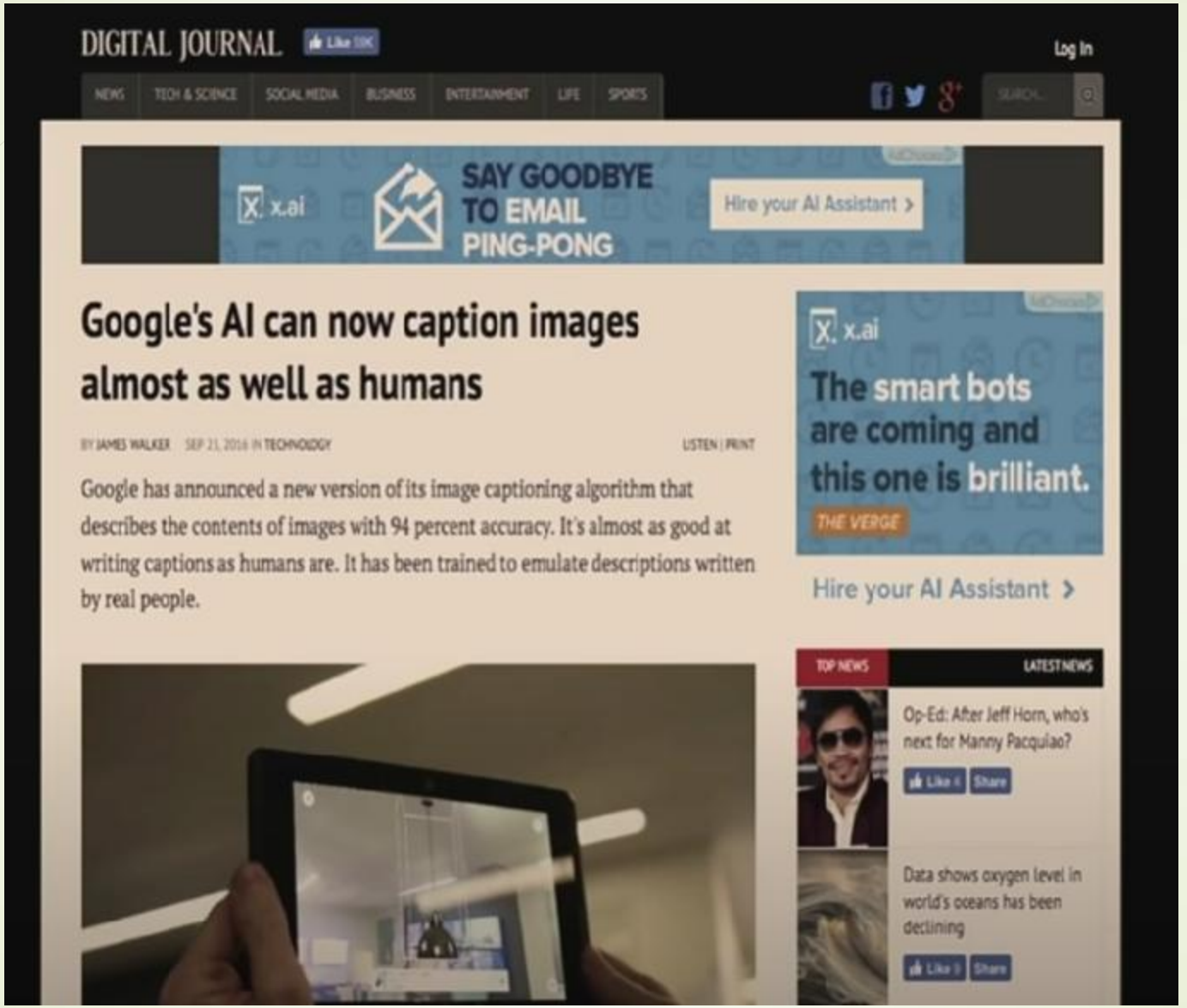
  Deep nets are awesome and transformative.

  But still do not perform like humans on object recognition.

  What about harder problems, like understanding an image?

  "image captioning"...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Google's AI can now caption images almost as well as humans
BY JAMES WALKER SEP 21, 2016 IN TECHNOLOGY
LISTEN | PRINT
Google has announced a new version of its image captioning algorithm that describes the contents of images with 94 percent accuracy. It's almost as good at writing captions as humans are. It has been trained to emulate descriptions written by real people.
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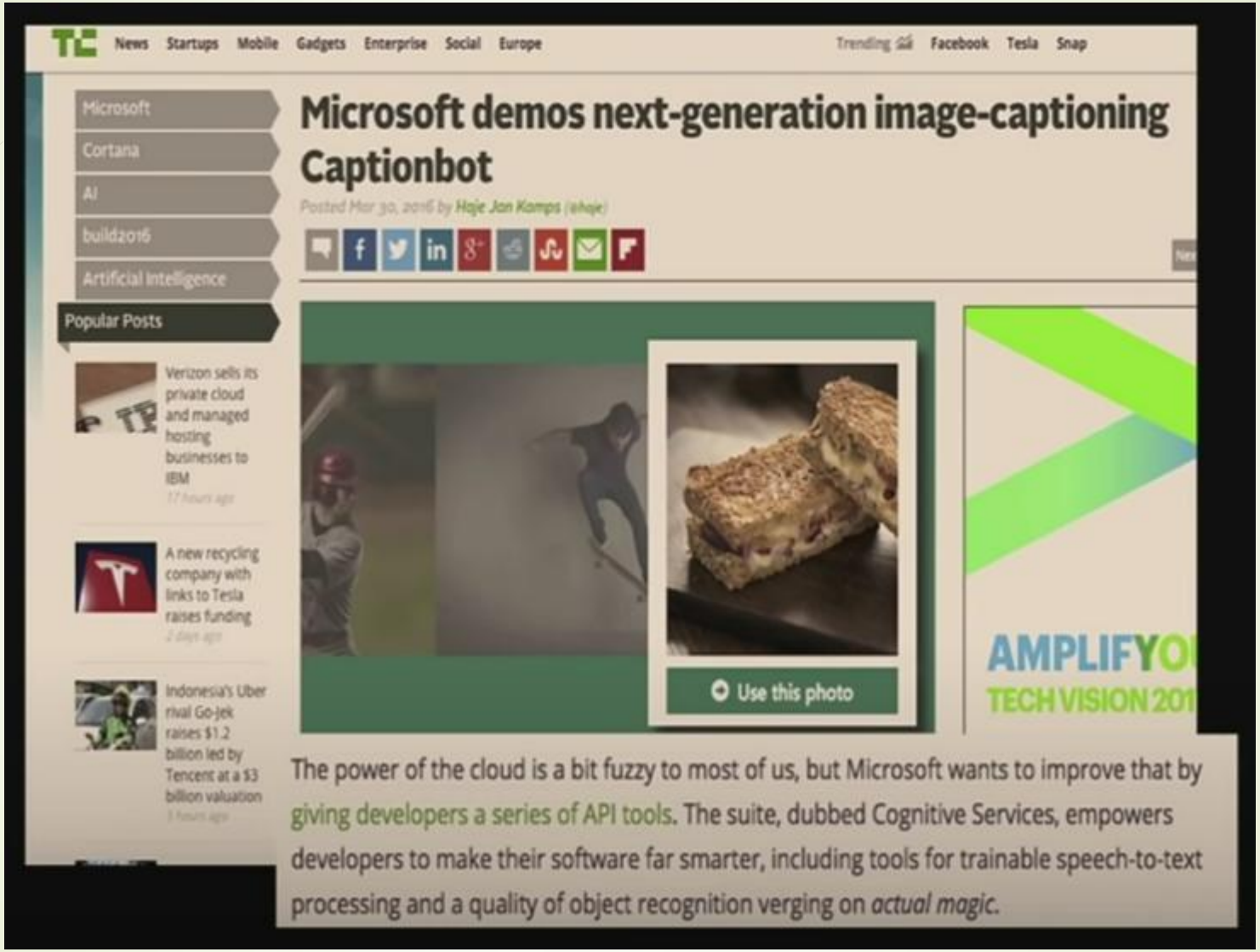
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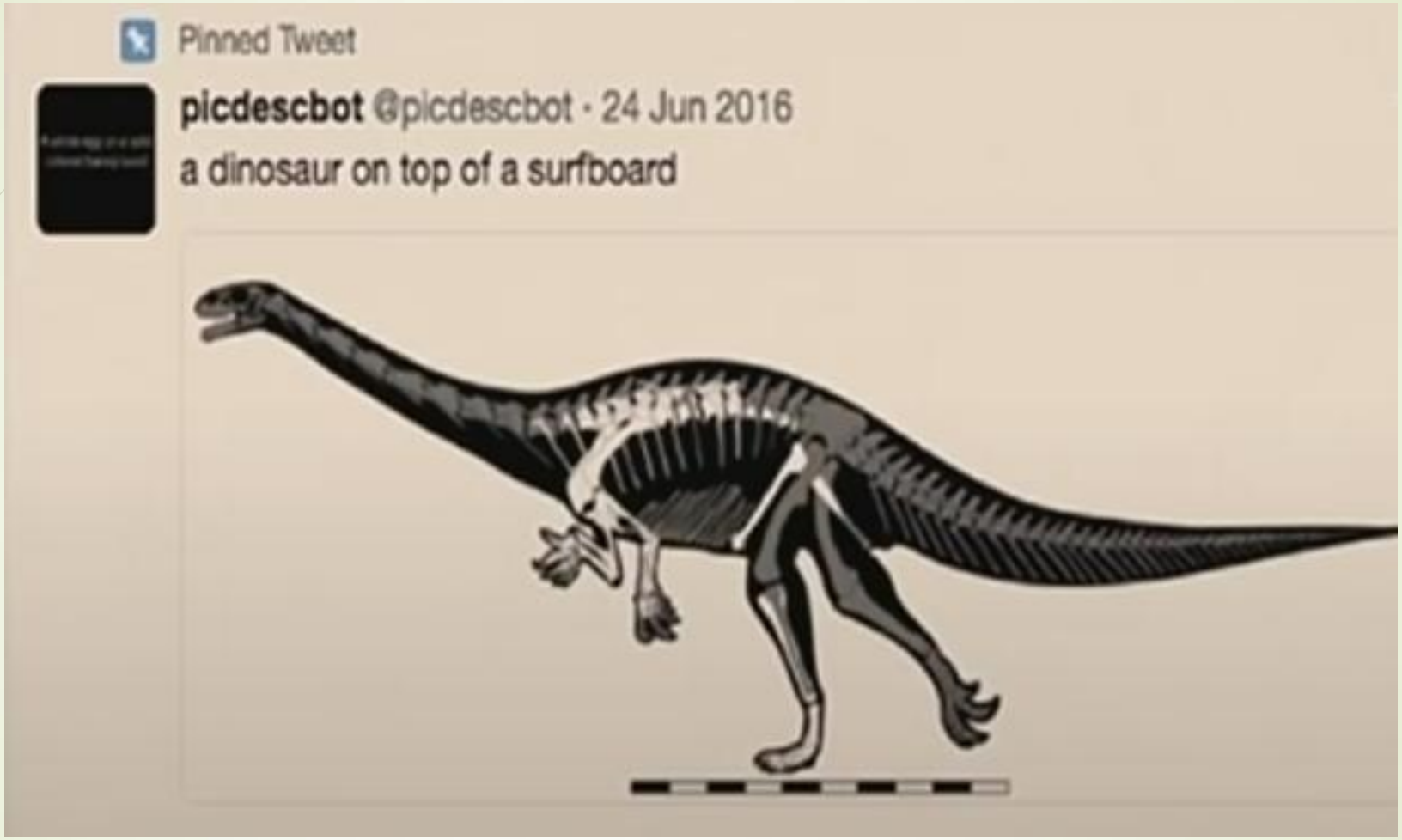
Indonesia's Uber rival Go-Jek raises $1.2 billion led by Tencent at a $3 billion valuation
Microsoft demos next-generation image-captioning Captionbot
Posted Mar 30, 2016 by Haje Jan Kamps (@haje)
Use this photo
AMPLIFY
TECH VISION 201
The power of the cloud is a bit fuzzy to most of us, but Microsoft wants to improve that by giving developers a series of API tools. The suite, dubbed Cognitive Services, empowers developers to make their software far smarter, including tools for trainable speech-to-text processing and a quality of object recognition verging on actual magic.

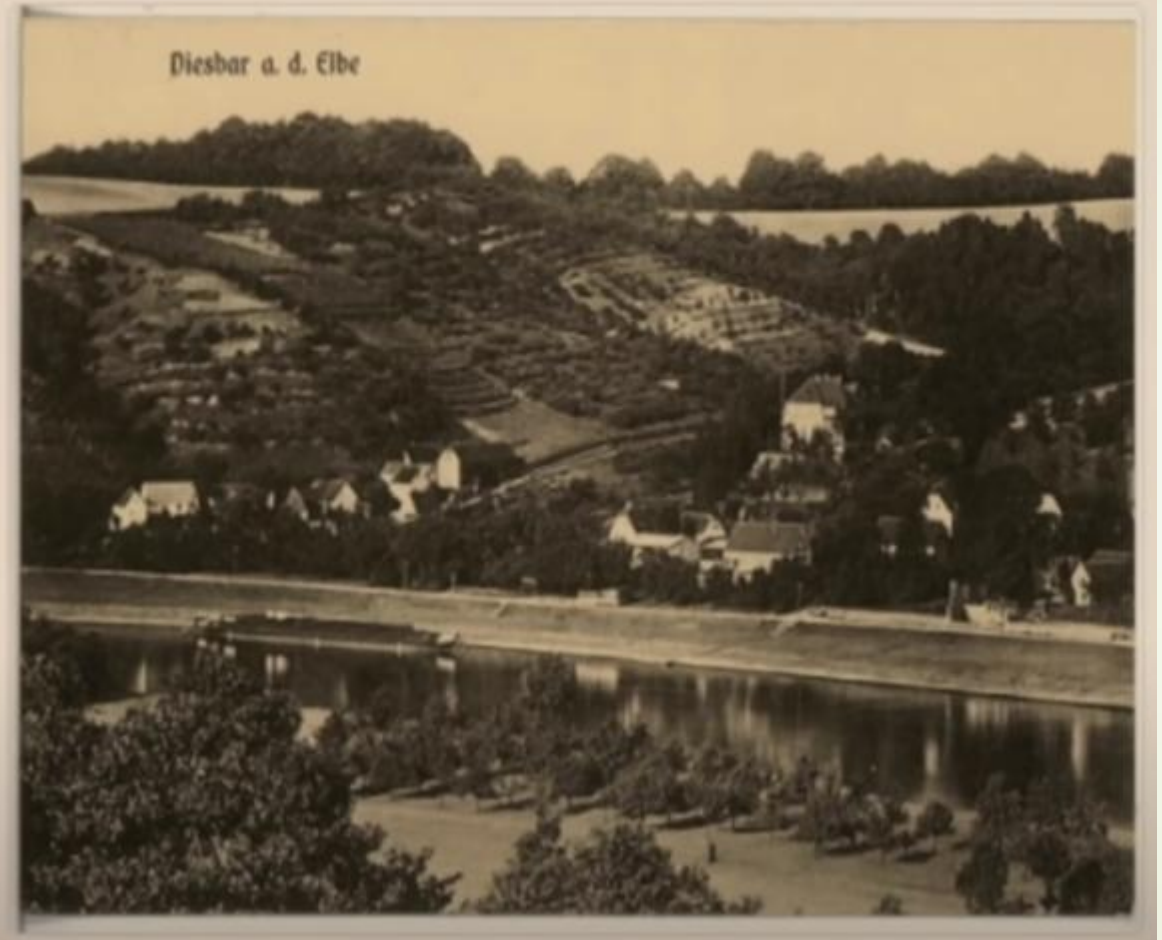

Pinned Tweet
picdescbot @picdescbot · 24 Jun 2016
a dinosaur on top of a surfboard

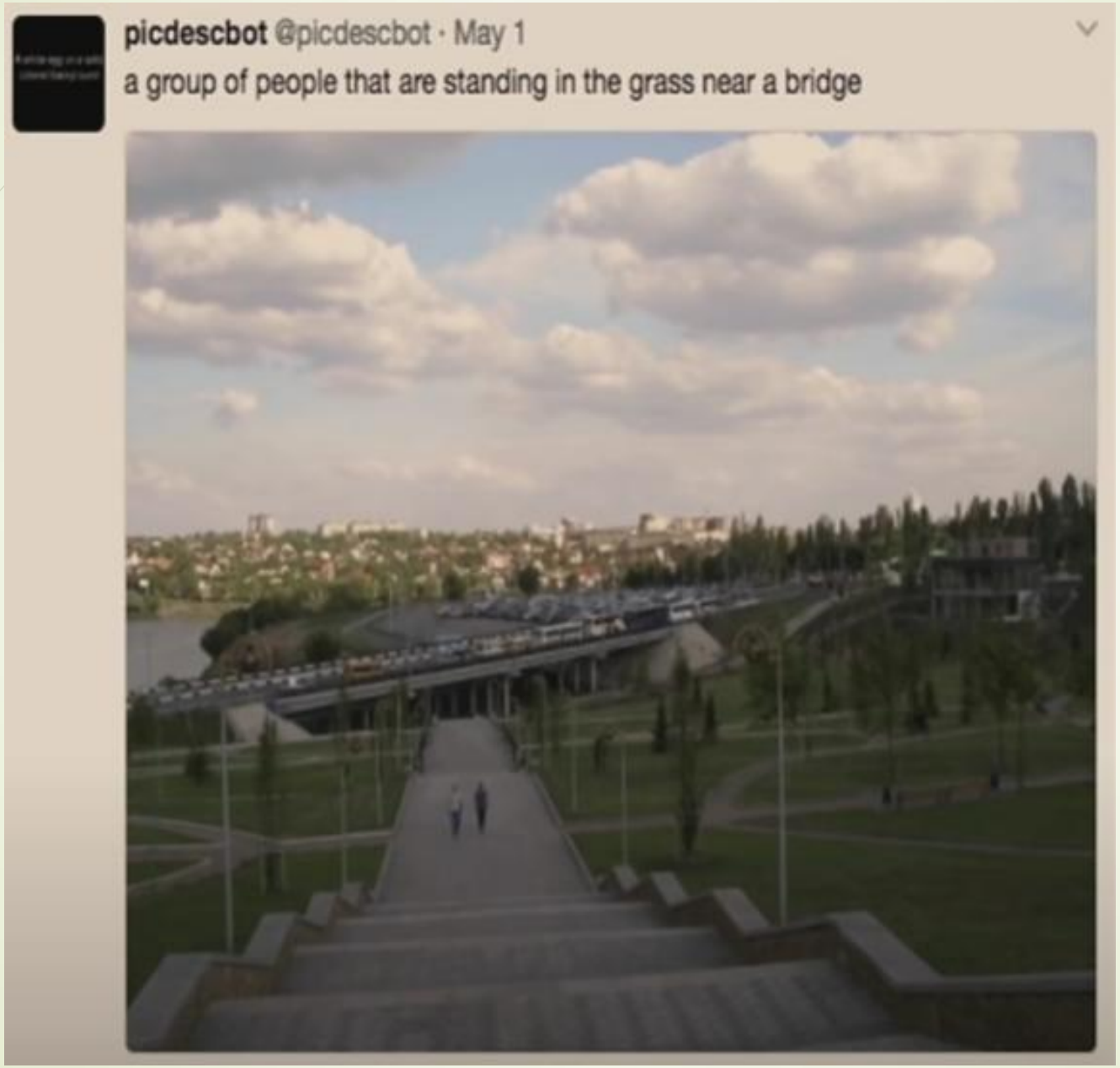
picdescbot @picdescbot · 3h

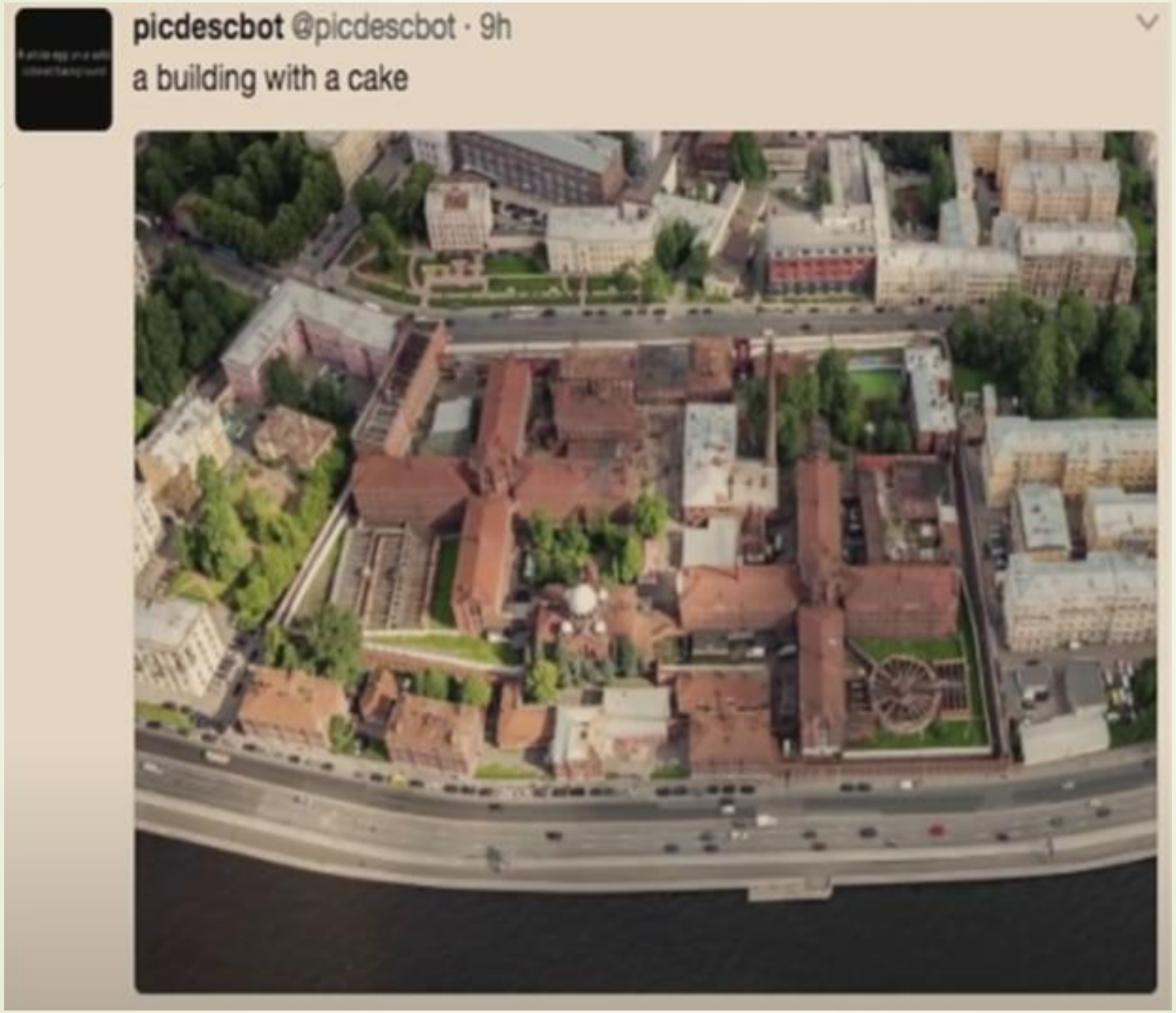
a group of people on a field playing football

picdescbot @picdescbot · May 2

a vintage photo of a pond




picdescbot @picdescbot · May 1
a group of people that are standing in the grass near a bridge


picdescbot @picdescbot · 9h
a building with a cake


picdescbot @picdescbot · 21h
a necklace made of bananas

Official White House photo by Pete Souza. Image is in the public domain.

Big idea (Tenenbaum):
Both humans & deep nets are good at *pattern recognition*.
What humans, but not machines, are good at: *building models to understand the world*.
e.g. What do some people here know but the guy on the scale doesn't?
Why is Obama smiling?
Why is this funny?

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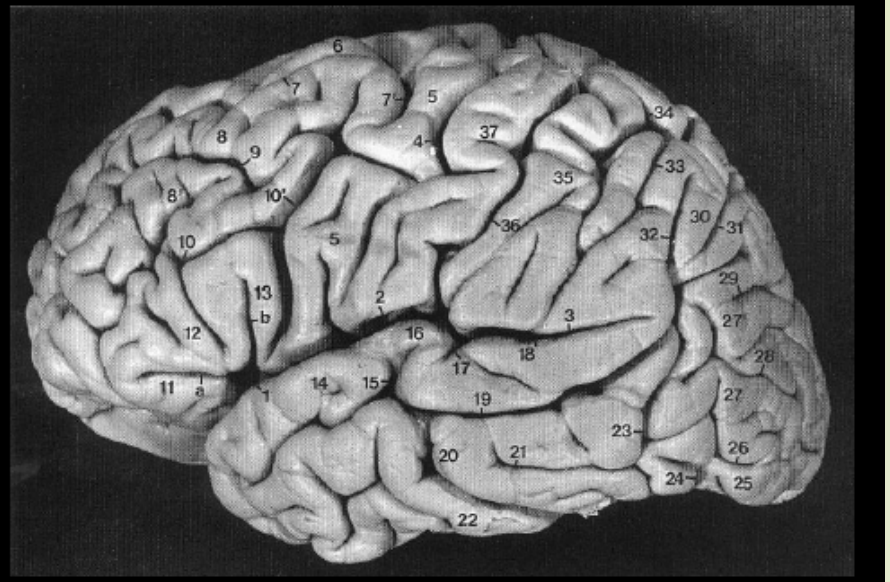
- To advance AI.
  AI has much to learn from the brain.

  & the fourth reason...

More generally, no current AI system can…..
navigate new situations,
infer what others believe,
use language to communicate,
write poetry and music to express how they feel, or
create math to
build bridges, devices, and life-saving medicines*.

- Because it is the greatest intellectual quest of all time.

How can we study the human brain?



Question:
How does this thing work?

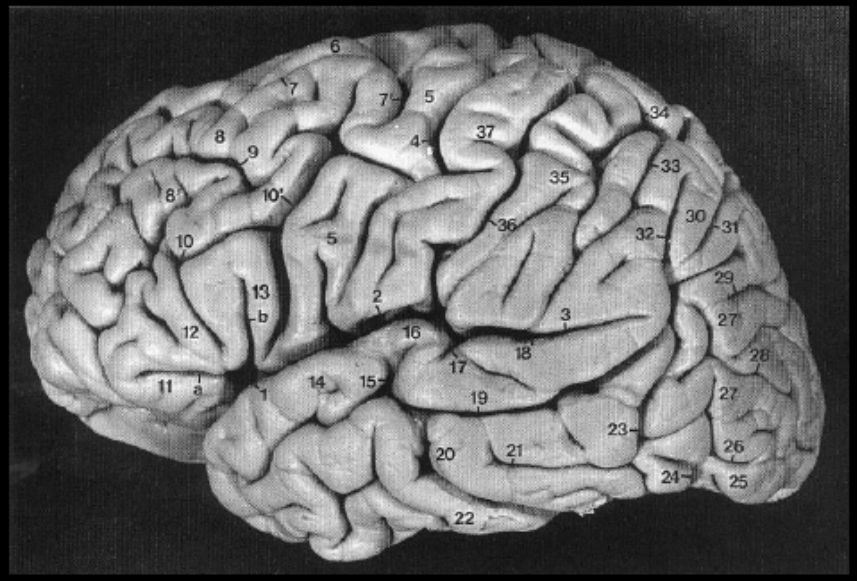
Can Approach @ Multiple levels:
molecules and their interactions
properties of individual neurons
circuits of interacting neurons
brain regions
networks of brain regions

The somewhat different question we ask in this course:
How does the brain give rise to the mind?

To answer this question, we need to start with the mind.
And the various mental functions it includes, like…

Perception:
vision
hearing
Cognition
language
thinking about
people
things

How can we study the human brain?



For each mental function we will:

1. Understand how it works in minds
   what is computed and how?

2. Look at its brain basis:
   specialized brain machinery?
   what information is represented?
   when?
   how?

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How can we study the human brain?

For each mental function we will:

1. Understand how it works in minds
   what is computed and how?
   = lots of cognitive science!
2. Look at its brain basis:
   specialized brain machinery?
   what information is represented?
   when?
   how?

How do we answer these questions?

Lots of Methods

→ Psychophysics
  RT & accuracy
  Illusions

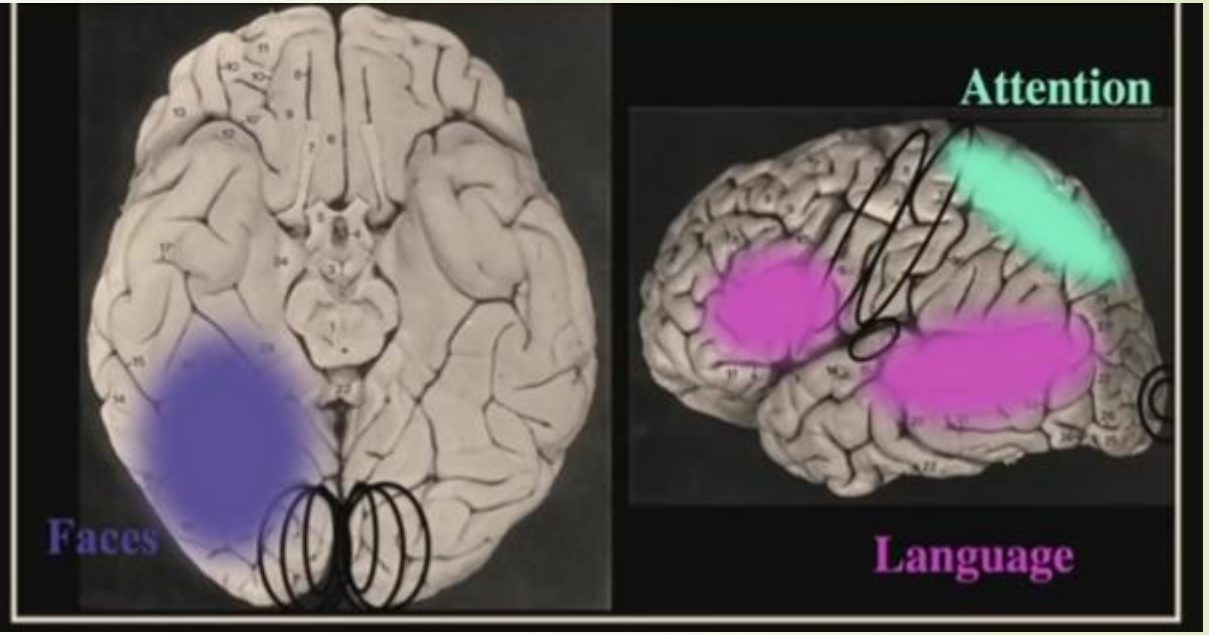
→ Neuropsychology Patients
  fMRI
  Neurophysiology
    animals
    humans (ECoG)
  EEG (scalp electrodes) ERPs
  Magnetoencephalography (MEG)
  Diffusion tractography

Which mental functions will we consider in this course?

The ones for which this research enterprise has made progress.

All of this is quite recent...

What we knew about the Functional Organization of the Human Brain circa 1990



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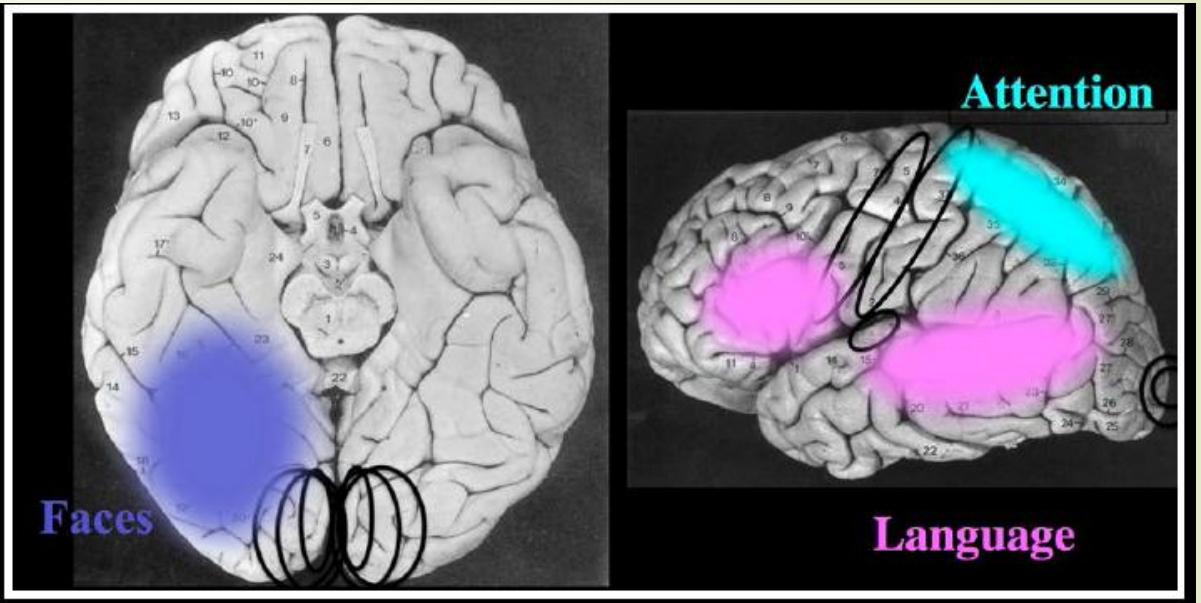
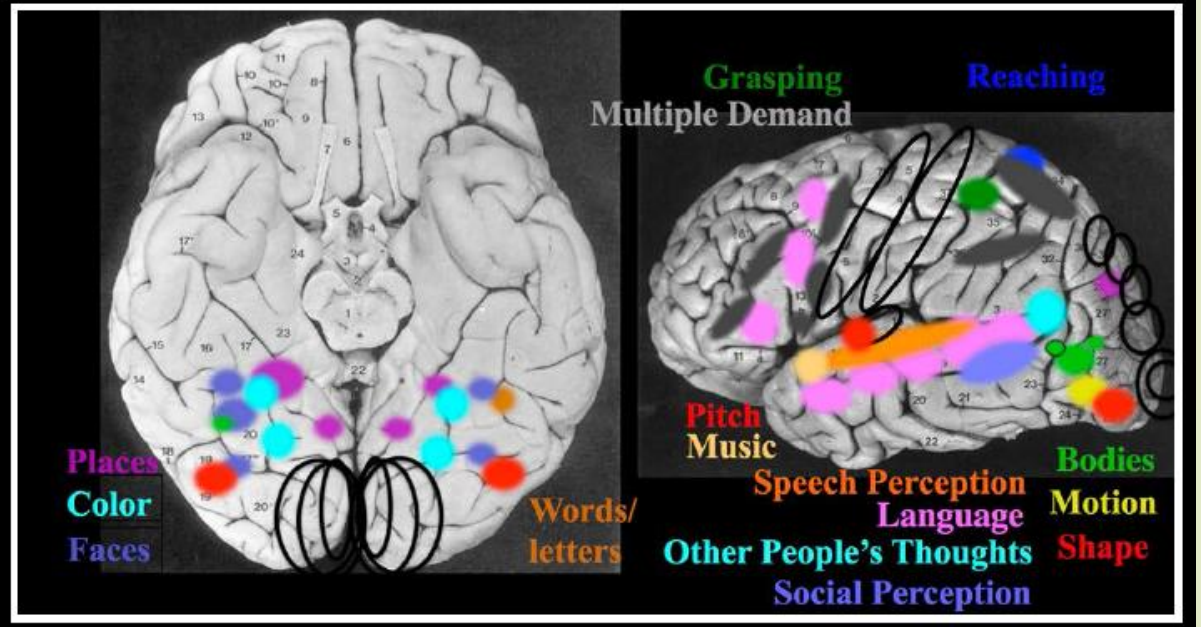


What we Know Now

- We now know the ~function of dozens of brain regions.
- This is new and important.
- And has made possible a great deal of progress.



What we will study about the human brain?

- What (if anything) is "special" about the human brain?
- Where does knowledge come from?
  How much genetic, how much experience?
- How plastic are our minds and brains?
  can we change the structure of our minds/brains?
  by training?
  after brain damage?
- Can we think without language?
- Can we perceive/understand/think/decide without awareness?

Our brain relies on the spatial relationships between different facial features, such as the distance between the eyes and the mouth, to recognize faces. When a face is inverted, these spatial relationships are disrupted, making it more difficult for the brain to recognize and process the facial features.

The effect of face inversion on the human fusiform face area

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[b]*Massachusetts General Hospital Nuclear Magnetic Resonance Center, Charlestown, MA 02129, USA*

[c]*Department of Psychology, Harvard University, Cambridge, MA 02138, USA*

What question?
What design?
What exactly was done?
What finding?
What interpretation?

Received 26 March 1998; accepted 12 May 1998

Abstract

How were the data analyzed?

Inversion severely impairs the recognition of greyscale faces and the ability to see the stimulus as a face in two-tone Mooney images. We used functional magnetic resonance imaging to study the effect of face inversion on the human fusiform face area (FFA). MR signal intensity from the FFA was reduced when greyscale faces were presented upside-down, but this effect was small and inconsistent across subjects when subjects were required to attend to both upright and inverted faces. However when two-tone faces were inverted, the MR signal from the FFA was substantially reduced for all subjects. We conclude that (i) the FFA responds to faces per se, rather than to the low-level visual features present in faces, and (ii) inverted greyscale faces can strongly activate this face-specific mechanism. © 1998