

Historical background: I2 and CBMM





MIT Intelligence Initiative

9.S915 What is Intelligence?

Fall 2011

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**The Center for
Brains, Minds and Machines**

Summer School at Woods Hole



9.S915: Aspects of a Computational Theory of Intelligence

HOME

COURSE INFORMATION

SCHEDULE & ASSIGNMENTS

READINGS & VIDEOS



Instructors

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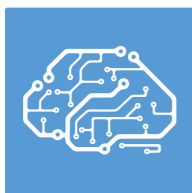
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The Center for Brains, Minds and Machines



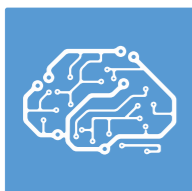
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Pedestrian accidents occur every day
in our increasingly intensive traffic environment.



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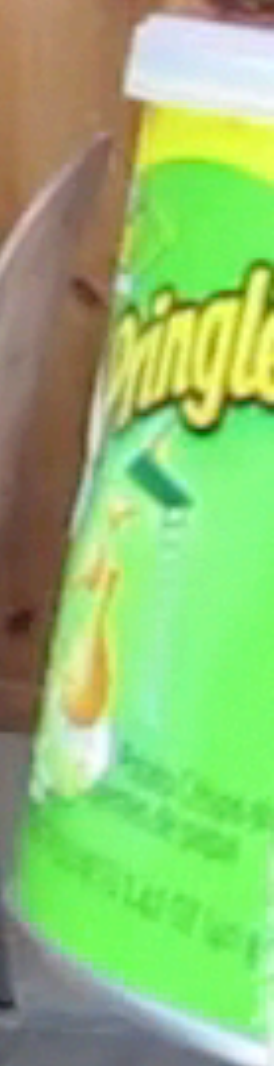


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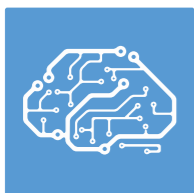


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Vision Accumulated knowledge and technology, now in place, enables a rapid leap in our scientific understanding of intelligence and our ability to replicate intelligence in engineered systems.

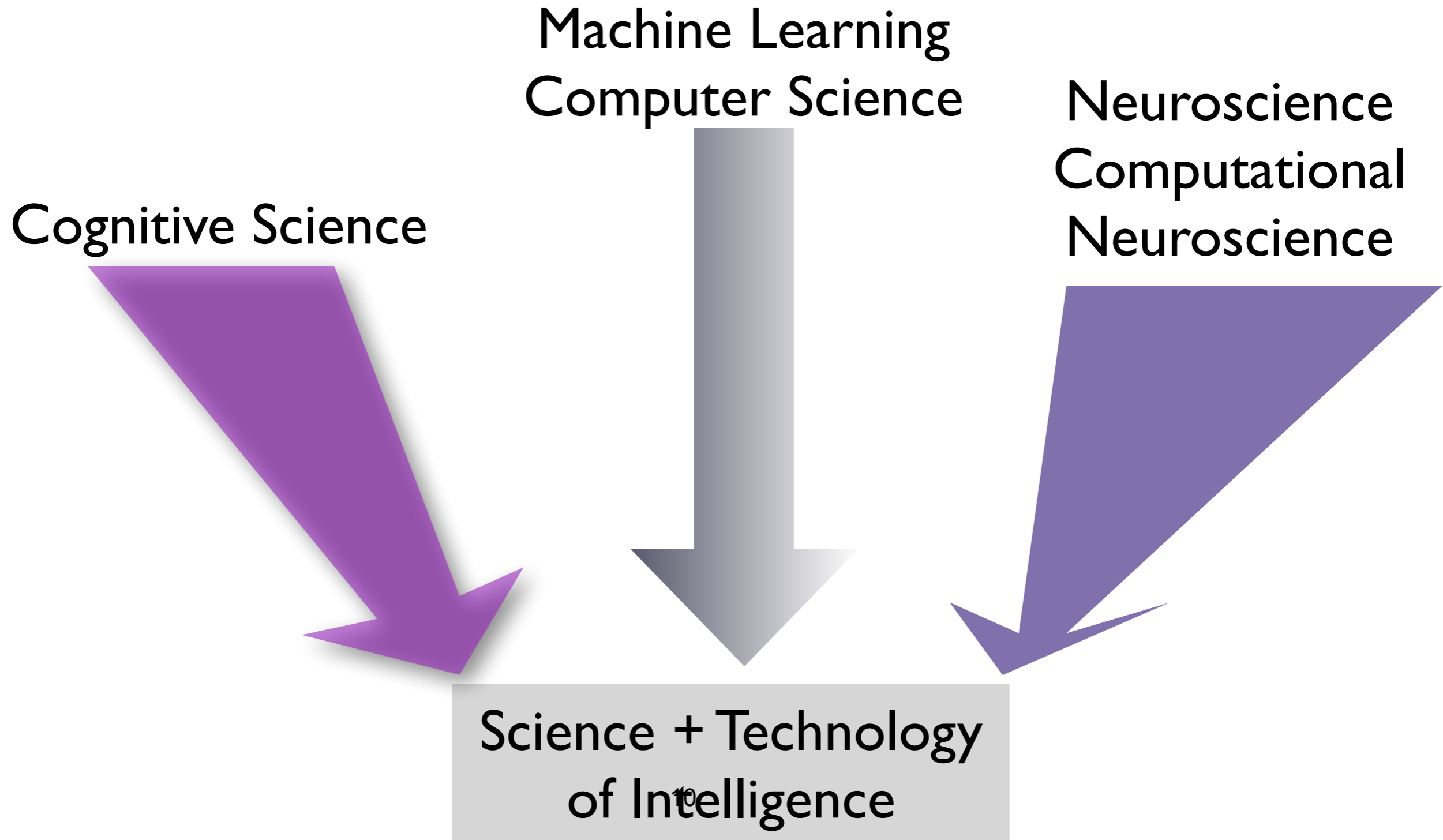
Mission We aim to create a new field by bringing together computer scientists, cognitive scientists and neuroscientists to work in close collaboration. The new field – the Science and Engineering of Intelligence – is dedicated to developing a computationally centered understanding of human intelligence and to establishing an engineering practice based on that understanding.



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Vision for CBMM

Convergence of progress: a key opportunity



MIT

Boyden, Desimone, Kaelbling, Kanwisher,
Katz, Poggio, Sasanfar, Saxe,
Schulz, Tenenbaum, Ullman, Wilson,
Rosasco, Winston

Harvard

Blum, Kreiman, Mahadevan,
Nakayama, Sompolinsky,
Spelke, Valiant

Rockefeller

Freiwald

Allen Institute

Koch

UCLA

Yuille

Stanford

Goodman

Cornell

Hirsh

Hunter

Epstein,...

Wellesley

Hildreth, Conway...

Puerto Rico

Bykhovaskaia, Vega...

Howard

Manaye,...



IIT
Metta, Rosasco,
Sandini

A*star
Tan

Hebrew U.
Shashua

MPI
Buelthoff

Genoa U.
Verri

Weizmann
Ullman

City U. HK
Smale

NCBS
Raghavan



Google
Norvig

IBM
Lemnios

Microsoft
Blake

Siemens

Schlumberger

GE

DeepMind
Hassabis

Boston Dynamics
Raibert

Orcam
Shashua

Rethink Robotics
Brooks

MobilEye
Shashua





Robert Rwebangira
Computer Science

Howard University



Kebreten Manaye
Physiology &
Biophysics

Universidad Central del Caribe



Maria Bykhovskaia
Neuroscience



Josh Brumberg
Psychology

Queen's College



Martin Chodorow
Psychology

Hunter College



Susan Epstein
Computer Science



William Sakas
Computer Science



Irving Vega
Biology

University of Puerto Rico



Raphael Arce Nazario
Computer Science



Patti Ordóñez
Computer Science



Bevil Conway
Neuroscience

Wellesley College



Ellen Hildreth
Computer Science



Mike Wiest
Neuroscience

Thrust 1:
Development of
Intelligence

Josh Tenenbaum

Thrust 2:
Circuits for
Intelligence

Gabriel Kreiman

Thrust 5: Theory of Intelligence

Tomaso Poggio

Thrust 3:
Visual Intelligence

Shimon Ullman

Thrust 4:
Social Intelligence

Nancy Kanwisher

THRUST 5.2

THRUST 5.3

Thrust 5.1

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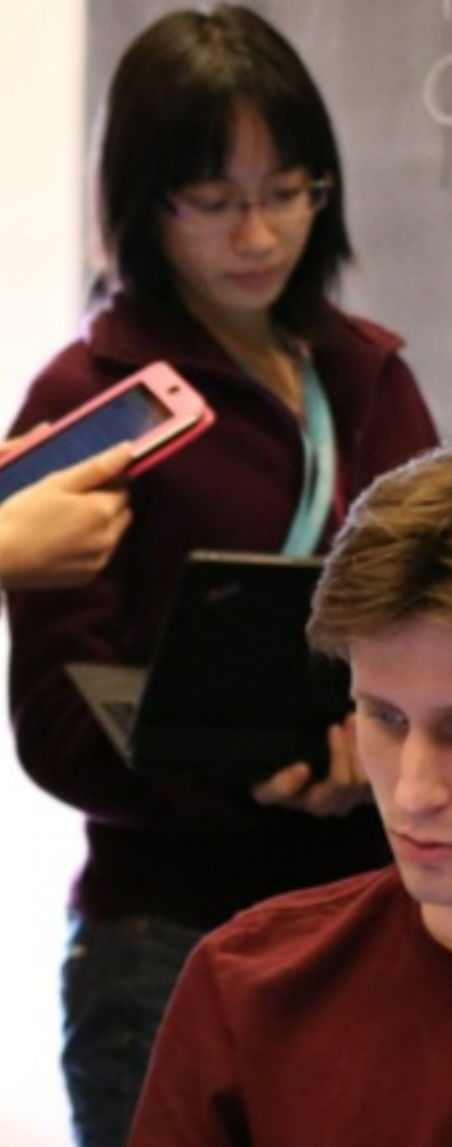
Huxian

Thru

$$\langle gI, \dots \rangle$$

$$\sum_k \langle gI \rangle$$

$$\sum \eta c$$



Visual Understanding: A view from the future



Recognizing objects, agents and events:

This is an amusement park.
Several people are walking.
There is a stroller in front of the fence.
Two women are carrying bags.
No one is riding the carousel.

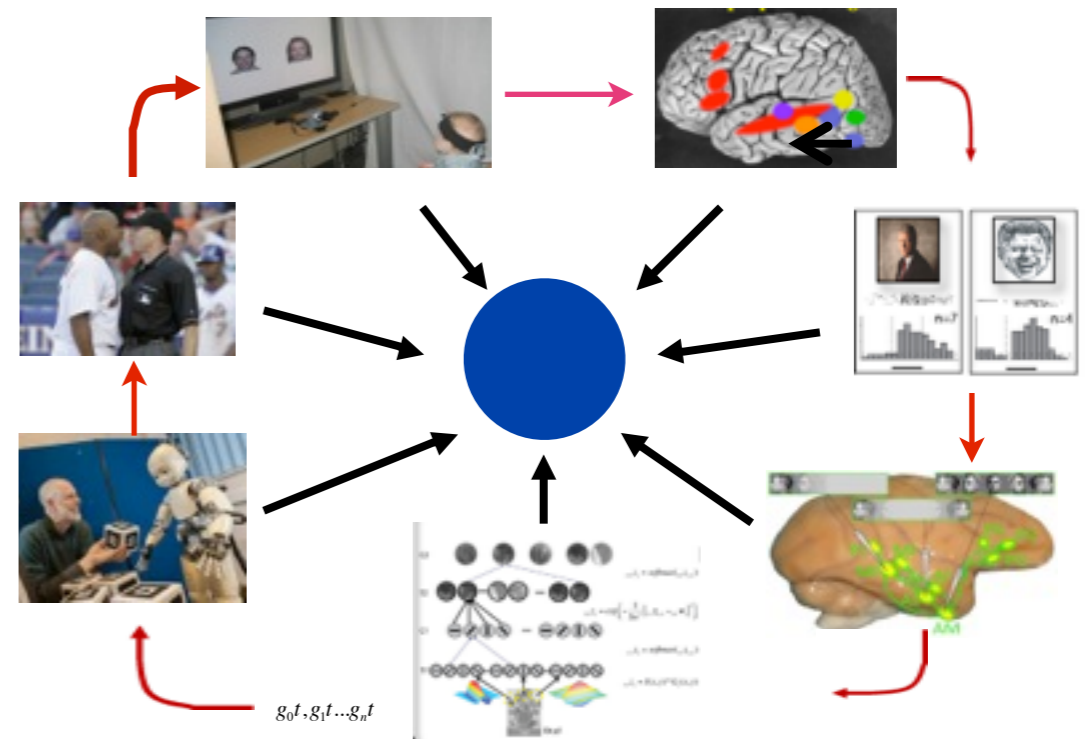
Answering queries:

What is parked in front of the fence?
What color is the door that says pull?
Are any people looking at each other?

Generating narratives:

It's a sunny day at the amusement park. A blonde young mother in rolled-up blue jeans is waiting with her baby by the carousel. Two friends are walking up to meet her ...

The core CBMM challenge: measuring progress

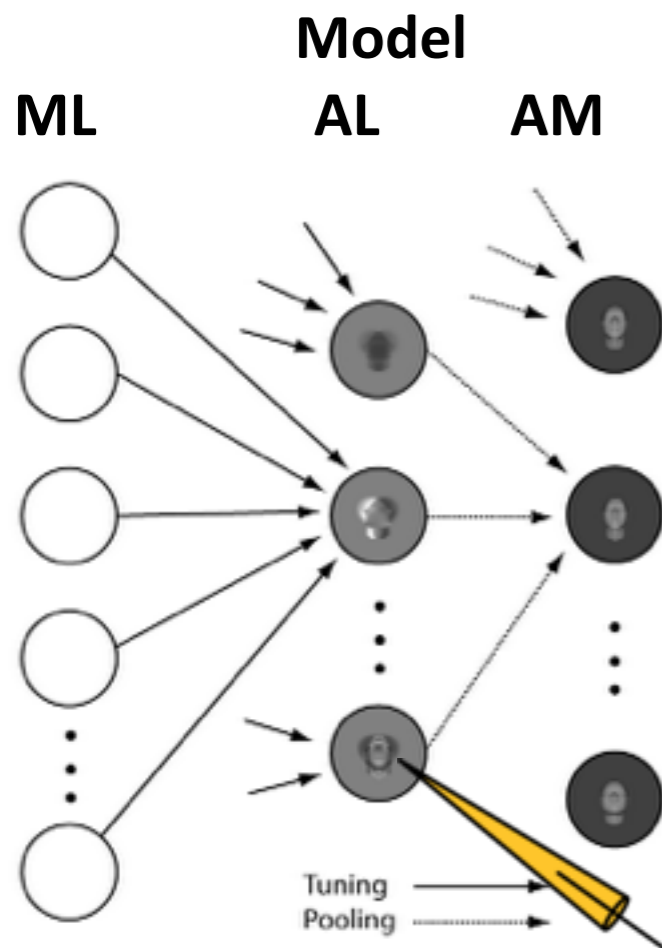
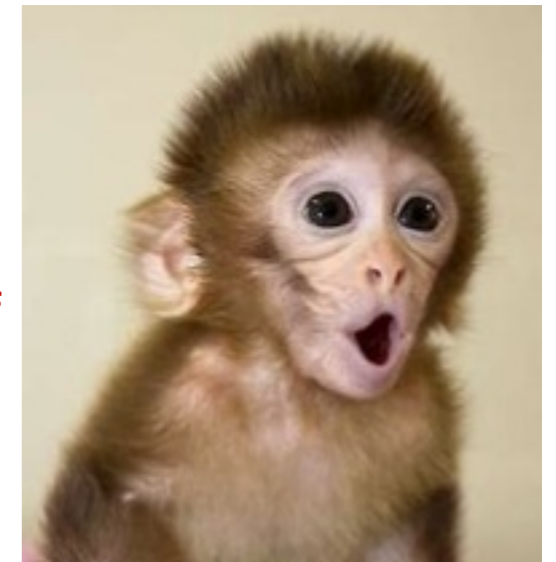
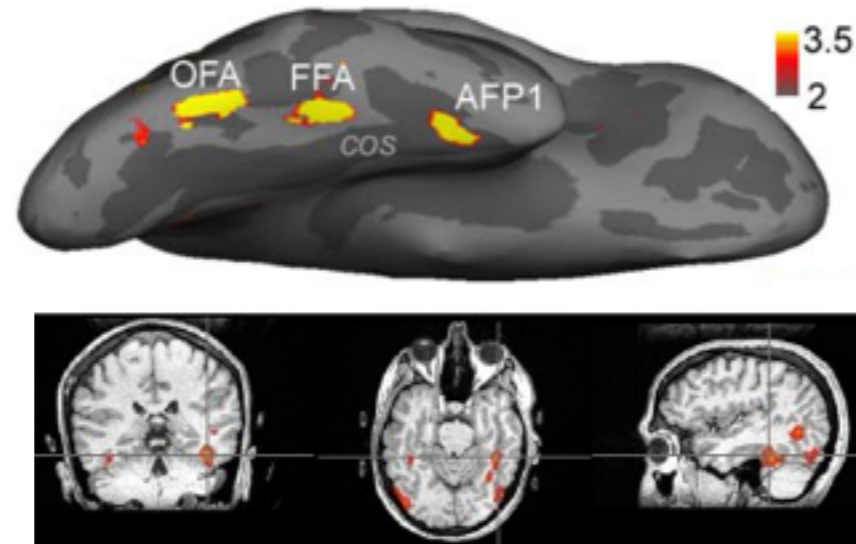


The core challenge is to develop computational models from experiments that answer questions₁₇ about images and videos such as

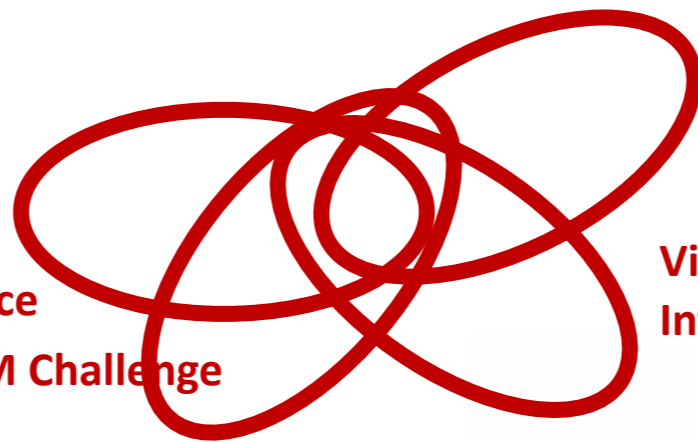
- *what is there / who is there / what is the person doing*
- and eventually more difficult questions such as
- *who is doing what to whom?*
- *what happens next?*

at the computational, psychophysical and neural levels.

The who question: face recognition from experiments to theory

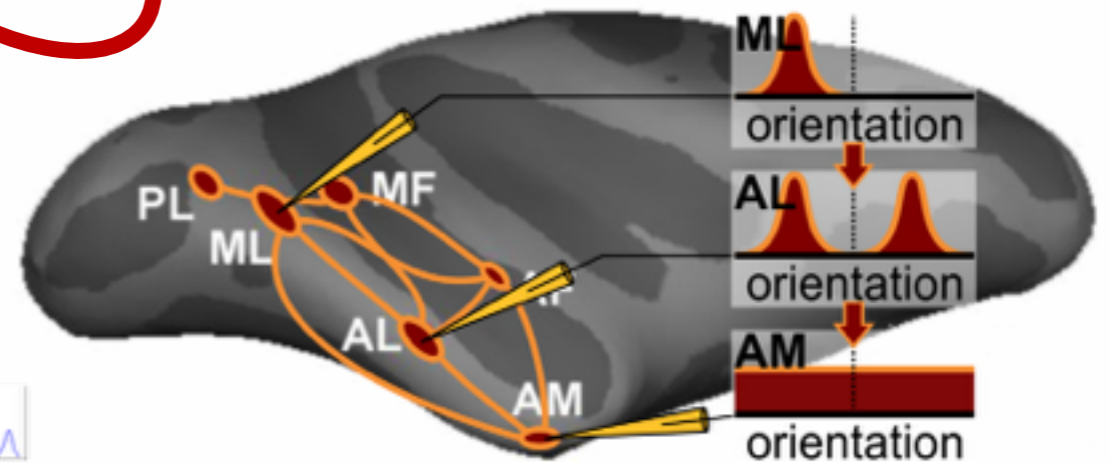
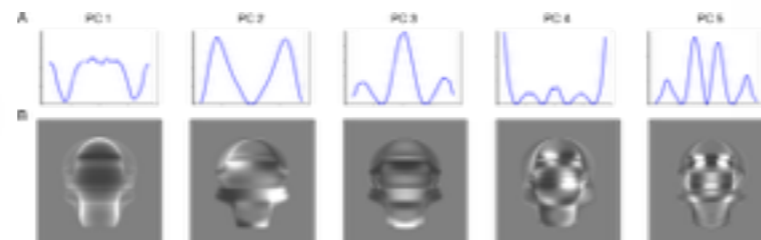


Social
Intelligence
CBMM Challenge



Neural Circuits of
Intelligence

Visual
Intelligence



Remark: a paradigm shift in machine learning?

The first phase (and successes) of ML:
supervised learning: $n \rightarrow \infty$



The next phase of ML: unsupervised learning of
invariant representations for learning: $n \rightarrow 1$