Welcome to 9.17 !

Image courtesy of EMSL on Flickr. CC BY-NC-SA.

- *100 billion computing elements*
- *solves problems not soluble by any previous machine*
- *requires only 20 watts of power!*

Key algorithms are still ***classified***

Class 1: overview

- Goals, syllabus, grading, expectations, etc.
- Overview of methods used to study the brain
- Discussion on animals in research
- Lab tour and safety discussion

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Expectations

What you should expect of us:

- Prepared to teach topic
- Eager to help with techniques
- Eager to answer questions
- Available outside of class
- Feedback on your work

What we expect of you:

- Be prepared for each lab
- Eager to learn techniques
- Ask questions!
- Seek help!
- Work submitted on time

Adding and dropping 9.17

Adding 9.17: Students on the wait list that attend the first week will have priority if a spot becomes available by the start of week 2. No adds will be allowed after the end of week 2, and week 2 quizzes and attendance will count in the final grade for ALL students.

Dropping 9.17: We understand that you may decide to drop the course for any reason. However, because space is limited we kindly ask that you let Susan Lanza in the BCS office know of your drop by the start of week 2. If you do not do this or decide to drop the course at a later date, you may get on the wait list for the course in a future year, but first-time entrants on the wait list will get priority.

Listener status for 9.17: Listener status is currently not allowed in 9.17.

Documents you have been given today:

9.17 Lab handbook (Lab Manual)

Your 9.17 Lab notebook (empty)

Components of your 9.17 grade:

- quizzes (11) -- only best 10 will count
- lab reports (2)
- lab notebook (11) -- only best 10 will count
- Matlab tutorials
- in-lab participation
- in-recitation participation

Brain and Cognitive Sciences at MIT

Course 9.17: Systems Neuroscience Laboratory

Each week:

Monday lecture: background on lab

Tues recitation: prepare by reading one paper

Wed laboratory: prepare by reading protocol, background readings, prepare your lab notebook

Quiz given at start of each lab *:

- lecture material
- recitation papers and questions
- lab preparation material

(* there are 11 quizzes, but you get to throw one out!)

Course 9.17: Systems Neuroscience Laboratory

Lab reports:

- You will learn how to write a short scientific paper.
- A description of what is expected and how we will provide feedback and grading of your lab reports is on the class web site.
- Because you will typically work in teams of 2-3 in each lab, the data in each lab report will often be identical. However, **WE EXPECT EACH OF YOU TO WRITE YOUR OWN LAB REPORT**. Duplicate sentences or paragraphs in lab reports are considered to be a form a plagiarism and, as MIT students, you already know that this is extremely unethical. If this, or any other form of plagiarism (e.g. sentences copied from references without citation) is apparent in your lab report, the report will receive a grade of zero, and you may be referred to the MIT Committee on Discipline.

The primary grading criteria for the lab reports are:

1) Proper organization (Is the proper material in the proper section?)
2) Clarity (Are the key points obvious? Is it easy to read and understand?)
3) Conciseness (Are there wasted sentences? Too much redundancy?)
4) Quality of data and figures (Are data figures appropriate and clear?)

Detailed grading criteria will be posted online and you will receive feedback from us on first lab report (chance to revise).

Lab notebook:

- Goal is to teach you how do document your experimental work

1. Outline protocol for lab BEFORE your lab session (you will be asked to leave the lab until your notebook shows your experimental plan)
2. Make all notes, data, and drawings regarding your lab in your notebook
3. Turn in a copy of your lab notebook pages for the lab when you leave the lab.

9.17 Handbook:

- Overall course grade.

- quizzes, lab reports (2), in-lab participation, Matlab tutorials, recitation participation, lab notebook

- FAQs: missed / late policies, office hours, etc.

- Lots of advice and guidance on how to prepare your lab reports, etc.

Brain and Cognitive Sciences at MIT

Course 9.17: Systems Neuroscience Laboratory

Final grade sheet

(in 9.17 handbook)

Student: Jane Doe
Section: Wed
Primary TA: TA name

Total 9.17 points: 0 (Sum of six boxes below)
Max 9.17 points: 1000
Final letter grade: >900 = A, >800 = B, >700 = C, >600 = D

Quizzes- Best 10 of 11

No.	Topic	Points	of Max
1	Practical Lab (both)	____	30
2	C. Anatomy (Tye)	____	30
3	Cockroach (Tye)	____	30
4	Frog (DiCarlo)	____	30
5	Rat Phys. (Tye)	____	30
6	Rat Phys. (Tye)	____	30
7	Matlab (DiCarlo)	____	30
8	Fly (DiCarlo)	____	30
9	Fly (DiCarlo)	____	30
10	Fly (DiCarlo)	____	30
11	Fly (DiCarlo)	____	30
Total quiz points:		0	300

Lab Notebook - Best 10 of 11

No.	Topic	Points	of Max
1	Practical Lab	____	10
2	Classic Anatomy	____	10
3	Cockroach	____	10
4	Frog	____	10
5	Rat Physiology	____	10
6	Rat Physiology	____	10
7	Fly Wet Lab I	____	10
8	Fly Movie Design	____	10
9	Fly Wet Lab II	____	10
10	Fly Data Analysis	____	10
11	EEG/MRI	____	10
Total notebook points:		0	100

Matlab projects

No.	Topic	Points	of Max
0	Plotting	____	10
1	Spike detection	____	20
2	Movie creation	____	30
3	Data analysis	____	40
Total Matlab points:		0	100

Research reports

No.	Topic	Points	of Max
1	Rat Phyisology	____	200
2	Fly Vision	____	200
Total report points:		0	400

Free extension used?:

Recitation Participation

No.	Topic	Points	of Max
1	Recitation	____	40
Total particip. points:		0	40

Lab participation

No.	Topic	Points	of Max
1	Anatomy	____	15
2	General Phys.	____	15
3	Barrel Phys.	____	15
4	Fly Vision		15
Total particip. points:		0	60

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Introduction

Genes and molecules
↓
Cellular components
↓
Neurons
↓
Interaction of many neurons
↓
Behavior

The fundamental goal of neuroscience is to understand the brain mechanisms that give rise to behavior

"Consciousness" "Theory of mind"

"Understanding causality" "Reasoning"

"Learning" "Language"

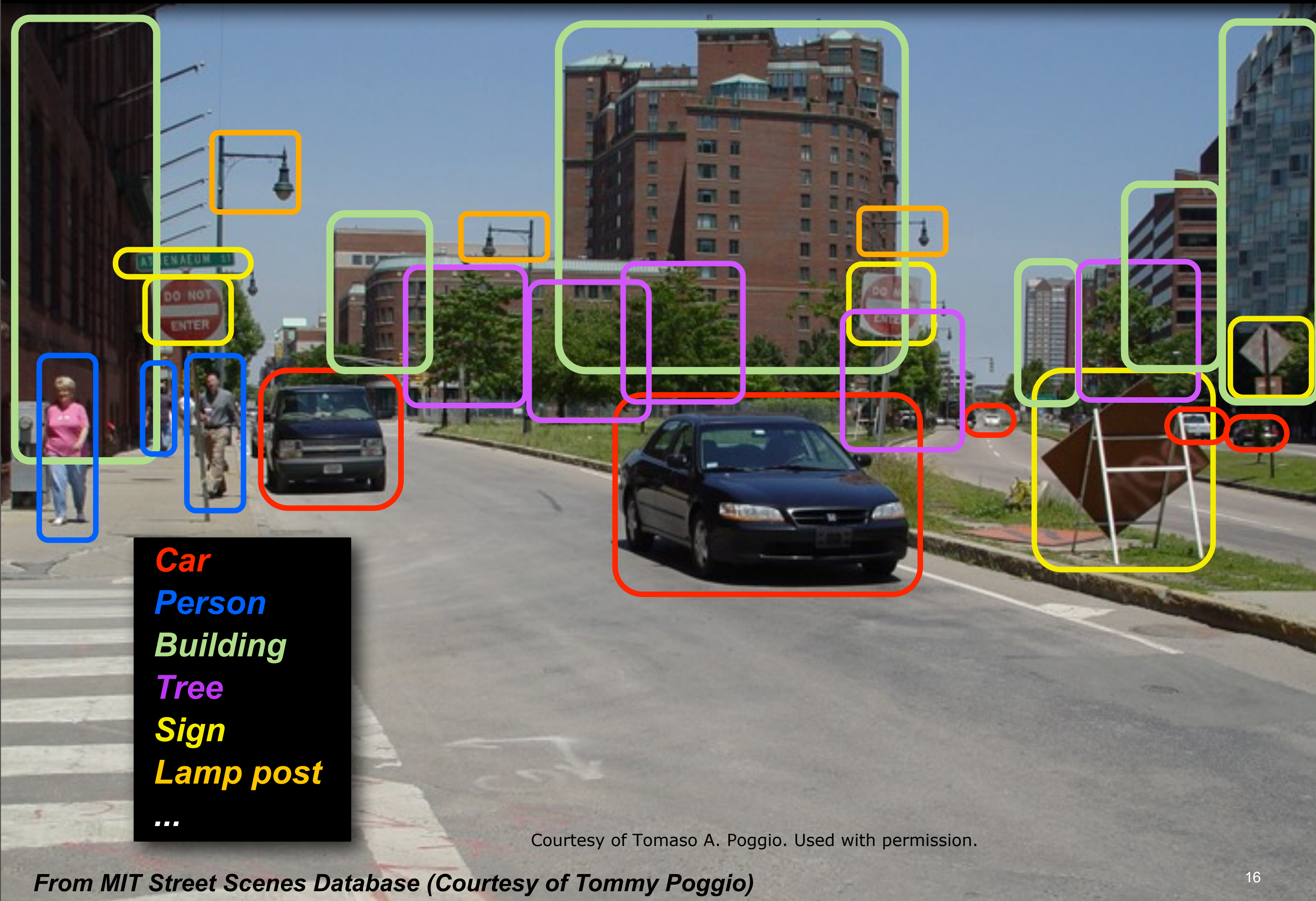
"Emotion" "Memory" "Decision making"

"Motivation"

"Perception" "Intent"

"Recognition" "Action"

Scene "understanding"

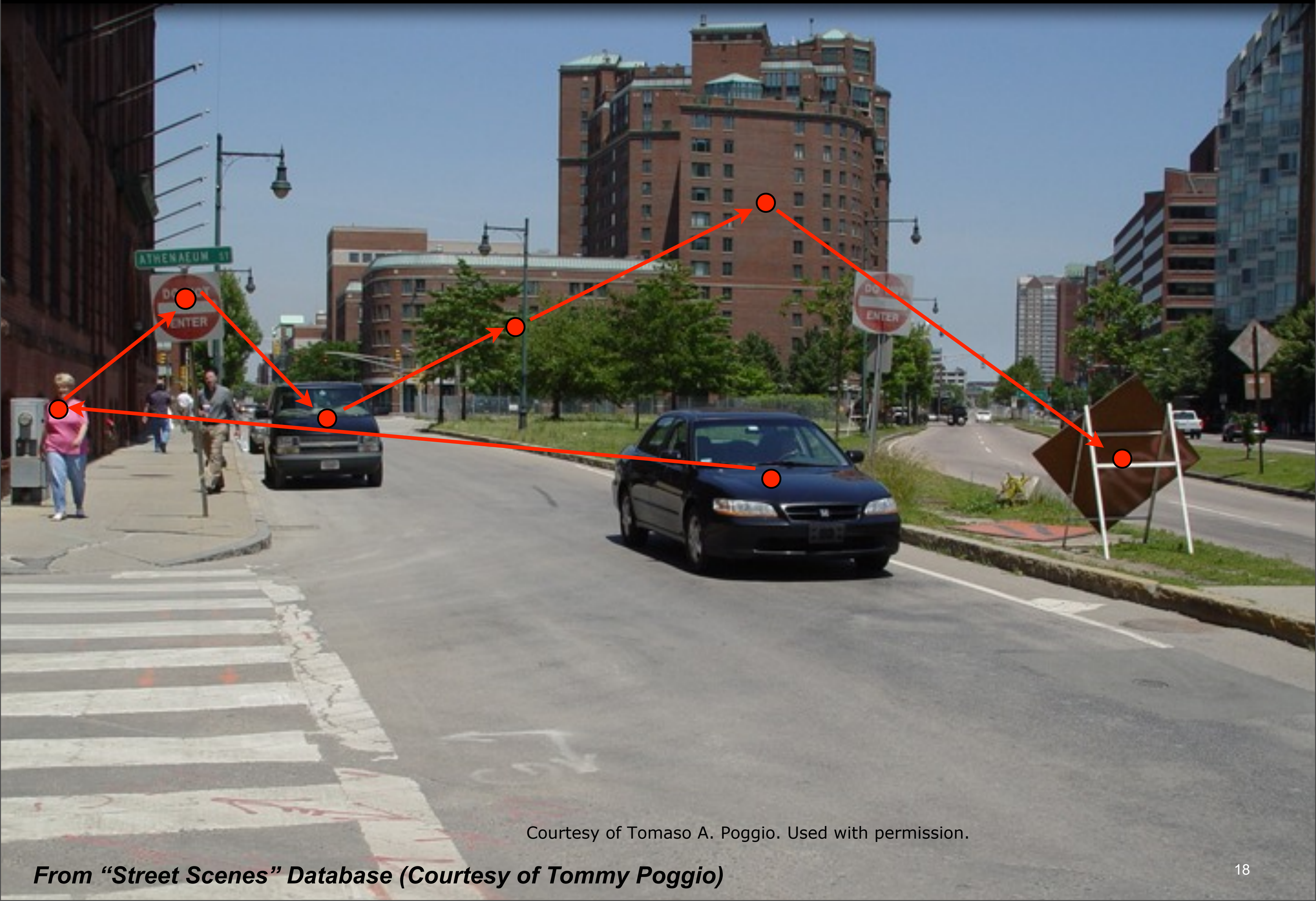


From MIT Street Scenes Database (Courtesy of Tommy Poggio)

Serial snapshot analysis → scene “understanding”

Courtesy of Tomaso A. Poggio. Used with permission.

Serial snapshot analysis → scene "understanding"



From "Street Scenes" Database (Courtesy of Tommy Poggio)

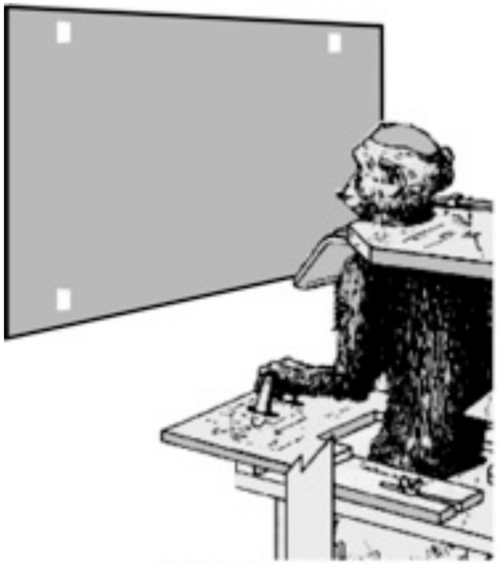
Serial snapshot analysis → scene “understanding”

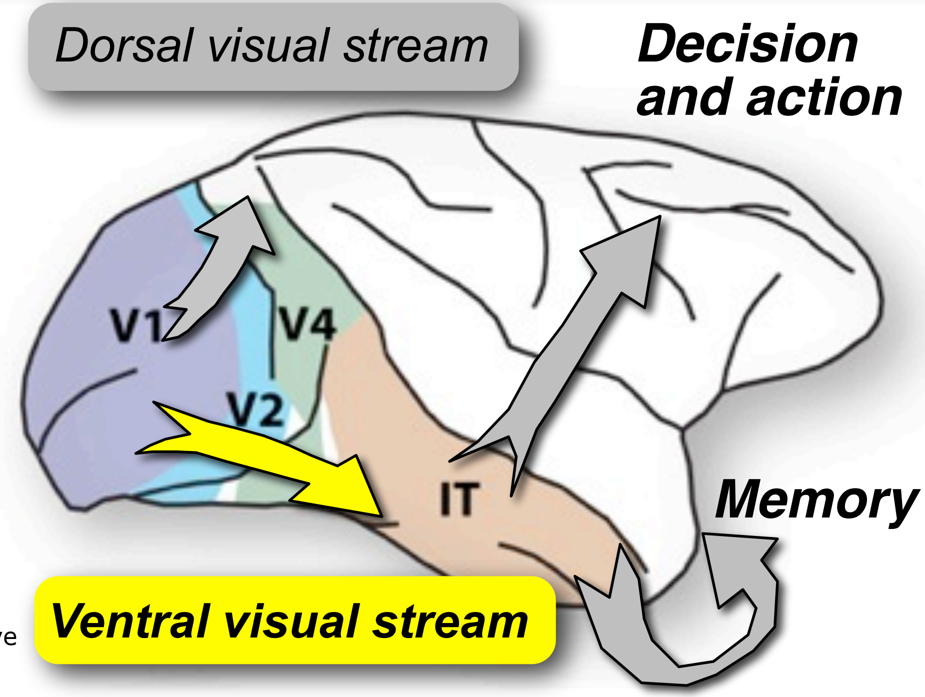
Snapshot (core) object detection

- *Fast (~200 msec)*
- *Feels effortless*
- *Large number of objects*
- *No pre-cueing needed*
- *Tolerant to variation*

Our mission: Understand how the brain constructs a neuronal representation that underlies core object detection

The ventral visual processing stream

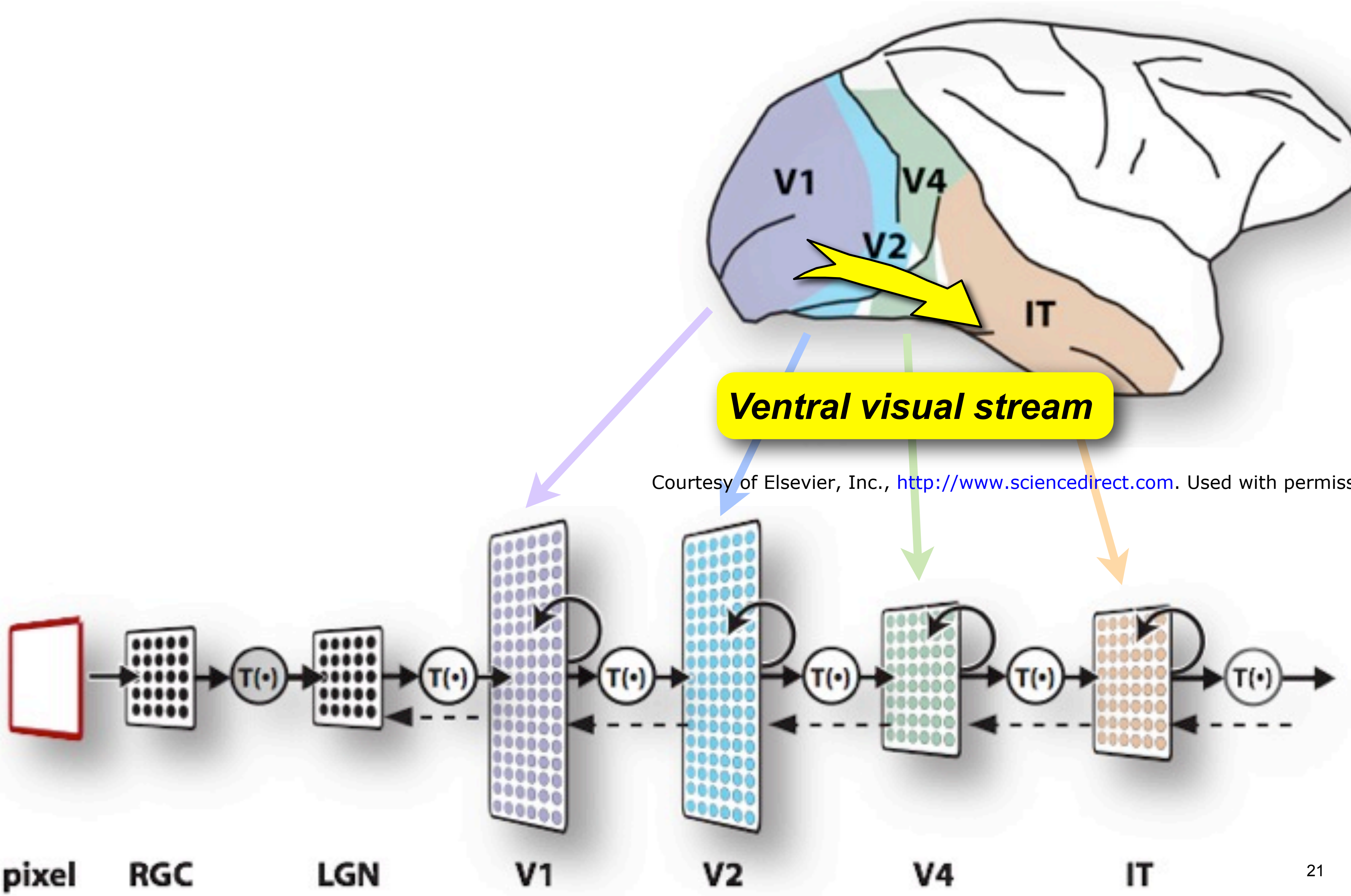




Houses critical circuits and resulting neuronal representations for object recognition.

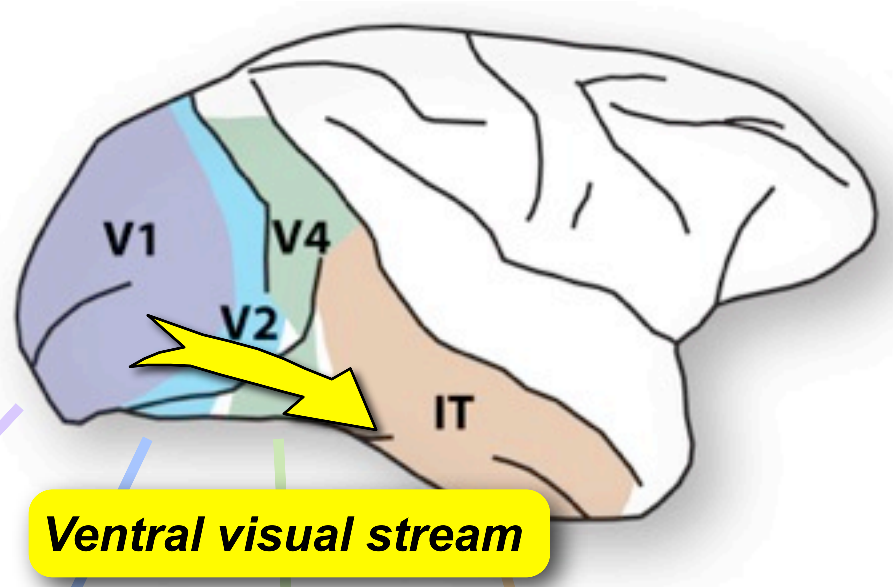
We can study those representations at the level of neuronal spikes.

The ventral visual processing stream



The ventral visual processing stream

Image: Kimberly Brown-Azzarello. Flickr. CC BY-NC.



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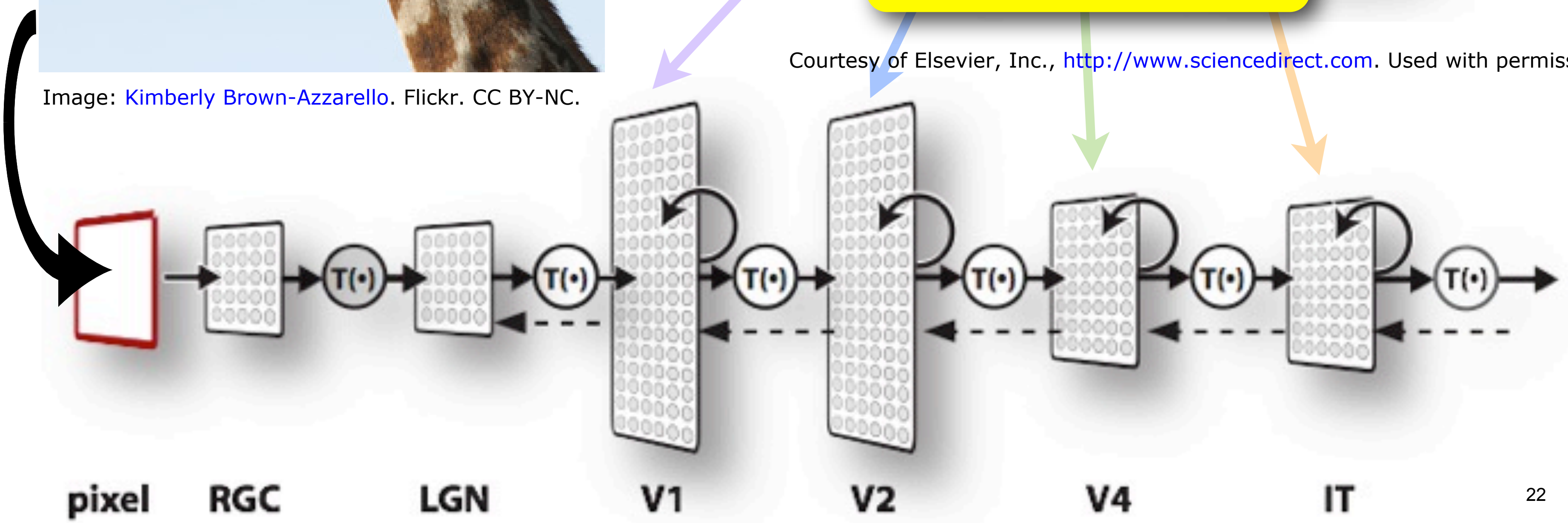

The ventral visual processing stream

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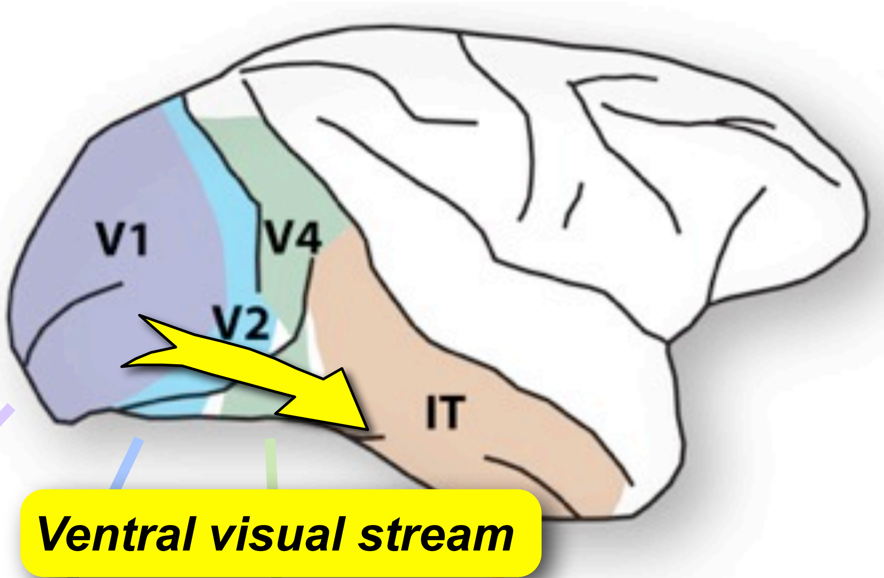

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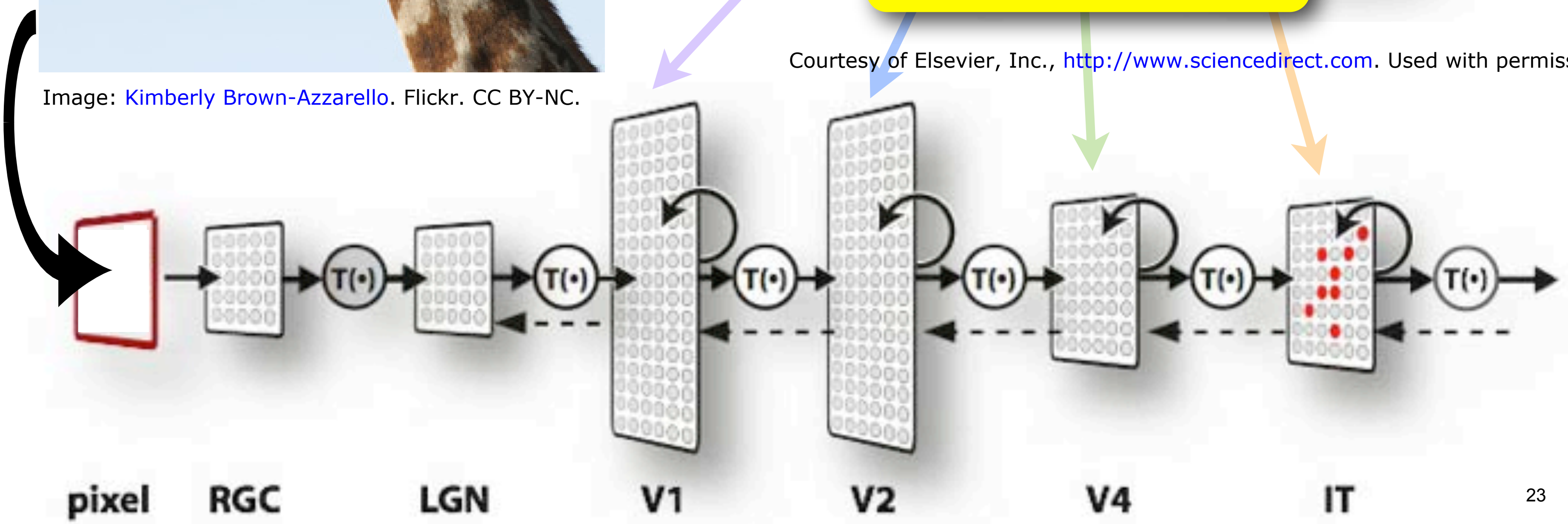

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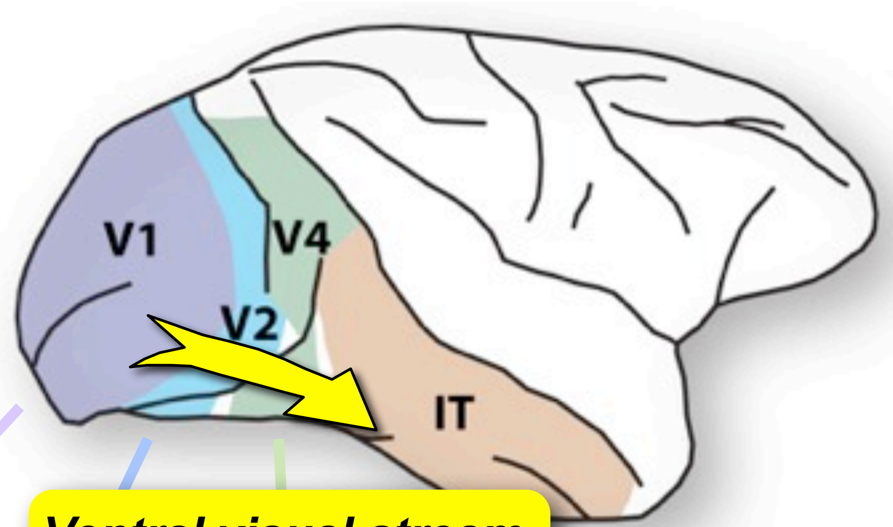
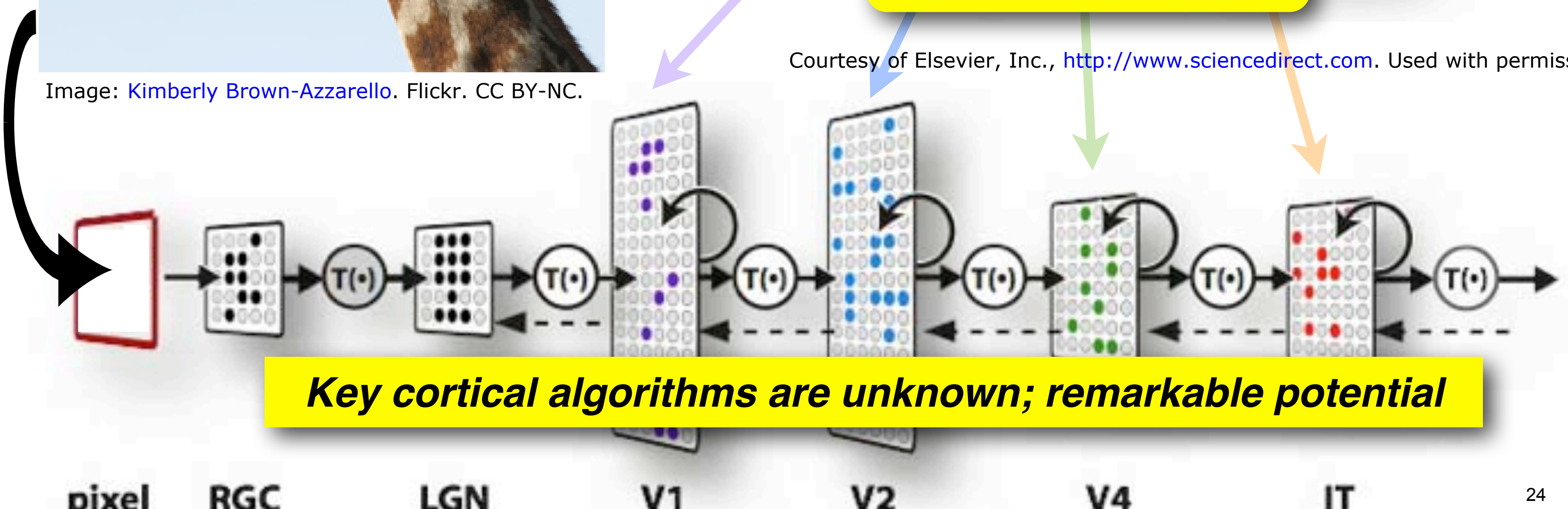


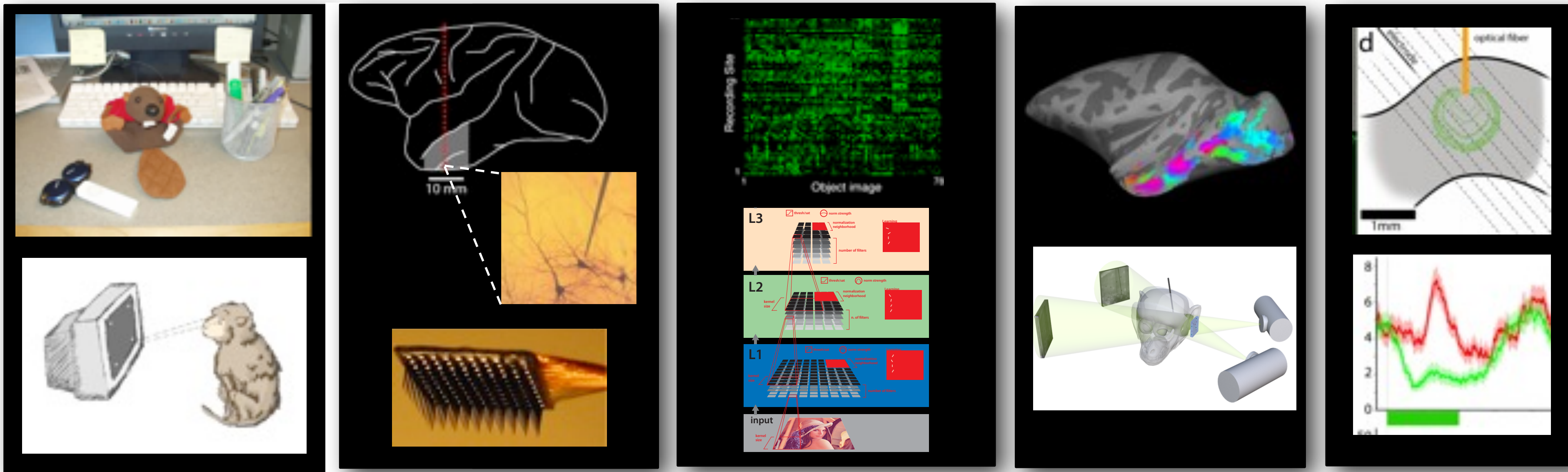
Ventral visual stream

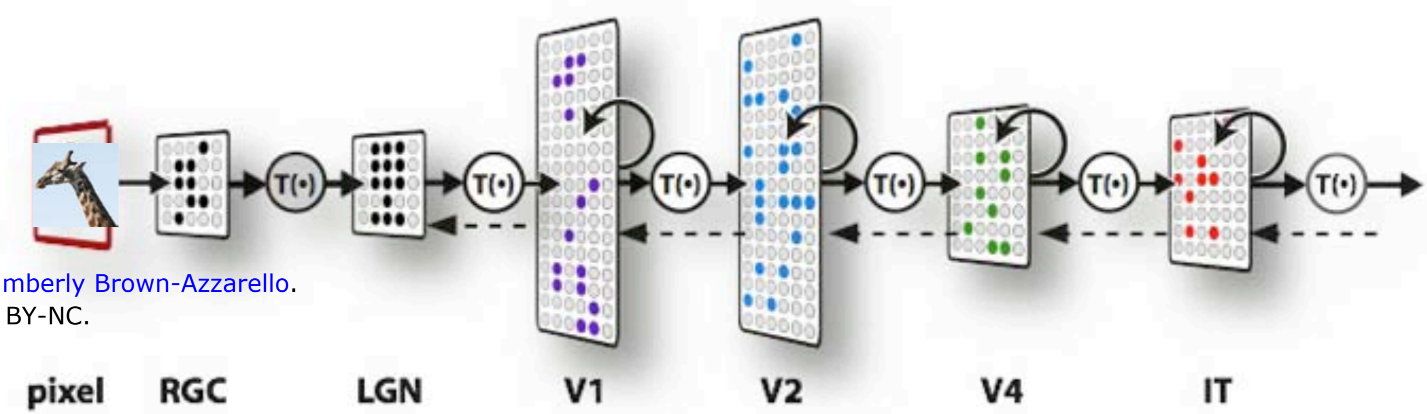


Key cortical algorithms are unknown; remarkable potential

Our primary tools:

Behavior | *Physiology* | *Computation* | *Imaging* | *Intervention*





Emotion: the basis of motivated behavior

- **Emotions** = evaluation of environment
  Motivation = response to environment
  (Kuhl, 1986)

- **Emotions** provide a system to evaluate environmental stimuli and **motivate** a behavioral response (D'Amasio, 1994; Tooby & Cosmides, 1990)

- **Amygdala** critical for assigning **motivational** significance to environmental stimuli
  (Brown & Schafer 1888; Kluver & Bucy, 1937)

- Amygdala evolutionarily conserved; dubbed "reptilian brain (Maclean, 1969)

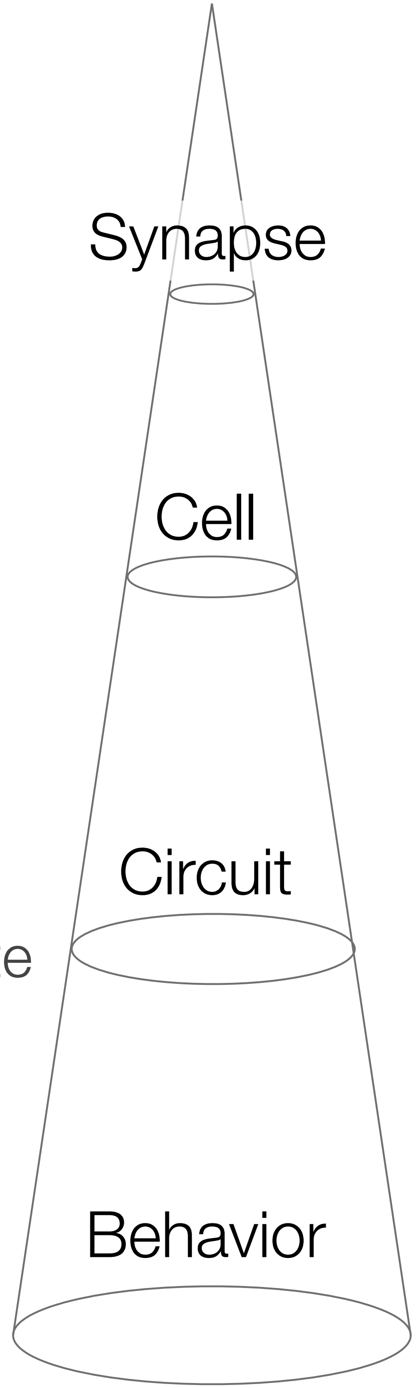
Neural basis of motivated behavior

How can the balance of **synaptic input** influence behavior?

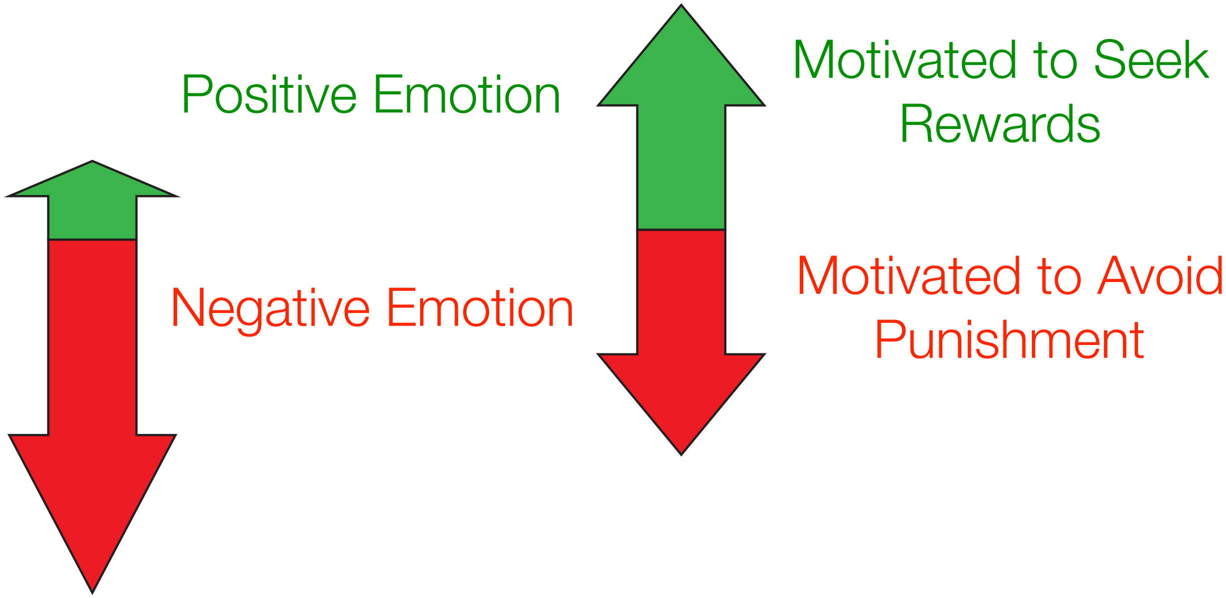
How do different **cell types** contribute to distinct aspects of behavior?

What **neural circuits** mediate motivated behaviors?

What processes underlie motivated **behavior**?



Why do we care about emotion and motivation?



Anxiety

Addiction

Depression

Genes and molecules
↓
Cellular components
↓
Neurons
↓
Interaction of many neurons
↓
Behavior

Introduction

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Genes and molecules

↓

Cellular components

↓

Neurons

↓

Interaction of many neurons

↓

Behavior

Level	Functions investigated	Preparations	Techniques
Molecular neuroscience (DNA, proteins, transmitters)	- Channel function - Signaling cascades - Neurotransmitter processing - Modifications to above: (development, memory)	-DNA solutions -Protein solutions -Cell fractions -Cell cultures - Brain slices - transgenic animals*	- Xray crystallography - DNA and protein sequence analysis - in situ hybridization - genetic manipulations **-models / computation**
Cellular neuroscience (whole neurons)	- neurotransimission - signal integration - neuronal plasticity - neuronal development	- Cell cultures - Isolated nerve - Brain slices - detailed, simulated neurons - transgenic animals*	- electron microscopy - chemical manipulations - intra-cellular electrophysiology - immunohistochemistry - two-photon microscopy **-models / computation**
Systems neuroscience (interactions of groups of neurons)	- system architecture - system connectivity - neuronal signaling - neuronal transfer functions - neuronal coding of information - neuronal computation - links between neuronal properties and behavior	- Brain slices - invertebrates - anesthetized vertebrates - awake vertebrates - awake,non-human primates - simulated neuronal networks - transgenic animals*	- gross anatomy, histology - immunohistochemistry - tract tracing - extra-cellular electrophysiology - intra-cellular electrophysiology - multi-unit electrophysiology - chronic electrophysiology - electrical microstimulation - pharmacological stimulation/inhibition - brain lesions - intrinsic signal imaging - animal behavior and psychophysics **- models / computation**
Cognitive neuroscience (emergent, complex behavior)	- Perception - Motor control - Memory - Decision/reasoning - Language - Consciousness?	- human subjects - simulated brain processes	- human psychophysics - behavioral observations - functional MRI **-models / computation**

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Systems neuroscience (interactions of groups of neurons)	- system architecture - system connectivity - neuronal signaling - neuronal transfer functions - neuronal coding of information - neuronal computation - links between neuronal properties and behavior	- Brain slices - invertebrates - anesthetized vertebrates - awake vertebrates - awake,non-human primates - simulated neuronal networks - transgenic animals*	- gross anatomy, histology - immunohistochemistry - tract tracing - extra-cellular electrophysiology - intra-cellular electrophysiology - multi-unit electrophysiology - chronic electrophysiology - electrical microstimulation - pharmacological stimulation/inhibition - brain lesions - intrinsic signal imaging - animal behavior and psychophysics **- models / computation**

What is the right tool for the job?

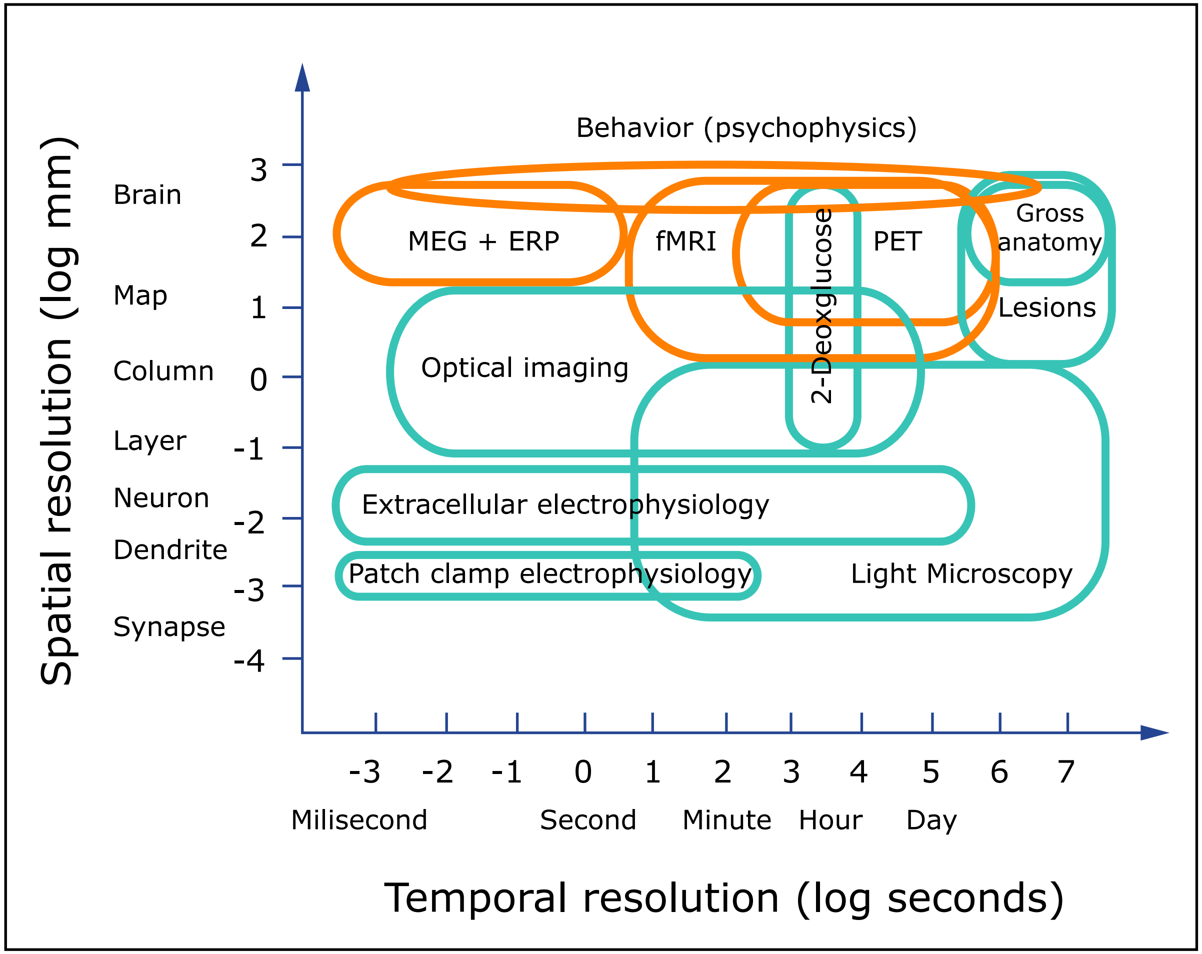

Image by MIT OpenCourseWare.

Use of animals in this class:

- It is not possible to study the nervous system without handling actual neural tissue. Thus, several of the classes will use animals (rats, frogs, cockroaches, flies).

- We have made every attempt to reduce the number of animals used in this course. Several labs use simulations instead of animals.

- All animal procedures are in accordance with NIH guidelines are approved by MIT's Committee on Animal Care.

- We will have a presentation on the use on animals in research and teaching from an MIT veterinarian.

- If you are uncomfortable with the use of animals, please contact one of us immediately after this introduction (TODAY).

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- (Add/drop/etc. Please put your name on sign up sheet before you leave. See Steve Russo for this!)

9.17 Systems Neuroscience Lab
Spring 2013