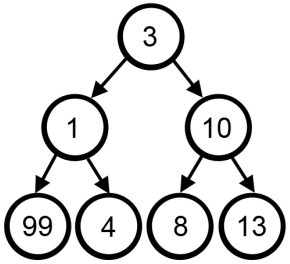
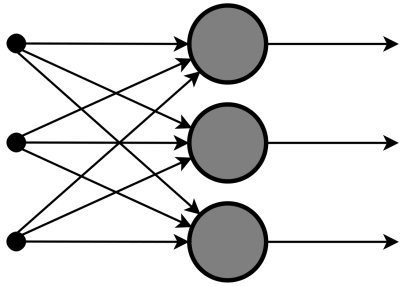
CSE 40171:
Artificial Intelligence



Course Introduction / Introduction to AI

Course Info:

- CSE 40171: Artificial Intelligence
- Instructor: Walter Scheirer (wscheire@nd.edu; @wjscheirer)
- Office: 321C Stinson-Remick
- Lectures: MWF 3:30-4:20pm DeBartolo Hall 125
- Office Hours: Mon. & Weds. 1-3:15pm and by appointment.

Course Website:
https://www.wjscheirer.com/teaching/ai/ai-fall-2019/

Course Slack Channel

#cse-40171-fa19

nd-cse.slack.com

Grad TA:

- **Sophia Abraham**
- sabraha2@nd.edu
- Office Hours: Fri. 9-11am
  - Center for Digital Scholarship (Hesburgh Library)

Undergrad TAs:

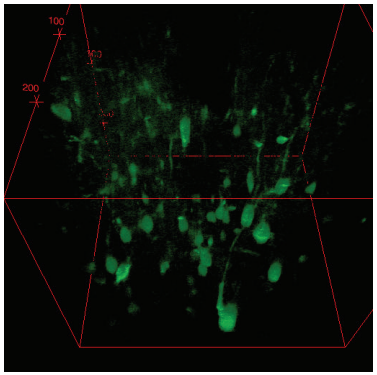
Mike Eisemann (meiseman@nd.edu)

Fiona McCarter (fmccarte@nd.edu)

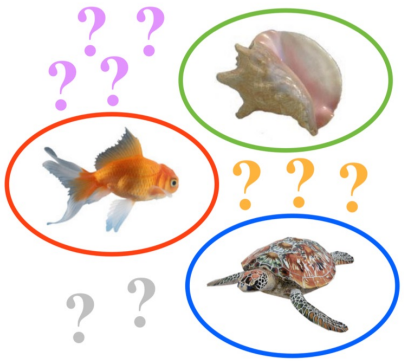
About me

- Joined Notre Dame Summer 2015
  - Ph.D. from the University of Colorado 2009
  - 2007 — 2012 Security Startup Securics, Inc.
  - 2012 — 2015 **Harvard University Center for Brain Science**
- Research in Computer Vision and Machine Learning

Reverse engineering biological vision



Tools for Neuroscience



Statistical methods for visual recognition

Digital Humanities

How about you?

- Introduce yourself.
- Any experience with Neural Networks, Psychology, Neuroscience, or Statistics?
- What interests you about artificial intelligence?

Course Overview

- 33 lectures
- 1 documentary film screening (*AlphaGo*)
- 2 Invited Talks
- 8 homework assignments
- 2 quizzes (in-class)
- 1 group project
  - Project proposal
  - Project update
  - Final deliverable in lieu of final exam

Course Overview

*Full syllabus on course website

Grading

Component	Points
Participation Participation in class, film response, office hours, and slack chats.	100
Homeworks Homework assignments.	8 × 100
Project Final group project.	700
Quizzes In-class quizzes.	2 × 200
Total	**2000**

Important Dates

Homework #1 (Artificial Neural Networks)	Released: 9/9; Due: 9/16
Film Response	Released: 9/18; Due: 9/23
Homework #2 (Search Strategies)	Released: 9/23; Due: 9/30
Homework #3 (Search Strategies)	Released: 10/2; Due: 10/9
Homework #4 (Neural Network Search)	Released: 10/11; Due: 10/18
Quiz 1	10/30
Homework #5 (Segmentation for Connectomics)	Released: 11/6; Due: 11/13
Homework #6 (Neural Nets. with Anatomical Fidelity)	Released: 11/15; Due: 11/22
Homework #7 (Neural Nets. with Biological Dynamics)	Released: 11/25; Due 2/2
Homework #8 (Bayesian Read-outs)	Released 12/4; Due: 12/11
Quiz 2	12/11

Course Overview

*Full syllabus on course website

The group (3-4 students) project will consist of several milestones, including a project proposal, interim project update, and a final deliverable including a full report and complete code and data.

Important Dates

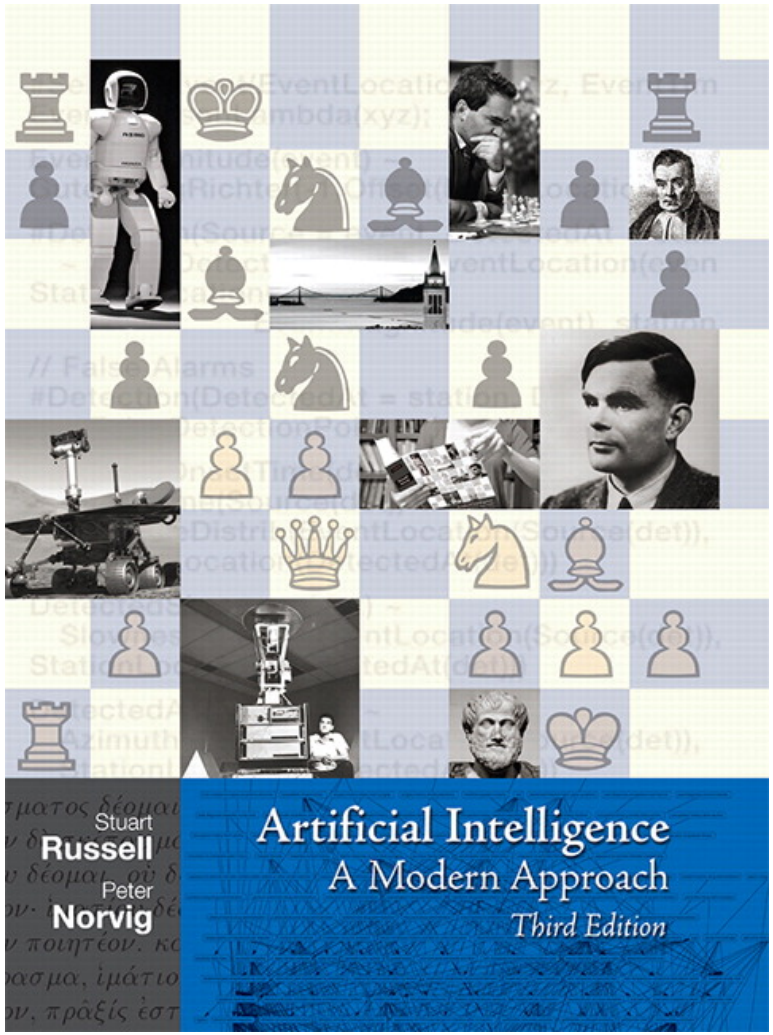
Project Proposal	Instructions Released: 10/28; Due: 11/4
Project Update	Instructions Released: 11/18; Due: 11/25
Final Deliverable	Released: 12/1; Due: 12/18

Prerequisites

Required prerequisite course: N/A

You need to be comfortable programming in Python

Textbook



Other readings will be posted to the course website; keep an eye on the class schedule

Course Objectives

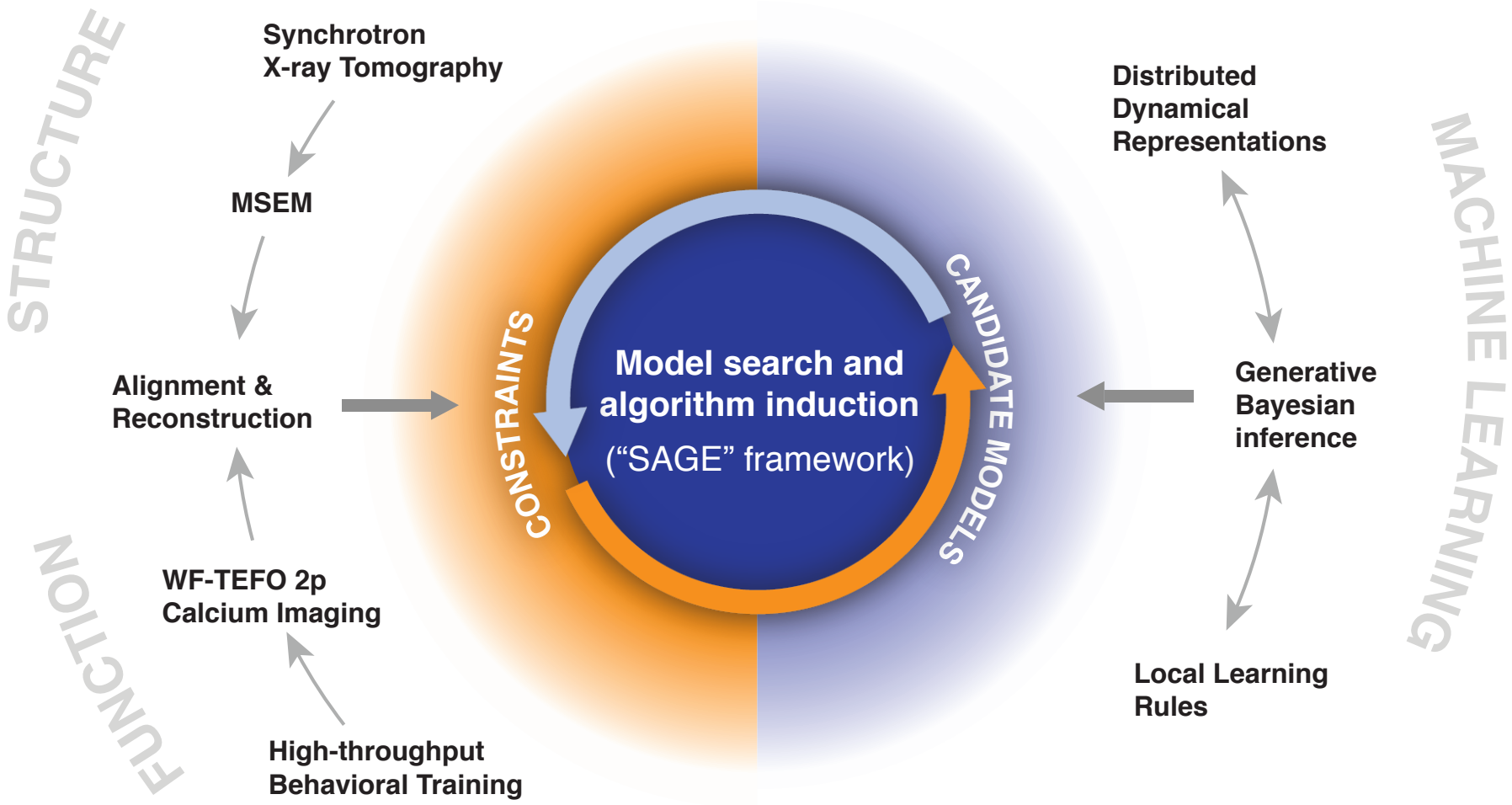
- **Understand** the philosophical underpinnings of the field and motivations for pursuing the replication of certain competencies of the brain.
- **Relate** real-life problems to perceptual and cognitive models that are able to solve aspects of them in an efficient manner.
- **Deploy** general search algorithms that can be applied to a wide variety of tasks.
- **Formulate** decision making processes that can be used for planning and classification purposes.

Course Objectives

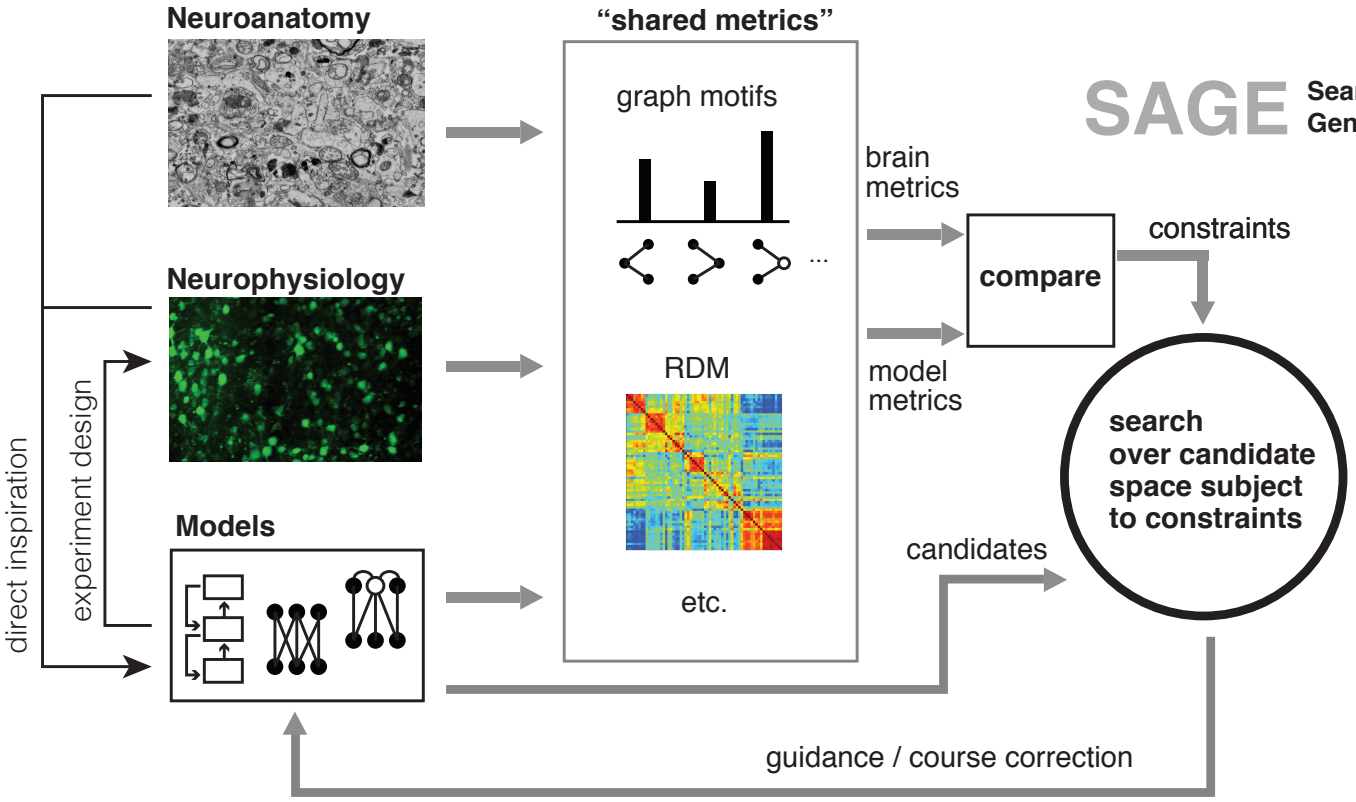
- **Build** intelligent agents that perform simple tasks in an autonomous fashion.
- **Learn** task-specific models from large collections of labeled training data samples using algorithms that are optimized using numeric solvers.
- **Utilize** the Pytorch framework for building solutions to problems related to games, computer vision, natural language processing, and other general data science applications.
- **Identify** problems that are solvable with today's AI algorithms and others that require novel solutions.

Course Objectives

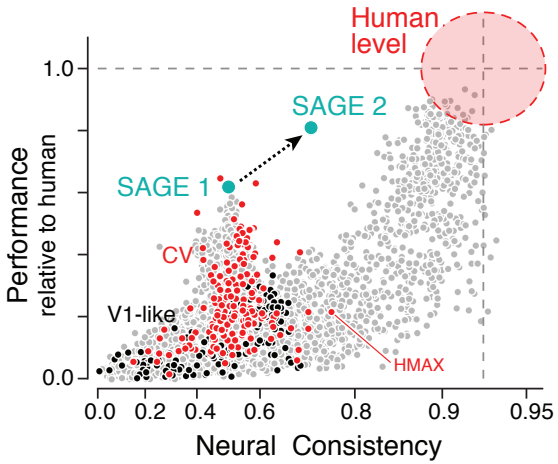
- **Grasp** the aspects of artificial intelligence where neuroscience and computer science come together to form the basis of a new class of learning algorithms.


STRUCTURE
Synchrotron
X-ray Tomography
MSEM
Alignment &
Reconstruction
FUNCTION
WF-TEFO 2p
Calcium Imaging
High-throughput
Behavioral Training
CONSTRAINTS
Model search and
algorithm induction
("SAGE" framework)
CANDIDATE MODELS
Distributed
Dynamical
Representations
Generative
Bayesian
inference
Local Learning
Rules
MACHINE LEARNING

Machine Learning Algorithms from Wet Lab Experimentation



SAGE **Search for Architectures by Generation and Evaluation**

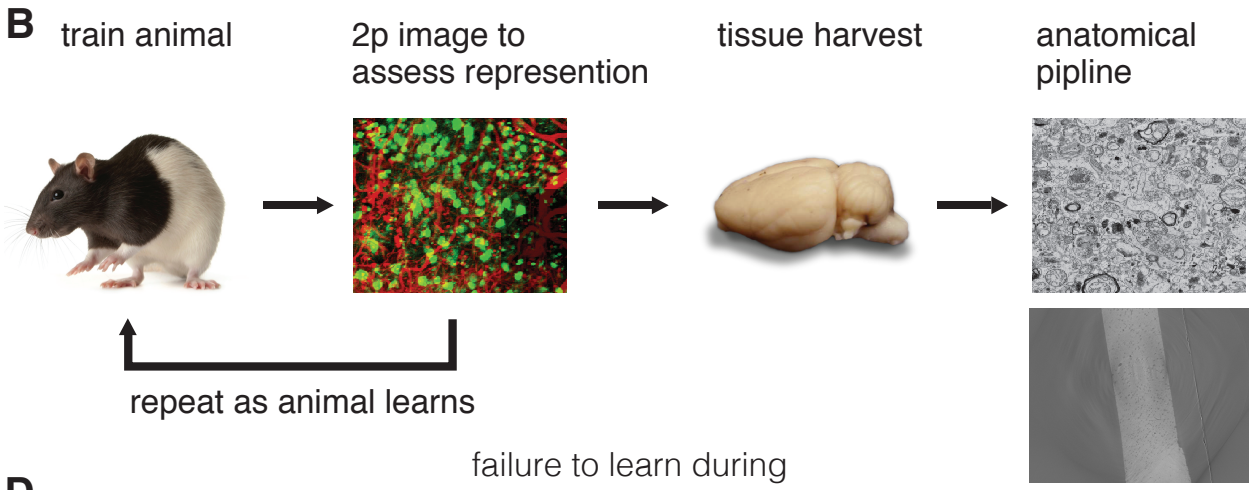


Search those regions of model space that perform well and are neurally-consistent

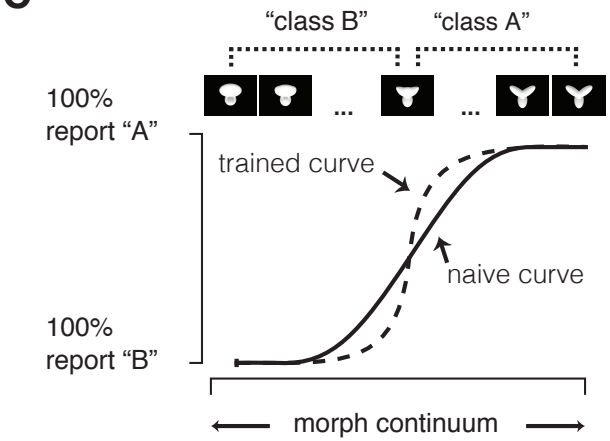
Experimental workflow

A

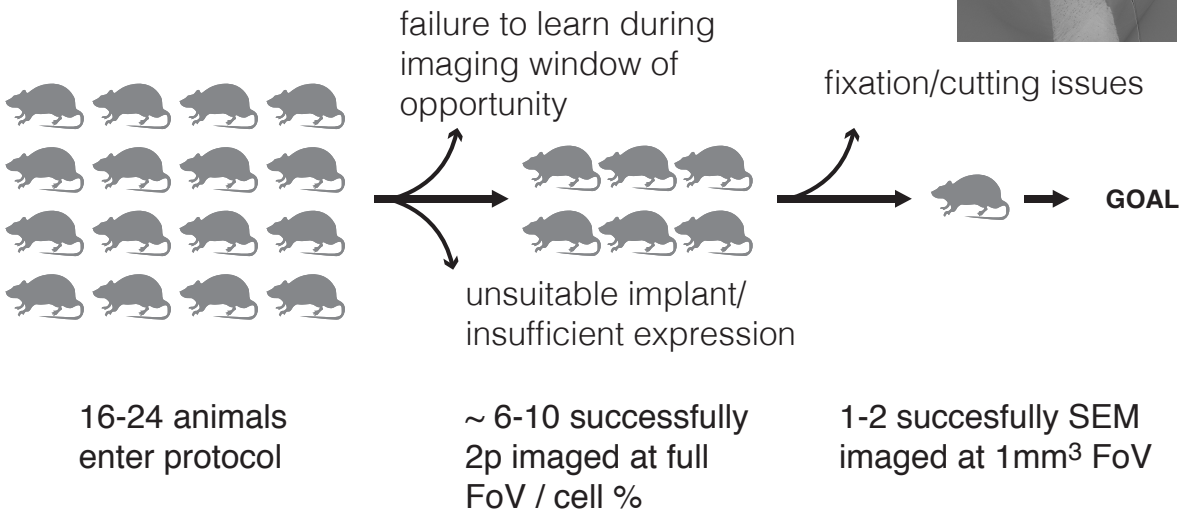
B



C



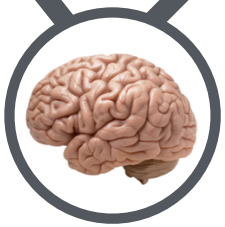
D



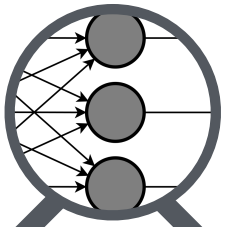
Course Roadmap

Introduction
(week 1)

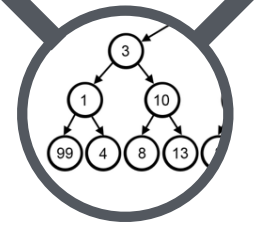
Bio. Intelligence
(week 2)



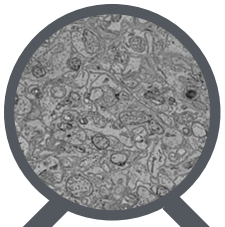
Neural Networks
(week 3)



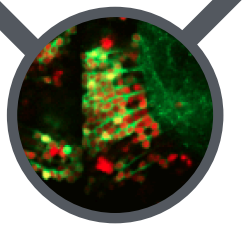
Search Problems
(weeks 4 - 9)



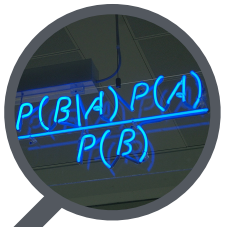
Brain Structure
(weeks 12 - 13)



Brain Function
(weeks 14 - 15)



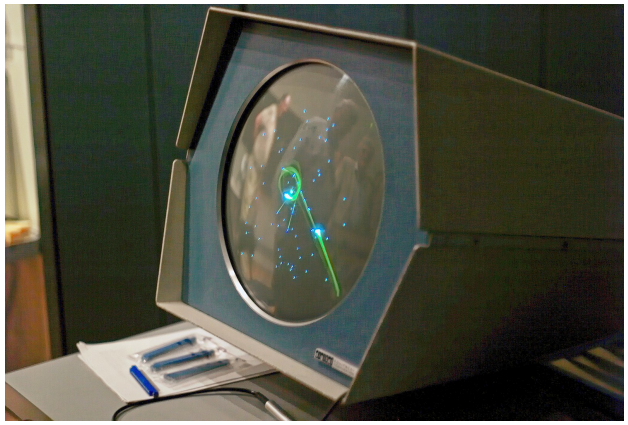
Decisions
(week 16)



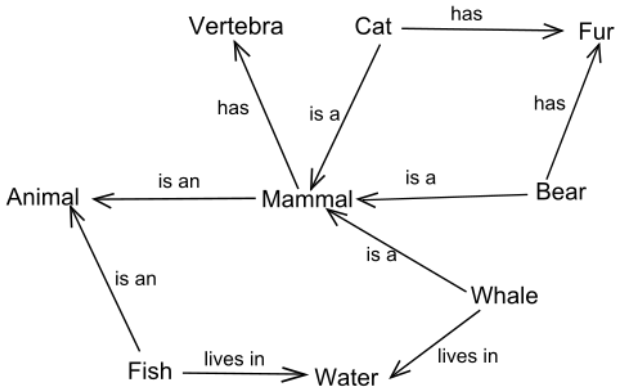
A brief history of AI

Once a historical footnote…

Thinking Machines CM-5 "FROSTBURG" at the National Cryptologic Museum. CC BY-SA 2.5 Mark Pellegrini



Spacewar running on PDP-1 CC BY 2.0 Joi Ito



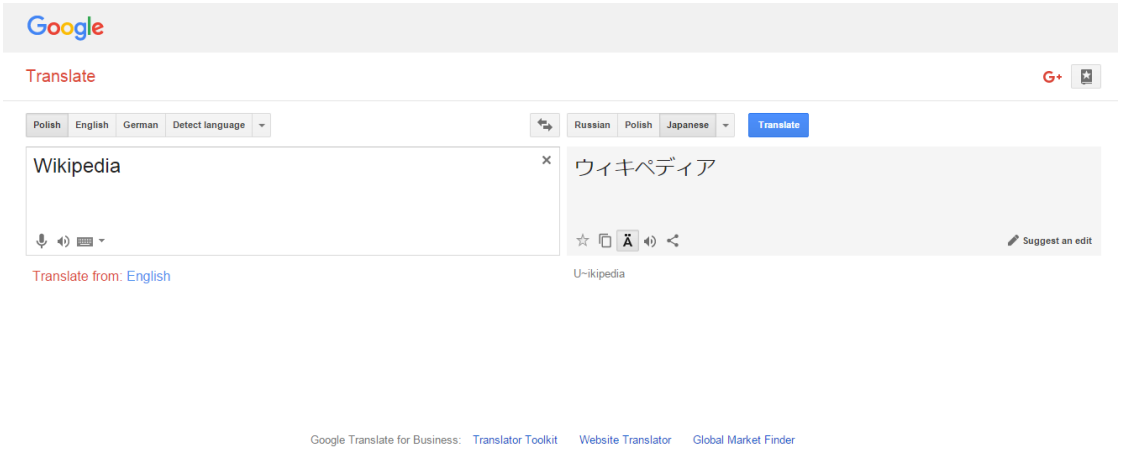
mindpixel Digital Mind Modeling Project

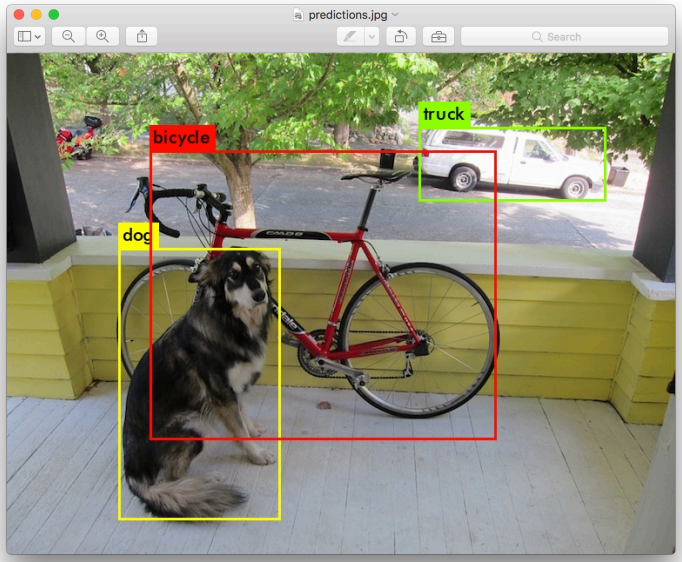
Lettvin Pitts CC BY-SA 3.0 Iapx86

…now big business

Testing the Tesla autopilot (self-driving mode) CC BY 2.0 Marc van der Chijs

AlphaGo CC BY 2.0 Prachatai

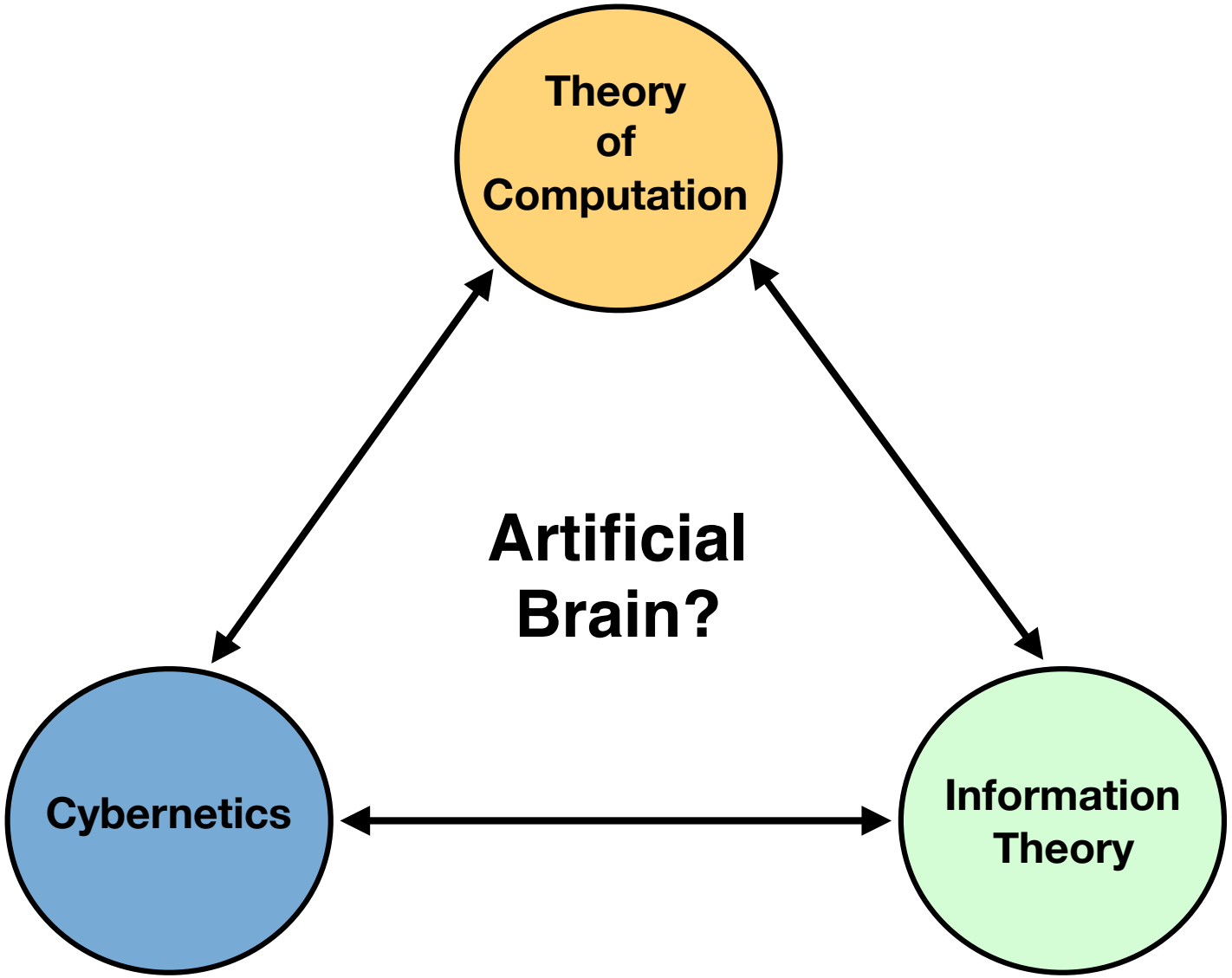




https://pjreddie.com/darknet/yolo/

The early years

The 1950s…

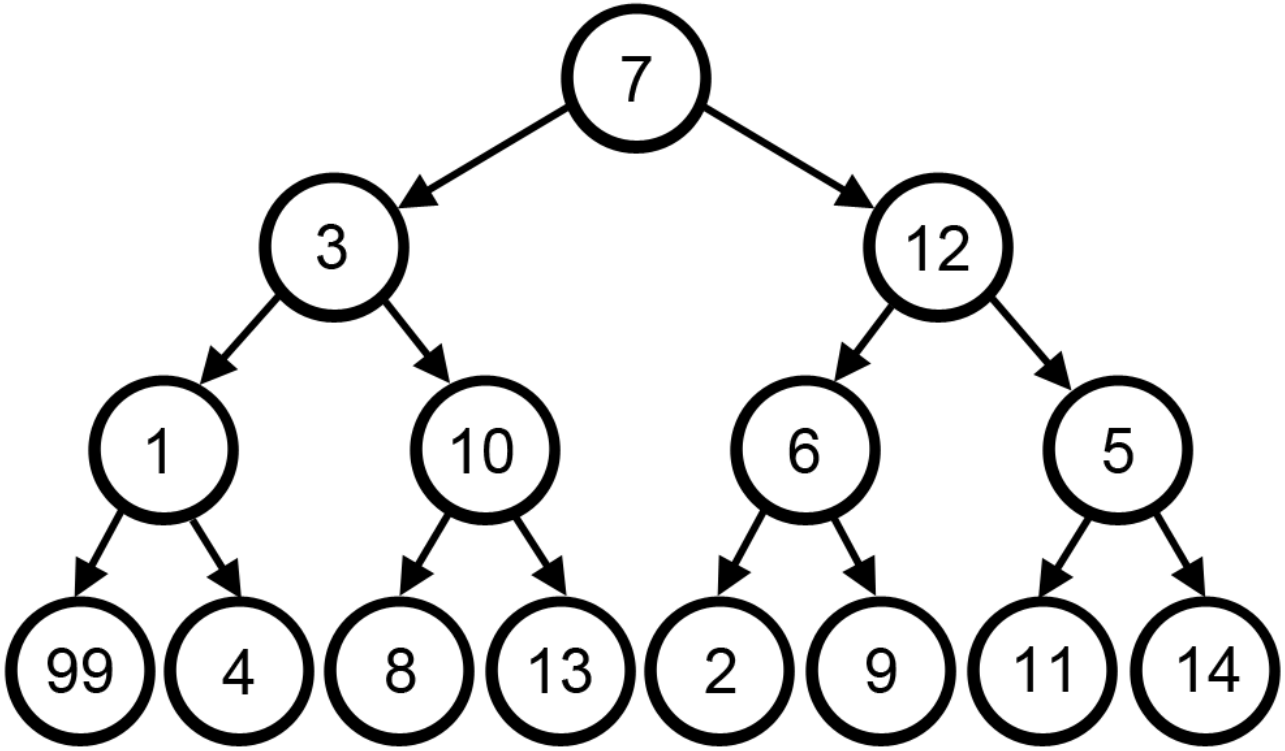

Theory of Computation
Artificial Brain?
Cybernetics
Information Theory

Dartmouth Summer Program in Artificial Intelligence, June-August 1956

Photo Source: Achievement.org

The mid 50s to mid 70s:
The (so-called) golden years

Reasoning as search



A example of greedy algorithm, searching the largest path in a tree.

The Blocks World

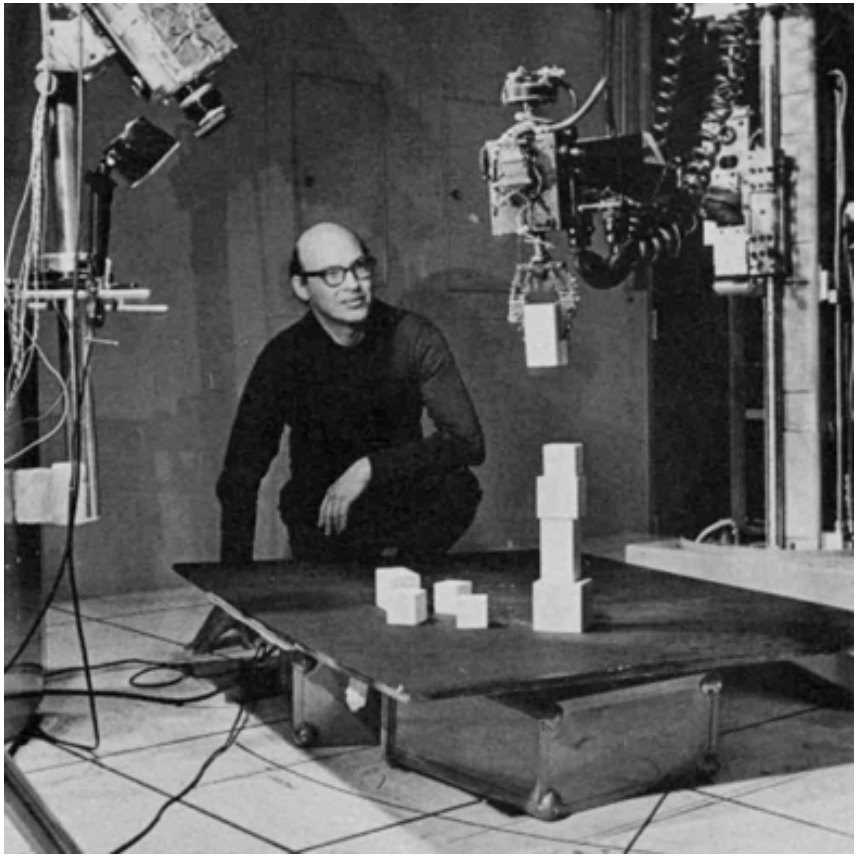
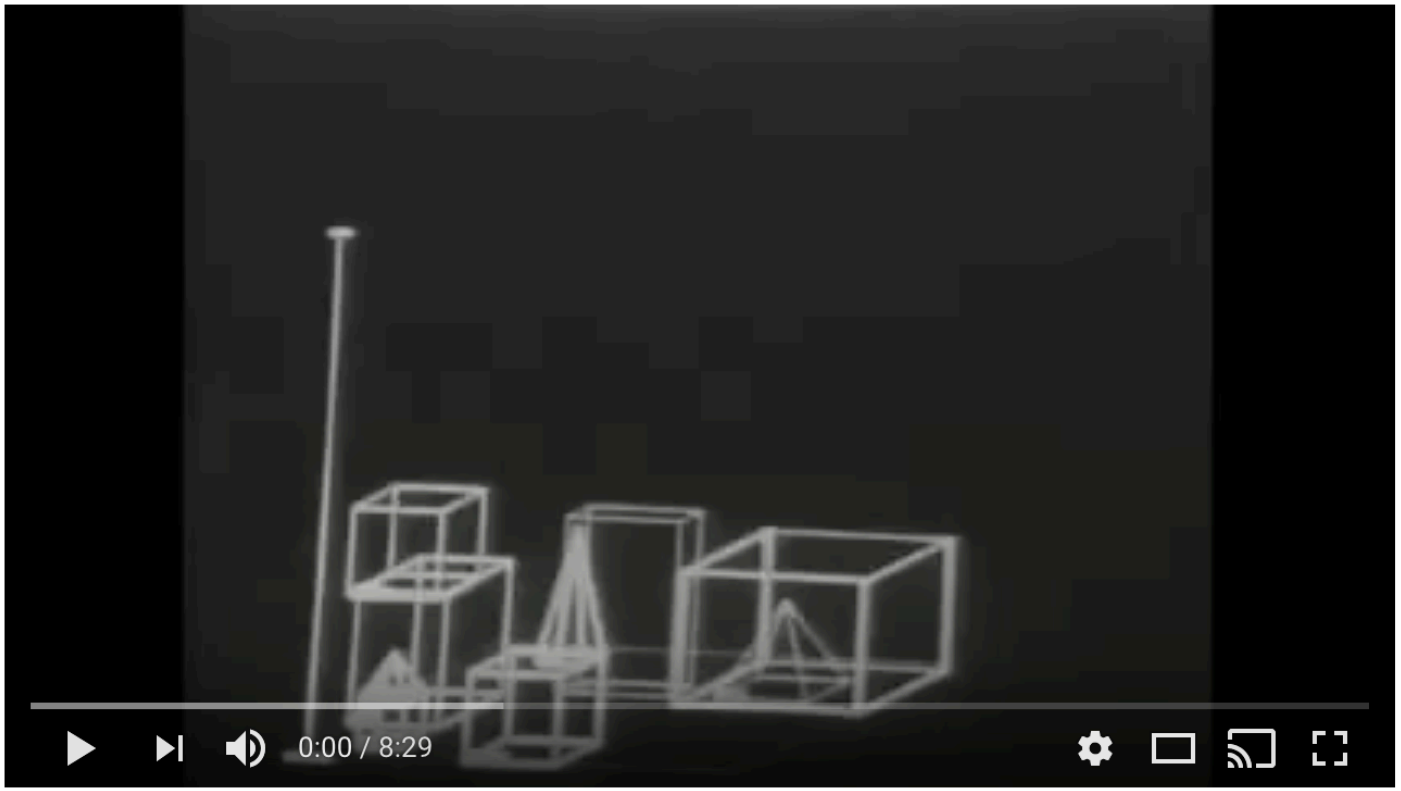


Photo Source: MIT Technology Review

SHRDLU



https://www.youtube.com/watch?v=bo4RvYJYOzI

ELIZA

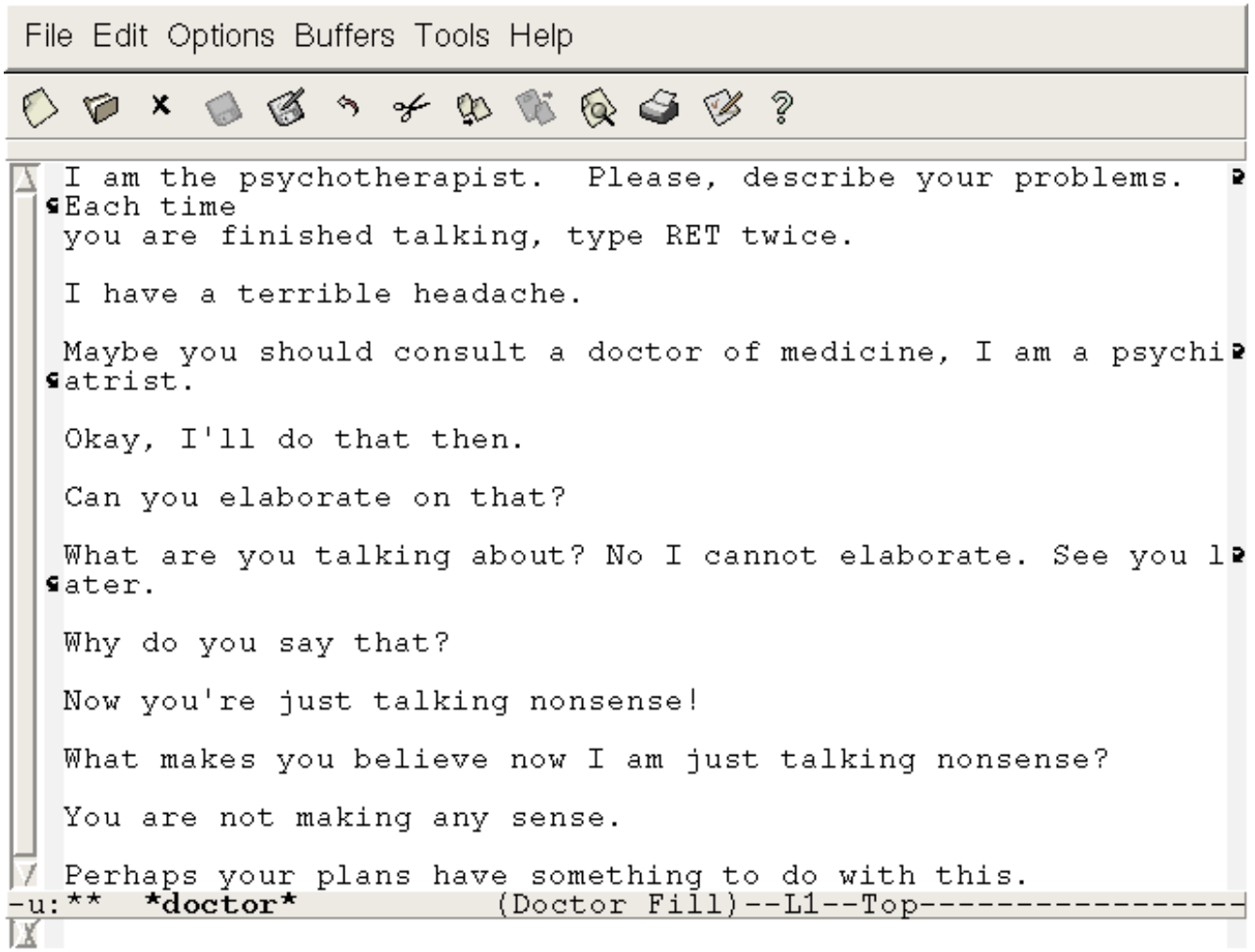


Image Credit: Wikipedia User Ysangkok

Brash Optimism

“within ten years a digital computer will be the world’s chess champion" and "within ten years a digital computer will discover and prove an important new mathematical theorem.”

- H.A. Simon and Allen Newell

“machines will be capable, within twenty years, of doing any work a man can do.”

- H.A. Simon

“Within a generation... the problem of creating ‘artificial intelligence’ will substantially be solved.”

- Marvin Minsky

“In from three to eight years we will have a machine with the general intelligence of an average human being.”

- Marvin Minsky