Lecture 2:
What is AI?

Artificial Intelligence
CS-UY-4613-A / CS-GY-6613-I

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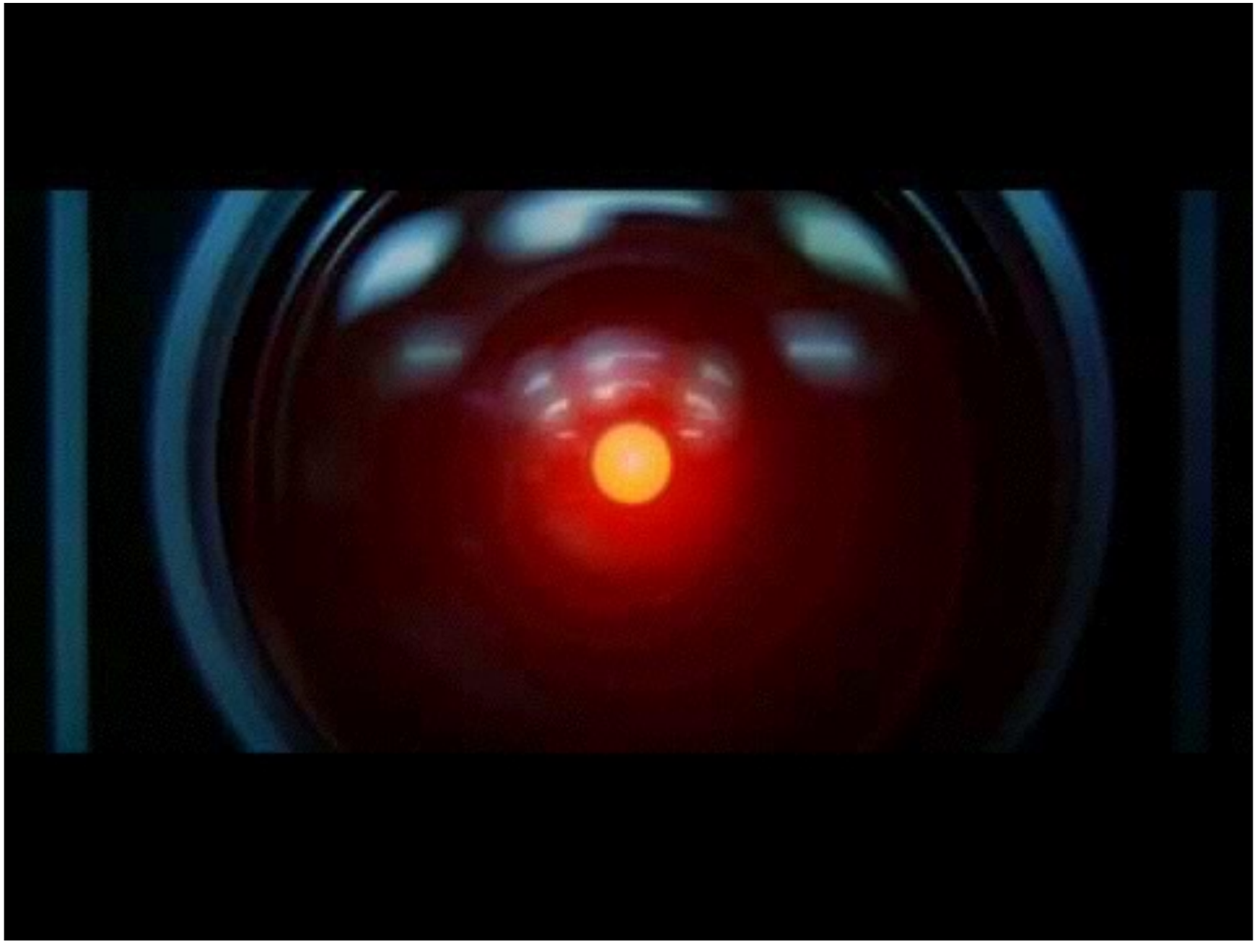
This lecture

- Perspectives on and history of AI
- AI is just…? (This one weird thing!)
- Syllabus redux
- How this course will work
    - Including, in particular, the group project

Who am I?

- From Malmö, Sweden
- Studied: Lund (Sweden) >> Sussex >> Essex (UK)
- Worked: Lugano (Switzerland) >> Copenhagen >> NYU
- philosophy + psychology >> artificial intelligence + robotics >> games
- Current research focus: AI in games (player modeling, procedural content generation, evolutionary computation)

Artificial Intelligence



What is AI?

“the study and design of intelligent agents”

“a branch of computer science dealing with the simulation of intelligent behavior in computers”

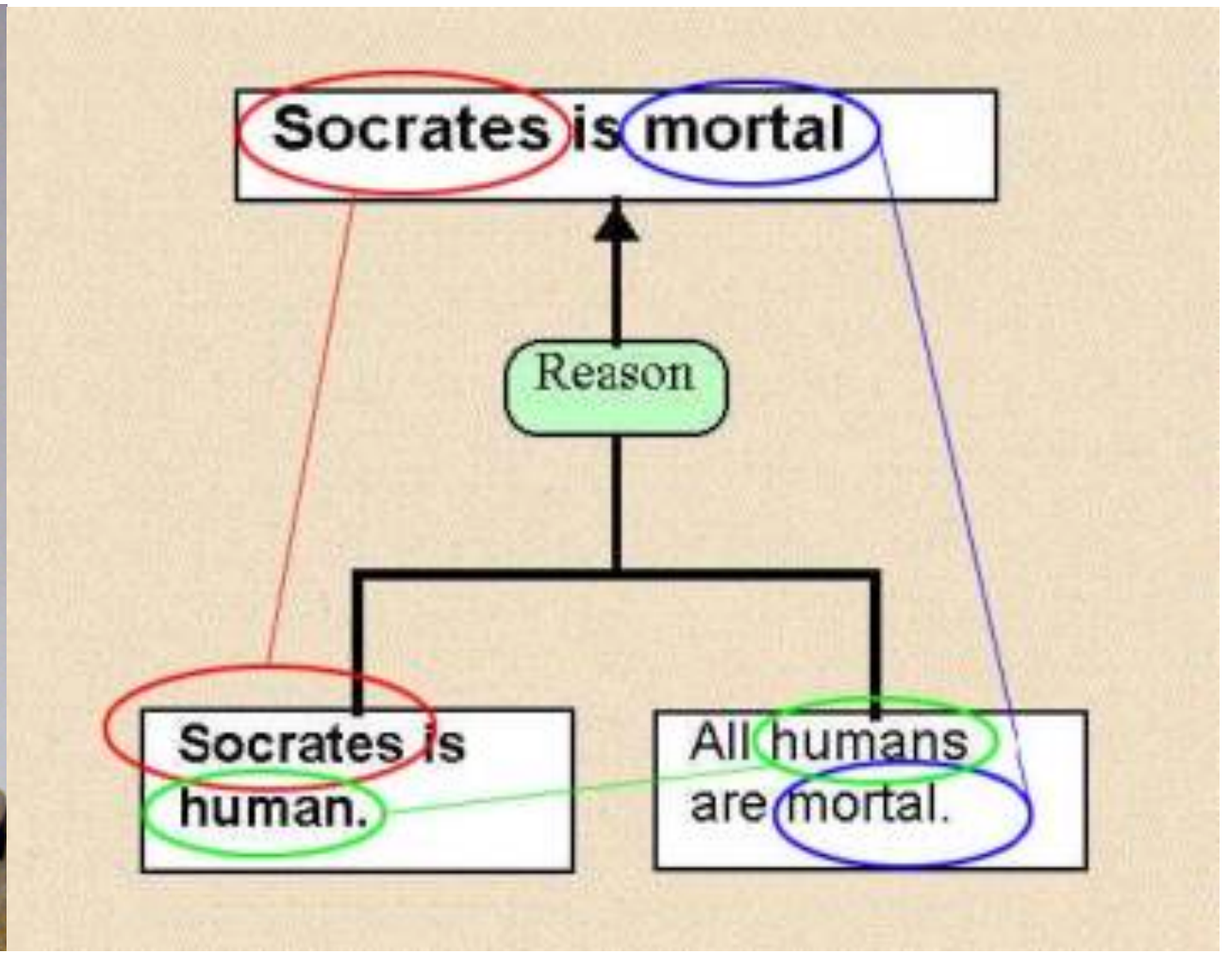
“the quest to make machines able to perform tasks which normally require human intelligence”

“any kind of computer science method that doesn’t work well yet; when it works, it’s not AI”

Questions from philosophy

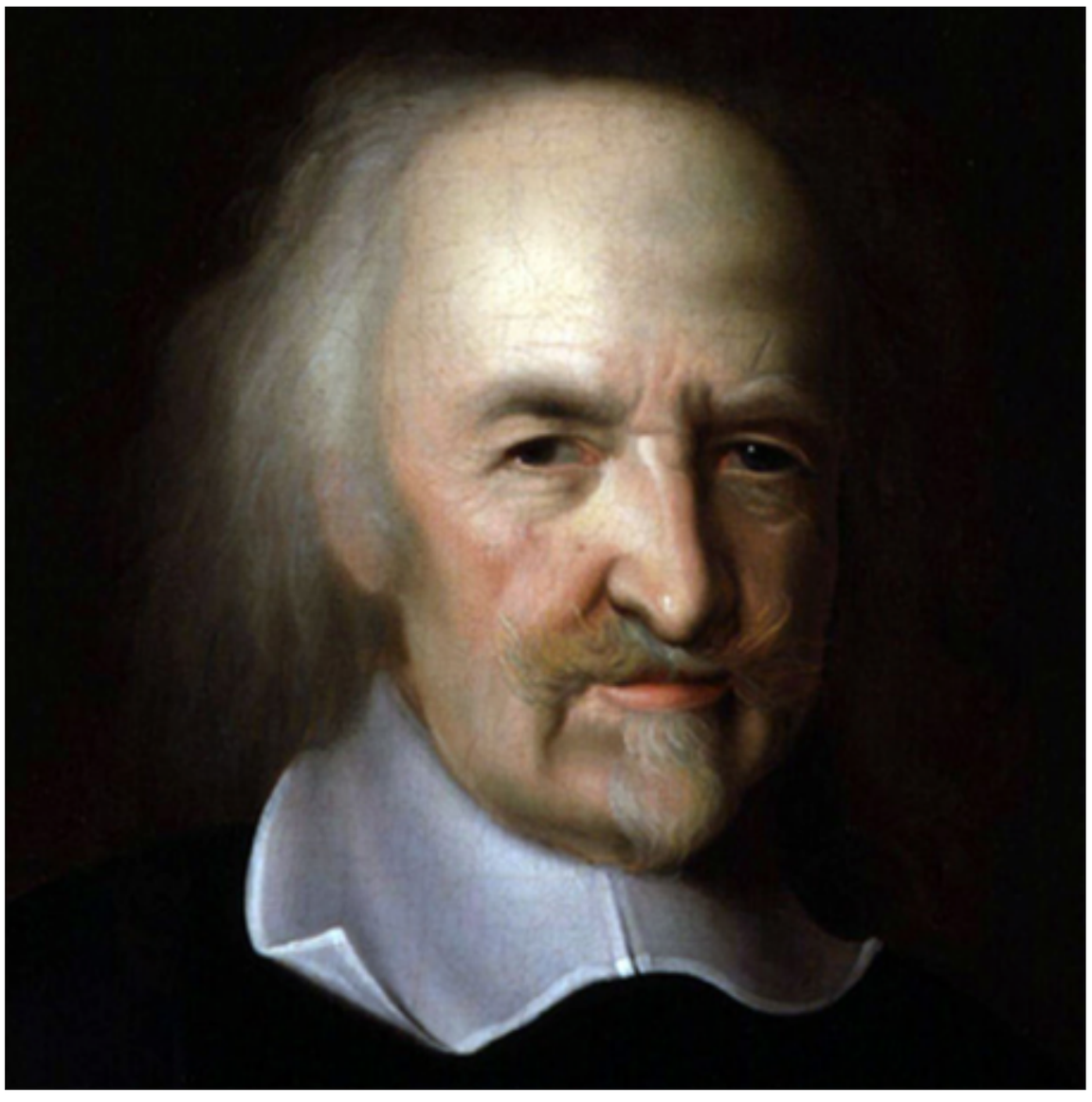
- Can formal rules be used to draw valid conclusions?
- How does the mind arise from the physical brain?
- Where does knowledge come from?
- How does knowledge lead to action?

Aristotle: syllogisms



4th century BC

Hobbes: mechanical reason



- Reasoning like “mental addition and subtraction”
- Artificial animal: “For what is the heart but a spring; and the nerves, but so many strings; and the joints, but so many wheels.”

17th century

Leibniz: universal language

- “when there are disputes among persons, we can simply say: Let us calculate, without further ado, to see who is right"

17th century BC

How do we get knowledge?

Plato: rationalism

- Deduce from innate knowledge

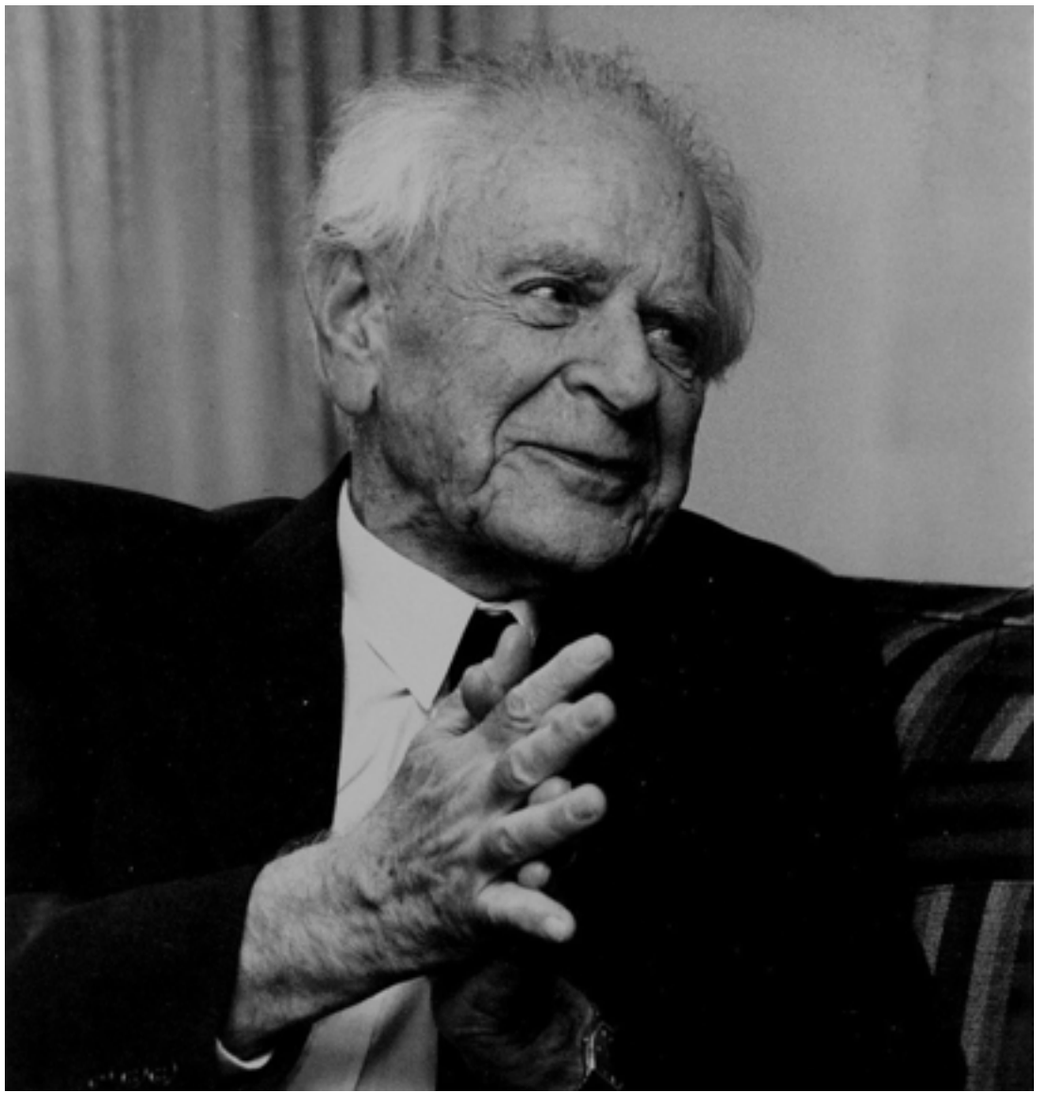
Aristotle: Empiricism

- Learn from our senses

Hume: induction

- We generalize from multiple observations

Popper: critical rationalism

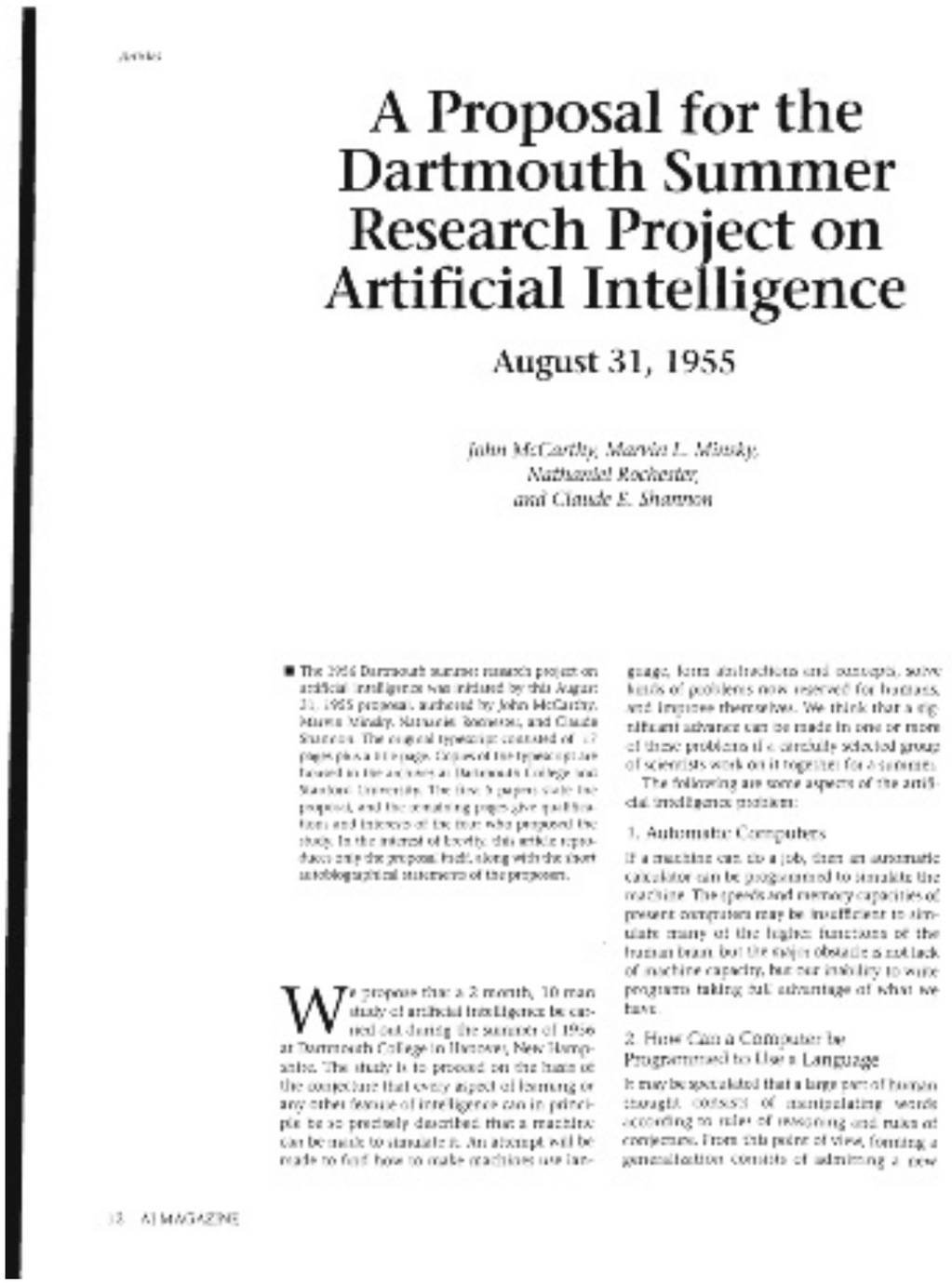


- We advance hypotheses, and try to falsify them based on our sense experiences

Other fields

- Psychology: how do we think?
- Neuroscience: what is that thinking based on?
- Economics: what is rational action?
- Engineering: what can we implement AI in?

The birth of AI: 1956



A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence

August 31, 1955

John McCarthy, Marvin L. Minsky,
Nathaniel Rochester,
and Claude E. Shannon

■ The 1956 Dartmouth summer research project on artificial intelligence was initiated by this August 31, 1955 proposal, authored by John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon. The original typescript consisted of 17 pages plus a title page. Copies of the typescript are housed in the archives at Dartmouth College and Stanford University. The first 5 pages state the proposal, and the remaining pages give qualifications and interests of the four who proposed the study. In the interest of brevity, this article reproduces only the proposal itself, along with the short autobiographical statements of the proposers.

We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.

The following are some aspects of the artificial intelligence problem:

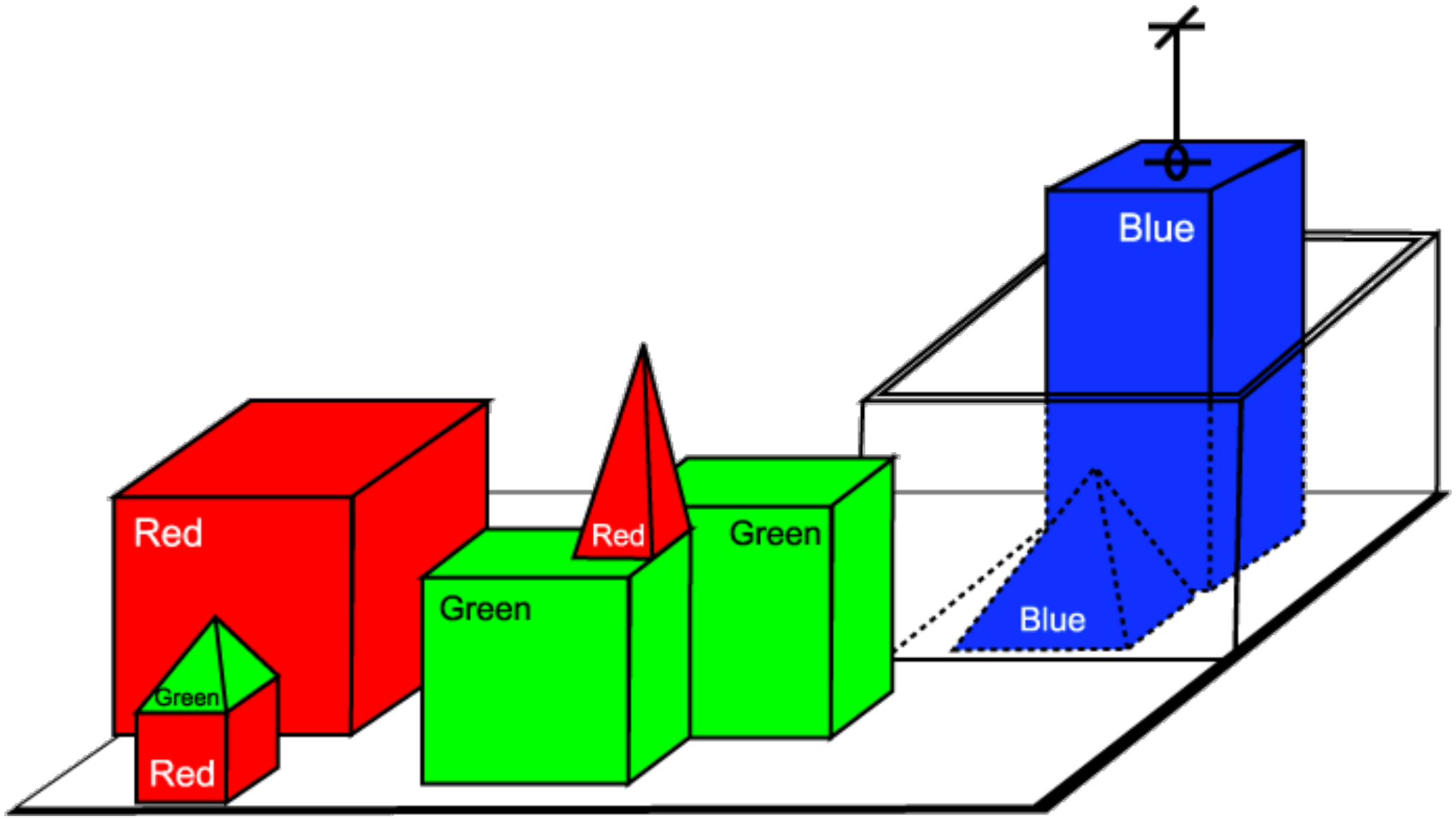
1. Automatic Computers

If a machine can do a job, then an automatic calculator can be programmed to simulate the machine. The speeds and memory capacities of present computers may be insufficient to simulate many of the higher functions of the human brain but the major obstacle is not lack of machine capacity, but our inability to write programs taking full advantage of what we have.

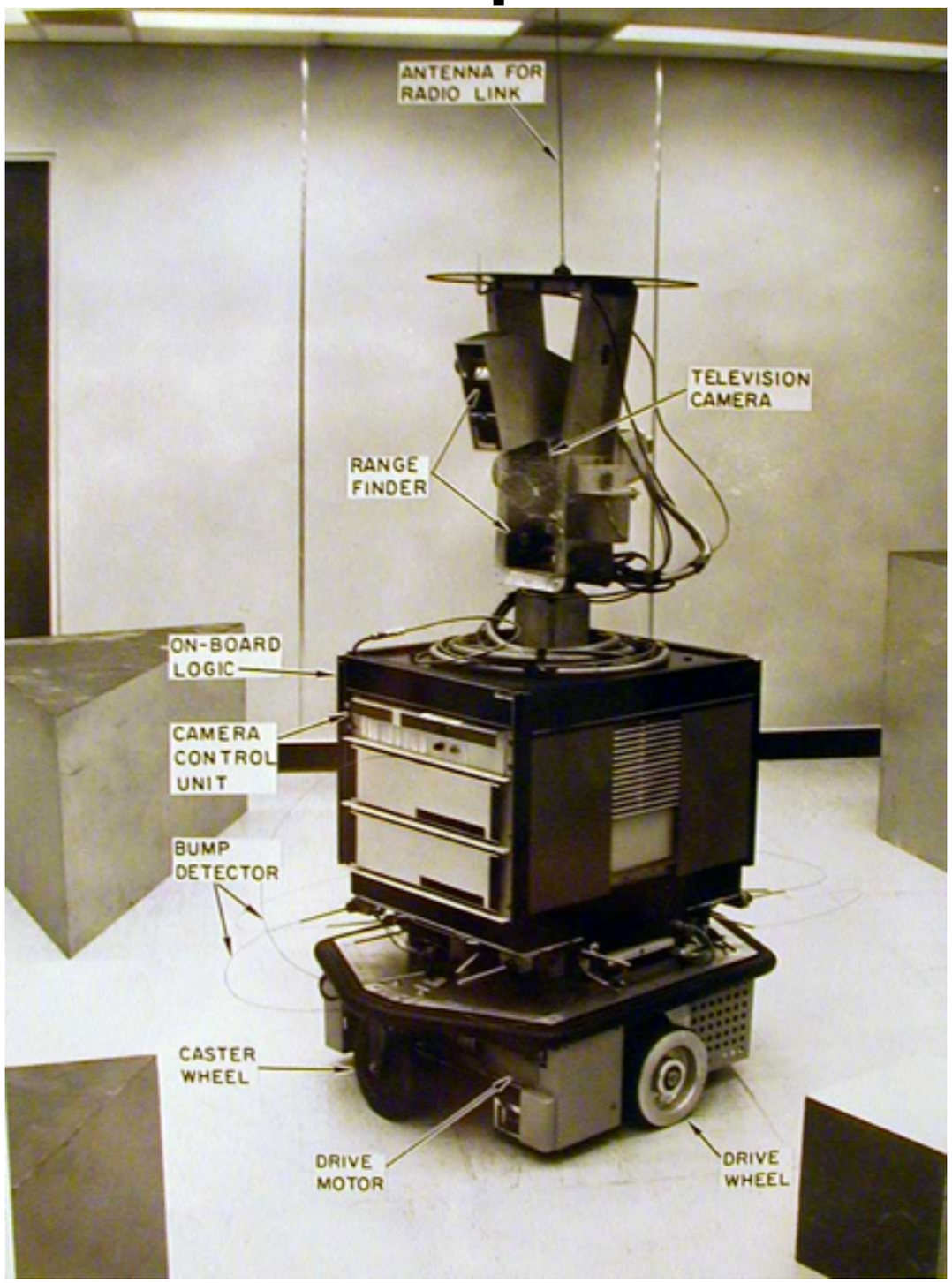
2. How Can a Computer be Programmed to Use a Language

It may be speculated that a large part of human thought consists of manipulating words according to rules of reasoning and rules of conjecture. From this point of view, forming a generalization consists of admitting a new

Great expectations

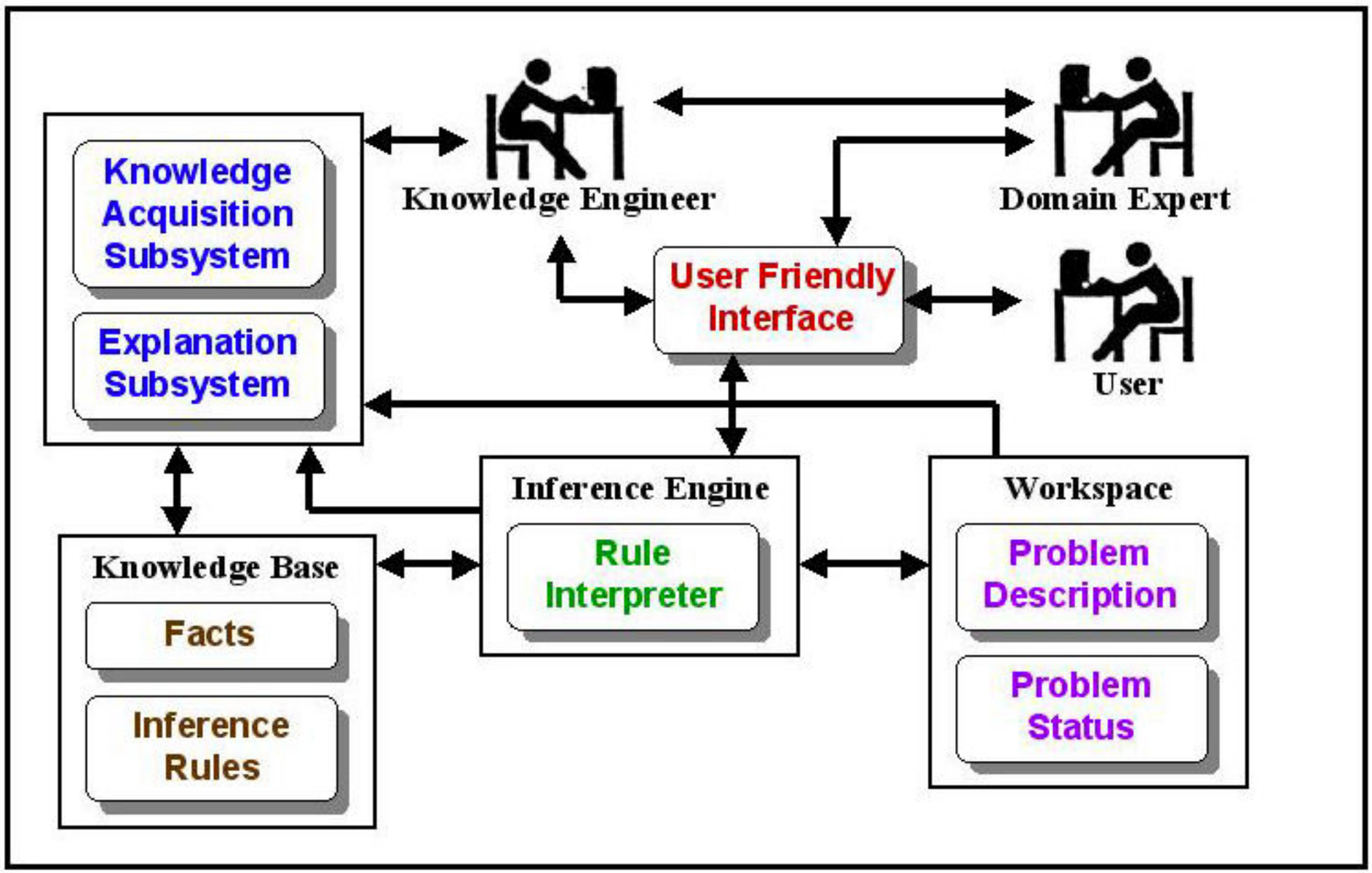


Greater expectations

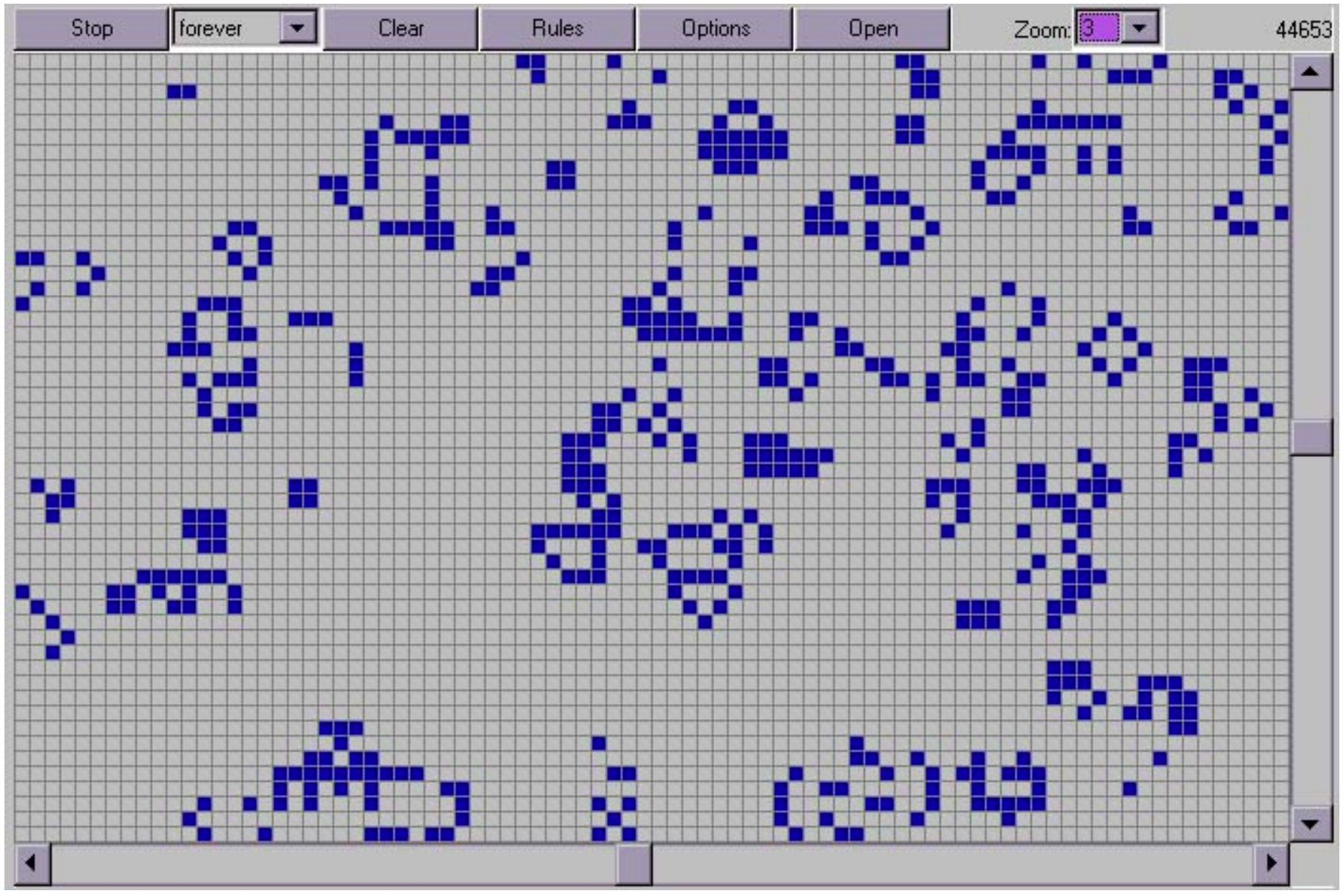


AI Winter

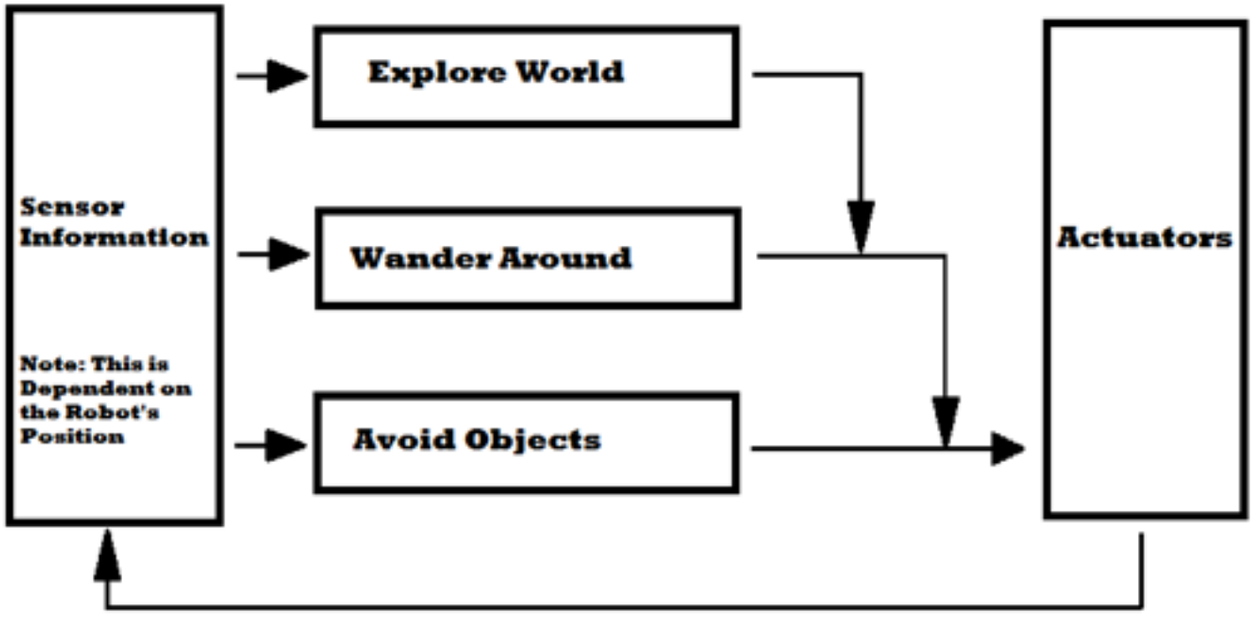
Expert systems



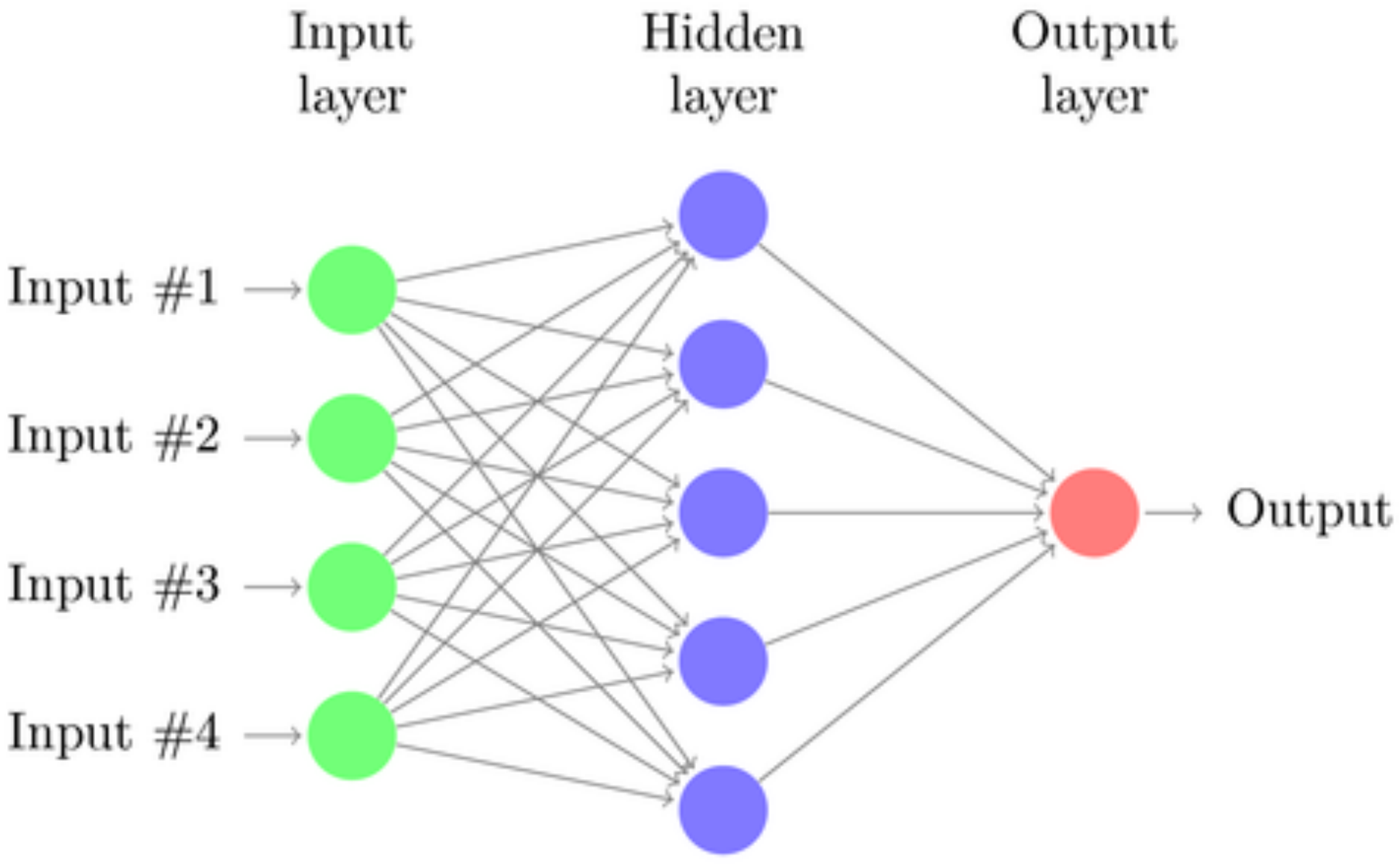
Biological inspiration



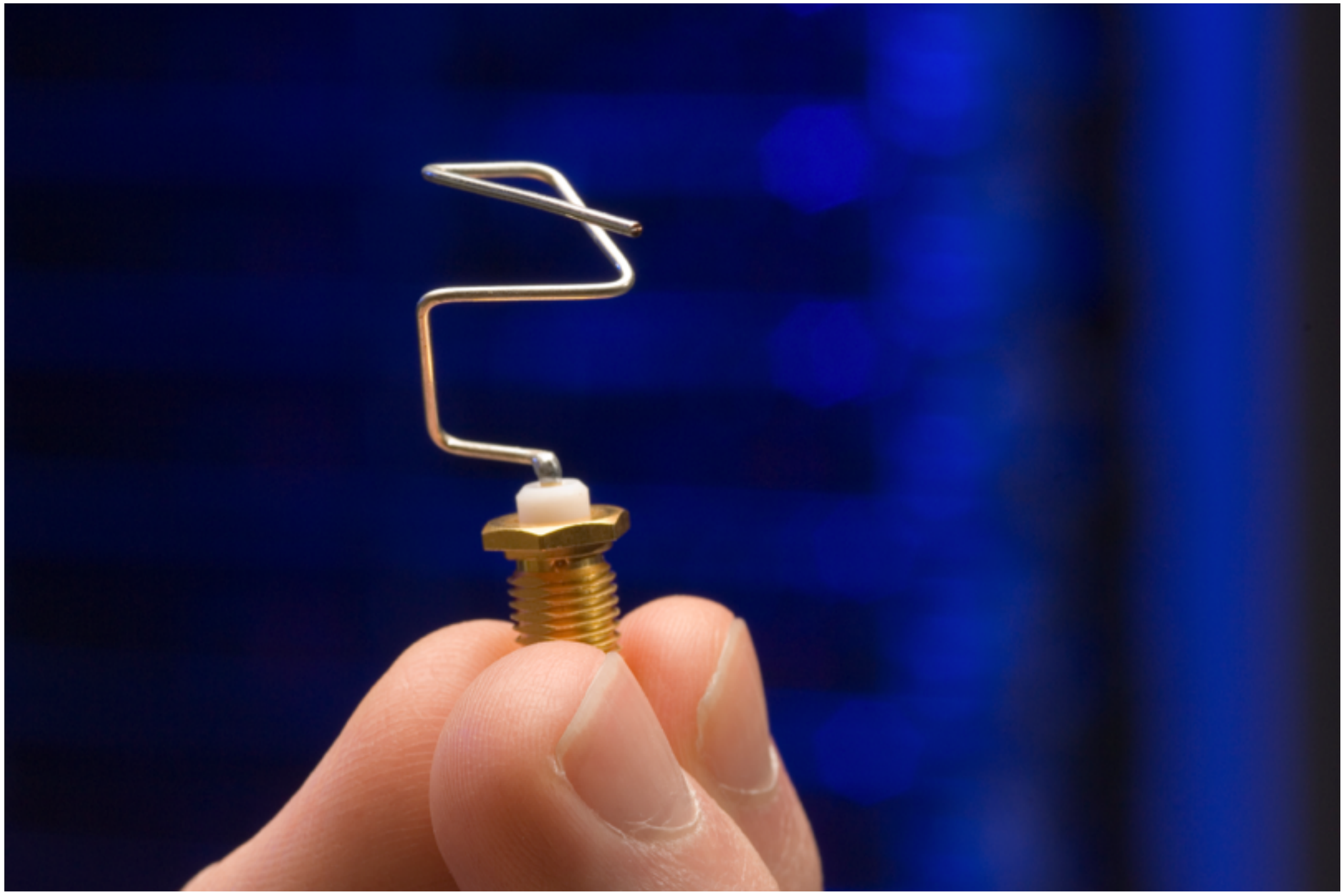
New AI, new robotics



Neural networks



Evolutionary computation



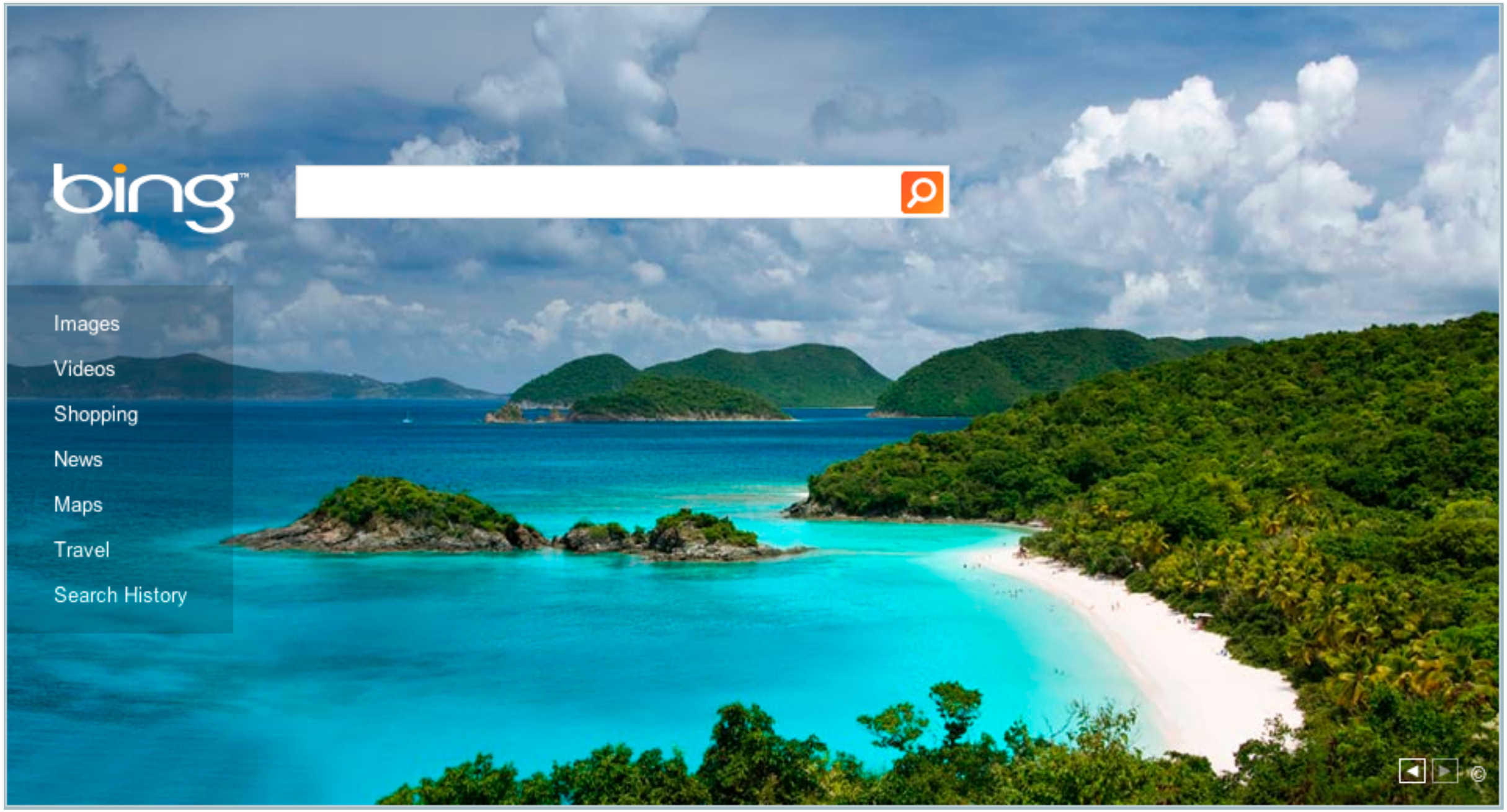
Current applications and concerns

- Crowdsourced: top applications of AI
- Spam filters
- Roomba
- Video games
- Image and voice recognition
- Search engines
- Language processing
- Google maps
- Autonomous cars
- Stock predictions

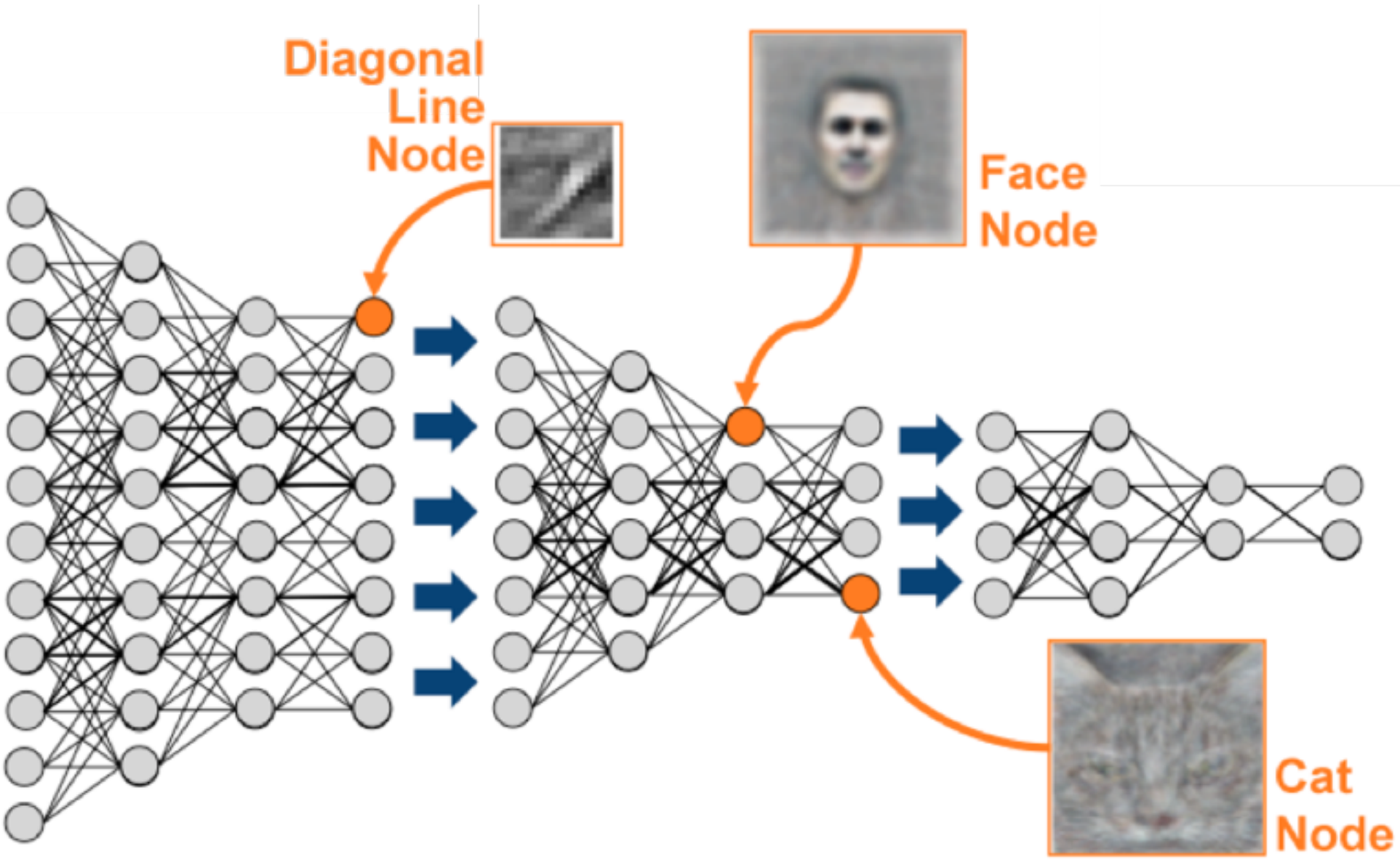
Data mining


Big
Analytics
Predictive
Mining
Analysis
Statistical
Learning
Data
Machine
Science
data
Databases
Markov
Astronomy
books
Guide
Models
analytics
predictive
time
editors
Highly
major
Reasoning
John
definitely
series
Eric
one
histories
number
focus
list
Seven
available
science
analysis
important
comprehensive
many
Nicholas
id
Predictions
CATS
David
Time
New
uncountable

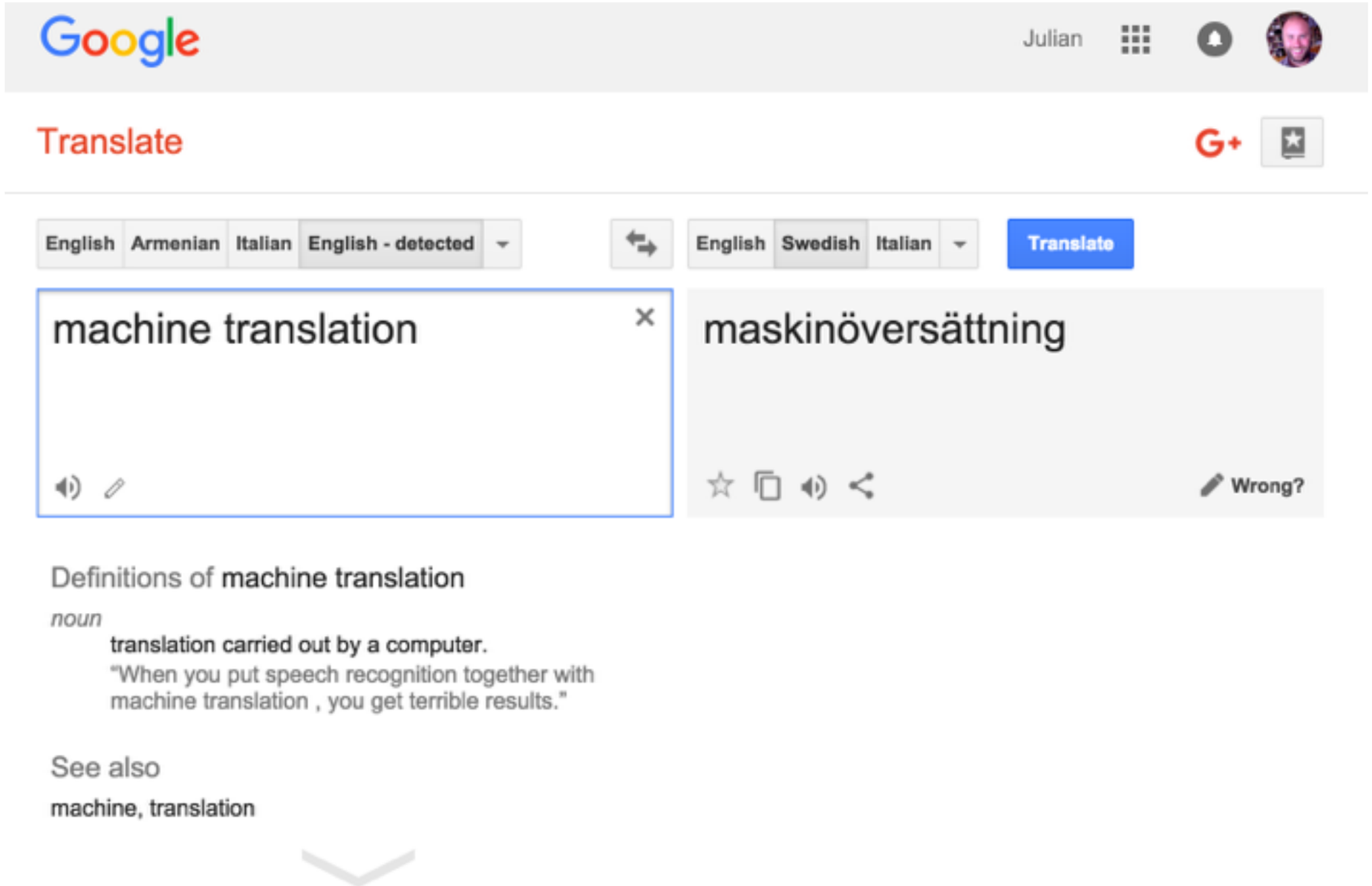
Search engines



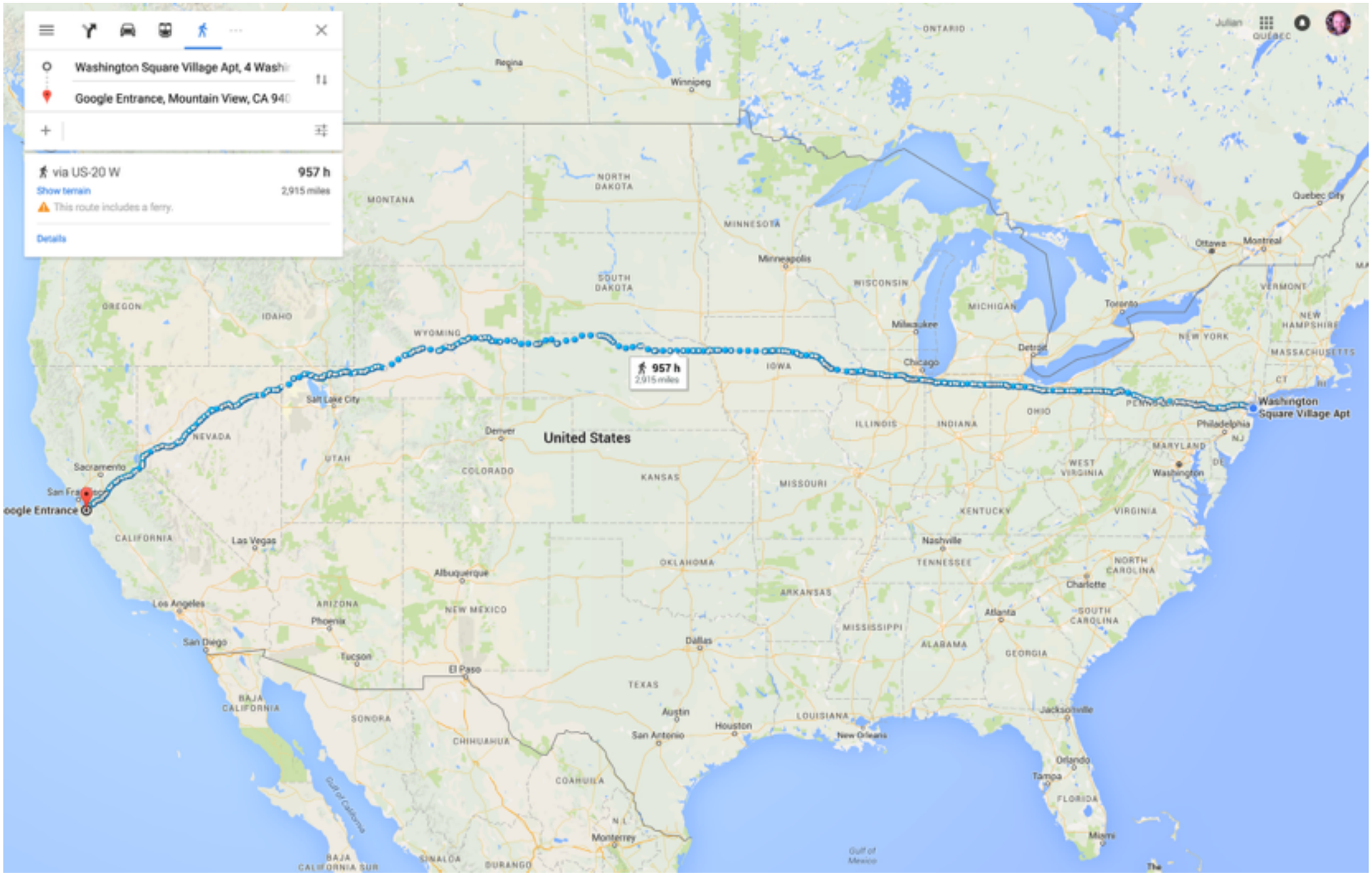
Deep learning



Machine translation



Routing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This route includes a ferry.
Details
957 h
2,915 miles
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Winnipeg
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QUÉBEC
Julian
MONTANA
NORTH DAKOTA
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Minneapolis
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MICHIGAN
Toronto
Milwaukee
Chicago
Detroit
Ottawa
Montreal
Quebec City
VERMONT
NEW HAMPSHIRE
NEW YORK
MASSACHUSETTS
OREGON
IDAHO
WYOMING
IOWA
Salt Lake City
NEVADA
UTAH
Denver
COLORADO
KANSAS
MISSOURI
ILLINOIS
INDIANA
OHIO
Philadelphia
NJ
MARYLAND
WEST VIRGINIA
Washington
KENTUCKY
VIRGINIA
Sacramento
San Francisco
CALIFORNIA
Las Vegas
Albuquerque
OKLAHOMA
Nashville
TENNESSEE
NORTH CAROLINA
Charlotte
ARKANSAS
Los Angeles
ARIZONA
Phoenix
NEW MEXICO
San Diego
Tucson
El Paso
Dallas
MISSISSIPPI
ALABAMA
GEORGIA
Atlanta
SOUTH CAROLINA
TEXAS
BAJA CALIFORNIA
SONORA
CHIHUAHUA
Austin
Houston
San Antonio
LOUISIANA
New Orleans
Jacksonville
Orlando
Tampa
FLORIDA
COAHUILA
Monterrey
Miami
BAJA CALIFORNIA SUR
SINALOA
DURANGO
Gulf of California
Gulf of Mexico

Self-driving cars

Walking robots

Military robots

Games

Games

Superintelligence?

What is AI?

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It’s all just search

AI as search

- Search for plans, strategies, policies, models, objects, proofs…

Course overview 2.0:

It’s all just search

Sep 9: What is AI?

- Overview and history of the field
- Problem solving as search
- Applications of AI, particularly games and robotics
- Info on and discussion about group projects

Sep 16: Uninformed search

- Breadth-first
- Uniform cost
- Depth-first
- Iterative deepening

Sep 23: Informed search and optimization

- A*
- Heuristics
- Hill-climbing
- Simulated annealing

Sep 30: Evolutionary search

- Evolution strategies
- Genetic algorithms
- Genetic programming
- Crossover, mutation
- Fitness landscapes

Oct 7: Adversarial search

- Minimax
- Alpha-beta pruning
- Evaluation functions
- Chance nodes

Oct 14: Logical agents

- Propositional logic
- Knowledge representation using logic
- Inference
- *We can search in the space of logical statements*

Oct 21: Midterm

- *You'll be searching for answers to the questions in the exam*

Oct 28: First-order logic

- Knowledge representation using predicate logic
- Inference in predicate logic
  - *Inference is a form of search*

Nov 4: Supervised learning

- Concept learning
- Linear discriminant functions
- Perceptrons
- Neural networks
- *Searching for functions that predict a target/class from features in a set of input data*

Nov 11: Supervised learning

- Decision tree learning

- *Searching for decision trees*

Nov 18: Reinforcement learning

- Policy search
- Temporal difference learning
- *Searching for policies that solve a problem*

Nov 25: Robotics

- Types of robot architectures
- Planning and path planning *(searching for plans and paths)*
- Localization and mapping *(searching for the location that matches what the sensors say)*
- Reactive methods
- Learning in robotics *(searching for policies or models)*

Dec 2: Philosophy & Q/A

- Philosophical foundations of artificial intelligence
- Intelligence versus consciousness
- Superintelligence
- Are you a robot?
- Questions and answers on course content

Dec 9: Final exam

- *More searching for answers that will give you a good grade*

Hand-in date for projects

- TBA (very soon)

Other basic information

This course

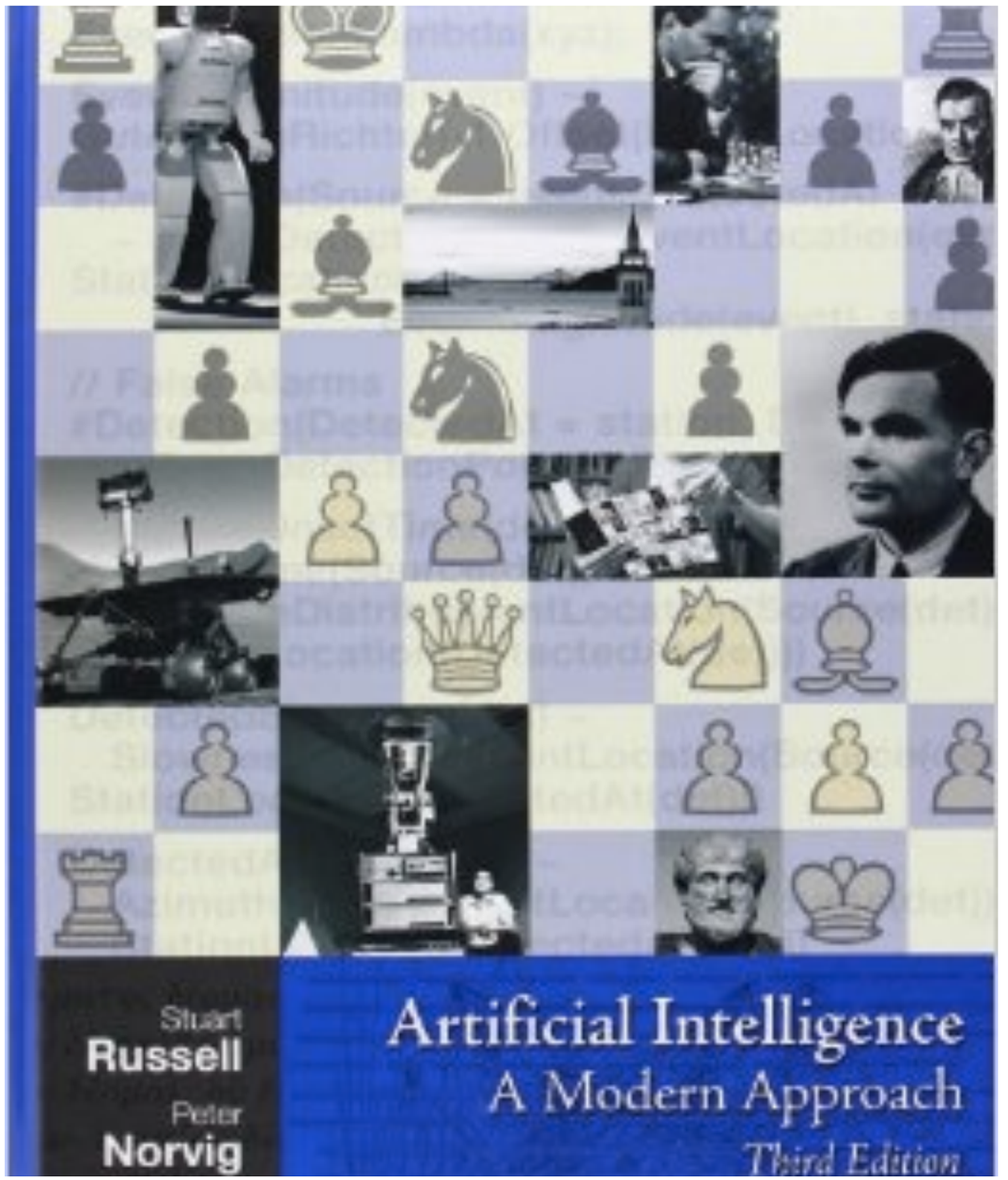
- An introduction to artificial intelligence (AI)
- Prerequisites: intermediate programming skills, an algorithms and data structures course, interest in the topic
- Meant to give you both an overview of the field, knowledge of useful methods and hands-on experience with a group project

AI for Games

- Special topics course given next spring
- Builds on this course, and focuses on the application of AI to games (mostly videogames)
- *If you took AI for Games last spring, that was a different course with large overlaps with the current AI course. If you took that course, it is* ***not recommended*** *that you take this course (AI).*

Course literature

- “Artificial Intelligence: a Modern Approach” by Russell and Norvig
- Classic book, very comprehensive and useful but a but old-fashioned
- The course will not strictly follow the book, and less than half of it will be covered
- Occasionally additional readings will be given
- See course slides!



Course overview

- Sep 9 to Oct 14: Introduction, AI as search, various search strategies.

- Oct 21: Midterm exam

- Oct 28 to Dec 2: Logic, learning, applications, philosopy.

- Dec 9: Final exam

- Dec 14 (preliminary): Final project hand-in.

Grading

- 30% midterm
- 30% final exam
- 40% group project

Exams are meant to test your extensive knowledge of the complete course material. The group project is meant to allow you to indulge in a project that interests you within the general area of the course.

Group project

- Assemble in groups of three students (any exceptions run through me)

- Choose a benchmark task

- Part I of project: Implement and compare a number of algorithms on your benchmark problem

- Part 2 of project: Do something fun and interesting with your benchmark problem!

    - For example, invent a hybrid algorithm

Some suggestions for benchmark problems

- One of the CIG/AIIDE game competitions
  - Fighting game competition
  - General game playing competition
    - Mario AI competition, Pac-Man etc…
- Planning/scheduling/timetabling benchmark
- Robot simulator + task (Gazebo, Webots etc)
- Propose something new!