FLORIDA ATLANTIC UNIVERSITY
COLLEGE OF ENGINEERING & COMPUTER SCIENCE

Hot Topics in 10 Hours

ARTIFICIAL INTELLIGENCE BOOTCAMP

MONDAY, AUGUST 10 – FRIDAY, AUGUST 14

Oge Marques, PhD

Professor

College of Engineering and Computer Science


WELCOME
WELKOM
YÔKOSO
PÓ LA BWAM
VÆLKOMIN
ÜDVÖZLET
DEGEMER MAD
WILLKOMEN
MIRÉ SE VINI
WILLKOMMEN
DOBRODOŠLI
MARHABAN
BIENVENIDO
WELKUM
BARUUKH HABA
BABI GALOUST
SWAGATHAAM
MARSHA YOG YLA
BONVENON
BONAVINUTA
HOSGELDINIZ
I BISIMILA
WITAJ
XÓS GELMISSINIZ
NAMASTE
BIENVENUE
AMREHBA SISSWÈNE
BENVINGUTS
SWAAGA
FÁILTE
SWAGATA
ULIHELISOI
BENVIDO
WOLKOM
ONGI ETORRI
VÍTEJTE
GABITE

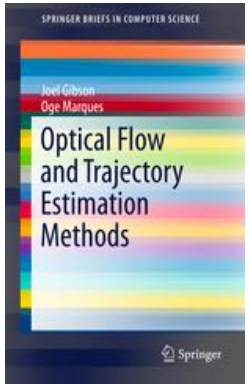
Introductions

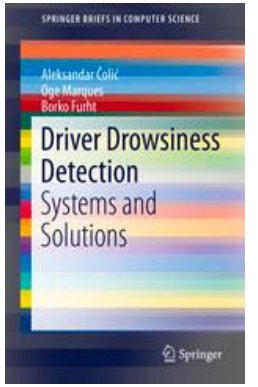
My research interests

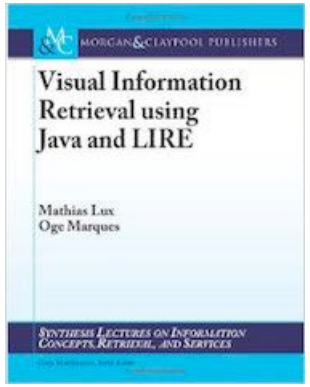
Intelligent processing of visual information

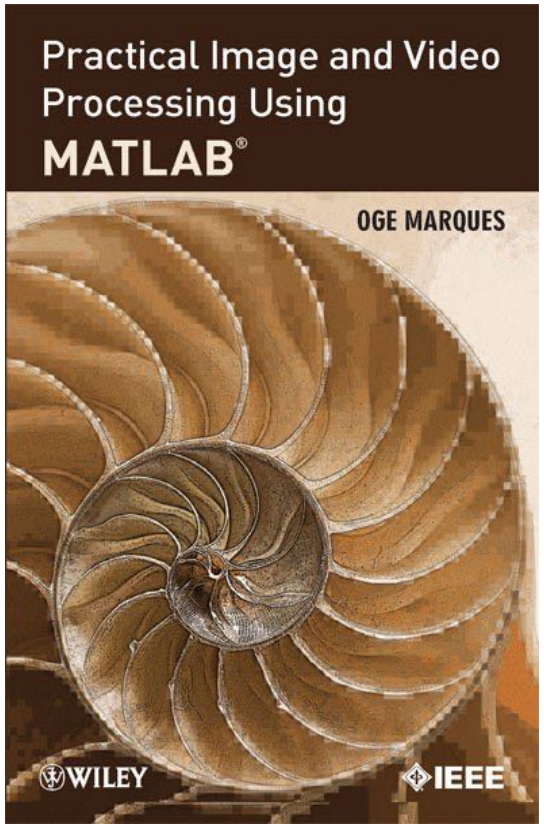
- image processing
- medical image analysis
- computer vision
- human vision
- artificial intelligence
- machine learning
- deep learning

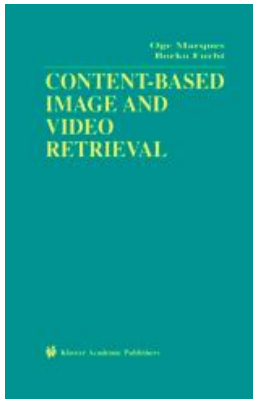
My work: selected books

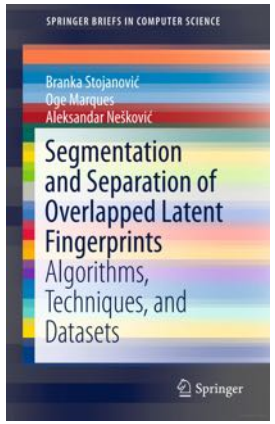


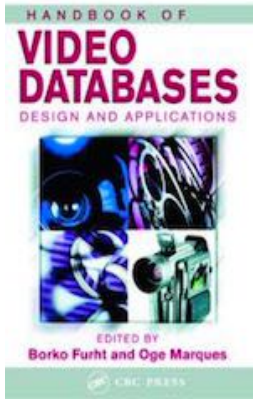


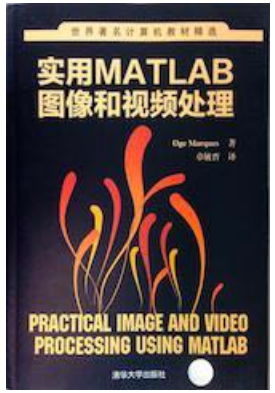


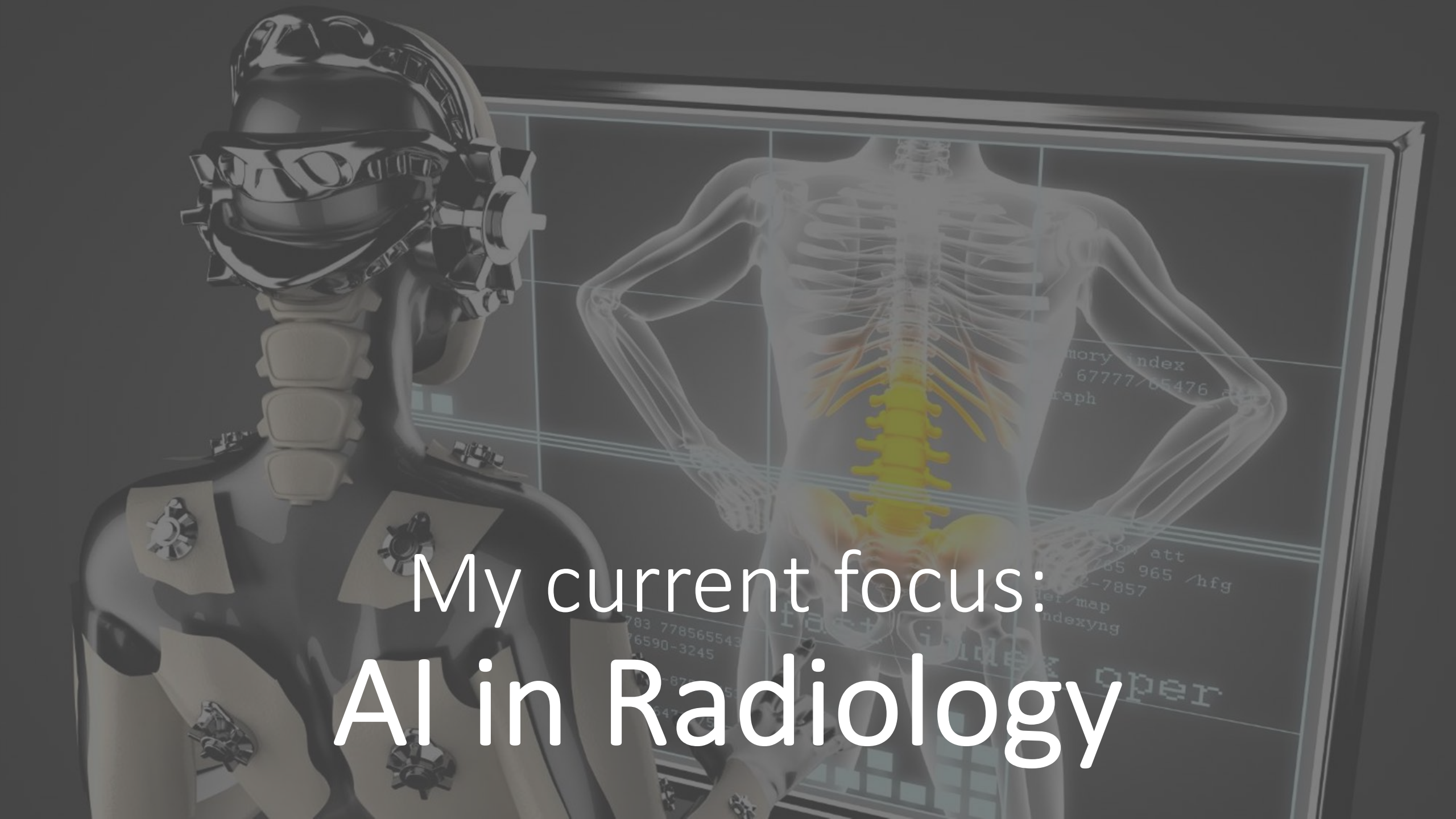












My current focus:

AI in Radiology

Your turn

Please use the Canvas Discussion Board forums to answer the question:

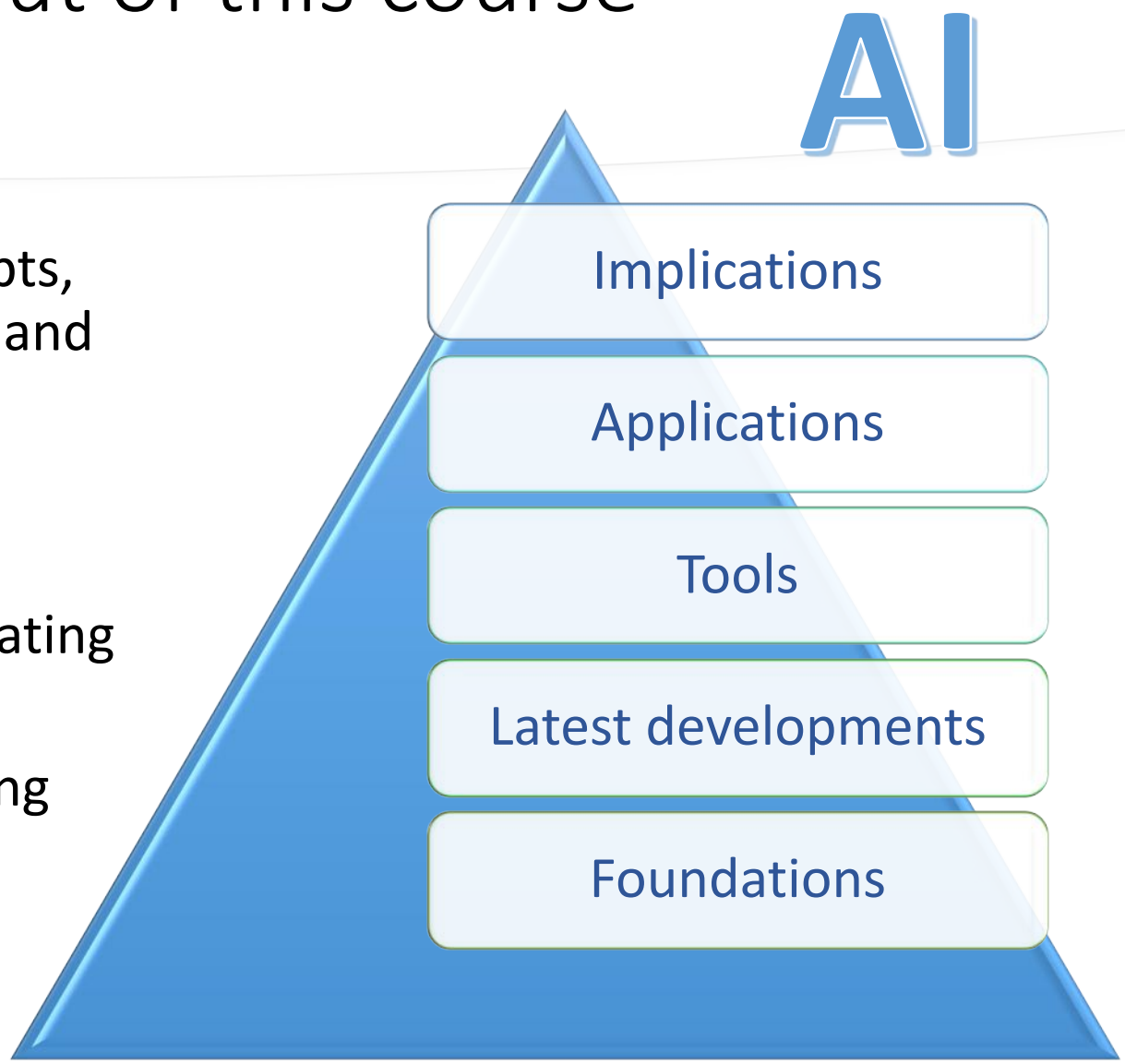
Why are you taking this course?

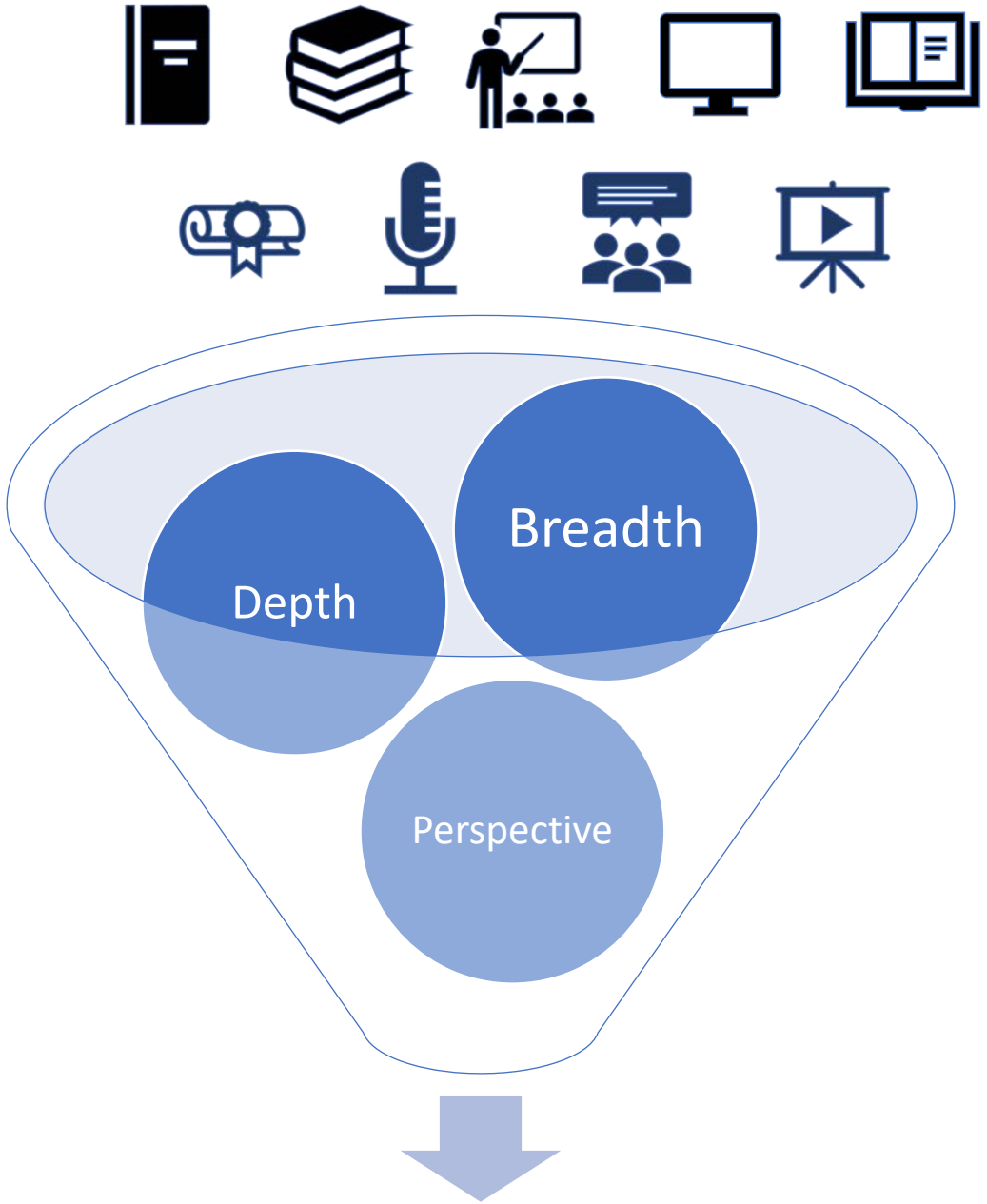
Today's agenda

- Course goals and scope
- Course logistics
- [1a] Fundamentals of AI: history, techniques, applications, and examples
- [1b] Fundamentals of Machine Learning (ML) & Deep Learning (DL)

What I hope you will get out of this course

1. Learn the basic **foundations**, main concepts, and terminology of AI, machine learning, and deep learning.
2. Interact with hands-on **examples** of applications of AI in numerous domains.
3. Become resourceful and capable of navigating the web of online AI **resources**.
4. Become more **discriminating** when reading about new developments in AI.
5. Improve your understanding of the **risks, challenges, and implications** of AI.





Your learning goals

Course overview

- **Module 1:**
  - Fundamentals of AI: history, techniques, applications
  - Fundamentals of Machine Learning (ML) and Deep Learning (DL)
- **Module 2:**
  - The Machine Learning workflow: from data acquisition to deployment of a solution
  - Example of a ML workflow
- **Module 3:**
  - Neural Networks: fundamentals and examples
  - Deep Learning architectures
- **Module 4:**
  - Transfer Learning
  - Deep Learning examples in computer vision, natural language processing, and medical diagnosis.
- **Module 5:**
  - AI and DL beyond the code: implications, risks, ethical considerations.
  - Lifelong learning: courses to take at FAU, books, newsletters, YouTube channels, podcasts, and other resources.

Keys to success

- Put the time and effort
- Take (and share) good notes
- Play with some tools
- Participate in discussion board forums
- Communicate often
- Stay curious

Your mileage may vary

Questions

Artificial Intelligence Bootcamp

Lecture 1a: Fundamentals of AI: history, techniques, applications

Oge Marques, PhD

Professor

College of Engineering and Computer Science

FAU FLORIDA ATLANTIC UNIVERSITY

@ProfessorOge

Outline

1. What is AI?
   [definitions / history]
2. AI: how does it work?
   [techniques / terminology]
3. What AI can do?
   [applications]
4. What AI can’t do?
   [limitations]

Part 1:

What is AI?

Key idea:

AI is hard to define

What is Intelligence?

Defining artificial intelligence isn't just difficult; it's impossible, not the least because we don't really understand human intelligence.

Source: Loukides and Lorica (2016) https://www.oreilly.com/ideas/what-is-artificial-intelligence

Artificial intelligence is hard to define…

Merriam-Webster:

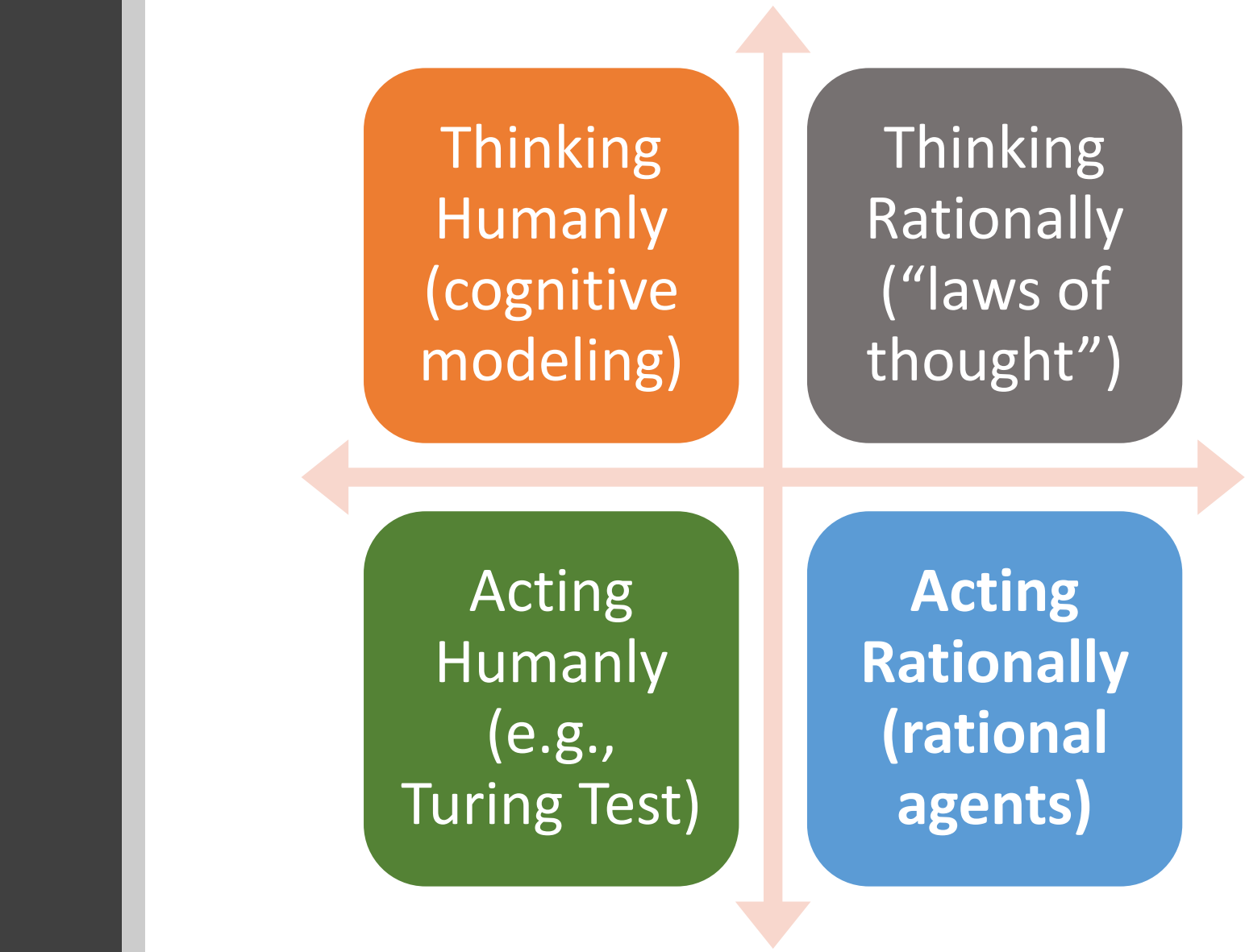
- a branch of computer science dealing with the simulation of intelligent behavior in computers
- the capability of a machine to imitate intelligent human behavior

Encyclopedia Britannica:

- the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings

Sources: Merriam-Webster and Encyclopedia Britannica

Artificial Intelligence definitions: categories



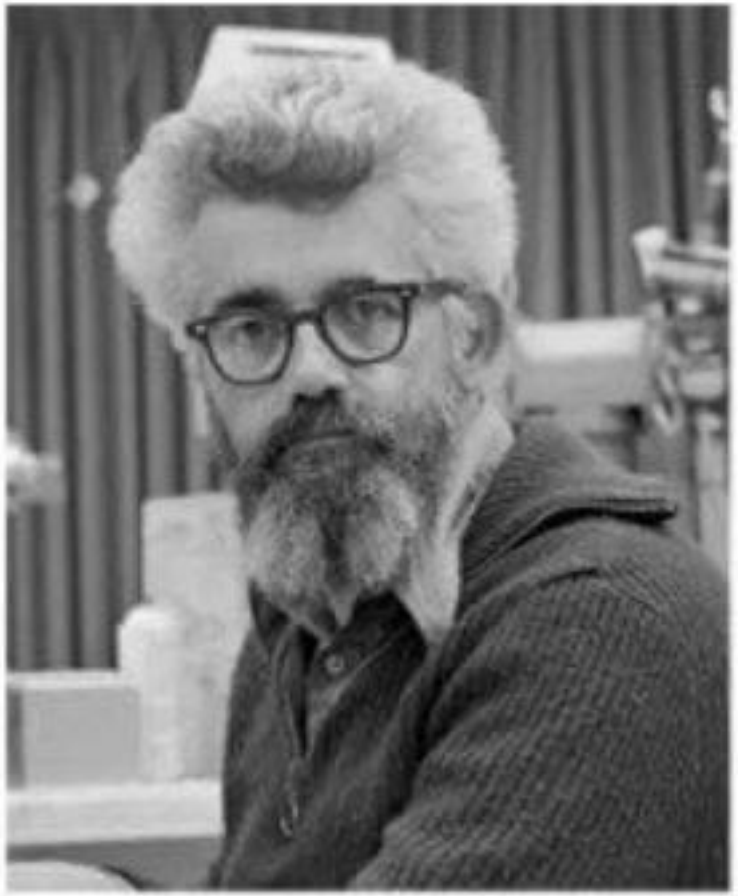
Source: (Russell & Norvig 2011)

Key idea:

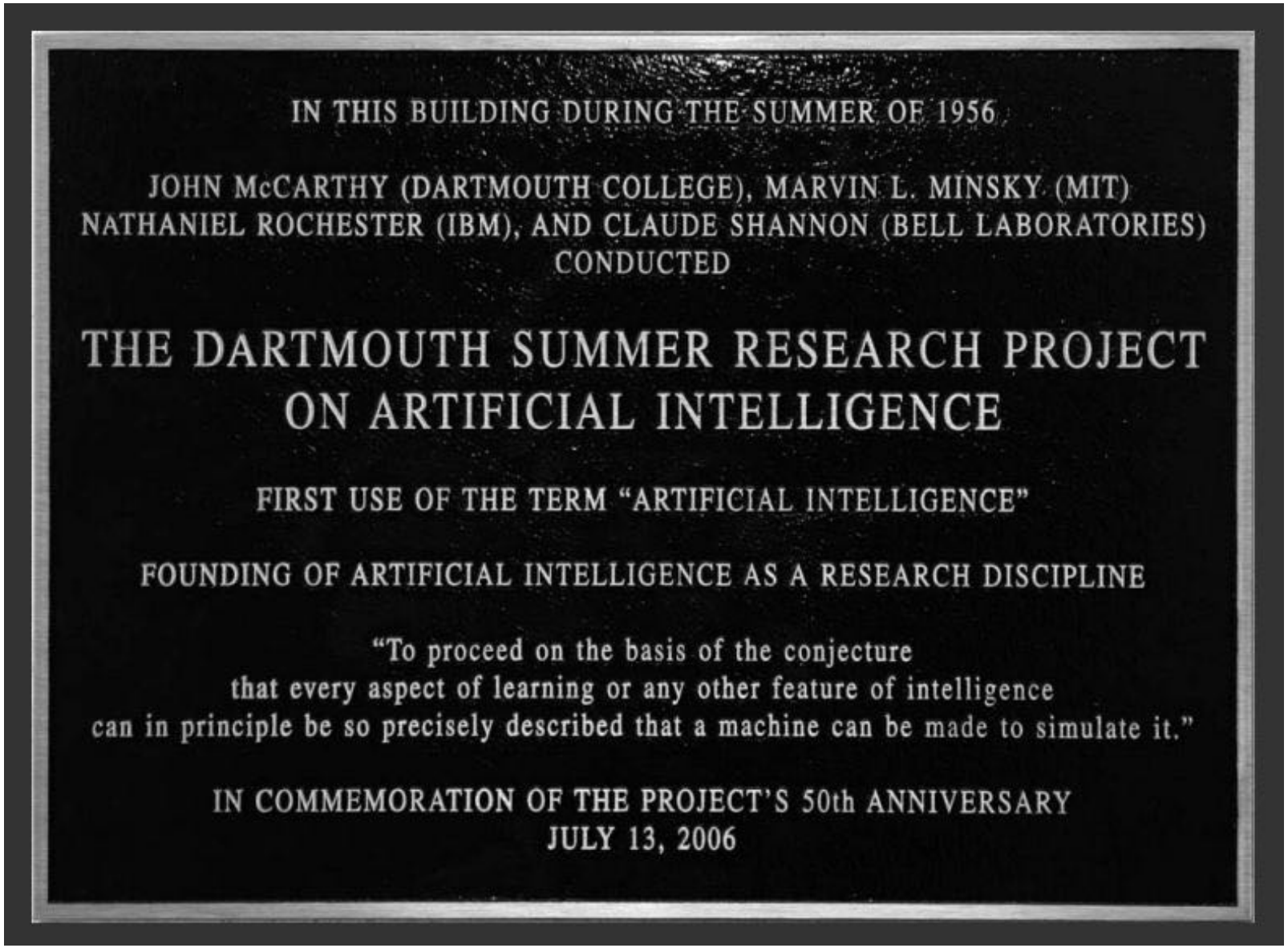
AI has made promises before…

Dartmouth Workshop 1956

> “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 .”



John McCarthy



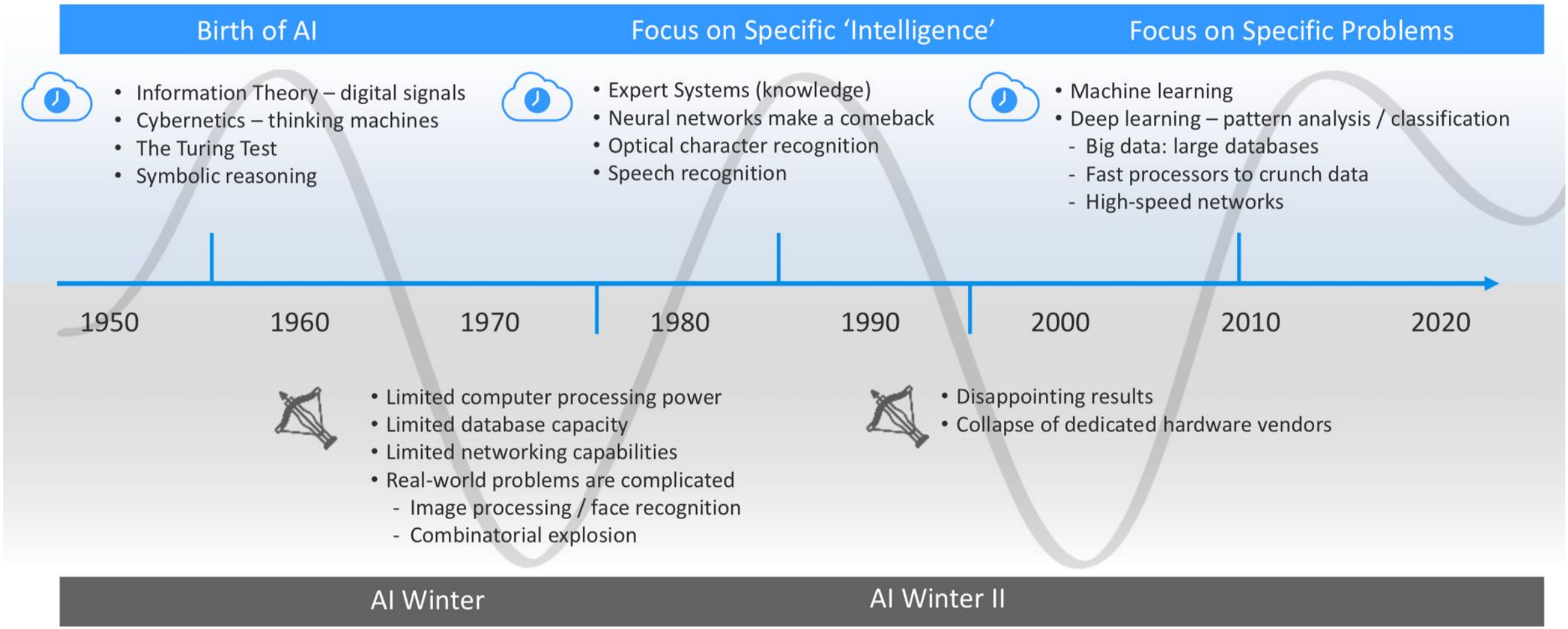
"machines will be capable, within twenty years, of doing any work a man can do."

Herbert Simon (1965)

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

Marvin Minsky (1970)

An AI Timeline



Source: https://www.slideshare.net/dlavenda/ai-and-productivity

Key idea:

AI is a very hot area (again) today!

AI progress: driving forces

Advances in **computer hardware**

Availability of **huge volumes of data**

Better **algorithms**

Machine learning solutions to **highly visible problems**

Better **sensors**

Source: Loukides and Lorica (2016)

1976 – 1st Digital Camera

0.01 MP / 3.75 lbs / $10K

2014 – Digital Camera

>10 MP / 0.03 lbs / $10

← 1 BILLION TIMES BETTER →

← 1,000x Resolution & 1,000 lighter & 1,000 cheaper

Key idea:

AI has had several highly visible successes

1997

Garry Kasparov, left, plays chess against Deep Blue in 1997. Feng-Hsiung Hsu, one of Deep Blue's designers, moves the pieces for the computer.

2011


PIENSE
THINK
ΣΚΕΨΟΥ
DENKE
PENSER
$300,000
$1,000,000
$200,000
KEN
WATSON
BRAD

2016

ALPHAGO

TRIBECA FILM FESTIVAL 2017

BFI LONDON FILM FESTIVAL OFFICIAL SELECTION 2017

WINNER TRAVERSE CITY FILM FESTIVAL 2017

OFFICIAL SELECTION MILL VALLEY FILM FESTIVAL 2017

Official Selection WARSAW FILM FESTIVAL

VIFF Official Selection 2017

2018: AlphaZero

The New York Times

ESSAY

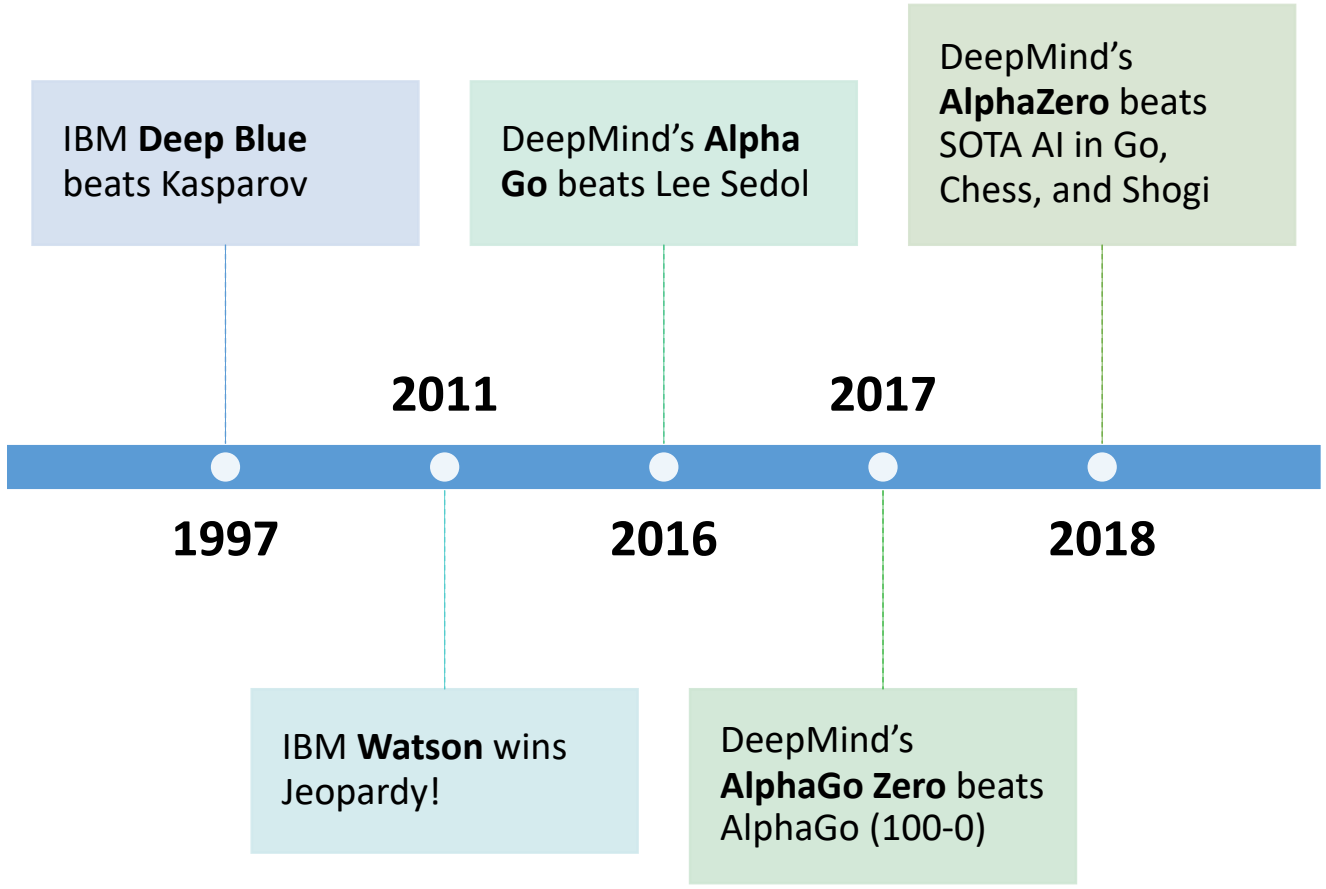
One Giant Step for a Chess-Playing Machine

The stunning success of AlphaZero, a deep-learning algorithm, heralds a new age of insight — one that, for humans, may not last long.

By Steven Strogatz

Dec. 26, 2018

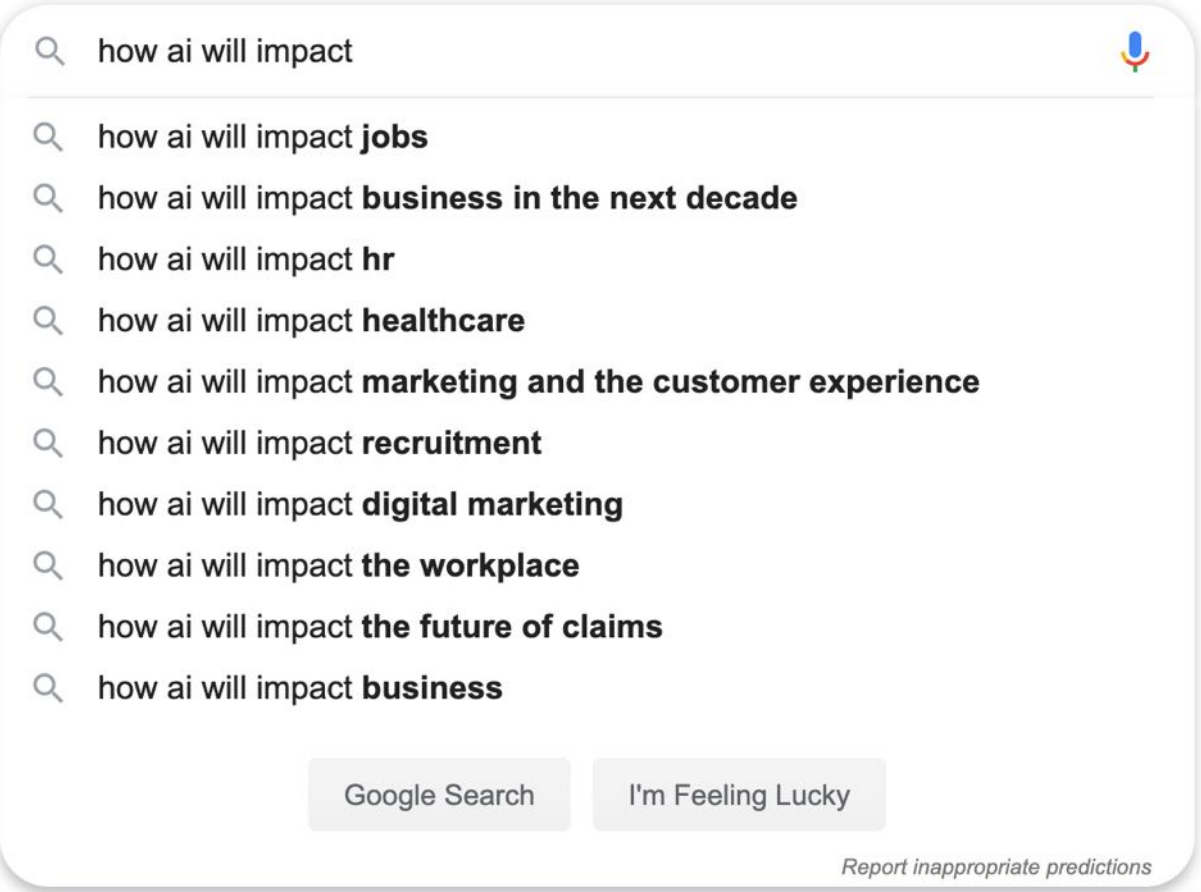
Selected high-profile successes



What do they have in common?

Key idea:

AI will impact every area of human activity


how ai will impact
how ai will impact jobs
how ai will impact business in the next decade
how ai will impact hr
how ai will impact healthcare
how ai will impact marketing and the customer experience
how ai will impact recruitment
how ai will impact digital marketing
how ai will impact the workplace
how ai will impact the future of claims
how ai will impact business
Google Search
I'm Feeling Lucky
Report inappropriate predictions

Key idea:

Once it becomes a product,
we don’t call it AI anymore

Emmy-winning US TV Shows

Police Detective TV Dramas

Critically Acclaimed Witty TV Shows


CLEAN
iRobot
Roomba


Smart Home
Security
Lighting
Network
Camera
40%
21°C
69.8°F
09:37
ON
37°C
98.6°F
CLOUDY


Your location
Arrivals
14 min
1 hr 44
1 hr 46
14 min
SOUTH HOMES
16 min
14 min


Front of Check


306,962 views
Romero and 2 others
Sep 26, 2017 at 13:35
Pixie Me Productions added 3 ne
André Vallecillo
Sep 26, 2017 at 13:34


ADVERTISING
CREATIVE
CREATIVE
Dictionary


Hi, how can I help?

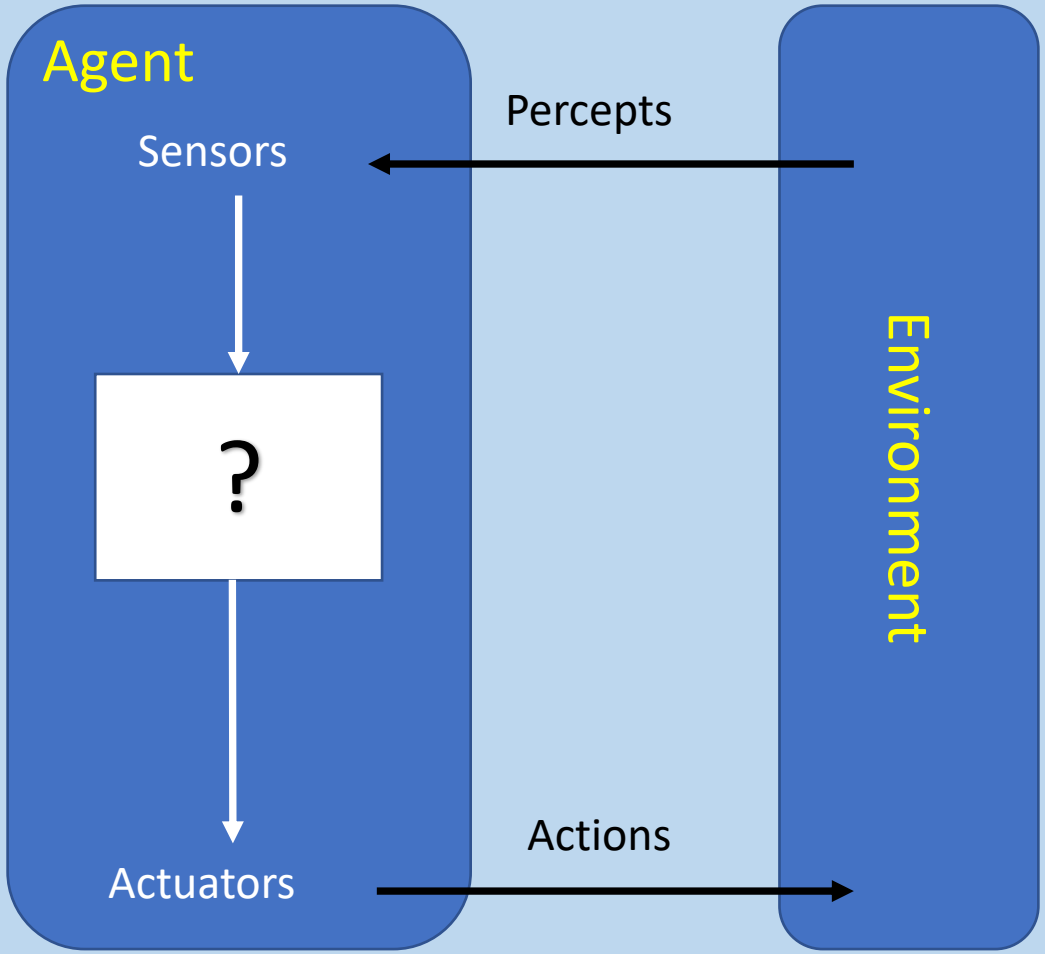
Part 2:

AI: how does it work?

Key idea:

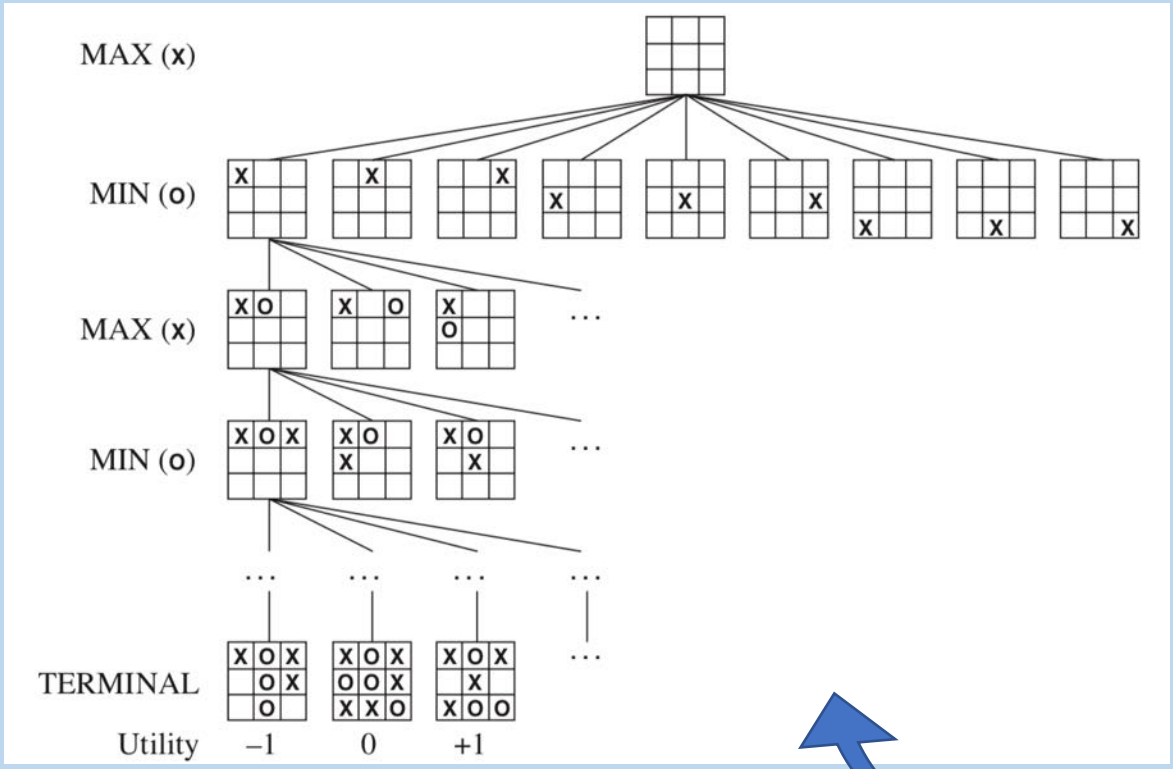
AI programs are agents that interact with an environment

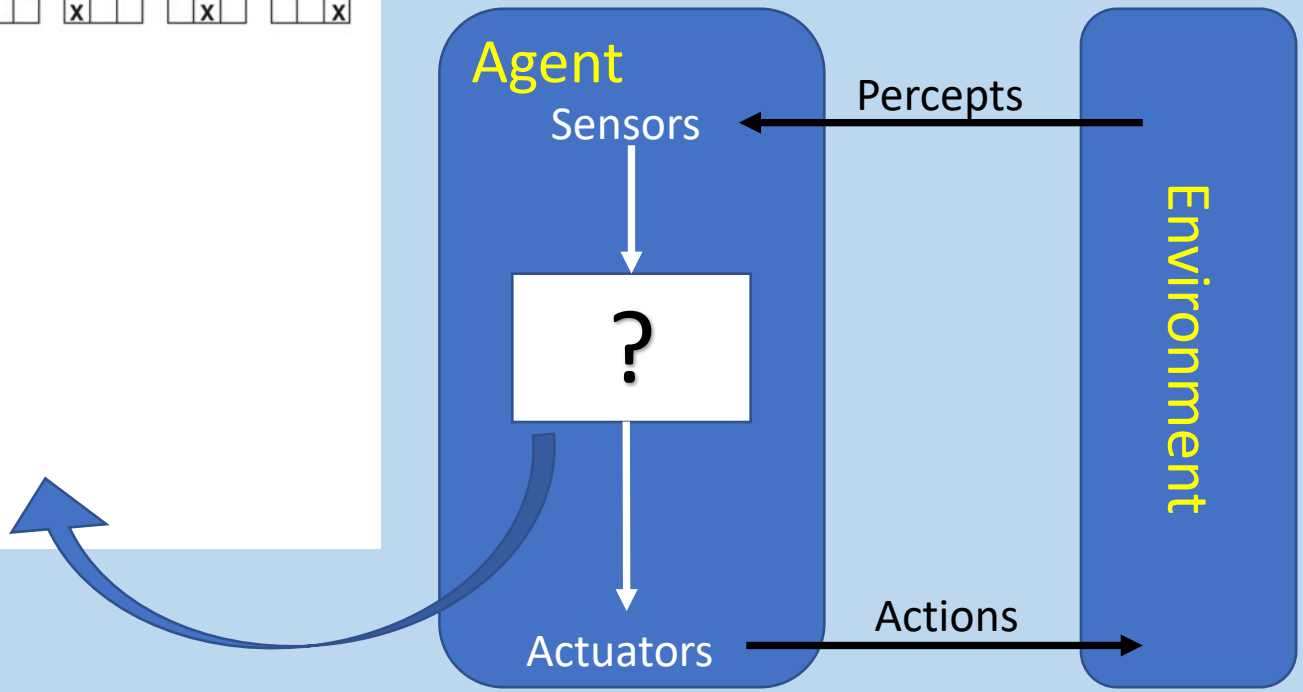
Agents and environment

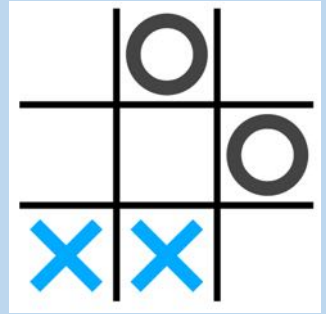


Source: (Russell & Norvig 2011)

Agents and environment

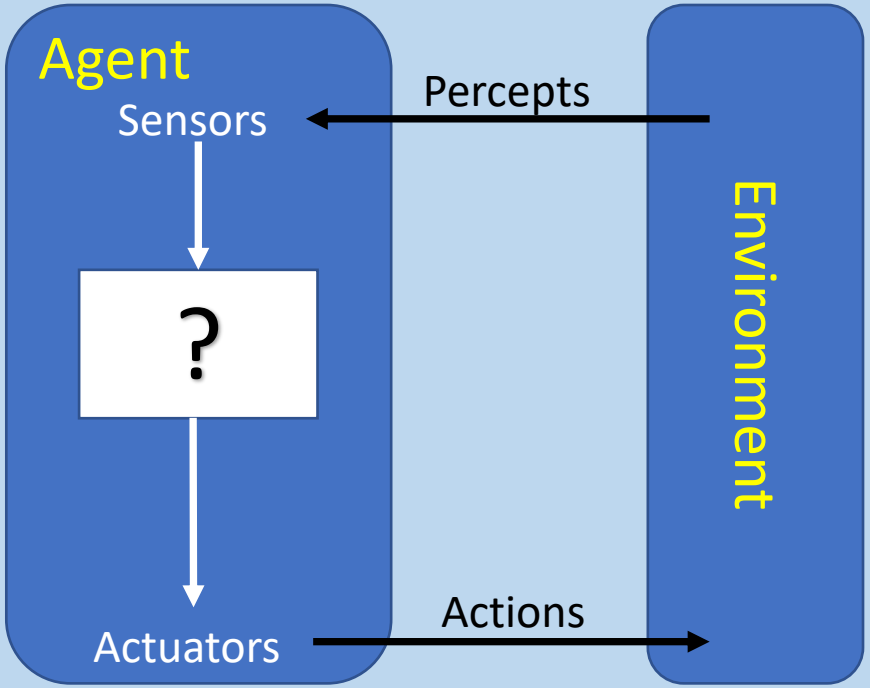






Source: (Russell & Norvig 2011)

Agents and environment



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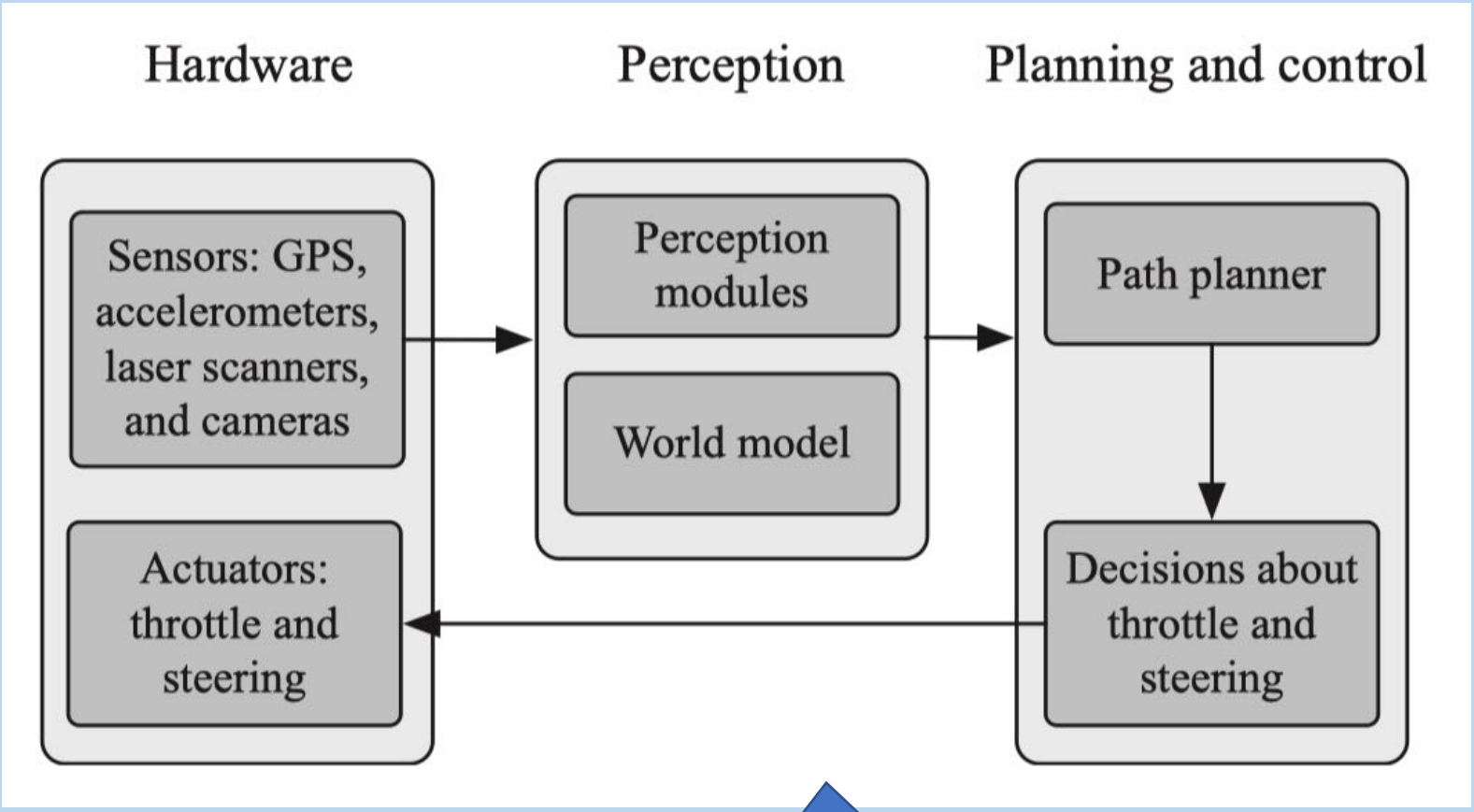
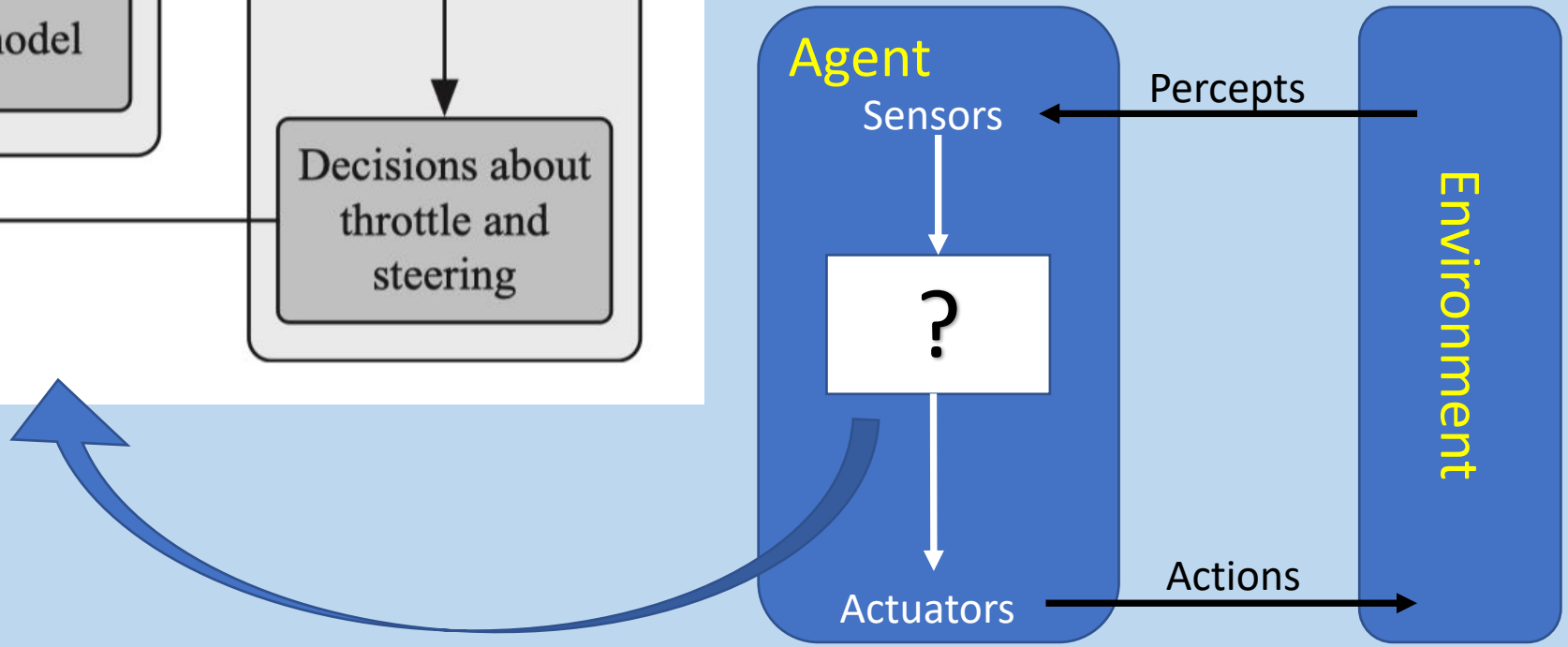
Agents and environment





Source: (Russell & Norvig 2011)

Rational agents

- For each possible percept sequence, a rational agent should:
  - select an action that is expected to maximize its performance measure,
  - based on the evidence provided by the percept sequence and
  - whatever built-in knowledge the agent has.

Source: (Russell & Norvig 2011)

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Source: (Russell & Norvig 2011)

Rational agents

- In a nutshell, AI has focused on the study and construction of agents that ***do the right thing***.
- Important reminders
  - Perfect rationality is not feasible in complex environments
    - We might need to settle for ***limited rationality***
  - The **value alignment problem**
    - The values or objectives put into the machine must align with those of the human.
      - Ultimately, we want agents that are provably beneficial to humans.

Source: (Russell & Norvig 2020)

Agent Type	Performance Measure	Environment	Actuators	Sensors
Robot soccer player	Winning game, goals for/against	Field, ball, own team, other team, own body	Devices (e.g., legs) for locomotion and kicking	Camera, touch sensors, accelerometers, orientation sensors, wheel/joint encoders
Internet book-shopping agent	Obtain re-quested/interesting books, minimize expenditure	Internet	Follow link, enter/submit data in fields, display to user	Web pages, user requests
Autonomous Mars rover	Terrain explored and reported, samples gathered and analyzed	Launch vehicle, lander, Mars	Wheels/legs, sample collection device, analysis devices, radio transmitter	Camera, touch sensors, accelerometers, orientation sensors, , wheel/joint encoders, radio receiver

PEAS:

Performance measure,

Environment,

Actuators,

Sensors

Environment types

- **Fully observable** (vs. partially observable): An agent's sensors give it access to the complete state of the environment at each point in time.
- **Deterministic** (vs. stochastic): The next state of the environment is completely determined by the current state and the action executed by the agent.
- **Episodic** (vs. sequential): The agent's experience is divided into atomic "episodes" (each episode consists of the agent perceiving and then performing a single action), and the choice of action in each episode depends only on the episode itself.

Environment types

- **Static** (vs. dynamic): The environment is unchanged while an agent is deliberating.
- **Discrete** (vs. continuous): A limited number of distinct, clearly defined percepts and actions.
- **Single agent** (vs. multiagent): An agent operating by itself in an environment.

What are the environment types of…

- Tic-tac-toe
- Chess
- Go
- DOTA 2
- Self-driving vehicles
- The real world

- **Fully** vs. **partially** observable
- **Deterministic** vs. **stochastic**
- **Episodic** vs. **sequential**
- **Static** vs. **dynamic**
- **Discrete** vs. **continuous**
- **Single agent** vs. **multiagent**

Agent types (in order of increasing generality)

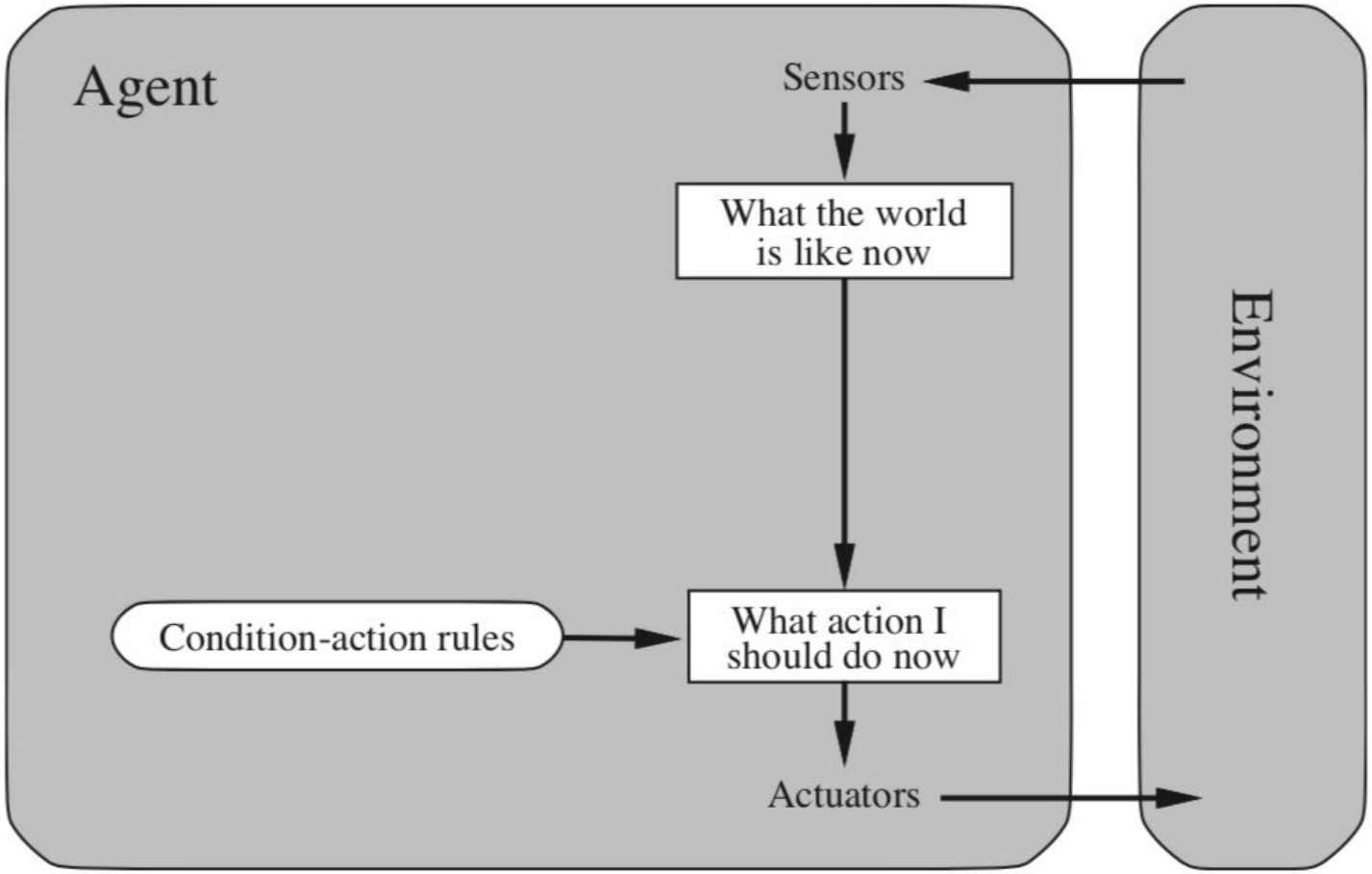
Simple reflex agents

Agents that keep track of the world

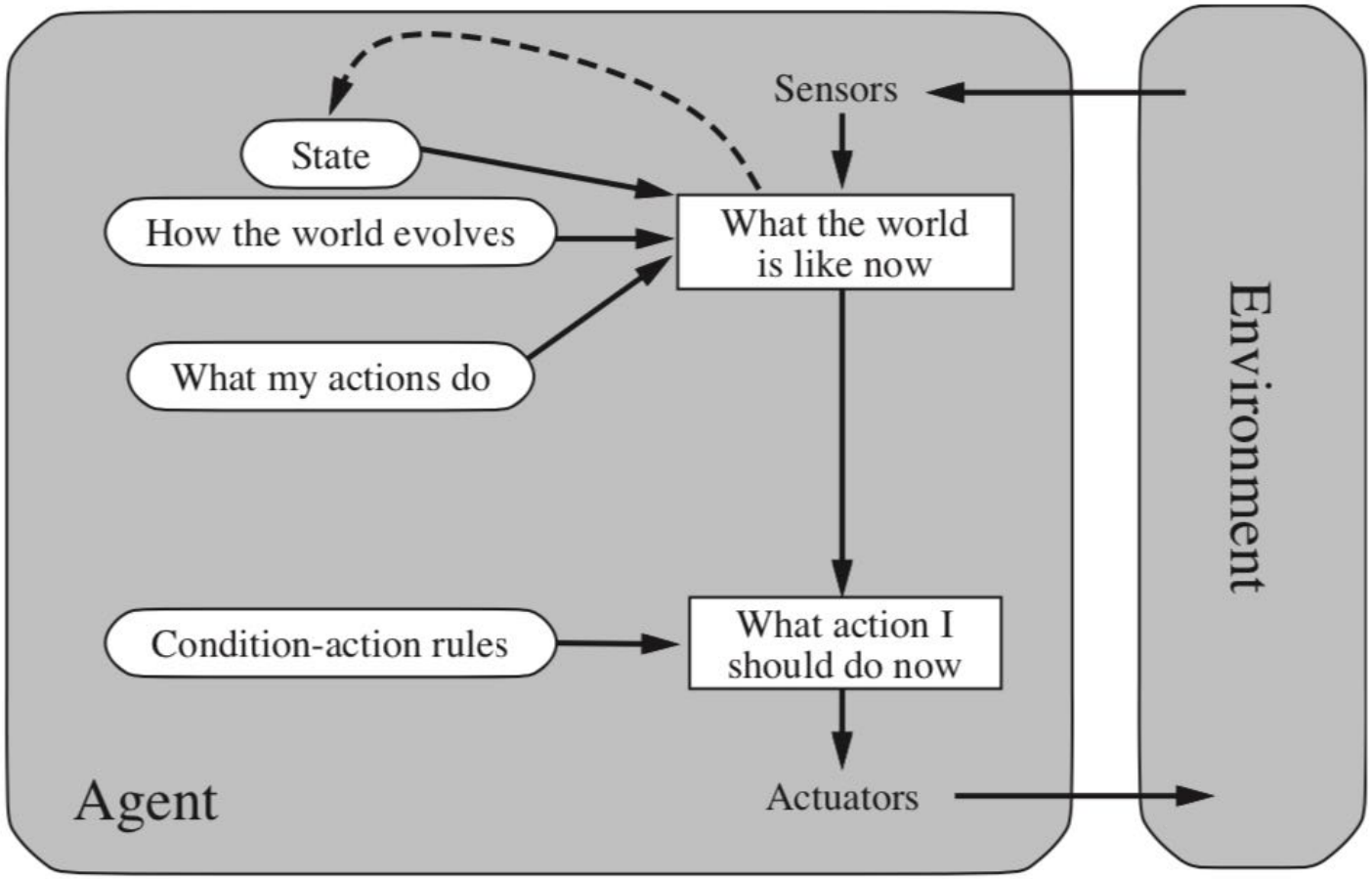
Goal-based agents

Utility-based agents

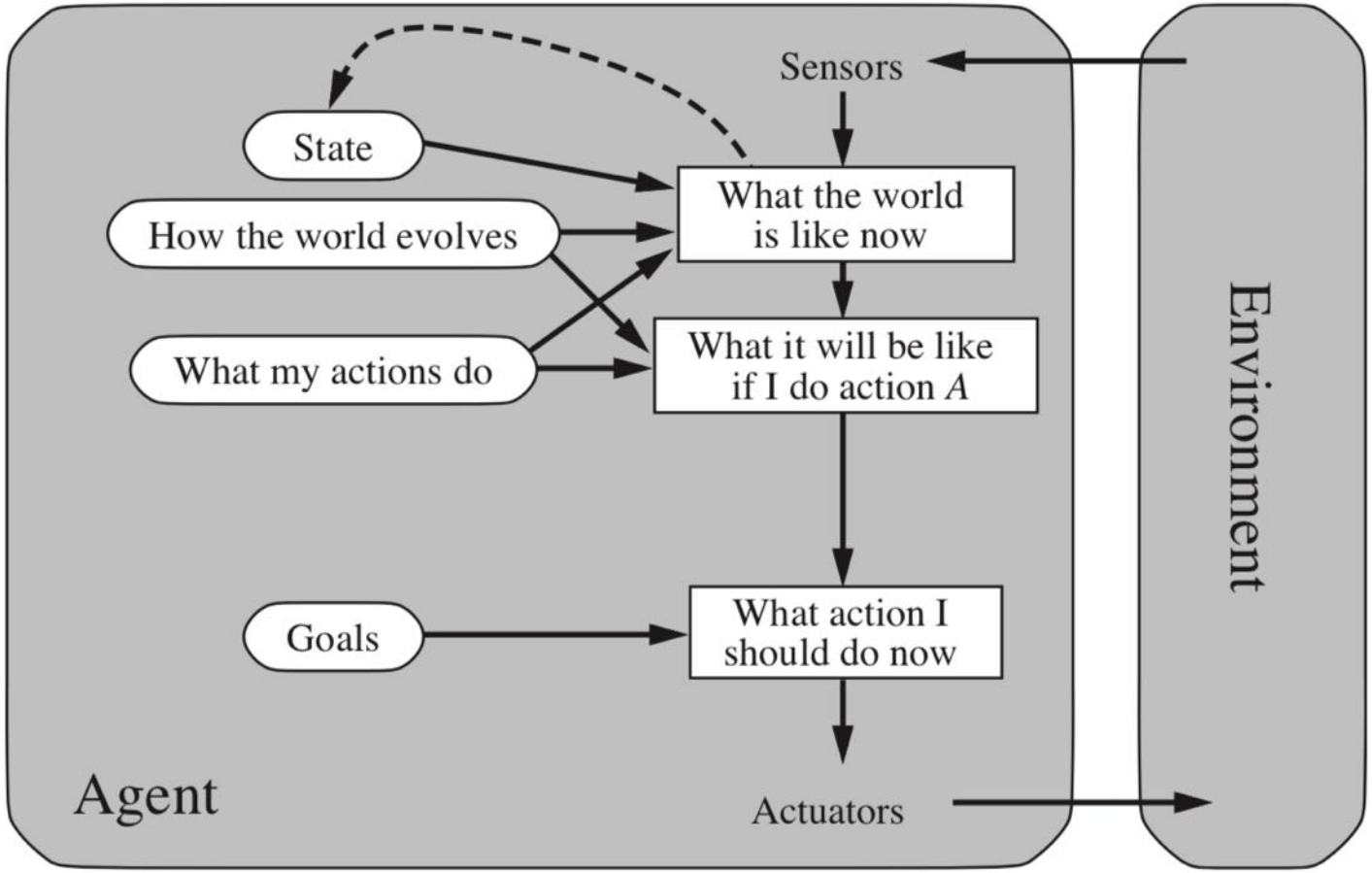
Simple reflex agents



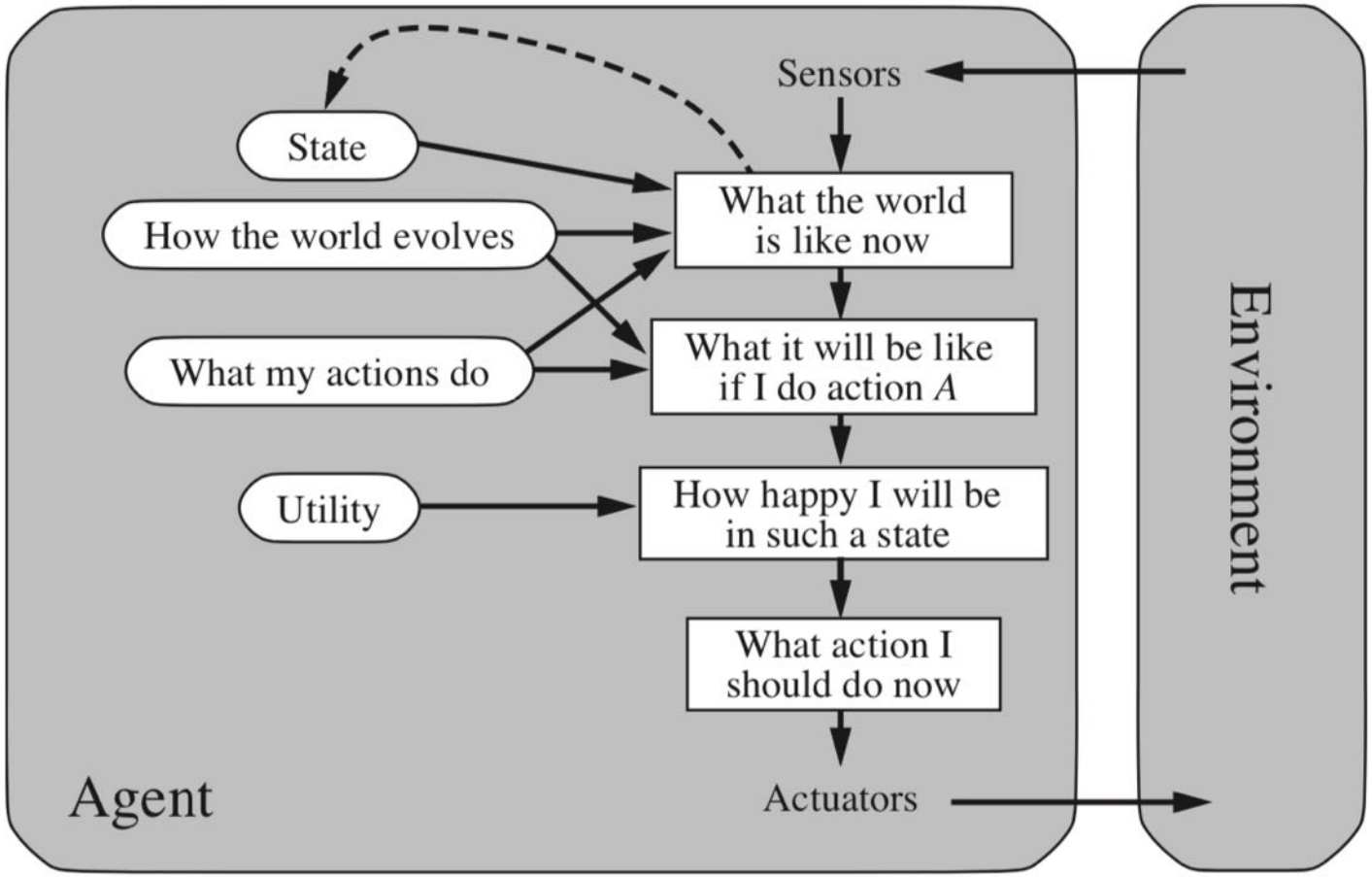
Agents that keep track of the world (Agents with internal states)



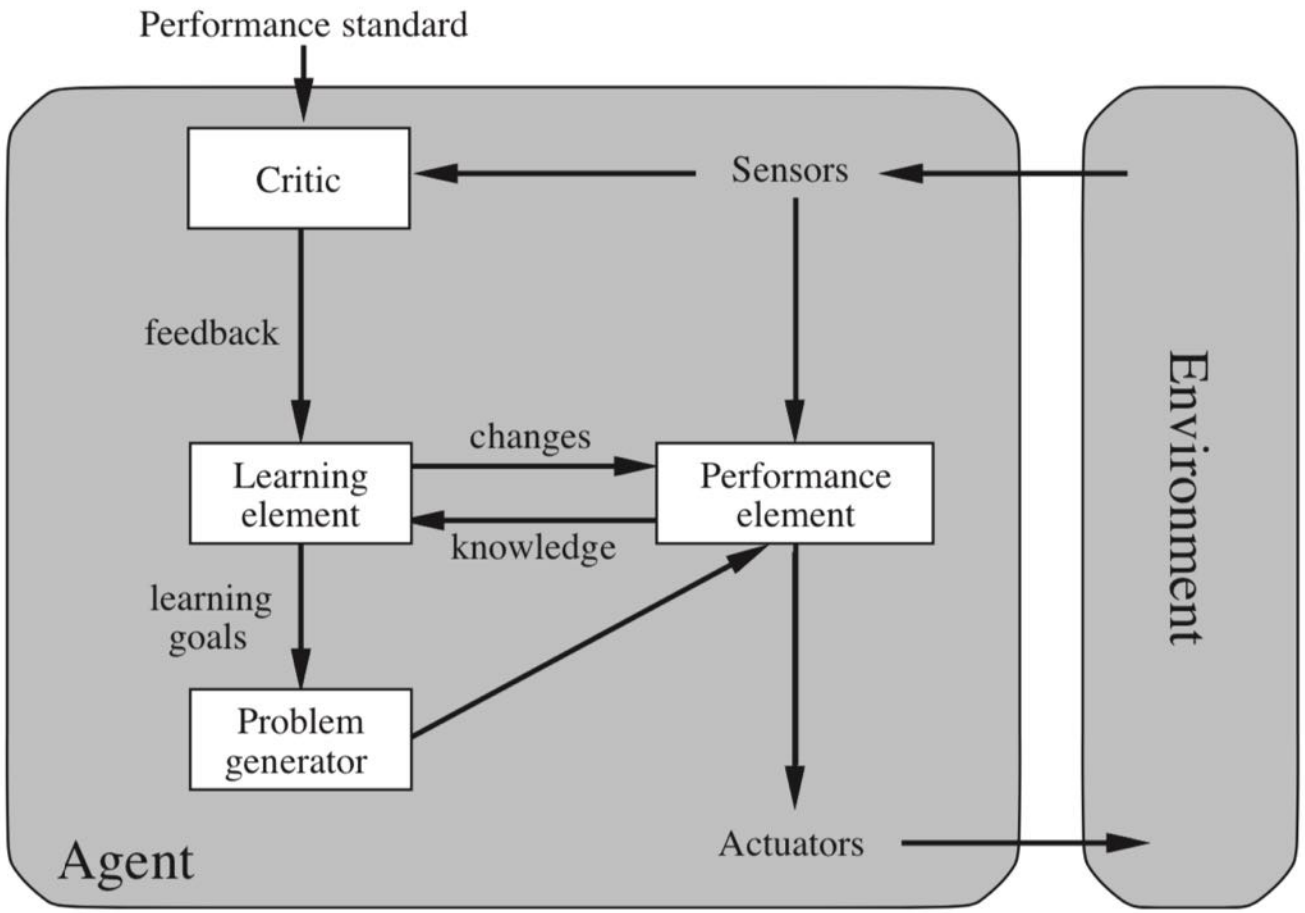
Model-based, goal-based agent



Model-based, utility-based agent



A general learning agent



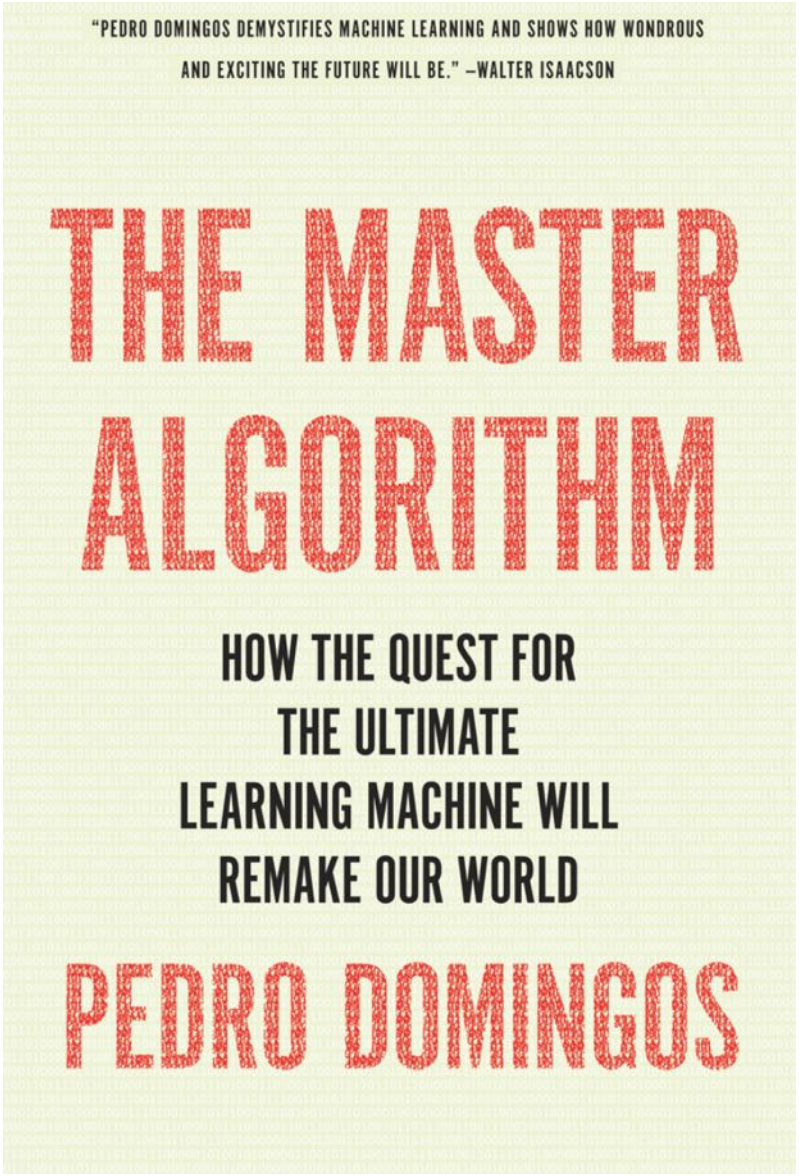
Key idea:

The problem of AI has been approached in many ways

The Master Algorithm

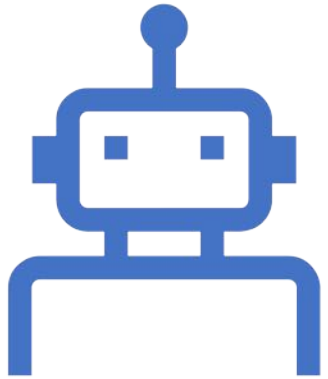
(by Pedro Domingos)

"All knowledge—past, present, and future—can be derived from data by a single, universal learning algorithm."



How Do Machines Learn?

- Neuroscience
- Evolution
- Physics
- Statistics
- Computer Science



Source: P. Domingos

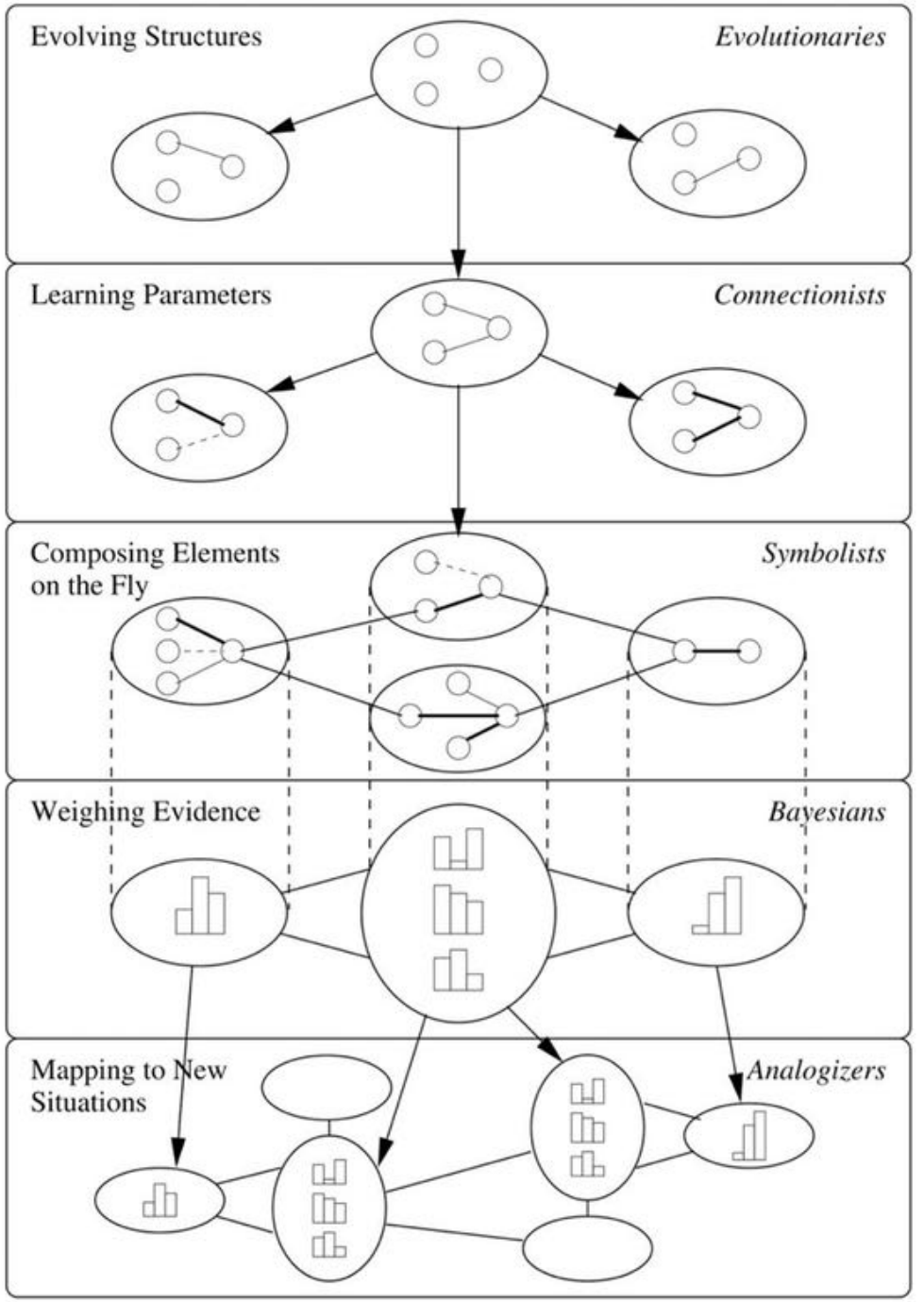
The 5 tribes of Machine Learning

TRIBE	ORIGINS	MASTER ALGORITHM
Symbolists	Logic, philosophy	Inverse deduction
Connectionists	Neuroscience	Backpropagation
Evolutionaries	Evolutionary biology	Genetic programming
Bayesians	Statistics	Probabilistic inference
Analogizers	Psychology	Kernel machines

Source: P. Domingos

The 5 tribes

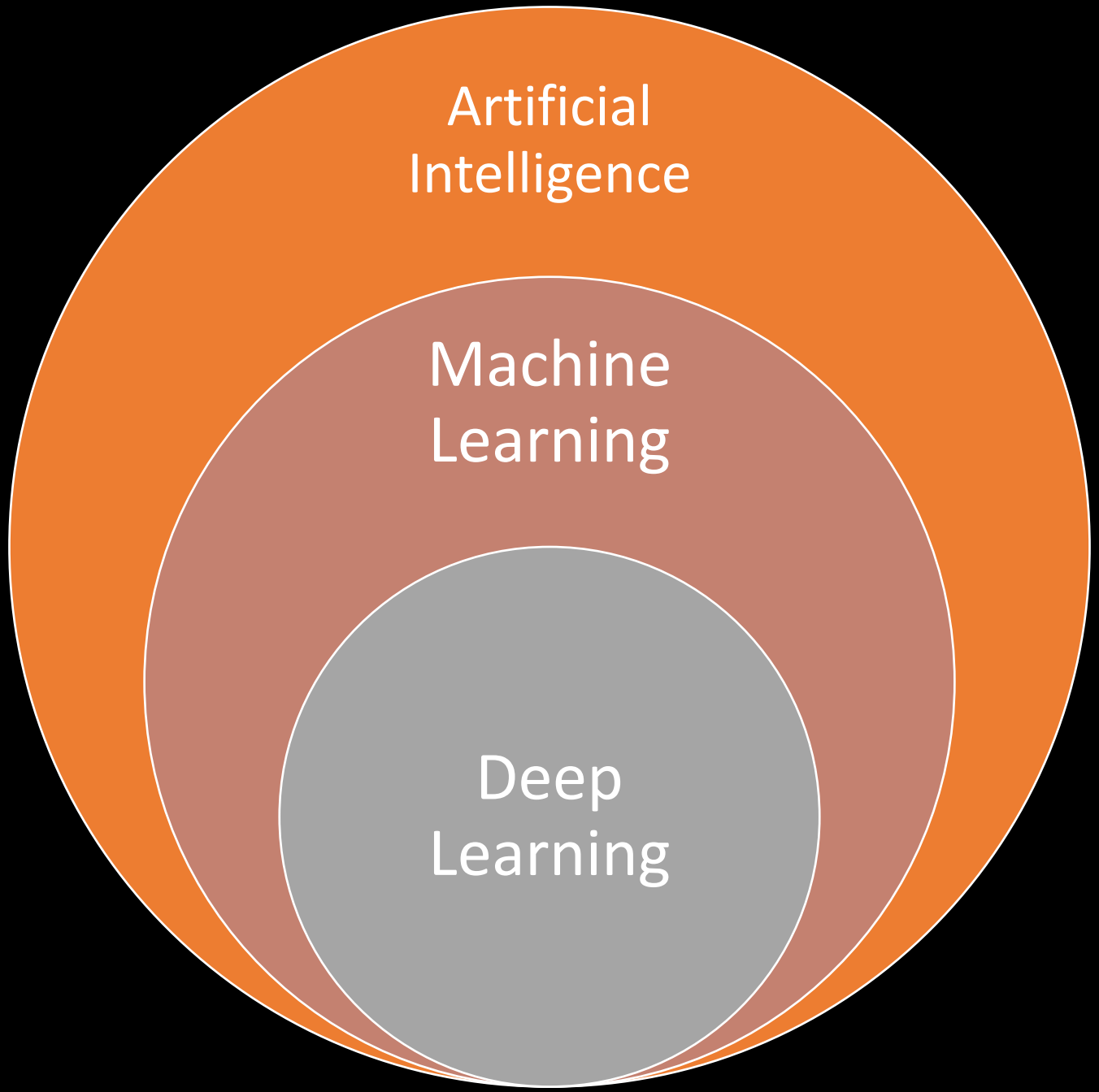
- “Each tribe’s solution to its central problem is a brilliant, hard-won advance.
- But the true Master Algorithm must solve all five problems, not just one.”



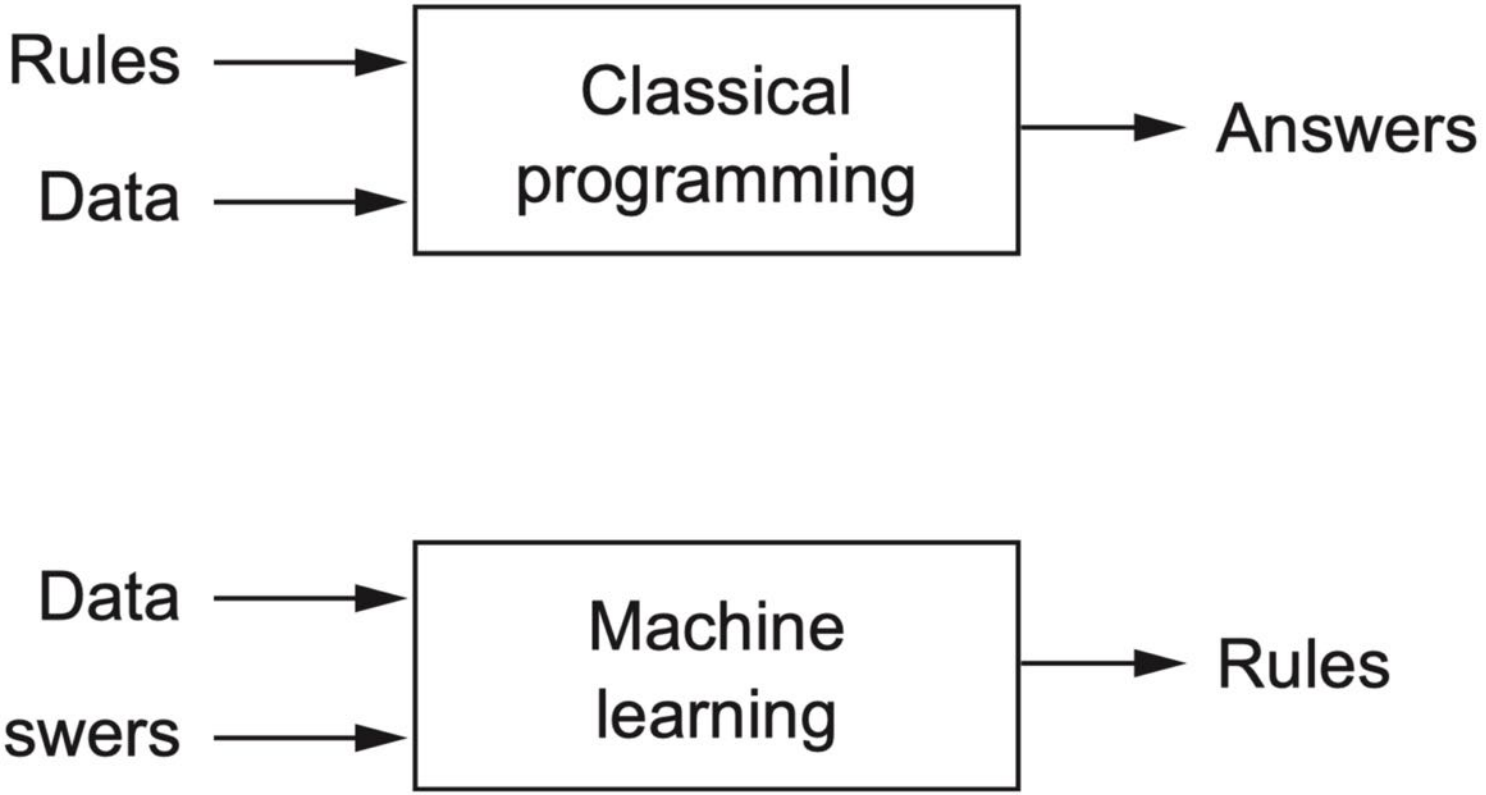
The search for a “Master Algorithm”

Key idea:

Most of today's AI use
Machine Learning
(Deep Learning)


Artificial
Intelligence
Machine
Learning
Deep
Learning

Machine Learning: a new programming paradigm

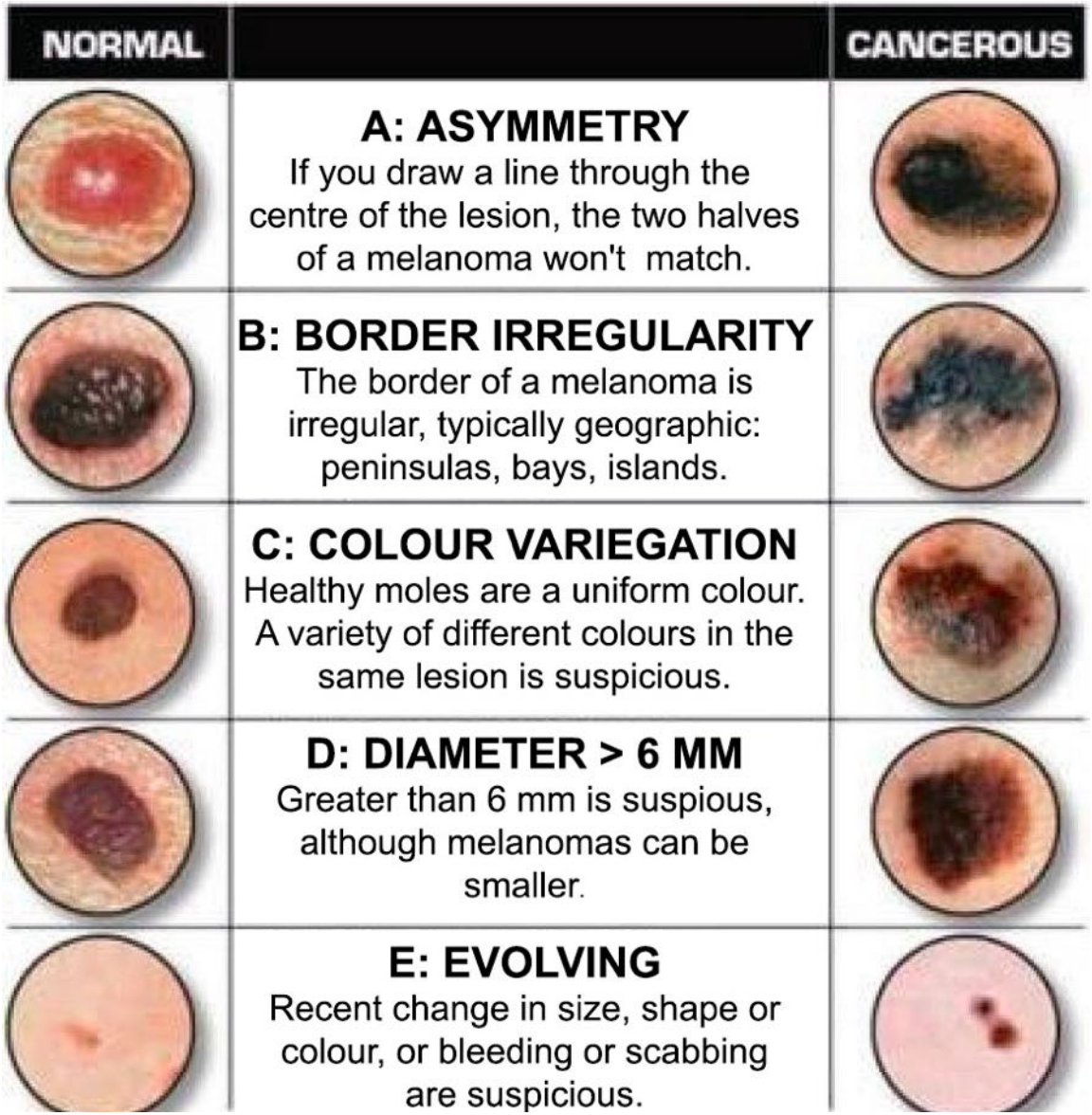


Source: F. Chollet

Example: skin lesion classification

Old method:

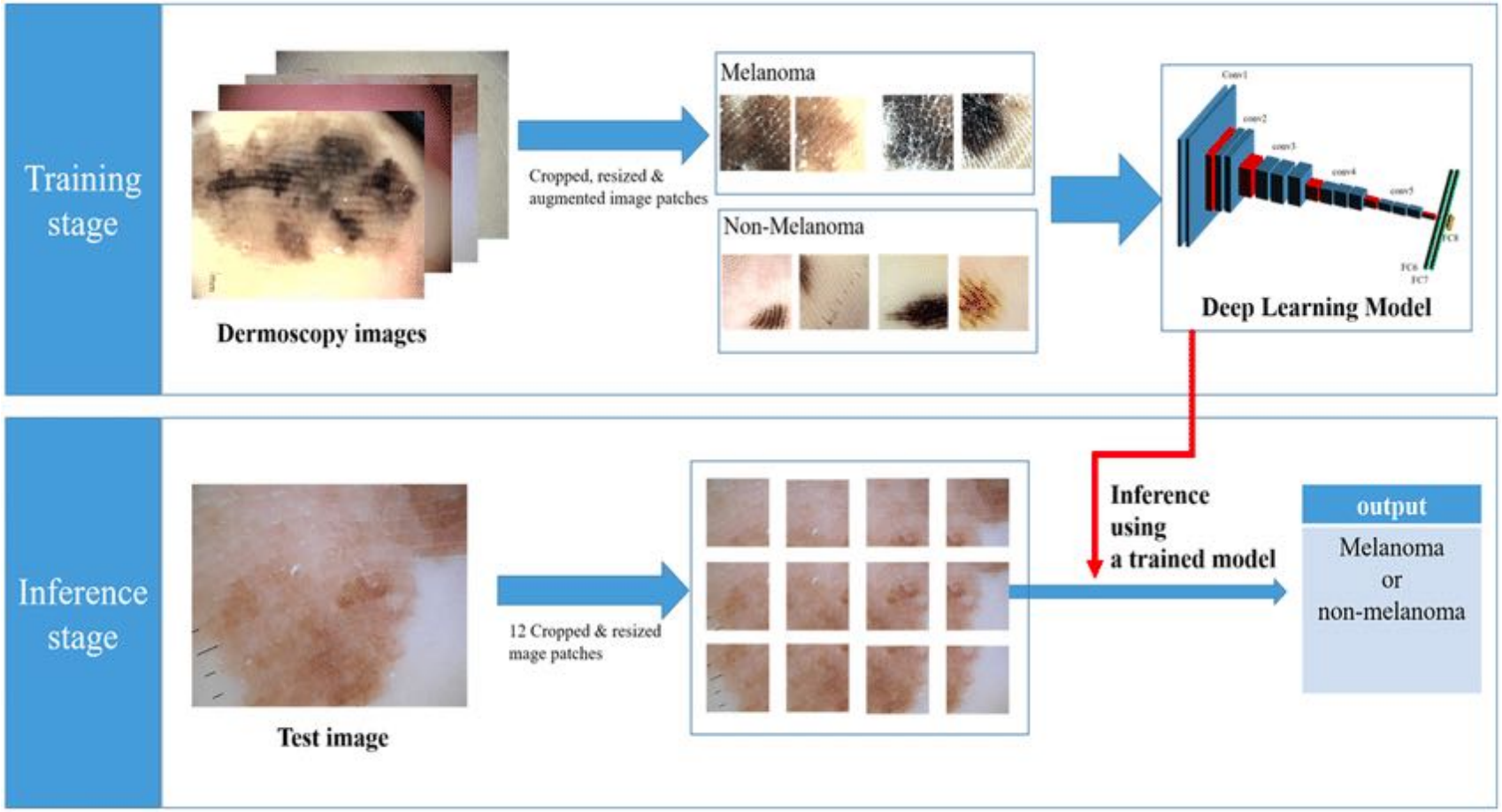
1. Learn rules from human expert
2. Write (encode) rules by hand
3. Test with (new) data
4. Refine and improve



Example: skin lesion classification

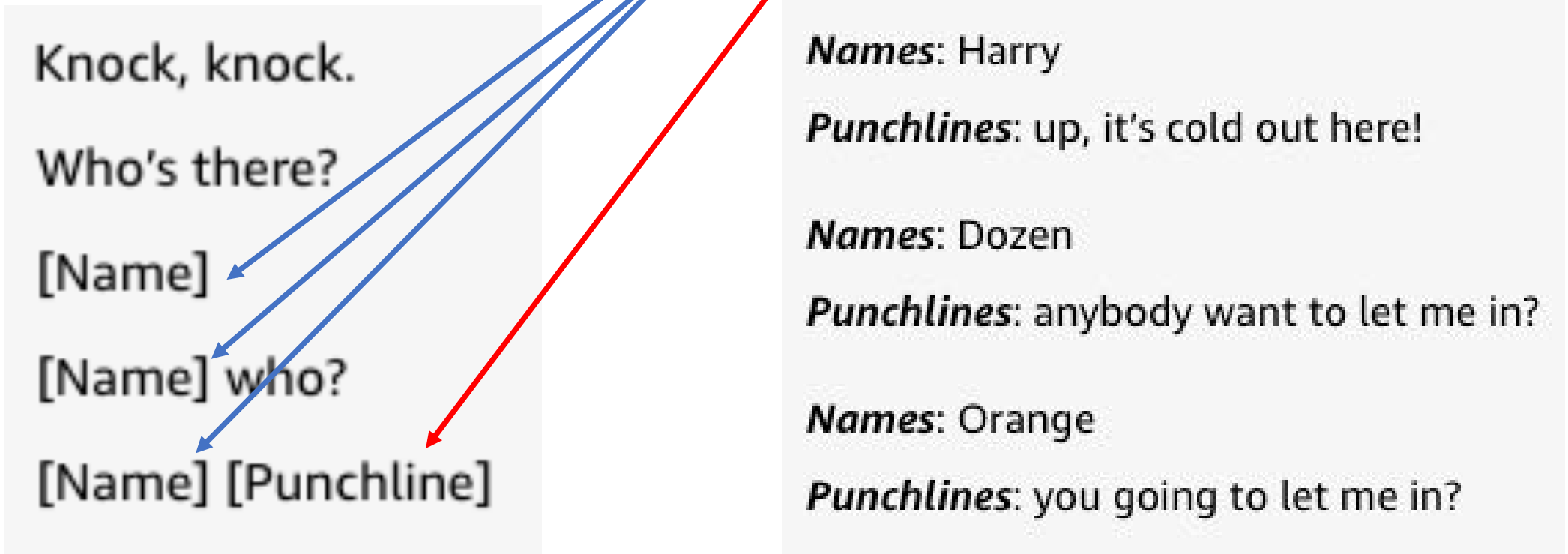
New method:

1. Feed neural network with 1000s of labeled examples
2. Let the neural network learn the rules by itself
3. Test with new data
4. Refine and improve



Another example: knock-knock jokes

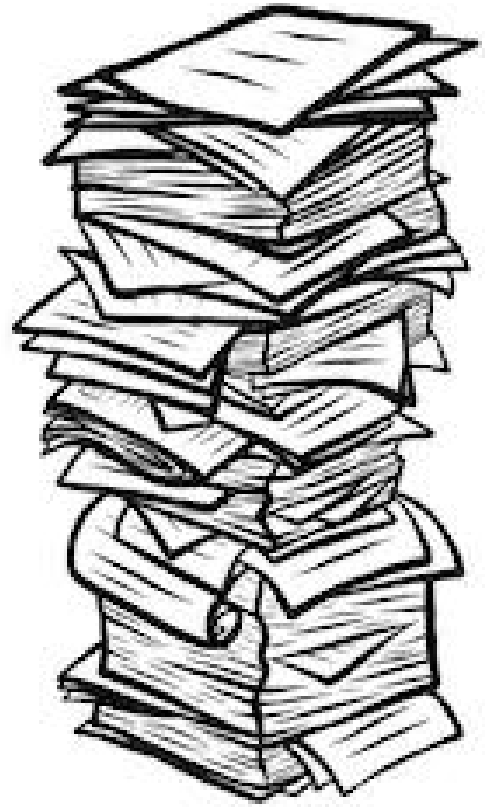
- Rule-based AI



Another example: knock-knock jokes

- Machine Learning

"Here are some jokes; try to make more of these."



Knock-knock jokes: early attempts

k k k k k
kk k kkkok
k kkkk
k

kk
kk k kk

keokk k

k
k

noo,

Lnoc noo

Kor?

hnos h nc

pt'b oa to'

asutWtnl

toy nooc

doc kKe

w ce

e

nooc hock hork

aKoo kWhoc

Khock

hors Whnes Whee

noo oooc

Koo?

loo

noc no'c Wno h orea

ao no oo k KeockWnork Koos

Thoe

nock K ock

Koc

hoo

KKock Knock Thock Whonk

Knock Knock

Who's There?

Iane

Aatar who?

Aaane who?

Aan who?

Anac who?

Iobe who?

Irata who?

Knock-knock jokes: getting there…

Knock Knock

Who's There?

Bool

Hane who?

Scheres are then the there

Knock, knock.

Who's there?

A cow with no lips.

A cow with no lips who?

A cow with no lips says ooo ooo ooooooo.

Knock-knock jokes: not quite…

Knock Knock

Who's There?

Alec

Anic who?

Wow co poo the tho tho door to the soout oo ooo oooo ooo oo oo oo oo ooo oo oo

oo ooo ooo oooo ooo ooo oo oo ooo ooo ooo ooo ooo oo oo ooo ooo ooo ooo oo

Knock-knock jokes: later on…

Knock Knock

Who's There?

Bet

Beef who?

Beef ano with no lips asslly.

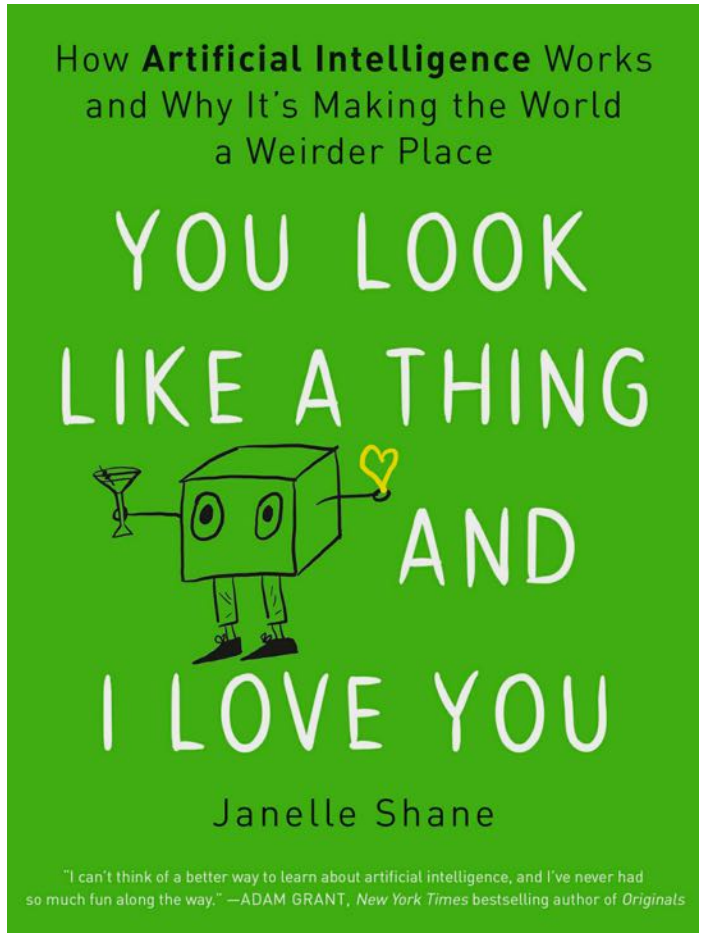
Knock Knock

Who's There?

Alec

Alec who?

Alec-Knock Knock jokes.



https://aiweirdness.com/

https://youtu.be/2ZiPEOFnK1o


THIS IS YOUR MACHINE LEARNING SYSTEM?
YUP! YOU POUR THE DATA INTO THIS BIG PILE OF LINEAR ALGEBRA, THEN COLLECT THE ANSWERS ON THE OTHER SIDE.
WHAT IF THE ANSWERS ARE WRONG?
JUST STIR THE PILE UNTIL THEY START LOOKING RIGHT.
DATA
ANSWERS

Key idea:

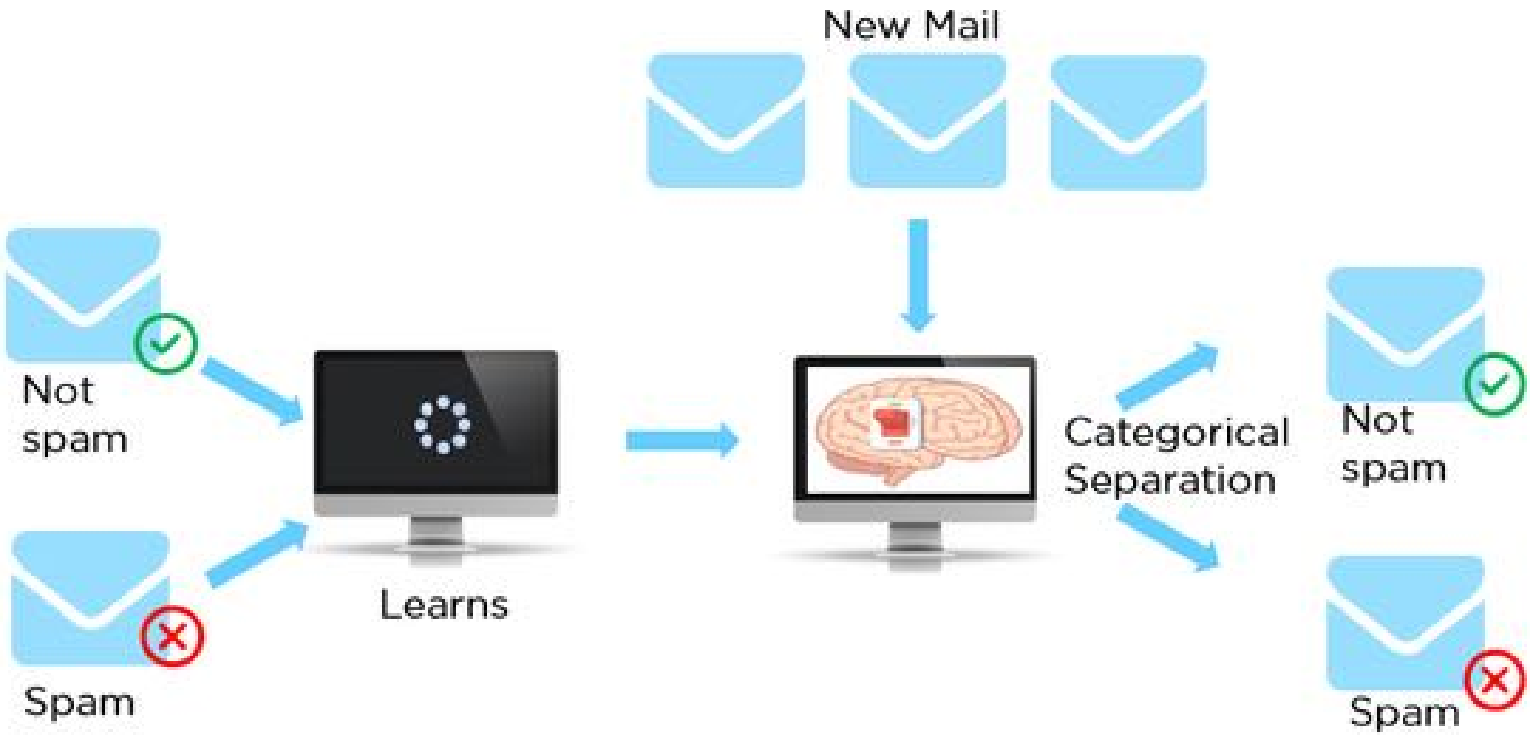
Machines can learn in many ways

Types of learning

- In **supervised learning** the agent *observes some example input–output pairs and learns a function that maps from input to output*.
- In **unsupervised learning** the agent learns patterns in the input even though *no explicit feedback is supplied*.
- In **reinforcement learning** the agent learns from a series of *reinforcements—rewards or punishments*.
- Many other variants

Source: (Russell & Norvig 2011)

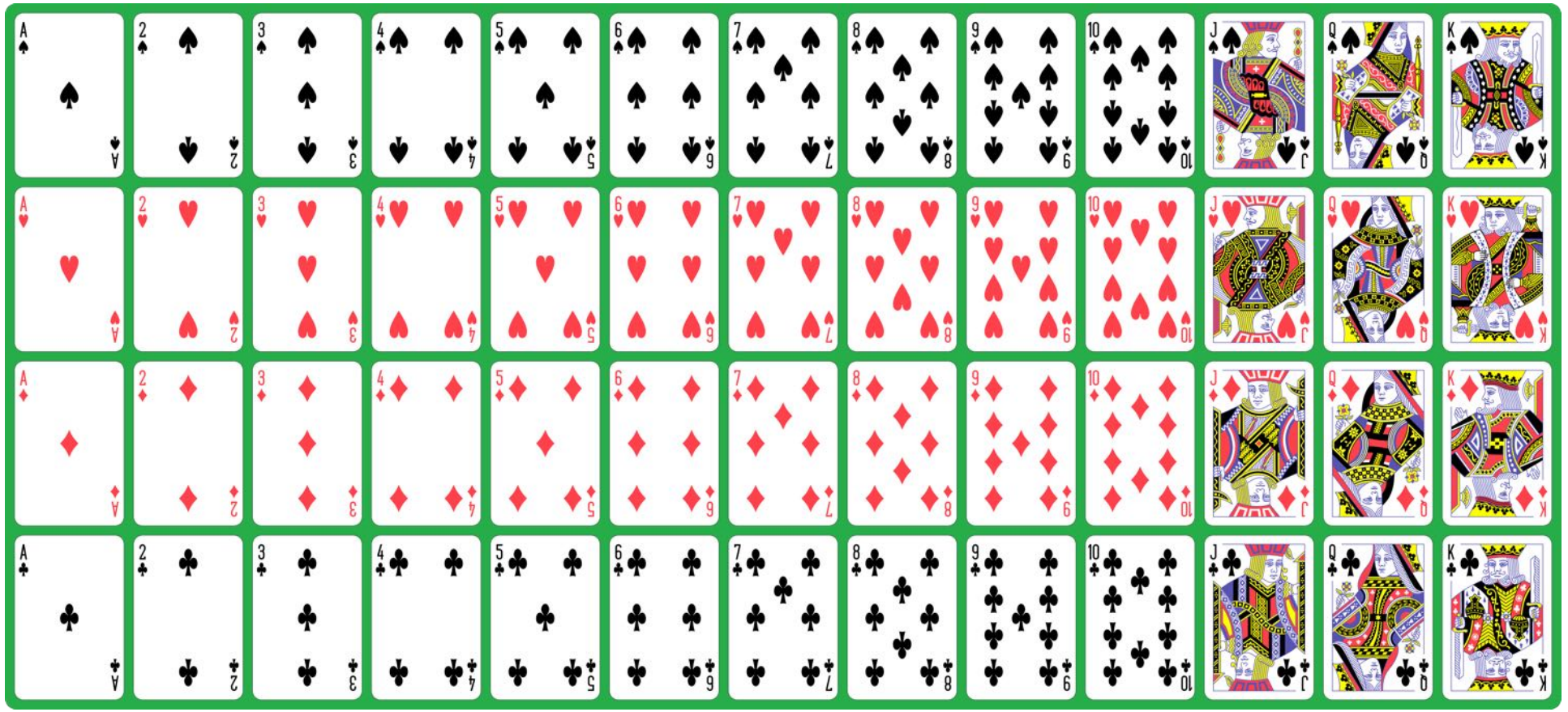
Supervised learning



Enables the machine to be trained to classify observations into some class

Unsupervised learning

- Clustering



2013

Reinforcement Learning

Part 3:

What can AI do today?

Key idea:

Not all AI systems are created equal

Dimensions of AI

- **Strength** (how intelligent is it?)
- **Breadth** (does it solve a narrowly defined problem, or is it general?)
- **Training** (how does it learn?)
- **Capabilities** (what kinds of problems are we asking it to solve?)
- **Autonomy** (are AIs assistive technologies, or do they act on their own?)

Source: Loukides and Lorica (2016)

Narrow vs. General AI

- What we have today is mostly **narrow AI**

"You can add narrow AIs ad infinitum, but a pile of narrow intelligences will never add up to a general intelligence."

Source: Loukides and Lorica (2016)

Key idea:

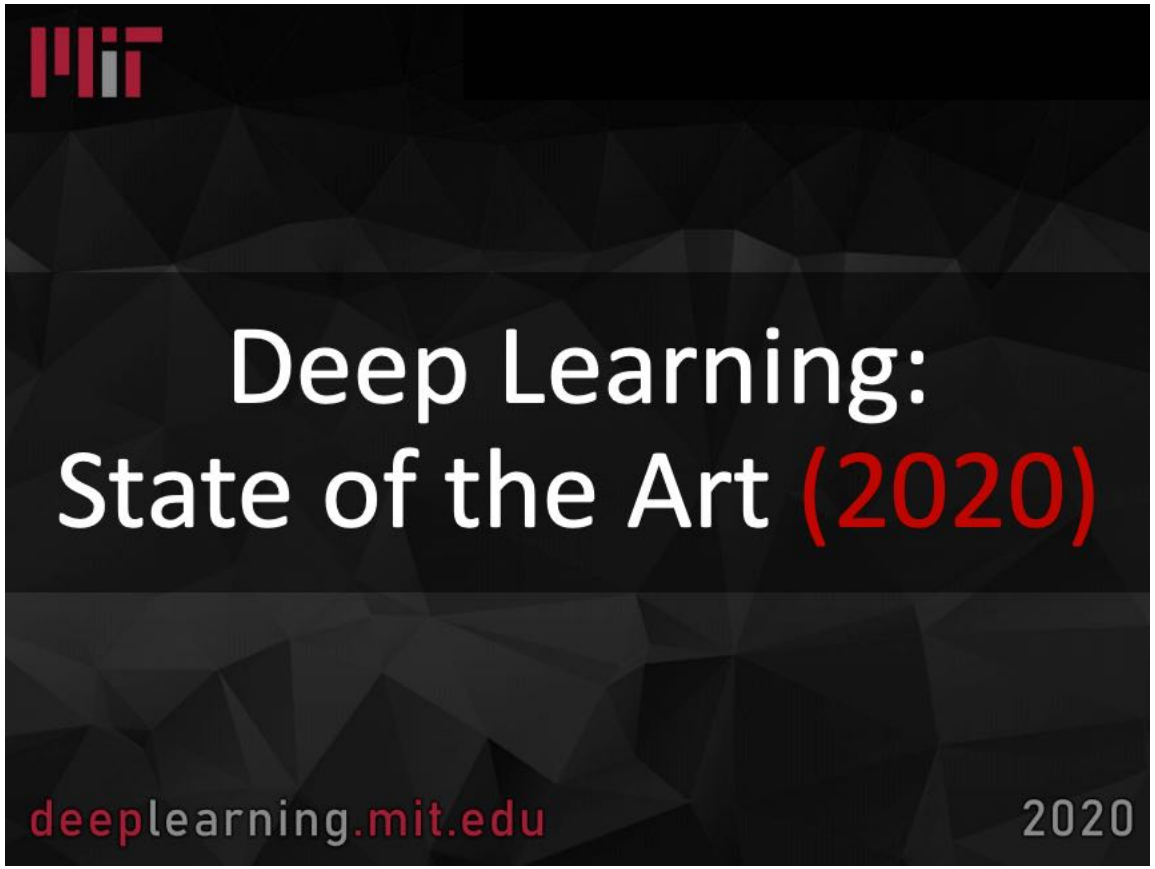
Deep Learning has led to many impressive (narrow) AI successes

What deep learning AI has achieved so far

- Near-human-level **image classification**
- Near-human-level **speech recognition**
- Near-human-level **handwriting transcription**
- Improved machine **translation**
- Improved **text-to-speech conversion**
- **Digital assistants** such as Google Now and Amazon Alexa
- Near-human-level **autonomous driving**
- Improved **ad targeting**, as used by Google and Bing
- Improved **search results** on the web
- Ability to **answer natural-language questions**
- Superhuman **Go** playing

Source: Lex Fridman (2019)

Deep Learning State of the Art (2020) - MIT



Slides also available (see link on Canvas)

https://youtu.be/0VH1Lim8gL8

Hands on!

Fun examples of AI in action!

Visual Arts: DYI style transfer

https://deepart.io/

1 **Upload photo**

The first picture defines the scene you would like to have painted.

2 **Choose style**

Choose among predefined styles or upload your own style image.

3 **Submit**

Our servers paint the image for you. You get an email when it's done.

Try it now

Visual Arts: DYI style transfer

https://deepart.io/

Write With Transformer

Get a modern neural network to
auto-complete your thoughts.

This web app, built by the Hugging Face team, is the official demo of the
`🤗/transformers` repository's text generation capabilities.

Models

GPT-2

The almighty king of text generation, GPT-2 comes in four available sizes, only three of which have been publicly made available. Feared for its fake news generation capabilities, it currently stands as the most syntactically coherent model. A direct successor to the original GPT, it reinforces the already established pre-training/fine-tuning killer duo. From the paper: Language Models are Unsupervised Multitask Learners by Alec Radford, Jeffrey Wu, Rewon Child, David Luan, Dario Amodei and Ilya Sutskever.

Start writing

The meaning of life is that nothing is impossible.

AI will

- not stop us.
- be an enormous part of the future of humankind
- take us to the edge of the galaxy.

Two plus two is

two.

not an even number, so we will take the

four...and then the four plus one is five

Two minus two is

equal to the number one minus one eq…

still four; three is still three.

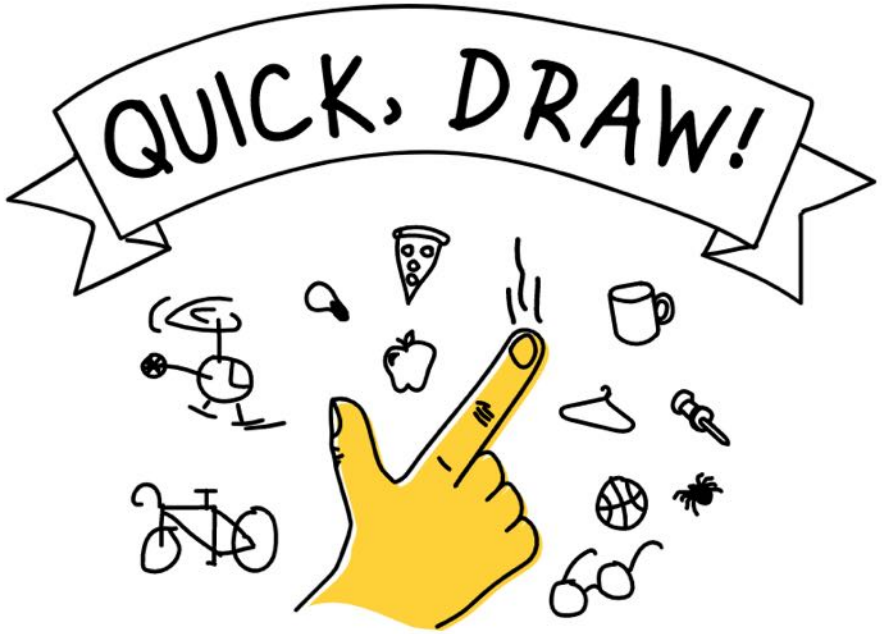
a good deal.

Oge Marques is best known for

Oge Marques is best known for his work in the history of English and American folklore, but in recent years he has published books about the lives of animals and birds, including one about the life of a bird that lives inside a jar and one about a pig named Peanut.

Quick, Draw!

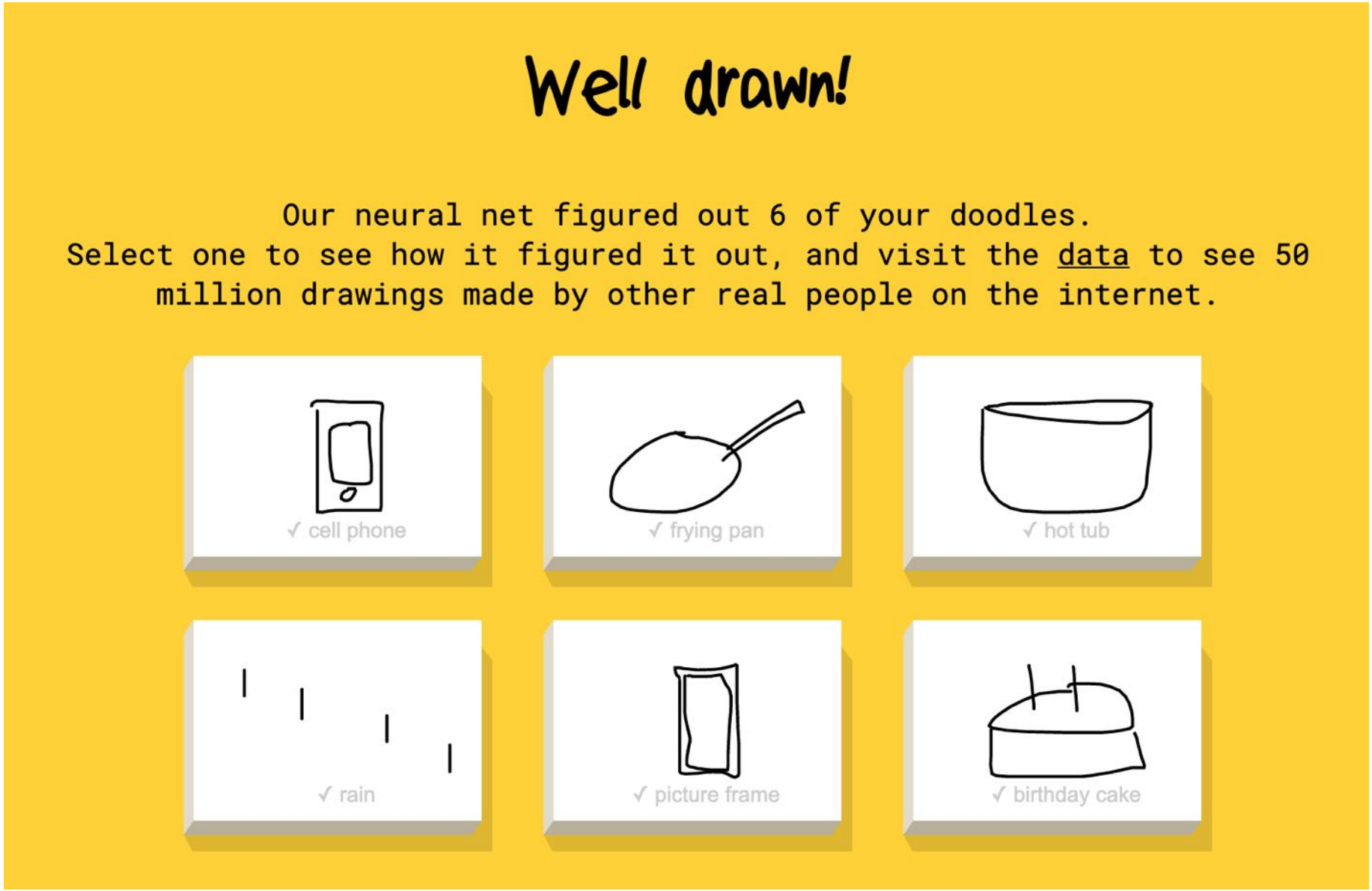
https://quickdraw.withgoogle.com/



Can a neural network learn to recognize doodling?

Help teach it by adding your drawings to the world's largest doodling data set, shared publicly to help with machine learning research.

Let's Draw!



I made these six doodles. A neural network guessed all of them correctly.
https://quickdraw.withgoogle.com/shared/eGePEpSKImNd

The Quick, Draw! Dataset

The Quick Draw Dataset is a collection of 50 million drawings across 345 categories, contributed by players of the game Quick, Draw!.

https://github.com/googlecreativelab/quickdraw-dataset

Part 4:

What can’t AI do today?

Key idea:

There is still a lot that AI can't do!

What AI can do well

- Perform some simple, well-defined tasks as well as or better than humans
- Find and act upon patterns in data – including patterns invisible to humans
- Get better at performing certain tasks when given lots of labeled, well-organized data from which to learn

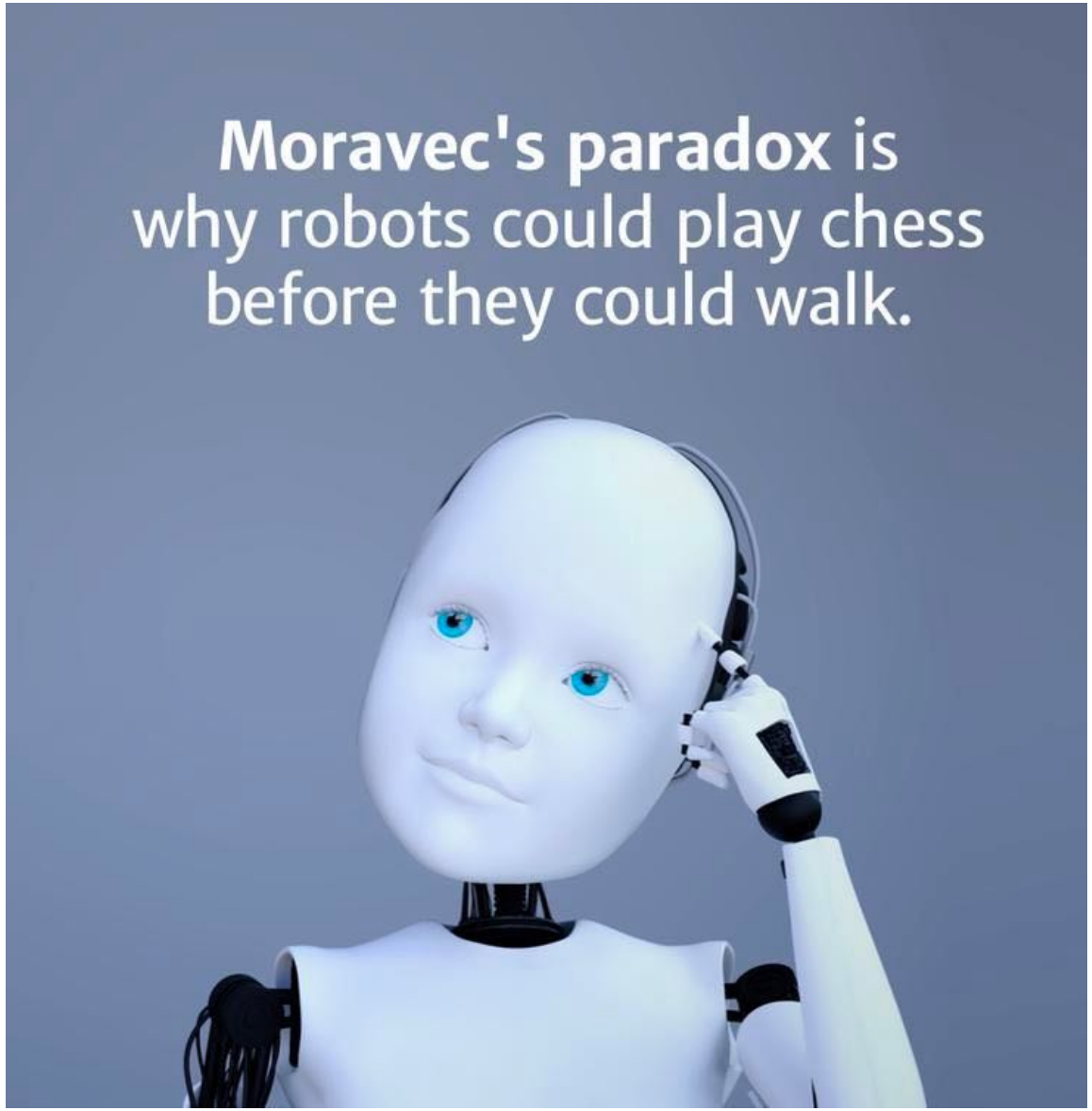
What AI can't do well

- Perform any entire job better than humans can
- Explain its mechanism for finding patterns in information or what those patterns mean
- Understand the context that surrounds a given task
- Learn from unorganized, unlabeled, or small amounts of data
- Perform tasks that require creativity, empathy, or complex judgment

Source: The Artificial Intelligence Primer - Booz Allen Hamilton Inc.

Moravec’s Paradox

- "it is comparatively easy to make computers exhibit adult level performance on intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility.”



Examples of what today's AI can't do!

Textual understanding

🍽 The Restaurant

"A man went into a restaurant and ordered a hamburger, cooked rare. When it arrived, it was burned to a crisp.

The waitress stopped by the man's table.
"Is the burger okay?" she asked.
"Oh, it's just great," the man said, pushing back his chair and storming out of the restaurant without paying.

The waitress yelled after him, "Hey, what about the bill?"
She shrugged her shoulders, muttering under her breath, "Why is he so bent out of shape?"

Source: Melanie Mitchell. "Artificial Intelligence."

Question:

Did the man eat the hamburger?

🍽 The Restaurant

"A man went into a restaurant and ordered a hamburger, cooked rare.
When it arrived, it was burned to a crisp.

The waitress stopped by the man's table.
"Is the burger okay?" she asked.
"Oh, it's just great," the man said, pushing back his chair and storming out of the restaurant without paying.

The waitress yelled after him, "Hey, what about the bill?"
She shrugged her shoulders, muttering under her breath, "Why is he so bent out of shape?"

Source: Melanie Mitchell. "Artificial Intelligence."

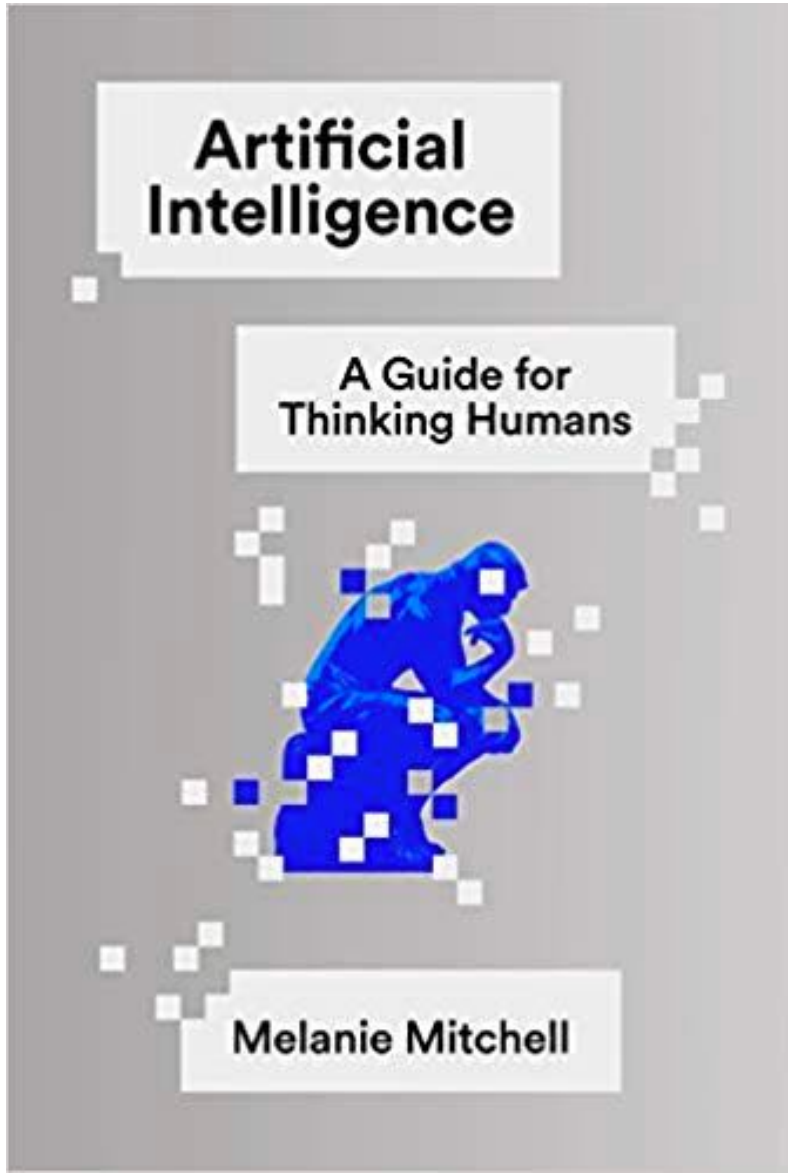
🍽 The Restaurant (French translation)

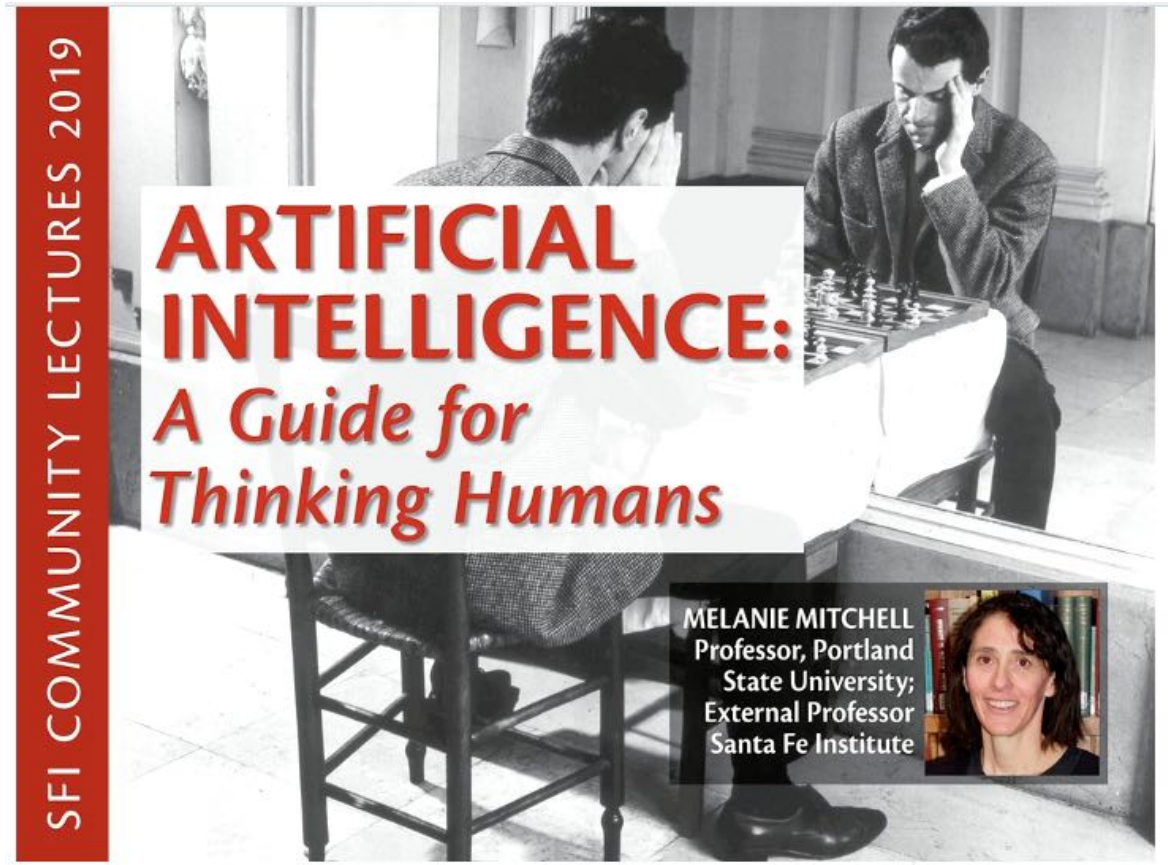
"A man entered a restaurant and ordered a hamburger, cooked infrequent. When he arrived, he got burned at a crunchy.

The waitress stopped walking in front of the man's table.
"Is the hamburger doing well?" She asked.
"Oh, it's terrific," said the man while putting his chair back and while going out of the restaurant without paying.

The waitress shouted after him, "Say, what about the proposed legislation?" She shrugged her shoulders, mumbling in her breath, "Why is he so distorted?"

Source: Melanie Mitchell. "Artificial Intelligence."





https://vimeo.com/372705678 https://youtu.be/NMUqvhuDZtQ

Examples of what today's AI can't do!

Image understanding

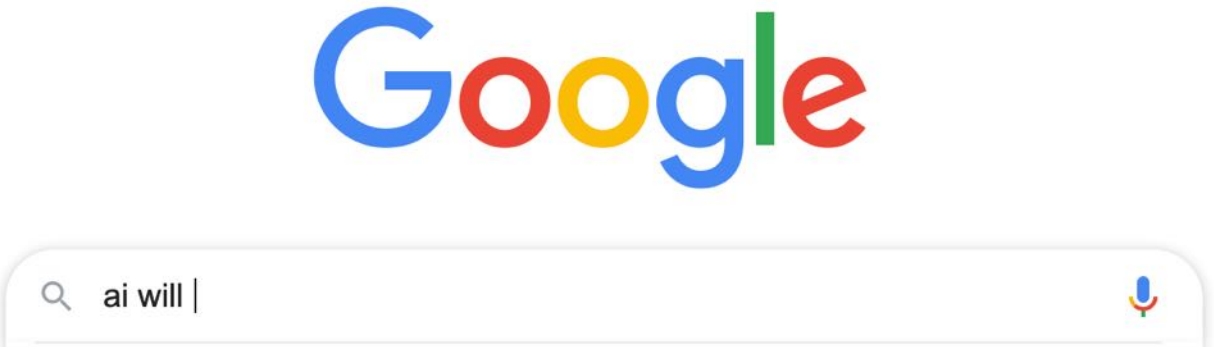
“AI, explain this photo to me”

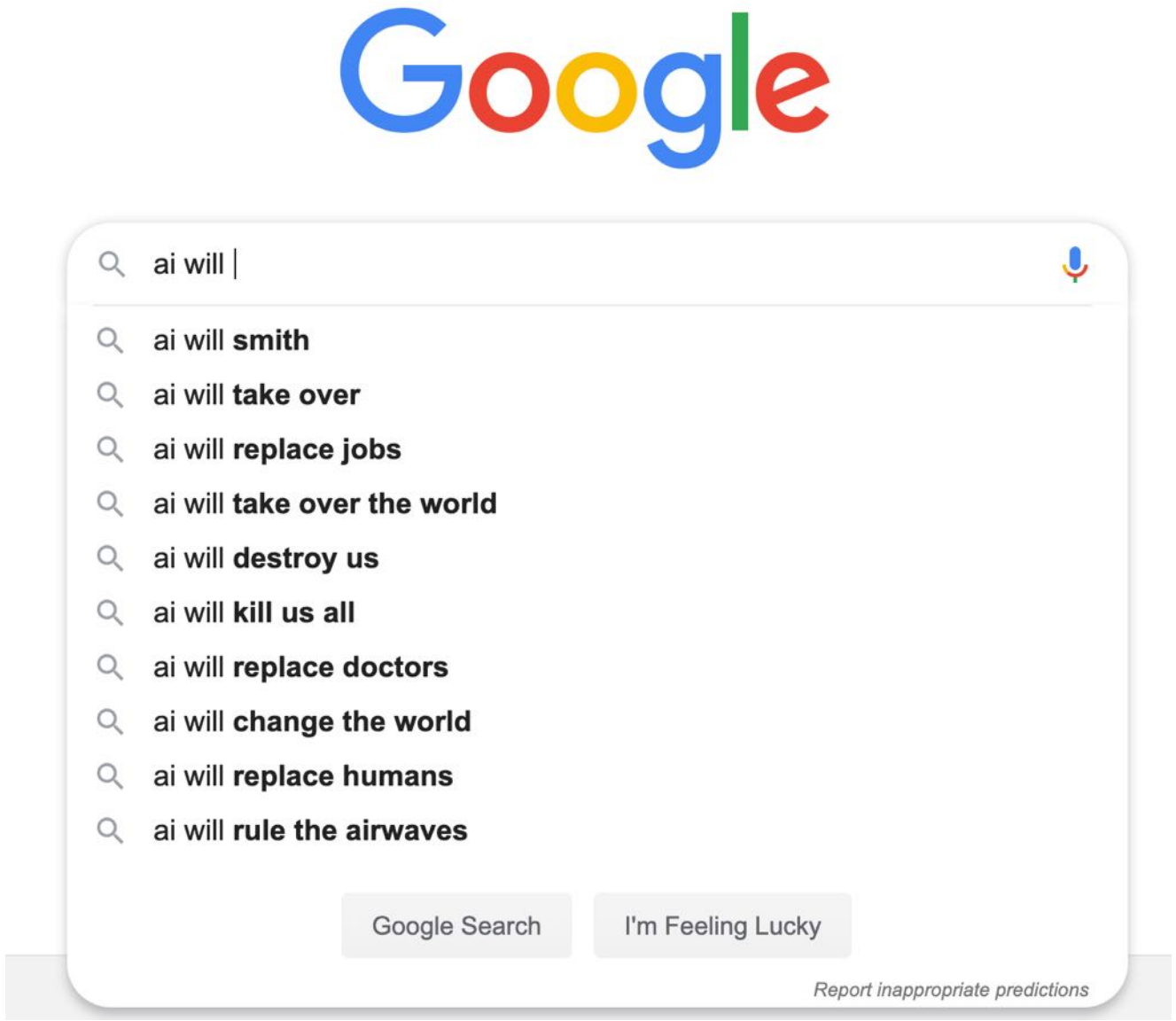
Key limitations of today's AI

- Most solutions lack:
  - Common sense
  - Context
  - True reasoning abilities
  - Ability to infer (semantic) meaning or handle causality
- Most solutions:
  - Show signs of brittleness
  - Require enormous amounts of data, computing power, and resources

Final thoughts

Should we be afraid of AI?


Google
ai will


Google
ai will
ai will smith
ai will take over
ai will replace jobs
ai will take over the world
ai will destroy us
ai will kill us all
ai will replace doctors
ai will change the world
ai will replace humans
ai will rule the airwaves
Google Search
I'm Feeling Lucky
Report inappropriate predictions

Should you be scared of AI?

Scared?

- No!

Prepared?

- Yes!

“People worry that computers will get too smart and take over the world, but the real problem is that they're too stupid and they've already taken over the world.”

Pedro Domingos