CAP 6635 – Artificial Intelligence

Lecture 2

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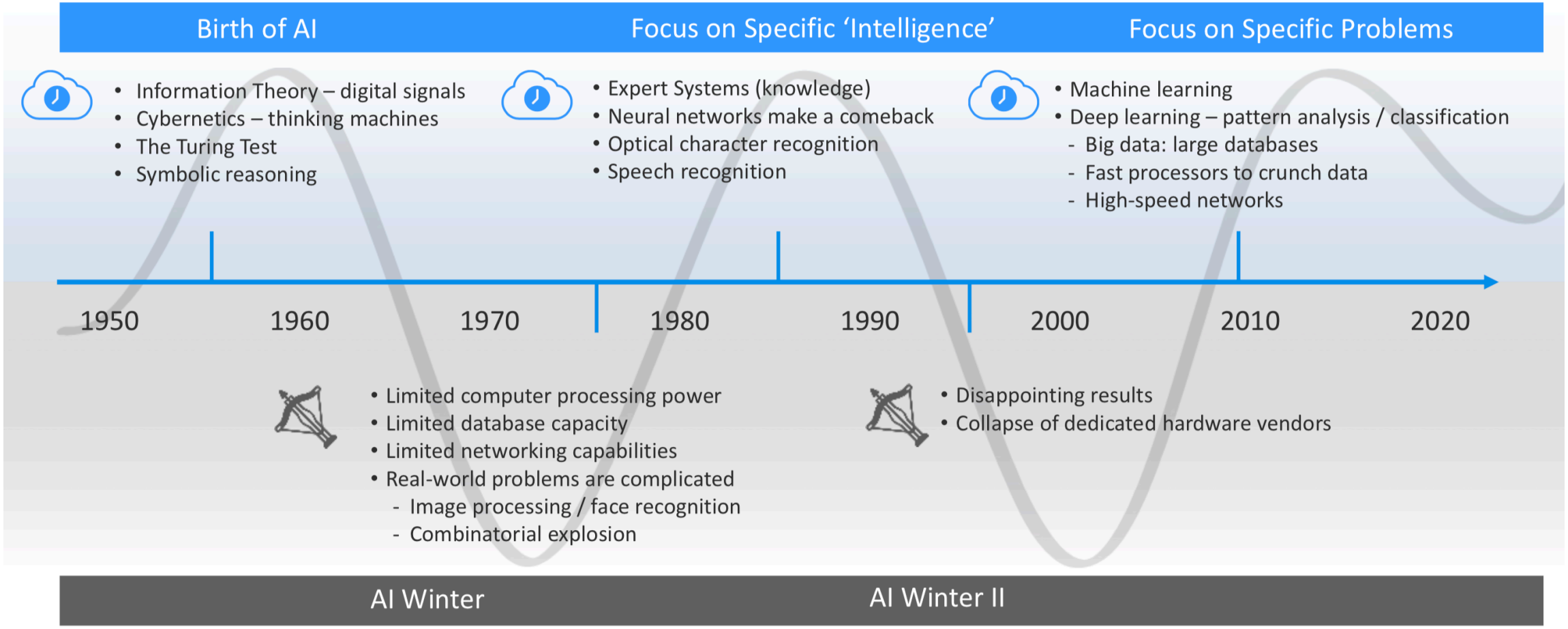
Previously
on CAP 6635…

Key idea:

Artificial Intelligence has made promises and predictions before

An AI Timeline

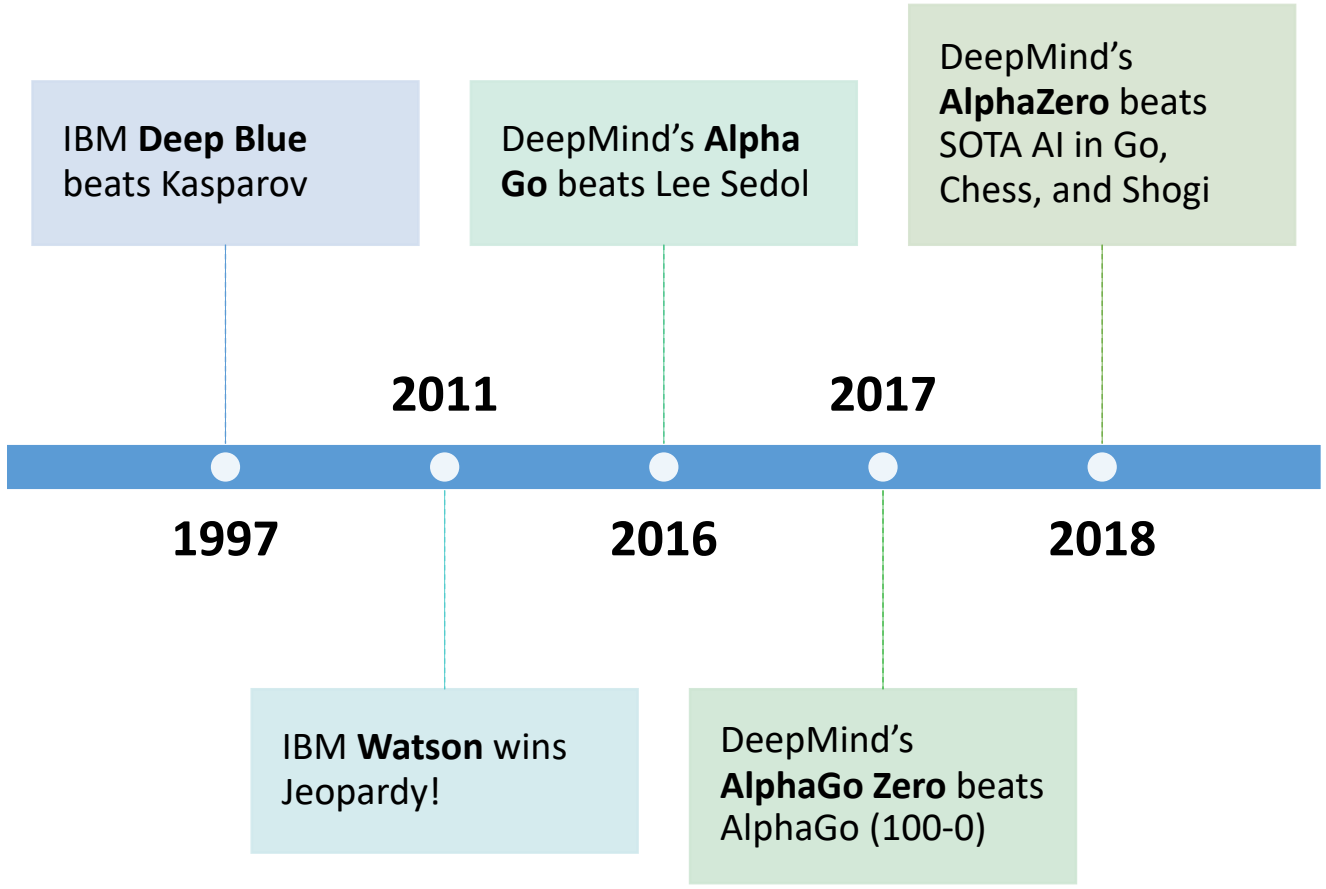


Source: https://www.slideshare.net/dlavenda/ai-and-productivity

Key idea:

AI has had several highly visible successes

Selected high-profile successes



What do they have in common?

Key idea:

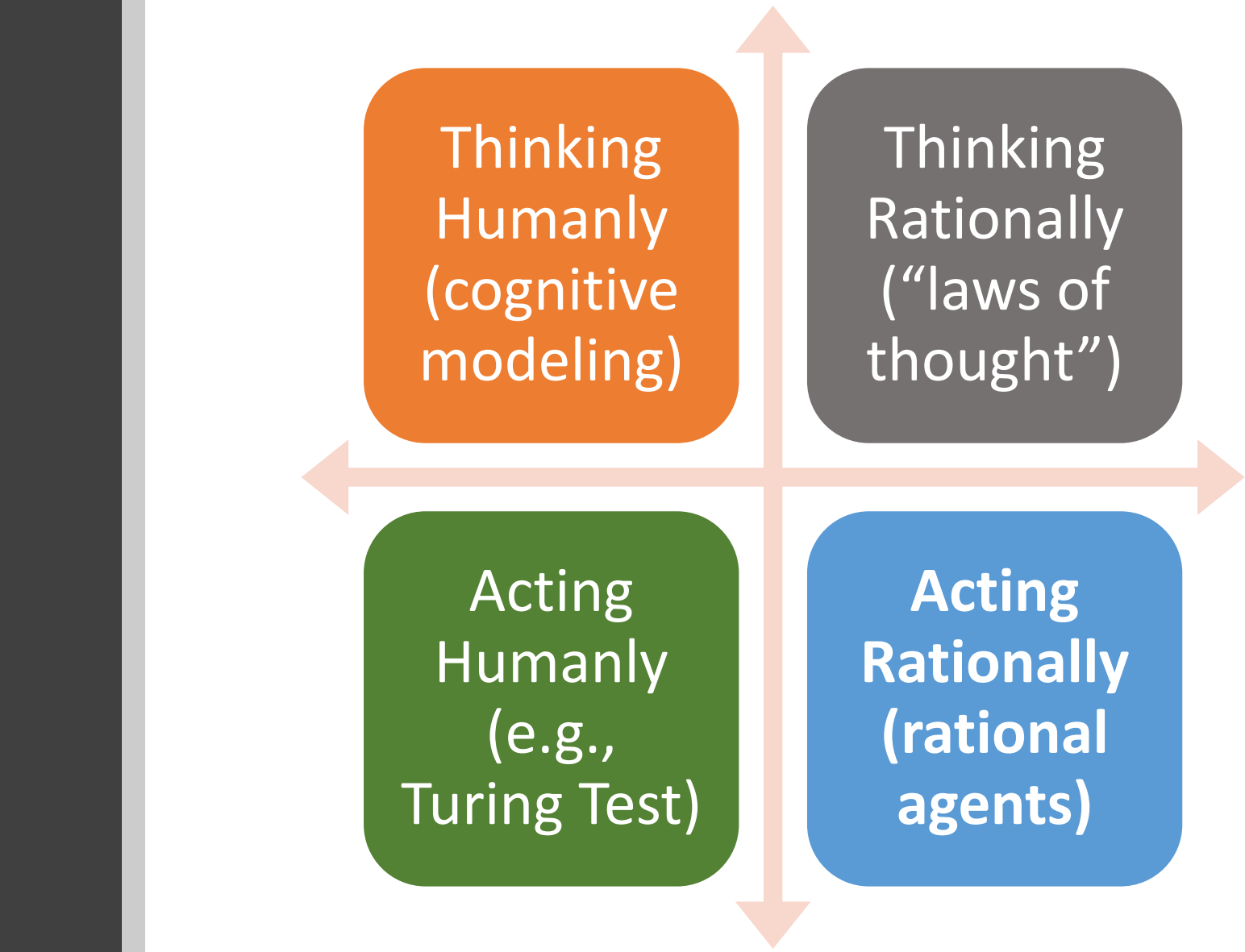
AI is hard to define

What is Artificial 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 definitions: categories



Source: (Russell & Norvig 2011)

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) https://www.oreilly.com/ideas/what-is-artificial-intelligence

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**

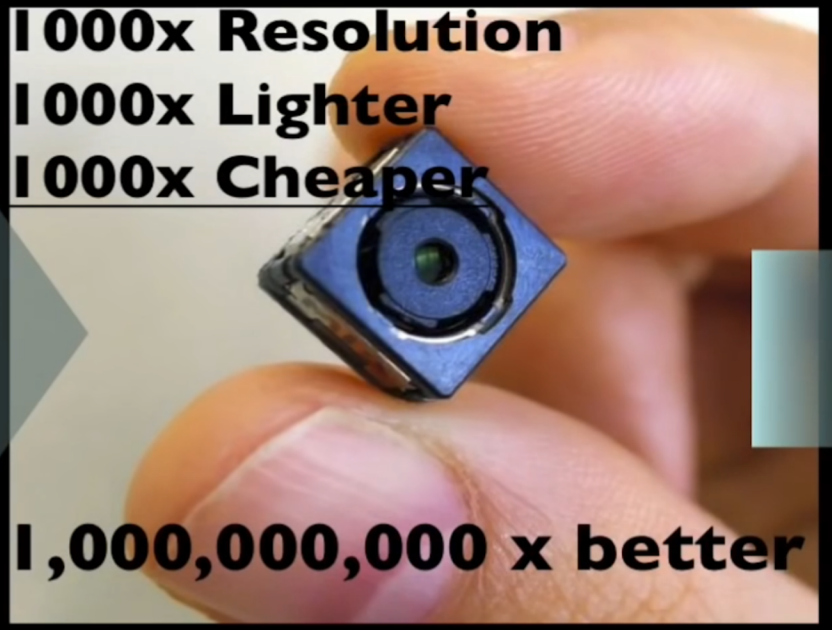
Machine learning solutions to **highly visible problems**

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 →

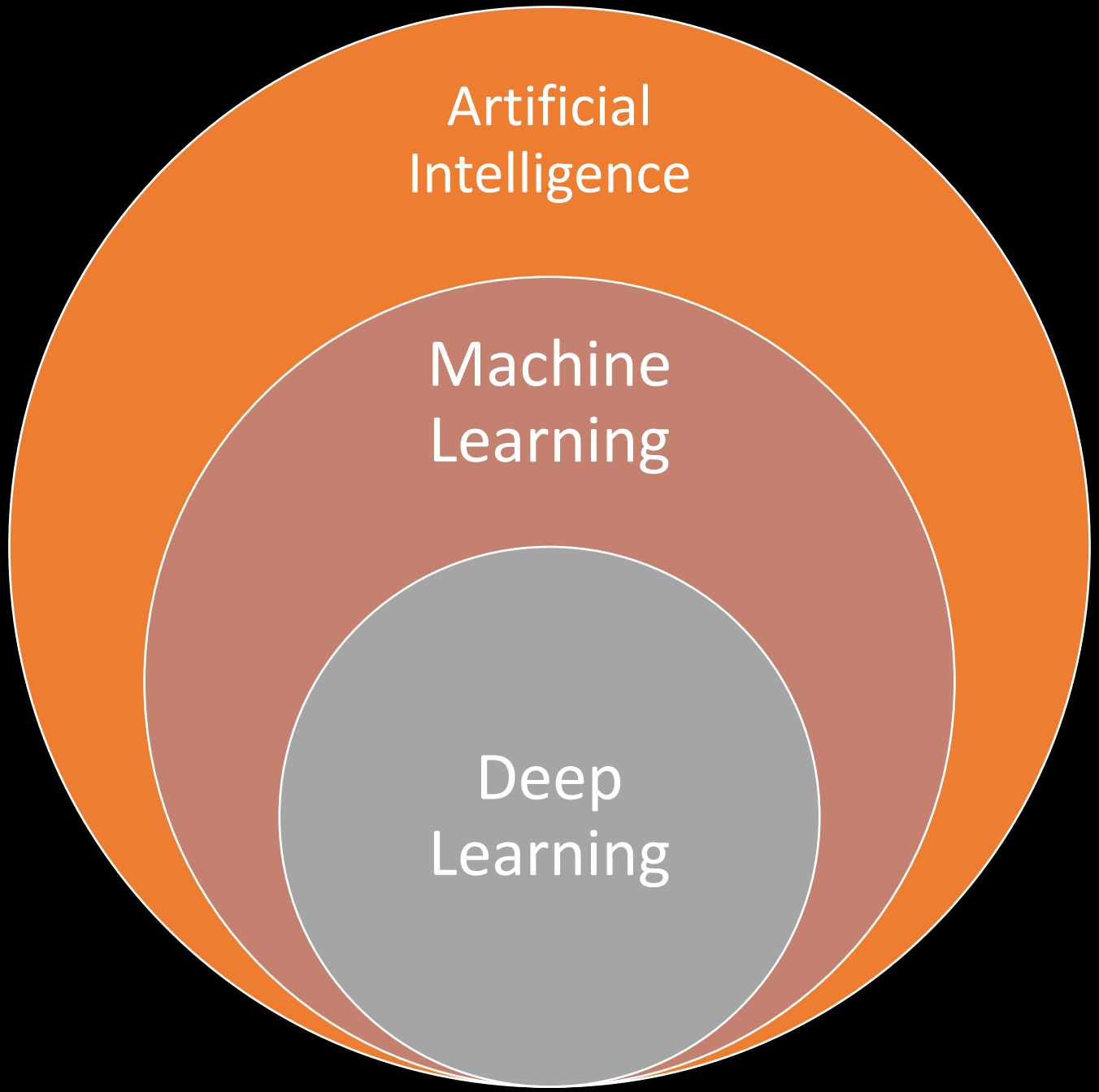
← 1,000x Resolution & 1,000 lighter & 1,000 cheaper

What is driving AI's progress?

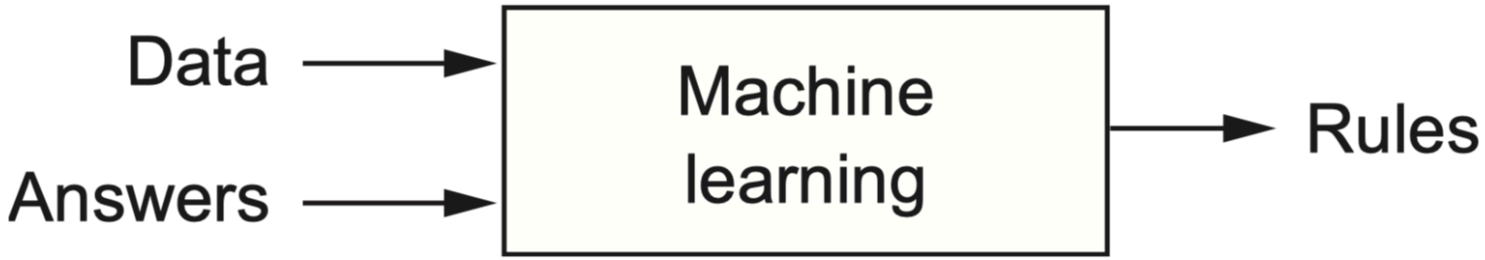
New material starts here…

Key idea:

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


Artificial
Intelligence
Machine
Learning
Deep
Learning

Machine Learning: a new programming paradigm

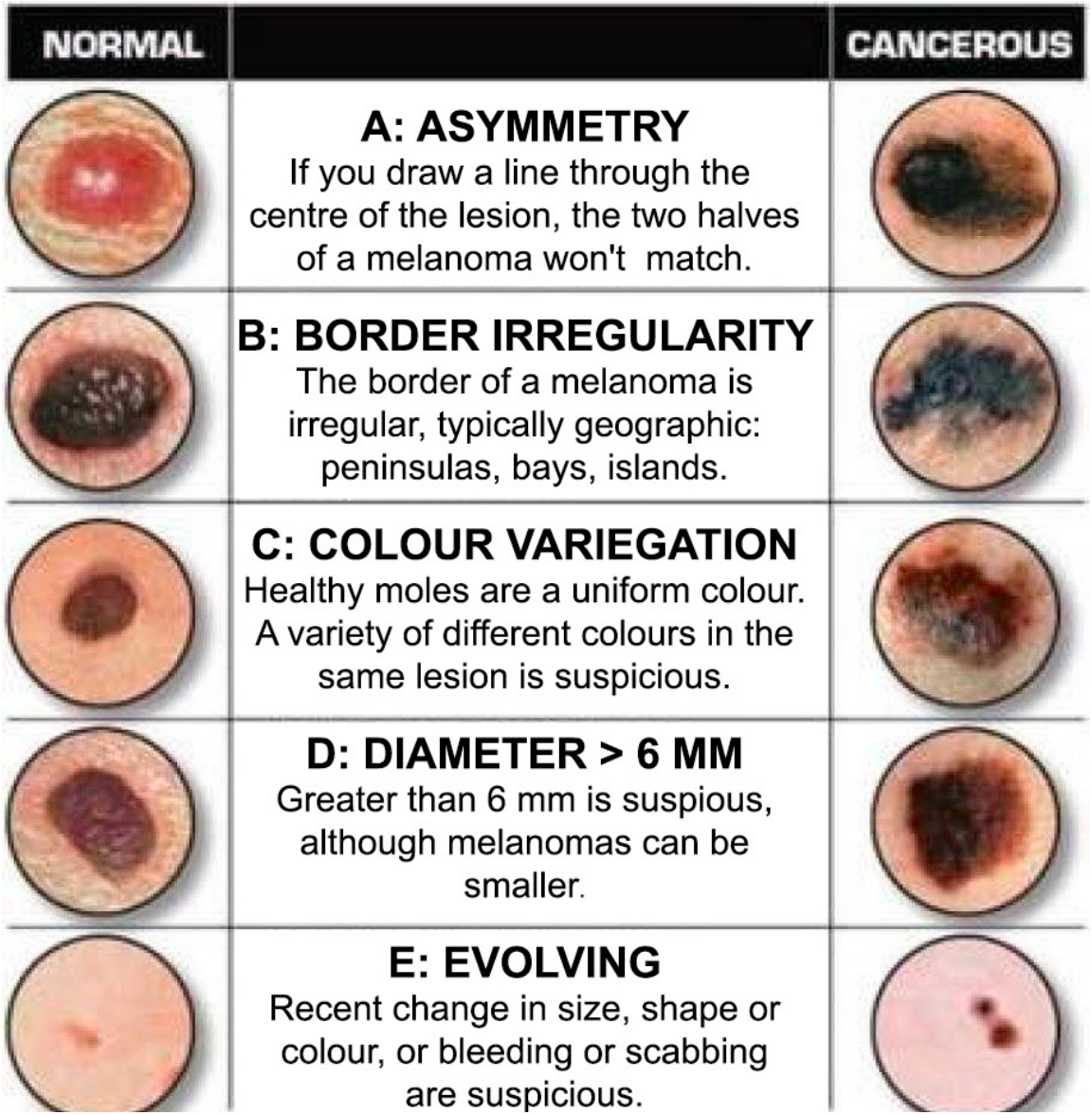


Source: F. Chollet

Example: skin lesion classification

Old method:

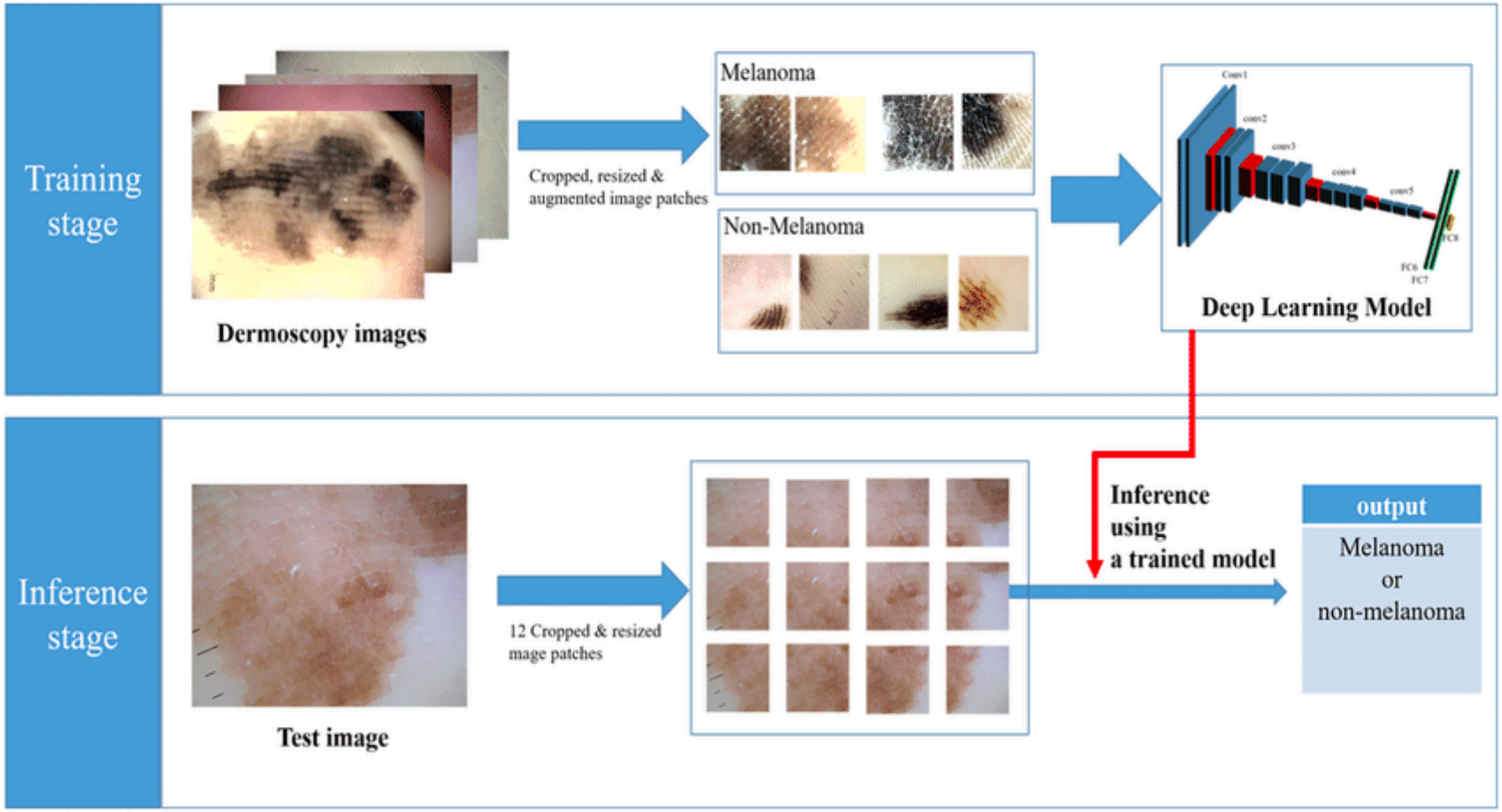
1. Learn rules from human expert
2. Write (encode) rules by hand
3. Test with (new) data
4. Refine and improve



Example: skin lesion classification

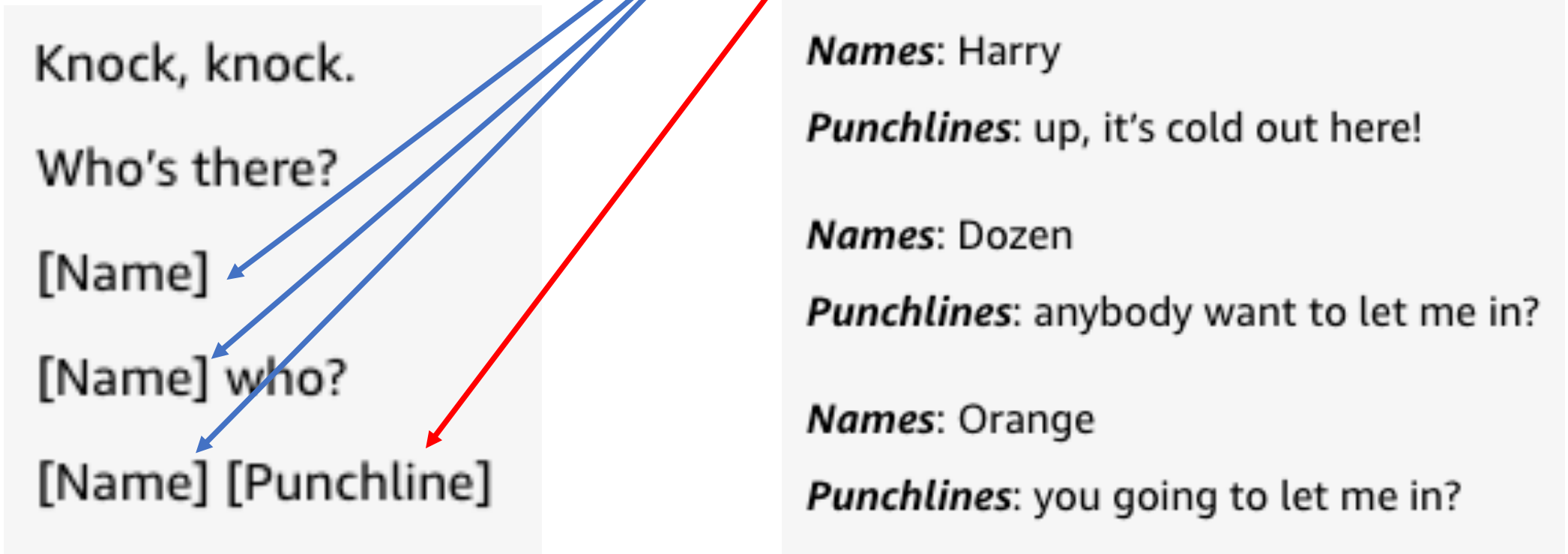
New method:

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?

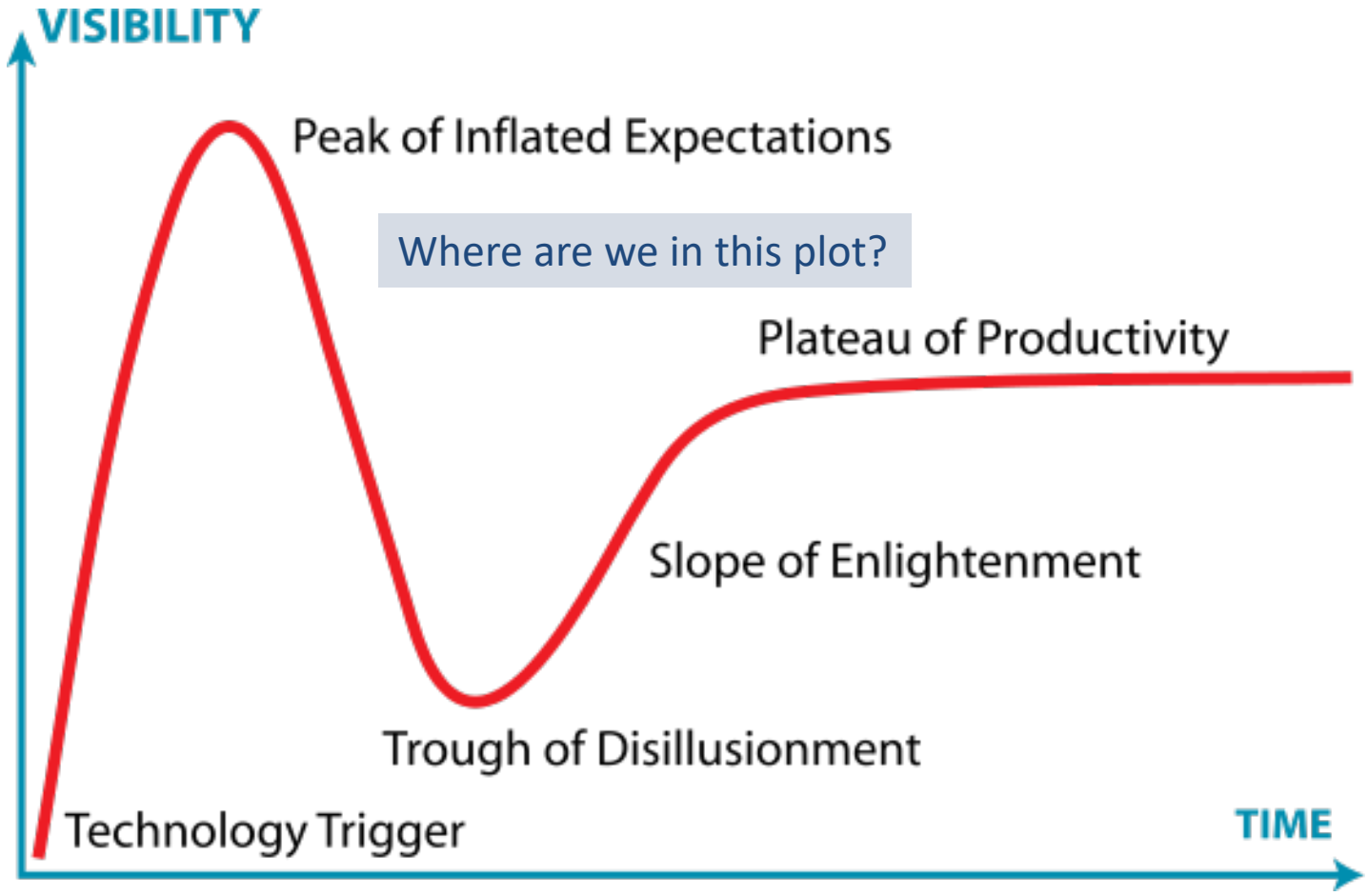
Alec-Knock Knock jokes.


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:

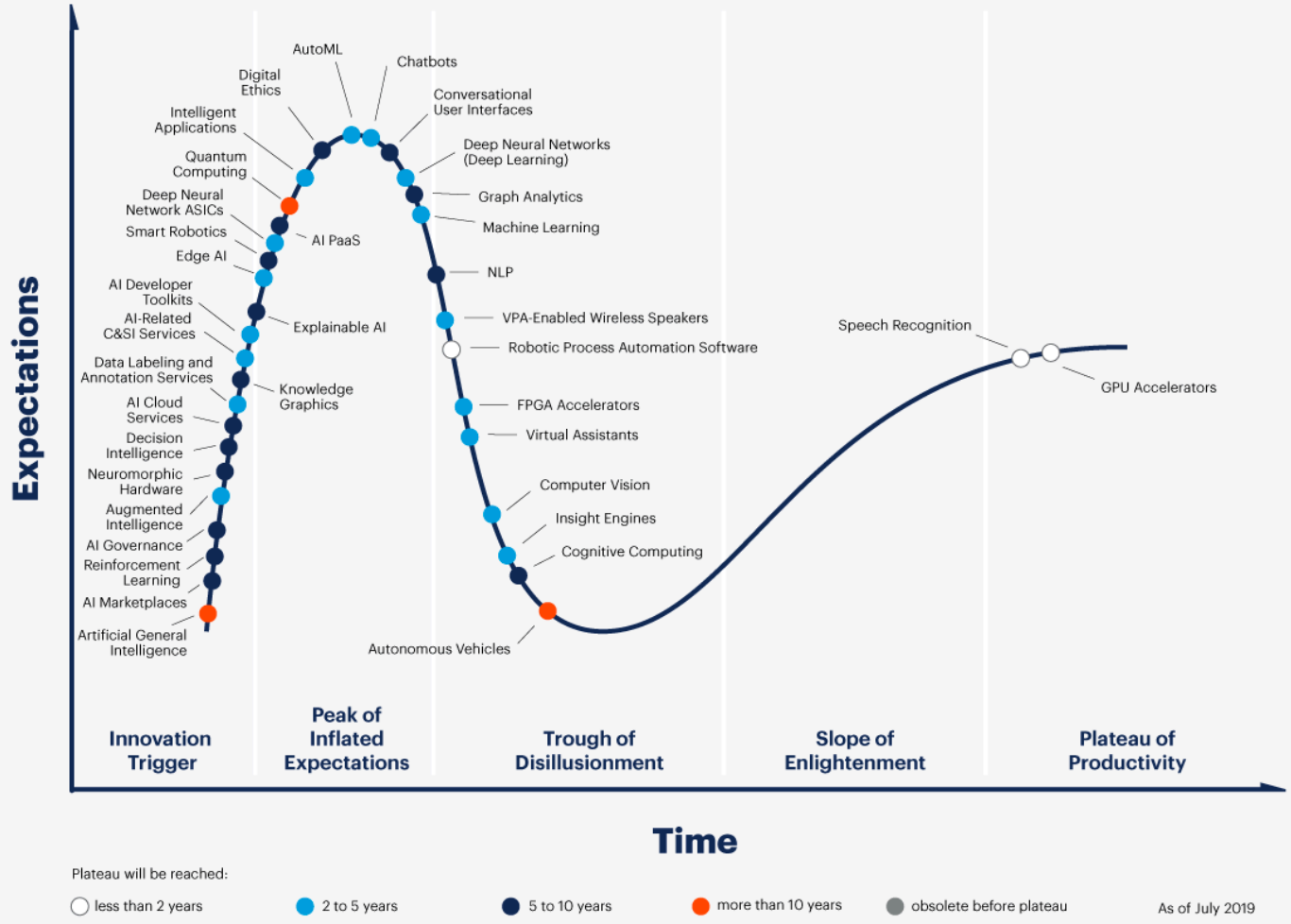
Deep Learning has become a buzzword, whose scope and definition keep changing

The deep learning phenomenon



Source: (Wikimedia)

Gartner Hype Cycle for Artificial Intelligence, 2019



gartner.com/SmarterWithGartner

Source: Gartner

Gartner

Gartner Hype Cycle for Emerging Technologies, 2019

gartner.com/SmarterWithGartner

Source: Gartner

Gartner

Do you *love* your child?

If you love your child,
teach them deep learning.

http://keras4kindergartners.com/

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)

Any sufficiently advanced technology is indistinguishable from magic.

— Arthur C. Clarke —

AZ QUOTES

Key idea:

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

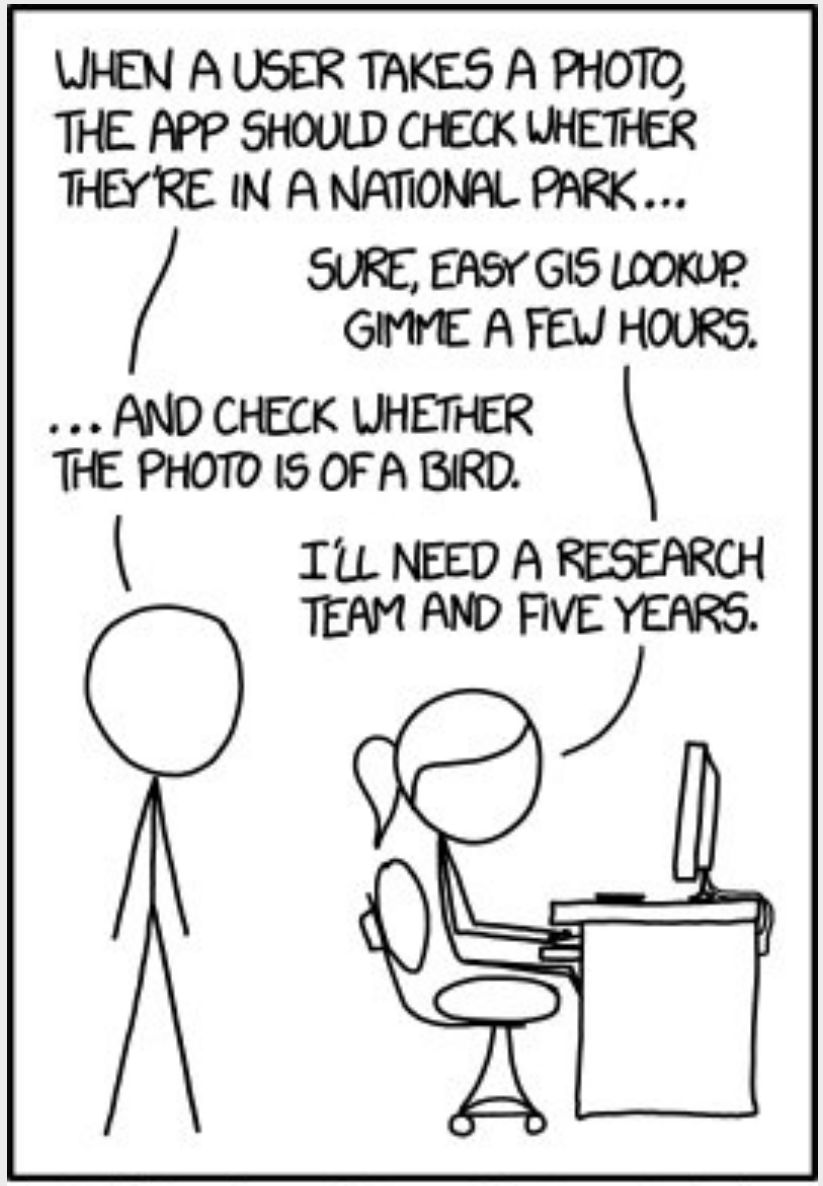
What AI can do well

- 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

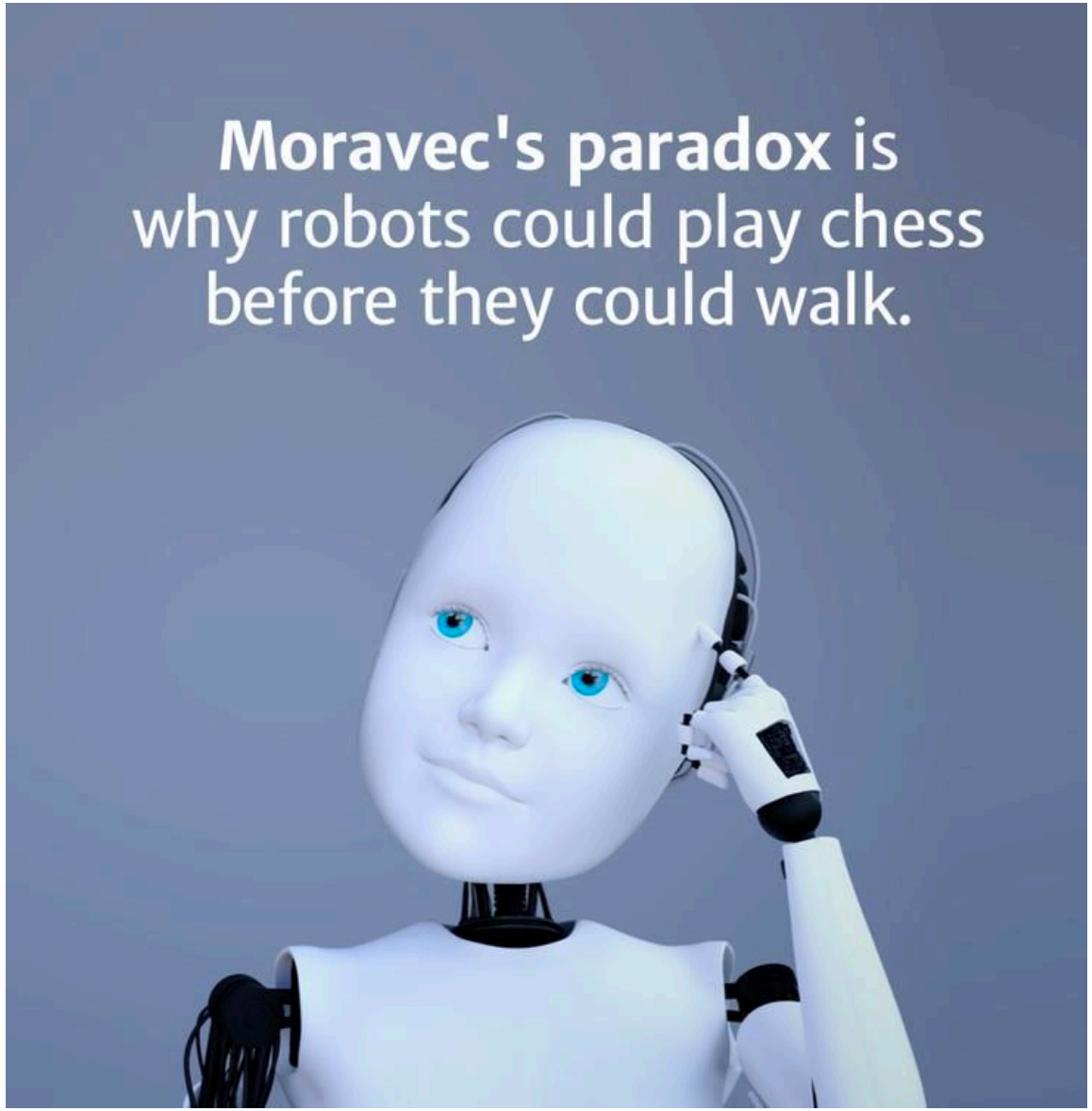
- Perform any entire job better than humans can
- Explain its mechanism for finding patterns in information or what those patterns mean
- Understand the context that surrounds a given task
- Learn from unorganized, unlabeled, or small amounts of data
- Perform tasks that require creativity, empathy,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

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


WHEN A USER TAKES A PHOTO, THE APP SHOULD CHECK WHETHER THEY'RE IN A NATIONAL PARK...
SURE, EASY GIS LOOKUP. GIMME A FEW HOURS.
...AND CHECK WHETHER THE PHOTO IS OF A BIRD.
I'LL NEED A RESEARCH TEAM AND FIVE YEARS.
IN CS, IT CAN BE HARD TO EXPLAIN THE DIFFERENCE BETWEEN THE EASY AND THE VIRTUALLY IMPOSSIBLE.

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.”



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

Example of something today's AI can't do!

🍽 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.
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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."

Another example of something today's AI can't do!

“AI, explain this photo to me”

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:

AI must be developed with FATE in mind

FATE

- Fairness
- Accountability
- Transparency
- Ethics

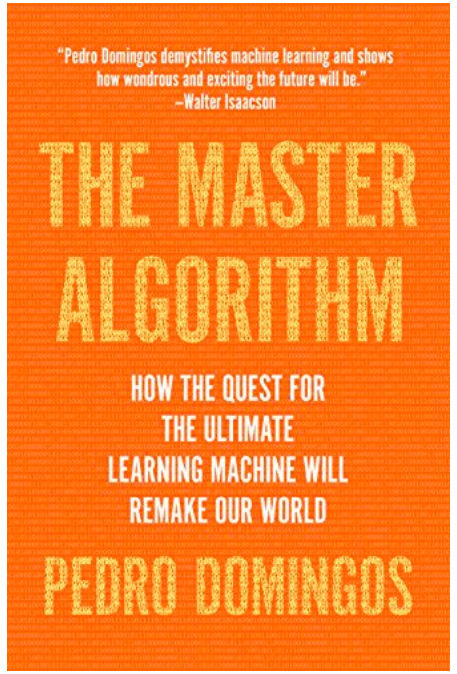
FATE - questions

- How can AI assist users and offer enhanced insights, while avoiding exposing them to discrimination in health, housing, law enforcement, and employment?
- How can we balance the need for efficiency and exploration with fairness and sensitivity to users?
- As our world moves toward relying on intelligent agents, how can we create a system that individuals and communities can trust?
- Is bias ever ethical?
- Is known intent required for consent?
- Is explaining a decision enough?

Concluding remarks

“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



History of AI

Past

The AI winter

Present

Many challenges and opportunities

Future

General AI?

“We’ve always said that human-level intelligence is 20 years off.

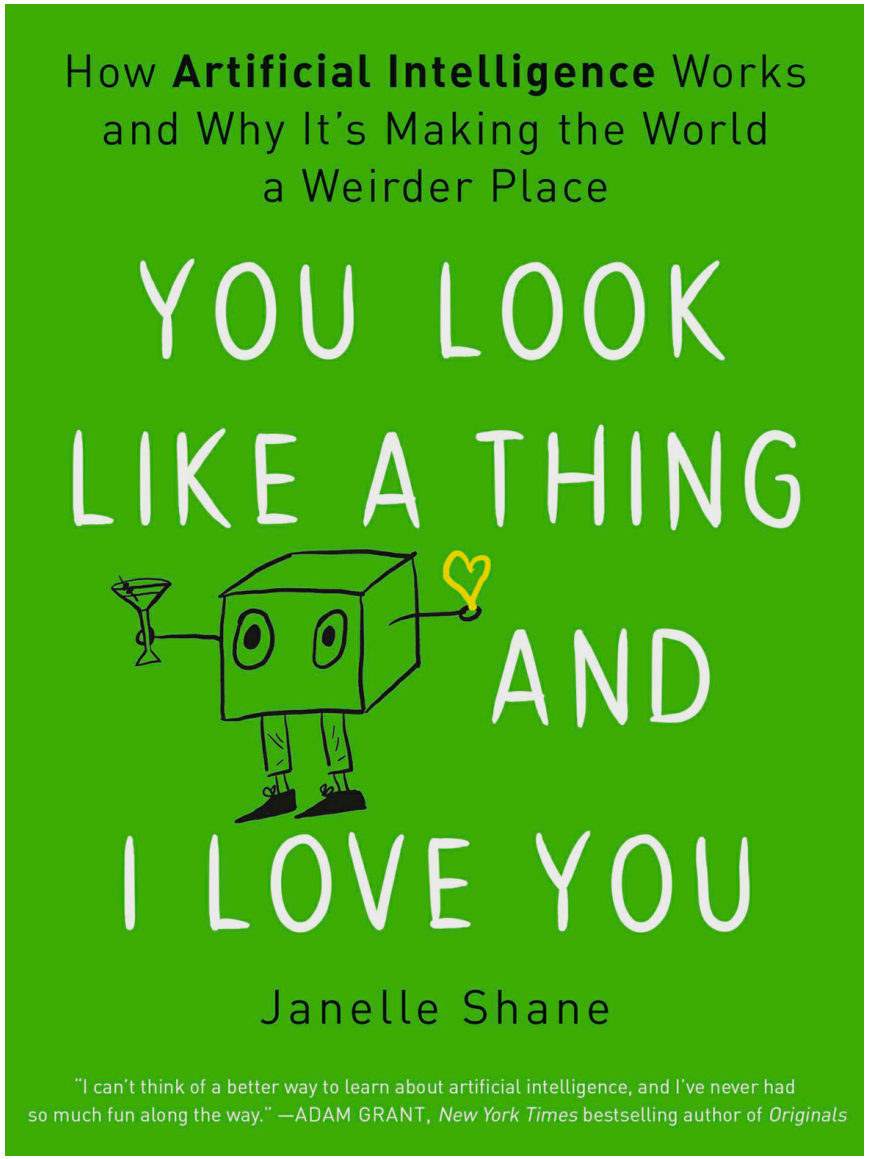
Eventually we’ll be right.”

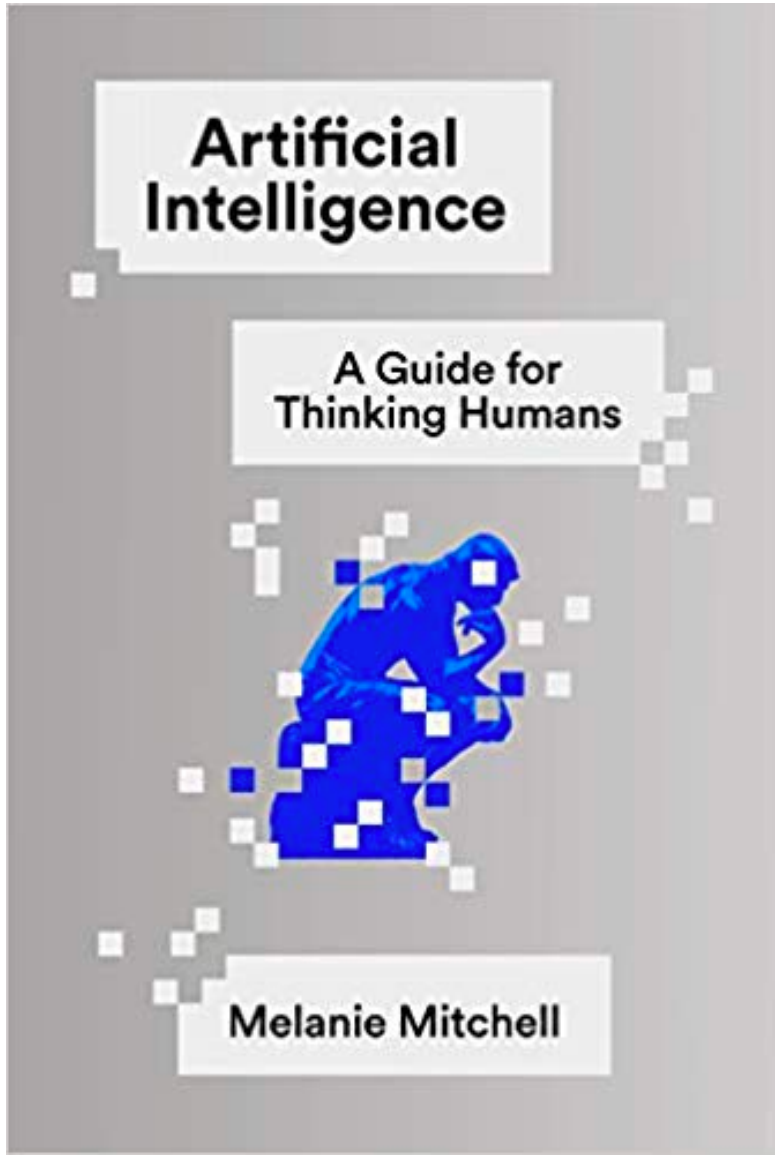
-- Patrick H. Winston (1943-2019)
Professor of Artificial Intelligence and Computer Science at MIT

“Floating assignment” #1

- For Topic 1:
  - Take Andrew Ng’s course “AI for Everyone” and summarize it
  - Read/watch Pamela McCorduck’s books/talks/interviews about the history of AI

Recommended reading





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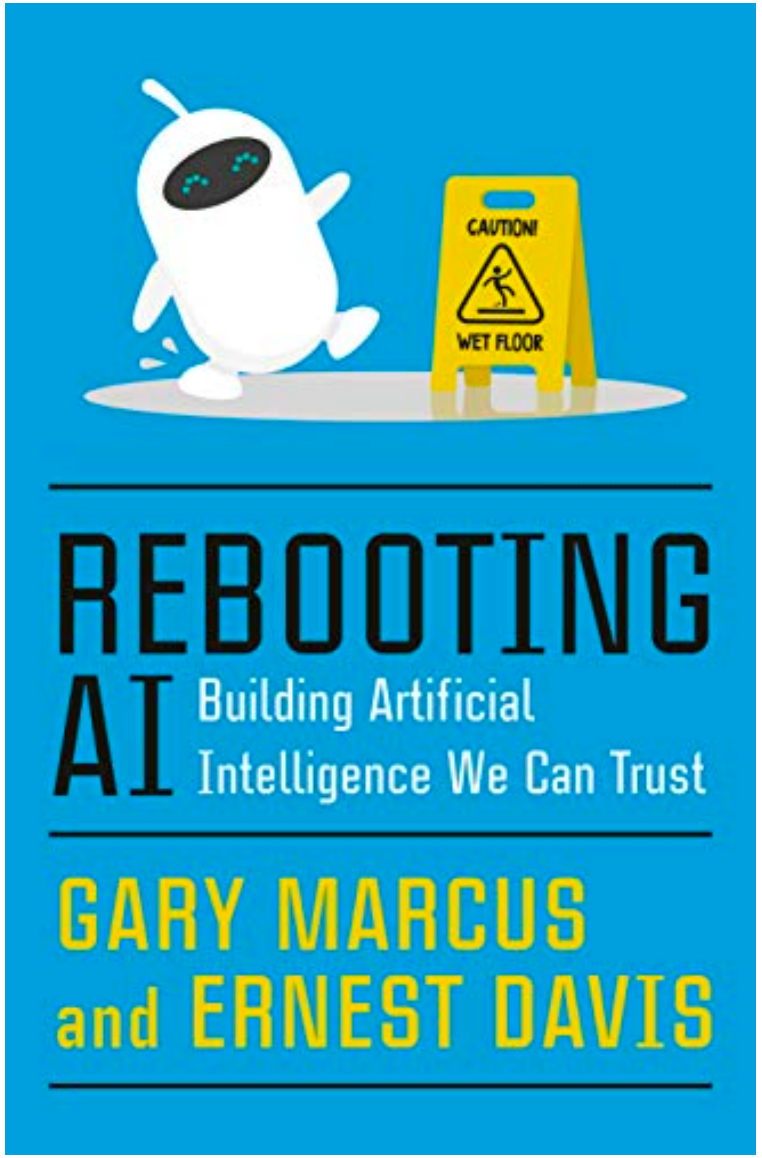
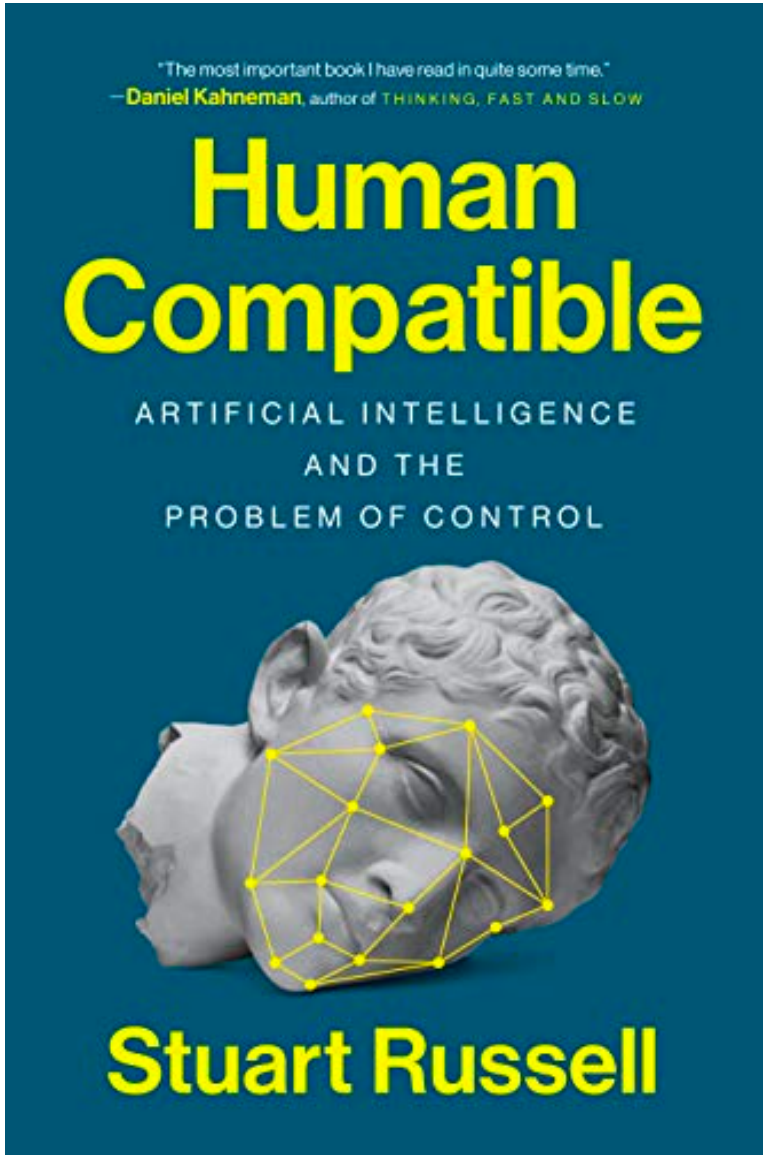




Recommended podcast

Apple Podcasts

Google Podcasts

Spotify

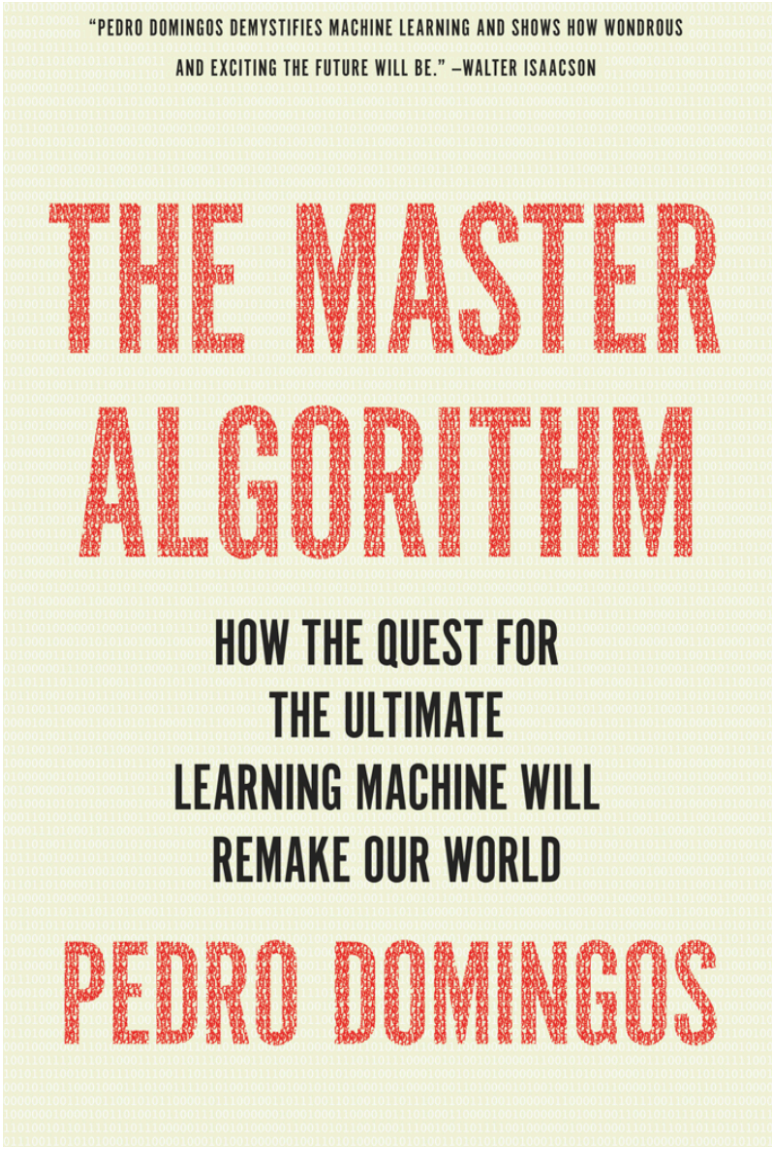
TuneIn

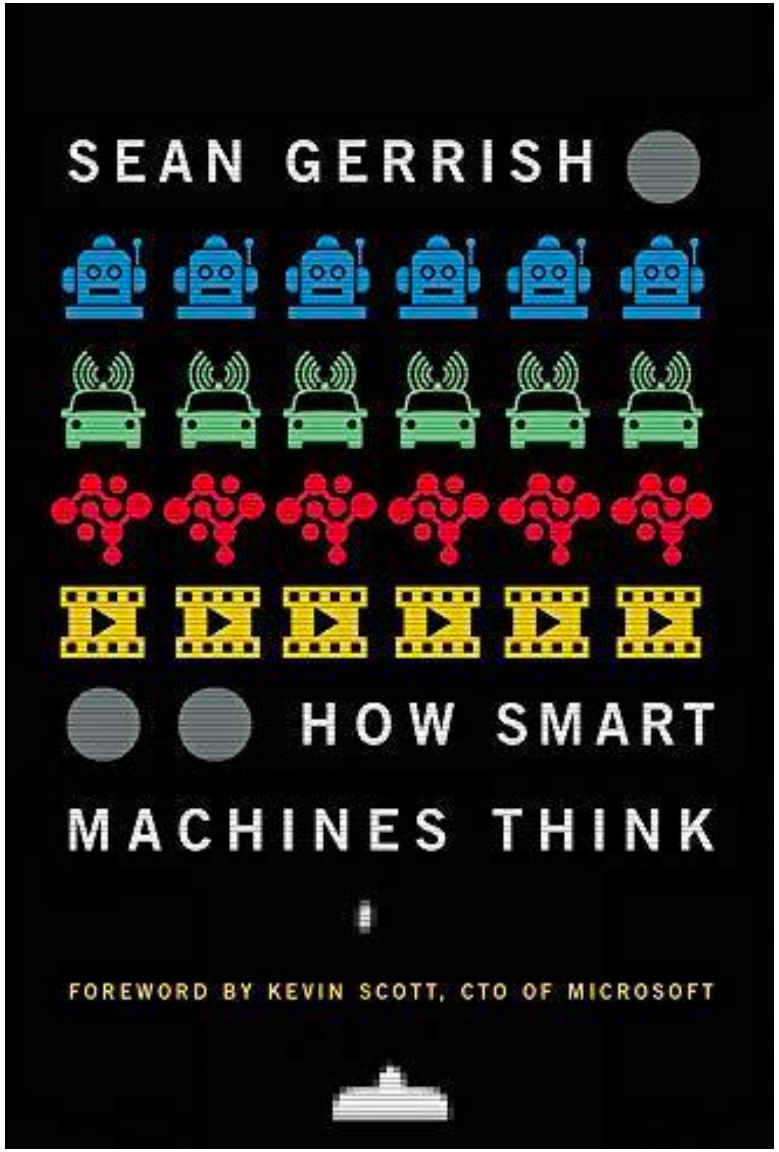
Android

Stitcher

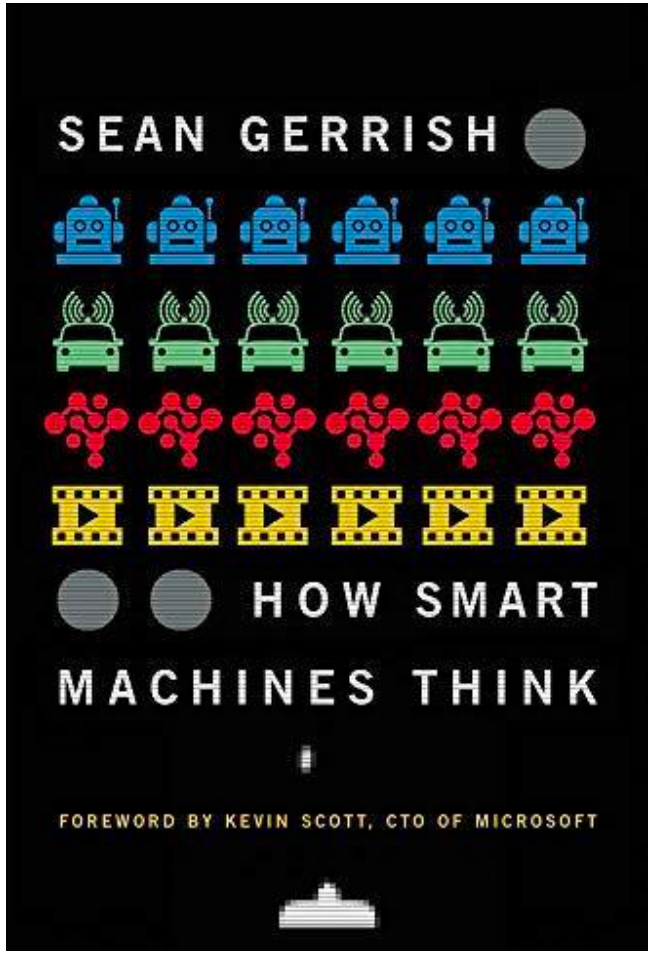
by Email

RSS



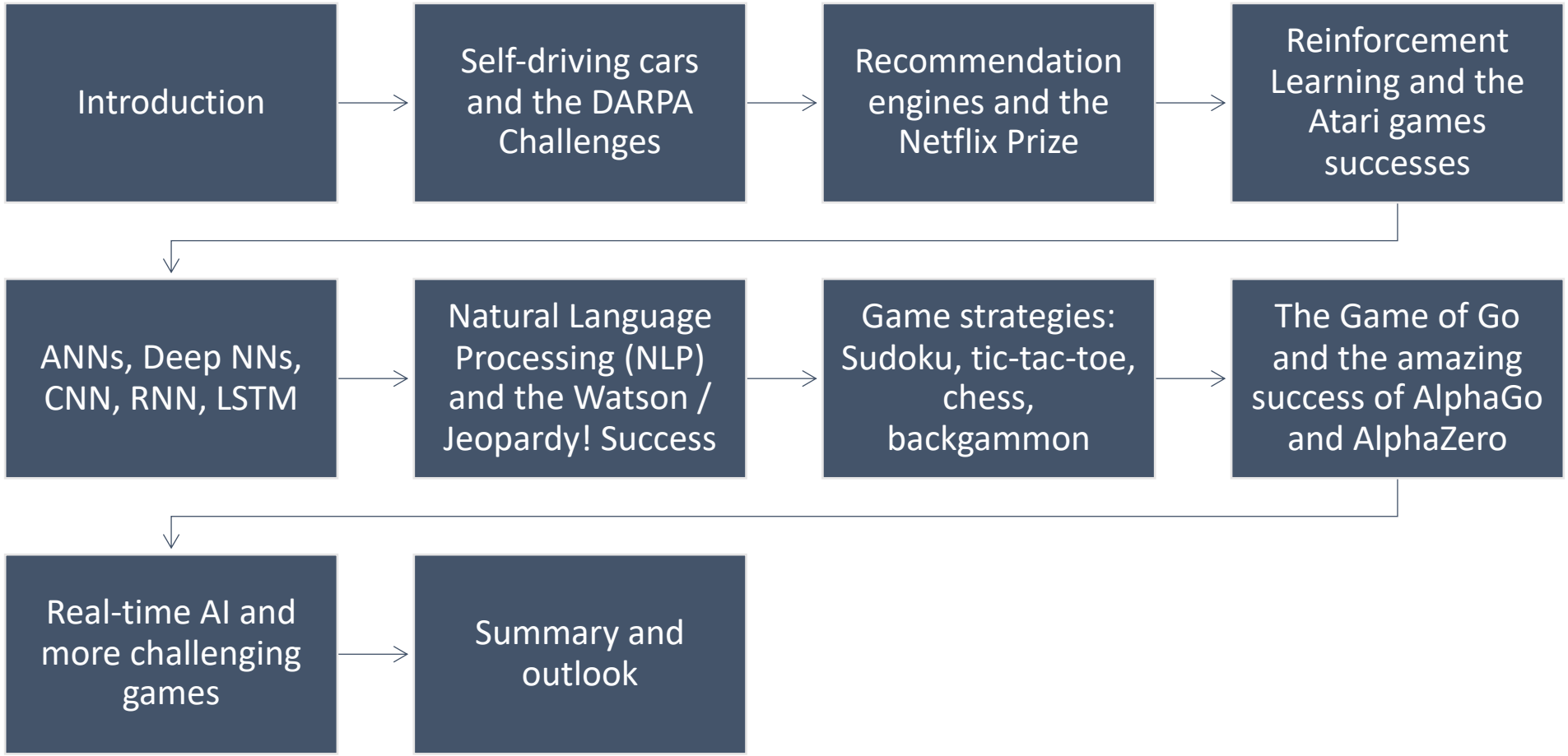


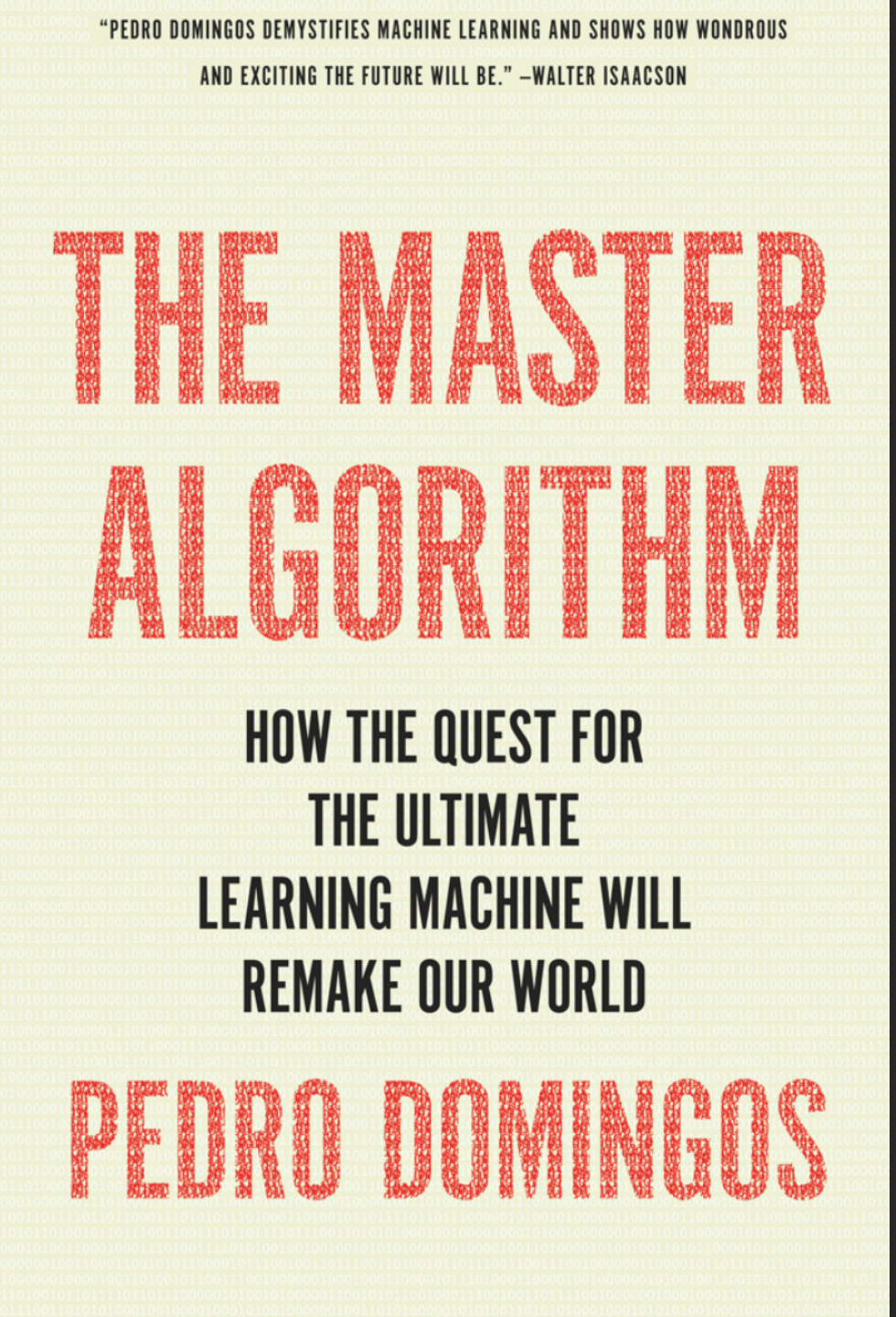
The "textbooks"



How smart machines think (by Sean Gerrish)

Overview


Introduction
Self-driving cars and the DARPA Challenges
Recommendation engines and the Netflix Prize
Reinforcement Learning and the Atari games successes
ANNs, Deep NNs, CNN, RNN, LSTM
Natural Language Processing (NLP) and the Watson / Jeopardy! Success
Game strategies: Sudoku, tic-tac-toe, chess, backgammon
The Game of Go and the amazing success of AlphaGo and AlphaZero
Real-time AI and more challenging games
Summary and outlook



The Master Algorithm

(by Pedro Domingos)

So How Do Machines Learn?

1. Fill in gaps in existing knowledge

2. Emulate the brain

3. Simulate evolution

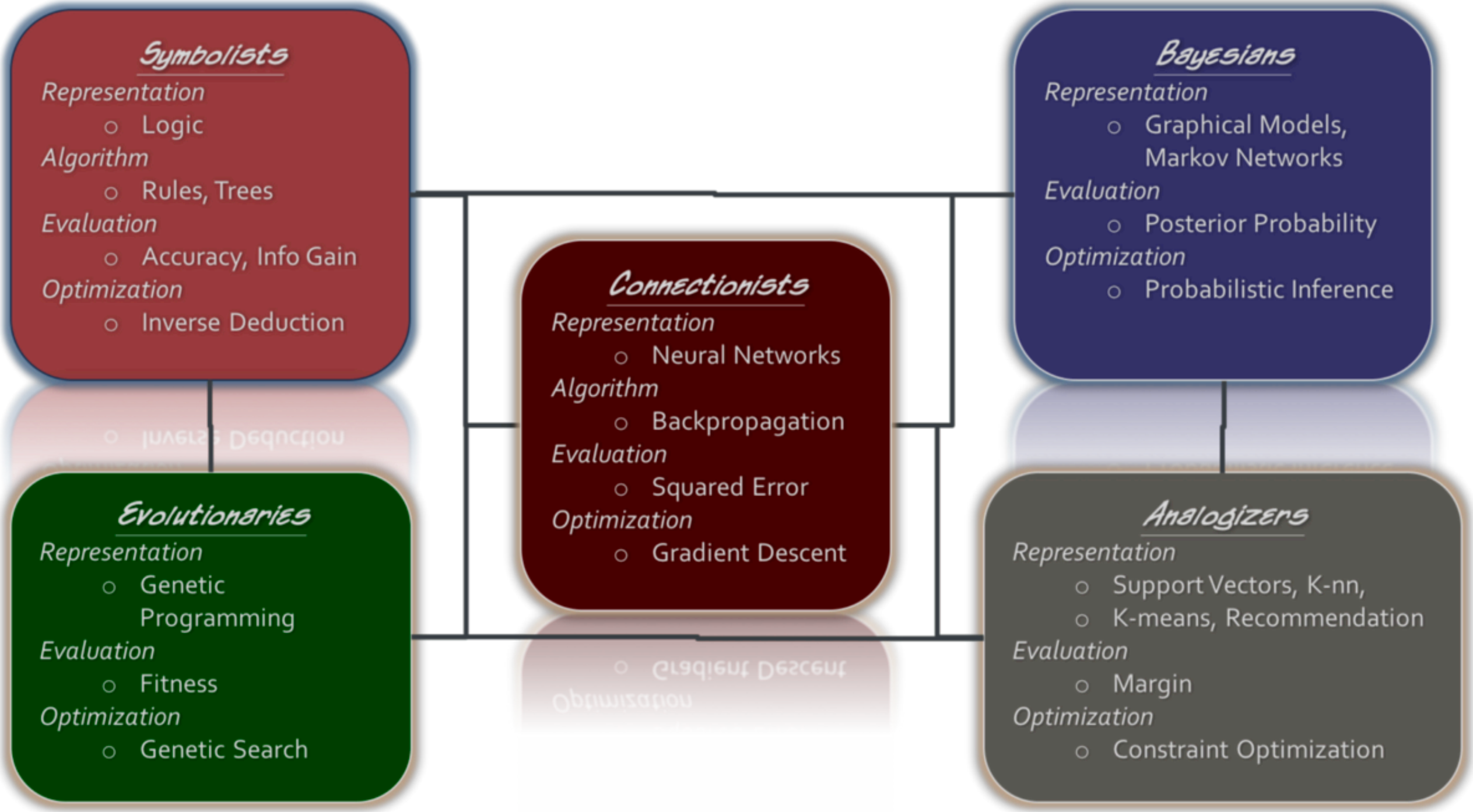
4. Systematically reduce uncertainty

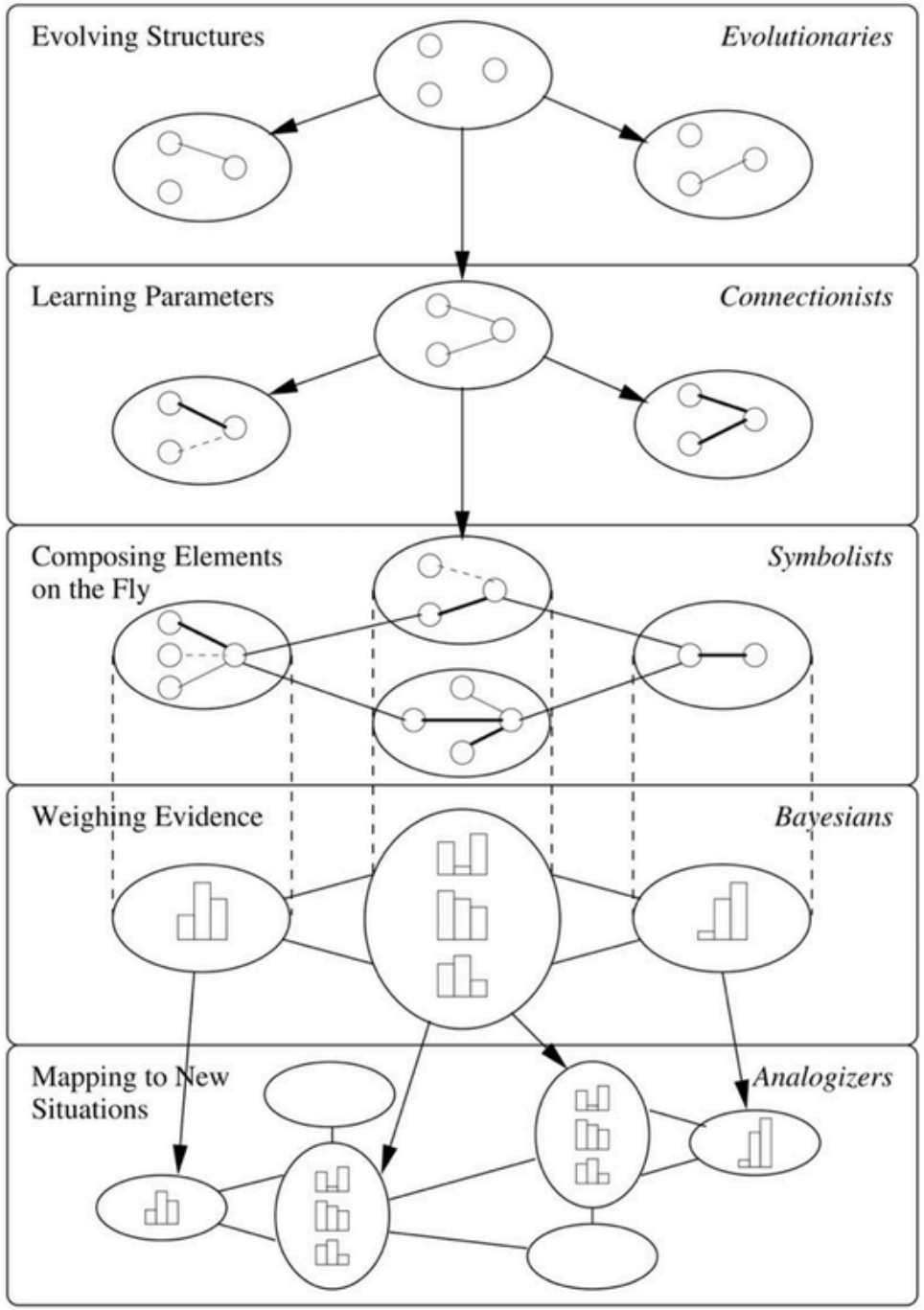
5. Notice similarities between old and new

The Five 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

Tribe	Strength	Technology
Symbolists	Structure Inference	Production Rule System Inverse Deduction
Connectionists	Estimating Parameters	Backpropagation Deep Learning
Bayesians	Weighing Evidence	HMM Graphical Model
Evolutionaries	Structure Learning	Genetic Algorithms Evolutionary Programming
Analogizers	Mapping to Novelty	kNN SVM


Symbolists
Representation
Logic
Algorithm
Rules, Trees
Evaluation
Accuracy, Info Gain
Optimization
Inverse Deduction
Bayesians
Representation
Graphical Models, Markov Networks
Evaluation
Posterior Probability
Optimization
Probabilistic Inference
Connectionists
Representation
Neural Networks
Algorithm
Backpropagation
Evaluation
Squared Error
Optimization
Gradient Descent
Evolutionaries
Representation
Genetic Programming
Evaluation
Fitness
Optimization
Genetic Search
Analogizers
Representation
Support Vectors, K-nn,
K-means, Recommendation
Evaluation
Margin
Optimization
Constraint Optimization


Evolving Structures
Evolutionaries
Learning Parameters
Connectionists
Composing Elements
on the Fly
Symbolists
Weighing Evidence
Bayesians
Mapping to New
Situations
Analogizers