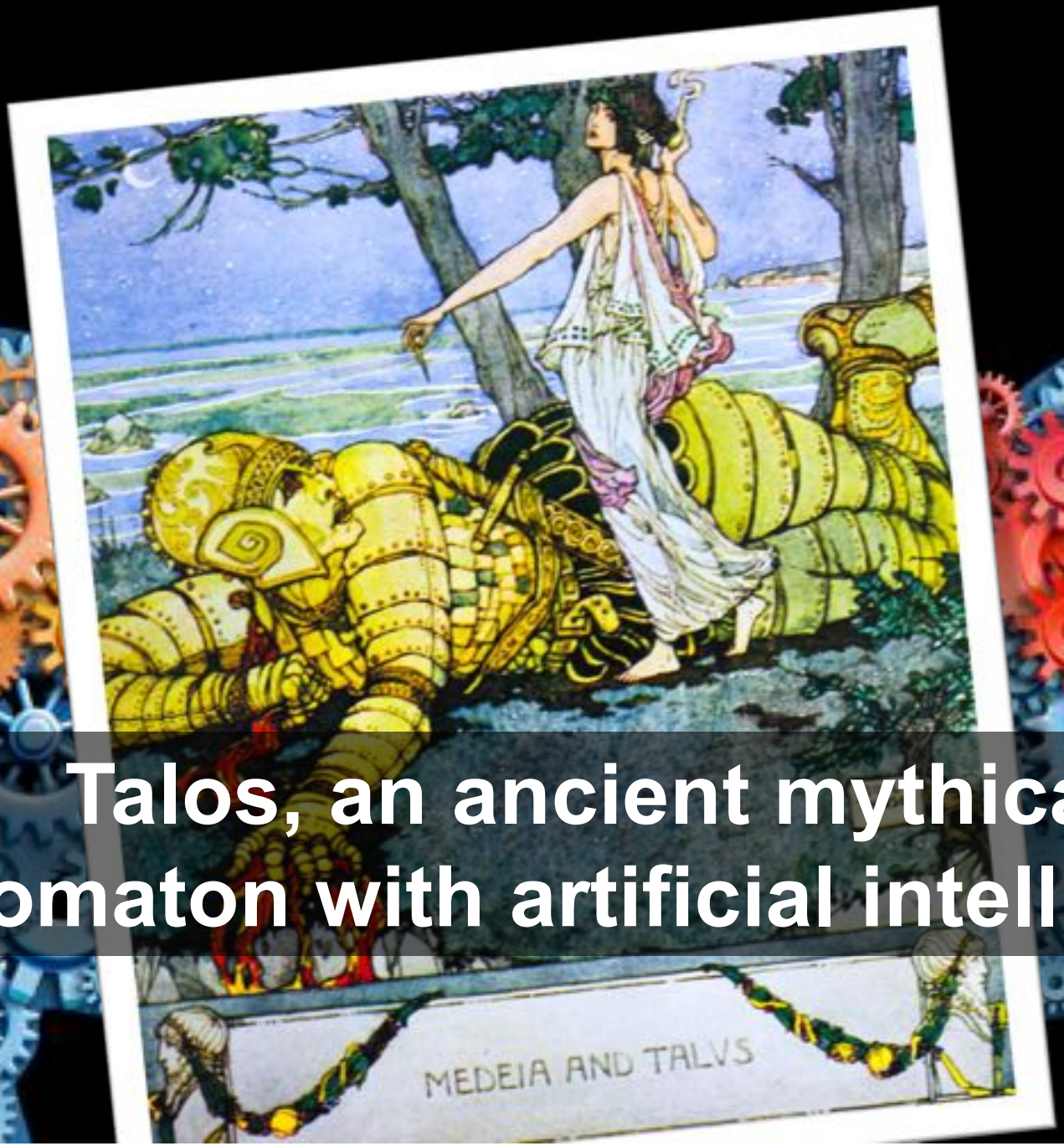
What is Artificial Intelligence and can it improve cardiac care?*

*Thanks for Prof. Sriraam Natarajan, PhD (UT Dallas) and many others for all the great collaborations

Prof Dr. Kristian Kersting

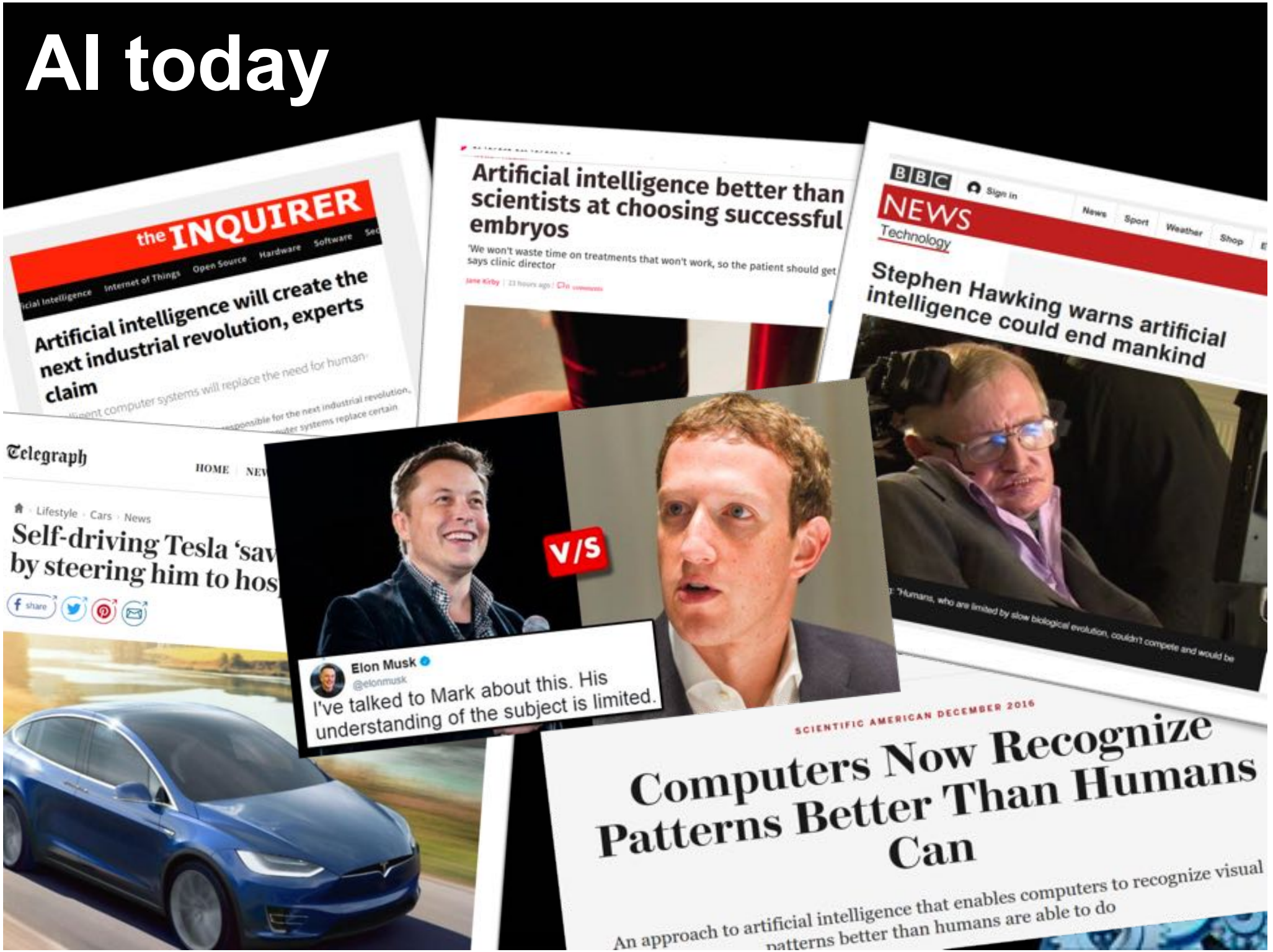
Image taken from „A Doctor's Prescription for More AI in Medicine"by Sumathi Reddy, The Wall Street Journal, March 4, 2019

The dream of AI is not new



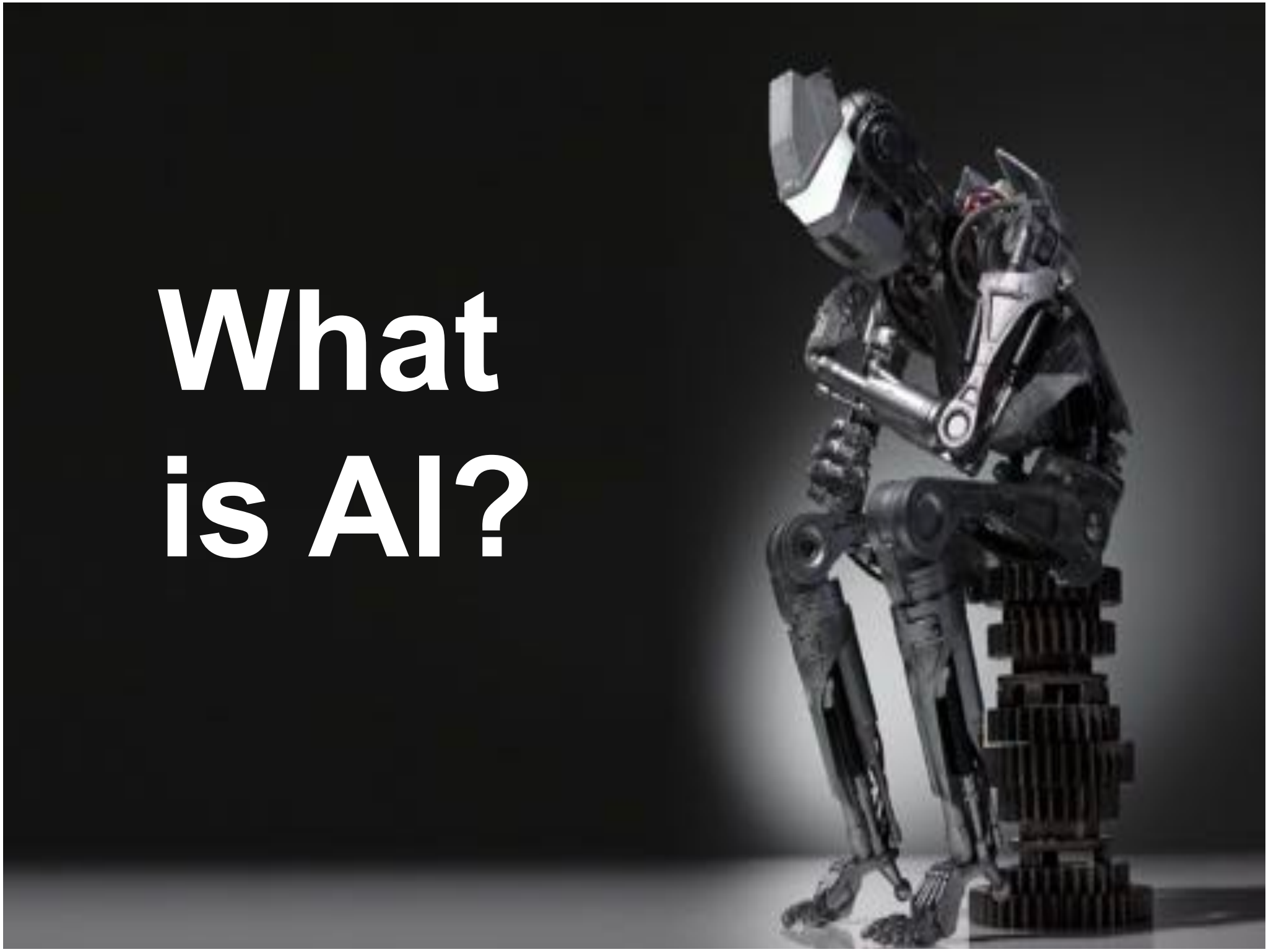
Talos, an ancient mythical automaton with artificial intelligence

AI today


the INQUIRER
Artificial intelligence will create the next industrial revolution, experts claim
Artificial intelligence better than scientists at choosing successful embryos
'We won't waste time on treatments that won't work, so the patient should get
says clinic director
BBC
NEWS
Technology
Stephen Hawking warns artificial intelligence could end mankind
Telegraph
Lifestyle · Cars · News
Self-driving Tesla 'sav
by steering him to hos
V/S
Elon Musk
@elonmusk
I've talked to Mark about this. His understanding of the subject is limited.
SCIENTIFIC AMERICAN DECEMBER 2016
Computers Now Recognize Patterns Better Than Humans Can
An approach to artificial intelligence that enables computers to recognize visual

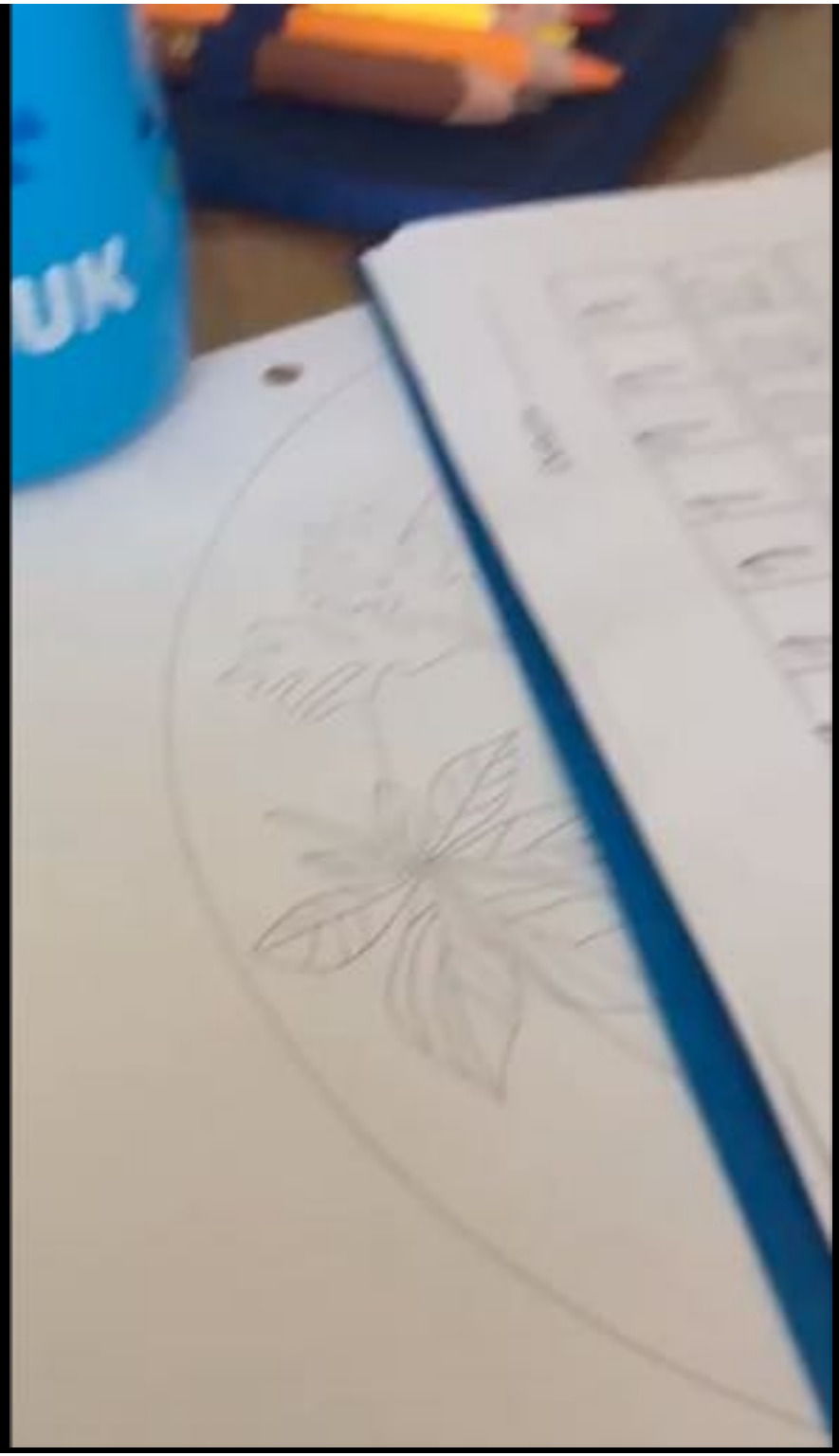
So, AI has many faces

What is AI?



Humans are smart

https://www.youtube.com/watch?v=XQ79UUlOeWc

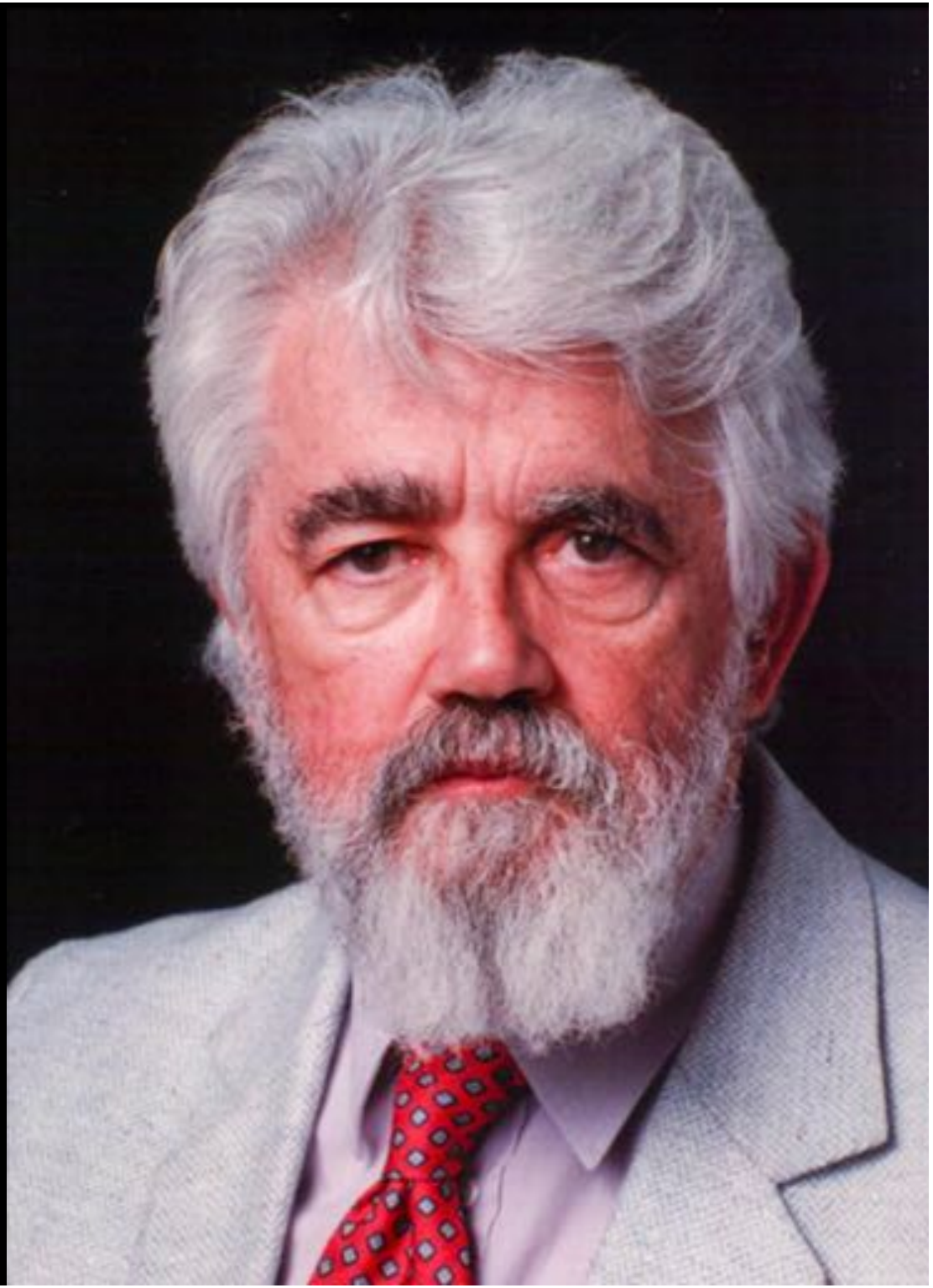


AI asks, can machines be smart, too?

„the science and engineering of making intelligent machines, especially intelligent computer programs.

It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.“

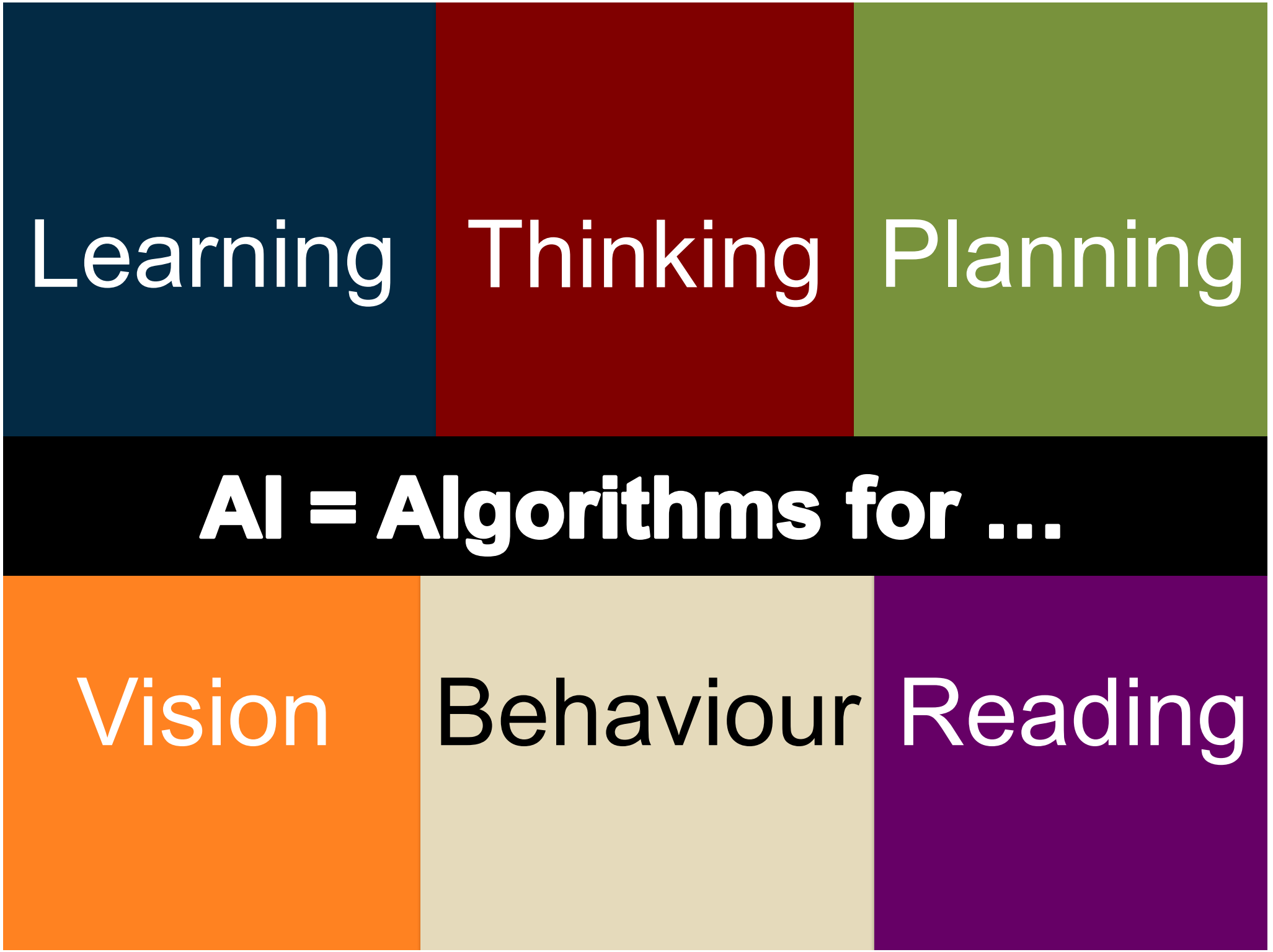
- John McCarthy, Stanford (1956), coined the term AI, Turing Awardee



AI wants to build intelligent computer programs. How do we do this?

We use algorithms:
unambiguous specifications of how to solve a class of problems – in finite time.

Think of it as a recipe!


Learning
Thinking
Planning
AI = Algorithms for ...
Vision
Behaviour
Reading

Machine Learning

the science "concerned with the question of how to construct computer programs that automatically improve with experience”

- Tom Mitchell (1997) CMU

Deep Learning

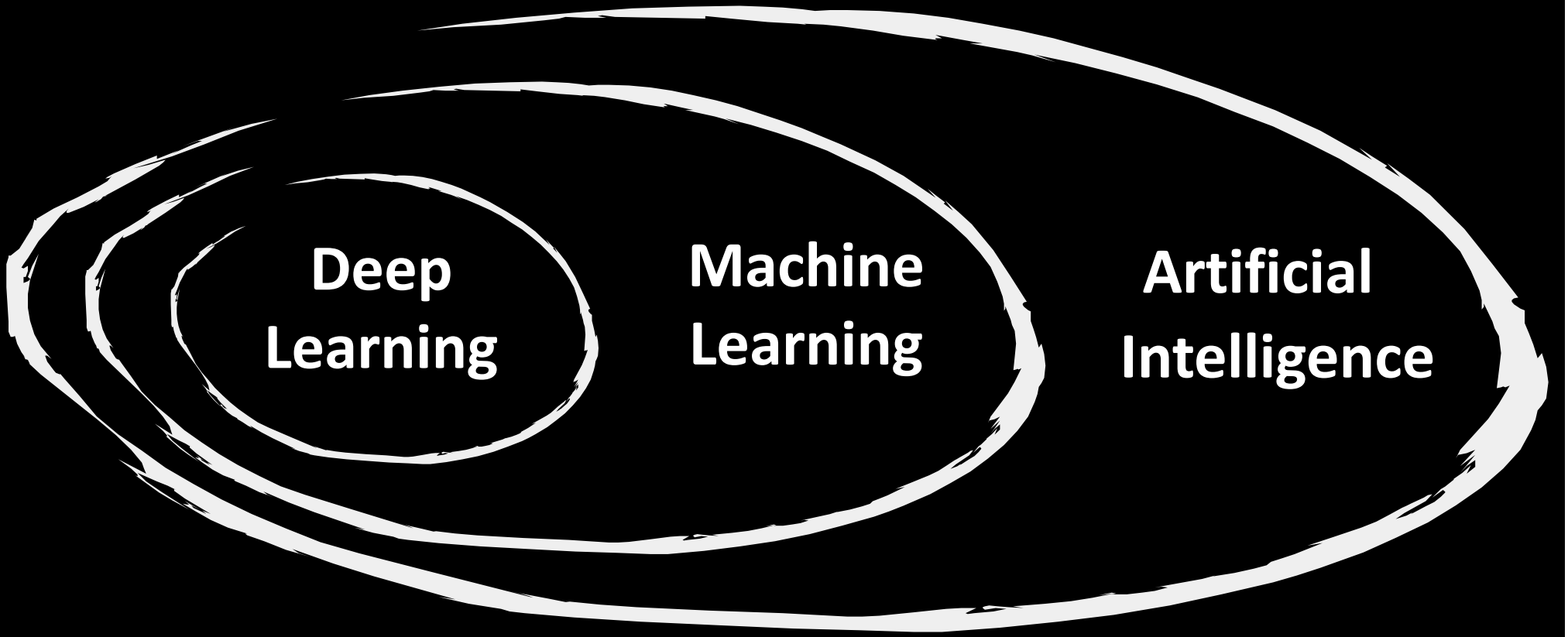
a form of machine learning that makes use of artificial neural networks

Geoffrey Hinton
Google
Univ. Toronto (CAN)

Yann LeCun
Facebook (USA)

Yoshua Bengio
Univ. Montreal (CAN)

Overall Picture



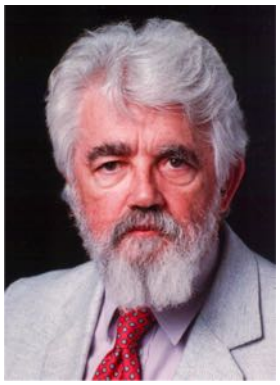
1956
AI is Born

A Proposal for the

DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

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.

Dartmouth Conference



John McCarthy

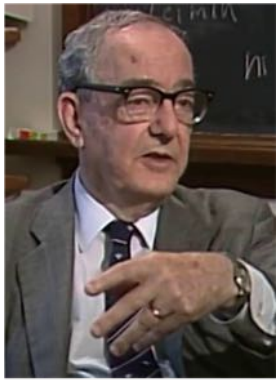
Turing Award 1971

Marvin Minsky

Turing Award 1969

Allen Newell

Turing Award 1975

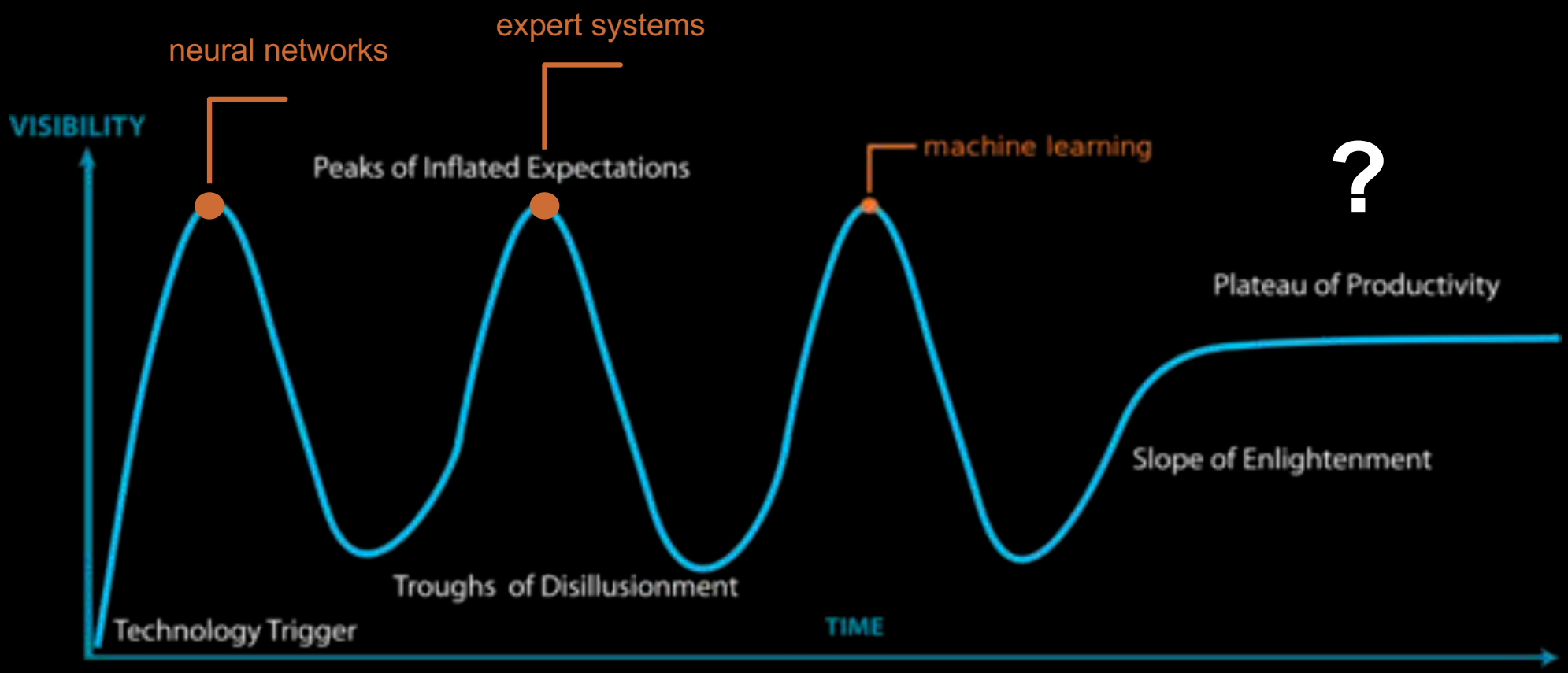


Herbert A. Simon

Turing Award 1975

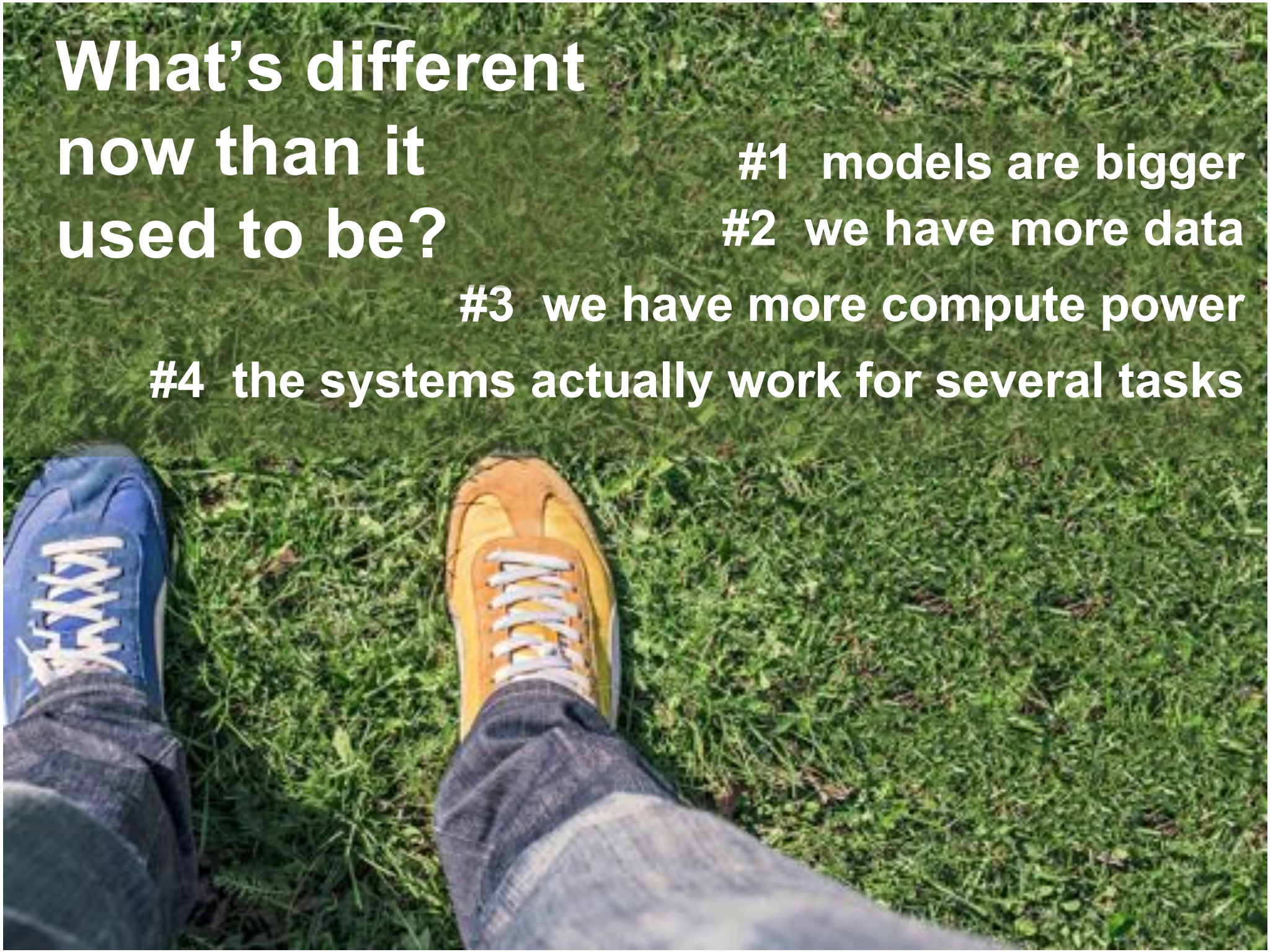
Nobel Prize 1978

A very short history of AI

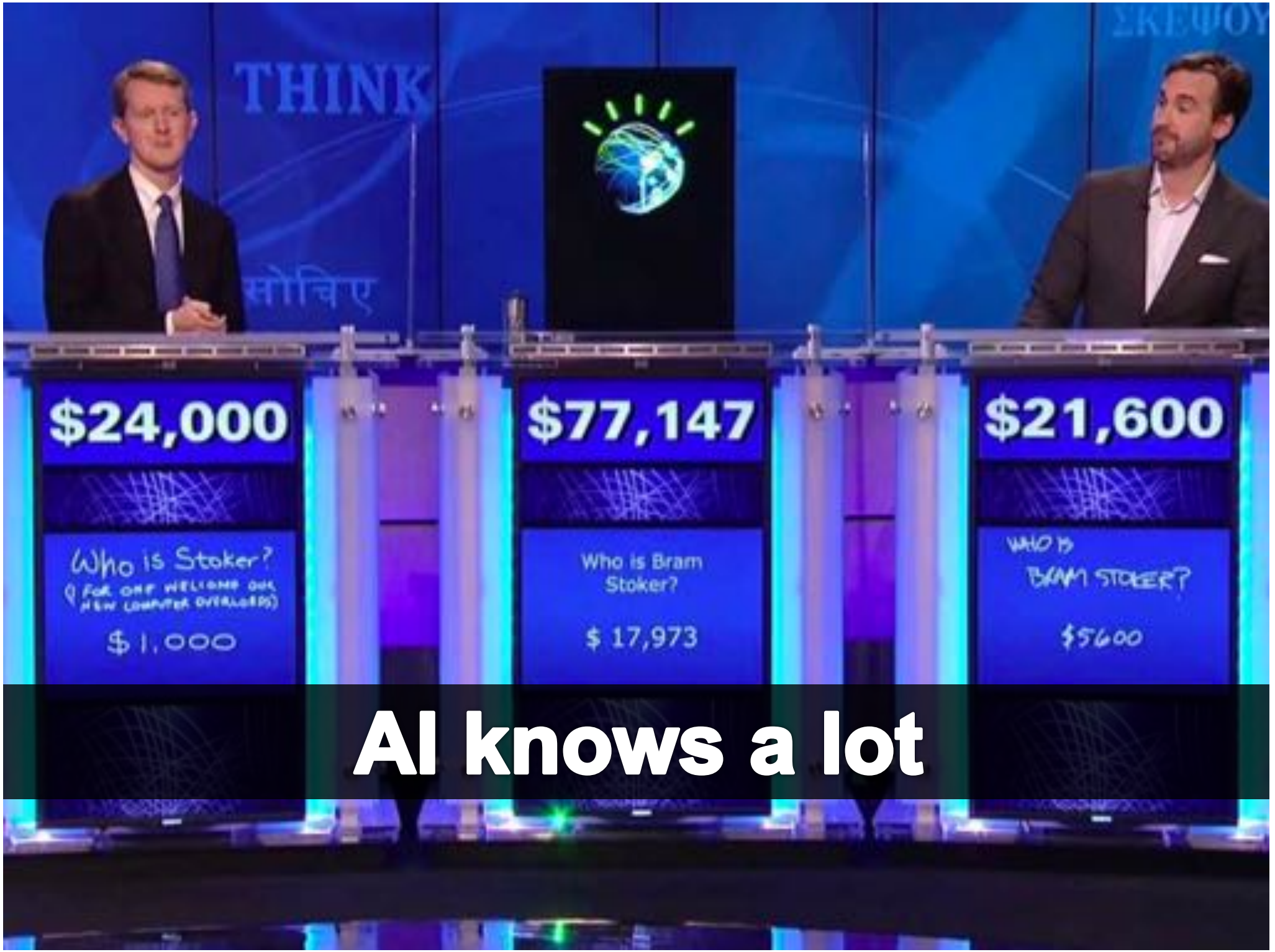


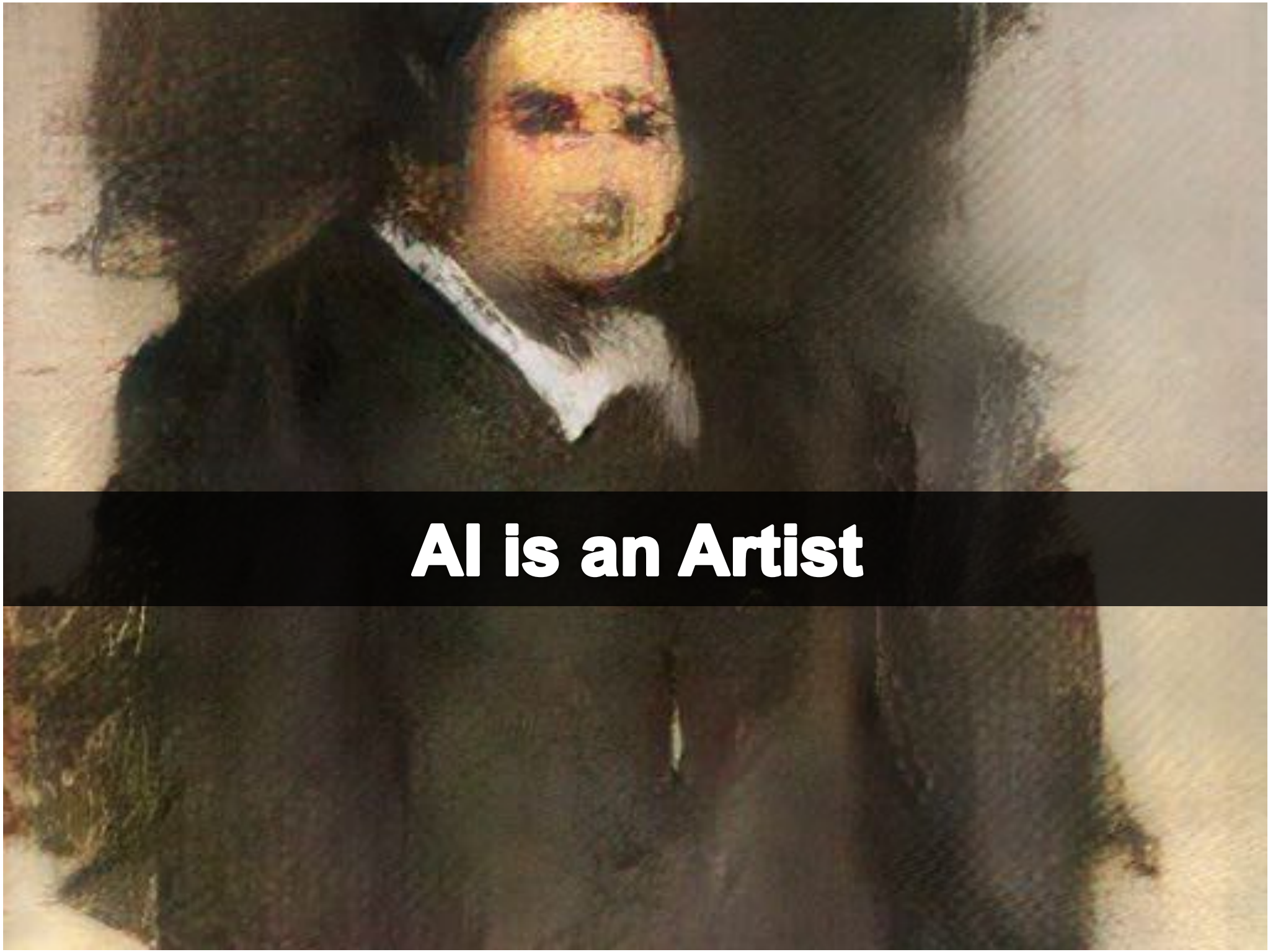
1956

2019


What's different now than it used to be?
#1 models are bigger
#2 we have more data
#3 we have more compute power
#4 the systems actually work for several tasks

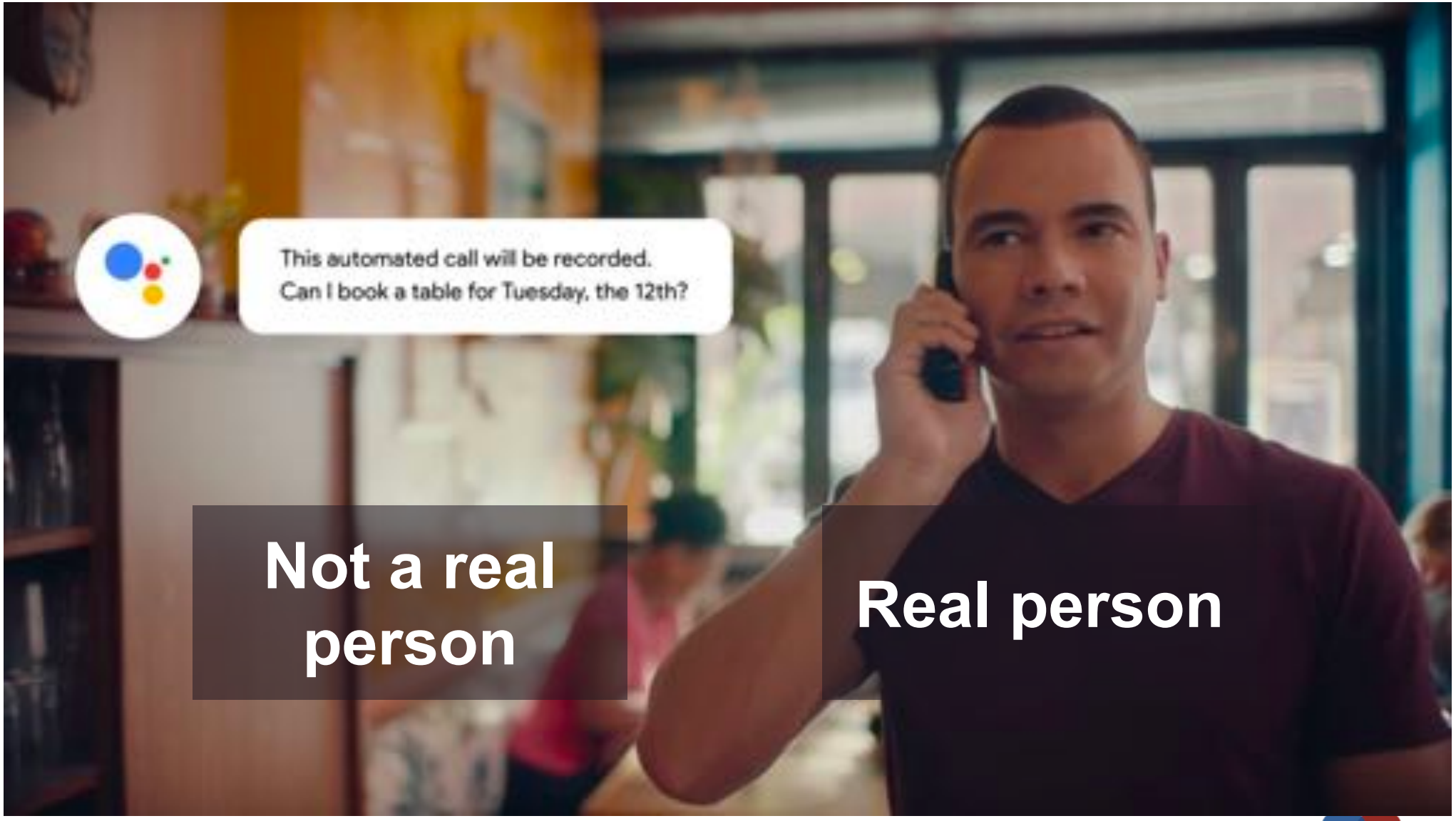

AI does the
laundry


THINK
$24,000
Who is Stoker?
$ 1,000
$77,147
Who is Bram Stoker?
$ 17,973
$21,600
WHO IS BRAM STOKER?
$5600
AI knows a lot


AI is an Artist


TECHNISCHE UNIVERSITÄT DARMSTADT
Schachmatt durch „CrazyAra"
19.02.2019
Künstliche Intelligenz schlägt mehrfachen Weltmeister im Einsetzschach
Der von den TU-Studierenden Johannes Czech, Moritz Willig und Alena Beyer entwickelte Bot „CrazyAra" hat den Schachprofi Justin Tan in einem Online-Match der Schach-Variante „Crazyhouse" mit 4:1 geschlagen. Gelernt hat der Bot mittels künstlicher neuronaler Netze, was ihm erlaubt, vorausschauend Entscheidungen zu treffen. Das Besondere: Die Studierenden konnten damit einen Erfolg auf einem Feld feiern, das sonst von Giganten wie Google dominiert wird.
AI plays chess and GO
lichess.org
Chat room
ALPHAGO
LEE SEDOL
01:59:31
AlphaGo
Lee Sedol
CrazyAra vs JannLee (Man vs Machine - Crazyhouse Chess on lichess.org) · 2 days ag
Category: Chess

AI assists you



AI is harder then you think!

P(heart attack | )?

P(heart attack | )?

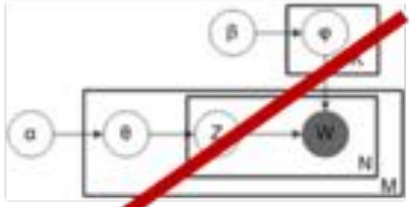
P(heart attack | 

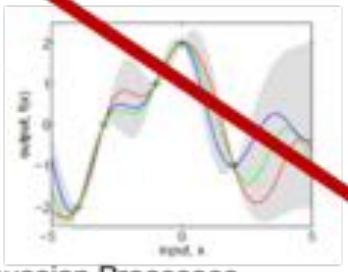
)?

P(heart attack | )?

Standard machine learning

Graphical models

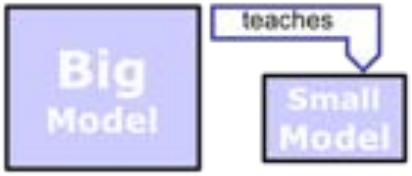




Gaussian Processes

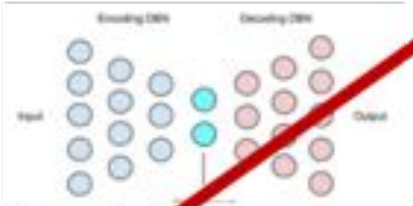
Features

Objects



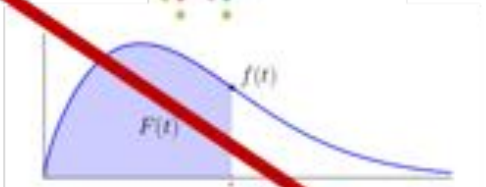
Distillation/LUPI

Boosting



Autoencoder
Deep Learning

Big Data Matrix Factorization



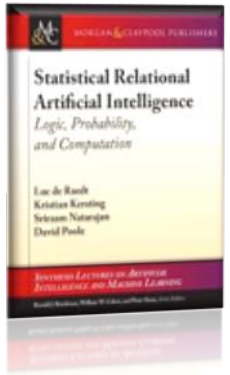
Diffusion Models

and many more …

P(heart attack | )?

Crossover of ML and DS with databases

De Raedt, Kersting, Natarajan, Poole: Statistical Relational Artificial Intelligence: Logic, Probability, and Computation. Morgan and Claypool Publishers, ISBN: 9781627058414, 2016.



KATHOLIEKE UNIVERSITEIT LEUVEN

THE UNIVERSITY OF TEXAS AT DALLAS

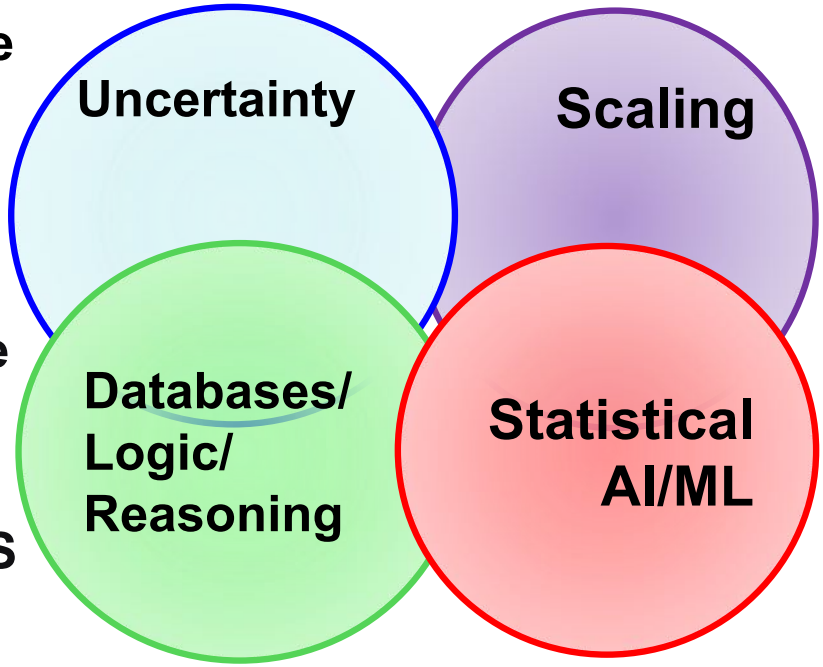
TECHNISCHE UNIVERSITÄT DARMSTADT

THE UNIVERSITY OF BRITISH COLUMBIA

building general-purpose data science and ML machines

make the ML/DS expert more effective and employing domain knowledge

increases the number of people who can successfully build ML/DS applications



Nat Rev Genet. 2012 May 2;13(6):395-405

Heart diseases and strokes – cardiovascular disease – are expensive for the world

According to the World Heart Federation, cardiovascular disease cost the European Union EURO169 billion in 2003 and the USA about EURO310.23 billion in direct and indirect annual costs. By comparison, the estimated cost of all cancers is EURO146.19 billion and HIV infections, EURO22.24 billion

Electronic Health Records
A new opportunity for AI to save our Lifes

EHRs are dirty and interconnected

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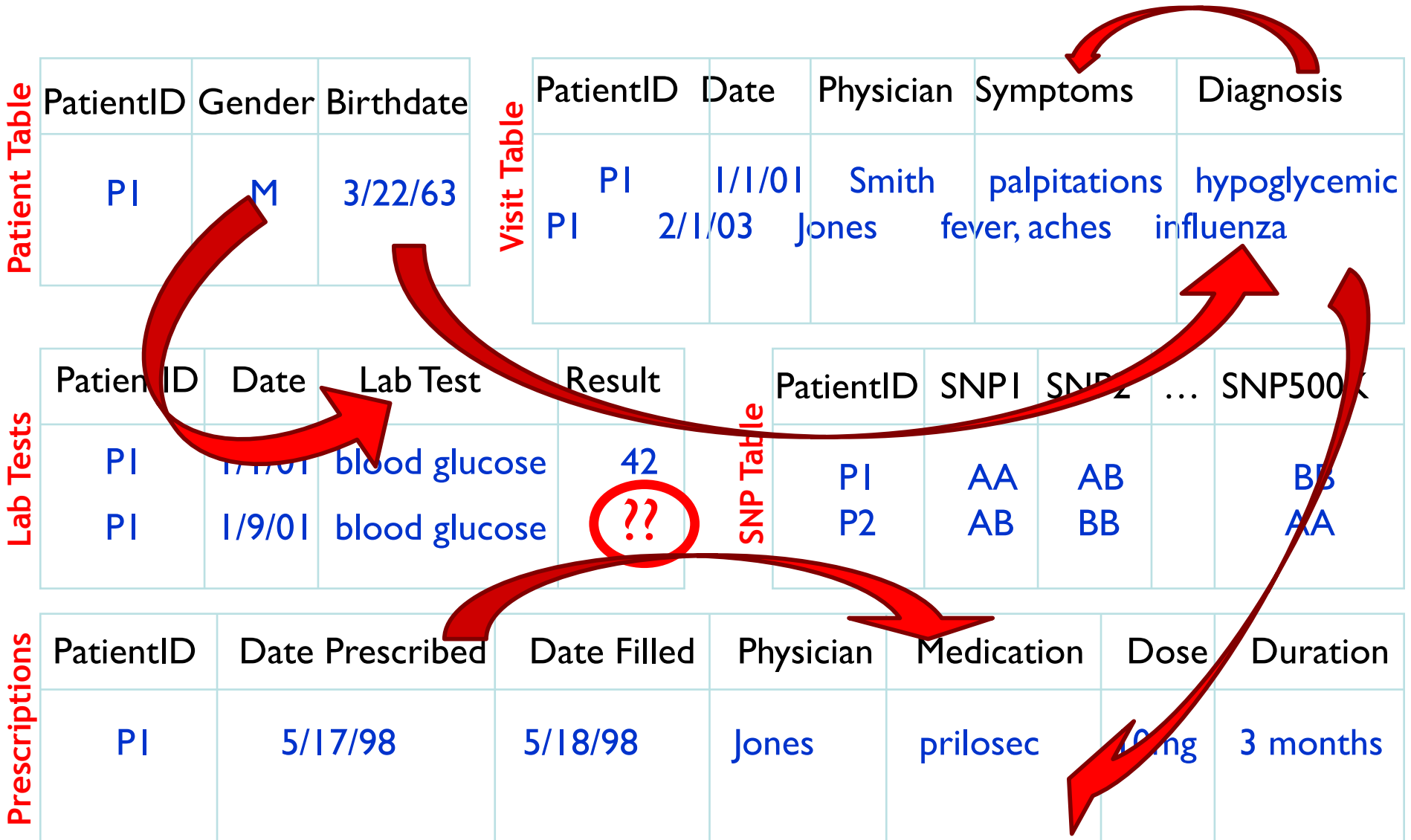
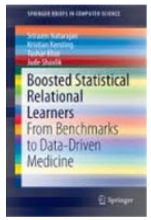


Natarajan, Khot, Kersting, Shavlik. Boosted Statistical Relational Learners. Springer Brief 2015



Understanding Electronic Health Records

Atherosclerosis is the cause of the majority of
Acute Myocardial Infarctions (heart attacks)

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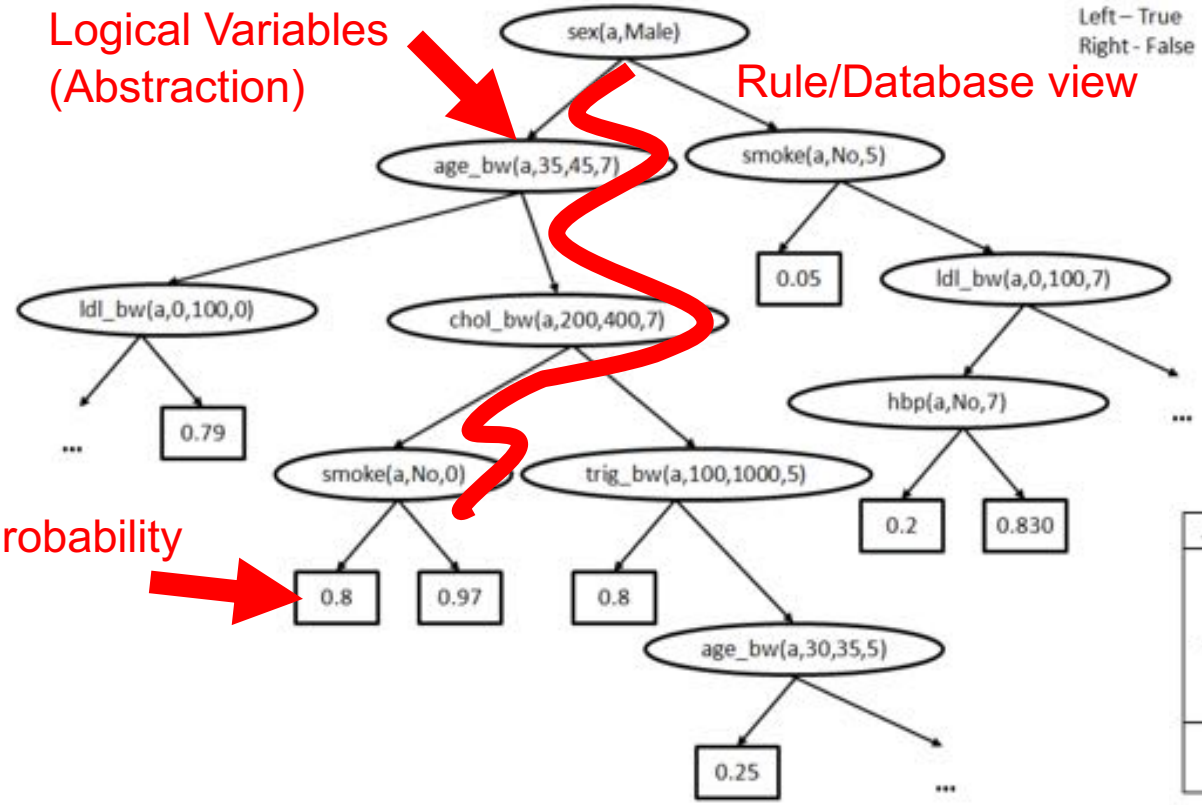
Logical Variables
(Abstraction)

Rule/Database view

Probability



[Circulation; 92(8), 2157-62, 1995; JACC; 43, 842-7, 2004]

Algorithm	Accuracy	AUC-ROC
J48	0.667	0.607
SVM	0.667	0.5
AdaBoost	0.667	0.608
Bagging	0.677	0.613
NB	0.75	0.653
RPT	0.669*	0.778
RFGB	0.667*	0.819

The higher, the better

25%

Algorithm for Mining Markov Logic Networks	Likelihood The higher, the better	AUC-ROC The higher, the better	AUC-PR The higher, the better	Time The lower, the better
Boosting	0.81	0.96	0.93	**9s**
LSM	0.73	0.54	0.62	**93 hrs**

11% 78% 50% 37200x faster

state-of-the-art

[Kersting, Driessens ICML´08; Karwath, Kersting, Landwehr ICDM´08; Natarajan, Joshi, Tadepelli, Kersting, Shavlik. IJCAI´11; Natarajan, Kersting, Ip, Jacobs, Carr IAAI `13; Yang, Kersting, Terry, Carr, Natarajan AIME ´15; Khot, Natarajan, Kersting, Shavlik ICDM´13, MLJ´12, MLJ´15, Yang, Kersting, Natarajan BIBM`17]

The Quest for a „good“ AI

How could an AI programmed by humans, with no more moral expertise than us, recognize (at least some of) our own civilization’s ethics as moral progress as opposed to mere moral instability?

„The Ethics of Artificial Intelligence“ Cambridge Handbook of Artificial Intelligence, 2011

Nick Bostrom

Future of Humanity Institute

University of Oxford

Eliezer Yudkowsky

MIRI

Machine Intelligence Research Institute

One of the
key questions:

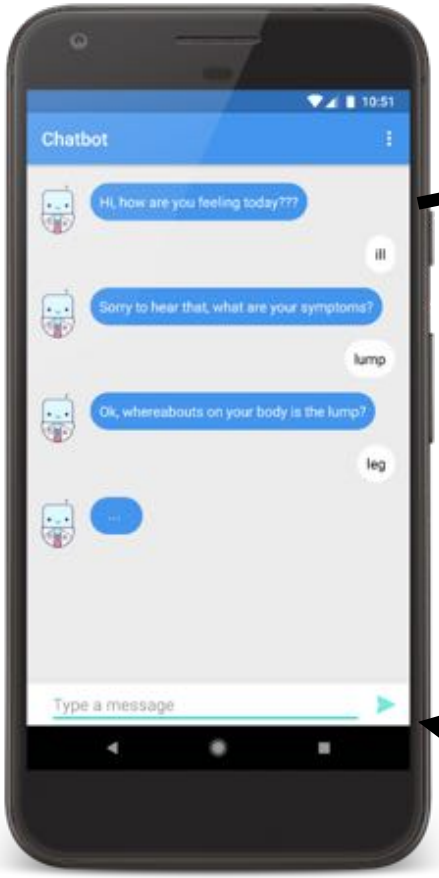
**Can we teach
morality
to machines?**

The Moral Choice Machine

Not all stereotypes are bad

[Jentzsch, Schramowski, Rothkopf, Kersting AIES 2019]

AAAI / ACM conference on ARTIFICIAL INTELLIGENCE, ETHICS, AND SOCIETY



Generate embedding for new question **„Should I … ?“**

Embedding of **„Yes, I should“**

Embedding of **„No, I should not“**

Calculate cosine similarity

Calculate cosine similarity

Report most similar asnwer

The Moral Choice Machine

Not all stereotypes are bad

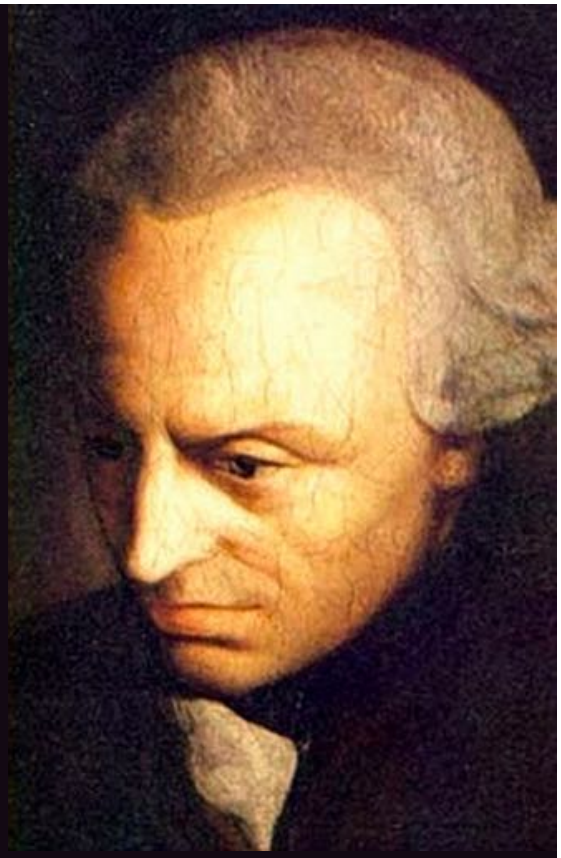
[Jentzsch, Schramowski, Rothkopf, Kersting AIES 2019]

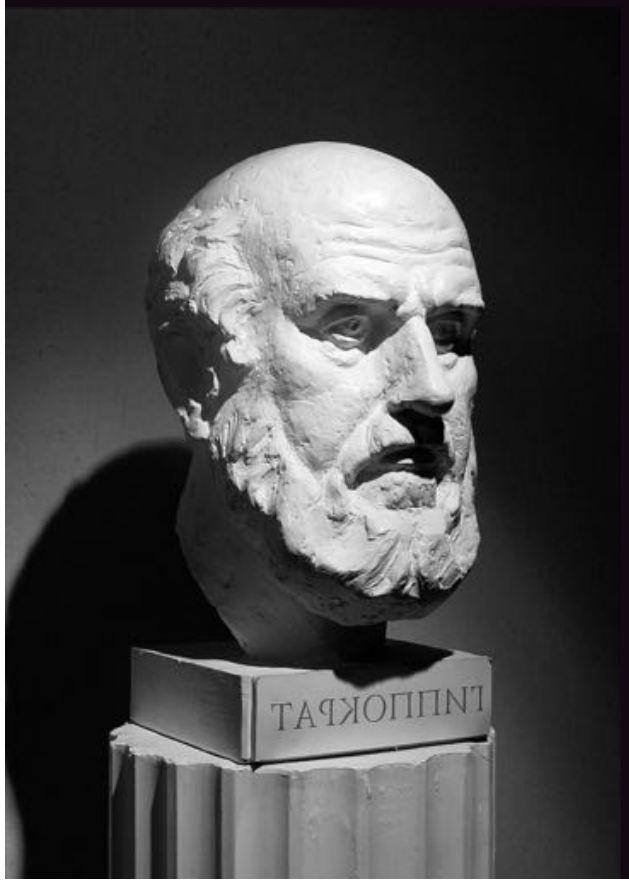
AAAI / ACM conference on
ARTIFICIAL INTELLIGENCE, ETHICS, AND SOCIETY

TECHNISCHE UNIVERSITÄT DARMSTADT

https://www.hr-fernsehen.de/sendungen-a-z/hauptsache-kultur/sendungen/hauptsache-kultur,sendung-56324.html

So yes there seems to be ways to teach medicine and moral to machines





but there is still a lot to be done! AI is a team sport. We need you!