Fundamentals of AI

Introduction and the most basic concepts

Part I. Artificial Intelligence (AI)

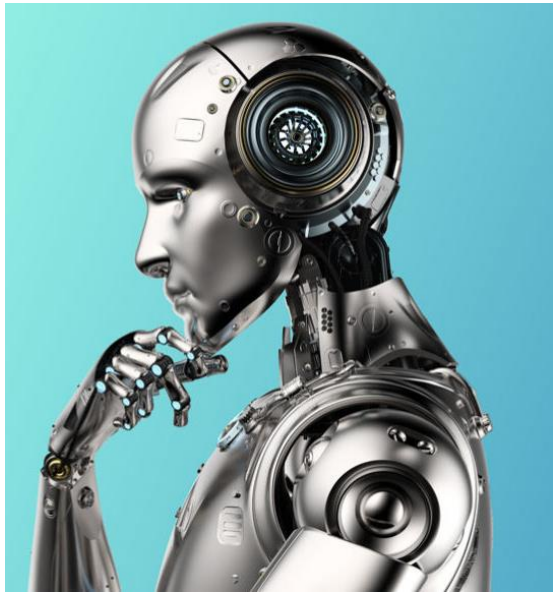
what is it?

where we are?

where do we go to?

Many definitions of AI

- Artificial intelligence is a long-term dream of humanity to create ‘thinking machine’
- As a scientific discipline is founded in 1950s, the term coined at the Dartmouth AI conference by John McCarthy
- Huge ups and downs in the expectations (e.g., read about the dispute between Rosenblatt and Minsky)



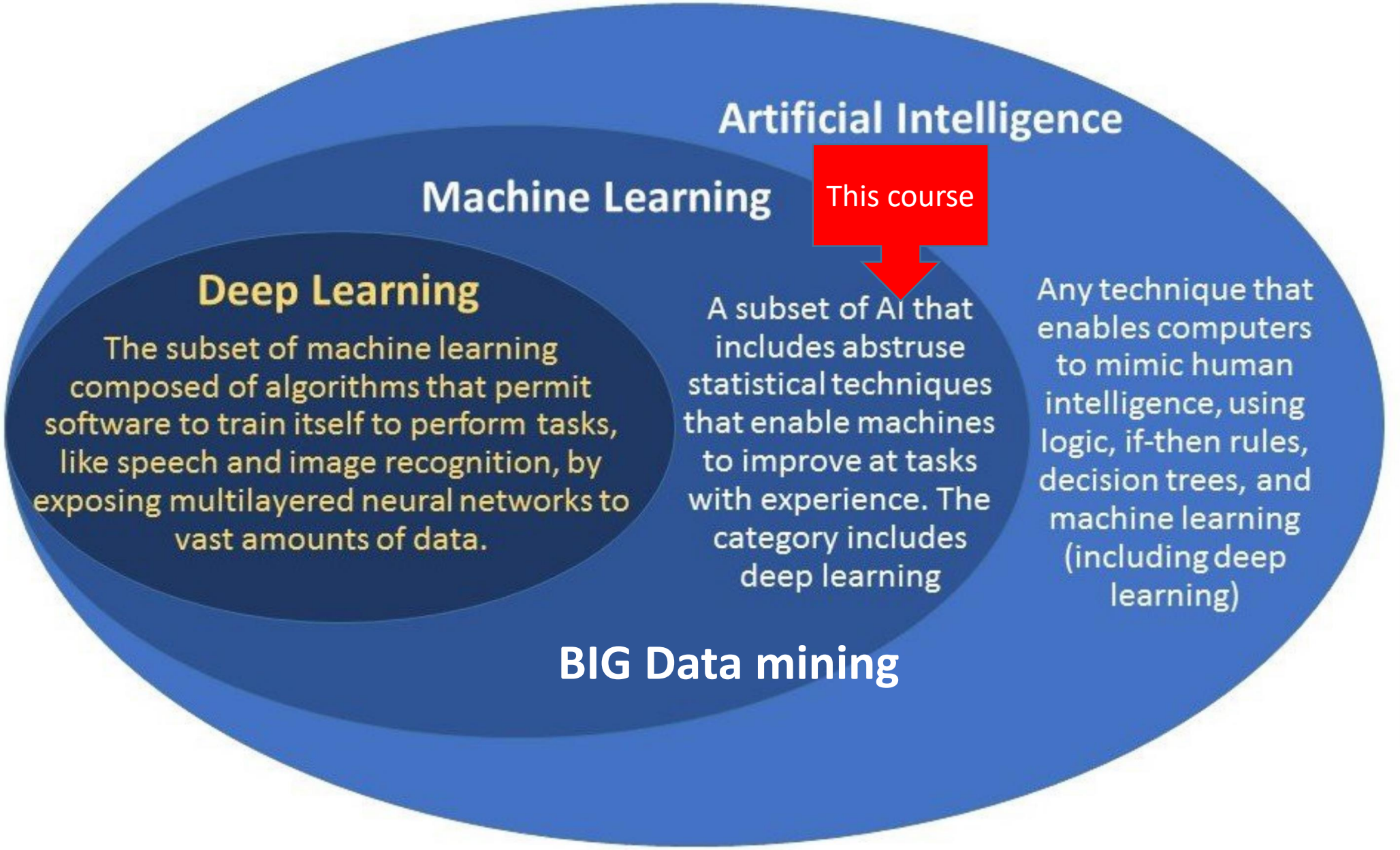
An AI cocktail party

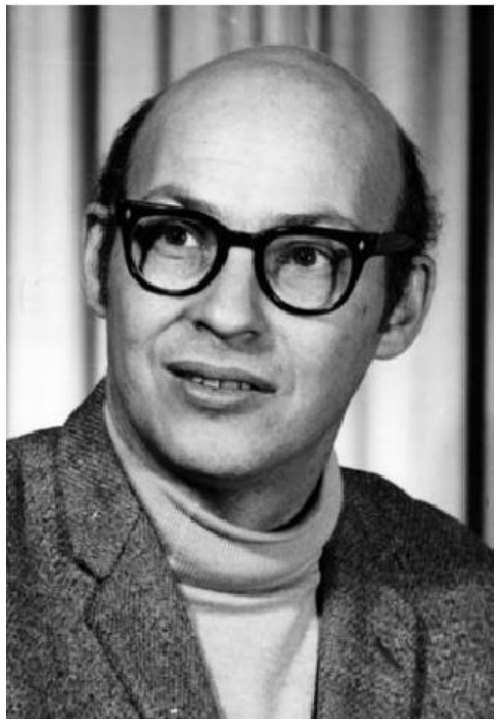
“Natural AI” questions.....

- Can we make something that is as intelligent as a human?
- Can we make something that is as intelligent as a bee?
- Can we get something that is really evolutionary and self improving and autonomous and flexible....?

“Algorithmic AI” questions.....

- Can we save this plant $20million a year by improved pattern recognition?
- Can we save this bank $50million a year by auto fraud detection?
- Can we start a new industry of handwriting recognition / automated negotiation / helpdesks / ....?


Artificial Intelligence
Machine Learning
This course
Deep Learning
The subset of machine learning composed of algorithms that permit software to train itself to perform tasks, like speech and image recognition, by exposing multilayered neural networks to vast amounts of data.
A subset of AI that includes abstruse statistical techniques that enable machines to improve at tasks with experience. The category includes deep learning
Any technique that enables computers to mimic human intelligence, using logic, if-then rules, decision trees, and machine learning (including deep learning)
BIG Data mining



Marvin Minsky,
Semantic Scholar
courtesy MIT Museum,

Marvin Minsky's Problems for AI

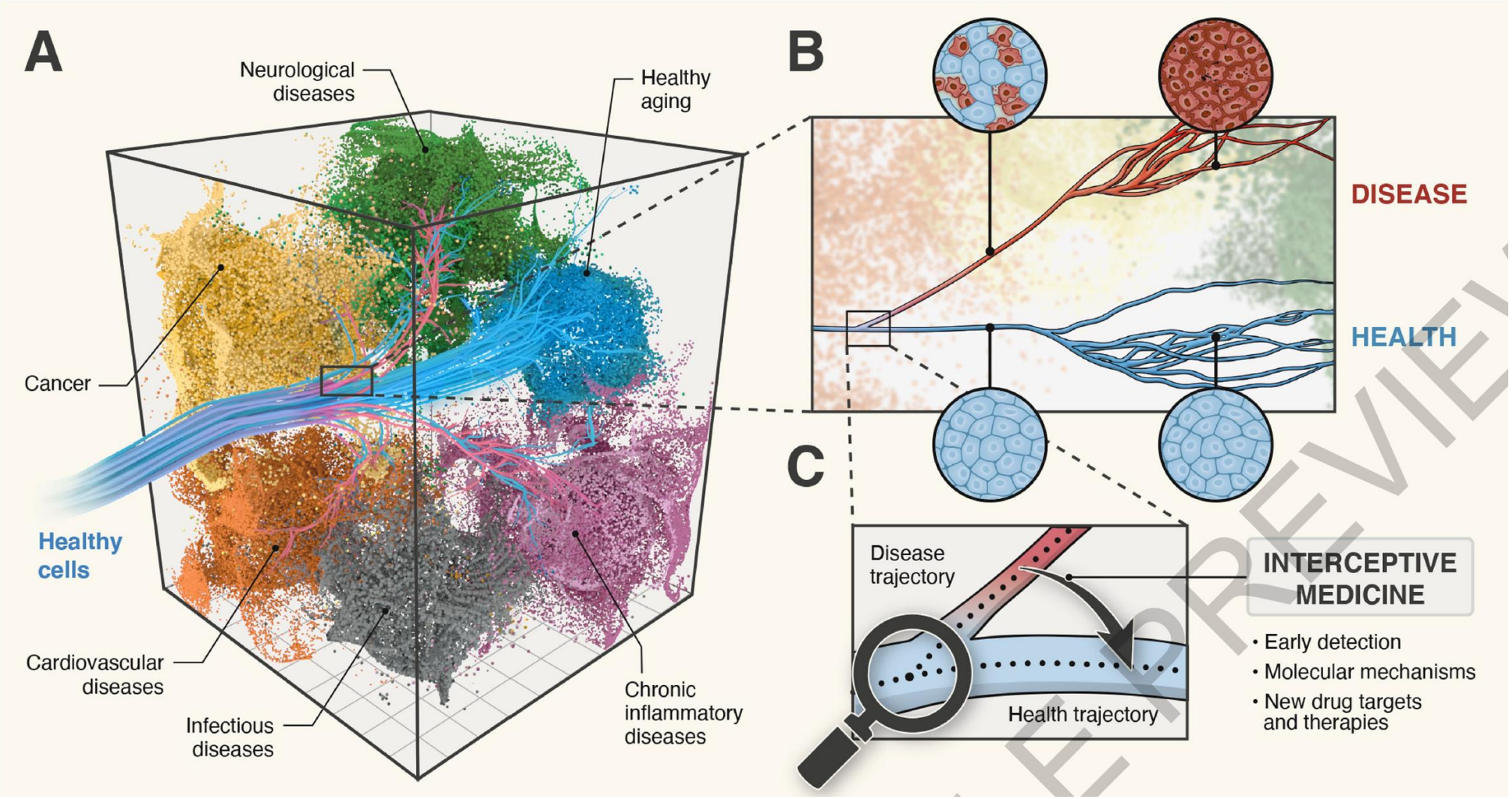
"It is convenient to divide the problems into five main areas:

- Search,
- **Pattern-Recognition,**
- **Learning,**
- Planning,
- and Induction… .

- Minsky's problems focused research on the most important technical issues.
- We are currently seeing great success in these areas.

Minsky, M. (1961). Steps toward artificial intelligence. *Proceedings of the IRE, 49*(1), 8-30.

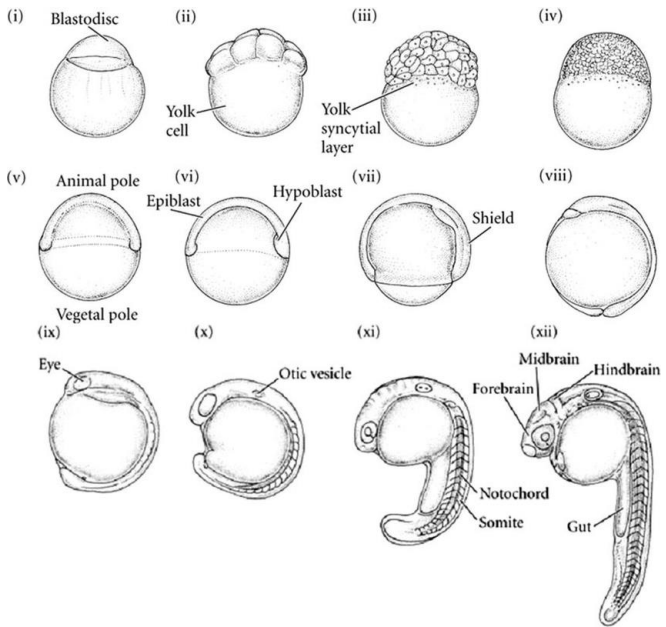
AI in medicine, genomics and omics



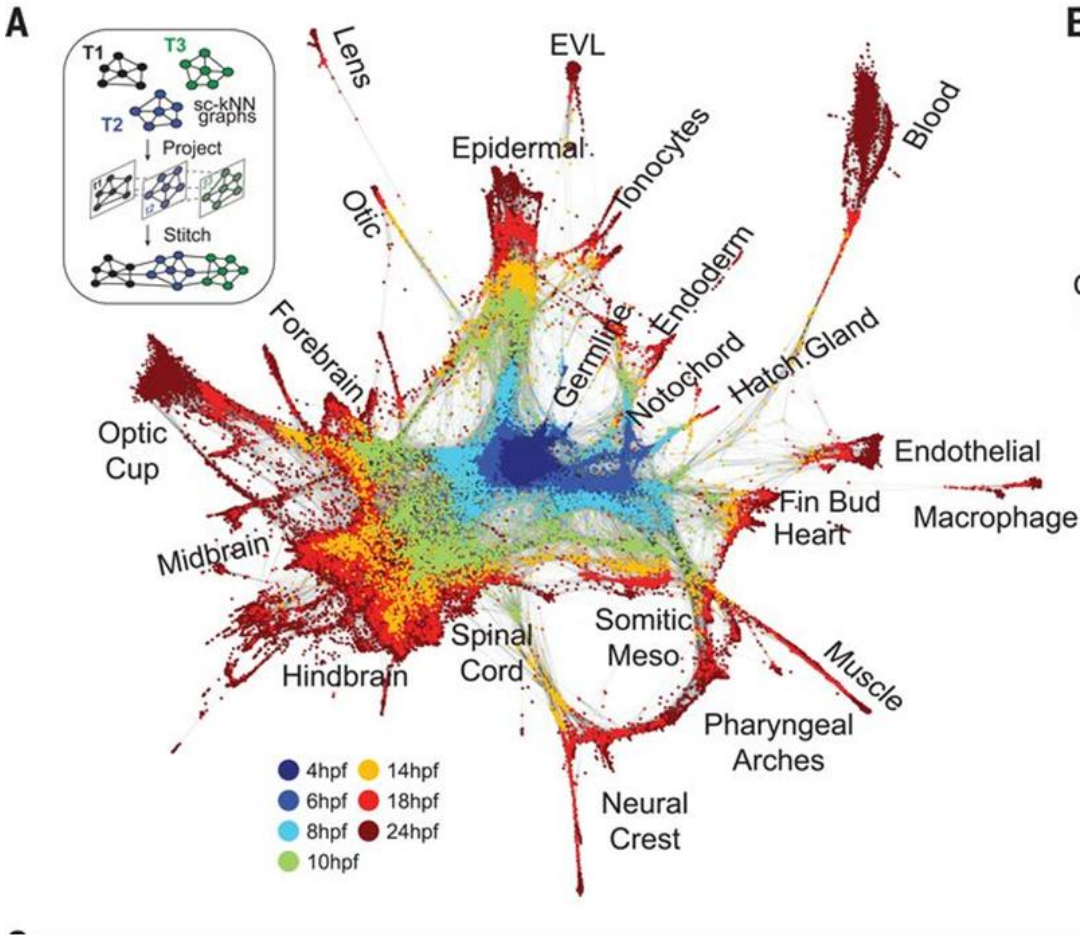
(from Rajewsky et al, 2020, Nature)

Single cell omics: how biology becomes a field of data science

Biological (physical) view



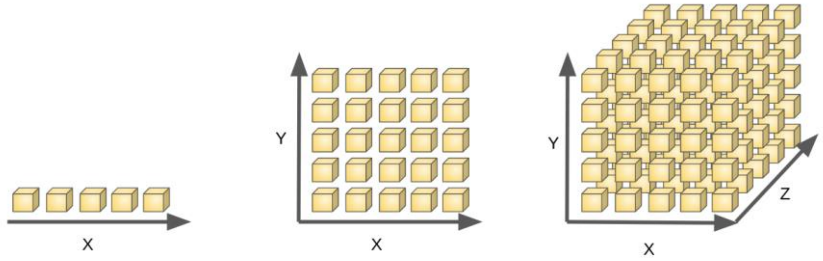
Single cell omics view



From Wagner et al, Science, 2018

Role of **Big Data + Big Models + Big Compute** in successful AI applications

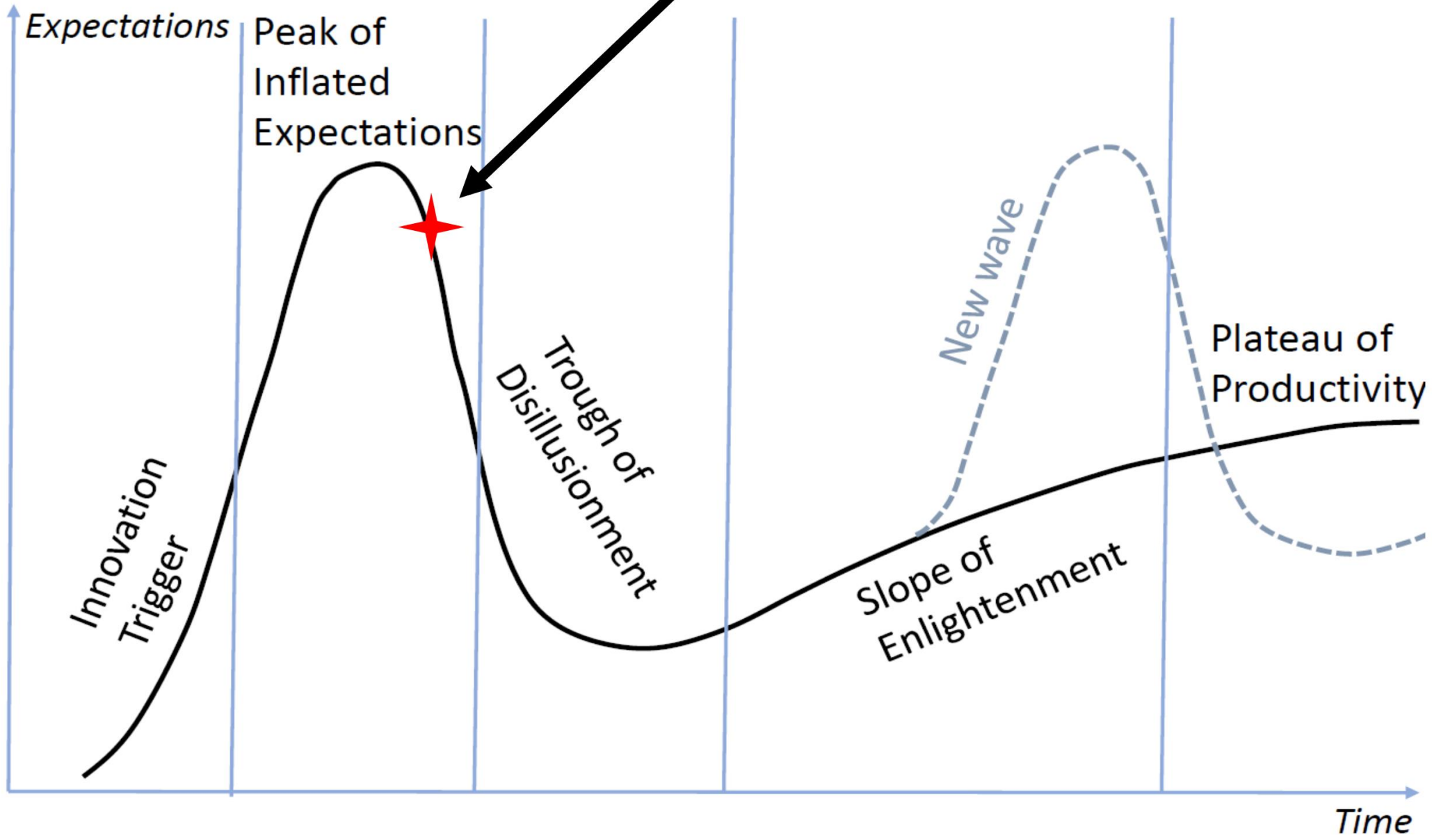
- 21st century is the century of complexity (Stephen Hawking)
- Large number of observations cover more degrees of freedom of complex systems:
  - Data requirement grows exponentially with dimensionality!



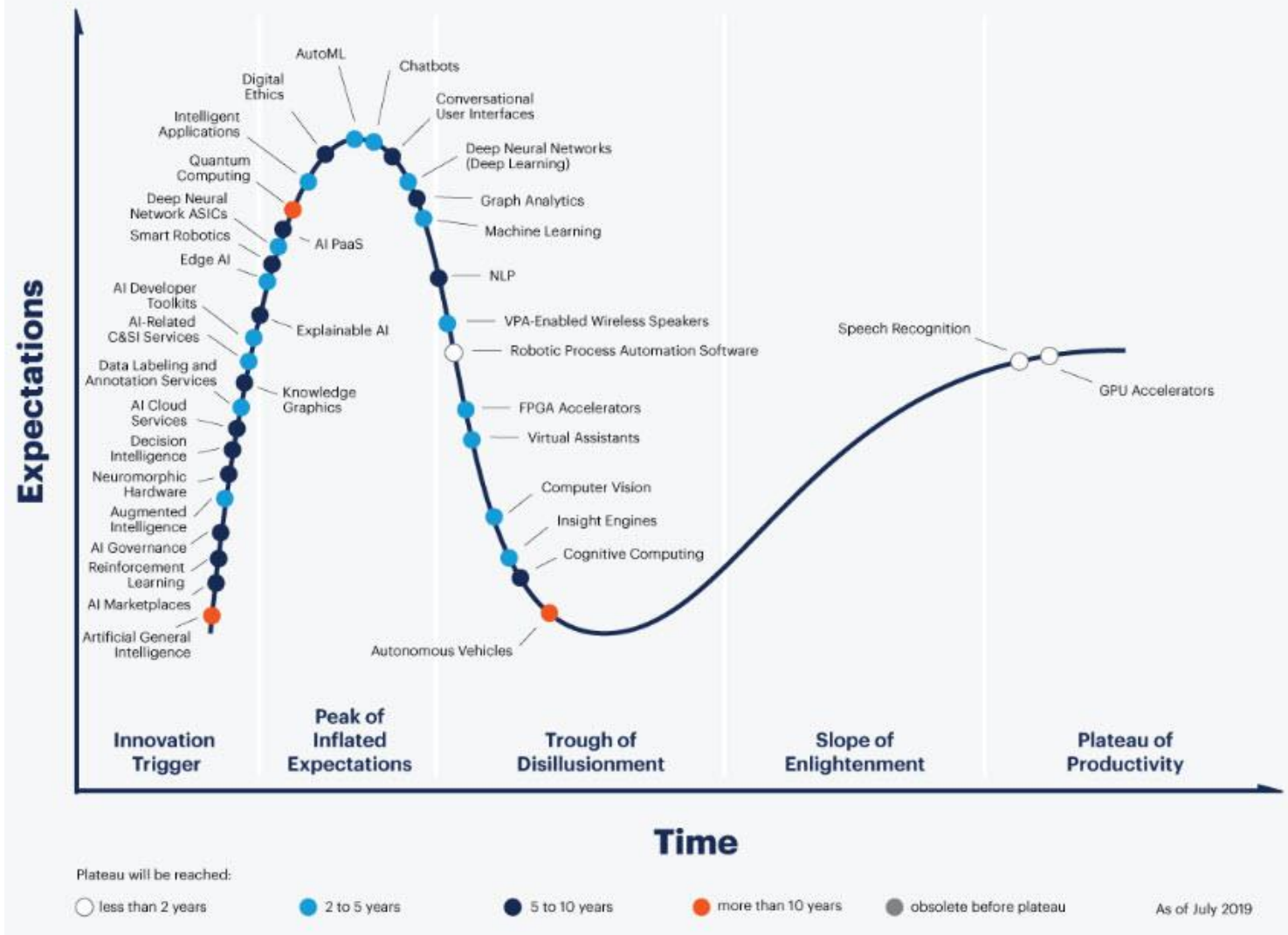
- Using big data we can determine parameters of more complex and larger models which better capture the complexity or real-life phenomena (this is a hypothesis)
- Big models can go beyond simple human intuition

Gartner Hype Cycle: we are here

AI Spring?



Gartner Hype Cycle for Artificial Intelligence, 2019



https://www.gartner.com/smarterwithgartner/top-trends-on-the-gartner-hype-cycle-for-artificial-intelligence-2019

AI ‘winters’: 1974–1980, 1987–1993, mid 2000s…

The term ‘Artificial Intelligence’
coined at the 1956 Dartmouth conference

- Many researchers in AI in the mid 2000s deliberately called their work by other names, such as **informatics**, **machine learning**, **analytics**, **knowledge-based systems**, **business rules management**, **cognitive systems**, **intelligent systems**, **intelligent agents** or **computational intelligence**, to indicate that their work emphasizes particular tools or is directed at a particular sub-problem. Although this may be partly because they consider their field to be fundamentally different from AI, it is also true that the new names help to procure funding by avoiding the stigma of false promises attached to the name "artificial intelligence"

Two major current AI problems

1. **AI makes unexpected mistakes**, and will make them in the future

2. **Decisions of Neural AI are not transparent** and, therefore, cannot be explained logically.

A Tesla electric car crashed into a highway barrier in Mountain View, California, on March 23, 2018. Investigators confirmed that Autopilot was partially to blame.

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IBM Watson gave 'unsafe and incorrect' cancer treatment options

by Colm Gorey

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A new AI winter will come if we don't focus on the problem of AI errors and AI explainability

And only those applications will survive where errors are not very dangerous

Three major flavor of machine learning

- **Supervised learning**
  - classification, regression
- **Unsupervised learning**
  - clustering, dimensionality reduction, manifold learning
- **Reinforcement learning**

Active learning, Transfer learning, Representation learning, etc.

Real practice is almost always a hybrid approach