AI101

Lecture 1: What is AI

What is, and what isn't AI?

https://www.youtube.com/watch?v=x4O8pojMF0w

What is, and what isn't AI?

Not an easy question to answer!

Reasons:
- There is no official definition
- Science Fiction Influence
- Easy tasks can become very hard
- Hard tasks are mastered on a non-human level
- The public perception of AI is nebulous
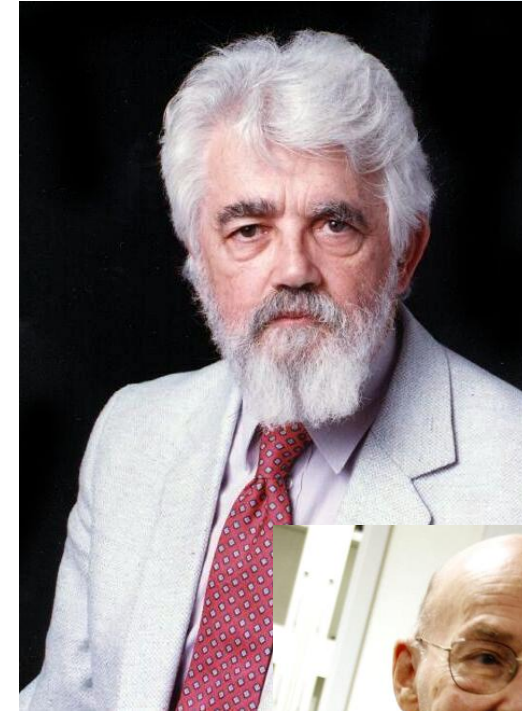
But lets try to define AI for us…

What is, and what isn't AI?

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, Turing Award 1971

The science of making machines do things that would require intelligence if done by men.

Marvin Minsky, Turing Award 1969

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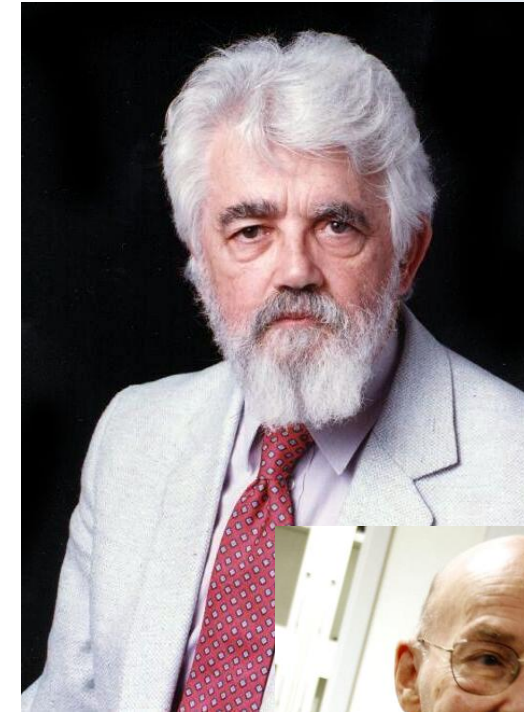
What is Intelligence

What is Intelligence

What is Intelligence
Turing Test

- **Question**: When does a system behave intelligently?

- **Assumtion**: An entity is intelligent if it cannot be distinguished from another intelligent entity by observing its behavior.

- **Test**: Human interrogator interacts with two players, A and B (one of them is a computer) blind.

- If the interrogator cannot determine which player, A or B, is a computer and which is a human, the computer is said to pass the test.
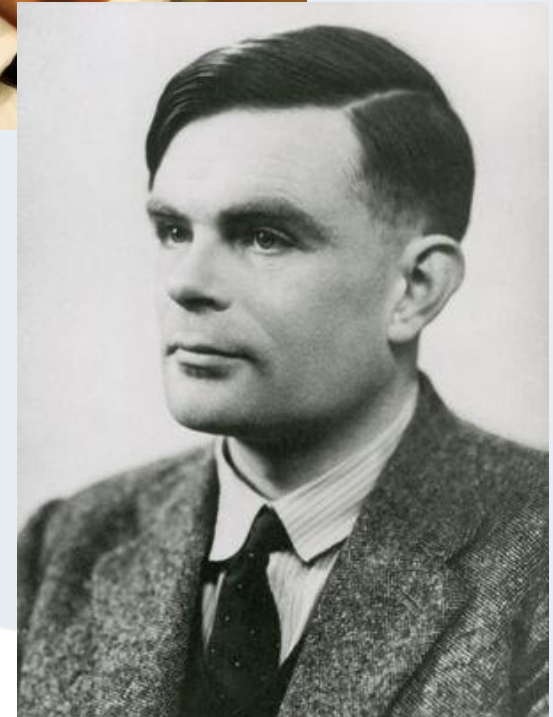
What is Intelligence
Turing Test

Test still relevant now, yet might be the wrong question.

Requires the collaboration of major components of AI: knowledge, reasoning, language understanding, learning, . . .

But hard/not reproducible and constructive or amenable to mathematical analysis.

Followup Question:
Does being human-like mean you are intelligent?

What is Intelligence
The Chinese Room Argument

Question: Is intelligence the same as intelligent behavior?

Assumption: Even if a machine behaves in an intelligent manner, it does not have to be intelligent at all

Test:

1. A person who doesn't know Chinese is locked in a room. Outside the room is another person who can slip notes written in Chinese inside the room but cannot interact with the person in the room else.

2. The person inside the room has detailed instructions how to answer each question without translating it or understanding it at all.

Follow-up Question:
Is the person in the room intelligent? Is a self-driving car intelligent?

What is Intelligence
Do we need to know what an intelligent system is?

The question of how an intelligent being is defined, is a long and difficult one, but...

"unlikely to have any more effect on the practice of AI research than philosophy of science generally has on the practice of science."

John McCarthy

Is this true? What do you think?

Characteristics of AI
One AI to rule them all?

General vs Narrow AI

A general AI or strong AI is defined to so that it can handle any intellectual task, while a narrow or weak one is specified to deal with a one concrete or a set of specified tasks. This is the same distinction between being intelligent and acting intelligent. While strong AI is generally a goal in research, currently we are using primarily narrow AI.

Characteristics of AI
An AI should be…

Adaptability
The ability to improve performance by learning from experience

Autonomous
The ability to perform tasks in environments without constant guidance by a user/expert.

Characteristics of AI
Rationality

Law of Thoughts
Beginning of reasoning and the question of what 'correct' argument and thought processes are.

Rational Behavior
The question of "doing the right thing". In systems that act rationally, the "right thing" is that what is expected to maximize the achievement given the available information.

So what is AI?

Different definitions due to different criteria
Two dimensions:

1. Thought processes/reasoning vs. behavior/action

2. Success according to human standards vs.
   success according to an ideal concept of intelligence
   (rationality)

	Human	Rationality
Think	Systems that think like humans	Systems that think rationally
Act	Systems that act like humans	Systems that act rationally

Characteristics of AI
Rationality

Rational behavior has two advantages over the law of thoughts

- It is more general (in many situations, a provably correct action does not exist)
- It is more amenable (rationality can be defined and optimized)

But rationality is rarely a very good model of reality.

Cognitive Science
Systems that think like humans

How do humans think?
Theory is based on scientific theories of internal brain activities (cognitive model):

- Predicting and testing human behavior

- Identification from neurological data

Cognitive Science brings together computational models from AI and experimental techniques from psychology to construct precise and testable theories of the mind. Cognitive Science is often viewed distinct from AI but this is wrong. As at TU Darmstadt, both are twin disciplines!

**Cognitive Neuroscience**: How does the brain work at the neuronal level?

Foundations of AI

Different fields have contributed to AI and build the foundation of modern AI:

- **Philosophy**: Logic, reasoning, mind as a physical system, foundations of learning, language and rationality.

- **Mathematics**: Formal representation and proof algorithms, computation, (un)decidability, (in)tractability, probability.

- **Psychology**: adaptation, phenomena of perception and motor control.

- **Economics**: formal theory of rational decisions, game theory.

- **Linguistics**: knowledge representation, grammar.

- **Neuroscience**: physical substrate for mental activities.

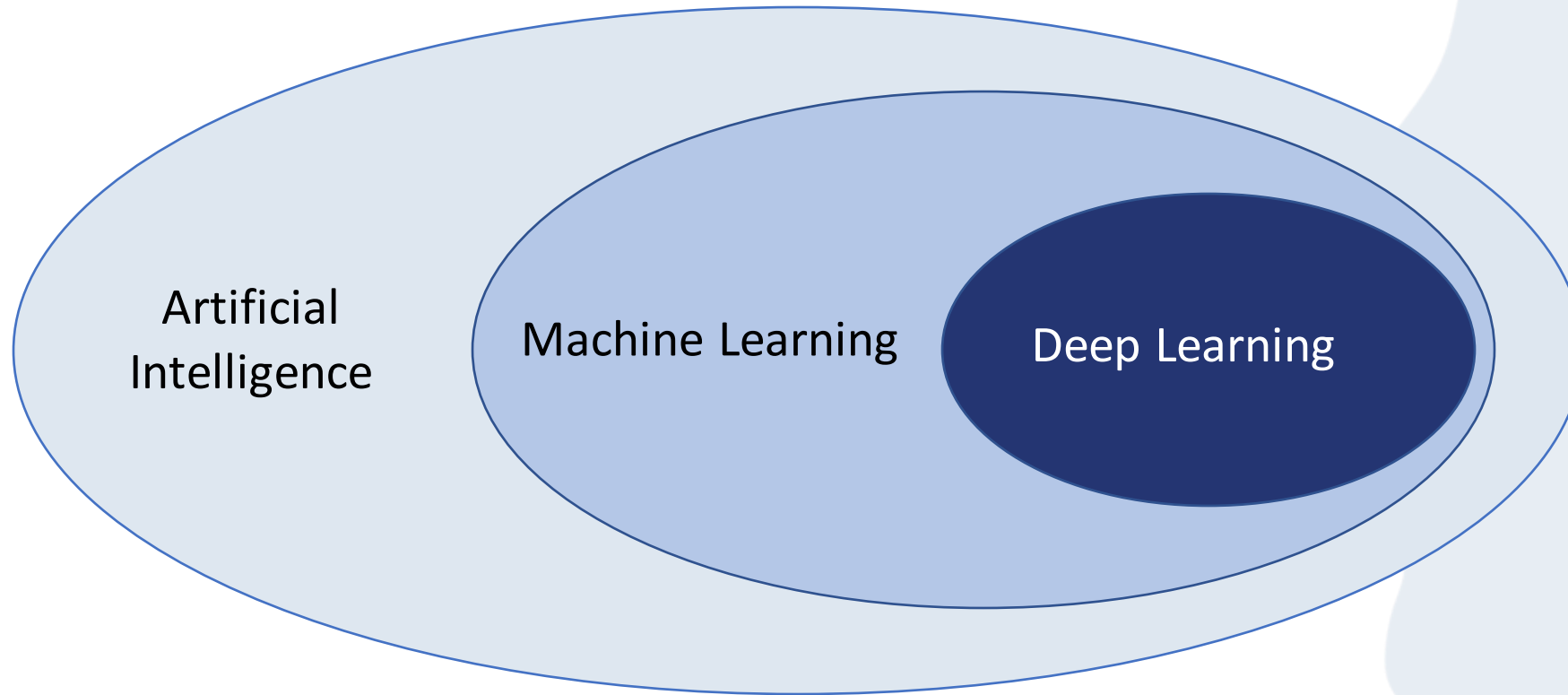- **Control theory**: homeostatic systems, stability, optimal agent design.

Foundations of AI
History of AI in a nutshell
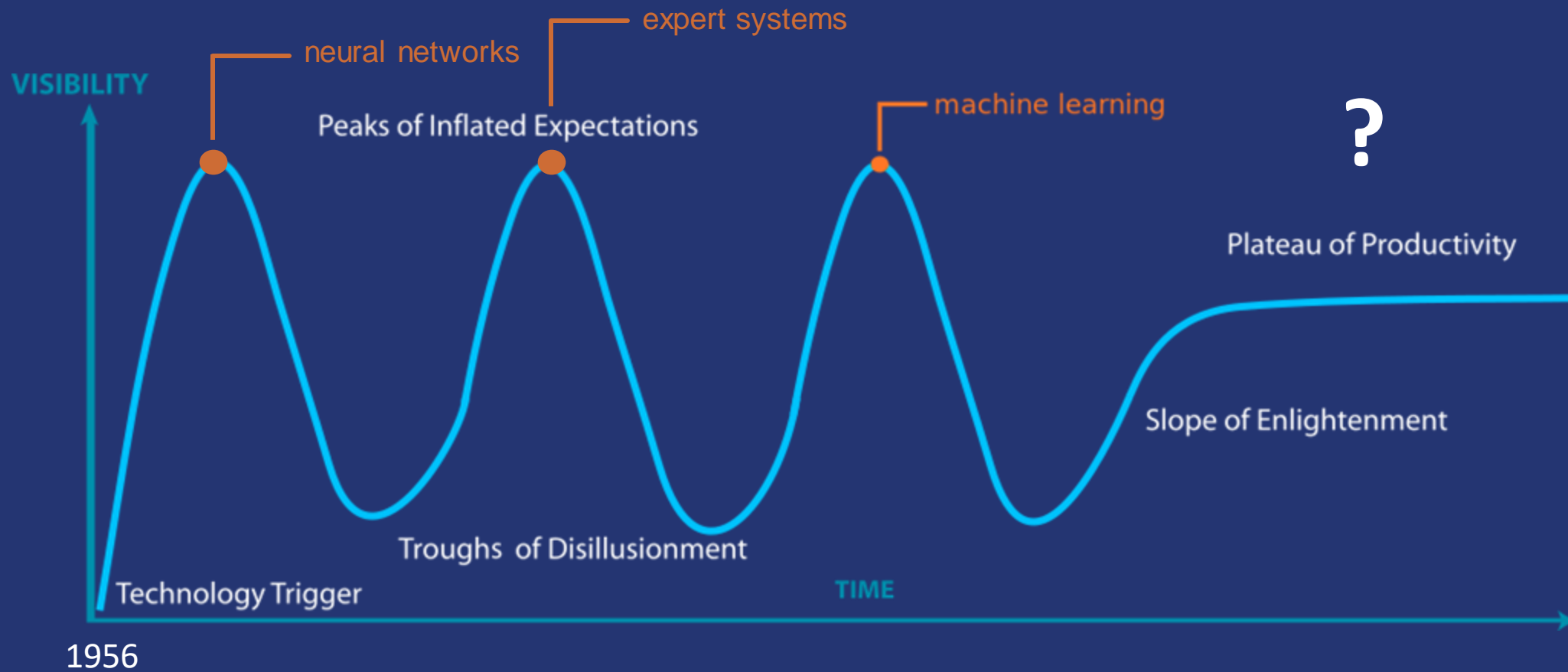
Related Fields and Taxonomy of AI
Taxonomie of AI

Related Fields and Taxonomy of AI
Subdisciplines of AI

From top left to bottom right: Prof. Peters, Prof. Von Stryk, Prof. Chalvatzaki, Prof. Binnig, Prof. Istvan, Prof. Mezini, Prof. Koch, Prof. Kersting, Prof. Roth, Prof. Fellner, Prof. Gurevych, Prof. Rothkopf, Prof. Jäkel

Related Fields and Taxonomy of AI
Subdisciplines of AI

- Machine Learning   (Peters, Roth, Kersting,...)
- Deep Learning   (Roth, Kersting,...)
- Search and Optimization   (Weihe,...)
- Robotics   (Peters, von Stryk, Chalvatzaki...)
- Natural Language Processing   (Gurevych,...)
- Computer Vision   (Roth, Fellner, Kuijper,...)
- Cognitive Science   (Rothkopf, Jäkel, Kersting, Walles,...)
- AI Systems   (Binnig, Istvan, Koch, Mezini,...)
- Data Science   (Binnig, Istvan,…)
- ...

Applied AI in Modern Fields

- Autonomous Planning and Scheduling

- Games (Planning, Reasoning, Understanding, …)

- Natural Language Processing (Text Generation, Understanding, Translation, Speech Recognition, …)

- Robotics (Autonomous driving, …)

- Scientific Discovery (AI found new quasars, proved theorems,…)

- Computer Vision (Autonomous vehicles, Classification, Segmentation,…)

- …

What AI can and cannot do
AI as an Artist: Dall·E 2

https://www.youtube.com/watch?v=qTgPSKKjfVg
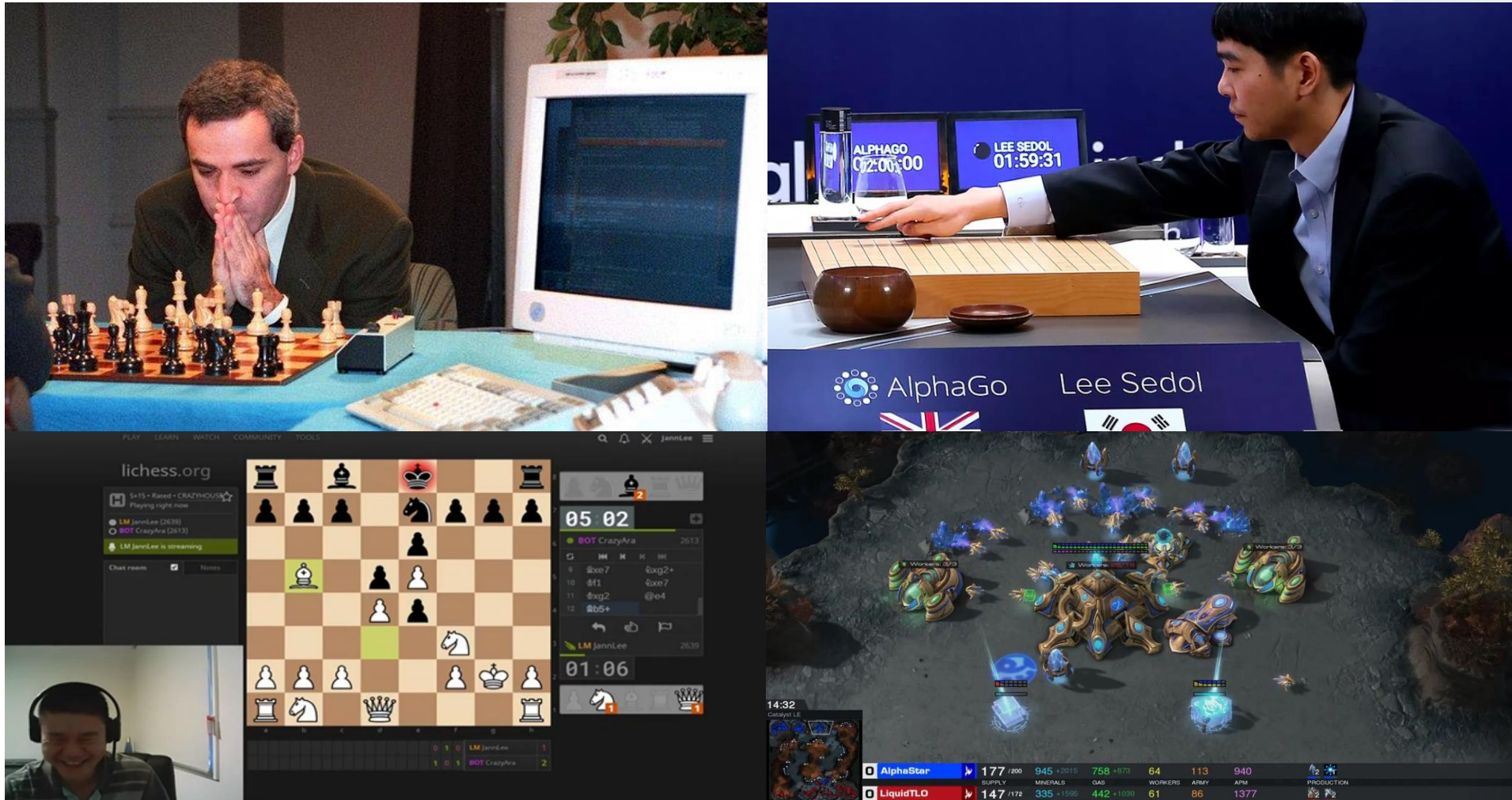
What AI can and cannot do
AI as an Artist: Stable Diffusion

Stable Diffusion generates images to the topics of this lecture

What AI can and cannot do
AI playing Games

From top left to bottom right: AI plays chess (DeepBlue), AI plays Go (AlphaGo), AI plays Crazyhouse Chess (CrazyAra), AI plays Starcraft 2 (AlphaStar)

What AI can and cannot do
AI as an Assistant

What AI can and cannot do
AI drives cars

https://www.youtube.com/watch?v=XAQeL8eflT0

What AI can and cannot do

BUT...

The New York Times

Opinion

A.I. Is Harder Than You Think

By Gary Marcus and Ernest Davis
Mr. Marcus is a professor of psychology and neural science. Mr. Davis is a professor of computer science.
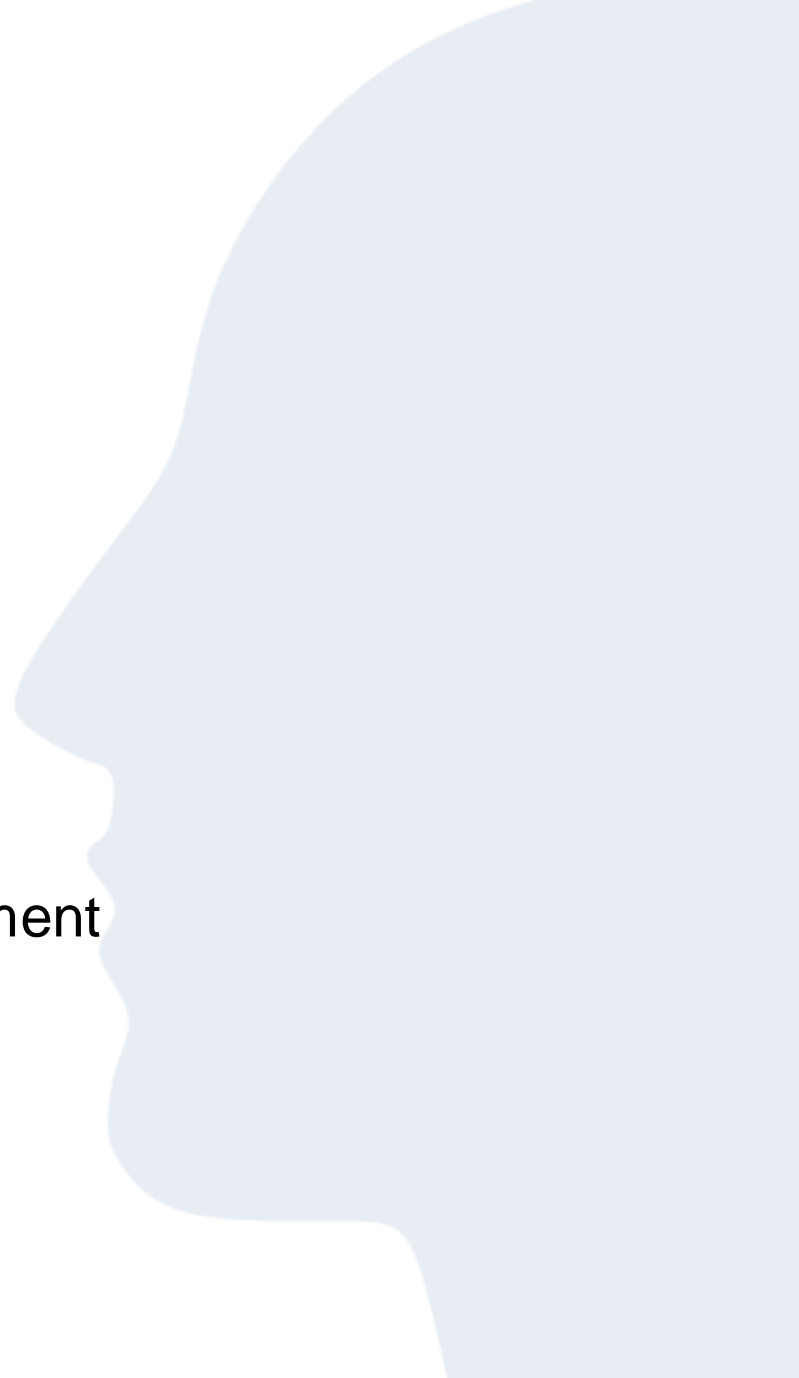
May 18, 2018

Gary Marcus

Ernest Davis

What AI can and cannot do
"A.I. is harder than you think"

- Current AI is often isolated to single problems

- Current AI is not superhuman in every task

- AI models are not without bias

- Fundamental differences in how AI perceive the world/environment
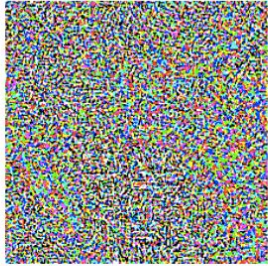
What AI can and cannot do
AI can be biased

https://www.youtube.com/watch?v=NaWJhlDb6sE

What AI can and cannot do
AI can be tricked

"panda"
57.7% confidence

+

=

"gibbon"
99.3 % confidence

https://www.youtube.com/watch?v=XaQu7kkQBPc
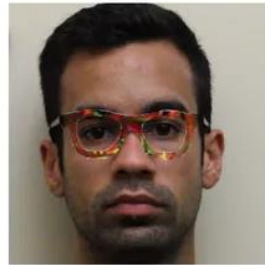
Summary

- What is AI
- What is Intelligence
- Characteristics of AI
- Potential of AI

You should be able to:

- Explain what AI can be
- Express some (philosophical) problems related to AI (Turing Test, Chinese Room, Bias,…)
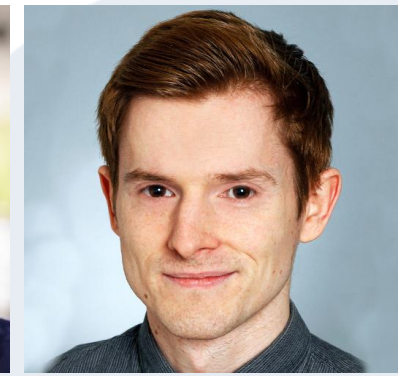
Next Week: AI Systems

AI101

Organizational

Who we are

Lecture
Prof. Kristian Kersting,
Dr. Martin Mundt
Artificial Intelligence and Machine Learning Lab (AIML)

Exercise
Jannis Blüml,
Johannes Czech

Timeslot
Wednesdays at 16:15 in S2|02 C205 Lecture
Wednesdays at 18:05 in S2|02 C205 Exercise (directly after the lecture)

Material and Questions (Forum)
Can be found in Moodle (https://moodle.**informatik**.tu-darmstadt.de/)

Outline of this course

1. What is AI   Week 1-2
2. Search   Week 3 - 5
3. Knowledge, Reasoning and Planning   Week 6 - 9
4. Introduction into (Machine)
   Learning and Neural Networks   Week 10 - 11
5. Implications of AI, Summary and Outlook   Week 12

Exercise and Exam

Exercise

- Weekly exercises
- Weekly presentation of solutions and Q&A
- Will be held in German
- No correction
- Not relevant for bonus
- Relevant for the exam

Bonus

More information in the first exercise

- Group project over the semester
- Will be held in German
- "Present" a topic of the lecture

Exam

- Date: ...
- 90min written exam
- Exam is in German

Recommended Literature

> Russel and Norvig, **Artificial Intelligence: A Modern Approach**
>
> - Prentice Hall, 4th Edition 2020
> - Recommended text book to follow the lecture

- Douglas R. Hofstadter, **Gödel, Escher, Bach**
    - Basic Book, New York 1979, Classic, inspiring, readable, original intro into AI
- Kersting, Lambert, Rothkopf: **Wie Maschinen lernen: Künstliche Intelligenz verständlich erklärt**
    - Springer, 2019, Good book to learn the basics
- Aurélien Géron, **Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow**
    - O'Reilly, 2nd Edition 2019, Good book to start programming neural networks