Artificial Intelligence in Medicine

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Division of Physical Medicine and Rehabilitation, Dept. of Medicine

Fellow, Alberta Machine Intelligence Institute (Amii)

UNIVERSITY OF ALBERTA
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Artificial Intelligence in ~~Medicine~~ thinking, moving, and perceiving

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C.O.I. DISCLOSURE

No affiliation (financial or otherwise) with a pharmaceutical, medical device or communications organization.

Unrelated to the content or ideas noted in this talk:
Senior Staff Research Scientist with DeepMind

Learning Objectives

1. be able to **define artificial intelligence (AI), machine learning (ML)**, and related concepts from the field of intelligent systems.

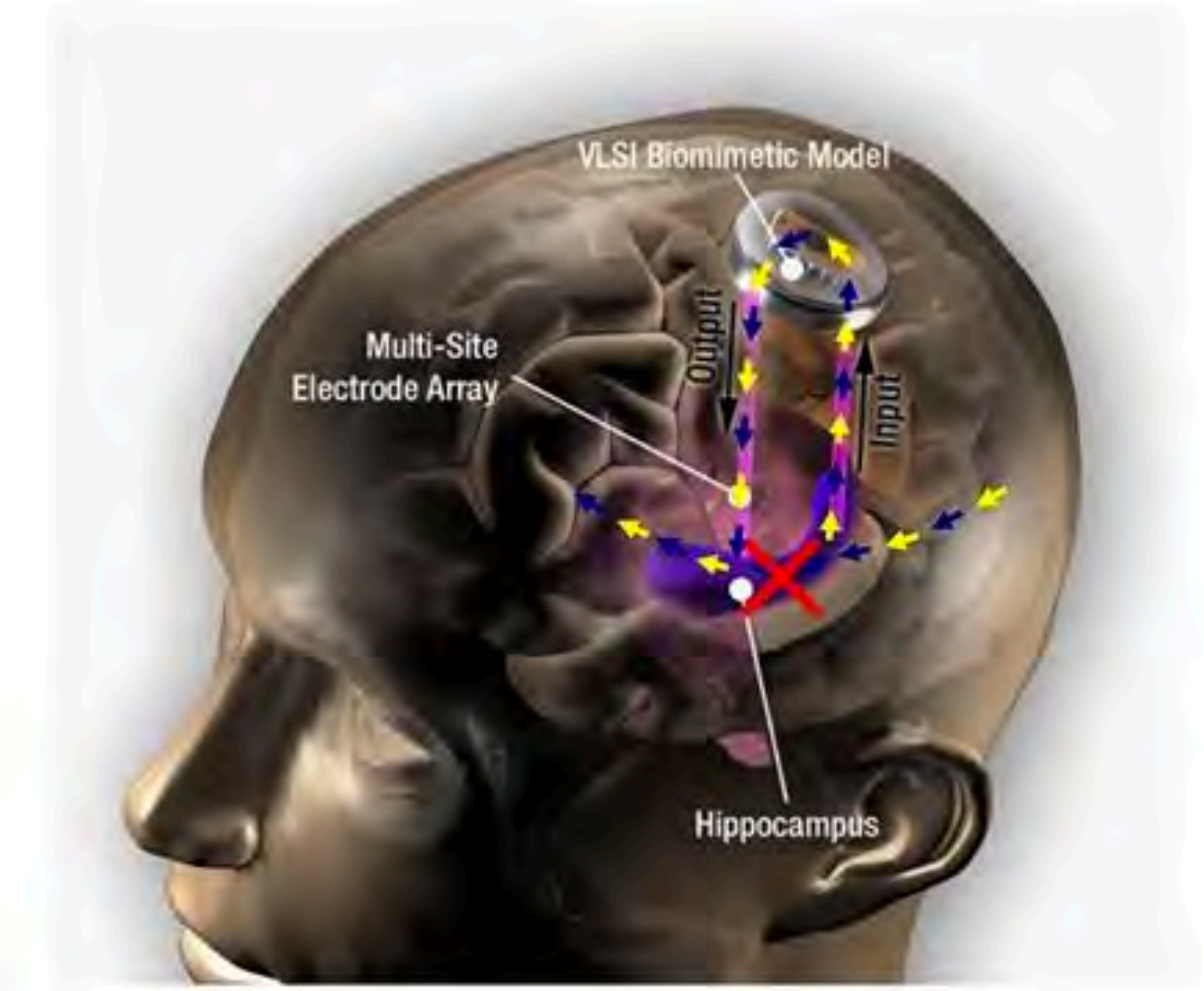
2. be able to describe and **discuss the defining characteristics of AI and ML**.

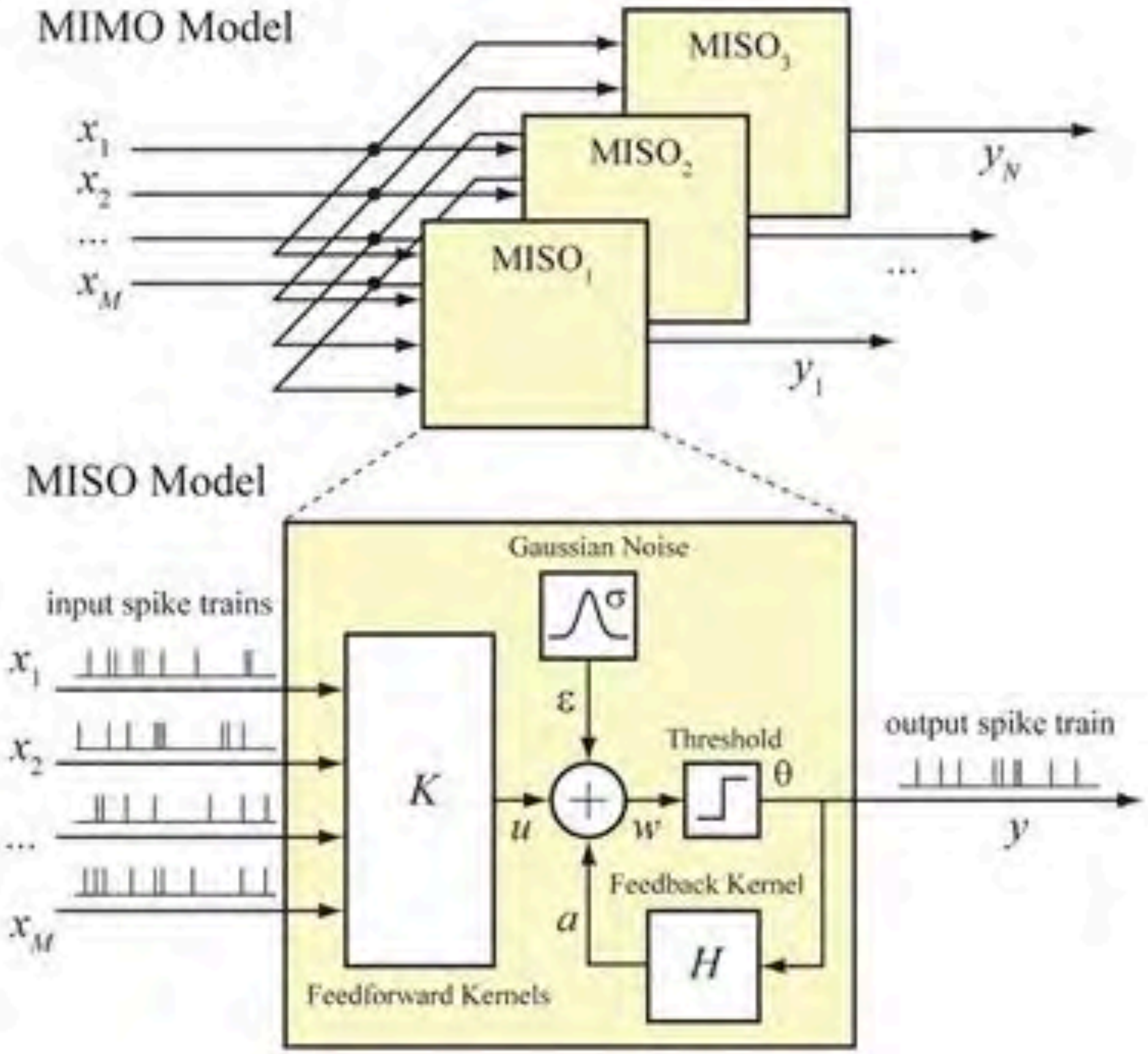
3. be able to describe and **discuss how AI has been applied in medicine** (specifically with regard to muscles and nerves).

4. be able to **estimate the impact emerging intelligent systems technology** will have on your own life, practice, study, or work within the next 5-10 years.

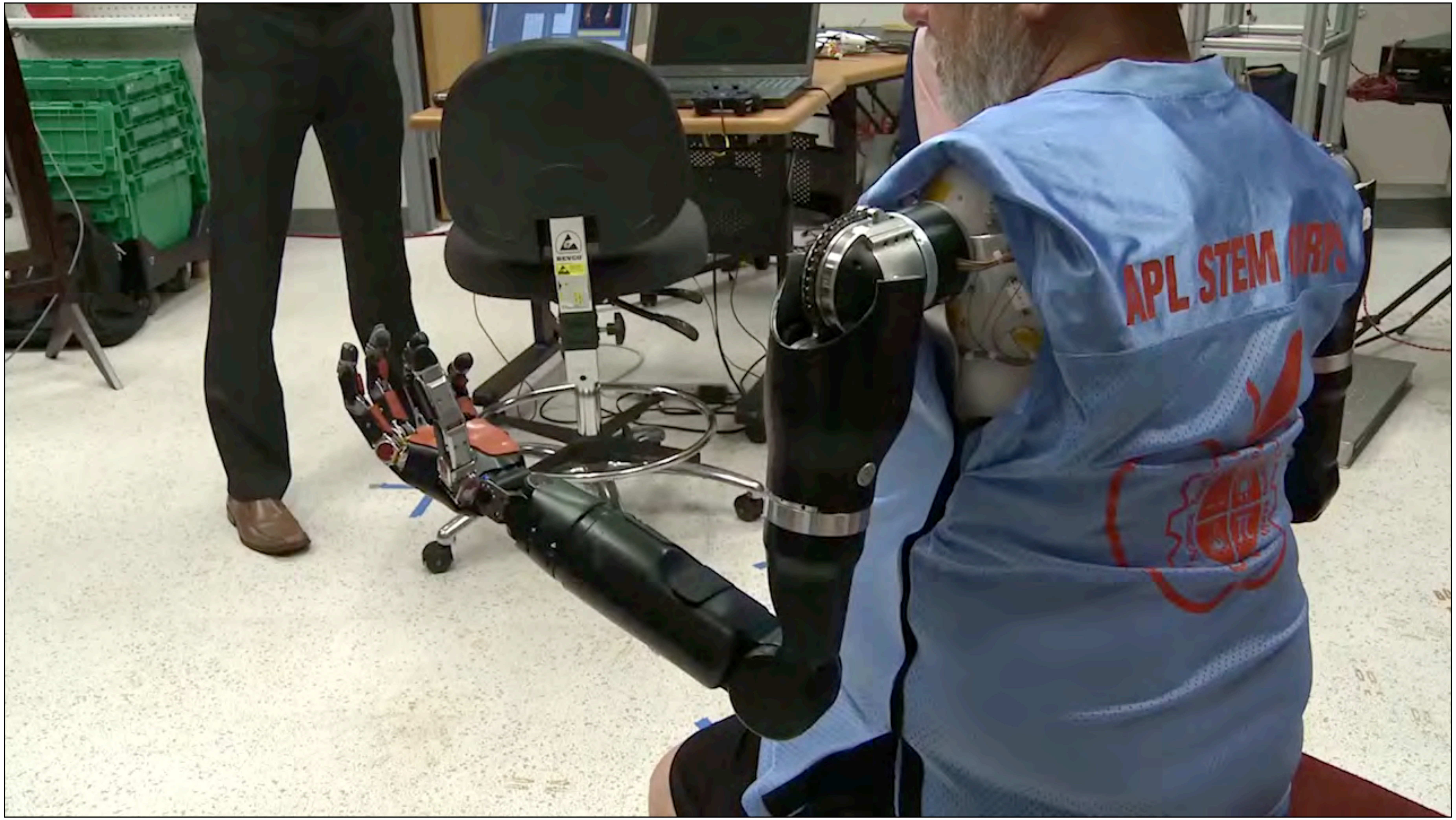
5. be able to **find and cite appropriate resources for future self-study** on AI and its application within medicine.

Direct brain-computer interfaces: study participant Jan Scheuermann feeding herself with a robotic limb (University of Pittsburgh); http://www.upmc.com/media/media-kit/bci/Pages/default.aspx



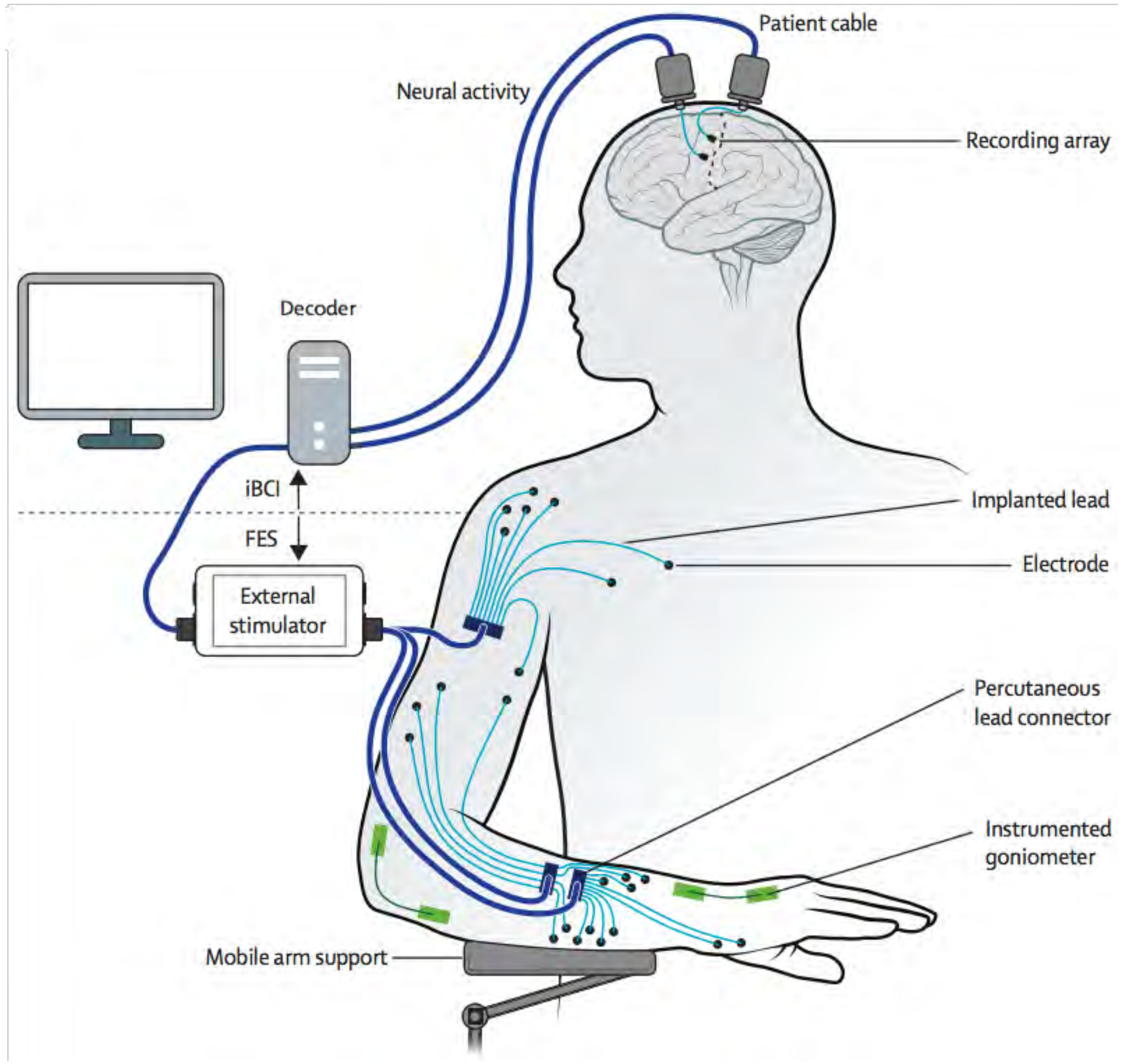


Direct brain-computer interfaces: *memory protheses* from the Center for Neural Engineering, Viterbi School of Engineering. https://cne.usc.edu/neural-prosthesis-for-hippocampal-memory-function/ and IEEE Trans Neural Syst Rehabil Eng. 2018, 26(2):272-280.



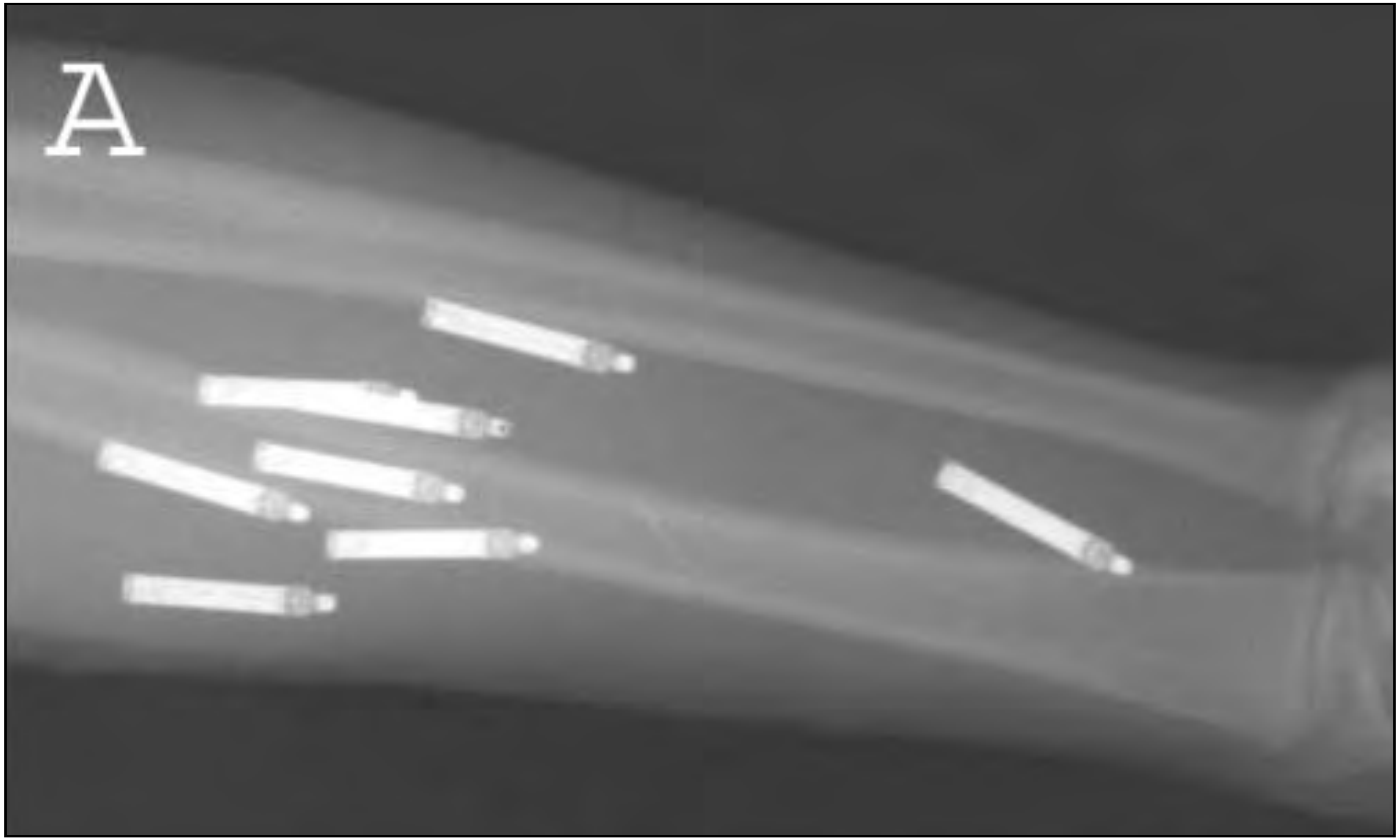
Brain-body-machine interfaces: “Amputee Makes History with APL’s Modular Prosthetic Limb” (JHU Applied Physics Laboratory); https://youtu.be/9NOncx2jU0Q

Brain-body-machine interfaces: “APL’s Modular Prosthetic Limb Reaches New Levels of Operability” (JHU Applied Physics Laboratory); https://youtu.be/-0srXvOQIu0



Brain-body-machine interfaces: "Restoration of reaching and grasping movements through brain-controlled muscle stimulation in a person with tetraplegia: a proof-of-concept demonstration" Ajiboye, A Bolu et al., *The Lancet*, Volume 389 , Issue 10081, 1821-1830, 2017.

Brain-body-machine interfaces: “Brain-Machine Interface @ EPFL- Wheelchair” (École polytechnique fédérale de Lausanne); https://youtu.be/0-1sdtnuqcE



Brain-body-machine interfaces: Baker et al., "Continuous Detection and Decoding of Dexterous Finger Flexions With Implantable MyoElectric Sensors," IEEE TNSRE 18(4):424-32, 2010.

Commercially Deployed
Pattern Recognition for Prostheses

Muse

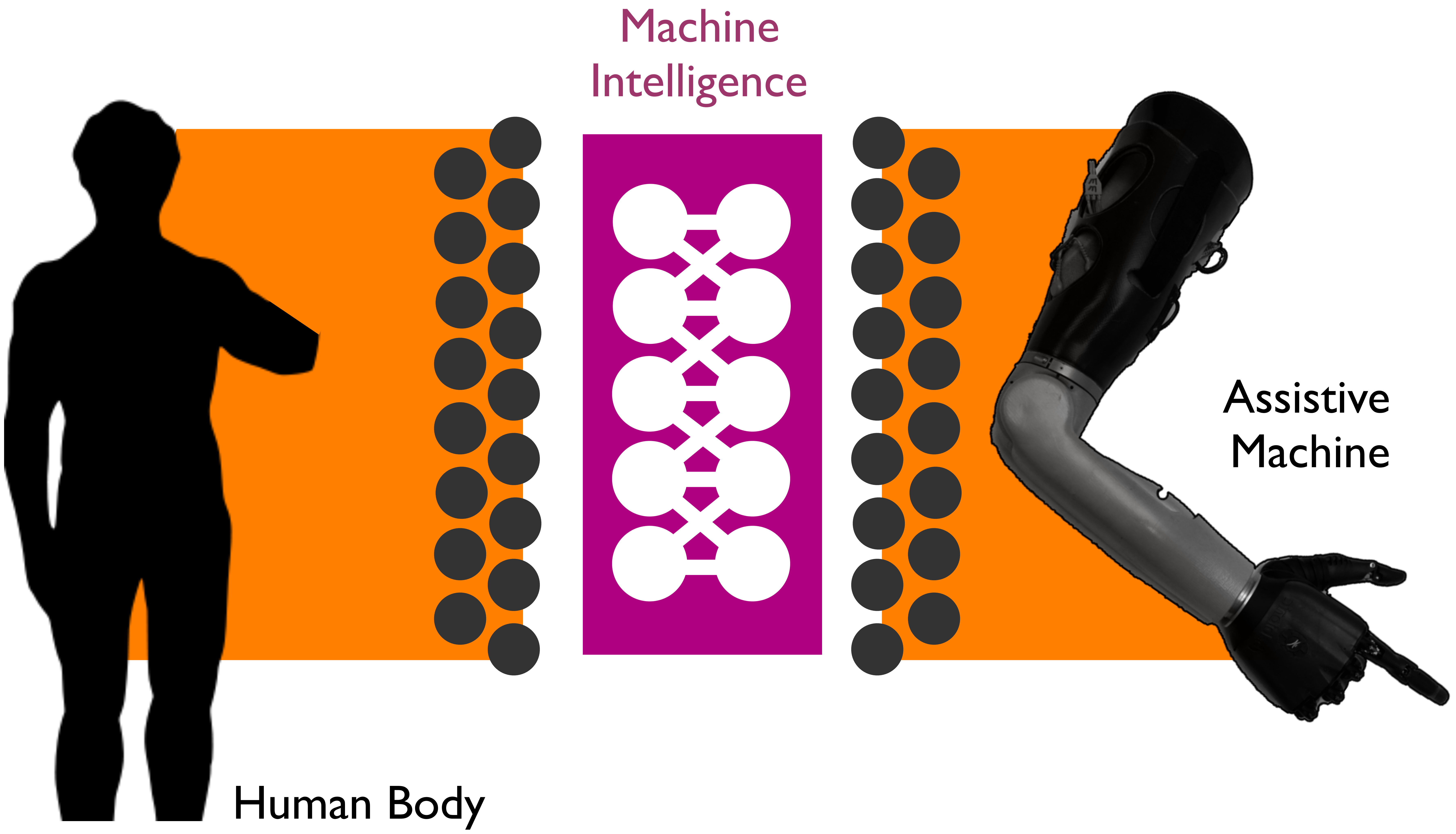
Myo (Thalmic Labs)

Consumer-Available BCI and BMI

These examples

all involve machine intelligence

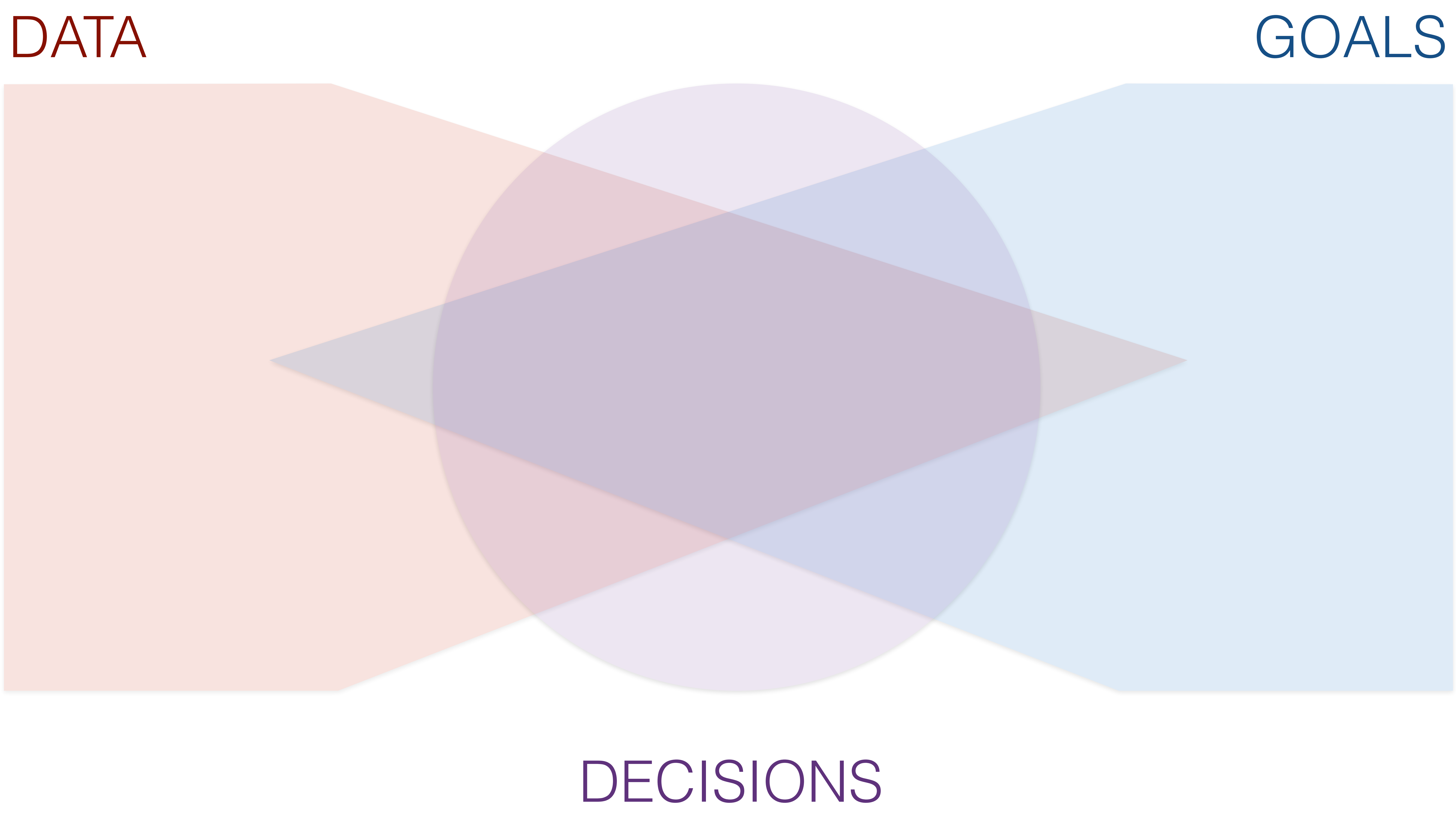
or machine learning



Machine Intelligence
Assistive Machine
Human Body

?

Hallmarks of Intelligence:
Artificial, Machine (and Human)



Hallmarks of Intelligence:

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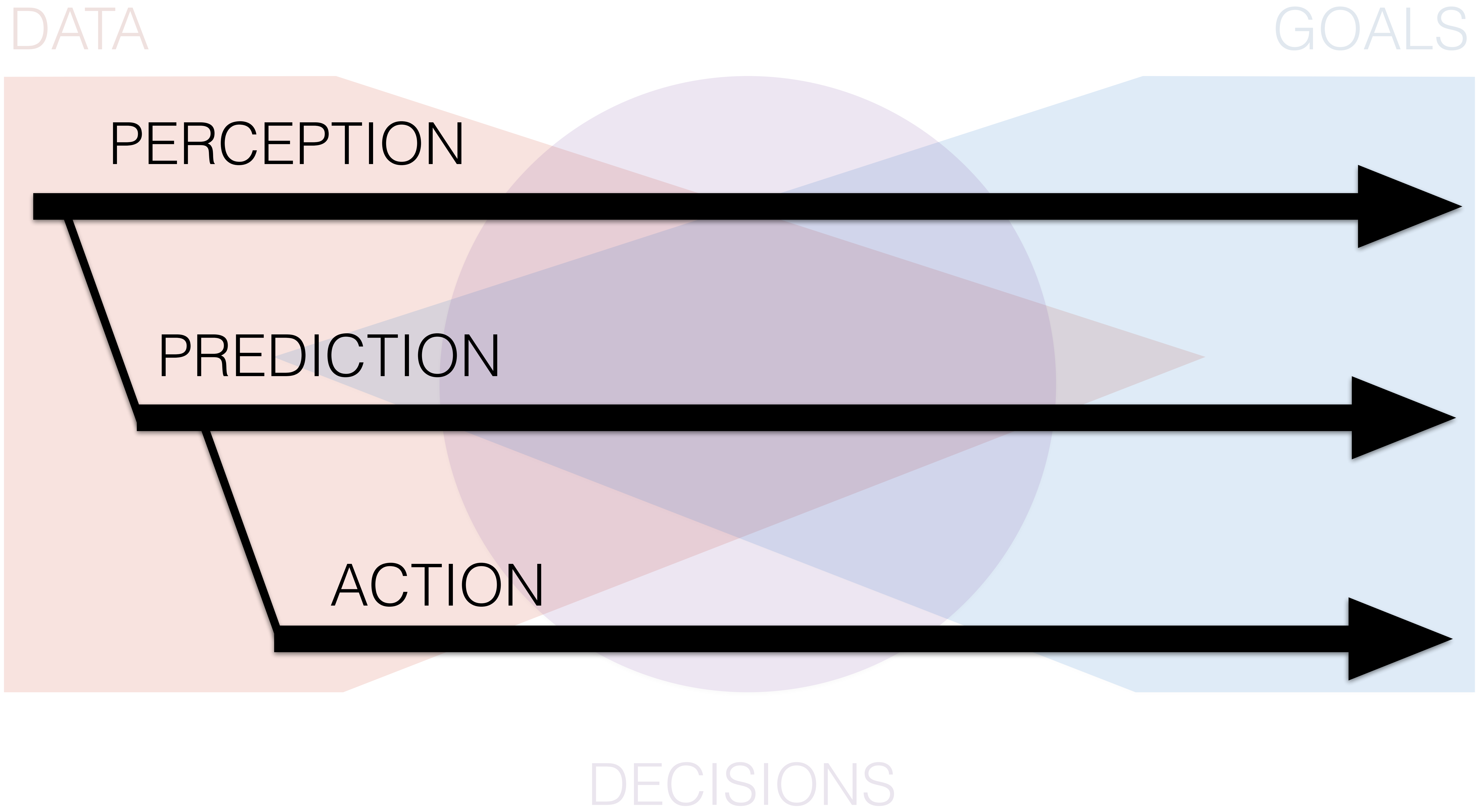

Hallmarks of Intelligence:

Artificial, Machine (and Human)

Intelligent or not?

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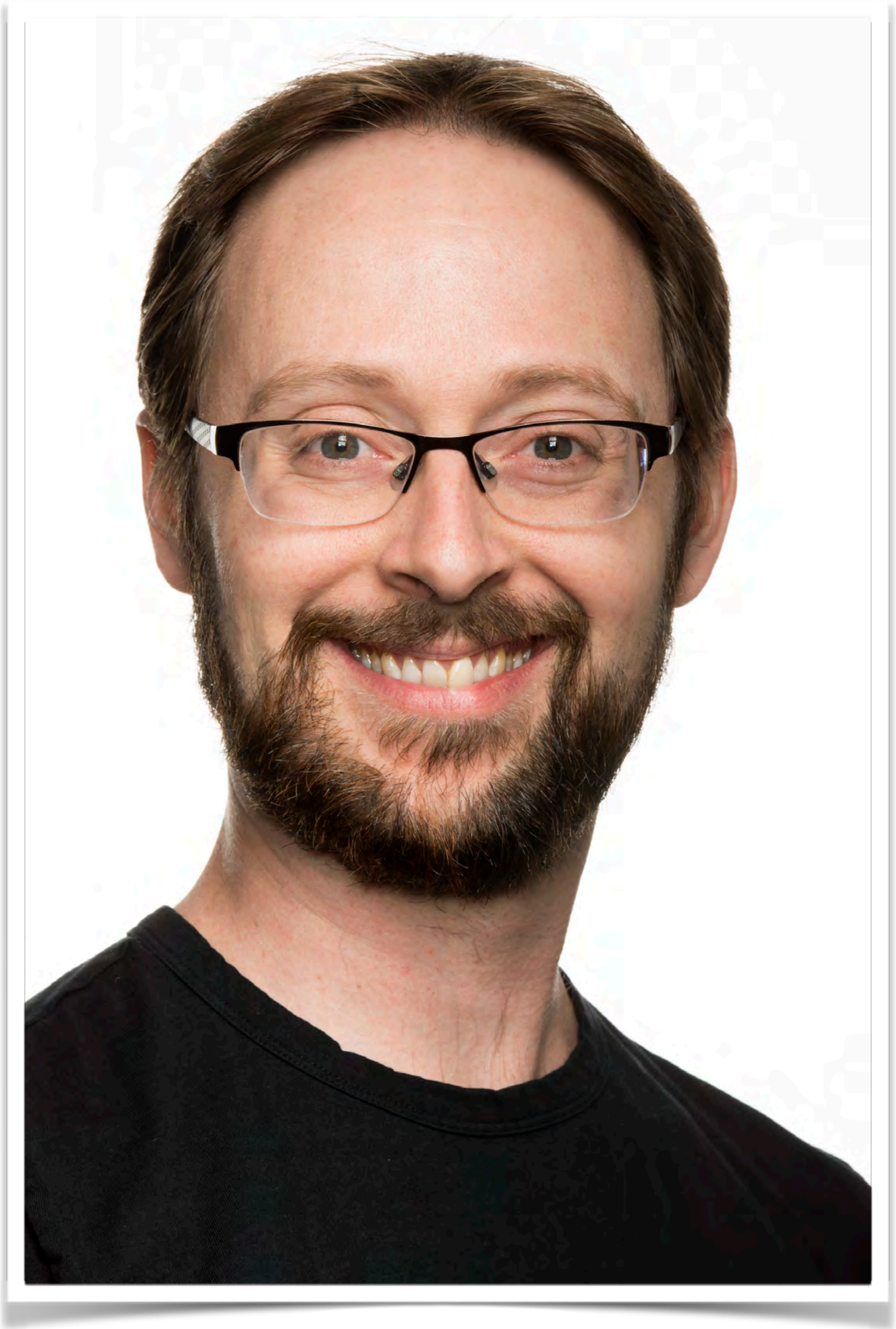
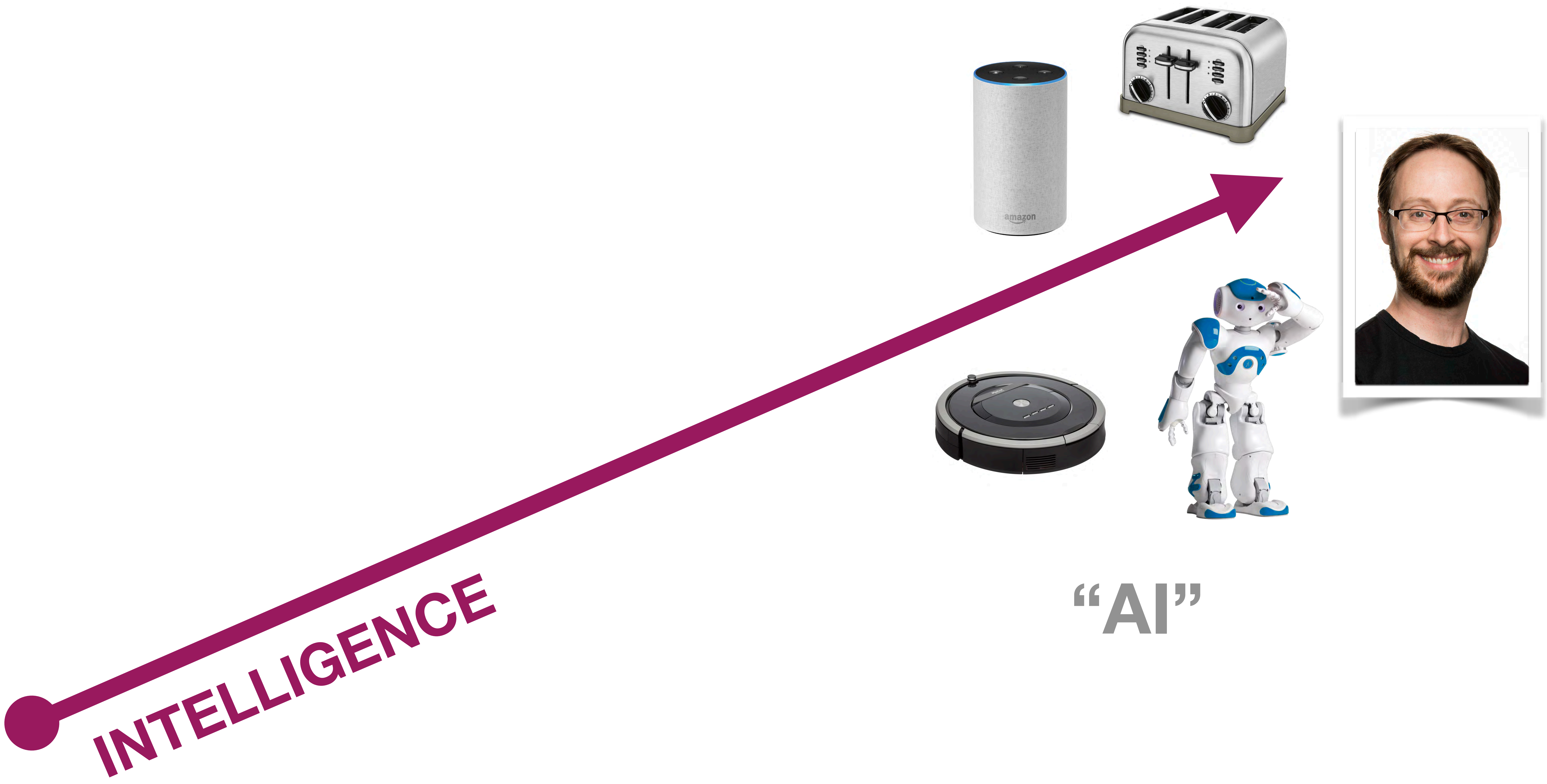


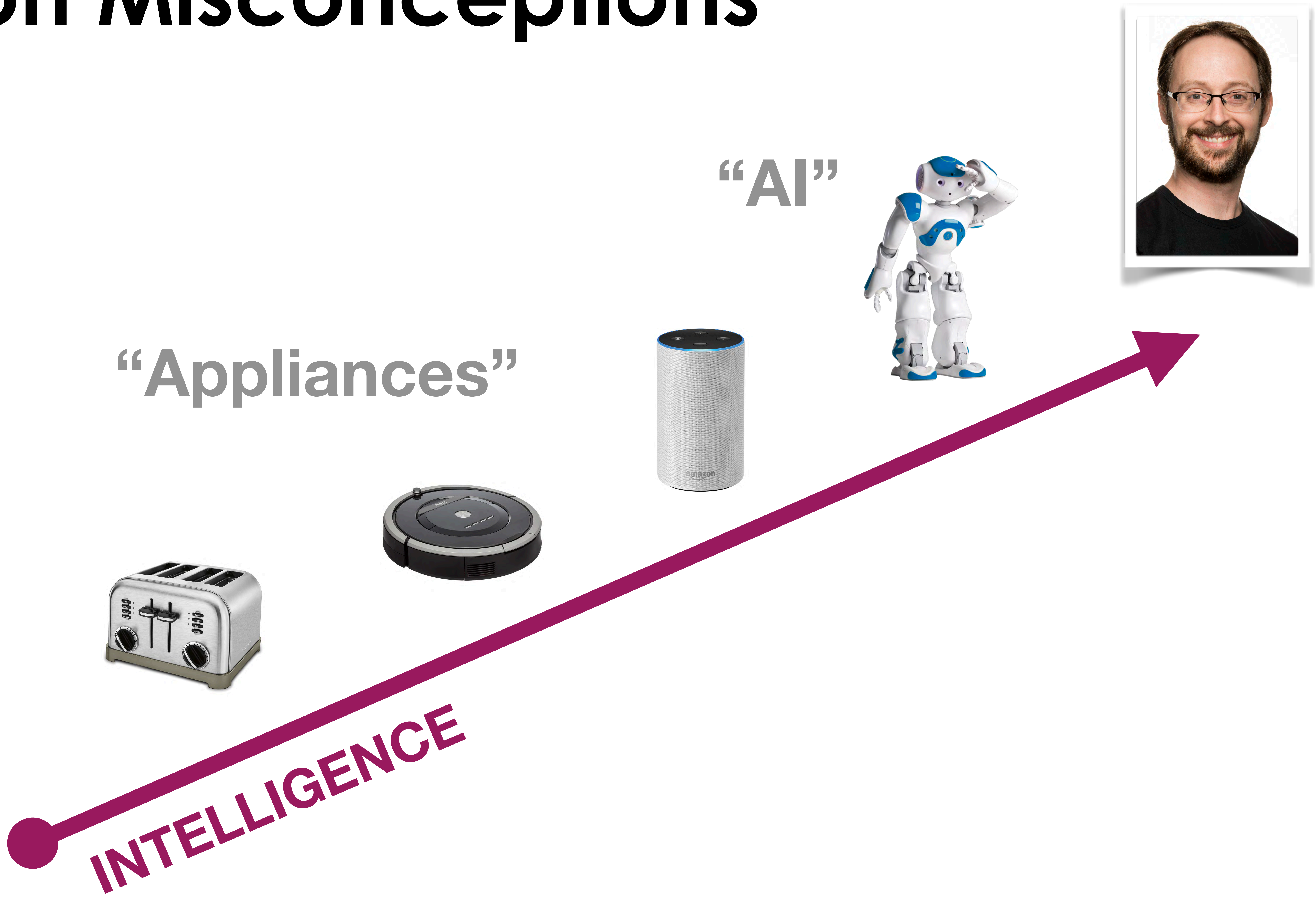
Intelligent or not?

Common Misconceptions

Common Misconceptions

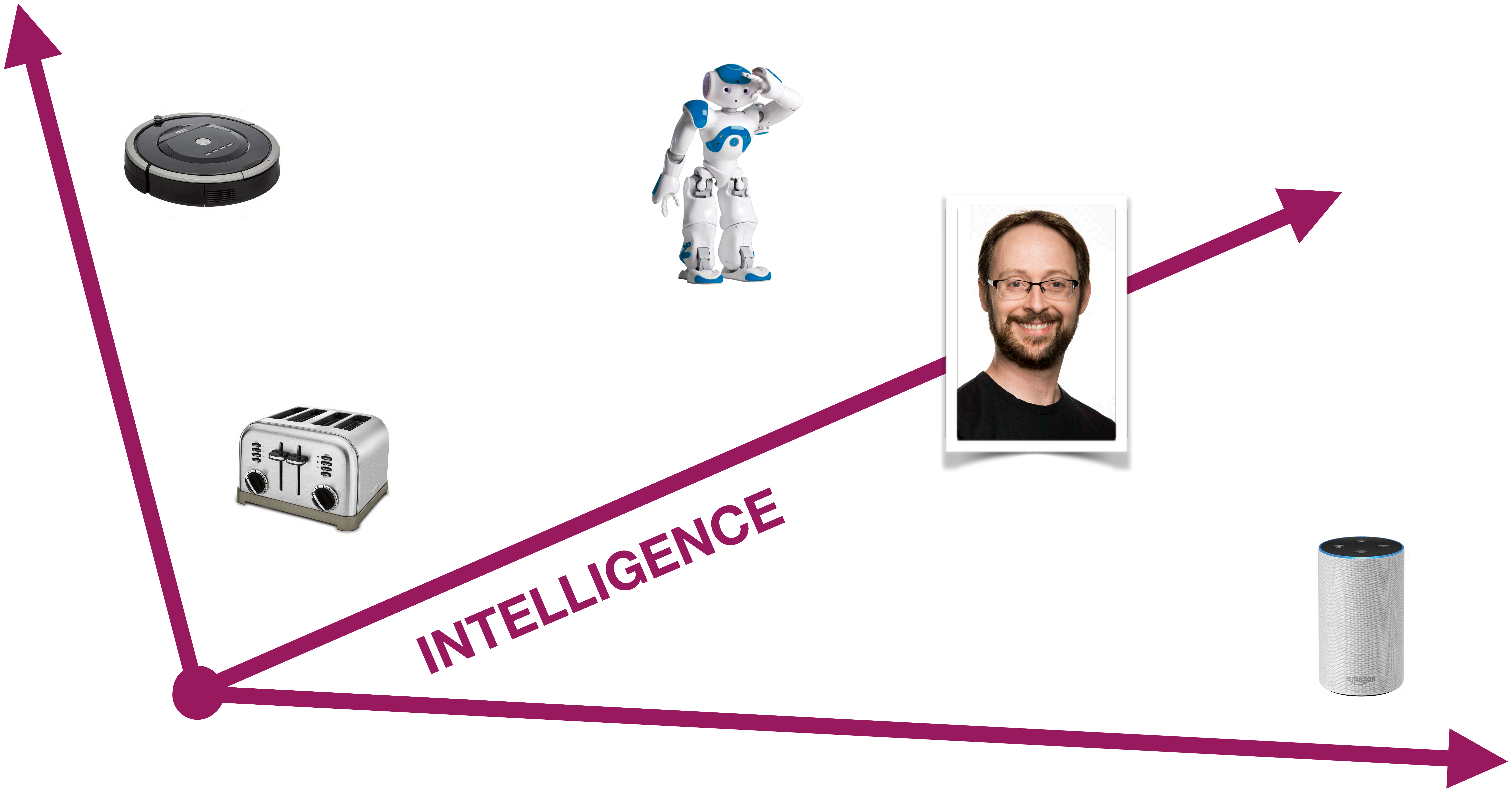


Common Misconceptions



Data, Decisions, Goals

Perception, Prediction, Action

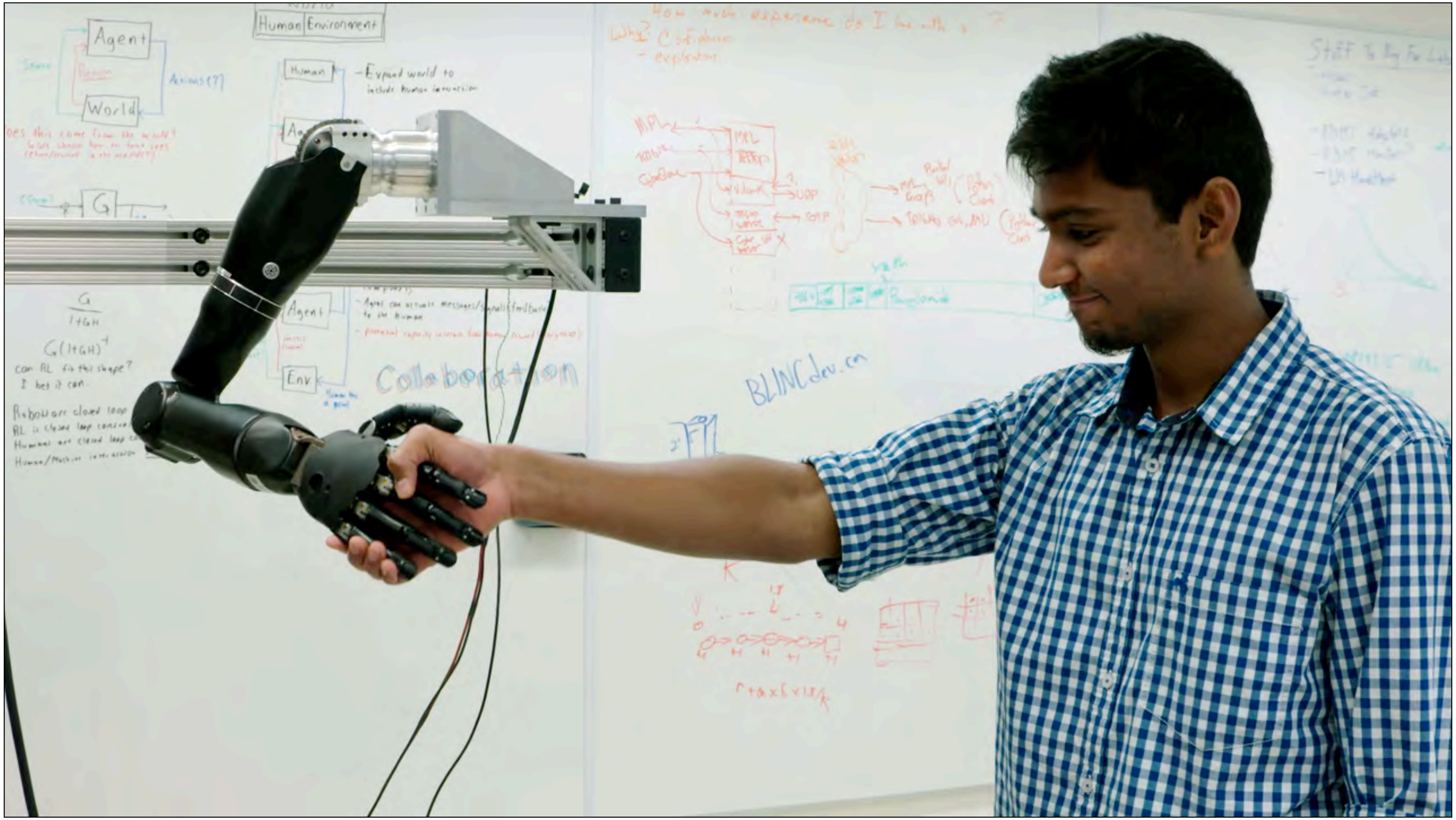


Why Machine Intelligence?

- **Enhanced control** over a changing and increasingly complex world.
- **Anticipation** of future events and outcomes.
- **General tools** for solving hard problems.

"Controlling complex systems and extracting knowledge from massive amounts of data."

Examples: finance, healthcare, energy, resources, transport, information processing.



Pilarski Lab
August 2016

Why Learning?

- **Things are Unknown:**
  known ends but unclear means.
- **Things are Complex:**
  scaling up is demanding or impossible.
- **Things Change:**
  systems need to adapt!

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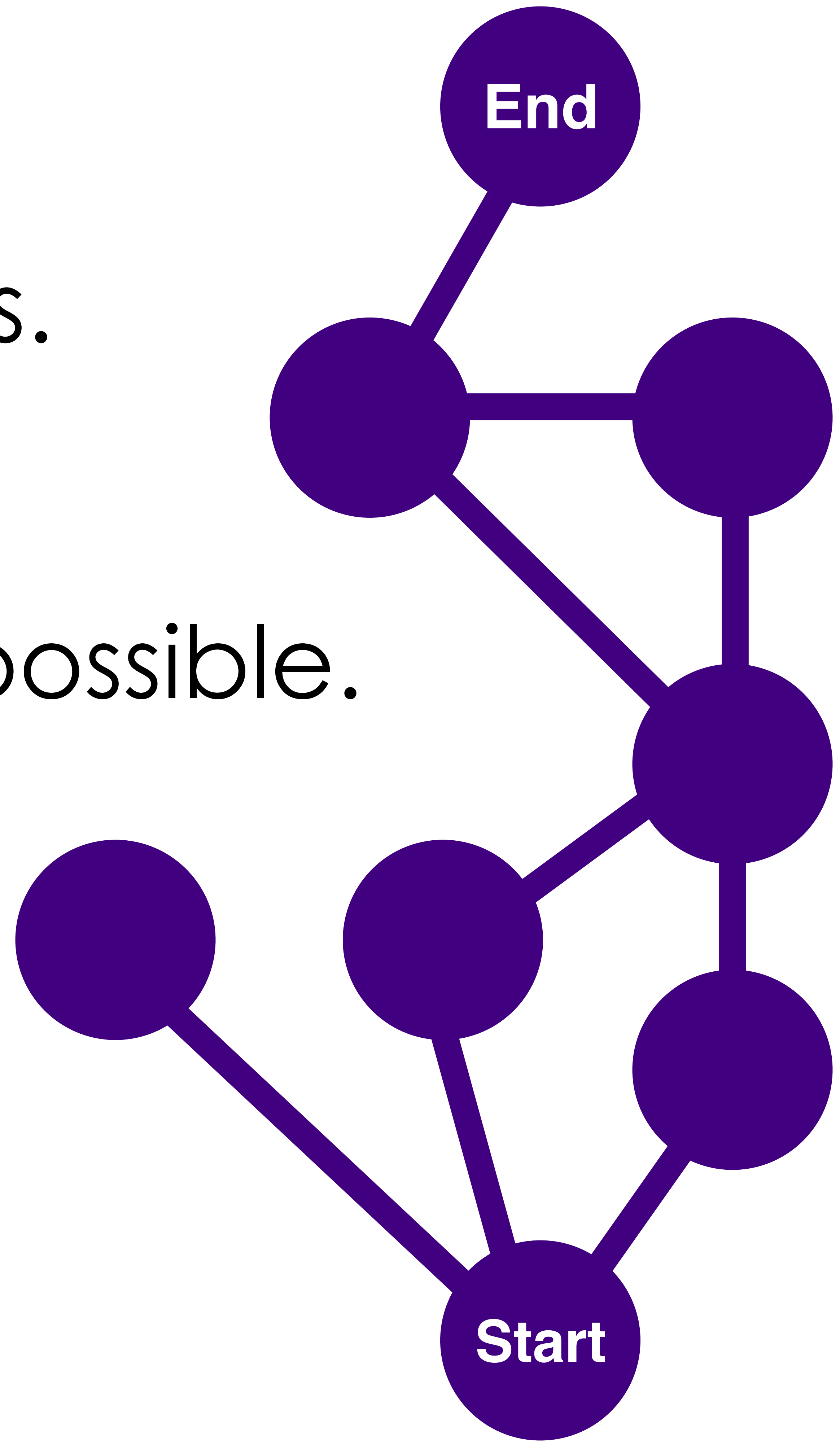

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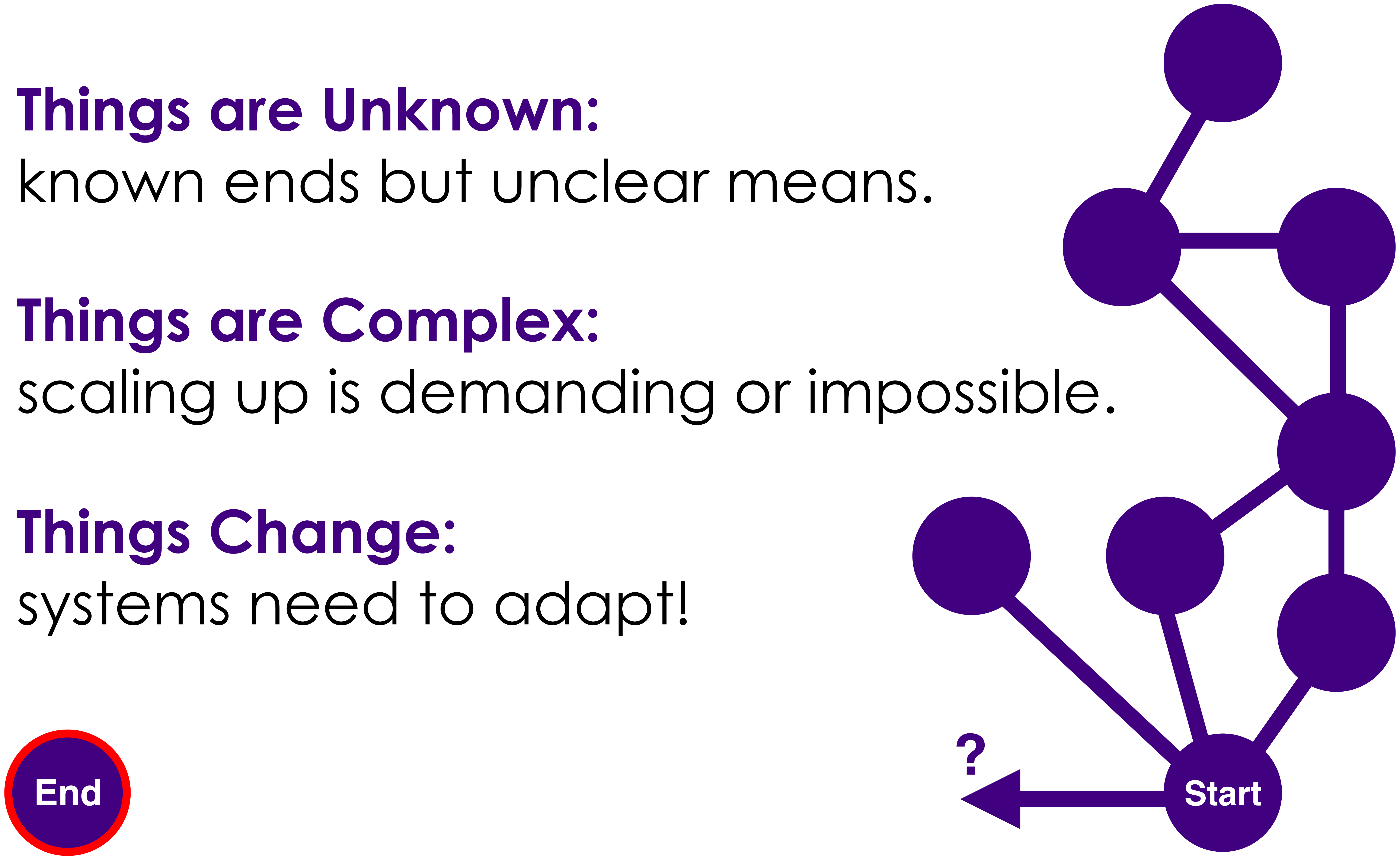
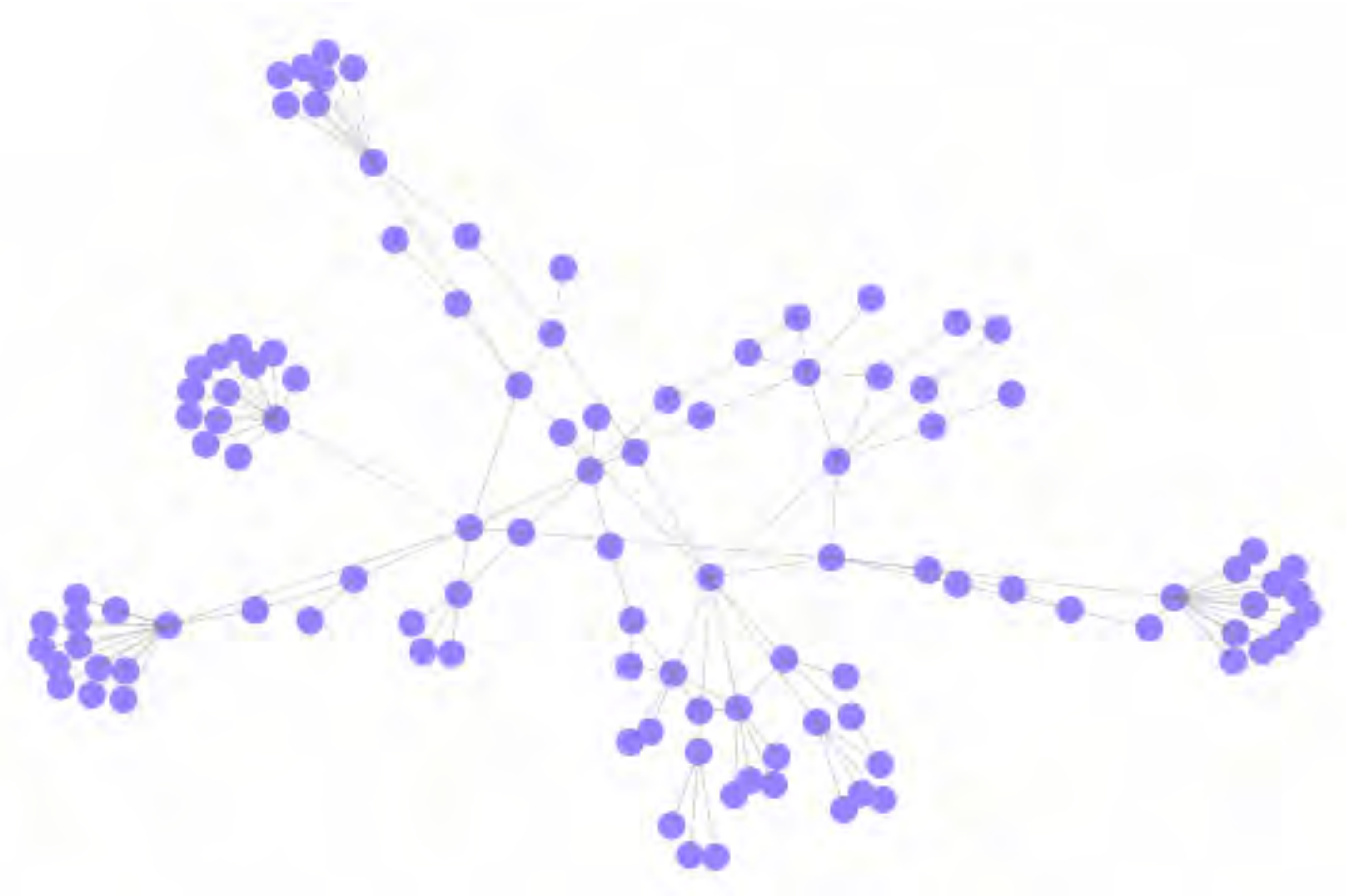


AI and ML in Medicine

1. Helping to understand patient populations (**generalization**);
2. Helping to understand individual patients (**personalization**);
3. Helping choose and improve interventions (**optimization**):
   - by connecting patients to assistive devices;
   - by helping deploy treatment strategies.

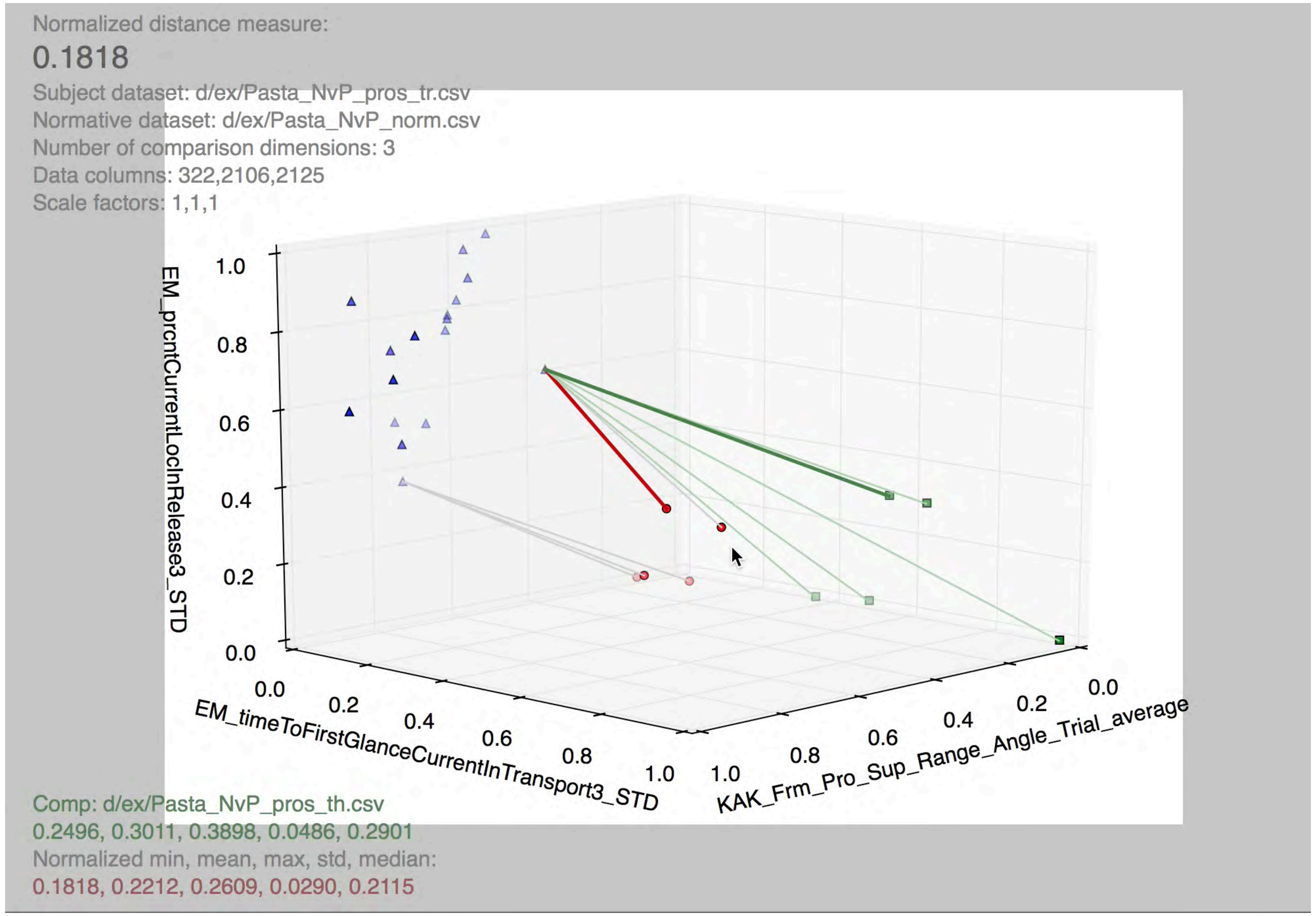
AI and ML in Medicine



Helping to understand populations (**generalization**).

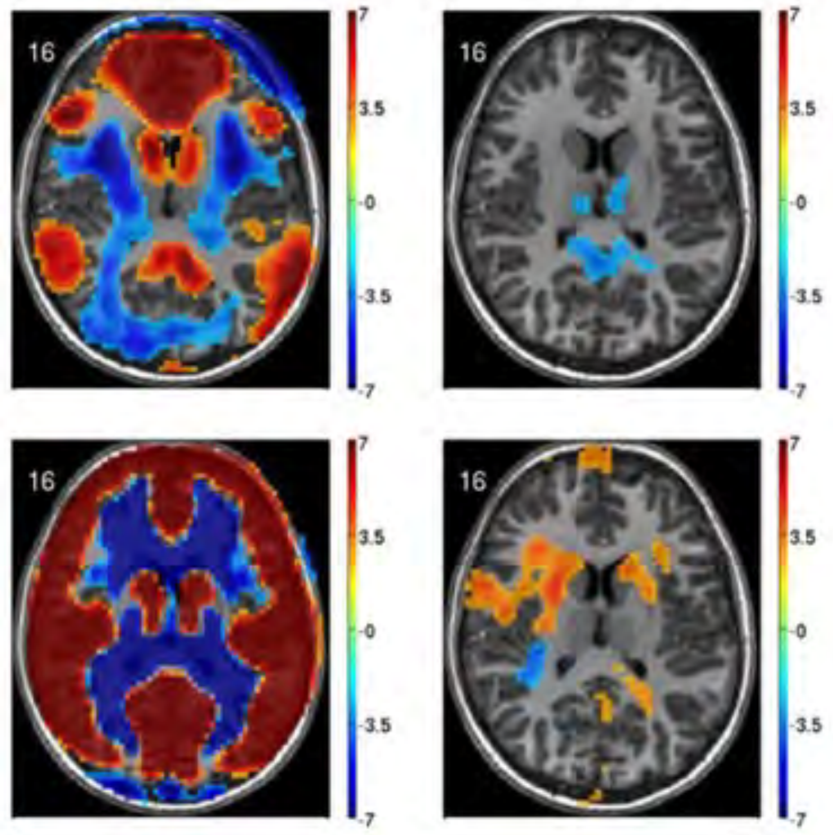
http://www.humanconnectomeproject.org/

AI and ML in Medicine



Helping to understand individuals (**personalization**).

AI and ML in Medicine



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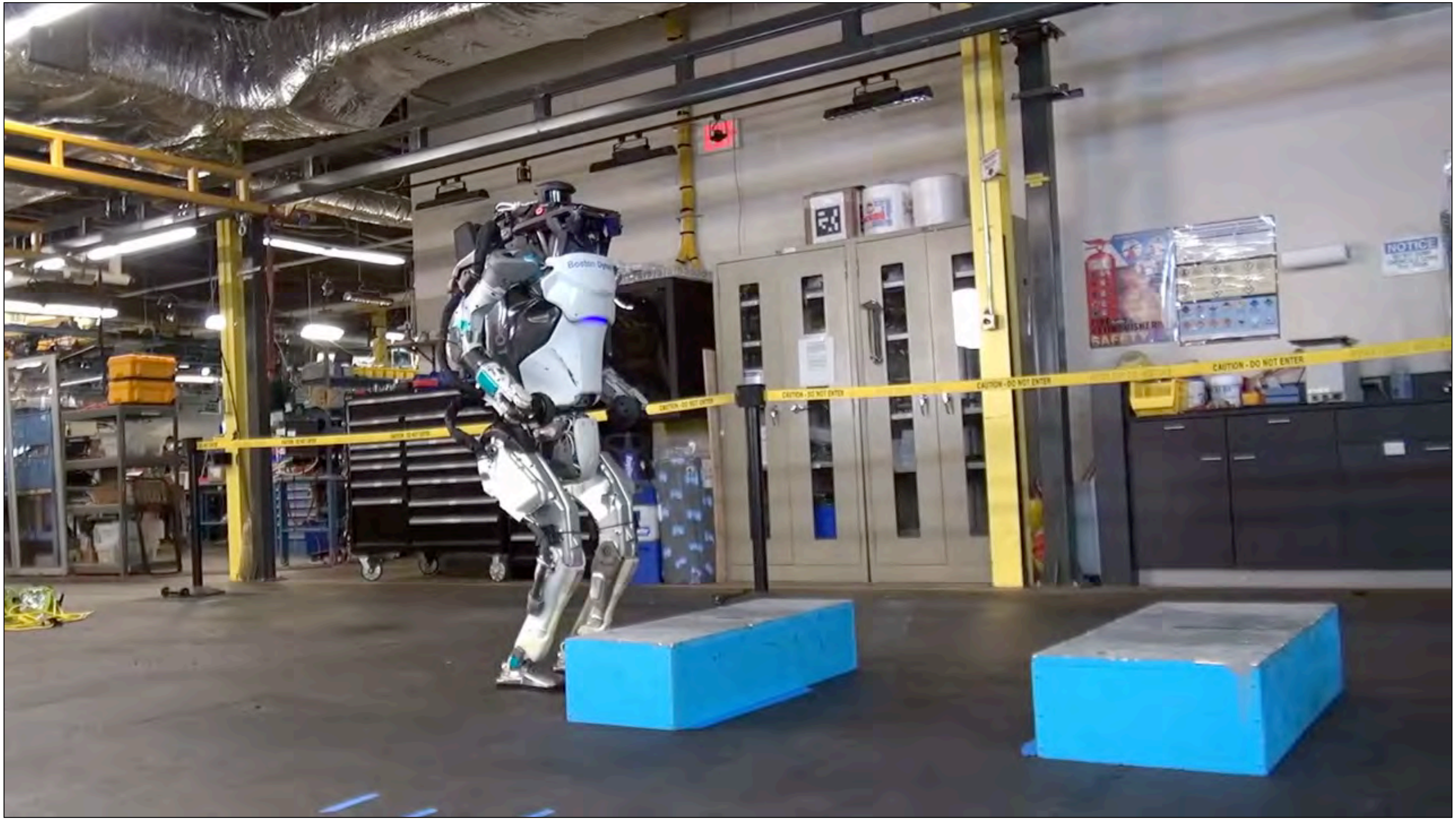


And in case you were wondering what the robots are up to these days…

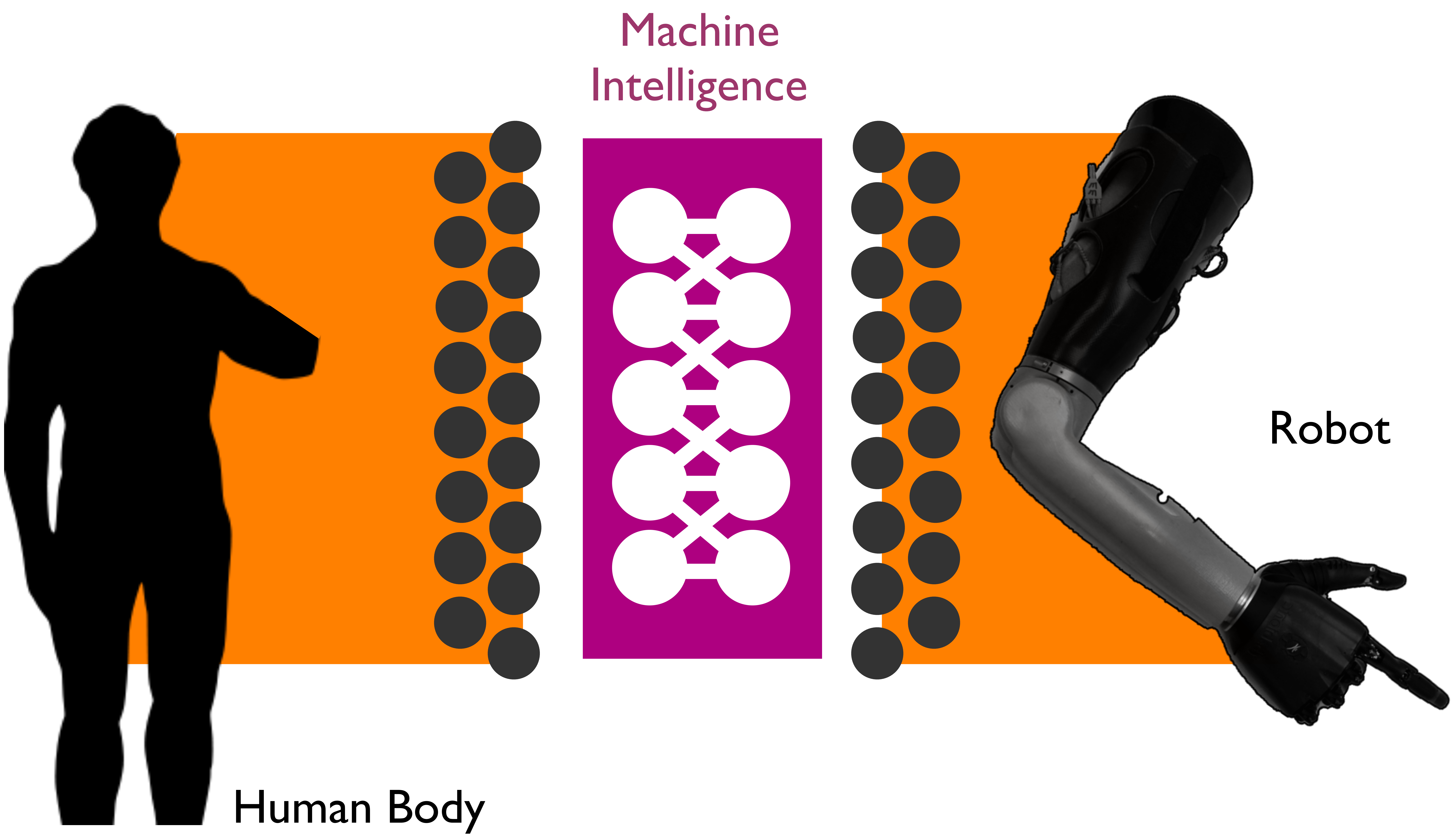
Atlas Robot (Boston Dynamics): https://youtu.be/fRj34o4hN4I

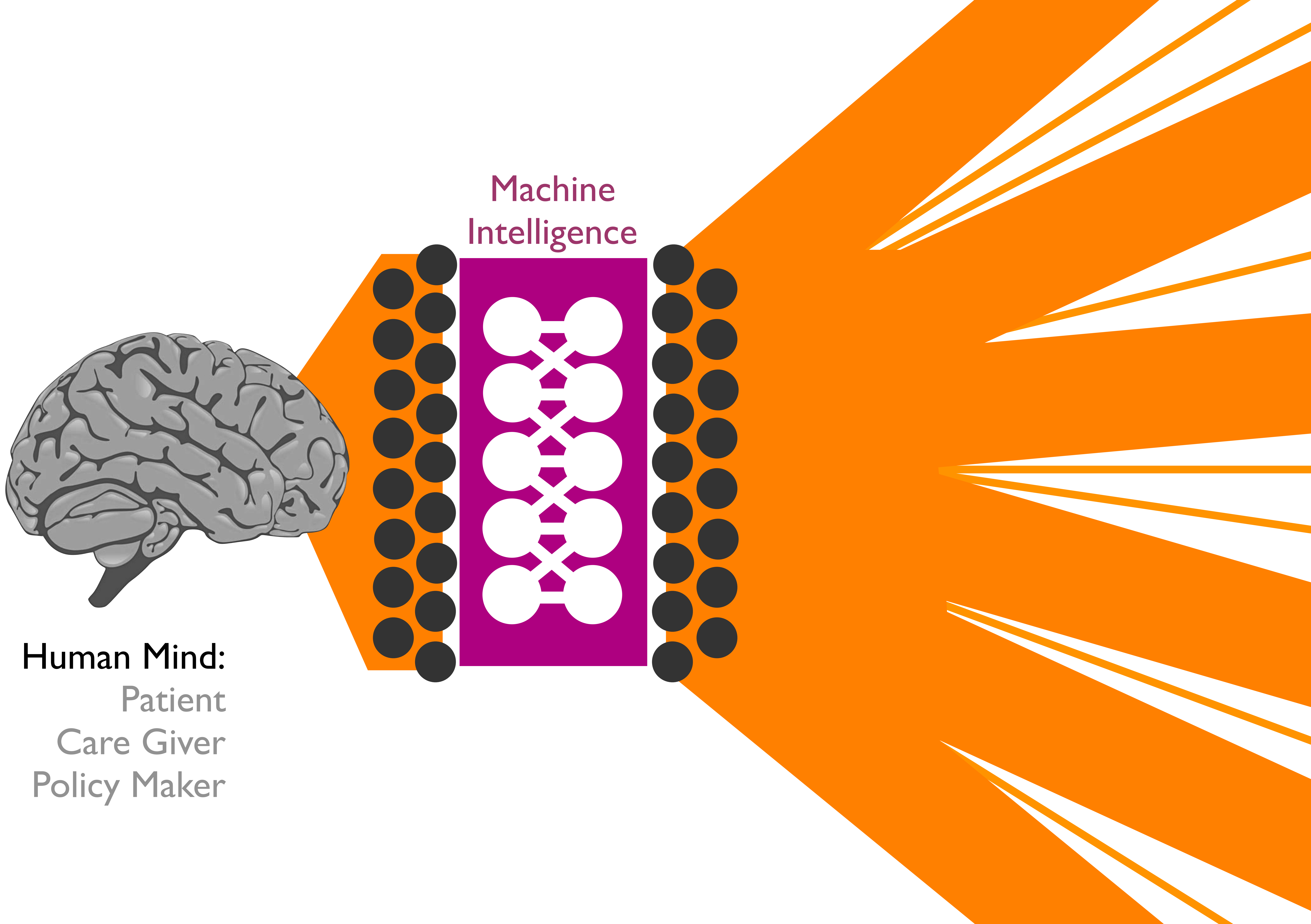
Exoskeletons: UC Berkeley spin-off suitX exoskeleton technology;
https://www.youtube.com/watch?v=I3roYI3CB2Y

Looking Forward: Complex Bodies, Multidisciplinary Care

If a patient's body and mind are comprised of both biology and technology, how do we best treat the whole patient?

- patients may (do) consider their technology part of themselves;
- biology and technology may not be easily separable;
- biological and technical care may not be easily separable;
- normal care may soon involve experts in ***muscles***, ***nerves***, and ***bones***, alongside experts in ***hardware***, ***software***, and ***data science***.


Machine Intelligence
Robot
Human Body


Machine
Intelligence
Human Mind:
Patient
Care Giver
Policy Maker

Questions

... and thank you very much!

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