
Advances in Machine Learning

Heni Ben Amor, Ph.D.
Assistant Professor
Arizona State University



Generative Adversarial Networks



- | **Introduced by Goodfellow et al. 2014**
- | **Estimate generative models via adversarial process**
- | **A generator network and a discriminator network**
- | **Adversarial game between them**
- | **Each side gets better during training**

Generating Faces

Generated by a GAN

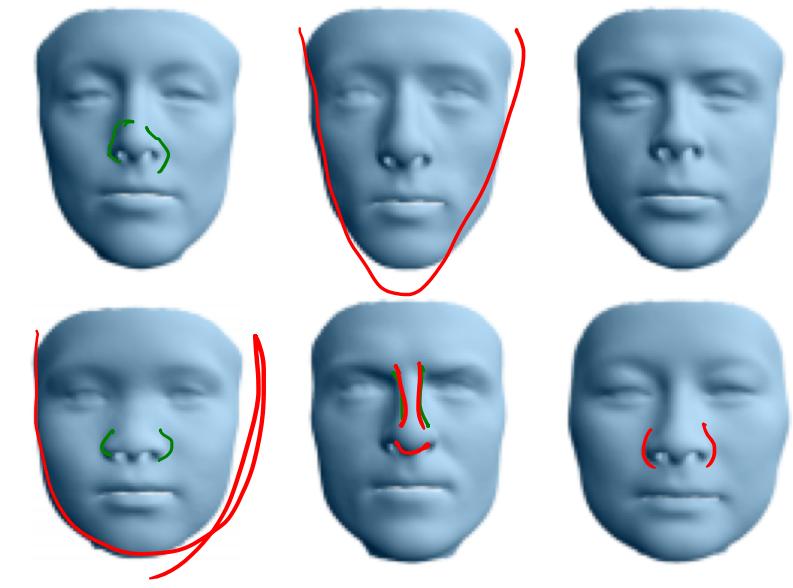


2D Face Generation

Image source: <https://arxiv.org/pdf/1406.2661.pdf>

↑
True data
points

Generated



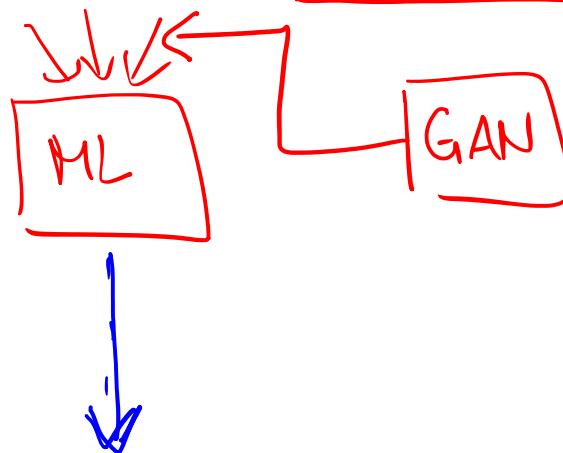
3D Face Generation

Image source: <https://arxiv.org/pdf/1905.00307.pdf>

Why Generative?

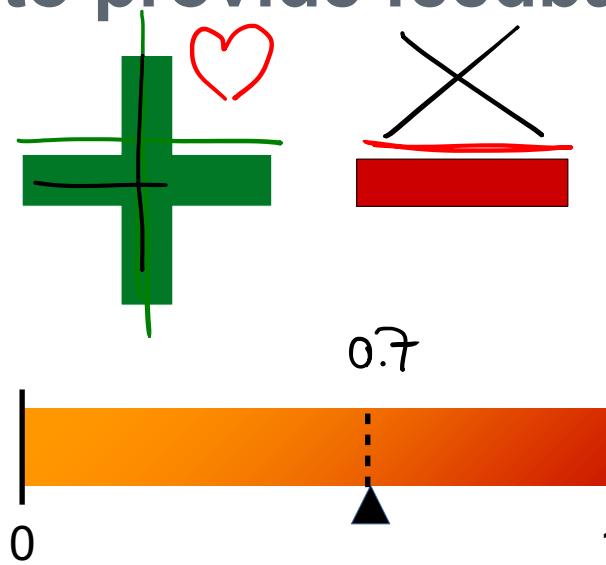
| Generative approaches are very powerful.

- They allow you to synthesize complex data.
 - Music generation, text generation, video etc.
- Works also for data that is difficult to analyze.
- You can also use them to augment data sets.

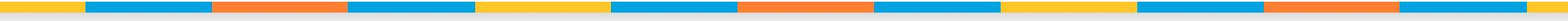


Human-in-the-Loop Learning

- | So far, teacher is only involved at the beginning.
- | What if human teacher is continuously involved?
- | How can we ensure safety?
- | How can we avoid fatigue?
- | What is the best interface to provide feedback?



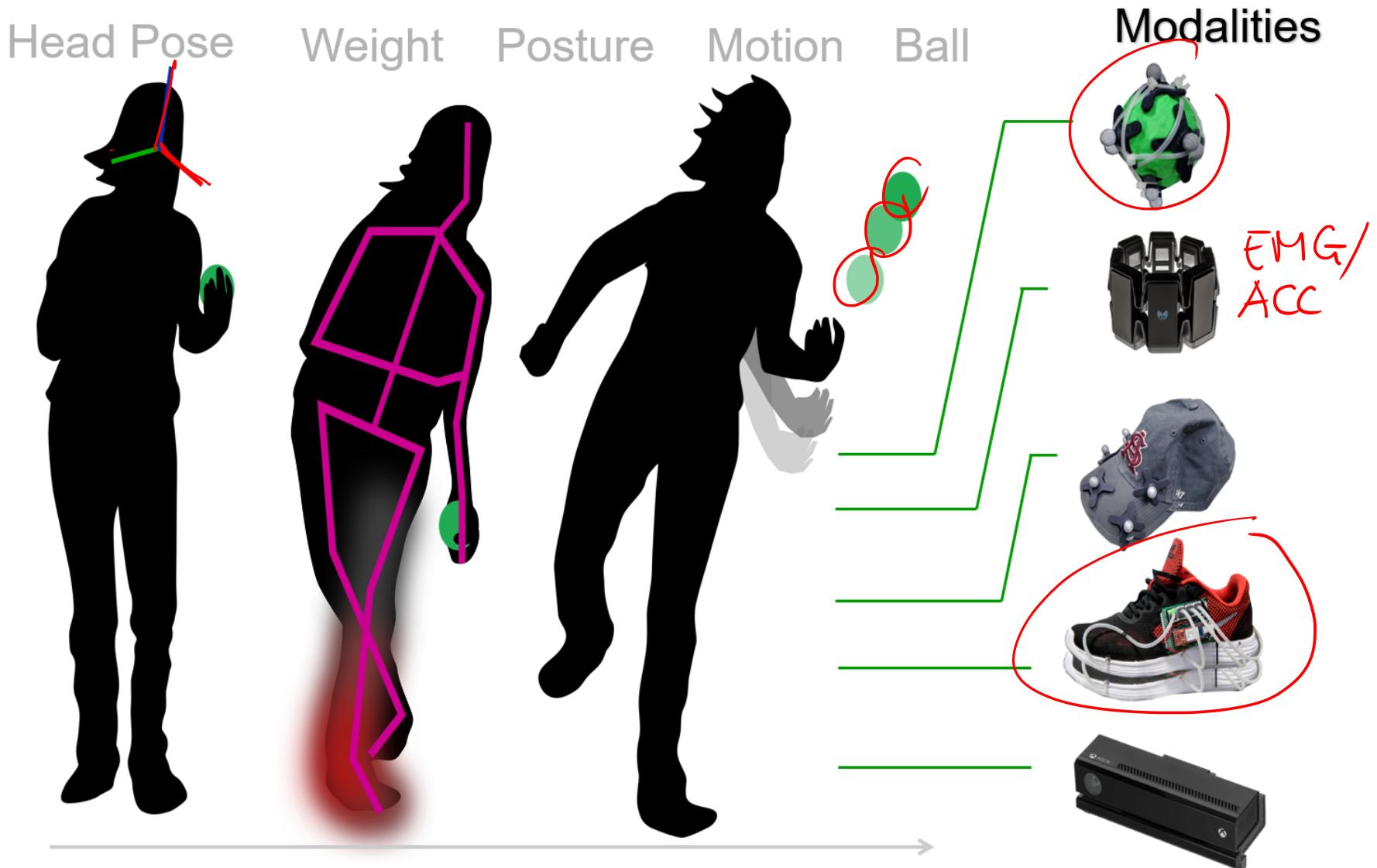
Human-Robot Interaction

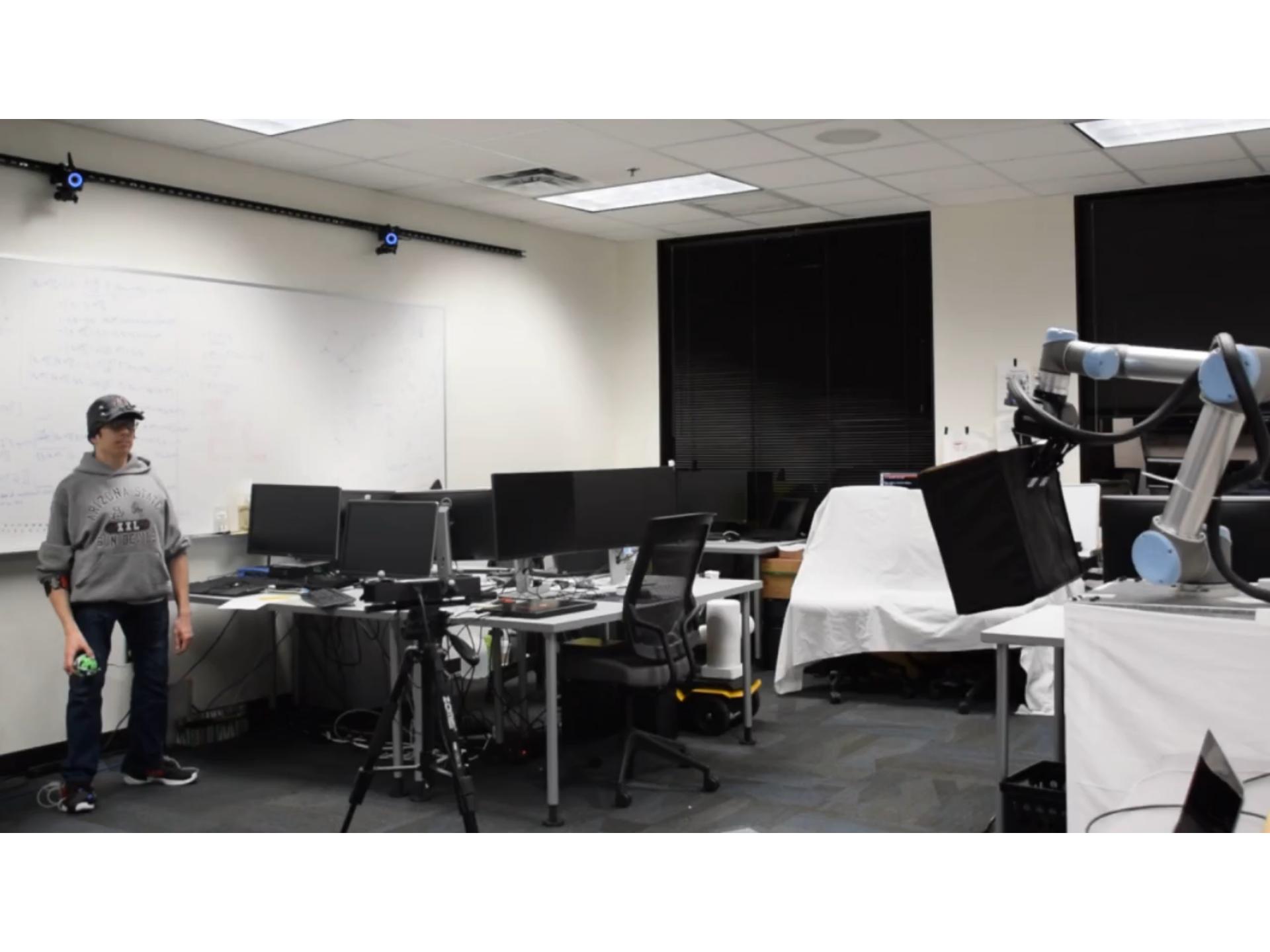


- | Intention inference
- | Requires robots to “read” human behavior
- | Predictive models of human partner
- | Reasoning in time and space
- | Incorporating multiple modalities
 - Examples: vision, sound, accelerometer, etc.



Catching a Ball





Learning to Interact by Observation

| Observe humans' interacting and create generative models

Observe



learn

Act / Assist



reproduce



OFFLINE

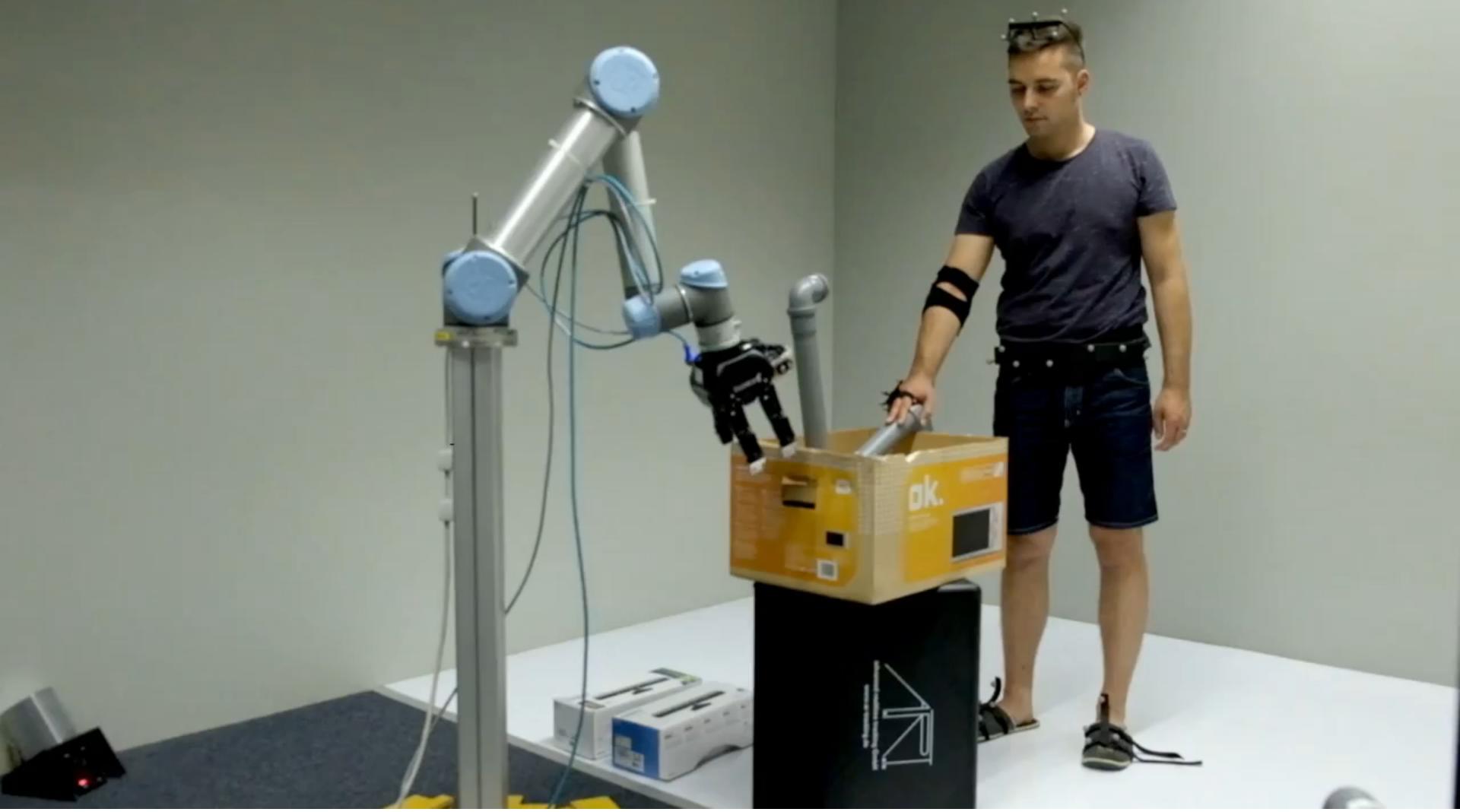


Image Captioning

Understand content of image



Standard: a man on a motorcycle on the road

Ours: a man is working on a motorcycle in a parking lot



a couple of bears standing on top of a rock

two brown bears standing next to each other on a rock



two chairs and an umbrella on a beach

two beach chairs under an umbrella on the beach

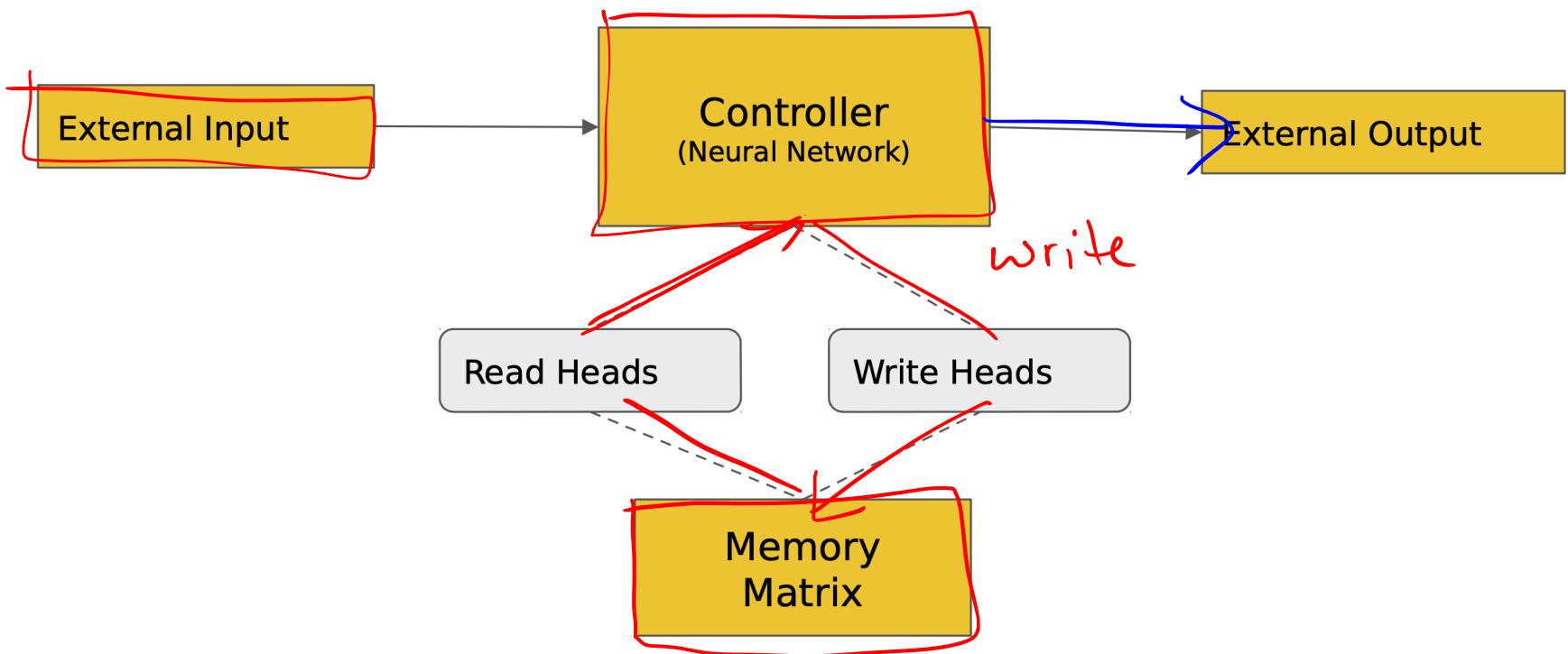


a laptop computer sitting on top of a wooden desk

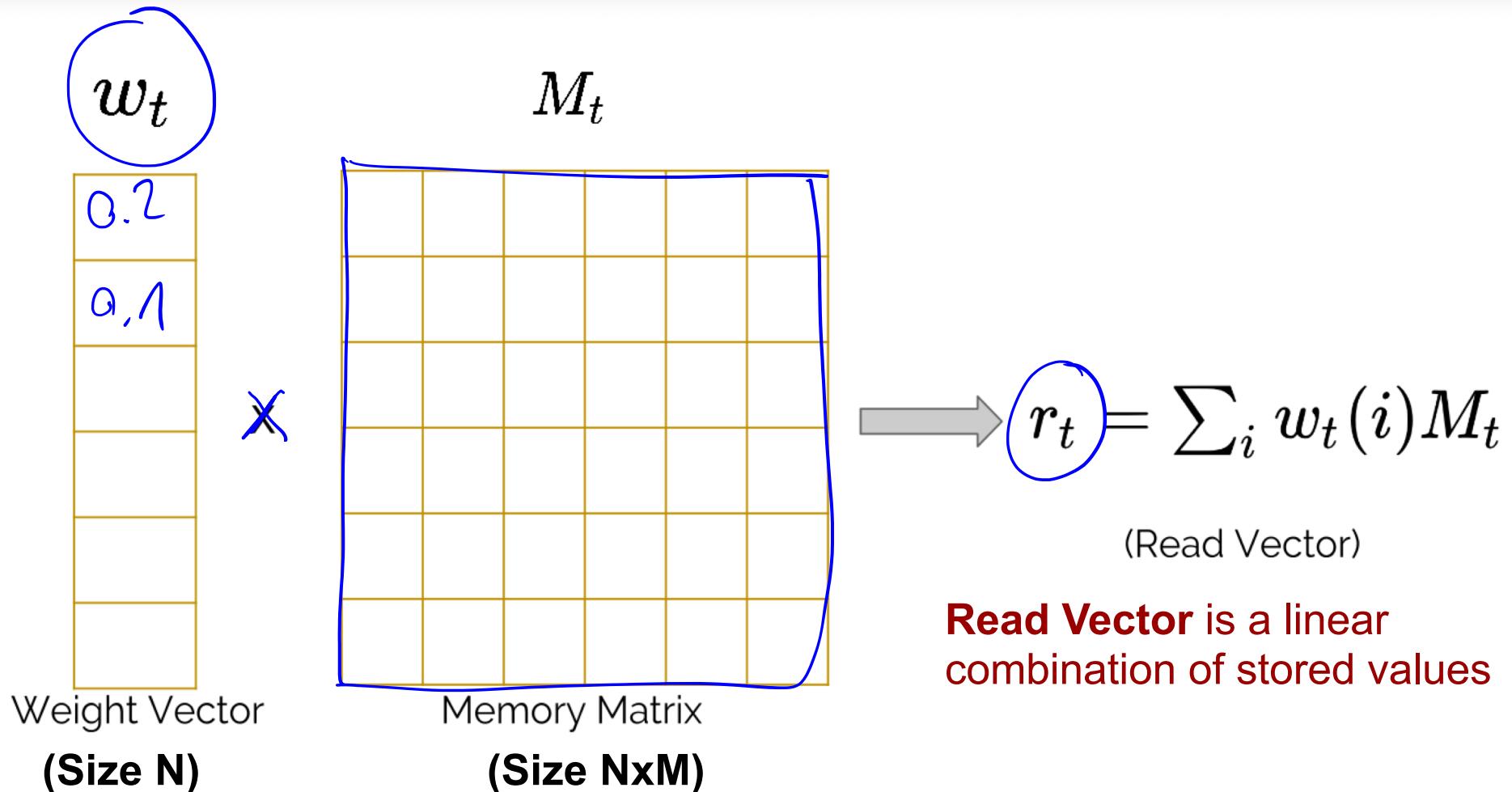
a desk with a laptop and a keyboard

Neural Turing Machines

- | Neural Nets with explicit memory
- | Read and write operations to store data
- | No forgetting → drawback of LSTM



Memory Access: Reading



N = Number of Memory Locations

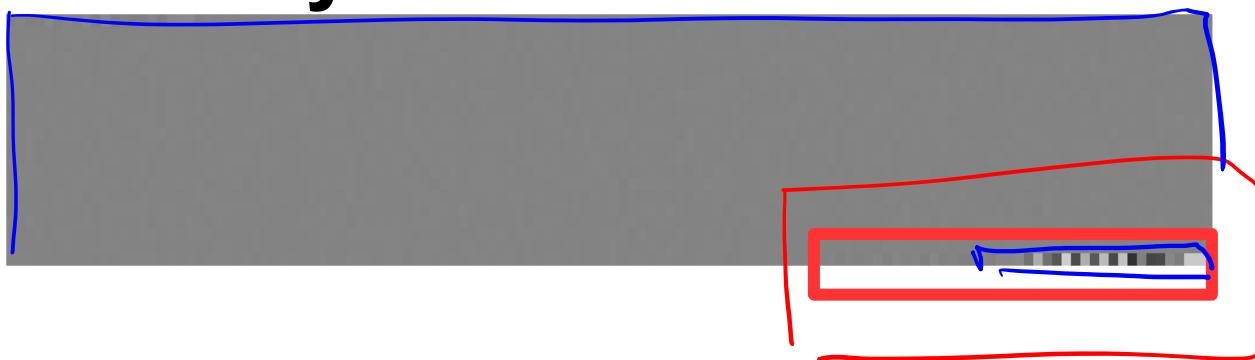
M = Size of the Stored Vector

Explicit Memory Access

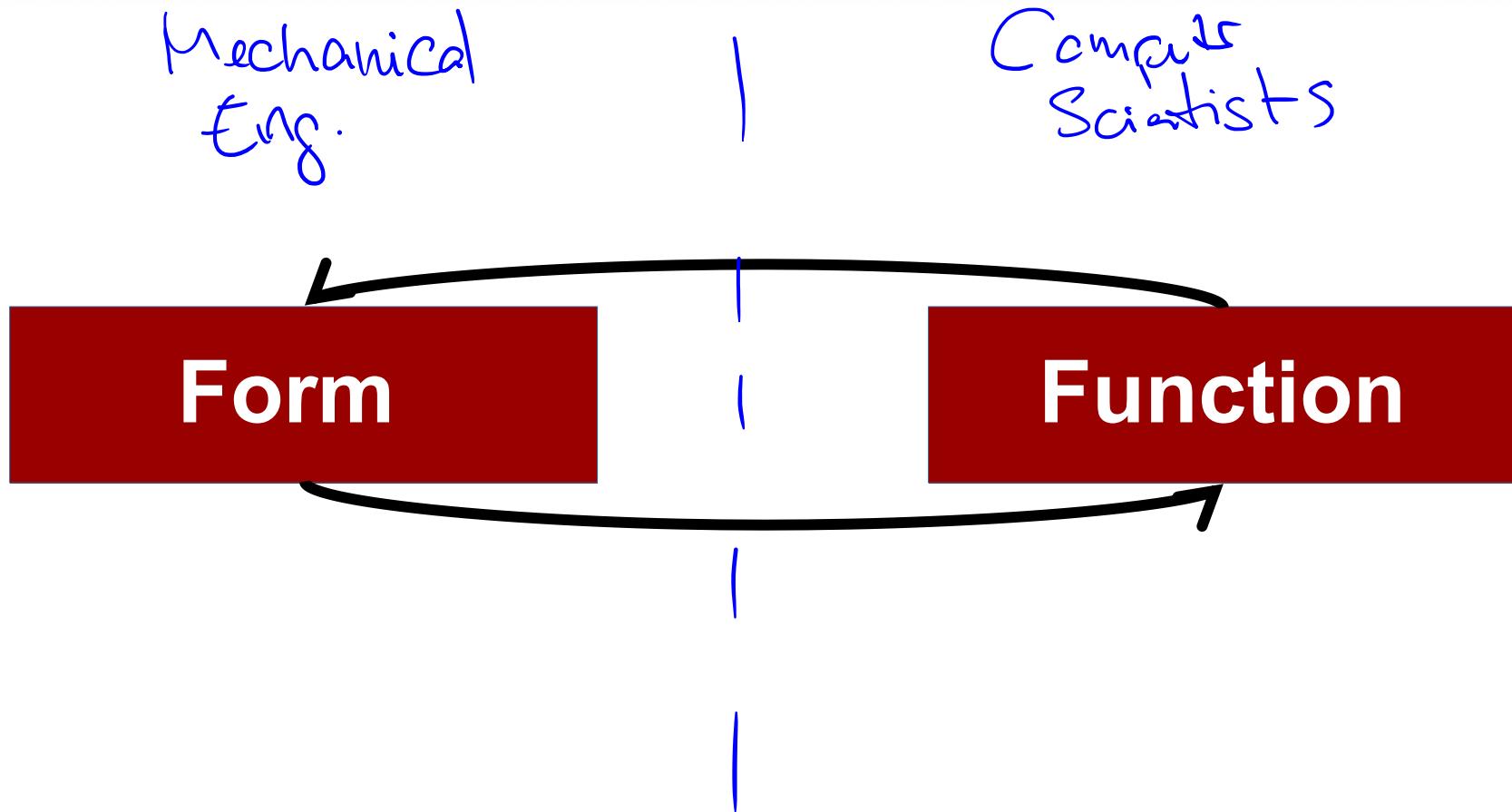
Situation



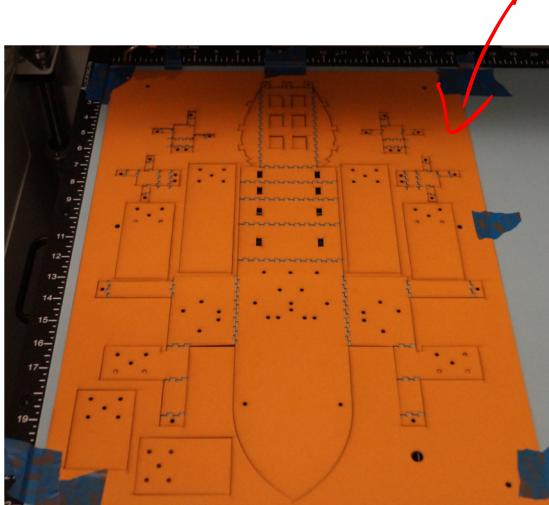
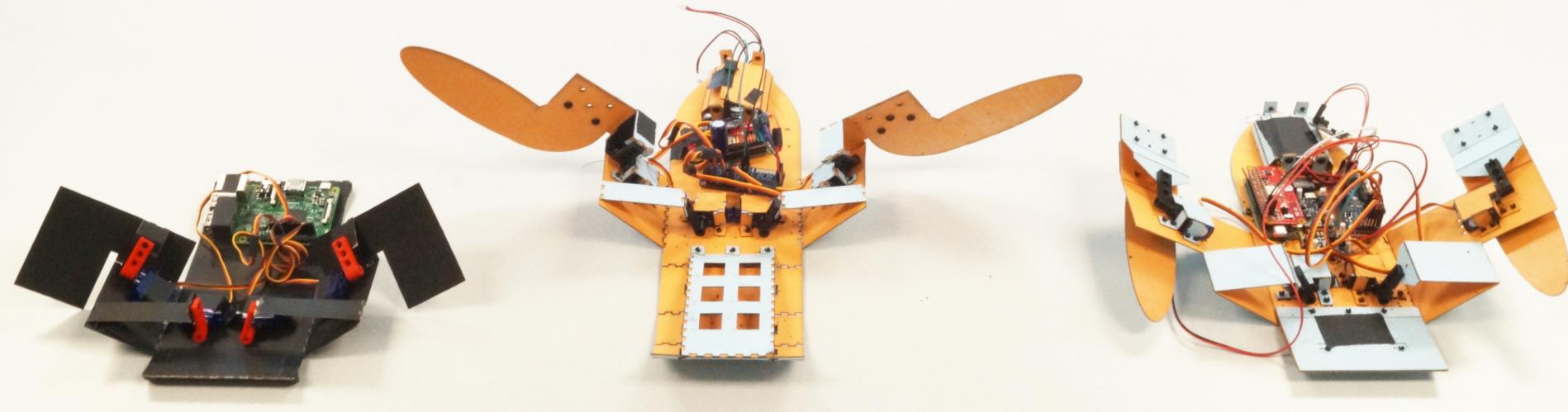
Memory

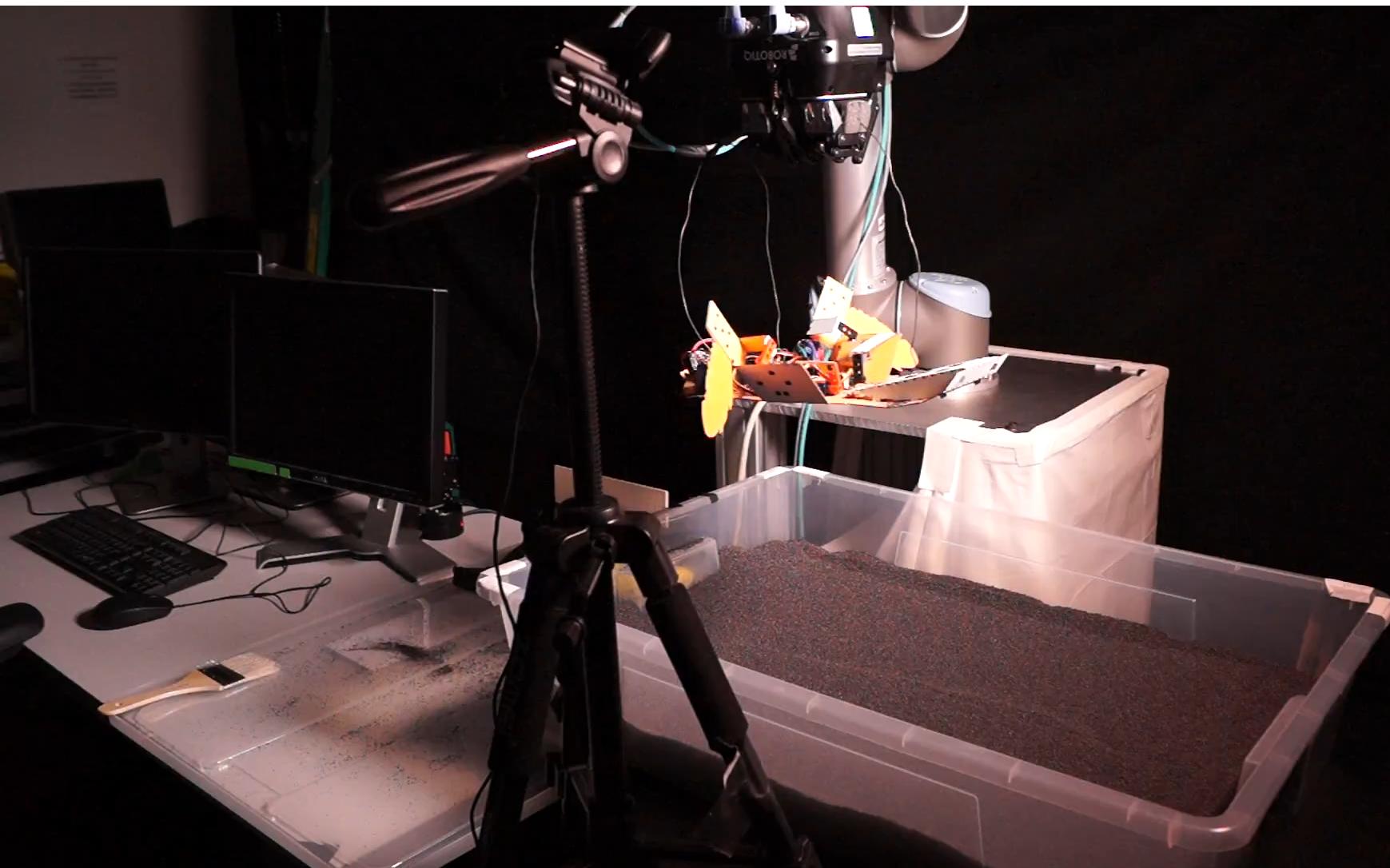


Machine Learning of Form and Function



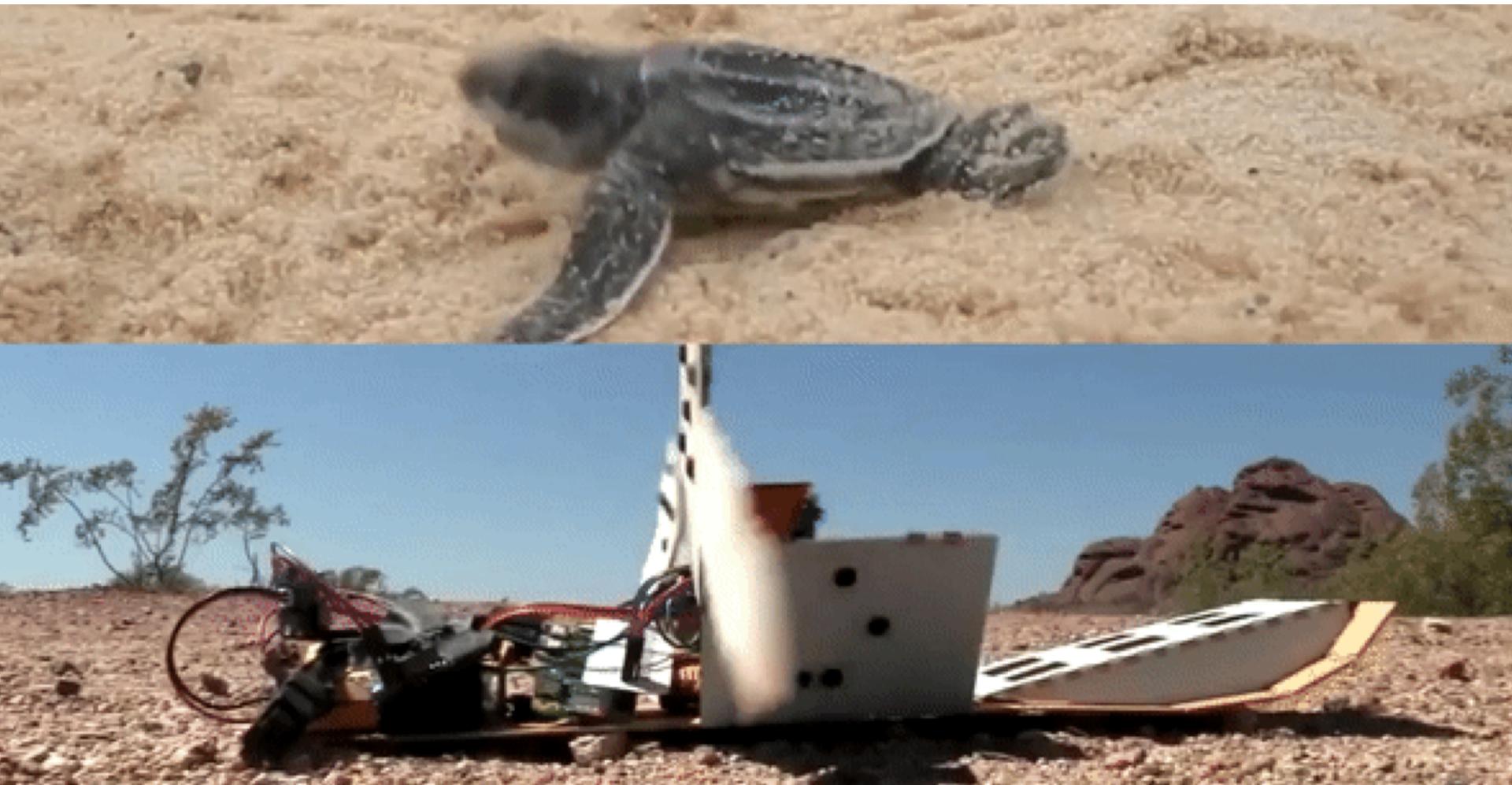
Machine Learning of Form and Function







Sea Turtle vs. C-Turtle



Summary



- | Machine learning is a very active field
- | Many new learning architectures proposed
- | Neural Turing Machines
- | Generative Adversarial Networks
- | New interaction models with human teacher
- | Enables systems with complex abilities