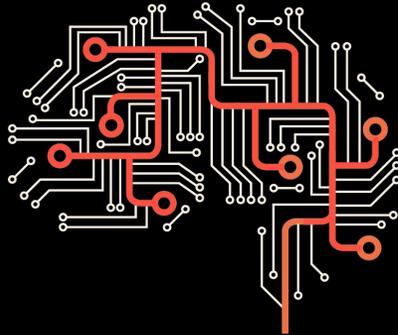
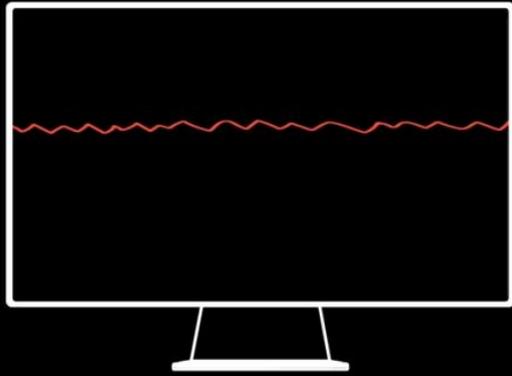


AI THAT LEARNS FROM THE HUMAN BRAIN



THE QUALIA PROBLEM



Passive brain-computer interfaces

Enables a machine to adapt to humans implicitly, potentially even without their awareness.

Mental workload
Emotions
Interpretations
Context-related responses
Intentions



Zander, T. O., & Kothe, C. (2011). Towards passive Brain–Computer Interfaces: Applying Brain–Computer Interface technology to Human–Machine Systems in general. *Journal of Neural Engineering*, 8(2), 025005.

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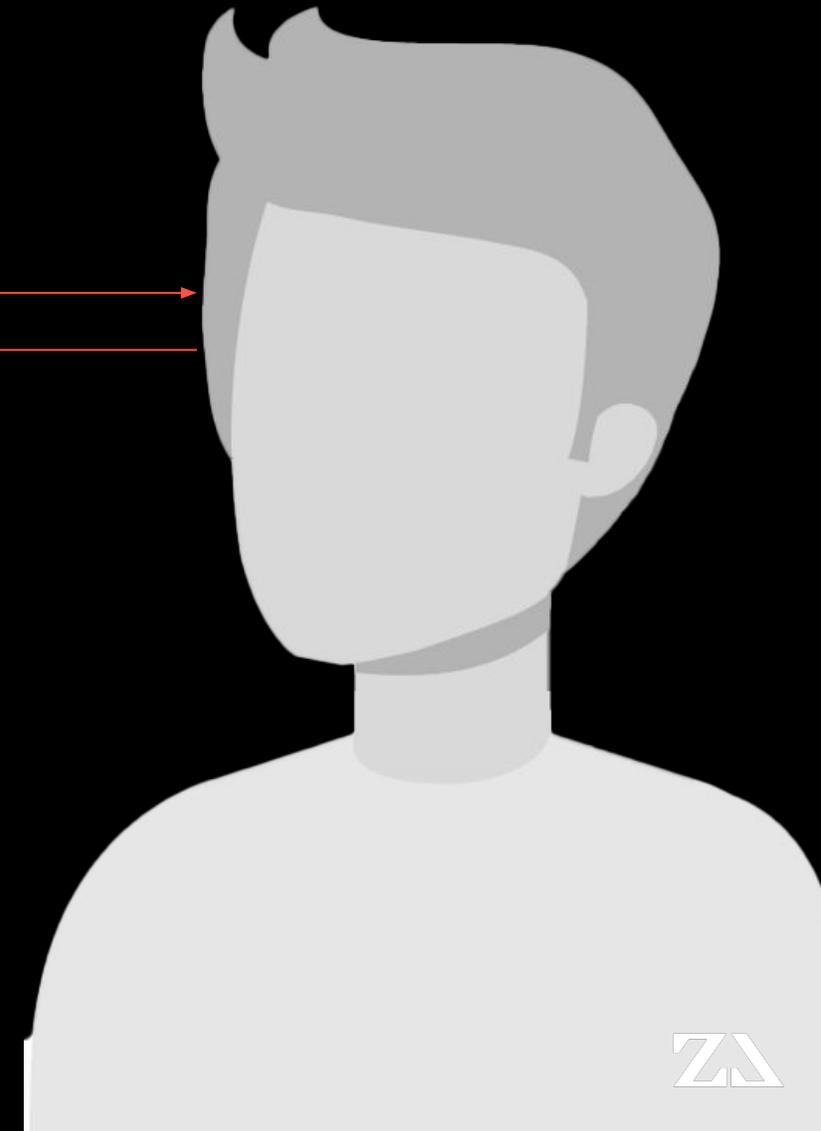
Neuroadaptive reinforcement learning

Multiple pBCI dimensions

- X_1 Level of surprise
- X_2 Degree of error
- X_3 Current workload
- \vdots
- \vdots



X_1
 X_2
 X_3
 \vdots
 X_N

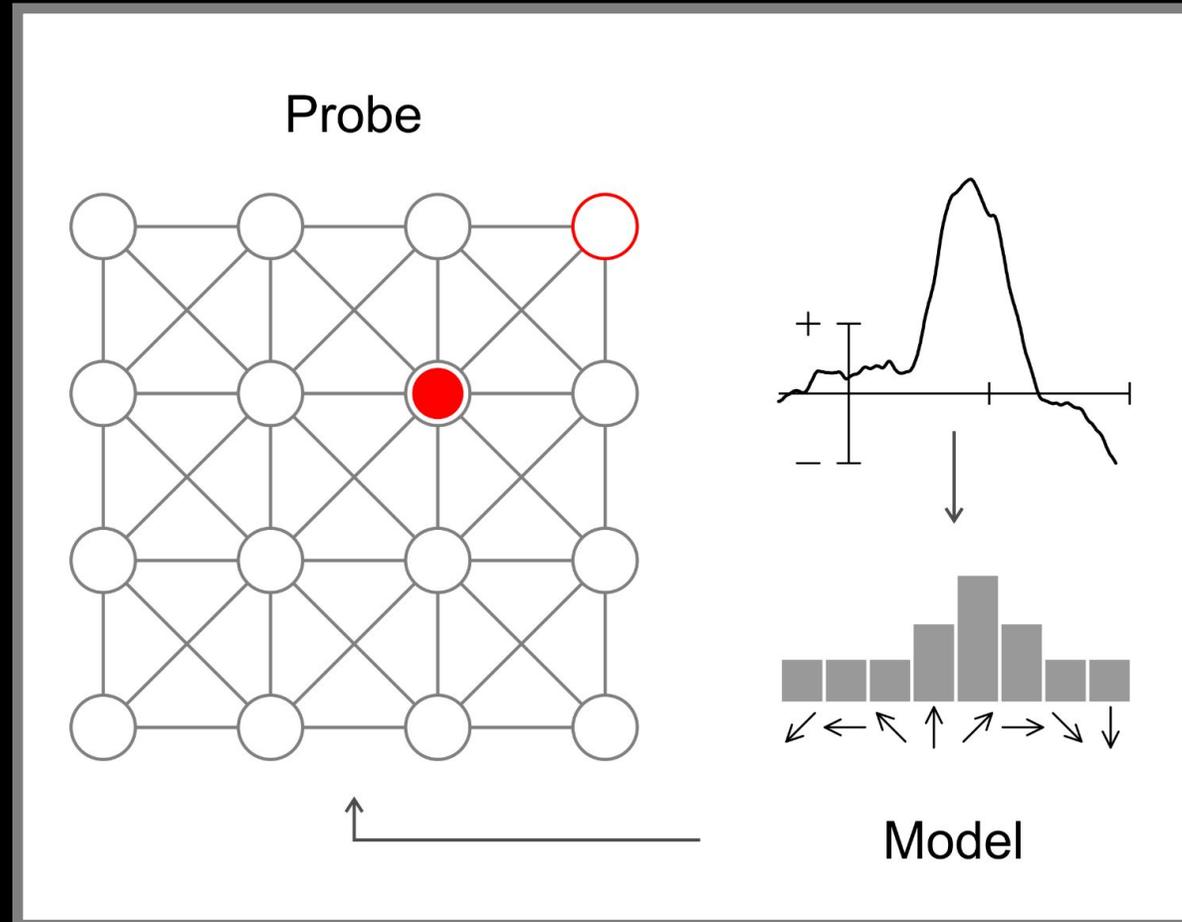


IMPLICIT CURSOR CONTROL



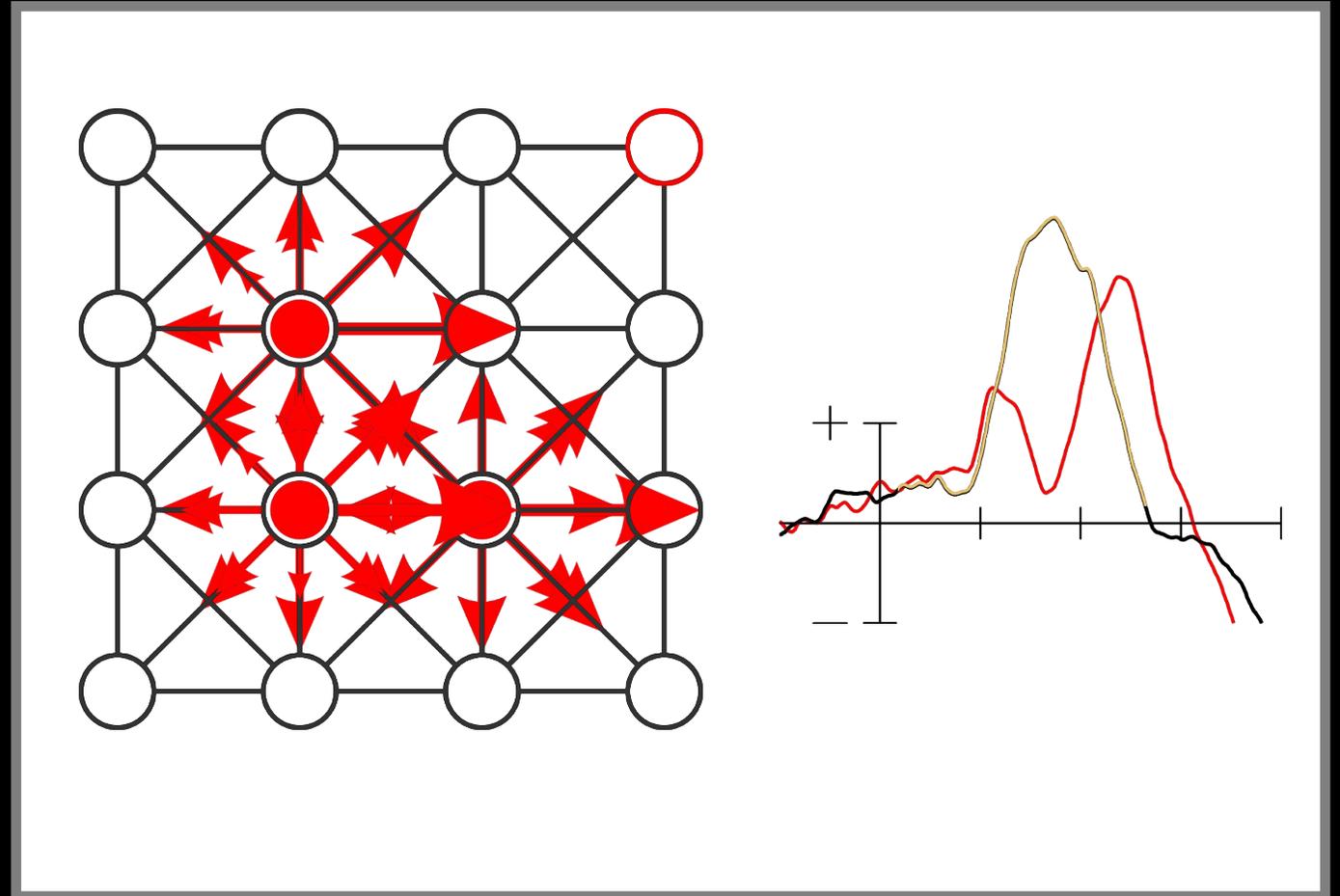
Generating a model of the human perspective

A model of directional preferences



Neuroadaptive reward function

Reinforcement learning
with a brain-based
reward function



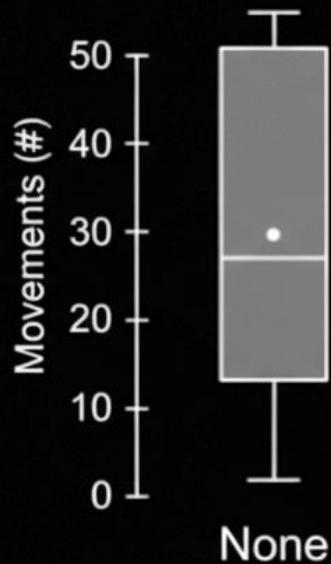
IMPLICIT CURSOR CONTROL

Replay:
11-6x6-4.csv

Results

Measure: Number of steps to reach a target

4 × 4 Grid



Median: 27

6 × 6 Grid



90

Real-world obstacles

0-15 min

User training

The user learns how to generate appropriate control signals

10-45 min

Machine training

The machine learns to detect these signals on labeled data

Long term

Application

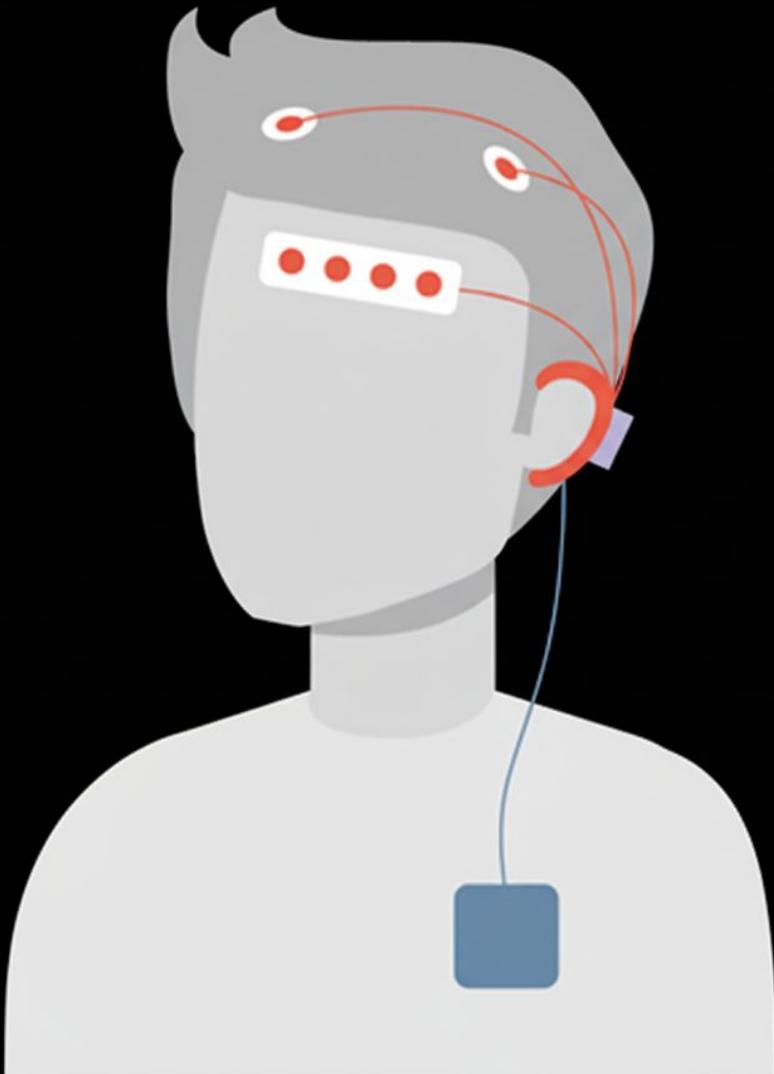
The machine interprets the EEG data online



(c) Brain Products GmbH

Mobile, wearable hardware

Zypher[©]



EEG

- Unobtrusive
- Modular
- Self-applicable

Amplifier

- Behind the ear
- Miniaturized

System-on-a-chip (SoC)

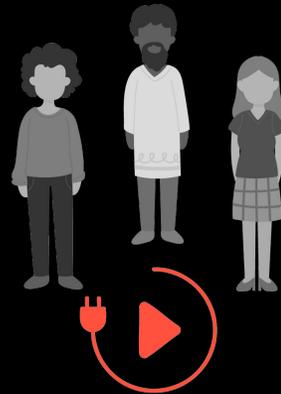
- Digital signal processor
- Artifact rejection
- pBCI classifiers



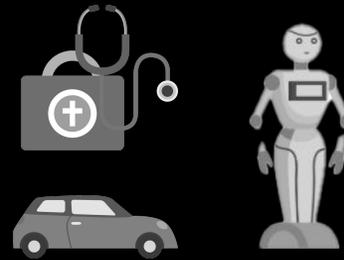
UNIVERSAL CLASSIFICATION



Generalize over large amounts of data



Plug & play application



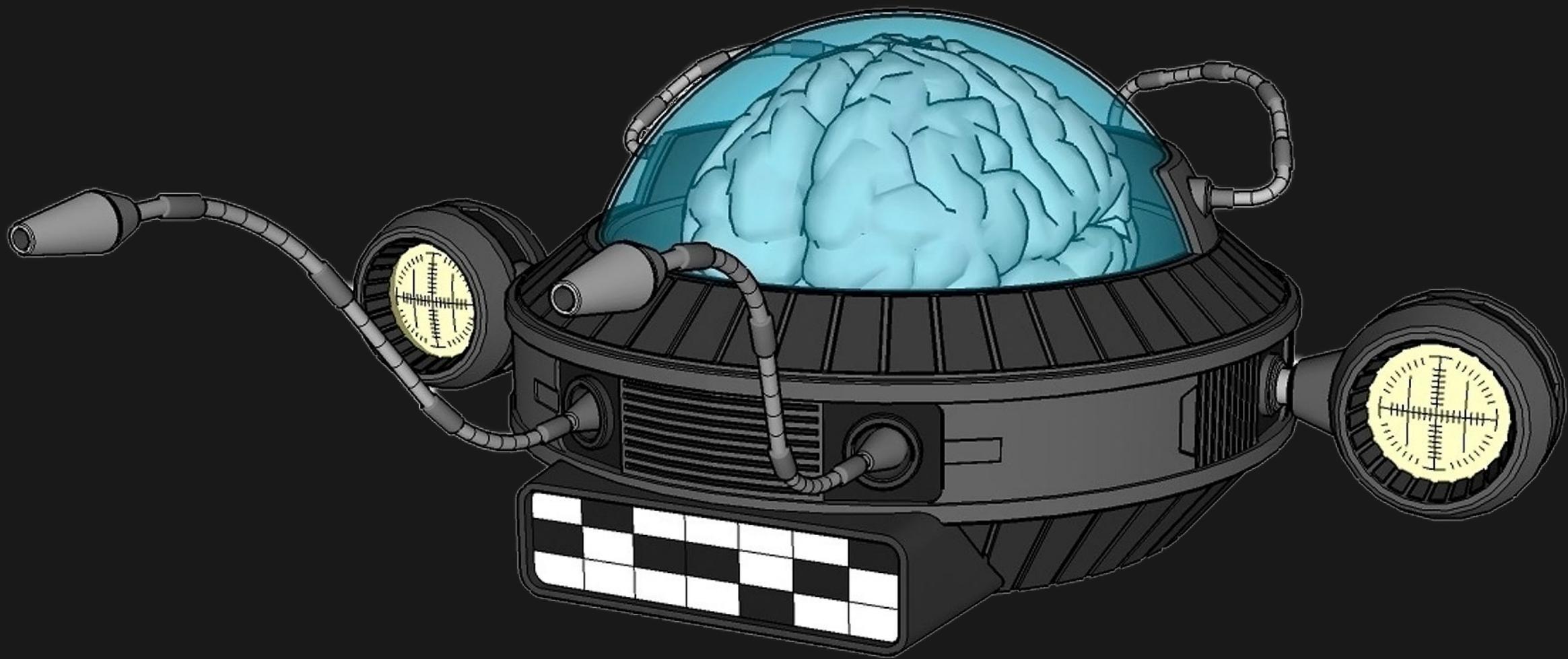
Applicable in all contexts



Agnostic of sensor systems



CHANGING THE WORLD





**THE
FUTURE IS
YOURS**