A Brief Introduction to Non-Invasive Brain-Computer Interfaces

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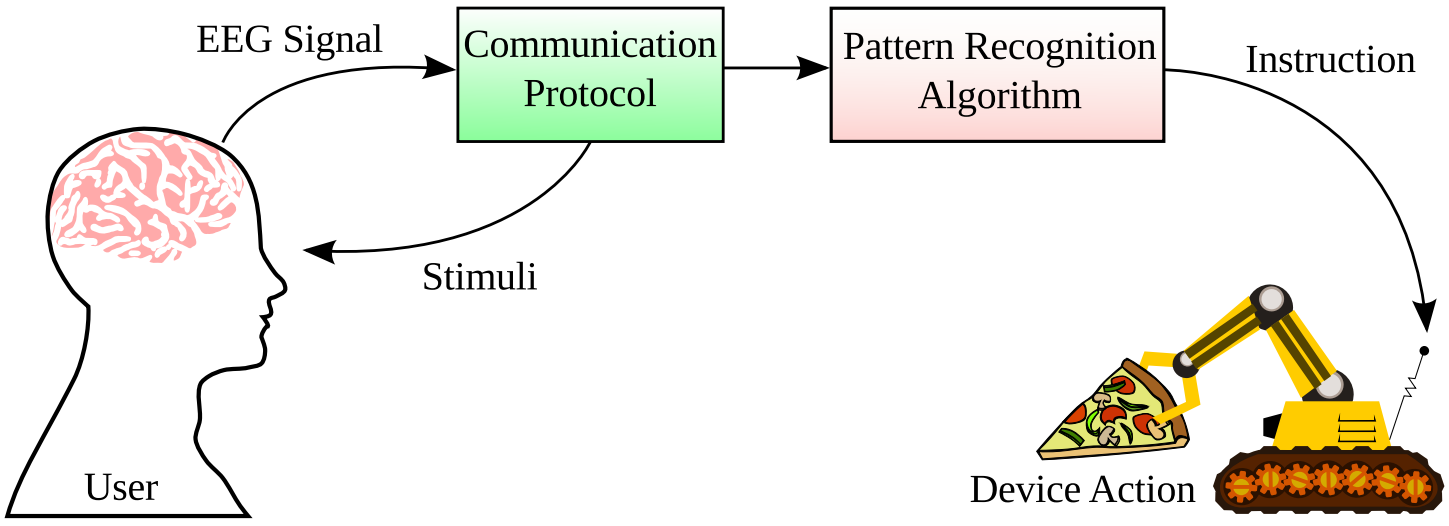
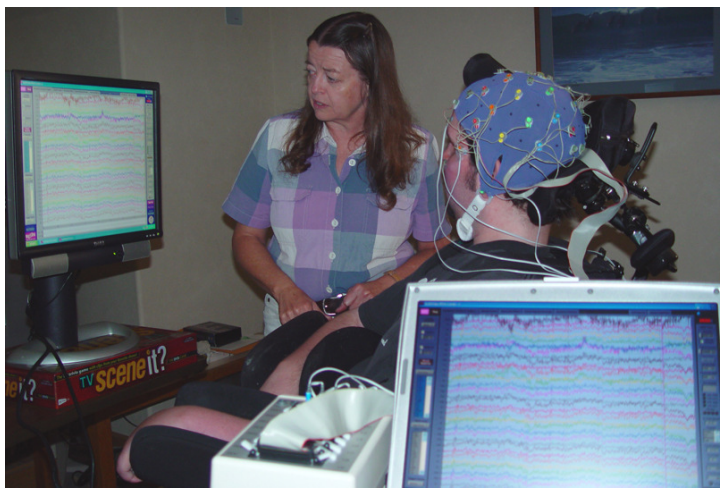
Brain-Computer Interfaces

- Brain-Computer Interface (BCI)
- Direct communication between brain and machine
- Bypasses innate motor-based means of communication
- Control a computerized device using only thoughts
- Voluntary changes in mental state, not mind reading!
- Uses patterns associated with mental cues



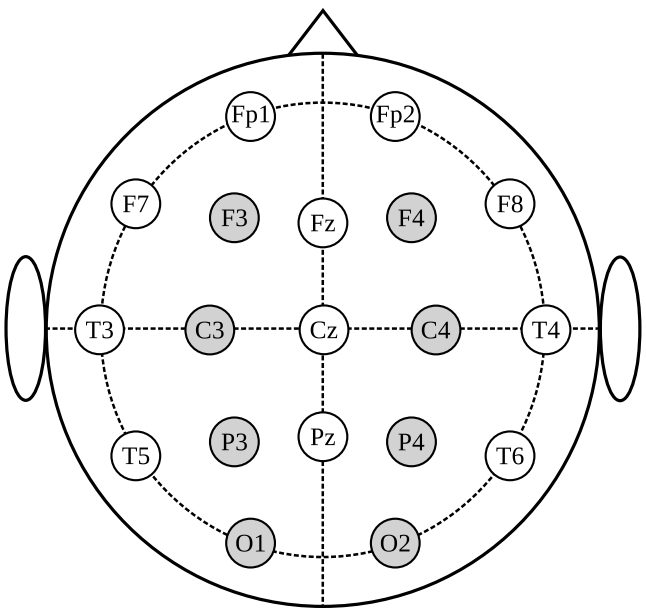
Uses for BCI

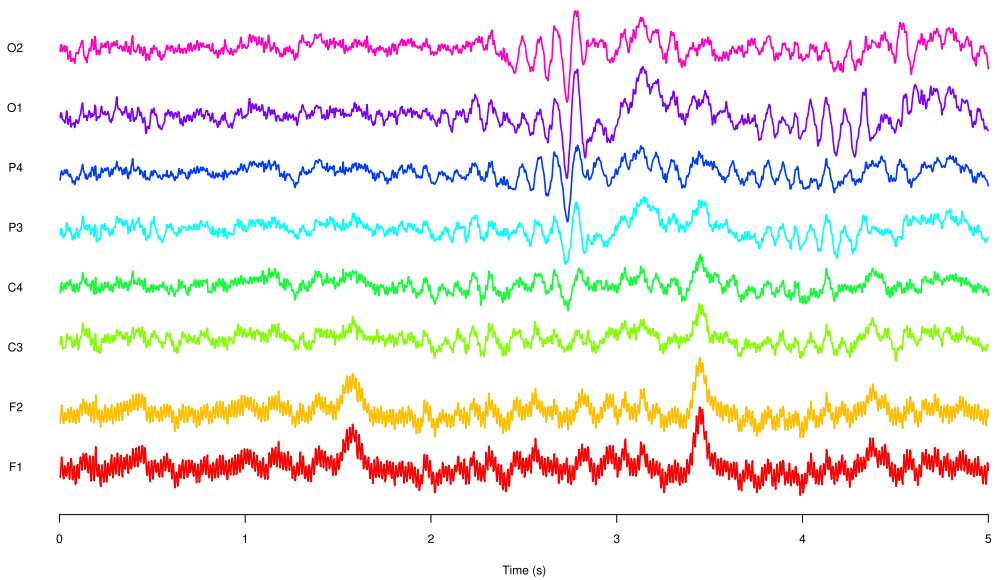
- BCI have many potential uses
- Reestablish communication with people who are Locked-in
  - Aware but unable to communicate, e.g., ALS
- Assistive technology
  - electric wheelchairs, computers, environmental controls
- Rehabilitation
  - learning to rewire parts of the brain
- input devices, video games, monitoring emotions



Electroencephalography

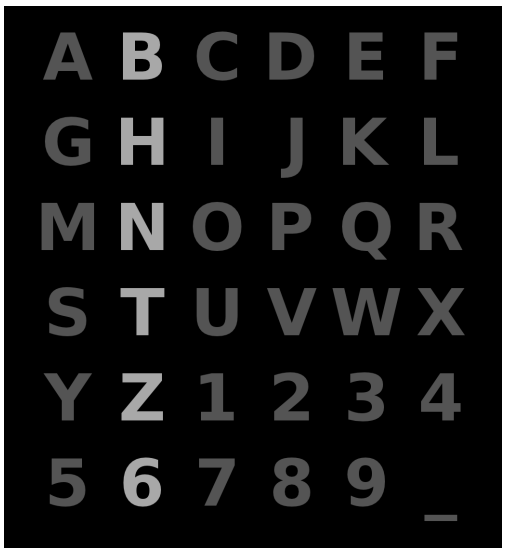
- Electroencephalography (EEG) to measure brain activity
- Non-invasive, portable, relatively inexpensive
- Superficial & noisy signals

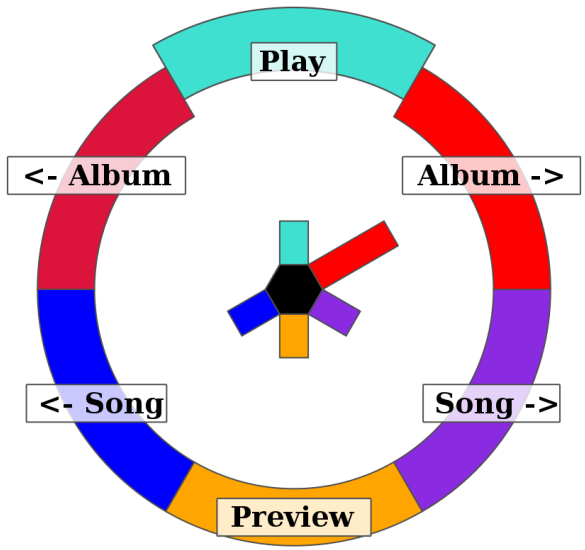




Synchronous BCI

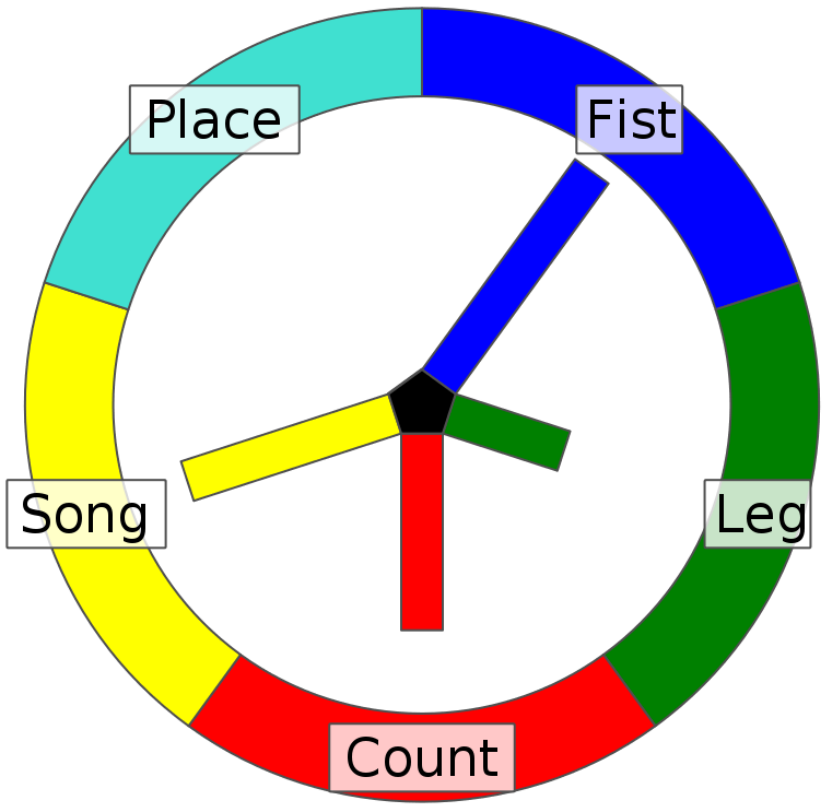
- Synchronous BCI use patterns associated with external stimuli
- P300 speller is an example
- User looks for a specific character in a series or grid of flashing characters





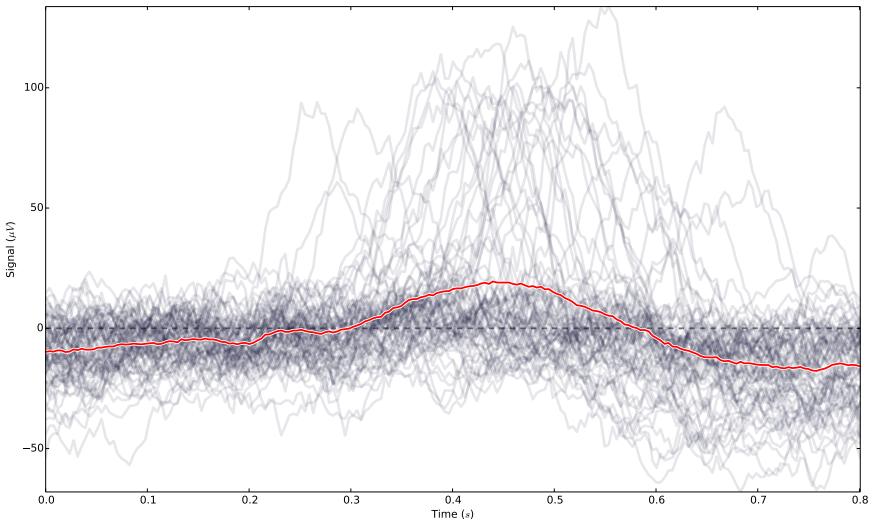
Asynchronous BCI

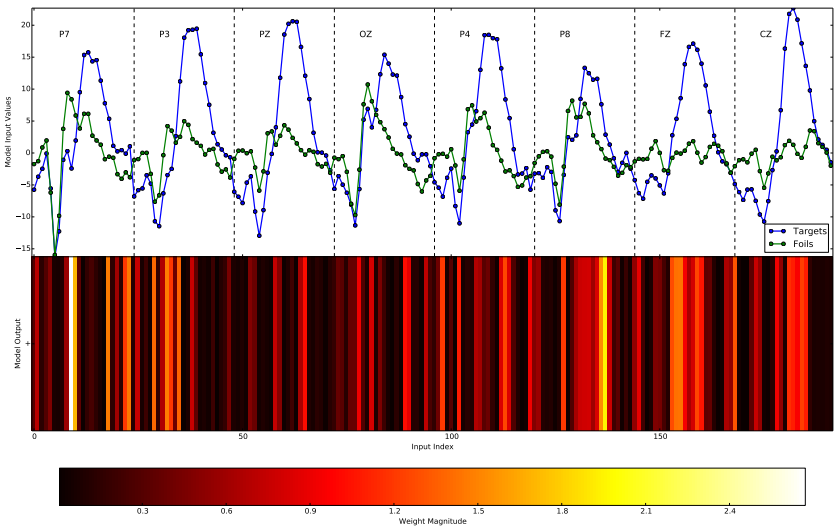
- Asynchronous BCI do not require external stimuli
- Mental Tasks is an example
- Imagine left arm moving moves to the left while silently singing a song moves to the right



Machine Learning & Pattern Analysis

- Machine Learning algorithms identify patterns in EEG
- This can be very difficult because
  - different for each person
  - change over time
  - noise & artifacts
  - the brain is complex!





Future of BCI

- The field of BCI is still in its infancy
- Explosion of BCI research in recent years
- Some people now rely on BCI
- Several companies are working on commercial products
- Personal predictions:
  - 3–5 years: commercial synchronous BCI available as assistive technology
  - 5–10 years: commercial asynchronous BCI available as assistive technology
  - in our lifetimes: BCI will be commonplace, e.g., assistive technology, games, google glass, sophisticated biofeedback

Thanks!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