Curiosity Cloning: Neural Analysis of the scientific interest

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• Autonomy in space exploration is necessary.

• The bandwidth of an exploration mission is very limited.

• Rover to select autonomously what is scientifically relevant.

• NASA MER rovers (Opportunity and Spirit) software upgrade was in this direction

  • dust-devil & cloud automated detection

  • Pattern matching
Pure pattern matching, Scientific Richness Index or other classifiers are programmed to find what we already know: **the expected**.

Q: Can we code the interest in the unexpected?

(Scientific) Curiosity?
Motivation

• An alternative to **explicit** and **specific** definition of what we are looking for...(e.g., dust-devils)

• Present experts (e.g., experts on mars geology) a lot of images
  
  • Rate

• Images/Rating pairs can form a **training** set for a **classifier**

• The classifier could be **downloaded** on a rover
  
  • Robot brain would be a “clone” of the scientist’s interest, curiosity, expertise
Motivations

• So how can we do it?

• Why not “push-the-button” technique?

• Why not “interrogation” technique?
Motivations

• So how can we do it?

• Why not “push-the-button” technique?
• Why not “interrogation” technique?

• Because:
  • we can go much faster
  • we can escape conscious filtering

→ Find a biometric signature of a subject’s curiosity and expertise, arguably embedded in the brain waves
ERPs and P300

ERP
Event-Related Potentials
*Electrical Potentials associated with specific sensory, perceptual, cognitive, or motor events*

P300 is a positive wave that occurs about 300 ms after the onset of the target/rare (oddball) stimulus among a sequence.

- *scalp distribution (Pz>Cz>Fz)*

Hard to detect:
differences of 1-2 microvolts/noise/artefacts

Solutions:
Signal averaging
Filtering
Pattern recognition techniques
• P300 related to the “oddball” paradigm
• We want to use ERPs to detect the scientifically interesting
• Allow a fast collection of data on the relation between environment stimuli and curiosity
• Train a machine to exhibit a similar response
• Download on the rovers software the curiosity and expertise of different scientists
• Bioengineering, Artificial Intelligence
• 2 parallel ARIADNA studies with:
  • Dublin City University (DCU)
    • “cheap” 4-node EEG device
  • École publique Ecole Polytechnique Fédérale de Lausanne (EPFL)
    • 32-nodes “complex” device
Tools

Curiosity Cloning Image Viewer
CCViewer On sourceforge

“Aquick application designed to display series of images with a special focus on display quality and extremely precise display timing. The project provides a tool for use in scientific experiments involving display of visual stimuli.”
The three image sets

Set #1: Reliability vs speed

Set #2: Detecting 3 classes

Set #3: Scientific Curiosity
Earth Observation
Envisat
Meris instrument
SESSION A:
Approx 7 min long
- Count the amount of hurricane images
- We postprocess/analyse

SESSION B:
Approx 3 min long
- Count the images you find “interesting”
- We provide a probabilistic ranking of what you find interesting

NEWTON 2