Final Report: Brain Dataset

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July 25, 2016

Overview

Dataset: WAY-EEG-GAL

Experiment recording human grasp and lift tasks[1]

- 12 participants, 9 series recorded each
- EEG: 32 brain electrodes recorded at 5kHz
- EMG: 5 muscle sensors at 4kHz
- kinetic: 36 position/force signals at 500Hz
- objects to grasp with different surface friction/weight (165-660g)
- preprocessing: trials provided in windowed format (event timing relative to window)

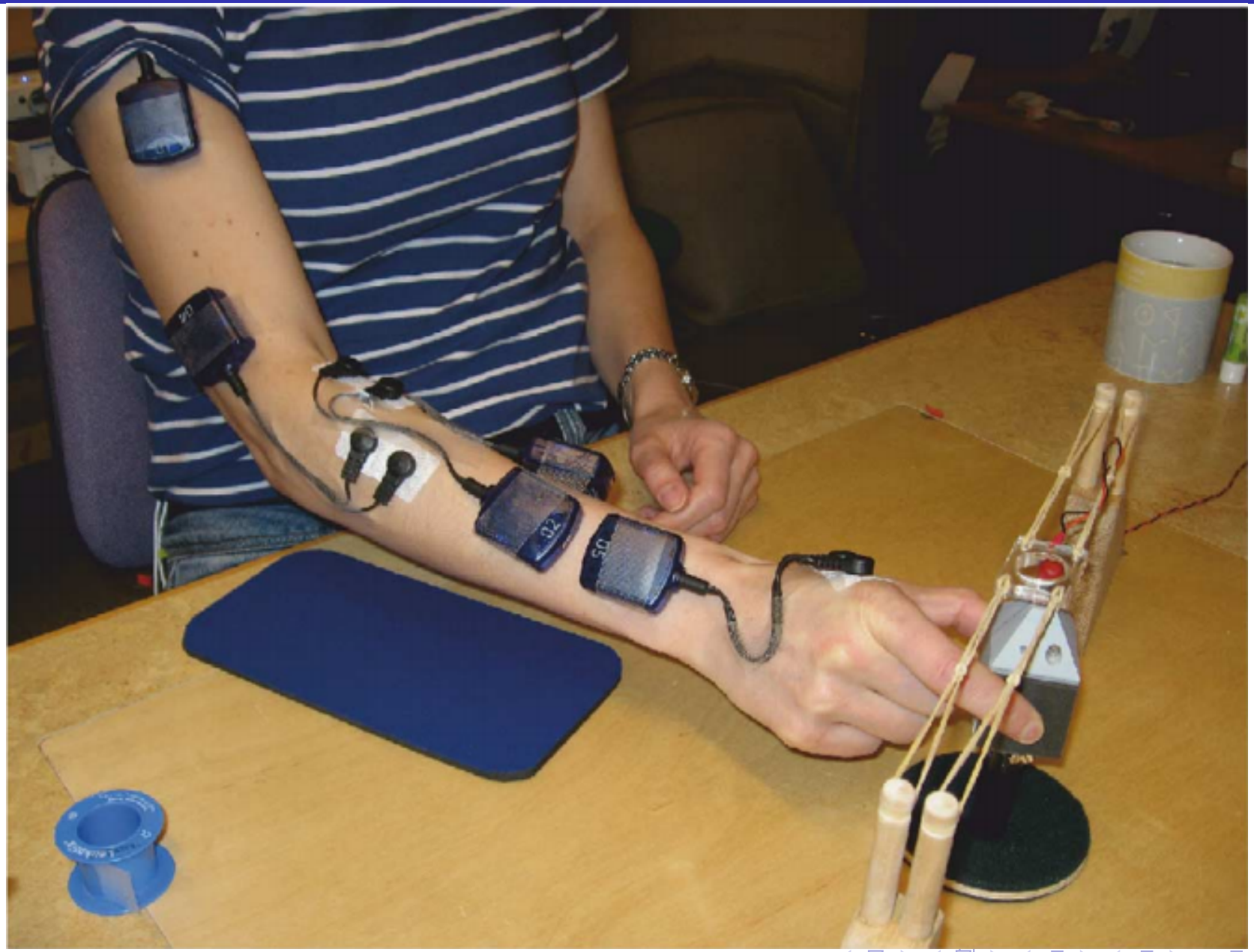
[1] Data source: Luciw, M. D., Jarocka, E. & Edin, B. B. FigShare http://dx.doi.org/10.6084/m9.figshare.988376 (2014).

Experiment

Single trial procedure

- start command signaled visually by LED
- participant moves hand to object
- grasp object
- move object to target position
- hold position
- LED signal, to move object back to initial position
- hand release object
- move hand back to resting position

Experiment



Methodology

t-SNE

- expectation
- result

Methodology

General developement

- Theano (Python)
- libraries: climin, breze

Data preparation

- Input normalization to -1/1 range (tanh activation optimization)
- imagine one lifting trial as a single learning sample
  - recordings have different length, therefore equalize it!
  - zero padding $\rightarrow$ learning in danger of being misguided
  - tail cut $\rightarrow$ targets fall of, fails to learn sometimes
- separation into sets of 300 data point records length **improves learning.... Why did Smagt tell us to do that??)**
- Subsampling (10Hz) of EMG data
- Data set split: train/valid/test $\rightarrow$ 0.8/0.1/0.1

Methodology

Recurrent Neural Network

- assuming predictability in human planning $\rightarrow$ history matters
- Network design:
  - 100 neurons
  - 1 hidden layer
  - tanh activation function
  - 50 samples per batch
  - optimizer: Adadelta
- parameter weight initialization by uniform normal distribution
- spectral radius
- Important weights: some samples are more important than others
- Bernoulli cross entropy loss

Methodology

Learning Targets

- one dim multi class vector vs. mult dim one-hot-encoding
- Selection of 16 predefined events
  1. LEDOn/LEDOff: study participant command
  2. tHandStart/tHandStop: hand moving
  3. trial_DurReach: time needed to move hand to object
  4. tLiftOff: start lift object
- Targets - defined over (multiple) intervals in between events
  1. move hand to target
  2. lift object
  3. hold object phase
  4. replace object
- Data shape
  - Input: [time slice, features, sensors] $\rightarrow$ [300 x 2428 x 5/32]
  - Target: [time slice, features, targets] $\rightarrow$ [300 x 1320 x 1]

Results (1): t-SNE

- Figure of t-SNE of EEG data $\rightarrow$ Seperability of trials
- Possible to separate with standard NN
- Figure of t-SNE of EMG data $\rightarrow$ As expected

Results (2): RNN

- Overview of the targets
- Hand move to target works good.
- Touch phase target also quite ok.
- hand move back target also (partially) sucessful
- Comparison: Training with data of one person vs. data of more participants
- etc.

Pitfalls

- Prediction do not fit to the target borders exactly
- No working early stopping criterion (so far)
- Targets within the lift phase cannot be predicted properly
- etc.

Blocks of Highlighted Text

Block 1

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Multiple Columns

Heading

1. Statement
2. Explanation
3. Example

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Table

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table : Table caption

Theorem

Theorem (Mass–energy equivalence)

$E = mc^2$

Verbatim

Example (Theorem Slide Code)

```
\begin{frame}
\frametitle{Theorem}
\begin{theorem}[Mass--energy equivalence]
$E = mc^2$
\end{theorem}
\end{frame}
```

Figure

Uncomment the code on this slide to include your own image from the same directory as the template .TeX file.

Citation

An example of the `\cite` command to cite within the presentation:

This statement requires citation [Smith, 2012].

References

John Smith (2012)

Title of the publication

Journal Name 12(3), 45 – 678.

The End