On data reduction in EEG monitoring

Comparison between ambulatory and non-ambulatory recordings

Alex Casson

Esther Rodriguez-Villegas

With thanks to the National Society for Epilepsy and
the University of Freiburg for the provision of EEG data

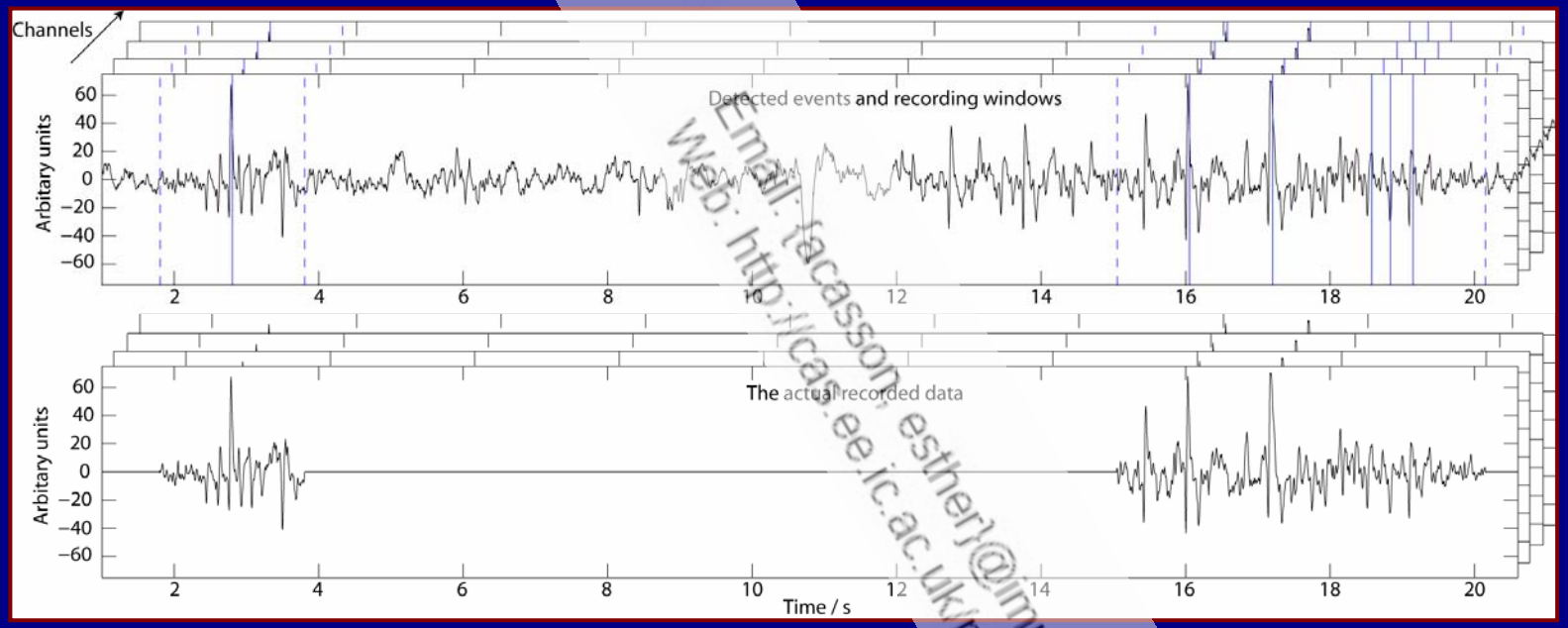
Objectives

- We aim to:
  - Demonstrate that signal processing on ambulatory EEG doesn't have worse performance than on inpatient EEG.
  - As result we can test our algorithm on either type.
  - In addition we find that our algorithm performance is maintained across testing sites.

- Our results are necessarily algorithm specific, but are a good indicator for other applications.
- The aim is only for the comparison, not a full evaluation of the algorithm.

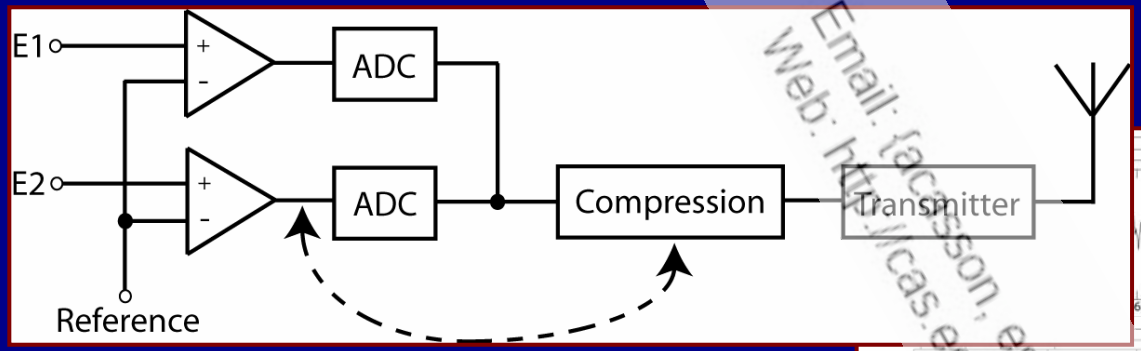
Algorithm aim

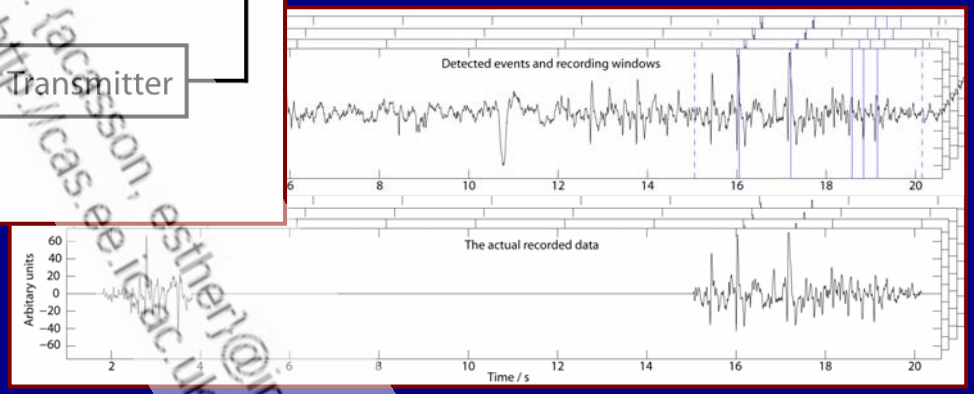
- Data reduction via discontinuous recording.
  - Simultaneously reduces data for transmission and analysis.
  - Only record interictal events at present.



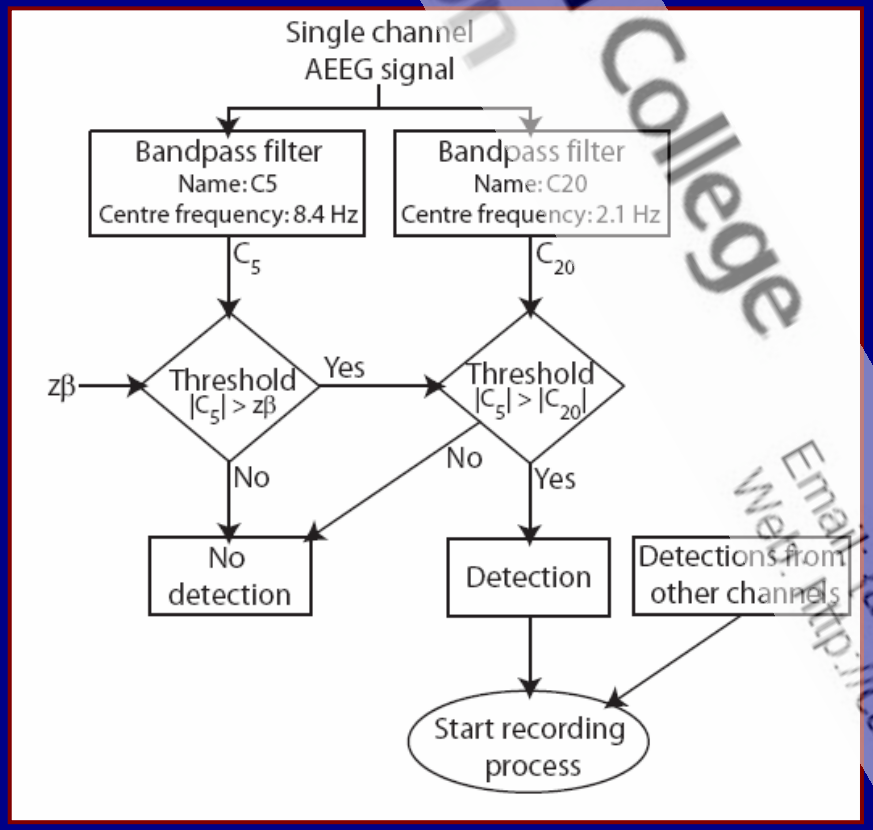
Analysis aim

- Aim is for use online in portable EEG so have to ensure performance is maintained compared to inpatient data.
- Number of studies looking at human interpretation of ambulatory vs inpatient recordings.
  - We now look at computer interpretation.





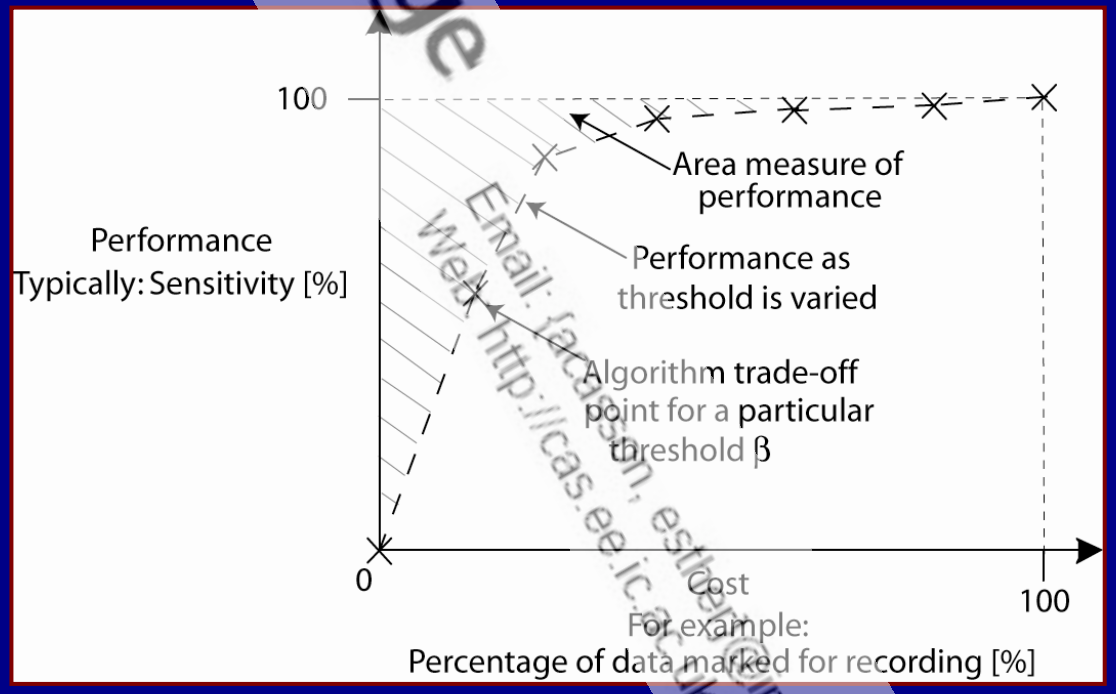
Algorithm variant



- Only 10 channels analysed.
  - Selected as subset common to all recordings.
- 19 thresholds between:
  - $\beta^2 = 0.1 – 1$ are used.
- Record 1.25 s of all channels EEG before and after each detection.

Methods

- Two separate analyses carried out:
  - One to investigate the sensitivity and one for the amount of data reduction.



Sensitivity analysis

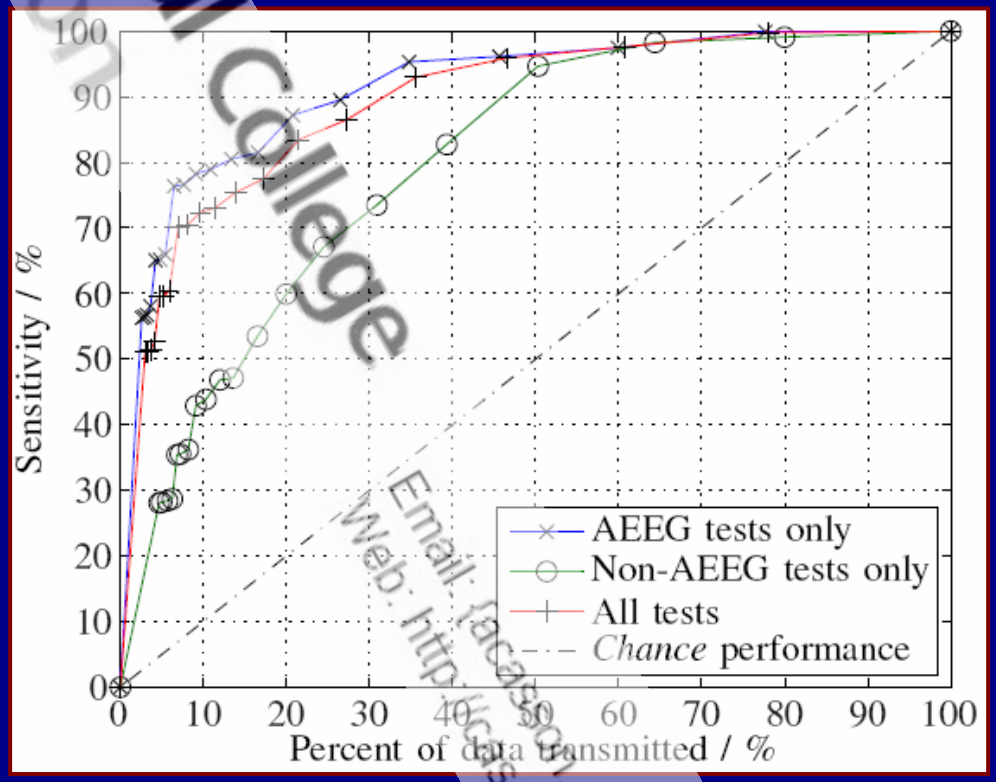
- Aim to show that expert marked events can be correctly detected in both ambulatory and non-ambulatory data.

- 13 patients analysed:
  - AEEG: 8 patients, 173 events in 26 hours of data.
  - Non-AEEG: 5 patients, 726 events in 9 hours of data.

- Normalise for amount of data tested: [Casson and Rodriguez-Villegas, 2008]
  - Apply to both axes.

$$\text{Sensitivity} = \frac{1}{\sum_{i=1}^{M} \frac{T_i}{N_i}} \sum_{i=1}^{M} \frac{D_i}{N_i} \cdot \frac{T_i}{N_i} \times 100\%$$

Results



- Performance is superior on ambulatory recordings.
  - Possibly an unexpected result so confirm with more data.

Data reduction analysis

- Analyse long term data and find data reduction figure.
  - Algorithm is intended for use on long term data.
  - Removed marking overheads.

- 6 patients analysed, 3 AEEG and 3 non-AEEG from two testing sites.
  - AEEG: 66 hours.
  - Non-AEEG: 68 hours.

- No weighting is applied to results.
- Records are analysed prospectively.

Results

- Ambulatory performance is still better.
  - Anticipate using a threshold in the 0.2 – 0.3 region.

Threshold (β^2)	Percentage of total data transmitted / %	
	AEEG data: Patients 19–21	Non-AEEG data: Patients 16–18
0.10	66.3	71.1
0.15	48.9	55.6
0.20	37.1	43.1
0.25	29.1	33.3
0.30	23.3	25.9
0.35	19.2	20.4
0.40	16.2	16.3
0.45	13.8	13.2
0.50	12.0	10.7

Checking

- Algorithm has been checked at multiple levels of abstraction.
- Amount of data tested has been normalised.
- Using two testing sites corrects for different recording processes.
- Data reduction analysis corrects for different marker interpretations.

Our explanation

- Ambulatory recordings have large numbers of artefacts.
  - Although interictal events are still identifiable, hence clinical utility.
- Overt artefacts are easily identified and not marked for recording.
  - Hence large data reduction.
- AEEG artefacts thus improve the algorithm performance, not decrease it as may be expected.

Conclusions

- Performance of our algorithm is maintained across testing sites.
- Is acceptable to test algorithm performance on both AEEG and non-AEEG data.
- No loss of performance is found on AEEG data.
  - Online signal processing of EEG in wearable EEG devices is feasible.

Summary

- ✓ Analysed the performance of a data reduction algorithm with both inpatient and AEEG data.
- ✓ Tested both the data reduction and the sensitivity trade-off in approximately 7 days of data.
- ✓ AEEG data gave superior performance in both cases.
- ✓ The online processing of EEG signals in wearable devices is feasible without any loss in performance.