Detecting Signatures of Cocaine Using On-Body Sensors

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Problem Description

Cocaine is a powerful, addictive stimulant drug made from coca plants native to South America.

The long term goal of this work is to improve our understanding of addiction, identify addiction triggers and design personalized interventions.

In this work, we study the problem of detecting cocaine use based on physiological data collected from wearable on-body sensors.

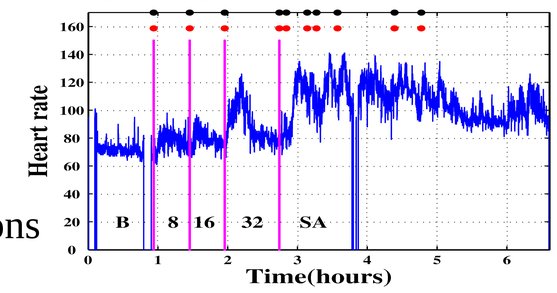
Can we reliably detect cocaine use with wearable on-body sensors and machine learning algorithms?

Experiment Design

Part of ongoing National Institute on Drug Abuse (NIDA) approved study we add physiological sensors to the following component,

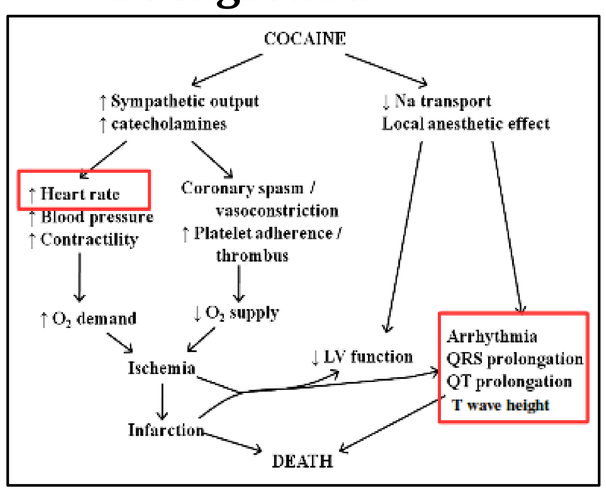
Cocaine day

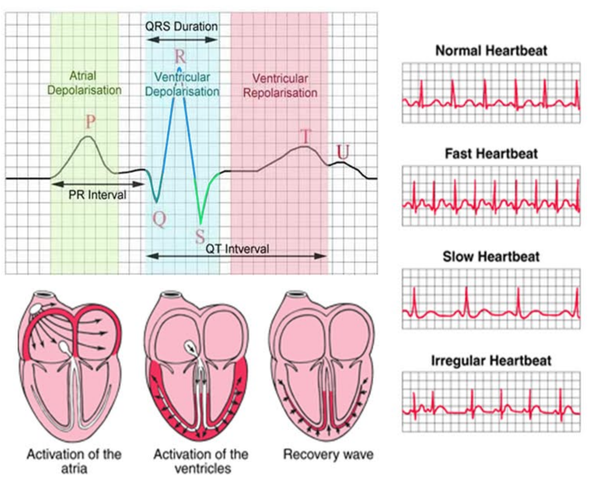
- 7 day dry-out period
- Session I: Baseline
- Session II: Fixed 8mg, 16 mg, 32 mg
- Session III: Self administration sessions



Subjects receive intravenous bolus of 8, 16, and 32 mg\70kg respectively with a 100kg cap. All cocaine self-administration sessions take place at the Yale Center for Clinical Investigations Hospital Research Unit.

Background



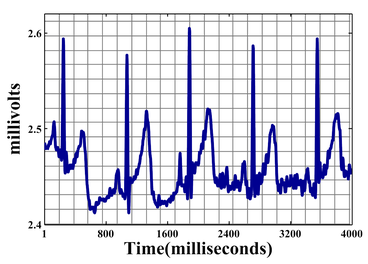


Schwartz et al., Tella et al., Foltin et al., Trippenbach et al., Regalado et al., Magnano et al., Levin et al., Hale et al.,

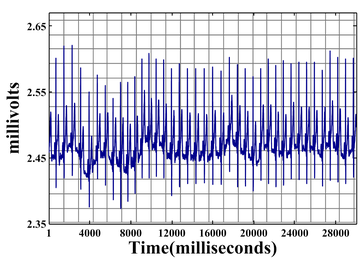
Data Collection

- Six subjects have completed the protocol
- Behavior data: Start and end times of sessions, dosage levels
- Raw ECG data
  - Zephyr BioHarness 3 chest band
  - Samsung Nexus phone
  - Communicates via bluetooth
  - Sampling frequency 250Hz

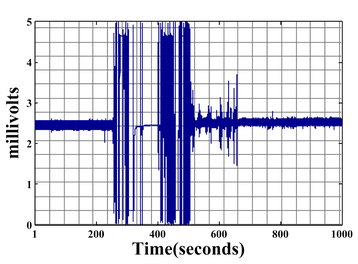
a) Noise



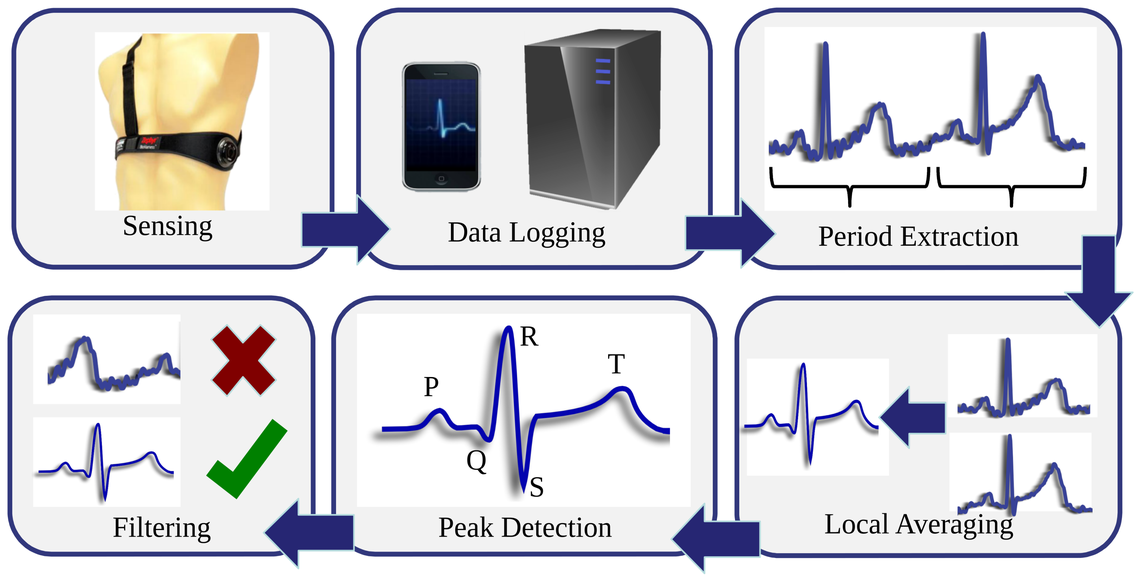
b) Baseline drift



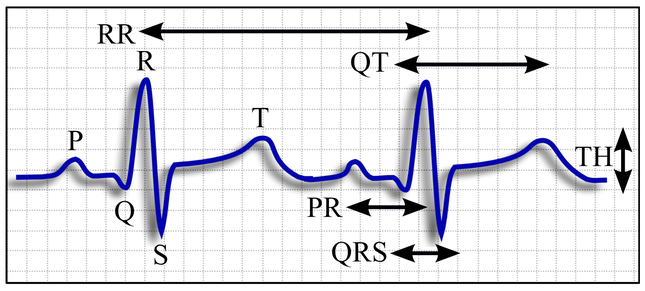
c) Sensor Dropout



Processing Pipeline



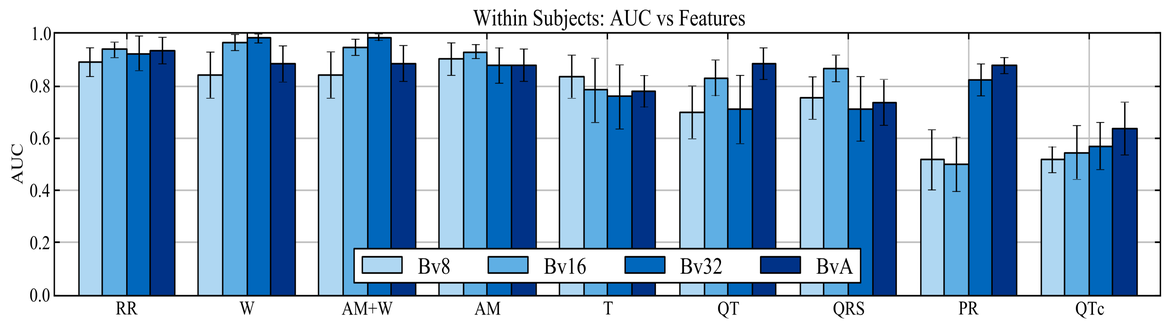
Feature Extraction



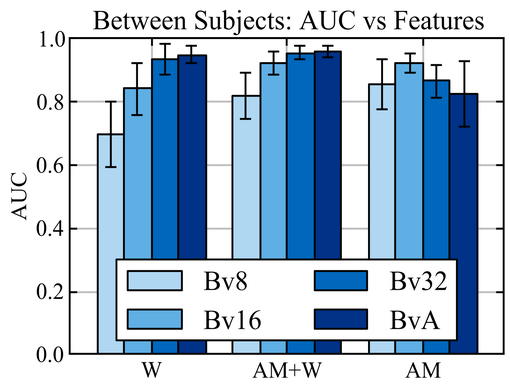
Id	Description
QTc	Corrected QT interval
AM	All morphological features
W	Waveform features
AM +W	All morphological features + Waveform features

Results

Within-Subject Classification



- Cocaine detection problem: baseline vs. 8mg, etc
- Train-test set partition time preserved
- Linear Logistic regression classifier
- Report the Area under Receiver Operating Characteristics curve (AUC) due to sample imbalances



Between-Subject Classification

- Six-fold cross validation
- Penalized logistic regression classifier

Conclusion

- Collected wireless ECG data from experienced cocaine users in clinical settings
- Developed a computational pipeline for inferring morphological features from noisy ECG waveforms
- **Reliably detect cocaine use based on data from wearable ECG sensors using appropriate feature sets**

Future Work

More Sensors: Additional sensors to deploy in these settings

Better Models: Probabilistic model to simultaneously label all peaks, non-linear classifiers

Data Analysis: Predict craving attacks using click and infusion data

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