Detecting Signatures of Cocaine Using On-Body Sensors
Annamalai Natarajan¹, Abhinav Parate¹, Edward Gaiser², Gustavo Angarita², Robert Malison², Benjamin Marlin¹, Deepak Ganesan¹
¹School of Computer Science, University of Massachusetts, Amherst
²Department of Psychiatry, Yale School of Medicine, New Haven

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/70 kg respectively with a 100 kg cap. All cocaine self-administration sessions take place at the Yale Center for Clinical Investigations Hospital Research Unit.

Background

Feature Extraction

### Within-Subject Classification

<table>
<thead>
<tr>
<th>Id</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>QTc</td>
<td>Corrected QT interval</td>
</tr>
<tr>
<td>AM</td>
<td>All morphological features</td>
</tr>
<tr>
<td>W</td>
<td>Waveform features</td>
</tr>
</tbody>
</table>

Results

- Cocaine detection problem: baseline vs. 8 mg, 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

<table>
<thead>
<tr>
<th></th>
<th>Bv8</th>
<th>Bv16</th>
<th>Bv32</th>
<th>BvA</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM+W</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM+W</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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