Machine Learning and Regression Modelling of Dynamic Urban Soundscapes: A multilevel approach

Thesis Outline – Andrew Mitchell

# Introduction

## Research Summary

## The SSID Project

### Project collaborators

### Motivation for the SSID Project

## Research Aims

## Soundscape Indices and Metrics

## Application of SSID

## Summary of Novel Research

## Chapter Summary and Thesis Overview

# Literature Review

## Impact of Urban Noise on Health and Well-being

## Current Methods of Assessing and Addressing Urban Noise

### Acoustical Parameters

### EU Noise Mapping

### Shortcomings

## Noise Complaints

## Soundscape Studies

### World Soundscape Project

### Swedish Soundscape Quality Protocol

### ISO Standards

## Existing Predictive Models

# Methods

## Data Collection (SSID Protocol)

### Spatial Recording

### Ambisonic Encoding

### Lab Design?

### VR Reproduction

## Questionnaire

## Psychoacoustics and Auditory Perception

### Psychoacoustic Parameters

### Feature Selection

## Machine Learning and Regression Techniques

### Clustering Analysis

### Modelling Likert-type Data

#### Multiple Linear Regression

#### Ordinal Logistic Regression

#### Multi-output Regression

### Multi-level Models

# ~~Key Chapter: Characterizing the Temporal Behaviour of Dynamic Urban Soundscapes~~

## Introduction

## Methods

## Results and Discussion

### Presence of 1/*f* in urban soundscapes

### Statistical relationship to pleasantness ratings

### Ordinal logistic models based on temporal and acoustic features

# Key Chapter: Personal Factors and Psychophysiological Impacts of Urban Soundscapes (Psycho Lit Review and WHO)

# Key Chapter: A Deep Learning Approach to Sound Source Recognition and Annoyance Detection (DeLTA)

## Introduction

## Methods

### Data collection

### Clustering analysis

## Results

### Sound Source Profiles

### Perceived Affective Quality ratings

### Psychological well-being mediates soundscape formation within different sound source profiles

### Regression models

## Discussion

# Key Chapter: Bayesian Multi-level regression model for predicting soundscape and large-scale feature selection (Feature Selection)

## Introduction

## Methods

### Multi-level regression modelling

## Results

### Multiple levels of soundscape formation

### Feature Selection

The first step of the feature selection is a filtering process. Given the exceptionally large number of features, many of which are colinear with each other, we need to begin through an exploration of the input features which are most highly correlated with the outputs, however there are two challenges for this approach. The first is that at this stage, we don’t want to be limited to only identifying the strength of linear relationships, so standard correlations (i.e. Pearson) are not an option. Likewise, since the model itself takes account of the multilevel structure of the location-based data, this correlation analysis should do so as well. To address both of these challenges, we calculate the multi-level mutual information between each of the input acoustic features and the output perceptual features.

#### Acoustic features

#### Non-acoustic features

### Model Design

## Discussion

### Interpretation

### Implementation and use cases

# Key Chapter: Soundscape Modelling Applications for Smart Cities: Early case studies (Lockdown and Milan papers) and Theory-based Practice Recommendations (Circumplex Critique)

## Introduction

## Methods

### SSID data collection

### Sensor network and IFSTTAR data collection

## Results

## Discussion

# Conclusion

## Summary

## Findings

## Limitations and Recommendations for Future Research

# Bibliography