jSymbolic2: Extracting Features from Symbolic Music Representations

SIMSSA: Single Interface for Music Score Searching and Analysis

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jMIR

Overview

A vast amount of research performed by music theorists, musicologists and other music researchers focuses on symbolic music representations. Unfortunately, relatively few MIR-oriented software tools are available to assist such research on very large collections of scores.

jSymbolic2, a significant expansion of the earlier jSymbolic1 software and part of the jMIR framework, is a free and fully open-source Java framework designed to at least partially address this shortcoming. Its primary function is to extract a large number (141) of statistical descriptors / features from digital symbolic scores. These can then be used to directly assist researchers in search and analysis-based tasks, as well as in sophisticated work incorporating machine learning.

SIMSSA Integration

- The SIMSSA project involves applying optical music recognition to the huge number of digitized scores held at libraries around the world, and storing the results in easily accessible and searchable databases
- All the scores in the SIMSSA Elvis and Musiclibs databases will ultimately be annotated with features extracted from them by jSymbolic2
- This will allow searches based on feature values
  - e.g., could filter results based on the amount of chromaticism in a piece, or the amount of parallel motion between voices
- Can learn multidimensional combinations of features that allow sophisticated searches
  - e.g., the level of tonality of a piece, where this is estimated based on the values of several existing features
- Can use features to train classification models for directly assisting research by music scholars
  - e.g., identifying composers of Renaissance pieces with unknown attribution

jMei2Midi

jSymbolic2 incorporates a new custom MEI parser and MEI-to-MIDI converter called jMei2Midi, which can also be used as standalone software. jMei2Midi performs a more extensive level of conversion of MEI than any other converter, and also maintains a channel for preserving and transmitting information that cannot be represented as MIDI.

Input Formats

- MIDI
- MEI
- MusicXML (using a Rodan conversion workflow)

Output Formats

- ACE XML
- Weka ARFF
- CSV

Designing New Features

- jSymbolic2 is also a highly flexible platform for developing and testing new features
- Modular and extensible feature implementations
- Easy to iteratively build new features of increasing sophistication by incorporating values of existing features in new features
- jSymbolic2 automatically handles all infrastructure relating to feature dependencies and scheduling
- Substantial unit testing infrastructure available

Usability and Interfaces

- Graphical user interface (see Figure 1)
- Command line interface
- Java API for programmatic use
- Rodan workflow for distributed processing
- Detailed on-line manual (see Figure 2)
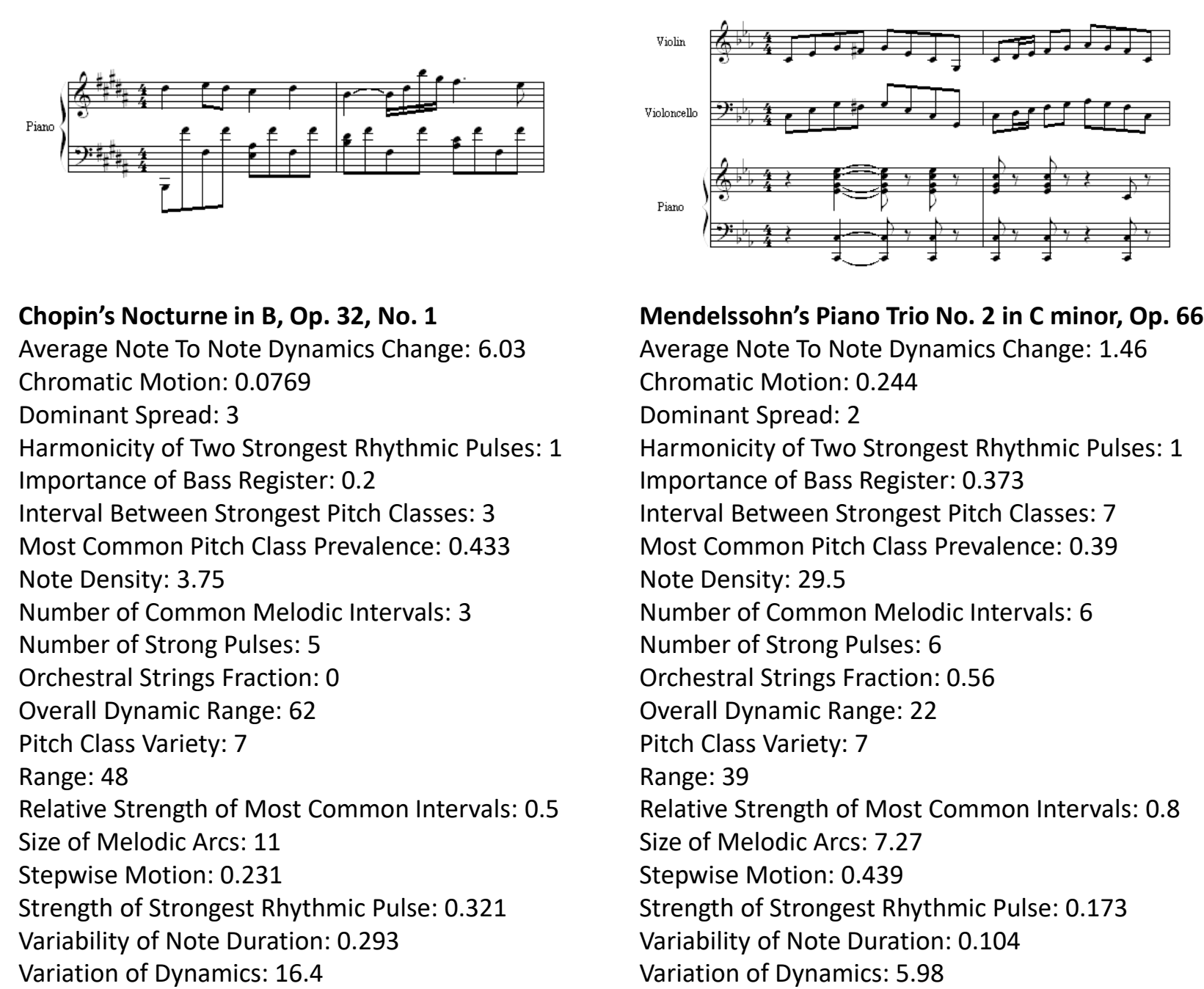
Miscellaneous Advantages

- Performs windowed feature extraction, as well as feature extraction over entire pieces
- Specialized configuration file can be used to apply consistent settings across sessions, as well as to keep a record of settings used in annotating individual musical datasets with extracted feature values

Features Extracted

141 features are currently extracted, with an additional 21 features under development. The features are divided amongst the following 7 types:

- **Instrumentation:** Which instruments are present, and which are emphasized relative to others? Both pitched and non-pitched instruments are considered.
- **Texture:** How many independent voices are there and how do they interact (e.g., polyphonic or homophonic)? What is the relative importance of different voices?
- **Rhythm:** Features are calculated based on the time intervals between note attacks and the durations of individual notes. What meter and what rhythmic patterns are present? Is rubato used? How does rhythm vary between voices?
- **Dynamics:** How loud are notes and what kinds of variations in dynamics occur?
- **Pitch Statistics:** How common are various pitches relative to one another, in terms of both absolute pitches and pitch classes? How tonal is the piece? What is its range? How much variety in pitch is there?
- **Melody:** What kinds of melodic intervals are present? How much melodic variation is there? What can be observed from melodic contour measurements? What types of phrases are used and how often are they repeated?
- **Chords:** What vertical intervals are present? What types of chords do they represent? How much harmonic movement is there, and how fast is it?
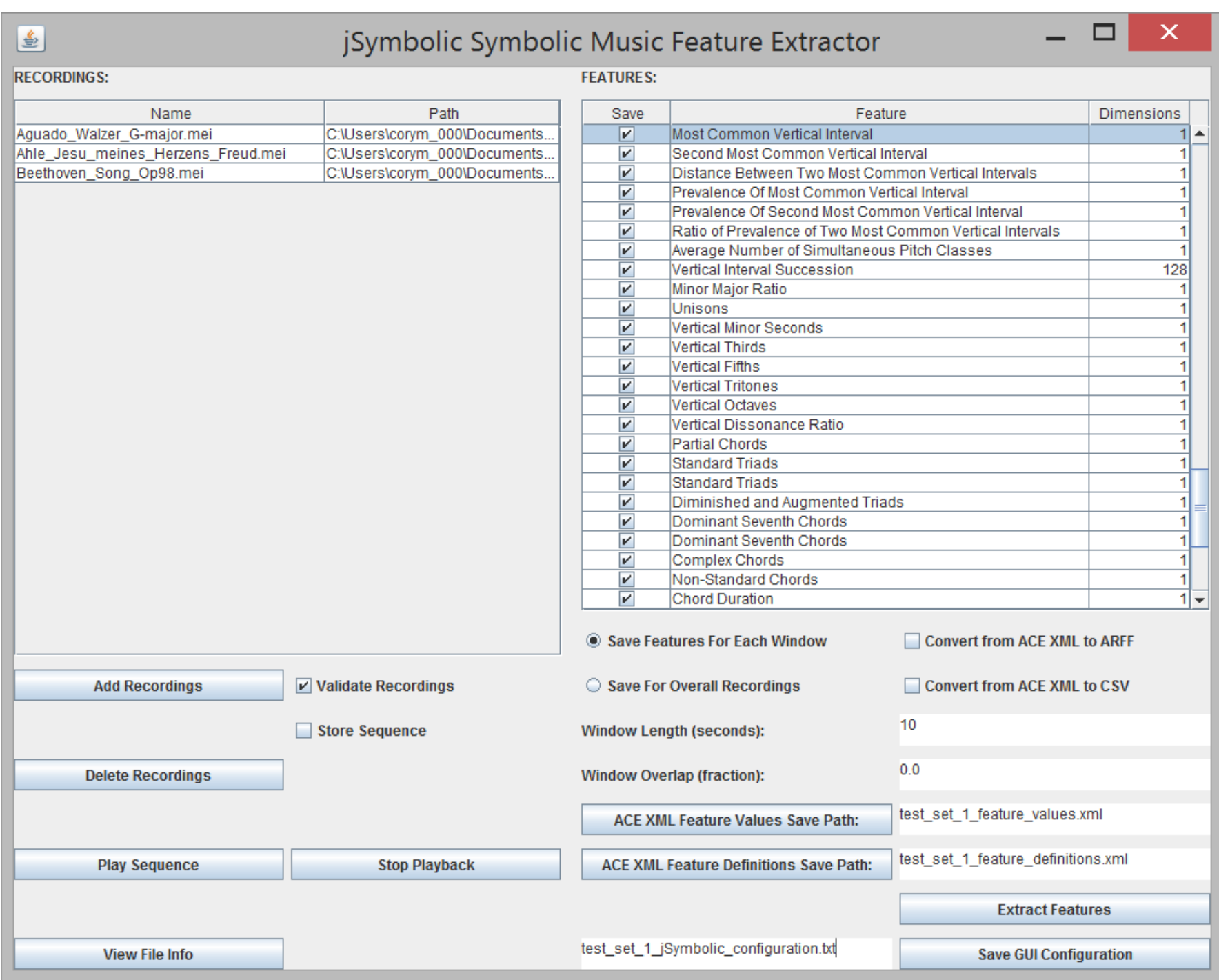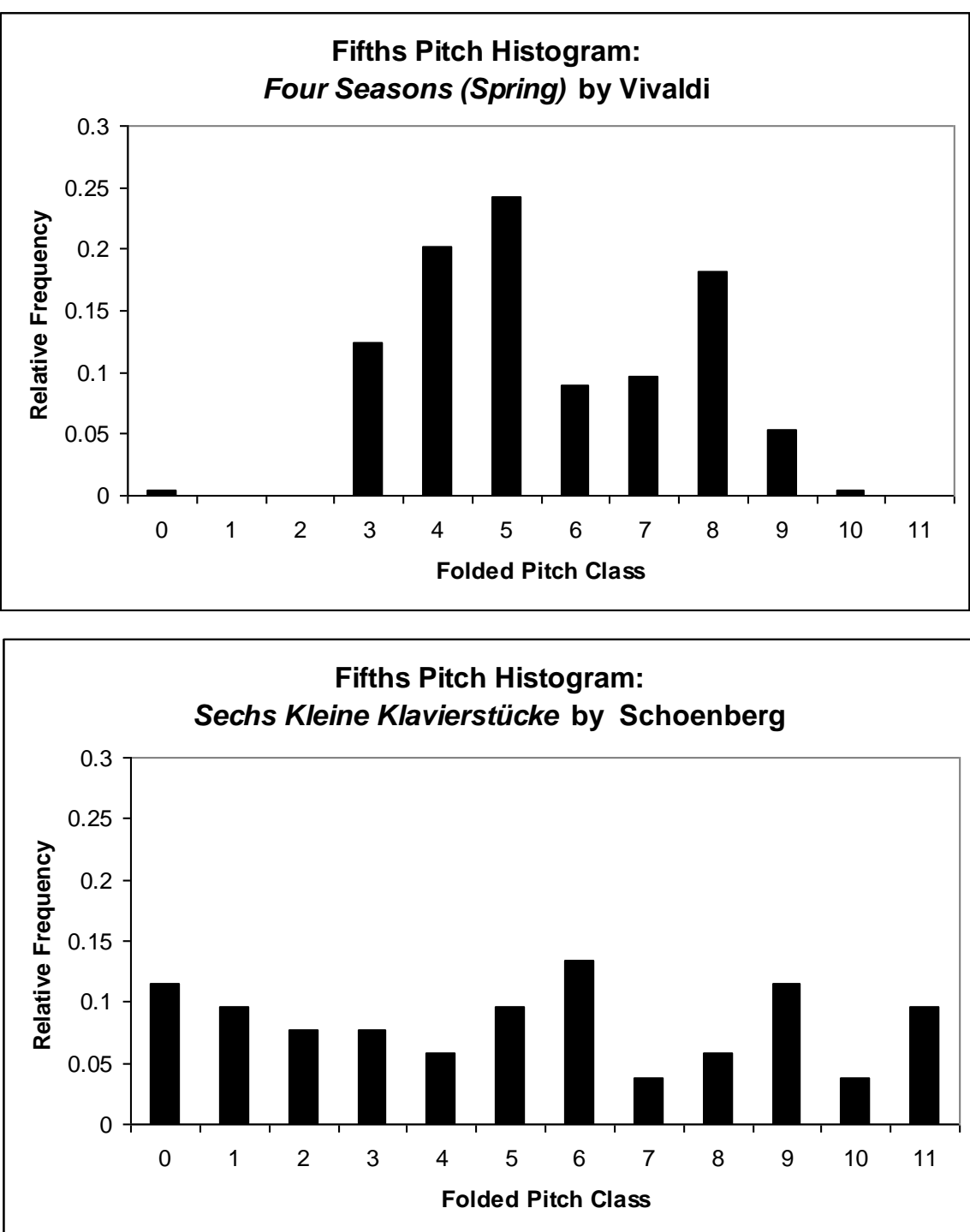
A Few Sample Features

Chopin's Nocturne in B, Op. 32, No. 1
Average Note To Note Dynamics Change: 6.03
Chromatic Motion: 0.0769
Dominant Spread: 3
Harmonicity of Two Strongest Rhythmic Pulses: 1
Importance of Bass Register: 0.2
Interval Between Strongest Pitch Classes: 3
Most Common Pitch Class Prevalence: 0.433
Note Density: 3.75
Number of Common Melodic Intervals: 3
Number of Strong Pulses: 5
Orchestral Strings Fraction: 0
Overall Dynamic Range: 62
Pitch Class Variety: 7
Range: 48
Relative Strength of Most Common Intervals: 0.5
Size of Melodic Arcs: 11
Stepwise Motion: 0.231
Strength of Strongest Rhythmic Pulse: 0.321
Variability of Note Duration: 0.293
Variation of Dynamics: 16.4

Mendelssohn's Piano Trio No. 2 in C minor, Op. 66
Average Note To Note Dynamics Change: 1.46
Chromatic Motion: 0.244
Dominant Spread: 2
Harmonicity of Two Strongest Rhythmic Pulses: 1
Importance of Bass Register: 0.373
Interval Between Strongest Pitch Classes: 7
Most Common Pitch Class Prevalence: 0.39
Note Density: 29.5
Number of Common Melodic Intervals: 6
Number of Strong Pulses: 6
Orchestral Strings Fraction: 0.56
Overall Dynamic Range: 22
Pitch Class Variety: 7
Range: 39
Relative Strength of Most Common Intervals: 0.8
Size of Melodic Arcs: 7.27
Stepwise Motion: 0.439
Strength of Strongest Rhythmic Pulse: 0.173
Variability of Note Duration: 0.104
Variation of Dynamics: 5.98

Sample Feature Histograms

Fifths Pitch Histogram: *Four Seasons (Spring)* by Vivaldi

Fifths Pitch Histogram: *Sechs Kleine Klavierstücke* by Schoenberg

Figure 1: jSymbolic2 GUI.
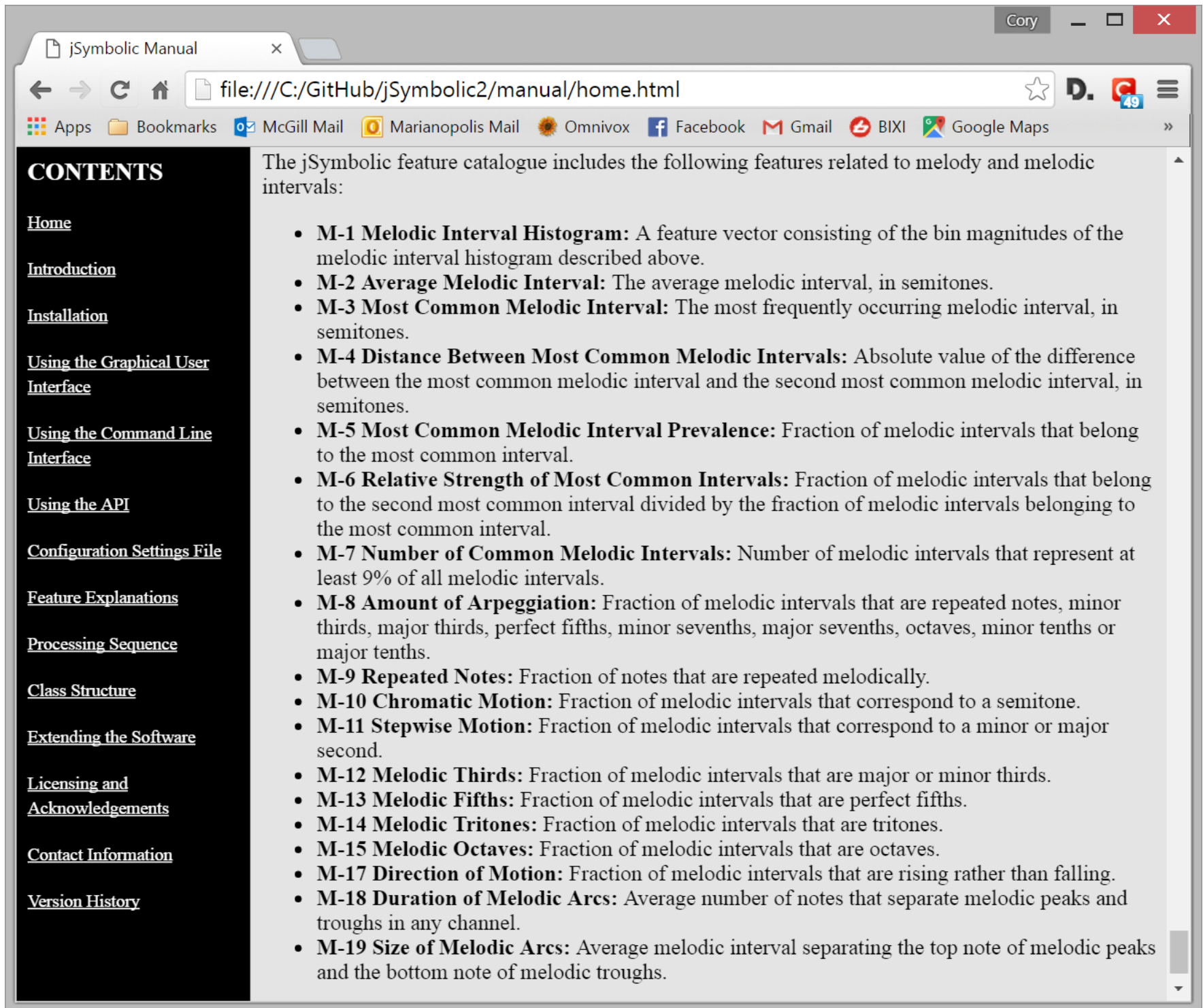
Figure 2: jSymbolic2 manual.

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