

# THOUGHTS ON SUSTAINABILITY

## 8 years later

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Social Sciences and Humanities  
Research Council of Canada

Conseil de recherches en  
sciences humaines du Canada

Canada

# Digging into Data round 2

**ELVIS:** Electronic Locator of Vertical Interval Successions: The First Large Data-Driven Research Project on Musical Style

- **The ELVIS Database:** an online database of c. 6000 searchable symbolic scores of polyphonic music 1300-1900
- **VIS:** a software tool that can search for repeated musical patterns – *not just melodies*, but counterpoint and harmony
- **Research on changes in musical style** over time using the ELVIS Data and tools

Started us off in new research directions; profound impact

# ELVIS

## Music Research with Computers

The image is a collage of four panels representing the ELVIS system components:

- MUSIC ANALYSIS FRAMEWORK »**: A dark grey panel showing Python code for a music analysis framework. The code includes comments and function definitions for handling musical events and formatting.
- COUNTERPOINT WEB APP »**: A teal panel showing a web interface for choosing settings for an experiment to run. It includes options for Intervals and Interval n-grams.
- DATABASE OF SYMBOLIC MUSIC »**: A dark grey panel showing a database entry for "Symphony No. 7" by Sibelius. It includes fields for Piece, Comments, Composer, Dates of Composition, Collections, Number of voices, and Tags (secular).
- RESEARCH ACTIVITIES »**: A red panel showing musical notation on a staff.

# Digging into Data round 2: 3 Teams

**Canada, McGill:** Julie Cumming, PI (+ 17 students)

- Peter Schubert, Music Theory
- Ichiro Fujinaga, Music Technology
- René Rusch, Music Theory
- Jonathan Wild, Music Theory
- Cynthia Leive, Head Librarian, Marvin Duchow Music Library

**US:** Michael Scott Cuthbert, MIT, PI

- Ian Quinn, Yale (+ 2 students)

**UK: University of Aberdeen:** Frauke Jürgensen, UK PI (+ 1 student)

- George Coghill, Computing Science, University of Aberdeen
- Ian Knopke, Research Fellow and Data Scientist at the BBC
- Stephanie Colley, Student Research Assistant, University of Aberdeen

# ELVIS database -- Challenges

- How much data?
  - Initial attempt in ELVIS was to get as much data as possible, regardless of quality, from anywhere we could find it: **Aggregation**
  - As we did more research using datasets and machine learning, we realized that our results could be seriously compromised by inconsistent data, and that quality is important
- How good? is the
  - Metadata
  - Provenance (digital and physical)
  - Encoding quality and format (Nápoles et al., “Encoding Matters,” 2018)
  - Accuracy and consistency of the musical scores requires a well-defined workflow (Cumming et al., “Methodologies for Creating Symbolic Corpora of Western Music before 1600” 2018)

# ELVIS database -- Challenges

- Intellectual property issues
  - Many symbolic files have been made available for free online
  - This does not mean that we had permission to redistribute them on our own database
  - Distributing files require an explicit licence
  - Creative Commons licences can clarify what is required for re-use or distribution of materials
- We did not do this in the original ELVIS database, and were asked to take down (or hide) files, and to add a statement and agreement in the first login for the database
- We agreed

# ELVIS database -- Challenges

ELVIS Database

About

Search

Browse ▾

Create ▾

(0) 

Account ▾

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# After Digging into Data

SIMSSA: “Single Interface for Music Score Search and Analysis.”

**Ichiro Fujinaga**, PI (Cumming, co-leader)

- \$2.5 million dollar Partnership grant over 7 years
- Social Sciences and Humanities Research Council of Canada (SSHRC)
  - Optical Music Recognition (Fujinaga)
  - Search and Analysis (Cumming)
- Allowed us to continue work begun in ELVIS



# simssa.ca



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**SIMSSA**

ABOUT

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ACTIVITIES ▾

PROJECTS AND LINKS ▾

BLOG

OPPORTUNITIES

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**SIMSSA** | Single Interface for Music  
| Score Searching and Analysis

# New Database: SIMSSA DB

- New data model, inspired by
  - DIAMM, an online Medieval music manuscript database with inventories and links to images
  - RISM, an international catalogue of musical sources (print and online)
  - IFLA-LRM (Library Reference Model), a conceptual model for bibliographic information
- Describes
  - Provenance: users can enter a source (e.g., IMSLP, a crowd-sourced database of public-domain music scores) or a chain of “parent” sources
  - Information about software and digitization workflows
  - Relationships: arrangements, parts, prints, subsections
- Currently hosts symbolic files (MIDI, Music XML, MEI), with plans to support audio and scanned images for Optical Music Recognition

# New Database: SIMSSA DB

- Search can combine content and metadata
  - Content search based on Cory McKay's jSymbolic, which extracts musical features (e.g. range, rhythm) on upload; will include melodic and harmonic search
  - Users will be able to batch download search results and use these filters to develop research corpora
- Consistent metadata
  - Harvest metadata from VIAF (Virtual International Authority File)
  - Use controlled vocabulary from the Library of Congress Medium of Performance Thesaurus
- Preserve specific datasets connected to publications on Zenodo and in DB

## Metadata facets

### Search

amor

### Genre (Type of Work)

- Frottola(1)
- Madrigal(8)

### Genre (Style)

- Renaissance(9)

### Composer

- Festa, Sebastiano(4)
- Pisano, Bernardo(4)
- Tromboncino, Bartolomeo(1)

### Instrument/Voice

- Voice(9)

### Sacred or Secular

- Sacred(9)

### File Format

- midi(8)
- sibelius(8)
- xml(8)

**FILTER**

## Search results

9 results for "amor"

11 files match the feature search parameters. Only **highlighted** files match all search parameters.

### Amore amor quando io speravo

Composer(s): **Pisano, Bernardo 1490--1548** +

Section(s):

- o **Amore amor quando io speravo**

Genres (Type of Work): **Madrigal**

Genres (Style): **Renaissance**

Collection(s) of Sources: **Florence, Italy, Biblioteca Nazionale Centrale, MS Magliabechi XIX.164-167**

File(s) Holding Complete Musical Work:

- o **sibelius**
- o **midi**
- o **xml**

File(s) Holding an Individual Section:

### Hor vedi Amore che giovinetta donna

Composer(s): **Pisano, Bernardo 1490--1548** +

## Musical content

Please note that features only apply to valid MIDI, Music XML and MEI files, and will exclude file formats from Sibelius, Finale, etc. For an explanation of all features, please consult the [jSymbolic Manual](#).

Chords and Vertical Interval Features

Dynamics Features

Instrumentation Features

Melodic Interval Features

**Musical Texture Features**

Average Number of Independent Voices:

**1 - 3.804**

Contrary Motion:

**0.1578 - 0.1924**

Importance of Loudest Voice:

**0 - 1**

Maximum Number of Independent Voices:

**1 - 4**

# VIS (Analysis tool for vertical interval successions)

- Initial web app was very limited
- Developed a more flexible user interface that allowed users to build a workflow by combining different jobs
- Each improvement in the code required fixes to the interface
- We decided continue to develop VIS as a Python Library (<https://github.com/ELVIS-Project/vis-framework>): easier to maintain than a public interface
- We still use VIS in our research, but it requires people with coding experience; every user discovers bugs and fixes them

# Why is this kind of research important?

- Most research on musical style done on the basis of a very small amount of data, and on personal impressions
- Many of these impressions/hypotheses, when tested against quantitative data, are proved false
- We have found this time after time, in work on
  - style features of composers
  - characteristic features of musical genres
  - size of musical “vocabulary” of repeated contrapuntal combinations (it does not follow Zipf’s law)

# Lessons learned

## **Database**

- Balance quantity with quality in collecting data
- Harvest metadata from authoritative sources where possible
- Work out licencing issues as you build your database
- Encoding matters

## **Analysis software**

- Balance ease of use and flexibility
- We have moved in the direction of flexibility

# New SSHRC project: Mapping the Musical Landscape of the 16<sup>th</sup> Century (MML16)

- Online database of inventories of all sources of polyphonic music in the sixteenth century, with link to online images
- There exist several long established online databases of inventories for segments of the repertory
  - DIAMM (Digital Image Archive of Medieval Music – to c. 1550)
  - RISM (Répertoire International des Sources Musicales)
  - Books of Hispanic Polyphony
  - Many print catalogues (music publishers, composers, etc.)



# New SSHRC project: Mapping the Musical Landscape of the 16<sup>th</sup> Century (MML16)

- Our plan is to
  - Work with RISM to improve usability
  - Create a comprehensive tool that will be able to search all three of these online databases, using linked data: **Federation**
  - Create an interface for scholars to contribute inventories
  - Incorporate Linked Open Data structures to enable sophisticated searches
- Ultimately we will do Optical Music Recognition on the images of the scores, resulting in music in symbolic notation, which will go into the new SIMSSA database

# Thoughts on today's presentations: Dig that Lick and ELVIS

Both require

- Translation of music into a searchable symbolic format
  - Audio (Dig that Lick)
  - Notated score (ELVIS)
- A robust database with a clear structure
- Both search for repeated musical material expressed as n-grams
- Questions about what “counts as” a lick ... and what is generic

# Thoughts on today's presentations: Annotation/transcription of digital audio

Two use digital audio recordings to analyze language

- ACLEW (Analyzing Child Language Experiences Around the World): Annotation of daylong audio recordings to understand how children learn language
- SPADE (Speech Across Dialects of English): analysis of shorter audio recordings, with a focus on sociolinguistics

One uses digital audio to analyze music

- Dig that Lick: Analyzing Large-scale Data for Melodic Patterns in Jazz Performances

# Thoughts on today's presentations: Annotation/transcription of digital audio

- In every case there is a “translation” and/or “transcription” and/or “analysis” and/or “annotation” phase from audio to some kind of representation, that can be linked back to the audio
- Do these projects have something to learn from each other?
- How easy is it to go from the “analysis” to the audio and back?
- Is the end goal to freeze these corpora (audio and annotation) so that others can use them in a static state? Or will they keep evolving? How do you preserve completed work while continuing to improve the data?

# Thoughts on today's presentations: Working with digital images of a dead language

- MTAAC: Machine Translation and Automated Analysis of Cuneiform Languages
- As in the audio cases, there is a “translation” and/or “annotation” stage
  - Working with pre-existent corpora – what kinds of guarantee is there that the visual data will be remain available?
  - Is it easy to go back and forth between the visual image and the transcription?
  - How do you evaluate the Machine translation?

# Thank you!

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