SIMSSA DB: A Database for Computational Musicological Research

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Topics

- Currently available musicological research databases and repositories
- Data needs of computational musicology and MIR
- The SIMSSA DB
  - Features and jSymbolic
  - Archiving research
  - Design priorities
  - Data model
  - Prototype interface

Existing music research databases

- There are several excellent on-line databases available that provide researchers with access to:
  - Musical metadata
    - e.g. Bach Digital
  - Images of scores and manuscripts
    - e.g. Musiclibs
  - Audio recordings
    - e.g. Naxos Digital (paid service)

Symbolic music repositories (1/2)

- However, there are relatively few research-grade on-line repositories of symbolic music
  - i.e. Finale, Sibelius, Music XML, MEI, MIDI, etc. files
- Most symbolic music repositories that do exist tend to either:
  - Have unreliable data and metadata (intended for non-specialist use rather than rigorous musicological research)
    - e.g. Classical Archives or Musescore
  - Be limited in scope
    - e.g. the SEILS dataset
  - Have relatively limited metadata structuring and only basic search functionality
    - e.g. Kern Scores

Symbolic music repositories (2/2)

- Those few research-grade symbolic music repositories that do exist are used heavily by musicologists and MIR researchers
  - e.g. the Josquin Research Project
- This makes it clear how much such resources are needed by the research community

Computational musicology and MIR

- Automated data extraction software, statistical analysis techniques and machine learning now allow us to:
    - □ Study huge quantities of music very quickly
        - More than any human could reasonably look at
    - □ Empirically validate (or repudiate) our theoretical predictions
    - □ Do purely exploratory studies of music
    - □ See music from fresh perspectives

We need symbolic data

- But to take full advantage of these techniques, researchers need symbolic music files
  - □ Lots of symbolic music files
  - □ Varied symbolic music files
  - □ High-quality and symbolic music files
  - □ Consistently encoded symbolic music files
- So where can researchers get these?
  - □ *<pause type=“dramatic”>1 sec</pause>* . . .

Introducing the SIMSSA DB

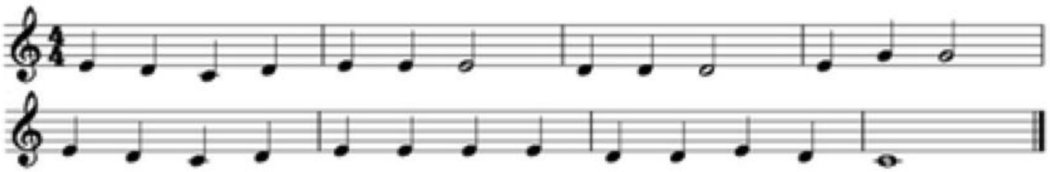
- Emphasizes research-grade symbolic music files
- Permits flexible, high-quality searchable metadata
  - Of the kinds specifically needed by musicologists and MIR researchers
  - Allows modelling of complex relationships
  - Provenance is given particular centrality
- Allows records to be kept of the specific files (and other related information) used in individual research studies
- Permits content-based (as well as metadata-based) search and analysis
  - Let's expand on this for a moment . . .

The notion of a “feature”

- A feature is a piece of information that characterizes something (e.g. a piece of music) in a simple way
- Usually a simple numerical value
  - A feature can be a single value, or it can be a set of related values (e.g. a histogram)
- Can be extracted from pieces in their entirety, or from segments of pieces
- Can use features to compare and look for patterns in different music in a macro sense

Example: A basic feature

- Range (1-D): Difference in semitones between the highest and lowest pitches



- Value of this feature: 7
  - □ G - C = 7 semitones

- In practice, of course, we want many features, not just one . . .

jSymbolic (1/2)

- jSymbolic is our software platform for automatically extracting features from symbolic music (ISMIR 2018)
- Extracts 246 unique features (version 2.2)
  - □ Some of these are multi-dimensional, including histograms
  - □ Extracts a total of 1497 separate values (version 2.2) per symbolic music file

jSymbolic (2/2)

- Types of information accessed by jSymbolic features:
  - Pitch statistics
  - Melody / horizontal intervals
  - Chords / vertical intervals
  - Texture
  - Rhythm
  - Instrumentation
  - Dynamics

SIMSSA DB and jSymbolic features

- jSymbolic is being integrated into the SIMSSA DB
  - □ Whenever a file is added to the DB, features are automatically extracted and used to index the file
- Users can use these features to search the DB based on musical content as well as metadata
  - □ e.g. retrieve all pieces composed by J. S. Bach in Leipzig that contain vertical tritones or parallel fifths
- Researchers can also download and use features directly as input to statistical analysis and machine learning tools (or use manual analysis) to study things such as:
  - □ Composer attribution (MedRen 2017, ISMIR 2017)
  - □ Genre (MedRen 2018, ISMIR 2010)
  - □ Regional styles (APM 2018)

Archiving research

- Researchers can submit information on particular studies they performed
  - Specifically which symbolic music files were used
  - Specifically which features (if any) were used
  - Workflows, results, analysis, conclusions, publications and other related data
- Essential for repeatability, direct comparison of approaches, iterative refinements, etc.
  - jSymbolic configuration files can be auto-generated for each study in order to facilitate this

Design priorities (1/8)

- Make the repository as accessible as possible to all music researchers, regardless of technological training
  - □ As users
  - □ As data (and metadata) contributors
  - □ As editors / validators
- This requires a front-end that is easy-to-use
  - □ And that hides details of the data model from users that they do not need to be aware of

Design priorities (2/8)

- Use authority control and cataloguing standards to reduce ambiguity and redundancy (and increase consistency) as much as possible
- Initial focus on VIAF authority files, but also looking at:
  - FRBR
  - Wikidata
  - RISM’s Muscat and authority files
  - RDA
  - Library of Congress
- Populate fields with URIs and use linked open data practices when possible
  - But also allow contributors to enter raw text into fields (to meet the realistic needs of and constraints faced by musicologists)

Design priorities (3/8)

- Information relating to quality control and file encoding methodology must be kept
  - □ Who submitted data or metadata
  - □ Who verified or edited data or metadata
  - □ Who (or what software) encoded a symbolic music file, and using what settings
    - Encoding methodologies can significantly influence results if one is not careful (ISMIR 2018)

Design priorities (4/8)

- Keeping a record of provenance is musicologically essential
  - □ Each symbolic music file is linked to a specific source (digital or physical)
  - □ Each source can be linked to its parent source(s) through chains of provenance
  - □ e.g. an MEI file is derived from a printed score J. S. Bach score, which is derived from a hand-written copyist’s manuscript, which is derived from a (potentially lost) original manuscript hand-written by Bach

Design priorities (5/8)

- Maintain a conceptual separation between abstract musical works and particular instantiations of them (as expressed by symbolic files and sources)
  - Multiple versions of the same abstract work can exist, and these should be both associated with and differentiated from one another
  - e.g. different symbolic encodings
  - e.g. different editions, arrangements, etc. of a work

Design priorities (6/8)

- Make it possible to divide abstract musical works into abstract sections and parts
  - □ Symbolic files sometimes contain whole pieces, and sometimes only parts of pieces
- Make it possible to keep track of complex relationships between works, sections and parts
  - □ e.g. a movement of one mass might be reused in another mass
  - □ e.g. an orchestral score and a piano reduction of it have different parts, but they are the same work and have the same sections

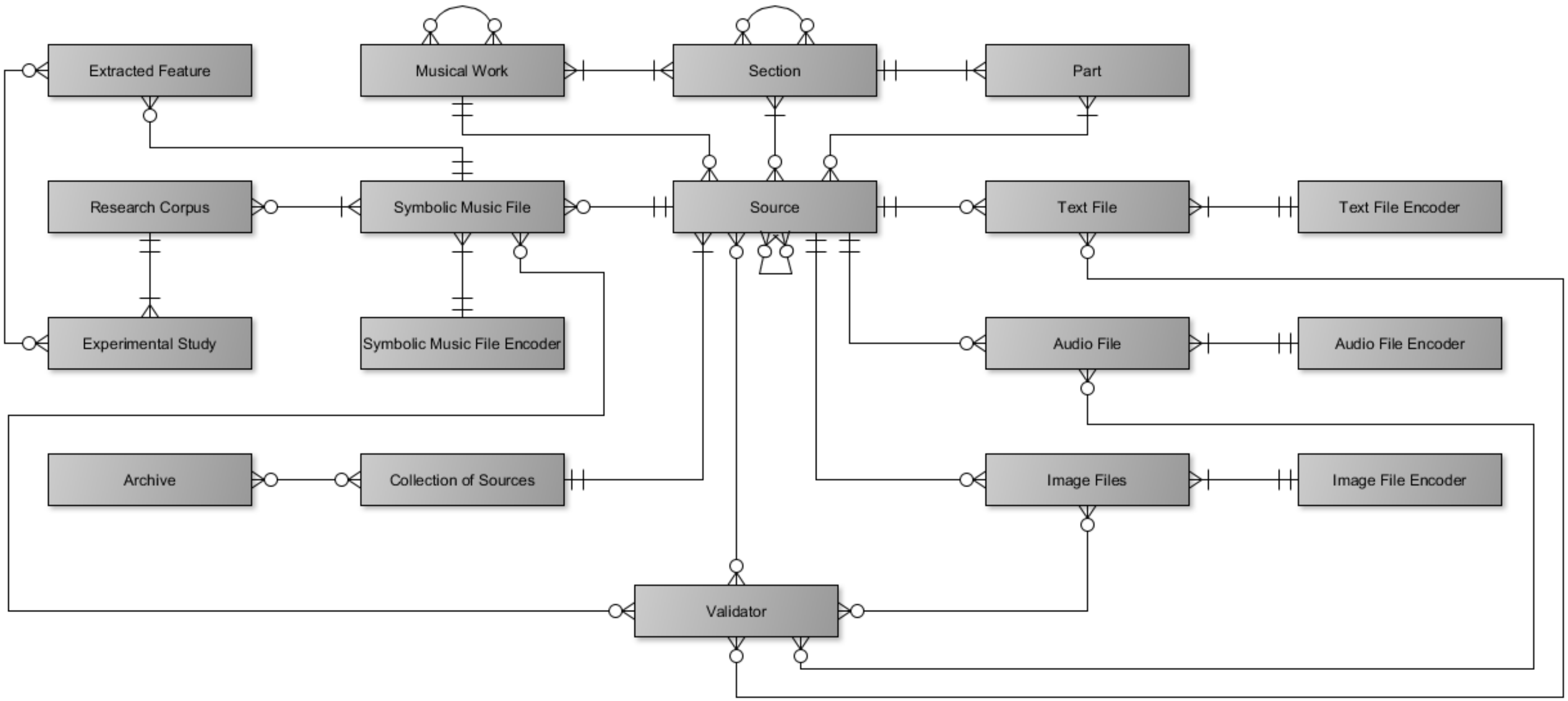
Design priorities (7/8)

- Make it possible to link an abstract musical work (and its sections and parts) to instantiations in multiple formats
  - Symbolic music files
  - Musical texts
  - Images of scores or manuscripts
  - Audio files
- Although our primary focus is on symbolic music, this data is ultimately all related . . .

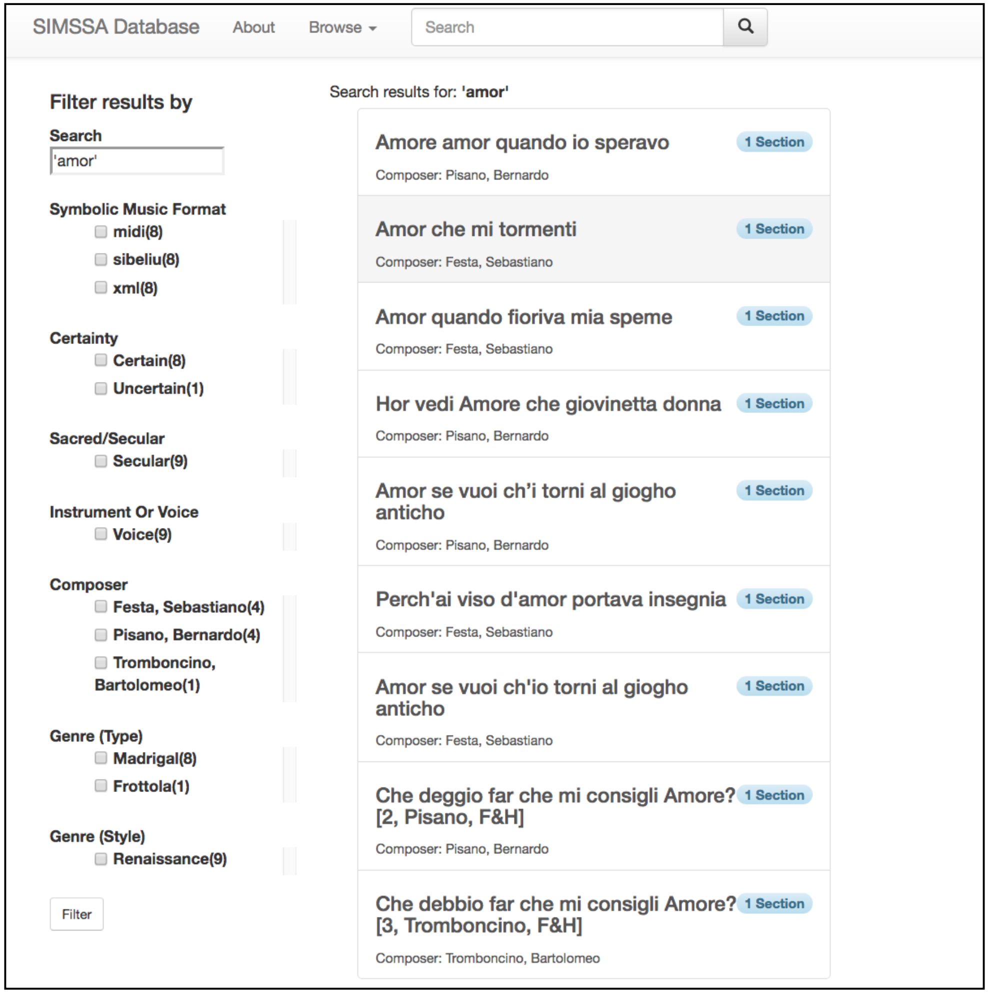
Design priorities (8/8)

- Long-term, we want to:
  - □ Link our data to the contents of other repositories
    - e.g. DOREMUS, Josquin Research Project, etc.
    - We are putting a design emphasis on making it possible to import or export information using linked open data frameworks
    - IIIF-compatibility will certainly help with respect to images
  - □ Take as input symbolic files auto-generated from images using OMR
    - As the technology improves
  - □ Take as input symbolic files auto-generated from audio files using automatic transcription algorithms
    - As the technology improves

Overview ERD of our data model



Prototype interface (1/3)



Filter results by

Search

'amor'

Symbolic Music Format
- □ midi(8)
- □ sibeliu(8)
- □ xml(8)

Certainty
- □ Certain(8)
- □ Uncertain(1)

Sacred/Secular
- □ Secular(9)

Instrument Or Voice
- □ Voice(9)

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

Genre (Type)
- □ Madrigal(8)
- □ Frottola(1)

Genre (Style)
- □ Renaissance(9)

Filter

Search results for: **'amor'**

Amore amor quando io speravo — 1 Section
Composer: Pisano, Bernardo

Amor che mi tormenti — 1 Section
Composer: Festa, Sebastiano

Amor quando fioriva mia speme — 1 Section
Composer: Festa, Sebastiano

Hor vedi Amore che giovinetta donna — 1 Section
Composer: Pisano, Bernardo

Amor se vuoi ch'i torni al giogho anticho — 1 Section
Composer: Pisano, Bernardo

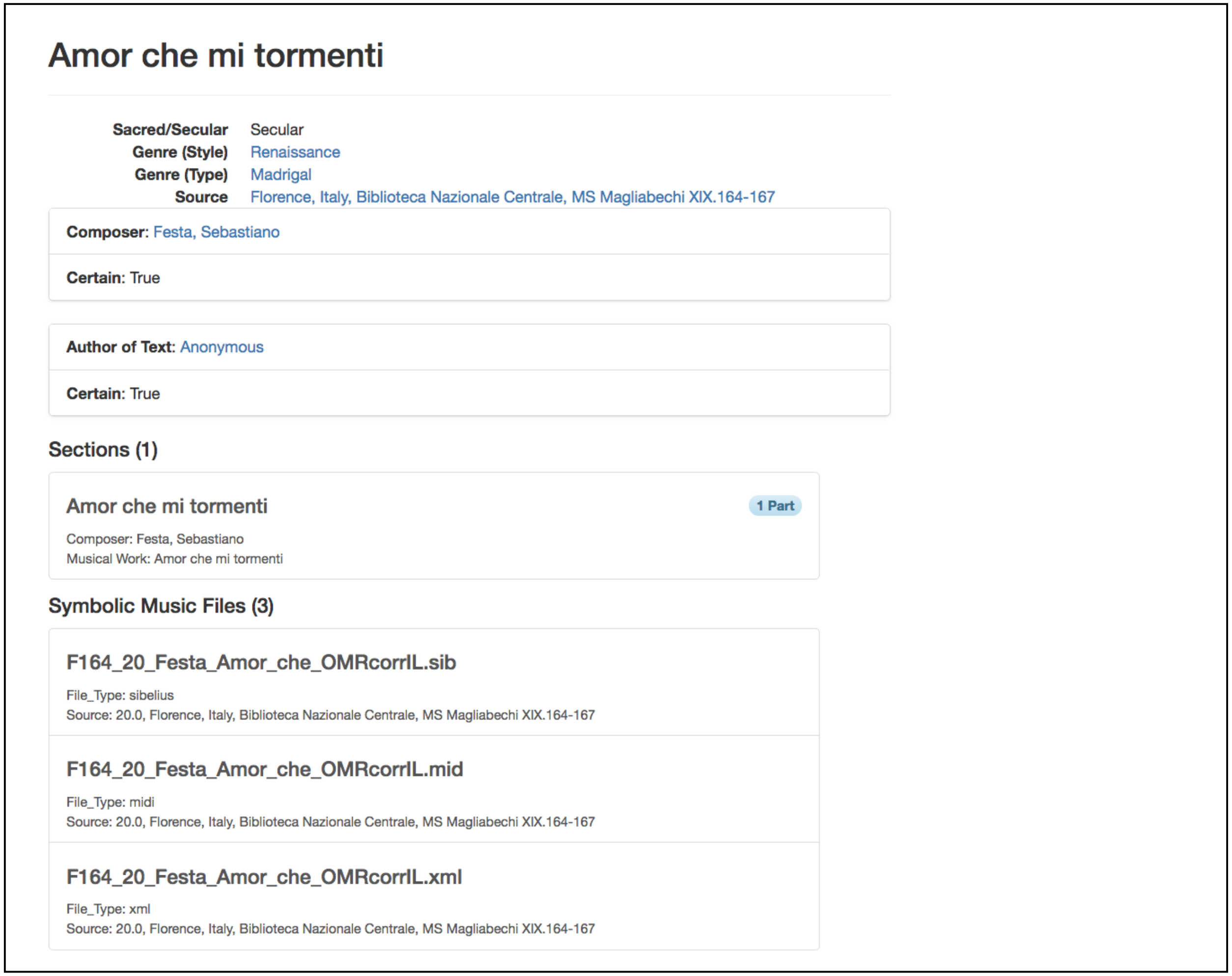
Perch'ai viso d'amor portava insegnia — 1 Section
Composer: Festa, Sebastiano

Amor se vuoi ch'io torni al giogho anticho — 1 Section
Composer: Festa, Sebastiano

Che deggio far che mi consigli Amore? [2, Pisano, F&H] — 1 Section
Composer: Pisano, Bernardo

Che debbio far che mi consigli Amore? [3, Tromboncino, F&H] — 1 Section
Composer: Tromboncino, Bartolomeo

Prototype interface (2/3)



Amor che mi tormenti

Sacred/Secular	Secular
Genre (Style)	Renaissance
Genre (Type)	Madrigal
Source	Florence, Italy, Biblioteca Nazionale Centrale, MS Magliabechi XIX.164-167

Composer: Festa, Sebastiano

Certain: True

Author of Text: Anonymous

Certain: True

Sections (1)

Amor che mi tormenti

Composer: Festa, Sebastiano
Musical Work: Amor che mi tormenti

Symbolic Music Files (3)

F164_20_Festa_Amor_che_OMRcorrlL.sib

File_Type: sibelius
Source: 20.0, Florence, Italy, Biblioteca Nazionale Centrale, MS Magliabechi XIX.164-167

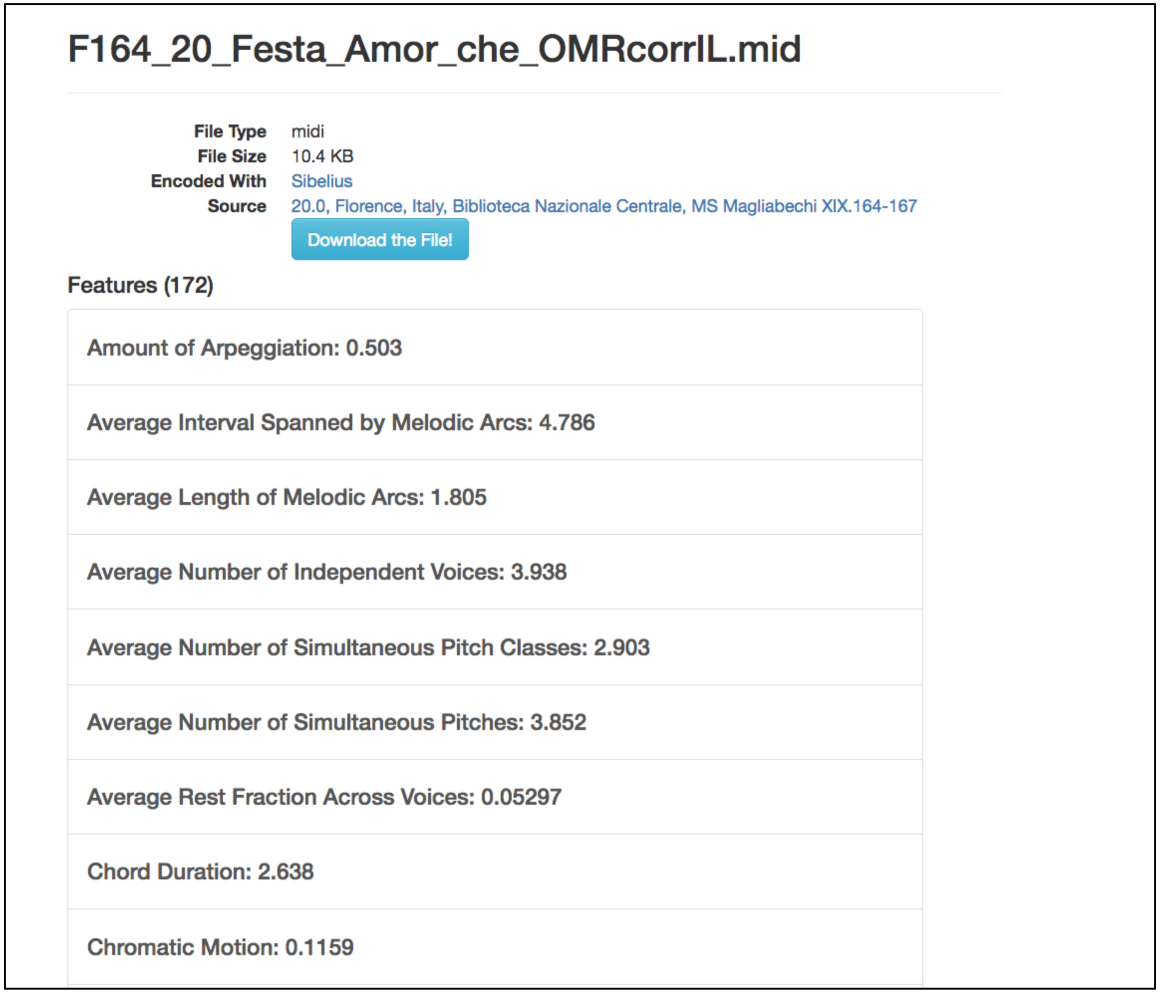
F164_20_Festa_Amor_che_OMRcorrlL.mid

File_Type: midi
Source: 20.0, Florence, Italy, Biblioteca Nazionale Centrale, MS Magliabechi XIX.164-167

F164_20_Festa_Amor_che_OMRcorrlL.xml

File_Type: xml
Source: 20.0, Florence, Italy, Biblioteca Nazionale Centrale, MS Magliabechi XIX.164-167

Prototype interface (3/3)



F164_20_Festa_Amor_che_OMRcorrIL.mid

File Type	midi
File Size	10.4 KB
Encoded With	Sibelius
Source	20.0, Florence, Italy, Biblioteca Nazionale Centrale, MS Magliabechi XIX.164-167

Features (172)

- Amount of Arpeggiation: 0.503
- Average Interval Spanned by Melodic Arcs: 4.786
- Average Length of Melodic Arcs: 1.805
- Average Number of Independent Voices: 3.938
- Average Number of Simultaneous Pitch Classes: 2.903
- Average Number of Simultaneous Pitches: 3.852
- Average Rest Fraction Across Voices: 0.05297
- Chord Duration: 2.638
- Chromatic Motion: 0.1159

Highlights of the SIMSSA DB

- Designed to meet the specific needs of researchers wishing to engage in large-scale computational musicological and MIR research
- Focus on symbolic music files
  - □ But also permits links with images, audio files and texts
- Emphasis on accessibility to researchers
- Emphasis on quality and consistency of both metadata and data
  - □ Authority control and cataloguing standards
- Modeling of complex musical relationships
  - □ Relationships between (abstract) works, sections and parts
  - □ Mapping musical instantiations (e.g. files) to abstract musical entities
  - □ Emphasis on provenance
- Archiving of experiments
- Content-based search and analysis based on features
  - □ As well as metadata-based searches, of course

Thanks for your attention

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Conseil de recherches en sciences humaines du Canada

Canada

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Fonds de recherche sur la société et la culture
Québec

DDMAL
Distributed Digital Music Archives & Libraries Lab

SIMSSA
Single Interface for Music Score Searching and Analysis

jMIR