

ELVIS

Electronic Locator of Vertical Interval
Successions

The First Large Data-Driven Research
Project on Musical Style

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McGill



Schulich School of Music
École de musique Schulich



Social Sciences and Humanities
Research Council of Canada

Conseil de recherches en
sciences humaines du Canada

Canada

Digging into Data Challenge Grant

International competition, US, UK, Canada, Netherlands

- January 2012-January 2014;
- 14 teams awarded out of 67 applicants
- \$125 K Canada, \$175 K US, £91 K UK

Team

- Canada/McGill: Julie Cumming, Musicology, PI
 - Ichiro Fujinaga, Music Technology
 - Jonathan Wild, Music Theory
 - René Rusch, Music Theory
 - Peter Schubert, Music Theory
 - Cynthia Leive, Head Librarian, Marvin Duchow Music Library
- US: Michael Cuthbert, Musicology (MIT), PI
 - Ian Quinn, Music Theory (Yale)
- UK/U of Aberdeen: Frauke Jürgensen, Musicology, PI,
 - George Coghill, Computer Science

Advisory Board

- Thomas Cobb (L'Université du Québec à Montréal, Département de didactique des langues)
- Richard Freedman (Haverford College, Musicology, and CESR, Tours)
- Robert Gjerdingen (Northwestern University, Music Theory and Cognition)
- David Headlam (Eastman School of Music, Music Theory, and University of Rochester, Electrical and Computer Engineering)
- David Huron (Ohio State University, School of Music and Center for Cognitive Science)
- Laurent Pugin (Répertoire International des Sources Musicales Bern, and University of Geneva)
- Jesse Rodin (Stanford University, Musicology)
- David Smith (University of Aberdeen, Music)

McGill Students on the ELVIS team

- Christopher Antila (MA Music Theory)
- Gregory Burlet (MA Music Technology)
- Natasha Dillabough (MA Music Theory)
- Daniel Donnelly (PhD Musicology)
- Jamie Klassen (BA Mathematics and Statistics)
- Catherine Motuz (PhD Musicology)
- Jacob Sagrans (PhD Musicology)

Former students

- Ashley Burgoyne (PhD Music Technology)
- Remi Chiu (PhD Musicology)

John Sinclair: *Corpus, Concordance, and Collocation* (1991)

Searches large amounts of text (*Corpora*)
for the most common words (*Concordance*)
and recurring clusters of words (*Collocation*)

In the process he learns new things about how language works.

How can we apply his methods to music?

What is the musical analogue to a word?

Vertical intervals = letters

Pedro Cerone, 1613:

“Just as we need only 22 letters to make thousands of orations, we only need 22 [vertical] intervals to make all music.”

El melopeo, Book 9 ch. 3, p. 565.

Pairs of vertical intervals = words

Johannes Tinctoris

Diffinitorium (the first music dictionary, early 1470s;
published 1495)

Liber de arte contrapuncti (1477)

Book I is a **dictionary of interval pairs**, linked by melodic motions, including

- **all** the pairs of consonant intervals

Intervals are sorted: (alphabetized or “intervalized”) as follows:

- by size of first interval (small to large)
- by size of second interval (small to large)
- by melodic motion of one voice (small to large)

Ian Quinn discovered that the

- distribution of two-chord progressions in Bach's chorales resembled that of words in natural-language corpora

and suggested that we should

- “think of [two-chord] progressions, not chords, as playing the role that words play in language.”

Quinn, I. 2010. Are pitch-class profiles really ‘key for key’? *Zeitschrift der Gesellschaft für Musiktheorie* 7:151–163.

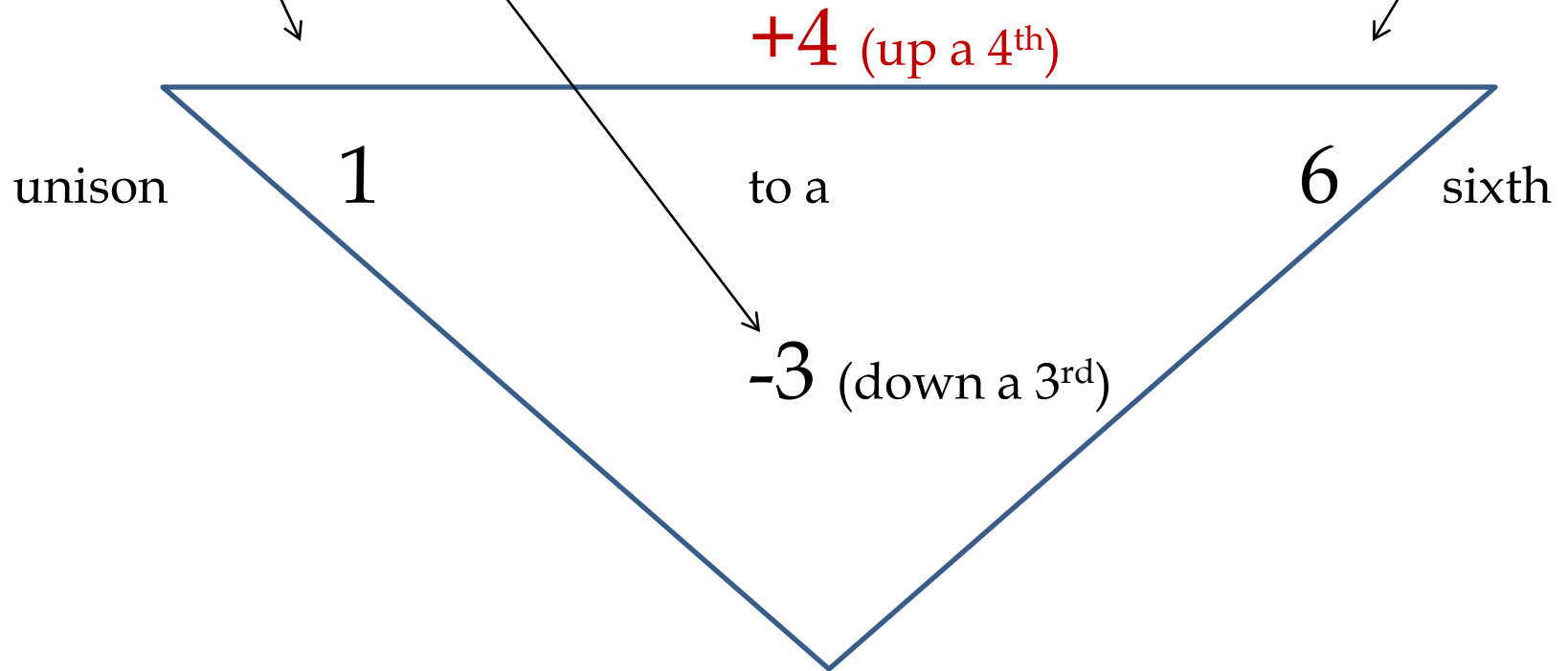
Triangle or Bigram

Vertical interval succession

First vertical interval

Second vertical interval

Melodic interval of lower voice



[Motion of
upper voice:

+5

+4

+3

+2]



Intervals:

1

6

1

6

1

6

1

6

Motion of

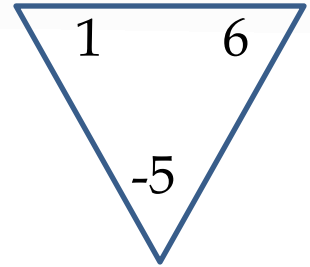
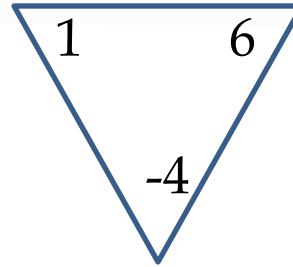
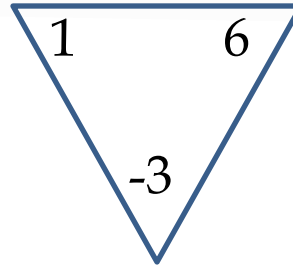
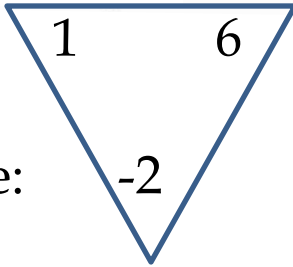
lower voice:

-2

-3

-4

-5



Lassus duo no. 8, *Sancti mei* (excerpt)

Shown with vertical intervals for every half note (upper line of nos.)
and lower-voice motion (lower line of nos.)

x= rest in one voice; (5) = voice crossing

26

6 3 2 3 x 3 5 3 5 8 5 3 5 6 5 3 (5) (3) 3 6
+3 1 -2 +2 -3 1 -3 1 +4 1 -3 1 +2 1 +5 1 -3 -2 -2

- bis, e-go red-dam vo-

31

7 6 10 3 1 3 x 3 6 8 5 3 5 6 5 3 3 6 7 6 8
1 -4 +8 1 -3 1 -3 +4 1 -3 1 +2 1 -3 -2 -2 1 -2

- bis, e-go red-dam vo-bis.

We can now have a computer search for the most frequent:

- “letters”: vertical intervals
- “words” (interval pairs, or bigrams)
- “collocations” (n-grams: strings of 3, 4, 5, 6... intervals)

We know of some recurrent collocations already:

- Cadences
- Stretto fuga (strict imitation after a short time interval, with prescribed melodic motions)
- Modules

Lassus duo no. 8, *Sancti mei*

A cadential chain of interval pairs in the final measures

31

3
-2
6
-2
7
1
6
-2
8

bis.

Lassus duo no. 8, *Sancti mei*

Modules as Collocations

26

6 3 2 3 x 3 5 3 5 8 5 3 5 6 5 3 (5) (3) 3 6
 +3 1 -2 +2 -3 1 -3 1 +4 1 -3 1 +2 1 -5 1 -3 -2 -2

- bis, e- go red- dam vo-

31

7 6 10 3 1 3 x 3 6 8 5 3 5 6 5 3 3 6 7 6 8
 1 -4 -8 1 -3 1 -3 +4 1 -3 1 +2 1 -3 -2 -2 1 -2

- bis e- - go, e- - go red- dam vo- bis.

How could we expand these ideas to other musical repertoires?

ELVIS was born.

Use computers to locate repeated successions of vertical intervals (or chords) linked by melodic motions in Western classical music 1300–1900.

Big Data

Music freely available in symbolic notation

- MusicXML
- MIDI
- Kern
- MEI, etc.

More available every day.

We've located thousands of pieces (or movements).

A single 4-minute, 4-voice piece, MM=60 has

- 240 chords
- 1440 2-voice vertical intervals

Software

music21

Cuthbert and Ariza 2010.

<http://mit.edu/music21/>

PerlHumdrum Analysis Toolkit

Huron, Knopke, Jürgensen

Knopke, 2008

More generally: ELVIS will allow us to search for musical “collocations” at multiple levels

- the piece,
- the composer,
- the genre,
- the period, and
- various combinations of the above.

We can use our findings to

- analyze individual pieces
- characterize the style of a composer
- learn about genre characteristics
- develop “native-speaker” competency in many different styles of music
- **track style change**

Jack Hitt. “Words on Trial: Can Linguists Solve Crimes that Stumped the Police? *The New Yorker*, July 23, 2012, 24-29.

Carole Chaski, executive director of the Institute for Linguistic Evidence, markets linguistic software that identifies patterns hidden in syntax. She thinks the work is best done quantitatively, through brute computational force, not qualitatively by subjective scholars.

Robert Leonard, a forensic linguist, argues that human interpretation is a requirement.

Roger Shuy: Forensic linguistics can do for language crimes ... what DNA has done for violent crimes.

Vertical interval successions (triangles or bigrams) = **counterpoint**

or chords linked by melody or bassline (another kind of bigram) = **harmony**

melodic motions = **melody**

can be considered the DNA of music.

When the DNA changes, the style changes.

What have we done at McGill ?

Created the Elvis database: <http://elvis.music.mcgill.ca/>
around 4000 pieces so far

Drupal – Team of students

- upload files and
- provide metadata
 - required fields and
 - tags
 - faceted searches, choice of file type

Data -

- Mostly early music so far;
- Yale team concentrating on 18th-and 19th-century music
- data sets available on the web (Classical midi archive, choral wiki, etc.)
- donated by supportive scholars: Rob Wegman, Jesse Rodin, Richard Freedman, and others

Software development

- Christopher Antila has developed software for doing our triangle queries (VIS), including sorting and displaying the data
- Ashley Burgoyne has developed software for doing lots of pieces at the same time (Mr Job)
- Gregory Burlet has worked on our Drupal database
- The team is working out more specific research questions and strategies that use this data, e.g.:
 - What are the most common bigrams, trigrams, etc., for each period?
 - How do individual works compared to aggregate data?
 - What is the relationship between mode and counterpoint?

Thank you!

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<http://elvis.music.mcgill.ca/>

If you wish to contribute music notation files (.xml, .mus, .sib, .mid or other similar files) to the ELVIS database, please get in touch with christopher.antila@mail.mcgill.ca and we'll supply you with a password to the ELVIS database