

DDMAL

DISTRIBUTED DIGITAL MUSIC
ARCHIVES & LIBRARIES LAB



Ichiro Fujinaga

Music Technology Area
Department of Music Research
Schulich School of Music

McGill University

Plan

- ❖ OMR (optical music recognition)
- ❖ SIMSSA Project
- ❖ LinkedMusic Project

Optical Music Recognition (OMR)

A process of converting images of music scores into a symbolic computer representation, such as MIDI, MusicXML, or MEI (Music Encoding Initiative).

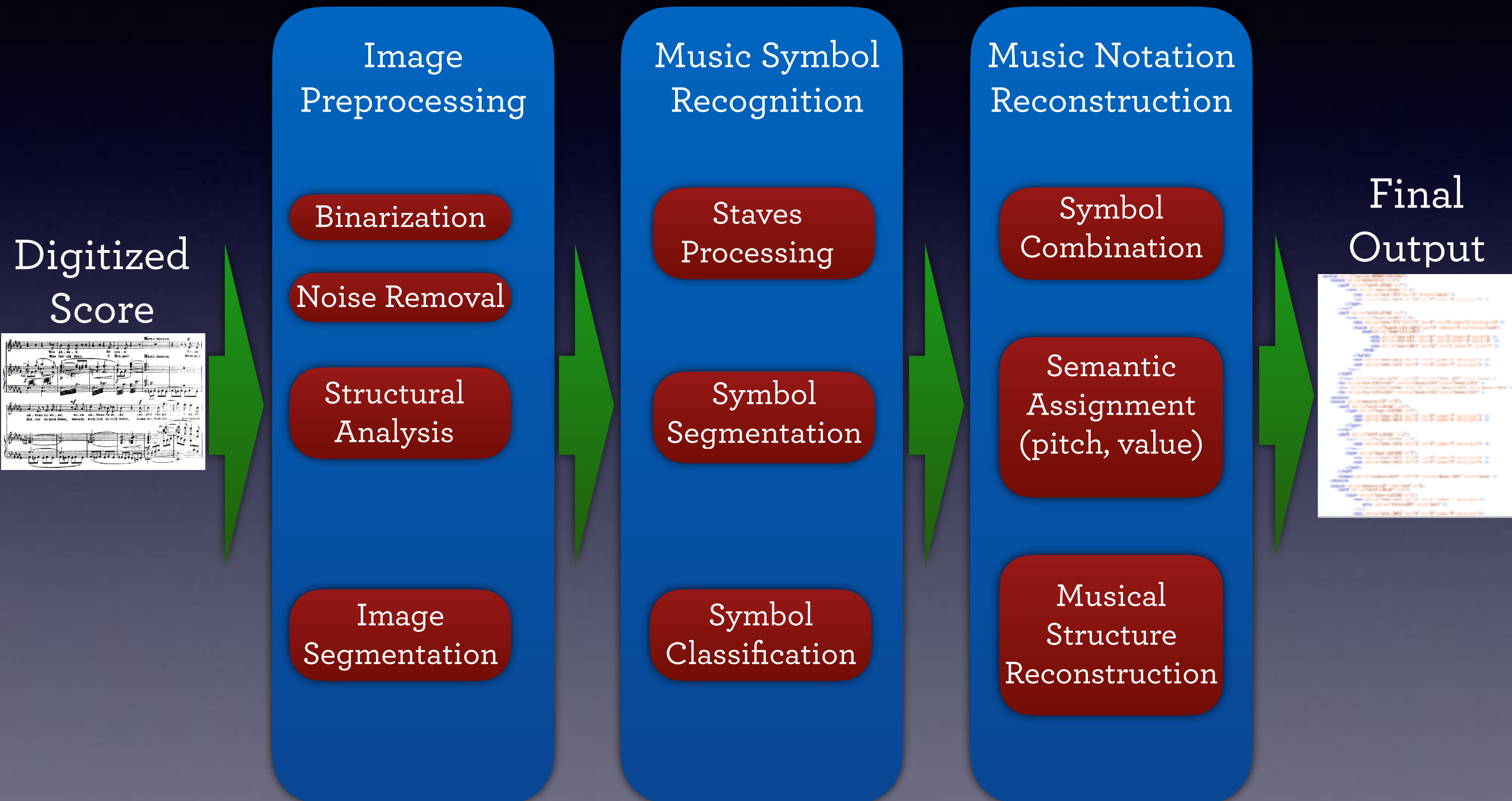


OMR



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        </tuplet>
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Steps Involved in OMR

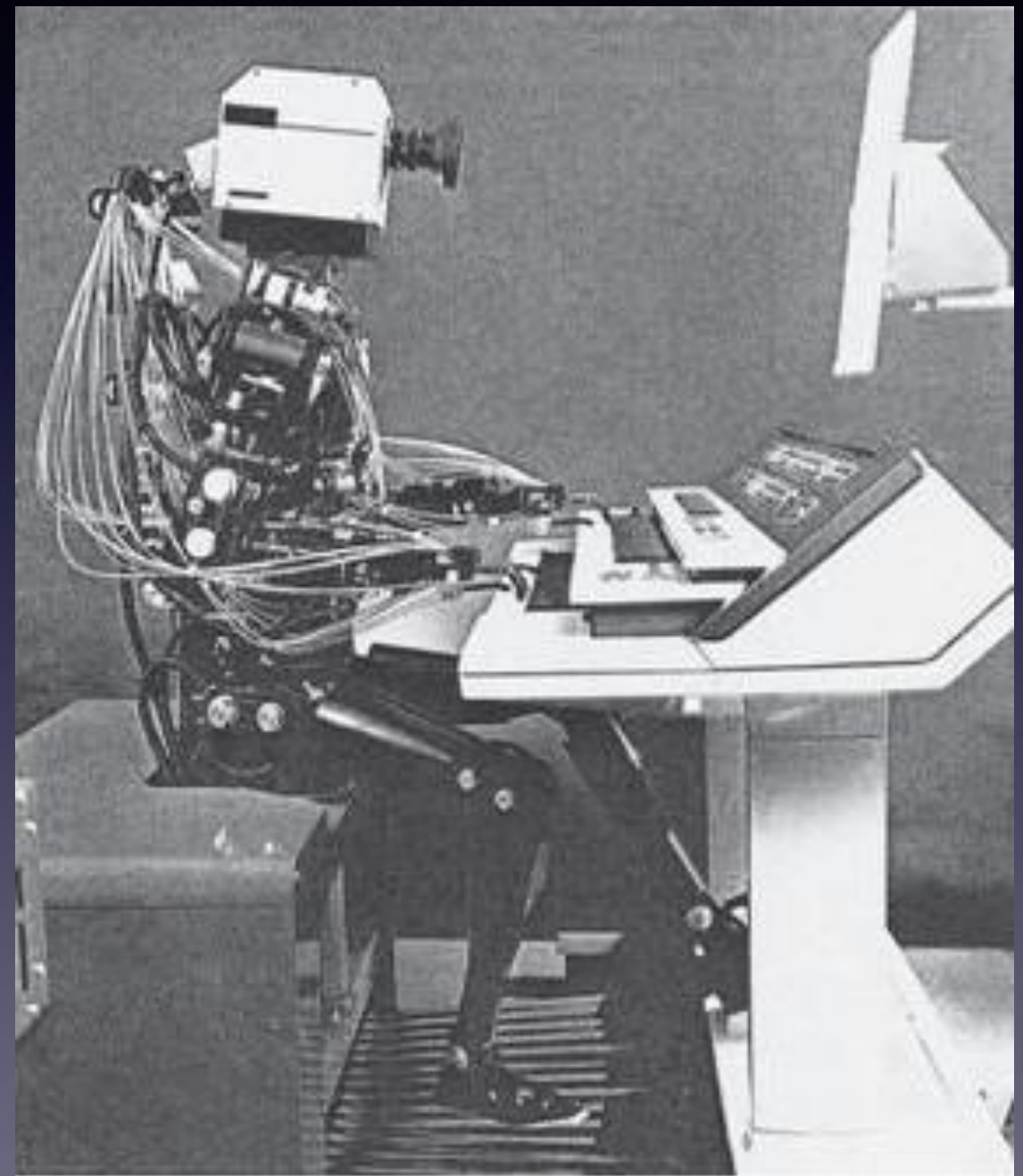


Why is OMR important?

- ❖ Automatic playback
- ❖ Rearrangements
 - ❖ Transpositions
 - ❖ Change of mode (Major /Minor)
- ❖ Symbolic music analysis
 - ❖ Searching
 - ❖ Data mining
 - ❖ Distant reading
- ❖ Reprints (for publishers)
- ❖ Braille output
- ❖ Score following

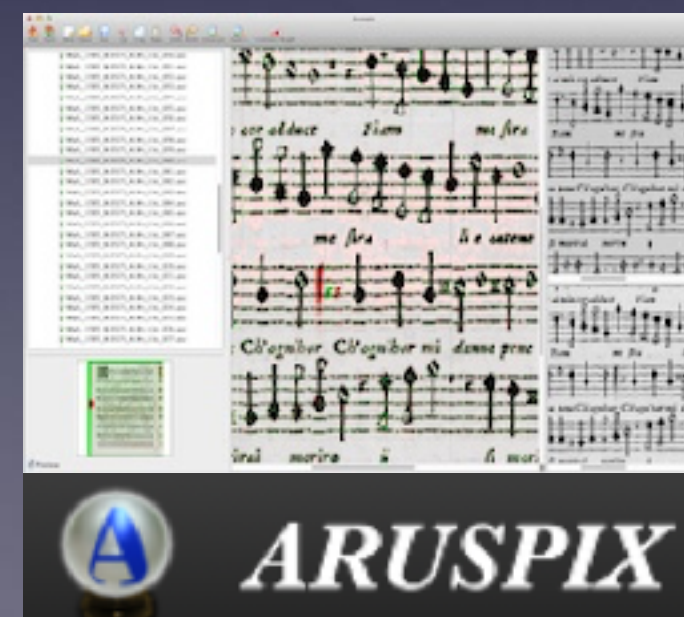
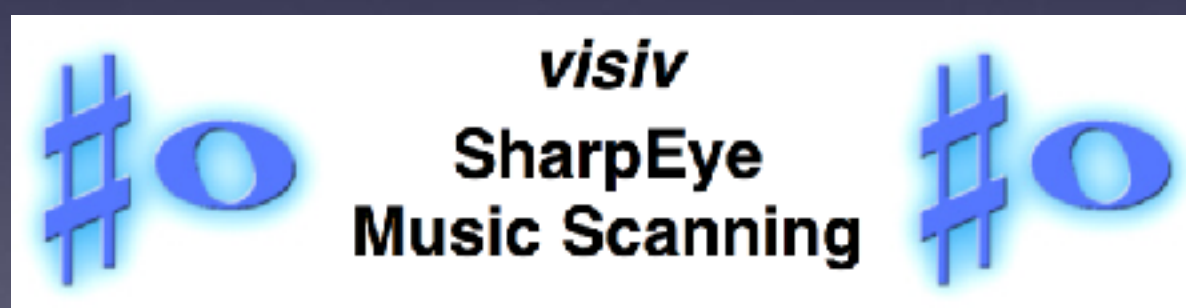
A Brief History of Optical Music Recognition (OMR)

- ❖ 1966: First PhD dissertation on OMR
- ❖ 1970: First published digital scan of music
- ❖ 1984: First robot with OMR capabilities



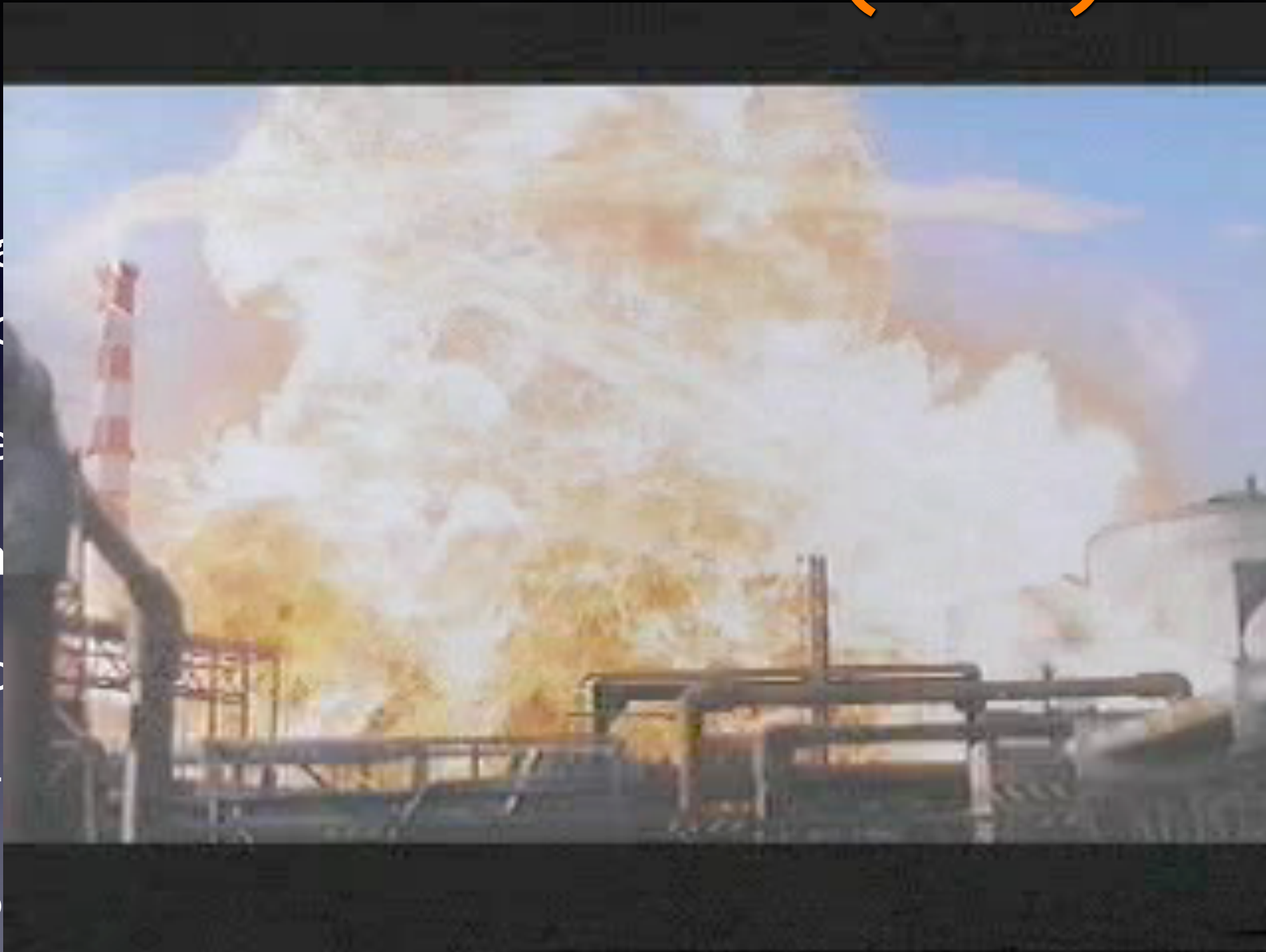
<https://www.scaruffi.com/mind/ai/wabot.jpg>

OMR Software



Birth of Gamera (2001)

- ❖ Fra
- rec
- ❖ De
- ❖ Im
- ❖ Do
- ❖ Sy
- ❖ Po



)

atch

Generalized Algorithms and Methods for Enhancement and Restoration of Archives

SIMSSA | Single Interface for Music | Score Searching and Analysis

- ❖ Think: “Google Scores”
- ❖ Similar to “Google Books” minus Google
 - ❖ OMR (optical music recognition) to enable full-text search
 - ❖ Sophisticated music analysis and query
- ❖ Access to digitized scores world-wide from a single website
- ❖ 12-year project: 2011–2022: \$4.4M

The Vision: Global Music Library

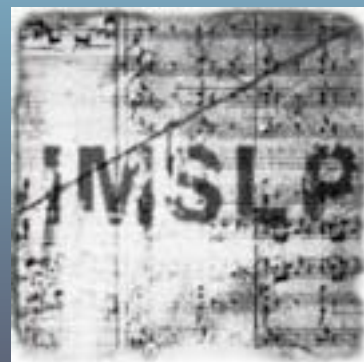
Tools



Music Encoding Initiative

Humdrum

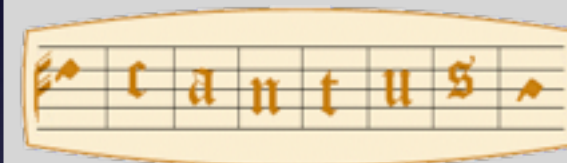
music21



Early Music Online

Music Treasures Consortium

Metadata & Text

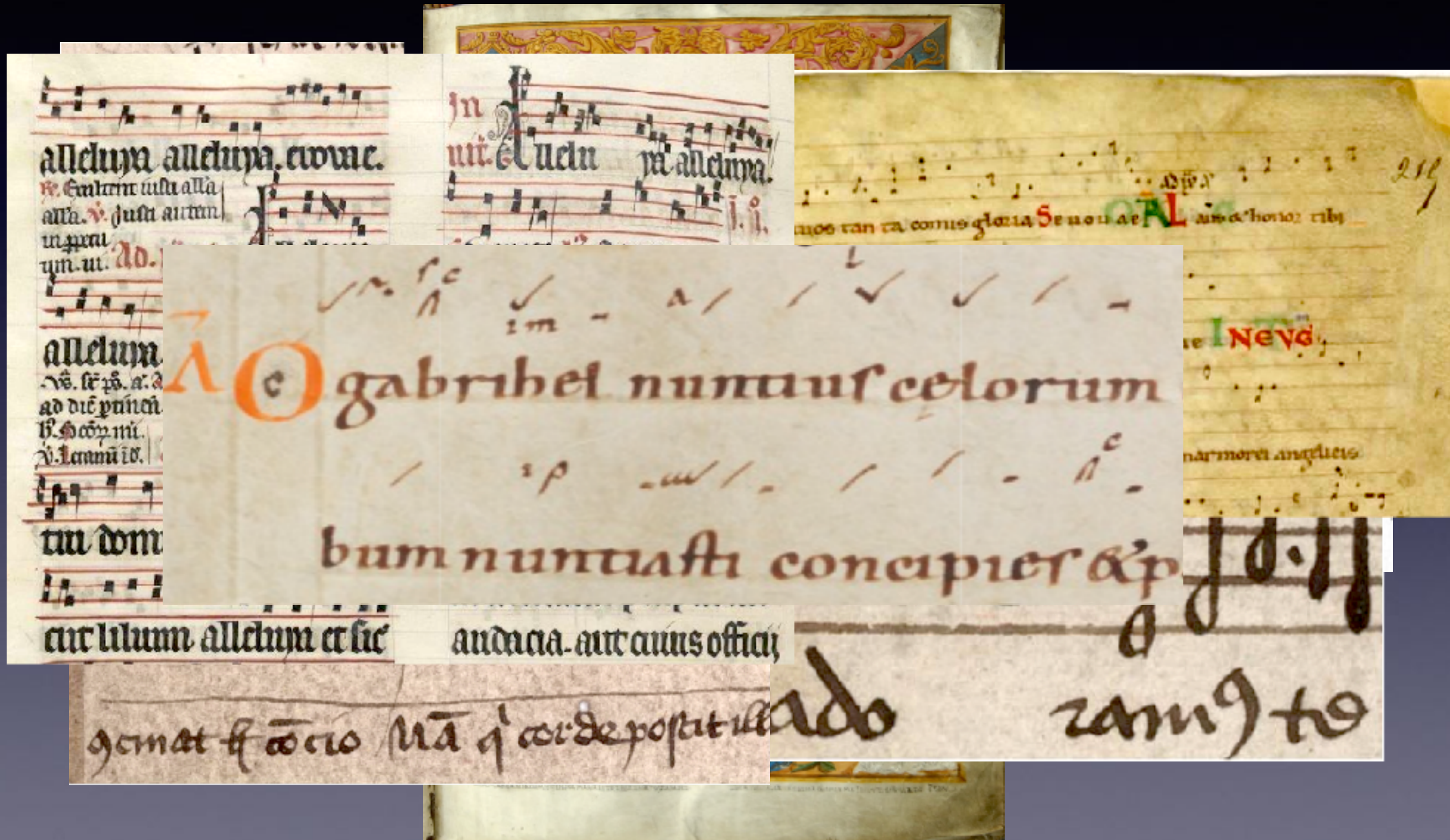


SIMSSA Team

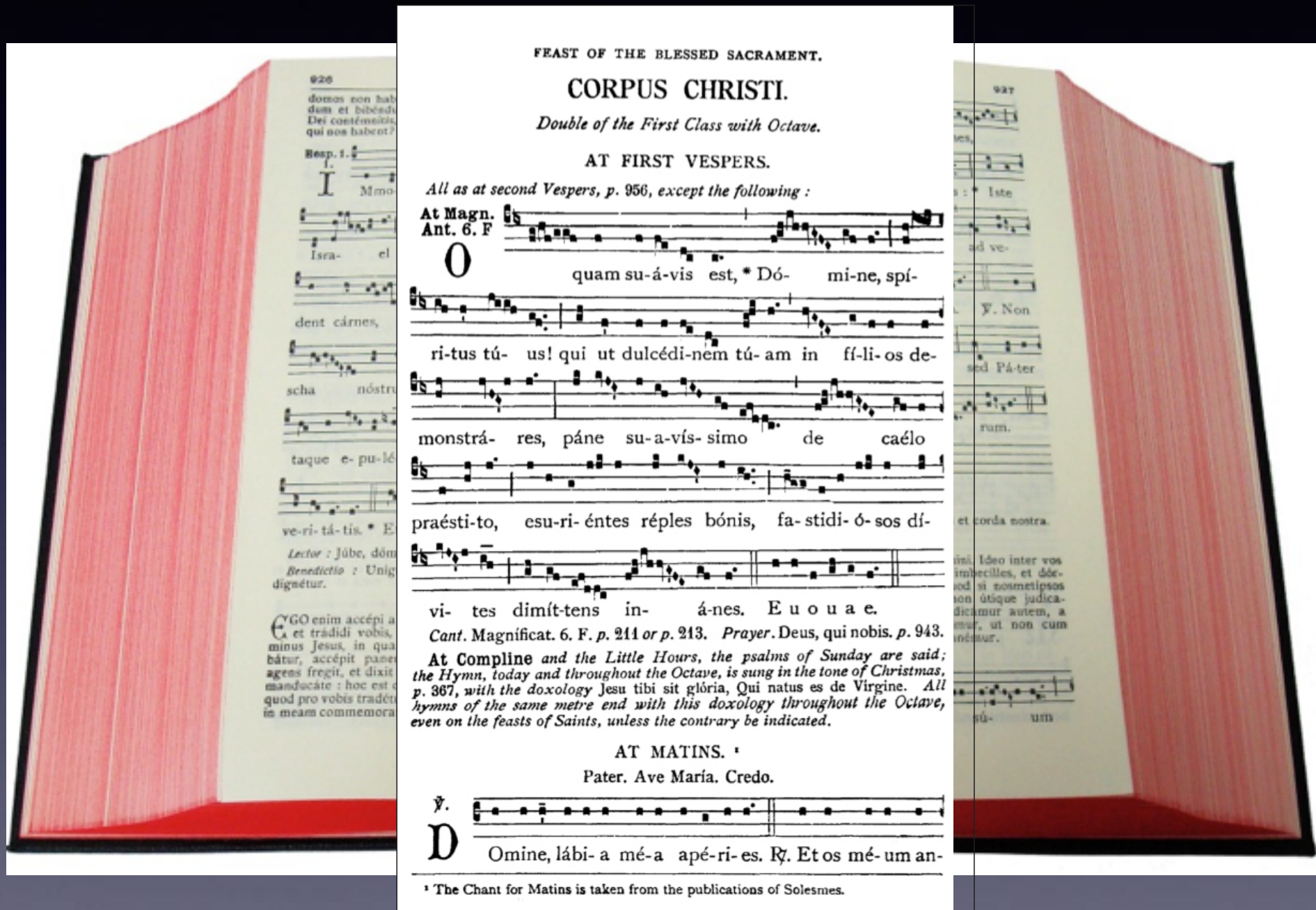
- ❖ Musicologists (20)
- ❖ Music Librarians (8)
- ❖ Music Technologists (11)
- ❖ Partners (23) including:
 - ❖ Bavarian State Library
 - ❖ Bibliothèque nationale de France
 - ❖ British Library
 - ❖ Harvard University Music Library
 - ❖ HathiTrust Research Center
 - ❖ New York Philharmonic Archives

Neume Notation

Early Western Music Notation System: 10th–16th Century



2011: *Liber Usualis* Project



FEAST OF THE BLESSED SACRAMENT.
CORPUS CHRISTI.
Double of the First Class with Octave.

AT FIRST VESPERS.

All as at second Vespers, p. 956, except the following :

At Magn.
Ant. 6. F

O quam su-á-vis est, * Dó- mi-ne, spí-
ri-tus tú- us! qui ut dulcédi-nem tú- am in fí-li- os de-
monstrá- res, páne su-a-vís- simo de caélo
praesti-to, esu-ri- éntes réples bónis, fa- stidi- ó- sos dí-
vi- tes dimít-tens in- á-nes. E u o u a e.

Cant. Magnificat. 6. F. p. 211 or p. 213. Prayer. Deus, qui nobis. p. 943.

At Compline and the Little Hours, the psalms of Sunday are said; the Hymn, today and throughout the Octave, is sung in the tone of Christmas, p. 367, with the doxology Jesu tibi sit glória, Qui natus es de Virgine. All hymns of the same metre end with this doxology throughout the Octave, even on the feasts of Saints, unless the contrary be indicated.

AT MATINS. ¹
Pater. Ave María. Credo.

D Omine, lábi- a mé-a apé-ri- es. R̃. Et os mé- um an-

¹ The Chant for Matins is taken from the publications of Solesmes.

Full-text search of 2,000 pages of Latin text and square notation

Search the Liber Usualis

What is this? [Find out more about what we are trying to do.](#)



Result 1 of 40 for edcdeee

Current page: 157 of 2340

X. — For feasts of the Blessed Virgin. 2. 45

in gló- ri- a Dé- i Pa- tris. A- men.

4. **S** Anctus, * Sántus, Sántus Dóminus Dé- us Sá-
ba- oth. Pléni sunt caéli et térra gló- ri- a tú- a. Hosánna
in excél- sis. Benedíctus qui vé- nit in nómine Dómi-
ni, Hosánna in excél- sis.

XII. c.

4. **A** -gnus Dé- i, * qui tóllis peccáta múndi : mí- se- ré-
re nó- bis. Agnus Dé- i, * qui tóllis peccáta múndi : mí-
se- ré- re nóbis. Agnus Dé- i, * qui tóllis peccáta múndi :

Preprocessing: Aruspix

FEAST OF THE BLESSED SACRAMENT.
CORPUS CHRISTI.
Double of the First Class with Octave.

AT FIRST VESPERS.

All as at second Vespers, p. 956, except the following :

At Magn.
Ant. 6. F

O quam su-á-vis est, * Dó-mi-ne, spí-
ri-tus tú-us! qui ut dulcédi-nem tú-am in fí-li-os de-
monstrá-res, páne su-a-vís-simo de caélo
praesti-to, esu-ri-éntes réples bónis, fa-stidi-ó-sos dí-
vi-tes dimít-tens in-á-nes. E u o u a e.
Cant. Magnificat. 6. F. p. 211 or p. 213. Prayer. Deus, qui nobis. p. 943.

At Compline and the Little Hours, the psalms of Sunday are said, the Hymn, today and throughout the Octave, is sung in the tone of Christmas, p. 367, with the doxology Jesu tibi sit glória, Qui natus es de Virgine. All hymns of the same metre end with this doxology throughout the Octave, even on the feasts of Saints, unless the contrary be indicated.

AT MATINS. †
Pater. Ave María. Credo.

†. **D** Omine, lábi-a mé-a apé-ri-es. R̃. Et os mé-um an-

† The Chant for Matins is taken from the publications of Solesmes.

FEAST OF THE BLESSED SACRAMENT.
CORPUS CHRISTI.
Double of the First Class with Octave.

AT FIRST VESPERS.

All as at second Vespers, p. 956, except the following :

At Magn.
Ant. 6. F

O mi-ne, spí-
ri-tus in fí-li-os de-
monstrá-res, páne su-a-vís-simo de caélo
praesti-to, esu-ri-éntes réples bónis, fa-stidi-ó-sos dí-
vi-tes dimít-tens in-á-nes. E u o u a e.
Cant. Magnificat. 6. F. p. 211 or p. 213. Prayer. Deus, qui nobis. p. 943.

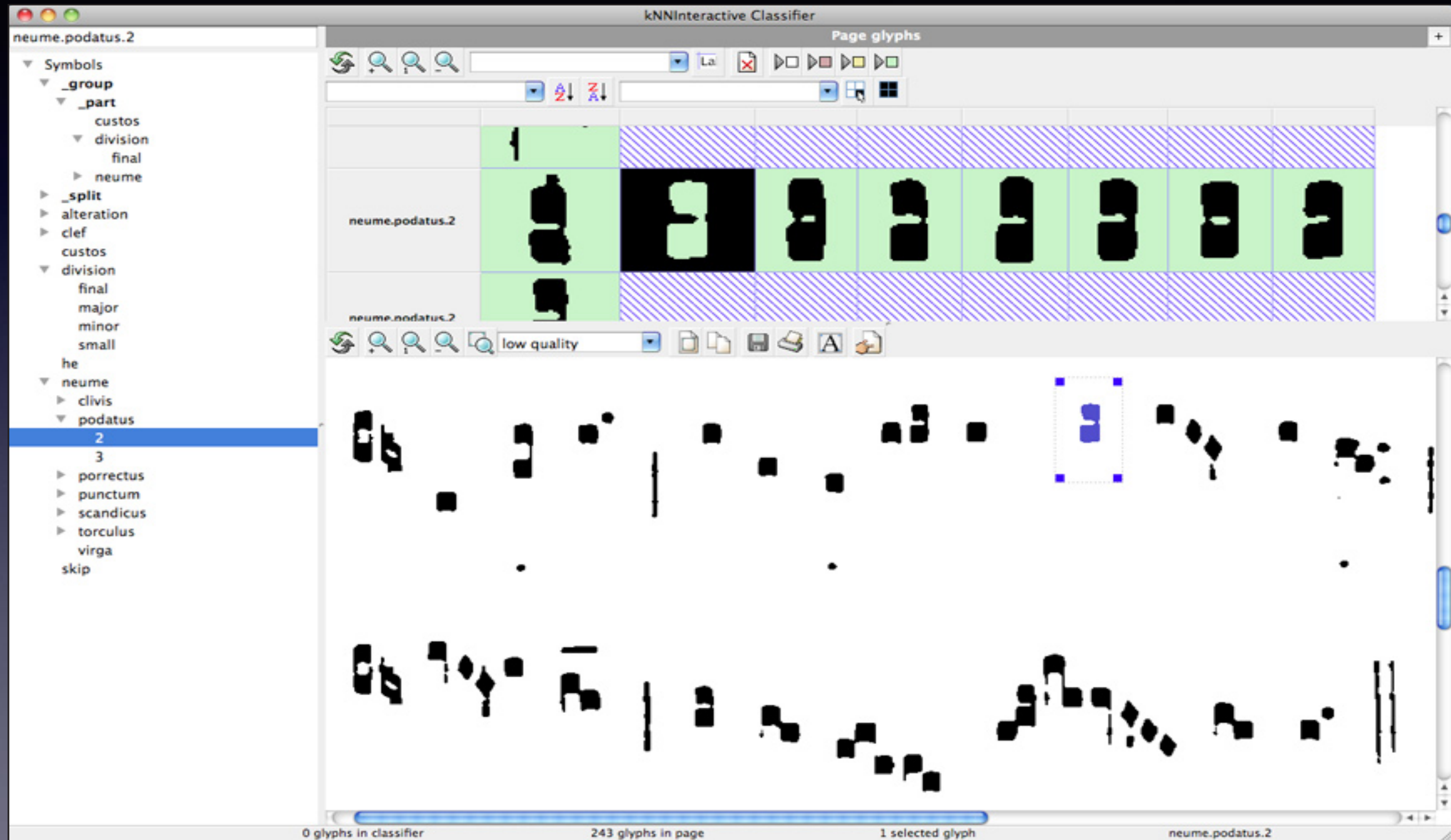
At Compline and the Little Hours, the psalms of Sunday are said, the Hymn, today and throughout the Octave, is sung in the tone of Christmas, p. 367, with the doxology Jesu tibi sit glória, Qui natus es de Virgine. All hymns of the same metre end with this doxology throughout the Octave, even on the feasts of Saints, unless the contrary be indicated.

AT MATINS. †
Pater. Ave María. Credo.

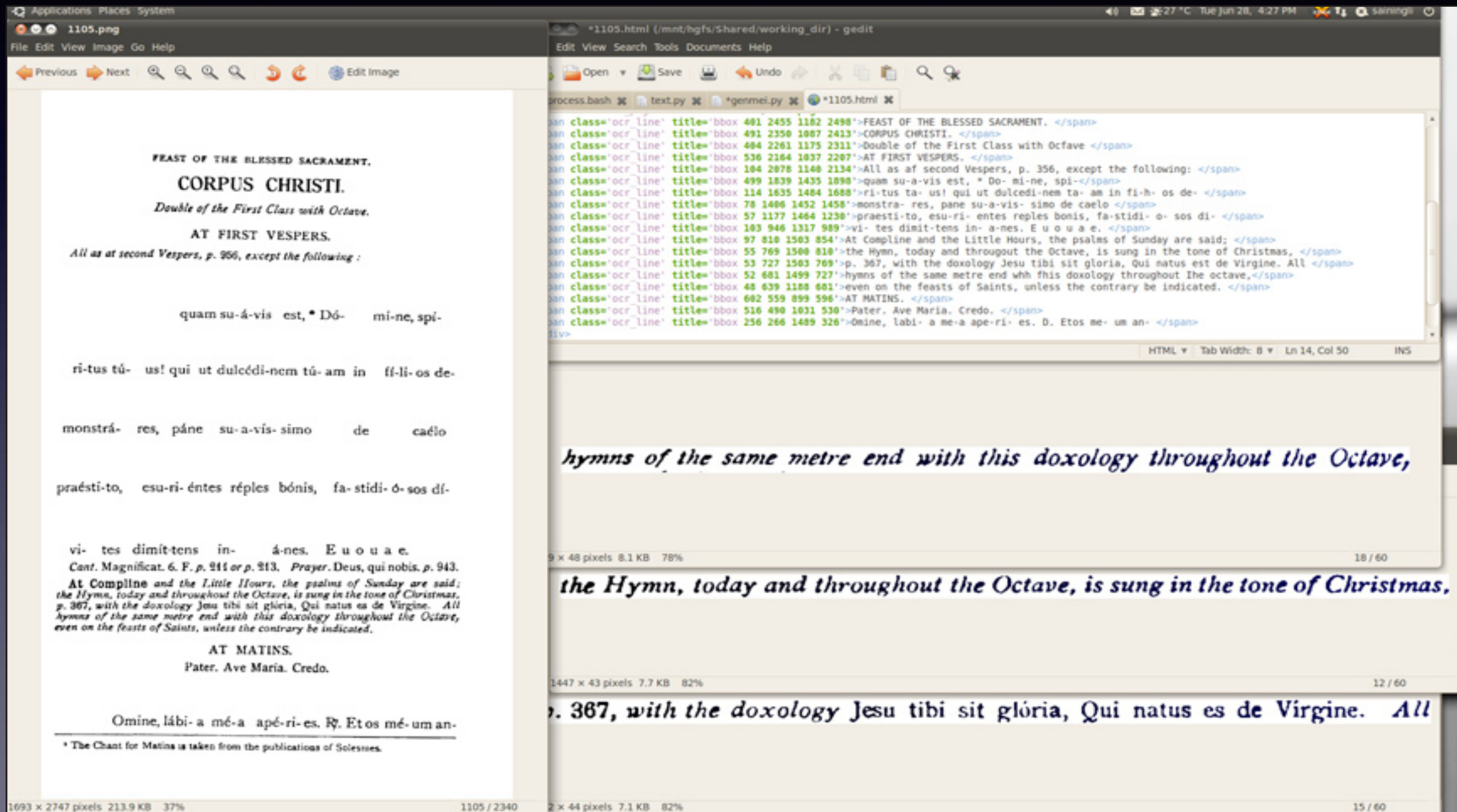
†. **D** Omine, lábi-a mé-a apé-ri-es. R̃. Et os mé-um an-

† The Chant for Matins is taken from the publications of Solesmes.

Music recognition: *Gamera*



Text recognition: Ocropus



The image displays a text recognition workflow using Ocropus. On the left, a scanned image of a liturgical page is shown. On the right, the corresponding HTML-annotated version is displayed, with various text elements highlighted and labeled with bounding boxes and titles.

FEAST OF THE BLESSED SACRAMENT.
CORPUS CHRISTI.
Double of the First Class with Octave.
AT FIRST VESPERS.
All as at second Vespers, p. 356, except the following:

quam su-á-vis est, * Dó- mi-ne, spi-
 ri-tus tú- us! qui ut dulcédi-nem tú- am in fí-li- os de-
 monstra- res, páne su-a-vis- simo de caelo
 praesti-to, esu-ri-éntes réples bónis, fa- stidi- ó- sos dí-
 vi- tes dimit-tens in- á-nes. E u o u a e.
Cant. Magnificat. 6. F. p. 911 or p. 913. Prayer. Deus, qui nobis. p. 943.
At Compline and the Little Hours, the psalms of Sunday are said; the Hymn, today and throughout the Octave, is sung in the tone of Christmas, p. 367, with the doxology Jesu tibi sit gloria, Qui natus es de Virgine. All hymns of the same metre end with this doxology throughout the Octave, even on the feasts of Saints, unless the contrary be indicated.
AT MATINS.
 Pater. Ave Maria. Credo.
 Omine, lábi- a mé- a apé-ri- es. R. Et os mé- um an-
 * The Chant for Matins is taken from the publications of Solesmes.

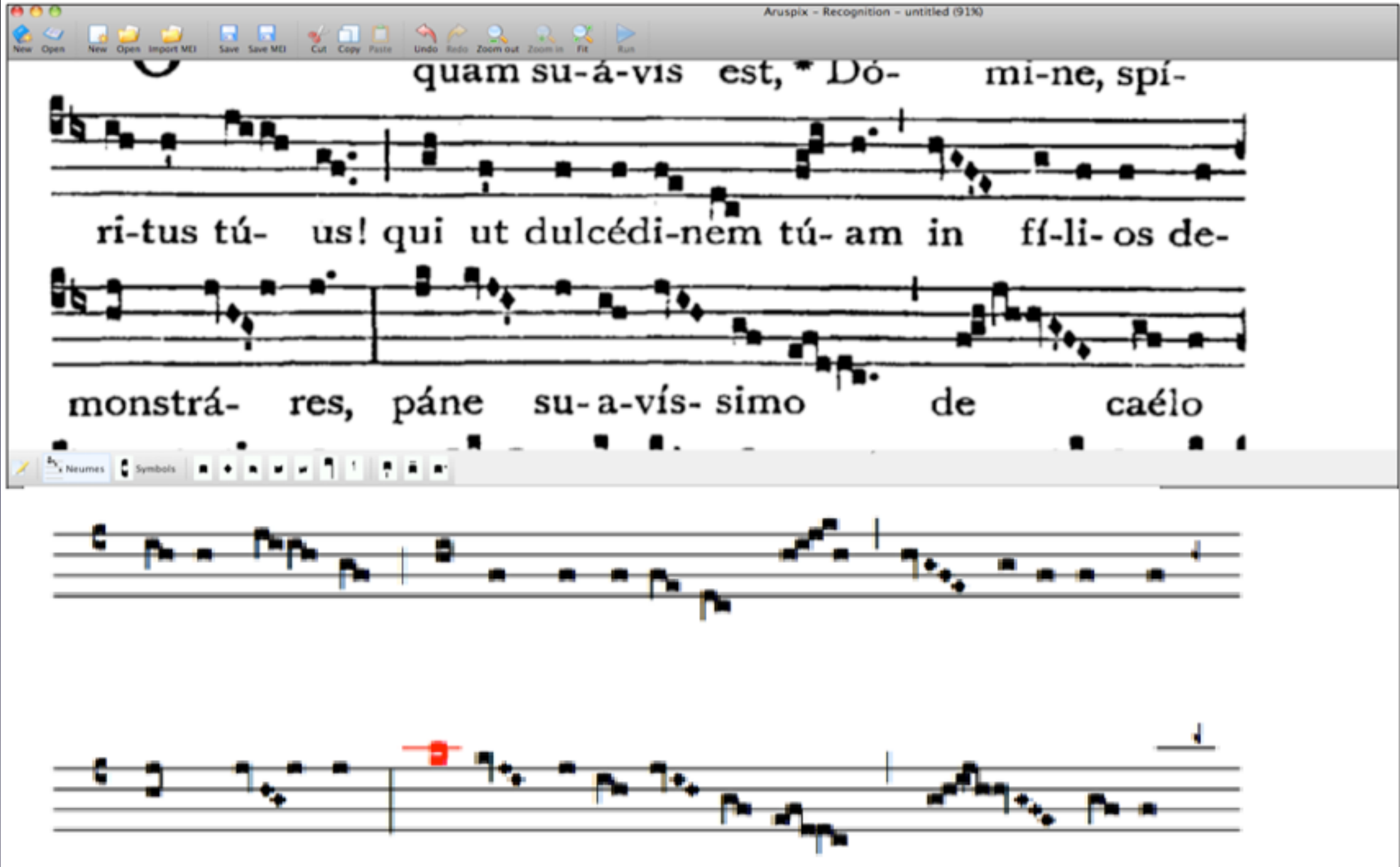
**FEAST OF THE BLESSED SACRAMENT. **
**CORPUS CHRISTI. **
**Double of the First Class with Octave **
**AT FIRST VESPERS. **
*All as at second Vespers, p. 356, except the following: *
*quam su-a-vis est, * Do- mi-ne, spi- *
*ri-tus ta- us! qui ut dulcedi-nem ta- am in fi-h- os de- *
*monstra- res, pane su-a-vis- simo de caelo *
*praesti-to, esu-ri- entes reples bonis, fa-stidi- o- sos di- *
*vi- tes dimit-tens in- a-nes. E u o u a e. *
*At Compline and the Little Hours, the psalms of Sunday are said; *
*the Hymn, today and throughout the Octave, is sung in the tone of Christmas, *
*p. 367, with the doxology Jesu tibi sit gloria, Qui natus est de Virgine. All *
*hymns of the same metre end whh this doxology throughout the octave, *
*even on the feasts of Saints, unless the contrary be indicated. *
**AT MATINS. **
**Pater. Ave Maria. Credo. **
**Omne, labi- a me-a ape-ri- es. D. Etos me- um an- **

hymns of the same metre end with this doxology throughout the Octave,

the Hymn, today and throughout the Octave, is sung in the tone of Christmas,

p. 367, with the doxology Jesu tibi sit glória, Qui natus es de Virgine. All

Pitch correction: *Aruspix*



The screenshot displays the Aruspix software interface, titled "Aruspix - Recognition - untitled (913)". The interface features a menu bar with options: New, Open, New Open, Import MEI, Save, Save MEI, Cut, Copy, Paste, Undo, Redo, Zoom out, Zoom in, Fit, and Run. The main area shows three staves of musical notation with square notes. The lyrics are: "quam su-á-vis est, * Dó-mi-ne, spí-ri-tus tú-us! qui ut dulcédi-nem tú-am in fí-li-os de-monstrá-res, páne su-a-vís-simo de caélo". Below the staves, there is a toolbar with "Neumes" and "Symbols" buttons, followed by a row of icons representing different musical symbols.

Web interface: *Diva.js*

FEAST OF THE BLESSED SACRAMENT.
CORPUS CHRISTI.
Double of the First Class with Octave.
AT FIRST VESPERS.
All as at second Vespers, p. 956, except the following :

At Magn.
Ant. 6. F

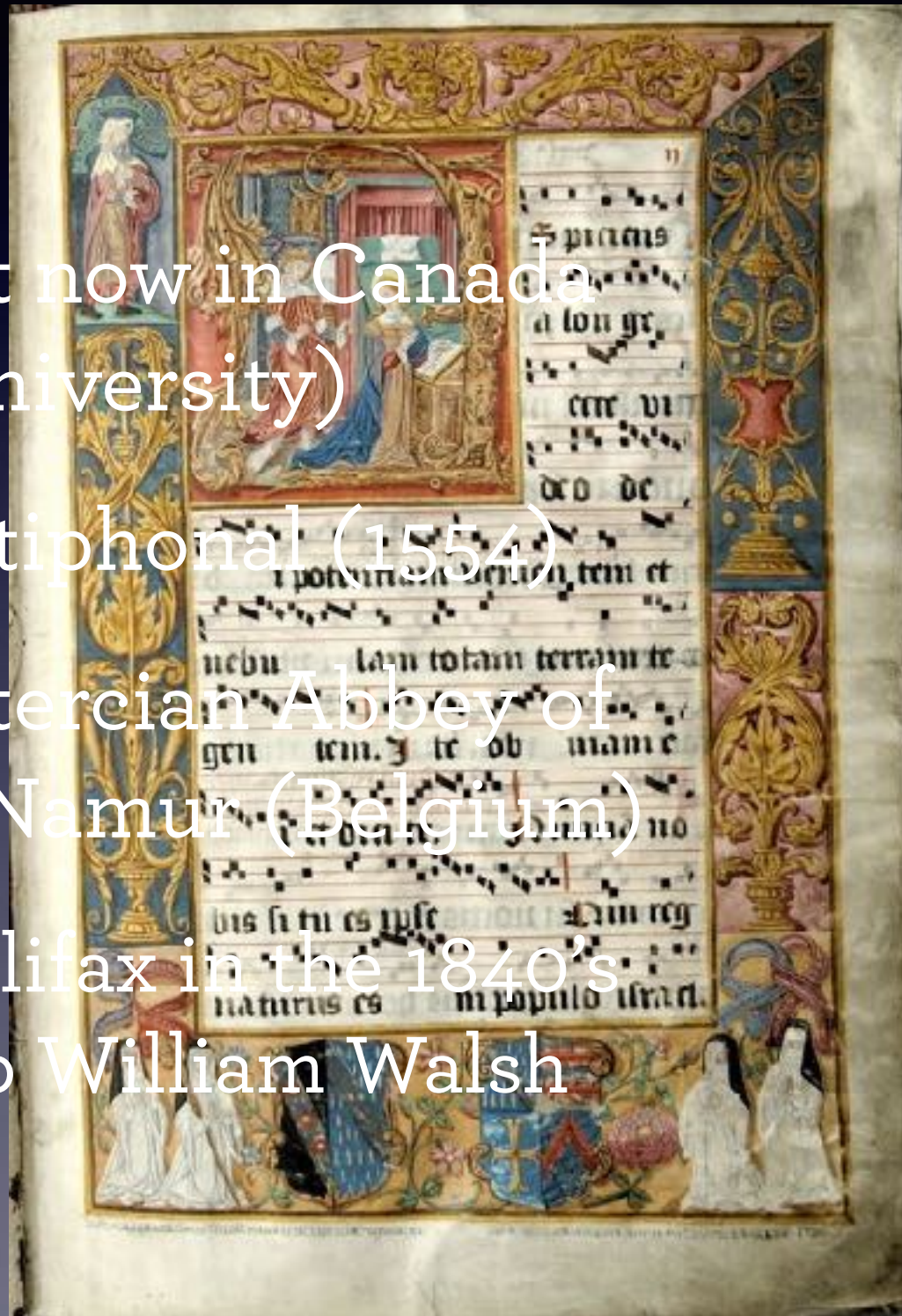
O quam su-á-vis est, * Dó- mi-ne, spí-
ri-tus tú- us! qui ut dulcédi-nem tú- am in fí-li- os de-
monstrá- res, páne su-a-vís- simo de caélo

FGACA Strict pitch sequence Search Clear

previous Found 77 results for FGACA next

2012: *Salzinnes* Project

- ❖ A manuscript now in Canada (St. Mary's University)
- ❖ *Salzinnes* Antiphonal (1554)
- ❖ From the Cistercian Abbey of *Salzinnes* in Namur (Belgium)
- ❖ Brought to Halifax in the 1840's by Archbishop William Walsh



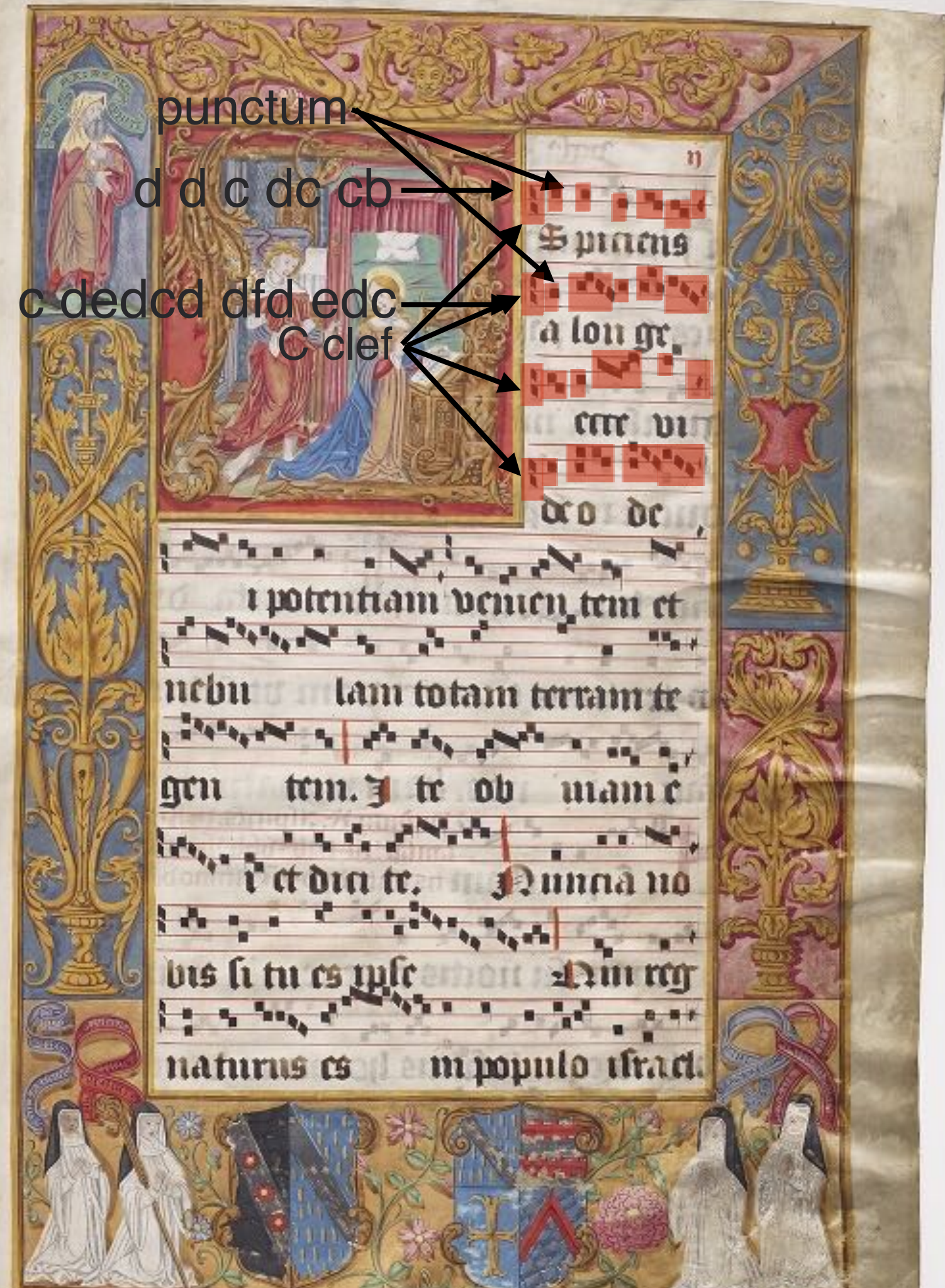
2013: Rodan

Andrew Hankinson

❖ Rodan: Remote Online Document Analysis Network

❖ We
rec





Greyscale

Binarization

Border Removal

Lyric Removal

Staff Removal

Shape Classification

Music Reconstruction

Shape/Image Alignment



Layout Analysis

Calvo's Method

Greyscale

Binarization

Border Removal

Lyric Removal

Staff Removal

Shape Classification

Music Reconstruction

Shape/Image Alignment

Three Different Outputs in One Step! Using Deep Neural Networks



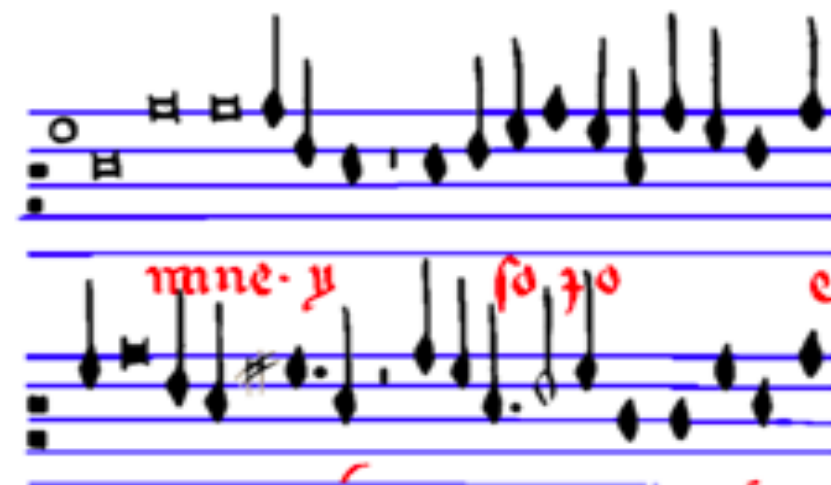
(a) Input image



(b) Binarization



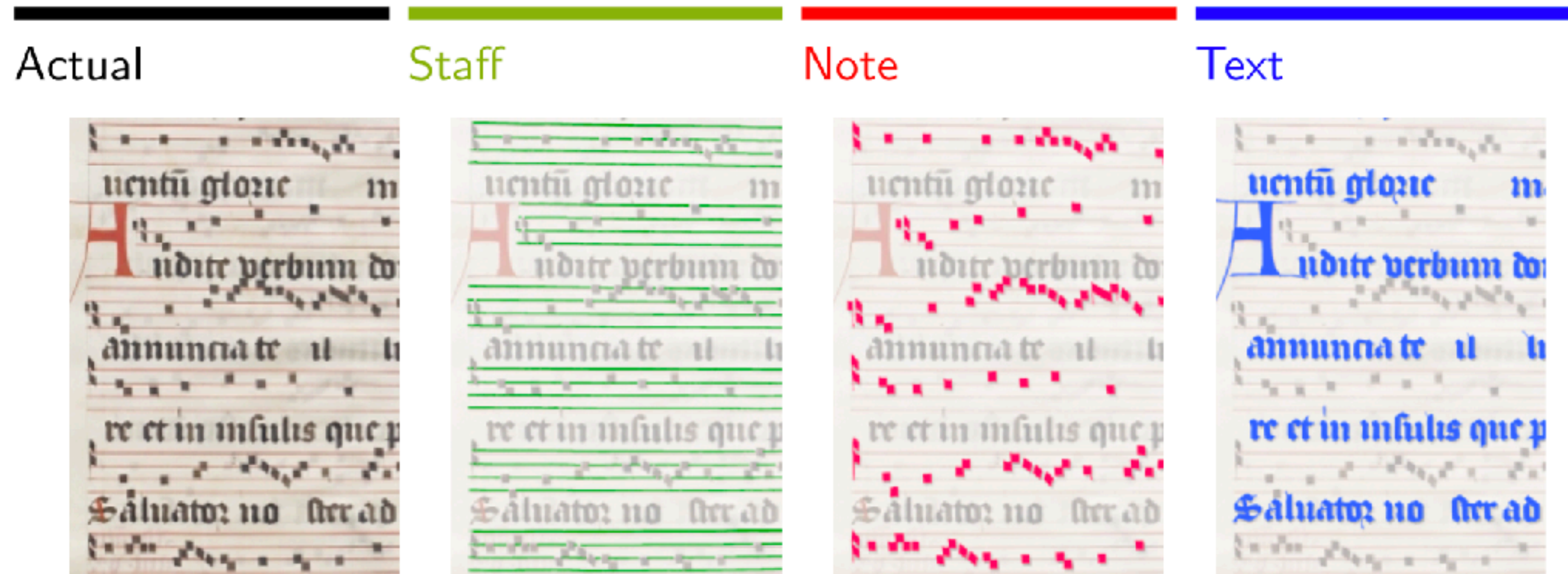
(c) Text detection



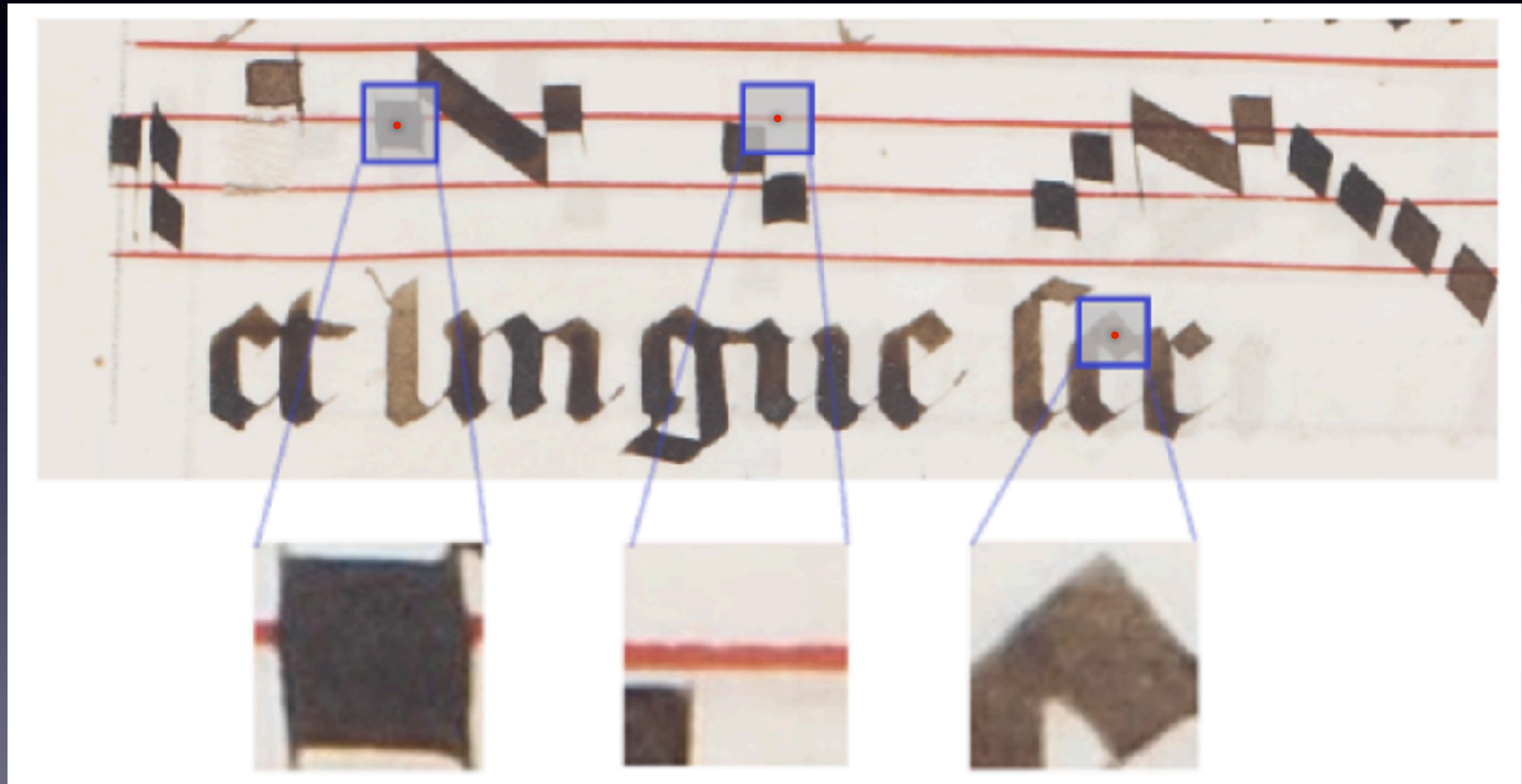
(d) Staff-line detection

Separation of Staves, Notes & Texts

Jorge Calvo Zaragoza • Paco Castellanos

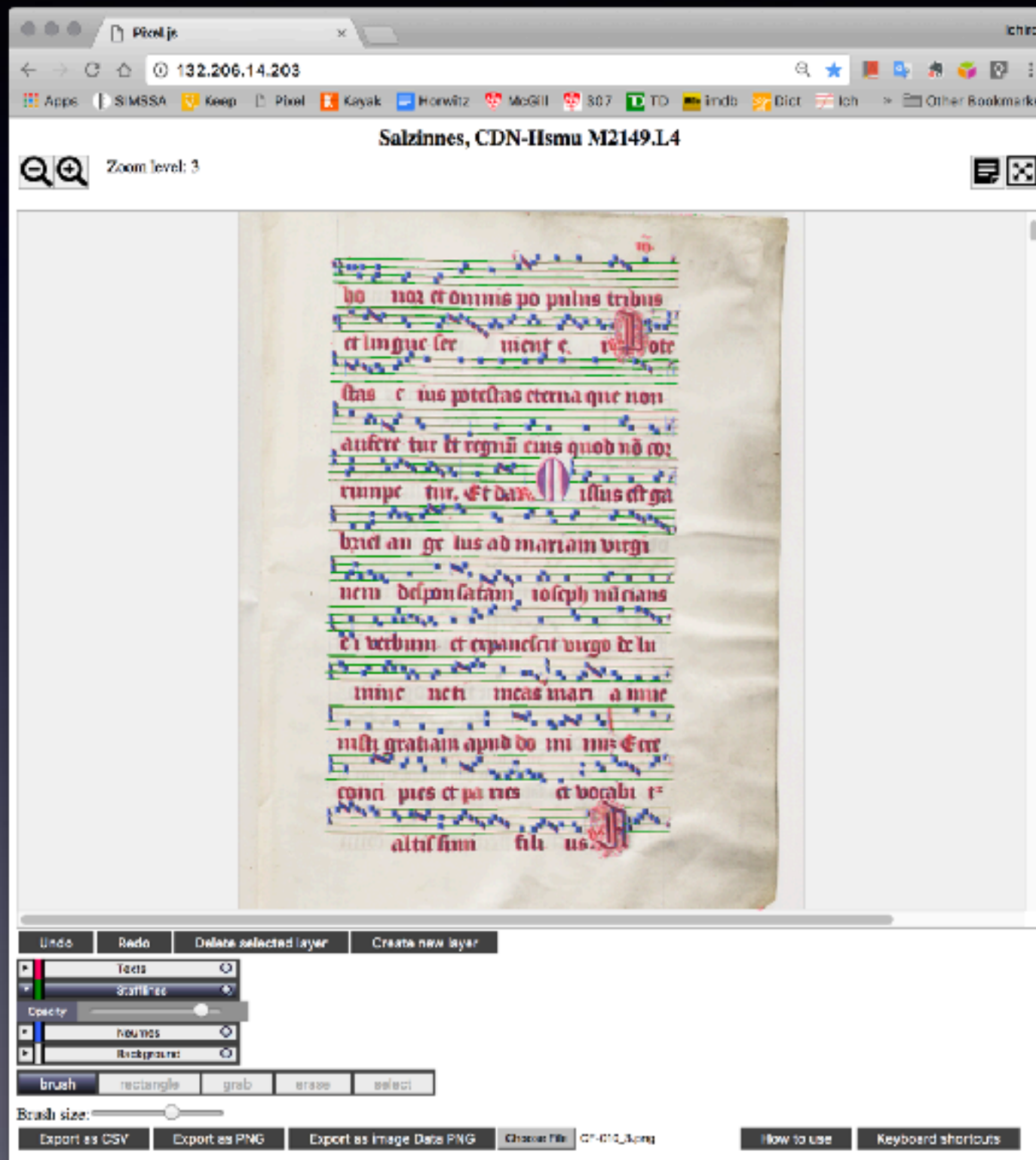


Creating the Ground Truth

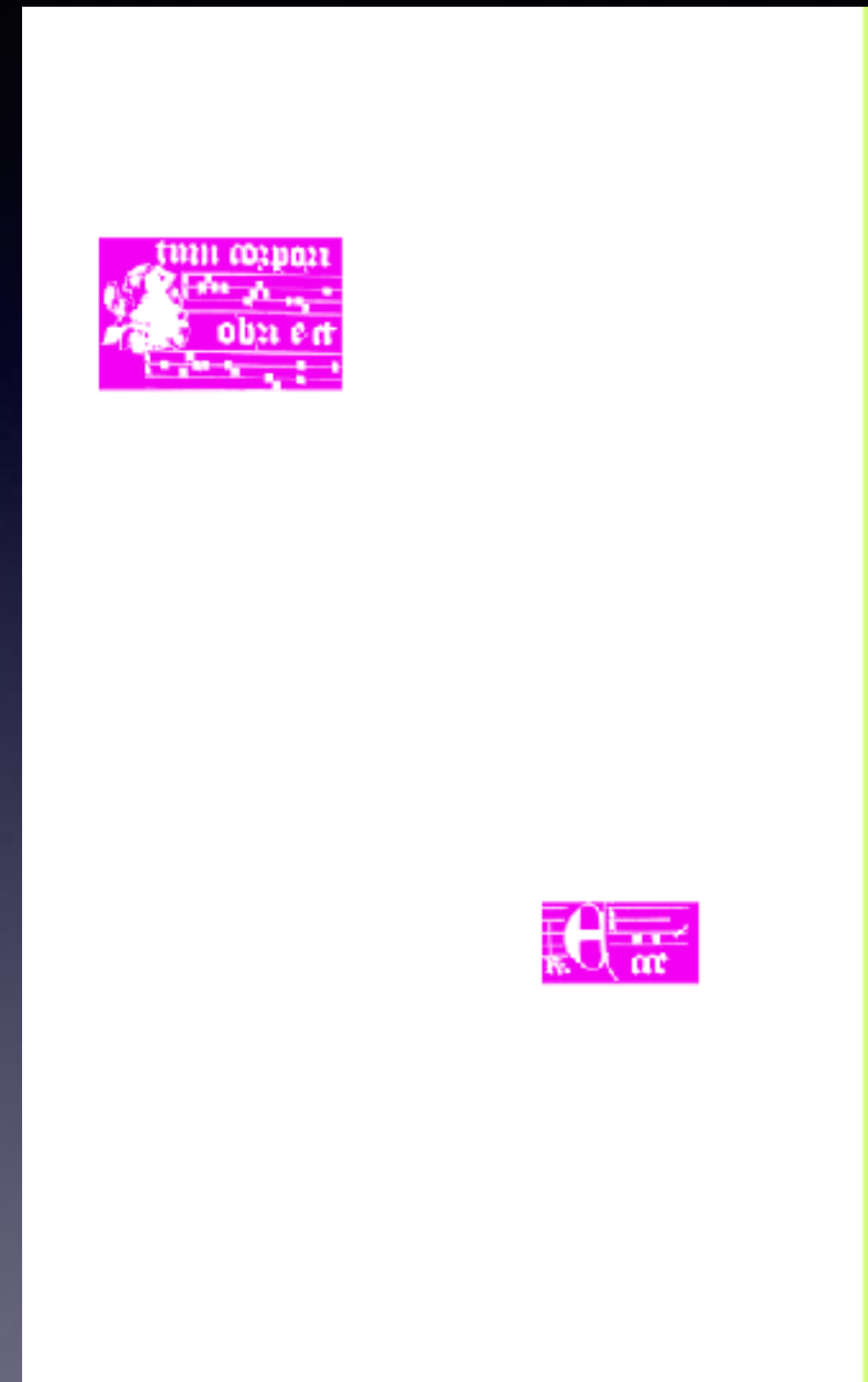
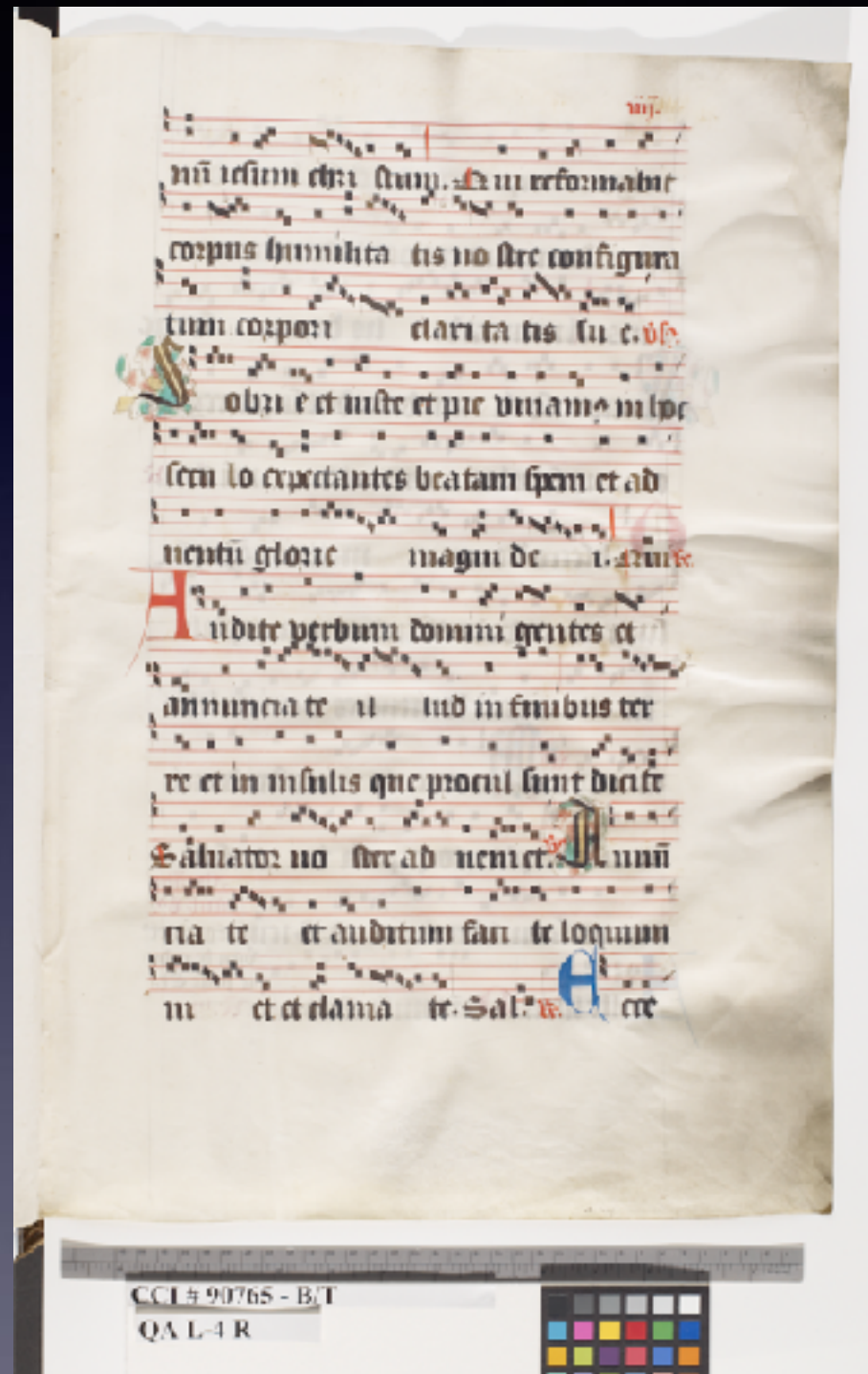


Pixel.js: Ground Truth Creator

Zeyad Saleh, Ké Zhang & Eric Liu



Partial Creation of Ground Truth



To classify over 30 million pixels: 3 days (24 hours)!

Ground Truth



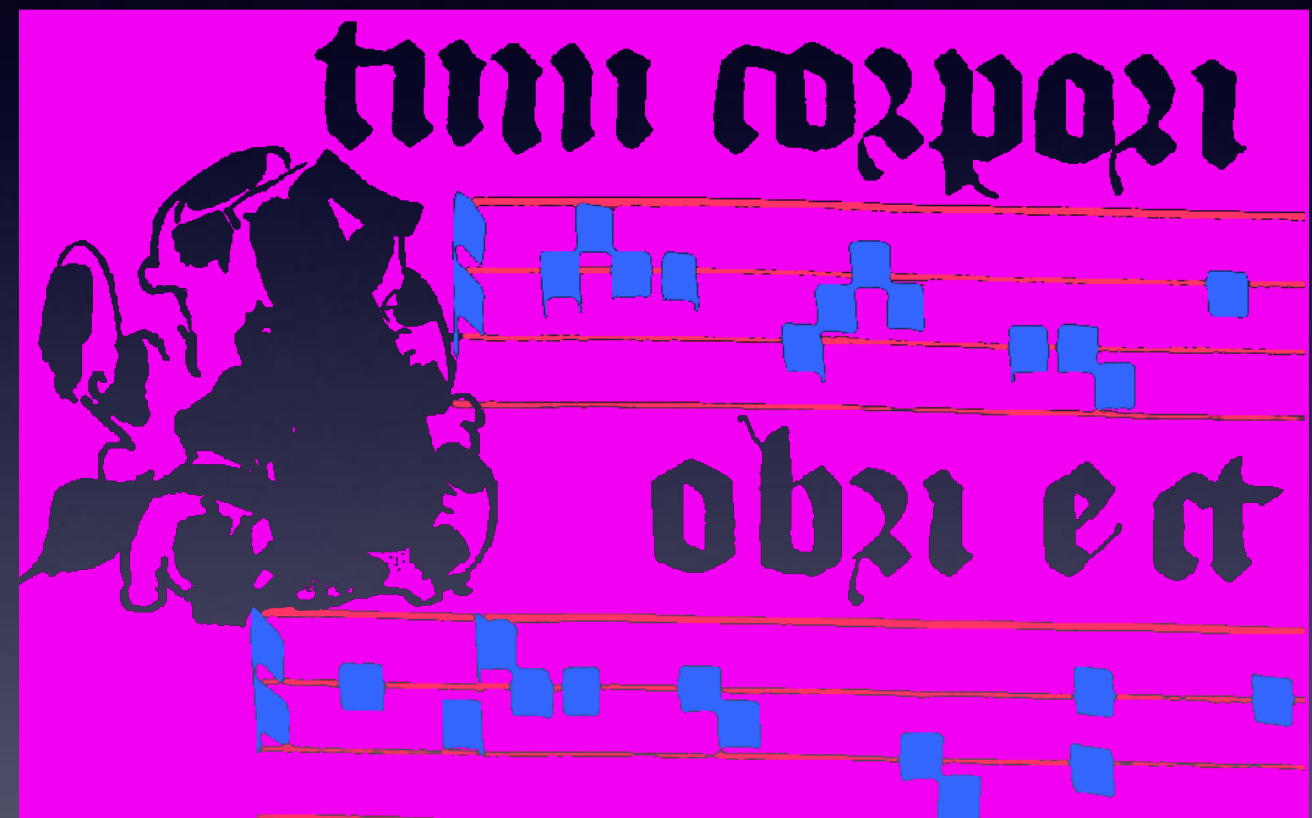
tini coxpozi

obzi et

Original Image & Ground Truth

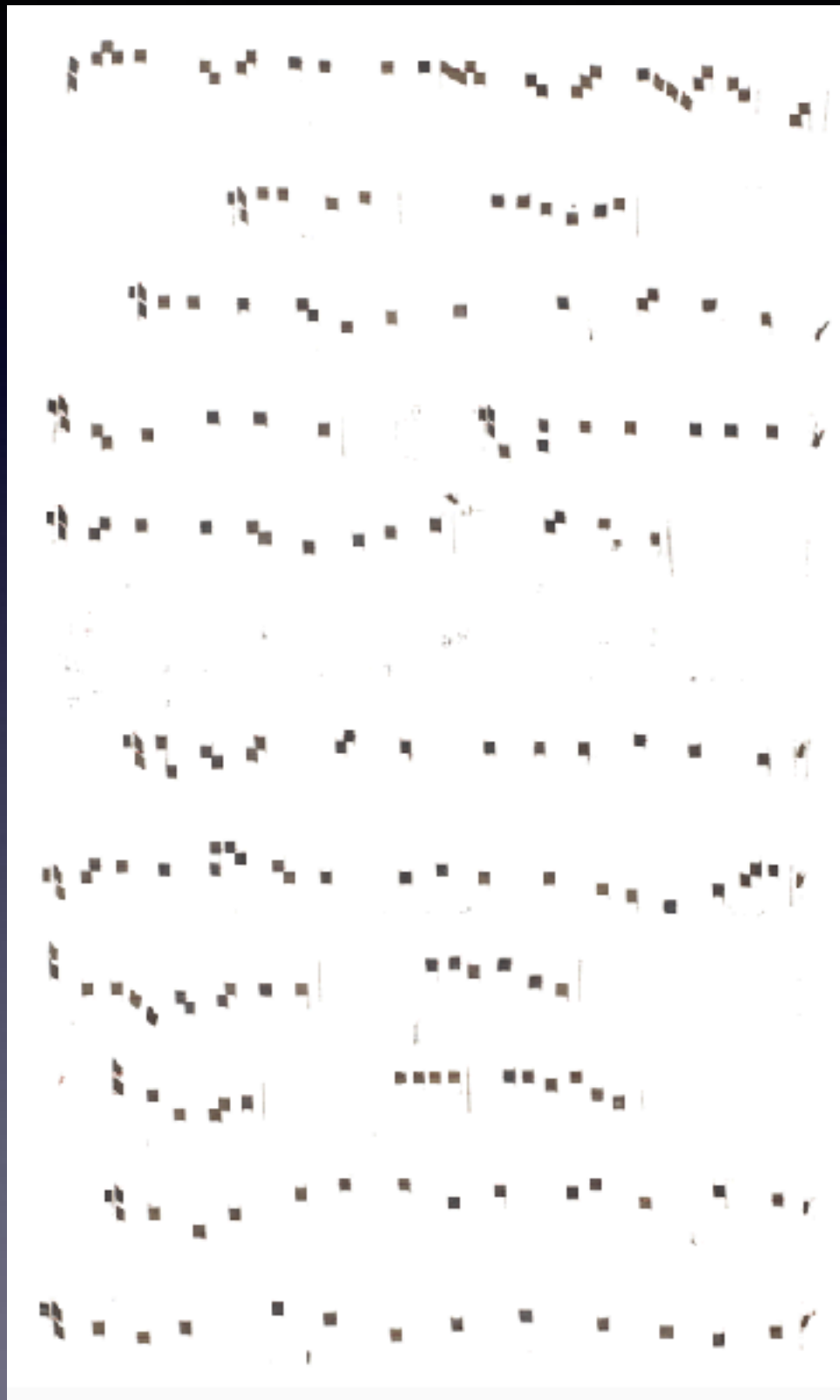


Original Image



Ground Truth

Classification of a Page: Notes



Classification of a Page: with Staves

VI.

flecte quia cito veniet salus tu a. Dis.

In laud. Anti. **A**lleluia. ps. Misereere mei. V. "

Ueni ad liberandum nos. Domine

deus virtutum. V. **E**t ostende faciem

tuam et salvi erimus. Domine. V. "

Splendor paternae. V. **E**mitte agnū domine

dominatorei terre. De petra deserti ad montem

filie syon. Ad benedictus Antiphona.

Spiritus sanctus in te descendet ma

ria ne ti meas habebis in utero filius

dei alleluia. V. Benedictus. Ad p̄mā. an

Alleluia. ps. Beati immaculati. V. "

Conditor alme siderum eterna lux cre

dentium christe redemptor omnium ex



Classification of a Page

VI.

flere quia cito veniet salus tu a. Dis.

In laud. Anti. **A**lleluia. ps. Misereere mei. V. m.

Quem ad liberandum nos. Domine

deus virtutum. V. **E**t ostende faciem

tuam et salui erimus. Domine. V. m.

Splendor paternae. V. m. **E**mitte agnū domine

dominatorem terre. De petra deserti ad montem

filie syon. Ad benedictus Antiphona.

Spiritus sanctus in te descendet ma

ria ne ti meas habebis in utero filius

dei alleluia. m. Benedictus. Ad p̄mā. aū

Alleluia. ps. Beati immaculati. V. m.

Conditor alme siderum eterna lux cre

dentium christe redemptor omnium ex

VI.

flere quia cito veniet salus tu a. Dis.

In laud. Anti. **A**lleluia. ps. Misereere mei. V. m.

Quem ad liberandum nos. Domine

deus virtutum. V. **E**t ostende faciem

tuam et salui erimus. Domine. V. m.

Splendor paternae. V. m. **E**mitte agnū domine

dominatorem terre. De petra deserti ad montem

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dei alleluia. m. Benedictus. Ad p̄mā. aū

Alleluia. ps. Beati immaculati. V. m.

Conditor alme siderum eterna lux cre

dentium christe redemptor omnium ex

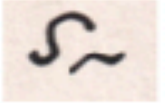
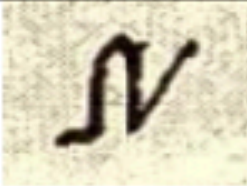
Minh Anh Nguyen

SIMSSA | Single Interface for Music
Score Searching and Analysis



- ❖ The Music Encoding Initiative (MEI) is a community-driven effort to define a system for encoding musical documents in a machine-readable file format (XML).
- ❖ In development since 1999.
- ❖ MEI is based on Text Encoding Initiative (TEI).
- ❖ MEI is an alternative to MusicXML.

Neume Mapping Table to MEI

Torculus 3				
3 pitches: n-h-l				
	21,5 (10r) pleritudine m	Torculus	neume.torculus	<pre><neume> <nc tilt= "e" /> <nc angled= "true" tilt= "n" intm= "u" /> <nc tilt= "se" intm= "d" /> </neume></pre>
	21,5 (10r) tua	Torculus	neume.torculus	<pre><neume> <nc curve= "a" /> <nc tilt= "nw" intm= "u" /> <nc curve= "c" intm= "d" /> </neume></pre>
	21,5 (10r) et	Torculus melodic	neume.torculus	<pre><neume> <nc tilt= "e" /> <nc angled= "true" tilt= "n" intm= "u" /> <nc tilt= "se" intm= "d" rel_len= "1" /> </neume></pre>
		Torculus	neume.torculus	<pre><neume> <nc curve= "a" /> <nc tilt= "n" intm= "u" curve= "c" /> <nc con= "g" tilt= "ne" angled= true intm= "d" /> </neume></pre>
Torculus resupinus 4				
4 pitches: n-h-l-h				
	21,12 (10r) nostrum	Torculus resupinus	neume.torculus_resupinus	<pre><neume> <nc tilt= "e" /> <nc tilt= "n" angled= "true" intm= "u" /> <nc tilt= "s" intm= "d" /> <nc angled= "true" tilt= "ne" intm= "u" /> </neume></pre>
	22,13 (10v) tribaisti	Torculus resupinus	neume.torculus_resupinus	<pre><neume> <nc curve= "a" /> <nc tilt= "n" intm= "u" /> <nc tilt= "se" intm= "d" /> <nc angled= "true" tilt= "ne" intm= "u" /> </neume></pre>

Neume Mapping Tool

Imane Chafi

[Home](#)
[New neume](#)
[About us](#)
[Contact](#)
[Help](#)
[Log-out](#)
[User1](#)

Punctum

Images:



Name:

Punctum

Folio:

1/r9

Description:

Punctum

Classification:

neume.punctum

Update

Delete

Mei Snippet:

```

1 //mei snippet for neume.punctum
2 - <neume>
3 -   <nc>
4 ⚠ </neume>

```

Pes

Images:



Name:

Pes

Folio:

1r3, 1r5

Description:

Classification:

neume.pes.b.3

Update

Delete

Mei Snippet:

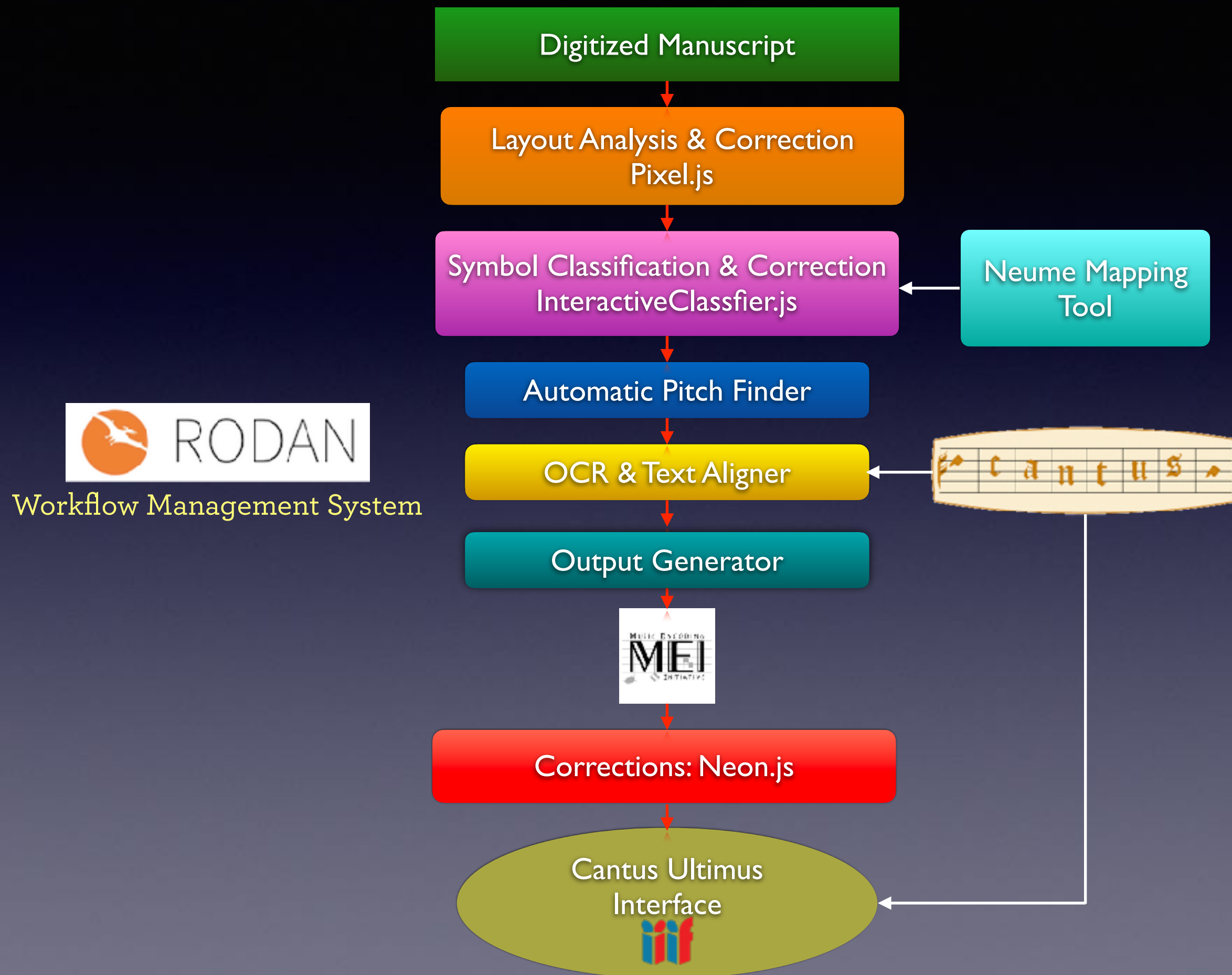
```

1 //mei snippet for neume.pes.b.3
2 - <neume>
3   <nc/>
4   <nc intm = "25"/>
5 </neume> <
6 ⚠

```

element parse error: Error: invalid tagName:

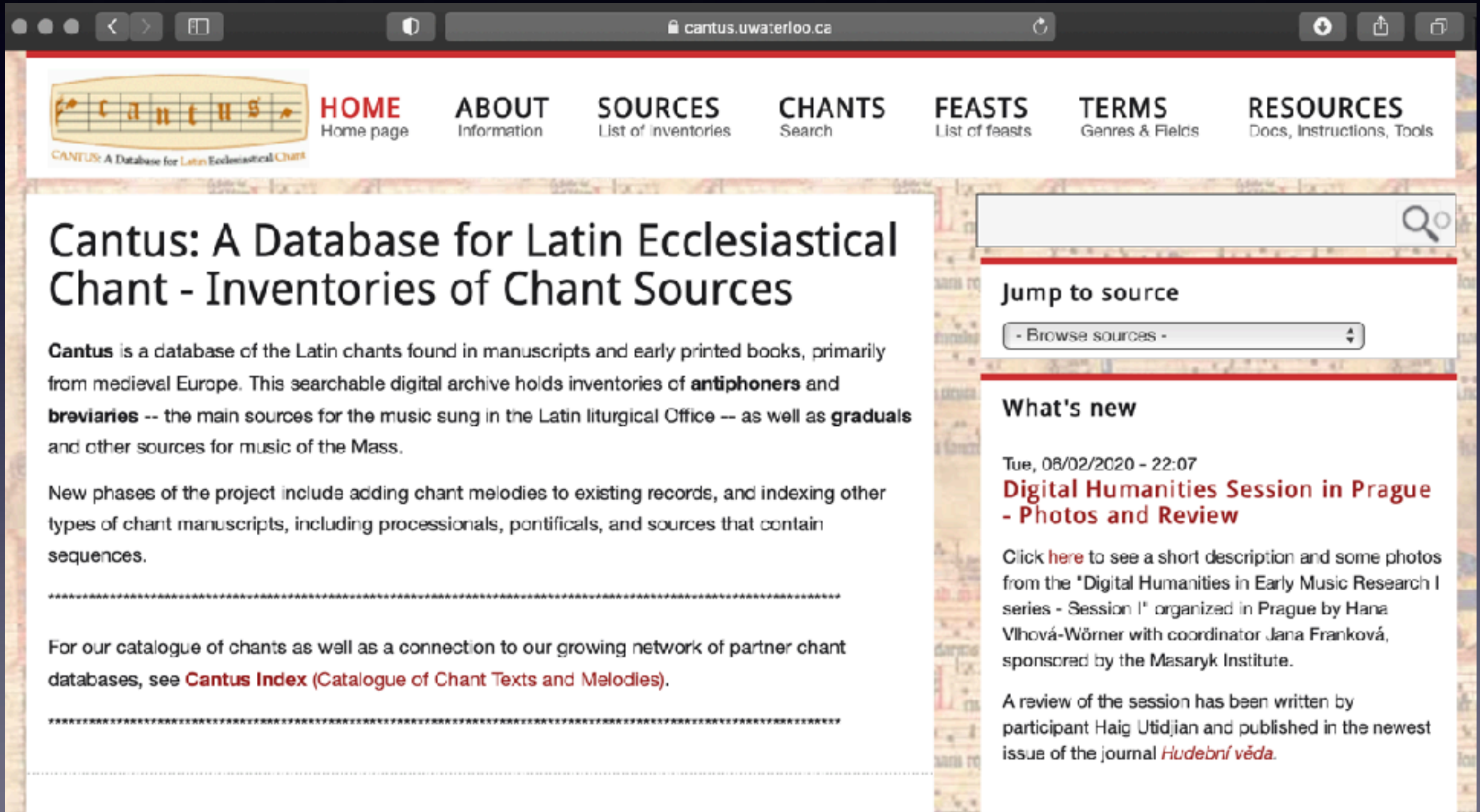
SIMSSA Workflow for Neume Notation



Cantus Database

Debra Lacoste • Jan Kolářek • Jennifer Bain

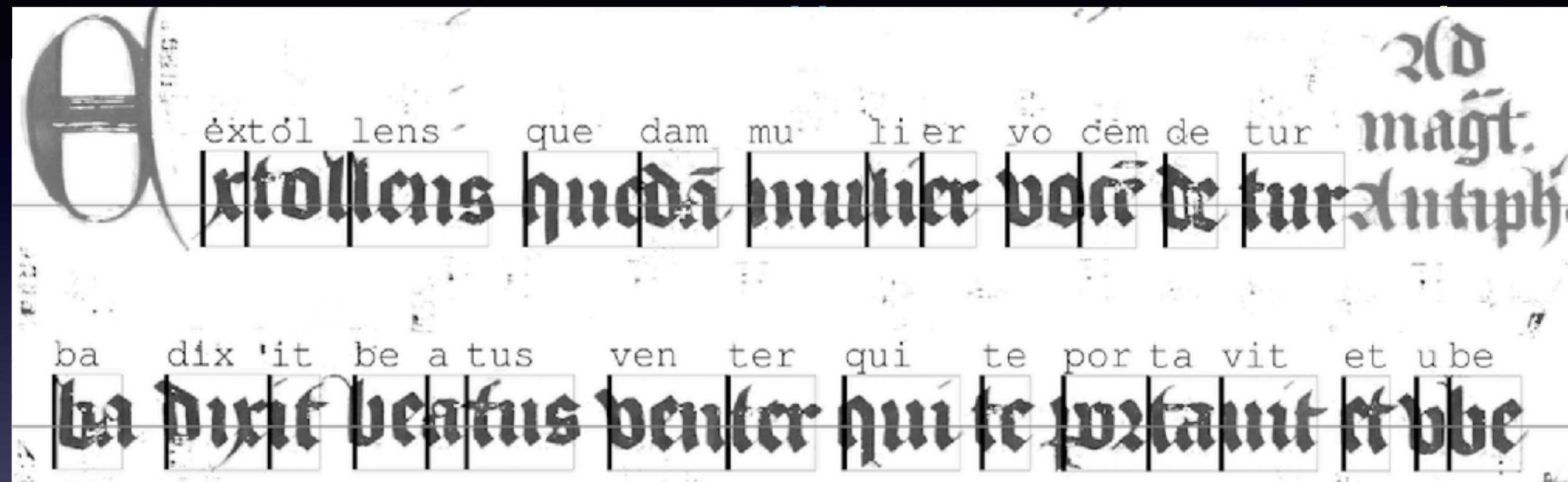
Junhao Wang • Jacob deGroot-Maggetti



The screenshot shows the Cantus Database website interface. At the top, there is a navigation bar with links: HOME (Home page), ABOUT (Information), SOURCES (List of inventories), CHANTS (Search), FEASTS (List of feasts), TERMS (Genres & Fields), and RESOURCES (Docs, Instructions, Tools). Below the navigation bar is a search bar and a "Jump to source" dropdown menu set to "- Browse sources -". The main content area features the title "Cantus: A Database for Latin Ecclesiastical Chant - Inventories of Chant Sources" and a description: "Cantus is a database of the Latin chants found in manuscripts and early printed books, primarily from medieval Europe. This searchable digital archive holds inventories of **antiphoners** and **breviaries** -- the main sources for the music sung in the Latin liturgical Office -- as well as **graduals** and other sources for music of the Mass." It also mentions new phases of the project and provides a link to the "Cantus Index (Catalogue of Chant Texts and Melodies)". On the right side, there is a "What's new" section dated Tue, 08/02/2020 - 22:07, announcing a "Digital Humanities Session in Prague - Photos and Review" and providing a link to see a short description and photos from the "Digital Humanities in Early Music Research I series - Session I" organized in Prague by Hana Vihová-Wörner with coordinator Jana Franková, sponsored by the Masaryk Institute. It also mentions a review of the session by participant Haig Utidjian published in the journal *Hudební věda*.

OCR & Text Aligner

Timothy de Reuse



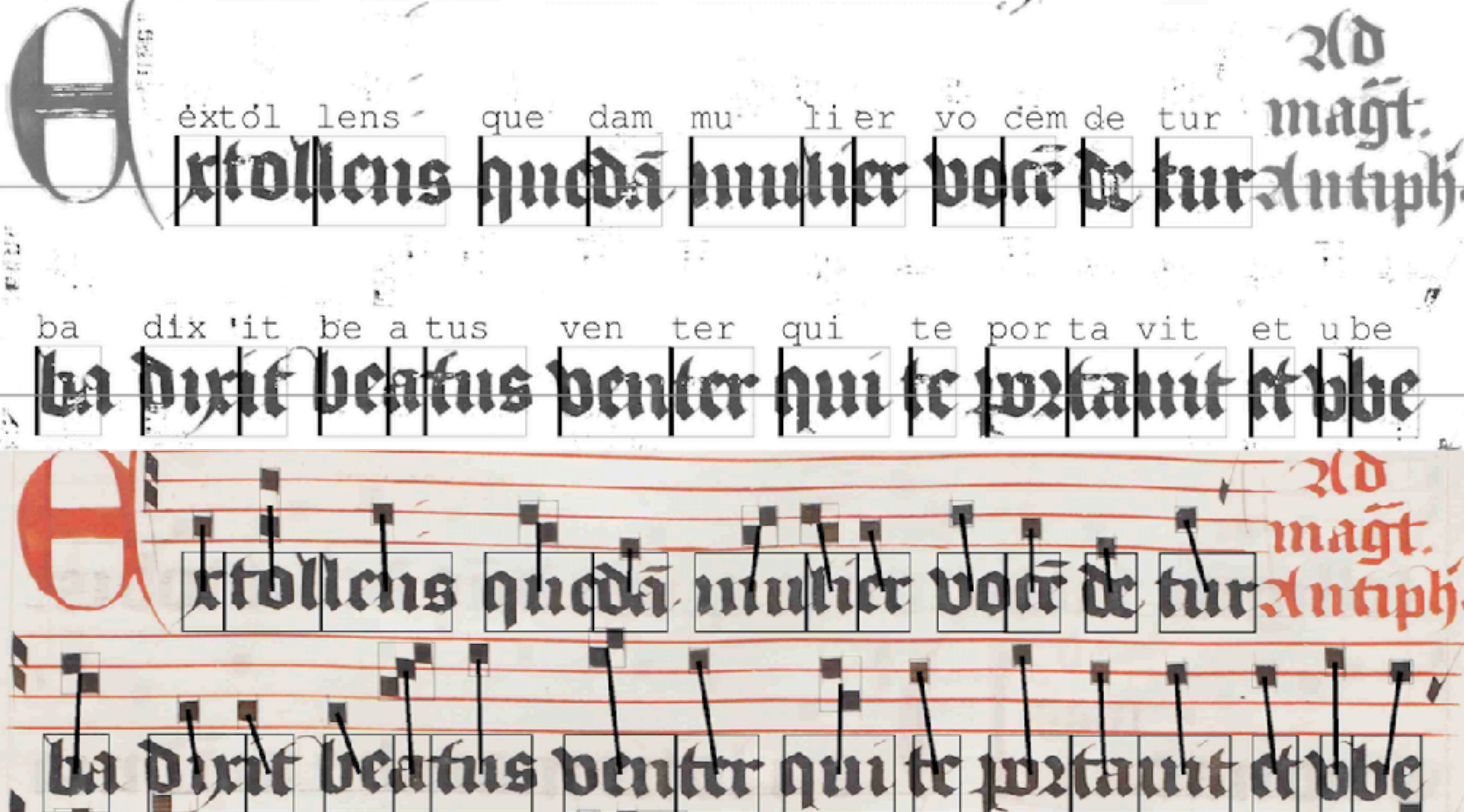
From Cantus Database

Extollens quaedam mulier vocem de tur-
ba dixit beatus venter qui te portavit et ube...

- ❖ OCR used: OCRopus (recurrent neural network: LSTM)
- ❖ Sequence alignment: Needleman-Wunsch algorithm

OCR & Text Aligner

Timothy de Reuse



extol lens que dam mu li er vo cem de tur magt. Antiph.

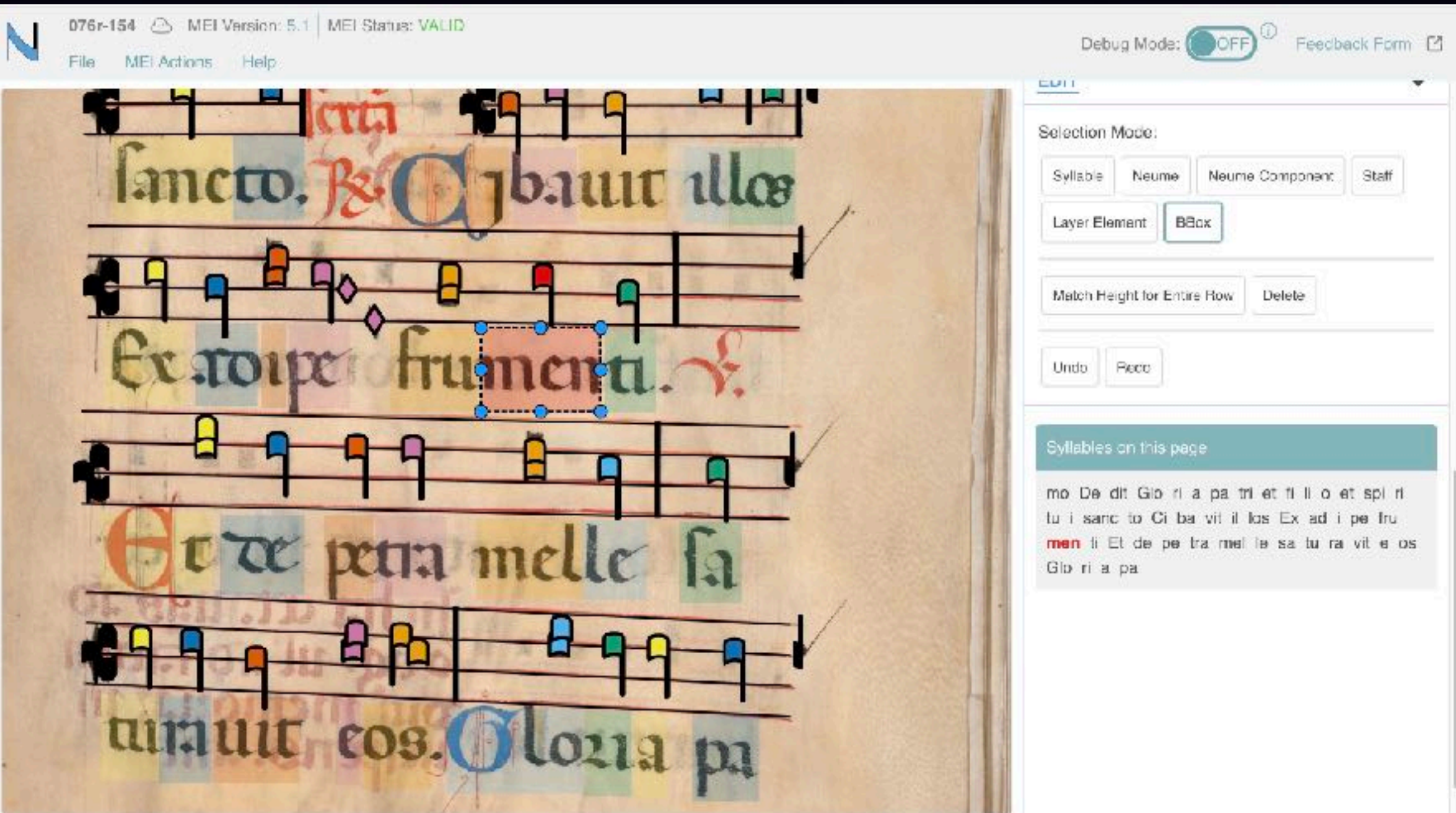
ba dix it be a tus ven ter qui te por ta vit et ube

extol lens que dam mu li er vo cem de tur magt. Antiph.

ba dix it be a tus ven ter qui te por ta vit et ube

Neume Editor ONline: Neon

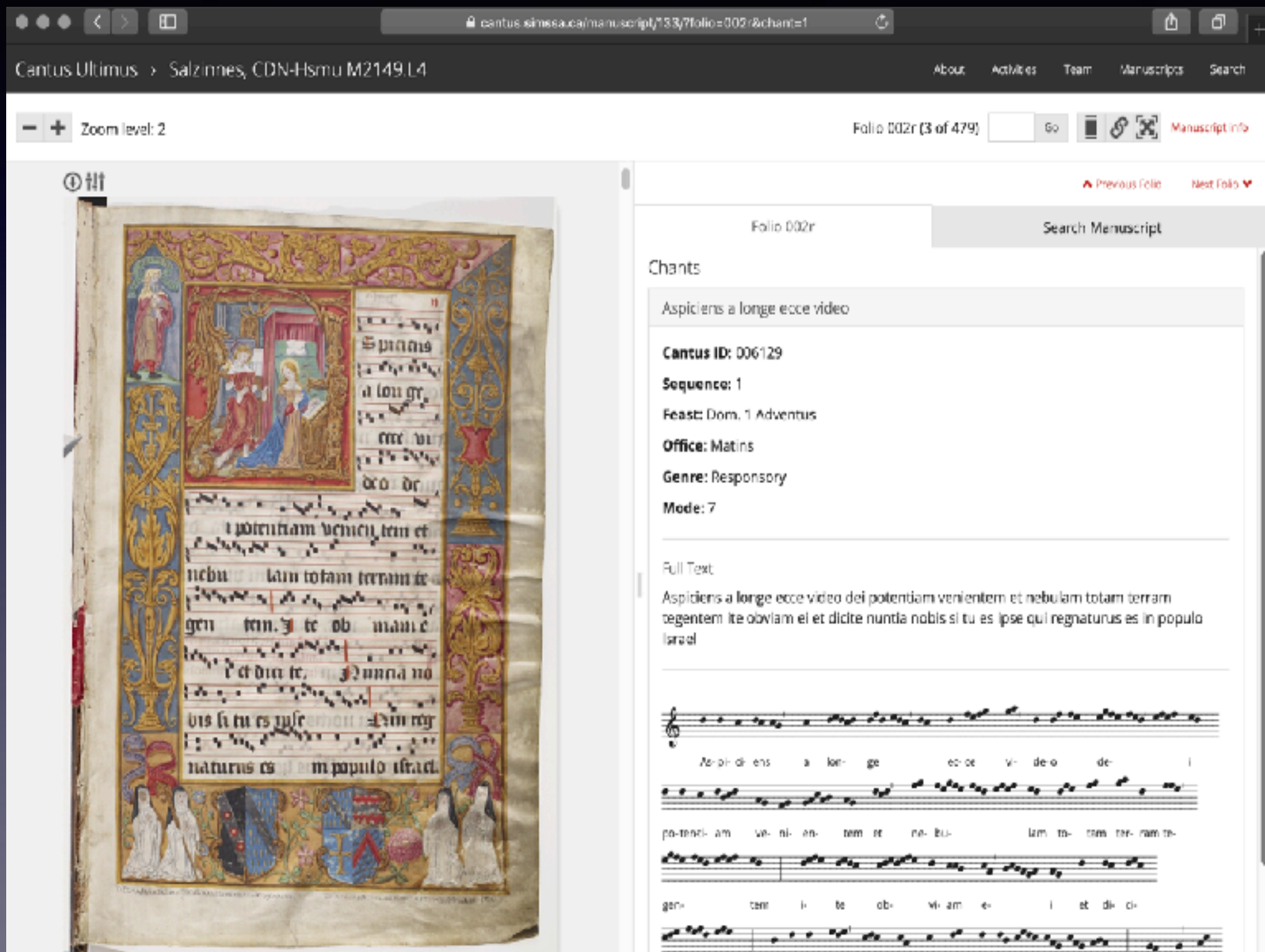
Juliette Regimbal • Caitlin Hutnyk • Yinan Zhou



The screenshot displays the Neon Neume Editor interface. On the left, a manuscript page is shown with neumes (colored square notes) on staves and Latin text in Gothic script. The text includes "sancto. & Cibaui illos", "Ex roipe frumenti.", "Et de petra melle fa", and "tumult eos. Gloria pa". The interface includes a top menu bar with "File", "MEI Actions", and "Help". A status bar at the top indicates "076r-154", "MEI Version: 5.1", and "MEI Status: VALID". On the right, a sidebar contains a "Debug Mode" toggle (set to OFF), a "Feedback Form" link, and an "EDIT" section. The "EDIT" section includes a "Selection Mode" dropdown with options: Syllable, Neume, Neume Component, Staff, Layer Element, and BBox. Below these are buttons for "Match Height for Entire Row" and "Delete". At the bottom of the sidebar, there are "Undo" and "Redo" buttons. A "Syllables on this page" section lists the following text: "mo De dit Glo ri a pa tri et fi li o et spi ri tu i sanc to Ci ba vit il los Ex ad i pe tru men ti Et de pe tra mel le sa tu ra vit e os Glo ri a pa".

Cantus Ultimus Interface

Néstor Nápoles • Dylan Hillerbrand



The screenshot displays the Cantus Ultimus web interface. The browser address bar shows the URL: `cantus.simsa.ca/manuscript/1337/folio=002r&chant=1`. The page title is "Cantus Ultimus > Salzines, CDN-Hsmu M2149.L4". The interface includes a navigation bar with links: "About", "Activities", "Team", "Manuscripts", and "Search". Below the navigation bar, there is a "Zoom level: 2" control and a "Folio 002r (3 of 479)" indicator. The main content area is split into two panels. The left panel shows a high-resolution image of a manuscript page (Folio 002r) with a large, ornate initial 'S' and a full page of musical notation. The right panel displays the digital transcription of the manuscript page. It includes a "Search Manuscript" bar and a "Chants" section. The "Chants" section lists the following information: "Cantus ID: 006129", "Sequence: 1", "Feast: Dom. 1 Adventus", "Office: Matins", "Genre: Responsory", and "Mode: 7". Below this, the "Full Text" section shows the Latin text: "Aspiciens a longe ecce video dei potentiam venientem et nebulam totam terram regentem ite obviam ei et dicite nuntia nobis si tu es ipse qui regnaturus es in populo israel". The text is accompanied by a digital musical score with notes and lyrics.

LinkedMusic

- ❖ Be able to search across various music databases from one website
 - ❖ Database integration using linked data
- ❖ Universal Musical Instrument Lexicon
 - ❖ Create a crowd-sourced website
 - ❖ Images and recordings of musical instruments
 - ❖ Name of the instrument in the local language
- ❖ Funded for 7 years (2022–2029): \$3.2M

LinkedMusic: Co-applicants (7)

- ❖ Jennifer Bain
(Dalhousie University)
- ❖ Housman Behzadi (McGill)
- ❖ Julie Cumming (McGill)
- ❖ Debra Lacoste
(University of Waterloo)
- ❖ Audrey Laplante
(Université de Montréal)
- ❖ Cory McKay
(Marianopolis College)
- ❖ Laurent Pugin (RISM-Digital)

LinkedMusic: Collaborators (18)

- ❖ Rachelle Chiasson-Taylor
(Library and Archives Canada)
- ❖ Julia Craig-McFeely
(Oxford University)
- ❖ Jürgen Diet
(Bavarian State Library)
- ❖ Robin Desmeules (McGill)
- ❖ Simon Dixon
(Queen Mary, University of London)
- ❖ Jon Dunn (Indiana University)
- ❖ Andrew Hankinson (RISM Digital)
- ❖ Johannes Kepper
(University of Paderborn)
- ❖ Kevin Kishimoto
(Stanford University)
- ❖ David Lewis
(Goldsmiths, University of London)
- ❖ Jonathan Manton (Yale University)
- ❖ Kevin Page (University of Oxford)
- ❖ Alastair Porter (UPF / MetaBrainz)
- ❖ Jenn Riley (McGill)
- ❖ Patrick Savage (Keio University)
- ❖ David Weigl (University of Music and
Performing Arts Vienna)
- ❖ Susan Weiss
(Johns Hopkins University)
- ❖ Frans Wiering
(University of Utrecht)

LinkedMusic: Partners (9)

- ❖ Bavarian State Library (Jürgen Diet)
- ❖ British Library
- ❖ Calcul Québec
- ❖ Dalhousie University (Jennifer Bain)
- ❖ MetaBrainz Foundation (Alastair Porter)
- ❖ RISM Digital (Laurent Pugin)
- ❖ Université de Montréal (Audrey Laplante)
- ❖ University of Oxford (Julia Craig-McFeely)
- ❖ University of Waterloo (Debra Lacoste)

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- ❖ Perry Roland (University of Virginia)
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- ❖ Xavier Serra (University of Pompeu Fabra)

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- ❖ Vi-An Tran

❖ Postdoctoral Fellow

- ❖ Anna de Bakker

❖ Graduate Students

- ❖ Kyrie Bouressa

- ❖ Hanwen Zhang

- ❖ Kun Fang

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- ❖ Lucas March

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❖ Researchers

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- ❖ Geneviève Gates-Panneton

- ❖ Yinan Zhou

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- ❖ Antoine Phan
- ❖ Linnea Kirby
- ❖ Mai Lyn Puittinen
- ❖ Sebastien Chow
- ❖ Simon Ngassam
- ❖ Sichen Meng (intern?)
- ❖ Caroline Guo (part time)
- ❖ Zhanna Klimanova (part time)

LinkedMusic.ca

[LinkedMusic](#)[ABOUT](#)[PARTICIPANTS](#)[ACTIVITIES](#)[REFERENCES](#)[VIM](#)[OPPORTUNITIES](#)[CONTACT US](#)

Select Language ▾

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Google

Translate

LinkedMusic

The goal of our new LinkedMusic Partnership is to link music databases through metadata schemas: structures for organizing information stored in a database. This will go a long way towards bringing online music search to the same level of sophistication currently possible for text-based resources, allowing us to answer fundamental questions about music and how it interacts with human creativity, society, culture, and history.

Our goals include:

- Develop a comprehensive international metadata schema for music
- Develop mapping tools to map extant metadata schemas onto our new schema
- Index aggregated metadata to enable simultaneous search of individual databases

For more information, please contact [Ichiro Fujinaga](#).

L'objectif de notre nouveau partenariat LinkedMusic est de lier des bases de données musicales par des schémas de métadonnées, des structures d'organisation de l'information stockées dans une base de données. Ce projet contribuera grandement à amener la recherche de musique en ligne au même niveau de sophistication que la recherche de ressources textuelles, nous permettant ainsi de répondre à des questions fondamentales sur la musique et comment elle interagit avec la créativité, la société, la culture et l'histoire humaines.

Initial 14 Databases

1. RISM
2. DIAMM
3. Cantus Database
4. Cantus Index
5. Cantus Ultimus
6. SIMSSA DB
7. Canadian Chant Database
8. Global Jukebox
9. Dig That Lick
10. MusicBrainz
11. AcousticBrainz
12. CritiqueBrainz
13. ListenBrainz
14. Motet Database

Summary

- ❖ Optical Music Recognition (OMR)
- ❖ SIMSSA (Single Interface for Music Score Searching and Analysis)
 - ❖ Neume notation
 - ❖ Gamera
 - ❖ Rodan
- ❖ LinkedMusic

Dinner on Wednesday Night

❖ 6 pm Kim Fung (second floor, 1111 Rue Saint-Urbain)

Acknowledgements

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Paco Castellanos
Imane Chafi
Jiali Cheng
Remi Chiu
Morgane Ciot
Nat Condit-Schultz
Kemal Conger
Julie Cumming
Alex Daigle
Jacob deGroot-Maggetti
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Anna de Bakker
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Deepanjan Roy
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Martha Thomae
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Vi-An Tran
Finn Upham
Gabriel Vigliensoni
Eli Waksbaum
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Tim Wilfong
Mike Winters
Ling-Xiao Yang
Jinho Yoon
Ké Zhang
Max Zhang
Yinan Zhou

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McGill



Schulich School of Music
École de musique Schulich



Centre for Interdisciplinary Research
in Music Media and Technology



**Fonds de recherche
Société et culture**

Québec



Digital Research
Alliance of Canada

Alliance de recherche
numérique du Canada

Calcul Québec

LinkedMusic Team @McGill: Summer 2024





A Practical Guide to Frontend Dev

Yinan Zhou
DDMAL, McGill University
Training Week 2025 Summer

Outline

- Formatting
- Linting
- Typing
- Testing

Formatting



What is a formatter?

A **formatter** is a tool that automatically rewrites your code to follow a consistent **style** and **formatting** rules.

- Indentation and spacing
- Semicolons
- Single/Double quotes
- Etc.



EditorConfig

Maintains consistent **basic** editor behavior across different IDEs/editors and developers

- Indentation
- Line endings
- Final newline at end of file

Prettier

Automatically formats code to follow a consistent style

- Wrapping
- Spacing
- Quotes
- Semicolons
- Bracket placement
- Etc.

Linting

What is linting?



<https://i.ytimg.com/vi/nE6u9Y2HqFE/maxresdefault.jpg>



What is a linter?

A **linter** is a tool that analyzes your code for **errors**, **bad practices**, or style issues — and often suggests or enforces improvements.

- Syntax errors
- Undefined variables
- Dangerous patterns
- Etc.



ESLint

Popular linter for JavaScript

- Customizable
- Support TypeScript
- Works with Prettier

Typing



TypeScript

JavaScript + types = safer code

- Detects type mismatches
- Great for large codebases

Testing



Cypress E2E Testing

- Tests in a real browser
- Human-readable syntax
- Live debugger and time-travel



Three Phases

1. Set up the application state
2. Take an action
3. Make an assertion about the resulting application state

Introduction to Docker

DDMAL 2025 May

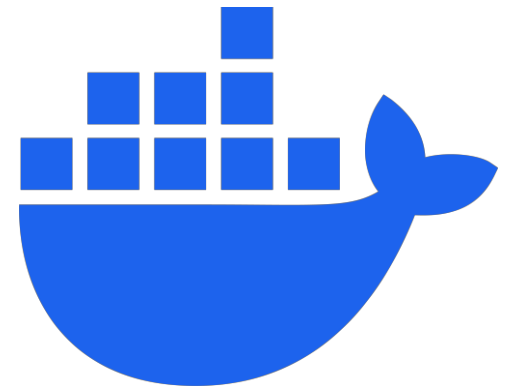
Hanwen Zhang

Outline

- What is Docker?
- Key Docker concepts
- Docker architecture
- Basic Docker commands
- Docker compose, Docker swarm, and Kubernetes
- Docker for Rodan

What is Docker?

- An open-source platform for developing, shipping, and running applications
- Uses containerization technology
- Packages software with all dependencies
- “Build once, run anywhere” philosophy



The Problem Docker Solves

- **Old way:** “It works on my machine.”
- Different environments cause inconsistencies
- Dependency conflicts
- Setup complexity
- Scaling challenges

Why Docker Matters

- **Consistency:** Same environment everywhere
- **Isolation:** Applications run independently
- **Efficiency:** Less resource-intensive than virtual machines
- **Portability:** Works across different platforms
- **Scalability:** Easy to scale applications

Docker vs. Virtual Machines

Docker	Virtual Machines
Share host OS	Full OS per instance
Lightweight (MBs), fast startup	Heavy (GBs), slow boot
Ideal for microservices	Good for full OS isolation
Lower resource usage	Higher overhead

Core Docker Concepts

Image – Snapshot or blueprint (e.g., python:3.11-alpine)

Container – Running instance of an image

Dockerfile – Script with instructions to build an image

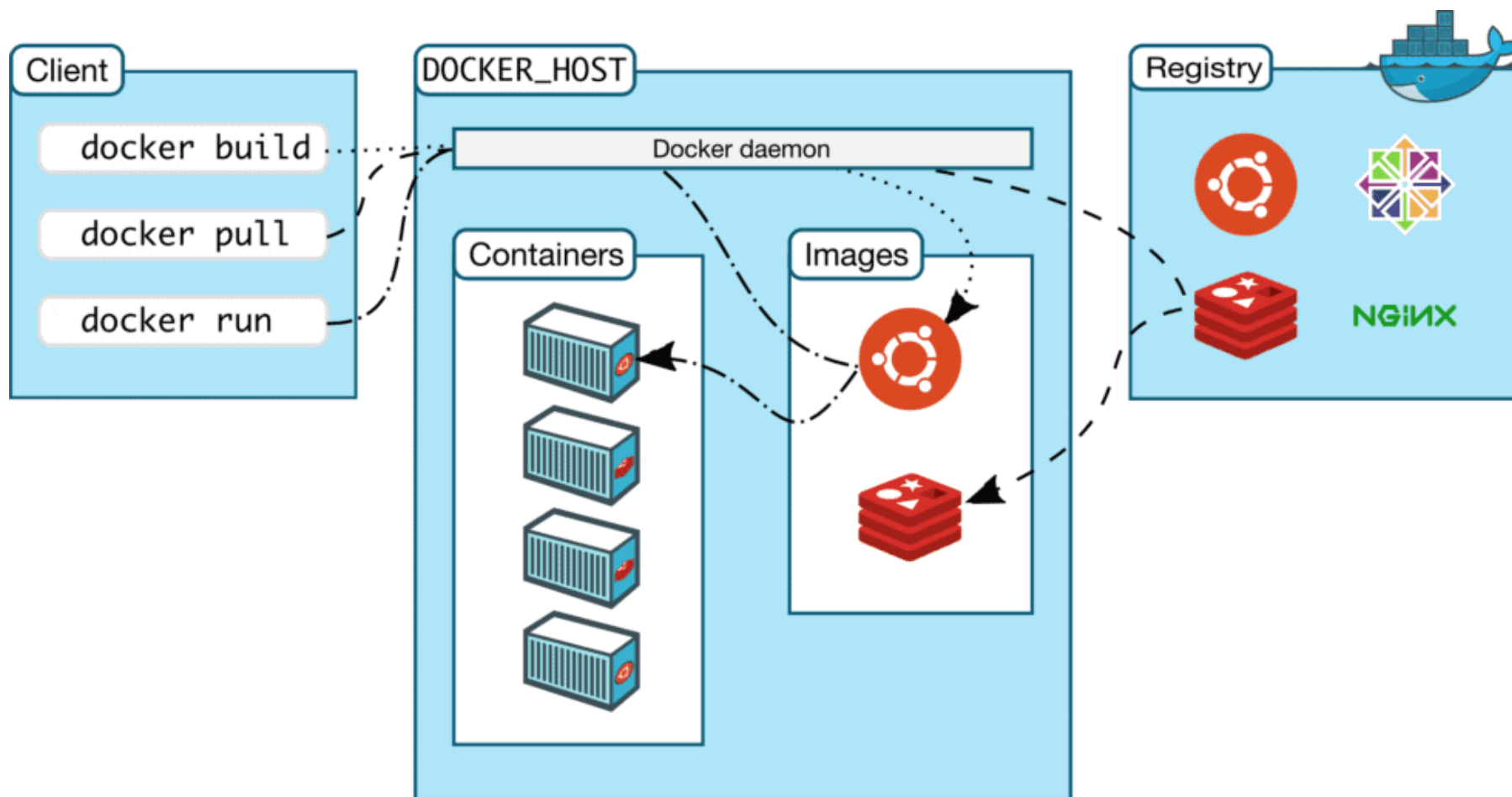
Volume – Store data outside the container (e.g., DB files)

Docker Hub – Public image registry (like GitHub)

Docker Architecture

- Client-server architecture
- Docker client communicates with Docker daemon
- Docker daemon manages building, running containers
- Docker registry stores images
- Docker volumes provide persistent storage

Docker Architecture



Demo

app.py

```
from flask import Flask
app = Flask(__name__)

@app.route("/")
def hello():
    return "Hello, Docker!"

if __name__ == "__main__":
    app.run(host="0.0.0.0", port=5000)
```

Dockerfile

```
# Use a lightweight Python image
FROM python:3.11-slim

# Set working directory
WORKDIR /app

# Copy only what's needed
COPY app.py .

# Install Flask
RUN pip install flask

# Expose port
EXPOSE 5000

# Run the app
CMD ["python", "app.py"]
```


Basic Docker Commands

```
● ● ●  
  
# List all containers (including stopped)  
docker ps -a  
  
# Stop a container  
docker stop [container_id_or_name]  
  
# Open an interactive shell inside a running container  
docker exec -it [container_id_or_name] bash  
  
# View the logs from a container  
docker logs [container_id_or_name]  
  
# Show detailed info about the Docker system and swarm status  
docker info  
  
# List all running services in the swarm  
docker service ls  
  
# View detailed info about tasks (containers) for a service  
docker service ps [service_id] --no-trunc
```

Docker Compose

- **What is Docker Compose?**
 - Tool for defining and running multi-container Docker applications
- **Key benefits:**
 - Define the application stack in a single YAML file
 - Start all services with a single command
 - Share the same configuration across environments
 - Manage container dependencies and networking
- **Common usage:**
 - Development environments
 - Automated testing
 - CI/CD pipelines

Docker Swarm

- **What is Docker Swarm?**
 - Native clustering and orchestration solution for Docker
- **Key concepts:**
 - **Swarm:** Cluster of Docker nodes
 - **Node:** Docker Engine instance (manager or worker)
 - **Service:** Definition of tasks to execute
 - **Task:** Container running on a node
- **Core features:**
 - Declarative service model
 - Built-in load balancing
 - Scaling services up/down
 - Desired state reconciliation
 - Multi-host networking
 - Rolling updates

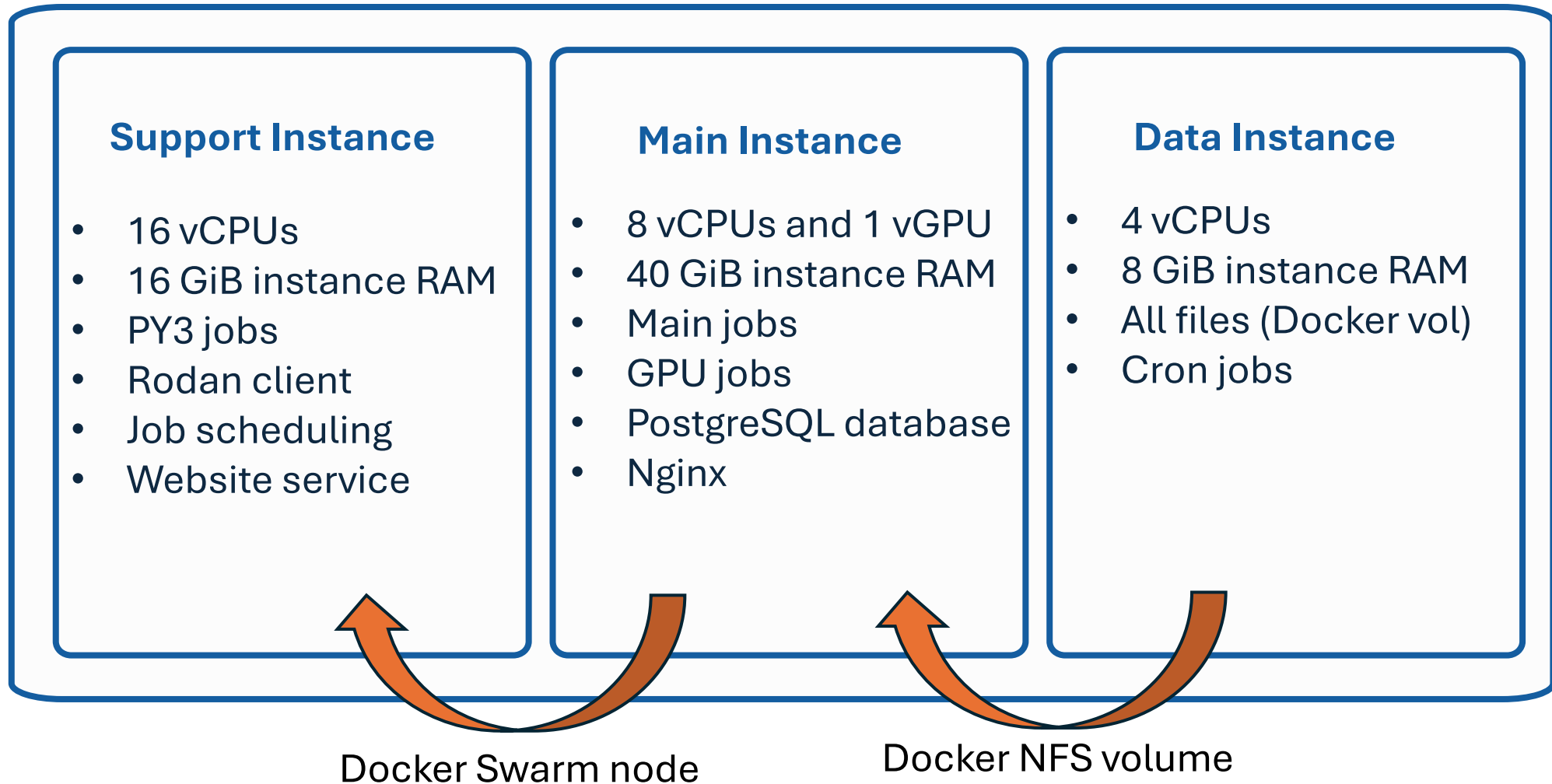
Kubernetes

- **What is Kubernetes?**
 - Open-source platform for automating deployment, scaling, and management of containerized applications
- **Core advantages:**
 - Auto-scaling based on demand
 - Self-healing capabilities
 - Automated rollouts and rollbacks
 - Horizontal infrastructure scaling
 - Service discovery and load balancing
 - Storage orchestration
- **Key concepts:**
 - **Cluster:** Set of nodes running containerized applications
 - **Node:** Worker machine (VM or physical) in the cluster
 - **Pod:** Smallest deployable unit (one or more containers)
 - **Deployment:** Manages pods and replica sets
 - **Service:** Exposes an application running on pods

Docker Compose vs. Swarm vs. Kubernetes

Feature	Docker Compose	Docker Swarm	Kubernetes
Purpose	Local dev (multi-container)	Lightweight orchestration	Full production orchestration
Setup complexity	Very low	Low	High
Scaling	Manual	Built-in (--replicas)	Automatic
Load balancing	No	Yes	Yes (via services/ingress)
Rolling updates	No	Yes	Yes
Production-ready	No	Limited use	Yes (industry standard)

Rodan Server with Docker Swarm



Best Practices

- Use official base images when possible
- Minimize layers to reduce image size
- Do not run as root inside containers
- Use .dockerignore file
- Tag images meaningfully
- Clean up unused images and containers
- Ask ChatGPT

Thank you.

CantusDB: an introduction

Anna de Bakker
DDMAL Training Week 2025

overview:

Historical overview:

What is CantusDB for?

How did it arise?

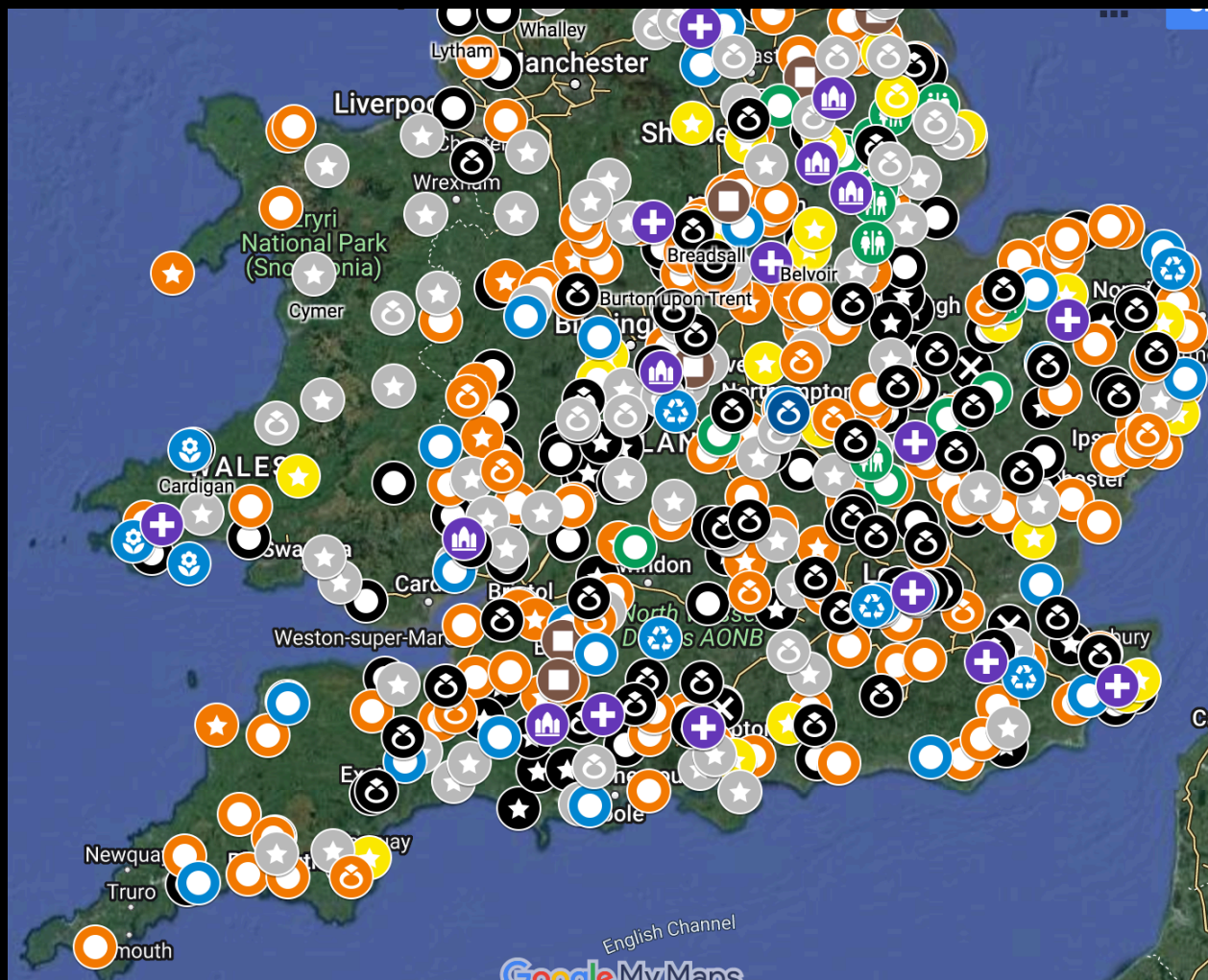
Who uses it and how?

What kinds of things does it record?

What's the relationship to LinkedMusic?

some historical context

-Medieval Europe had *a lot* of churches
[citation needed]



(that's
a lot of chant!)

Every non-mendicant monastery in England and Wales dissolved 1536-1539 (map: J.A. Cameron)
Colours denote different monastic orders (types of communities)

some historical context

- Medieval Europe had *a lot* of churches
[citation needed]
- Each of those might have 8-9 services a day
- Each service might have 5-40 things to sing



some historical context



- What to sing varies depending on the feast (what's being celebrated)
- Feasts can vary from place to place
- order of items can differ

-most of this data is recorded in surprisingly durable form!

Knowledge of trends—> *what* a particular community sang about, *how* they chose to do it, *who else* they were connected to



some historical context

- music is hard [citation needed]
- text is easy!
- initial efforts to catalog (on paper!) in 1960s

1375 Amen amen ¹ dico vobis, quia ² plorabitis et flebitis ³ vos, mundus autem gaudebit; vos autem contrista- bimini, sed ⁴ tristitia vestra vertetur in gaudium, alleluia. ⁵ 1 - C: <i>un seul</i> amen. 2 - C: quia <i>manque</i> . 3 - S: flevitis. 4 - C: vos autem contristabimini sed <i>manque</i> . 5 - C: <i>deux</i> alleluia.	<i>Dom. III post Pascha</i>	84	C B E M V	H R F S L
1376 Amen amen dico vobis: Si quid petieritis Patrem in nomine meo, dabit vobis, alleluia alleluia.	<i>Dom. V post Pascha</i>	86		L
1377 Amen amen dico vobis: Si quis sermonem meum servaverit, mortem non gustabit ¹ in aeternum. 1 - C: videbit.	<i>Dom. de Passione</i>	66	C	D

Hesbert, Corpus Antiphonarium Officii
vol.3, 1968

some historical context

- these text-centred efforts become the core of Cantus Index (not our topic today)
- basically a catalog of every known chant *text*, standardized and attached to an ID

CANTUS INDEX
ONLINE CATALOGUE FOR MASS AND OFFICE CHANTS

ABOUT
Information

CHANTS
Catalogue of texts

MELODIES
Catalogue of melodies

GENRES
List of genres

FEASTS
List of feasts

CONTACT
Drop us a note

200293

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Genre: **A**

Full text: Anna Christi thalamum intrans cum honore cinamomum balsamum superat odore

Feast: **Annae**

Notes: AH v.25 #19;

[Add new comment](#)

» [Suggest a change in full text](#)

» [Suggest a minor variant](#)

Chant Resources (Links)

» [Search this chant in online resources](#)

Melodies in sources

» [Display the melodies connected with this chant](#)

Fulltext search

Genre
- Any -

Search

Cantus ID

Authoring information

Chant added by: **Cantus Manuscript Database**

Post date: 11/08/2012 - 09:31

Last update: 01/06/2019 - 16:46

Proofread by: **Debra**

Chants with similar words / phrases

	Full text
a00328 A	Anna maris stella mater tu crimina pelle quae Jesu Christi thalamum mundo peperisti principium vite quo vivunt Ismaelitae ex te namque pia processit virgo Maria
ah50031.1 H	Inventor rutili dux bone luminis qui certis vicibus tempora dividis merso sole chaos ingruit horridum lucem redde tuis Christe fidelibus Per Christum genitum summe pater tuum in quo visibilis stat...

so...what's CantusDB?

- split from “Cantus Index” in 2012
- CantusDB records every chant in a manuscript :
i.e. every instantiation of a chant in some place
- basically, a Table of Contents for many chant manuscripts, with standardized references
- maintained by DDMAL in cooperation with the Digital Analysis of Chant Transmission (DACT) project

so...what's CantusDB?

- cantusindex.org : over 60,000 chant *texts*
- Cantus Database (<https://cantusdatabase.org>) : over 539,000 chant items
- There are several other “Cantus Network” databases using the same metadata fields
- Together these have metadata on over a million chants

so...what's CantusDB?

- this data is entered by scholars and their minions
 - cleaned up by admins before publication
- (N.b. scholars would probably do this work anyway!)



In sollempnitate famuli dei Arnulphi conuss. Villariensis, q.e. ii k.I.¹

First Vespers

Chant type	Mode	Incipit	Source
Antiphon	1	Celebretur hodierna (with large capital)	None
Antiphon	2	Hic fertur	<i>Vita</i> 1.1.1
Antiphon	3	Cumque foret	<i>Vita</i> 1.1.4
Antiphon	4	Hic Arnulfus	<i>Vita</i> 1.1.7
[Chapter]		Dilectus a deo et hominibus.	<i>Ecclesiasticus</i> 45:1
Responsory	1	O vere felicem puer Arnulphum	<i>Vita</i> 1.1.10
Verse	1	Carnalem in eo	<i>Vita</i> 1.1.10
Hymn	8	Gaude mater ecclesia (with incipit)	Various
Versiculus		In die glorie	?
Magnificat antiphon	3	Magnificat nunc anima	None
[Collect]			

Compline

Hymn	7	Arnulpho congratulemur (with incipit)	None
------	---	---------------------------------------	------

First Nocturn

CantusDB is very useful for:

- finding chants and seeing where they occur
- finding images of a chant
- seeing what was done in some place
- or what was done on some day!

Search Chants

Displaying 1-9 of 9 chants.

» [Search lucas on CantusIndex.org](#)

Keyword search

Contains

Service

Feast

Genre

Position

Cantus ID

Mode

Melodies

Siglum	Folio	Incipit/Full Text	Feast	Service	Genre	Position	Cantus ID	Mode	FT	Mel	Image
A-KN CCI 1012	026v	Hanc vero quam Lucas peccatricem Hanc vero quam Lucas peccatricem mulierem Joannes Mariam nominat illam esse Mariam credimus de qua Marcus septem daemonia ejecta fuisse testatur septem enim daemonia habuit quae universis viciis plena fuit sed ecce quia turpitudinis suae maculas aspexit lavanda ad fontem misericordiae cucurrit	Mariae Magdalенаe	M	R	14	601730	3	✓	🎵	Image
A-KN CCI 589	052r	Hanc vero quam Lucas Hanc vero quam Lucas	Mariae Magdalенаe	M	R	12	601730	*			Image
D-FUI Aa 55	125r	Hanc vero quam Lucas Hanc vero quam Lucas	Mariae Magdalенаe	M	R	3.2	601730	3			Image
D-KNd 215	197v	Hanc vero quam Lucas peccatricem Hanc vero quam Lucas peccatricem mulierem Joannes Mariam nominat illam esse Maria credimus de qua Marcus septem demonia ejecta fuisse testatur et septem enim demonia habitat quae universis vitis plena fuit sed ecce quia turpitudinis suae maculas aspexit lavando ad fontem misericordie currit	Mariae Magdalенаe	M	R	1.3	601730	?	✓		Image
F-Pn Latin 1112	298v	Jucundare plebs fidelis cujus pater Jucundare plebs fidelis cujus pater est in caelis reCOLens Ezechielis prophetae praeconia Circa thronum majestatis cum spiritibus beatis quattuor diversitatis astant animalia Est Joannes testis ipsi dicens in apocalypsi vere vidi vere scripsi vera testimonia Formam primam aquilinam et secundam leoninam sed humanam et bovinam duo gerunt alia Formae formant figurarum	Matthaei	MI	Sq		ah55007.1		✓		Image

Also have a melody search based on Volpiano

Anna Christi thalamum intrans cum

Source

Karlsruhe, Badische Landesbibliothek - Musiksammlung, Aug. LX

Folio
a035r

Sequence
14

Feast	Service	Genre	Position	Cantus ID	Mode
Annae	L	A	1	200293	*

Full text as in Source (standardized spelling)

Anna Christi thalamum intrans cum honore cinnamomum balsamum superat odore

Full text as in Source (source spelling)

Anna xpisti thalamum intrans cum honore cinamomum balsamum superat odore

Image link

<https://digital.blb-karlsruhe.de/blbhs/content/pageview/1253449>

Image link (Cantus Ultimus)

<https://cantus.simssa.ca/manuscript/123612/?folio=a035r&chant=14>

Concordances

Summary

Cantus Database (CD)	7 concordances
----------------------	----------------

▼ Hide concordance details

Source	Incipit	Office Genre Position	Feast	Mode	Database
D-KA Aug. LX, a035r 	Anna Christi thalamum intrans cum	L A 1	Annae	*	CD
DK-Kk 3449 8o [10] X, 069r 	Anna Christi thalamum intrans	L A 1	Annae	1	CD
F-CA Impr. XVI C 4, 149v	Anna Christi thalamum intrans	V2 A 1	Annae	1	CD

...an international
reference point for
all kinds of chant-
related data!

CantusDB is also
useful for
comparing one
example of chant to
others

Image link (Cantus Ultimus)

<https://cantus.simssa.ca/manuscript/123612/?folio=a035r&chant=14>

Concordances

Summary

Cantus Database (CD)	7 concordances
----------------------	----------------

▼ Hide concordance details

Source	Incipit	Office Genre Position	Feast	Mode	Database
D-KA Aug. LX, a035r 	Anna Christi thalamum intrans cum	L A 1	Annae	*	CD
DK-Kk 3449 8o [10] X, 069r 	Anna Christi thalamum intrans	L A 1	Annae	1	CD
F-CA Impr. XVI C 4, 149v	Anna Christi thalamum intrans	V2 A 1	Annae	1	CD
MA Impr. 1537, 408r 	Anna Christi thalamum intrans cum	L A 1	Annae	1	CD
NZ-Wt MSR-03, 183r 	Anna Christi thalamum intrans cum	L A 1	Annae	1	CD
PL-Kkar 1 (Rkp 12), 105	Anna Christi thalamum intrans	L A 1	Annae	1	CD
PL-Kkar 3 (Rkp 15), 121r	Anna Christi thalamum intrans	L A 1	Annae	1	CD

Melodies

Displaying 2 melodies from the following databases:

Chant	Melody
DK-Kk Gl. Kgl. S. 3449 8o [10] X 069r L A 1 Annae Cantus ID: 200293	 M:1
NZ-Wt MSR-03 183r L A 1 Annae Cantus ID: 200293	 M:1 Anna Christi thalamum intrans cum honore cinamomum balsamum superat odore

Two main types of objects in CantusDB: *sources* and *chants*

Browse sources

Displaying 1 - 245 of **245** sources

Segment

CANTUS Database

General search (siglum, city, description ..)

Enter any part of a word

Indexing notes

Search for indexers, proofreaders, editors.

Provenance (origin / history)

- Any -

Century

- Any -

Full source / fragment

- Any -

Apply

Reset

Siglum	Summary	Date/Origin	Image link	Chants / Melodies
A-Gu 29	Fourteenth-century antiphoner in two volumes (with A-Gu 30) from the Abbey of Sankt Lambrecht (...)	14th century St-Lambrecht	Images	4291 / 5
A-Gu 30	Fourteenth-century antiphoner in two volumes (with A-Gu 29) from the Abbey of Sankt Lambrecht (...)	14th century St-Lambrecht	Images	5490
A-KN 1010	Twelfth-century antiphoner from Klosterneuburg, Austria. Four-line dry-point staves with D-, F-, A...	12th century Klosterneuburg	Images	2384 / 410
A-KN 1011	Fourteenth-century antiphoner from Klosterneuburg, Austria. Five-line	14th century	Images	2744

Sources

- each represent a manuscript or fragment
- have information about type of book & current location
- paragraphs for longer form description
- some data about who worked on the inventory
- navigation to sections of manuscript (+external links)

Montréal, McGill University - Rare Books and Special Collections - Manuscript Collection, MS Medieval 0073

[View](#) | [Edit](#)

Cantus Siglum
CDN-Mrb MS Medieval 0073

Holding Institution
[Montréal, McGill University - Rare Books and Special Collections - Manuscript Collection \(CDN-Mrb\)](#)

Manuscript/Print
Manuscript

Summary
Miscellaneous choirbook from Northern Italy, made of 10 independent codicological units produced in different periods for a total of 143 un-numbered folios, with several lacunae. Written in various Gothic hands on vellum; square notation on red, 4-line staves. The surface of the leaves measures from 465 x 335 mm to 455 x 320 mm; the writing surface varies more widely according to the fragment. According to Seymour De Ricci, MS 73 was written in the 15th century, yet with all probability most of the quires were produced much earlier, between the late 13th century and the early 14th. Obtained in Florence by Dr. Casey Wood on November 5th, 1930, MS 73 was added soon thereafter to the McGill Library collection, on 21 January 1931.

Liturgical Occasions
MS 73 restricts itself to selected liturgical occasions and, for some of them, it features the unusual combination of items for the office and the mass.
F. 1r, 11,000 Virgin Martyrs of Cologne (office, one sequence, and two alleluias); f. 23r, Thomas Aquinas (office and mass); f. 53v, Corpus Christi and its octave (office and mass); f. 87r, Moving of Thomas's relics (office); f. 101r, Corpus Christi and its octave (office); f. 116r, Conversion of Paul (office); f. 127r, Common of Saints (office); f. 131r, Sexagesima Sunday (office); f. 138v, Quinquagesima Sunday (office).

Notes on the Inventory

Incipit/CantusID

CDN-Mrb MS Medieval 0073

Select a folio: Select a feast:

- » [View all chants](#)
- » [View full inventory](#)
- » [View inventory with images](#)
- » [CSV export](#)
- » [Search chants in this source](#)
- » [Search melodies in this source](#)
- » [Analyse this source \(Cantus Analysis Tool\)](#)

CANTUS Database

CDN-Mrb MS Medieval 0073

Provenance: **Dominican**
Date: **14th century**
Cursus: **Secular**
Inventoried by:

- [Alessandra Ignesti](#)
Schulich School of Music, McGill University

Proofreader:

- [Brayden Olson](#)

The inventory for CDN-Mlr MS Medieval 0073 was prepared by Alessandra Ignesti (McGill University), with proofreading by Brayden Olson (Dalhousie University).
Contributor: **Alessandra Ignesti**

Sources

Typical source
edit page

Note: some
information is
fixed
vocabulary;
some fields
reference
external
concepts

Edit Source Montréal, McGill University - Rare Books and Special Collections - Manuscript Collection, MS Medieval 0073

[View](#) | [Edit](#)

Holding Institution:

Montréal, McGill University - Rare B...x ▾

Shelfmark:*

MS Medieval 0073

Primary Cantus Database
identifier for the source (e.g.
library shelfmark, DACT ID, etc.)

Name:

A colloquial or commonly-used
name for the source

Segments:

- ☐ Benedicamus Domino
- ☒ Canadian Chant Database
- ☐ Cantorales in the Americas
- ☐ Chinese Catholic Plainchant
- ☐ Sequence Database
- ☒ CANTUS Database

Provenance (origin / history):

Dominican x ▾

If the origin is unknown, select a location where the source was used later
in its lifetime and provide details in the "Provenance notes" field.

Provenance notes:

Complete Source/Fragment:

Fragmented ▾

More exact indication of the provenance (if necessary)

Century:

x 14th century x

Manuscript/Print:

Manuscript ▾

Date:

Date of the source, if known (e.g. "1541")

Cursus:

Secular ▾

Chants

Lots of information:

- where they are in the book
- when they were sung

View | Edit

Sponsus pulcher prae omnibus rex

Source

Montréal, McGill University – Rare Books and Special Collections – Manuscript Collection, MS Medieval 0073

Folio	Sequence	Feast	Service	Genre	Position	Cantus ID	Mode
001v	3	XI milium Virginum	V	A	M	a02039	1

Differentiae Database



66d

Full text as in Source (standardized spelling)

Sponsus pulcher prae omnibus rex et sponsus virginum candidatis virginibus purpureis per gladium suum junxit conubium caeli iungendo civibus per passionis bravium super astris invexit

Full text as in Source (source spelling)

Sponsus pulcher pre omnibus rex et sponsus virginum candidatis virginibus purpureis per gladium suum iunxit connubium celi iungendo civibus per passionis bravium super astris invexit | alleluya | ~Magnificat | Euouae

Image link (Cantus Ultimus)

<https://cantus.simssa.ca/manuscript/680970/?folio=001v&chant=3>

Incipit/CantusID

Source navigation

CDN-Mrb MS Medieval 0073

001v

>

001r <

>

002r

» Display facsimile (001v)

Display previous chants ▾

Folio: 001v – Feast: XI milium Virginum

1	V R	Haec est dies*	a02055
2	V W	Adducentur regi virginis post eam	800008.1
3	V A M	Sponsus pulcher prae omnibus rex	a02039

Display next chants ▾

CANTUS Database

CDN-Mrb MS Medieval 0073

Provenance: Dominican

Cursus: Secular

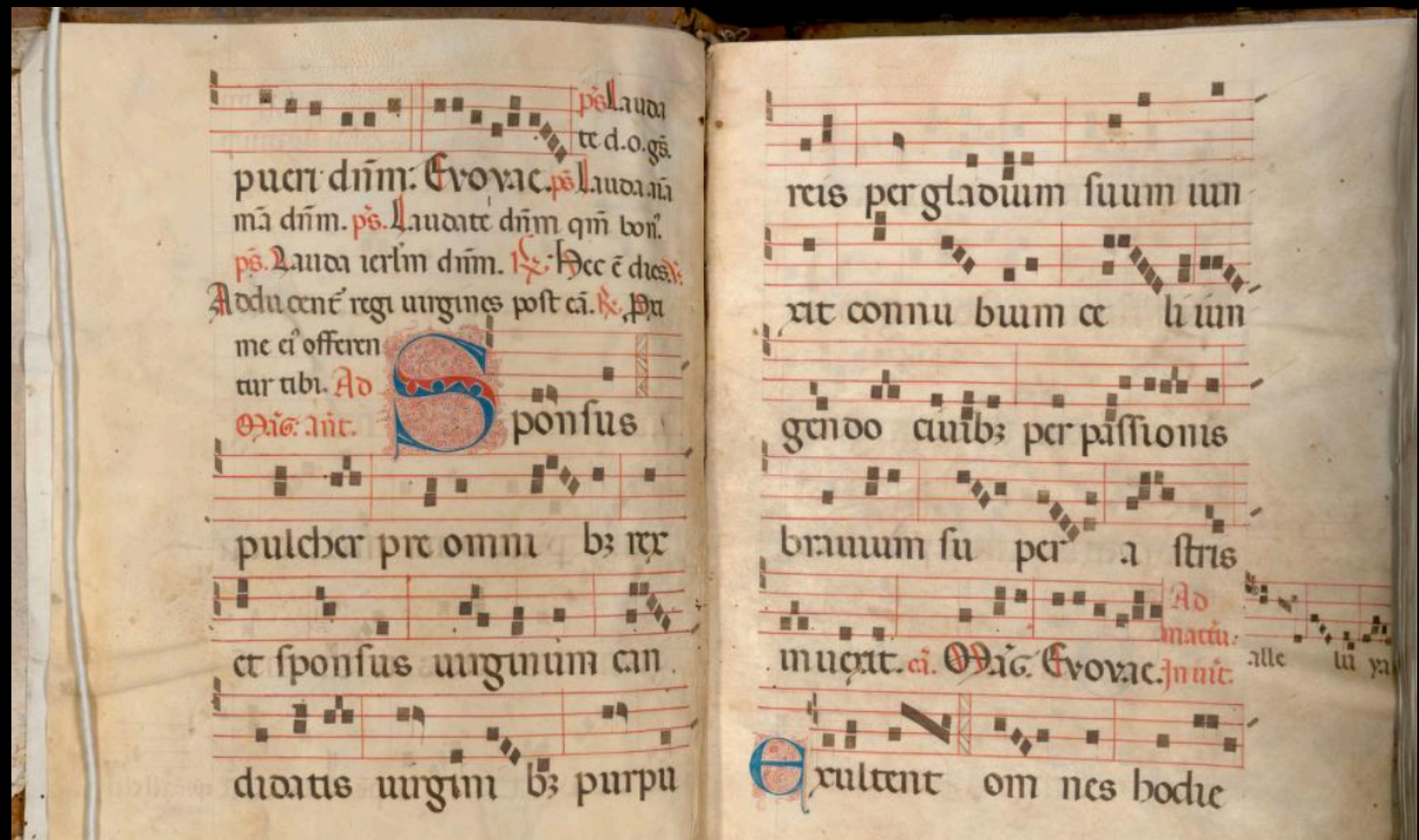
Inventoried by:

• Alessandra Ignesti

Schulich School of Music, McGill University

-some chants
have no music

-other things on the page may be in the DB as metadata



Chants

Typical chant
edit page

[View](#) | [Edit](#)

Marginalia: Folio: Sequence:

Feast: x v

Service: x v

Genre: x v

Position: Cantus ID: Melody ID: Project: v

Function: v

Mode: Finalis: Differentia: Extra: Polyphony: v

Differentiae Database:

For a list of Differentia IDs, refer to the [Differentiae Database](#).

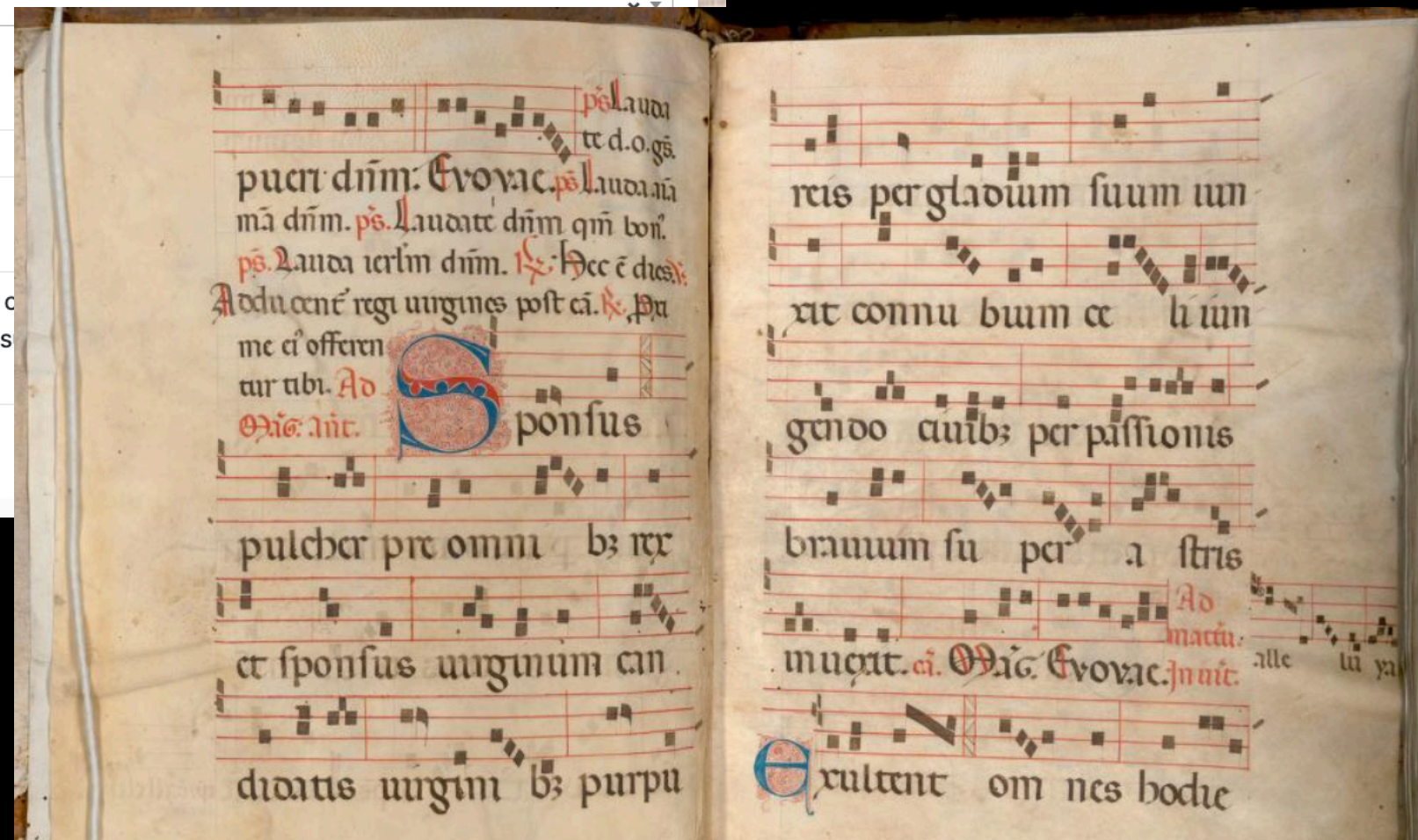
Addendum:

Full text as in Source (standardized spelling):*

Sponsus pulcher prae omnibus rex et sponsus virginum c
conubium caeli jungendo civibus per passionis bravium s

Full text as in Source (standardized spelling) proofread: ☒

[Copy full text below](#)



orienting yourself in a liturgical manuscript

- 'folio numbers' instead of page numbers
 - 50r = 'recto' (front) of the fiftieth leaf; 50v is the back
- rubrics ('red'): give instructions/stage directions
 - feasts
 - time of day
 - types of chant
 - other information as needed

uisita et eos illuc reuoca unde tuerunt per culpam. evo vae. *a.*

O mundi domina regio ex semine orta ex tunc iam xpe procel
sic aluo tamquam sponsus de thalamo hic iacet in precepto
qui et sidera regit. evo vae. *a.* **O** thoma didime per xpm

quem meruisti tangere te precibus rogamus alisonis succurre
nobis miseris ne dampnemur cum impiis in aduentu iudias.

O iherusalem ciuitas dei summi leua in circuitu
portulos tuos et uide dominum deum tuum quia iam uenit. sol

uere te amicus. evo vae. *In vigilia. Haurians domi. Inuit.*

Hodie facis quia uenit domi nus et mane uidebitis

gloriam eius. *p.* Venite. *In. i. 2. a.* Veni domi. *in.* *Costate. e.*

Sanctificamini hodie et estote parati. Quia die cr

astina uidebitis maiestatem dei in uobis.

Hodie facis quia uenit domi nus et mane uidebitis glo

riam eius. *Quia die.* **O** nstantes estote

uidebitis auxilium domini super uos iudea et iheru

salem nolite time re. *Tras egre die mini* et do mi

nus e rit uo bis cum. *s.* **H**os qui in puluere estis

aspergiamini et lauda te ecce dominus uenit cum salu

te. *Tras e.* **D**ecil la ocul ta habitat o ne

su a egres sus est filius dei descendit uisitare et consolari om

nes qui cum de toto corde de sidera bant. *s.* **E**x syon spesies

recons eius deus noster manifeste ue nuer. *Descendet.* *s.*

Sanctificamini filii israhel de ar domi nus in die

emini au si na descen der do mi nus. *Et auferet a*

uo bis om nem lan guo rem. *s.* **E**cce domi

nus uenit ut saluos uos fan ar et illuminet abscondita tene

bra cum. *Et au.* *In. ii. 2. a.* **P**aratus esto israhel in occursum

domini quoniam uenit. evo vae. *s.* *Trasina die delebitur.* *Laus. i.*

Hodie facis quia uenit dominus et mane uidebitis gloriam

time of day

name of
the feast

Einsiedeln, 15v-16r

Some examples of rubrics



McGill Ms 0073



McGill MS 0018

some useful vocabulary

- types of chant (“Genre” in Cantus DB):
 - responsory (long, multipart structure)
 - antiphons (go with psalms)
- ‘incipits’ give the beginning of a chant you are expected to know/have somewhere else
- ‘differentiae’: shorthand for a formula to chant a psalm on.
 - text is usually ‘euouae’=seculorum amen

uisita et eos illuc reuoca unde tuerunt per culpam. evo vae. *a.*

O mundi domina regio ex semine orta ex tunc iam xpe procel
sic aluo tamquam sponsus de thalamo hic iacet in preseprio
qui et sydera regit. evo vae. *a.* **O** thoma didime per xpm

quem meruisti tangere te precibus rogamus alisonis succurre
nobis miseris ne dampnemur cum impiis in aduentu iudias.

O iherusalem ciuitas dei summi leua in circuitu
portulos tuos et uide dominum deum tuum quia iam uenit. sol

uere te amicus. evo vae. *In vigilia. Haurians domi. Inuit.*

Hodie facis quia ueniet domi nus et mane uidebitis
gloriam eius. *p. Venite. In. i. 2. a. Veni domi. in. Costate. e.*

Sanctificamini hodie et estote parati. *Quia die*
stina uidebitis maiestatem dei in uobis.

Hodie facis quia ueniet domi nus et mane uidebitis gl
nam eius. *Quia die.* **O** nstantes estote

uide bitis auxilium domini super uos iudea et iheru
sa lem nolite time re. *Tras egre die mini et do mi*

nus e ar uo bis am. *s.* **H**os qui in puluere estis
expergissamini et lauda te ecce dominus ueniet cum salu

te. *Tras e.* **D**e il la ocul ta habitat o ne
su a egres sus est filius dei descendet uisitare et consolari om

nes qui cum de toto corde de sidera bant. *s.* **E**x syon spesies
decorus eius deus noster manifeste ue nuer. *Descender*

Sanctificamini filii israhel de ar domi nus in die
emini au sti na descen der do mi nus. *Et auferet a*

uo bis om nem lan guo rem. *Ecce domi*
nus ueniet in fumes os fan ar et illuminet abscondita tene

bra rum. *Ex au. In. i. 2. a. Paratus esto israhel in occursum*
domini quoniam uenit. evo vae. *s.* *Trasina die delebitur. Laus. a.*

Hodie facis quia ueniet dominus et mane uidebitis gloriam

responsories

cues to repeat music

verses

uisita et eos illuc reuoca unde tuerunt per culpam. *evovae. a.*

O mundi domina regio ex semine orta ex tunc iam xpe procel
 sic aluo tamquam sponsus de thalamo hic iacet in prespio
 qui et sidera regit. *evovae. a.* **O** thoma didime per xpm
 quem meruisti tangere te precibus rogamus alisonis succurre
 nobis miseris ne dampnemur cum impiis in aduentu iudias.
evovae. a. **O** iherusalem ciuitas dei summi leua in circuitu
 uallos tuos et uide dominum deum tuum quia iam uenit. sol
 uere te a uinculis. *evovae. In vigilia. Manutians domi. Inuit. In don*
Hodie facis quia ueniet domi nus et mane uidebitis
 gloriam eius. *p. Venite. In. i. 2. a. Veni domi. in. Costate. e.*
Sanctificamini ho die et estote para ti. Quia die an
 tina uidebi tis maiesta tem de i in uo bis.
Hodie facis quia ueniet domi nus et mane uidebitis glo
 riam eius. *Quia die. a.* **O** nstantes estote

uide bitis auxilium domini super uos iudea et iheru
 sa lem nolite time re. *Tras egre die mini et do mi*
 nus e rit uo bis cum. *s.* **H**os qui in puluere estis
 expergissamini et lauda te ecce dominus ueniet cum salu
 te. *Tras e.* **D**e il la ocul ta habitati o ne
 sua egres sus est filius de i descendet uisitare et consolari om
 nes qui cum de toto corde de sidera bant. *s.* **E**x syon spesies
 decous eius deus noster manifeste ue nuer. *Descender. s.*
Sanctificamini filij israhel de ar domi nus in die
 emmi an si na descen der do mi nus. *Et auferet a*
 uo bis om nem lan guo rem. *s.* **E**cce domi
 nus ueniet ut saluos uos fan ar et illuminet abscondita tene
 bra rum. *Et au. In. i. 2. a.* **P**aratus esto israhel in occursum
 domini quoniam uenit. *evovae. s.* *Trasina die delebitur. Laus. a.*
Hodie facis quia ueniet dominus et mane uidebitis gloriam

antiphons

differentiae

Chants

Typical chant
edit page

-again note
differences in
fixed/free and
internal/external
metadata fields

[View](#) | [Edit](#)

Marginalia: Folio: Sequence:

Feast:

Service:

Genre:

Position: Cantus ID: Melody ID: Project:

Function:

Mode: Finalis: Differentia: Extra: Polyphony:

Differentiae Database:

For a list of Differentia IDs, refer to the [Differentiae Database](#).

Addendum: Chant range:

Full text as in Source (standardized spelling):*

Sponsus pulcher prae omnibus rex et sponsus virginum cand
conubium caeli jungendo civibus per passionis bravium supe

Full text as in Source (standardized spelling) proofread: ☒

[Copy full text below](#)



Some ~~world domination~~ data linking ideas



Some ~~world domination~~ data linking ideas

- “institution” linked to RISM at **source** level (done!)
- “book type” could be linked to external authorities (currently not controlled vocabulary)
- “notation”, “provenance” likewise not controlled

Edit Source Montréal, McGill University - Rare Books and Special Collections - Manuscript Collection, MS Medieval 0073

[View](#) | [Edit](#)

Holding Institution:
Montréal, McGill University - Rare B...x ▾

Shelfmark:*
MS Medieval 0073
Primary Cantus Database identifier for the source (e.g. library shelfmark, DACT ID, etc.)

Name:
A colloquial or commonly-used name for the source

Segments:
☐ Benedicamus Domino
☒ Canadian Chant Database
☐ Cantorales in the Americas
☐ Chinese Catholic Plainchant
☐ Sequence Database
☒ CANTUS Database

Provenance (origin / history):
Dominican x ▾
If the origin is unknown, select a location where the source was used later in its lifetime and provide details in the "Provenance notes" field.

Provenance notes:

Complete Source/Fragment:
Fragmented ▾

Some ~~world domination~~ data linking ideas

- text linked to Cantus Index at [chant](#) level
- “feast” being added to WikiData for external authority
- “differentia” linked to Differentia Database (but not other musical information)

The screenshot shows a web form with the following fields and values:

- View | Edit** (links)
- Marginalia:** (empty)
- Folio:*** 001v
- Sequence:*** 3
- Feast:** XI milium Virginum (highlighted by an orange box)
- Service:** [V] First Vespers
- Genre:** [A] Antiphon
- Position:** M
- Cantus ID:** a02039 (highlighted by an orange box)
- Melody ID:** (empty)
- Project:** -----
- Function:** -----
- Mode:** 1
- Finalis:** (empty)
- Differentia:** (empty)
- Extra:** (empty)
- Polyphony:** -----
- Differentiae Database:** 66d (highlighted by an orange box)

For a list of Differentiae IDs, refer to the [Differentiae Database](#).

Thank you!

DDMAL DISTRIBUTED DIGITAL MUSIC
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Canada

LinkedMusic

Introduction



Ichiro Fujinaga

Music Technology Area, Schulich School of Music

McGill University

LinkedMusic: Key Concepts

- ❖ Be able to search across various music databases from one website
- ❖ Universal Music Instrument Lexicon (formerly known as Virtual Instrument Museum)
 - ❖ Create a crowd-sourced website
 - ❖ Images and recordings of musical instruments
 - ❖ Name of the instrument in the local language
 - ❖ Basically a front-end for displaying and editing musical instrument data on Wikidata
- ❖ Funded for 7 years (2022–2029): \$3.2M
 - ❖ SSHRC Partnership Grant
 - ❖ FRQSC Research Team Support Grant
 - ❖ McGill University

LinkedMusic Project Meeting II

21 October 2023: McGill University, Montreal



Lutz, Julie Cumming, Susan Forscher Weiss, Dylan Hillerbrand, David Lewis, Houman Behzadi, Kevin Kishimoto, Jon Manton, Robin Desmeules

LinkedMusic Workshop IV

7 April 2024: Dalhousie University



- ❖ **Guest speaker:** Jan Hajič
- ❖ **Participants:** Jennifer Bain (host), Debra Lacoste, Andrew Hankinson, Anna de Bakker, Dylan Hillerbrand, Julia Craig-McFeely, Tim Expert, Houman Behzadi, Lucero Enríquez Rubio, Julie Cumming, Lionel Li-Xing Hong, Phoebe Durand-McConnell, Marcia Ostashevski

LinkedMusic Workshop V

24 June 2024: Lisbon, Portugal



- ❖ **Guest speaker:** Ichiro Fujinaga
- ❖ **Participants:** Elsa de Luca, (host), Martha Thomae, Alessandra Ignesti, Craig Sapp, Debra Lacoste, Jennifer Bain, Manuel Pedro Ferreira, Francesco Orio, João Pedro d'Alvarenga, Antoine Pham, Hana Vlhová-Wörner

LinkedMusic Project Meeting III

26 October 2024: McGill University, Montreal



Lucy, Jane Cunningham, Susan Forscher Weiss, Dylan Finn-Khan, David Lewis, Houman Behzadi, Kevin Kishimoto, Jon Manton, Robin Desmeules

LinkedMusic.ca

Google
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LinkedMusic

我们新成立的 LinkedMusic Partnership 的目标是通过元数据架构（用于组织数据库中存储的信息的结构）链接音乐数据库。这将大大有助于将在线音乐搜索提升到与当前基于文本的资源相同的复杂程度，使我们能够回答有关音乐以及音乐如何与人类创造力、社会、文化和历史互动的基本问题。

我们的目标包括：

- 制定全面的国际音乐元数据模式
- 开发映射工具，将现有的元数据模式映射到我们的新模式上
- 索引聚合元数据，以便同时搜索各个数据库

如需了解更多信息，请联系 [Ichiro Fujinaga](#)。

L'objectif de notre nouveau partenariat LinkedMusic est de lier des bases de données musicales par des schémas de métadonnées, des structures d'organisation de l'information stockées dans une base de données. Ce projet contribuera grandement à amener la recherche de musique en ligne au même niveau de sophistication que la recherche de ressources textuelles, nous permettant ainsi de répondre à des questions fondamentales sur la musique et comment elle interagit avec la créativité, la société, la culture et l'histoire humaines.

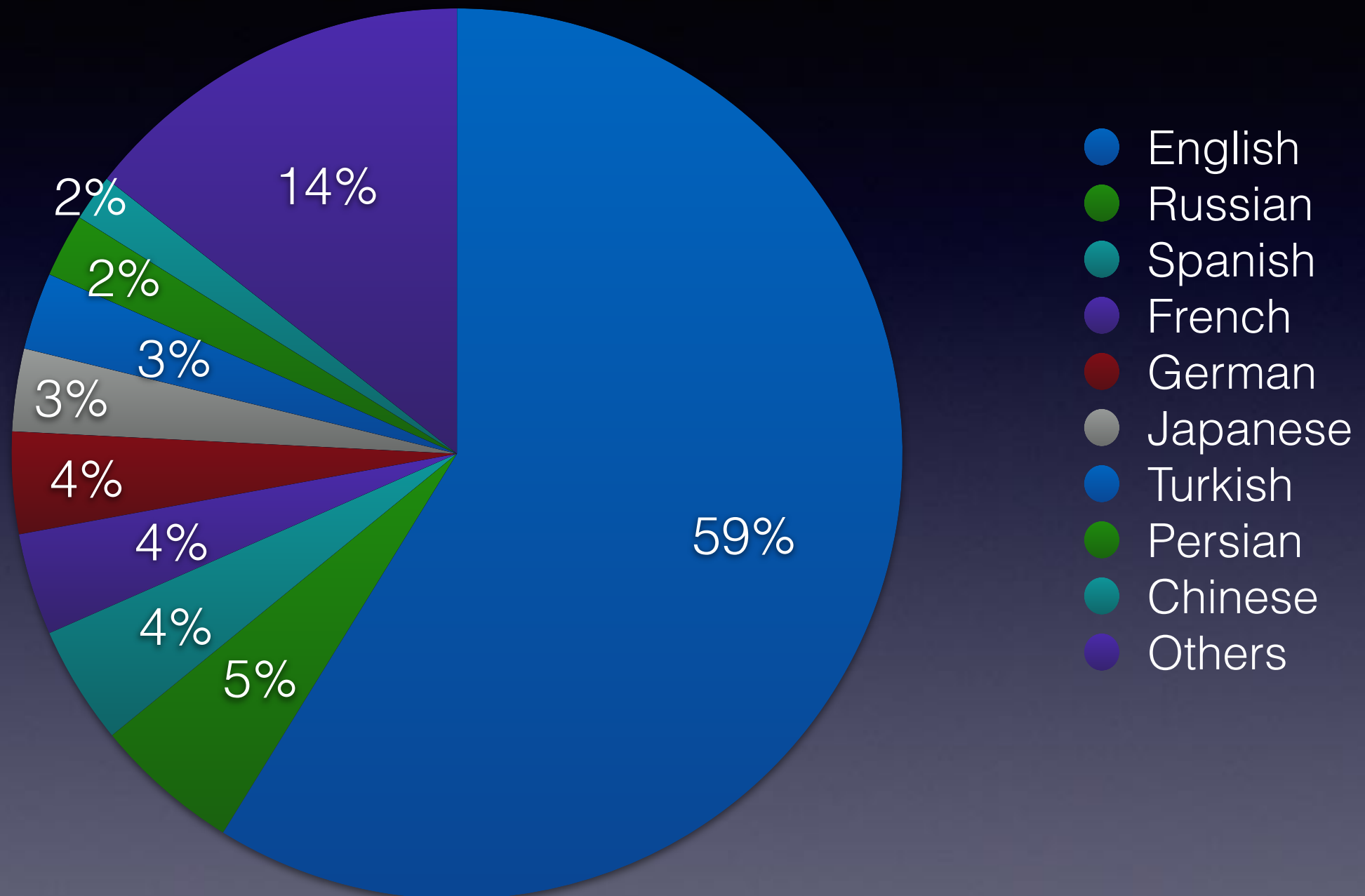
Nos objectifs incluent :

Goals of LinkedMusic

- ❖ Make musical information accessible to more people in the world
- ❖ Make musical queries available in languages other than English

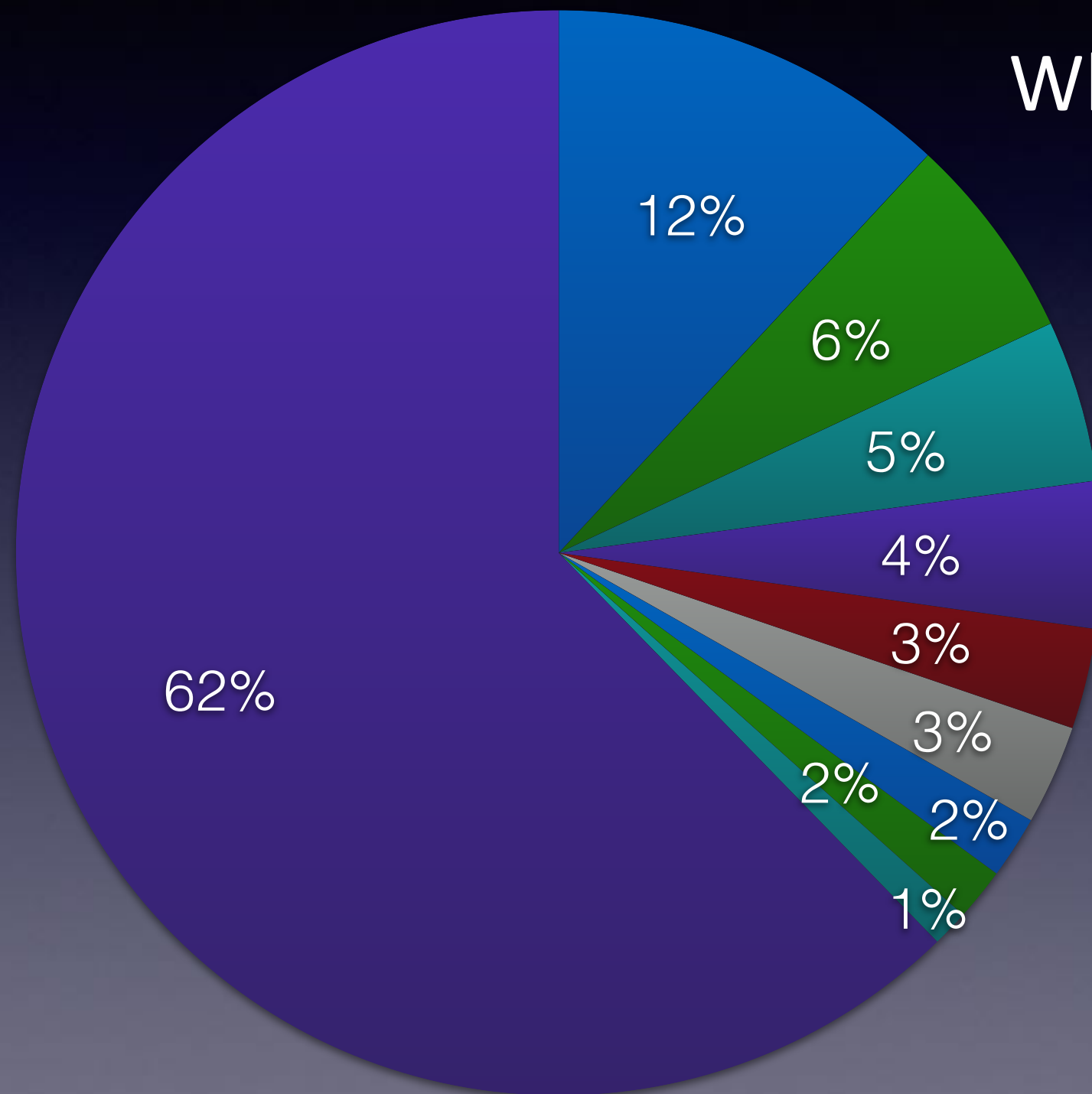
Languages most frequently used for web content as of January 2023, by share of websites (statista.com)

59% of the Web is English



Languages spoken as a First Language

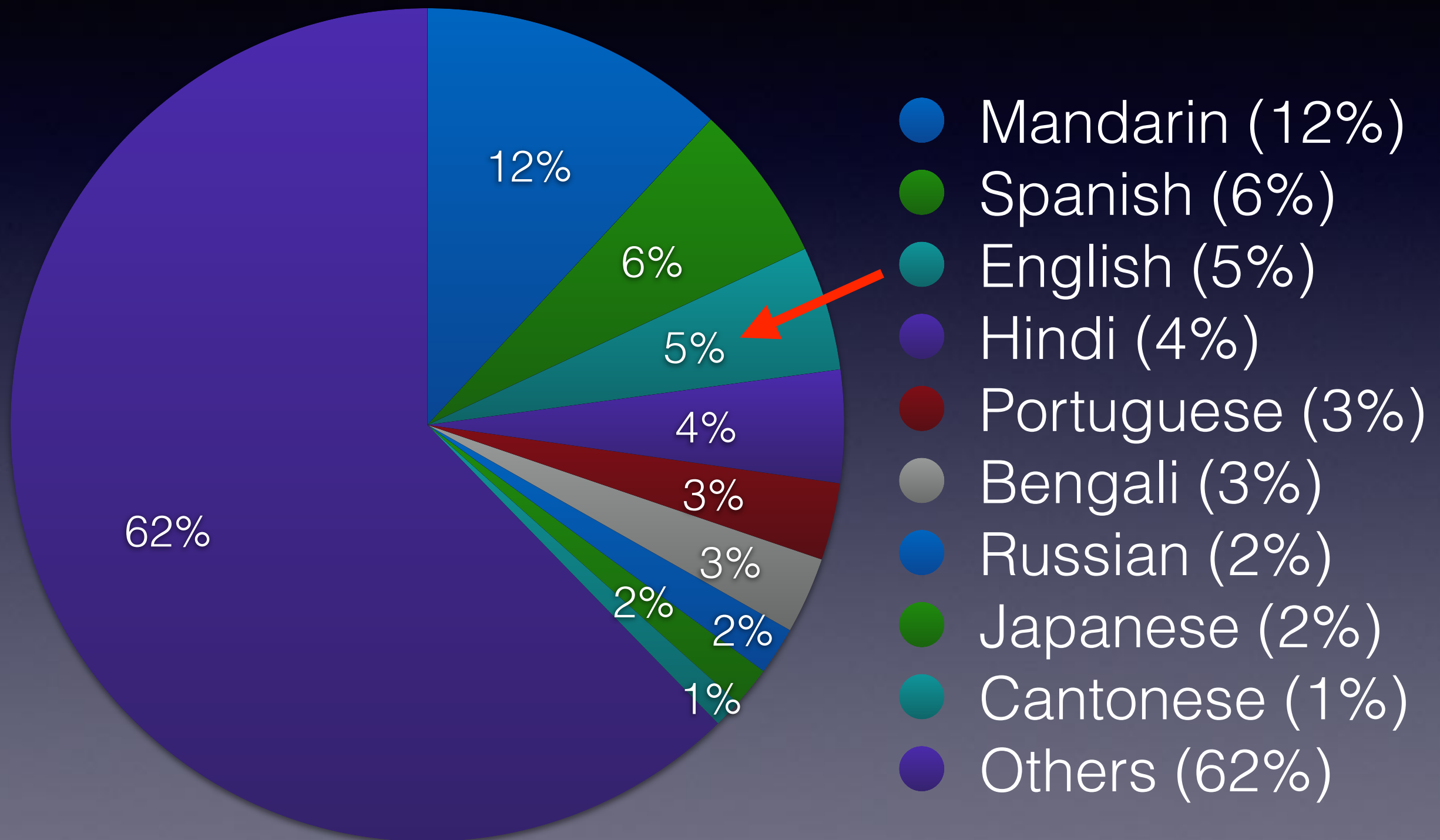
(Wikipedia: 2023)



Which slice is English?

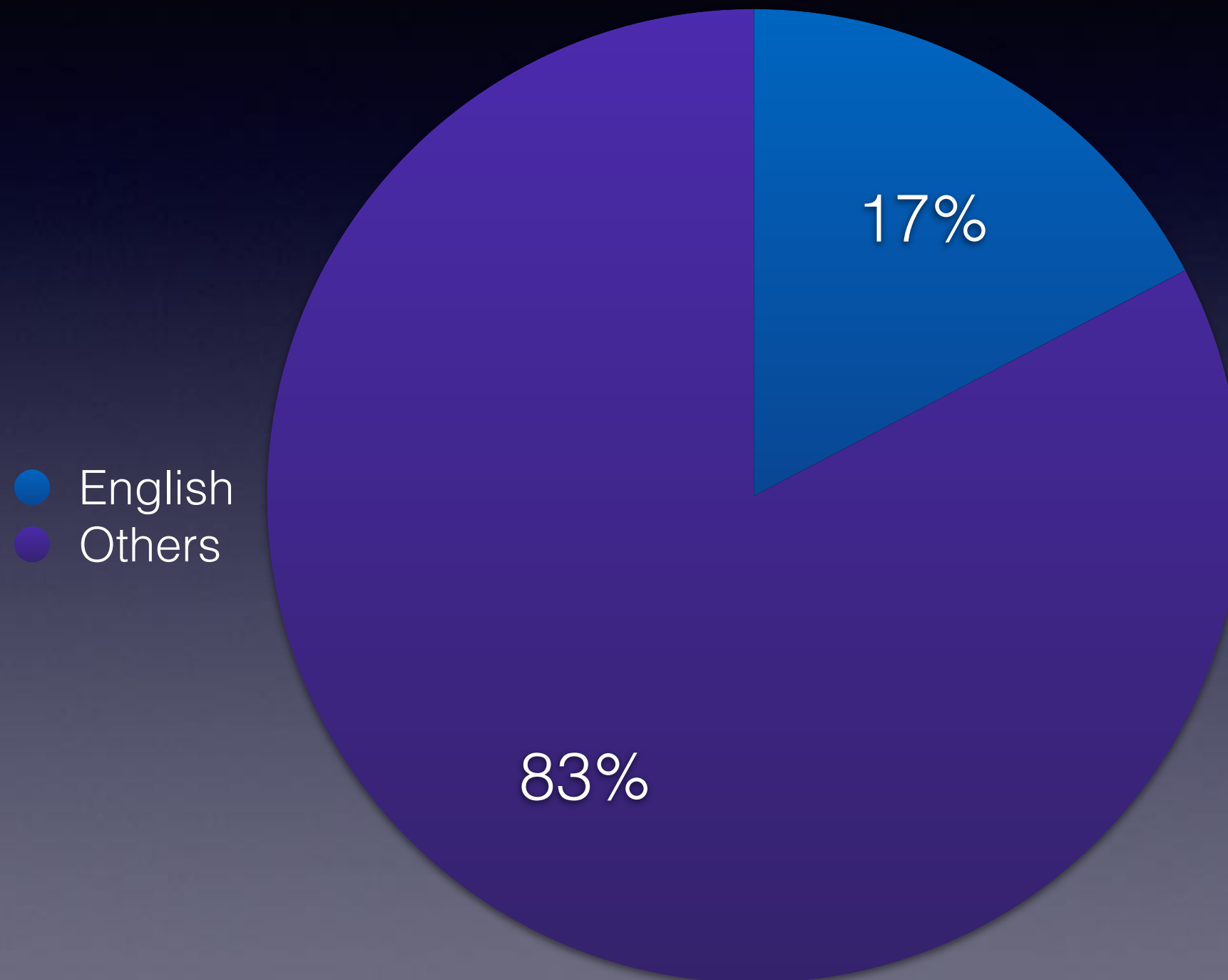
Languages spoken as First Language

(Wikipedia: 2023)

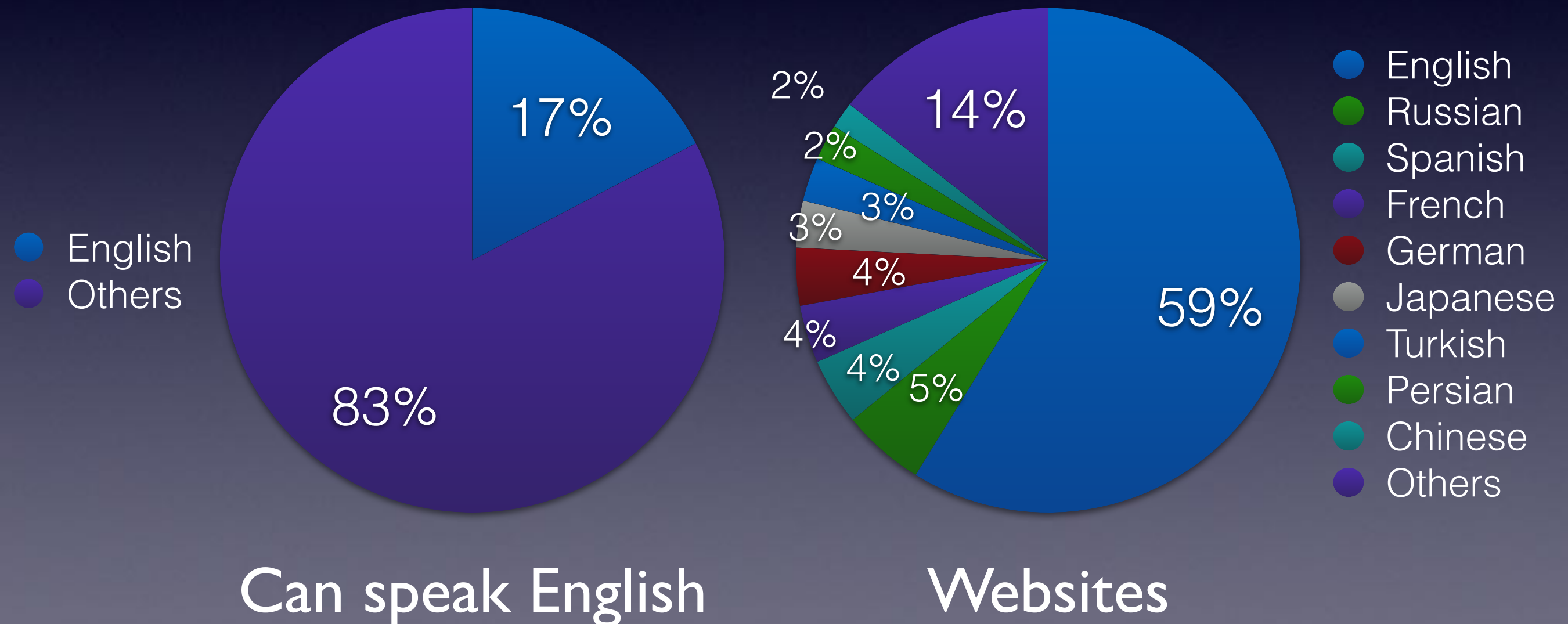


Who can speak English?

(www.babbel.com)



Who can speak English? Compared to websites



Initial 14 Databases

- | | |
|----------------------------|--|
| 1. SIMSSA DB | 9. DTL1000 (Dig That Lick) |
| 2. Cantus Ultimus | 10. MusicBrainz |
| 3. Cantus Database | 11. AcousticBrainz |
| 4. DIAMM | 12. CritiqueBrainz |
| 5. RISM | 13. ListenBrainz |
| 6. Cantus Index | 14. MOTET Database
(Jennifer Thomas) |
| 7. Canadian Chant Database | |
| 8. Global Jukebox |  15. TheSession.org |

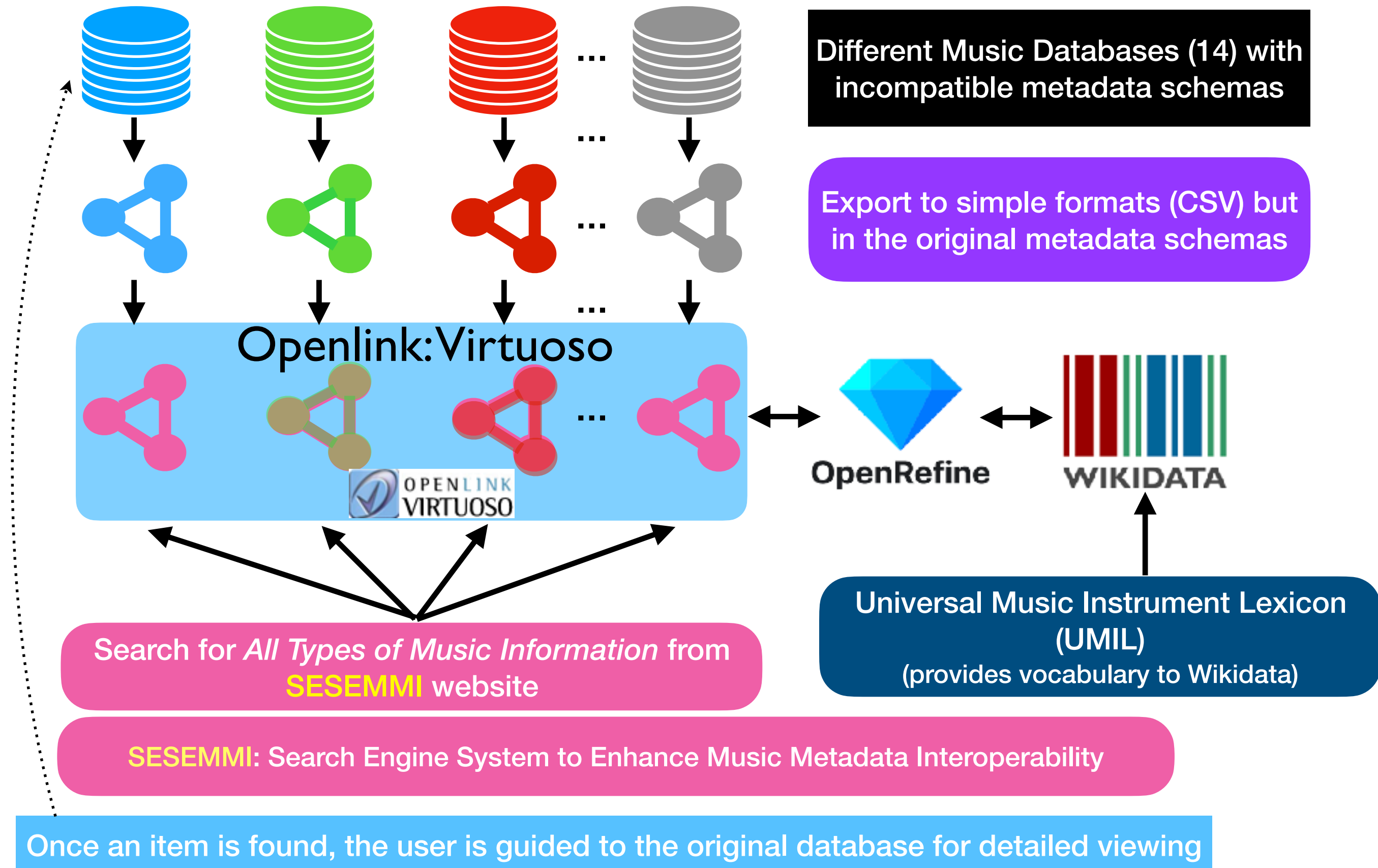
“Lazy Searching”

- ❖ Lazy Learning vs Greedy Learning
 - ❖ Lazy learning: k-nearest neighbour
 - ❖ Greedy learning: artificial neural networks
- ❖ Harvesting vs Federated Search
 - ❖ Harvesting search: Google
 - ❖ Harvested data is indexed
 - ❖ Federated search: Kayak, Google Flights, Expedia
 - ❖ Needs APIs (Application Programming Interface) on the client side (e.g., airlines and hotels)
- ❖ Lazy searching: Harvesting without indexing

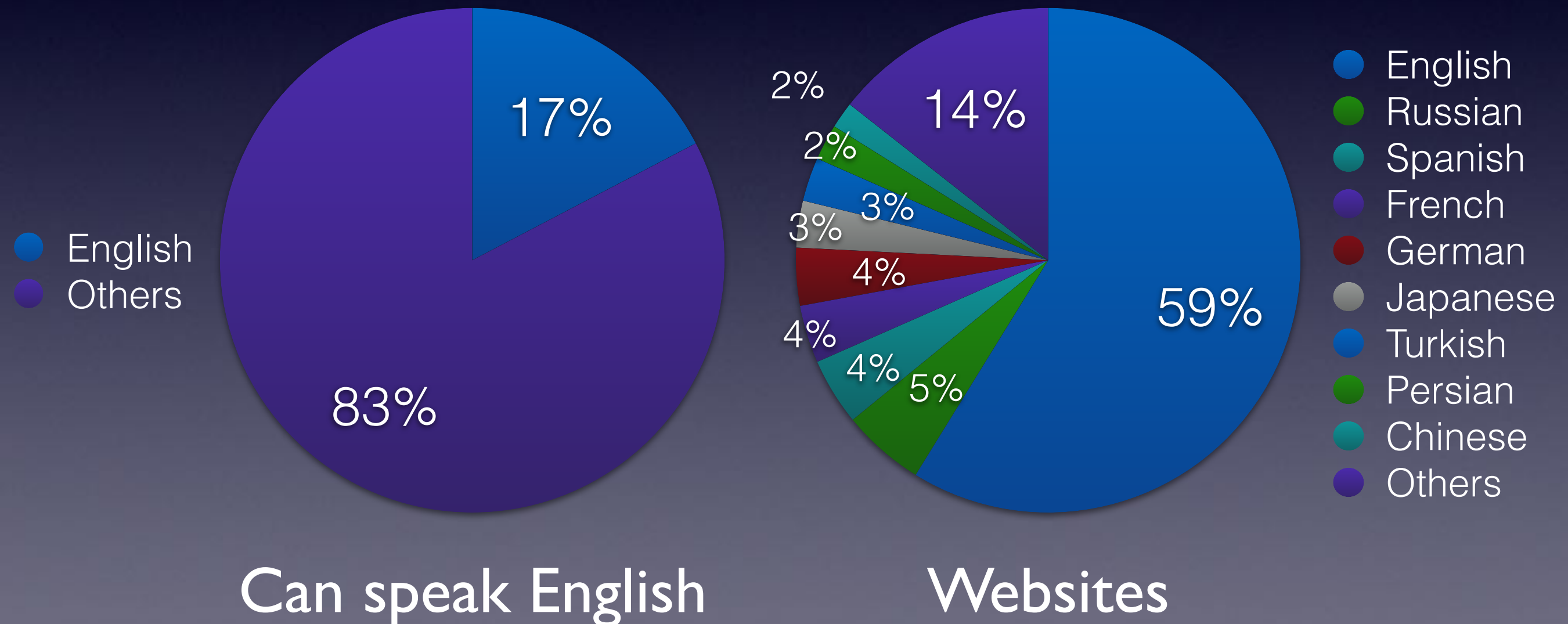
Current Basic Process

- ❖ Combine various sources and dump them into our LinkedMusic Data Lake: OpenLink Virtuoso
- ❖ Reconcile schema (properties) and vocabularies to Wikidata using OpenRefine
- ❖ Use SPARQL and other search engines (e.g., Solr, ElasticSearch) for queries

LinkedMusic Overall Process: Virtuoso Version



Who can speak English? Compared to websites



UMIL (Universal Musical Instrument Lexicon)

Formerly known as VIM (Virtual Instrument Museum)

- ❖ Name of musical instruments may be needed for query
- ❖ Music instrument names varies across languages and cultures
- ❖ A way to translate musical instrument names in as many language as possible
- ❖ User-friendly interface to populate musical instruments in Wikidata

Hornbostel-Sachs Classification

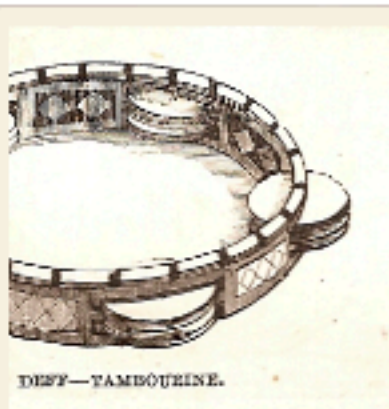
1 - Idiophones	43
2 - Membranophones	9
3 - Chordophones	61
4 - Aerophones	61
5 - Electrophones	4
Unclassified	84

More facet search coming...

INSTRUMENT LIST

English

Instrument name language



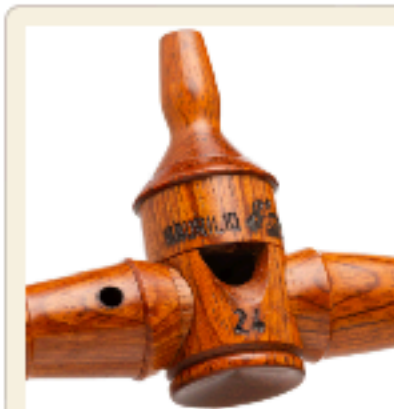
Tambourine



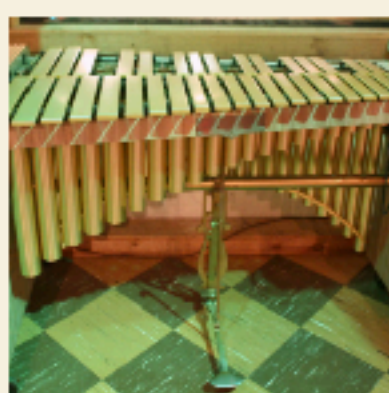
Triangle



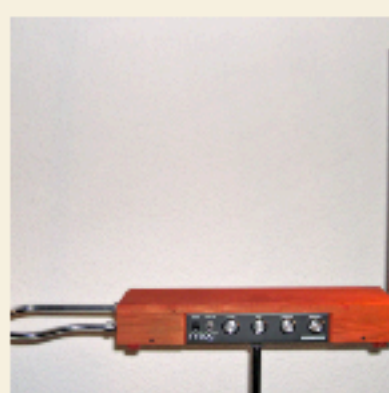
Zill



Whistle



Vibraphone



Theremin



Hurdy-Gurdy



Snare Drum



Tabla



Transposing
Instrument



Pan Flute



Marimba

Overview of technologies used in LinkedMusic

- ❖ Linked Data
- ❖ Semantic Web
- ❖ Ontologies
- ❖ RDF
- ❖ SPARQL
- ❖ Wikidata
- ❖ OpenRefine

What is Linked Data?

- ❖ Linked data is a method to create interlinked data sets that can be accessed by both humans and machines.
- ❖ It facilitates data integration and enhance the interoperability of diverse datasets.
 - ❖ RDF (Resource Description Framework)
 - ❖ URIs (Uniform Resource Identifiers)
 - ❖ JSON-LD (JavaScript Object Notation for Linked Data)

What is the Semantic Web?

The Semantic Web is an extension of the World Wide Web that enables data to be linked, shared, and used by computers.

Benefits

❖ Interoperability

- ❖ Linked Data
- ❖ Data Integration
- ❖ Knowledge Representation

❖ Machine Understanding

- ❖ Inference and Reasoning
- ❖ Search and Discovery

Semantic Web: Interoperability

- ❖ The Semantic Web aims to enhance data interoperability by providing a common framework for representing and linking data across diverse sources, formats, and domains. This facilitates data integration and exchange between different systems and organizations.
- ❖ This is usually achieved through **Linked Data** using:
 - ❖ **RDF** (Resource Description Framework)
 - ❖ **URIs** (Uniform Resource Identifiers)

Semantic Web: Data Integration

- ❖ Using standardized ontologies and vocabularies, the Semantic Web simplifies the process of integrating data from multiple sources.
- ❖ Particularly useful for applications that need to access and analyze diverse datasets.

Semantic Web: Data Integration

- ❖ Using *standardized ontologies and vocabularies*, the Semantic Web simplifies the process of integrating data from multiple sources.
- ❖ Particularly useful for applications that need to access and analyze diverse datasets.

What is an ontology?

- ❖ Ontology is a structured and formal representation of knowledge that defines concepts, their attributes, and the relationships between them in a specific domain or subject area.
- ❖ Ontologies are used to establish **a common understanding and shared vocabulary** for a particular field of knowledge.
- ❖ Examples: FOAF, DBpedia, and CIDOC-CRM

What is RDF?

- ❖ Resource Description Framework (RDF) is designed to be a universal data representation format.
- ❖ It promotes data interoperability by providing a common framework for expressing data and its relationships, making it easier to integrate data from various sources and domains.
- ❖ RDF Statement (Triples):
 - ❖ Subject - Predicate - Object
 - ❖ Kaija Saariaho - Born - 1952

What is SPARQL?

- ❖ SPARQL (SPARQL Protocol and RDF Query Language)
- ❖ An RDF query language
- ❖ Allows users to query databases that can be mapped to RDF

An example of SPARQL query

Who was the mother of Clara Schumann?

```
SELECT *
```

```
WHERE {
```

```
?person_of_interest rdfs:label "Clara Schumann"@en.
```

```
?person_of_interest dbp:mother ?mom.
```

```
}
```

SPARQL query @DBpedia

Why Wikidata?

Why I like it

- ❖ Totally free: Public Domain (CC0)
- ❖ Flexible ontology and schema
- ❖ URI (Unique Resource Identifiers) are numeric
 - ❖ Language-agnostic
 - ❖ MARC fields: 100 (authors), 245 (title), 260 (publisher), etc.
- ❖ Loose crowd-sourced editing
 - ❖ Entities / items (QID) can easily be added
 - ❖ Properties (PID) need some group consent
- ❖ *OpenRefine* knows about Wikidata
- ❖ Very large, growing source of information

Wikidata Triples

- ❖ Wikidata triples: Item - Property - Value
 - ❖ Equivalent to RDF: Subject - Predicate - Object
- ❖ Example: Maria Anna Mozart - Sibling of - W. A. Mozart
Q157928 - P3373 - Q254

Very large, growing source of information

- ❖ 107,267,269 data items (as of 2023-10-14)
- ❖ 117,353,950 data items (as of 2025-05-06)
- ❖ Wikidata is only 13 years old (from ~2012)
- ❖ Acting as a consolidator of URIs. Becoming a central hub of information on the Internet
 - ❖ VIAF (Virtual International Authority File) (from ~2003)
 - ❖ Fanny Mendelssohn: <https://viaf.org/viaf/2535006>
 - ❖ Wikidata: <https://www.wikidata.org/wiki/Q57286>

What's wrong with Wikidata?

- ❖ Disorganized
 - ❖ Anyone can add or modify anything
 - ❖ For example, musical instruments
- ❖ No authority
 - ❖ Looser than Wikipedia

Ontologies in Wikidata

- ❖ Wikidata has the concepts of “Instance of” (P31) and “Subclass of” (P279)
- ❖ Its ontology and schema can be extended and modified by the Wikidata community, which makes it a dynamic and ever-evolving knowledge base
- ❖ Users can add new classes and properties, leading to a more flexible and adaptable structure

OpenRefine

- ❖ A tool for data hygiene (data cleaning)
- ❖ Helps convert databases to RDF format
 - ❖ Mostly with table-like data format (e.g., spreadsheets)
- ❖ Knows about Wikidata
 - ❖ Finds Wikidata IDs for Items, Properties, and Values
 - ❖ The process is called “reconciliation”
 - ❖ Row headings → Item (subject)
 - ❖ Column headings → Property (predicate)
 - ❖ Cell values → Value (object)

An example of how OpenRefine works

Courtesy of Julie Cumming (Motet Database)

Source name	Abbreviation	Dates	Provenance	Type of source	Size (cm)
Motetti C. Venice, Petrucci, 1504.	1504/1	1504	Italy, Venice	Motets	16 x 23
Fragmenta missarum, Venice, Petrucci, 1505	1505/1	1505	Italy, Venice	Masses	16 x 23
Attaingnant, Treze motetz musicaulz Paris: Attaingnant, 1531	1531/5	1531	France	Tablature, keyboard	
Der ander theil des Lautenbuchs. Nuremberg, Petreius, 1536	1536/13	1536	Germany, Nuremberg	Tablature, lute	
Bologna, Civico Museo Bibliografico Musicale, MS Q18.	Bologna Q18	1502-6	Italy, Bologna	Textless, chansons, laude and frottole	17 x 24

Automatic Reconciliation using Wikidata + Manual Reconciliation

https://rism.online/sources/993103780	1504/1	Q6148	Q641	Q188285	16 x 23
https://rism.online/sources/993103788	1505/1	Q6153	Q641	Masses	16 x 23
https://rism.online/sources/993104054	1531/5	Q6431	France	Q17126140	
https://rism.online/sources/993104150	1536/13	Q6457	Q2090	Q119855423	
https://www.diamm.ac.uk/sources/1389	Bologna Q18	1502-6	Q1891	Textless, chansons, laude and frottole	17 x 24

A new task for LinkedMusic Project

- ❖ Improve the quality of musical information in Wikidata
 - ❖ Provide interfaces for editing, e.g., UML, Saints' Days
 - ❖ Provide visualization interfaces to identify missing or erroneous data (e.g., “Transposing Instrument”)

Current Basic Process of Making LinkedMusic Data Lake

- ❖ Combine various data sources and dump them into our LinkedMusic Data Lake
- ❖ Use SPARQL and other search engines (e.g., Solr, ElasticSearch) for queries

NLQ2SPARQL

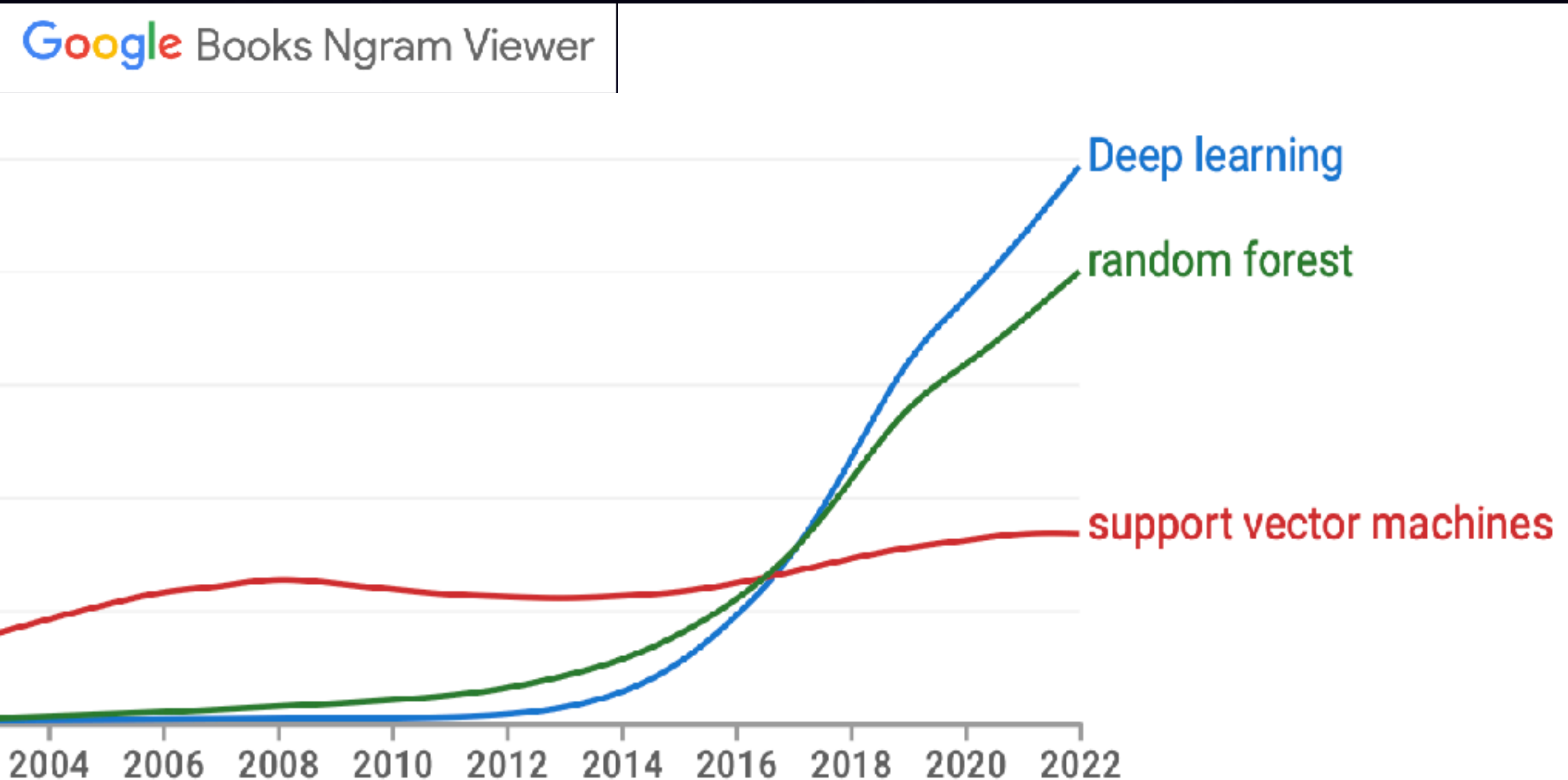
- ❖ Natural Language Query to SPARQL query conversion
- ❖ SPARQL: SPARQL Protocol and RDF Query Language

How to Train Your Computer

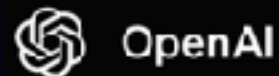
- ❖ Ground up
- ❖ Fine Tuning
- ❖ In-Context Learning (“In-Context Education”)
- ❖ RAGs retrieval augmented generation

How to Train Your Computer

A Brief History of Machine Learning



On November 30, 2022 OpenAI announces ChatGPT !


[Research](#)
[Products](#)
[Safety](#)
[Company](#)


AH

Andrew Hankinson <andrew.hankinson@rism.digital>

andrew

December 6, 2022 at 5:06 AM

Whoa.

[Hide](#)

To: Ichiro Fujinaga <ichiro.fujinaga@mcgill.ca>,

Cc: Laurent Pugin <laurent.pugin@rism.digital>

Hi Ich, Laurent,

Further to the question of LinkedMusic and doing user interfaces for finding music materials...

Have you seen ChatGPT? It's incredibly cool.

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests.

What is ChatGPT?

- ❖ ChatGPT is a type of Large Language Model (LLM)
- ❖ Designed specifically for conversation by OpenAI

What is a Large Language Model (LLM)?

- ❖ A type of artificial neural networks called *transformers*
- ❖ Initially trained for language understanding using deep learning techniques
- ❖ LLMs are pre-trained on massive datasets: text, images, music
- ❖ They have generative capabilities: text, images, music
- ❖ GPT stands for Generative Pre-trained Transformer

History of Large Language Models (LLM)

Date	Google	Date	Facebook	Anthropic
2017	Transformer paper	2023-02	LLaMA	
2018	BERT	2023-03	T	Claude
2019	T5	2023-07	LLaMA 2	Claude 2
2020		2024-03	-3	Claude 3
2021	LaMDA	2024-04	LLaMA 3	
2022	PaLM	2024-06	(Nov)	Claude 3.5 Sonnet
2023	Bard (Mar)		May)	
2024	Gemini (Feb)	2024-07	LLaMA 3.2 (May)	
		2024-09	LLaMA 3.3	

Issues in training an LLM

❖ Size

- ❖ Training data
- ❖ Model size

❖ Time

- ❖ Training time

❖ Cost

- ❖ Computing time
- ❖ Environment impact

LLMs	Size	Training time	Cost
ChatGPT	175B	34 days	\$4.6M
LLaMA 3	8B/70B	3/21 Days	
LLaMA 3.1	405B	2 Months	
GPT-4	1,760B	3–4 Months	~\$500M
Gemini	1,560B		~\$1–2B

How to Train Your Computer

- ❖ ~~Ground up~~
- ❖ Fine Tuning
- ❖ In-Context Learning (“In-Context Education”)
- ❖ RAGs retrieval augmented generation

How to Train Your Computer: Fine-tuning

- ❖ A type of transfer learning
 - ❖ Start with a pre-trained model
 - ❖ Retrain with new dataset by adjusting parameters
- ❖ “Catastrophic forgetting”
- ❖ Still requires some computing resources

How to Train Your Computer

- ❖ ~~Ground up~~
- ❖ ~~Fine Tuning~~
- ❖ In-Context Learning (“In-Context Education”)
- ❖ RAGs retrieval augmented generation

How to Train Your Computer: In-Context Learning

- ❖ Prompt engineering
- ❖ Provide the context before the prompt
 - I'm preparing a slide presentation for academics.*
 - Please make some slides for explaining In-Context Learning.*
- ❖ No training necessary! 😊
- ❖ Has no memory, however 😞 “In-Context Education”
- ❖ Restrictions on size of the context window (token limits)
 - ❖ ChatGPT: 2,000 words
 - ❖ ChatGPT 4o: 96,000 words
 - ❖ Claude 3.1 Sonnet: 150,000 words
 - ❖ Google Gemini: 750,000 words

How to Train Your Computer

- ❖ ~~Ground up~~
- ❖ ~~Fine Tuning~~
- ❖ In-Context Learning (“In-Context Education”) ✓
- ❖ RAGs retrieval augmented generation

How to Train Your Computer: RAG (Retrieval Augmented Generation)

- ❖ Combine dynamic search with LLM
- ❖ Documents or other data, including databases, are retrieved then used as an additional context for LLM prompt
- ❖ User preferences can also be retrieved for personalized response
- ❖ Future research avenue (e.g., Knowledge Graph Embeddings)

LLMs and LinkedMusic

- ❖ LLM (ChatGPT) is used for NLQ2PARQL (Natural Language Query to SPARQL) with in-context learning
 - ❖ More about queries on Thursday
- ❖ LinkedMusic may become unnecessary as LLMs improve over the next few years

Comparing queries: Google vs SPARQL

- ❖ Google: “17th-century German composers who died in London”
- ❖ SPARQL: “17th-century German composers who died in London”
- ❖ ChatGPT3: 17th-century German composers who died in London
- ❖ ChatGPT: “Generate SPARQL for Wikidata: 17th-century German composers who died in London”
- ❖ With Handel: Wikidata (2023-10-21)
- ❖ With Handel: Wikidata (2024-06-29)
- ❖ ChatGPT4o: 17th-century German composers who died in London
- ❖ Claude: 17th-century German composers who died in London

Screenshot 2024-10-01

Claude 3.5 Sonnet

Claude
17th-Century German Composers in London

IF

17th-century German composers who died in London

Here are some notable 17th-century German composers who died in London:

- Johann Christoph Pepusch (1667-1752)
 - Born in Berlin, died in London
 - Known for arranging music for The Beggar's Opera
- George Frideric Handel (1685-1759)
 - Born in Halle, died in London
 - One of the most famous Baroque composers
 - Wrote many operas, oratorios including Messiah
- Johann Christian Bach (1735-1782)
 - Born in Leipzig, died in London
 - Youngest son of Johann Sebastian Bach
 - Known as the "London Bach"

IF

Reply to Claude...




Claude 3.5 Sonnet

Screenshot 2025-05-06

Claude 3.7 Sonnet

IF 17th-century German composers who died in London

Here are several 17th-century German composers who died in London:

1. Johann Christoph Pepusch (1667-1752) - Born in Berlin, he moved to England around 1700 and became an influential figure in London's musical life. Although he died in 1752 (slightly outside the 17th century), he was born in the 17th century and spent his later years in London.
2. Jakob Greber (c. 1673-1731) - A German baroque composer who worked in London and died there.
3. Georg Frideric Handel (1685-1759) - Though born in Halle, Germany in the late 17th century, Handel moved to London in 1712 and became naturalized as a British subject in 1727. He died in London in 1759. While his death occurred in the 18th century, he was born in the 17th century and is perhaps the most famous German composer to have died in London.

The list of German composers who were both born in the 17th century AND died in London

Reply to Claude...



Claude 3.7 Sonnet ▾



Future projects

- ❖ Public UML: Crowd sourcing
- ❖ NLQ2SQL for Cantus Database (Lucas March)
- ❖ Continuous Integration for NLQ2SPARQL
 - ❖ Integrate database reconciliation as part of the in-context learning
- ❖ Investigate the use of RAG (Retrieval-Augmented Generation) for queries
- ❖ Use LLMs to generate frontend (e.g., sortable table)
- ❖ Continue to update Wikidata: e.g., Saints and Feasts
- ❖ How to keep Wikidata updated and correct

Future Meetings

- ❖ LinkedMusic Workshops:
 - ❖ Music Encoding Conference in London, UK
 - ❖ Monday 2 June 2025: 2 pm
 - ❖ IAML in Salzburg
 - ❖ Sunday 6 July 2025: 3 pm

Possible Future Workshop Sites

- ❖ 2026 / 05: MEC (Tokyo, Japan)
- ❖ 2026 / 06: IAML (Thessaloniki, Greece)
- ❖ 2027 / 03: MLA (TBA)
- ❖ 2027 / 08: IMS Congress (University of Stavanger, Norway)

Acknowledgements



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numérique du Canada

Calcul Québec

These slides were created with the assistants from ChatGPT, Claude, and Gemini.

SIMSSA / LinkedMusic Team @McGill

Summer 2024



Hanwen Zhang

Lucas March

Kyrie Bouressa

Anna de Bakker

Cole Thierrin

Ichiro Fujinaga

Yueqiao Zhang

Dylan Hillerbrand

Yinan Zhou

Junjun Cao

Kun Fang

Geneviève Gates-Panneton (MIA)

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Universal Musical Instrument Lexicon

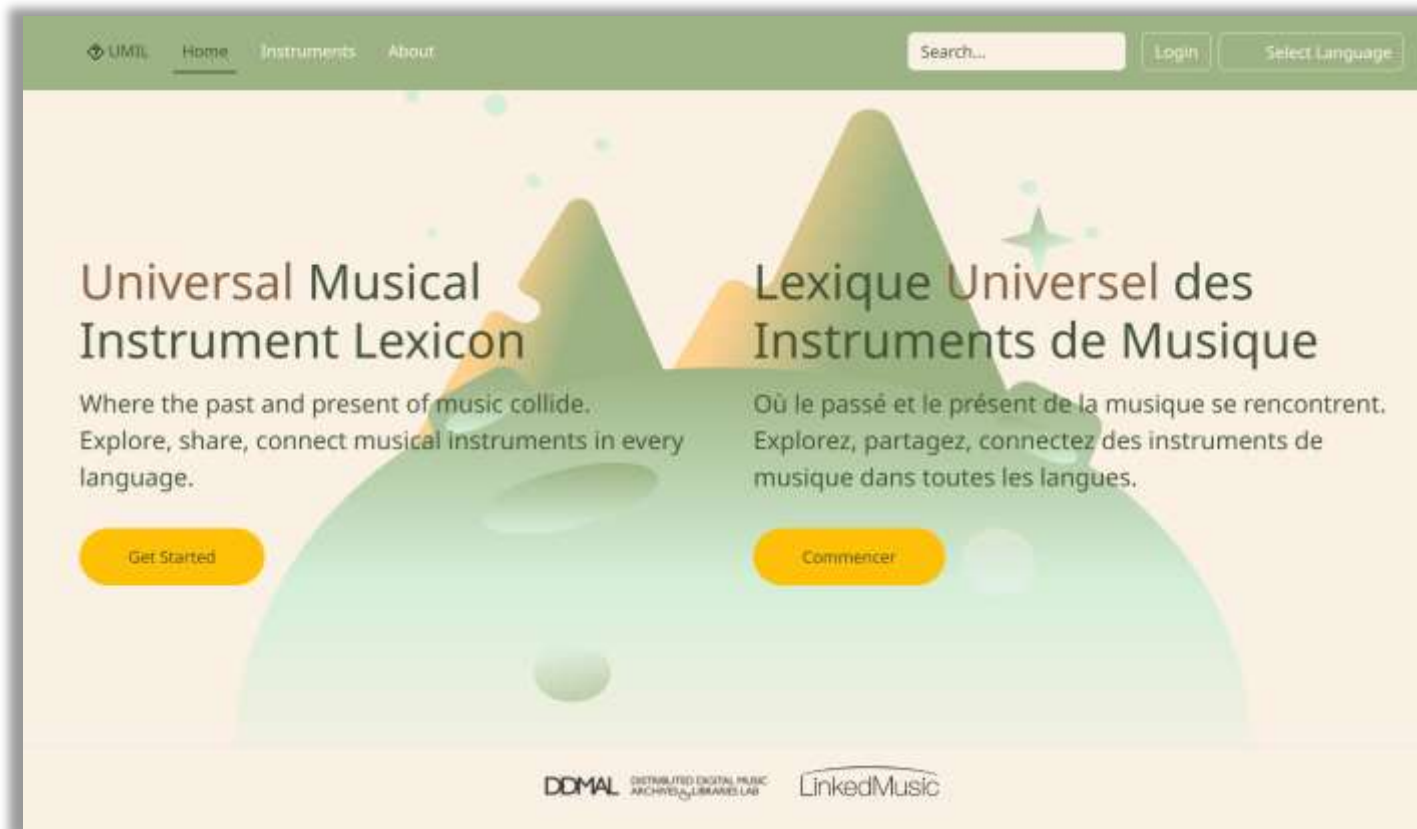
DDMAL Training Week

2025-05-06

Presented by Kun Fang

Overview

- Crowdsources **names** and **images** of instruments
- **Multilingual** interface for easy contribution
- Simplifies editing and publishing to **Wikidata**



Why do we need UMIL?

- **Addressing Issues with Wikidata**
 - **Data Quality:** Incomplete or inaccurate instrument data
 - *UMIL ensures cleaner, well-organized data through community contributions.*
 - **Convenience:** lacks a user-friendly way to view/edit all instrument information at once
 - *UMIL offers a centralized platform where users can easily view, edit, and submit instrument data.*

Why do we need UMIL?

- **UMIL's Key Functions**

- **Crowdsourcing platform** where users can...
 - Contribute new instruments
 - Submit instrument names in different languages
 - Upload instrument images
- **Interacts with Wikidata**
 - Get information **from** Wikidata
 - Publish information **to** Wikidata

How to Get Started?

- Visit UMIL: <https://vim.simssa.ca/>
- UMIL's **Github Repo**: <https://github.com/DDMAL/VIM>
- UMIL is a **Django**-based project.
- Please follow the **README** file to get familiar with:
 1. Installation for Local Development
 - Requirements: Docker Engine with Compose V2
 - Initial Set-Up Instructions
 - Debugging: **django-debug-toolbar** and **django-extensions**
 2. Installation for Deployment
 3. Managing Database Migrations
 4. Loading Data
 5. Additional Tools for Python Development: **Poetry**

Current Progress

- 1. Display & Search Instruments**
- 2. View & Edit Mode for Instrument**

Module 1: Display & Search Instruments

800+ Musical Instruments

Hornbostel-Sachs Classification

- 1 - Idiophones (131)
- 2 - Membranophones (62)
- 3 - Chordophones (275)
- 4 - Aerophones (278)
- 5 - Electrophones (29)
- Unclassified

More facet search coming...

Multi-languages

English ▼

- English
- Français

Showing 1 to 20 of 801

View 20 | 50 | 100 per page

Hornbostel-Sachs Classification Faceted Search

Guitar

Trumpet

Clarinet

Bass Clarinet

Bagpipes

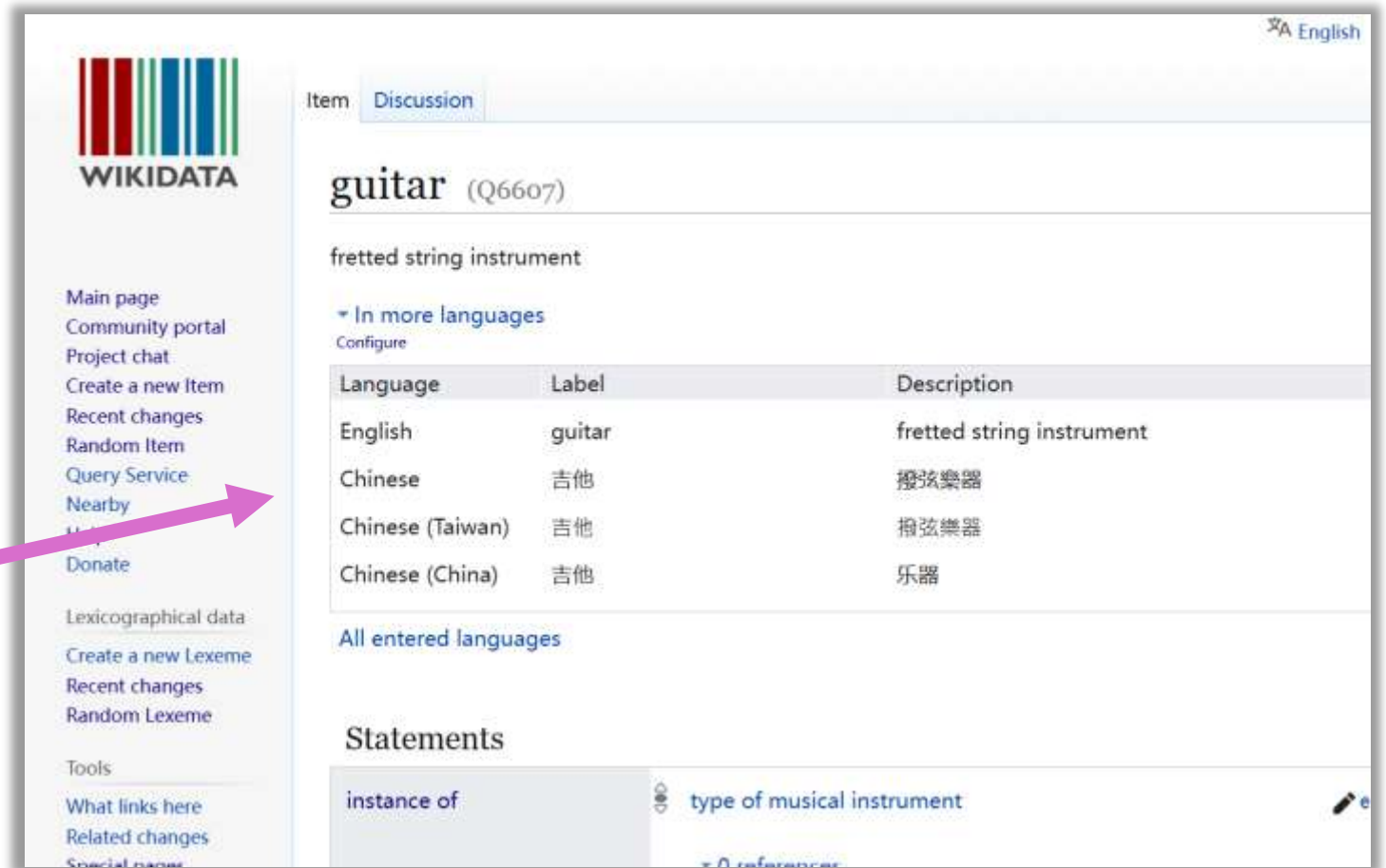
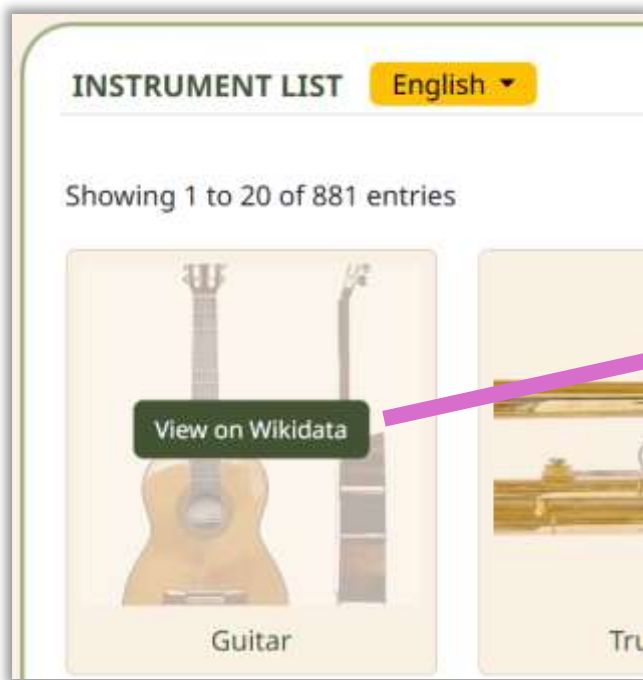
Trombone

Violin

Cello

Module 2: View & Edit Mode for Instrument

- **View Mode**



Module 2: View & Edit Mode for Instrument

- **Edit Mode**

Logged-in users can edit instrument information

Login

Email Address

Password

[Sign in](#)

[Forgot your password?](#)

[Don't have an account? Create a new account](#)

INSTRUMENT LIST [English](#)

Showing 1 to 20 of 881 entries



[Add instrument name](#)

[Upload new images](#)

[View on Wikidata](#)

Guitar



Tr

- **Add instrument names**
- **Add images**
- **Create new instruments**

Module 2: View & Edit Mode for Instrument

- **Edit Mode: Add Instrument Names**

Input fields: Language*, Name*, Source*, Description, Alias

Add New Name for **Guitar** (wikidata ID:Q6607)

Language	Name	Source	Description	Also known as	
Type to search	Enter name	Enter source	Enter description	Enter alias	Remove
Type to search	Enter name	Enter source	Enter description	Enter alias	Remove

Add another row

☐ Do you want to publish also to Wikidata?

Publish

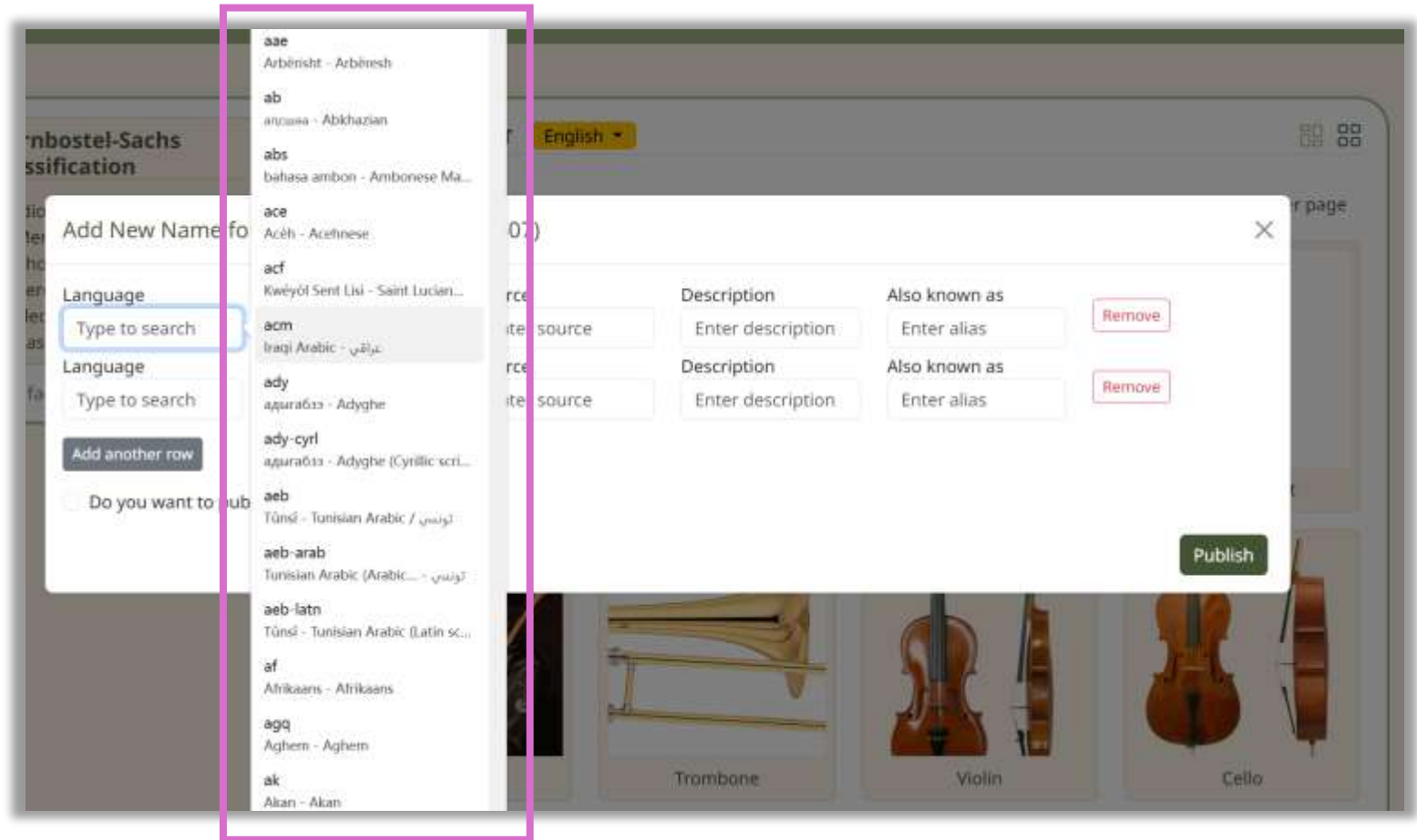
Add more names at once

Check this box to publish to Wikidata

Module 2: View & Edit Mode for Instrument

- **Edit Mode: Multi-language Support**

- Choose a language in the list (**600+ languages**)
- Identified by **Wikidata's language code** (e.g., “en”, “fr”)
- Get the language list by calling **Wikidata API**



What's Next?

Call for Contributions!

1. Interact with Wikidata: Add New Names

- **Where do we use the Wikidata API when adding new names?**
 - Get Wikidata's latest language list
 - Get/Set instrument information
 - Name
 - Description
 - Alias
 - ...

2. Interact with Wikidata: Add New Images

- **Objective:** Uploaded images will appear directly on **the instrument's Wikidata page**.
- **How it works:**
 - **Step 1:** Upload image to **Wikimedia Commons**
 - *Wikimedia Commons is a free media repository where images, videos, and audio are stored and shared.*
 - **Step 2:** Retrieve the **name of the uploaded image**.
 - **Step 3:** Link the image name to the instrument's **"image" property (P18)**.



3. Interact with Wikidata: Create New Instruments

- **Expected result**
 - Calling Wikidata API to create non-existing instruments to Wikidata.
 - Design a user-friendly way to publish new instruments to Wikidata.
 - The process is similar to “Add new names”.

Challenges: Interacting with Wikidata

Challenge 1: Make Edits to Wikidata

- Requires a Wikidata account of a specific type: **Auto-confirmed user** to publish content.
- **Solution**
 - Create a DDMAL account; Contributions made through UMIL will be published using this account.

New users [\[edit \]](#)

Any logged-in user may maintain a watchlist at [Special:Watchlist](#), and may email any other user (unless blocked from doing so) by using [Special:EmailUser](#). While they no longer have the editing rate limit, they must still answer a CAPTCHA prompt when adding new external links until they become autoconfirmed or confirmed.

Autoconfirmed users [\[edit \]](#)

An account with at least 4 days of age and at least 50 edits (90 days and 100 edits for editors from Tor nodes; abuse filter can potentially delay or revert automatic promotion) is said to be **autoconfirmed**. Any user account which does not meet these requirements can be granted the **confirmed** permission and receive the same permissions. Autoconfirmed users no longer need to respond to CAPTCHAs for most actions, **can edit** **semi-protected** pages, and can move most pages (except items and properties, which are simply renamed by changing the appropriate labels instead).

Challenge 2: Upload Images to Wikimedia

- **Copyright issues** for uploading images.
- **Solution**
 - Follow **Wikimedia's copyright policy** by asking users to complete a **questionnaire**
 - Review content before publishing
 - **Human review:** Conducted by the UMIL team
 - **Automatic check tools:** Further investigate existing mechanisms for checking/filtering inappropriate content



Call for better solutions!

Other Challenges

1. **User-Friendliness** When Interacting with Wikidata
2. Ensuring **Accuracy** of Submitted Information
3. Encouraging Contributions in **Multiple Languages**
(Especially Native Language for That Instrument)

Summary: To-Do List

- Interaction with Wikidata (high priority)
 - Upload instrument names to Wikidata
 - Upload images to Wikidata
 - Create non-existing instruments to Wikidata
- Multi-language support (medium priority)
 - Re-design the website language and instrument language
- Frontend adjustment (low priority)
 - Make UMIL looks reasonable on mobile phones

Thank you!

Linked Music Data Lake



Yueqiao Zhang

2025 May 7 Training Session

Outline

01

Intro

02

Motivations & Goals

03

RDF

04

Supported Sources

05

Workflow & Methods

06

Future

PROJECT GOALS

Music metadata lives in many silos. Our goal was to:

- *Aggregate* all of these into one place.
- *Reconcile* entities against a common vocabulary (Wikidata).
- *Expose* the result as RDF, so researchers and applications can query across collections seamlessly.

01 Siloed Metadata

- Different communities, different databases
 - Little or no cross-walk between them
-

02 Heterogeneous Formats

- CSV, JSON-Lines, RDF, XML, proprietary dumps
 - Varying schemas for the same core concepts
-

03 Divergent Identifiers

- Each source rolls its own IDs for works, performers, editions
 - No “global authority” to bind them together
-



REPO Guide

<https://github.com/DDMAL/linkedmusic-datalake>

code

Cantus DB

MusicBrainz

RISM

The Session

Contains scripts used for fetching, converting, and some database-specific functions.

data

Cantus DB

MusicBrainz

RISM

The Session

Simssa DB

Contains raw, converted, and reconciled dataset files. Some are not there, but will be created by the scripts.

doc

Cantus DB

MusicBrainz

RISM

The Session

Simssa DB

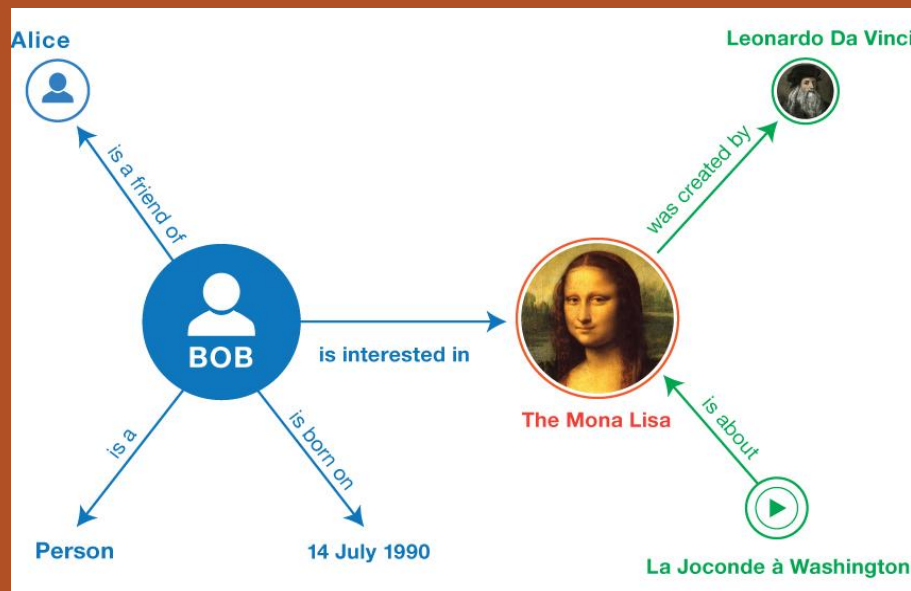
OpenRefine tips

etc...

Contains documents for our past decisions, records, and work logs and operational manuals.

RDF

What is RDF?



Resource Description Framework

Triple-based model: Subject → Predicate → Object

URIs as identifiers for things and relationships

Graph structure: Easily joins data across domains

Serialization formats: Turtle, RDF/XML, JSON-LD

```
<Bob> <is a> <person>.
<Bob> <is a friend of> <Alice>.
<Bob> <is born on> <the 4th of July 1990>.
<Bob> <is interested in> <the Mona Lisa>.
<the Mona Lisa> <was created by>
  <Leonardo da Vinci>.
<the video 'La Joconde à Washington'>
  <is about> <the Mona Lisa>
```

SUPPORTED SOURCES

A brief overview of the databases I went through for the past year

Cantus DB

A scholarly repository of Latin chant melodies drawn from medieval manuscripts and early printed books, provided in **CSV format** for easy integration and analysis.

MusicBrainz

An open music encyclopedia that curates extensive metadata on artists, releases, and recordings; its public **JSON-Lines** dumps are parsed into our data lake via **RDFLib**.

RISM

The Répertoire International des Sources Musicales is an international catalogue of historical musical sources—manuscripts, prints, and related documents—offered as **RDF** datasets for deep musicological research.

The Session

A community-driven archive of Irish traditional tunes, whose public **CSV** datasets we reconcile against Wikidata to link folk-music heritage across sources.

Simssa DB

A discovery platform for symbolic music files (including MEI, Kern, MusicXML, and MIDI) evolved from the Digging into Data project, currently under active development.

HOW IT WORKS

STEP 01 - Preprocessing

Fetch raw data dumps in various formats (RDF, JSONL, CSV) from each source.

TOOLS INVOLVED

→ Fetch python scripts

STEP 02 - Schema

Convert the database into RDF. Understand, extract the schema.

TOOLS INVOLVED

→ Various conversion scripts
→ OpenRefine RDF plugin

STEP 03 - Reconcile

Reconcile RDF table rows against Wikidata using OpenRefine (plus an "archive" of manual fixes).

TOOLS INVOLVED

→ OpenRefine Reconciliation
→ Wikidata
→ A LOT of Research

STEP 04 - Transform

Transform reconciled raw RDF into RDF Turtle and load into our Virtuoso staging endpoint.

TOOLS INVOLVED

→ RDF Transform Plugin
→ OpenRefine
→ Virtuoso Staging

FETCHING & *PREPROCESSING*

See more detailed explanations for how to use scripts in the doc folder.

STEP 01 - fetching

We fetch raw data from various sources, usually by python scripts.

Example

The `fetch.py` script in MusicBrainz code folder retrieves the latest version data and downloads them.

STEP 02 - converting

We parse the downloaded raw files into CSV or RDF by customized scripts.

Example

MusicBrainz provides archived files. We unzip them and convert them into RDF.

STEP 03 - extra works

For specific sources, we need some additional work.

Example

MusicBrainz does not provides the full `genre` export. We need to retrieve it independently.

STEP 04 - schema

In OpenRefine, we need to specify the schema of the RDF graph for the export in RDF.

Example

RISM provides raw RDF that requires reconciliation. We can edit the RDF Transform in OpenRefine.

OpenRefine part 1 ttl Permalink

Save RDF Transform Undo

Open... Export ▾ Help

Facet / Filter Undo / Redo 1 / 1

17896 records

Extensions RDF Transform ▾ RDF ▾ Wikibase ▾

Extract... Apply...

Filter

0. Create project

1. Save RDF Transform

1

next > last >

www.w3.org/2000/01/rdf-schema#label

http://www.wi...

n, Wolfenbüttel; Celle; ...@none

https://rism.online/i

Manuscript copy; SK-BRnm MUS XVIII

František (1786-1858)@none

none

@en

@en

; Manuscript copy; E-SE 18/42@en

RDF Transform

The RDF template below specifies how the RDF data is generated from your tabular data. The cells in each record of your data will get placed into nodes within the transform. Configure the transform by using column names and values, computed strings, or specified IRI as a subject, property, and object resources or literals. Compute strings using GREL. [See the docs.](#)

Base IRI: http://127.0.0.1:3333/ Edit

Transform Preview

Available Namespaces: rdf rdfs owl xsd vcard foaf + Add Manage

* R: subject

Add type...

> http://www.w3.org...#type →

> http://www.w3.org...#label →

> http://www.wikida...rop/direct/P195 →

> http://www.wikida...rop/direct/P361 →

> http://www.wikida...prop/direct/P50 →

Add Root Node

* R: http://www.w3.org...-syntax-ns#type

Add type...

Add object...

* L: http://www.w3.org...df-schema#label

Add object...

* R: http://www.wikida...rop/direct/P195

Add type...

Add object...

* R: http://www.wikida...rop/direct/P361

Add type...

Add object...

* R: http://www.wikida...prop/direct/P50

Add type...

Add object...

* R: ...

Add type...

Add object...

Add property...

Add property...

Add property...

Add property...

Add property...

Add property...

Add property...

Add property...

Import Template

Export Template

Save

2 OK Cancel

ENTITY *RECONCILIATION*

01

LOAD

- Load into OpenRefine
- Configure Wikidata Reconciliation Service
- Customize Auto-Match properties

02

AUTO MATCH

- Transform cells (e.g. dates)
- Set Auto-Match thresholds
- Auto-Match results

03

EDGE CASE

- Resolve homonyms by context (e.g. names, birth/death dates)
- Split or merge entries for compound works

04

REVIEW

- Flag low confidence or no-match rows
- Edit or discard reconciliation judgements

05

ARCHIVE

- Keep decisions in `/ArchiveForReconciledEntries` folder for future reference and reducing manual works

RDF *EXPORT*

Upload

In many cases, we should repeat the entire procedure again on another dataset file for the same database, then we should merge all the exported RDF graph into a complete full graph (e.g. RISM).

After carefully reconciling entities...

Re-Examine RDF Transform

We might add some rows after reconciliation. We re-examine the RDF Transform according to our updated RDF graph.

RDF Export

We are now ready to export the RDF graph. The RDF Transform plugin also provides us with various RDF serialization format, which we can adapt to our purpose.

Repeating

In many cases, we should repeat the entire procedure again on another dataset file for the same database, then we should merge all the exported RDF graph into a complete full graph (e.g. RISM).

ROADS *AHEAD*



01

Improving Reconciliation: leverage automated entity linking models to reduce manual work.

02

Updating and Importing New Sources: keep all the existing ones updated and add more archives in the future.

03

Public Endpoint: integrate the Natural Language Query to SPARQL and move from staging to production with documentation and examples.

04

Community Contributions: welcome pull requests for new mappings, scripts, and ontology extensions

QUESTIONS?

LinkedMusic

Querying



Ichiro Fujinaga

Music Technology Area, Schulich School of Music

McGill University

Current Basic Process of Making LinkedMusic Data Lake

- ❖ Combine various data sources and dump them into our LinkedMusic Data Lake
- ❖ Use SPARQL and other search engines (e.g., Solr, ElasticSearch) for queries

NLQ2SPARQL

- ❖ Natural Language Query to SPARQL query conversion
- ❖ SPARQL: SPARQL Protocol and RDF Query Language

Our Solution

1. Export the database to text files
2. Convert to RDF (Resource Description Framework / linked data)
3. Store as text files (archive)
4. Import into an RDF graph database
5. Query using natural languages with ChatGPT

Example: Sessions Database

Database of Traditional Irish Music sessions

TUNES
DISCOGRAPHY
TRIPS
SESSIONS
EVENTS
DISCUSSIONS

THE SESSION
Log in or Sign up

Fáilte

Search
Tunes
for
SEARCH

The Session is a community website dedicated to Irish traditional music.

You can **find tunes** to play, **find sessions** to play them in, and **join in discussions** about the music. You can also **find events** (like concerts and festivals), or **explore the track listings of recordings**.

You can contribute too. If you're already a member, you can **log in**. If you're not yet a member, membership is free and it only takes a moment to **sign up**.

You can also **install The Session app** on your phone or computer.

1. Export the database to text files

A sample of CSV file of events in Sessions Database

events_id	event	dtstart	dtend	venue	address	town	area	country
https://thesession.org/events/3310	—	1900-01-01 00:00:00	1900-01-01 00:00:00	—		Ober-Kainsbach	Hessen	Germany
https://thesession.org/events/11	Colm Gannon, Sean Mckeon And John Blake	2006-06-07 09:30:00	2006-06-07 12:00:00	The Goalpost	226 Water Street	Quincy	Massachusetts	USA
https://thesession.org/events/5	Brid O'Donohue	2006-06-09 08:00:00	2006-06-09 00:00:00	Glór	Causeway Link	Ennis	Clare	Ireland
https://thesession.org/events/6	National Celtic Festival	2006-06-09 19:00:00	2006-06-12 15:00:00	Various Venues		Portarlinton	Victoria	Australia
https://thesession.org/events/7	The Irish Connections Festival	2006-06-09 19:00:00	2006-06-11 00:00:00	Irish Cultural Centre	200 New Boston Drive	Canton	Massachusetts	USA
https://thesession.org/events/19	Louisville Irish Fest	2006-06-10 11:00:00	2006-06-11 06:00:00	Belvedere/River Front Plaza		Louisville	Kentucky	USA
https://thesession.org/events/4	élan Concert (feat Damien Mullane And Sam Proctor)	2006-06-10 20:00:00	2006-06-10 23:30:00	Irish Cultural Centre	5 Black's Road	Hammersmith	London	England
https://thesession.org/events/2	Edel Fox And Ronan O'Elaberty	2006-06-10 21:30:00	2006-06-10	The Crosses Of Annagh		Miltown Malbay	Clare	Ireland

2. Convert to RDF (linked data)

Assign each item to an URI (Universal Resource Identifier) using OpenRefine and Wikidata

☐ town	☐ area	☐ country
Ober-Kainsbach	Hessen	Germany



☐ town	☐ town_wiki	☐ area	☐ area_wiki	☐ country	☐ country_wiki
Ober-Kainsbach Choose new match	https://www.wikidata.org/wiki/Q2008827	Hesse Choose new match	https://www.wikidata.org/wiki/Q1199	Germany Choose new match	https://www.wikidata.org/wiki/Q183

3. Store as text files (archive)

- ❖ Convert the CSV file with URI to flattened RDF (Resource Description Framework), e.g.:
 - ❖ Turtle
 - ❖ JSON-LD
 - ❖ N-Quads
- ❖ Also known as RDF serialization
- ❖ To be stored in a long-term archive

4. Import into an RDF graph database

We use an open-source software called Virtuoso



Other open-source examples include:



5. Query using natural languages (1)

Usually RDF database is queried using SPARQL (SPARQL Protocol and RDF Query Language)

SPARQL Query Editor
About
Tables
Conductor
Facet Browser
Permalink

Extensions:
cxml
save to dav
sponge
User: SPARQL

Default Data Set Name (Graph IRI)

Query Text

Results Format
HTML

Execute Query
Reset

5. Query using natural languages (2)

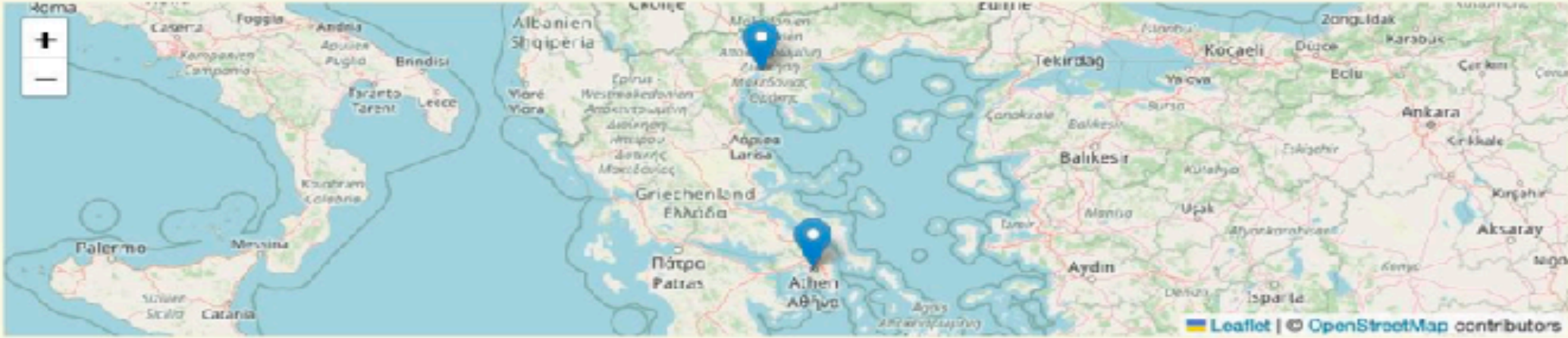
Example query: “Find sessions that took place in Greece”

TUNES
DISCOGRAPHY
TRIPS
SESSIONS
EVENTS
DISCUSSIONS

Sessions

Search for sessions on in

Searching for sessions in “Greece”



- The Lucky Sparrow Irish Pub**, Athens, Athens, Greece
Added by Athens Irish Festival 9 months ago.
- The Dubliner**, Thessaloniki, Makedonia, Greece
Added by lukegarry 3 years ago. Updated 2 months ago.

5. Query using natural languages (3)

Example query: **“Find sessions that took place in Greece”**

Equivalent SPARQL code:

```
PREFIX wd: <http://www.wikidata.org/entity/>
PREFIX wdt: <http://www.wikidata.org/prop/direct/>

SELECT ?session
WHERE {
    ?session rdf:type thesession:sessions .
    ?session wdt:P17 wd:Q41 .
}
```

Comment: P17 is the country property and Q41 is Greece in Wikidata

5. Query using natural languages (4)

Inserting the SPARQL query in Virtuoso

SPARQL Query Editor
About
Tables
Conductor
Facet Browser
Permalink

Extensions:
cxml
save to dav
sponge
User: SPARQL

Default Data Set Name (Graph IRI)

http://sample/thesession/reconciled

Query Text

```

PREFIX wd: <http://www.wikidata.org/entity/>
PREFIX wdt: <http://www.wikidata.org/prop/direct/>

SELECT ?session
WHERE {
    ?session rdf:type thesession:sessions .
    ?session wdt:P17 wd:Q41 .
}
    
```

Results Format

HTML

Execute Query
Reset

5. Query using natural languages (5)

Executing the SPARQL query in Virtuoso

SPARQL | HTML5 table

session

<https://thesession.org/sessions/7243>

<https://thesession.org/sessions/8020>

7243	The Dubliner	Katouni 16	Thessaloniki
8020	The Lucky Sparrow Irish Pub	Triptolemou 44	Athens

But we cannot ask general users to create
SPARQL queries!

5. Query using natural languages (6)

ChatGPT to rescue!

I have an RDF database reconciled with Wikidata.

It contains
country it

Create a c
in Greece.

```
PREFIX wd: <http://www.wikidata.org/entity/>
PREFIX wdt: <http://www.wikidata.org/prop/direct/>

SELECT ?session
WHERE {
    ?session rdf:type thesession:sessions .
    ?session wdt:P17 wd:Q41 .
}
```

sions

This prompt produces the correct SPARQL code!
(most of the time)

Demo 1

- ❖ Enter in ChatGPT:
- ❖ In my database reconciled with Wikidata, sessions are of type <https://thesession.org/sessions>, and the name of each session is stored in property P2561. Generate a complete SPARQL code to:
Find all sessions that took place in Greece.
- ❖ ChatGPT
- ❖ Virtuoso

Demo 1b

Query in different languages

- ❖ Enter in ChatGPT:
- ❖ In my database reconciled with Wikidata, sessions are of type <https://thesession.org/sessions>, and the name of each session is stored in property P2561. Generate a complete SPARQL code to:
找到嘅希臘嘅演奏會
(“Find all sessions that took place in Greece”).
- ❖ ChatGPT
- ❖ Virtuoso

Demo 2 (1)


thesession.org



[Log in or Sign up](#)
[TUNES](#)
[DISCOGRAPHY](#)
[TRIPS](#)
[SESSIONS](#)
[EVENTS](#)
[DISCUSSIONS](#)



Tunes

Search in for  [SEARCH](#)



Searching jigs in Dmajor for “Malcolm”

1. **Malcolm’s New Fiddle** (Jerry Holland’s)
JIG

2. **Malcolm Johnstone** JIG

Demo 2 (2)

❖ Enter in ChatGPT:

Given an RDF database reconciled with Wikidata, and

...

```
wd:Q170412 rdf:type owl:Class ; rdfs:label "tune" .
```

```
wdt:P136 rdfs:type owl:DatatypeProperty ; rdfs:label "genre" .
```

```
wdt:P826 rdfs:type owl:DatatypeProperty ; rdfs:comment "This property is also used about the tonality of a tune etc" .
```

```
wdt:P2561 rdfs:label "name" .
```

...

Generate SPARQL for the following[Note: SPARQL be syntactically correct such as ``filter[contains(lcase(str[?x])` ]:`

Find the tunes of genre “jig”, of “D major”, having “Malcolm” in its name.

❖ ChatGPT

❖ Virtuoso

Demo 3

Queries not available on TheSession

❖ Enter in ChatGPT:

Given an RDF database with properties[wdt:P2561] reconciled with Wikidata, and

""

<<https://thesession.org/sessions>> a owl:Class .

""

Generate complete and correct SPARQL for the following:

Find a session named "Hurley's Irish Pub"

❖ ChatGPT

❖ Virtuoso

Demo 4

Queries with TheSession and Wikidata

❖ Enter in ChatGPT:

Given an RDF graph <<http://sample/thesession/reconciled>>, the properties and classes of instances are reconciled with Wikidata as much as possible, so regarding SPARQL queries across different databases, we use `graph <...>` and `service <...>`. and Given:

```
@prefix thesession: <https://thesession.org/>. thesession:sessions a owl:Class.
```

```
wdt:P17 rdfs:domain <https://thesession.org/sessions>.
```

```
wdt:P2561 rdfs:domain <https://thesession.org/sessions>.
```

```
--for graph <http://sample/thesession/reconciled>
```

```
wdt:P361 rdfs:domain <ex:country>. wd:Q27468 rdfs:label "Eastern Europe".
```

```
--for service <https://query.wikidata.org/sparql>
```

Make sure to generate a correct SPARQL for the following question(Note: Use the properties or classes as above primarily; traverse wikidata before local graph):

Which sessions took place in Eastern Europe?

❖ ChatGPT

❖ Virtuoso

Conclusions

- ❖ By converting a database to an RDF graph database, we can search the database with natural language queries
- ❖ Because we use ChatGPT, we can make queries in many different natural languages: “找到嘅希臘嘅演奏會”
- ❖ We can even make queries that were not possible with the original web interface
- ❖ Furthermore, because we reconciled with Wikidata, we can query with concepts that were not defined in the original database: “Find sessions in Eastern Europe”
- ❖ Because RDF graphs can be stored as text files, we can easily archive them for long-term preservations

Future Directions

- ❖ We are improving our prompts so that ChatGPT makes fewer errors
 - ❖ Prompt Engineering
 - ❖ In-context Learning
- ❖ We can even ask ChatGPT to create a web interface with sorting capabilities in real time (e.g., Val Town)

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ARCHIVES & LIBRARIES LAB



Centre for Interdisciplinary Research
in Music Media and Technology

Fonds
de recherche

Québec



Digital Research
Alliance of Canada

Alliance de recherche
numérique du Canada

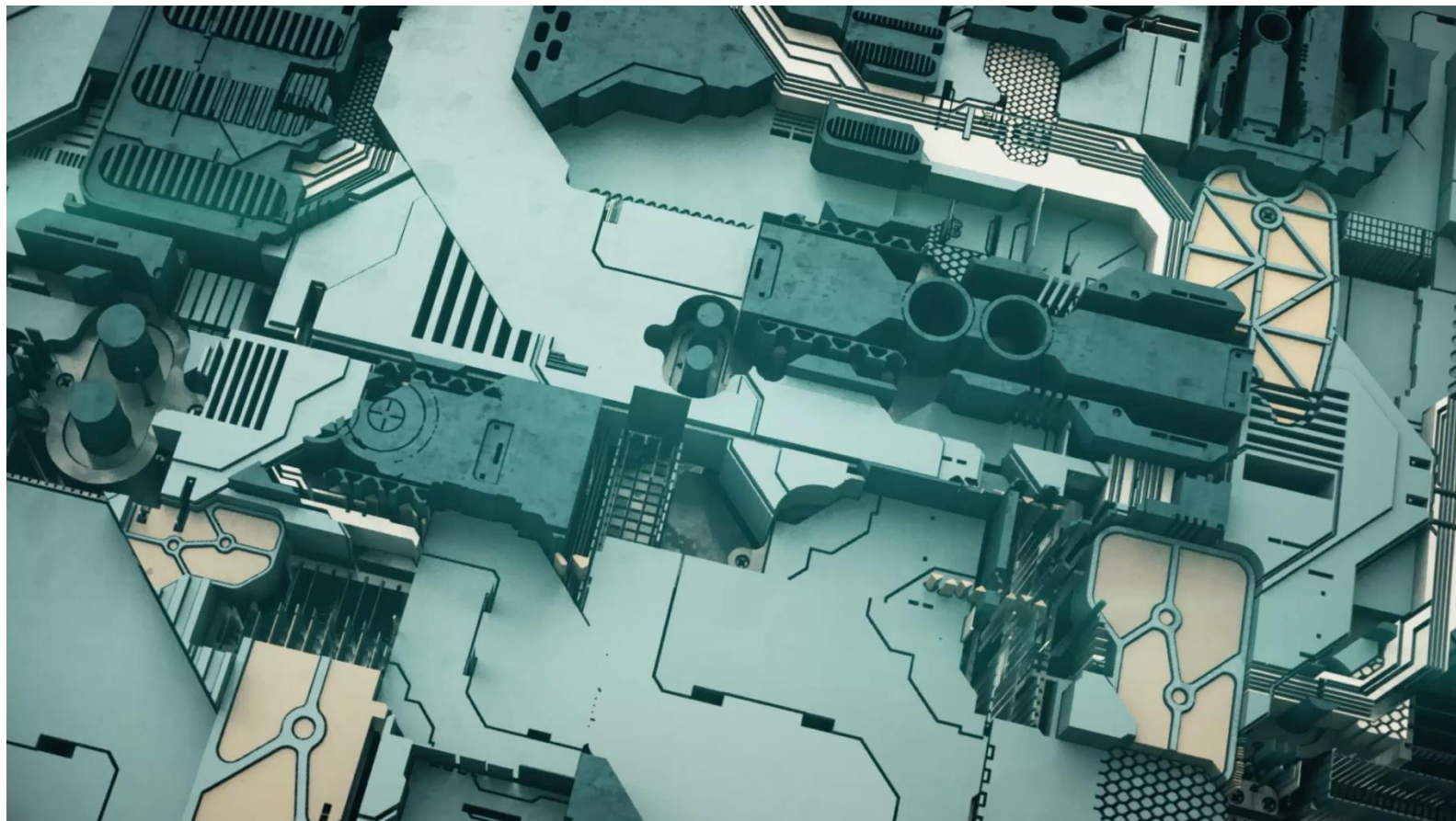
Calcul Québec

These slides were created with the assistants from ChatGPT, Claude, and Gemini.

End-to-end OMR: what is it, and how do we do it?

DDMAL Training Week
2025

Kyrie Bouressa



Optical Music Recognition (OMR)

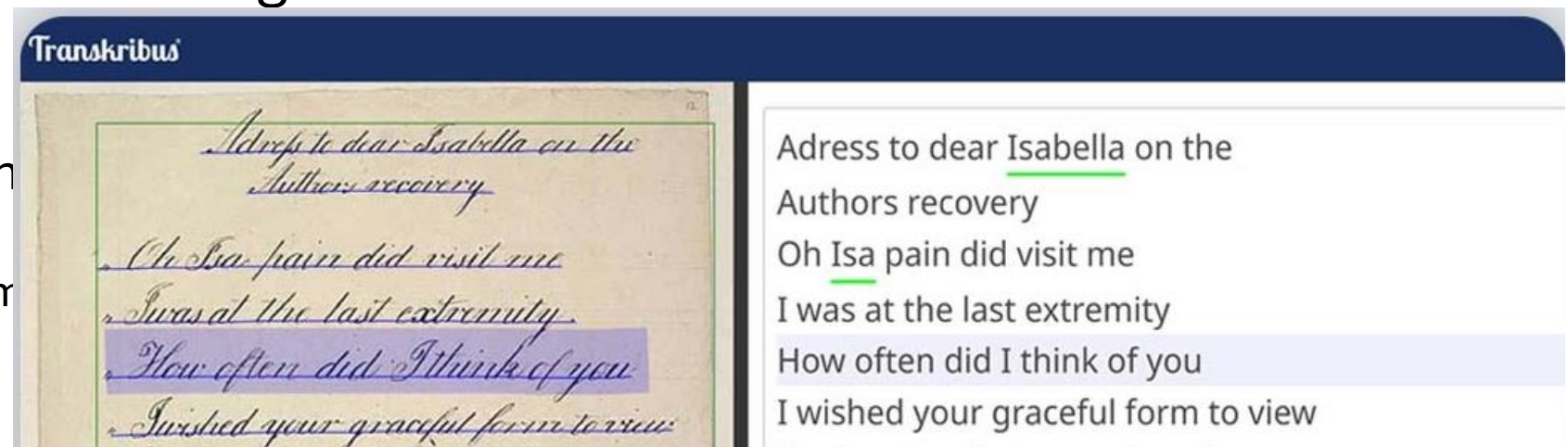
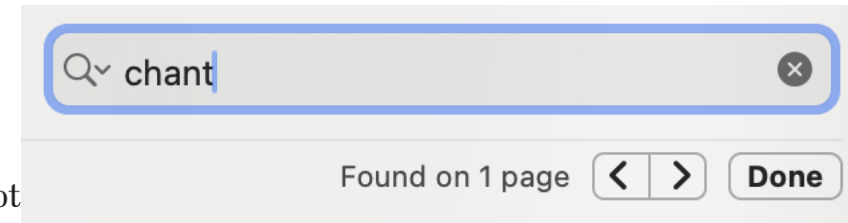
Optical Music Recognition (OMR) is the process of converting scanned images of pages of music into computer readable and manipulable symbols. We [DDMAL] focus on creating music recognition tools for libraries, archives and musicologists, and specialize in working with early music notation.

Searching for letters, words, and phrases

- You're probably familiar with OCR (optical *character* recognition):
 - Allows for the searching of a word or a phrase in a digital document
- OCR relies on internal knowledge of type/script
 - “standard” OCR
 - Historical/handwritten
 - Requires training
 - Requires a LOT of sam

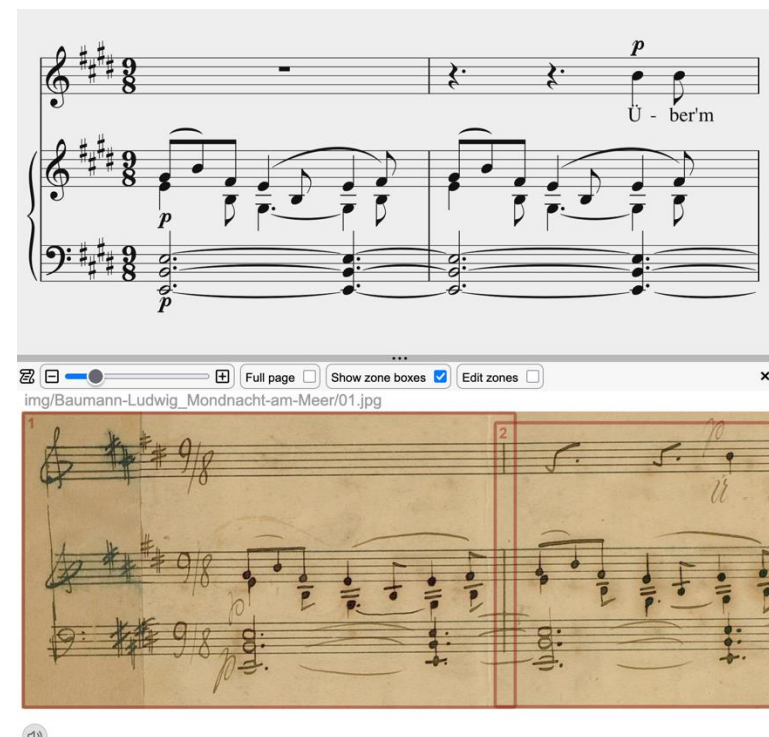
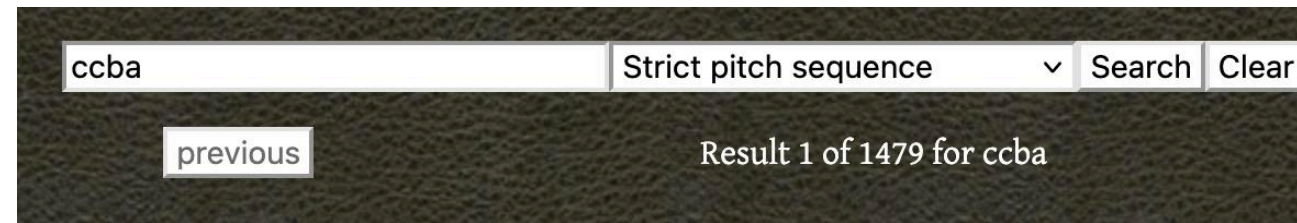
1968.
LØW, *Liturgica Islandica* (Bibliot

inger, *A Comparative Study of Chant Melodies from Fragments of the lost Nidaros* 1999; Lori Kruckenberg and Andreas Haug, *The Sequences of Nidaros. A Nordic European Context*, Trondheim, 2006.



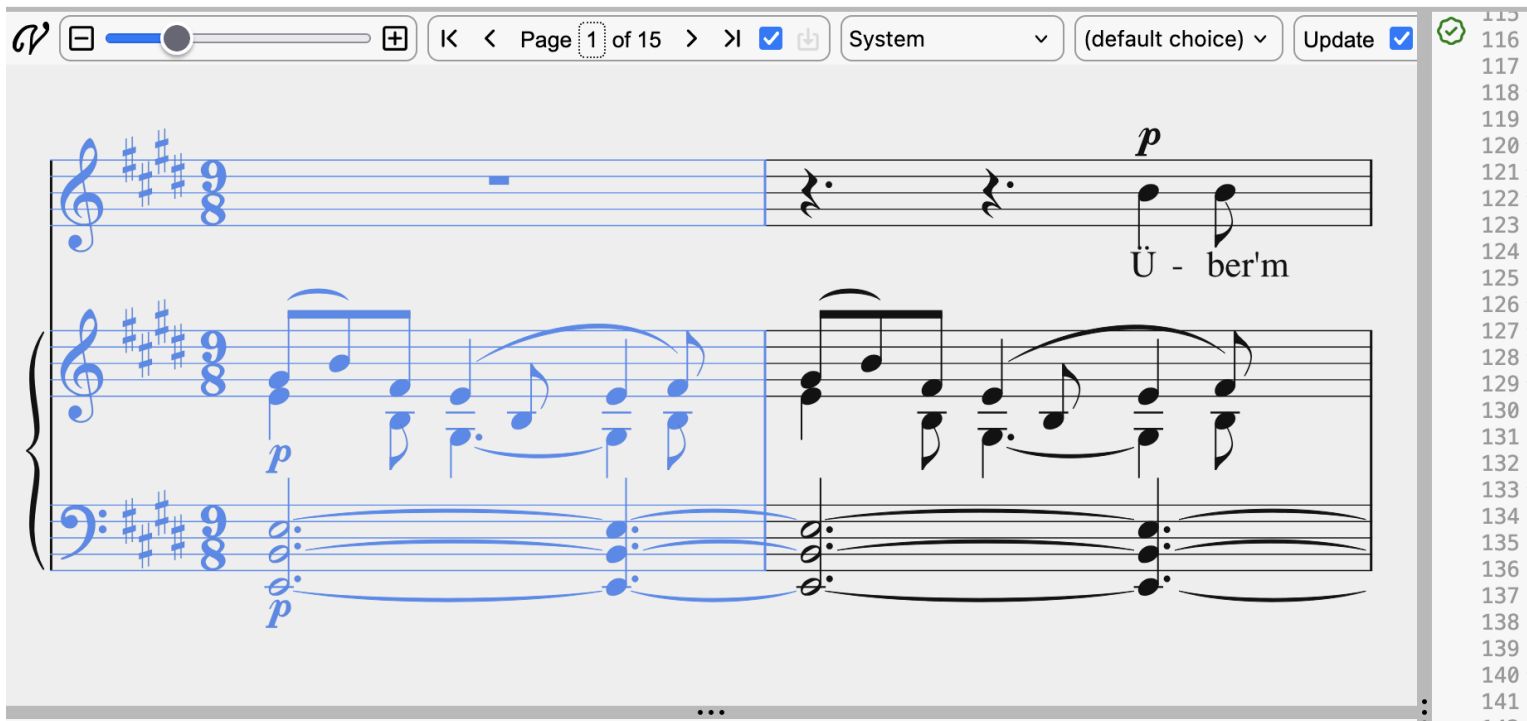
Searching for notes, intervals, and phrases

- OMR allows us to search a piece of music for specific notes, intervals, phrases, or contours.
 - “How many times does a descending fall of a fourth happen in this piece?”
 - “How many times does this melody show up?”
 - “Where are these intervals?”
- OMR *also* relies on internal knowledge of type/script
 - “modern” OMR
 - Historical/handwritten OMR
 - Requires training
 - Requires a LOT of samples



How do we get there?

- Meet *MEI*! A way we can encode *symbolic* musical notation to it can be represented and translated in the same (or another) symbolic format.
 - (*Yinan will talk more about this in a bit!*)
 - Music Encoding Initiative
 - Symbolic: represents a thing you need training to learn



The screenshot shows a music notation software interface. The top bar includes a navigation pane, a page indicator showing 'Page 1 of 15', and a 'System' dropdown menu. The main area displays a musical score with three staves. The top staff is a vocal line in treble clef with a key signature of three sharps (F#, C#, G#) and a 9/8 time signature. It contains a whole rest followed by a half note 'Ü' and a quarter note 'ber'm', both marked with a piano (*p*) dynamic. The bottom two staves are a piano accompaniment in treble and bass clefs, also with a key signature of three sharps and a 9/8 time signature. The piano part features complex rhythmic patterns with many beamed sixteenth and thirty-second notes, marked with a piano (*p*) dynamic. A vertical line indicates the current position in the score.

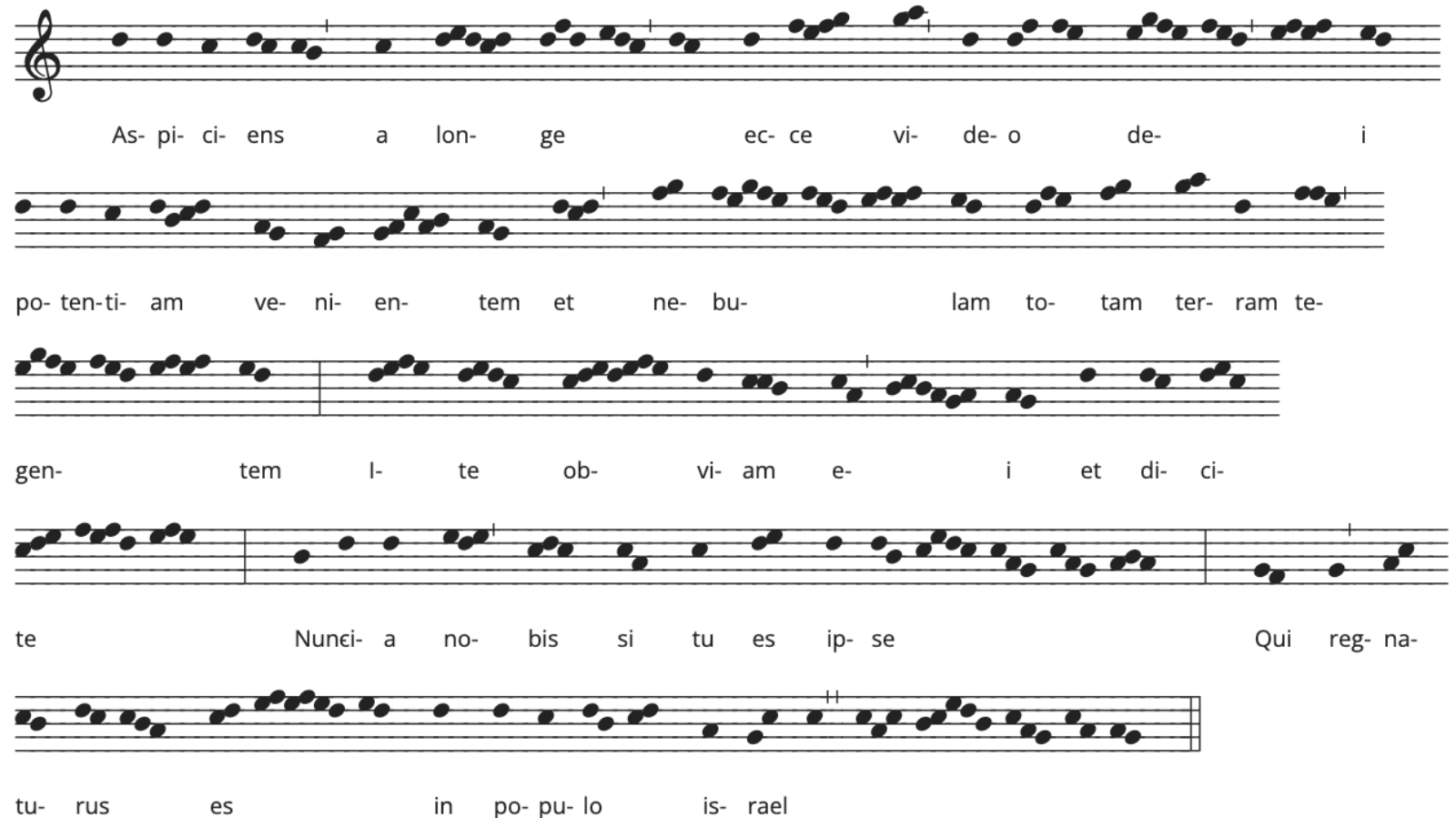
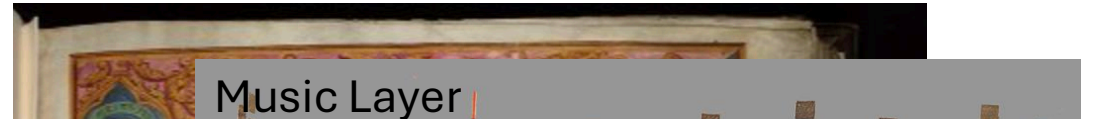
```
</staffGrp>
</scoreDef>
<section xml:id="s1">
  <pb xml:id="plndmm31" facs="#surface_01J46HF9ZHFCAXXRM4J
  <measure xml:id="mx6o18t" facs="#zone_01J46HF9ZJRHWGJ7WCN
    <staff xml:id="m1s1" n="1">
      <layer xml:id="m1s1l1" n="1">
        <mRest xml:id="mh3e7dd"/>
      </layer>
    </staff>
    <staff xml:id="m1s2" n="2">
      <layer xml:id="m1s2l1" n="1">
        <beam xml:id="b0aj44f">
          <note xml:id="n1rjzmja" dur="8" facs="#zn58tx
            <accid xml:id="aumny1r1" accid.ges="s"/>
          </note>
          <note xml:id="n1dnbrb8" dur="8" oct="4" pname=
            <note xml:id="n5wq0db" dur="8" oct="4" pname=
              <accid xml:id="ak9pbxx1" accid.ges="s"/>
            </note>
          </beam>
          <note xml:id="nc35f0i" dur="4" oct="4" pname="e"
          <note xml:id="n1yr73h0" dur="8" oct="3" pname="b
          <note xml:id="ng791c8" dur="4" oct="4" pname="e"
          <note xml:id="n1d6f7mf" dur="8" oct="4" pname="f
            <accid xml:id="aa7jy6k2" accid.ges="s"/>
          </note>
```

Drawback: manually
doing this is a pain

Machine Learning and OMR

Seeking to train models to recognize music, staves, and text:

automate the image → digital transcription pipeline



As- pi- ci- ens a lon- ge ec- ce vi- de- o de- i
po- ten- ti- am ve- ni- en- tem et ne- bu- lam to- tam ter- ram te-
gen- tem I- te ob- vi- am e- i et di- ci-
te Nunci- a no- bis si tu es ip- se Qui reg- na-
tu- rus es in po- pu- lo is- rael

SIMSSA and the *Liber Usualis*

How can we search for:

- *Specific notes*
- *Strict pitch sequences*
- *Transposed pitch sequences*
- *Contour*
- *Intervals*
- *Text?*

Search the Liber Usualis

What is this? Find out more about what we are trying to do.

previous next

Go to page Go

Current page: 26 of 2340

Neumes

☒ Strict pitch sequence

Transposed pitch sequence

Contour

Intervals

Text

xxvj. Rules for Interpretation.

Example:

Kyrie VII

Ký- ri- e e- lé- i- son.

Ký- ri- e e- lé- i- son.

which must be rendered in this way:

no breath breath

Ký- ri- e e- lé- i- son.

4. Finally the close of a whole period is marked either by a full bar, or by a double bar at the end of the piece, or at the end of an important division of the piece. Here breath must be taken and a longer pause be made. In the modern notation this pause is indicated by a quaver rest which is placed before or after the bar line, in accordance with the rhythm of the phrase following.

In pieces normally sung by alternating choirs (as in the *Kyrie, Gloria, Credo* etc), the double bar indicates a change of Choir. In such cases the pause will vary according to its importance in the melody and the text.

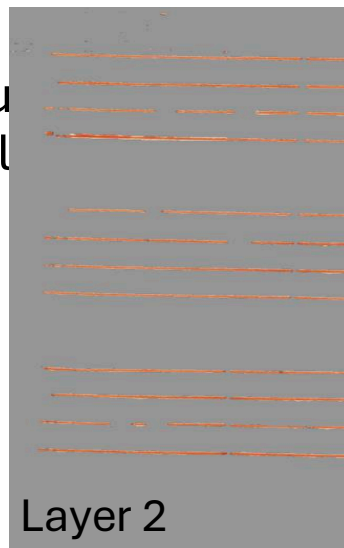
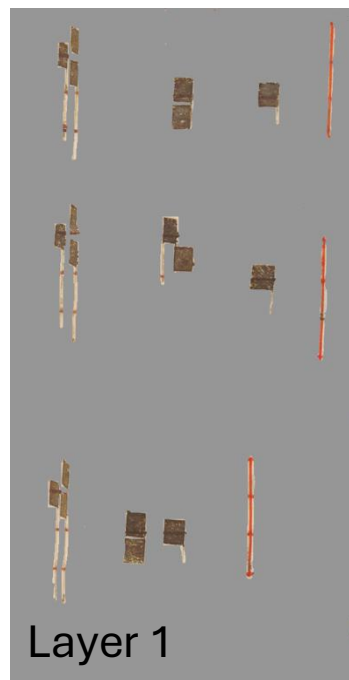
5. The *Comma* allows only a rapid breath without break in the movement, hence during the value of the preceding note:

6. Though breath need not necessarily be taken at every bar-line, yet, on the other hand, in the more elaborate pieces (graduals, alleluia, offertories) it is sometimes necessary and indeed excellent to breathe between the bars marked in the book. It is impossible to give minute rules for doing this correctly. All that need be said here is that breath must be taken in such cases *a)* without



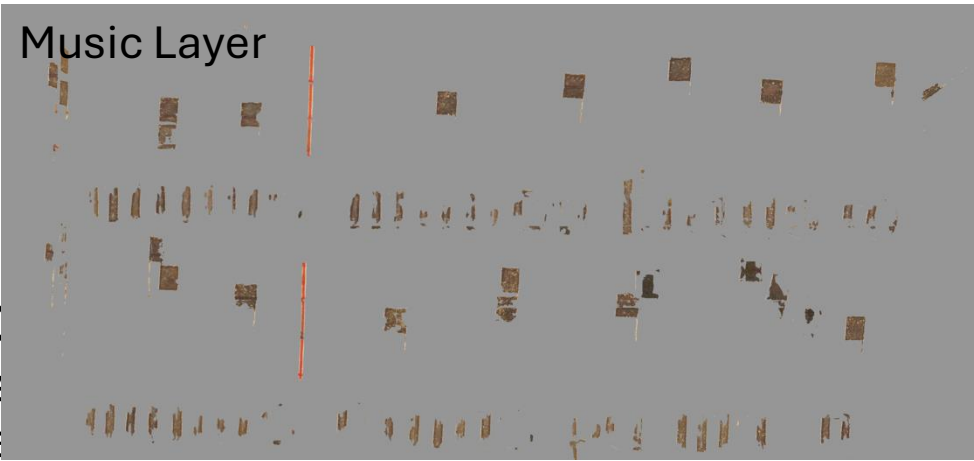
Rodan Phase 1

- Input an image
- Annotate sections of the image
 - Teach the machine: a student needs a lot of examples!
 - I'll talk about depth shortly



Root

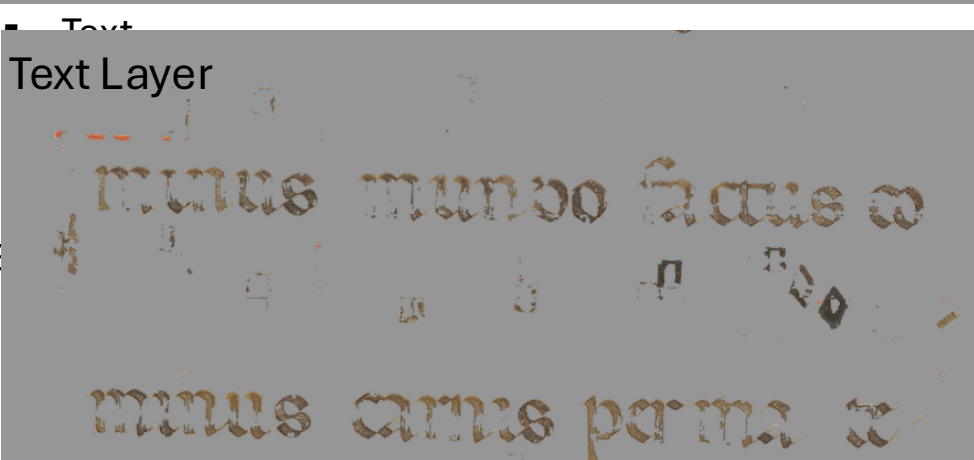
- Train a image



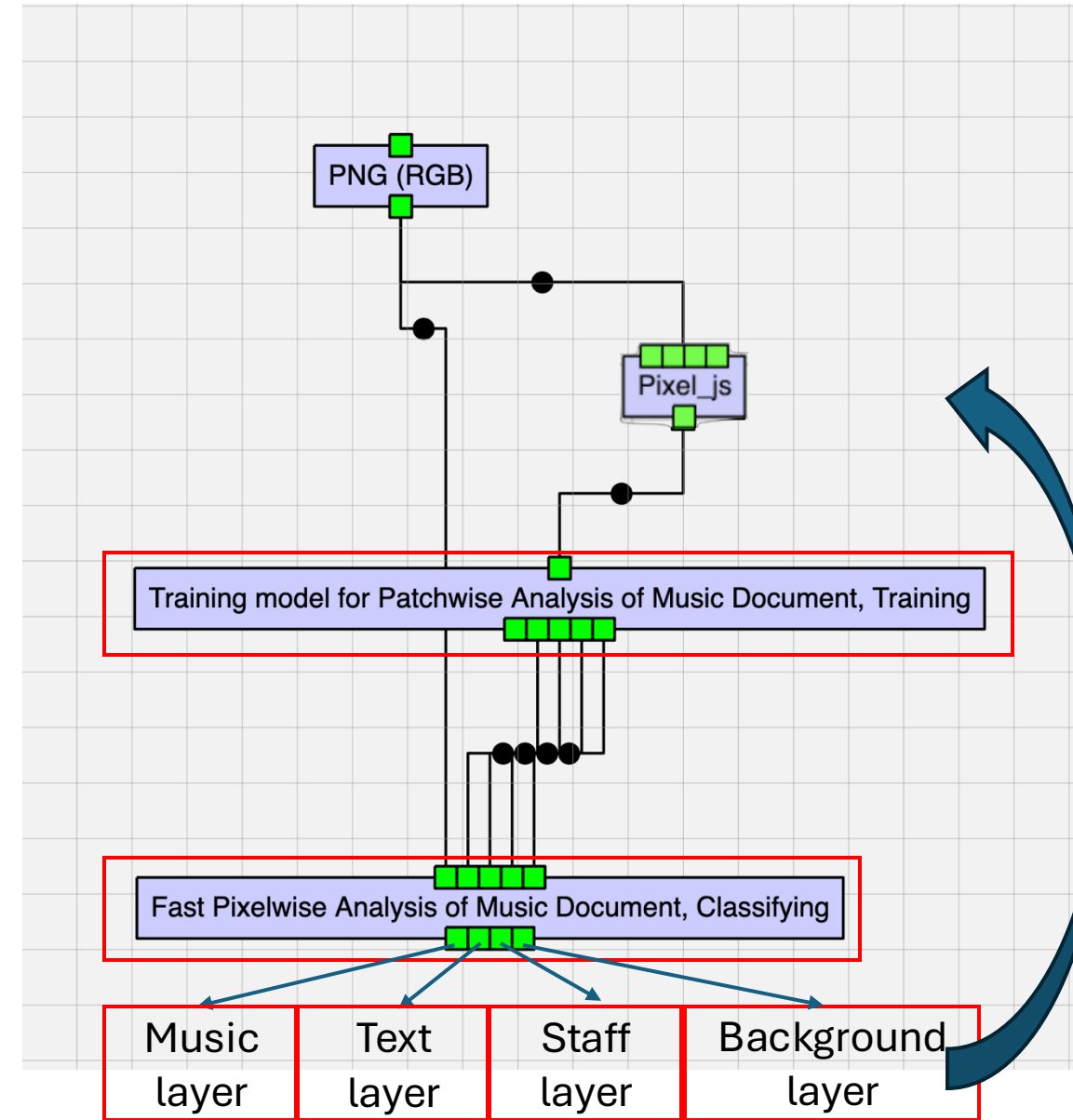
- The a ve

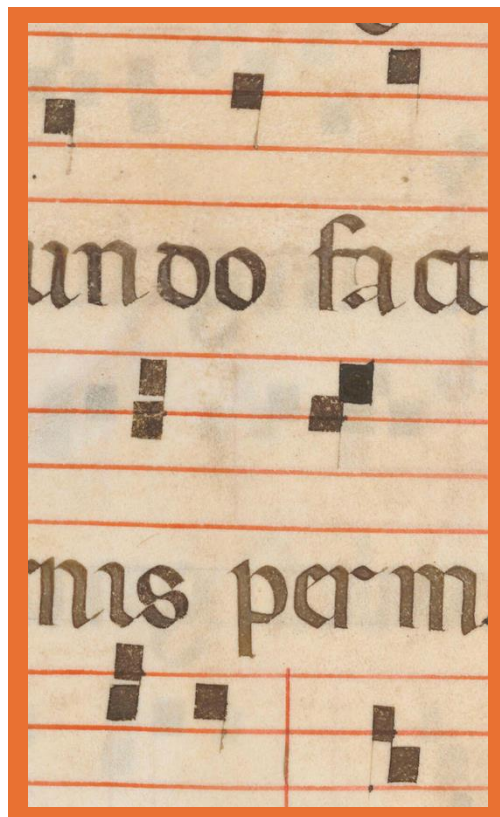
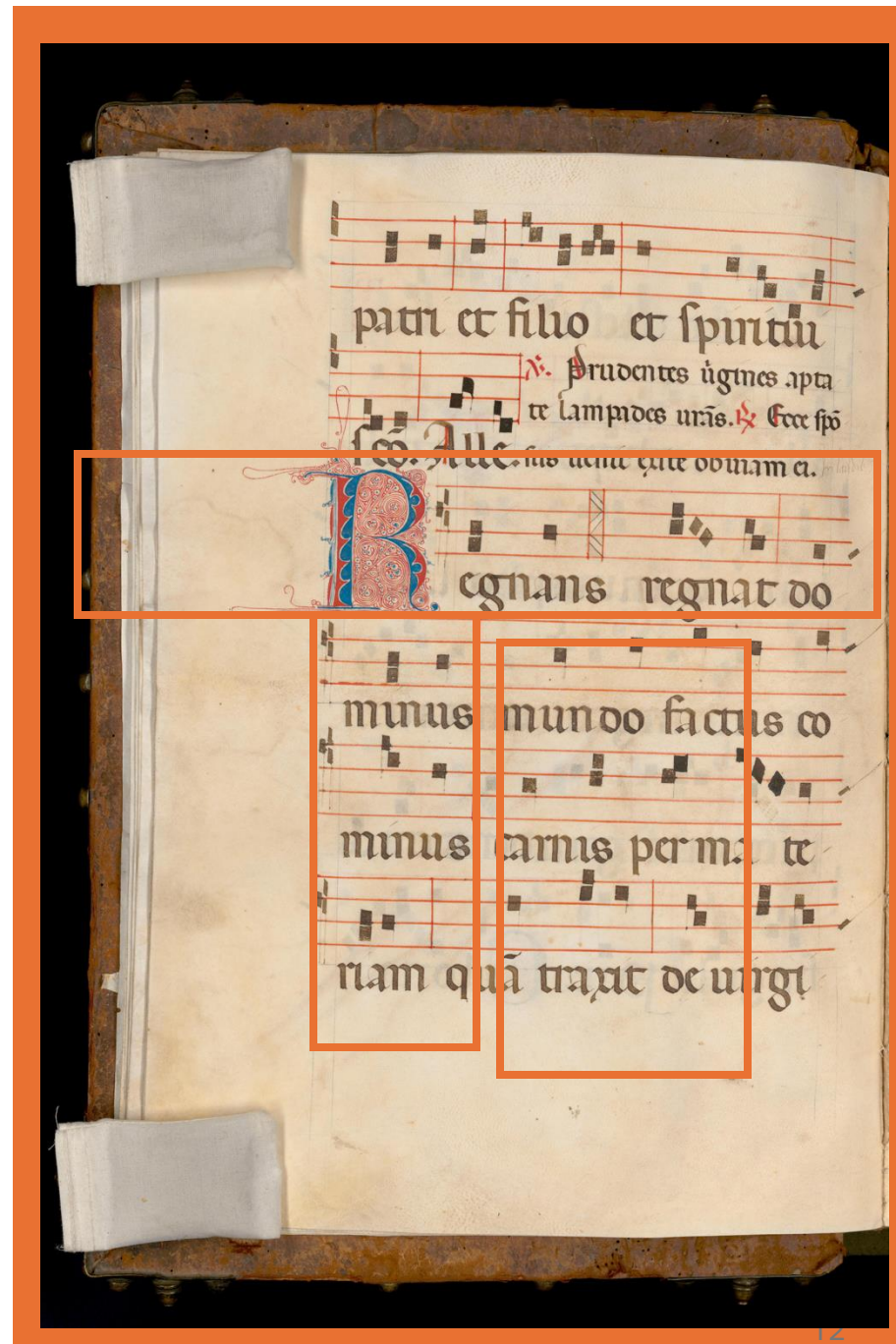


- Class tries t

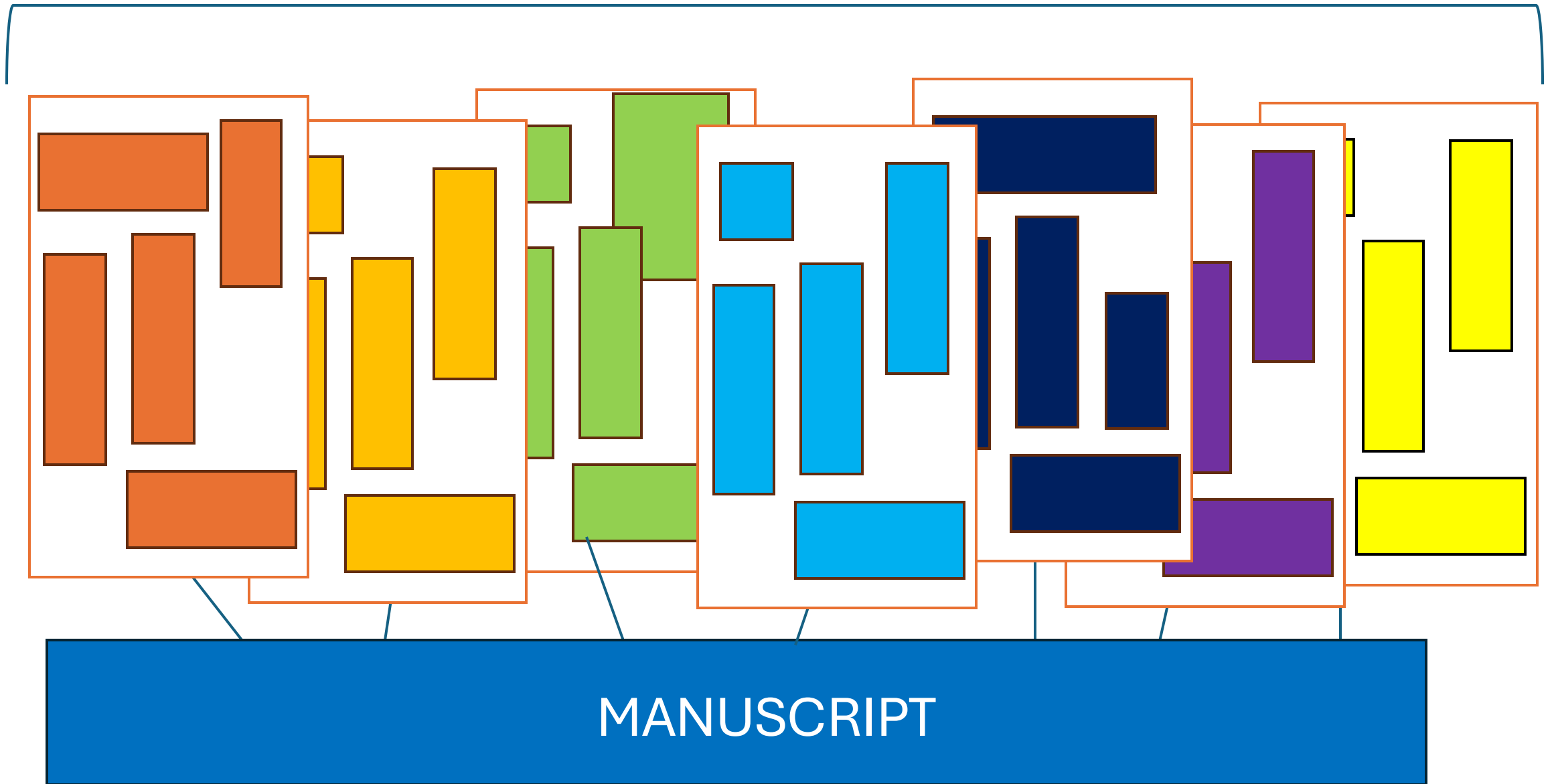


- Corre
- Repea





“Whole” Model



Phase 2: Note-level Classifying

Stage 1: Interactive (Manual) Classifying

Music layers can now be separated from text and staff—now what?

- Learning types of neumes
- Recognizing different versions of the same neumes, clefs, custodes

We do this manually to train the classifier, until it begins sorting neumes accurately.

Gen will talk about this more in a bit!



neume.virga
neume.podatus2b
neume.clivis
clef.c

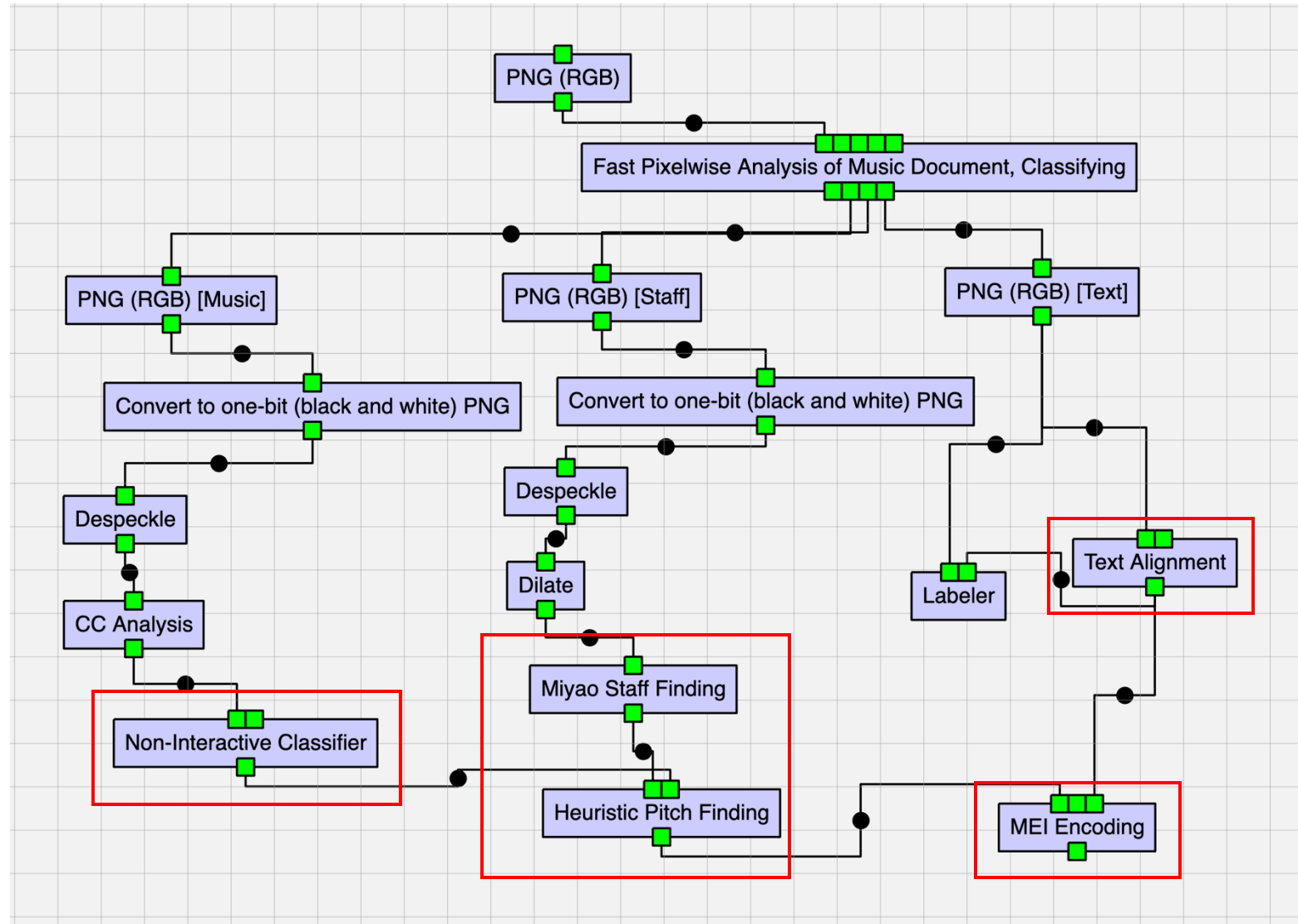
Etc.

Phase 2: Note-level Classifying

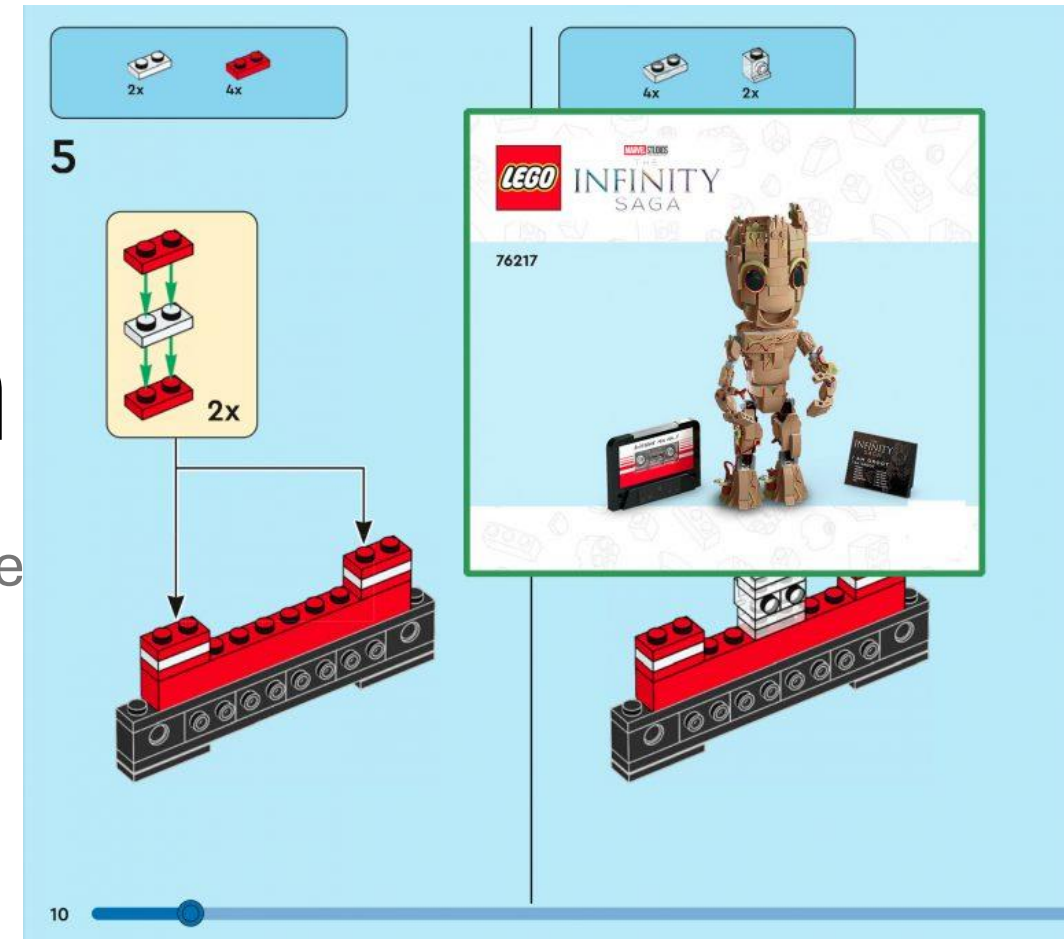
Stage 2: **Non-Interactive** (automatic) Classifying

Rodan can now sort neume types even if they look a little different from one another

- Neumes are identified in an MEI format
 - Neume.virga
- Staff layer gets analysed
- Text transcript is applied to the text layer
- An MEI file is produced



Remember: MEI is an instruction manual!



collaudando dominum
Qui summe stola glorie
quum sacra tum virginū
decoravit eximie. *ps* venite.
In pmo
noctno:
Ant. **Q**uiescis mundi
parib; virgi. nes querū

This manuscript page features Gregorian chant notation on four-line red staves. The text is written in a Gothic script. The first line is 'collaudando dominum'. The second line begins with a large blue initial 'Q' for 'Qui summe stola glorie'. The third line begins with a large green initial 'q' for 'quum sacra tum virginū'. The fourth line begins with a large red initial 'd' for 'decoravit eximie'. The fifth line begins with a large blue initial 'Q' for 'Quiescis mundi'. The sixth line begins with a large red initial 'p' for 'parib; virgi. nes querū'. There are several small red initials and rubrics interspersed throughout the text.

Hoc facite
in meam commemo
rationem. *Me*
mor
ero et tabe scet in me
anima mea hoc facite.

This manuscript page features Gregorian chant notation on four-line red staves. The text is written in a Gothic script. The first line is 'Hoc facite'. The second line begins with a large blue initial 'i' for 'in meam commemo'. The third line begins with a large red initial 'M' for 'Memento'. The fourth line begins with a large blue initial 'm' for 'memor'. The fifth line begins with a large red initial 'e' for 'ero et tabe scet in me'. The sixth line begins with a large blue initial 'a' for 'anima mea hoc facite.'.

Okay, it's encoded
and corrected—now
what?

Cantus Ultimus

Welcome to Cantus Ultimus

The main objective of this research is to incorporate the latest optical music recognition (OMR) technologies with plainchant manuscripts in order to transform the existing **CANTUS** database into a state-of-the-art research environment in which both music and text are fully searchable.

You can view currently available manuscripts on the **Manuscripts page**.

This research is part of the **SIMSSA project**.

For more information, please contact **Ichiro Fujinaga**.

SIMSSA | Single Interface for Music
| Score Searching and Analysis



Social Sciences and Humanities
Research Council of Canada

Conseil de recherches en
sciences humaines du Canada

Canada



McGill



Schulich School of Music
École de musique Schulich

DDMAL

DISTRIBUTED DIGITAL MUSIC
ARCHIVES & LIBRARIES LAB



Centre for Interdisciplinary Research
in Music Media and Technology

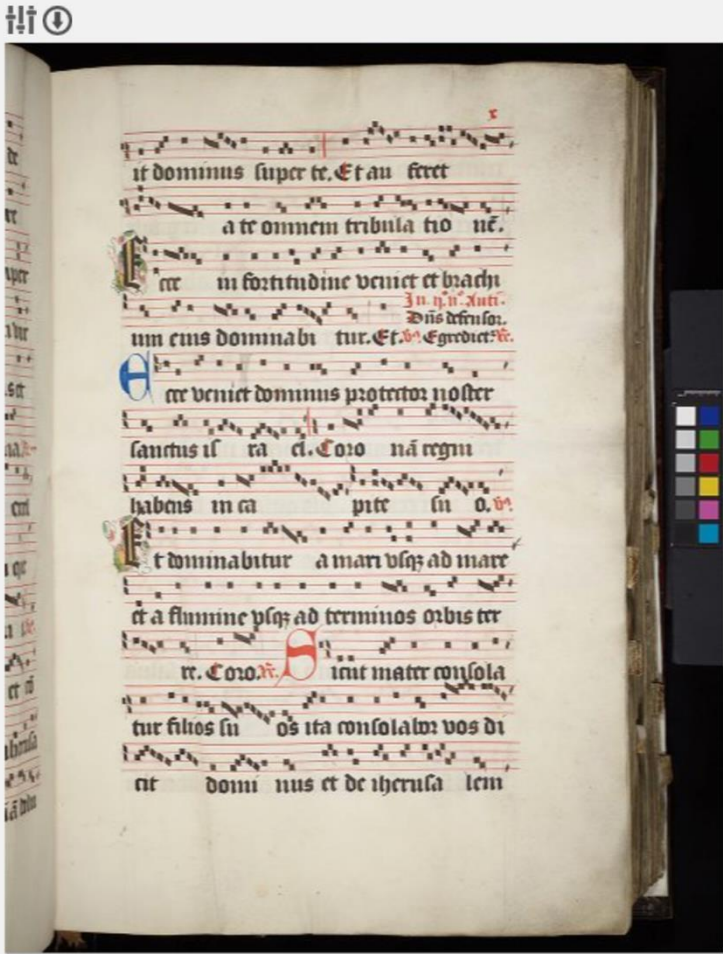
Fonds de recherche
Société et culture

Québec



Zoom level: 1.00

Folio 010r (27 of 497) Go Manuscript info



Go to first chant Previous Folio Next Folio

Folio 010r Search Manuscript

Chants

Ecce in fortitudine veniet et

Cantus ID: 006290b (Visit record in Cantus Database)

Sequence: 1

Feast: Dom. 2 Adventus

Office: Matins

Genre: Responsory verse

Mode: 1

Full Text

Ecce in fortitudine veniet et brachium ejus dominabitur

Ec ce in for ti tu di ne ve ni et et bra chi um e ius do mi na bi tur Et

Play Audio Stop Audio

Bringing it back—Getting Started

Input Port: Image

Available Resources

TABLE FILTERS

Creator

Created

mm/dd/yyyy, --:--:-- --

Name

Uploaded or generated:

Uploaded

Name

Created

Salzannes_012r

kyrieb

Salzannes_131v

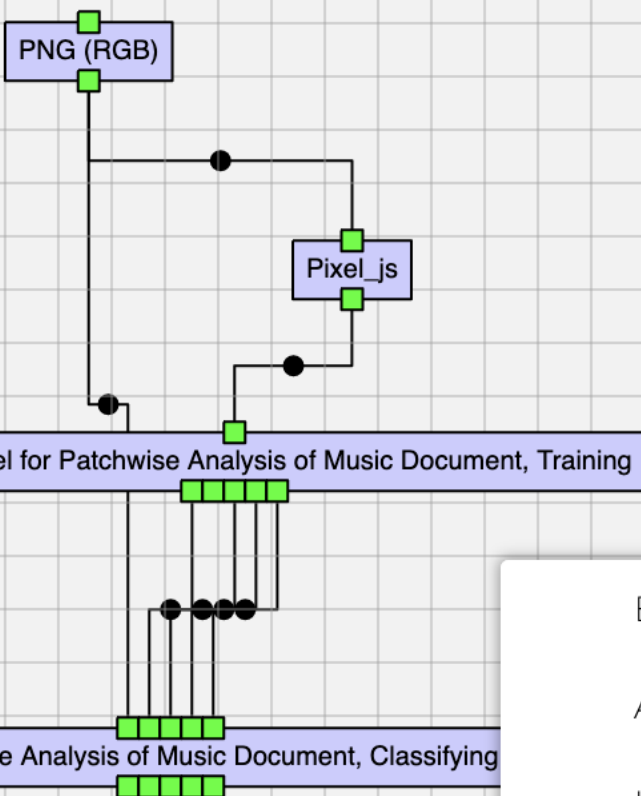
kyrieb

05

16:42:43

rgb+pn

a



Edit Name/Description

Add Job

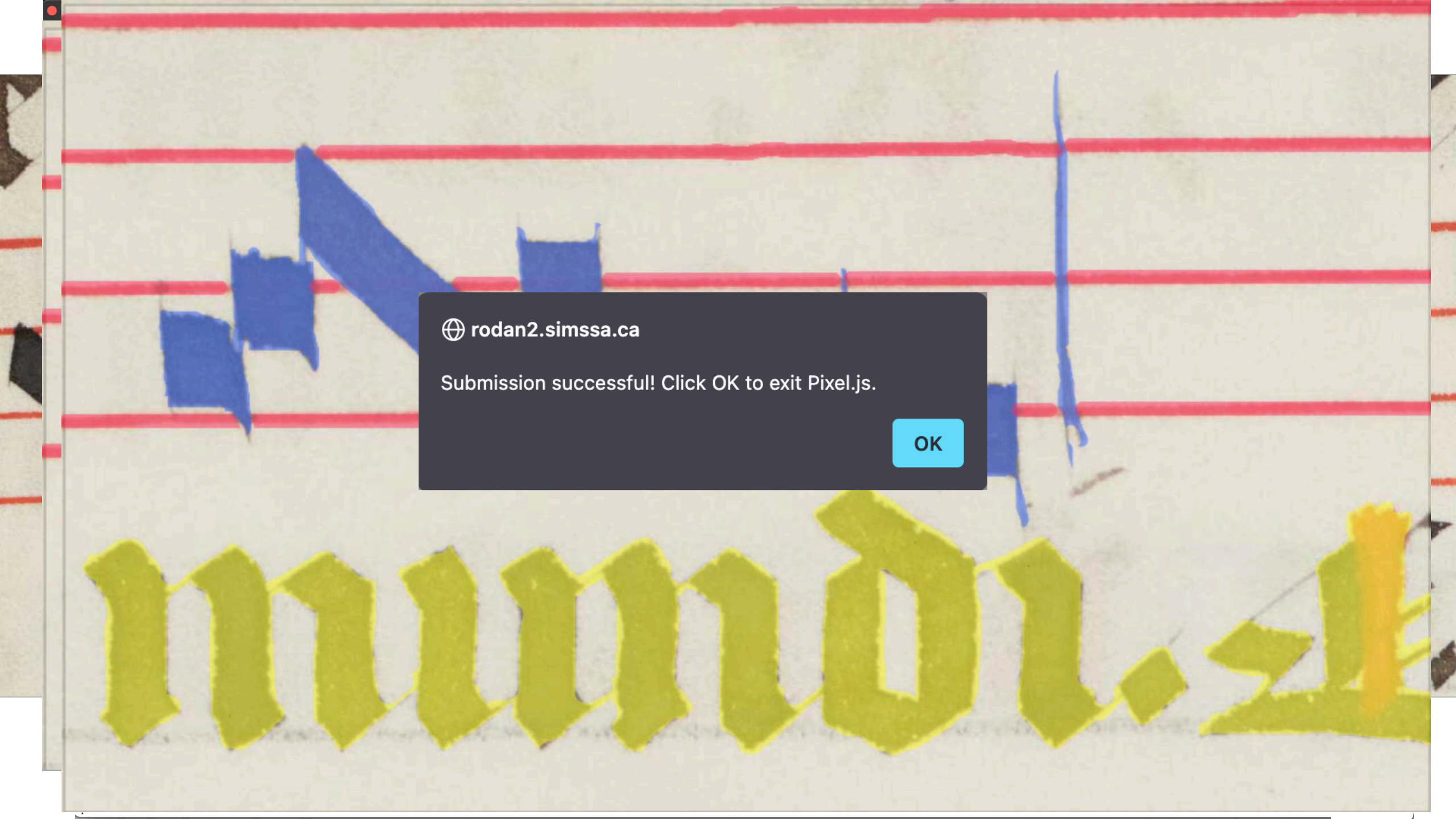
Import Workflow

Clear Assigned Resources

Run

document, Training

sifying



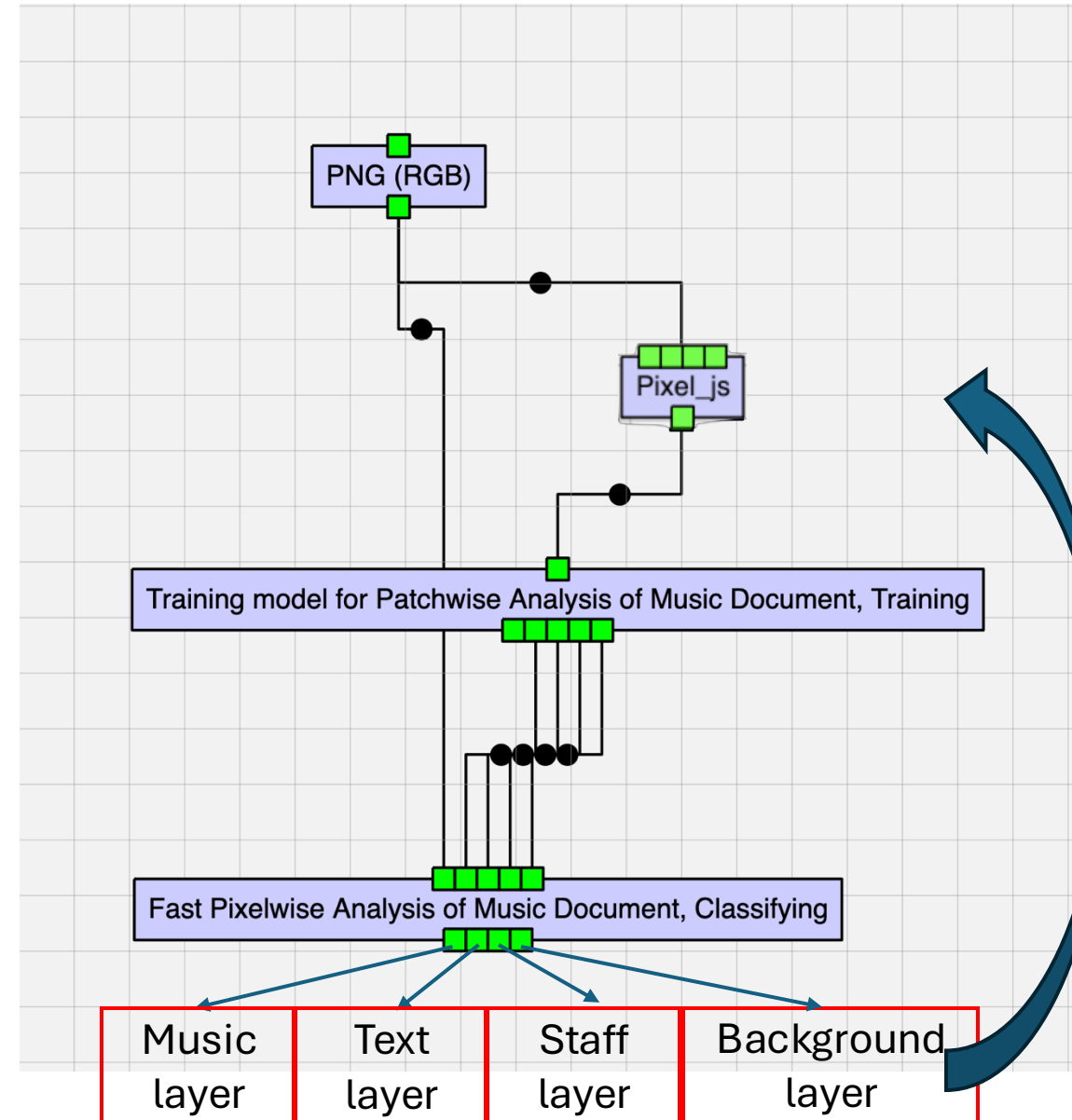
🌐 rodan2.simssa.ca

Submission successful! Click OK to exit Pixel.js.

OK

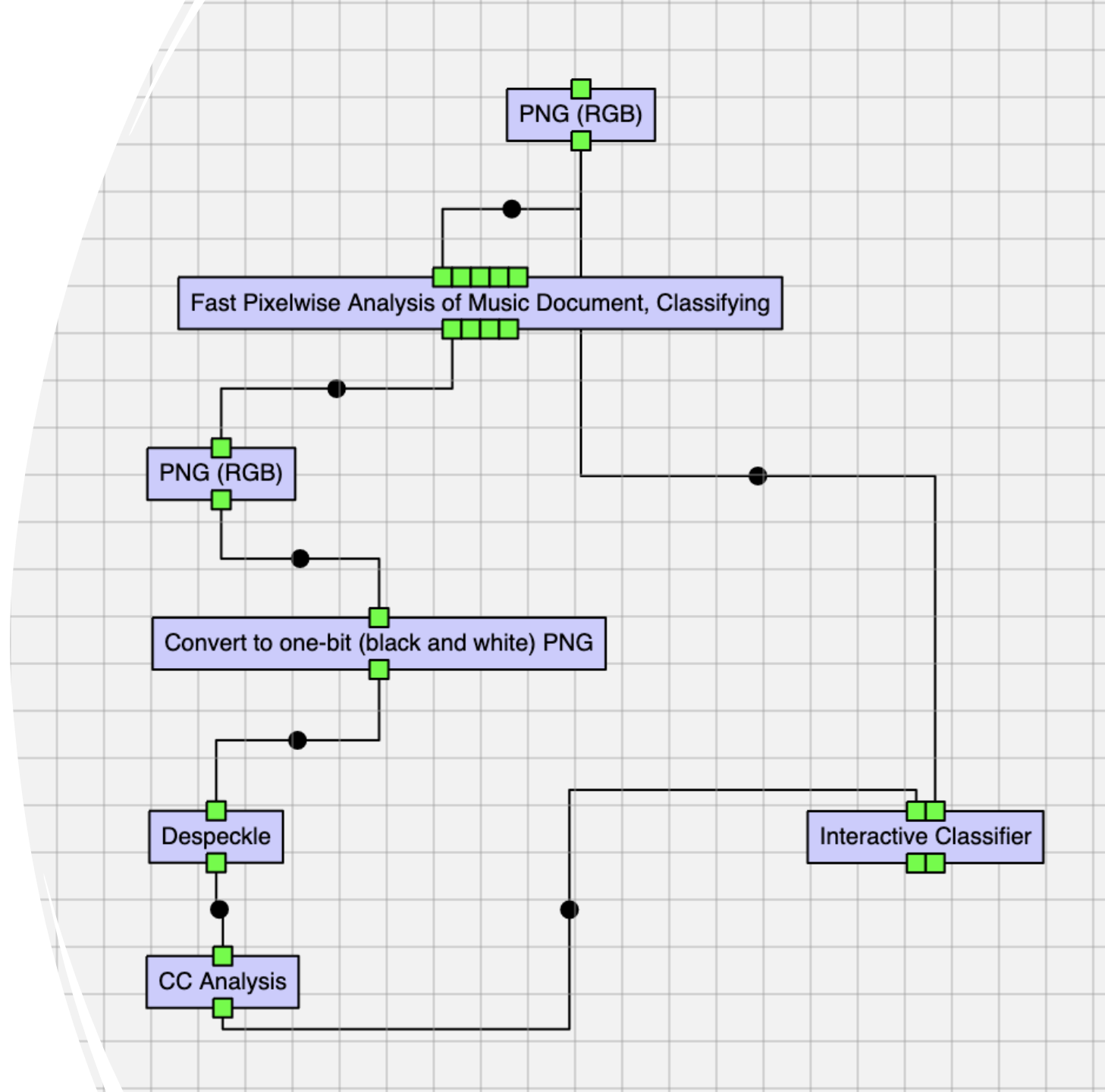
Phase 2: Train, Classify, Correct

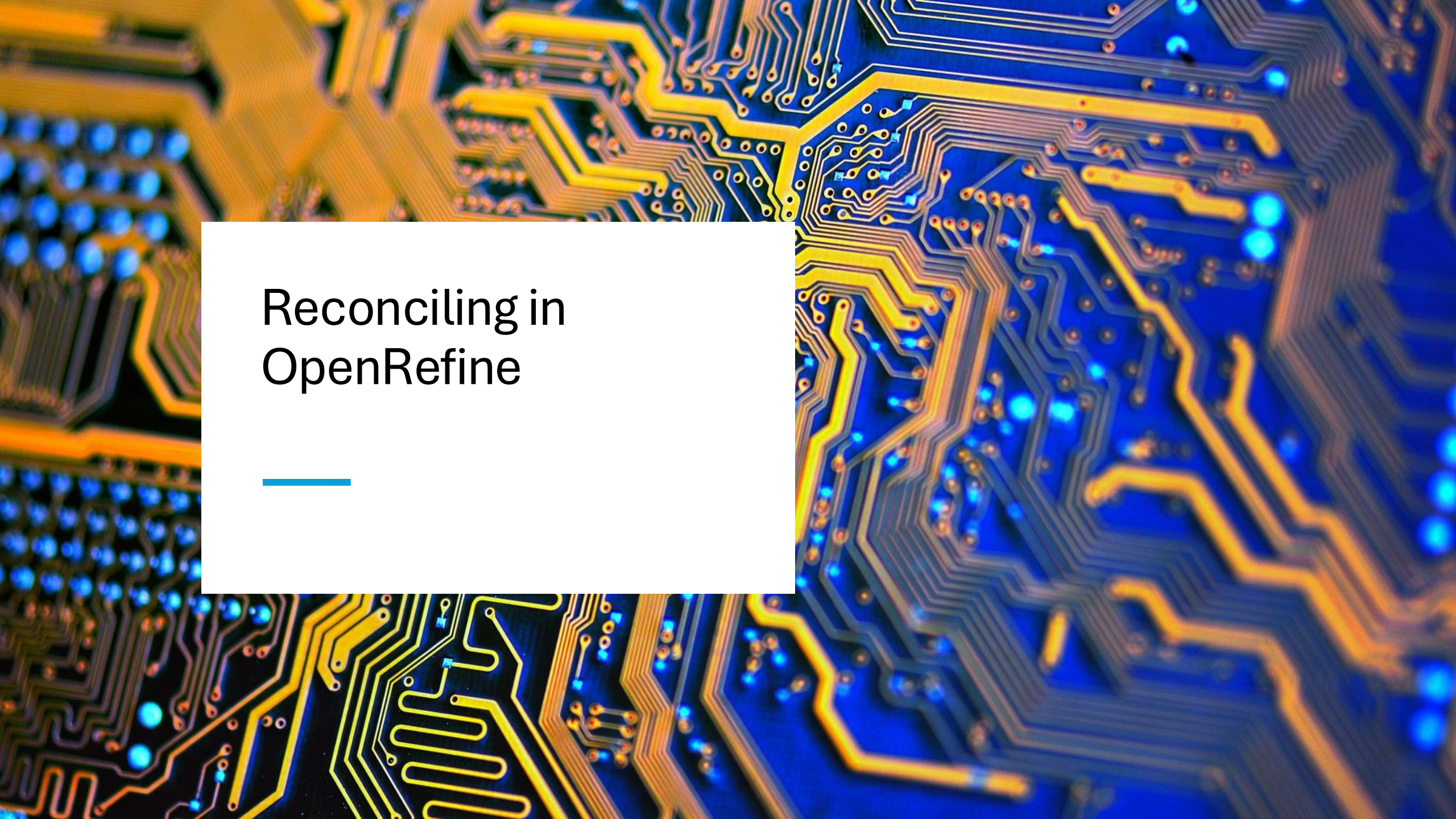
- Pixel sample used as training input
- Models used to separate image into four layers
- Input those layers into pixel and correct them
- Change images per iteration as needed; want models to generalize!



Phase 2: Into the IC

- Input image
- Assign best models
- Begin training for individual neume recognition
- Gen!



The background of the slide is a high-resolution, artistic photograph of a printed circuit board (PCB). The image shows a dense network of intricate, glowing traces in bright yellow and orange, set against a deep blue background. Numerous small, circular components, possibly solder joints or vias, are visible along the traces, some of which also exhibit a blue glow. The lighting creates a sense of depth and complexity, highlighting the fine details of the electronic manufacturing process.

Reconciling in OpenRefine

What is OpenRefine?

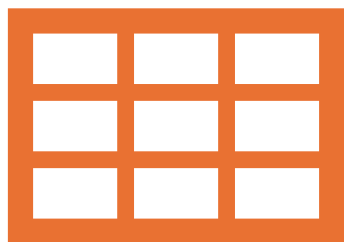


OpenRefine

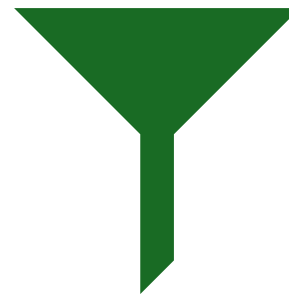
OpenRefine is a powerful free, open source tool for working with messy data: cleaning it; transforming it from one format into another; and extending it with web services and external data.

Our goal is to empower everyone to meaningfully engage with data by providing an accessible open source tool and nurturing a diverse, supportive community.

What is Reconciliation?



Reconciliation in OpenRefine is the process of matching plain text data in your dataset to unique identifiers (like Wikidata Q-codes).



This allows for: **enriched, linked data** that can be used for research, visualization, or further transformation.

Getting started: what you'll need

A dataset with
names, places, or
entities to reconcile

A CSV file,
usually

OpenRefine
installed (free!)

Internet access

Wikidata
reconciliation
utilizes a web
API

Big concept takeaways

Reconcile

Facet

Cluster

Step 1: Into OpenRefine

- Upload dataset to OpenRefine
- Click “create project” -> Upload CSV (or TSV, Excel, etc.!)
- Review preview, hit “create”

Sample dataset:

Person	Role
Johann Sebastian Bach	Composer
Marie Curie	Scientist
Plato	Philosopher

Create project

Open project

Import project

Language settings

Extensions

« start over Configure parsing options

Project name OpenRefine Sample 1.xlsx

Tags

Create project »

	Person	Profession
1.	Johann Sebastian Bach	Composer
2.	Marie Curie	Chemist
3.	Plato	Philosopher

Parse data as

Excel files

JSON files

Line-based text files

CSV / TSV / separator-based files

Fixed-width field text files

PC-Axis text files

MARC files

JSON-LD files

RDF/N3 files

RDF/XML files

Worksheets to Import

Select all Deselect all

☒ OpenRefine Sample 1.xlsx#Sheet1

4 rows

☐ Ignore first 0 line(s) at beginning of file
☒ Parse next 1 line(s) as column headers
☐ Discard initial 0 row(s) of data
☐ Load at most 0 row(s) of data

☒ Store blank rows
☒ Store blank columns
☒ Store blank cells as nulls
☐ Store file source
☐ Store archive file
☐ Import all cells as text

Update preview

☐ Disable auto preview



Version 3.9.3 [TRUNK]

Preferences

Help

About

3 rows

Show as: **rows** records

Show: 5 10 25 50 100 500 1000 rows

▼ All			▼ Person	▼ Profession
☆	🗨	1.	Facet ▶	Composer
☆	🗨	2.	Text filter	Chemist
☆	🗨	3.	Edit cells ▶	Philosopher
			Edit column ▶	
			Transpose ▶	
			Sort...	
			View ▶	
			Reconcile ▶	

Open... Export ▾ Help

Extensions Wikibase ▾

it < previous 1 ▾ -3 next > last »

Reconcile column Person

Reconcile each cell to an entity of one of these types:

☒ human
Q5

☐ impact crater
Q55818

☐ charitable organization
Q708676

☐ television film
Q506240

☐ comic strip
Q838795

☐ asteroid
Q3863

☐ entity
Q35120

☐ Reconcile against type:

☐ Reconcile against no particular type

☒ Auto-match candidates with high confidence

Maximum number of candidates to return

Also use relevant details from other columns:

Column	As property
Profession	

Back

Start reconciling...

Cancel

3 rows

Show as: **rows** records Show: **5** 10 25 50 100 500 1000 rows

▼ All		▼ Person	▼ Profession
☆	🗨	1. Johann Sebastian Bach ☒ ☒ Johann Sebastian Bach (100) ☒ ☒ Johann Sebastian Bach (100) ☒ ☒ Johann Sebastian Bach discography (78) ☒ ☒ Create new item Search for match	edit Composer
☆	🗨	2. Marie Curie Choose new match	
☆	🗨	3. Plato ☒ ☒ Plato (100) ☒ ☒ Plato the Comic (100) ☒ ☒ Plato (100) ☒ ☒ Create new item See more Search for match	

Match this cell



Match all identical cells

Cancel

[Johann Sebastian Bach](#) (Q638391)

German painter, grandson of the composer

3 rows

Show as: **rows** records

Show: 5 **10** 25 50 100 500 1000 rows

☐ All		☐ Person		☐ Profession
		1.	Johann Sebastian Bach Choose new match	Composer
		2.	Marie Curie Choose new match	Chemist
		3.	Plato Choose new match	Philosopher

Nov

• Once
Wiki

- T
 - W
 - B
- for

Add columns from reconciled column Person

Add property

occupation

Suggested properties

award received

child

country of citizenship

educated at

employer

ethnic group

father

field of work

image

member of political party

mother

native language

occupation

place of birth

place of burial

Preview

Reset

Person	occupation remove configure	place of birth remove configure
Johann Sebastian Bach	composer	Eisenach
	organist	
	harpsichordist	
	violinist	
	conductor	
	choir director	
	concertmaster	
	musicologist	
	music educator	
	virtuoso	
	school teacher	
Marie Curie	physicist	Warsaw
	chemist	
	university teacher	
Plato	philosopher	Athens
	epigrammatist	
	poet	
	writer	

OK

Cancel

idate”

19 rows

Show as: **rows** records Show: 5 10 25 50 100 500 1000 rows

▼ All		▼ Person	▼ occupation	▼ place of birth	▼ date of birth	▼ Profession
☆	🗨	1. Johann Sebastian Bach Choose new match	composer Choose new match	Eisenach Choose new match	1685-03-21T00:00:00Z	Composer
☆	🗨	2.	organist Choose new match			
☆	🗨	3.	harpsichordist Choose new match			
☆	🗨	4.	violinist Choose new match			
☆	🗨	5.	conductor Choose new match			
☆	🗨	6.	choir director Choose new match			
☆	🗨	7.	concertmaster Choose new match			
☆	🗨	8.	musicologist Choose new match			
☆	🗨	9.	music educator Choose new match			
☆	🗨	10.	virtuoso Choose new match			
☆	🗨	11.	school teacher Choose new match			
☆	🗨	12. Marie Curie Choose new match	physicist Choose new match	Warsaw Choose new match	1867-11-07T00:00:00Z	Chemist
☆	🗨	13.	chemist Choose new match			
☆	🗨	14.	university teacher Choose new match			
☆	🗨	15. Plato Choose new match	philosopher Choose new match	Athens Choose new match	0428-01-01T00:00:00Z	Philosopher
☆	🗨	16.	epigrammatist Choose new match			
☆	🗨	17.	poet Choose new match			
☆	🗨	18.	writer Choose new match			
☆	🗨	19.	philosopher of law Choose new match			

Common Issues

Multiple spellings or names for one item/person/entity

6 rows				
Show as:		rows	records	
Show:		5	10	25
		50	100	500
		1000	rows	
▼ All		▼ Location Name		▼ Notes
☆	🗨	1.	Reykjavik	Standard spelling
☆	🗨	2.	Reykyavik	Common typo
☆	🗨	3.	New York City	Official name
☆	🗨	4.	NYC	Common abbreviation
☆	🗨	5.	München	Native German spelling
☆	🗨	6.	Munich	Anglicized spelling

- Select type: `human settlement (Q486972)`
 - OR! Leave blank for broader matches
- Start reconciliation
 - Match correct items

6 rows		
Show as: rows records		Show: 5 10 25 50 100 500 1000 rows
▼ All	▼ Location Name	▼ Notes
★	1. Reykjavik ☒ ☒ Reykjavík (100) ☒ ☒ Reykjavik (100) ☒ ☒ Create new item Search for match	Standard spelling
★	2. Reykjavík Choose new match	Common typo
★	3. New York City Choose new match	Official name
★	4. New York City Choose new match	Common abbreviation
★	5. München ☒ ☒ Munich (100) ☒ ☒ München (100) ☒ ☒ München (100) ☒ ☒ Create new item See more Search for match	Native German spelling
★	6. Munich ☒ ☒ Munich (100) ☒ ☒ Munich (100) ☒ ☒ Munich (100) ☒ ☒ Create new item See more Search for match	Anglicized spelling

Add column based on column Location Name

New column name Wikidata Q-ID

On error ☒ set to blank ☐ store error ☐ copy value from original column

Expression

Language

General Refine Expression Language (GREL) ▾

cell.recon.match.id

No syntax error.

Preview

History

Starred

Help

row	value	cell.recon.match.id
1.	Reykjavik	Q1764
2.	Reykjavik	Q1764
3.	New York City	Q60
4.	NYC	Q60
5.	München	Q1958863
6.	Munich	Q1726

OpenRefine uses this;
GPT etc. are quite good with it

OK

Cancel

6 rows

Show as: **rows** records Show: 5 10 25 50 100 500 1000 rows

☐ All			☐ Location Name	☐ Wikidata Q-ID	☐ country	☐ Notes
☐	☐	1.	Reykjavík Choose new match	Q1764	Iceland Choose new match	Standard spelling
☐	☐	2.	Reykjavík Choose new match	Q1764	Iceland Choose new match	Common typo
☐	☐	3.	New York City Choose new match	Q60	United States Choose new match	Official name
☐	☐	4.	New York City Choose new match	Q60	United States Choose new match	Common abbreviation
☐	☐	5.	München Choose new match	Q1726	Germany Choose new match	Native German spelling
☐	☐	6.	Munich Choose new match	Q1726	Germany Choose new match	Anglicized spelling

Duplicate entries

- Cool, everything shows as it should and will group where it needs to go, but there are still duplicates—now what?
 - Can do this from either the corrected column, or from the “country” column
- You can do this by row or by table
 - I like to play it safe and add a “safety column” like the Q-ids to check my work before I bulk merge duplicates in an entire table

6 rows

Facet / Filter

Undo / Redo 15 / 15

Refresh

Reset all

Remove all

 Wikidata Q-ID

[change](#)

3 choices Sort by: name count

Cluster

Q1726 2

Q1764 2

Q60 2

Facet by choice counts

6 rows

Show as: rows records Show: 5 10 25 50 100 500 1000 rows

All		Location Name		Wikidata Q-ID	country	Notes
		1.	Reykjavík Choose new match	Q1764	Iceland Choose new match	Standard spelling
		2.	Reykjavík Choose new match	Q1764	Iceland Choose new match	Common typo
		3.	New York City Choose new match	Q60	United States Choose new match	Official name
		4.	New York City Choose new match	Q60	United States Choose new match	Common abbreviation
		5.	München Choose new match	Q1726	Germany Choose new match	Native German spelling
		6.	Munich Choose new match	Q1726	Germany Choose new match	Anglicized spelling

Reconcile

Facet / Filter

[Undo / Redo](#) 15 / 15



2 matching rows (6 total)

Refresh

 Wikidata

3 choices Sort by

Q1726 2

Q1764 2

Q60 2

Facet by choice of

Remove duplicate rows

Select columns used to identify duplicate rows

- ☐ Location Name
- ☒ Wikidata Q-ID
- ☐ country
- ☐ Notes

Select all

Deselect all

OK

Cancel

Remove matching rows

Remove duplicate rows

0 rows

 Notes

Native German spelling

atch

Anglicized spelling

atch

3 rows

Show as: **rows** records Show: 5 10 25 50 100 500 1000 rows

All			Location Name	Wikidata Q-ID	country	Notes
		1.	Reykjavík Choose new match	Q1764	Iceland Choose new match	Standard spelling
		2.	New York City Choose new match	Q60	United States Choose new match	Official name
		3.	München Choose new match	Q1726	Germany Choose new match	Native German spelling

Fuzzy Matching with Clustering in OpenRefine

- Go to the column you want to clean
 - E.g., “Location name”
- Click column drop-down
 - Edit cells
 - Cluster and edit
- Suggested clusters
 - Choose your clustering method

Keying Function

fingerprint

metaphone3

n-gram-fingerprint

Distance Function

levenshtein

levenshtein

levenshtein or PPM

Use Case

Good for basic typos

Good for phonetic variants

Good for messy text / OCR errors

Cluster and edit column "City"

Find groups of different cell values that might be other representations of the same thing. For example, "New York" and "new york" likely refer to the same concept and just differ by capitalization.

Method **Key collision**

☐ Auto-update

Merge? **Value**

☐

☐

☐

☐

Select all De

teksas

Cluster and edit column "City"

Find groups of different cell values that might be other representations of the same thing. For example, "New York" and "new york" likely refer to the same concept and just differ by capitalization, and "Gödel" and "Godel" probably refer to the same person. [Find out more...](#)

Method **Key collision**

Keying function **Metaphone3**

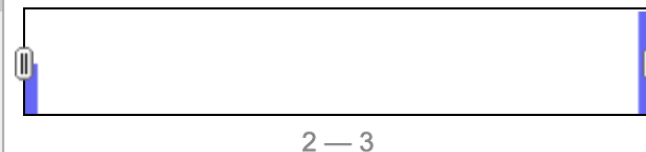
Manage clustering fuctions

☐ Auto-update

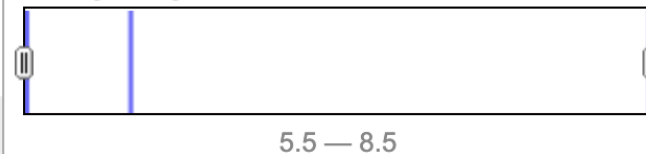
3 clusters found

Merge?	Values in cluster	New cell value	Cluster size	Row count
☐	☐ Texas (2 rows) ☐ teksas	Texas	2	3
☐	☐ Reykavik ☐ Reykyavik	Reykavik	2	2
☐	☐ London (2 rows) ☐ Lindon	London	2	3

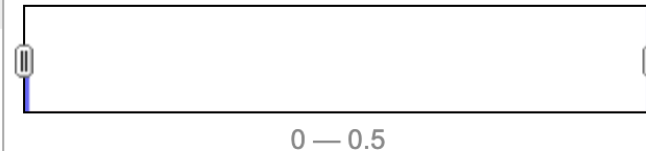
Rows in cluster



Average length of choices



Length variance of choices



14 rows

Show as: **rows** records Show: 5 10

▼ All		▼ City	
☆	🗨	1.	Reykjavík Choose new match
☆	🗨	2.	Reykjavík Choose new match
☆	🗨	3.	Reykjavík Choose new match
☆	🗨	4.	Reykjavík Choose new match
☆	🗨	5.	Reykjavík Choose new match
☆	🗨	6.	Reykjavík Choose new match
☆	🗨	7.	Reykjavík Choose new match
☆	🗨	8.	London Choose new match
☆	🗨	9.	London Choose new match
☆	🗨	10.	London Choose new match
☆	🗨	11.	London Choose new match
☆	🗨	12.	Texas City Choose new match
☆	🗨	13.	Texas City Choose new match
☆	🗨	14.	Texas City Choose new match

Facet / Filter

Undo / Redo 10 / 10

Refresh

Reset all

Remove all

✕ **City** change

4 choices Sort by: **name** count Cluster

London 3

lonfon 1

Reykjavík 7

Texas 3

Facet by choice counts

14 rows

Show as: **rows** records Show: 5 10 **25** 50 100 500

▼ All		▼ City	
☆	🗨	1.	Reykjavík Choose new match
☆	🗨	2.	Reykjavík Choose new match
☆	🗨	3.	Reykjavík Choose new match
☆	🗨	4.	Reykjavík Choose new match
☆	🗨	5.	Reykjavík Choose new match
☆	🗨	6.	Reykjavík Choose new match
☆	🗨	7.	Reykjavík Choose new match
☆	🗨	8.	London Choose new match
☆	🗨	9.	London Choose new match
☆	🗨	10.	London Choose new match
☆	🗨	11.	London Choose new match
☆	🗨	12.	Texas City Choose new match
☆	🗨	13.	Texas City Choose new match
☆	🗨	14.	Texas City Choose new match

- Facet ▶ **Text facet**
- Text filter
- Numeric facet
- Timeline facet
- Scatterplot facet...
- Custom text facet...
- Custom numeric facet...
- Customized facets ▶
- Edit cells ▶
- Edit column ▶
- Transpose ▶
- Sort...
- View ▶
- Reconcile ▶

14 rows

Show as: **rows** records Show: 5 10

▼ All	▼ City
☆	1. Reykjavík Choose new match
☆	2. Reykjavík Choose new match
☆	3. Reykjavík Choose new match
☆	4. Reykjavík Choose new match
☆	5. Reykjavík Choose new match
☆	6. Reykjavík Choose new match
☆	7. Reykjavík Choose new match
☆	8. London Choose new match
☆	9. London Choose new match
☆	10. London Choose new match
☆	11. London Choose new match
☆	12. Texas City Choose new match
☆	13. Texas City Choose new match
☆	14. Texas City Choose new match

14 rows

Show as: **rows** records Show: 5 10 25 50 100 500 1000 rows

▼ All	▼ City
☆	1. Reykjavík Choose new match
☆	2. Reykjavík Choose new match
☆	3. Reykjavík Choose new match
☆	4. Reykjavík Choose new match
☆	5. Reykjavík Choose new match
☆	6. Reykjavík Choose new match
☆	7. Reykjavík Choose new match
☆	8. London Choose new match
☆	9. London Choose new match
☆	10. London Choose new match
☆	11. London Choose new match
☆	12. Texas City Choose new match
☆	13. Texas City Choose new match
☆	14. Texas City Choose new match

Transform...

Edit all columns ▶

Facet ▶

Add blank rows ▶

Edit rows ▶

Edit columns ▶

View ▶

Star rows

Unstar rows

Flag rows

Unflag rows

Remove matching rows

Remove duplicate rows

3 rows

Show as: **rows** records Show: 5 10 25

▼ All	▼ City
☆	1. Reykjavík Choose new match
☆	2. London Choose new match
☆	3. Texas City Choose new match

You've made it!

Intro to OMR

Part 2

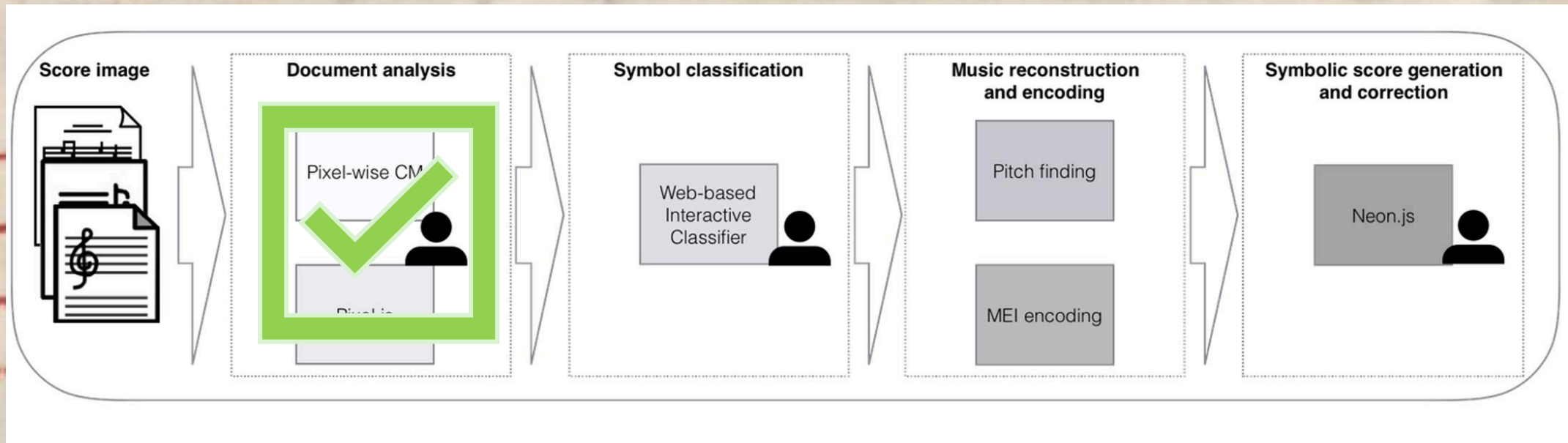
Geneviève Gates-Panneton

Rodan and Neon tester

OMR Continued

- Symbol classification – Interactive Classifier
- End-to-End Optical Music Recognition – e2e OMR
- Neon
- Cantus Ultimus

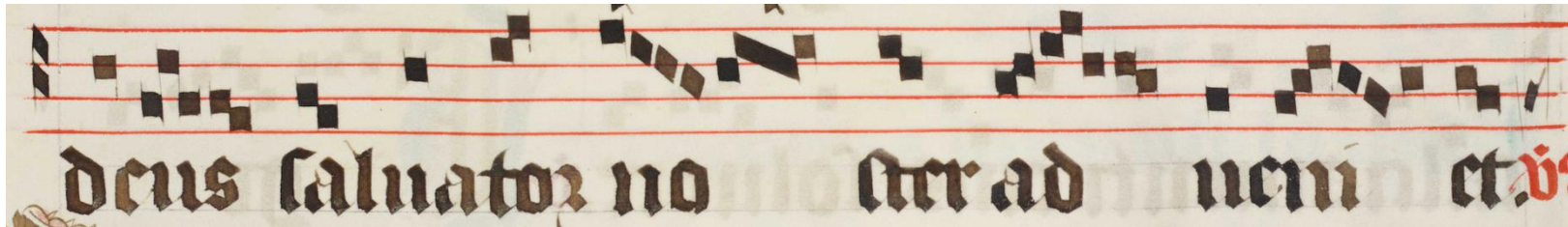
Symbol classification in the IC



Teaching the computer to separate a folio image into layers containing staff lines, glyphs, etc.

Teaching the computer to tell musical symbols apart and identify them correctly

Intro to square neume notation



Salzinnes

CDN-Hsmu M2149.L4



Einsiedeln

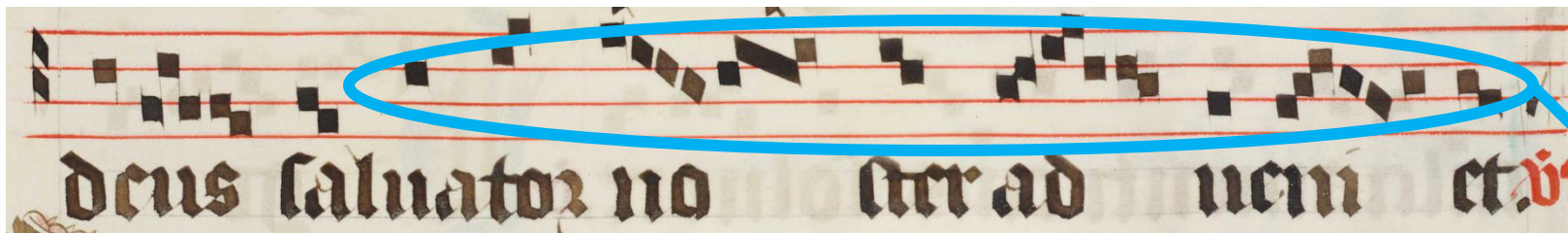
CH-E 611



MS73

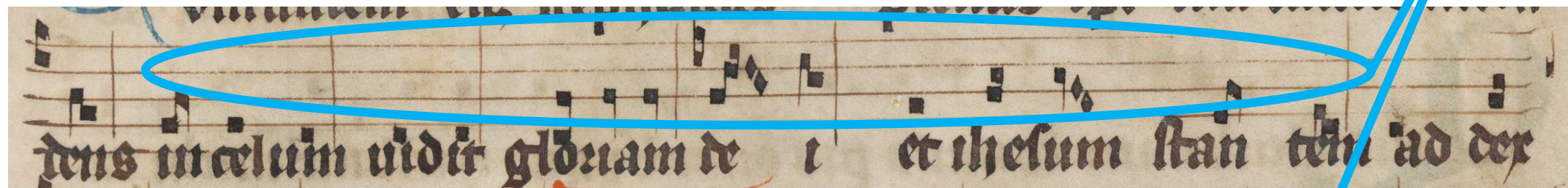
CDN-Mlr_MS73

4 lines of
staff



deus salvator noster adveni et.

Things that
are notes



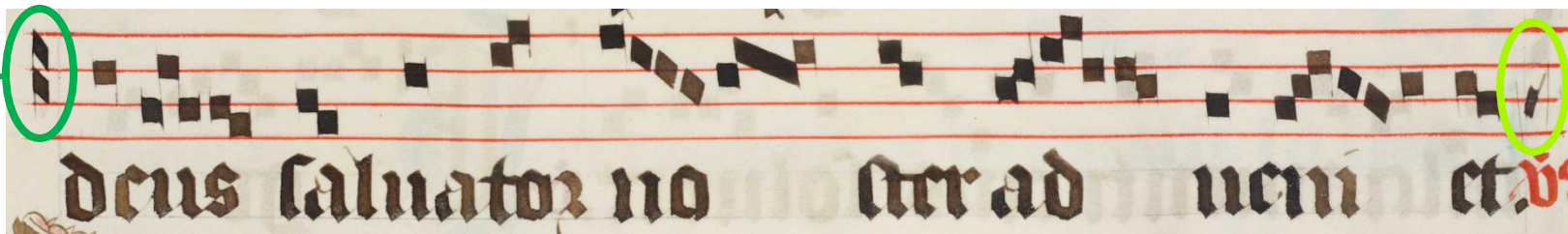
deus in celum vidit gloriam dei et ihesum stantem ad dexteram

Latin text

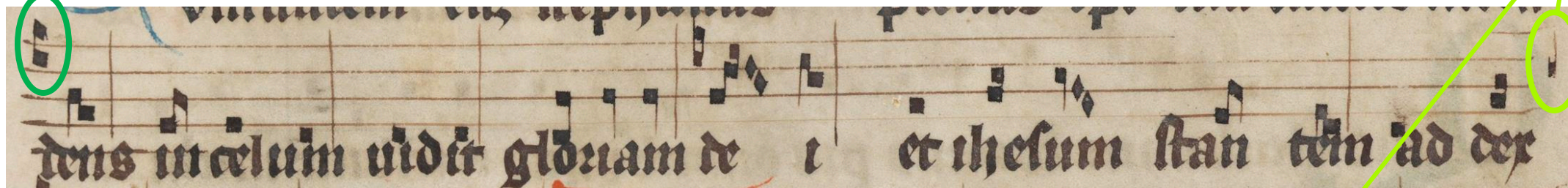


perduceret iherusalem

C clef



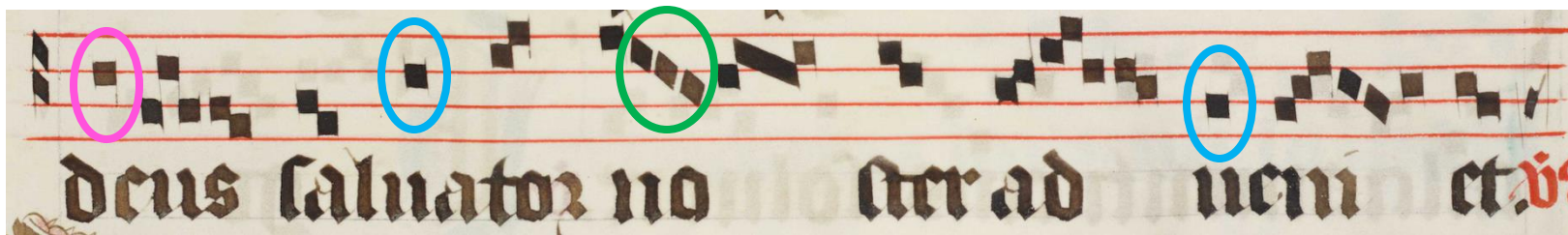
Custos –
Indicates
starting pitch
of next staff



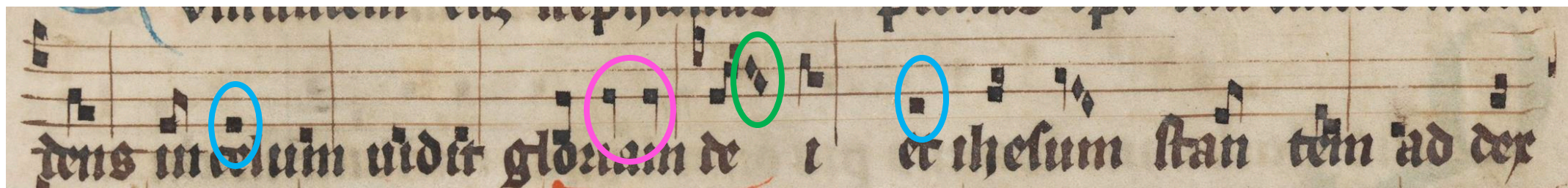
F clef



Punctum
=
Dot



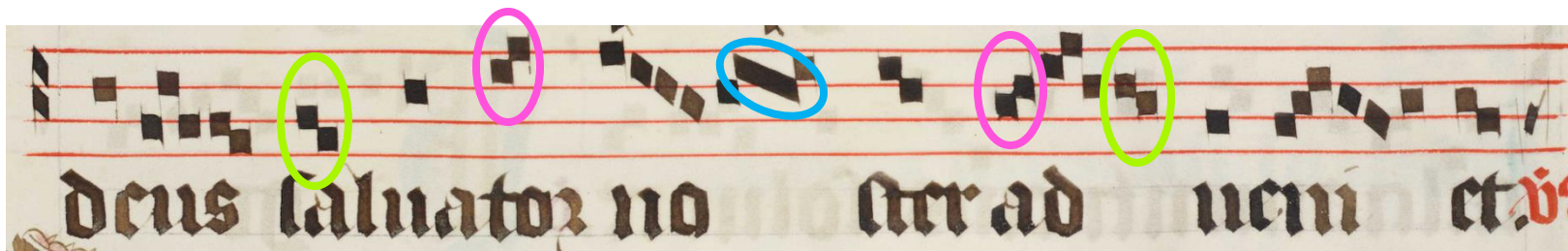
Virga
=
Dot with a
tail



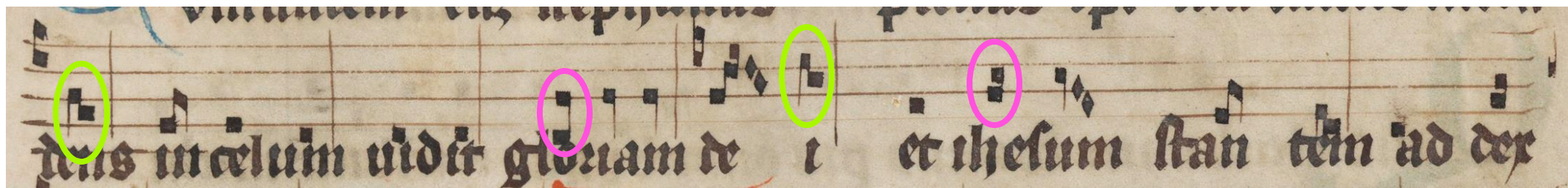
Inclinatum
=
Dot on an
angle



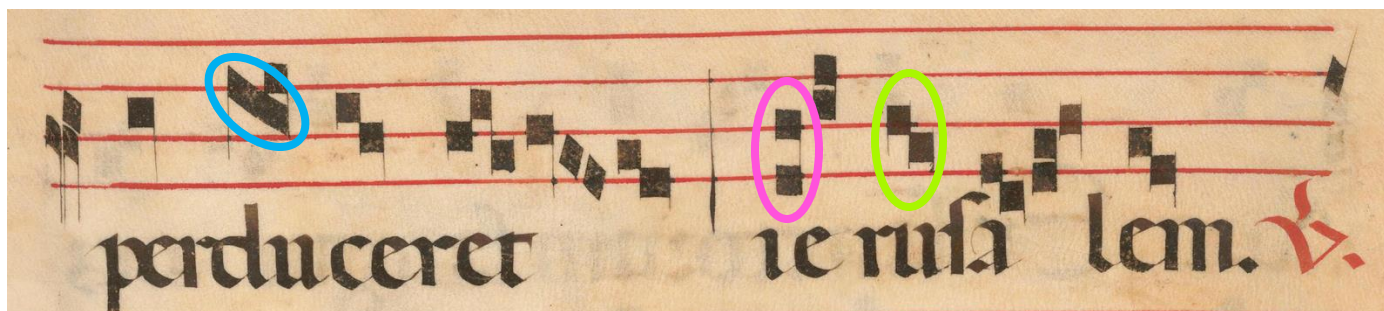
Podatus
=
Two-note
ascending
neume



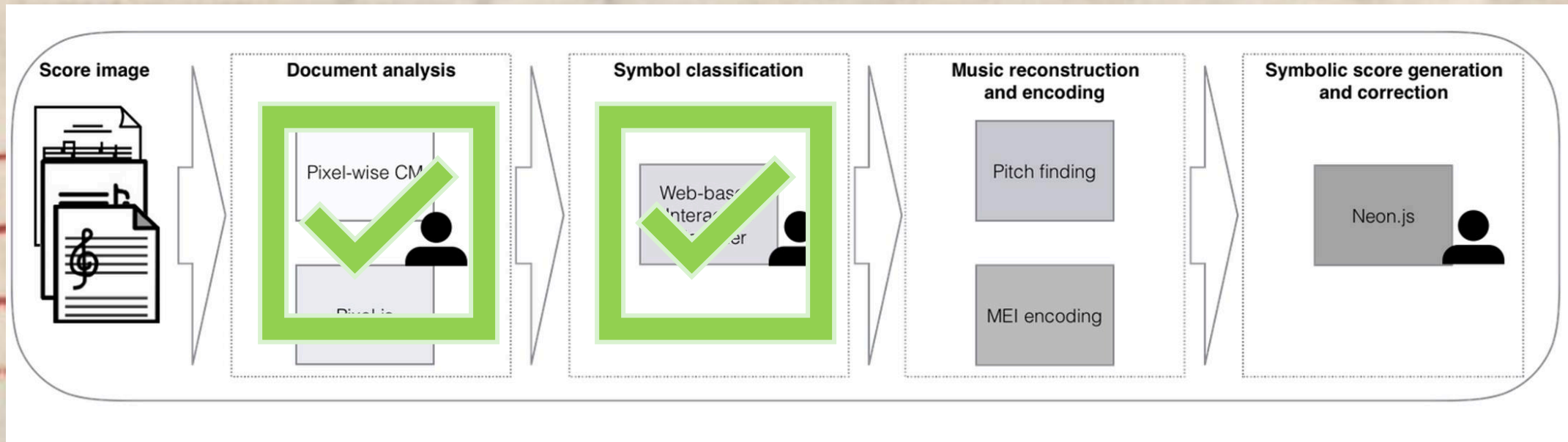
Clavis
=
Two-note
descending
neume



Oblique
=
Two-note
descending
neume



Back to business

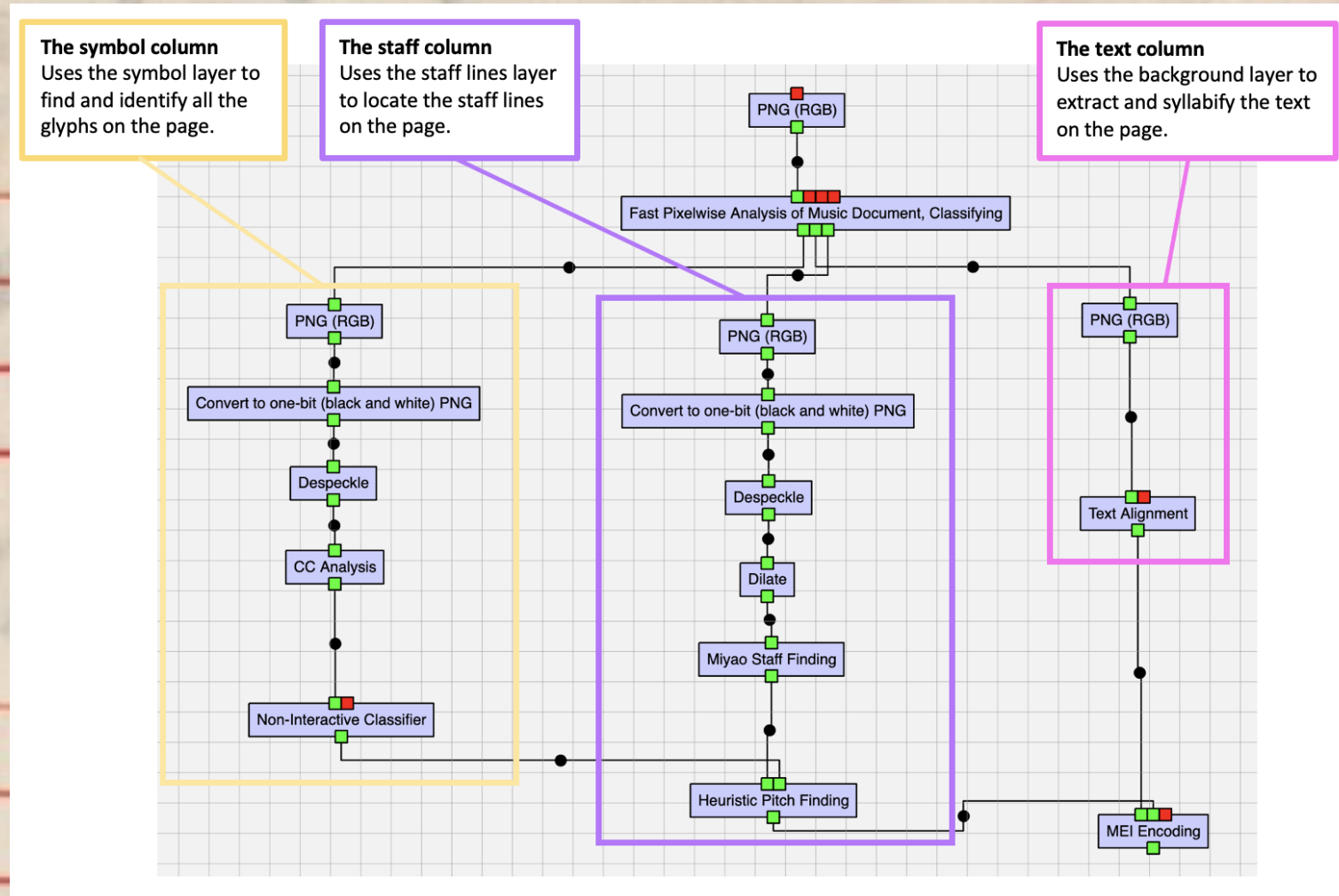


Teaching the computer to separate a folio image into layers containing staff lines, glyphs, etc.

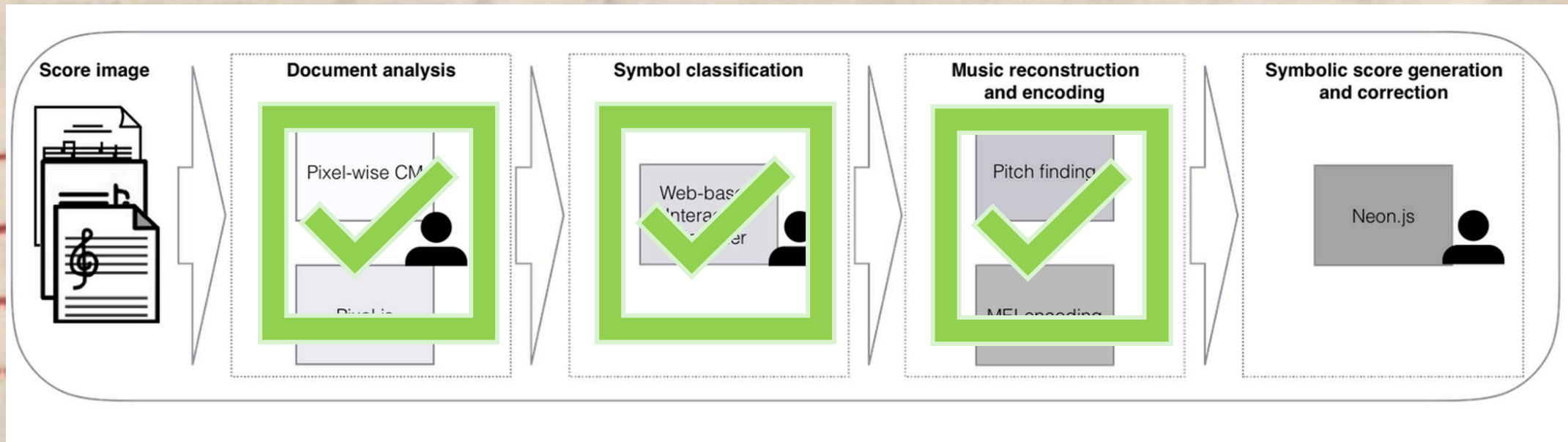
Teaching the computer to tell musical symbols apart and identify them correctly

End-to-end OMR!

End-to-end OMR



Neon



Teaching the computer to separate a folio image into layers containing staff lines, glyphs, etc.

Teaching the computer to tell musical symbols apart and identify them correctly

End-to-end OMR!

Neon

<https://ddmal.music.mcgill.ca/Neon/>

- + Zoom level: 3.00

Folio 001v (4 of 573)

Go



Manuscript info

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gen tem. } te ob uiam e i et dicit. Nuntia
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lo israhel. Qui qz terrigena et filij hominum
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Go to first chant

Previous Folio

Next Folio

Folio 001v

Search Manuscript

Neume ▾

Search

Available neumes



punctum



pes



distropha



clivis



scandicus



torculus

Neume search

Searching...

Zoom level: 3.00

Folio 001v (4 of 573)

Go



Manuscript info

Go to first chant Previous Folio Next Folio

Folio 001v

Search Manuscript

Neume

torculus

Search

Available neumes



punctum



pes



distropha



clivis



scandicus



torculus

3834 results for query: torculus

Folio	Neumes	Pitches	Contour
001v		d f e	
001v		e f e	
001v		d e c	
001v		e f e	



Music Encoding Initiative (MEI)

Yinan Zhou
DDMAL, McGill University
Training Week 2025 Summer

What is MEI?



MEI

- Encodes music scores, metadata, and editorial work
- Built using eXtensible Markup Language (XML)
 - ◆ HTML: for web pages
 - ◆ TEI: for text
 - ◆ MEI: for music

What does MEI look like?


```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <?xml-model href="https://music-encoding.org/schema/5.0/mei-all.rng" type="application/xml" schematypens="http://relaxng.org/ns/structure/1.0"?>
3 <?xml-model href="https://music-encoding.org/schema/5.0/mei-all.rng" type="application/xml" schematypens="http://purl.oclc.org/dsdl/schematron"?>
4 <mei
5   xmlns="http://www.music-encoding.org/ns/mei" meiversion="5.0"
6   <meiHead xml:id="m-cc2cc34c-56cb-40fe-97b9-4f4b7ae83faf">
7     <fileDesc xml:id="m-0f28ed12-54a6-40bd-be31-d16ca7d137c7">
8       <titleStmt xml:id="m-4d9eeabe-75f6-439e-97f9-bb40a7909f1b">
9         <title xml:id="m-c85131ff-cf24-40f9-adaf-67c5be91bfcd">MEI Encoding Output (1.0.0)</title>
10       </titleStmt>
11       <pubStmt xml:id="m-74de0afe-1811-4536-831c-06c49919ead2"/>
12     </fileDesc>
13   </meiHead>
14   <music>
15     <facsimile xml:id="m-5a58254a-8580-49cd-9bad-23381501407f">
16       <surface xml:id="m-07936488-2a37-4829-b18b-b44bd091a94b" lrx="4872" lry="6496">...
17     </surface>
18   </facsimile>
19   <body>
20     <mdiv xml:id="m-0b6a5779-e528-4467-bad0-822bb7f82a38">
21       <score xml:id="m-a349a683-99e3-4ff6-af3e-53de8a7b040c">
22         <scoreDef xml:id="m-17a8363d-e4bc-4dc3-a05c-bc1ff8c2612c">...
23       </scoreDef>
24       <section xml:id="m-48a24564-40a2-47d2-b96e-8f255d0d9bb3">
25         <staff n="1">
26           <layer n="1">
27             <pb xml:id="m-030a7c4d-21ad-4e1e-8d4a-2ec11d4346a8" facs="#m-07936488-2a37-4829-b18b-b44bd091a94b"/>
28             <sb n="1" facs="#m-1c9e019c-05df-4aa2-ab71-8ee5d031cdcc" xml:id="m-c4015cca-0784-4e9a-86f6-ac646b1ecab2"/>
29             <clef xml:id="m-d891b1f8-d9a6-4286-8a5b-3272e5c6e7e8" facs="#m-ce74aa6e-471f-487e-9b94-9ce7289af7f2" shape="C" line="4"/>
30             <syllable xml:id="m-e93d9626-a102-4982-b8eb-fa64068801b4">...
31           </syllable>
32           <divLine xml:id="m-16d4e772-9c62-41fe-af3a-0fe90f0975d0" facs="#m-35d490b5-e192-4aea-91e1-4b4a96d44e47" form="maxima"/>
33           <divLine xml:id="m-6bb7aa35-2b78-49aa-a28c-c39bc61eeea4" facs="#m-4a26ea6d-57c5-4abe-a044-e19218e496f7" form="maxima"/>
34           <accid xml:id="accid-0000001858106490" facs="#zone-0000000341653099" accid="f"/>
35           <divLine xml:id="m-5a9680dc-2912-41c8-a837-631b48d56f35" facs="#m-b102226b-2e68-43e7-baf2-f0872e47b145" form="maxima"/>
36           <syllable xml:id="m-d56c2ef3-297d-41ec-84b6-fbccd8ce6b0f">
37             <syll xml:id="m-7fe96bca-0f15-4171-b883-8a58566d5c9b" facs="#m-6ff3caed-62b0-4350-8db9-36eebceb3a4f">in</syll>

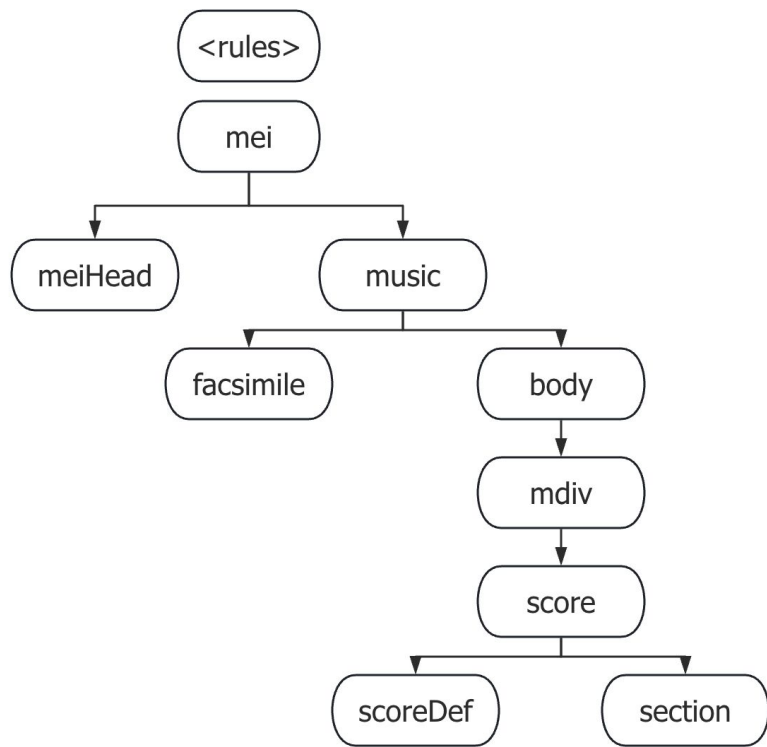
```

It looks like code

- Uses nested tags
- Human-readable
- Machine-readable

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <?xml-model href="https://music-encoding.org/schema/5.0/mei-all.rng" type="app
3 <?xml-model href="https://music-encoding.org/schema/5.0/mei-all.rng" type="app
4 <mei
5   xmlns="http://www.music-encoding.org/ns/mei" meiversion="5.0">
6   <meiHead xml:id="m-cc2cc34c-56cb-40fe-97b9-4f4b7ae83faf">
7     <fileDesc xml:id="m-0f28ed12-54a6-40bd-be31-d16ca7d137c7">
8       <titleStmt xml:id="m-4d9eeabe-75f6-439e-97f9-bb40a7909f1b">
9         <title xml:id="m-c85131ff-cf24-40f9-adaf-67c5be91bfcd">MEI Enc
10       </titleStmt>
11       <pubStmt xml:id="m-74de0afe-1811-4536-831c-06c49919ead2"/>
12     </fileDesc>
13   </meiHead>
14   <music>
15     <facsimile xml:id="m-5a58254a-8580-49cd-9bad-23381501407f">
16       <surface xml:id="m-07936488-2a37-4829-b18b-b44bd091a94b" lrx="4872
17     </surface>
18     </facsimile>
19     <body>
20       <mdiv xml:id="m-0b6a5779-e528-4467-bad0-822bb7f82a38">
21         <score xml:id="m-a349a683-99e3-4ff6-af3e-53de8a7b040c">
22           <scoreDef xml:id="m-17a8363d-e4bc-4dc3-a05c-bc1ff8c2612c">
23             </scoreDef>
24             <section xml:id="m-48a24564-40a2-47d2-b96e-8f255d0d9bb3">
25               <staff n="1">
26                 <layer n="1">
27                   <pb xml:id="m-030a7c4d-21ad-4e1e-8d4a-2ec11d43
28                   <sb n="1" facs="#m-1c9e019c-05df-4aa2-ab71-8ee
29                   <clef xml:id="m-d891b1f8-d9a6-4286-8a5b-3272e5
30                   <syllable xml:id="m-e93d9626-a102-4982-b8eb-fa
31                   </syllable>
32                   <divLine xml:id="m-16d4e772-9c62-41fe-af3a-0fe
33                   <divLine xml:id="m-6bb7aa35-2b78-49aa-a28c-c39
34                   <accid xml:id="accid-0000001858106490" facs="#
35                   <divLine xml:id="m-5a9680dc-2912-41c8-a837-631
36                   <syllable xml:id="m-d56c2ef3-297d-41ec-84b6-fb
37                   <syl xml:id="m-7fe96bca-0f15-4171-b883-8a
```

MEI Structure



```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <?xml-model href="https://music-encoding.org/schema/5.0/mei-all.rng" type="app
3 <?xml-model href="https://music-encoding.org/schema/5.0/mei-all.rng" type="app
4 <mei
5   xmlns="http://www.music-encoding.org/ns/mei" meiversion="5.0">
6   <meiHead xml:id="m-cc2cc34c-56cb-40fe-97b9-4f4b7ae83faf">
7     <fileDesc xml:id="m-0f28ed12-54a6-40bd-be31-d16ca7d137c7">
8       <titleStmt xml:id="m-4d9eeabe-75f6-439e-97f9-bb40a7909f1b">
9         <title xml:id="m-c85131ff-cf24-40f9-adaf-67c5be91bfcd">MEI Enc
10       </titleStmt>
11       <pubStmt xml:id="m-74de0afe-1811-4536-831c-06c49919ead2"/>
12     </fileDesc>
13   </meiHead>
14   <music>
15     <facsimile xml:id="m-5a58254a-8580-49cd-9bad-23381501407f">
16       <surface xml:id="m-07936488-2a37-4829-b18b-b44bd091a94b" lrx="4872
17     </surface>
18   </facsimile>
19   <body>
20     <mdiv xml:id="m-0b6a5779-e528-4467-bad0-822bb7f82a38">
21       <score xml:id="m-a349a683-99e3-4ff6-af3e-53de8a7b040c">
22         <scoreDef xml:id="m-17a8363d-e4bc-4dc3-a05c-bc1ff8c2612c">
23         </scoreDef>
24         <section xml:id="m-48a24564-40a2-47d2-b96e-8f255d0d9bb3">
25           <staff n="1">
26             <layer n="1">
27               <pb xml:id="m-030a7c4d-21ad-4e1e-8d4a-2ec11d43
28               <sb n="1" facs="#m-1c9e019c-05df-4aa2-ab71-8ee
29               <clef xml:id="m-d891b1f8-d9a6-4286-8a5b-3272e5
30               <syllable xml:id="m-e93d9626-a102-4982-b8eb-fa
31             </syllable>
32             <divLine xml:id="m-16d4e772-9c62-41fe-af3a-0fe
33             <divLine xml:id="m-6bb7aa35-2b78-49aa-a28c-c39
34             <accid xml:id="accid-0000001858106490" facs="#
35             <divLine xml:id="m-5a9680dc-2912-41c8-a837-631
36             <syllable xml:id="m-d56c2ef3-297d-41ec-84b6-fl
37               <syll xml:id="m-7fe96bca-0f15-4171-b883-8a5

```

Facsimile Module

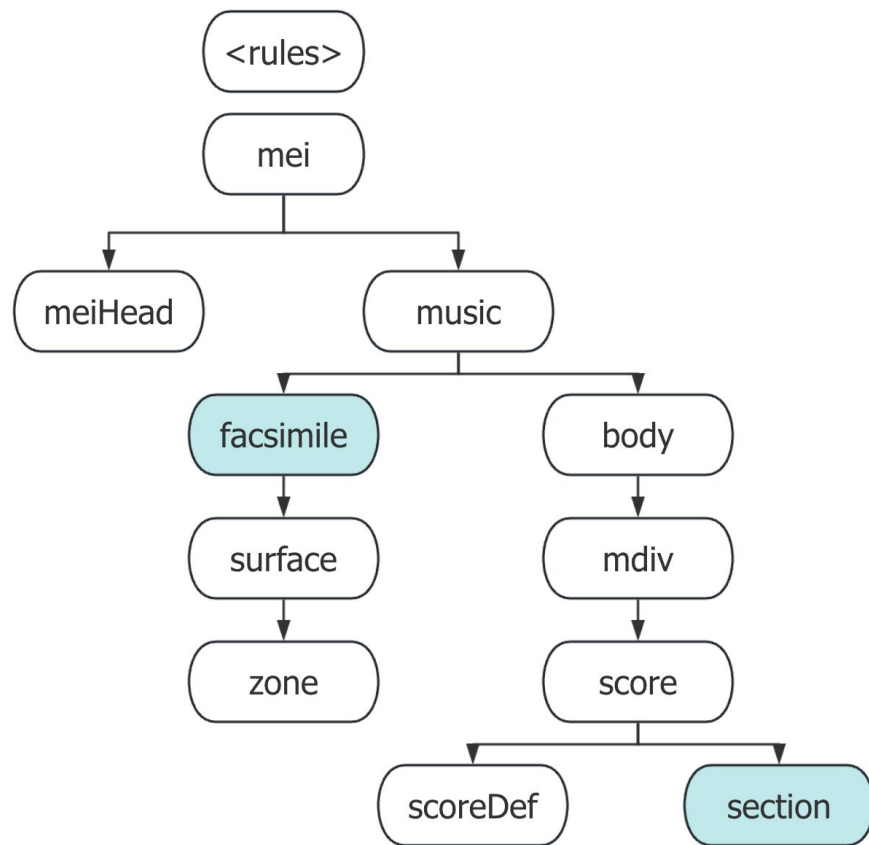
Why do we need facsimile?

- Regular MEI doesn't show information about po
- Positioning matters for OMR



Facsimiles

→ Connect an MEI file with an external image source



```
4 <mei>
14 <music>
15 <facsimile xml:id="m-5a58254a-8580-49cd-9bad-23381501407f">
16 <surface xml:id="m-07936488-2a37-4829-b18b-b44bd091a94b" lrx="4872" lry="6496">
54 <zone xml:id="zone-0000001032202072" lrx="1244" lry="2042" ulx="1044" uly="2042"/>
55 <zone xml:id="zone-0000001663683811" lrx="1315" lry="2928" ulx="1115" uly="2728"/>
56 <zone xml:id="zone-0000000510676243" lrx="3986" lry="2622" ulx="3786" uly="2422"/>
57 <zone xml:id="zone-0000001123102393" lrx="4019" lry="2579" ulx="3819" uly="2379"/>
58 </surface>
59 </facsimile>
60 <body>
61 <mdiv xml:id="m-0b6a5779-e528-4467-bad0-822bb7f82a38">
62 <score xml:id="m-a349a683-99e3-4ff6-af3e-53de8a7b040c">
63 <scoreDef xml:id="m-17a8363d-e4bc-4dc3-a05c-bc1ff8c2612c"> ...
67 </scoreDef>
68 <section xml:id="m-48a24564-40a2-47d2-b96e-8f255d0d9bb3">
69 <staff n="1">
70 <layer n="1">
71 <pb xml:id="m-030a7c4d-21ad-4e1e-8d4a-2ec11d4346a8" facs="#m-07936488-2a37-4829-b18b-b44bd091a94b"/>
72 <sb n="1" facs="#m-1c9e019c-05df-4aa2-ab71-8ee5d031cdcc" xml:id="m-c4015cca-0784-4e9a-86f6-ac646b1ecab2"/>
73 <clef xml:id="m-d891b1f8-d9a6-4286-8a5b-3272e5c6e7e8" facs="#m-ce74aa6e-471f-487e-9b94-9ce7289af7f2" shape="C" line="4"/>
74 <syllable xml:id="m-e93d9626-a102-4982-b8eb-fa64068801b4"> ...
80 </syllable>
81 <divLine xml:id="m-16d4e772-9c62-41fe-af3a-0fe90f0975d0" facs="#m-35d490b5-e192-4aea-91e1-4b4a96d44e47" form="maxima"/>
82 <divLine xml:id="m-6bb7aa35-2b78-49aa-a28c-c39bc61eeea4" facs="#m-4a26ea6d-57c5-4abe-a044-e19218e496f7" form="maxima"/>
83 <accid xml:id="accid-0000001858106490" facs="#zone-0000000341653099" accid="f"/>
84 <divLine xml:id="m-5a9680dc-2912-41c8-a837-631b48d56f35" facs="#m-b102226b-2e68-43e7-baf2-f0872e47b145" form="maxima"/>
85 <syllable xml:id="m-d56c2ef3-297d-41ec-84b6-fbccd8ce6b0f">
86 <syl xml:id="m-7fe96bca-0f15-4171-b883-8a5856ed5c9b" facs="#m-6ff3caed-62b0-4350-8db9-36eebceb3a4f">in</syl>
87 <neume xml:id="m-215f9505-9ffc-4486-be3a-d4fce75dab1d">
88 <nc xml:id="m-5c7d33d2-59d2-4d8f-854f-0c9bb4e72dfa" facs="#m-30cb5bce-a524-4b73-ad6b-460771fc2b07" oct="2" pname="a"/>
89 <nc xml:id="m-ccb98825-399a-462f-9790-4a514bdf894b" facs="#m-5a2d7859-e709-4849-b4cf-8f55bc4bbfe7" oct="2" pname="b"/>
90 <nc xml:id="m-0fa6d73c-2a57-47bc-855f-4aa4c23b0aa2" facs="#m-fcfc9293-3e83-4bcf-a0e4-15b17ff48f79" oct="2" pname="a"/>
91 </neume>
92 </syllable>
93 <custos facs="#m-f5f5415f-365f-4669-9865-a07bebf0e90c" oct="2" pname="f" xml:id="m-e247912b-91b1-40dd-b320-878c864e82cc"/>
94 <sb n="2" facs="#m-5ffcb1da-a98c-47fc-93b4-eb2f6bbd59c6" xml:id="m-fff34715-9c51-4ae8-b4e8-5151c053adce"/>
95 <clef xml:id="m-03697ea8-f975-48f6-abb7-57e20732b696" facs="#m-48b35456-4c19-4ccd-8682-1d0441902392" shape="C" line="4"/>
```

Attributes

Attributes

→ Describe details of musical elements

```
<nc xml:id="m-10c4dc04" facs="#m-4f016e77" oct="2" pname="f" tilt="n"/>
```

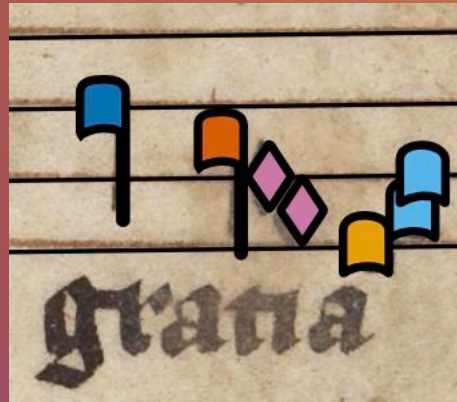
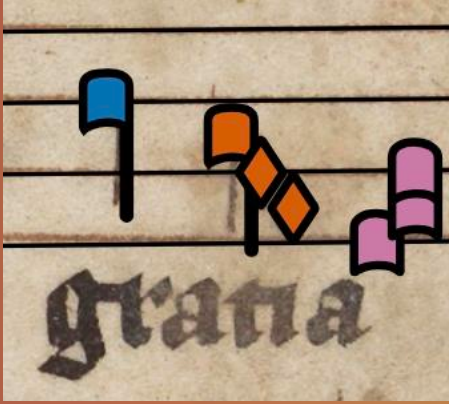
nc	nc@tilt="n"	nc@tilt="s"	clef@shape="C"	clef@shape="F"
Punctum	Reversed virga	Virga	C clef	F clef
				

MEI and Neon

Comparing MEI code with its rendering
in Neon to better understand both
(hopefully)

Geneviève Gates-Panneton

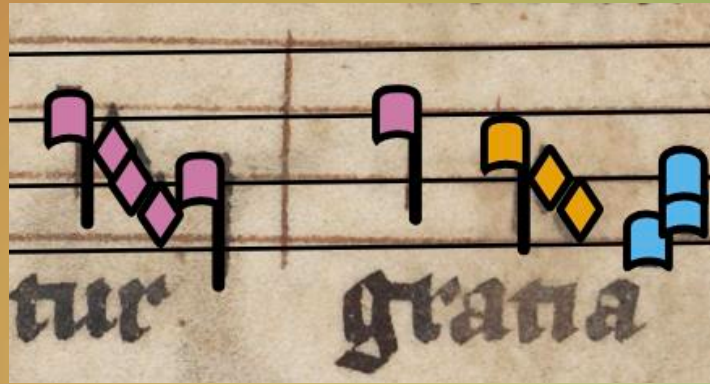
Neumes



```
<syllable xml:id="syllable-0000002095556033">
  <syl xml:id="syl-0000001757536115" facs="#zone-0000001167758960">gra</syl>
  <neume xml:id="m-4e516f1b-ee78-4e51-b67a-4ba2c4f040e9">
    <nc xml:id="m-12c1d644-e6c7-4646-93e6-0bf59b430a54" facs="#m-5e27f28b-d756-49a0-89b6-52f2eb04f19d" oct="4" pname="c" tilt="s"/>
  </neume>
</syllable>
<syllable xml:id="syllable-0000000172473945">
  <neume xml:id="neume-0000001621958538">
    <nc xml:id="m-ac679338-d98a-4e14-8a71-5a8c3bcc21e7" facs="#m-e4a5bf30-b383-4d66-a65c-ce50854a16f5" oct="3" pname="b" tilt="s"/>
    <nc xml:id="nc-0000001164240622" facs="#zone-0000001281785955" oct="3" pname="a" tilt="se"/>
    <nc xml:id="nc-0000000252947805" facs="#zone-0000000392411552" oct="3" pname="g" tilt="se"/>
  </neume>
  <syl xml:id="syl-0000001400462352" facs="#zone-0000000285061853">ti</syl>
</syllable>
<syllable xml:id="m-13e7ea03-2ba7-4ef3-b42c-5e92d64f1b4e">
  <syl xml:id="m-688436ea-77ba-4116-857c-31e5ab092756" facs="#m-53b65492-8bcd-4355-8fb8-51c0b5668d45">a</syl>
  <neume xml:id="m-c051cd9e-ae92-4054-94c2-93264c160cd3">
    <nc xml:id="m-91014e80-806e-4036-9f5b-2d20da86ab25" facs="#m-45aa348e-5854-4ee6-8abf-4b26c2ec20c4" oct="3" pname="f"/>
    <nc xml:id="m-a497db31-6159-413c-b599-e70088b00889" facs="#m-342a14fb-33f8-4256-b161-8f769a2f8a07" oct="3" pname="g"/>
    <nc xml:id="m-1b8b5366-c8ae-41f1-823e-0b4d6c36c230" facs="#m-5d53a733-d0a1-47e9-ae70-8109019052d0" oct="3" pname="a"/>
  </neume>
</syllable>
```

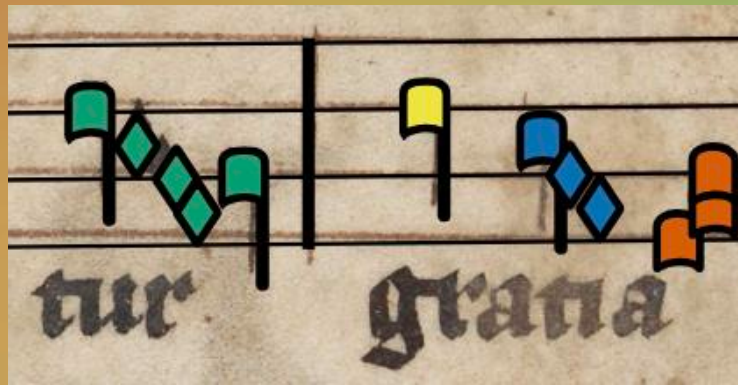
```
<syllable xml:id="a12pcd5f">
  <neume xml:id="m-4e516f1b-ee78-4e51-b67a-4ba2c4f040e9">
    <nc xml:id="m-12c1d644-e6c7-4646-93e6-0bf59b430a54" facs="#m-5e27f28b-d756-49a0-89b6-52f2eb04f19d" oct="4" pname="c" tilt="s"/>
  </neume>
  <syl xml:id="vs8lo5g" facs="#a18rz267"/>
</syllable>
<syllable xml:id="m1k0kmkt">
  <neume xml:id="l1s55u2x">
    <nc xml:id="m-ac679338-d98a-4e14-8a71-5a8c3bcc21e7" facs="#m-e4a5bf30-b383-4d66-a65c-ce50854a16f5" oct="3" pname="b" tilt="s"/>
  </neume>
  <neume xml:id="w1exw8r5">
    <nc xml:id="luzjmfq" facs="#t13mj1vg" oct="3" pname="a" tilt="se"/>
    <nc xml:id="o5u3248" facs="#x1ov7o3d" oct="3" pname="g" tilt="se"/>
  </neume>
  <syl xml:id="d1r74r9u" facs="#gvec1h4">ti</syl>
</syllable>
<syllable xml:id="m-13e7ea03-2ba7-4ef3-b42c-5e92d64f1b4e">
  <syl xml:id="m-688436ea-77ba-4116-857c-31e5ab092756" facs="#m-53b65492-8bcd-4355-8fb8-51c0b5668d45">a</syl>
  <neume xml:id="m-c051cd9e-ae92-4054-94c2-93264c160cd3">
    <nc xml:id="m-91014e80-806e-4036-9f5b-2d20da86ab25" facs="#m-45aa348e-5854-4ee6-8abf-4b26c2ec20c4" oct="3" pname="f"/>
  </neume>
  <neume xml:id="drrd1ie">
    <nc xml:id="m-a497db31-6159-413c-b599-e70088b00889" facs="#m-342a14fb-33f8-4256-b161-8f769a2f8a07" oct="3" pname="g"/>
    <nc xml:id="m-1b8b5366-c8ae-41f1-823e-0b4d6c36c230" facs="#m-5d53a733-d0a1-47e9-ae70-8109019052d0" oct="3" pname="a"/>
  </neume>
</syllable>
```


Syllables



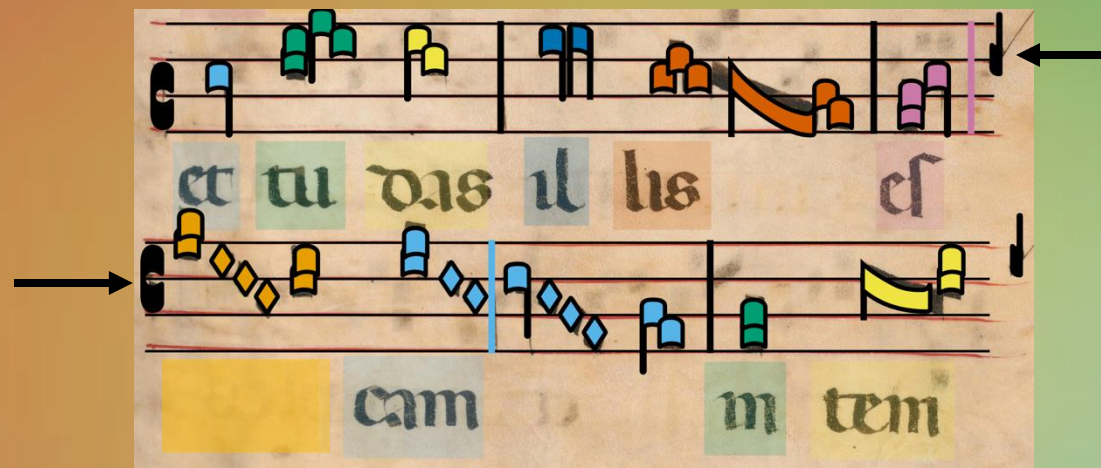
```
<syllable xml:id="ltuf5iw">
  <syl xml:id="m9h8ido" facs="#i1ft356f">tur</syl>
  <neume xml:id="j1r82lsk">
    <nc xml:id="m-9893a203-16e8-468f-ae9-5e9819e9d555" facs="#m-ec4d97b1-9a83-4635-b778-d0571bed4561" oct="4" pname="c" tilt="s"/>
    <nc xml:id="m-ce1e6232-7958-4011-83a5-7468a430c329" facs="#m-f50c5d37-abd3-43c5-8982-793a7e89a248" oct="3" pname="b" tilt="se"/>
    <nc xml:id="m-687f2cb3-5e73-425f-a373-7d8fab709b3a" facs="#m-e3255850-a5f0-408e-93cd-c4d014f0340a" oct="3" pname="a" tilt="se"/>
    <nc xml:id="u9ddu2v" facs="#qz2pgqb" oct="3" pname="g" tilt="se"/>
  </neume>
  <neume xml:id="mec7ouv">
    <nc xml:id="m-e9ce575b-3049-46d4-8272-f909adaf4c4d" facs="#m-8f3fd650-017d-4e35-a846-9478ad34c6fa" oct="3" pname="a" tilt="s"/>
  </neume>
  <neume xml:id="m-4e516f1b-ee78-4e51-b67a-4ba2c4f040e9">
    <nc xml:id="m-12c1d644-e6c7-4646-93e6-0bf59b430a54" facs="#m-5e27f28b-d756-49a0-89b6-52f2eb04f19d" oct="4" pname="c" tilt="s"/>
  </neume>
</syllable>
<syllable xml:id="m-f2041173-674d-4504-b480-3196f17ff554">
  <neume xml:id="l1s55u2x">
    <nc xml:id="m-ac679338-d98a-4e14-8a71-5a8c3bcc21e7" facs="#m-e4a5bf30-b383-4d66-a65c-ce50854a16f5" oct="3" pname="b" tilt="s"/>
    <nc xml:id="m-828b2d18-a8fc-4bf2-b61d-cc1d2009069e" facs="#m-b64a7581-8286-477e-91af-ecae90d305f0" oct="3" pname="a" ligated="false" tilt="se"/>
    <nc xml:id="m-96daae06-ffcb-44e5-8c3e-b5c36484a811" facs="#m-027aa70e-7b79-4603-b8dc-e70f6fc783d3" oct="3" pname="g" ligated="false" tilt="se"/>
  </neume>
  <syl xml:id="m-ef2ffd5f-0fa8-43f2-a16b-4f1598d40733" facs="#m-269659ab-4a40-4ec6-aaab-1cba0795812a">ti</syl>
</syllable>
<syllable xml:id="m-13e7ea03-2ba7-4ef3-b42c-5e92d64f1b4e">
  <syl xml:id="m-688436ea-77ba-4116-857c-31e5ab092756" facs="#m-53b65492-8bcd-4355-8fb8-51c0b5668d45">a</syl>
  <neume xml:id="m-c051cd9e-ae92-4054-94c2-93264c160cd3">
    <nc xml:id="m-91014e80-806e-4036-9f5b-2d20da86ab25" facs="#m-45aa348e-5854-4ee6-8abf-4b26c2ec20c4" oct="3" pname="f"/>
    <nc xml:id="m-a497db31-6159-413c-b599-e70088b00889" facs="#m-342a14fb-33f8-4256-b161-8f769a2f8a07" oct="3" pname="g"/>
    <nc xml:id="m-1b8b5366-c8ae-41f1-823e-0b4d6c36c230" facs="#m-5d53a733-d0a1-47e9-ae70-8109019052d0" oct="3" pname="a"/>
  </neume>
</syllable>
```

Syllables



```
<syllable xml:id="syllable-0000001424531883">
  <syl xml:id="syl-0000002083193614" facs="#zone-0000000448771436">tur</syl>
  <neume xml:id="neume-0000000269140093">
    <nc xml:id="m-9893a203-16e8-468f-ae9-5e9819e9d555" facs="#m-ec4d97b1-9a83-4635-b778-d0571bed4561" oct="4" pname="c" tilt="s"/>
    <nc xml:id="nc-0000000398872946" facs="#zone-0000001937024034" oct="3" pname="b" tilt="se"/>
    <nc xml:id="m-ce1e6232-7958-4011-83a5-7468a430c329" facs="#m-f50c5d37-abd3-43c5-8982-793a7e89a248" oct="3" pname="a" tilt="se"/>
    <nc xml:id="m-687f2cb3-5e73-425f-a373-7d8fab709b3a" facs="#m-e3255850-a5f0-408e-93cd-c4d014f0340a" oct="3" pname="g" tilt="se"/>
  </neume>
  <neume xml:id="neume-0000001001348582">
    <nc xml:id="m-e9ce575b-3049-46d4-8272-f909adaf4c4d" facs="#m-8f3fd650-017d-4e35-a846-9478ad34c6fa" oct="3" pname="a" tilt="s"/>
  </neume>
</syllable>
<divLine xml:id="m-af154c10-89af-476c-a349-f7fff6e9302c" facs="#m-e1a4aca8-60ca-4f9a-bc07-7e1dc745b944" form="maxima"/>
<syllable xml:id="syllable-0000002095556033">
  <syl xml:id="syl-0000001757536115" facs="#zone-0000001167758960">gra</syl>
  <neume xml:id="m-4e516f1b-ee78-4e51-b67a-4ba2c4f040e9">
    <nc xml:id="m-12c1d644-e6c7-4646-93e6-0bf59b430a54" facs="#m-5e27f28b-d756-49a0-89b6-52f2eb04f19d" oct="4" pname="c" tilt="s"/>
  </neume>
</syllable>
<syllable xml:id="syllable-0000000172473945">
  <neume xml:id="neume-0000001621958538">
    <nc xml:id="m-ac679338-d98a-4e14-8a71-5a8c3bcc21e7" facs="#m-e4a5bf30-b383-4d66-a65c-ce50854a16f5" oct="3" pname="b" tilt="s"/>
    <nc xml:id="nc-0000001164240622" facs="#zone-0000001281785955" oct="3" pname="a" tilt="se"/>
    <nc xml:id="nc-0000000252947805" facs="#zone-0000000392411552" oct="3" pname="g" tilt="se"/>
  </neume>
  <syl xml:id="syl-0000001400462352" facs="#zone-0000000285061853">ti</syl>
</syllable>
<syllable xml:id="m-13e7ea03-2ba7-4ef3-b42c-5e92d64f1b4e">
  <syl xml:id="m-688436ea-77ba-4116-857c-31e5ab092756" facs="#m-53b65492-8bcd-4355-8fb8-51c0b5668d45">a</syl>
  <neume xml:id="m-c051cd9e-ae92-4054-94c2-93264c160cd3">
    <nc xml:id="m-91014e80-806e-4036-9f5b-2d20da86ab25" facs="#m-45aa348e-5854-4ee6-8abf-4b26c2ec20c4" oct="3" pname="f"/>
    <nc xml:id="m-a497db31-6159-413c-b599-e70088b00889" facs="#m-342a14fb-33f8-4256-b161-8f769a2f8a07" oct="3" pname="g"/>
    <nc xml:id="m-1b8b5366-c8ae-41f1-823e-0b4d6c36c230" facs="#m-5d53a733-d0a1-47e9-ae70-8109019052d0" oct="3" pname="a"/>
  </neume>
</syllable>
```

Toggled syllables

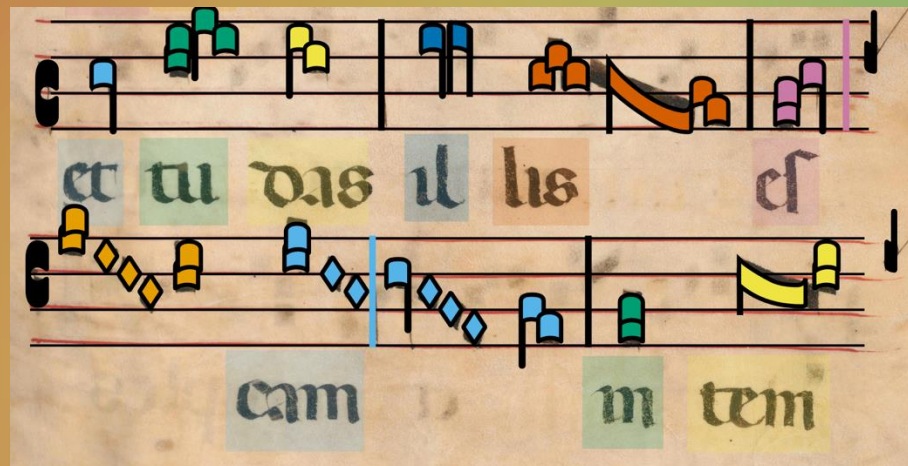


```

<syllable xml:id="r1yqcr4d">
  <syl xml:id="m1h2tgyw" facs="#h1iud6yz">es</syl>
  <neume xml:id="p16hc89l">
    <nc xml:id="m-923c3ad4-3922-4a02-a051-c91d43c9eec5" facs="#m-39bba908-67ef-4d34-93ee-ab9a147482aa" oct="3" pname="b"/>
    <nc xml:id="m-8bc3fe96-e065-4ff6-ad91-bac29c53d621" facs="#m-6b87083c-0529-45d3-adec-c4e5189c8e59" oct="4" pname="c"/>
    <nc xml:id="m-c637a4b4-274c-4dd2-9f2a-954d12275e65" facs="#m-d88d9e7c-acde-4594-8f98-6ce2d8baf1e2" oct="4" pname="d" tilt="s"/>
  </neume>
  <divLine xml:id="idgcrjw" facs="#q18g0z2l" form="maxima"/>
</syllable>
<custos oct="4" pname="e" xml:id="m-13f4706d-7806-476d-a694-99af314c1187" facs="#m-79ebe216-639e-4c9d-a16e-6f0634c5ae80"/>
<sb n="6" facs="#m-e03a3b98-3cbd-4caa-9988-18a0e7f50fa3" xml:id="m-b84c1d1e-831a-4948-a699-a09dd6b81e1e"/>
<clef xml:id="m-ca2ddb2b-7eb5-4b5b-8fe5-138fc126fba" facs="#m-f6eddd2a-ce70-4e0c-8578-7d96c14d6204" shape="C" line="3"/>
<syllable xml:id="ogw830">
  <syl xml:id="h1gaw57t" facs="#w1m9z052"/>
  <neume xml:id="gz2v36k">
    <nc xml:id="m-5af8bc1b-5e0a-409c-b7d6-88930ee9c616" facs="#m-702c7002-f52a-49d1-a993-e727298d750d" oct="4" pname="e"/>
    <nc xml:id="m-524b845b-9f6e-4192-9258-f9f551e77c56" facs="#m-10e32a75-1fdc-4f66-94eb-4062bdf3d609" oct="4" pname="f"/>
    <nc xml:id="m-9612f563-4d02-427b-aff2-389992afaf68" facs="#m-00349e98-8f2f-47f4-ad00-54fc1b984bc3" oct="4" pname="d" tilt="se"/>
    <nc xml:id="m-83ef43dd-1add-4a15-9a62-fe1707cd1179" facs="#m-b54d46fe-d1b9-4482-9816-4f41f57fc6ae" oct="4" pname="c" tilt="se"/>
    <nc xml:id="m-8585b8d0-5826-43ea-b383-dc9240b51849" facs="#m-25cabd8f-5092-4771-bb72-ebdda2645a23" oct="3" pname="b" tilt="se"/>
  </neume>
  <neume xml:id="h1q2xlry">
    <nc xml:id="i1q8x73" facs="#z12q1ycm" oct="4" pname="c"/>
    <nc xml:id="l174xt79" facs="#b1n4xm45" oct="4" pname="d"/>
  </neume>
</syllable>

```


Toggled syllables



```
<syllable xml:id="r1yqcr4d" precedes="#ogw830">
  <syl xml:id="m1h2tgyw" facs="#h1iud6yz" >es</syl>
  <neume xml:id="p16hc89l">
    <nc xml:id="m-923c3ad4-3922-4a02-a051-c91d43c9eec5" facs="#m-39bba908-67ef-4d34-93ee-ab9a147482aa" oct="3" pname="b"/>
    <nc xml:id="m-8bc3fe96-e065-4ff6-ad91-bac29c53d621" facs="#m-6b87083c-0529-45d3-adec-c4e5189c8e59" oct="4" pname="c"/>
    <nc xml:id="m-c637a4b4-274c-4dd2-9f2a-954d12275e65" facs="#m-d88d9e7c-acde-4594-8f98-6ce2d8baf1e2" oct="4" pname="d" tilt="s"/>
  </neume>
  <divLine xml:id="idgcrjw" facs="#q18g0z2l" form="maxima"/>
</syllable>
<custos oct="4" pname="e" xml:id="m-13f4706d-7806-476d-a694-99af314c1187" facs="#m-79ebe216-639e-4c9d-a16e-6f0634c5ae80"/>
<sb n="6" facs="#m-e03a3b98-3cbd-4caa-9988-18a0e7f50fa3" xml:id="m-b84c1d1e-831a-4948-a699-a09dd6b81e1e"/>
<clef xml:id="m-ca2ddb2b-7eb5-4b5b-8fe5-138fc126fbea" facs="#m-f6eddd2a-ce70-4e0c-8578-7d96c14d6204" shape="C" line="3"/>
<syllable xml:id="ogw830" follows="#r1yqcr4d">
  <neume xml:id="gz2v36k">
    <nc xml:id="m-5af8bc1b-5e0a-409c-b7d6-88930ee9c616" facs="#m-702c7002-f52a-49d1-a993-e727298d750d" oct="4" pname="e"/>
    <nc xml:id="m-524b845b-9f6e-4192-9258-f9f551e77c56" facs="#m-10e32a75-1fdc-4f66-94eb-4062bdf3d609" oct="4" pname="f"/>
    <nc xml:id="m-9612f563-4d02-427b-aff2-389992afaf68" facs="#m-00349e98-8f2f-47f4-ad00-54fc1b984bc3" oct="4" pname="d" tilt="se"/>
    <nc xml:id="m-83ef43dd-1add-4a15-9a62-fe1707cd1179" facs="#m-b54d46fe-d1b9-4482-9816-4f41f57fc6ae" oct="4" pname="c" tilt="se"/>
    <nc xml:id="m-8585b8d0-5826-43ea-b383-dc9240b51849" facs="#m-25cabd8f-5092-4771-bb72-ebdda2645a23" oct="3" pname="b" tilt="se"/>
  </neume>
  <neume xml:id="h1q2xlry">
    <nc xml:id="i1q8x73" facs="#z12q1ycm" oct="4" pname="c"/>
    <nc xml:id="l174xt79" facs="#b1n4xm45" oct="4" pname="d"/>
  </neume>
</syllable>
```


Divisiones

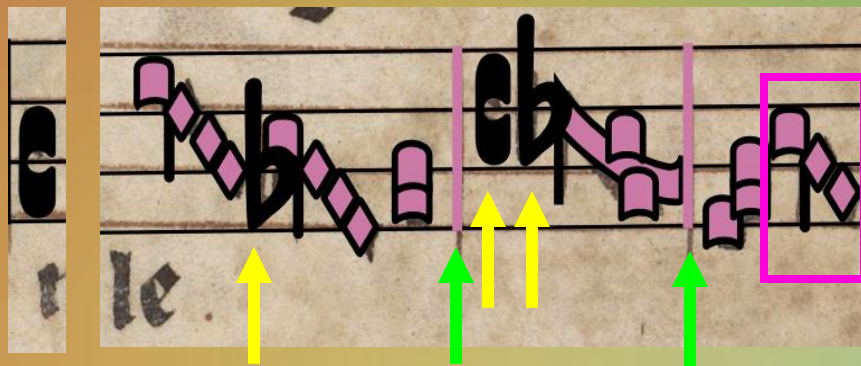


```
<syllable xml:id="m-e34dca3f-c631-491a-8cf1-e7388013ec3f">
  <syl xml:id="m-d513b4f7-1462-45eb-8c0e-8534ddb19492" facs="#m-f7b8c748-b19f-4b11-9905-a0ce1a3ab020">Mi</syl>
  <neume xml:id="m-303dd367-5395-43ec-9b96-588afb9038c8">
    <nc xml:id="m-61756a4d-9644-439e-b6cb-764ec7bf516f" facs="#m-86ff6d26-4e38-4f61-89ad-44ea43c3076e" oct="4" pname="c" tilt="n"/>
    <nc xml:id="m-85241867-484b-4e31-80f5-44bbec4ec9ab" facs="#m-93ffa2c2-3053-4cd2-adc7-e575627077ab" oct="3" pname="b"/>
  </neume>
</syllable>
<syllable xml:id="m-553679c3-54d3-487b-be4c-b1ebd4144e74">
  <syl xml:id="m-e10b9887-435e-4b1d-93fc-5e5d49d03ce2" facs="#m-8d9da152-c363-453f-9a9e-85a4ea2c500f">sit</syl>
  <neume xml:id="m-d109f9dc-8c2d-416b-b8d6-2c7f05c1e803">
    <nc xml:id="m-7a83aed8-0e29-4860-98c4-7e92c0d9d53e" facs="#m-0b51234b-c7f9-43ff-9825-1b6fb6d8829d" oct="4" pname="c"/>
    <nc xml:id="m-dbcbbf67-8ba1-4543-bc31-1eb0ec5cf4d8" facs="#m-5a39e866-98f9-402c-8c3b-016871c0afcb" oct="4" pname="d"/>
    <nc xml:id="m-187c36d0-2860-4a81-b3ca-517a54b9059b" facs="#m-4a9aba8d-6aa9-4aa0-842f-67d643f7b4b6" oct="4" pname="c"/>
    <nc xml:id="m-b306a4c2-be6e-4f52-a8a7-838de46ff7fa" facs="#m-bc721958-405e-4803-8d79-fbf86b2f2477" oct="3" pname="b"/>
    <nc xml:id="m-d33f4a58-dca8-4576-92c1-80a4c097f70b" facs="#m-7b38f835-1a99-4992-956b-7d1bbc5fcf81" oct="4" pname="c"/>
    <nc xml:id="m-819c014c-82ab-4d58-8696-2d77bcbb5ac8" facs="#m-d1eec9bf-7899-47bc-aea2-10453e8df38b" oct="3" pname="a"/>
    <nc xml:id="m-57693432-ed02-4348-905c-61539f5cad8a" facs="#m-5a643093-0b27-4331-969a-1907e3809db0" oct="3" pname="a" tilt="n"/>
    <nc xml:id="m-4e5cd325-c805-4c62-b541-9b6bbf80b954" facs="#m-9f86a9da-92ed-4408-a92b-64a96a483a4b" oct="3" pname="g"/>
  </neume>
</syllable>
<divLine xml:id="uxivaq1" facs="#q1q187r3" form="maxima"/>
```



```
<syllable xml:id="m-e34dca3f-c631-491a-8cf1-e7388013ec3f">
  <syl xml:id="m-d513b4f7-1462-45eb-8c0e-8534ddb19492" facs="#m-f7b8c748-b19f-4b11-9905-a0ce1a3ab020">Mi</syl>
  <neume xml:id="m-303dd367-5395-43ec-9b96-588afb9038c8">
    <nc xml:id="m-61756a4d-9644-439e-b6cb-764ec7bf516f" facs="#m-86ff6d26-4e38-4f61-89ad-44ea43c3076e" oct="4" pname="c" tilt="n"/>
    <nc xml:id="m-85241867-484b-4e31-80f5-44bbec4ec9ab" facs="#m-93ffa2c2-3053-4cd2-adc7-e575627077ab" oct="3" pname="b"/>
  </neume>
</syllable>
<syllable xml:id="m-553679c3-54d3-487b-be4c-b1ebd4144e74">
  <syl xml:id="m-e10b9887-435e-4b1d-93fc-5e5d49d03ce2" facs="#m-8d9da152-c363-453f-9a9e-85a4ea2c500f">sit</syl>
  <neume xml:id="m-d109f9dc-8c2d-416b-b8d6-2c7f05c1e803">
    <nc xml:id="m-7a83aed8-0e29-4860-98c4-7e92c0d9d53e" facs="#m-0b51234b-c7f9-43ff-9825-1b6fb6d8829d" oct="4" pname="c"/>
    <nc xml:id="m-dbcbbf67-8ba1-4543-bc31-1eb0ec5cf4d8" facs="#m-5a39e866-98f9-402c-8c3b-016871c0afcb" oct="4" pname="d"/>
    <nc xml:id="m-187c36d0-2860-4a81-b3ca-517a54b9059b" facs="#m-4a9aba8d-6aa9-4aa0-842f-67d643f7b4b6" oct="4" pname="c"/>
  </neume>
  <divLine xml:id="dline-0000001328159453" facs="#zone-0000000649568576" form="maxima"/>
  <neume xml:id="neume-0000000459266755">
    <nc xml:id="m-b306a4c2-be6e-4f52-a8a7-838de46ff7fa" facs="#m-bc721958-405e-4803-8d79-fbf86b2f2477" oct="3" pname="b"/>
    <nc xml:id="m-d33f4a58-dca8-4576-92c1-80a4c097f70b" facs="#m-7b38f835-1a99-4992-956b-7d1bbc5fcf81" oct="4" pname="c"/>
    <nc xml:id="m-819c014c-82ab-4d58-8696-2d77bcbb5ac8" facs="#m-d1eec9bf-7899-47bc-aea2-10453e8df38b" oct="3" pname="a"/>
  </neume>
  <neume xml:id="neume-0000001915701874">
    <nc xml:id="m-57693432-ed02-4348-905c-61539f5cad8a" facs="#m-5a643093-0b27-4331-969a-1907e3809db0" oct="3" pname="a" tilt="n"/>
    <nc xml:id="m-4e5cd325-c805-4c62-b541-9b6bbf80b954" facs="#m-9f86a9da-92ed-4408-a92b-64a96a483a4b" oct="3" pname="g"/>
  </neume>
</syllable>
```

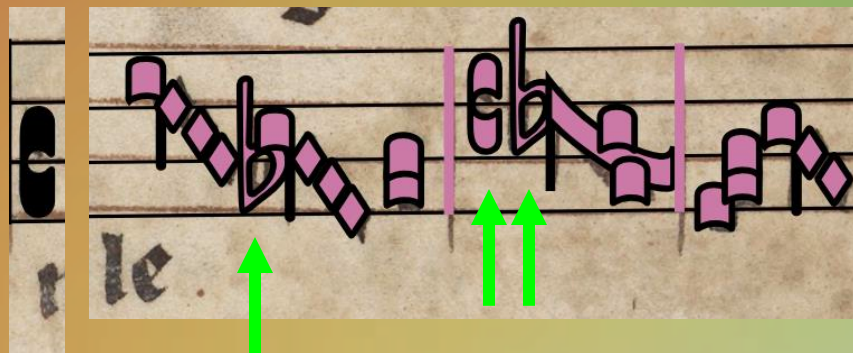
Clefs and accidentals



B
A
G

```
<syllable xml:id="syllable-0000000107081360">
  <syl xml:id="m-a82d9779-18b6-453b-bb1d-c4cfdba920b2" facs="#m-289055a3-d5b1-4bbf-8e4a-57edefd3b7cc">le</syl>
  <neume xml:id="m-556f16d6-3b32-4627-8c26-ea08599e7c55">
    <nc xml:id="m-912a7615-6f1f-4faa-b3bc-2f9e6a3006e0" facs="#m-c71f2bc1-9501-4d4f-a748-6e1b3797cbc4" oct="4" pname="f" tilt="s"/>
    <nc xml:id="m-54839914-0d3d-4b2a-b349-1c1768f1ea2f" facs="#m-4be7d4b4-18f4-460f-b4ae-4d2ba1c922d9" oct="4" pname="e" tilt="se"/>
    <nc xml:id="m-788e20fa-58c9-4034-8225-1e4e9febbd82" facs="#m-631ac04f-6fa0-4b4c-84b3-c8e2ca619631" oct="4" pname="d" tilt="se"/>
    <nc xml:id="m-7521e637-ffca-4270-b02f-48360e7dd9c4" facs="#m-23df0447-3b35-4e1e-bbac-0b0cf3c67e84" oct="4" pname="c" tilt="se"/>
  </neume>
  <neume xml:id="neume-0000001686106881">
    <nc xml:id="m-69445f1c-b9ab-4deb-bfff-d01056c4da6d" facs="#m-adfbf0d6-51ca-4eaa-98d9-948f64aef372" oct="4" pname="d" tilt="s"/>
    <nc xml:id="m-65a36dc8-741d-4fa3-9819-82d525cd75b1" facs="#m-dab90c1a-4171-4a0e-9156-36134e1c9433" oct="4" pname="c" tilt="se"/>
    <nc xml:id="m-94714093-81af-4a87-9ea5-e7e88fb19ed6" facs="#m-80966836-e7b4-42f9-933d-6b148cf42ffd" oct="3" pname="b" tilt="se"/>
    <nc xml:id="m-7f1b8bd5-7aec-4332-b0da-3f8da3bae572" facs="#m-56e747d3-8570-4c27-8496-ad3a0376dbcc" oct="3" pname="a" tilt="se"/>
  </neume>
  <neume xml:id="neume-000000088519460">
    <nc xml:id="m-40f38c70-23c9-43a9-8e8d-00ae783a02f7" facs="#m-ad0b5aaf-6ca5-46cb-a5dd-0b71883e9a14" oct="3" pname="b"/>
    <nc xml:id="m-2583661f-8768-4c07-98a9-cff9aaec4ece" facs="#m-3e34d45b-8265-451e-aa98-9a1c3d3e6d65" oct="4" pname="c"/>
  </neume>
  <divLine xml:id="m-607f3bad-ca71-4a98-a2af-627194ede655" facs="#m-0a60c6c5-2491-4e7a-b942-e1fc3c2f565b" form="maxima"/>
  <neume xml:id="neume-0000001002334329">
    <nc xml:id="m-02cee6c5-845f-40dd-9d06-76fb18f35d20" facs="#m-d3a008e3-9be0-4721-8775-858ad48b1623" oct="4" pname="e" ligated="true"/>
    <nc xml:id="m-3cdf851f-d588-443e-b014-08860d9ca250" facs="#zone-0000002040041643" oct="4" pname="c" ligated="true"/>
    <nc xml:id="nc-0000002111254339" facs="#zone-0000002061531143" oct="4" pname="d"/>
    <nc xml:id="nc-0000000943535767" facs="#zone-0000001339987311" oct="3" pname="b"/>
  </neume>
  <divLine xml:id="m-8dbc33e8-c072-48d4-adaa-33f7c62dd922" facs="#m-8dc58fa7-a83e-4371-982f-2da03dc44e7d" form="maxima"/>
  <neume xml:id="m-28beb8a5-dada-496e-bd7d-e74fd1ada589">
    <nc xml:id="m-68d4df1e-c9d1-4992-a552-7478dad28468" facs="#m-f4282e55-8d71-4926-82a1-7996263f94e9" oct="3" pname="a"/>
    <nc xml:id="m-97bf977f-a9b2-497b-9aa5-f1ba9fd17828" facs="#m-f798d035-4da1-453c-ad12-fe248c287f8d" oct="3" pname="b"/>
    <nc xml:id="m-b8a3cf9-7773-44ec-91a2-475f71ccd54a" facs="#m-163e26df-2178-4a9f-b380-23cb8893c52f" oct="4" pname="c"/>
  </neume>
  <neume xml:id="neume-0000000275735372">
    <nc xml:id="m-60a8c942-ac1a-438c-bc38-0be45a7a39ed" facs="#m-9e03f514-6c5f-422b-90f4-d4636f944e32" oct="4" pname="d" tilt="s"/>
    <nc xml:id="m-5ed995e9-a175-4660-8f53-eb9903e81850" facs="#m-d2f252b3-f6b0-4554-bccf-ec344c0067f1" oct="4" pname="c" tilt="se"/>
    <nc xml:id="m-99e1fe79-fb0d-44ae-9982-b61ed63506ca" facs="#m-ae8a862c-fb0c-4a10-bdef-eea0698411ff" oct="3" pname="b" tilt="se"/>
  </neume>
</syllable>
<accid xml:id="accid-0000001800857329" facs="#zone-0000001734069650" accid="f"/>
<clef xml:id="m-e2d7a885-315f-4f19-991b-12381690e218" facs="#m-a553f082-a7f1-437b-99f4-15a701d082b3" shape="C" line="3"/>
<accid xml:id="gek73l9" facs="#cba7m4w" accid="f"/>
```


Clefs and accidentals



```
<syllable xml:id="syllable-0000000107081360">
  <syl xml:id="m-a82d9779-18b6-453b-bb1d-c4cfdba920b2" facs="#m-289055a3-d5b1-4bbf-8e4a-57edefd3b7cc">le</syl>
  <neume xml:id="m-556f16d6-3b32-4627-8c26-ea08599e7c55">
    <nc xml:id="m-912a7615-6f1f-4faa-b3bc-2f9e6a3006e0" facs="#m-c71f2bc1-9501-4d4f-a748-6e1b3797cbc4" oct="4" pname="f" tilt="s"/>
    <nc xml:id="m-54839914-0d3d-4b2a-b349-1c1768f1ea2f" facs="#m-4be7d4b4-18f4-460f-b4ae-4d2ba1c922d9" oct="4" pname="e" tilt="se"/>
    <nc xml:id="m-788e20fa-58c9-4034-8225-1e4e9febbd82" facs="#m-631ac04f-6fa0-4b4c-84b3-c8e2ca619631" oct="4" pname="d" tilt="se"/>
    <nc xml:id="m-7521e637-ffca-4270-b02f-48360e7dd9c4" facs="#m-23df0447-3b35-4e1e-bbac-0b0cf3c67e84" oct="4" pname="c" tilt="se"/>
  </neume>
  <accid xml:id="accid-0000001800857329" facs="#zone-0000001734069650" accid="f"/>
  <neume xml:id="neume-0000001686106881">
    <nc xml:id="m-69445f1c-b9ab-4deb-bfff-d01056c4da6d" facs="#m-adfbf0d6-51ca-4eaa-98d9-948f64aef372" oct="4" pname="d" tilt="s"/>
    <nc xml:id="m-65a36dc8-741d-4fa3-9819-82d525cd75b1" facs="#m-dab90c1a-4171-4a0e-9156-36134e1c9433" oct="4" pname="c" tilt="se"/>
    <nc xml:id="m-94714093-81af-4a87-9ea5-e7e88fb19ed6" facs="#m-80966836-e7b4-42f9-933d-6b148cf42ffd" oct="3" pname="b" tilt="se"/>
    <nc xml:id="m-7f1b8bd5-7aec-4332-b0da-3f8da3bae572" facs="#m-56e747d3-8570-4c27-8496-ad3a0376dbcc" oct="3" pname="a" tilt="se"/>
  </neume>
  <neume xml:id="neume-000000088519460">
    <nc xml:id="m-40f38c70-23c9-43a9-8e8d-00ae783a02f7" facs="#m-ad0b5aaf-6ca5-46cb-a5dd-0b71883e9a14" oct="3" pname="b"/>
    <nc xml:id="m-2583661f-8768-4c07-98a9-cff9aaec4ece" facs="#m-3e34d45b-8265-451e-aa98-9a1c3d3e6d65" oct="4" pname="c"/>
  </neume>
  <divLine xml:id="m-607f3bad-ca71-4a98-a2af-627194ede655" facs="#m-0a60c6c5-2491-4e7a-b942-e1fc3c2f565b" form="maxima"/>
  <clef xml:id="m-e2d7a885-315f-4f19-991b-12381690e218" facs="#m-a553f082-a7f1-437b-99f4-15a701d082b3" shape="C" line="3"/>
  <accid xml:id="gek73l9" facs="#cba7m4w" accid="f"/>
  <neume xml:id="neume-0000001002334329">
    <nc xml:id="m-02cee6c5-845f-40dd-9d06-76fb18f35d20" facs="#m-d3a008e3-9be0-4721-8775-858ad48b1623" oct="4" pname="c" ligated="true"/>
    <nc xml:id="m-3cdf851f-d588-443e-b014-08860d9ca250" facs="#zone-000002040041643" oct="3" pname="a" ligated="true"/>
    <nc xml:id="nc-0000002111254339" facs="#zone-0000002061531143" oct="3" pname="b"/>
    <nc xml:id="nc-0000000943535767" facs="#zone-0000001339987311" oct="3" pname="g"/>
  </neume>
  <divLine xml:id="m-8dbc33e8-c072-48d4-adaa-33f7c62dd922" facs="#m-8dc58fa7-a83e-4371-982f-2da03dc44e7d" form="maxima"/>
  <neume xml:id="m-28beb8a5-dada-496e-bd7d-e74fd1ada589">
    <nc xml:id="m-68d4df1e-c9d1-4992-a552-7478dad28468" facs="#m-f4282e55-8d71-4926-82a1-7996263fdc9e" oct="3" pname="f"/>
    <nc xml:id="m-97bf977f-a9b2-497b-9aa5-f1ba9fd17828" facs="#m-f798d035-4da1-453c-ad12-fe248c287f8d" oct="3" pname="g"/>
    <nc xml:id="m-b8a3cfc9-7773-44ec-91a2-475f71ccd54a" facs="#m-163e26df-2178-4a9f-b380-23cb8893c52f" oct="3" pname="a"/>
  </neume>
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Thank you!

<https://ddmal.music.mcgill.ca/Neon/>



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