Digital Document Retrieval *using* Optical Music Recognition

Andrew Hankinson

John Ashley Burgoyne, Gabriel Vigliensoni, Alastair Porter,
Jessica Thompson, Wendy Liu, Remi Chiu, Ichiro Fujinaga

McGill

Schulich School of Music
École de musique Schulich

CIRMMT Centre for Interdisciplinary Research in Music Media and Technology

DDMAL DISTRIBUTED DIGITAL MUSIC ARCHIVES & LIBRARIES LAB

Retrieving digitized document images with content search

Advanced Book Search

books.google.com/advanced_book_search

Google books **Advanced Book Search** About Google

Find results

with **all** of the words

with the **exact phrase**

with **at least one** of the words

without the words

10 results

Google Search

Search: All books Limited preview and full view Full view only Google eBooks only

Content: All content Books Magazines

Language Return pages written in any language

Title Return books with the title

e.g. Books and Culture

Author Return books written by

e.g. Hamilton Mabie or "Hamilton Wright

10.5 million total volumes
5.5 million book titles
3.6 billion pages
~**1 Trillion** words
472 terabytes

We need OMR tools built for large-scale music digitization projects

HANKINSON *et al.* Document Image Retrieval using Optical Music Recognition. ISMIR 2012, Porto, Portugal

Full-Text Search Systems

Full-Music Search Systems

Flexible and robust OMR systems

Flexible and robust OMR systems

Digital storage and representation of recognition results

Flexible and robust OMR systems

Digital storage and representation of recognition results

Search systems for indexing and retrieval

Liber Usualis Prototype

Liber Usualis Prototype

- Roman Catholic liturgical service book

Liber Usualis Prototype

- Roman Catholic liturgical service book
- Neume (square note) notation

From 1st Vespers of the Feast of the Blessed Trinity to None on Saturday before the 1st Sunday of Advent.

Ant. 1.

Liber Usualis Prototype

- Roman Catholic liturgical service book
- Neume (square note) notation

Liber Usualis Prototype

- Roman Catholic liturgical service book
- Neume (square note) notation
- Monophonic “Gregorian chant”

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- Roman Catholic liturgical service book
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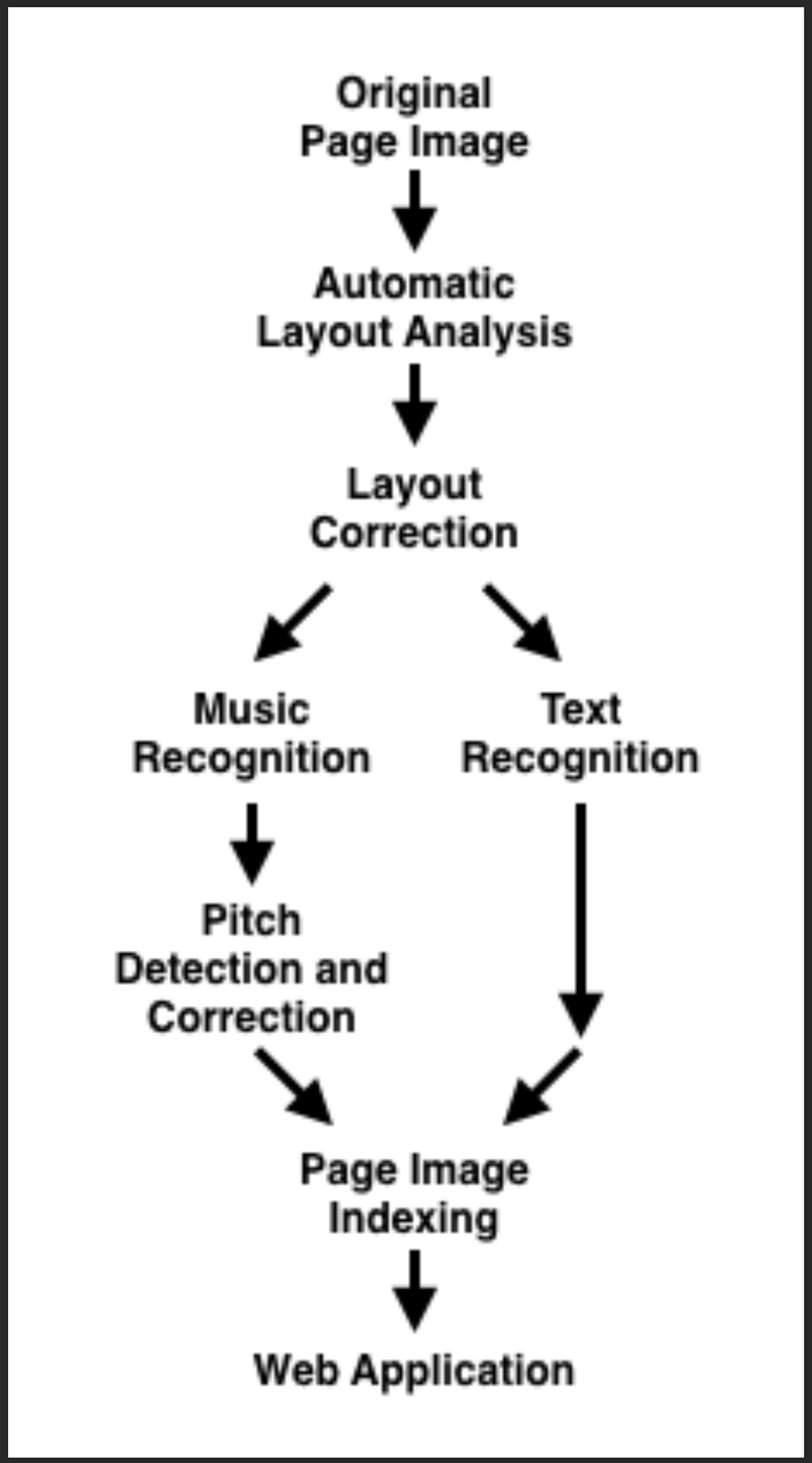
- Modernized by the monks at Solesmes, France in the 19th C.

Liber Usualis Prototype

- Roman Catholic liturgical service book
- Neume (square note) notation
- Monophonic “Gregorian chant”
- Modernized by the monks at Solesmes, France in the 19th C.
- 2340 page images

OMR Workflow



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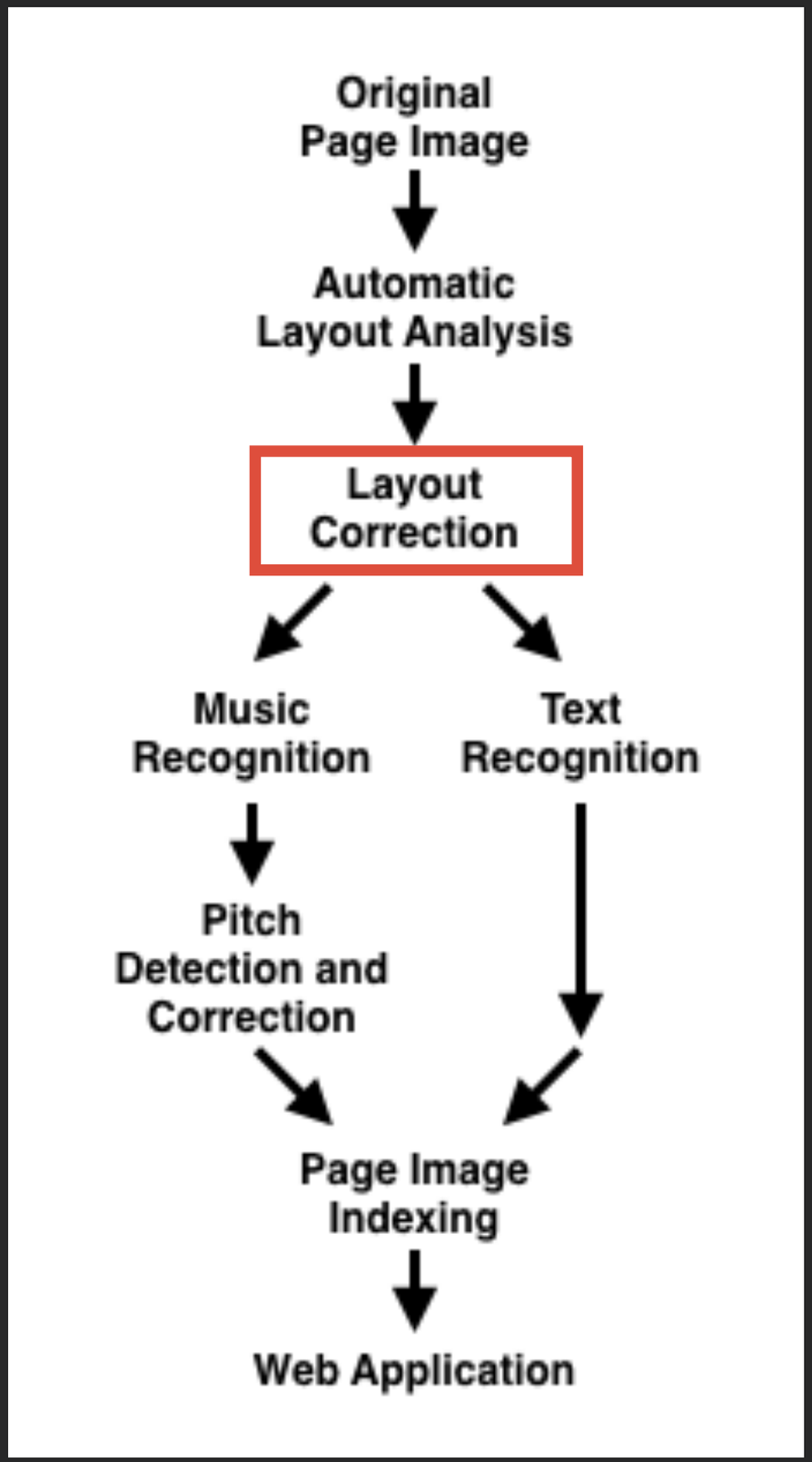
OMR Workflow



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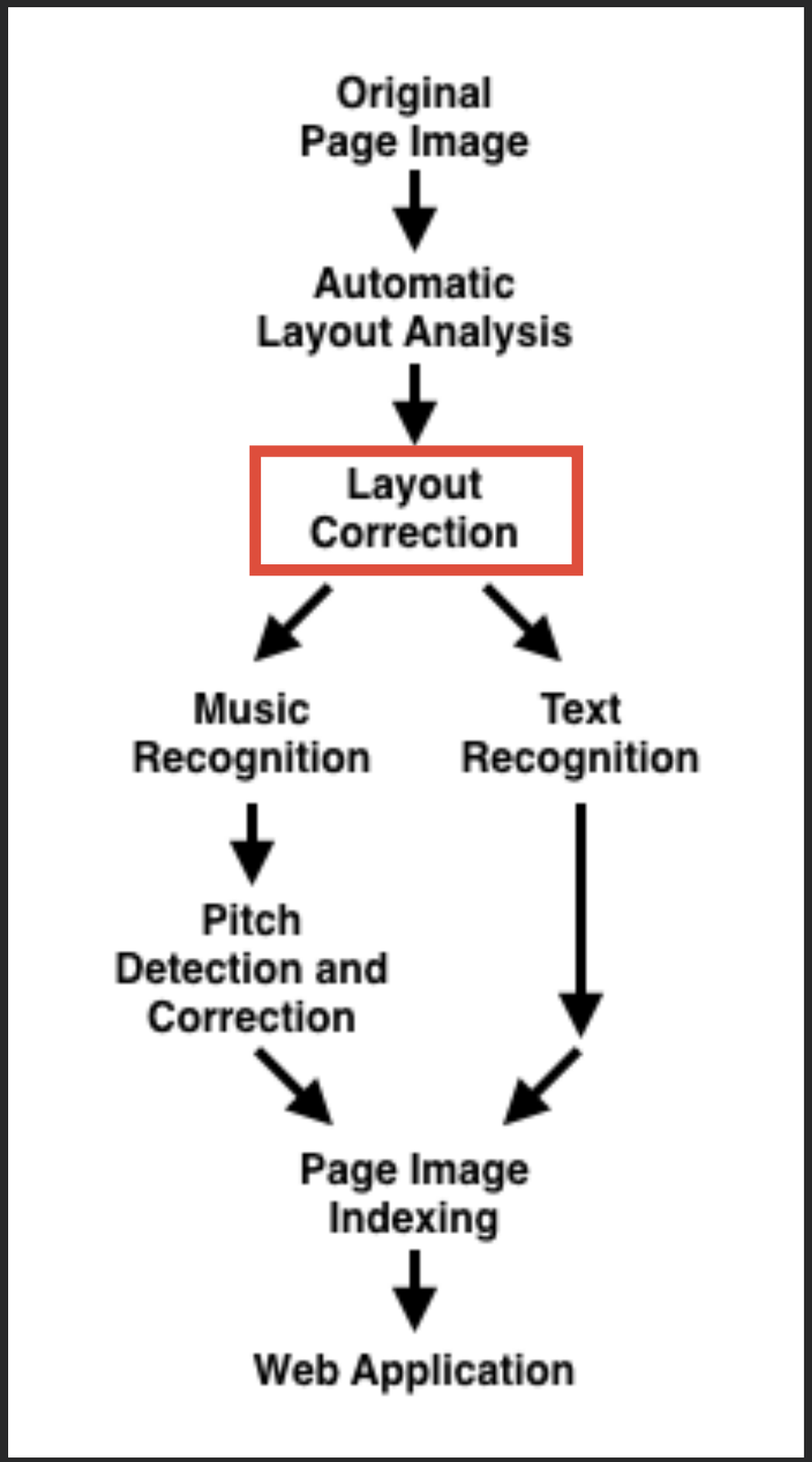
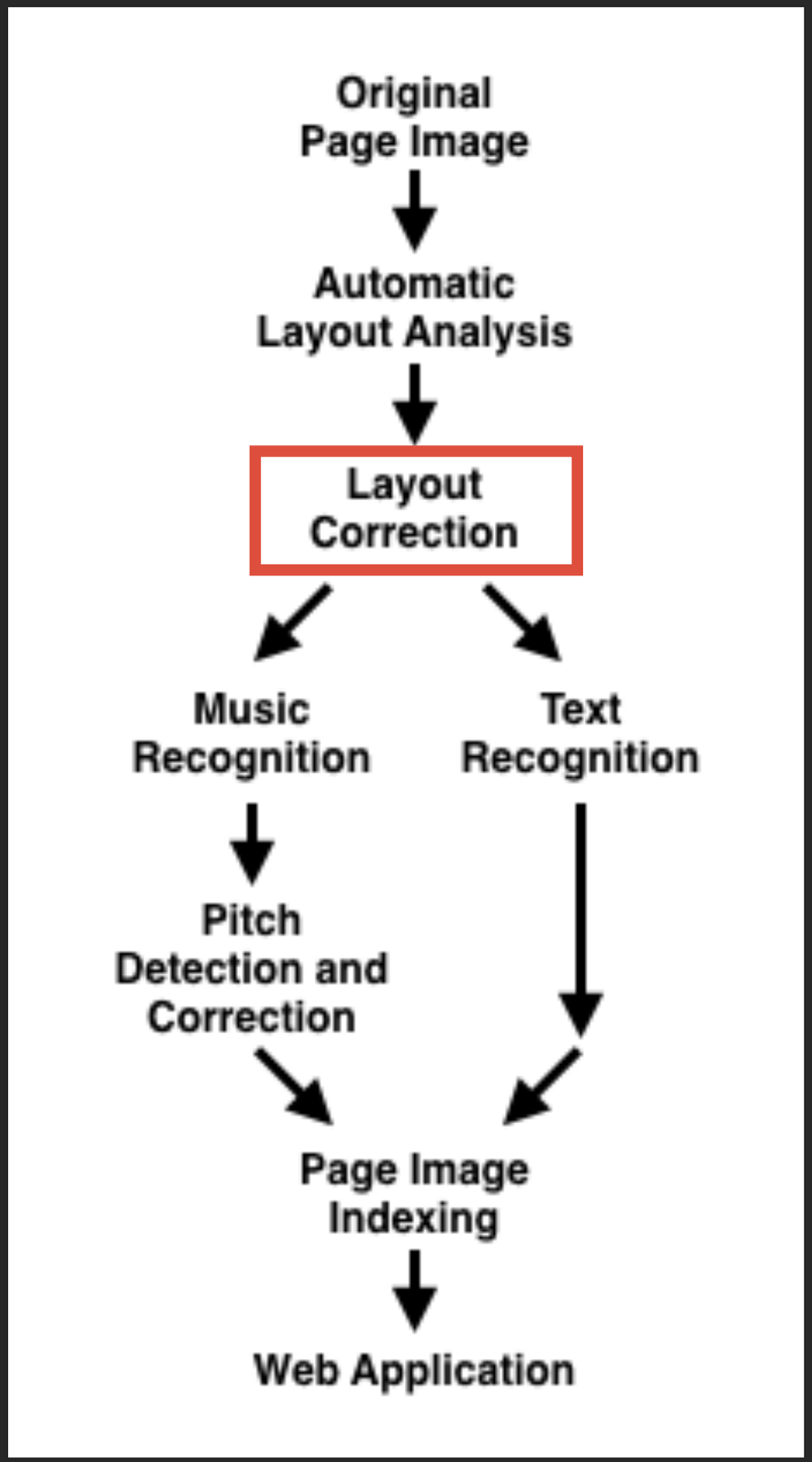
OMR Workflow

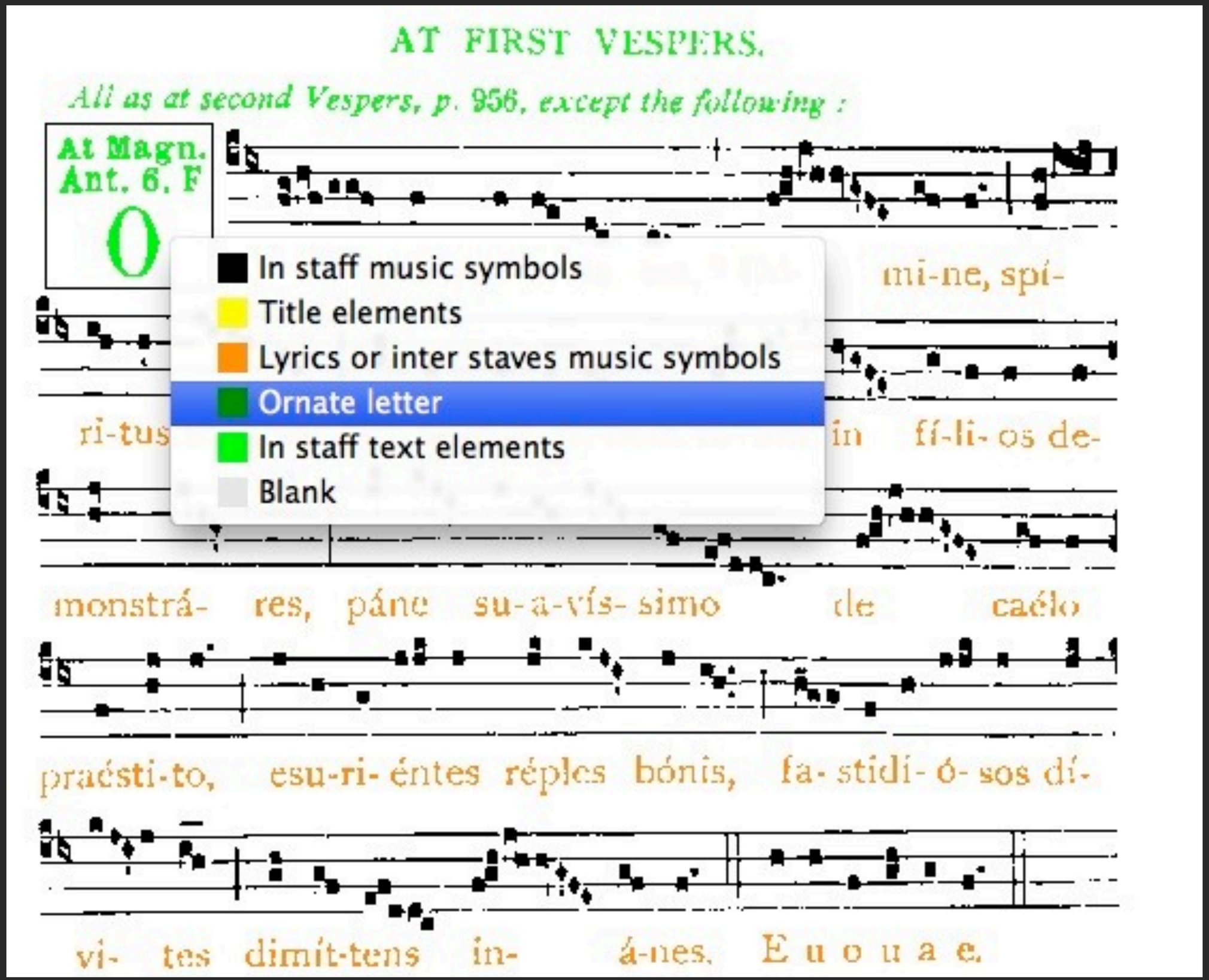


- Automatic layout analysis using Aruspix

OMR Workflow



- Automatic layout analysis using Aruspix
- Separate music and text layers


AT FIRST VESPERS.
All as at second Vespers, p. 956, except the following :
At Magn. Ant. 6. F
O
mi-ne, spi-
ri-tus
in fí-li-os de-
monstrá- res, páne su-a-vís-simo de caélo
praésti-to, esu-ri-éntes réples bónis, fa-stidi-ó-sos dí-
vi- tes dimit-tens in- á-nes. E u o u a e.
In staff music symbols
Title elements
Lyrics or inter staves music symbols
Ornate letter
In staff text elements
Blank

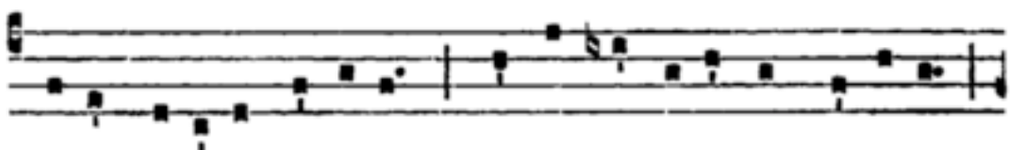
During Advent.

℣. Angelus Dómini nuntiávit Maríae.
℟. Et concépit de Spíritu Sáncto.

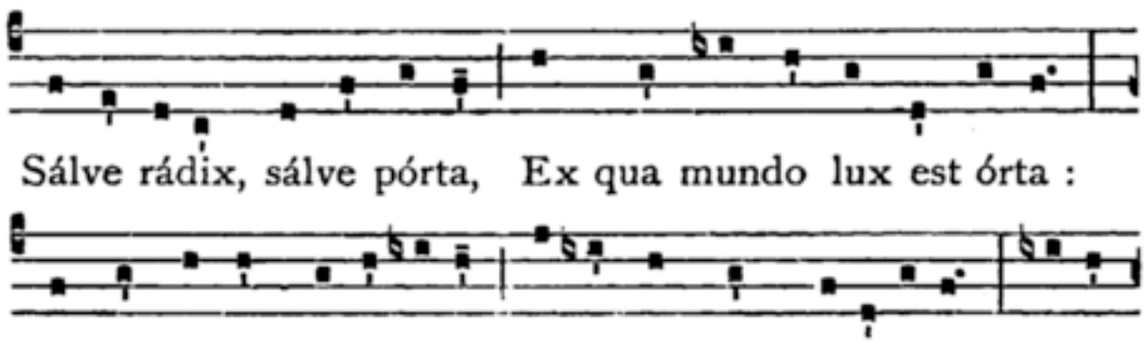
From 1st Vespers of Christmas to 2nd Vespers of the Purification.

℣. Post pártum Vírgo invioláta permansísti.
℟. Déi Génitrix intercéde pro nobis.

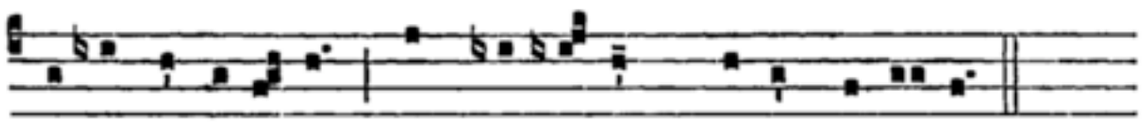
6.



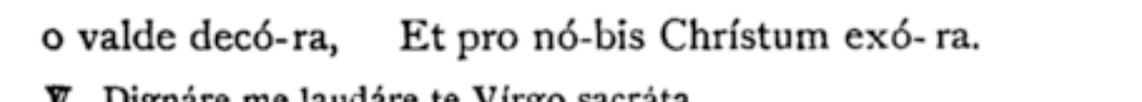
A -ve Regína caelórum, * Ave Dómina Ange-lórum :



Sálve rádix, sálve pórta, Ex qua mundo lux est órta :



Gáude Vírgo glo-ri- ósa, Su-per ómnes spe-ci- ósa : Vále,



o valde decó-ra, Et pro nó-bis Chrístum exó- ra.

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℟. Da míhi virtútem contra hóstes túos.

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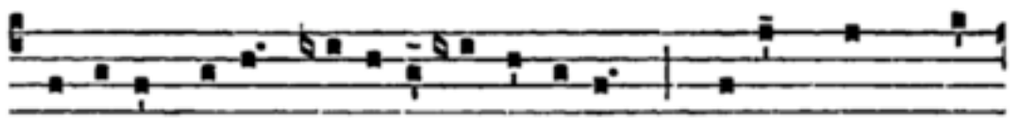
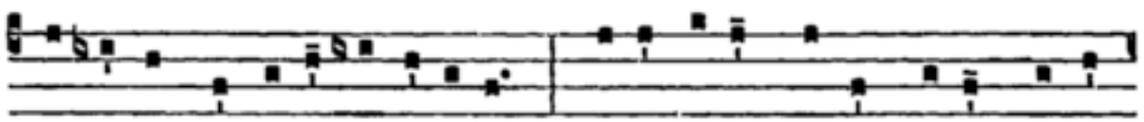
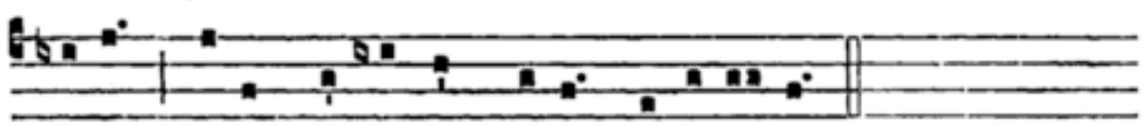
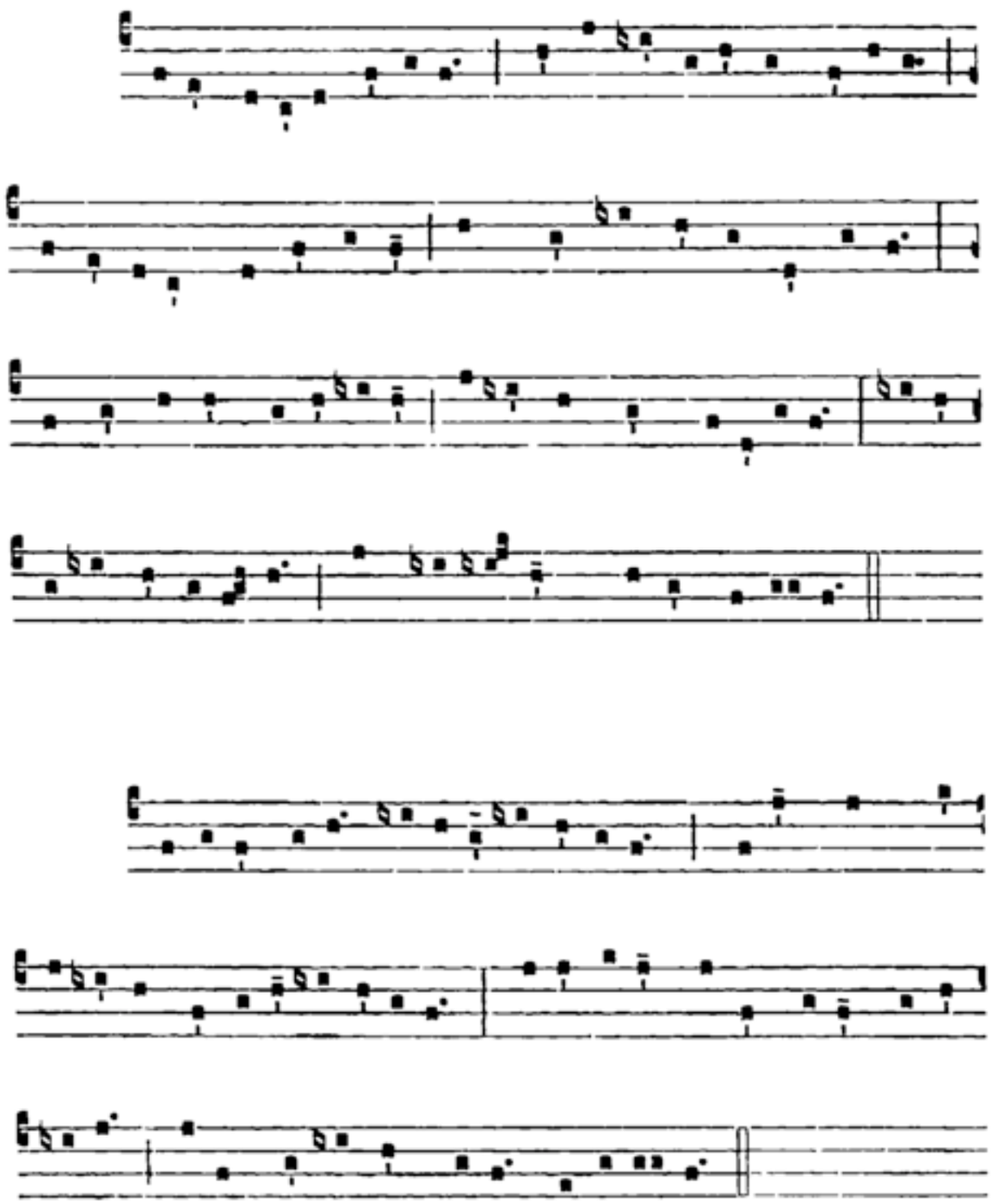


R Egína caéli * laetáre, alle-lú-ia : Qui- a quem me-



ru- ísti portáre, alle-lú-ia : Resurréxit, sic-ut dixit, alle-





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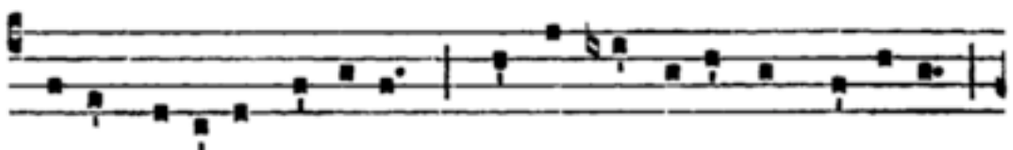

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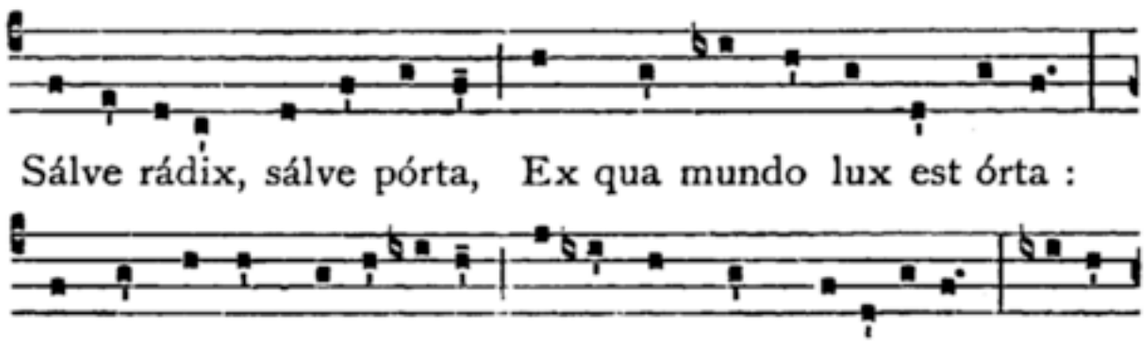

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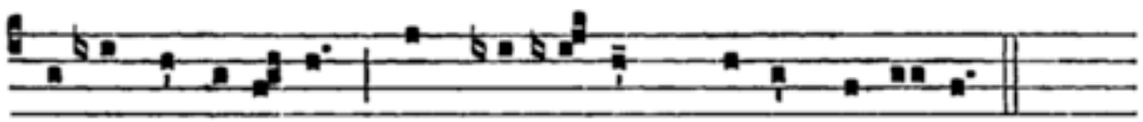

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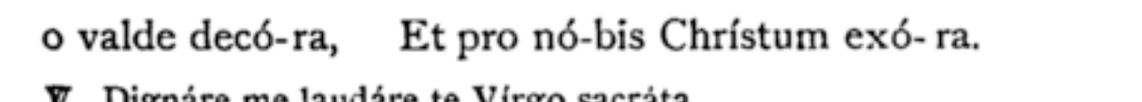

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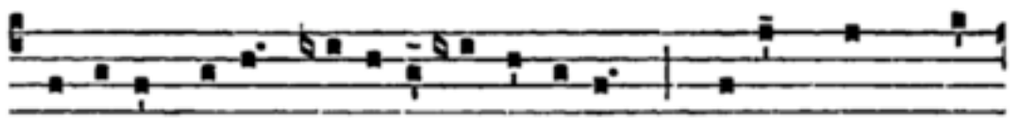

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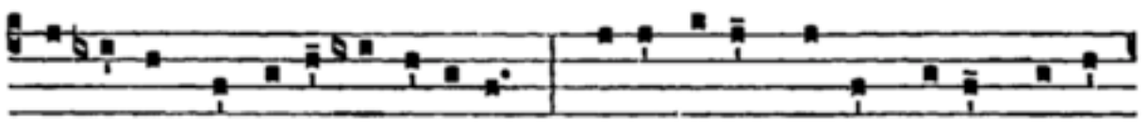

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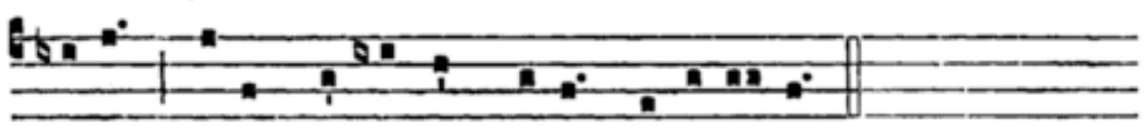

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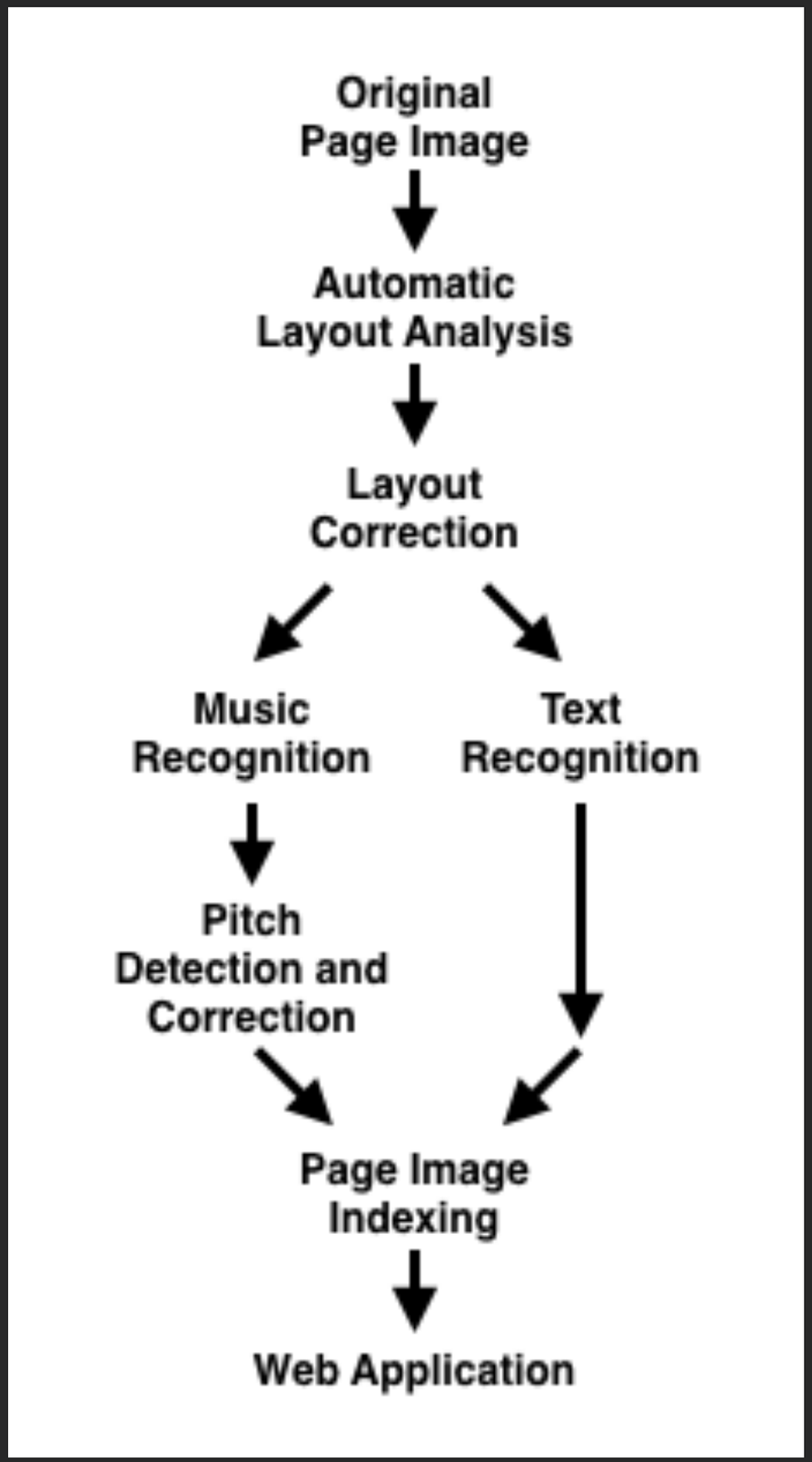

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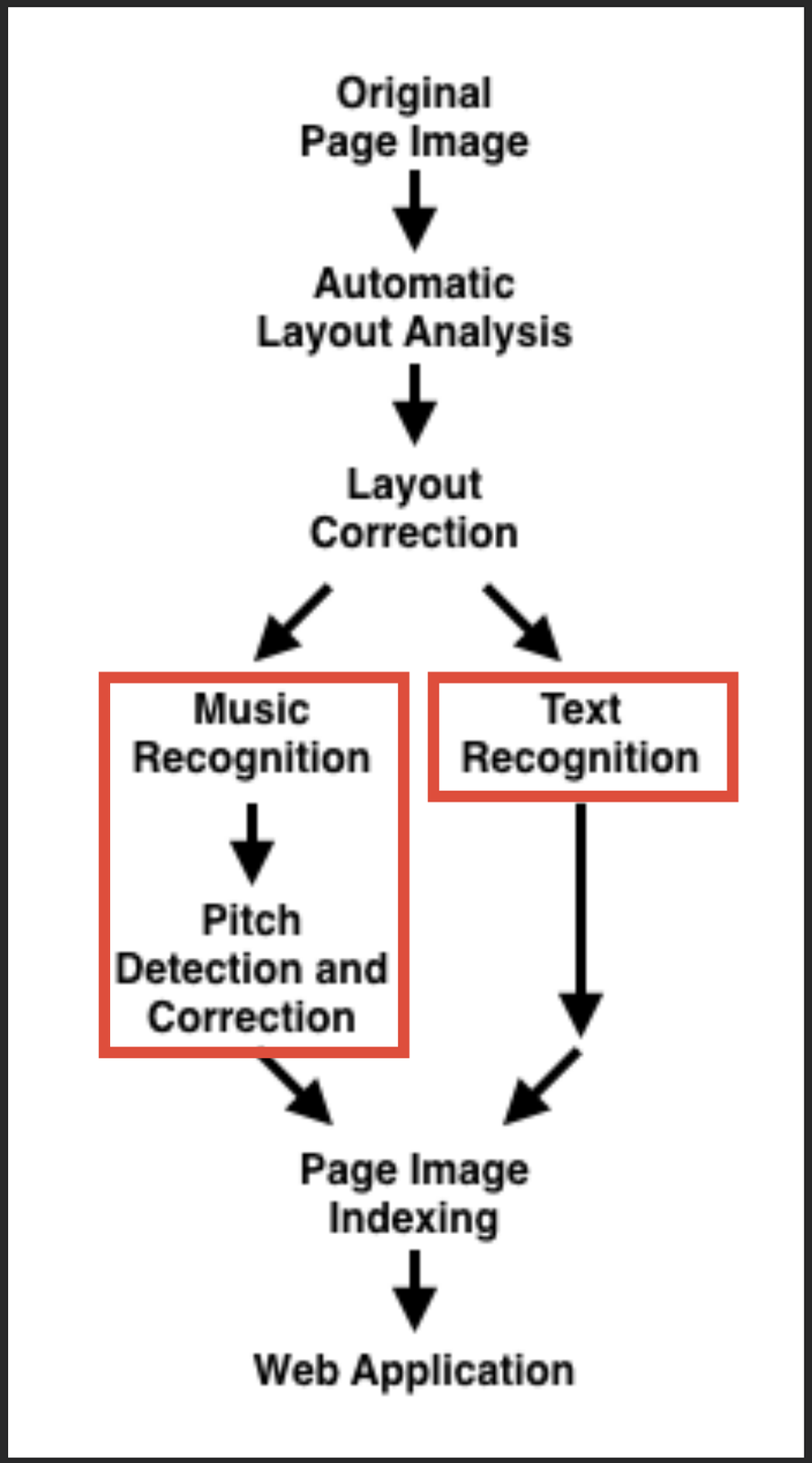

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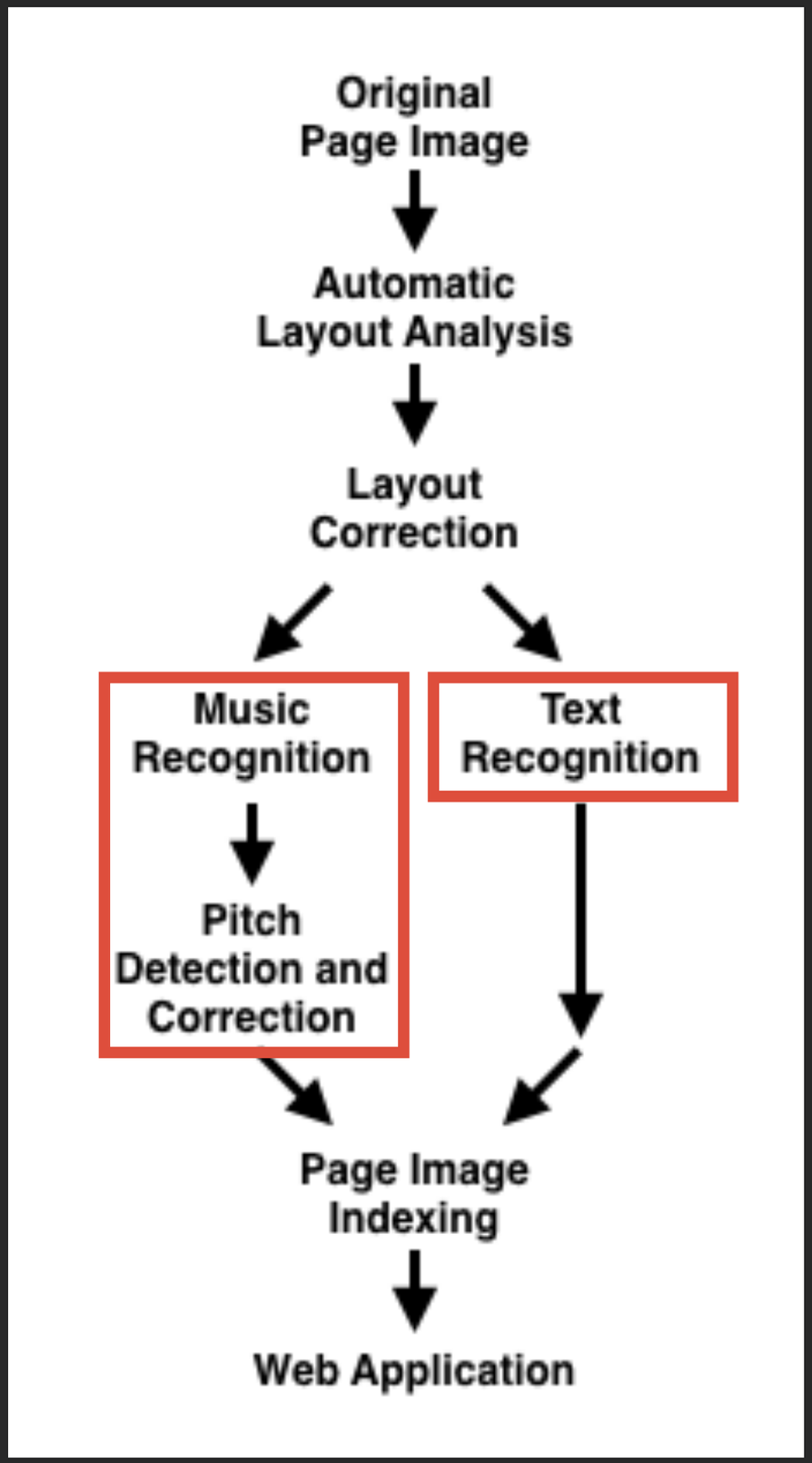
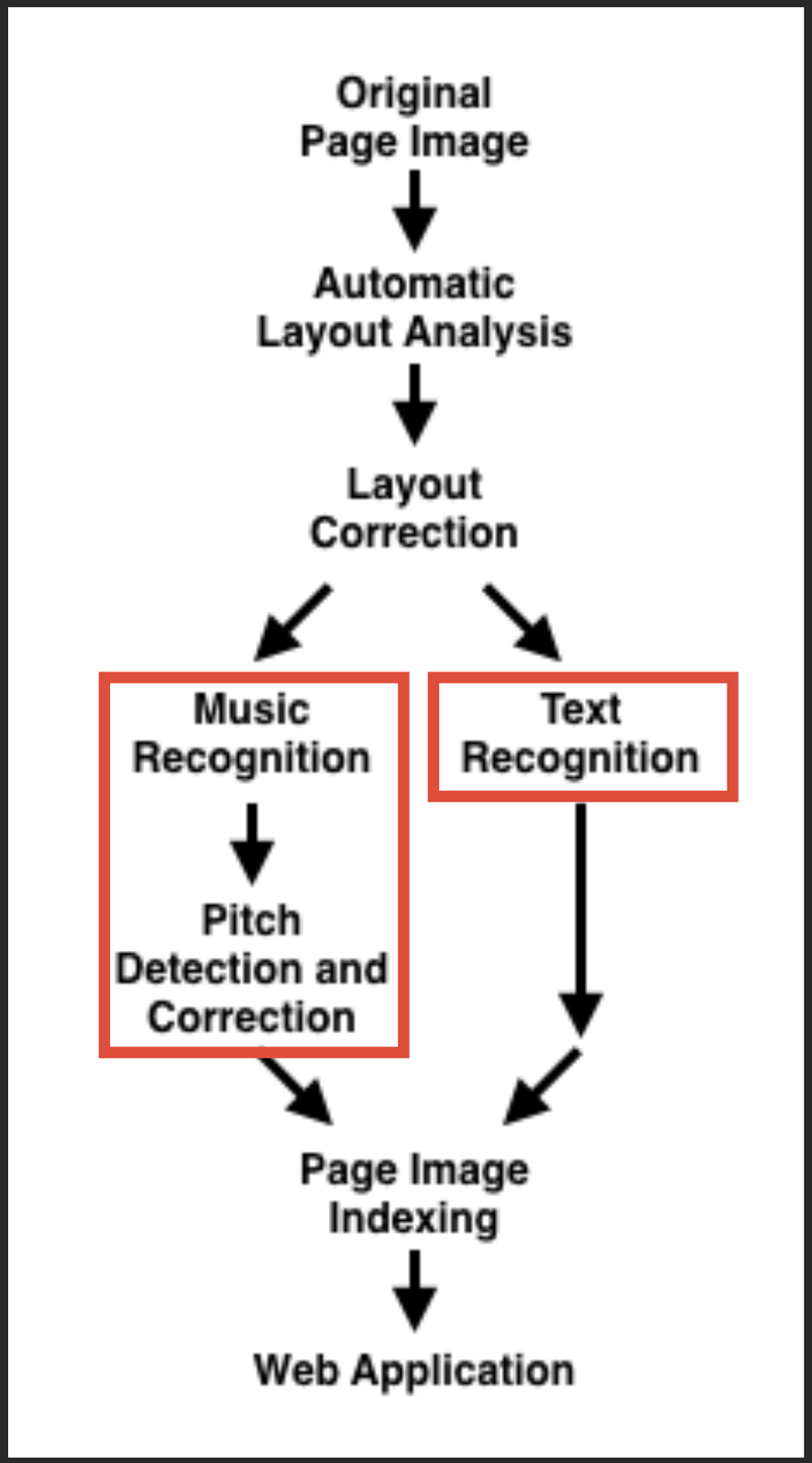


- Music images were sent to an OMR system (Gamera)

OMR Workflow



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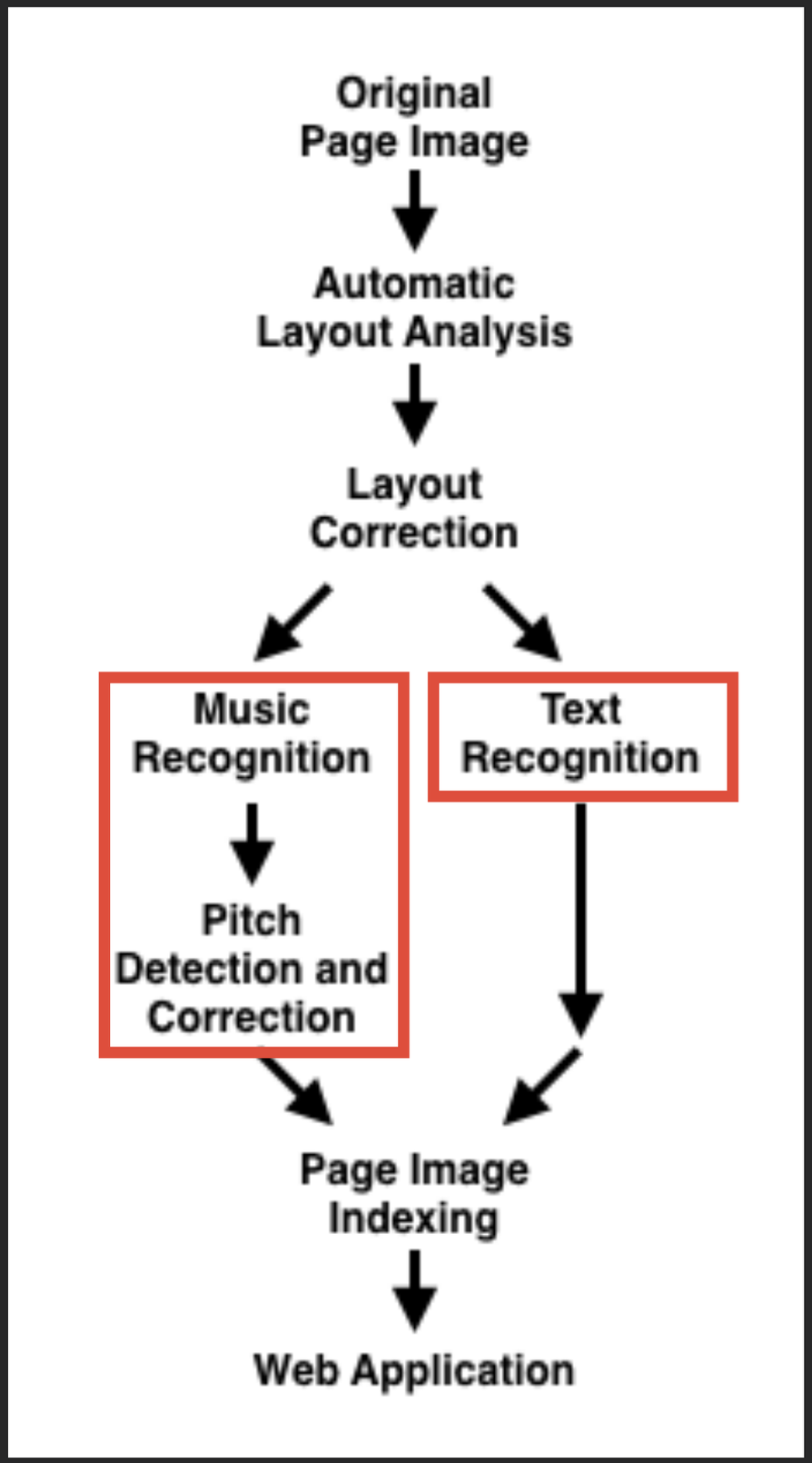
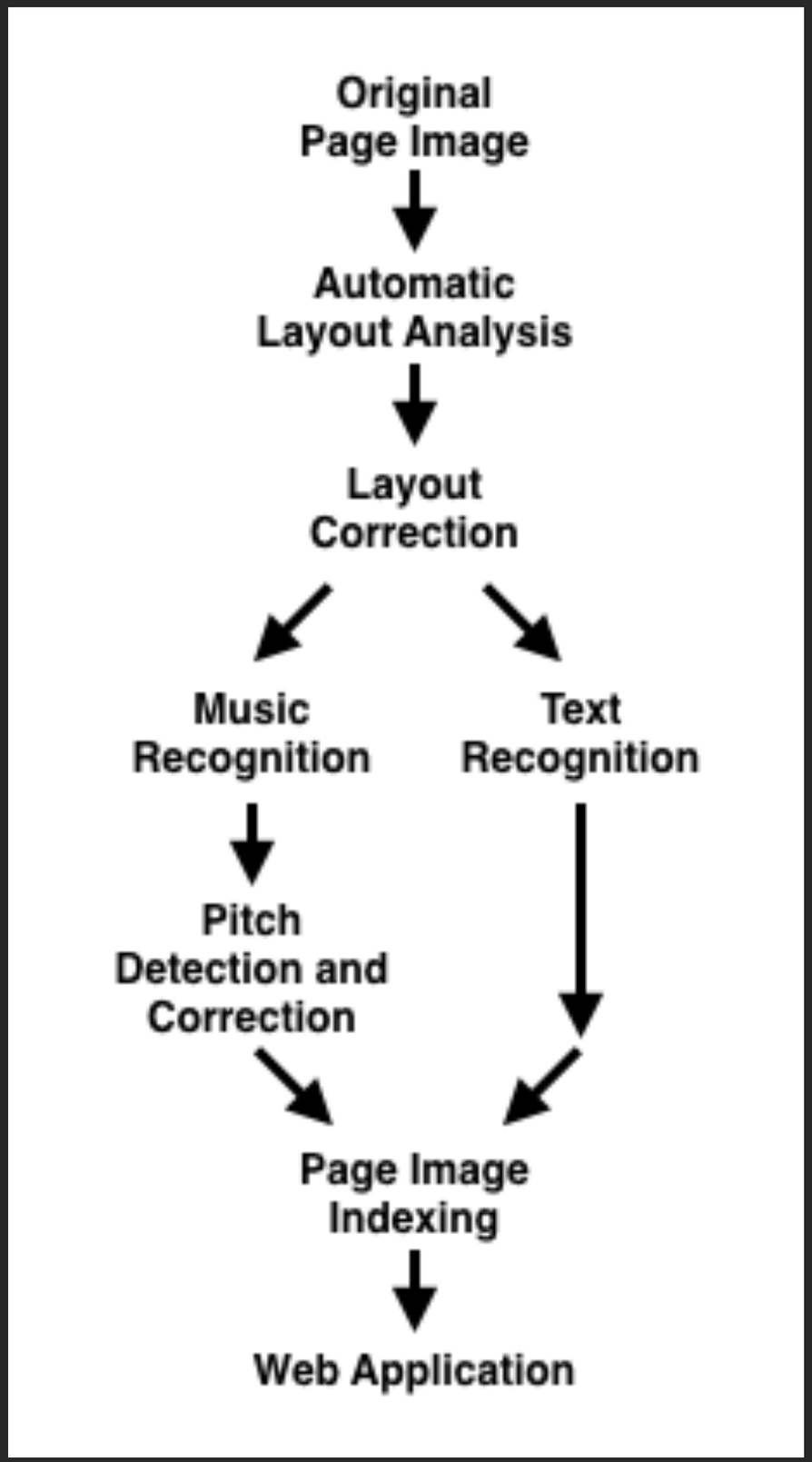
- Text was sent through an OCR process (OCRopus)

OMR Workflow



- Music images were sent to an OMR system (Gamera)
- Text was sent through an OCR process (OCRopus)
- Automatic recognition; human correction (of music)

OMR Workflow



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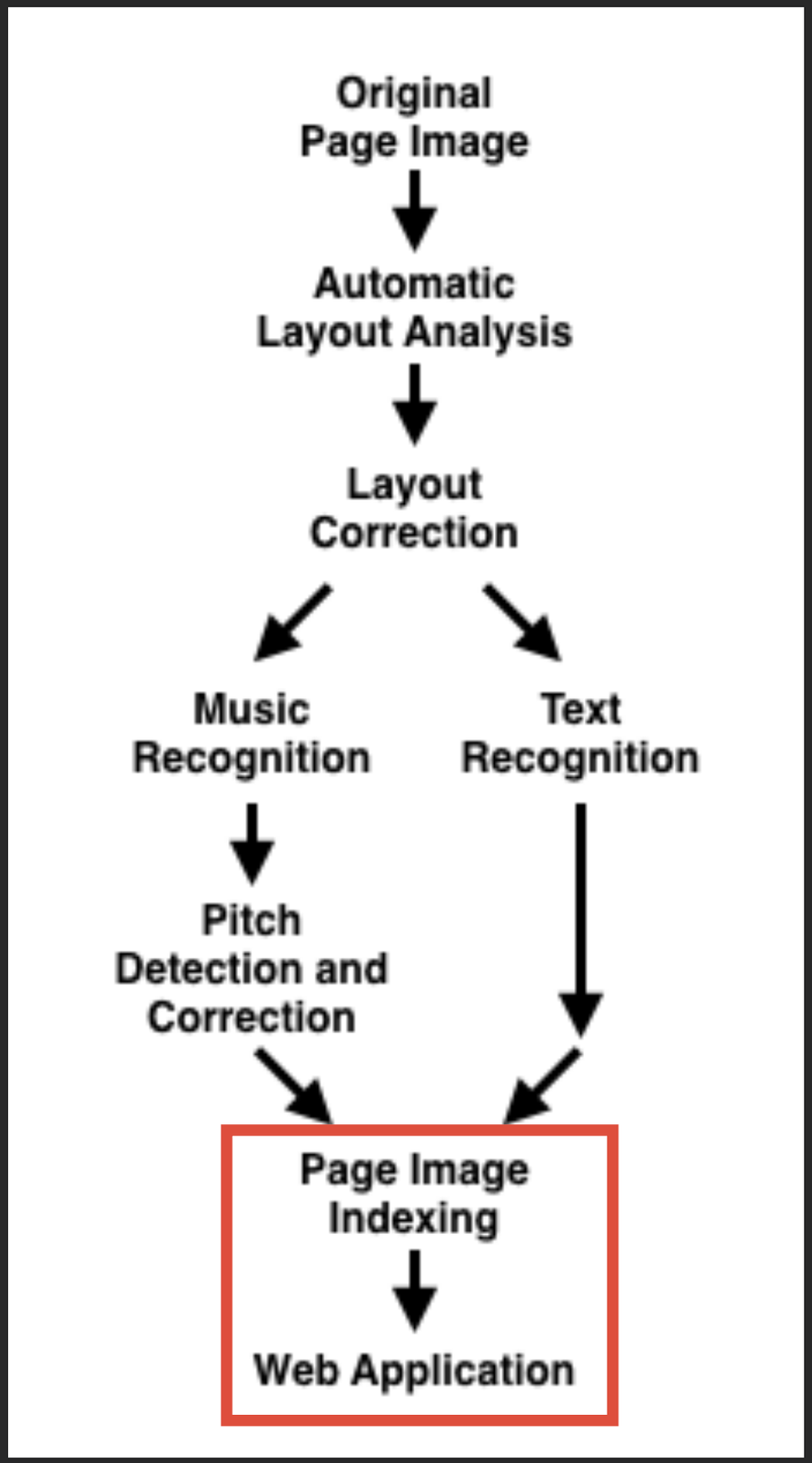

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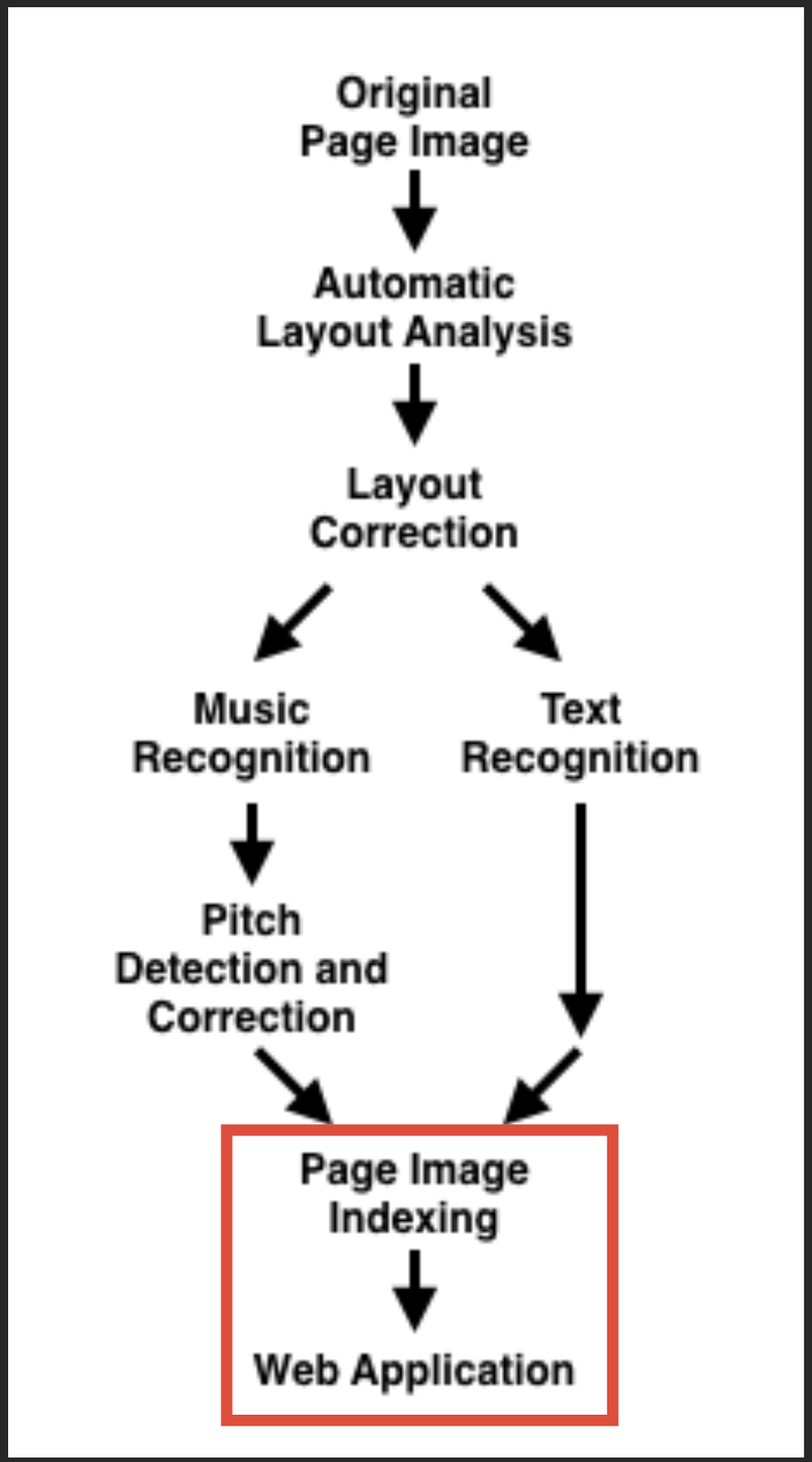
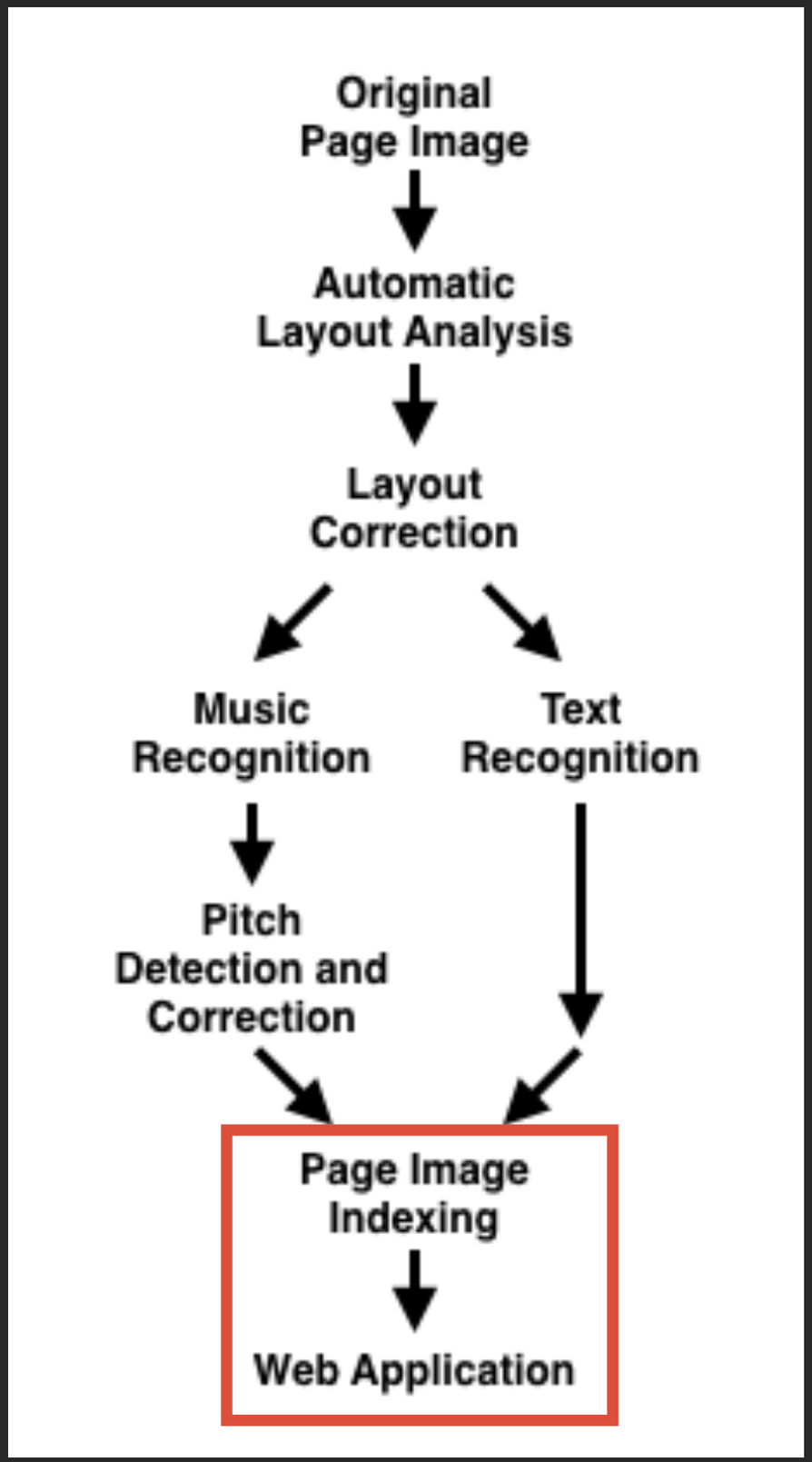


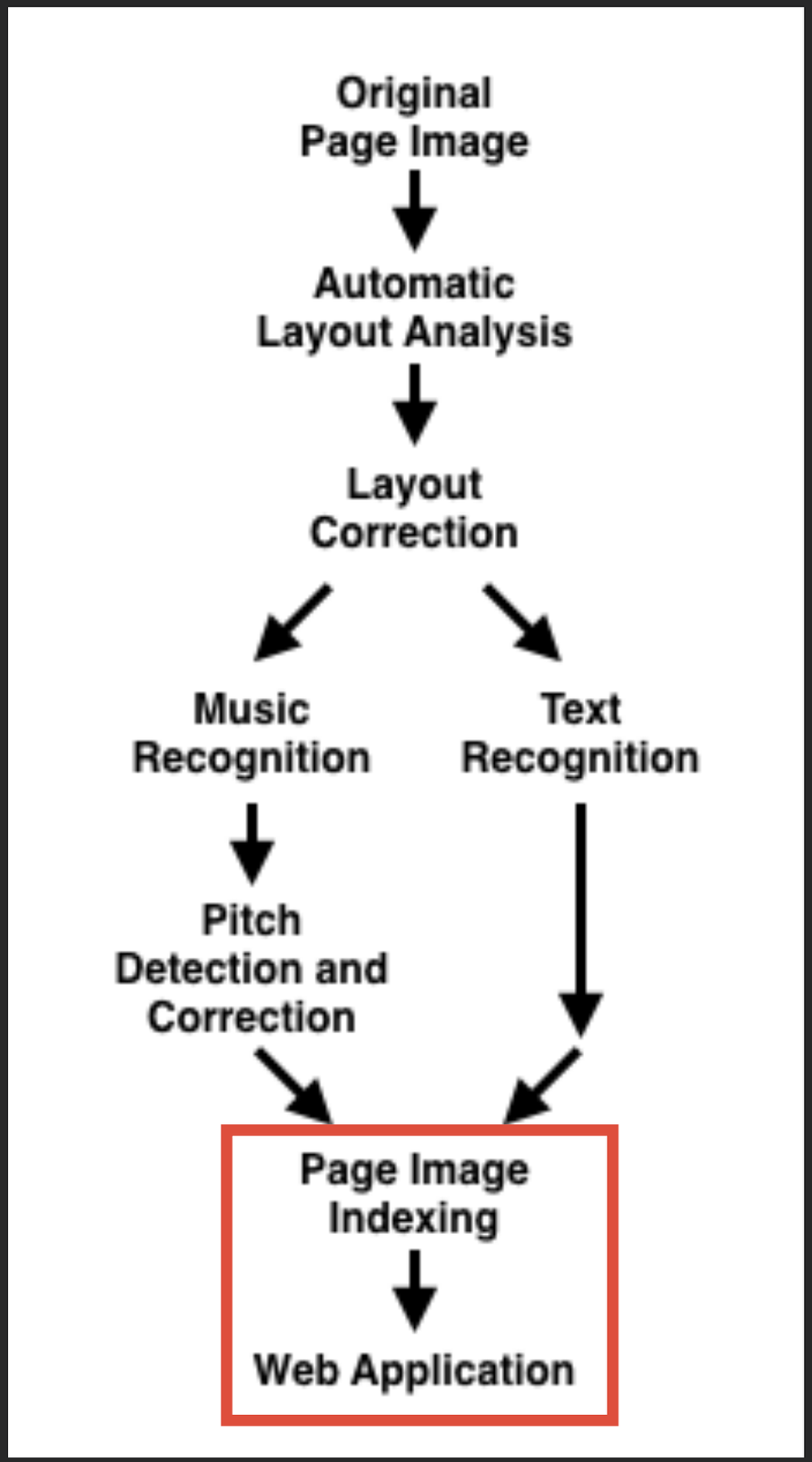
- Musical output encoded using the Music Encoding Initiative (MEI)

OMR Workflow



- Musical output encoded using the Music Encoding Initiative (MEI)
- Indexed with a search engine (Solr)

OMR Workflow



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- *n*-gram (2–10) of pitch name sequences and image coordinates

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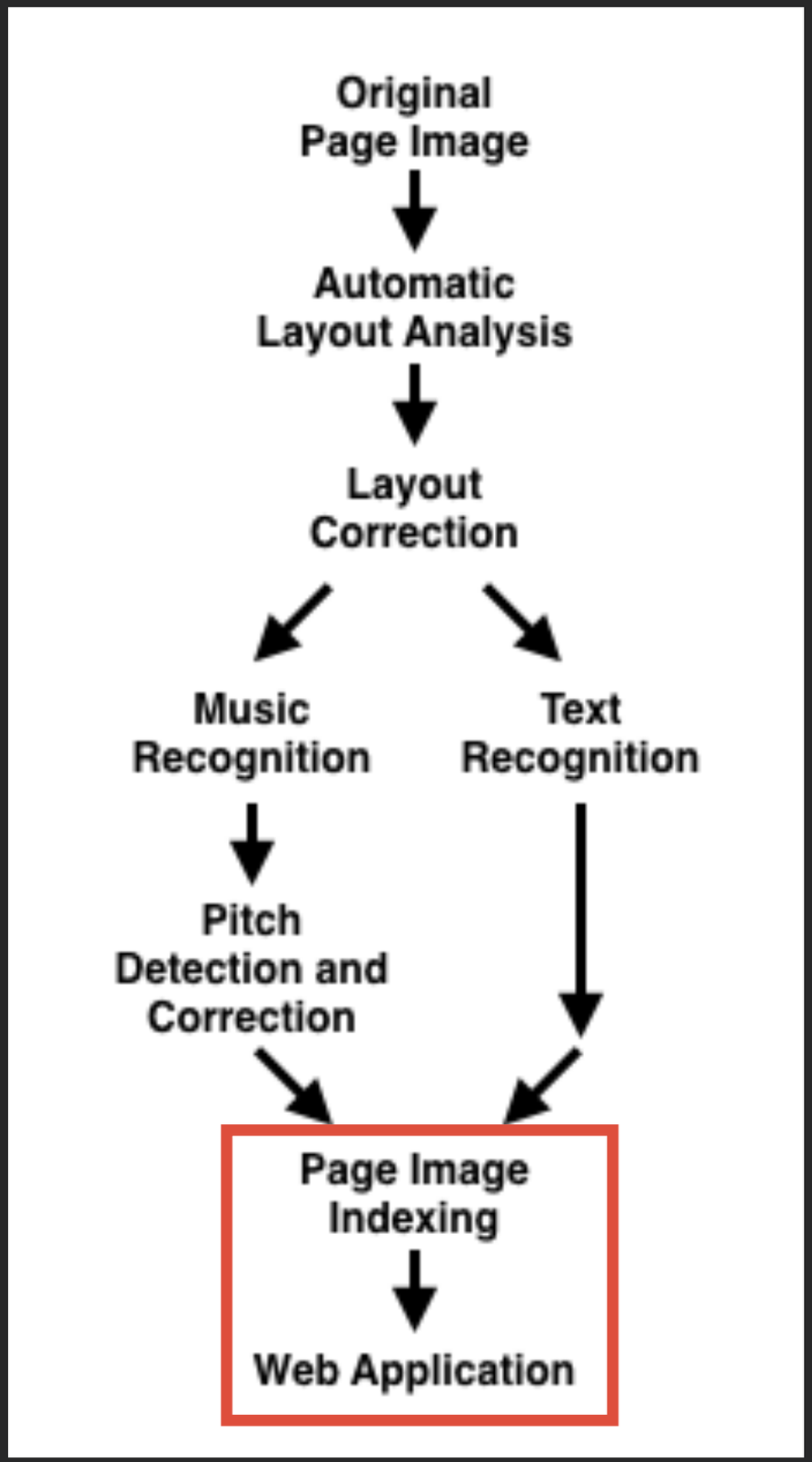

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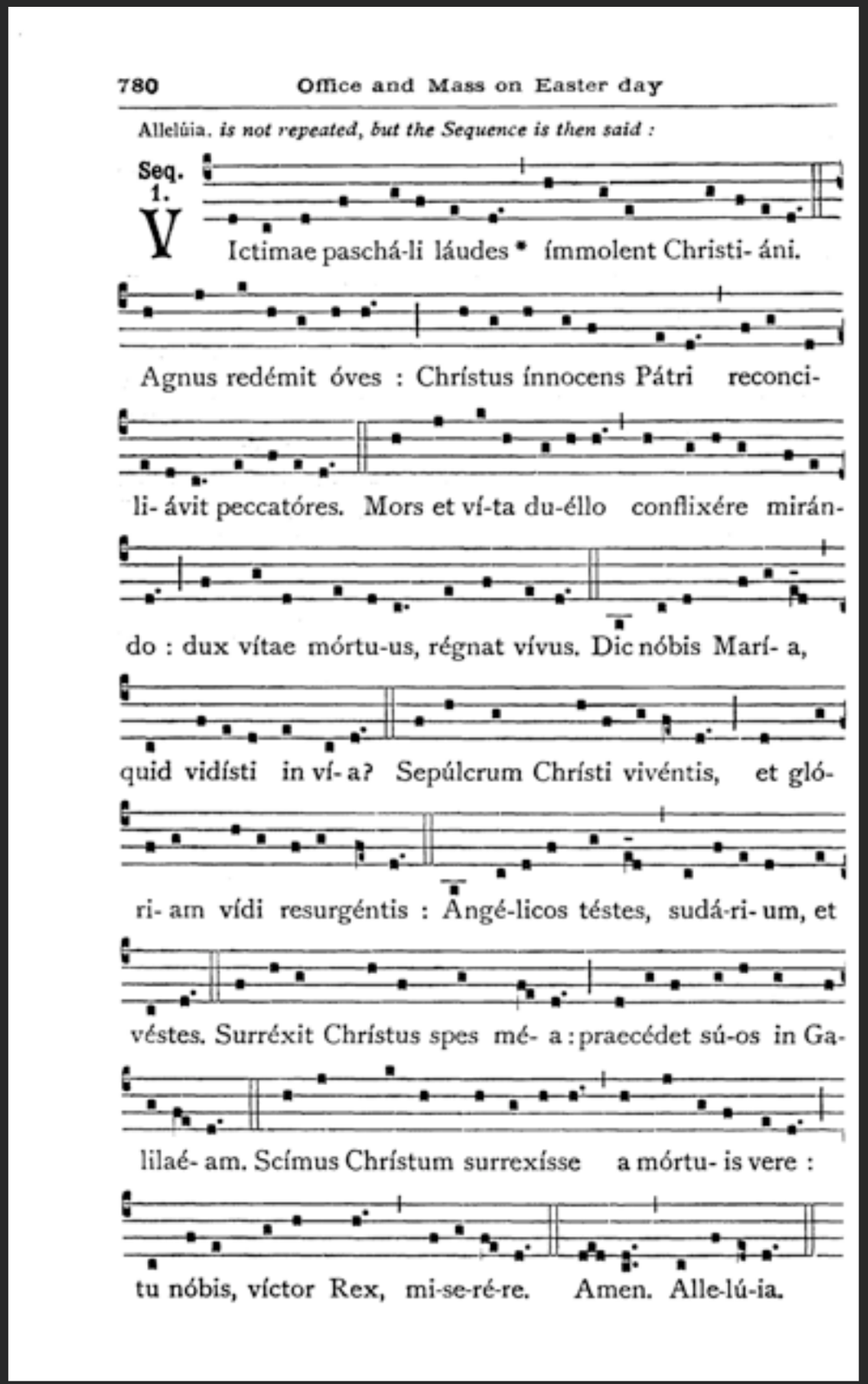
- *n*-gram (2–10) of pitch name sequences and image coordinates
- Web application front-end

Document Image Retrieval



780 Office and Mass on Easter day

Allelúia. *is not repeated, but the Sequence is then said :*

Seq. 1.

V Ictimae paschá-li láudes * ímmolent Christi- áni.

Agnus redémit óves : Chrístus ínnocens Pátri reconci-

li- ávit peccatóres. Mors et ví-ta du-éllo conflixére mirán-

do : dux vítae mórtu-us, régnat vívus. Dic nóbis Marí- a,

quid vidísti in ví- a? Sepúlcrum Chrísti vivéntis, et gló-

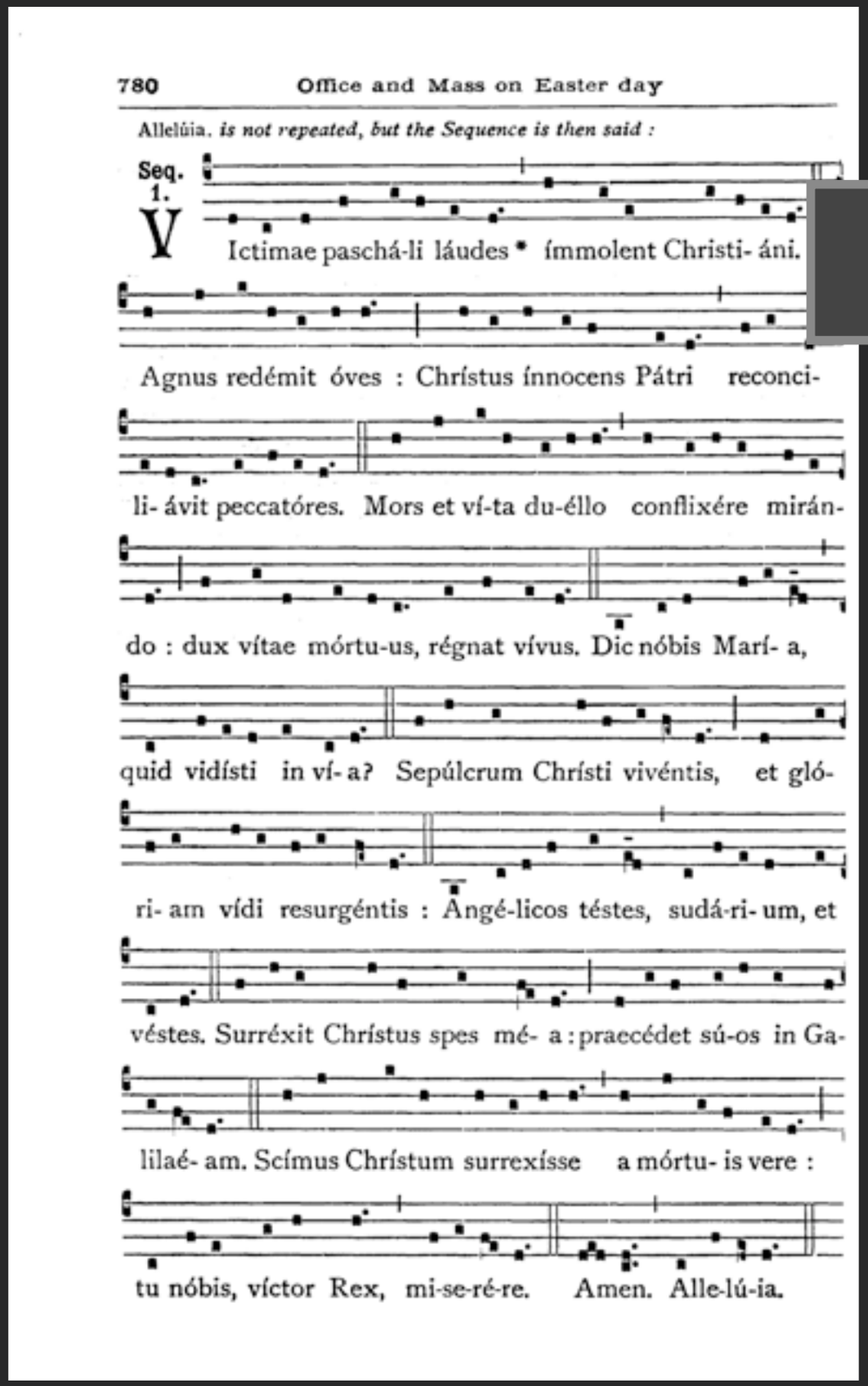
ri- am vídi resurgéntis : Angé-licos téstes, sudá-ri- um, et

véstes. Surréxit Chrístus spes mé- a : praecédet sú-os in Ga-

lilaé- am. Scímus Chrístum surrexísse a mórtu- is vere :

tu nóbis, víctor Rex, mi-se-ré-re. Amen. Alle-lú-ia.

Document Image Retrieval

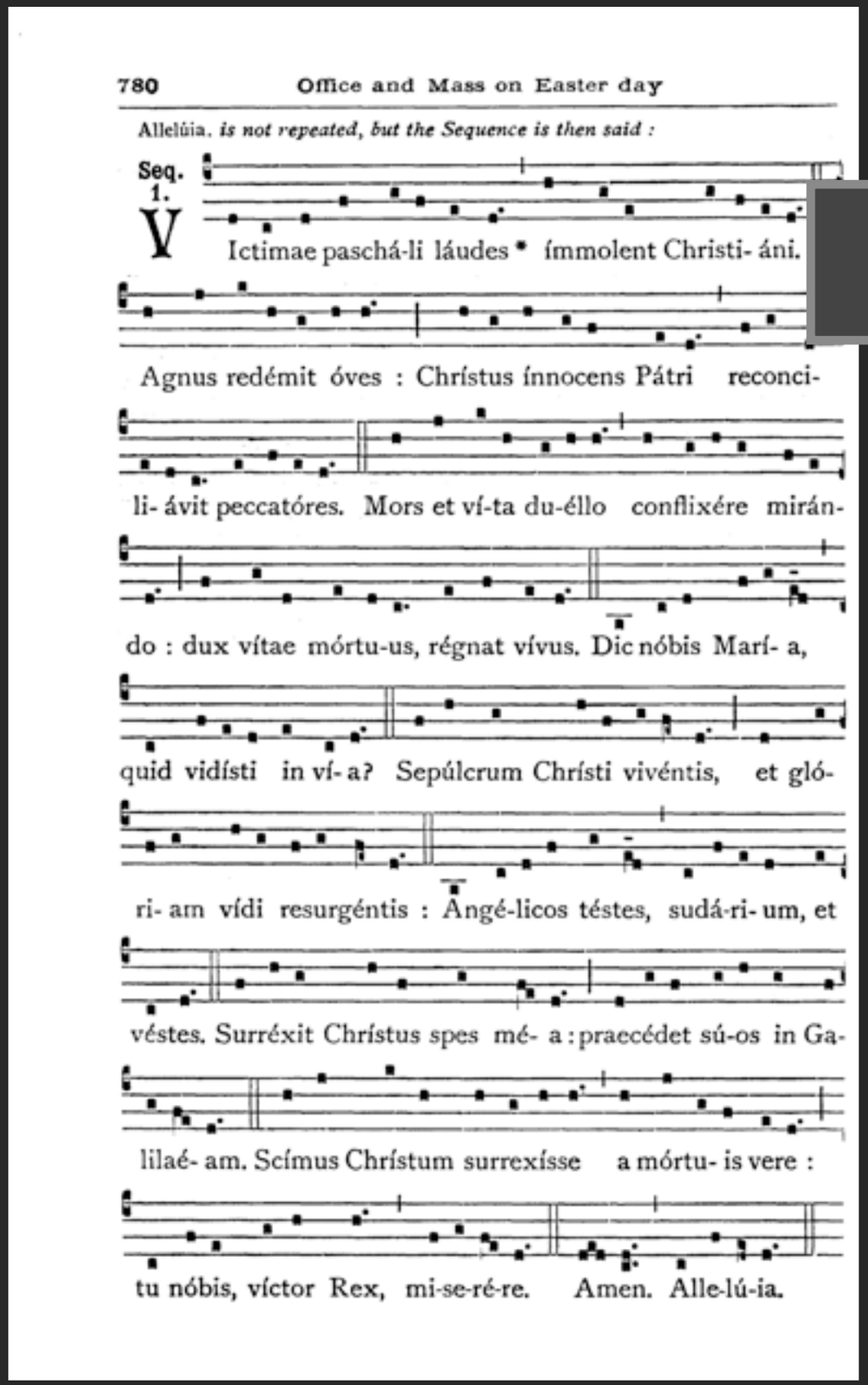


OMR System

Music Notation

```
Note: D
Location: X,Y
```
} .mei

Document Image Retrieval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OMR System

Music Notation

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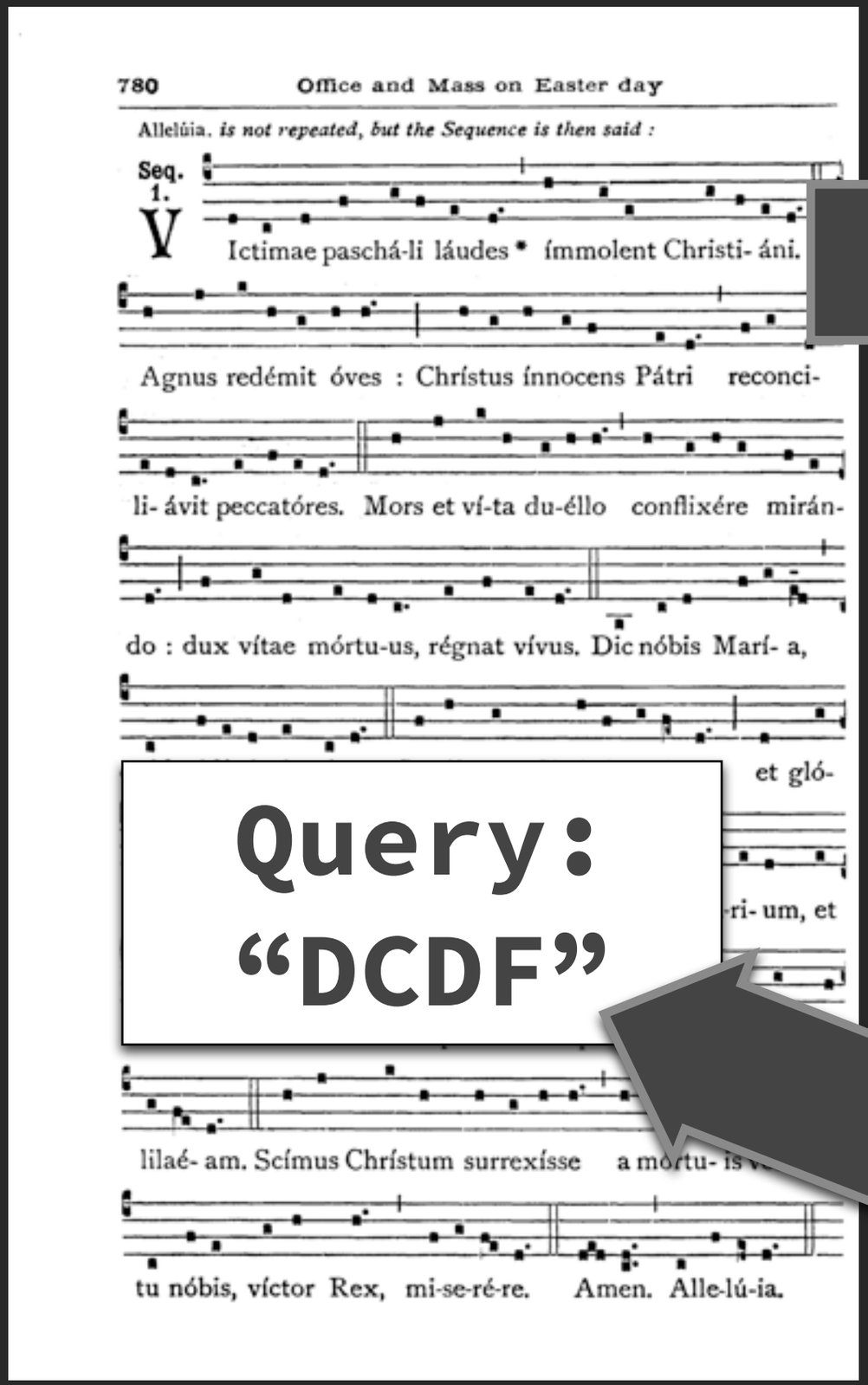
Location: X,Y
```
} `.mei`

Search Engine (Solr)

Document Image Retrieval



OMR System

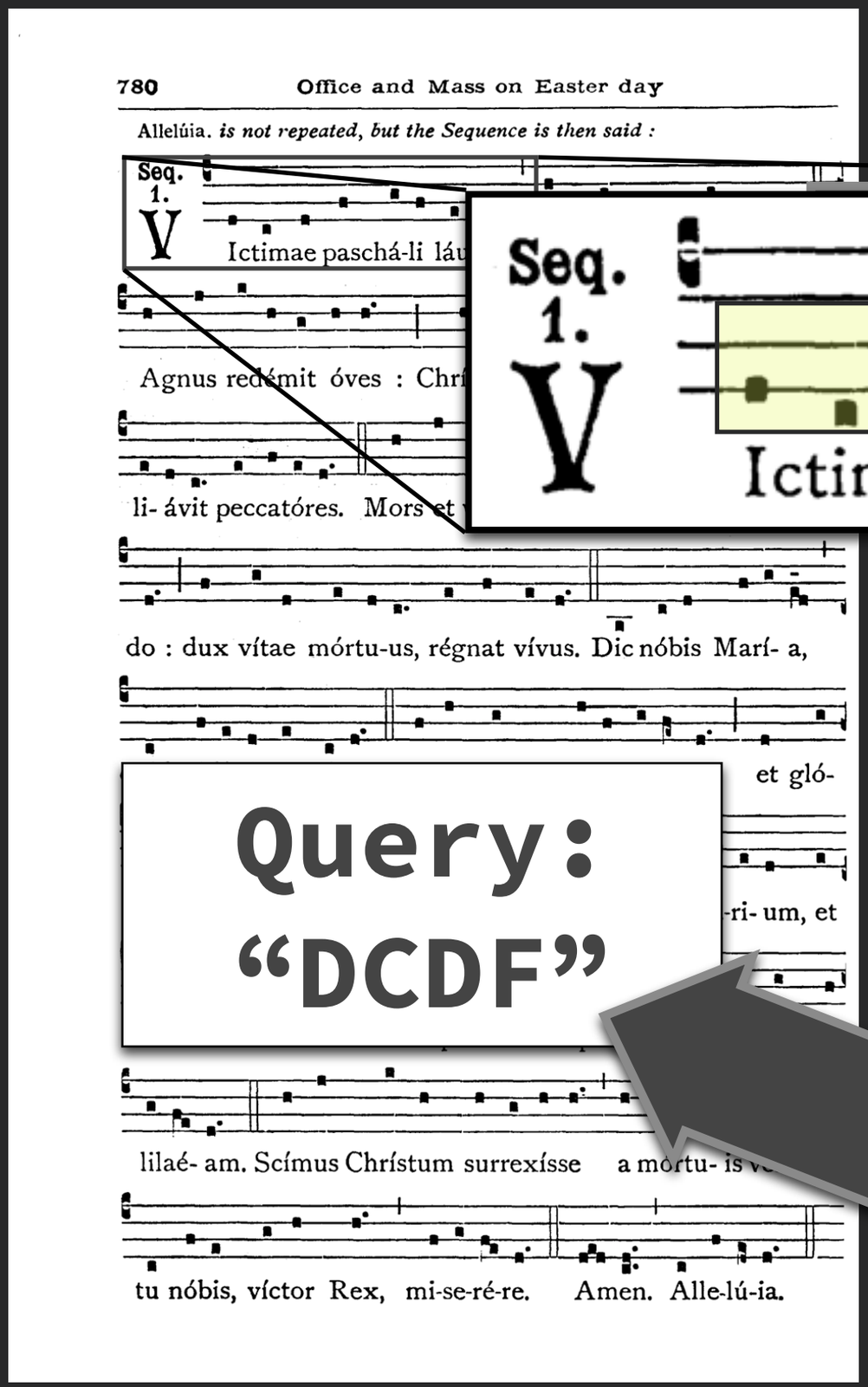
Music Notation

```
Note: D
Location: X,Y
```
} .mei

Search Engine (Solr)

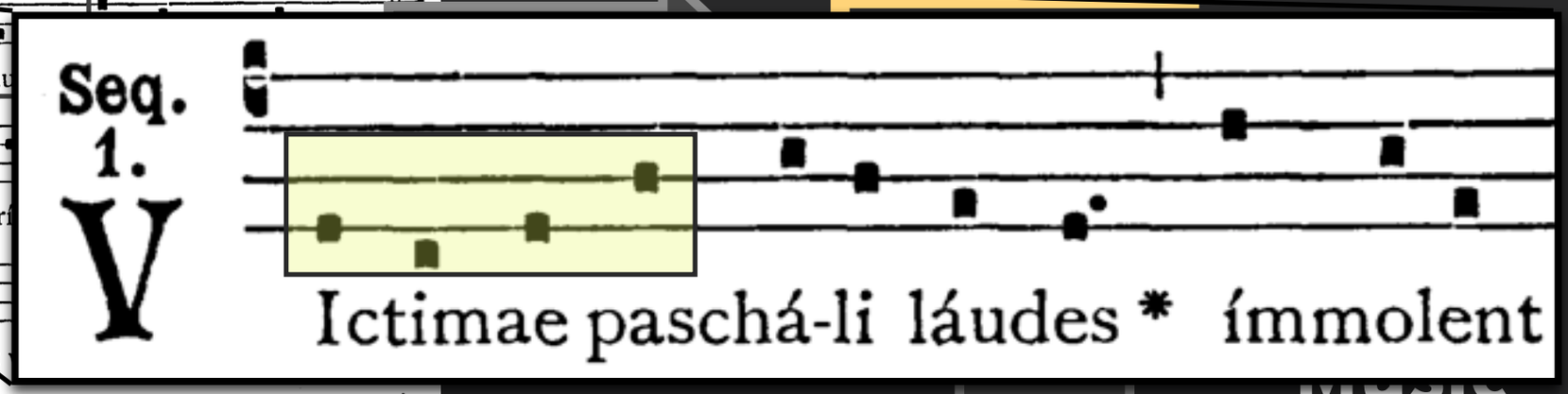
Query: “DCDF”

Document Image Retrieval



Query: "DCDF"

OMR System



Music Notation

```
Note: D
Location: X,Y
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} .mei

Search Engine (Solr)

Demo

http://ddmal.music.mcgill.ca/liber

Liber Usualis Outcomes

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- Full-Music Search is possible.

Liber Usualis Outcomes

- Full-Music Search is possible.
- Results correction is extremely time and labour intensive.

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- Desktop-based OMR software does not scale to large projects.

Liber Usualis Outcomes

- Full-Music Search is possible.
- Results correction is extremely time and labour intensive.
- Desktop-based OMR software does not scale to large projects.
- What does “full-music search” actually look like?

Future Developments

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- “Cloud”-based distributed OMR systems

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- “Cloud”-based distributed OMR systems
- “Pluggable” music notation recognition

Future Developments

- “Cloud”-based distributed OMR systems
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- Crowdsourcing correction interfaces

Future Developments

- “Cloud”-based distributed OMR systems
- “Pluggable” music notation recognition
- Crowdsourcing correction interfaces
- Search and analysis systems for music document image retrieval

Conclusion

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- OCR allows millions of books to be **searched and retrieved** in an instant

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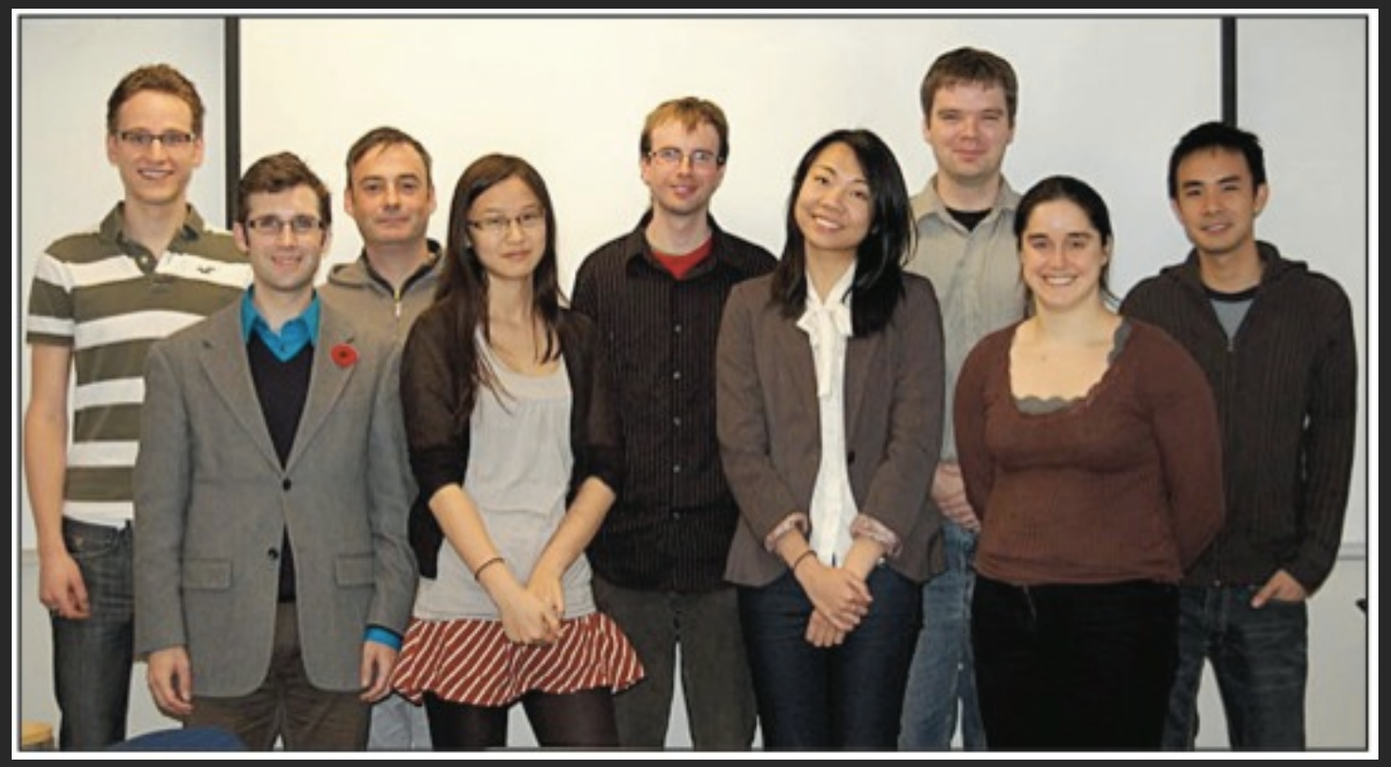
- We want to scale to **millions of books**, of **all notation types.**



Our outstanding R&D team, past and present:

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Thank you.

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