PAT 463/563 (Fall 2026)

Music & AI

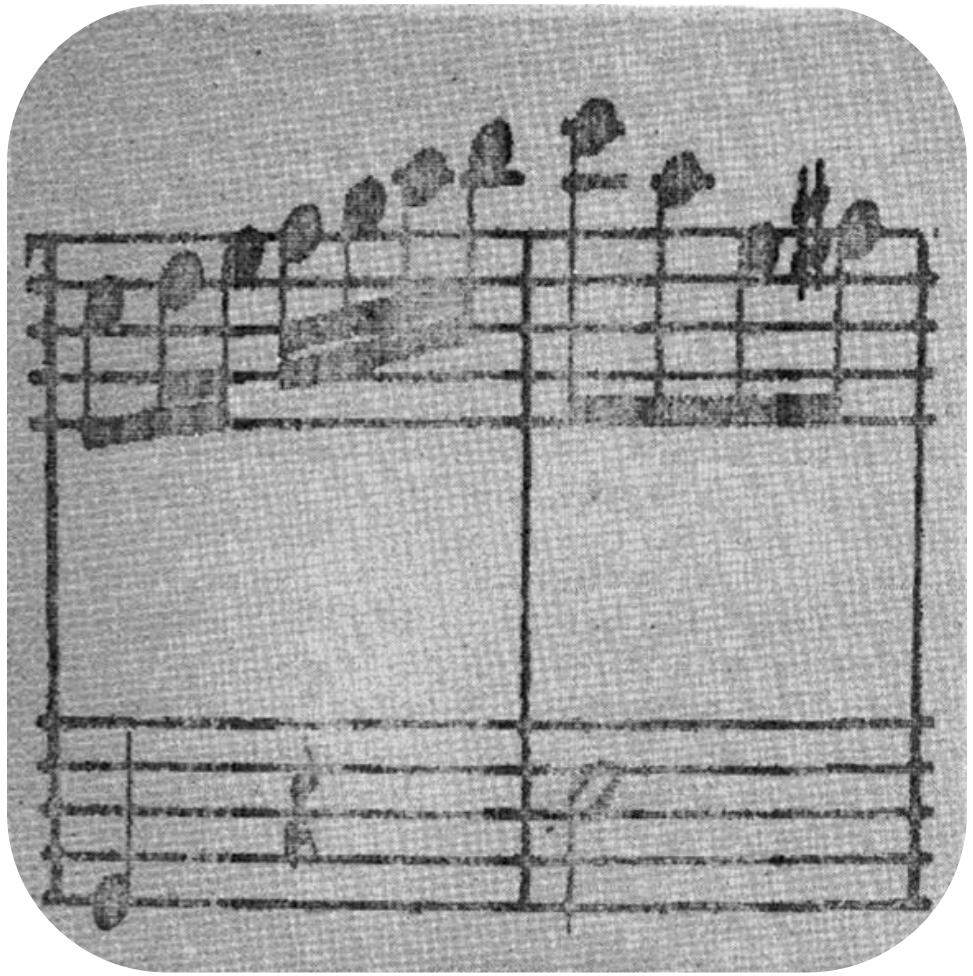
Lecture 13: Optical Music Recognition

Instructor: Hao-Wen (Herman) Dong

UNIVERSITY OF MICHIGAN

Optical Music Recognition

First Published Digital Scan of a Musical Score (1971)

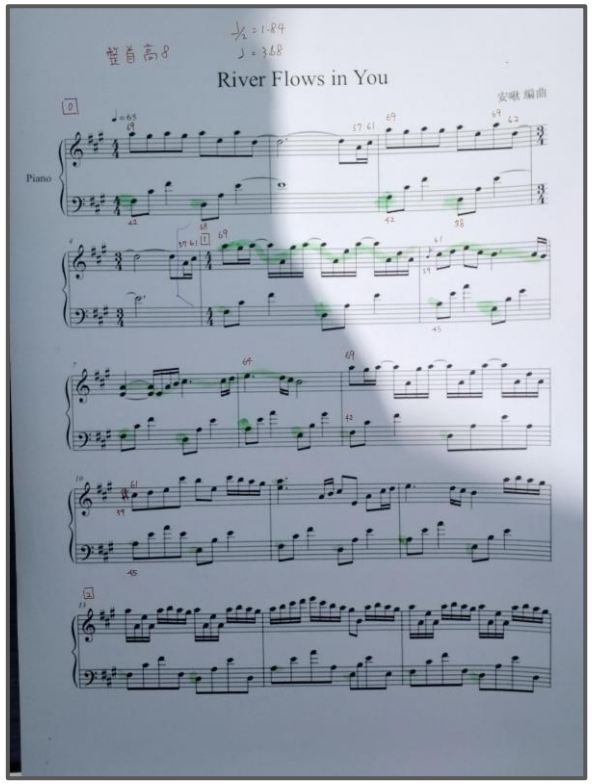


(Source: David S. Prerau)

David S. Prerau, CC BY-SA 4.0, via Wikimedia Commons.
David S. Prerau, "Computer pattern recognition of printed music," *Fall Joint Computer Conference*, 1972.
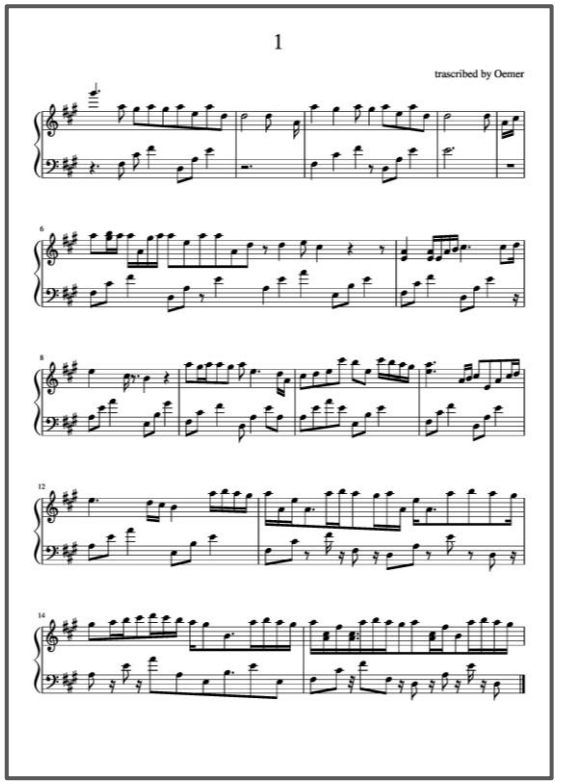
Optical Music Recognition (OMR)

- **Goal**: Convert **scanned sheet music** into **digital musical notation**



(Source: Oemer)

Optical Music Recognition
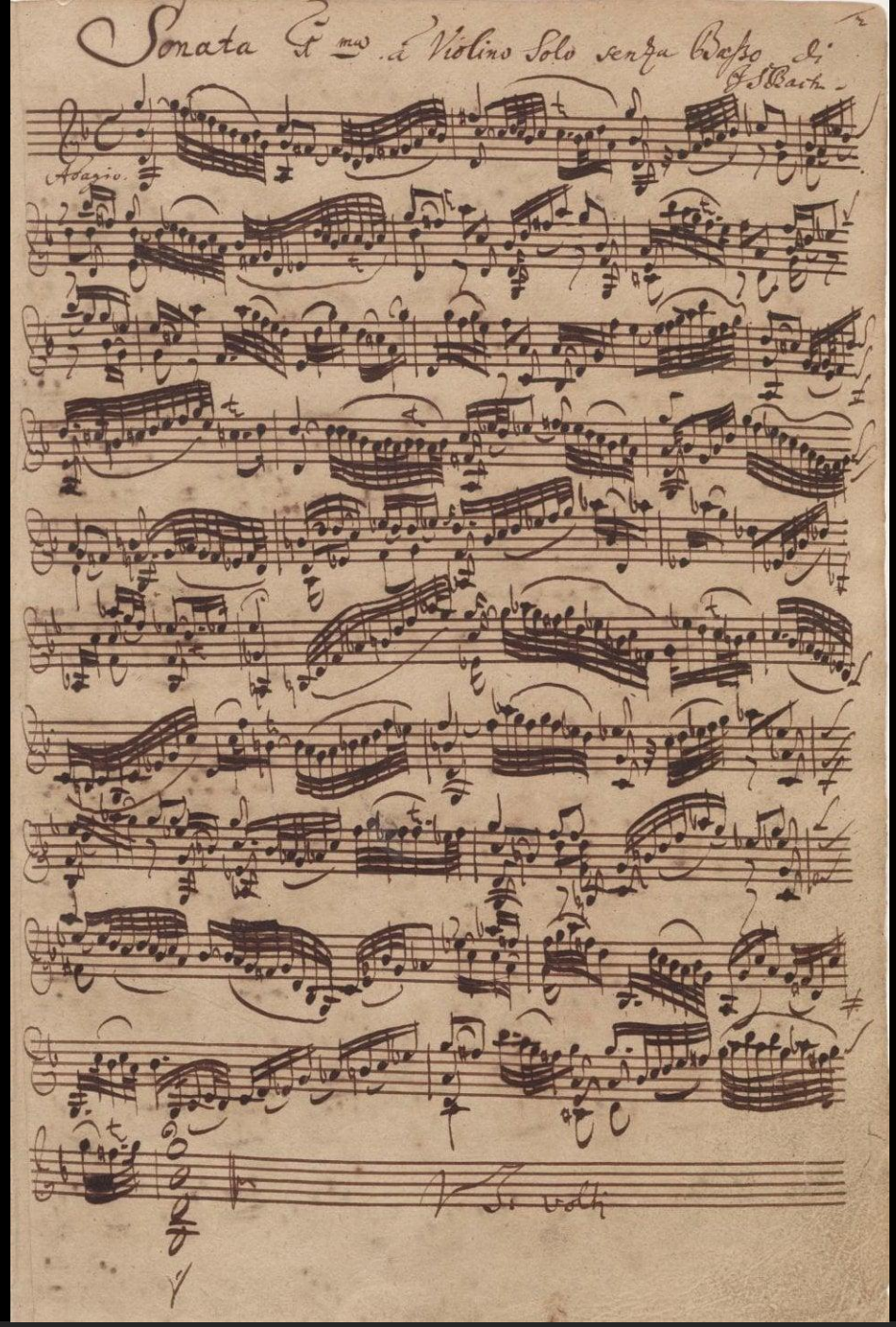


(Source: Oemer)

breezewhite.github.io/oemer/
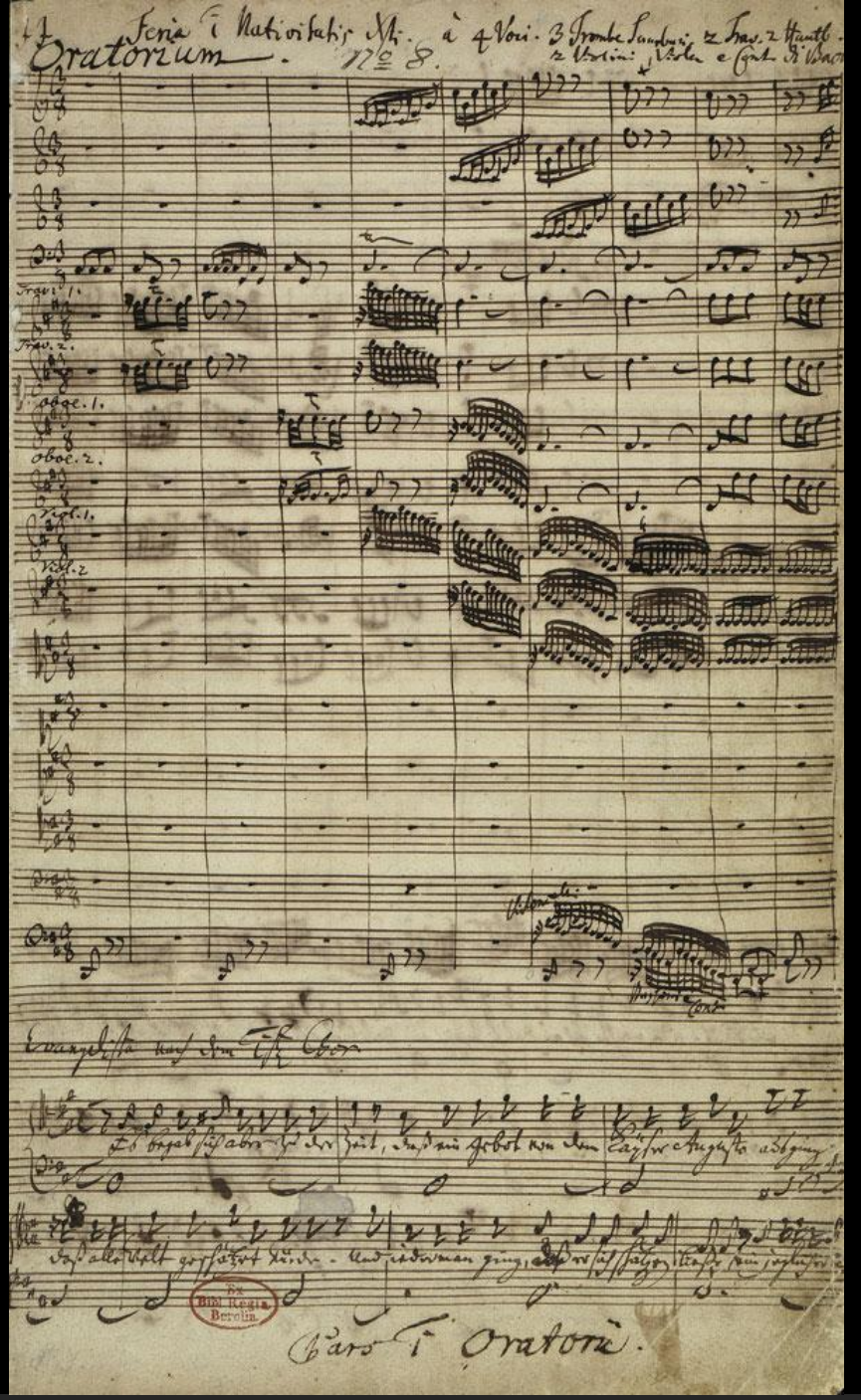
Challenges of OMR

Violin Sonata No. 1 in G minor
(BWV 1001)
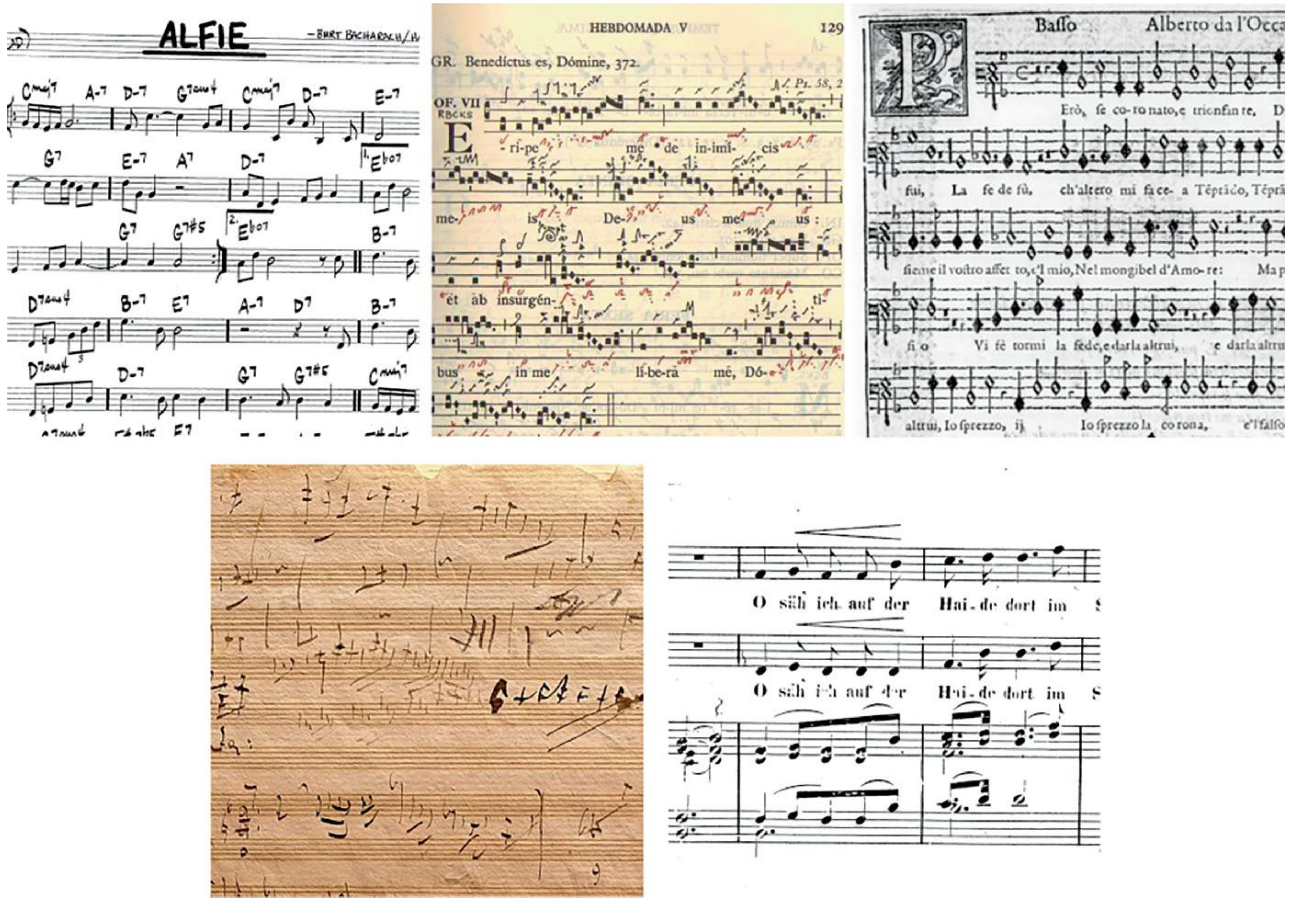


Challenges of OMR
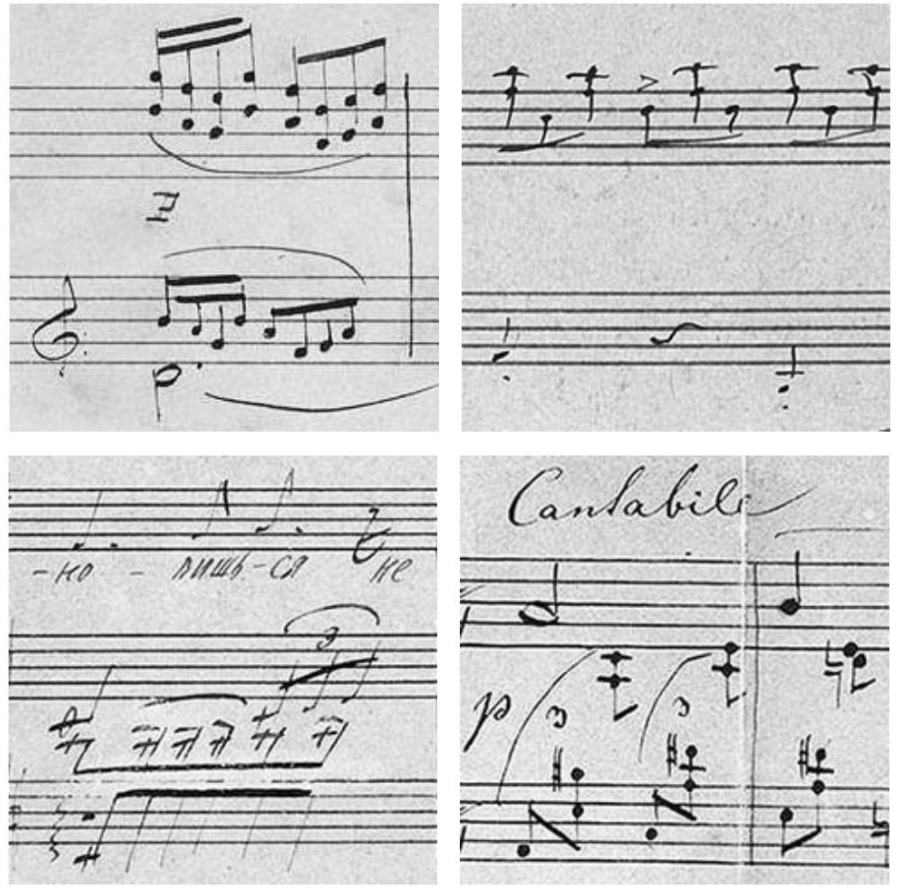
Weihnachtsoratorium
(Christmas Oratorio; BWV 248)



Challenges of OMR



(Source: Calvo-Zaragoza et al., 2018)
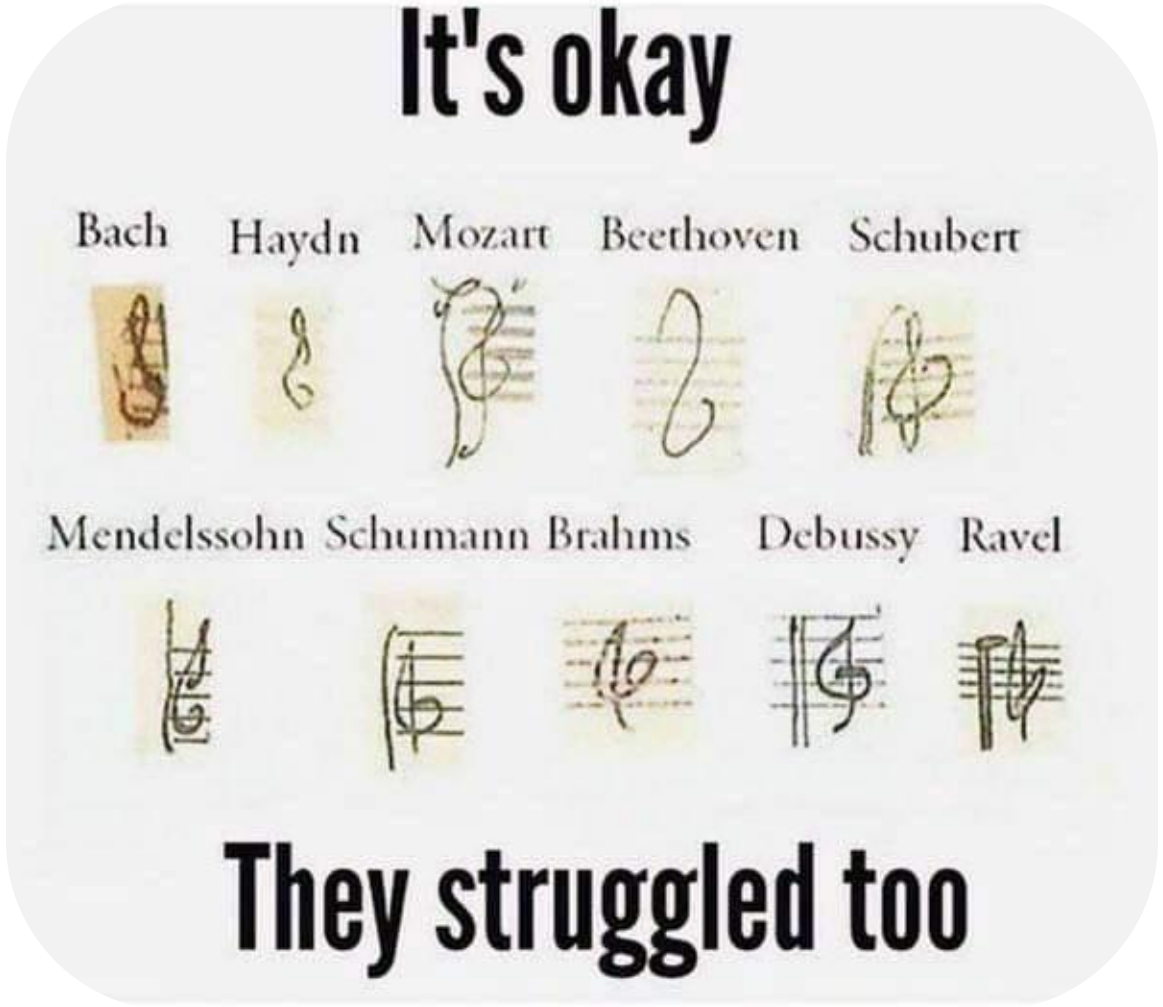


(Source: Novotný & Pokorný, 2015)

Jorge Calvo-Zaragoza, Juan C. Martinez-Sevilla, Carlos Penarrubia, and Antonio Rios-Vila, "Optical Music Recognition: Recent Advances, Current Challenges, and Future Directions," *ICDAR*, 2023.

Jiří Novotný and Jaroslav Pokorný, "Introduction to Optical Music Recognition: Overview and Practical Challenges," *DATESO*, 2015.

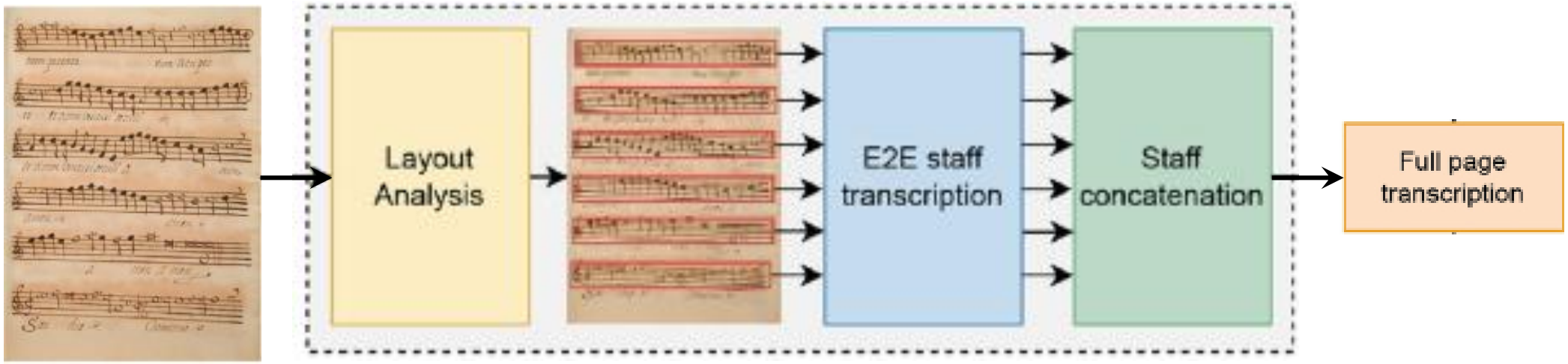
Challenges of OMR



(Source: Reddit)

reddit.com/r/lingling40hrs/comments/a1i920/it_seems_they_had_treble_writing_the_clef_v/

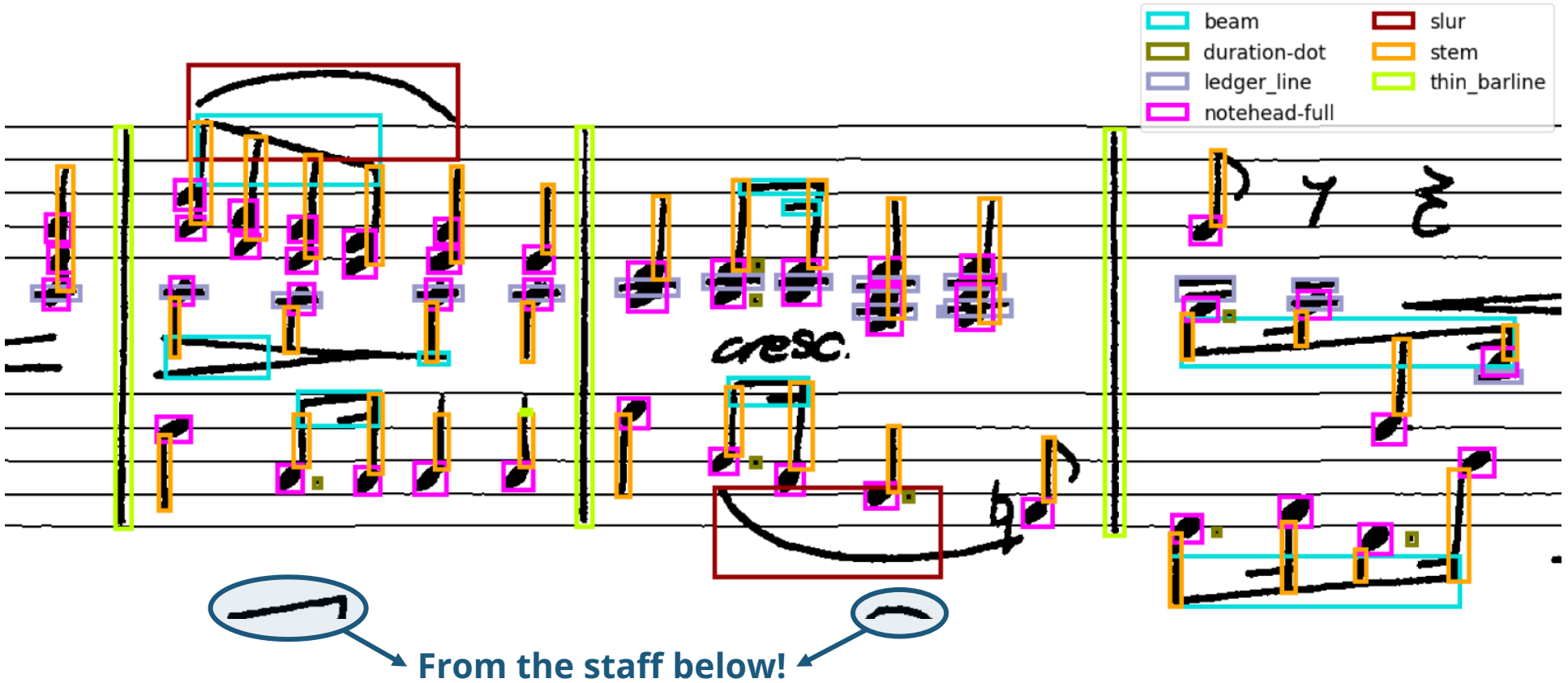
Common Pipeline of OMR Systems



(Source: Calvo-Zaragoza et al., 2018)

Jorge Calvo-Zaragoza, Juan C. Martinez-Sevilla, Carlos Penarrubia, and Antonio Rios-Vila, "Optical Music Recognition: Recent Advances, Current Challenges, and Future Directions," *ICDAR*, 2023.

Musical Object Recognition



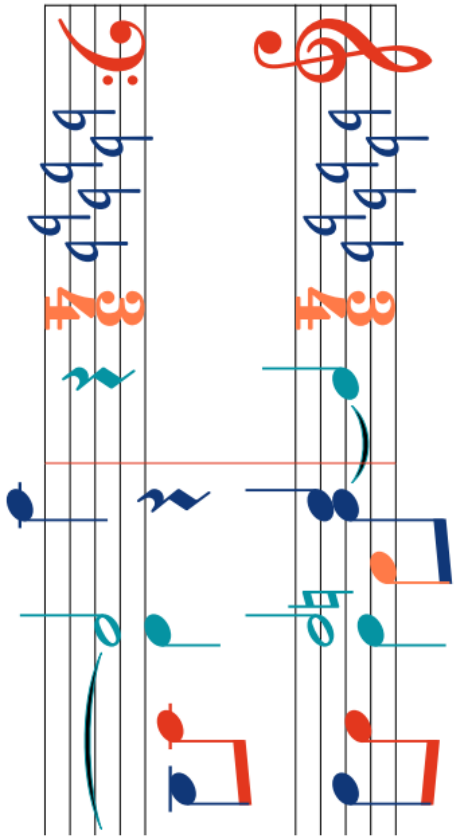
(Source: Pacha et al., 2018)

Alexander Pacha, Jan Hajič, and Jorge Calvo-Zaragoza, "A Baseline for General Music Object Detection with Deep Learning," *Applied Science*, 8(9):1488, 2018.

Example of OMR Output

Humdrum **kern representation

```
**kern      **kern
*clefF4     *clefG2
*k[b-e-a-d-g-c-]    *k[b-e-a-d-g-c-]
*M3/4       *M3/4
4r          ([4b-\
=           =
*^          *^
4r    4EE-/    8b-/L]    4g-\
.     .        8ee-/J    .
4B-/  [2E-\    4dd-/     2gn\
8c-/L .        8cc-/L    .
8d-/J .        8b-/J     .
```
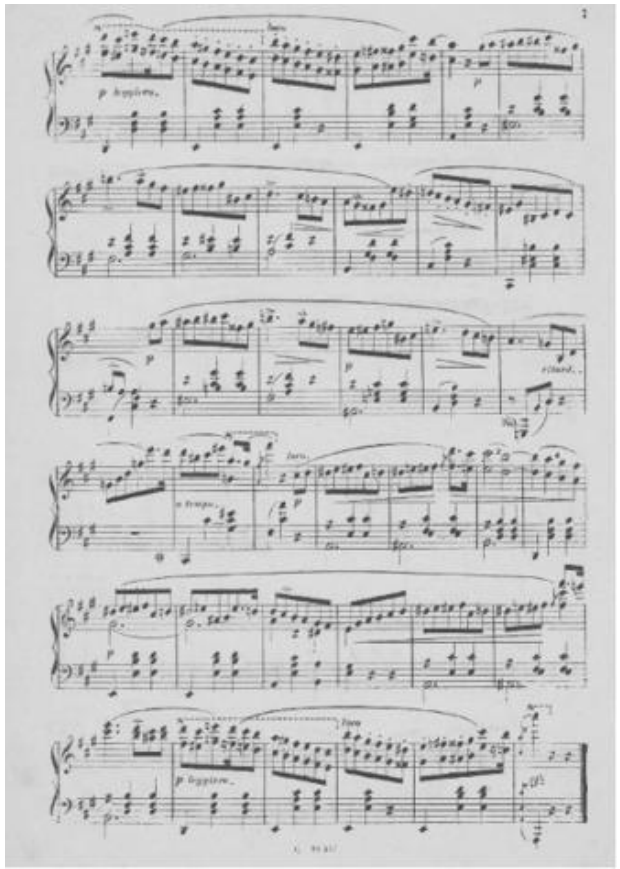


(Source: Ríos-Vila et al., 2026)
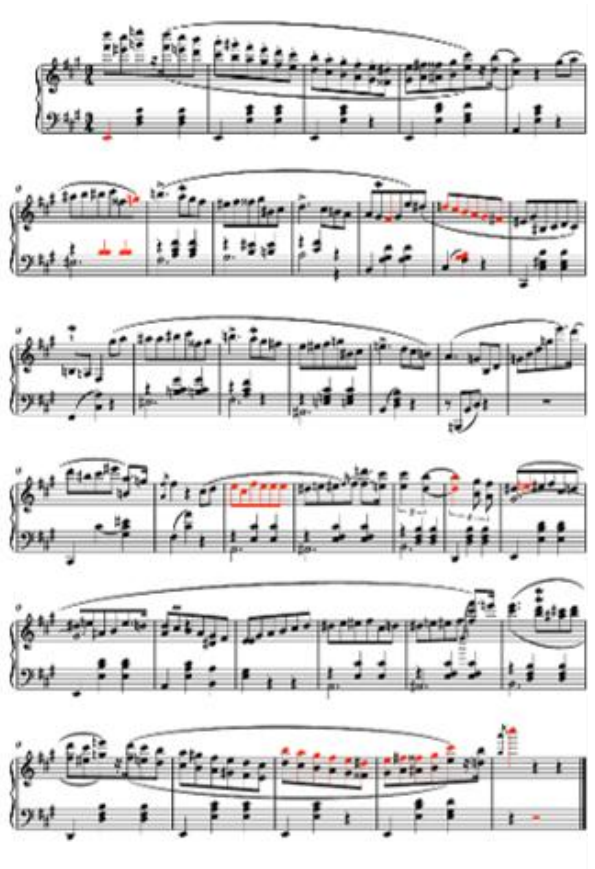
Antonio Ríos-Vila, Jorge Calvo-Zaragoza, David Rizo, and Thierry Paquet, "End-to-end full-page optical music recognition for pianoform sheet music," *International Journal of Computer Vision*, 134(49), 2026.

Example: Sheet Music Transformer (Ríos-Vila et al., 2026)

Input scanned sheet music



Rendered output
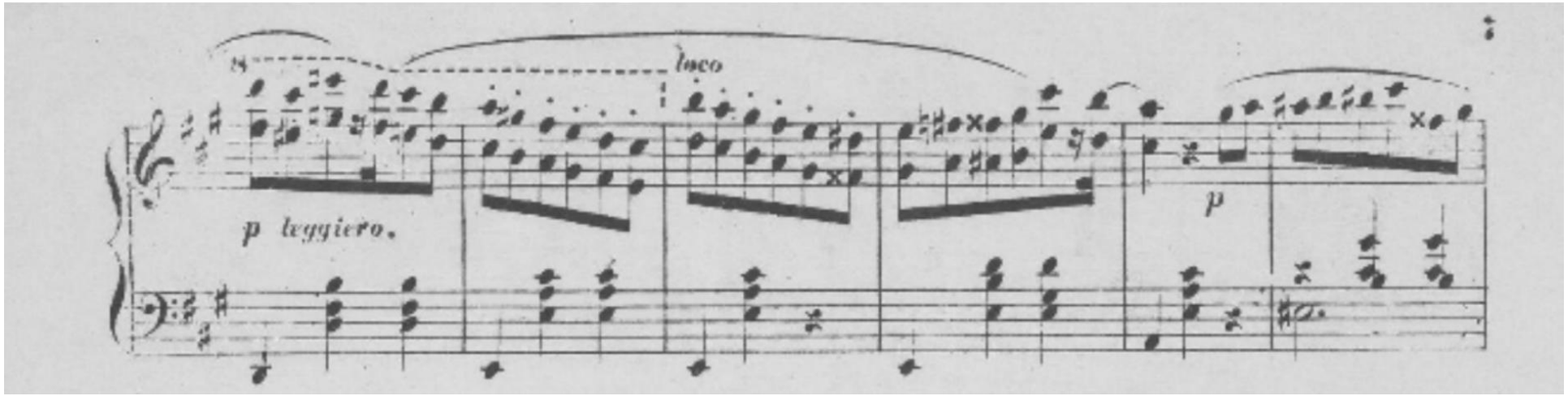


(Source: Ríos-Vila et al., 2026)
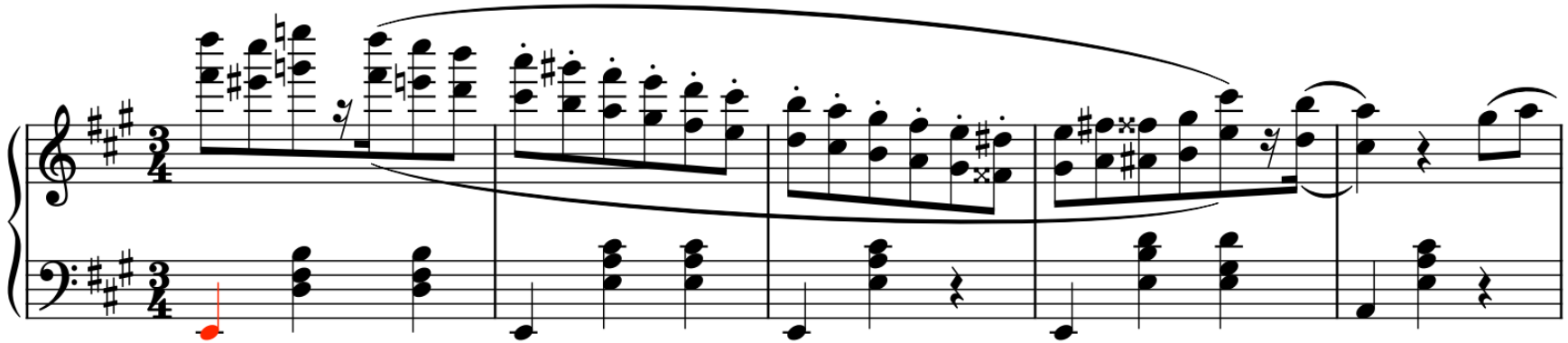
Antonio Ríos-Vila, Jorge Calvo-Zaragoza, David Rizo, and Thierry Paquet, "End-to-end full-page optical music recognition for pianoform sheet music," *International Journal of Computer Vision*, 134(49), 2026.

Example: Sheet Music Transformer (Ríos-Vila et al., 2026)

Input



Output
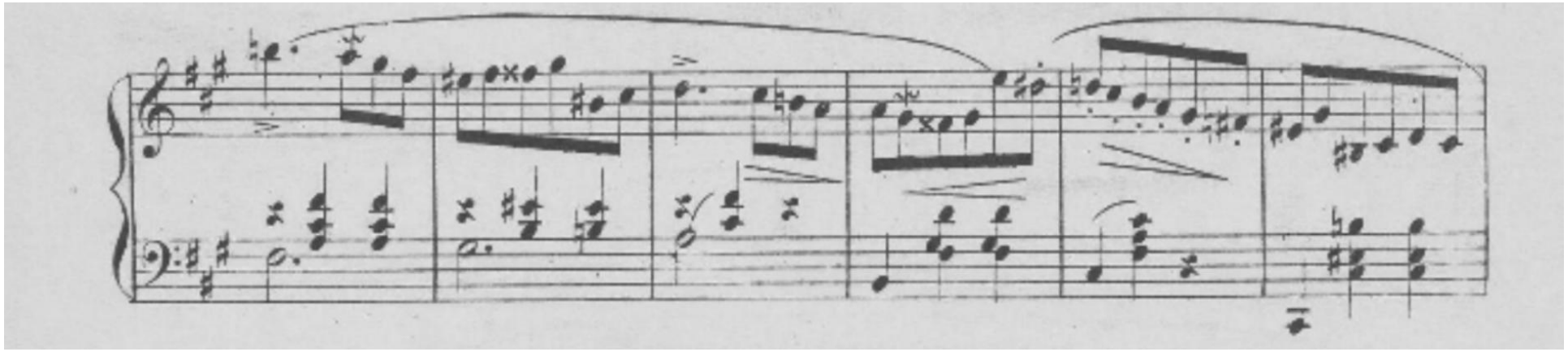


(Source: Ríos-Vila et al., 2026)
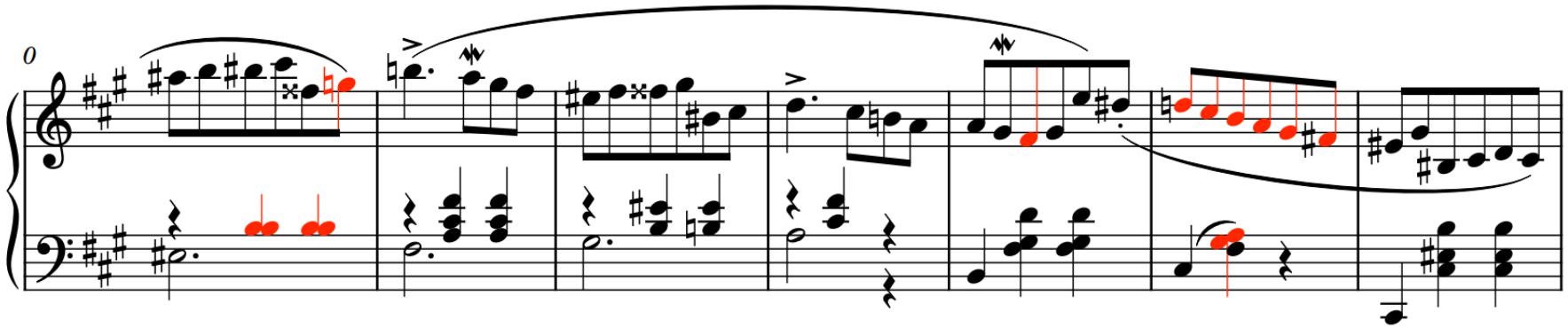
Antonio Ríos-Vila, Jorge Calvo-Zaragoza, David Rizo, and Thierry Paquet, "End-to-end full-page optical music recognition for pianoform sheet music," *International Journal of Computer Vision*, 134(49), 2026.

Example: Sheet Music Transformer (Ríos-Vila et al., 2026)

Input



Output

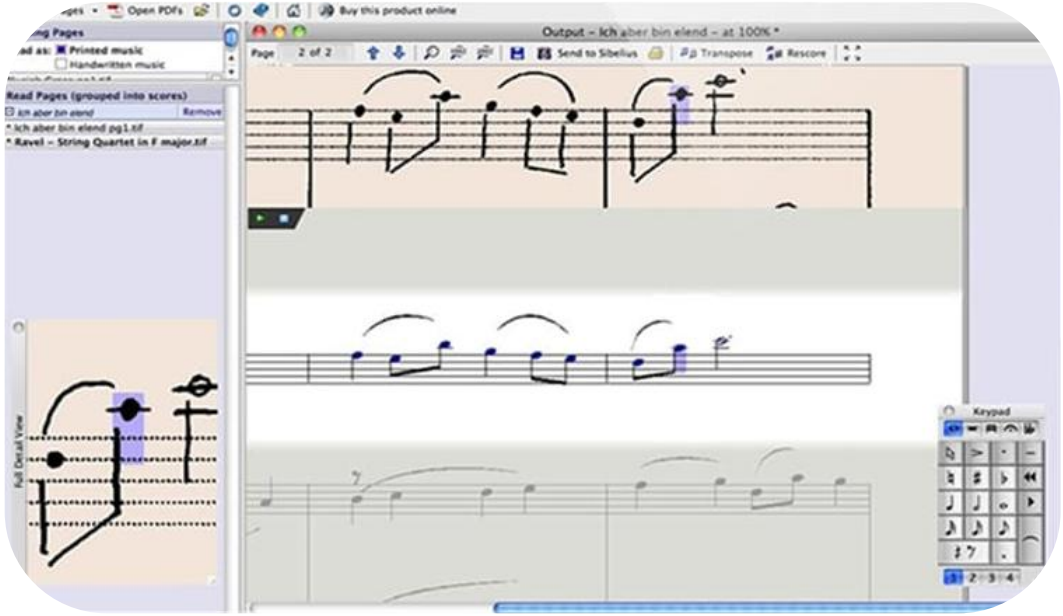


(Source: Ríos-Vila et al., 2026)

Antonio Ríos-Vila, Jorge Calvo-Zaragoza, David Rizo, and Thierry Paquet, "End-to-end full-page optical music recognition for pianoform sheet music," *International Journal of Computer Vision*, 134(49), 2026.

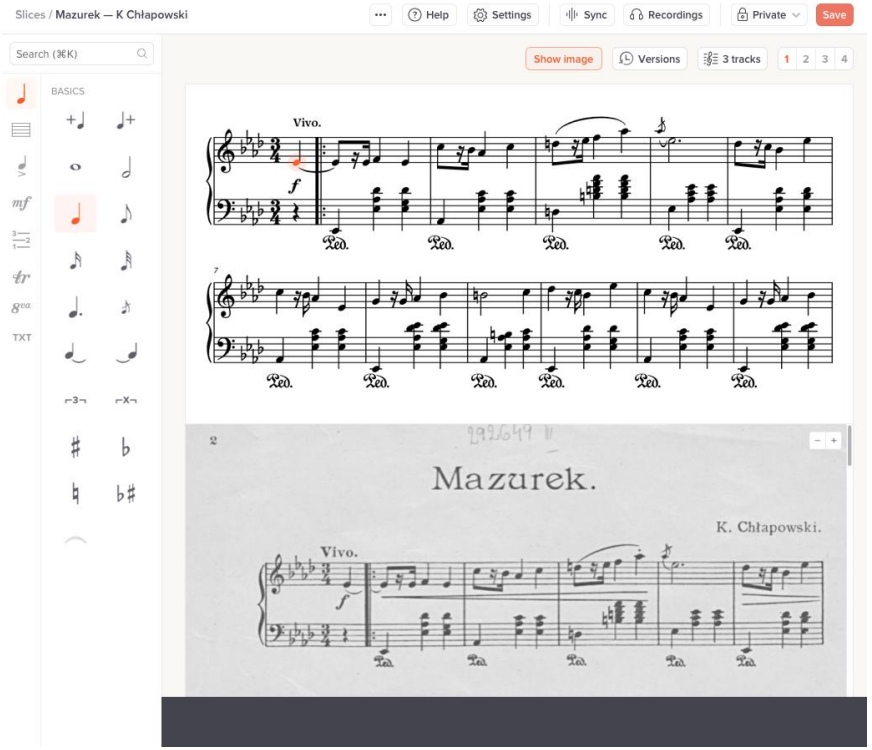
Commercial OMR Software

PhotoScore & NotateMe in Sibelius



(Source: Avid)

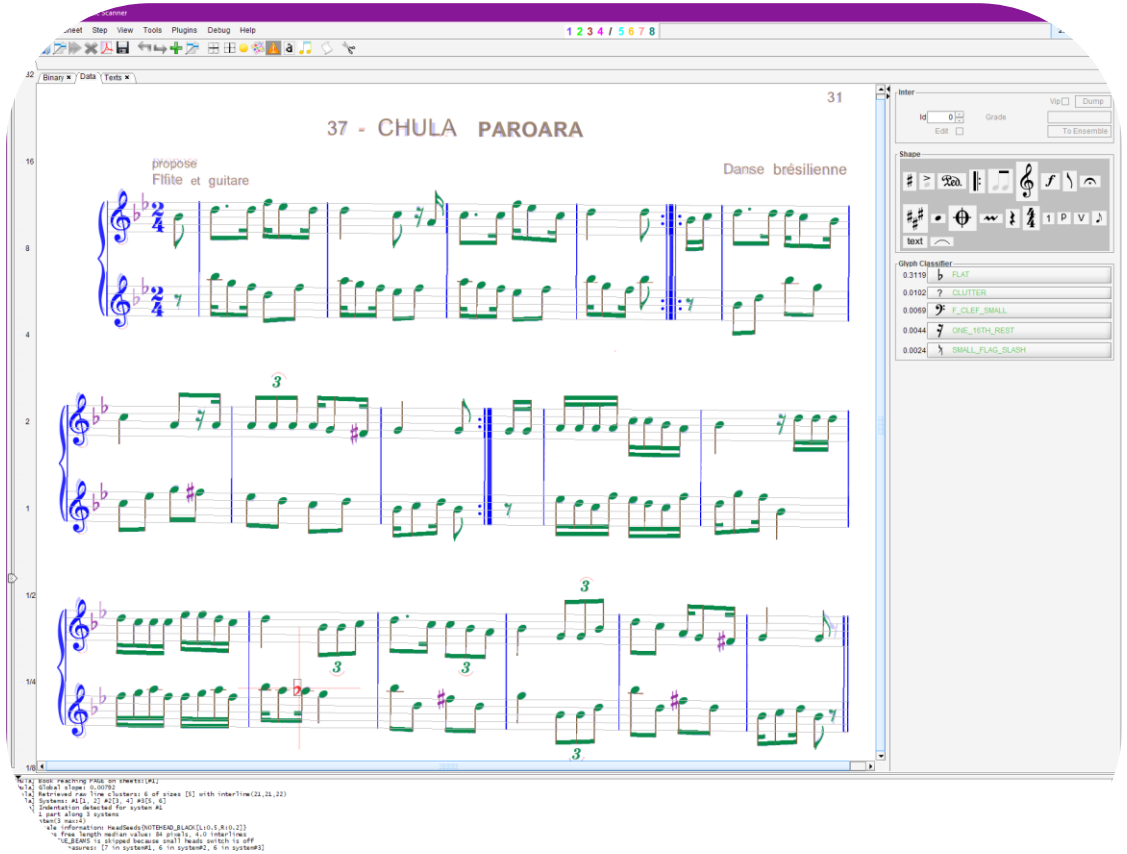
Soundslice



(Source: Soundslice)

avid.com/products/photoscore-and-notateme-ultimate
soundslice.com/sheet-music-scanner/
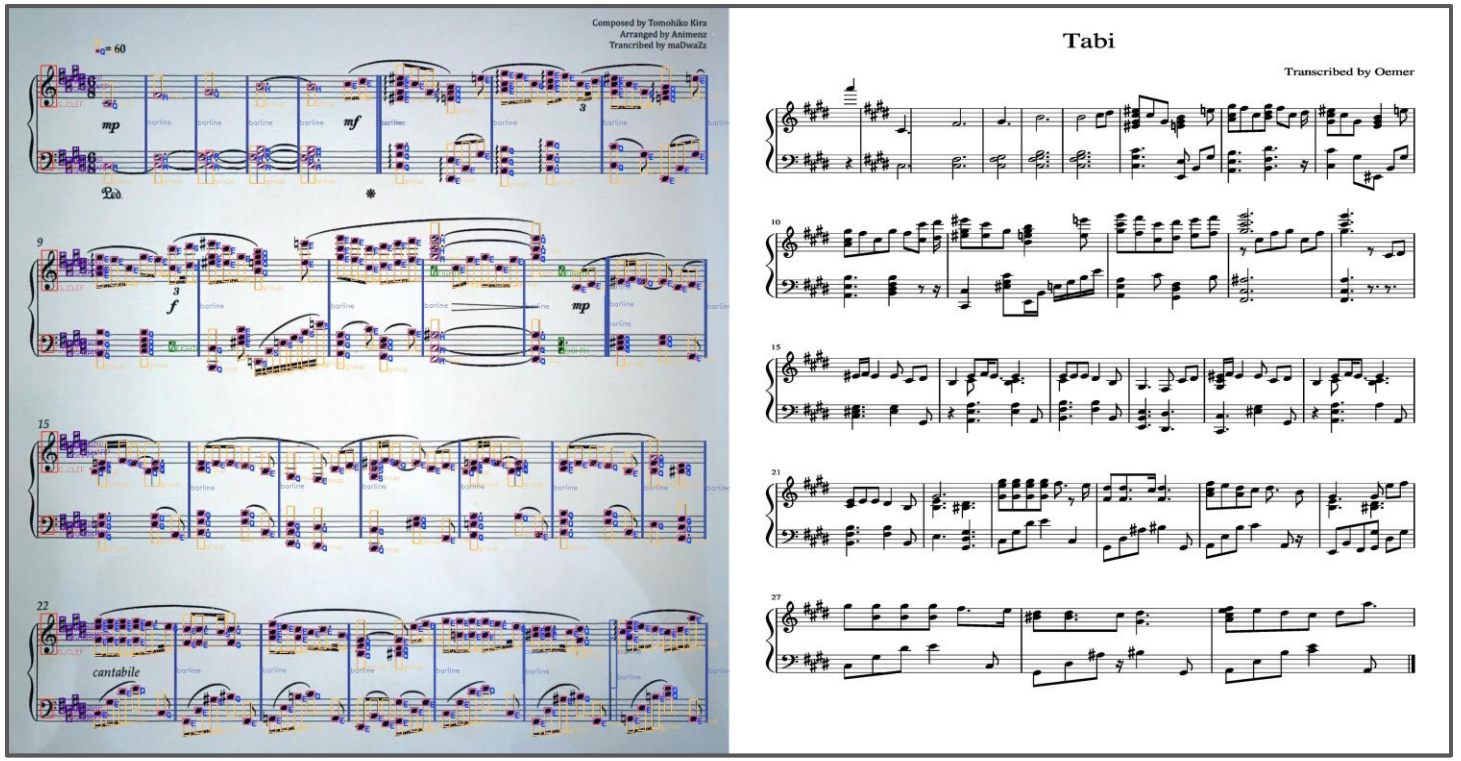
Open-source OMR Software: Audiveris

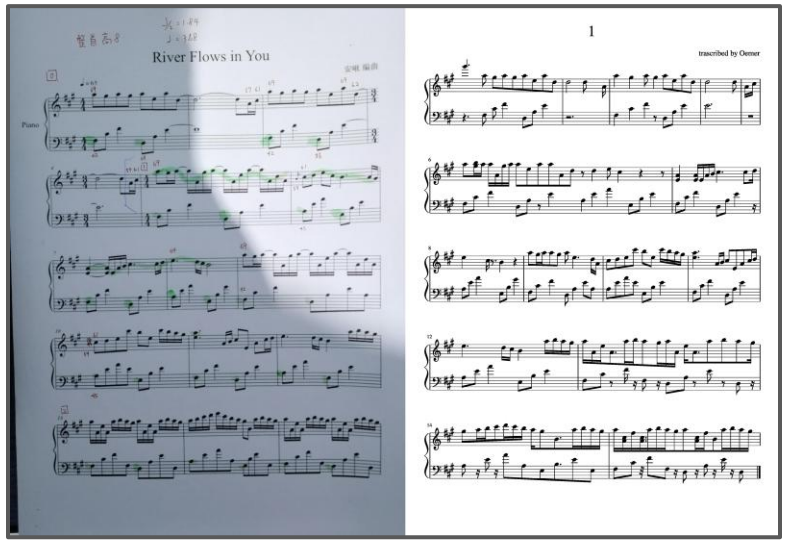


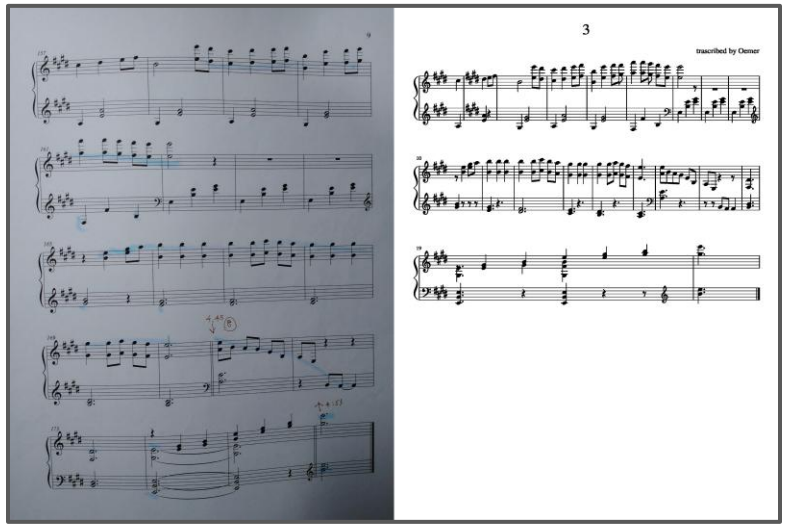
Audiveris

github.com/Audiveris/audiveris

Open-source OMR Software: Oemer







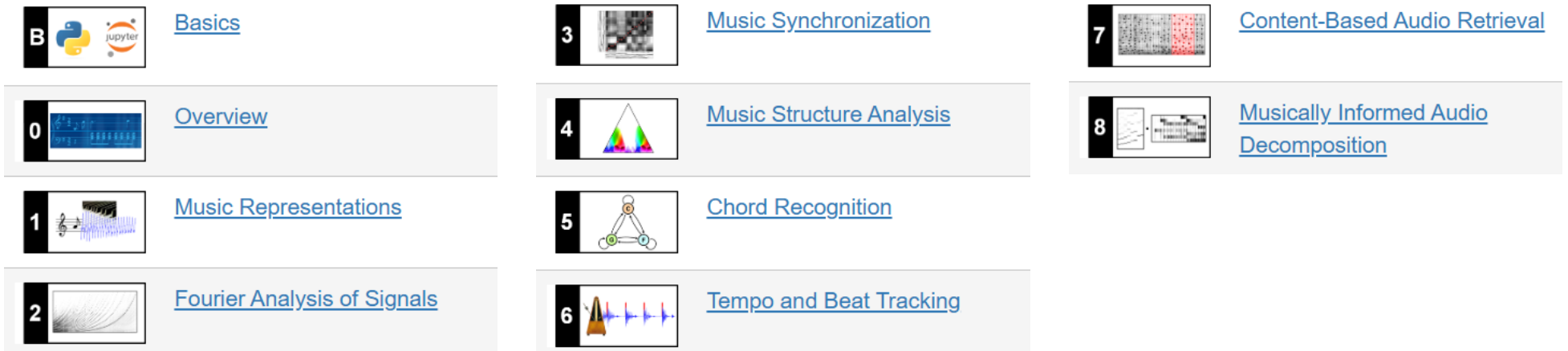
github.com/BreezeWhite/oemer

Resources on Optical Music Recognition (OMR)

- Jorge Calvo-Zaragoza, Jan Hajič jr., Alexander Pacha, and Ichiro Fujinaga, "Optical Music Recognition for Dummies," *Tutorials of ISMIR*, 2021. (slides)
- OMR Datasets: apacha.github.io/OMR-Datasets/

Resources on Music Information Research (MIR)

- Meinard Müller, "Fundamentals of Music Processing – Using Python and Jupyter Notebooks," *Springer*, 2021.
- Meinard Müller and Frank Zalkow, "FMP Notebooks: Educational Material for Teaching and Learning Fundamentals of Music Processing," *ISMIR*, 2019.
  - Jupyter notebooks available at audiolabs-erlangen.de/FMP



(Source: Müller & Zalkow, 2019)

Resources on Music Information Research (MIR)

- Masataka Goto, Jin Ha Lee, and Meinard Müller, "Exploring 25 Years of Music Information Retrieval: Perspectives and Insights," *Tutorials of ISMIR*, 2024.
- Geoffroy Peeters, Gabriel Meseguer-Brocal, Alain Riou, and Stefan Lattner, "Deep Learning 101 for Audio-based MIR," *Tutorials of ISMIR*, 2024. (book)
- Keunwoo Choi, György Fazekas, Kyunghyun Cho, and Mark Sandler, "A Tutorial on Deep Learning for Music Information Retrieval," *arXiv preprint arXiv:1709:04396*, 2017. (code)

Beyond Western Staff Notations

Early Music Notations

Hurrian Hymn
(c. 1400 BCE)



(Source: circlethroughnewyork.com)

Seikilos Epitaph
(c. 50-150 CE)



(Source: Artem.G)
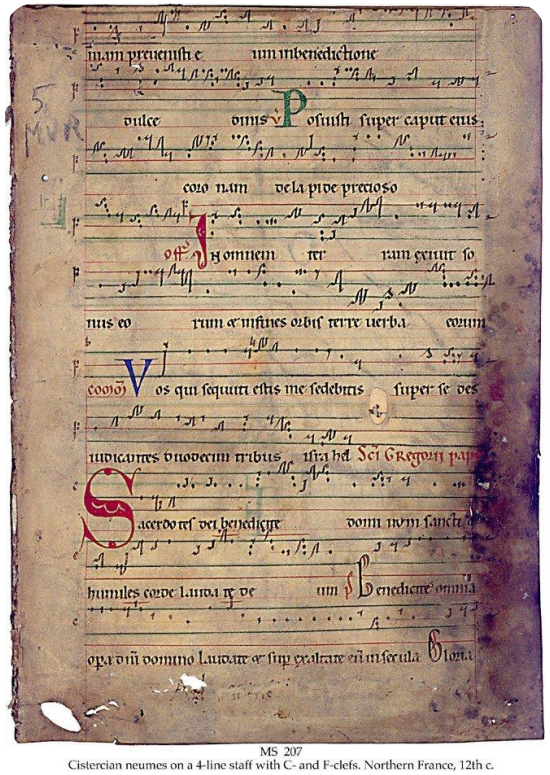


(Source: Lennart Larsen, Nationalmuseets fotograf)

circlethroughnewyork.com/blog/2017/2/13/dossier-on-the-hurrian-hymn
Artem.G, CC BY-SA 4.0, via Wikimedia Commons.
Lennart Larsen, Nationalmuseets fotograf, CC BY-SA 3.0, via Wikimedia Commons.

Early Music Notations

Neume notation


MS 207
Cistercian neumes on a 4-line staff with C- and F-clefs. Northern France, 12th c.
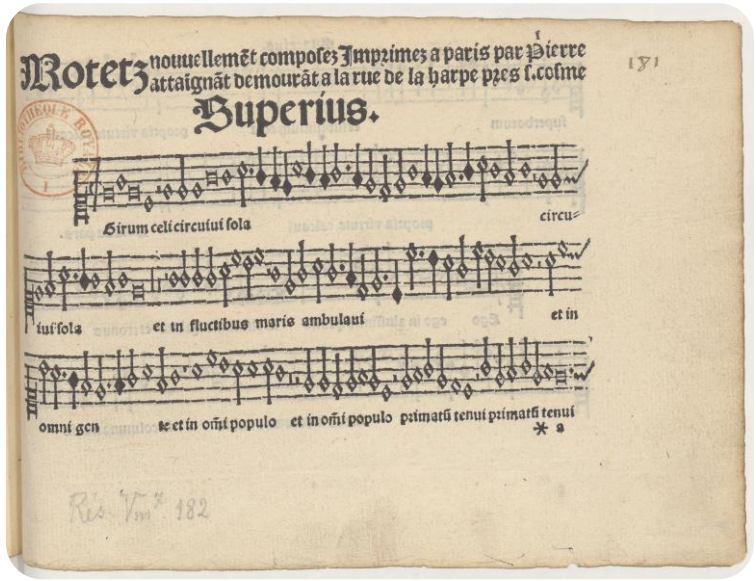
(Source: Wikimedia Commons)

Byzantine notation



(Source: Wikimedia Commons)

Mensural notation



(Source: Bibliothèque nationale de France)

Bhat notation



(Source: Wikimedia Commons)

Znamenny notation



(Source: Wikimedia Commons)

Bibliothèque nationale de France, Public domain, via Wikimedia Commons

Early Music Notations in East Asia

Jianzipu notation



(Source: Internet Archive)

Jeongganbo notation



(Source: Wikimedia Commons)

Honkyoku notation



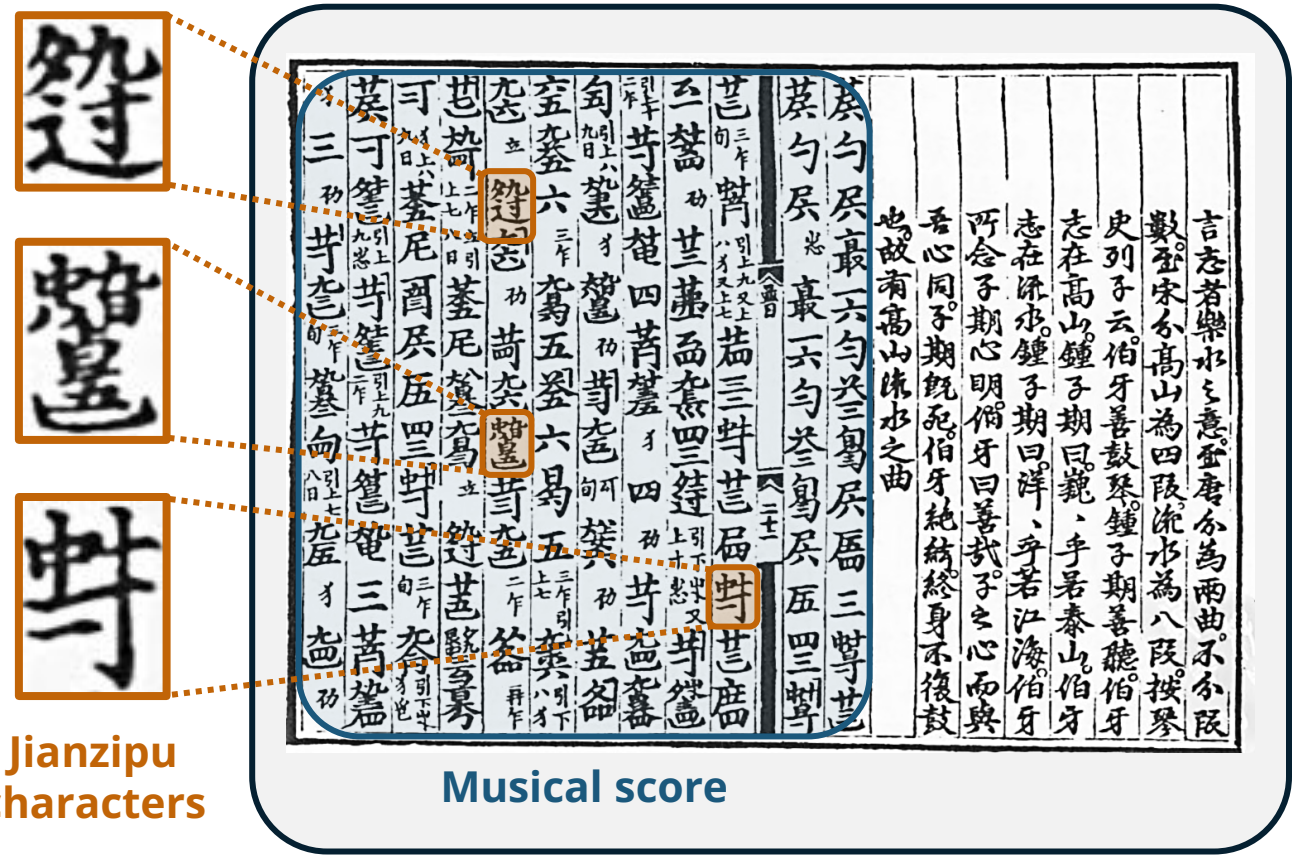
(Source: Kurahashi Yodo)

Kurahashi Yodo, CC BY-SA 4.0, via Wikimedia Commons

Jianzipu Notation

- Literally, “**reduced character**” notation
- Used in Song, Yuan, Ming & Qing dynasties (**c. 1100-1900**)
- A **tablature** notation
- Durations not recorded





(Source: Internet Archive)

Guqin



- Literally, “**Old Zither**”
- One of the oldest music traditions, among others

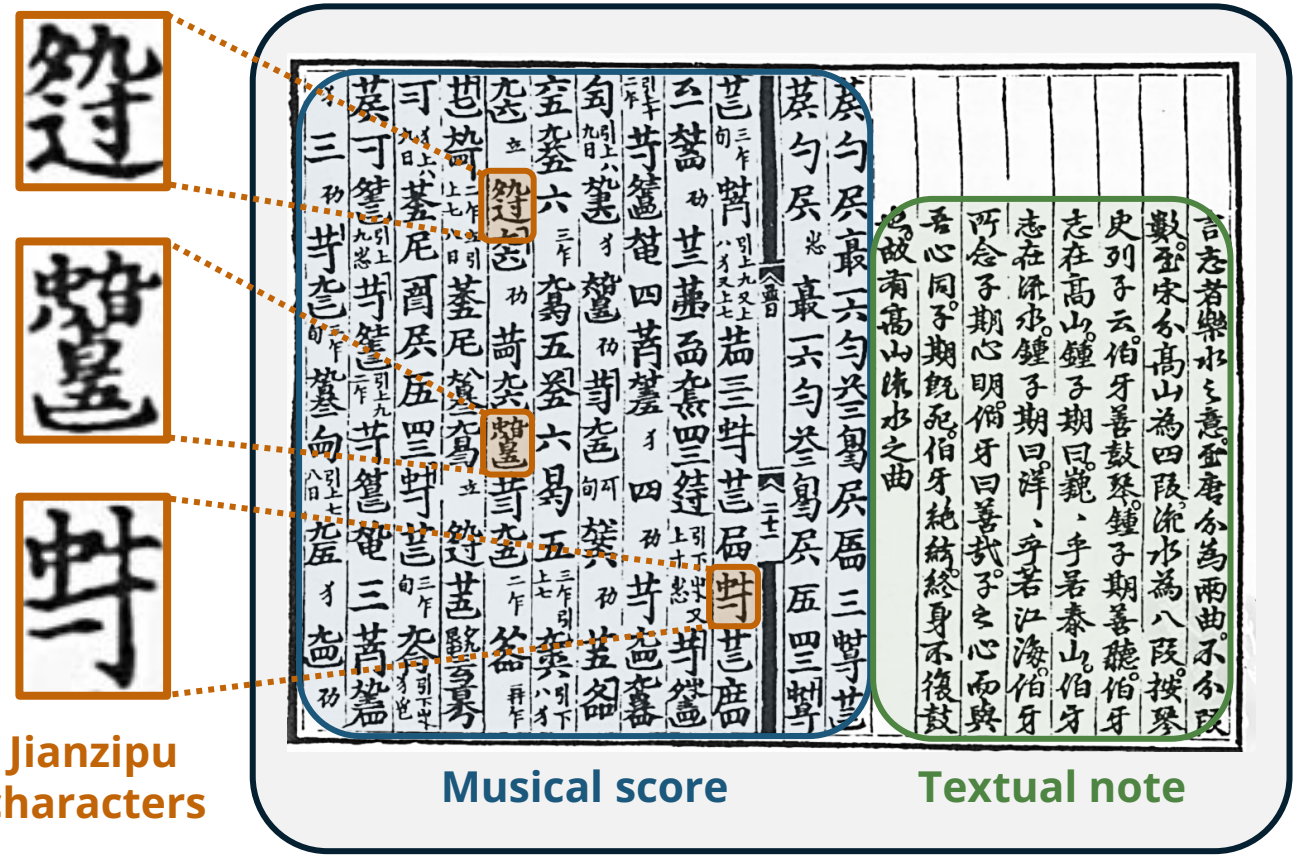


(Han et al., 2025)

Han Han, Vincent Lostanlen, and Mathieu Lagrange, “GuqinSonGest: A multimodal and historically grounded dataset of guqin playing techniques,” *Sound and Music Computing Conference (SMC), 2025*.

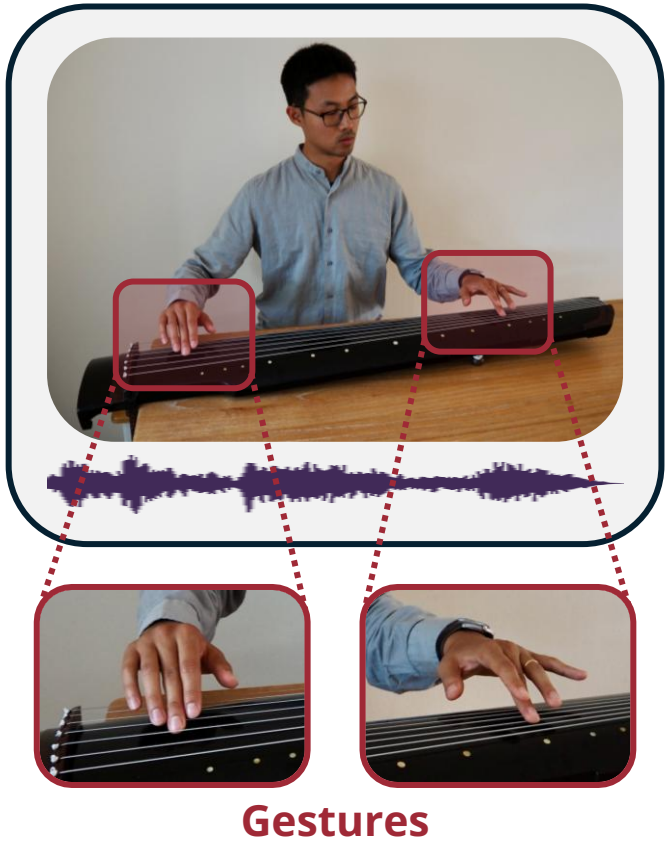
Aligning Surviving Notations & Living Practices

Surviving Notations



3,000-10,000 titles, 15,000+ pages

Living Practices

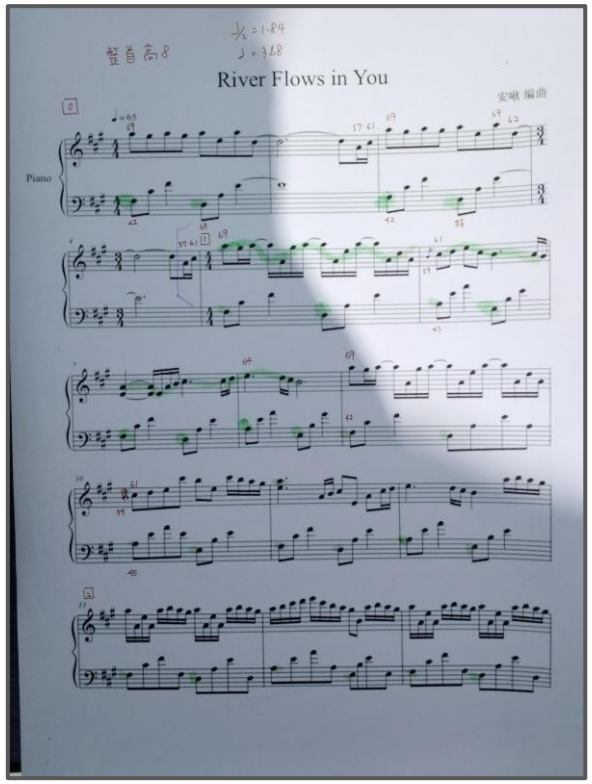


Pictured playing the guqin is Ming Wilson

Recap
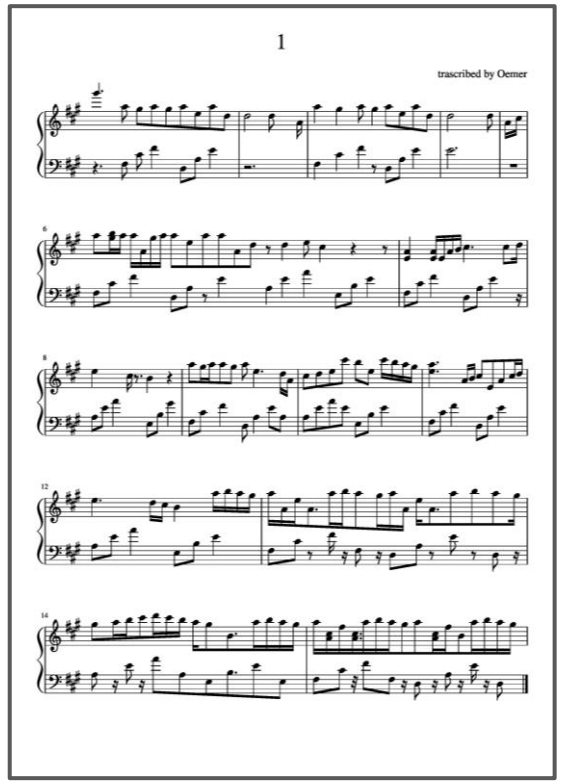
Optical Music Recognition (OMR)

- **Goal**: Convert **scanned sheet music** into **digital musical notation**



(Source: breezewhite.github.io)
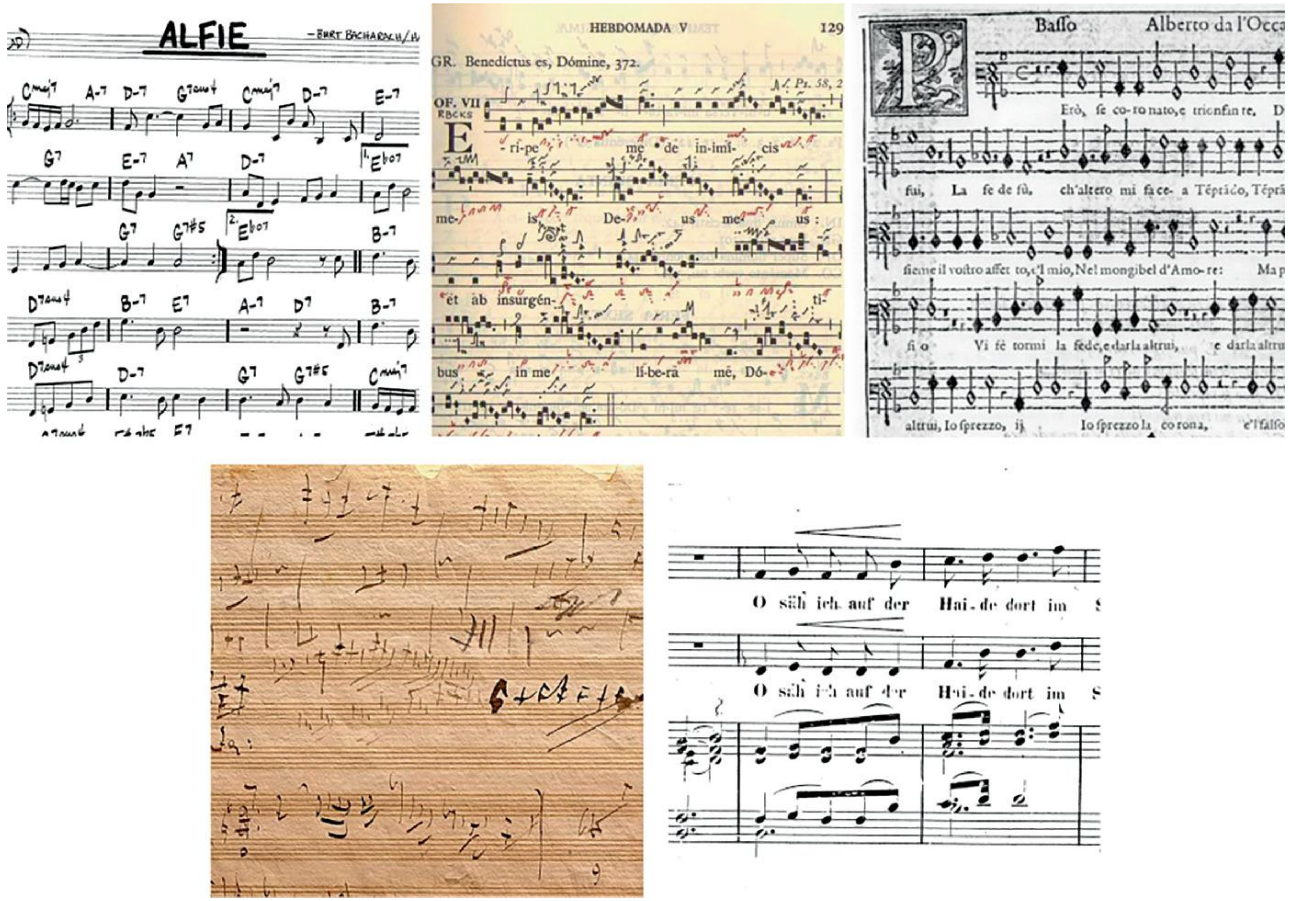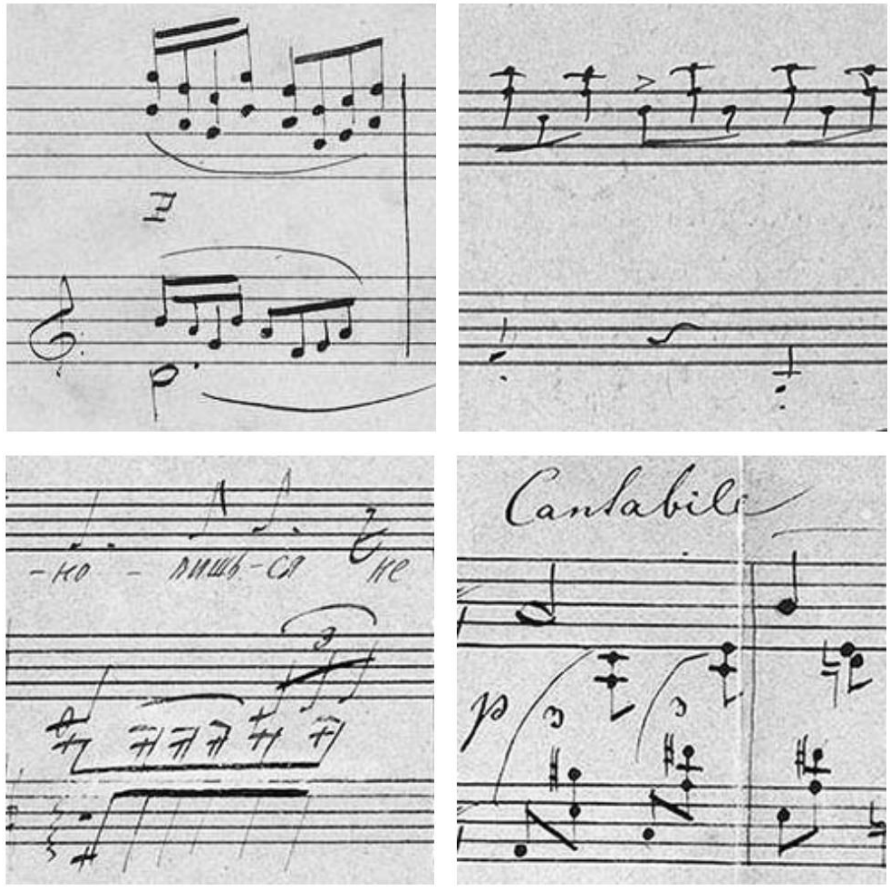




(Source: breezewhite.github.io)

breezewhite.github.io/oemer/

Challenges of OMR



(Source: Calvo-Zaragoza et al., 2018)

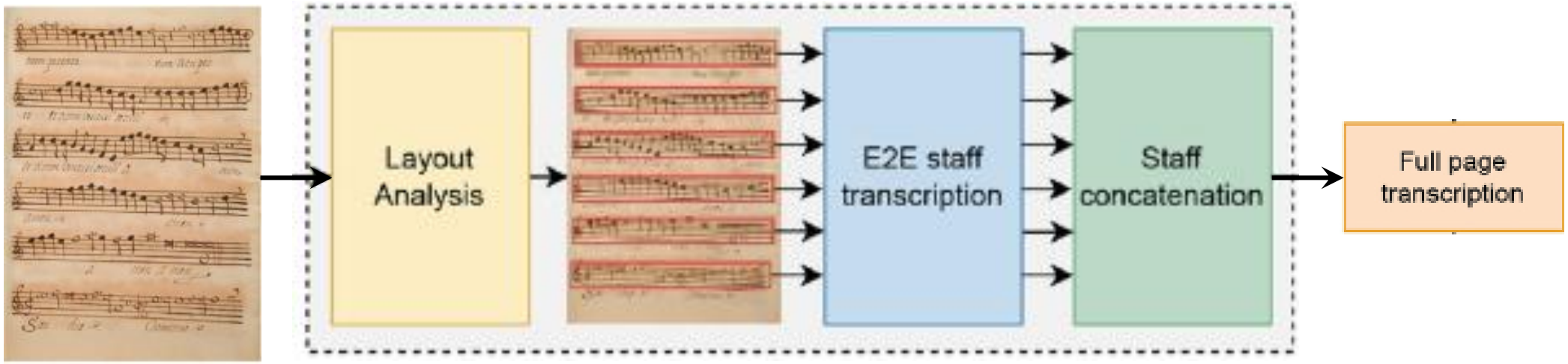


(Source: Novotný & Pokorný, 2015)

Jorge Calvo-Zaragoza, Juan C. Martinez-Sevilla, Carlos Penarrubia, and Antonio Rios-Vila, "Optical Music Recognition: Recent Advances, Current Challenges, and Future Directions," *ICDAR*, 2023.

Jiří Novotný and Jaroslav Pokorný, "Introduction to Optical Music Recognition: Overview and Practical Challenges," *DATESO*, 2015.

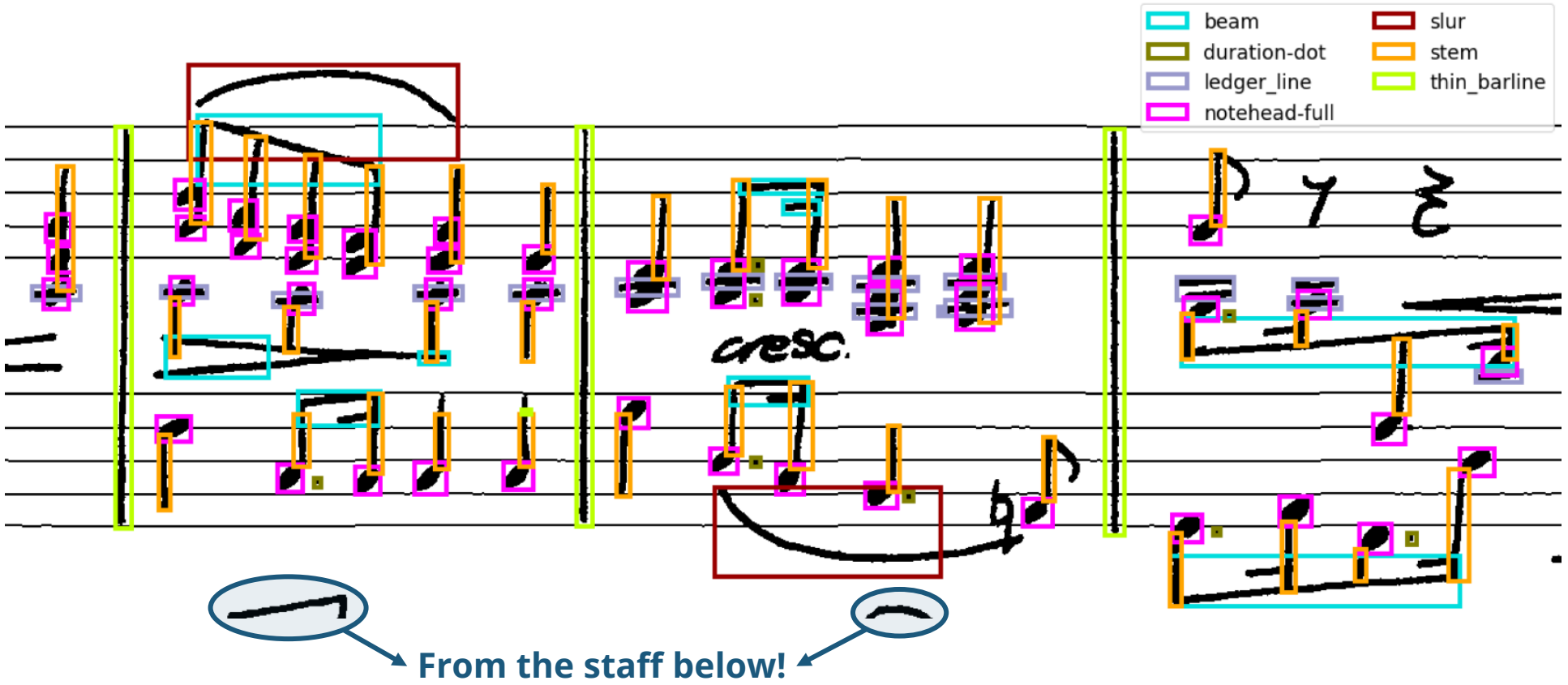
Common Pipeline of OMR Systems



(Source: Calvo-Zaragoza et al., 2018)

Jorge Calvo-Zaragoza, Juan C. Martinez-Sevilla, Carlos Penarrubia, and Antonio Rios-Vila, "Optical Music Recognition: Recent Advances, Current Challenges, and Future Directions," *ICDAR*, 2023.

Musical Object Recognition

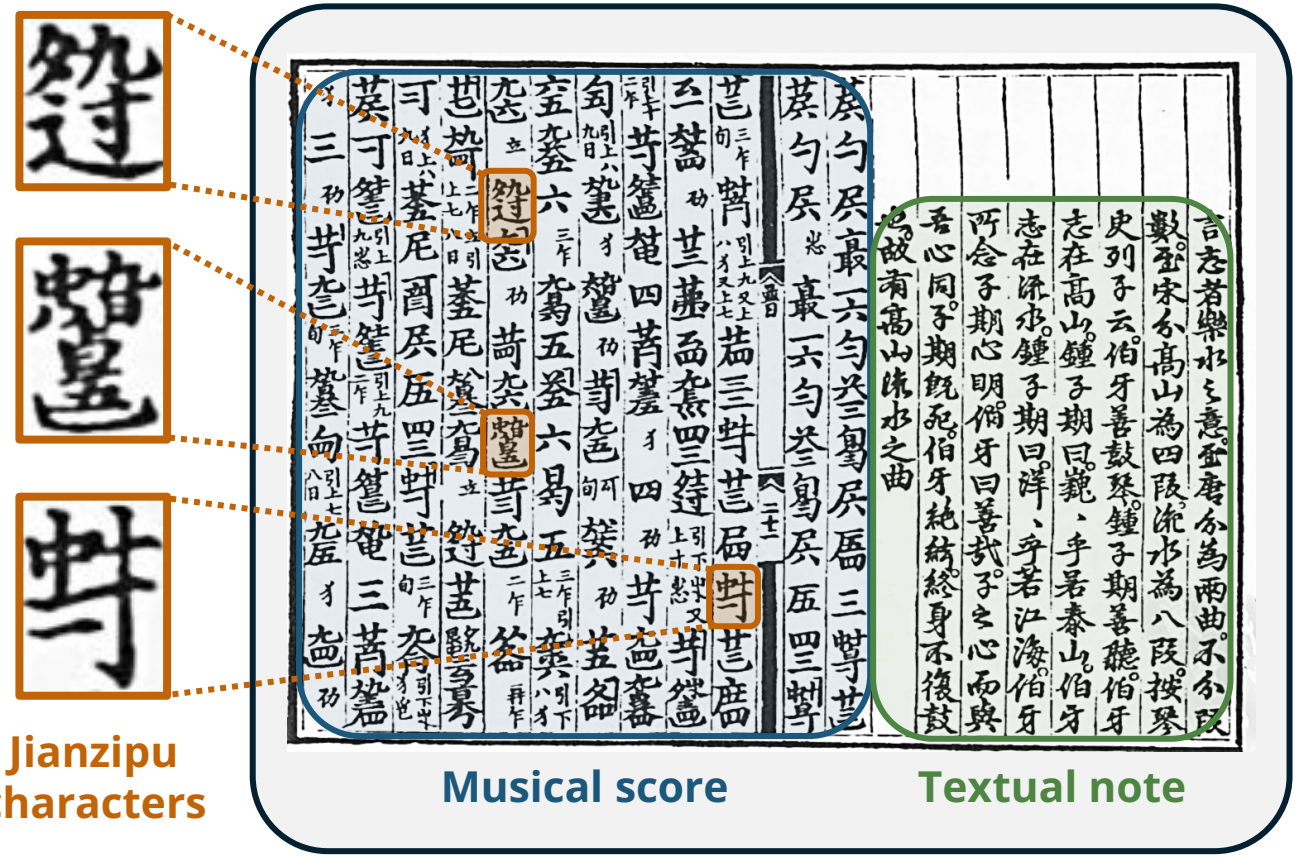


(Source: Pacha et al., 2018)

Alexander Pacha, Jan Hajič, and Jorge Calvo-Zaragoza, "A Baseline for General Music Object Detection with Deep Learning," *Applied Science*, 8(9):1488, 2018.

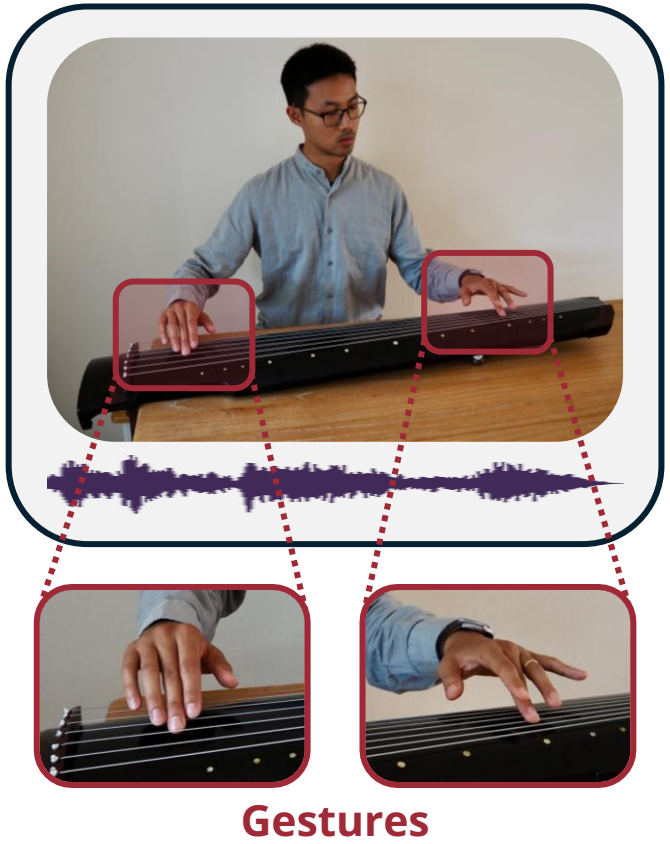
Aligning Surviving Notations & Living Practices

Surviving Notations



3,000-10,000 titles, 15,000+ pages

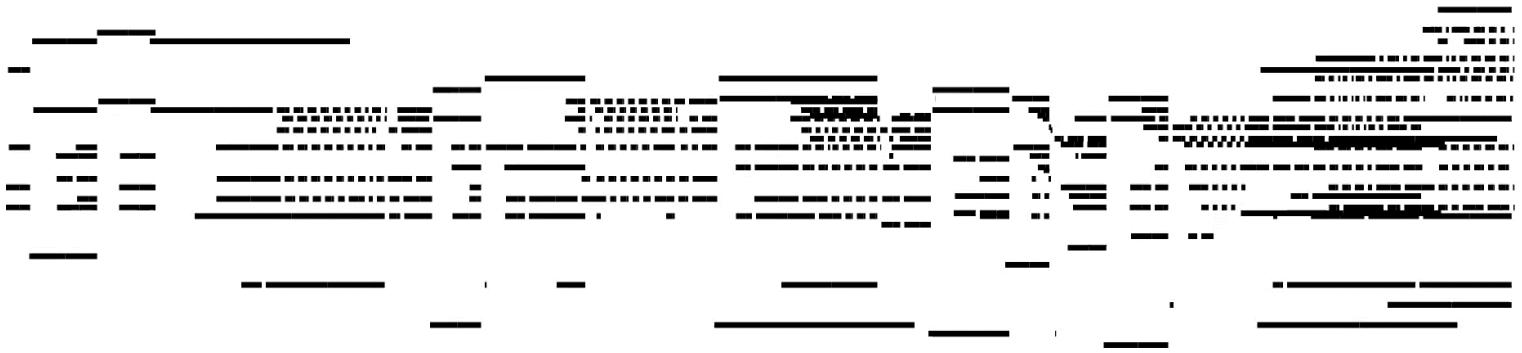
Living Practices



Pictured playing the guqin is Ming Wilson

Next Lecture

Language-based Music Generation



(Source: Huang et al., 2018)