



Universitat
Pompeu Fabra
Barcelona

MTG
Music Technology
Group



Knowledge Acquisition from Music Digital Libraries

Sergio Oramas, Mohamed Sordo

Motivation

- Musicological Knowledge is hidden between the lines
- Machines don't know how to read

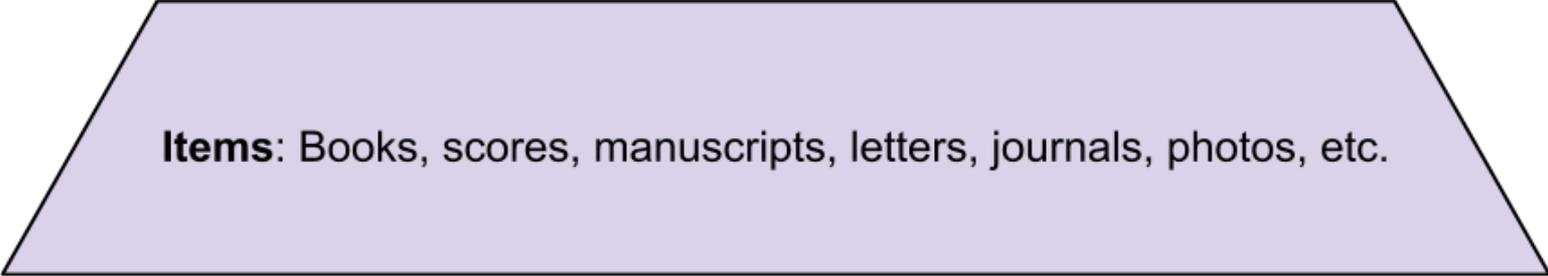


Why Knowledge Acquisition?

- Obtain knowledge automatically
- Make complex questions
- Visualize the information
- Improve navigation
- Share knowledge

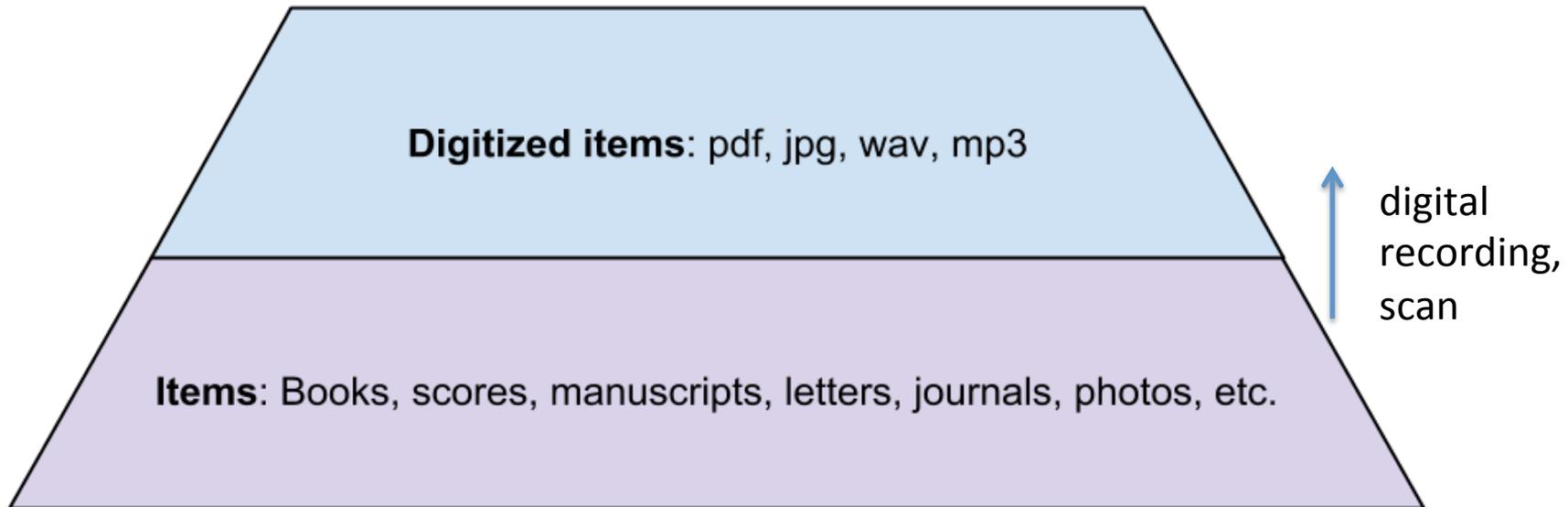


Musical Libraries

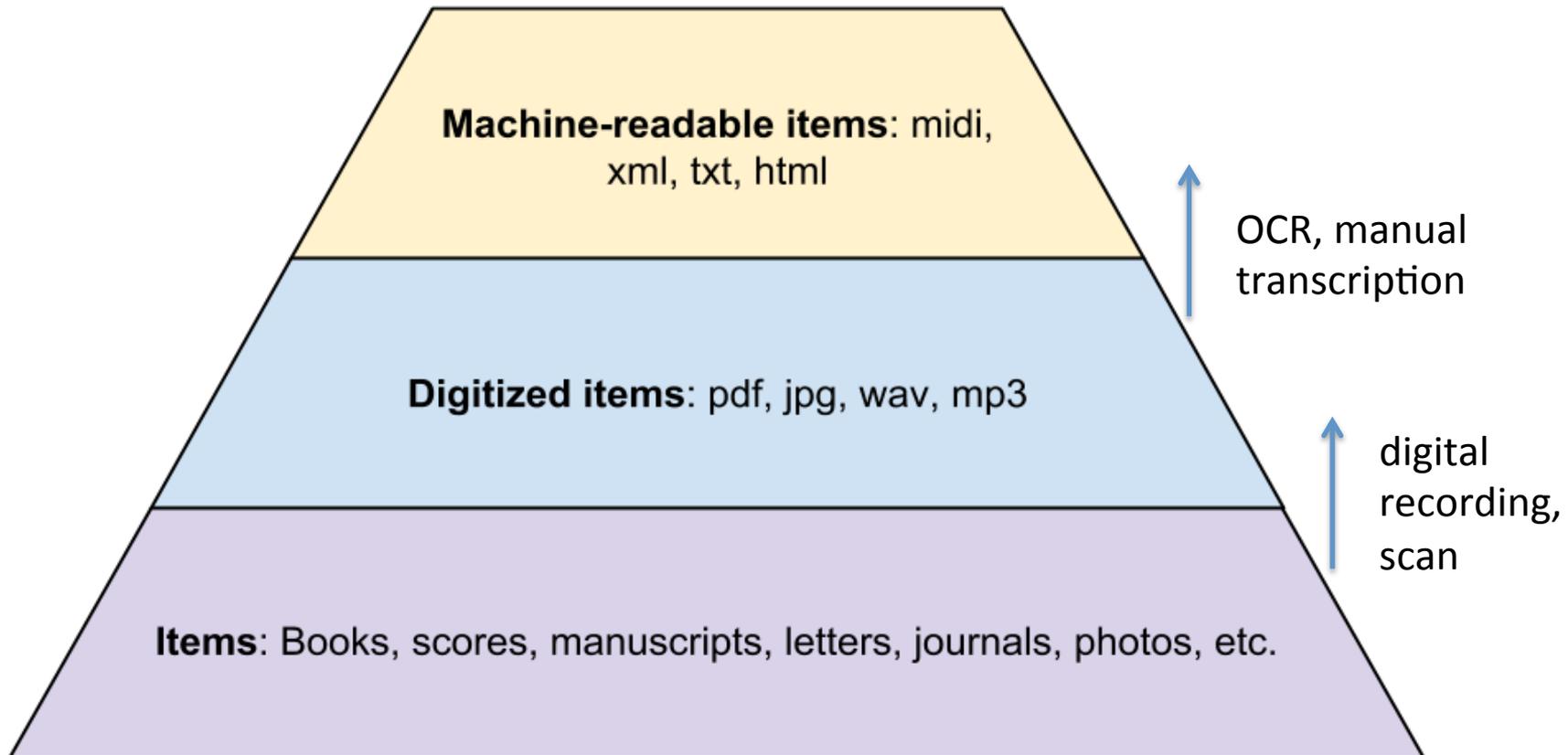


Items: Books, scores, manuscripts, letters, journals, photos, etc.

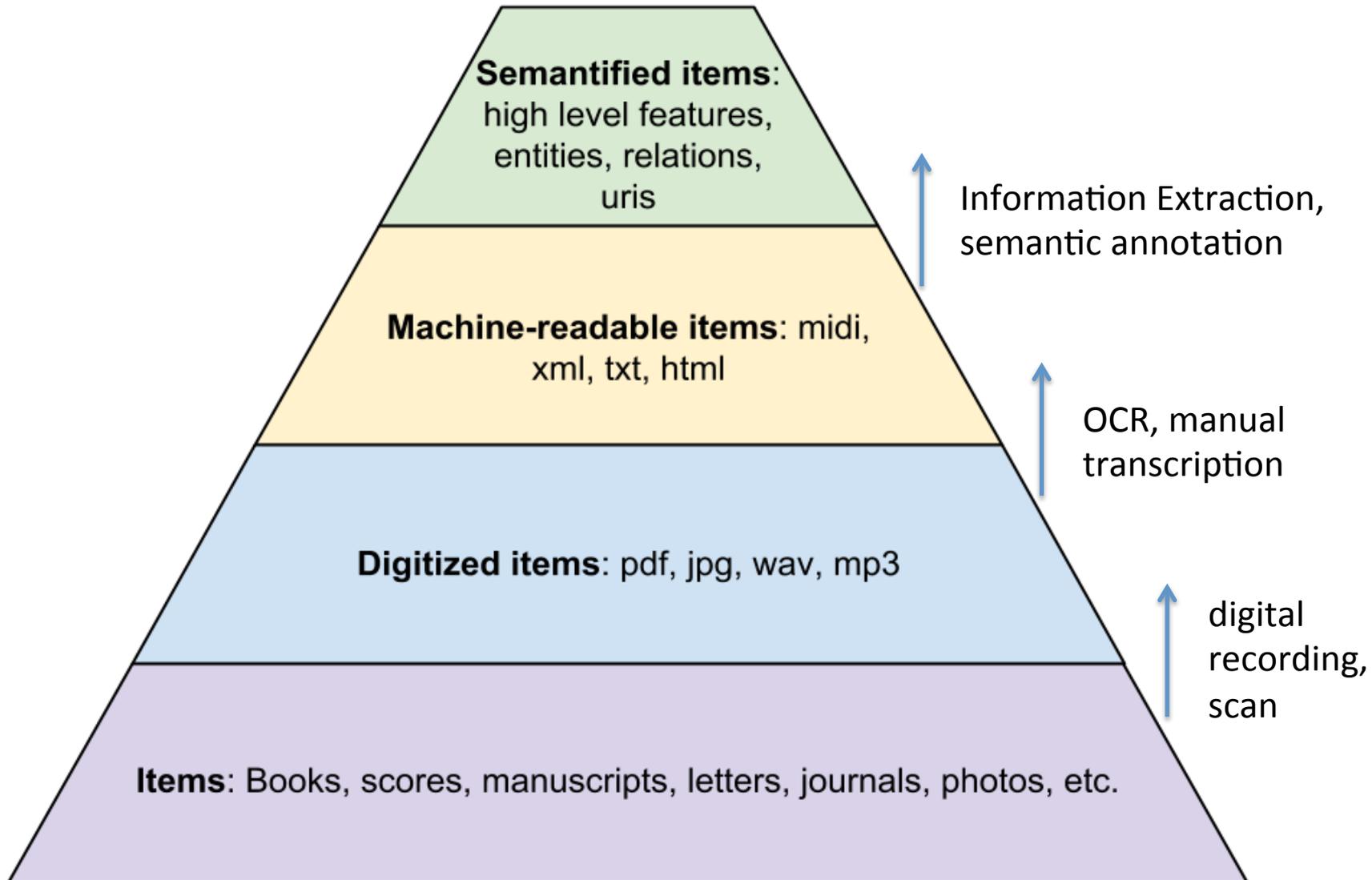
Musical Libraries



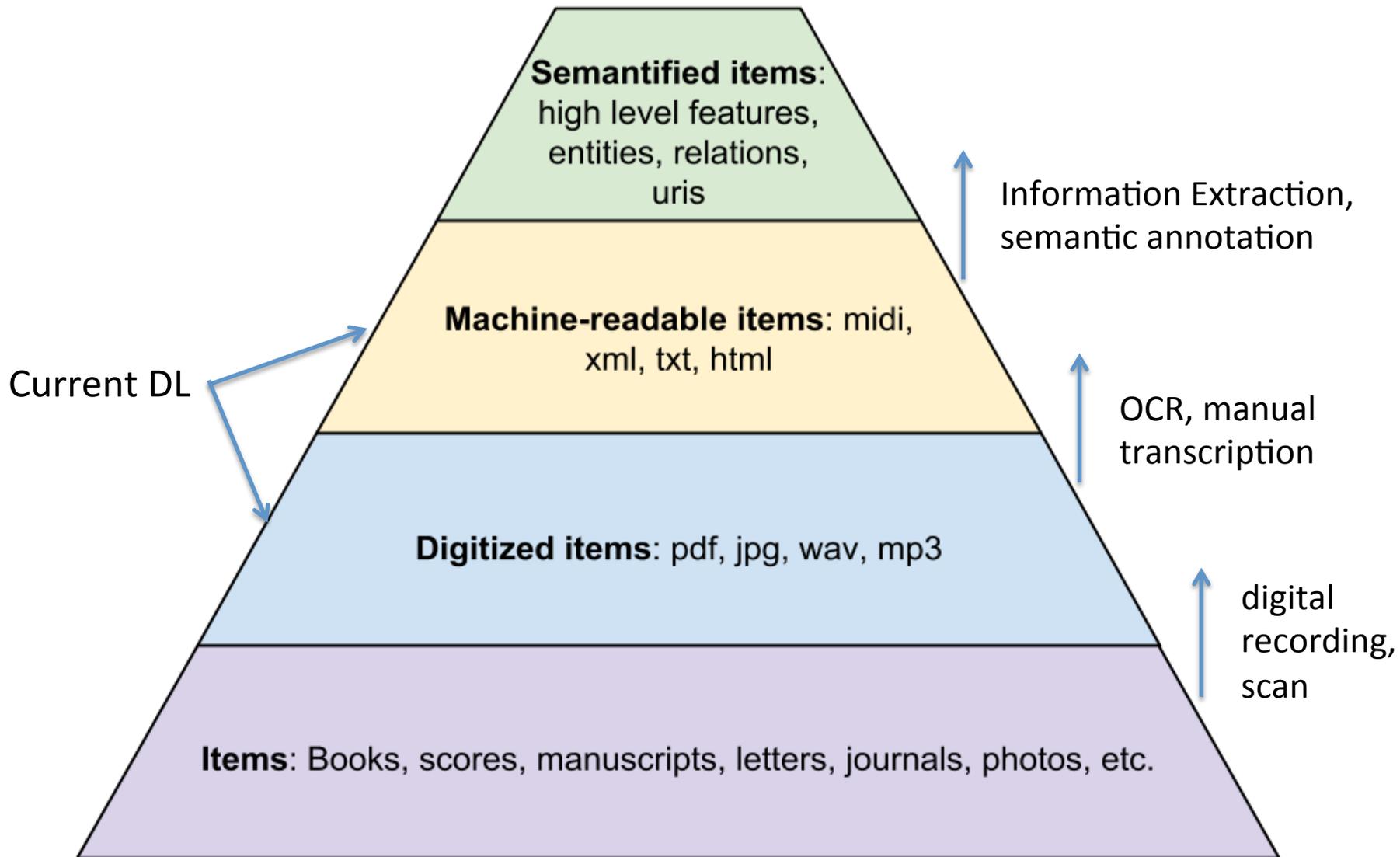
Musical Libraries



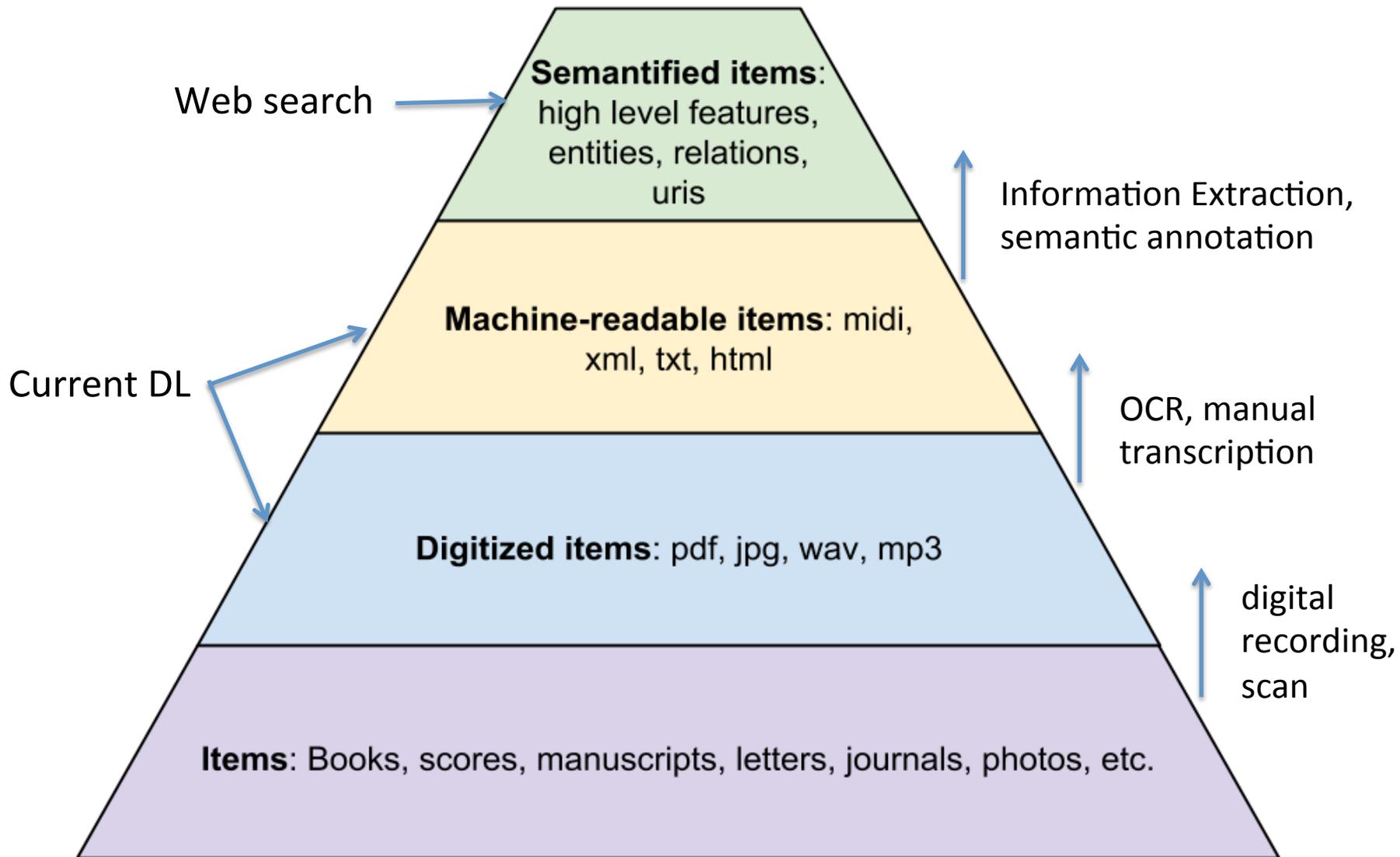
Musical Libraries



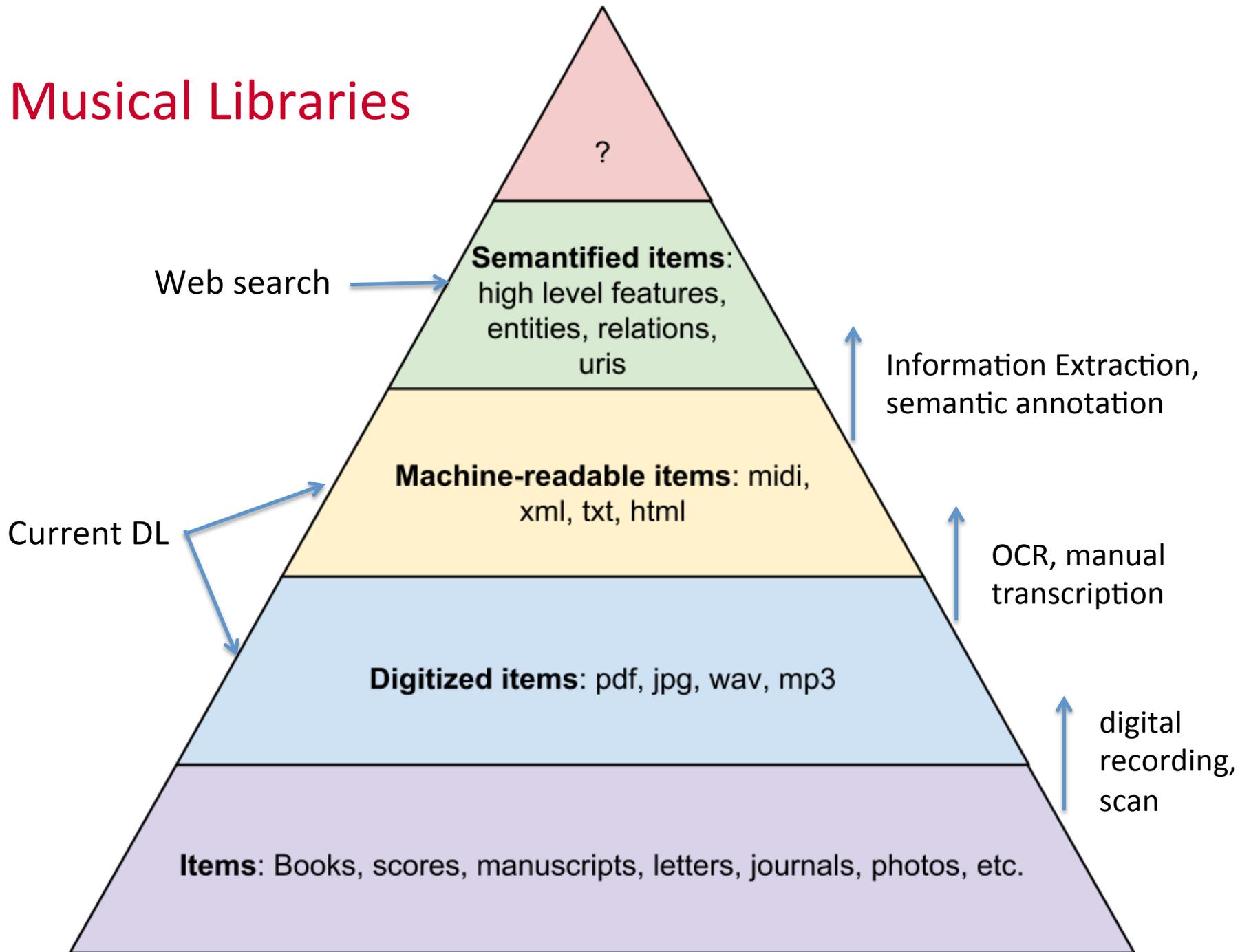
Musical Libraries



Musical Libraries

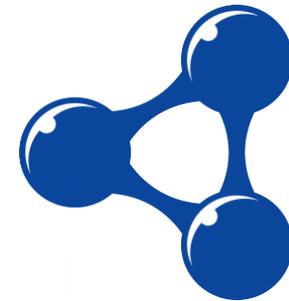


Musical Libraries



Semantic Web

- The **Semantic Web** aims at converting the current web, dominated by unstructured and semi-structured documents into a web of linked data.
- Achievements useful for Digital Libraries
 - Common framework for data representation and interconnection (RDF, ontologies)
 - Semantic technologies to annotate texts (Entity Linking)
 - Language for complex queries (SPARQL)



Wikipedia and DBpedia



- **Digital Encyclopedia**
- Unstructured
- Keyword search

- **Knowledge Base**
- Structured
- Query search



WIKIPEDIA
The Free Encyclopedia

Article **Talk**

Read **Edit** [View history](#)

Search

Claude Debussy

From Wikipedia, the free encyclopedia

"Debussy" redirects here. For other uses, see [Debussy \(disambiguation\)](#).

Claude-Achille Debussy^[1] (French: [klod aʃil debysɪ]^[2]; 22 August 1862 – 25 March 1918) was a French composer. Along with [Maurice Ravel](#), he was one of the most prominent figures associated with [Impressionist music](#), though he himself disliked the term when applied to his compositions.^[3] He was made [Chevalier](#) of the [Legion of Honour](#) in his native France in 1903.^[4] Debussy was among the most influential composers of the late 19th and early 20th centuries, and his use of non-traditional scales and [chromaticism](#) influenced many composers who followed.^[5]

Debussy's music is noted for its sensory content and frequent usage of [atonality](#). The prominent French literary style of his period was known as [Symbolism](#), and this movement directly inspired Debussy both as a composer and as an active cultural participant.^[6]

Contents [hide]

- 1 Early life
 - 1.1 Musical development
- 2 Personal life
- 3 Death
- 4 Music
 - 4.1 Style
 - 4.2 List of works
 - 4.3 Early works
 - 4.4 Middle works
 - 4.5 Late works
 - 4.6 Mathematical structuring
 - 4.7 Influences



Claude Debussy in 1908

- [Main page](#)
- [Contents](#)
- [Featured content](#)
- [Current events](#)
- [Random article](#)
- [Donate to Wikipedia](#)
- [Wikipedia store](#)

- [Interaction](#)
 - [Help](#)
 - [About Wikipedia](#)
 - [Community portal](#)
 - [Recent changes](#)
 - [Contact page](#)

- [Tools](#)
 - [What links here](#)
 - [Related changes](#)
 - [Upload file](#)
 - [Special pages](#)
 - [Permanent link](#)
 - [Page information](#)
 - [Wikidata item](#)
 - [Cite this page](#)

- [Print/export](#)
 - [Create a book](#)
 - [Download as PDF](#)
 - [Printable version](#)

About: [Claude Debussy](#)

An Entity of Type : [agent](#), from Named Graph : <http://dbpedia.org>, within Data Space : <dbpedia.org>



Claude-Achille Debussy (Saint-Germain-en-Laye, Francia, 22 de agosto de 1862 - París, 25 de marzo de 1918) fue un compositor francés y una figura central en la música europea de finales del siglo xix y comienzos del siglo xx y, junto a Maurice Ravel, una de las figuras más prominentes de la música impresionista, aunque al propio compositor no le gustaba este término cuando se aplicaba a sus composiciones. Fue nombrado Caballero de la Legión de Honor en 1903.

Property	Value
dbpedia-owl:abstract	<ul style="list-style-type: none"> Achille-Claude Debussy (French: [aʃil klod dəbysij]; 22 August 1862 – 25 March 1918) was a French composer. Along with Maurice Ravel, he was one of the most prominent figures associated with Impressionist music, though he himself intensely disliked the term when applied to his compositions. In France, he was made Chevalier of the Legion of Honour in 1903. Debussy was among the most influential composers of the late 19th and early 20th centuries, and his use of non-traditional scales and chromaticism influenced many composers who followed. Debussy's music is noted for its sensory content and frequent eschewing of tonality. The French literary style of his period was known as Symbolism, and this movement directly inspired Debussy both as a composer and as an active cultural participant. Claude-Achille Debussy (Saint-Germain-en-Laye, Francia, 22 de agosto de 1862 - París, 25 de marzo de 1918) fue un compositor francés y una figura central en la música europea de finales del siglo xix y comienzos del siglo xx y, junto a Maurice Ravel, una de las figuras más prominentes de la música impresionista, aunque al propio compositor no le gustaba este término cuando se aplicaba a sus composiciones. Fue nombrado Caballero de la Legión de Honor en 1903.
dbpedia-owl:alias	<ul style="list-style-type: none"> Debussy, Achille-Claude
dbpedia-owl:birthDate	<ul style="list-style-type: none"> 1862-08-22 (xsd:date)
dbpedia-owl:birthYear	<ul style="list-style-type: none"> 1862-01-01 (xsd:date)
dbpedia-owl:deathDate	<ul style="list-style-type: none"> 1918-03-25 (xsd:date)
dbpedia-owl:deathYear	<ul style="list-style-type: none"> 1918-01-01 (xsd:date)
dbpedia-owl:individualisedGnd	<ul style="list-style-type: none"> 118524186
dbpedia-owl:thumbnail	<ul style="list-style-type: none"> http://commons.wikimedia.org/wiki/Special:FilePath/Claude_Debussy_ca_1908,_foto_av_Félix_Nadar.jpg?width=300
dbpedia-owl:viafId	<ul style="list-style-type: none"> 6219636
dbpedia-owl:wikiPageExternalLink	<ul style="list-style-type: none"> http://debussypiano.com/ http://www.musopen.com/ http://www.quebec.ca/musique/catal/debussy/debcat.htm
dbpedia-owl:wikiPageID	<ul style="list-style-type: none"> 6260 (xsd:integer)
dbpedia-owl:wikiPageRevisionID	<ul style="list-style-type: none"> 605644927 (xsd:integer)
dbpprop:alternativeNames	<ul style="list-style-type: none"> Debussy, Achille-Claude
dbpprop:class	<ul style="list-style-type: none"> artist
dbpprop:date	<ul style="list-style-type: none"> November 2012
dbpprop:dateOfBirth	<ul style="list-style-type: none"> 1862-08-22 (xsd:date)
dbpprop:dateOfDeath	<ul style="list-style-type: none"> 1918-03-25 (xsd:date)
dbpprop:description	<ul style="list-style-type: none"> Performed by Robin Alciatore. Courtesy of Musopen Performed by Sarah Bassingthwaite

DBpedia

- Dbpedia example queries
 - Composers born in Vienna in XVIII Century
 - American jazz musicians that have written songs recorded by RCA Records
- Dbpedia graph applications
 - Entity Relevance
 - Entity Similarity
 - Entity Recommendation

Google Knowledge Graph

Google   Sergio   

Web Imágenes Vídeos Maps Libros Más ▾ Herramientas de búsqueda 

Cerca de 549,000 resultados (0.39 segundos)

Anton Webern - Wikipedia, la enciclopedia libre
https://es.wikipedia.org/wiki/Anton_Webern ▾
Webern nació en Viena, Austria, y fue bautizado Anton Friedrich Wilhelm von Webern. Siempre prescindió de sus nombres intermedios, y dejó de utilizar el von ...
[Biografía](#) - [La música de Webern](#) - [Lista de obras](#) - [Referencias](#)

Anton Webern - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/Anton_Webern ▾ [Traducir esta página](#)
Anton Webern (German: [ˈanton ˈveːbɐn] (listen); 3 December 1883 – 15 September 1945) was an Austrian composer and conductor. Along with his mentor ...

Anton Webern
www.antonwebern.com/ ▾ [Traducir esta página](#)
Site dedicated to one of the 20th century's greatest composers. Includes photos, biography, downloadable MP3s, opus list, and links. Requires Flash 8 to view.

Category:Webern, Anton - IMSLP/Petrucci Music Library ...
imslp.org/wiki/Category:Webern,_Anton ▾ [Traducir esta página](#)
7 mar. 2014 - Compositions by: Webern, Anton. The following 37 pages are in this category, out of 37 total. A. Das Augenlicht, Op.26 (Webern, Anton). B.

5 Movements, Op.5 (Webern, Anton) - IMSLP/Petrucci Music ...
[imslp.org/.../5_Movements,_Op.5_\(Webern,_Anton...](http://imslp.org/.../5_Movements,_Op.5_(Webern,_Anton...) ▾ [Traducir esta página](#)
31 may. 2014 - Webern - Five movements for String Quartet Op5.pdf. Publisher Info.: Vienna: Universal Edition, 1922. Plate U.E. 5888.5889. Copyright:.

Anton Webern

Compositor



Anton von Webern fue un compositor austríaco. Fue miembro de la llamada Segunda Escuela de Viena. Como estudiante y brillante seguidor de Arnold Schoenberg, es uno de los más conocidos exponentes del ... [Wikipedia](#)

Fecha de nacimiento: 3 de diciembre de 1883, Viena, Austria
Fecha de la muerte: 15 de septiembre de 1945, Mittersill, Austria
Educación: Universidad de Viena
Composiciones: Variations for Piano, op. 27, String Quartet, Más
Hijos: Amalie Webern
Padres: Amelie Geer, Carl von Webern

También se ha buscado Ver 15 más



Arnold Schönberg



Alban Berg



Pierre Boulez



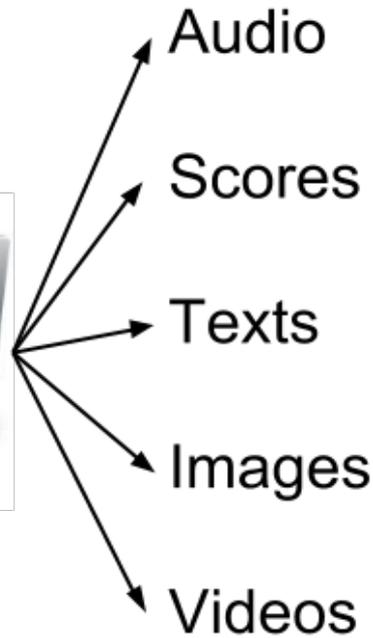
Igor Stravinski



Béla Bartók

Music Digital Libraries

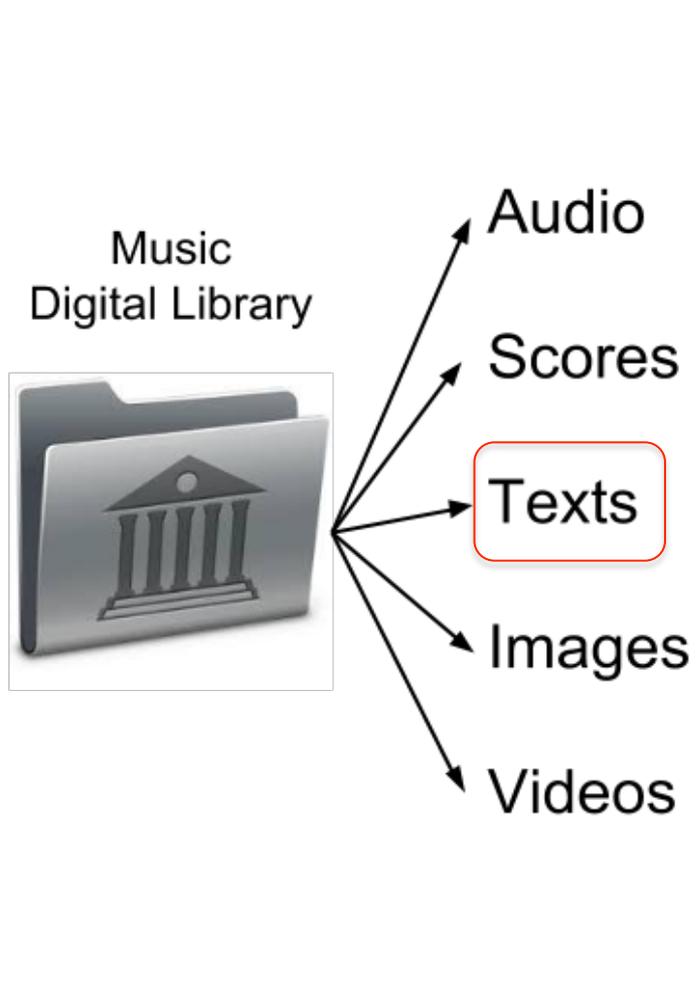
Music Digital Library



Dies ist ein Blindtext, vieles über die Schrift a setzt ist. Auf den erst Grauwert der Schriftflä kann man prüfen, wie lesen ist und wie sie ar Dies ist ein Blindtext, vieles über die Schrift a setzt ist. Auf den ersten Blick wird der Grauwert der Schriftfläche sichtbar. Dann kann man prüfen, wie gut die Schrift zu lesen ist und wie sie auf den Leser wirkt.

The collage includes: a snippet of a historical document with dense Latin text; musical notation on a staff; a red waveform representing audio; a wooden harpsichord; and a photograph of an orchestra performing.

Music Digital Libraries



Dies ist ein Blindtext, vieles über die Schrift a setzt ist. Auf den erst Grauwert der Schriftflä kann man prüfen, wie lesen ist und wie sie ar Dies ist ein Blindtext, vieles über die Schrift a setzt ist. Auf den ersten Blick wird der Grauwert der Schriftfläche sichtbar. Dann kann man prüfen, wie gut die Schrift zu lesen ist und wie sie auf den Leser wirkt.

Dataset: The New Grove

- Encyclopedic dictionary
- One of the largest reference works in Western music
- Artist biographies crawled from the Grove Music Online
 - 16,707 biographies (1st paragraph)
 - From pre-medieval to contemporary



Dataset: The New Grove

- What are the most relevant music schools?
- What are the artists most similar to Schoenberg?
- Which are the most represented roles in the Grove?
- Is there a migration tendency in artists? To which cities?
- What is the best city to die for a musician?



Dataset: The New Grove

Home | About | What's New | Subscriber Services | Contact Us | Help | Logout

Oxford Music Online

ALL CONTENT | BIOGRAPHIES | SUBJECT ENTRIES | TOOLS & RESOURCES

SEARCH

Search Only: Grove Music Online
[Advanced Search](#)

Grove Music Online

Results list | Next result »

Webern, Anton

Article Works Multimedia Related Content

Highlight On/Off Print Email Cite

Search within this article:

Kathryn Bailey.
Source: Grove Music Online
[Abbreviations](#)

Article contents

Webern, Anton (Friedrich Wilhelm von)

(*b* Vienna, 3 Dec 1883; *d* Mittersill, 15 Sept 1945). Austrian composer and conductor. **Webern**, who was probably Schoenberg's first private pupil, and Alban Berg, who came to him a few weeks later, were the most famous of Schoenberg's students and became, with him, the major exponents of 12-note technique in the second quarter of the 20th century. **Webern** applied the new technique more rigorously than either Schoenberg, who took many liberties, or Berg, who never used it exclusively; **Webern**'s strictness, and his innovative organization of rhythm and dynamics, were seized upon eagerly by Boulez and Stockhausen and other integral serialists of the Darmstadt School in the 1950s and were a significant influence on music in the second half of the century.

Information Extraction

Anton Webern

(b Vienna, 3 Dec 1883; d Mittersill, 15 Sept 1945). Austrian composer and conductor. Webern, who was probably Schoenberg's first private pupil, and Alban Berg, who came to him a few weeks later [...] Boulez and Stockhausen and other integral serialists of the Darmstadt School [...]

Information Extraction

Anton Webern

(b Vienna, 3 Dec 1883; d Mittersill, 15 Sept 1945). Austrian composer and conductor. Webern, who was probably Schoenberg's first private pupil, and Alban Berg, who came to him a few weeks later [...] Boulez and Stockhausen and other integral serialists of the Darmstadt School [...]

Information Extraction



Anton Webern

(b Vienna, 3 Dec 1883; d Mittersill, 15 Sept 1945). Austrian composer and conductor. Webern, who was probably Schoenberg's first private pupil, and Alban Berg, who came to him a few weeks later [...] Boulez and Stockhausen and other integral serialists of the Darmstadt School [...]



Information Extraction



Anton Webern

(b Vienna, 3 Dec 1883; d Mittersill, 15 Sept 1945). Austrian composer and conductor. Webern, who was probably Schoenberg's first private pupil, and Alban Berg, who came to him a few weeks later [...] Boulez and Stockhausen and other integral serialists of the Darmstadt School [...]



Information Extraction: Entity Linking



Anton Webern

(b Vienna, 3 Dec 1883; d Mittersill, 15 Sept 1945). Austrian composer and conductor. Webern, who was probably Schoenberg's first private pupil, and Alban Berg, who came to him a few weeks later [...] Boulez and Stockhausen and other integral serialists of the Darmstadt School [...]



Domain
Knowledge Base

Information Extraction: Relation Extraction

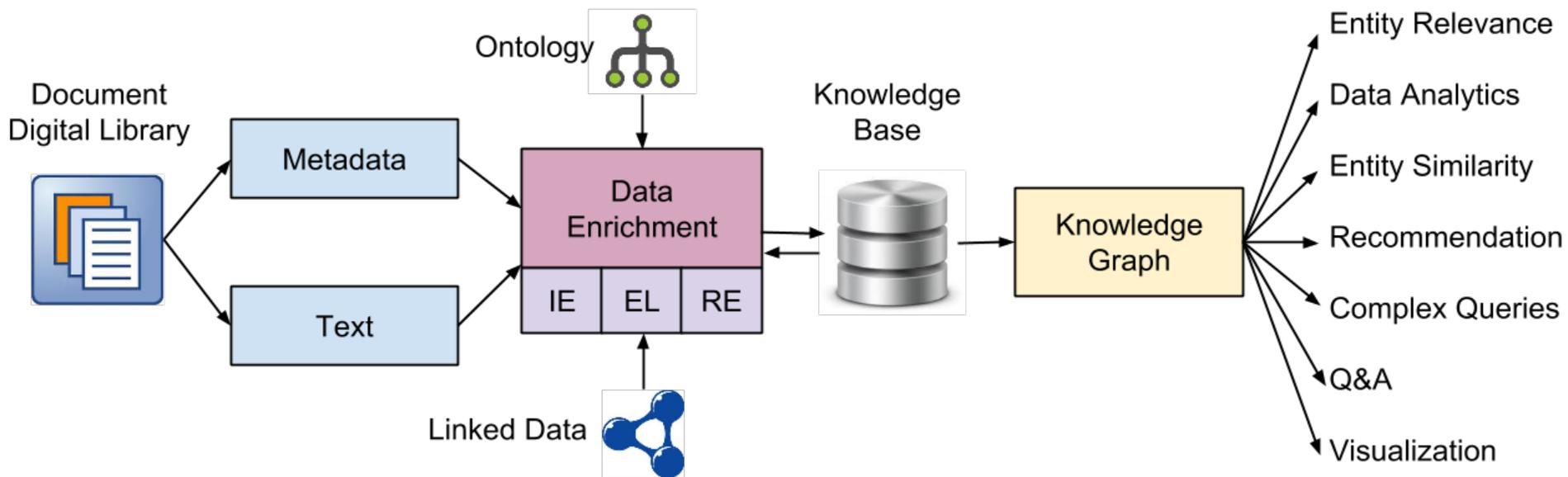
- Webern, who was probably Schoenberg's first private pupil

Information Extraction: Relation Extraction

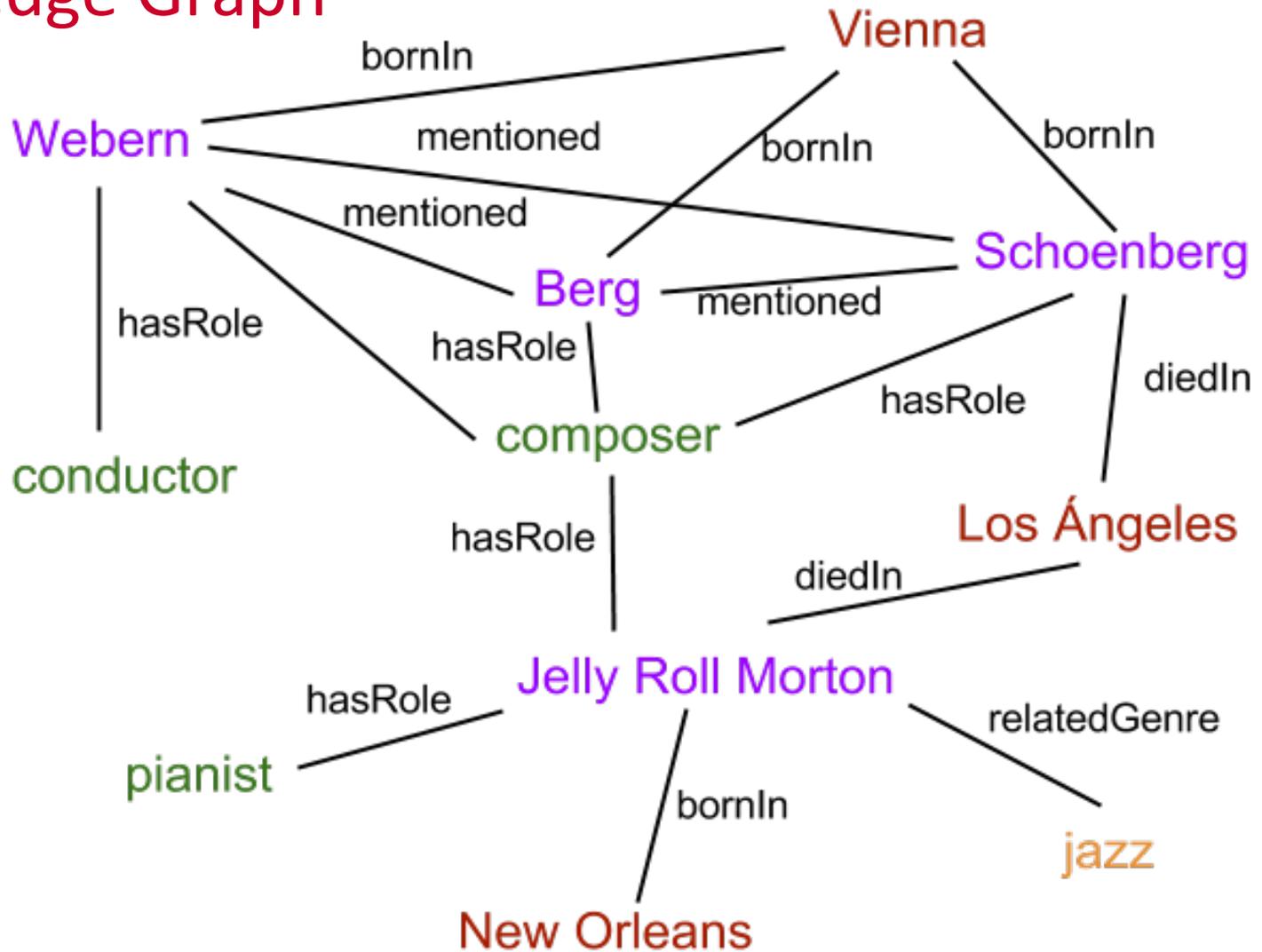
- Webern, who was probably Schoenberg's first private pupil



Methodology



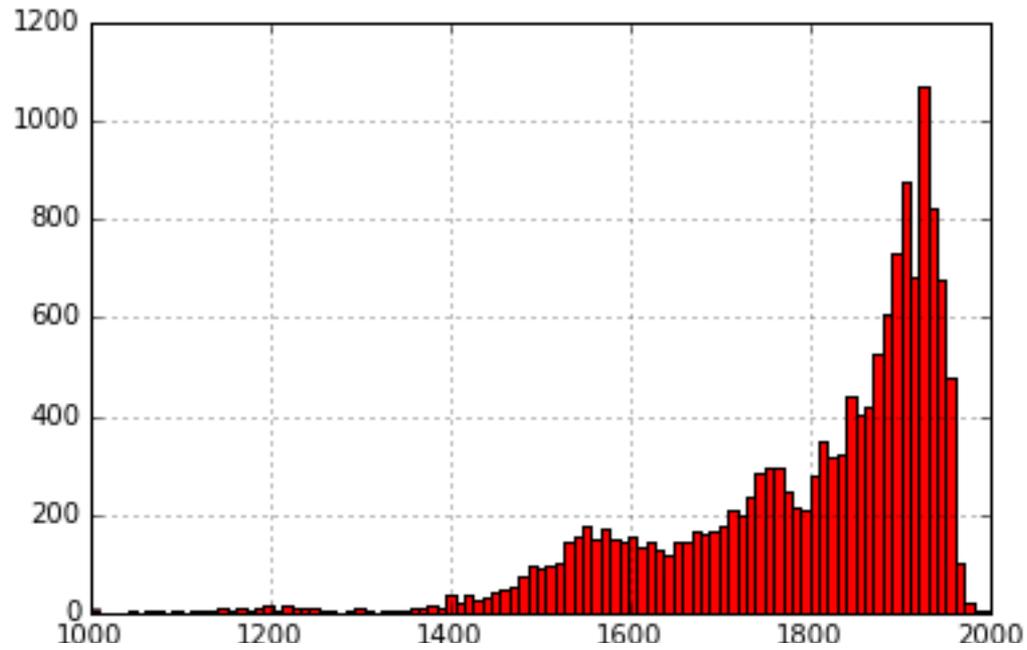
Knowledge Graph



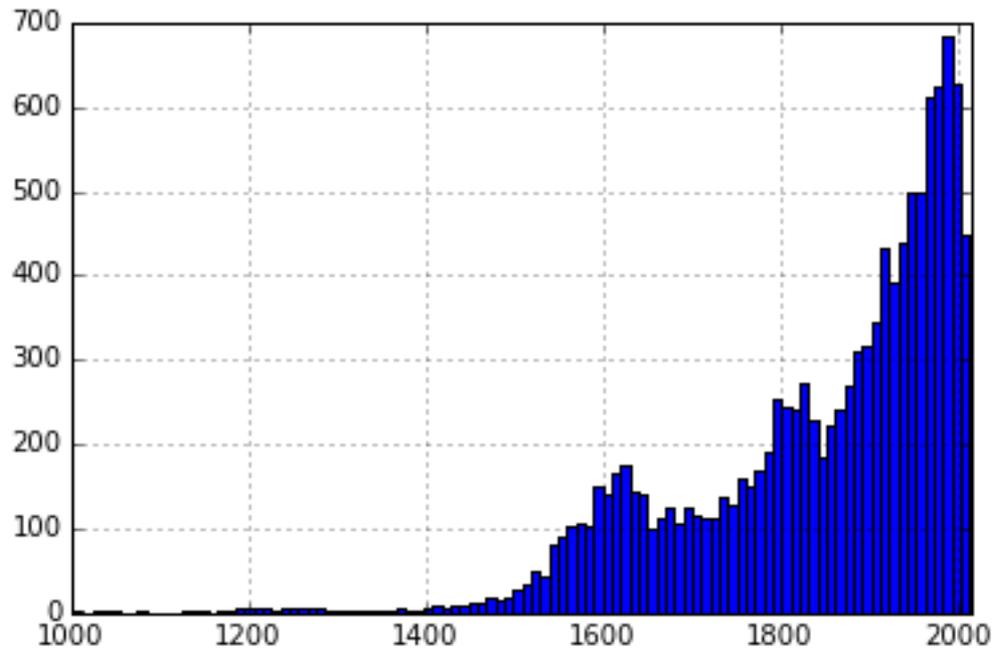
Knowledge Graph: Data Analytics

- 16,707 biographies
- 434 roles
- Graph
 - 47,367 nodes
 - 274,333 edges

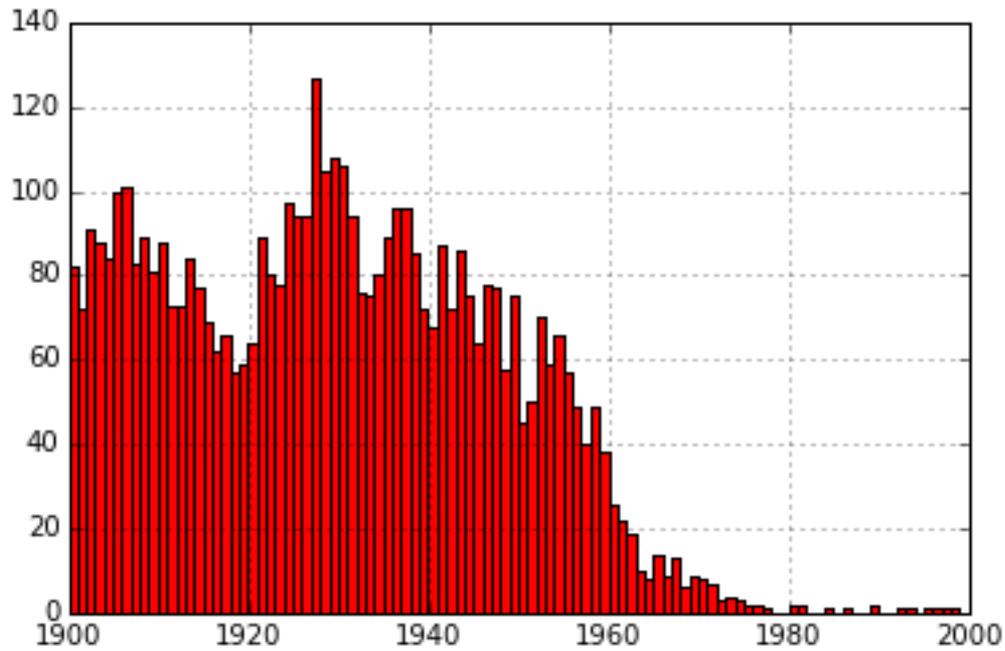
Role	Amount
composer	2618
teacher	1065
conductor	968
pianist	704
organist	676
singer	404
violinist	285
...	
musicologist	144
critic	133



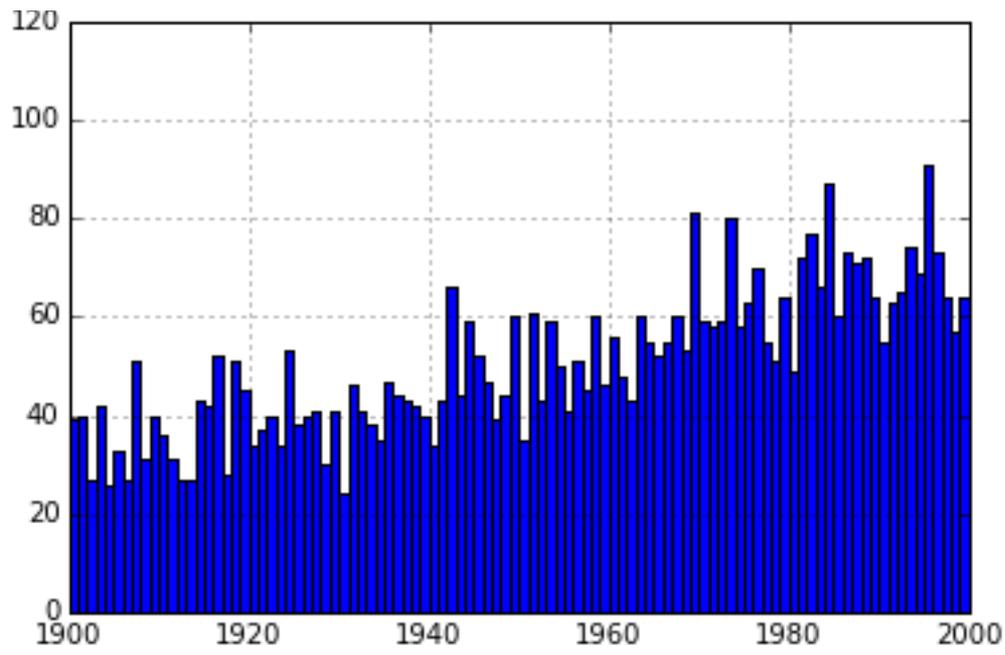
Birth Year



Death Year



Birth Year



Death Year

Knowledge Graph: Data Analytics

Country	Births	Deaths	Difference
United States	2317	2094	-10%
Italy	1616	1279	-21%
Germany	1270	1292	2%
France	991	1058	7%
United Kingdom	882	877	-1%

City	Births	Deaths	Difference
London	322	507	57%
Paris	304	720	137%
New York	266	501	88%
Vienna	177	292	65%
Rome	159	256	61%

Knowledge Graph: Entity Relevance

- City
 - Paris, London, Vienna, Rome, Venice, Berlin, Paris, New York
- Venue
 - Covent Garden Theatre, King's Theatre, Drury Lane, Carnegie Hall, Théâtre de la Monnaie, Stadttheater, Theatre Royal, ...
- Educational Institution
 - Paris Conservatoire, Moscow Conservatory, Juilliard School, St Petersburg Conservatory, Bmus, Prague Conservatory, Leipzig Conservatory, Vienna Hochschule für Musik, ...

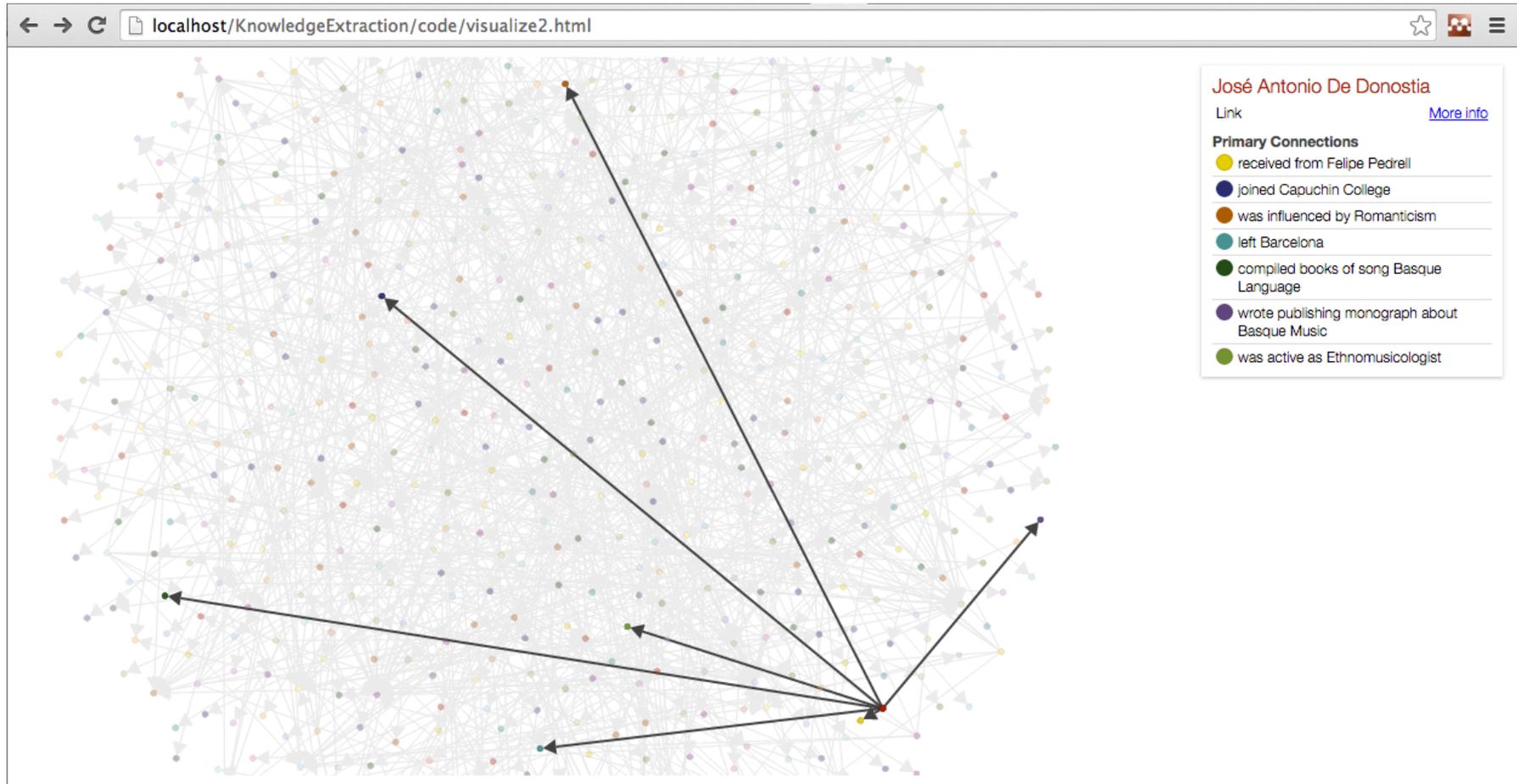
Knowledge Graph: Entity Relevance

- Biography subject
 - Haydn, Claude Debussy, Arnold Schoenberg, **Robert Stevenson**, Paul Hindemith, Giovanni Pierluigi da Palestrina, Gustav Mahler, Maurice Ravel, Jean-Philippe Rameau
 - Mozart?, Bach?, Wagner?
- Genre
 - chamber music, cappella, jazz, folk music, avant garde, baroque music, electronic music, musical theatre, plainchant

Knowledge Graph: Entity Similarity

- PageRank algorithm and Maximal Common Subgraph
- **Arnold Schoenberg:** Anton Webern, Paul Hindemith, Gustav Mahler, Alban Berg, Claude Debussy
- **Guido Adler:** Heinrich Jalowetz, Eusebius Mandyczewski, Robert Fuchs, Karl Weigl, Anton Wranitzky
- **Manuel de Falla:** Ricardo Viñes, Juan Vicente Lecuna, Enrique Granados, Miguel Llobet Soles, Luigi Russolo
- **Miles Davis:** Dizzy Gillespie, Herbie Hancock, Paul Chambers, Tony Williams, Cannonball Adderley

Relations Graph: Information Visualization



Relations Graph: Information Visualization

José Antonio De Donostia

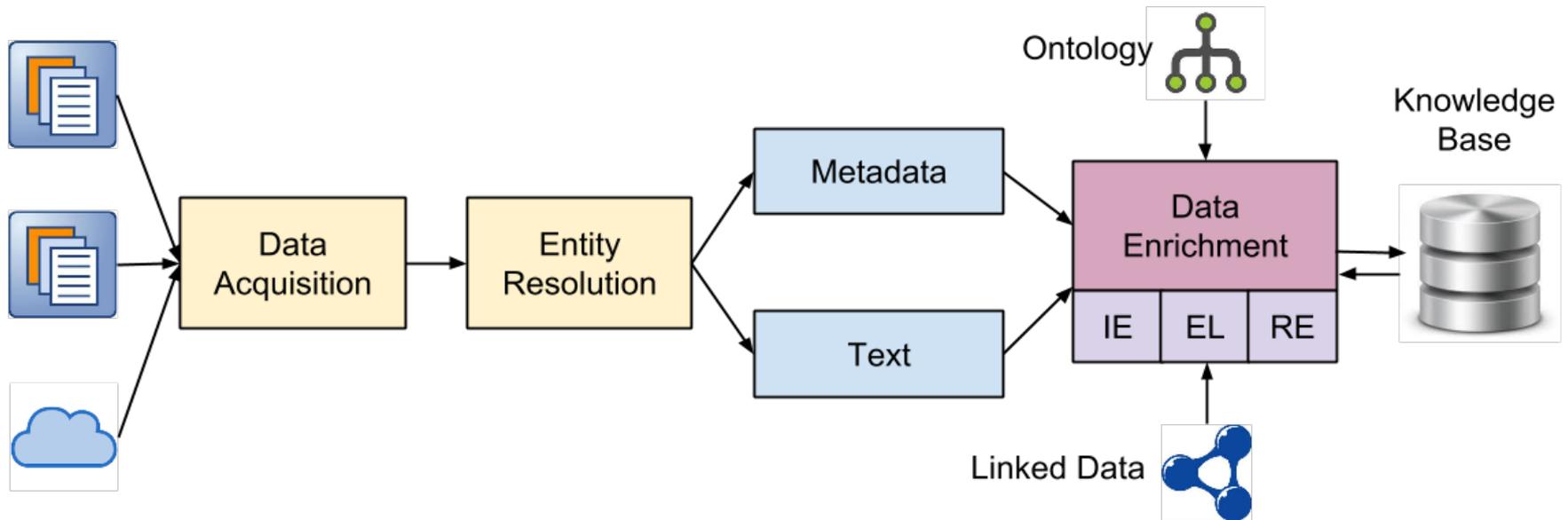
Link [More info](#)

Primary Connections

- received from Felipe Pedrell
- joined Capuchin College
- was influenced by Romanticism
- left Barcelona
- compiled books of song Basque Language
- wrote publishing monograph about Basque Music
- was active as Ethnomusicologist

Mixing Different Data Sources

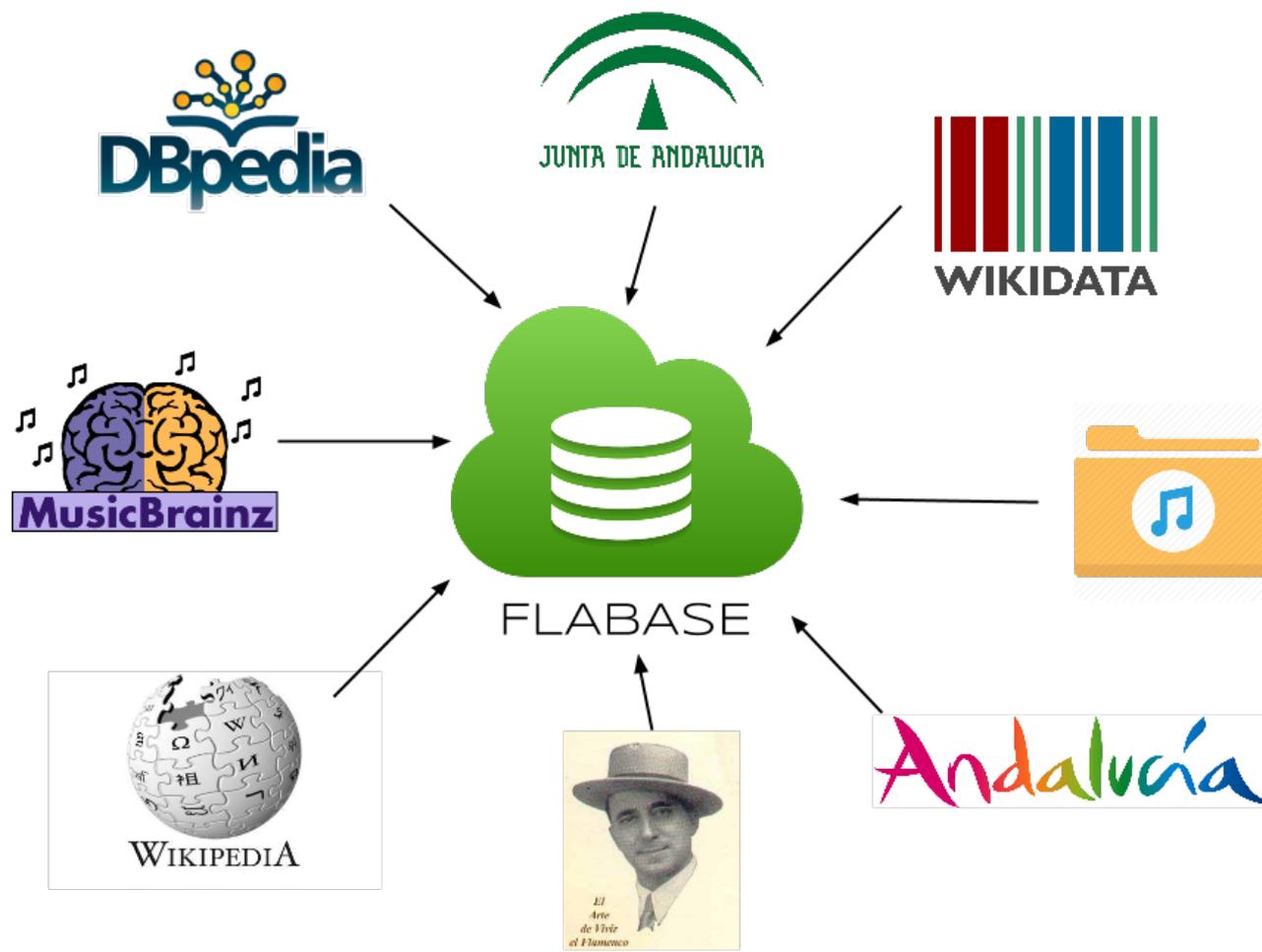
- Creation and curation of a library from Web content
- FlaBase: Flamenco Knowledge Base



Mixing Different Data Sources

- Data Acquisition
 - APIs
 - Web crawling
 - SPARQL endpoints
- Entity Resolution
 - String similarity between labels
 - Graph similarity (context information)

FlaBase: Flamenco Knowledge Base

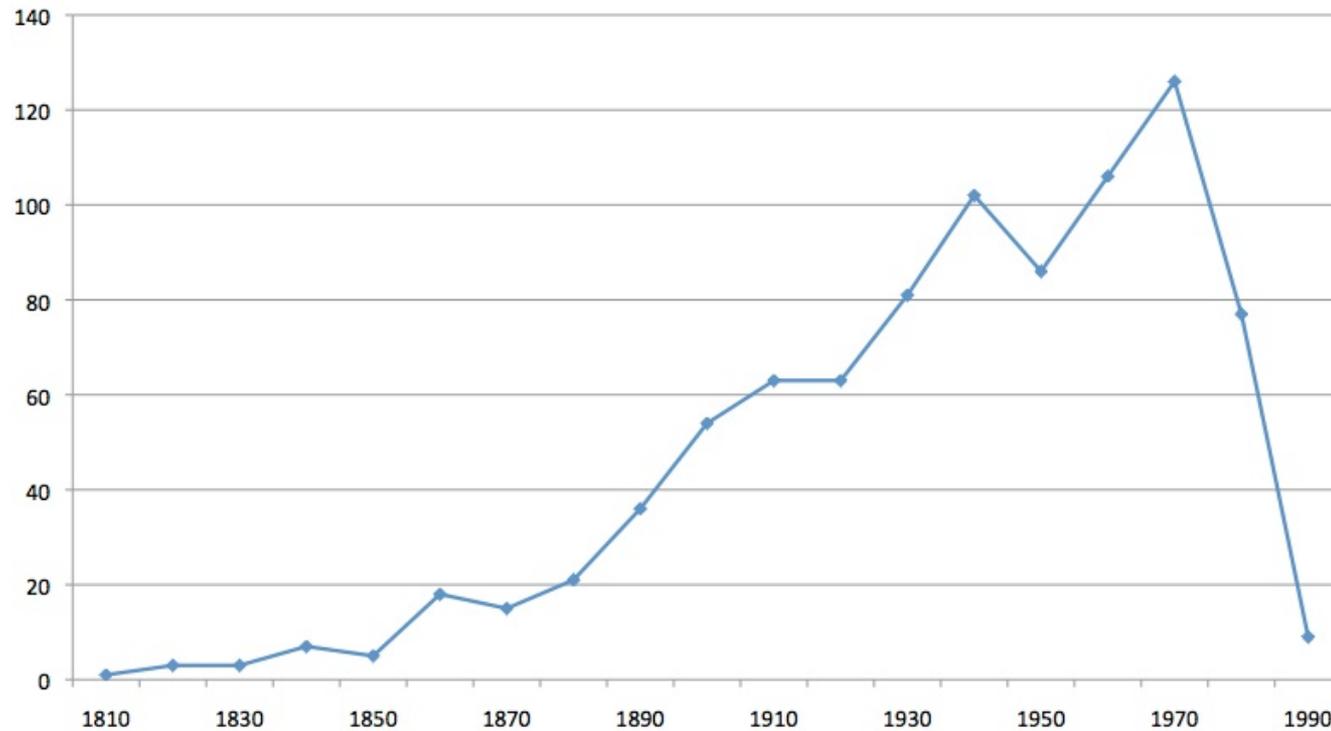


FlaBase: Flamenco Knowledge Base

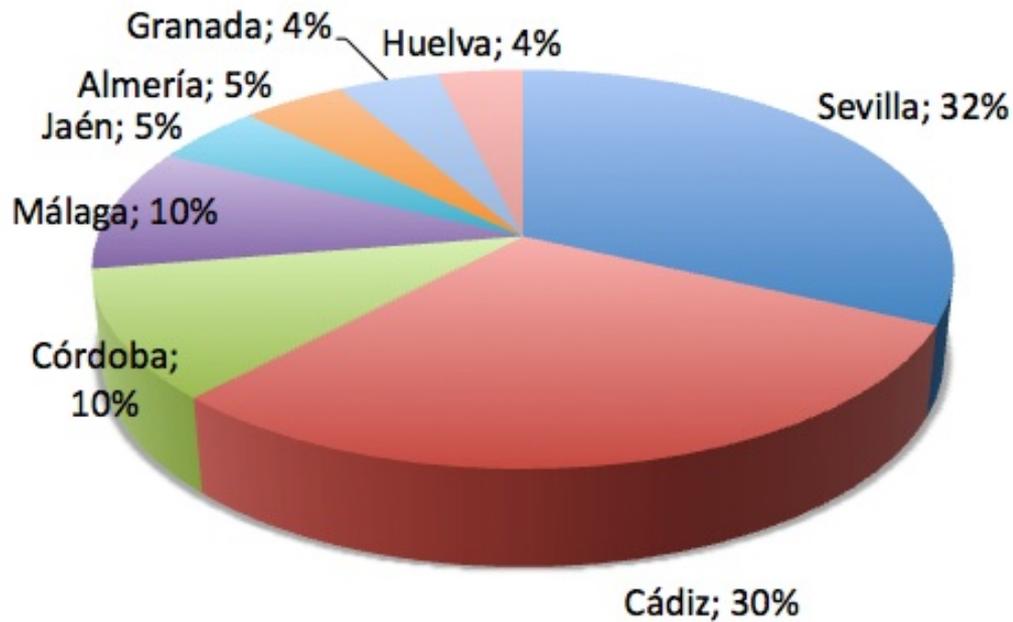
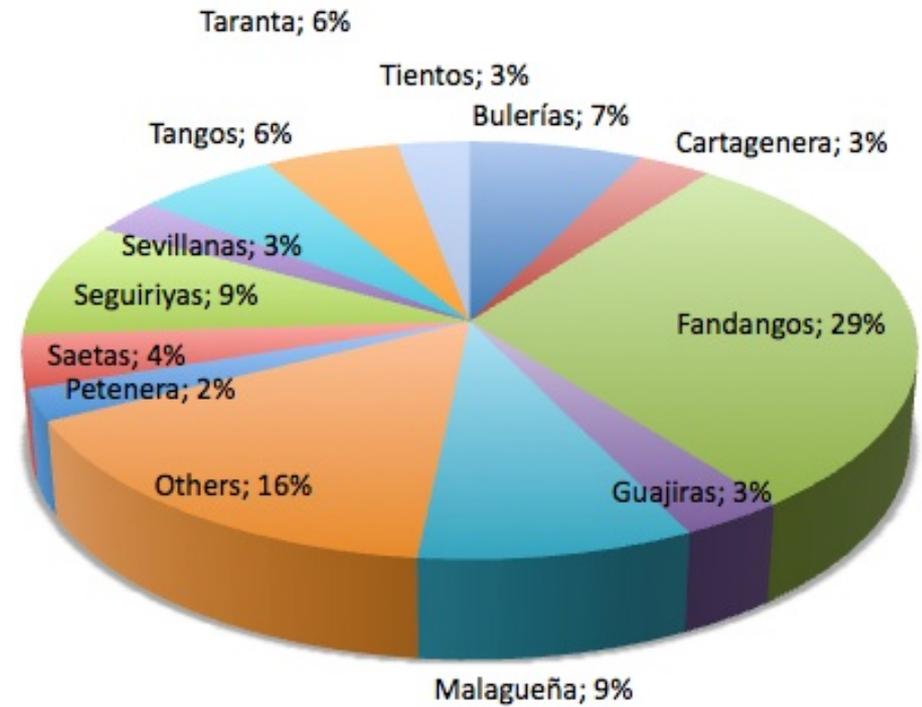
- Data gathered
 - 1,174 Artists (text biography)
 - 76 *Palos* (flamenco genres)
 - 2,913 Albums
 - 14,078 Tracks
 - 771 Andalusian locations
- Knowledge Extracted
 - Place of birth
 - Date of birth
 - Entity mentions in text

FlaBase: Data Analytics

- Number of artists by year of birth



FlaBase: Data Analytics



FlaBase: Artist Relevance

- Flamenco expert evaluation

<i>Cantaor</i>	Guitarist	<i>Bailaor</i>
Antonio Mairena Manolo Caracol La Niña de los Peines Antonio Chacón Camarón de la Isla	Paco de Lucía Ramón Montoya Niño Ricardo Manolo Sanlúcar Sabicas	Antonio Ruiz Soler Rosario Antonio Gades Mario Maya Carmen Amaya

	Top-5	Top-10
PageRank	0.933	0.633
HITS Authority	0.6	0.4

Precision Values

Conclusions

- Music Digital Libraries can benefit from semantic approaches
- Music Digital Libraries are still in an early stage of development compared to the Web (Linked Open Data, Google Knowledge Graph)
- Knowledge acquisition from Digital Libraries can help musicologists not only to search content, but also to discover new knowledge

Aknowledgments

- This work was partly funded by the COFLA2 research project (Proyectos de Excelencia de la Junta de Andalucía, FEDER P12-TIC-1362).



Bibliography

- Oramas S., Sordo M., Espinosa-Anke L., Serra X. (2015). *A Semantic-based approach for Artist Similarity*. International Society for Music Information Retrieval Conference ISMIR 2015. In Press.
- Oramas S., Gomez F., Gomez E., Mora J. (2015). *FlaBase: Towards the creation of a Flamenco Music Knowledge Base*. International Society for Music Information Retrieval Conference ISMIR 2015. In Press.
- Sordo, M., Oramas S., & Espinosa-Anke L. (2015). *Extracting Relations from Unstructured Text Sources for Music Recommendation*. International Conference on Applications of Natural Language to Information Systems NLDB 2015.
- Oramas S., Sordo M., Espinosa-Anke L. (2015). *A Rule-based Approach to Extracting Relations from Music Tidbits*. 2nd Workshop on Knowledge Extraction from Text at WWW 2015.
- Oramas S., Sordo M., Serra X. (2014). *Automatic Creation of Knowledge Graphs from Digital Musical Document Libraries*. Conference in Interdisciplinary Musicology CIM 2014.



Universitat
Pompeu Fabra
Barcelona

MTG
Music Technology
Group



Thanks!

Knowledge Acquisition from Music Digital Libraries

Sergio Oramas, Mohamed Sordo

sergio.oramas@upf.edu

[@sergiooramas](https://twitter.com/sergiooramas)



Universitat
Pompeu Fabra
Barcelona

MTG
Music Technology
Group