

Information Service Engineering

Lecture 14: ISE Applications - 2



Leibniz Institute for Information Infrastructure

Prof. Dr. Harald Sack

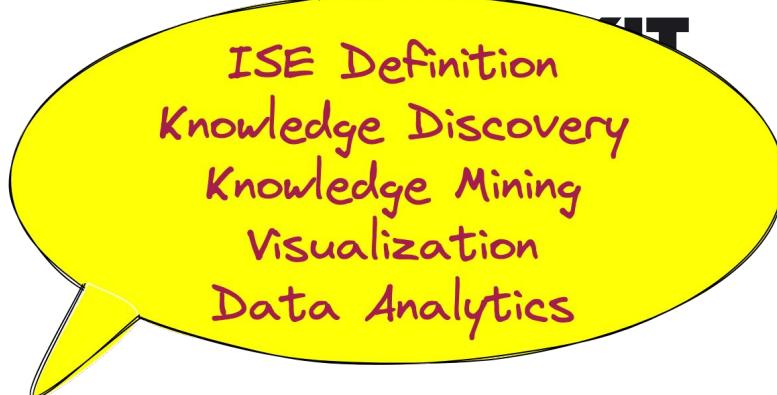
FIZ Karlsruhe - Leibniz Institute for Information Infrastructure

AIFB - Karlsruhe Institute of Technology

Summer Semester 2021

Information Service Engineering

Last Lecture: ISE Applications - I



ISE Definition
Knowledge Discovery
Knowledge Mining
Visualization
Data Analytics

- 5.1 What is Information Service Engineering?**
- 5.2 Knowledge Mining and Information Extraction I**
- 5.3 Knowledge Mining and Information Extraction II**
- 5.4 Hands On Data Analytics Example**
- 5.5 Semantic Annotation**
- 5.6 Semantic Search**
- 5.7 Exploratory Search**

5. ISE Applications

- 5.1 What is Information Service Engineering?
- 5.2 Knowledge Mining and Information Extraction I
- 5.3 Knowledge Mining and Information Extraction II
- 5.4 Hands On Data Analytics Example
- 5.5 Semantic Annotation**
- 5.6 Semantic Search
- 5.7 Exploratory Search



How do we find this?



"Indiae Orientalis, Insularumque Adiacientium Typus," from the Theatrum Orbis Terrarum of Abraham Ortelius, 1603 Latin edition

How to Annotate Information Resources



comment: "Two fearsome sea monsters attack a disabled ship off the shore of America, which is shown in close proximity to Japan."
position: area coordinates (x_1, y_1, x_2, y_1)

title: "Indiae Orientalis, Insularumque Adiacientium Typus"
book: "Theatrum Orbis Terrarum, Latin edition"
author: Abraham Ortelius
date: 1603

External
Information?

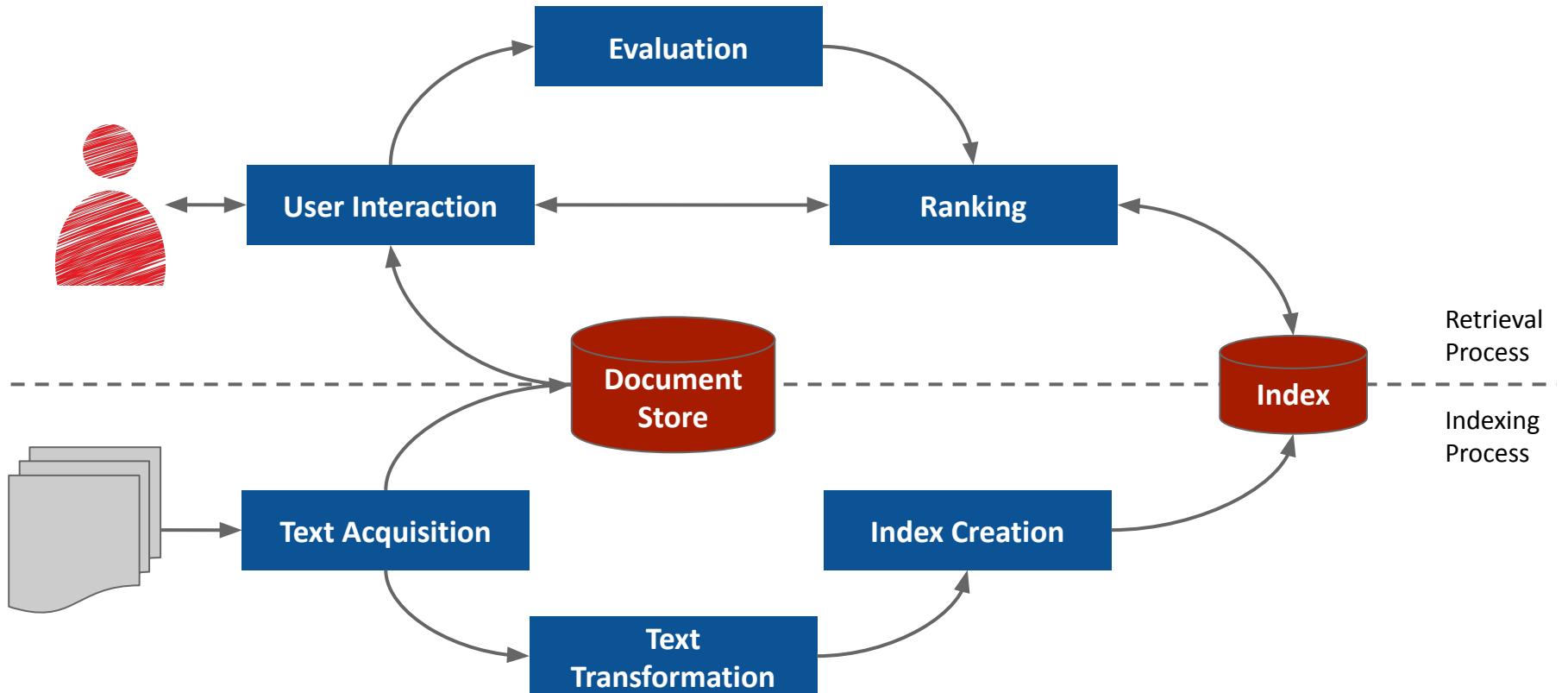
The Information Retrieval Dilemma Revisited



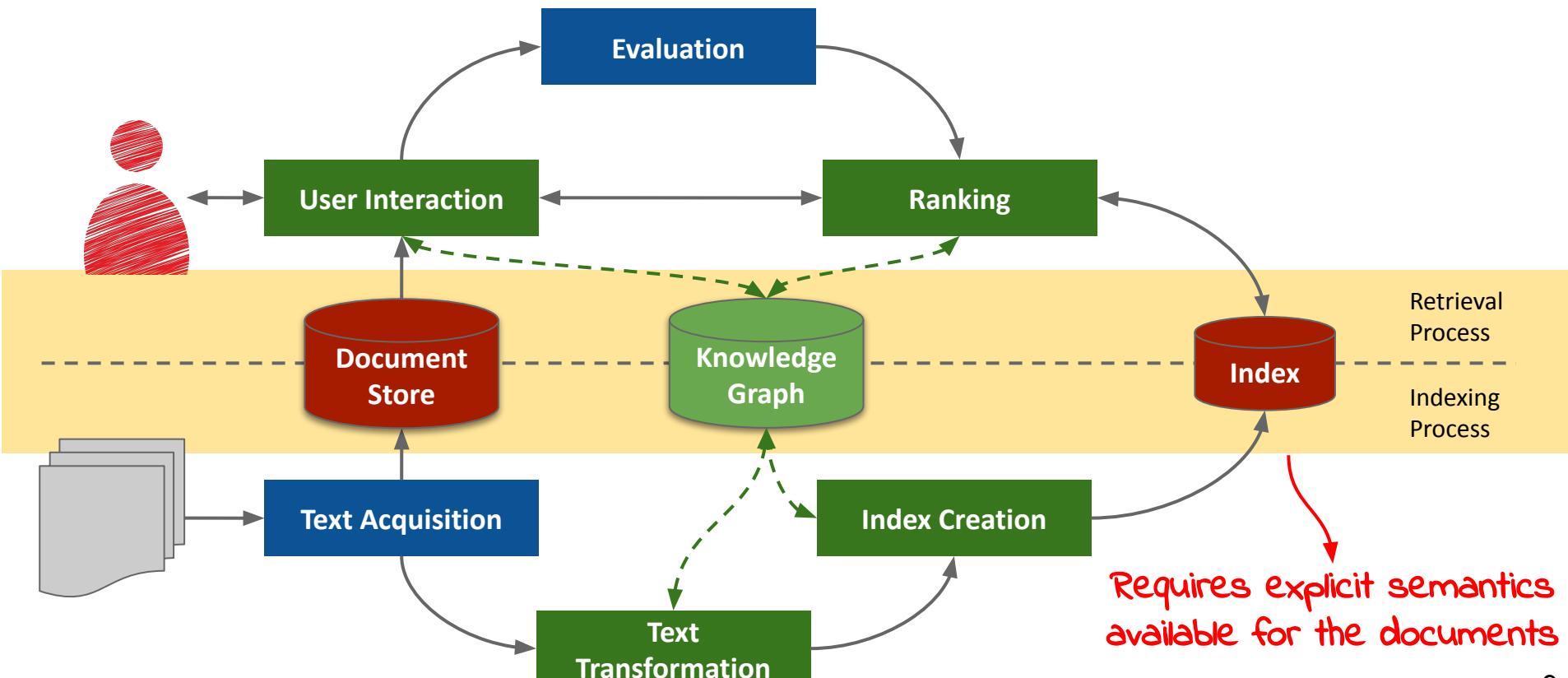
- Ambiguity of natural language (polysemy)
- Different words/expressions for the same concept (synonyms, metaphors, paraphrases,...)
- Implicit (hidden) information
- Context knowledge and experience



The Traditional Information Retrieval Process

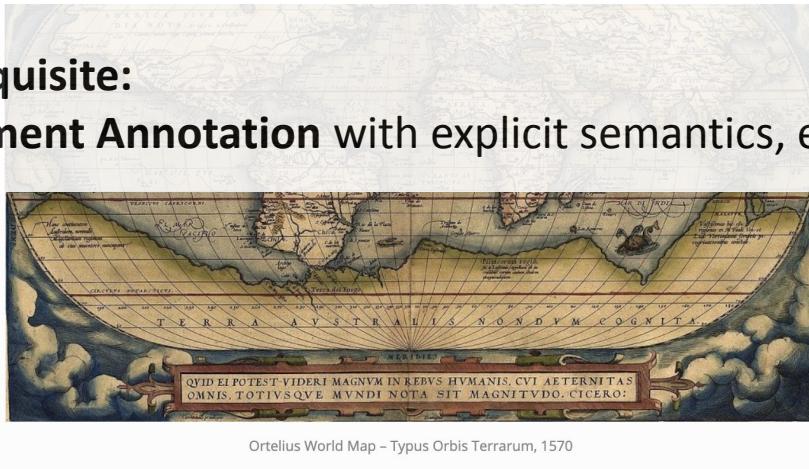


Semantic Technology Supported Information Retrieval



Semantic Technology Supported Information Retrieval

- Prerequisite:
Document Annotation with explicit semantics, e.g. semantic entities



On May 20, 1570, Belgian cartographer and geographer **Abraham Ortelius** published the first modern atlas, the *Theatrum Orbis Terrarum*, in Antwerp. It consists of 70 separate maps and sustaining text bound to form a book for engraving.

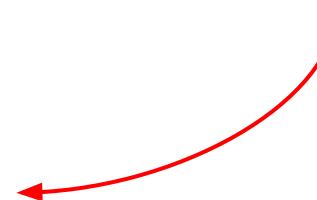
Abraham Ortelius – Early Years

Abraham Ortelius was born in Antwerp, but grew up in a small town near Antwerp. At a young age, he was appointed geographer to the Duke of Alva, who was the viceroy of the Netherlands. He traveled extensively throughout Europe, including France, Italy, and Spain.

Abraham Ortelius	
Abraham Ortelius (also Ortels, Orthellius, Wortels; 14 April 1527 – 28 June 1598) was a Flemish cartographer and geographer,	
birth year	1527
death year	1598
death place	Antwerp

- Enables entity-based Information Retrieval
 - Language independent

Example for
Semantic Annotation



<http://scihi.org/abraham-ortelius-theatrum-orbis-terrarum/>

Resources can be described via Metadata

- „Metadata is **structured, encoded data that describes the characteristics** of information bearing entities for the purpose of **identification, retrieval, evaluation** and **administration** of the described entities.“ (W.R. Durell, 1985)
- We distinguish
 - **Structured** and **unstructured** metadata
 - **Authoritative** and **non-authoritative** metadata
 - **Semantic** metadata

Structured Metadata

- Usually consist of **Name-Value pairs** (*Author = "Abraham Ortelius"*)
- Are **typed** (*Author is of type String*)
- **Semantics** (Meaning) of structured data relies on **common agreement**
e.g. via standard vocabularies such as [Dublin Core](#)

```
<head profile="http://dublincore.org/documents/dcq-html/">
  <title>Dublin Core</title>
  <link rel="schema.DC" href="http://purl.org/dc/elements/1.1/" />
  <link rel="schema.DCTERMS" href="http://purl.org/dc/terms/" />
  <meta name="DC.format" scheme="DCTERMS.EXT" content="text/html" />
  <meta name="DC.type" scheme="DCTERMS.DCMIType" content="Text" />
  <meta name="DC.publisher" content="Jimmy Wales" />
  <meta name="DC.subject" content="Dublin Core Metadaten-Elemente, Anwendungen" />
  <meta name="DC.creator" content="Björn G. Kulms" />
  <meta name="DCTERMS.license" scheme="DCTERMS.URI" content="http://www.gnu.org/copyleft/fdl.html" />
  <meta name="DCTERMS.rightsHolder" content="Wikimedia Foundation Inc." />
  <meta name="DCTERMS.modified" scheme="DCTERMS.W3CDTF" content="2006-03-08" />
</head>
```

Unstructured Metadata

- (Mostly) **text-based** metadata
- **Semantics** is determined via **natural language explanations**
(not necessarily via agreement)
- E.g.: description or content of a resource

resource



ASIA.

ASIA diuiditur ab Europa Tanai fluuiio, & linea ab eius fontibus tracta ad Grandicun Oceani Septentrionalis Sinum: ab Africa vero, Isthmo, qui est in ter mare Mediterraneum & Sinum Arabicum: cetera Oceanus & Maria ambunt. Hanc veteres multifariam diuisere: hodie vero eam in quinque partes, secundum eius Imperia, quibus administratur, nobis non ineptè diuidi posse videtur. Cuius prima pars, quae Europæ contigua est, & Magno Duci Moscouiae paret, Mari Glaciali, Obij fluuiio, Kytaialucu, & linea inde ducta ad Caspium mare, Isthmoque qui inter hoc Mare & Pontum Euxinum est, terminabitur. Secunda erit, que Magno Chamo Tartarorum Imperatori obedit, cuius fines à Meridie, sunt Mare Caspium, Iaxartes fluuius, Imaus mons; ab Ortu & Septentrione Oceanus: ab Occidente, iam dictum Ducus Moscouiae Regnum. Tertiam partem Ottomannorum prospria occupat, continetque quidquid terrarum est intra Pontum Euxinum, Mare Ægæum, (nunc Archipelagus dictum) Mediterraneumque, AEGyptum, Sinum Arabicum, Peñicumque, Tigrim fluuium, mare Caspium, & Isthmum, qui inter hoc, & Pontum Euxinum videtur est. Sub qua ta Regnum Perſia, quod hodi à Sophis gubernatur, comprehendetur; habet Ottomanos (quibulum continuum ferè bellum gerit) ab Occidente, Magni Chami Regnum à Septentrione; & in Orientem farè, Imaus mons, tenditur: à Meridie, Mare Caspium, & Isthmus, qui inter hoc, & Pontum Euxinum videtur.

unstructured metadata

Authoritative Metadata



Wilhelm Busch: Lehrer Lämpel (Max und Moritz, 1865)

- **Authoritative Metadata** have been created by a trusted (authoritative) source, as e.g.
 - the author of the described resource
 - a trusted expert

Non-Authoritative Metadata



- **Non-Authoritative Metadata**
have been created by a more or less unreliable source, as e.g.
 - the “users”
 - popular example:
Collaborative Annotation in
Social Tagging Systems

Semantic Annotation

- The term “annotation” implies to attach data to some other piece of data. It establishes a (typed) relation between the annotated data and the annotating data.
- The term “annotation” can denote both the process of annotating and the result of that process.
- Formal Model:
 - An annotation A is a tuple (a_s, a_p, a_o, a_c) , where
 - a_s is the subject of the annotation (the annotated data),
 - a_o is the object of the annotation (the annotating data),
 - a_p is the predicate (the annotation relation) that defines the type of relationship between a_s and a_o , and
 - a_c is the context in which the annotation is made.

Semantic Annotation

Formal Model



- An **annotation** A is a tuple (a_s, a_p, a_o, a_c) , where
 - a_s is the **subject** of the annotation (the annotated data),
 - a_o is the **object** of the annotation (the annotating data),
 - a_p is the **predicate** (the annotation relation) that defines the type of relationship between a_s and a_o , and
 - a_c is the **context** in which the annotation is made.

```
PREFIX dbr: <http://dbpedia.org/resource/> .  
PREFIX dbo: <http://dbpedia.org/ontology/> .  
  
:9787532717071 dbo:author dbr:Abraham_Ortelius.
```



- An **annotation** A is a tuple (a_s, a_p, a_o, a_c) , where
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```



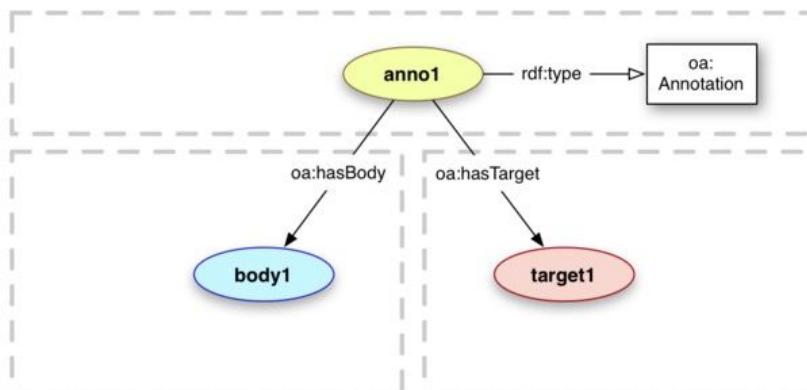
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```
PREFIX dbr: <http://dbpedia.org/resource/> .  
PREFIX dbo: <http://dbpedia.org/ontology/> .  
  
:9787532717071 dbo:author dbr:Abraham_Ortelius .
```

- created at Dec 11, 2017
- created by Lysander07
- ...

Web Annotation Ontology

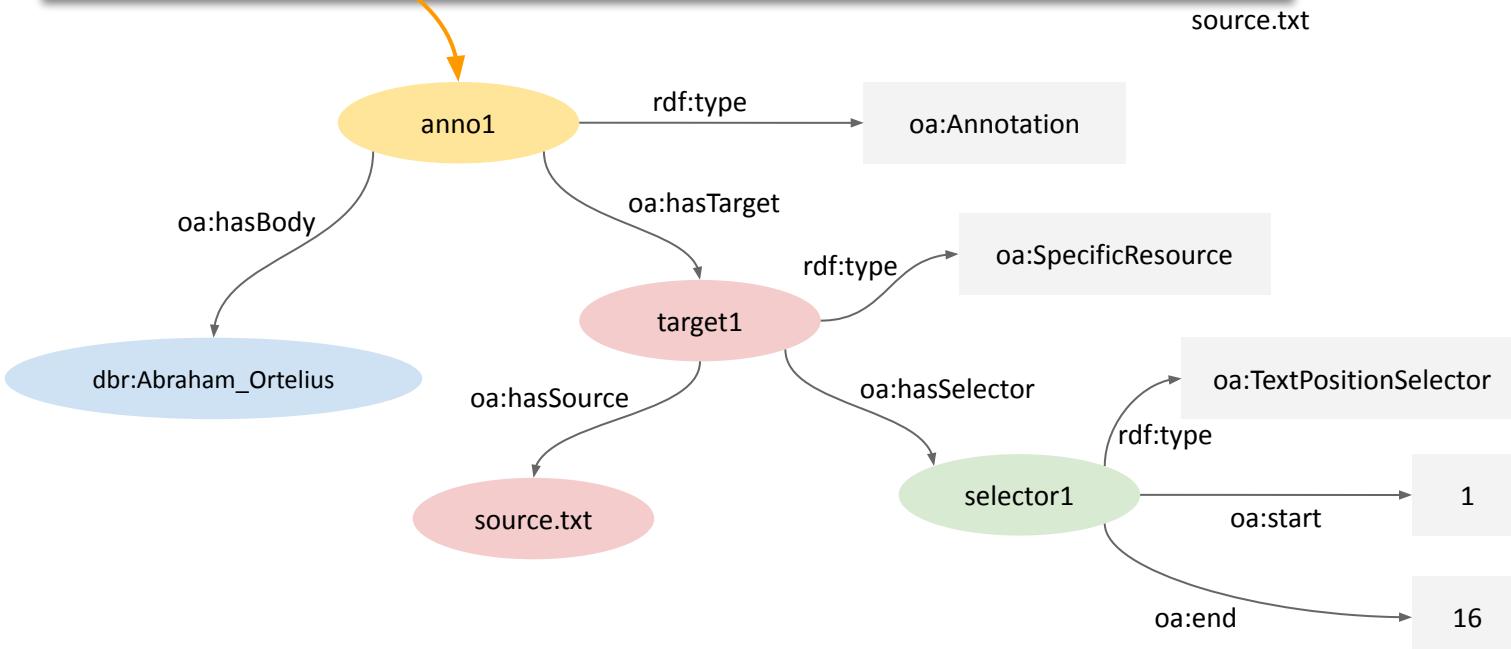
- The **Web Annotation Ontology** is a W3C Standard (2017)
 - "...specifies an interoperable framework for creating associations between related resources, annotations, using a methodology that conforms to the Architecture of the World Wide Web."



- The **Body** provides the information which is annotating the **Target**.

Semantic Annotation

Abraham Ortelius was a Brabantian cartographer, geographer, and cosmographer, conventionally recognized as the creator of the first modern atlas, the *Theatrum Orbis Terrarum*.



Abraham Ortelius (1527 - 1598)

5. ISE Applications

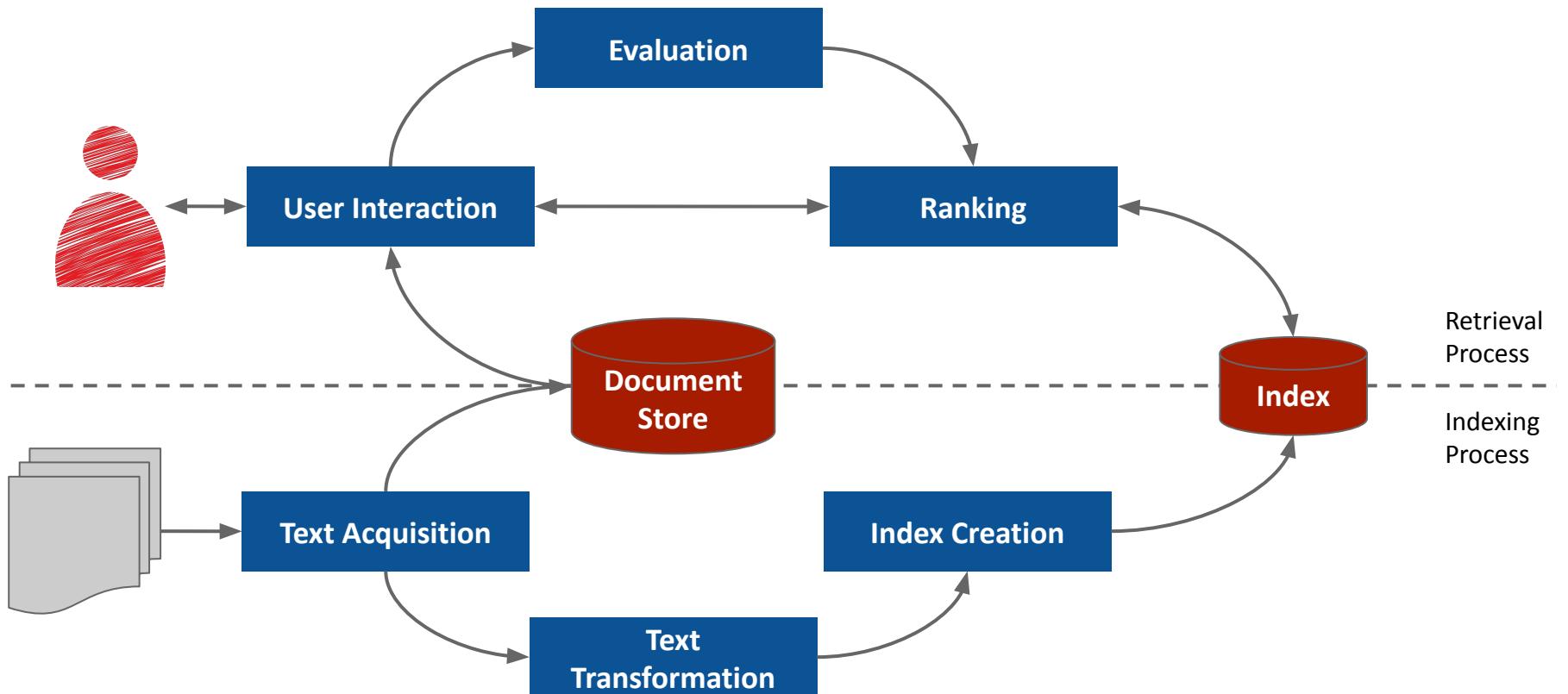
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- 5.7 Exploratory Search

The Information Retrieval Dilemma Revisited (Again)

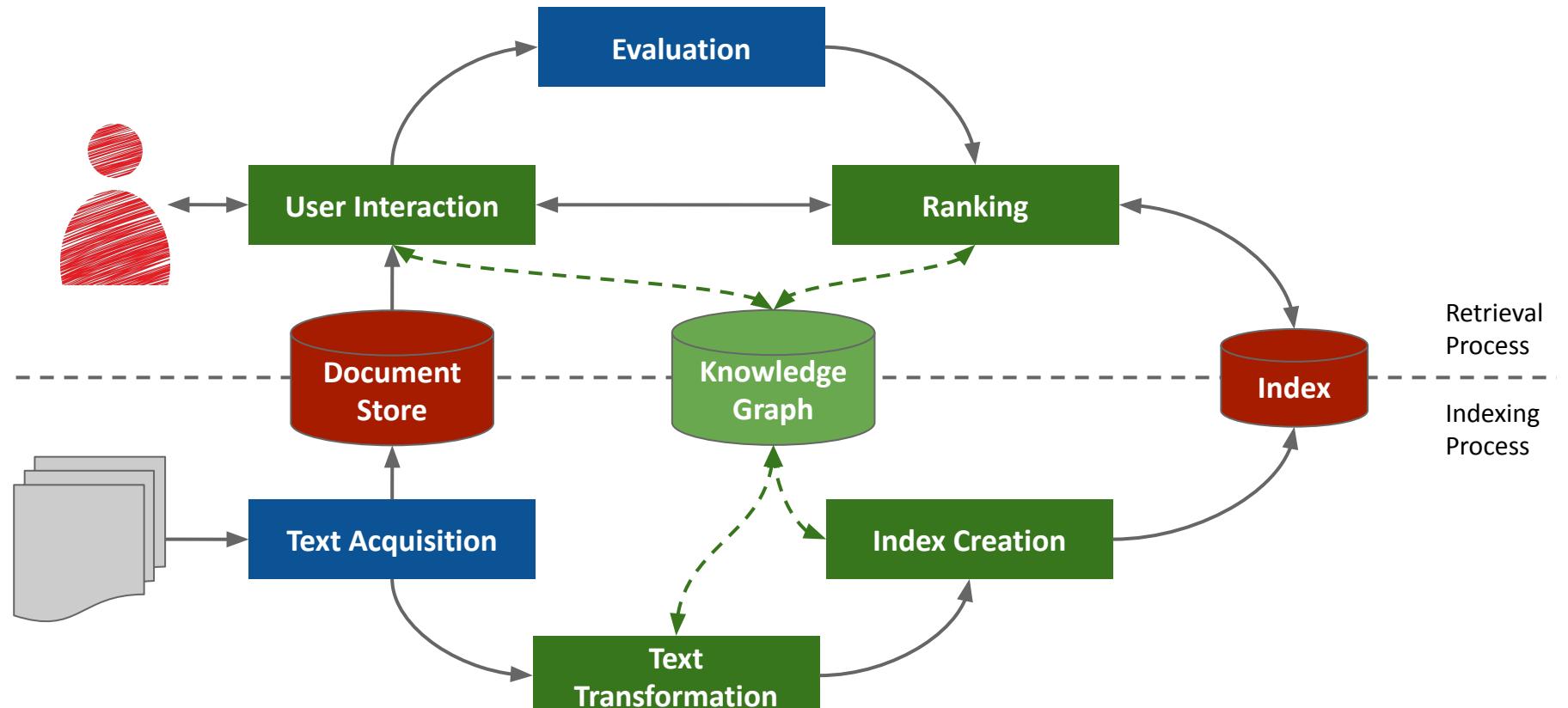


How can Knowledge Graphs support IR?

The Information Retrieval Process



Semantic Technology Supported Information Retrieval



Semantic Technology Supported Information Retrieval

- **Semantic Search is about**
 - going **beyond** documents and queries as **bag of words**,
 - having a **deeper understanding** of document contents by leveraging **world knowledge** as structured data,
 - going **beyond 10 blue links** and providing users with **direct answers** to their (natural language) questions.

Semantic Technology Supported IR

- **Prerequisite:** Annotation with explicit semantics, e.g. semantic entities
- Enables **entity-based Information Retrieval**
 - Language independent
- Makes use of underlying Knowledge Base, e.g.
 - content-based **similarities** among entities
 - content-based **relationships** between entities
- **Interoperable metadata** via semantic annotations
 - for content-based description
 - for structural and technical description
- **Content-Based Navigation and Result Filtering** (Search Facets)

Semantic Search vs. Keyword Based Search

- **Query String Refinement**
enables **more precise or more complete** search results.
- **Cross Referencing**
enables to complement search results with additional associated or similar information.
- **Fuzzy Search**
enables the determination of **nearby results** and **results related by content**.
- **Exploratory Search**
enables visualization and navigation of the search space.
- **Reasoning**
enables to complement search results with implicitly given information.

Entity Based Search

Simple Entity Matching

Query Processing:

Ortelius first Atlas

Named Entity Linking

dbr:Abraham_Ortelius dbr:Atlas

Indexing:

Ortelius publishes
first world atlas

On May 22, 1570,
bookmaking and
map-making history were
made. Abraham Ortelius, a
Flemish book collector and
engraver published the
Theatrum Orbis Terrarum
(Epitome of the Theater of
the World) — the world's
first atlas.

Entity Matching

Entity-Based Query Matching

- simple entity matching
- similarity-based entity matching
- relationship-based entity matching
- ...

Named Entity Linking

dbr:Atlas

Entity Based Search

Similarity-based Entity Matching

Query Processing:

Ortelius first Atlas

dbr:Abraham_Ortelius dbr:Atlas

Named Entity Linking

Indexing:

Mercator's atlas of Europe

Gerardus Mercator was perhaps the best-known mapmaker of all time. Rather than undertaking expeditions and mapping on the ground himself, however, he was an armchair cartographer.

Named Entity Linking

Entity Matching

Entity-Based Query Matching

- simple entity matching
- **similarity-based entity matching**
- relationship-based entity matching
- ...

two entities are considered **semantically similar**,

- if they share property-value pairs
- if they share properties with similar values

Entity Based Search

Relationship-based Entity Matching

Query Processing:

Ortelius first Atlas

dbr:Abraham_Ortelius dbr:Atlas

Named Entity Linking

Indexing:

Mercator's atlas of Europe

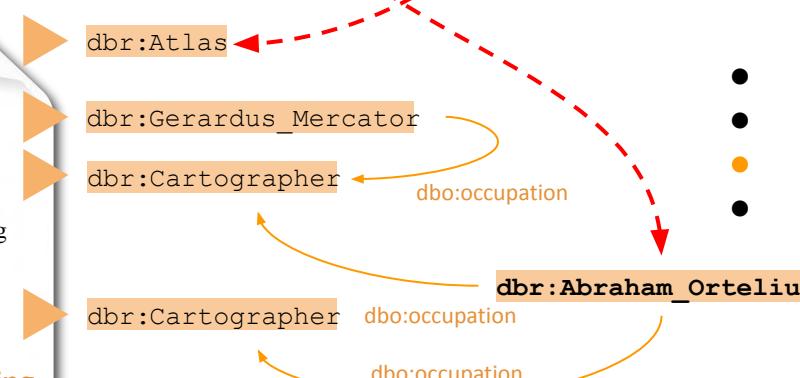
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Named Entity Linking

Entity Matching

Entity-Based Query Matching

- simple entity matching
- **similarity-based entity matching**
- **relationship-based entity matching**
- ...



Factoid Questions



when did abraham ortelius die?

[All](#)[News](#)[Shopping](#)[Images](#)[Videos](#)[More](#)[Tools](#)

About 899.000 results (0,65 seconds)

Abraham Ortelius / Date of death

June 28, 1598



Feedback

[Link to Google search query](#)

Factoid Questions



what was the profession of abraham ortelius?



All

News

Shopping

Images

Maps

More

Tools

Abraham Ortelius / Professions

Cartographer

Historian

Engraver

[Link to Google search query](#)

Factoid Questions



what nationality was abraham ortelius?



All

News

Shopping

Images

Maps

More

Tools

About 2.040.000 results (0,65 seconds)

Abraham Ortelius / Nationality

Duchy of Brabant

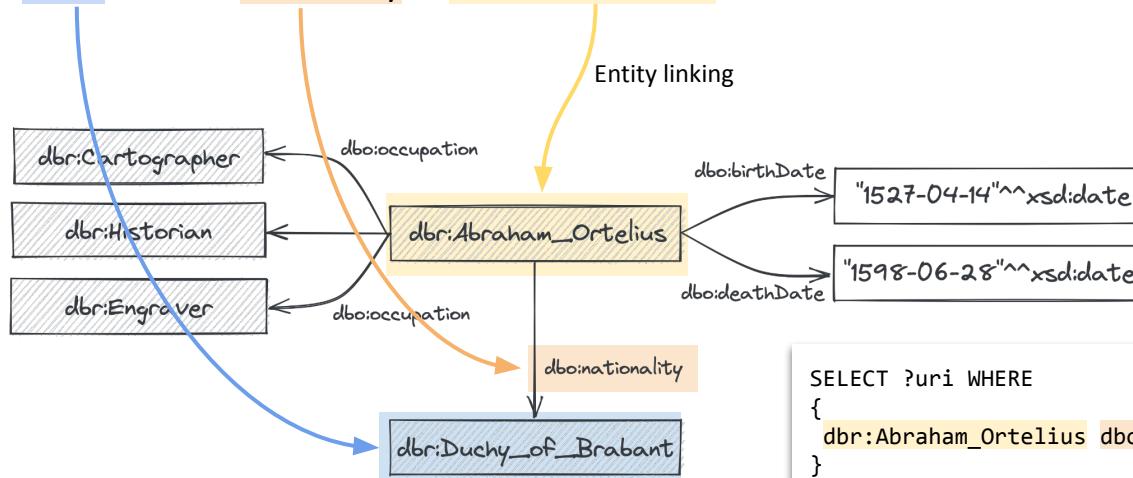


[Link to Google search query](#)

Factoid Questions

Question Answering over Knowledge Graphs

What was the nationality of Abraham Ortelius?



```

SELECT ?uri WHERE
{
    dbr:Abraham_Ortelius dbo:nationality ?uri .
}
    
```



Abraham Ortelius (1527 - 1598)

which Popes were in office during the lifetime of Abraham Ortelius?

which Frisian colleague of Ortelius is considered one of the co-founders of cartography?

which colleague of Ortelius died of kidney stones?

which places in Antarctica or the Moon are named after pioneers in cartography?

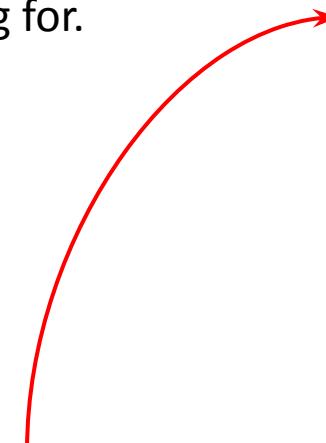
...

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The Retrieval Problem

- **Retrieval Problem:**
 - You are looking for **something specific**
i.e. you know what you are looking for.
- How to **specify your search request?**
 - e.g. for a (specific) book:
author name, title, etc.
- Often you are using
 - (unique) identifier
 - descriptive metadata

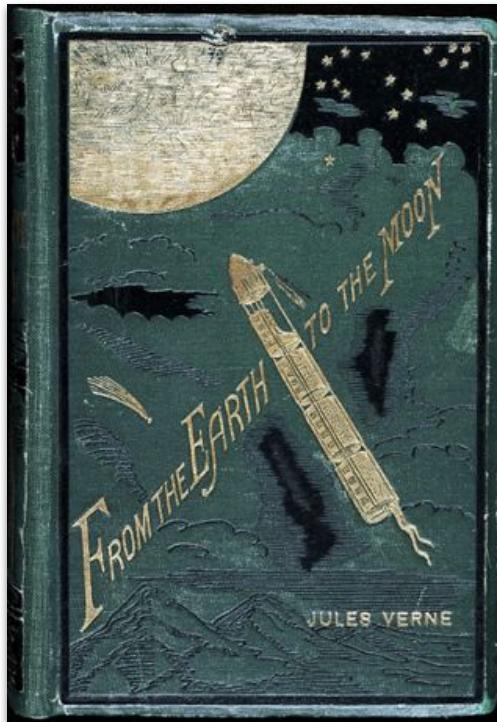


Author: Jules Verne

Title: From the Earth to the Moon

The Retrieval Problem

Index Lookup



V E R N E, Jules.
From the Earth to the Moon, Direct in
97 Hours 20 Minutes and a Trip Round It,
Sampson Low, Marston&Company,
London (1873),
viii, 323 p. plates.

GRC C.194.a.659, 12516.g.20

Retrieval vs. Exploration



- *Find another („comparable“) book,
(that will be of interest for me...)*
- *Find books of the same or of related topics*
- *How did the author / the topic develop over time?*
- *What else would I like to read?*
- ...



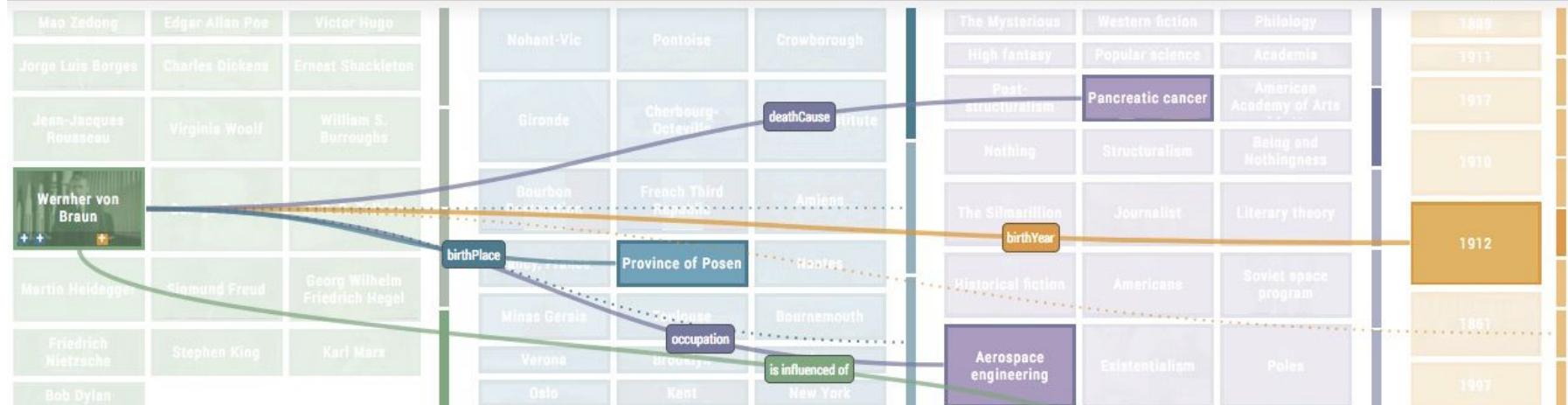
Exploratory Search



Traditional Libraries
enable Exploratory Search

...and intelligent
recommendations

Exploratory Search and Recommendation



January 30

2 Recommended Articles:

- #1 Edward Walter Maunder and the Sunspots
- #2 Ferdinand Freiherr von Richthofen and the Silk Road

<http://scihi.org/around-the-world-in-80-days/>

 Jules Verne


Jules Gabriel Verne (French: [ʒyl vɛʁn]; 8 February 1828 – 24 March 1905) was a French novelist, poet, and playwright best known for his adventure novels and his profound influence on the literary genre of science fiction. Born to bourgeois parents in the seaport of Nantes, Verne was trained to follow in his father's footsteps as a lawyer, but quit the profession early in life to write for magazines and the stage. His collaboration with the publisher Pierre-Jules Hetzel led to the creation of the Voyages Extraordinaires, a widely popular series of scrupulously researched adventure novels including Journey to the Center of the Earth, Twenty Thousand Leagues Under the Sea, and Around the World in Eighty Days. Verne is generally considered a major literary

DBpedia: Jules Verne



How to Explore the Information Space?

- If you **cannot find exactly** what you were looking for or if you **cannot exactly phrase** your search request, then you would be happy at least to **find something nearby**.
- **Similarity:**
Discover things and documents **similar** (but not necessarily related) to your original search request.
- **Relatedness:**
Discover things or documents that are closely **related** (but not necessarily similar) to your original search request.

Exploratory Search with Linked Data



http://dbpedia.org/resource/From_the_Earth_to_the_Moon

DBpedia Browse using ▾ Formats ▾

Faceted Browser Sparql Endpoint

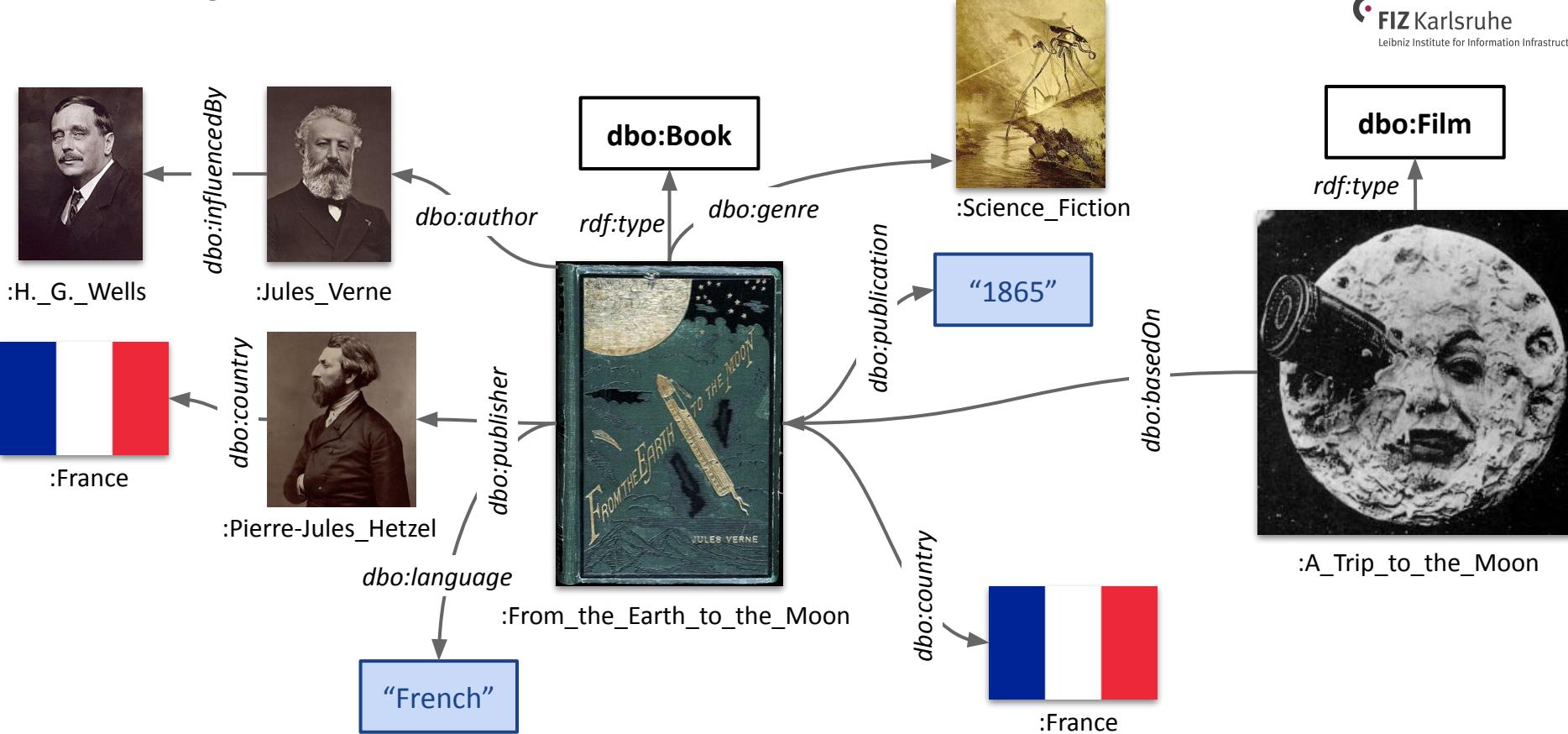
About: From the Earth to the Moon

An Entity of Type : work, from Named Graph : <http://dbpedia.org>, within Data Space : dbpedia.org

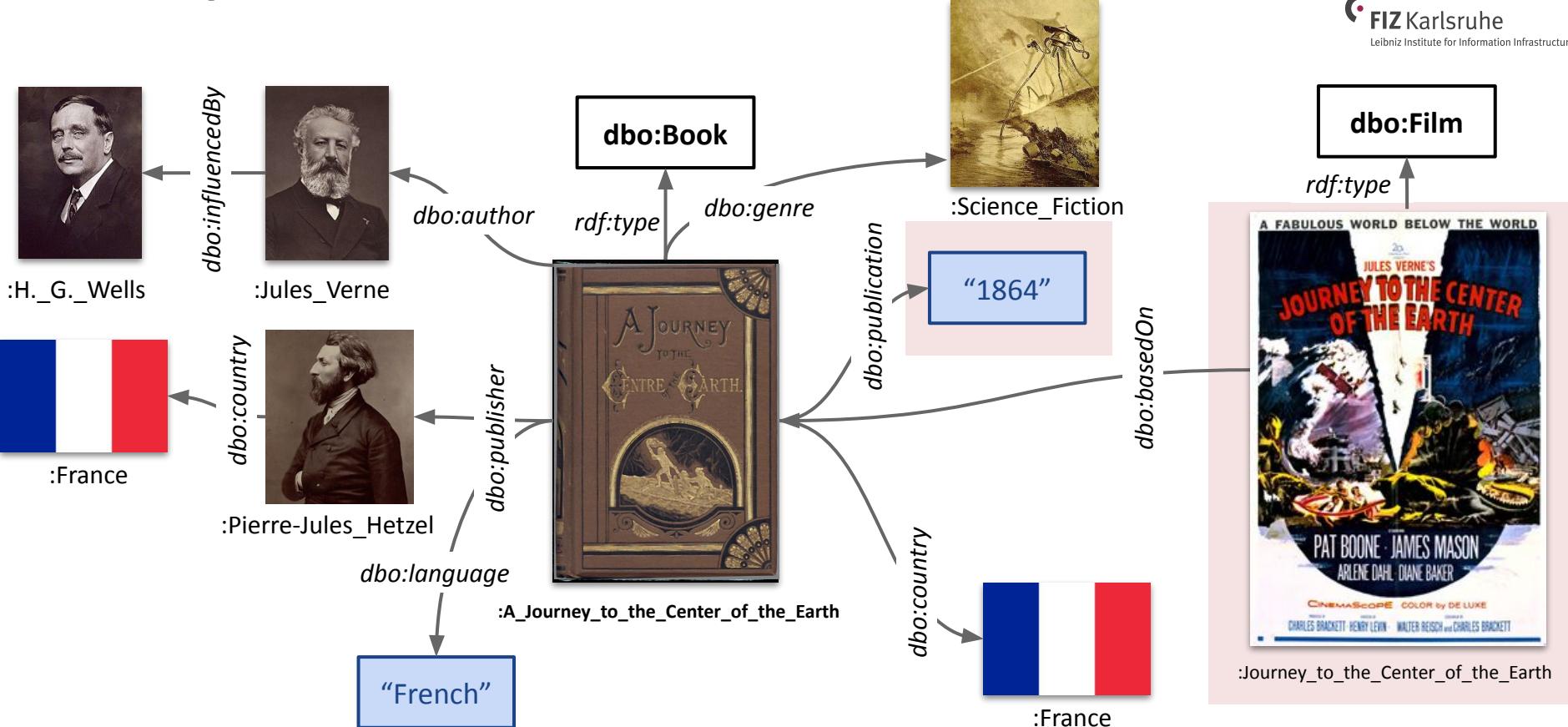
From the Earth to the Moon (French: De la terre à la lune) is an 1865 novel by Jules Verne.

Property	Value
dbo:abstract	<ul style="list-style-type: none"> Von der Erde zum Mond ist ein Roman des französischen Autors Jules Verne. Der Roman wurde erstmals 1865 unter dem französischen Titel De la Terre à la Lune von dem Verleger Pierre-Jules Hetzel veröffentlicht. Die erste deutschsprachige Ausgabe erschien 1873 unter dem Titel Von der Erde zum Mond. Der englische Titel des Romans lautet From the Earth to the Moon. Es handelt sich um ein frühes Werk des Science-Fiction-Genres, das die Mondfahrt um etwa hundert Jahre vorwegnimmt. Allerdings geht es hier vor allem noch um die Vorbereitung des Abenteuers. Der Roman Reise um den Mond (Autour de la Lune) von 1870 setzte die Geschichte fort. (de) From the Earth to the Moon (French: De la terre à la lune) is an 1865 novel by Jules Verne. It tells the story of the Baltimore Gun Club, a post-American Civil War society of weapons enthusiasts, and their attempts to build an enormous sky-facing Columbiad space gun and launch three people—the Gun Club's president, his Philadelphian armor-making rival, and a French poet—in a projectile with the goal of a moon landing. The story is also notable in that Verne attempted to do some rough calculations as to the requirements for the cannon and, considering the comparative lack of any data on the subject at the time, some of his figures are surprisingly close to reality. However, his scenario turned out to be impractical for safe manned space travel since a much longer muzzle would have been required to reach escape velocity while limiting acceleration to survivable limits for the passengers. The character of Michel Ardan, the French member of the party in the novel, was inspired by the real-life photographer Félix Nadar. (en)
dbo:author	dbr:Jules_Verne
dbo:illustrator	dbr:Henri_de_Montaut
dbo:literaryGenre	dbr:Science_fiction
dbo:mediaType	dbr:Hardcover
dbo:publisher	dbr:Pierre-Jules_Hetzel
dbo:series	dbr:Voyages_extraordinaires
dbo:thumbnail	wiki-commons:SpecialFilePath/From_the_Earth_to_the_Moon_Jules_Verne.jpg?width=300

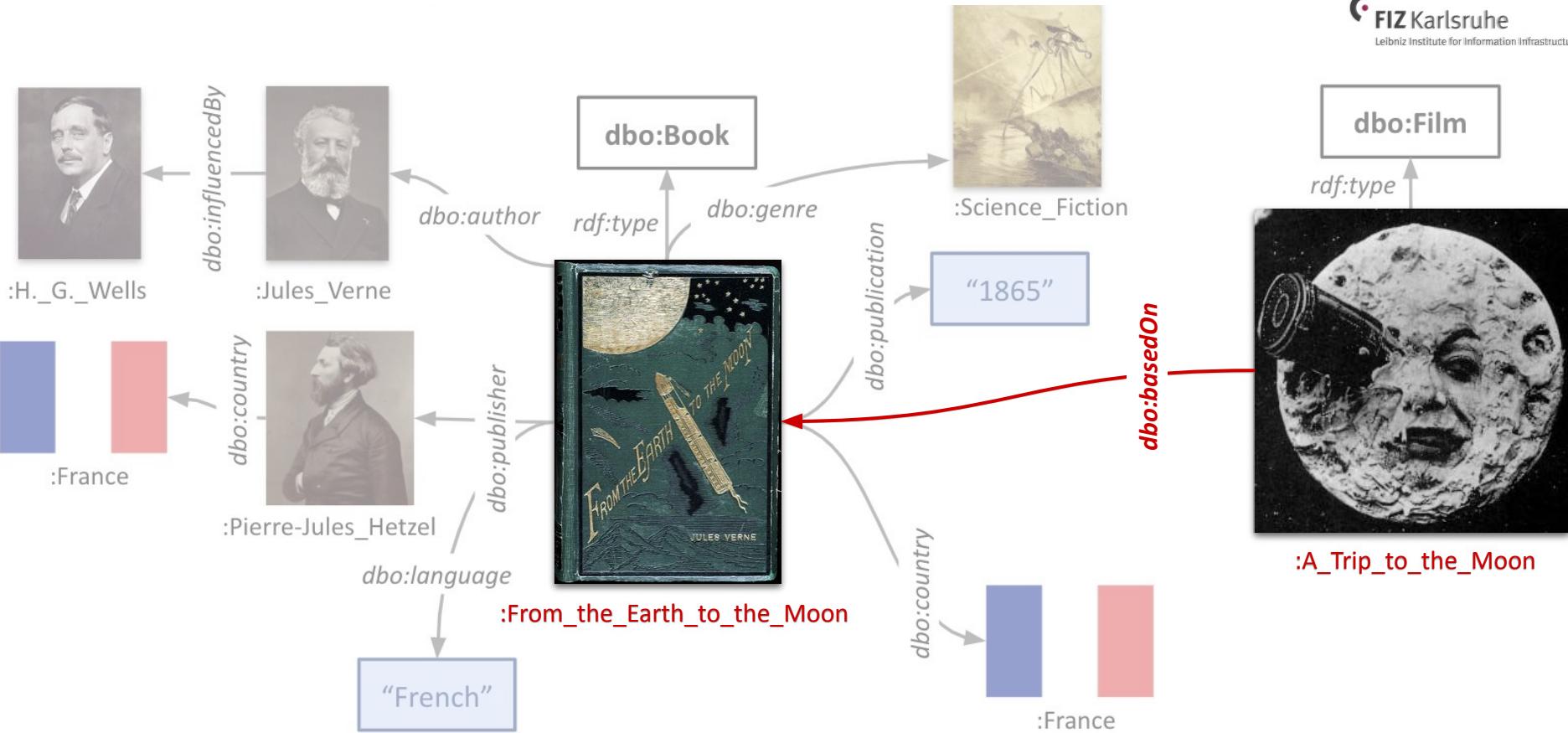
Similarity vs. Relatedness



Similarity



Relatedness



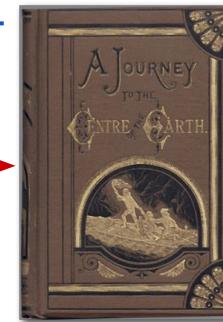
Exploratory Search Strategies

:From_the_Earth_to_the_Moon



dbo:Book

rdf:type

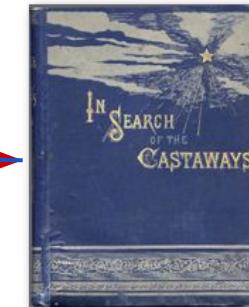


:A_Journey_to_the_Center_of_the_Earth

dbo:subsequentWork

dbo:previousWork

rdf:type

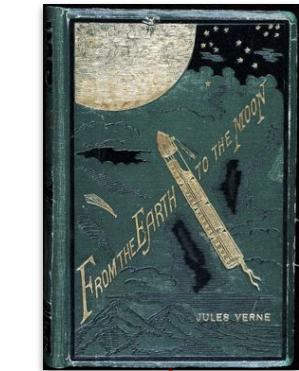


:In_Search_of_the_Castaways

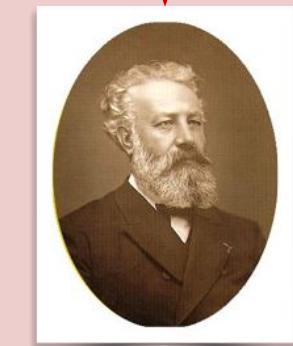
- Combining similarity and relatedness

Exploratory Search Strategies

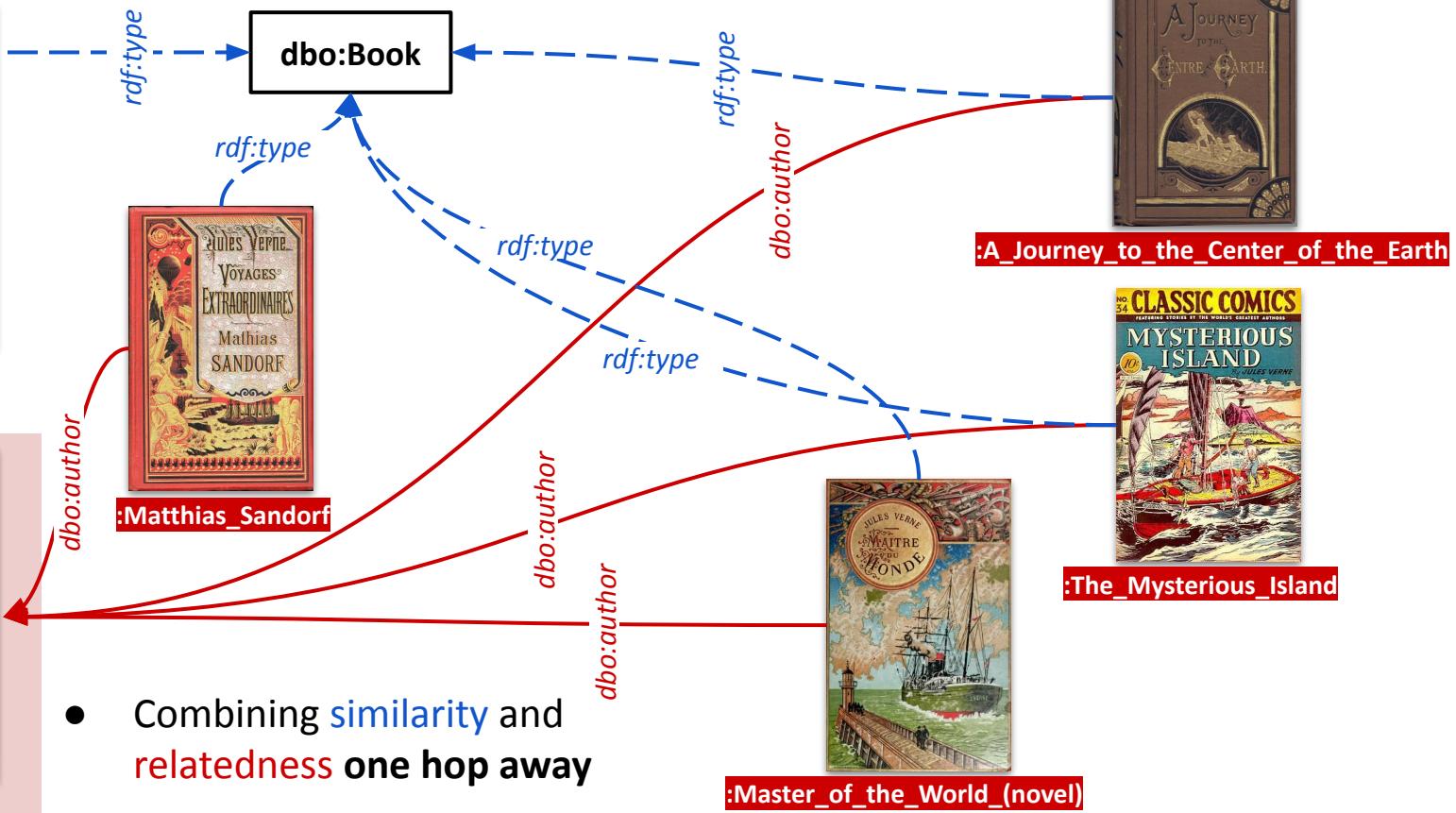
:From_the_Earth_to_the_Moon



dbo:author



:Jules_Verne



Exploratory Search Strategies

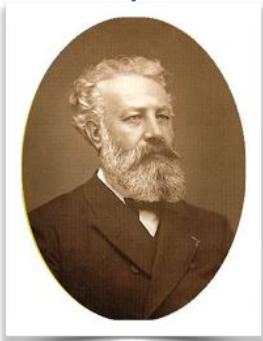
:From_the_Earth_to_the_Moon



rdf:type

dbo:Book

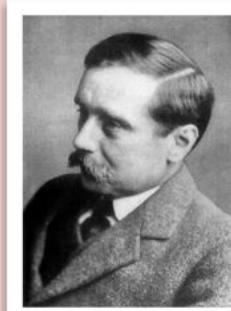
dbo:author



rdf:type

dbo:Writer

rdf:type



dbo:influenced

:H_G_Wells

- Combining **similarity** and **relatedness** two hops away

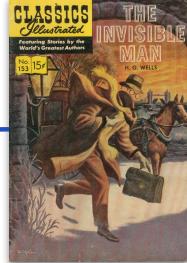
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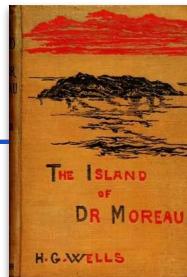
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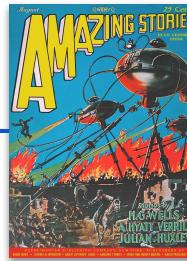
dbo:author



:The_Invisible_Man



:The_Island_of_Docctor_Moreau



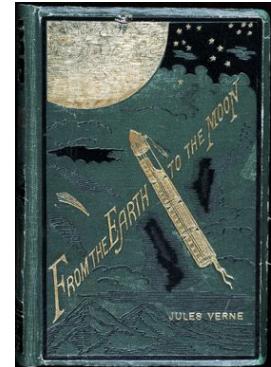
:The_War_of_the_Worlds

From Exploration to Recommendation

- **Exploratory Search** represents the activities carried out by searchers who are either:
 - **unfamiliar with the domain** of their goal (i.e. need to learn about the topic in order to understand how to achieve their goal),
 - **unsure about the ways** to achieve their goals (either the technology or the process),
 - or even **unsure about their goals** in the first place.
- **Recommender Systems** seek to predict the preference a user would give to an item.

Now, what should I read next?

- Imagine, you want to read Jules Verne's "From the Earth to the Moon", but it is currently not available in your library.
 - What to do?
 - General Idea to work with:
Retrieve **similar books** sharing properties & property values with "From the Earth to the Moon".
- Can easily be achieved via **SPARQL** and as e.g. DBpedia or Wikidata.



Now, what should I read next?

```
SELECT ?book (COUNT(DISTINCT ?o) as ?count)
WHERE {
    dbr:From_the_Earth_to_the_Moon ?p ?o .
    ?book rdf:type dbo:Book ;
        ?p ?o .
}
GROUP BY ?book
ORDER BY DESC(?count)
```



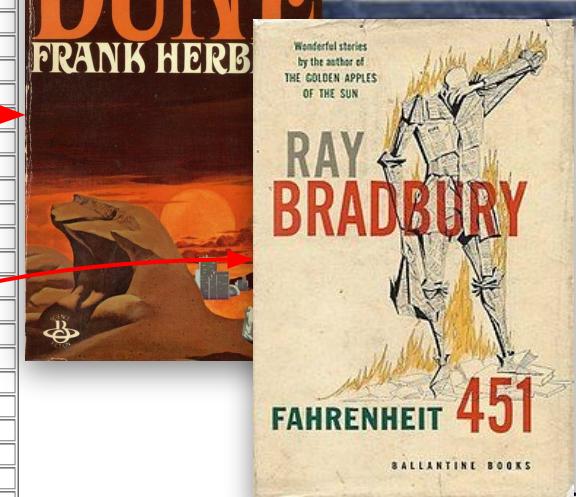
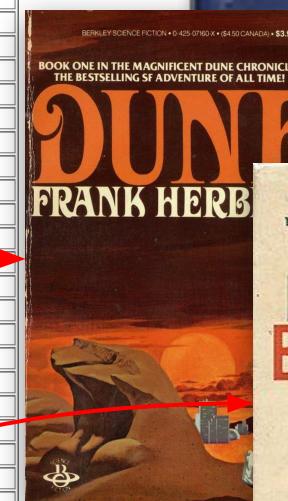
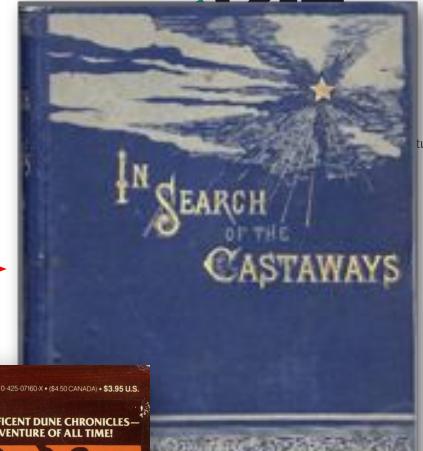
The actual query is a
bit more complicated.
But you will figure it
out easily ... ;-)

[SPARQL query](#)

Now, what should I read next?



author	book	score
"Jules_Verne"	"In_Search_of_the_Castaways"	42
"Jules_Verne"	"Godfrey_Morgan"	41
"Jules_Verne"	"Michael_Strogoff"	41
"Jules_Verne"	"Tribulations_of_a_Chinaman_in_China"	40
"Jules_Verne"	"Two_Years'_Vacation"	40
"Jules_Verne"	"The_Green_Ray"	39
"Jules_Verne"	"The_Castaways_of_the_Flag"	39
"Jules_Verne"	"The_Mighty_Orinoco"	39
"Jules_Verne"	"A_Drama_in_Livonia"	39
"Jules_Verne"	"Mathias_Sandorf"	37
"Jules_Verne"	"The_Lighthouse_at_the_End_of_the_World"	36
"Frank_Herbert"	"Dune_(novel)"	34
"Pierre_Boulle"	"Planet_of_the_Apes_(novel)"	33
"Émile_Zola"	"L'Assommoir"	33
"Émile_Zola"	"L'Argent"	33
"Émile_Zola"	"Le_Rêve_(novel)"	33
"Émile_Zola"	"La_Curée"	33
"Émile_Zola"	"Nana_(novel)"	33
"Émile_Zola"	"Au_Bonheur_des_Dames"	33
"Émile_Zola"	"La_Bête_humaine"	33
"H._G._Wells"	"The_Island_of_Doctor_Moreau"	32
"Stephen_King"	"Cycle_of_the_Werewolf"	32
"Stephen_King"	"The_Running_Man_(novel)"	32
"Victor_Hugo"	"The_Man_Who_Laughs"	32
"Émile_Zola"	"Pot-Bouille"	32
"Jules_Verne"	"Clovis_Dardentor"	32
"Honoré_de_Balzac"	"Père_Goriot"	32
"Émile_Zola"	"La_Faute_de_l'Abbé_Mouret"	32
"Guy_de_Maupassant"	"Bel_Ami"	32
"Victor_Hugo"	"Les_Misérables"	32
"Honoré_de_Balzac"	"Eugénie_Grandet"	32
"Jules_Verne"	"César_Cascabel"	32
"Ray_Bradbury"	"Fahrenheit_451"	31
"Agatha_Christie"	"Murder_on_the_Orient_Express"	31
"Stephen_King"	"Needful_Things"	31
"H._G._Wells"	"The_First_Men_in_the_Moon"	31
"Charles_Dickens"	"Nicholas_Nickleby"	31
"Voltaire"	"Candide"	31
"Honoré_de_Balzac"	"Le_Père_Goriot"	31



Now, what should I read next...?



Wikidata Query Service Examples Help More tools English

```

1 SELECT ?bookLabel ?authorLabel (COUNT(DISTINCT ?o) as ?score)
2 WHERE {
3   wd:Q53592 ?p ?o FILTER (ISURI(?o)).
4   ?book wdt:P7937 wd:Q8261 ;
5   ?p ?o ;
6   wdt:P50 ?author FILTER (?book != wd:Q53592) .
7   SERVICE wikibase:label { bd:serviceParam wikibase:language "en, de, fr" }
8 } GROUP BY ?bookLabel ?authorLabel
9 ORDER BY DESC(?score)
10 LIMIT 100
  
```

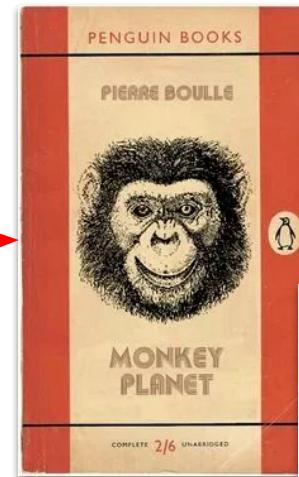


100 results in 54876 ms

Code Download Link

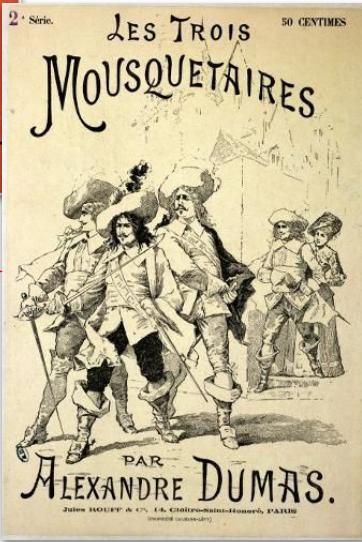
bookLabel	authorLabel	score
Planet of the Apes	Pierre Boulle	6
Germinal	Émile Zola	5
The Three Musketeers	Alexandre Dumas	5
Les Misérables	Victor Hugo	5
Les Liaisons dangereuses	Pierre Choderlos de Laclos	5
Bel Ami	Guy de Maupassant	5
In Search of Lost Time	Marcel Proust	5
Dédé	Achille Essebac	5
Clémie, histoire romaine	Madeleine de Scudéry	5
The Cathedral	Joris-Karl Huysmans	5
Ulysses	James Joyce	4
The Cat	Georges Simenon	4
Gulliver's Travels	Jonathan Swift	4

[Link to simple
WikiData SPARQL
Recommender](#)



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5. ISE Applications

- 5.1 What is Information Service Engineering?
- 5.2 Knowledge Mining and Information Extraction I
- 5.3 Knowledge Mining and Information Extraction II
- 5.4 Hands On Data Analytics Example
- 5.5 Semantic Annotation
- 5.6 Semantic Search
- 5.7 Exploratory Search

Information Service Engineering

Lecture Overview

1. Information, Natural Language and the Web
2. Natural Language Processing
3. Knowledge Graphs
4. Basic Machine Learning
5. ISE Applications

5. ISE Applications

Bibliography

- [Web Annotation Vocabulary](#), W3C Recommendation, 23 February 2017
- Exploratory Search Implementation at [SciHi.org](#)
- T. Tietz et al., [refer: a Linked Data based Text Annotation and Recommender System for Wordpress](#), Proc. of 2nd. Int. Workshop on Visualization and Interaction for Ontologies and Linked Data 2016, co-located with ISWC 2016, Vol. 1704, pp. 28-40.
(...only if you want to go deeper into exploratory search)

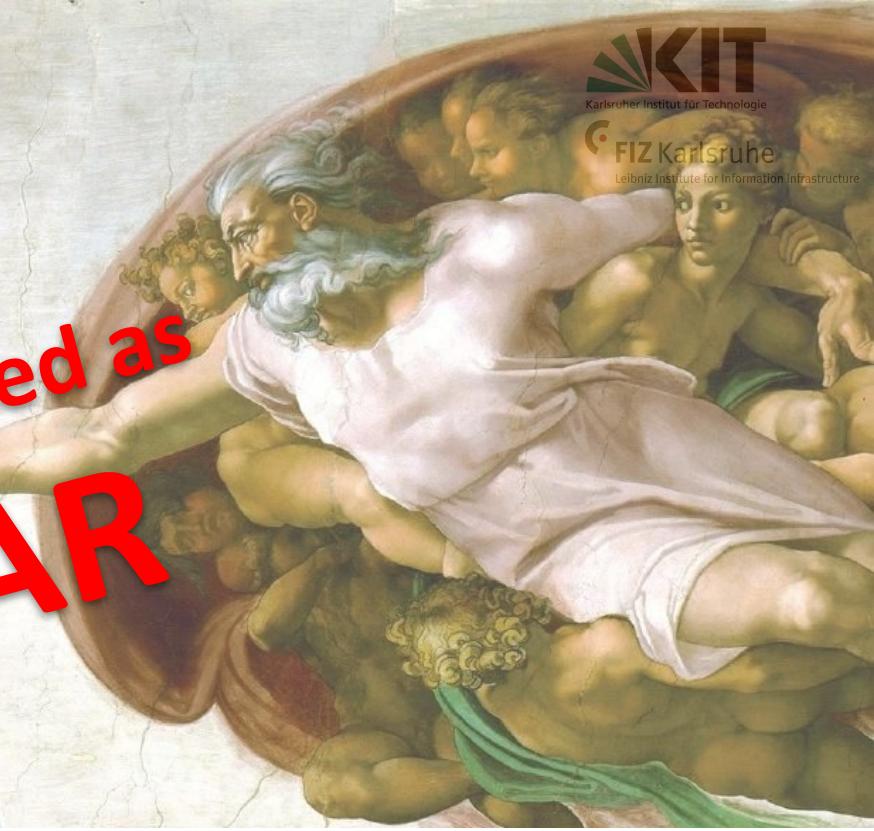
5. ISE Applications

Syllabus Questions

- How can Semantic Technologies improve traditional keyword-based Information Retrieval?
- What is entity-based search?
- What are the advantages and drawbacks of entity-based search compared with traditional keyword-based search?
- Explain exploratory search.
- How can Knowledge Graphs be leveraged for exploratory search?
- What is the difference between exploratory search and recommender systems?



Can also be credited as
SEMINAR

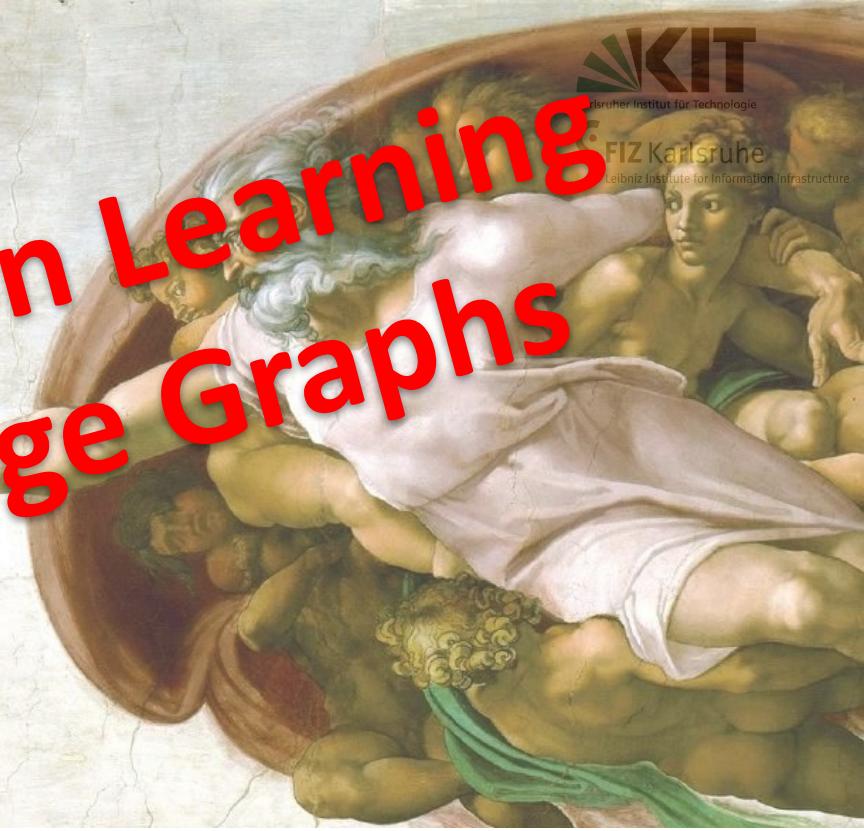
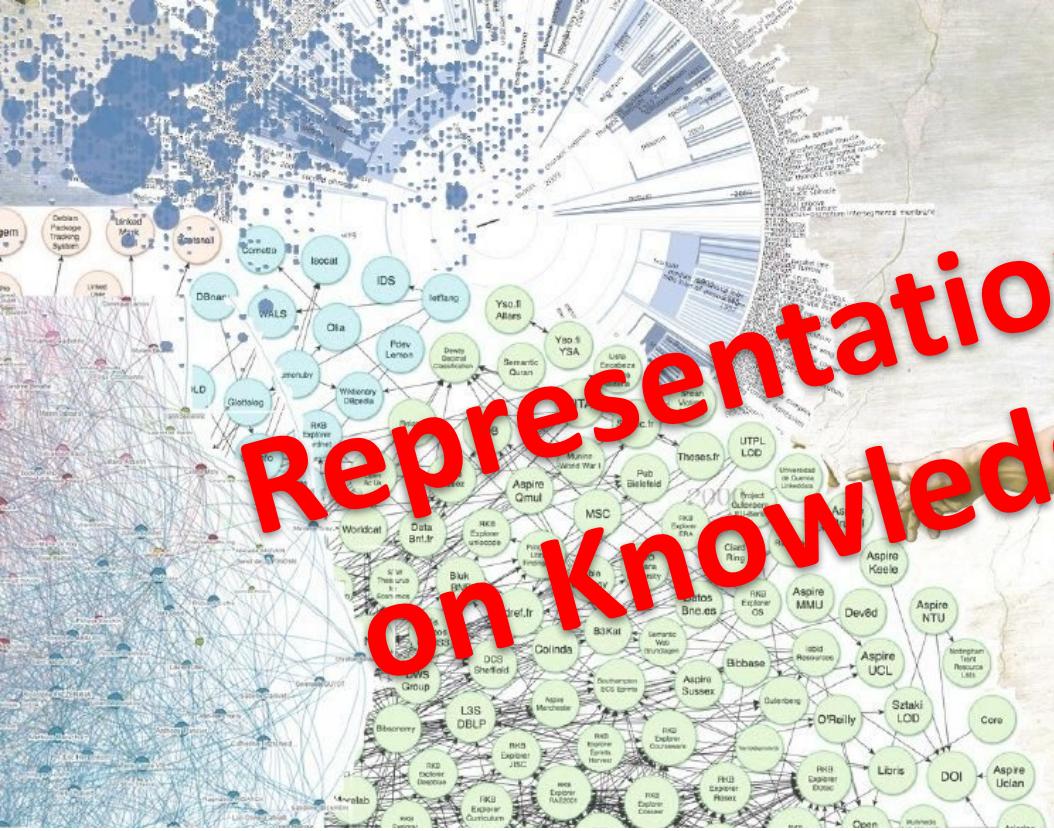


To be continued (Winter Semester 2021/22)

Information Service Engineering Project Course - Praktikum

Registration open: <https://portal.wiwi.kit.edu/>

Participation is restricted to 15 students max.



Representation Learning on Knowledge Graphs

Seminar WS 2021/22

Registration open: <https://portal.wiwi.kit.edu/>

Participation is restricted to 10 students max.