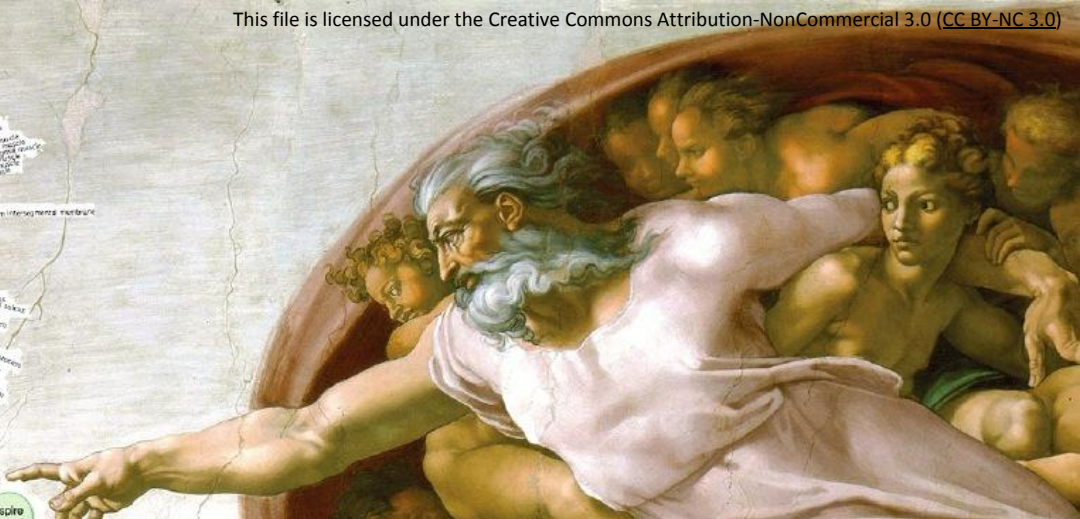




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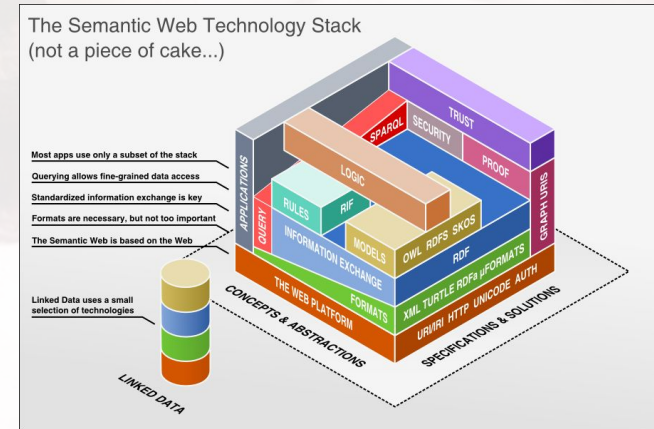
KIT
Karlsruher Institut für Technologie

Leibniz Institute for Information Infrastructure
Karlsruhe Institute of Technology
Spring 2018

Information Service Engineering

Lecture 4: Linked Data Engineering II

- 4.1 Linked Data Principles
- 4.2 Web Ontology Language OWL
- 4.3 Web Ontology Language OWL II
- 4.4 How to Query RDF with SPARQL
- 4.5 Complex Queries with SPARQL
- 4.6 More Complex SPARQL Queries**
- 4.7 Linked Data Knowledge Graphs



SPARQL Variable Assignment

Information Service Engineering - Lecture 4 Linked Data Engineering II - 4.6 More Complex Queries with SPARQL

- Example: Select all authors with their notable works and **date of publication**

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX dbo: <http://dbpedia.org/ontology/>
PREFIX dbp: <http://dbpedia.org/property/>

SELECT ?author ?work ?date
FROM <http://dbpedia.org/>
WHERE {
    ?author rdf:type dbo:Writer .
    ?author dbo:notableWork ?work .
    ?work dbp:releaseDate ?date .
} ORDER BY DESC(?date)
LIMIT 100
```

list the results in
descending order
according to the date

[query SPARQL endpoint](#)

author	work	date
http://dbpedia.org/resource/Caryl_Phillips	http://dbpedia.org/resource/The_Final_Passage	http://dbpedia.org/resource/London
http://dbpedia.org/resource/Caryl_Phillips	http://dbpedia.org/resource/The_Final_Passage	http://dbpedia.org/resource/1985_in_literature
http://dbpedia.org/resource/Richard_A._Lupoff	http://dbpedia.org/resource/Master_of_Adventure:_The_Worlds_of_Edgar_Rice_Burroughs	1965196819752005
http://dbpedia.org/resource/Michael_Robotham	http://dbpedia.org/resource/Life_or_Death_(novel)	2014
http://dbpedia.org/resource/Rob_Thurman	http://dbpedia.org/resource/Cal_Leandros_series	2006–03–07
http://dbpedia.org/resource/Joan_Brady_(American-British_writer)	http://dbpedia.org/resource/Theory_of_War	19921993
http://dbpedia.org/resource/Edna_O'Brien	http://dbpedia.org/resource/Casualties_of_Peace	19661967
http://dbpedia.org/resource/Alissa_Nutting	http://dbpedia.org/resource/Tampa_(novel)	2013
http://dbpedia.org/resource/Matt_James_(game_designer)	http://dbpedia.org/resource/Monster_Vault:_Threats_to_the_Nentir_Vale	2011
http://dbpedia.org/resource/Jon_McGregor	http://dbpedia.org/resource/Even_the_Dogs	2010–02–01
http://dbpedia.org/resource/Frank_Mentzer	http://dbpedia.org/resource/Dungeons_&_Dragons_Basic_Set	1977198119831991
http://dbpedia.org/resource/Henry_Handel_Richardson	http://dbpedia.org/resource/The_Fortunes_of_Richard_Mahony	1917192519291930
http://dbpedia.org/resource/Vladimir_Voinovich	http://dbpedia.org/resource/The_Life_and_Extraordinary_Adventures_of_Private_Ivan_Chonkin	196919792007
http://dbpedia.org/resource/Sita_Ram_Goel	http://dbpedia.org/resource/Catholic_Ashrams	19881994
http://dbpedia.org/resource/Sita_Ram_Goel	http://dbpedia.org/resource/History_of_Hindu-Christian_Encounters,_AD_304_to_1996	19861996
http://dbpedia.org/resource/Lydia_Chukovskaya	http://dbpedia.org/resource/Sofia_Petrovna	19651967
http://dbpedia.org/resource/John_Crowley	http://dbpedia.org/resource/Engine_Summer	http://dbpedia.org/resource/1979_in_literature
http://dbpedia.org/resource/Sita_Ram_Goel	http://dbpedia.org/resource/The_Story_of_Islamic_Imperialism_in_India	19821994
http://dbpedia.org/resource/Miho_Mosulishvili	http://dbpedia.org/resource/Vazha-Pshavela_(biographical_novel)	2011
http://dbpedia.org/resource/Jeannette_Walls	http://dbpedia.org/resource/Half_Broke_Horses	2010
http://dbpedia.org/resource/Jeannette_Walls	http://dbpedia.org/resource/Half_Broke_Horses	2009
http://dbpedia.org/resource/John_Crowley	http://dbpedia.org/resource/Little,_Big	http://dbpedia.org/resource/1981_in_literature
http://dbpedia.org/resource/W._Stanley_Moss	http://dbpedia.org/resource/Ill_Met_by_Moonlight	9223372036854775807
http://dbpedia.org/resource/John_Eric_Holmes	http://dbpedia.org/resource/Dungeons_&_Dragons_Basic_Set	1977198119831991
http://dbpedia.org/resource/Noriko_Ogiwara	http://dbpedia.org/resource/The_Jade_Trilogy	198819911996
http://dbpedia.org/resource/W._Stanley_Moss	http://dbpedia.org/resource/A_War_of_Shadows	195220142014
http://dbpedia.org/resource/Frank_Mentzer	http://dbpedia.org/resource/Dungeons_&_Dragons_Expert_Set	19811983
http://dbpedia.org/resource/Chabua_Amirejibi	http://dbpedia.org/resource/Data_Tutashkhia	19751985
http://dbpedia.org/resource/Nguyễn_Nhật_Ánh	http://dbpedia.org/resource/Cho_tôi_xin_một_vé_đi_tuổi_thơ	2008
http://dbpedia.org/resource/Josh_Dies	http://dbpedia.org/resource/The_Spinal_Cord_Perception	2006
http://dbpedia.org/resource/Alex_Scarrow	http://dbpedia.org/resource/TimeRiders	2010–02–04

SPARQL Variable Assignment

Information Service Engineering - Lecture 4 Linked Data Engineering II - 4.6 More Complex Queries with SPARQL

- Example: Select all authors with their notable works and **year of publication**

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX dbo: <http://dbpedia.org/ontology/>
PREFIX dbp: <http://dbpedia.org/property/>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
```

new variable assignment
with string manipulation
and regular expression

```
SELECT ?author ?work SUBSTR(REPLACE(STR(?date), "^[0-9]", ""), 1, 4) AS ?year
FROM <http://dbpedia.org/>
WHERE {
    ?author rdf:type dbo:Writer .
    ?author dbo:notableWork ?work .
    ?work dbp:releaseDate ?date .
    FILTER REGEX (?date, "[0-9]{4}")
} ORDER BY DESC(?year)
LIMIT 100
```

?date should
contain a
4-digit year

[query SPARQL endpoint](#)

author	work	year
http://dbpedia.org/resource/Henry_James	http://dbpedia.org/resource/The_Ambassadors	6190
http://dbpedia.org/resource/Henry_James	http://dbpedia.org/resource/The_Wings_of_the_Dove	3019
http://dbpedia.org/resource/Henry_James	http://dbpedia.org/resource/The_Ambassadors	2419
http://dbpedia.org/resource/Henry_James	http://dbpedia.org/resource/The_Wings_of_the_Dove	2119
http://dbpedia.org/resource/Maajid_Nawaz	http://dbpedia.org/resource/Islam_and_the_Future_of_Tolerance	2015
http://dbpedia.org/resource/Kevin_Kwan	http://dbpedia.org/resource/China_Rich_Girlfriend	2015
http://dbpedia.org/resource/Lena_Andersson_(author)	http://dbpedia.org/resource/Wilful_Disregard	2015
http://dbpedia.org/resource/Robert_Kurson	http://dbpedia.org/resource/Pirate_Hunters	2015
http://dbpedia.org/resource/Sam_Harris	http://dbpedia.org/resource/Islam_and_the_Future_of_Tolerance	2015
http://dbpedia.org/resource/Gilles_Tetreault	http://dbpedia.org/resource/The_One_Who_Got_Away	2015
http://dbpedia.org/resource/Chigozie_Obioma	http://dbpedia.org/resource/The_Fishermen_(Chigozie_Obioma_novel)	2015
http://dbpedia.org/resource/Sergio_Troncoso	http://dbpedia.org/resource/The_Nature_of_Truth	2014
http://dbpedia.org/resource/Chetan_Bhagat	http://dbpedia.org/resource/Half_Girlfriend	2014
http://dbpedia.org/resource/Dave_Eggers	http://dbpedia.org/resource/The_Circle_(Eggers_novel)	2013
http://dbpedia.org/resource/Dave_Eggers	http://dbpedia.org/resource/A_Hologram_for_the_King	2012
http://dbpedia.org/resource/Steve_Lillebuen	http://dbpedia.org/resource/The_Devil's_Cinema	2012
http://dbpedia.org/resource/Joanne_Harris	http://dbpedia.org/resource/Peaches_for_Monsieur_le_Cur�	2012
http://dbpedia.org/resource/R._Barri_Flowers	http://dbpedia.org/resource/Masters_of_True_Crime	2012
http://dbpedia.org/resource/Emily_M._Danforth	http://dbpedia.org/resource/The_Miseducation_of_Cameron_Post	2012
http://dbpedia.org/resource/Emilio_Salgari	http://dbpedia.org/resource/The_Black_Corsair	2011
http://dbpedia.org/resource/Sergio_Troncoso	http://dbpedia.org/resource/From_This_Wicked_Patch_of_Dust	2011
http://dbpedia.org/resource/Sergio_Troncoso	http://dbpedia.org/resource/Crossing_Borders:_Personal_Essays	2011
http://dbpedia.org/resource/Umera_Ahmad	http://dbpedia.org/resource/Pir-e-Kamil	2011
http://dbpedia.org/resource/Jonathan_Maberry	http://dbpedia.org/resource/Rot_&_Ruin	2010
http://dbpedia.org/resource/Surender_Mohan_Pathak	http://dbpedia.org/resource/Daylight_Robbery_(novel)	2010
http://dbpedia.org/resource/Gloria_Feldt	http://dbpedia.org/resource/No_Excuses_(book)	2010
http://dbpedia.org/resource/Amish_Tripathi	http://dbpedia.org/resource/The_Immortals_of_Meluha	2010
http://dbpedia.org/resource/Kęstutis_Kasparavičius	http://dbpedia.org/resource/The_Missing_Picture	2010
http://dbpedia.org/resource/David_Berman_(graphic_designer)	http://dbpedia.org/resource/Do_Good_Design	2009
http://dbpedia.org/resource/Abraham_Vergheze	http://dbpedia.org/resource/Cutting_for_Stone	2009
http://dbpedia.org/resource/G._B._Singh	http://dbpedia.org/resource/Gandhi_Under_Cross_Examination	2009
http://dbpedia.org/resource/V._V._Ganeshanathan	http://dbpedia.org/resource/Love_Marriage_(novel)	2008
http://dbpedia.org/resource/Joan_London_(Australian_author)	http://dbpedia.org/resource/The_Good_Parents	2008
http://dbpedia.org/resource/Jon_Smith	http://dbpedia.org/resource/Get_into_Bed_with_Google	2008
http://dbpedia.org/resource/Christopher_Kelly_(author)	http://dbpedia.org/resource/A_Push_and_a_Shove	2007

SPARQL Aggregate Functions

Information Service Engineering - Lecture 4 Linked Data Engineering II - 4.6 More Complex Queries with SPARQL

- Example: **How many** authors are there in DBpedia?

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX dbo: <http://dbpedia.org/ontology/>

SELECT COUNT(?author) AS ?num
FROM <http://dbpedia.org/>
WHERE {
    ?author rdf:type dbo:Writer .
}
```

aggregate
function

[query SPARQL endpoint](#)

SPARQL Aggregate Functions

Information Service Engineering - Lecture 4 Linked Data Engineering II - 4.6 More Complex Queries with SPARQL

- Example: How many **distinct authors** are there in DBpedia
who have entries for notable works?

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX dbo: <http://dbpedia.org/ontology/>

SELECT COUNT(DISTINCT(?author)) AS ?num
FROM <http://dbpedia.org/>
WHERE {
    ?author rdf:type dbo:Writer ;
            dbo:notableWork ?work .
}
```

[query SPARQL endpoint](#)

aggregate function and
variable assignment

SPARQL Aggregate Functions and Grouping

Information Service Engineering - Lecture 4 Linked Data Engineering II - 4.6 More Complex Queries with SPARQL

- Example: **Which author wrote how many** notable works?

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX dbo: <http://dbpedia.org/ontology/>

SELECT ?author COUNT(?work) AS ?num_works
FROM <http://dbpedia.org/>
WHERE {
    ?author rdf:type dbo:Writer ;
            dbo:notableWork ?work .
} GROUP BY ?author
ORDER BY DESC (?num_works)
```

aggregate
function

grouping the
results

[query SPARQL endpoint](#)

author	num_works
http://dbpedia.org/resource/Julian_Stockwin	16
http://dbpedia.org/resource/Vince_Powell	14
http://dbpedia.org/resource/Edna_O'Brien	14
http://dbpedia.org/resource/Roy_Clarke	13
http://dbpedia.org/resource/David_Mamet	12
http://dbpedia.org/resource/Edward_Stratemeyer	12
http://dbpedia.org/resource/Alan_Moore	12
http://dbpedia.org/resource/John_Banville	12
http://dbpedia.org/resource/Chris_Meledandri	11
http://dbpedia.org/resource/Brian_Cooke	11
http://dbpedia.org/resource/Dino_Stamatopoulos	10
http://dbpedia.org/resource/Agatha_Christie	10
http://dbpedia.org/resource/John_David_Morley	10
http://dbpedia.org/resource/Eric_Chappell	9
http://dbpedia.org/resource/Johnnie_Mortimer	9
http://dbpedia.org/resource/Charles_Dickens	9
http://dbpedia.org/resource/Samuel_Beckett	9
http://dbpedia.org/resource/Laurence_Marks_(British_writer)	9
http://dbpedia.org/resource/Mark_Evanier	9
http://dbpedia.org/resource/Rehmat_Aziz_Chitali	9
http://dbpedia.org/resource/David_Weir_(writer)	9
http://dbpedia.org/resource/Writings_of_Cicero	9
http://dbpedia.org/resource/Maurice_Gran	9
http://dbpedia.org/resource/Honoré_de_Balzac	9
http://dbpedia.org/resource/Russell_T_Davies	9
http://dbpedia.org/resource/Jean-Pierre_Thiollet	9
http://dbpedia.org/resource/Jim_Allen_(playwright)	9
http://dbpedia.org/resource/Cicero_Politics,_law,_philosophy,_rhetoric_1	9
http://dbpedia.org/resource/Joanne_Harris	8
http://dbpedia.org/resource/Neil_Gaiman	8
http://dbpedia.org/resource/Henry_James	8
http://dbpedia.org/resource/Vladimir_Nabokov	8
http://dbpedia.org/resource/Johann_Wolfgang_von_Goethe	8
http://dbpedia.org/resource/William_Trevor	8
http://dbpedia.org/resource/Dario_Fo	8

SPARQL Aggregate Functions and Grouping

Information Service Engineering - Lecture 4 Linked Data Engineering II - 4.6 More Complex Queries with SPARQL

- Example: Which author wrote **exactly 3** notable works (according to DBpedia)?

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX dbo: <http://dbpedia.org/ontology/>

SELECT ?author COUNT(?work) AS ?num_works
FROM <http://dbpedia.org/>
WHERE {
    ?author rdf:type dbo:Writer ;
            dbo:notableWork ?work .
} GROUP BY ?author
HAVING (COUNT(?work) = 3)
ORDER BY ?author
```

aggregate
function

grouping the
results

[query SPARQL endpoint](#)

author	num_works
http://dbpedia.org/resource/Abdullah_Hussain	3
http://dbpedia.org/resource/Abraham_Vergheze	3
http://dbpedia.org/resource/Adalbert_Stifter	3
http://dbpedia.org/resource/Adam_Grant	3
http://dbpedia.org/resource/Adam_Pettle	3
http://dbpedia.org/resource/Adam_Roberts_(British_writer)	3
http://dbpedia.org/resource/Adeerus_Ghayan	3
http://dbpedia.org/resource/Ahmad_Akbarpour	3
http://dbpedia.org/resource/Alan_Lawrence_Sitomer	3
http://dbpedia.org/resource/Alan_Plater	3
http://dbpedia.org/resource/Alan_Simpson_(scriptwriter)	3
http://dbpedia.org/resource/Alex_Miller_(writer)	3
http://dbpedia.org/resource/Algis_Budrys	3
http://dbpedia.org/resource/Alice_Sebold	3
http://dbpedia.org/resource/Aline_Brosh_McKenna	3
http://dbpedia.org/resource/Alison_Bechdel	3
http://dbpedia.org/resource/Alistair_MacLeod	3
http://dbpedia.org/resource/Aliya_Bukhari	3
http://dbpedia.org/resource/Alois_Jirásek	3
http://dbpedia.org/resource/Aluísio_Azevedo	3
http://dbpedia.org/resource/Amitav_Ghosh	3
http://dbpedia.org/resource/Amy_Hennig	3
http://dbpedia.org/resource/Anders_August	3
http://dbpedia.org/resource/Andrej_Blatnik	3
http://dbpedia.org/resource/Andrew_A_Smith	3
http://dbpedia.org/resource/Andrew_Marshall_(screenwriter)	3
http://dbpedia.org/resource/André_Brink	3
http://dbpedia.org/resource/Ann_C._Crispin	3
http://dbpedia.org/resource/Anne_Fine	3
http://dbpedia.org/resource/Anne_McCaffrey	3
http://dbpedia.org/resource/Anne_Parrish	3
http://dbpedia.org/resource/Anthony_Bailey_(author)	3
http://dbpedia.org/resource/Anthony_Bell_(director)	3
http://dbpedia.org/resource/Antonio_Ungar	3
http://dbpedia.org/resource/April_Genevieve_Tucholke	3

SPARQL Aggregate Functions

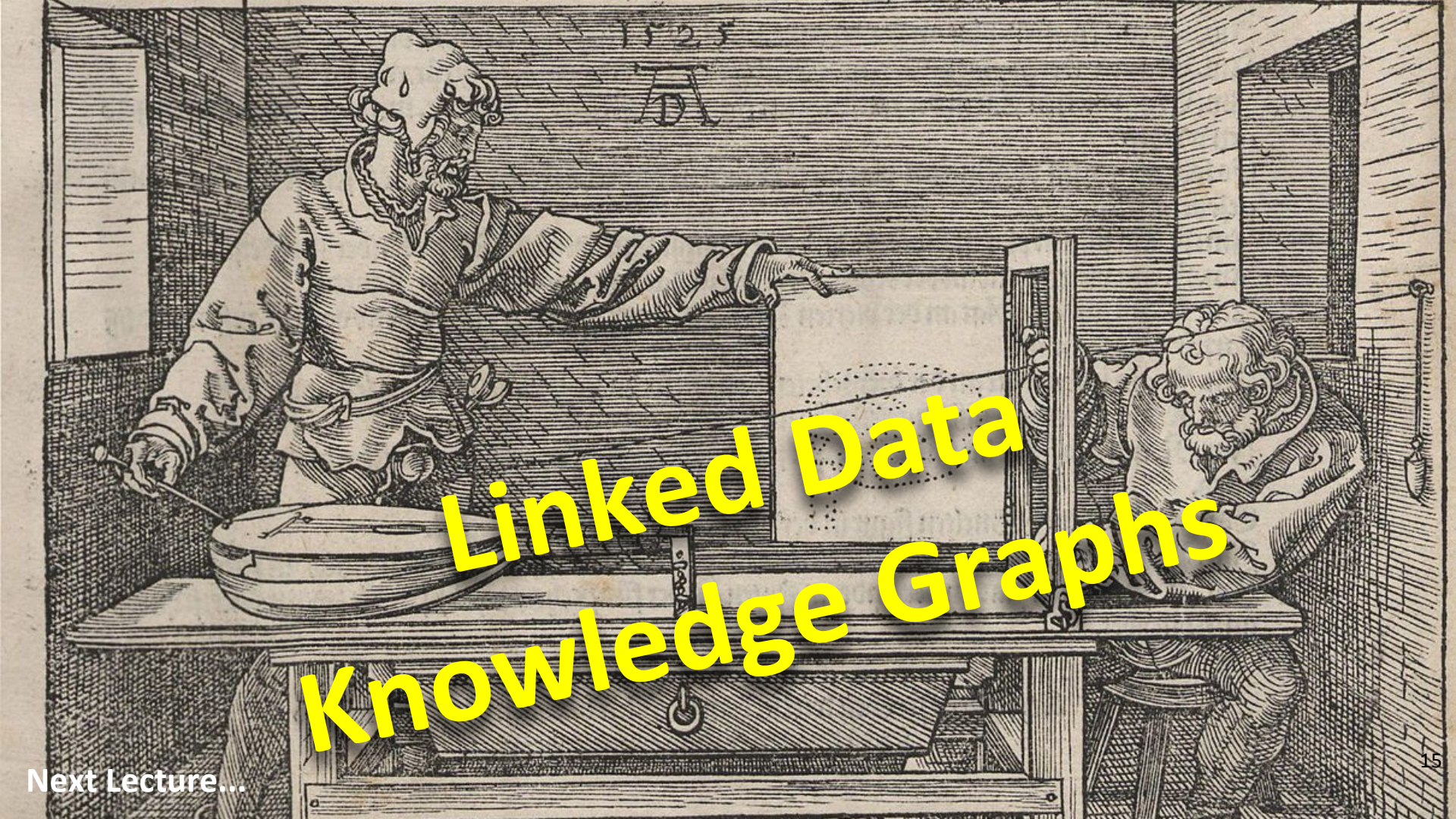
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- SPARQL 1.1 provides more aggregate functions
 - SUM
 - AVG
 - MIN
 - MAX
 - SAMPLE – „pick“ one non-deterministically
 - GROUP_CONCAT – concatenate values with a designated string separator

More SPARQL

Information Service Engineering - Lecture 4 Linked Data Engineering II - 4.6 More Complex Queries with SPARQL

- More SPARQL query functions
 - **ASK** - Check whether there is at least one result
 - **CONSTRUCT** - construct an RDF graph from a template,
 - **DESCRIBE** - return all facts (RDF triples) for resources
- More sophisticated SELECT queries with
 - Subqueries
 - Property paths
- SPARQL UPDATE
 - **INSERT / DELETE** RDF triples
 - **CREATE / DROP / COPY / MOVE** RDF graph
- SPARQL RDF(S)/OWL entailment



1525
A

Linked Data Knowledge Graphs

Next Lecture...

Picture References:

- P.15: Albrecht Dürer, Stich aus Dürers Anweisung zur Messung mit Zirkel und Richtscheid (1525)
https://commons.wikimedia.org/wiki/File:D%C3%BCrer_Stich_aus_Anweisung_2.jpg