Linked Data Engineering

Lecture 4: Querying RDF with SPARQL

4.3 More Complex SPARQL Queries

Prof. Dr. Harald Sack
FIZ Karlsruhe
Leibniz Institute for Information Infrastructure
Karlsruhe Institute of Technology
Autumn 2016

SPARQL - Variable Assignments

- 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/>


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

Linked Data Engineering , Prof. Dr. Harald Sack, FIZ Karlsruhe - Leibniz Institute for Information Infrastructure & Karlsruhe Institute of Technology

author	work	date
http://dbpedia.org/resource/John_Crowley	http://dbpedia.org/resource/Engine_Summer	http://dbpedia.org/resource/1979_in_literature
http://dbpedia.org/resource/John_Crowley	http://dbpedia.org/resource/Little,_Big	http://dbpedia.org/resource/1981_in_literature
http://dbpedia.org/resource/Beverly_Cleary	http://dbpedia.org/resource/Dear_Mr._Henshaw	http://dbpedia.org/resource/1983_in_literature
http://dbpedia.org/resource/Roald_Dahl	http://dbpedia.org/resource/Charlie_and_the_Chocolate_Factory	"* 1964 * 1967"@en
http://dbpedia.org/resource/Helen_Hooven_Santmyer	http://dbpedia.org/resource/%22...And_Ladies_of_the_Club%22	"*1982 *1984 *1985"@en
http://dbpedia.org/resource/Suetonius	http://dbpedia.org/resource/The_Twelve_Caesars	"AD 121"@en
http://dbpedia.org/resource/Daniel_Keyes	http://dbpedia.org/resource/Flowers_for_Algernon	"April 1959"@en
http://dbpedia.org/resource/Charlotte_Perkins_Gilman	http://dbpedia.org/resource/Herland_(novel)	"April 1979"@en
http://dbpedia.org/resource/Warren_Adler	http://dbpedia.org/resource/The_War_of_the_Roses_(novel)	"April 1981"@en
http://dbpedia.org/resource/David_Eddings	http://dbpedia.org/resource/The_Belgariad	"April 1982"@en
http://dbpedia.org/resource/Cormac_McCarthy	http://dbpedia.org/resource/Blood_Meridian	"April 1985"@en
http://dbpedia.org/resource/Daniel_Pinkwater	http://dbpedia.org/resource/Borgel	"April 1990"@en
http://dbpedia.org/resource/Patrick_McCabe_(novelist)	http://dbpedia.org/resource/The_Butcher_Boy_(novel)	"April 1992"@en
http://dbpedia.org/resource/Nancy_Farmer	http://dbpedia.org/resource/The_Ear,_the_Eye_and_the_Arm	"April 1994"@en
http://dbpedia.org/resource/Margaret_Clark_(writer)	http://dbpedia.org/resource/Fat_Chance_(Margaret_Clark_novel)	"April 1996"@en
http://dbpedia.org/resource/Daniel_Handler	http://dbpedia.org/resource/The_Basic_Eight	"April 1998"@en
http://dbpedia.org/resource/John_Peel_(writer)	http://dbpedia.org/resource/Legacy_of_the_Daleks	"April 1998"@en
http://dbpedia.org/resource/Julian_Stockwin	http://dbpedia.org/resource/Kydd_(novel)	"April 2001"@en
http://dbpedia.org/resource/Brian_Keene	http://dbpedia.org/resource/The_Rising_(Keene_novel)	"April 2003"@en
http://dbpedia.org/resource/Dan_Brown	http://dbpedia.org/resource/The_Da_Vinci_Code	"April 2003"@en
http://dbpedia.org/resource/Frans_Sammut	http://dbpedia.org/resource/The_Da_Vinci_Code	"April 2003"@en
http://dbpedia.org/resource/Cecelia_Ahern	http://dbpedia.org/resource/PS,_I_Love_You_(novel)	"April 2004"@en
http://dbpedia.org/resource/G._B._Singh	http://dbpedia.org/resource/Gandhi_Behind_the_Mask_of_Divinity	"April 2004"@en
http://dbpedia.org/resource/David_Mitchell_(author)	http://dbpedia.org/resource/Black_Swan_Green	"April 2006"@en
http://dbpedia.org/resource/Carole_Wilkinson	http://dbpedia.org/resource/Dragon_Moon	"April 2007"@en
http://dbpedia.org/resource/Joan_London_(Australian_author)	http://dbpedia.org/resource/The_Good_Parents	"April 2008"@en
http://dbpedia.org/resource/Hal_Clement	http://dbpedia.org/resource/Mission_of_Gravity	"April–July 1953 & 1954"@en
http://dbpedia.org/resource/Arthur_C._Clarke	http://dbpedia.org/resource/Rendezvous_with_Rama	"Aug 1973"@en
http://dbpedia.org/resource/Guy_Gavriel_Kay	http://dbpedia.org/resource/Tigana	"August 1990"@en
http://dbpedia.org/resource/David_Wellington_(author)	http://dbpedia.org/resource/Monster_Island_(Wellington_novel)	"August 2004 April 2006"@en
http://dbpedia.org/resource/Ariel_Levy	http://dbpedia.org/resource/Female_Chauvinist_Pigs	"August 2005"@en
http://dbpedia.org/resource/Premchand	http://dbpedia.org/resource/Bazaar-e-Husn	"Calcutta and Lahore"@en
http://dbpedia.org/resource/Henry_James	http://dbpedia.org/resource/The_Wings_of_the_Dove	"Constable: 30-Aug-1902"@en
http://dbpedia.org/resource/Laurence_Sterne	http://dbpedia.org/resource/The_Life_and_Opinions_of_Tristram_Shandy,_Gentleman	"December 1759 – January 1767"@en
http://dbpedia.org/resource/Henri_Barbusse	http://dbpedia.org/resource/Under_Fire_(novel)	"December 1916"@en
http://dbpedia.org/resource/David_Eddings	http://dbpedia.org/resource/The_Belgariad	"December 1984"@en
http://dbpedia.org/resource/Naomi_Klein	http://dbpedia.org/resource/No_Logo	"December 1999"@en
http://dbpedia.org/resource/J._D._Salinger	http://dbpedia.org/resource/Franny_and_Zooey	"Fall 1961"@en
http://dbpedia.org/resource/James_Fenimore_Cooper	http://dbpedia.org/resource/The_Last_of_the_Mohicans	"February 1826"@en
http://dbpedia.org/resource/Joseph_Conrad	http://dbpedia.org/resource/Heart_of_Darkness	"February 1899"@en
http://dbpedia.org/resource/Joanna_Russ	http://dbpedia.org/resource/The_Female_Man	"February 1975"@en
http://dbpedia.org/resource/Dean_Koontz	http://dbpedia.org/resource/Watchers_(novel)	"February 1987"@en
http://dbpedia.org/resource/Sharon_Carter_Rogers	http://dbpedia.org/resource/Drift_(novel)	"February 2002"@en
http://dbpedia.org/resource/Abraham_Verghese	http://dbpedia.org/resource/Cutting_for_Stone	"February 2009"@en
http://dbpedia.org/resource/Shimun_Vrochek	http://dbpedia.org/resource/Piter_(novel)	"February 2010"@en
http://dbpedia.org/resource/Amish_Tripathi	http://dbpedia.org/resource/The_Immortals_of_Meluha	"February 2010"@en

SPARQL - Variable Assignments

- 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#>


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

new variable assignment

author	work	year
http://dbpedia.org/resource/W._Stanley_Moss	http://dbpedia.org/resource/Ill_Met_by_Moonlight	9223372036854775807
http://dbpedia.org/resource/Frank_Mentzer	http://dbpedia.org/resource/Dungeons_&_Dragons_Basic_Set	1977198119831991
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/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/Dan_Wells_(author)	http://dbpedia.org/resource/I_Am_Not_a_Serial_Killer	20092010
http://dbpedia.org/resource/Joan_Brady_(American-British_writer)	http://dbpedia.org/resource/Theory_of_War	19921993
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/The_Story_of_Islamic_Imperialism_in_India	19821994
http://dbpedia.org/resource/Graham_Swift	http://dbpedia.org/resource/Shuttlecock_(novel)	19811985
http://dbpedia.org/resource/Frank_Mentzer	http://dbpedia.org/resource/Dungeons_&_Dragons_Expert_Set	19811983
http://dbpedia.org/resource/Edna_O'Brien	http://dbpedia.org/resource/Casualties_of_Peace	19661967
http://dbpedia.org/resource/Lydia_Chukovskaya	http://dbpedia.org/resource/Sofia_Petrovna	19651967
http://dbpedia.org/resource/Hermann_Hesse	http://dbpedia.org/resource/Siddhartha_(novel)	19222010
http://dbpedia.org/resource/Hermann_Hesse	http://dbpedia.org/resource/Siddhartha_(novel)	19221951
http://dbpedia.org/resource/Claire_de_Duras	http://dbpedia.org/resource/Ourika	18231824
http://dbpedia.org/resource/Kovid_Gupta	http://dbpedia.org/resource/Kingdom_of_The_Soap_Queen:_The_Story_of_Balaji_Telefilms	2014
http://dbpedia.org/resource/Devikumar_Ramalingam	http://dbpedia.org/resource/The_Celestial_Hunt	2014
http://dbpedia.org/resource/Kovid_Gupta	http://dbpedia.org/resource/Redrawing_India:_The_Teach_For_India_Story	2014
http://dbpedia.org/resource/John_King_(author)	http://dbpedia.org/resource/Headhunters_(novel)	2013
http://dbpedia.org/resource/Alissa_Nutting	http://dbpedia.org/resource/Tampa_(novel)	2013
http://dbpedia.org/resource/Brendan_I._Koerner	http://dbpedia.org/resource/The_Skies_Belong_to_Us	2013
http://dbpedia.org/resource/Charles_Montgomery_(writer)	http://dbpedia.org/resource/Happy_City	2013
http://dbpedia.org/resource/Lynn_Coady	http://dbpedia.org/resource/Hellgoing	2013
http://dbpedia.org/resource/Sahar_Delijani	http://dbpedia.org/resource/Children_of_the_Jacaranda_Tree	2013
http://dbpedia.org/resource/Lena_Andersson_(author)	http://dbpedia.org/resource/Wilful_Disregard	2013
http://dbpedia.org/resource/Kate_DiCamillo	http://dbpedia.org/resource/Flora_&_Ulysses	2013
http://dbpedia.org/resource/Steve_Rushin	http://dbpedia.org/resource/The_34-Ton_Bat	2013
http://dbpedia.org/resource/Mookonda_Poonacha_Nitin_Kushalappa	http://dbpedia.org/resource/The_Early_Coorgs	2013
http://dbpedia.org/resource/Andrew_Rugasira	http://dbpedia.org/resource/A_good_african_story:_how_a_small_company_built_a_global_coffee_brand	2013
http://dbpedia.org/resource/Varun_Agarwal	http://dbpedia.org/resource/How_I_Braved_Anu_Aunty_and_Co-Founded_a_Million_Dollar_Company	2012
http://dbpedia.org/resource/Lakshmi_Raj_Sharma	http://dbpedia.org/resource/The_Tailor's_Needle	2012
http://dbpedia.org/resource/Tom_Wolfe	http://dbpedia.org/resource/Back_to_Blood	2012
http://dbpedia.org/resource/Saurabh_Dudeja	http://dbpedia.org/resource/Love_You_Forever_Only_In_That_Way	2012
http://dbpedia.org/resource/Jennifer_Lanthier	http://dbpedia.org/resource/The_Stamp_Collector	2012
http://dbpedia.org/resource/Guy_Gavriel_Kay	http://dbpedia.org/resource/The_Summer_Tree	2012
http://dbpedia.org/resource/Ashwin_Sanghi	http://dbpedia.org/resource/The_Krishna_Key	2012
http://dbpedia.org/resource/Paul_Kastenellos	http://dbpedia.org/resource/Antonina:_A_Byzantine_Slut	2012
http://dbpedia.org/resource/P._D._James	http://dbpedia.org/resource/Death_Comes_to_Pemberley	2011
http://dbpedia.org/resource/Miho_Mosulishvili	http://dbpedia.org/resource/Vazha-Pshavela_(biographical_novel)	2011
http://dbpedia.org/resource/Ruta_Sepetys	http://dbpedia.org/resource/Between_Shades_of_Gray	2011
http://dbpedia.org/resource/Matt_James_(game_designer)	http://dbpedia.org/resource/Monster_Vault:_Threats_to_the_Nentir_Vale	2011
http://dbpedia.org/resource/Colson_Whitehead	http://dbpedia.org/resource/Zone_One	2011
http://dbpedia.org/resource/Paul_Kastenellos	http://dbpedia.org/resource/Count_No_Man_Happy:_A_Byzantine_Fantasy	2011
http://dbpedia.org/resource/Patrick_deWitt	http://dbpedia.org/resource/The_Sisters_Brothers	2011
http://dbpedia.org/resource/Dmitry_Glukhovsky	http://dbpedia.org/resource/Metro_2033_(novel)	2010
http://dbpedia.org/resource/Tom_McCarthy_(writer)	http://dbpedia.org/resource/C_(novel)	2010
http://dbpedia.org/resource/Jeannette_Walls	http://dbpedia.org/resource/Half_Broke_Horses	2010
http://dbpedia.org/resource/Jennifer_Egan	http://dbpedia.org/resource/A_Visit_from_the_Goon_Squad	2010

SPARQL - Variable Assignments

- 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#>


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
```

new variable assignment with string manipulation and regular expression

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/Sergio_Troncoso	http://dbpedia.org/resource/The_Nature_of_Truth	2014
http://dbpedia.org/resource/R._Barri_Flowers	http://dbpedia.org/resource/Masters_of_True_Crime	2012
http://dbpedia.org/resource/Steve_Lillebuen	http://dbpedia.org/resource/The_Devil's_Cinema	2012
http://dbpedia.org/resource/Emily_M._Danforth	http://dbpedia.org/resource/The_Miseducation_of_Cameron_Post	2012
http://dbpedia.org/resource/Dave_Eggers	http://dbpedia.org/resource/A_Hologram_for_the_King	2012
http://dbpedia.org/resource/Sergio_Troncoso	http://dbpedia.org/resource/From_This_Wicked_Patch_of_Dust	2011
http://dbpedia.org/resource/Shimun_Vrochek	http://dbpedia.org/resource/Piter_(novel)	2010
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/Amish_Tripathi	http://dbpedia.org/resource/The_Immortals_of_Meluha	2010
http://dbpedia.org/resource/Gloria_Feldt	http://dbpedia.org/resource/No_Excuses_(book)	2010
http://dbpedia.org/resource/G._B._Singh	http://dbpedia.org/resource/Gandhi_Under_Cross_Examination	2009
http://dbpedia.org/resource/David_Berman_(graphic_designer)	http://dbpedia.org/resource/Do_Good_Design	2009
http://dbpedia.org/resource/Abraham_Verghese	http://dbpedia.org/resource/Cutting_for_Stone	2009
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/Carole_Wilkinson	http://dbpedia.org/resource/Dragon_Moon	2007
http://dbpedia.org/resource/William_P._Young	http://dbpedia.org/resource/The_Shack	2007
http://dbpedia.org/resource/Tucker_Max	http://dbpedia.org/resource/I_Hope_They_Serve_Beer_in_Hell	2006
http://dbpedia.org/resource/Ben_Cormack	http://dbpedia.org/resource/The_Story_of_Egmo	2006
http://dbpedia.org/resource/David_Mitchell_(author)	http://dbpedia.org/resource/Black_Swan_Green	2006
http://dbpedia.org/resource/Brian_Keene	http://dbpedia.org/resource/The_Conqueror_Worms	2006
http://dbpedia.org/resource/John_Jantsch	http://dbpedia.org/resource/The_Commitment_Engine	2006
http://dbpedia.org/resource/Cecelia_Ahern	http://dbpedia.org/resource/If_You_Could_See_Me_Now_(Cecelia_Ahern_novel)	2005
http://dbpedia.org/resource/Carole_Wilkinson	http://dbpedia.org/resource/Garden_of_the_Purple_Dragon	2005
http://dbpedia.org/resource/Ariel_Levy	http://dbpedia.org/resource/Female_Chauvinist_Pigs	2005
http://dbpedia.org/resource/Daniel_Kehlmann	http://dbpedia.org/resource/Measuring_the_World	2005
http://dbpedia.org/resource/David_Wellington_(author)	http://dbpedia.org/resource/Monster_Island_(Wellington_novel)	2004
http://dbpedia.org/resource/Jon_Smith	http://dbpedia.org/resource/The_Bloke's_Guide_To_Pregnancy	2004
http://dbpedia.org/resource/Cecelia_Ahern	http://dbpedia.org/resource/PS,_I_Love_You_(novel)	2004
http://dbpedia.org/resource/G._B._Singh	http://dbpedia.org/resource/Gandhi_Behind_the_Mask_of_Divinity	2004
http://dbpedia.org/resource/Geoff_Ryman	http://dbpedia.org/resource/Air_(novel)	2004
http://dbpedia.org/resource/Ted_Dekker	http://dbpedia.org/resource/Three_(novel)	2003
http://dbpedia.org/resource/Brian_Keene	http://dbpedia.org/resource/The_Rising_(Keene_novel)	2003
http://dbpedia.org/resource/Stephan_Collishaw	http://dbpedia.org/resource/The_Last_Girl	2003
http://dbpedia.org/resource/David_Levithan	http://dbpedia.org/resource/Boy_Meets_Boy_(novel)	2003
http://dbpedia.org/resource/Dan_Brown	http://dbpedia.org/resource/The_Da_Vinci_Code	2003
http://dbpedia.org/resource/Jhumpa_Lahiri	http://dbpedia.org/resource/The_Namesake	2003
http://dbpedia.org/resource/Frans_Sammut	http://dbpedia.org/resource/The_Da_Vinci_Code	2003
http://dbpedia.org/resource/Margaret_Atwood	http://dbpedia.org/resource/Oryx_and_Crake	2003
http://dbpedia.org/resource/Sharon_Carter_Rogers	http://dbpedia.org/resource/Drift_(novel)	2002
http://dbpedia.org/resource/Laurie_Halse_Anderson	http://dbpedia.org/resource/Catalyst_(novel)	2002
http://dbpedia.org/resource/Avi_(author)	http://dbpedia.org/resource/Crispin:_The_Cross_of_Lead	2002
http://dbpedia.org/resource/Julian_Stockwin	http://dbpedia.org/resource/Kydd_(novel)	2001
http://dbpedia.org/resource/Andreas_Eschbach	http://dbpedia.org/resource/Eine_Billion_Dollar	2001

SPARQL - Aggregate Functions

- 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

SPARQL - Aggregate Functions

- 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 .
}
```

aggregate
function

SPARQL - Aggregate Functions

- 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

author	num_works
http://dbpedia.org/resource/Julian_Stockwin	16
http://dbpedia.org/resource/Vince_Powell	14
http://dbpedia.org/resource/Roald_Dahl	13
http://dbpedia.org/resource/Roy_Clarke	13
http://dbpedia.org/resource/Rexhep_Qosja	13
http://dbpedia.org/resource/Edward_Stratemeyer	12
http://dbpedia.org/resource/John_Banville	12
http://dbpedia.org/resource/Alan_Moore	11
http://dbpedia.org/resource/Chris_Meledandri	11
http://dbpedia.org/resource/Edna_O'Brien	11
http://dbpedia.org/resource/David_Mamet	11
http://dbpedia.org/resource/Brian_Cooke	11
http://dbpedia.org/resource/John_David_Morley	10
http://dbpedia.org/resource/Fyodor_Dostoyevsky	10
http://dbpedia.org/resource/Joseph_Conrad	10
http://dbpedia.org/resource/William_Trevor	9
http://dbpedia.org/resource/Samuel_Beckett	9
http://dbpedia.org/resource/Maurice_Gran	9
http://dbpedia.org/resource/Mark_Evanier	9
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/Laurence_Marks_(British_writer)	9
http://dbpedia.org/resource/Cicero	9
http://dbpedia.org/resource/Homer_Hickam	9
http://dbpedia.org/resource/Writings_of_Marcus_Tullius_Cicero	9
http://dbpedia.org/resource/Ismail_Kadare	9
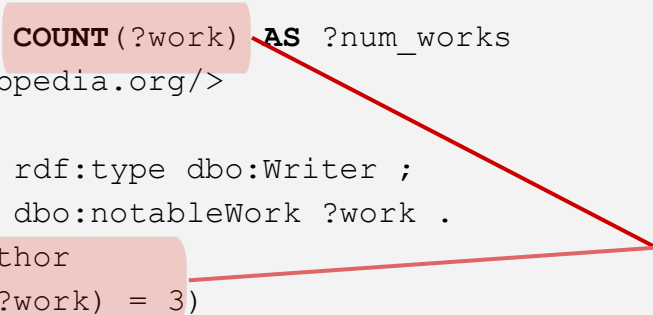
SPARQL - Aggregate Functions

- 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

author	num_works
http://dbpedia.org/resource/Abdullah_Hussain	3
http://dbpedia.org/resource/Abraham_Verghese	3
http://dbpedia.org/resource/Adalbert_Stifter	3
http://dbpedia.org/resource/Adam_Hamdy	3
http://dbpedia.org/resource/Adam_Roberts_(British_writer)	3
http://dbpedia.org/resource/Ahmad_Akbarpour	3
http://dbpedia.org/resource/Alan_Plater	3
http://dbpedia.org/resource/Algis_Budrys	3
http://dbpedia.org/resource/Alice_Sebold	3
http://dbpedia.org/resource/Alison_Bechdel	3
http://dbpedia.org/resource/Alistair_MacLeod	3
http://dbpedia.org/resource/Amish_Tripathi	3
http://dbpedia.org/resource/Amitav_Ghosh	3
http://dbpedia.org/resource/Amy_Hennig	3
http://dbpedia.org/resource/Amy_Holden_Jones	3
http://dbpedia.org/resource/Andrej_Blatnik	3
http://dbpedia.org/resource/Andrew_Marshall_(screenwriter)	3
http://dbpedia.org/resource/Ann-Marie_MacDonald	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/Anthony_Bell_(director)	3
http://dbpedia.org/resource/Antonio_Ungar	3
http://dbpedia.org/resource/Arnold_Lobel	3
http://dbpedia.org/resource/Aron_Eli_Coleite	3
http://dbpedia.org/resource/Arthur_Hailey	3

SPARQL - Aggregate Functions

- 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

SPARQL - Aggregate Functions

- Example: Compare an arbitrary title and non-english titles of notable Works by authors

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


SELECT (SAMPLE(?title) AS ?name)
       (GROUP_CONCAT(?alt_titles; SEPARATOR=", ") AS ?alt_names)
FROM <http://dbpedia.org/>
WHERE {
       ?author rdf:type dbo:Writer .
       ?author dbo:notableWork ?work .
       ?work rdfs:label ?title .
       ?work rdfs:label ?alt_titles .
       FILTER (LANG(?alt_titles)!="en")
} GROUP BY ?author
```

aggregate
function

query SPARQL endpoint

name	alt_names
"Cycle de la Compagnie noire"@fr	Cycle de la Compagnie noire, Cycle de la Compagnie noire, Cycle de la Compagnie noire, Cycle de la Compagnie noire, Czarna Kompania, Czarna Kompania, Czarna Kompania, Czarna Kompania, Чёрный отряд, Чёрный отряд, Чёрный отряд, Чёрный отряд, Das Rad der Zeit, Das Rad der Zeit, Das Rad der Zeit, Das Rad der Zeit, Das Rad der Zeit, Das Rad der Zeit, Das Rad der Zeit, Das Rad der Zeit, Das Rad der Zeit, Das Rad der Zeit, Das Rad der Zeit, La rueda del tiempo (saga), La rueda del tiempo (saga), La rueda del tiempo (saga), La rueda del tiempo (saga), La rueda del tiempo (saga), La rueda del tiempo (saga), La rueda del tiempo (saga), La rueda del tiempo (saga), La rueda del tiempo (saga), La rueda del tiempo (saga), La Roue du temps, La Roue du temps, La Roue du temps, La Roue du temps, La Roue du temps, La Roue du temps, La Roue du temps, La Roue du temps, La Roue du temps, La Roue du temps, La Roue du temps, La Roue du temps, La Ruota del Tempo, La Ruota del Tempo, La Ruota del Tempo, La Ruota del Tempo, La Ruota del Tempo, La Ruota del Tempo, La Ruota del Tempo, La Ruota del Tempo, La Ruota del Tempo, La Ruota del Tempo, La Ruota del Tempo, 時の車輪, 時の車輪, 時の車輪, 時の車輪, 時の車輪, 時の車輪, 時の車輪, 時の車輪, 時の車輪, 時の車輪, Het Rad des Tijds, Het Rad des Tijds, Het Rad des Tijds, Het Rad des Tijds, Het Rad des Tijds, Het Rad des Tijds, Het Rad des Tijds, Het Rad des Tijds, Het Rad des Tijds, Het Rad des Tijds, Het Rad des Tijds, Koło Czasu (cykl), Koło Czasu (cykl), Koło Czasu (cykl), Koło Czasu (cykl), Koło Czasu (cykl), Koło Czasu (cykl), Koło Czasu (cykl), Koło Czasu (cykl), Koło Czasu (cykl), Koło Czasu (cykl), Koło Czasu (cykl), Колесо Времени, Колесо Времени, Колесо Времени, Колесо Времени, Колесо Времени, Колесо Времени, Колесо Времени, Колесо Времени, Колесо Времени, Колесо Времени, Wheel of Time, Wheel of Time, Wheel of Time, Wheel of Time, Wheel of Time, Wheel of Time, Wheel of Time, Wheel of Time, Wheel of Time, Wheel of Time, 時間之輪, 時間之輪, 時間之輪, 時間之輪, 時間之輪, 時間之輪, 時間之輪, 時間之輪, 時間之輪, 時間之輪, 時間之輪, Das große Spiel (Buch), Das große Spiel (Buch), Das große Spiel (Buch), Das große Spiel (Buch), Das große Spiel (Buch), Das große Spiel (Buch), Das große Spiel (Buch), Das große Spiel (Buch), Das große Spiel (Buch), El juego de Ender, El juego de Ender, El juego de Ender, El juego de Ender, El juego de Ender, El juego de Ender, El juego de Ender, El juego de Ender, El juego de Ender, La Stratégie Ender, La Stratégie Ender, La Stratégie Ender, La Stratégie Ender, La Stratégie Ender, La Stratégie Ender, La Stratégie Ender, La Stratégie Ender, La Stratégie Ender, La Stratégie Ender, Il gioco di Ender, Il gioco di Ender, Il gioco di Ender, Il gioco di Ender, Il gioco di Ender, Il gioco di Ender, Il gioco di Ender, Il gioco di Ender, エンダーのゲーム, エンダーのゲーム, エンダーのゲーム, エンダーのゲーム, エンダーのゲーム, エンダーのゲーム, エンダーのゲーム, エンダーのゲーム, エンダーのゲーム, エンダーのゲーム, Gra Endera, Gra Endera, Gra Endera, Gra Endera, Gra Endera, Gra Endera, Gra Endera, Gra Endera, Gra Endera, Gra Endera, Игра Эндера, Игра Эндера, Игра Эндера, Игра Эндера, Игра Эндера, Игра Эндера, Игра Эндера, Игра Эндера, Игра Эндера, Игра Эндера, 安德的游戏, 安德的游戏, 安德的游戏, 安德的游戏, 安德的游戏, 安德的游戏, 安德的游戏, 安德的游戏, 安德的游戏, Ender's Game, Ender's Game, Ender's Game, Ender's Game, Ender's Game, Ender's Game, Ender's Game, Ender's Game, Ender's Game, Ender's Game
"Hamlet (Théâtre d'art de Moscou, 1911)"@fr	Hamlet (Théâtre d'art de Moscou, 1911), Hamlet (Théâtre d'art de Moscou, 1911), Hamlet (Théâtre d'art de Moscou, 1911), Hamlet produção do TAM 1911, Hamlet produção do TAM 1911, Hamlet produção do TAM 1911
"La Otra Rusia"@es	La Otra Rusia, La Otra Rusia, La Otra Rusia, Другая Россия (партия), Другая Россия (партия), Другая Россия (партия), Fuck Off, Amerika, Fuck Off, Amerika, Fuck Off, Amerika, Fuck Off, Amerika, Le poète russe préfère les grands nègres, Le poète russe préfère les grands nègres, Le poète russe préfère les grands nègres, Это я, Эдичка, Это я, Эдичка, Это я, Эдичка, Это я, Эдичка
"A Suitable Boy"@en	Pretendent do ręki, Pretendent do ręki
"中国影帝温家宝"@zh	中国影帝温家宝, 中国影帝温家宝
"نقطة أفضلية (فيلم)"@ar	نقطة أفضلية (فيلم), نقطة أفضلية (فيلم), نقطة أفضلية (فيلم), نقطة أفضلية (فيلم), نقطة أفضلية (فيلم), نقطة أفضلية (فيلم), نقطة أفضلية (فيلم), نقطة أفضلية (فيلم), نقطة أفضلية (فيلم), 8 Blickwinkel, 8 Blickwinkel, 8 Blickwinkel, 8 Blickwinkel, 8 Blickwinkel, 8 Blickwinkel, 8 Blickwinkel, 8 Blickwinkel, 8 Blickwinkel, 8 Blickwinkel, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Prospettive di un delitto, Prospettive di un delitto, Prospettive di un delitto, Prospettive di un delitto, Prospettive di un delitto, Prospettive di un delitto, Prospettive di un delitto, Angles d'attaque, Angles d'attaque, Angles d'attaque, Angles d'attaque, Angles d'attaque, Angles d'attaque, Angles d'attaque, Angles d'attaque, Angles d'attaque, Angles d'attaque, Angles d'attaque, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, バンテージ・ポイント, Vantage Point (film), Vantage Point (film), Vantage Point (film), Vantage Point (film), Vantage Point (film), Vantage Point (film), Vantage Point (film), Vantage Point (film), Vantage Point (film), Vantage Point (film), Vantage Point (film), Vantage Point (film), 8 części prawdy, 8 części prawdy, 8 części prawdy, 8 części prawdy, 8 części prawdy, 8 części prawdy, 8 części prawdy, 8 części prawdy, 8 części prawdy, 8 części prawdy, 8 części prawdy, Точка обстрела, Точка обстрела, Точка обстрела, Точка обстрела, Точка обстрела, Точка обстрела, Точка обстрела, Точка обстрела, Точка обстрела, Точка обстрела, 絕點緝兇, 絕點緝兇, 絕點緝兇, 絕點緝兇, 絕點緝兇, 絕點緝兇, 絕點緝兇, 絕點緝兇, 絕點緝兇, 絕點緝兇, 絕點緝兇, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point, Vantage Point
"Glastonbury Romance"@de	Glastonbury Romance, Glastonbury Romance
"Die Reise nach Petuschki"@de	Die Reise nach Petuschki, Die Reise nach Petuschki, Die Reise nach Petuschki, Die Reise nach Petuschki, Die Reise nach Petuschki, Moscou-sur-Vodka, Moscou-sur-Vodka, Moscou-sur-Vodka, Moscou-sur-Vodka, Moscou-sur-Vodka, Moskwa-Pietuszki, Moskwa-Pietuszki, Moskwa-Pietuszki, Moskwa-Pietuszki, Moskwa-Pietuszki, Moskwa-Pietuszki, Москва — Петушки, Москва — Петушки, Москва — Петушки, Москва — Петушки, Москва — Петушки
"Young Bess"@en	Die Thronfolgerin, Die Thronfolgerin, Die Thronfolgerin, Die Thronfolgerin, Die Thronfolgerin, Die Thronfolgerin, La regina vergine, La regina vergine, La regina vergine, La regina vergine, La regina vergine, La regina vergine, La Reine vierge, La Reine vierge, La Reine vierge, La Reine vierge, La Reine vierge, La Reine vierge, Young Bess, Young Bess, Young Bess, Young Bess, Young Bess, Young Bess, Малышка Бесс, Малышка Бесс, Малышка Бесс, Малышка Бесс, Малышка Бесс, Малышка Бесс
"Il conservatore"@it	Il conservatore, Il conservatore, July's People, July's People, July's People, 七月的人民, 七月的人民, 七月的人民
"EastEnders"@en	EastEnders, イーストエンダーズ, イーストエンダーズ, イーストエンダーズ, イーストエンダーズ, イーストエンダーズ, イーストエンダーズ, イーストエンダーズ, イーストエンダーズ, イーストエンダーズ, イーストエンダーズ, イーストエンダーズ, EastEnders, EastEnders, EastEnders, EastEnders, EastEnders, EastEnders, EastEnders, EastEnders, EastEnders, EastEnders, 东区人, 东区人, 东区人, 东区人, 东区人, 东区人, 东区人, 东区人, 东区人, EastEnders, EastEnders, EastEnders
	Fame (2009), Fame (2009), Fame (2009), Fame (2009), Fame (2009), Fame (2009), Fame (2009), Fame (2009), Fame (2009), Fame (película de 2009), Fame (película de 2009), Fame (película de 2009), Fame (película de 2009), Fame (película de 2009), Fame (película de 2009), Fame (película de 2009), Fame (película de 2009), Fame (película de 2009), Fame (película de 2009), Fame (film, 2009), Fame (film, 2009), Fame (film, 2009), Fame (film, 2009), Fame (film, 2009), Fame (film, 2009), Fame (film, 2009), Fame (film, 2009), Fame - Saranno famosi, Fame - Saranno famosi, Fame - Saranno famosi, Fame - Saranno famosi, Fame - Saranno famosi, Fame - Saranno famosi, Fame - Saranno famosi, Fame - Saranno famosi, Fame (film 2009), Fame (film 2009), Fame (film 2009), Fame (film 2009), Fame (film 2009), Fame (film 2009), Fame (film 2009), Fame (film 2009), Fame (film 2009), Слава (фильм, 2009), Слава (фильм, 2009), Слава (фильм, 2009), Слава (фильм, 2009), Слава (фильм, 2009), Слава (фильм, 2009), Слава (фильм, 2009), Слава (фильм, 2009), Слава (фильм, 2009), Слава (фильм, 2009), Fama (2009), Fama (2009), Fama (2009), Fama (2009), Fama (2009), Fama (2009), Fama (2009), Fama (2009), العالم السفلي: الصحوة (فيلم), العالم السفلي: الصحوة (فيلم), العالم السفلي: الصحوة (فيلم), العالم السفلي: الصحوة (فيلم), العالم السفلي: الصحوة (فيلم), العالم السفلي: الصحوة (فيلم), العالم السفلي: الصحوة (فيلم), العالم السفلي: الصحوة (فيلم), العالم السفلي: الصحوة (فيلم), العالم السفلي: الصحوة (فيلم), Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld - Il risveglio, Underworld - Il risveglio, Underworld - Il risveglio, Underworld - Il risveglio, Underworld - Il risveglio, Underworld - Il risveglio, Underworld - Il risveglio, Underworld - Il risveglio, Underworld : Nouvelle Ère, Underworld : Nouvelle Ère, Underworld : Nouvelle Ère, Underworld : Nouvelle Ère, Underworld : Nouvelle Ère, Underworld : Nouvelle Ère, Underworld : Nouvelle Ère, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening, Underworld: Awakening

Next: 04 - SPARQL Subqueries and Property Paths
Lecture 4 - Querying RDF with SPARQL - OpenHPI - Course Linked Data Engineering