

CC7220-1

LA WEB DE DATOS

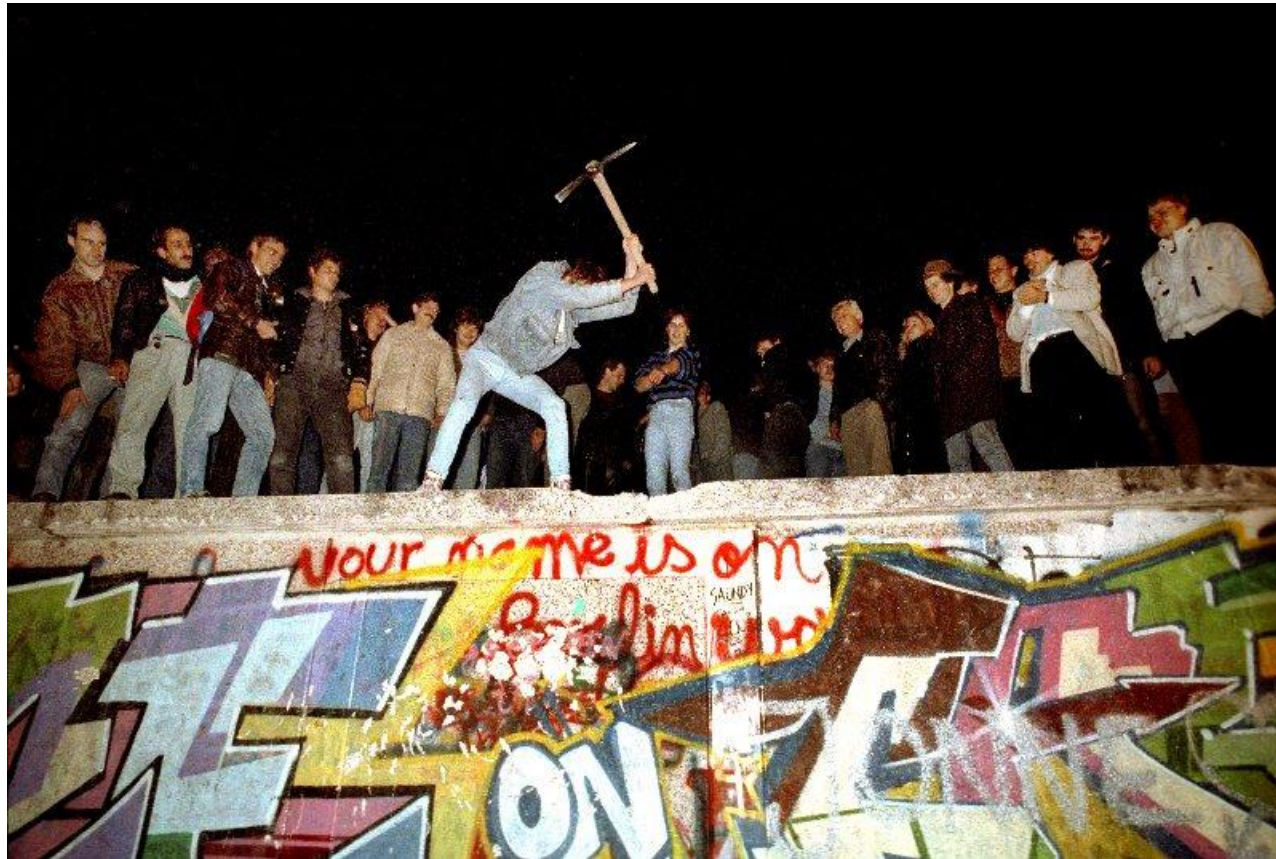
PRIMAVERA 2020

LECTURE 1: INTRODUCTION

Aidan Hogan
aidhog@gmail.com

THE WEB

THE WEB IS NOW 3 DECADES OLD



THE FUTURE OF THE WEB?



What will the Web be like in 3 decades time?



THE SEMANTIC WEB?

SEMANTIC WEB?

The Google logo is centered on the page, featuring its characteristic multi-colored letters: 'G' in blue, 'o' in red, 'o' in yellow, 'g' in blue, 'l' in green, and 'e' in red.

semantic web



Google Search

I'm Feeling Lucky

SEMANTIC WEB?



"The Semantic Web will bring structure to the meaningful content of Web pages, creating an environment where software agents roaming from page to page can readily carry out sophisticated tasks for users."

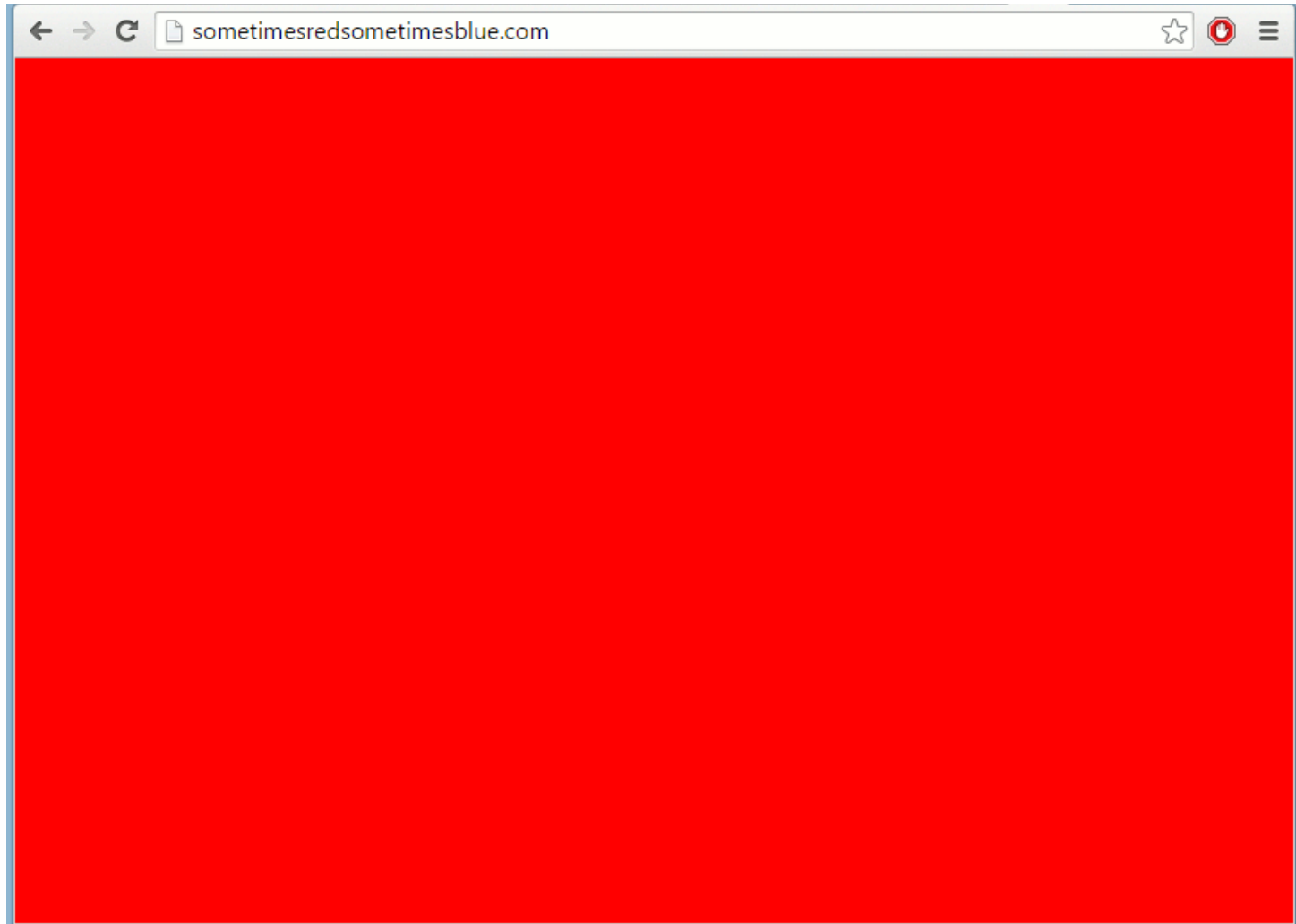
– Berners-Lee et al. (2001) "The Semantic Web" *Sci. American* 283: 34-43.



Consider answering: "What is the Web?"

WHAT'S WRONG WITH THE
CURRENT WEB?

THE CURRENT WEB IS FANTASTIC!



Google is also pretty great



movie what's in the box



Seven (stylized as SE7EN) is a 1995 American crime thriller **film** directed by David Fincher and written by Andrew Kevin Walker. It stars Brad Pitt, Morgan Freeman, Gwyneth Paltrow, John C. McGinley, R. Lee Ermey, and Kevin Spacey.



[Seven \(1995 film\) - Wikipedia](#)

[https://en.wikipedia.org/wiki/Seven_\(1995_film\)](https://en.wikipedia.org/wiki/Seven_(1995_film))



da da da dum symphony



[Web](#) [Videos](#) [News](#) [Shopping](#) [Images](#) [More](#) [Search tools](#)

About 107,000 results (0.36 seconds)



[Beethoven - Symphony No. 5 in C Minor \(1\) - YouTube](#)
www.youtube.com/watch?v=W2qW6fOtAMY



sometimes when i'm

- sometimes when i'm **alone i use comic sans**
- sometimes when i'm **alone i google myself**
- sometimes when i'm **alone i cry**
- sometimes when i'm **all alone**
- sometimes when i'm **dreaming**
- sometimes when i'm **sad i like to cut myself**
- sometimes when i'm **dreaming lyrics**
- sometimes when i'm **alone**
- sometimes when i'm **driving on the road at night**
- sometimes when i'm **alone i wonder**

Google Search

I'm Feeling Lucky

PROBLEM WITH THE CURRENT WEB:
LITERATURE VETERANS

DOING A REPORT FOR UNIVERSITY ...



Wants to find all:

- Nobel Prize winners in Literature
- Who fought in at least one war
- The year they won the prize
- And the year the war(s) started



... how would you solve this?

LOTS OF WIKIPEDIA TABS ...



W List of Nobel laureates in | x

W List of Nobel laureates in x W Sully Prudhomme - Wikip x

W List of Nobel laureates in x W Sully Prudhomme - Wikip x W Franco-Prussian War - Wil x

W List of Nobel laureates in x W Sully Prudhomme - Wikip x W Franco-Prussian War - Wil x W Theodor Mommsen - Wik x

https://en.wikipedia.org/wiki/Theodor_Mommsen

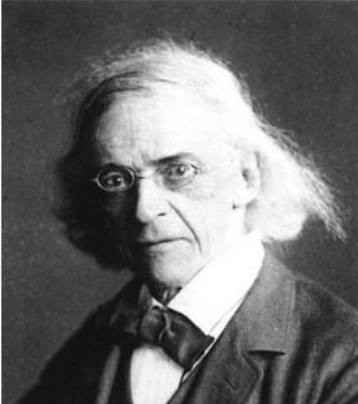
Not logged in Talk Contributions Create account Log in

Article Talk Read Edit View history Search

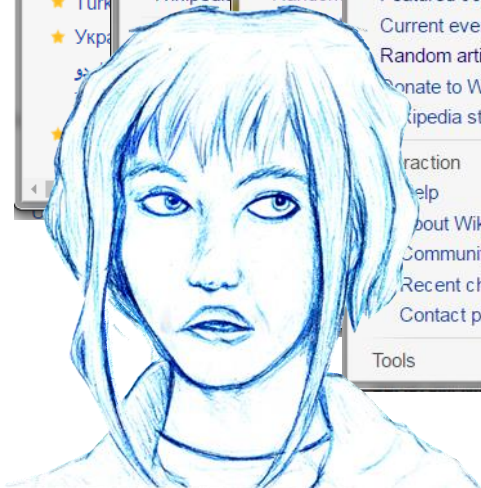
Theodor Mommsen

From Wikipedia, the free encyclopedia

Christian Matthias Theodor Mommsen (30 November 1817 – 1 November 1903) was a German classical scholar, historian, jurist, journalist, politician, archaeologist^[1] and writer generally regarded as one of the greatest classicists of the 19th century. His work regarding Roman history is still of fundamental importance for contemporary research. He received the Nobel Prize in Literature in 1902 for being "the greatest living master of the art of historical writing, with special reference to his monumental work, *A History of Rome*", after having been nominated by 18 members of the Prussian



Theodor Mommsen



THE LAUREATE ALGORITHM (3 DECADES ON)



results := \emptyset

for all *nobel-lit-winner* in *wiki-list*

year-prize := year of *nobel-lit-winner*

wars := search “war”, “conflict”, “battle” in *nobel-lit-winner*

for all *war* in *wars*

year-war := starting year of *war*

add *nobel-lit-winner*, *year-prize*, *war*, *year-war* to *results*

end

end

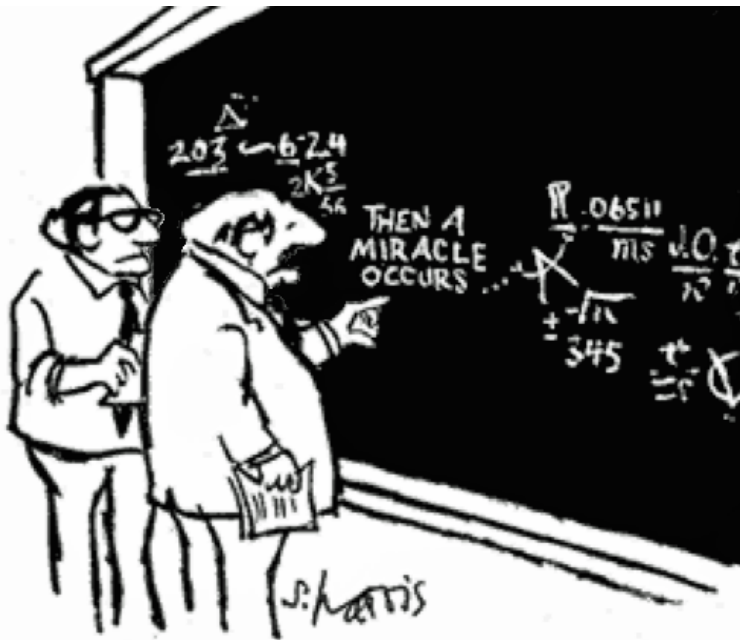
return *results*



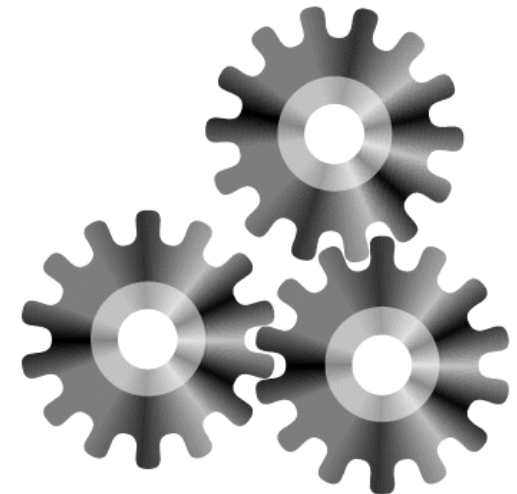
THE LAUREATE ALGORITHM (6 DECADES ON?)



```
nobel-lit-winner-and-wars := magical-sem-web-results()  
return nobel-lit-winner-and-wars
```



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."



DOING A REPORT FOR UNIVERSITY ...



Wants to find all:

- Nobel Prize winners in Literature
- Who fought in at least one war
- The year they won the prize
- And the year the war(s) started



... why is this query hard on the current Web?

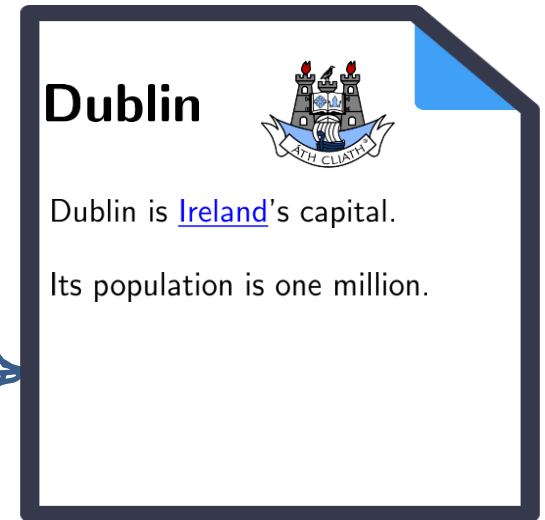
SO WHAT'S THE PROBLEM ...

THE CURRENT WEB IS DOCUMENT-CENTRIC

http://ex.org/Ireland



http://ex.org/Dublin



```
<html>
```

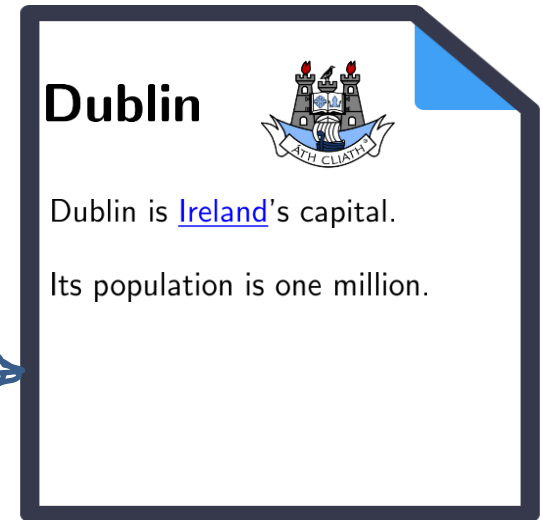
```
</html>
```

THE CURRENT WEB IS DOCUMENT-CENTRIC

http://ex.org/Ireland



http://ex.org/Dublin



```
<html>
  <body>
    <h1>Ireland</h1>
    <div class="flag"></div>
    <p>Ireland is a European country.</p>
    <p>Its capital is <a href="http://ex.org/Dublin">Dublin</a>.</p>
    ...
  </body>
</html>
```

(MOST OF IT) MAKES SENSE TO HUMANS

<http://ex.org/Ireland>

<http://ex.org/Dublin>

Ireland



Ireland is a European country.

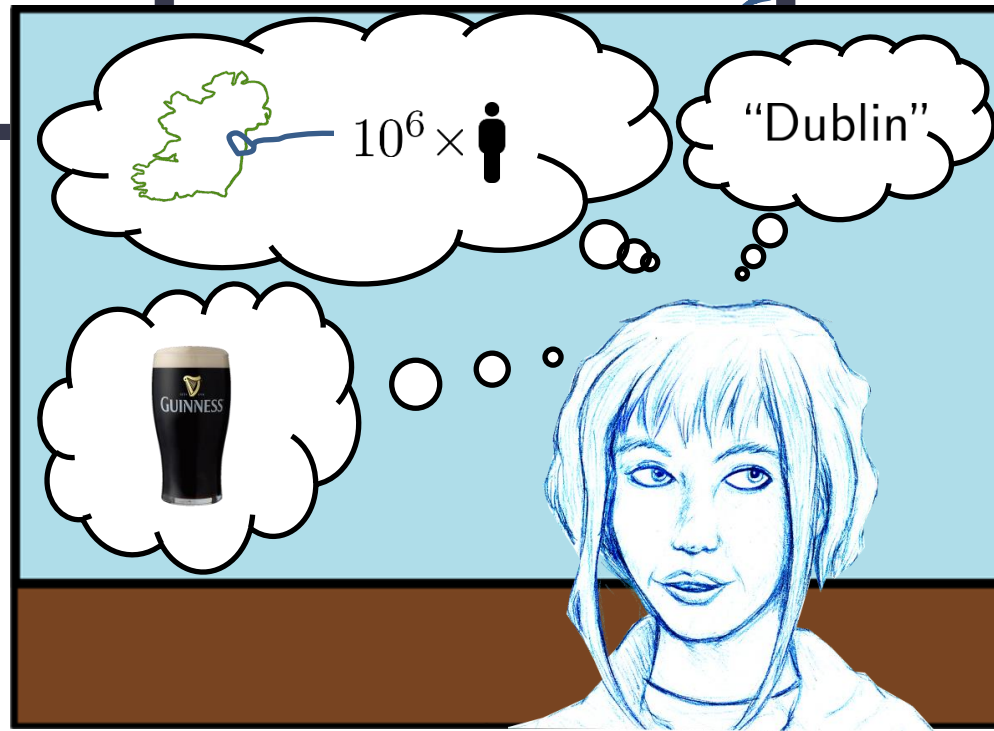
Its capital is [Dublin](#).

Dublin



Dublin is [Ireland](#)'s capital.

Its population is one million.



... ASSUMING THEY SPEAK THE LANGUAGE

<http://ex.org/Ireland>

<http://ex.cl/Dublín>

Ireland



Ireland is a European country.

Its capital is Dublin.

Dublín



Dublín es la capital de [Irlanda](#).

Su población es un millón.



EVEN WORSE FOR MACHINES

`http://ex.org/Ireland`

`http://ex.cl/Dublín`

Ireland



Ireland is a European country.

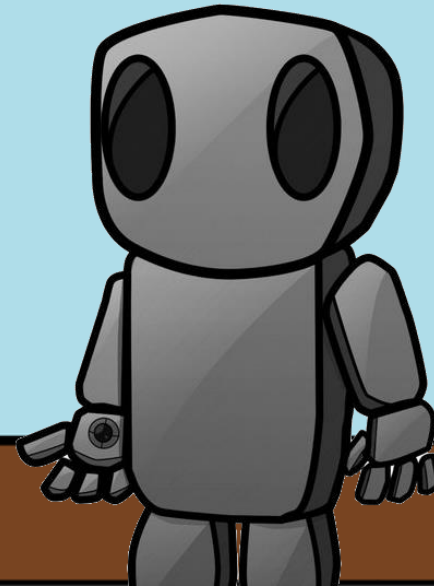
Its capital is [Dublin](#).

Dublín



Dublín es la capital de [Irlanda](#).

Su población es un millón.



YTYL NUGZY PUG MEBHOLYZ

`http://ex.org/0gyselw`

`http://ex.cl/Wdcsól`

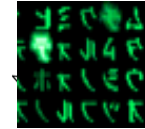
Ogyselw



Ogyselw oz e Ydguryel budlfgi.

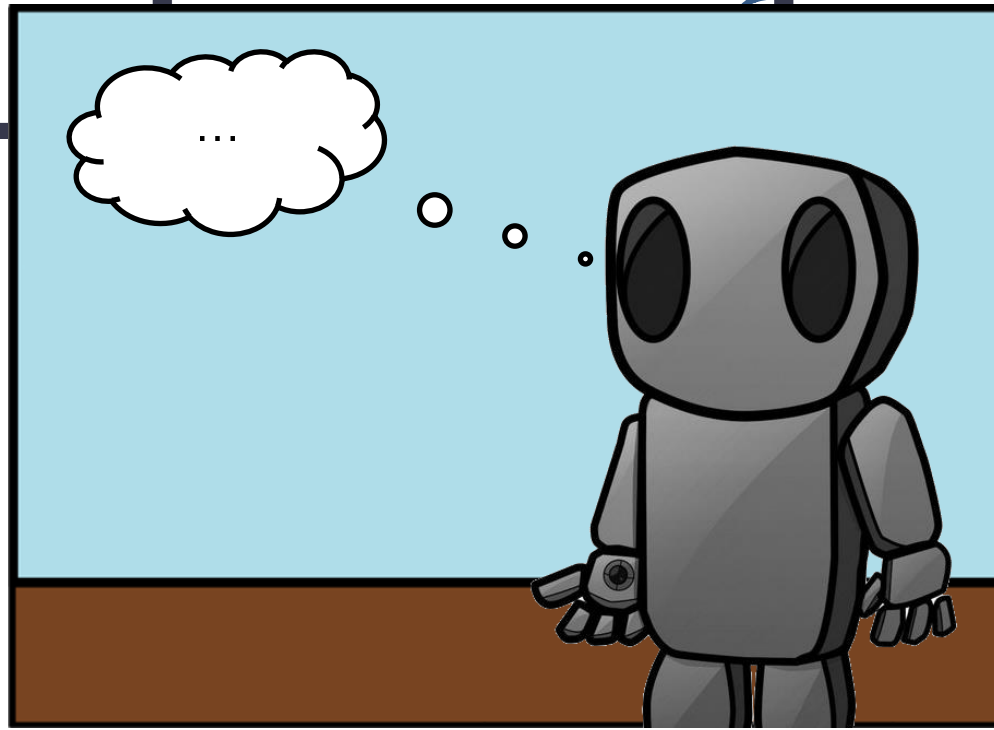
Ofz berofes oz [Wdcsol.](#)

Wdcsól



Wdcsól yz se berofes wy [Ogselwe.](#)

Zd rucseboúl yz dl mossúl.



SO WHAT'S THE PROBLEM ...

WHAT MACHINES CAN DO: FETCH DOCUMENTS

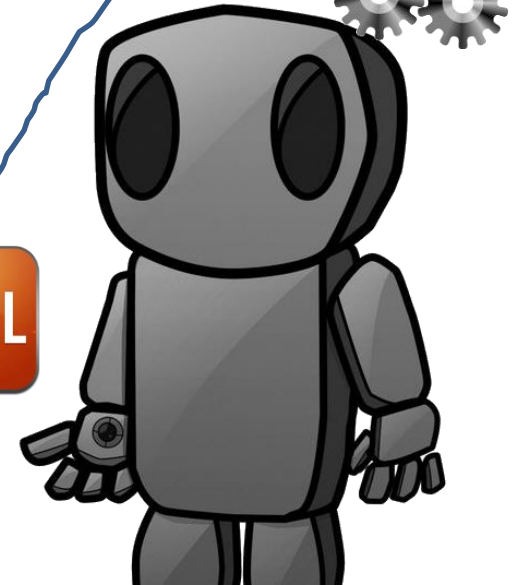


http://ex.org/

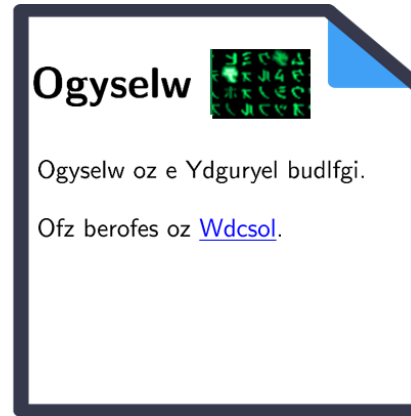


http://


HTML



WHAT MACHINES CAN DO: FIND DOCUMENTS

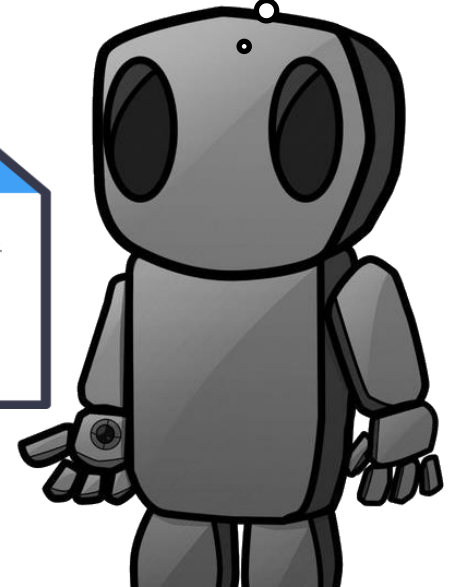
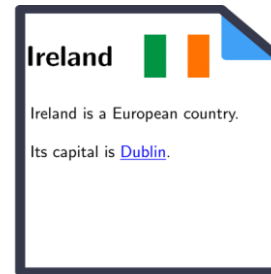


Google

ireland 

Google Search

I'm Feeling Lucky



ireland

ogyselw

WHAT MACHINES CANNOT DO: COMBINE SOURCES

`http://ex.org/Ogyselw`

`http://ex.cl/Wdcsól`

Ogyselw



Ogyselw oz e Ydguryel budlfgi.

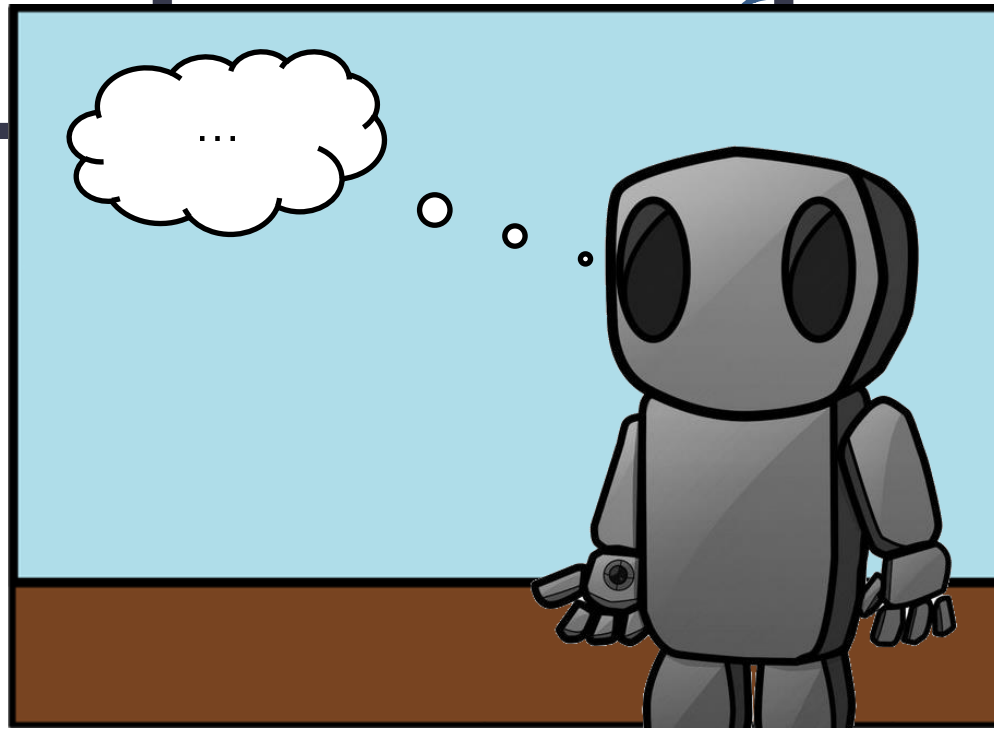
Ofz berofes oz [Wdcsol.](#)

Wdcsól



Wdcsól yz se berofes wy [Ogselwe.](#)

Zd rucseboúl yz dl mossúl.



TOWARDS A SEMANTIC WEB

MACHINES THAT “UNDERSTAND” THE WEB?

<http://ex.org/Ireland>

<http://ex.cl/Dublín>

Ireland



Ireland is a European country.

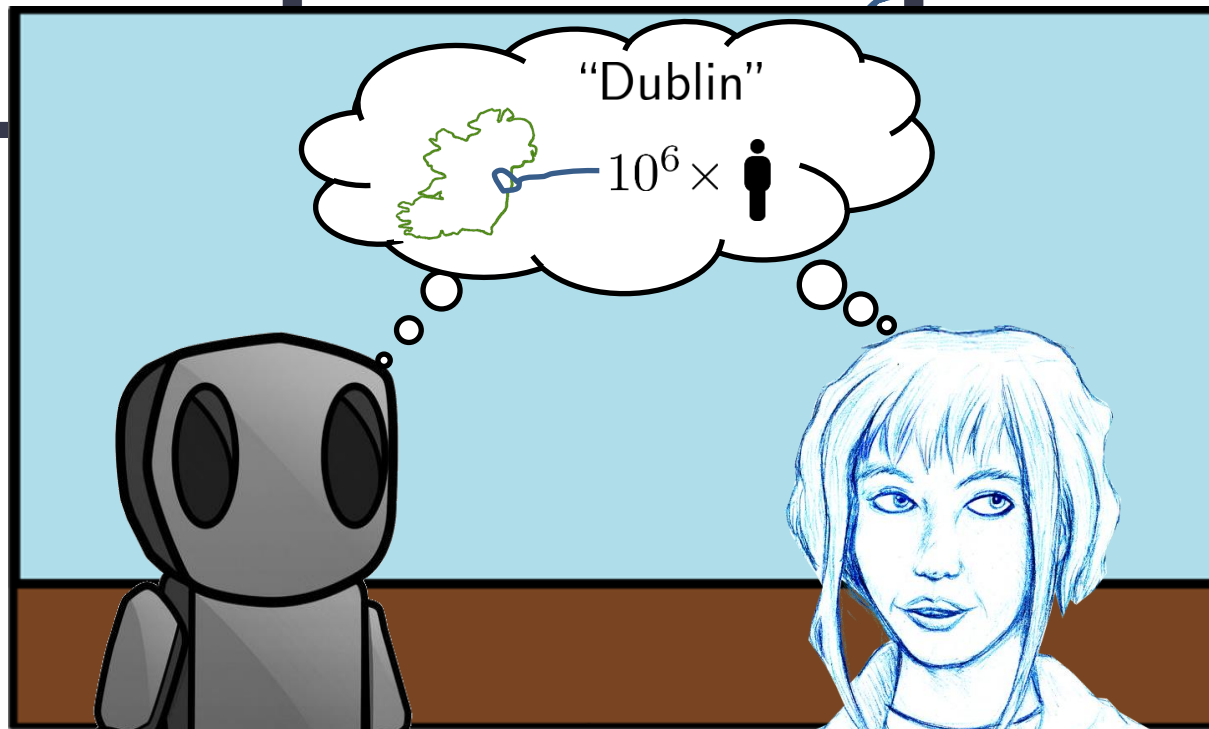
Its capital is [Dublin](#).

Dublín



Dublín es la capital de [Irlanda](#).

Su población es un millón.



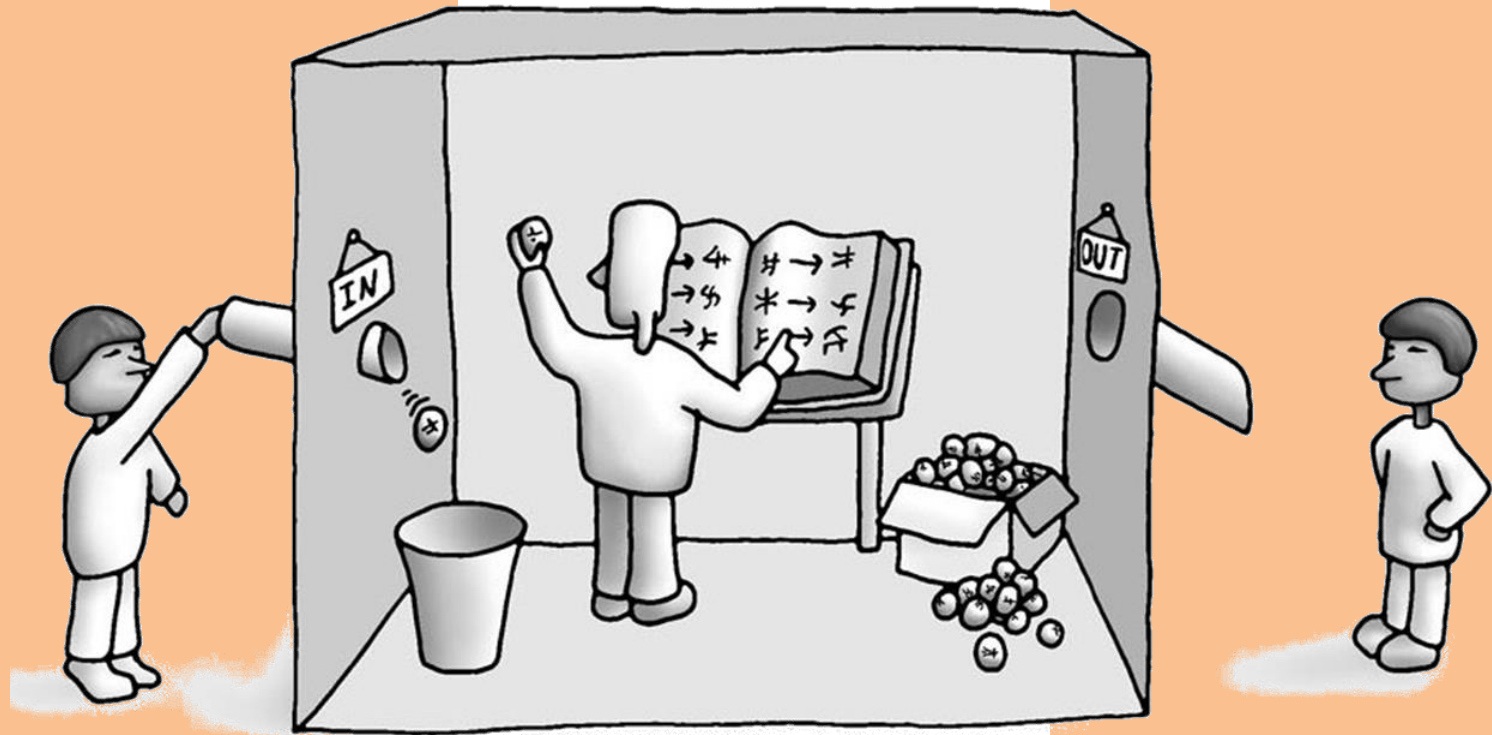
EDSGER W. DIJKSTRA



The question of whether computers
can think is like the question of
whether submarines can swim.

Edsger W. Dijkstra

SEARLE'S CHINESE ROOM ...



SEARLE'S CHINESE ROOM (NATURAL LANGUAGE)

<http://ex.org/Ogyselw>

<http://ex.org/Wdcsol>

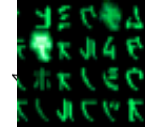
Ogyselw



Ogyselw oz e Ydguryel budlfgi.

Ofz berofes oz [Wdcsol](#).

Wdcsol



Wdcsol oz fhy berofes up [Ogyselw](#).

Ofz rurdsefoul oz uly mossoul.

INPUT: “Nhef oz fhy rurdsefoul up fhy berofes up Ogyselw?”

... what should the output be?

OUTPUT: “uly mossoul”



MULTIPLE NAMES, ONE THING ...



Ireland

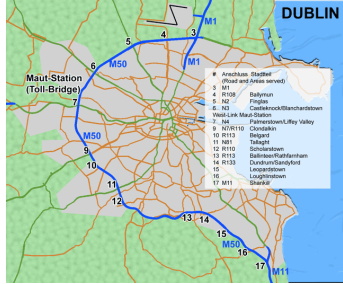
IE

Irlanda

Rep. of Ireland



ONE NAME, MULTIPLE THINGS ...



Dublín



MULTIPLE WAYS TO SAY THE SAME THING ...

Dublin's population is one million.

Dublin has a population of one million.

Dublin's population is 1,000,000.

Dublin has 1,000,000 inhabitants.

One million people live in Dublin.

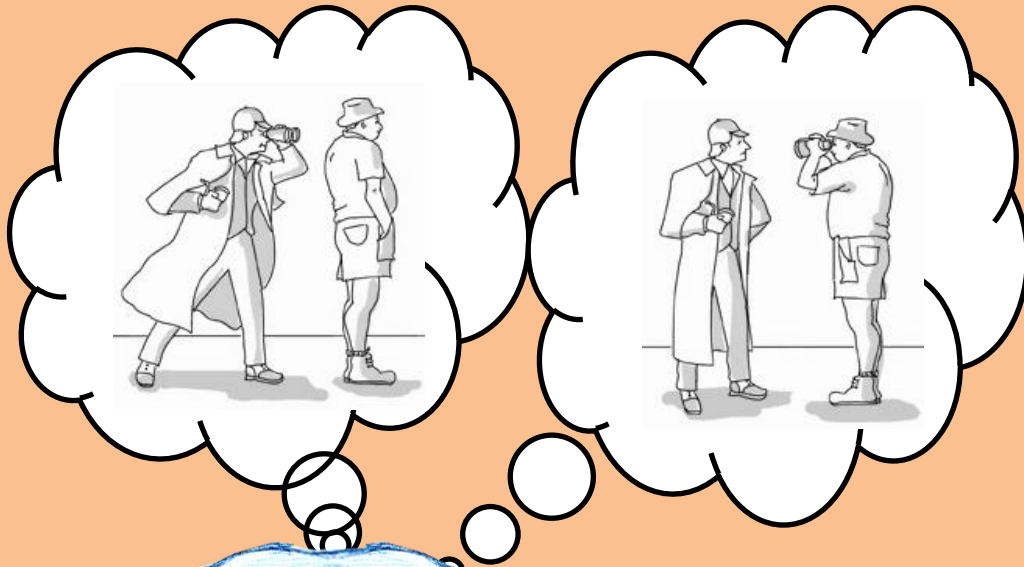
[Dublin] Its population is one million.

La población de Dublín es un millón.



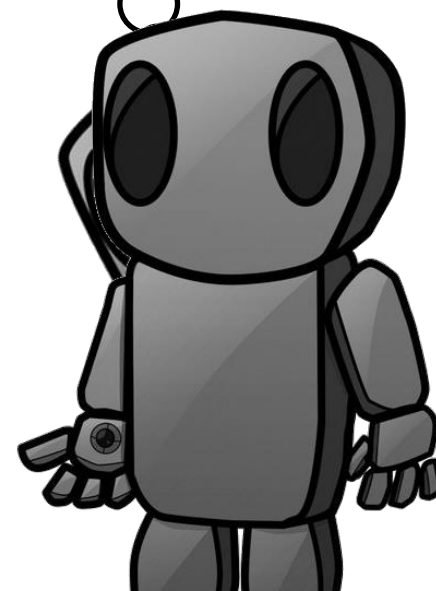
MULTIPLE MEANINGS FOR THE SAME SAYING ...

Sherlock saw the man using binoculars.

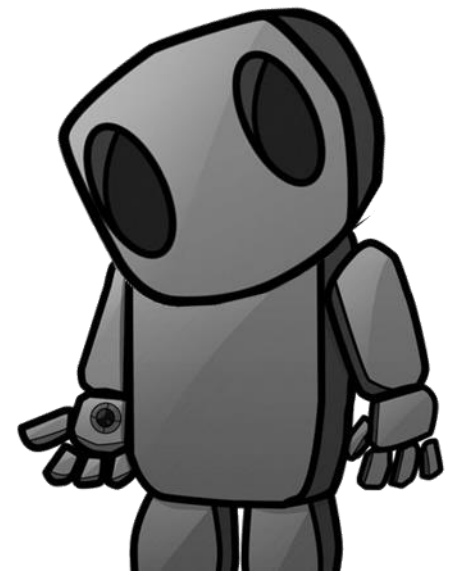


NOT SAYING WHAT IS MEANT ...

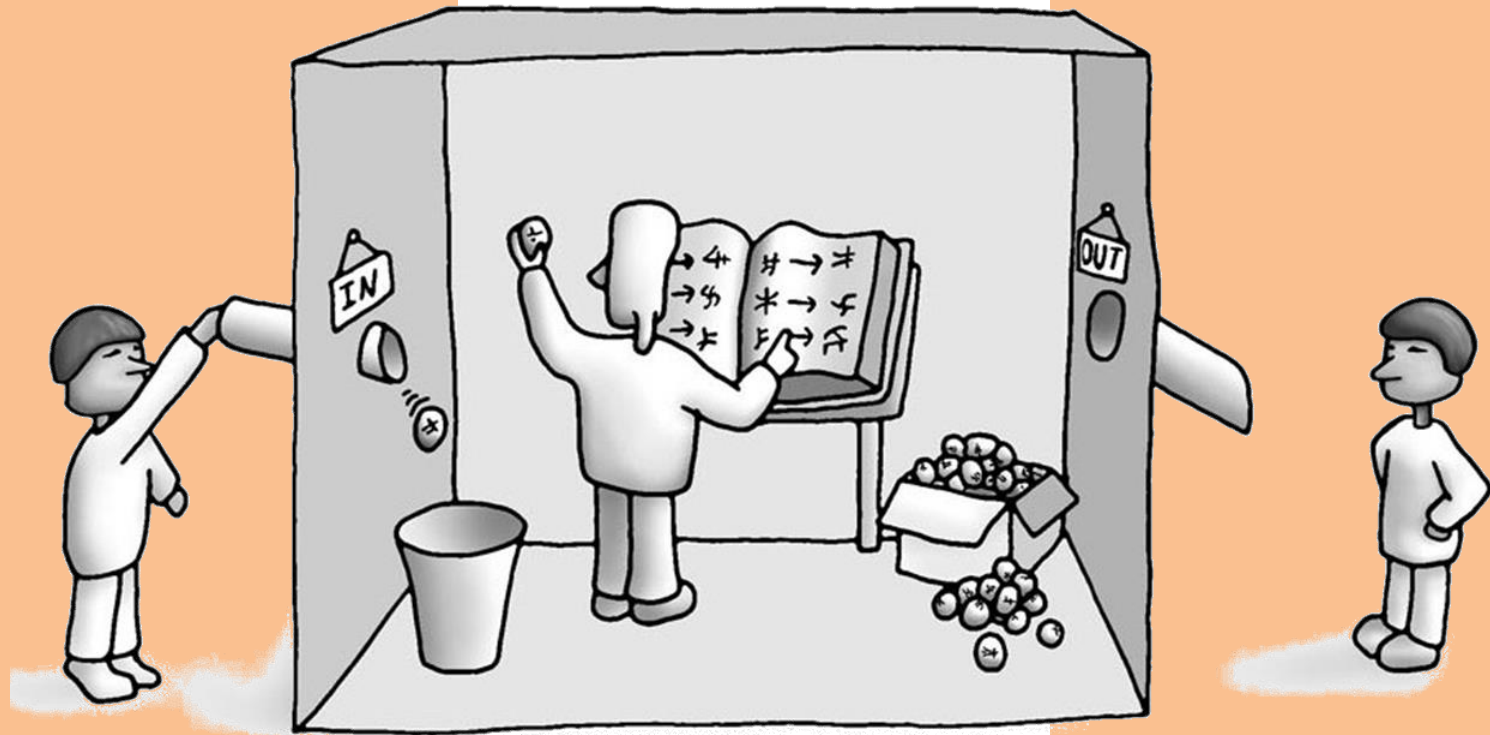
Fred está arriba la pelota.



THE SEMANTIC GAP



WHAT IF WE COULD "STRUCTURE" EVERYTHING ...



ONE SYMBOL, ONE MEANING ...



Ireland

IE

Irlanda

Rep. of Ireland

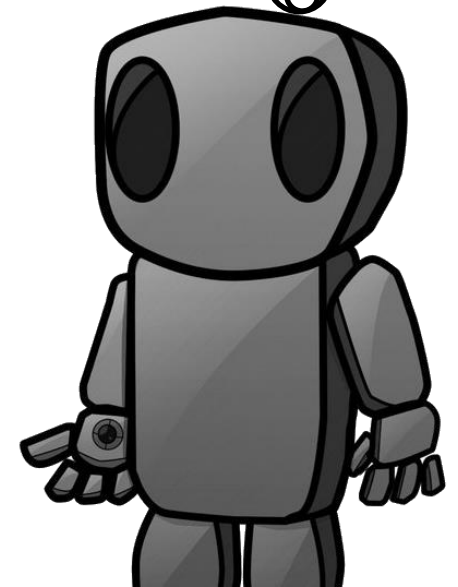


∩

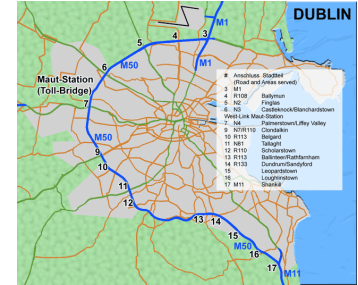
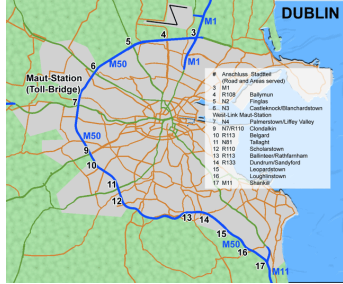
♂

☾

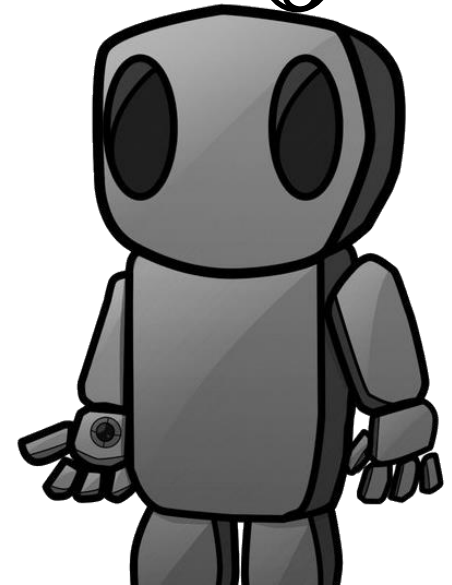
h



ONE SYMBOL, ONE MEANING ...



Dublín



ONE (SIMPLE) WAY TO SAY ONE THING ...

Dublin's population is one million.

Dublin has a population of one million.

Dublin's population is 1,000,000.

Dublin has 1,000,000 inhabitants.

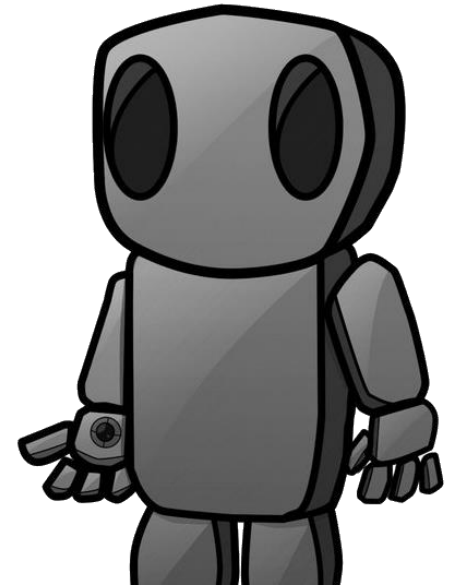
One million people live in Dublin.

[Dublin] Its population is one million.

La población de Dublín es un millón.

(Dublin,population,1000000)

(☿,♁,1000000)



SEARLE'S CHINESE ROOM (NATURAL LANGUAGE)

<http://ex.org/Ogyselw>

<http://ex.org/Wdcsol>

Ogyselw



Ogyselw oz e Ydguryel budlfgi.

Ofz berofes oz [Wdcsol](#).

Wdcsol



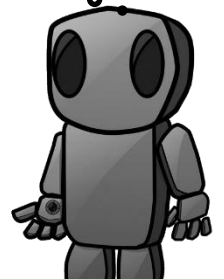
Wdcsol oz fhy berofes up [Ogyselw](#).

Ofz rurdsefoul oz uly mossoul.

INPUT: “Nhef oz fhy rurdsefoul up fhy berofes up Ogyselw?”

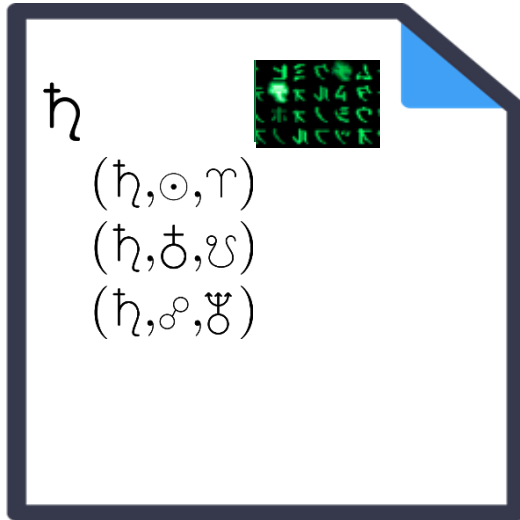
... what should the output be?

OUTPUT: “uly mossoul”

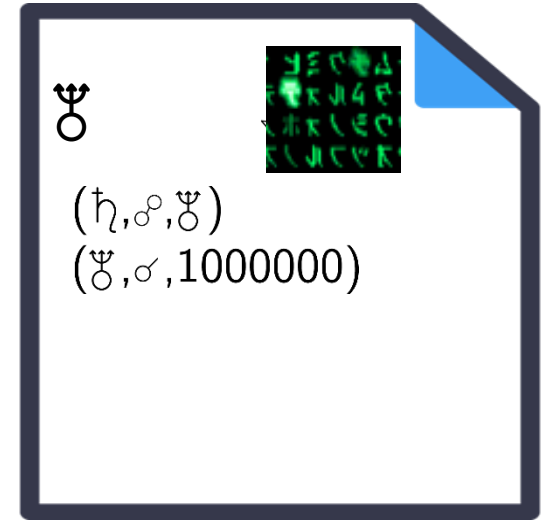


SEARLE'S CHINESE ROOM (SYMBOLIC)

<http://ex.org/h>



<http://ex.org/Ψ>



INPUT: “ $(h, \rho, x), (x, \sigma, y)$?”


... what should the output be?

OUTPUT: $\{(x \mapsto \Psi, y \mapsto 1000000)\}$




SEARLE'S CHINESE ROOM (SYMBOLIC)

<http://ex.org/Ireland>

Ireland 

(Ireland,partOf,Europe)
(Ireland,isA,Country)
(Ireland,capital,Dublin)

<http://ex.org/Dublin>

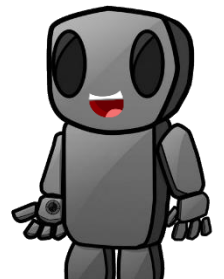
Dublin 

(Ireland,capital,Dublin)
(Dublin,population,1000000)

INPUT: “(Ireland,capital, x), (x ,population, y)?”

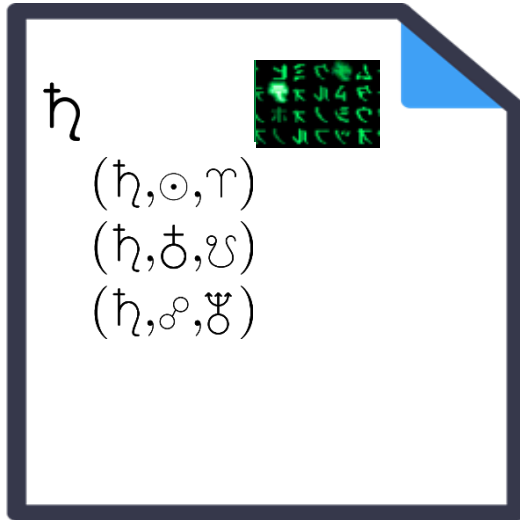
... what should the output be?

OUTPUT: $\{(x \mapsto \text{Dublin}, y \mapsto 1000000)\}$

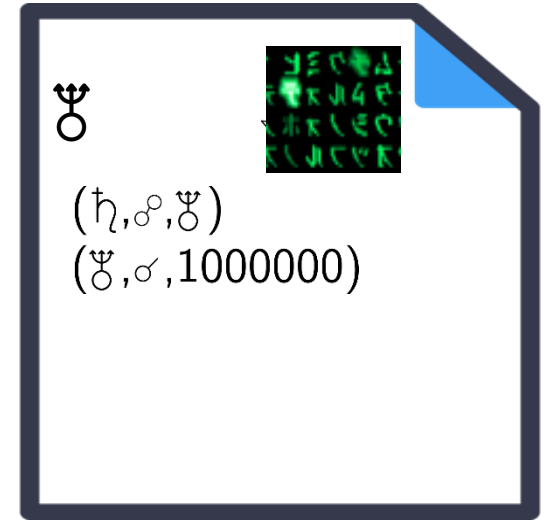


SEARLE'S CHINESE ROOM II

<http://ex.org/h>



<http://ex.org/y>



INPUT: “ (x, o, y) ?”

... what should the output be?

OUTPUT: $\{(x \mapsto h, y \mapsto r)\}$




SEARLE'S CHINESE ROOM II

<http://ex.org/Ireland>

Ireland 

(Ireland,partOf,Europe)
(Ireland,isA,Country)
(Ireland,capital,Dublin)

<http://ex.org/Dublin>

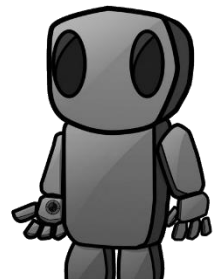
Dublin 

(Ireland,capital,Dublin)
(Dublin,population,1000000)

INPUT: “(x ,partOf, y)?”

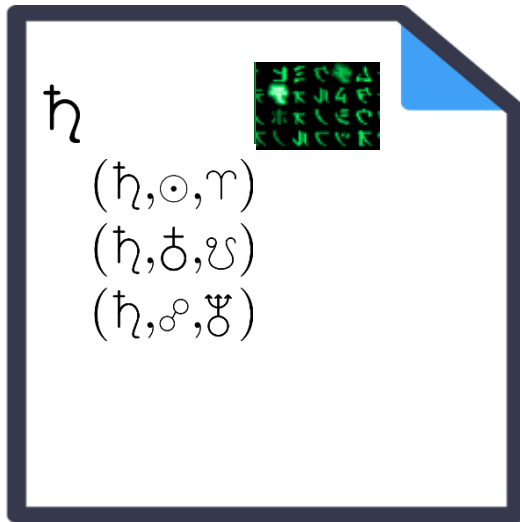
... what should the output be?

OUTPUT: $\{(x \mapsto \text{Ireland}, y \mapsto \text{Europe})\}$
 $(x \mapsto \text{Dublin}, y \mapsto \text{Ireland})?$

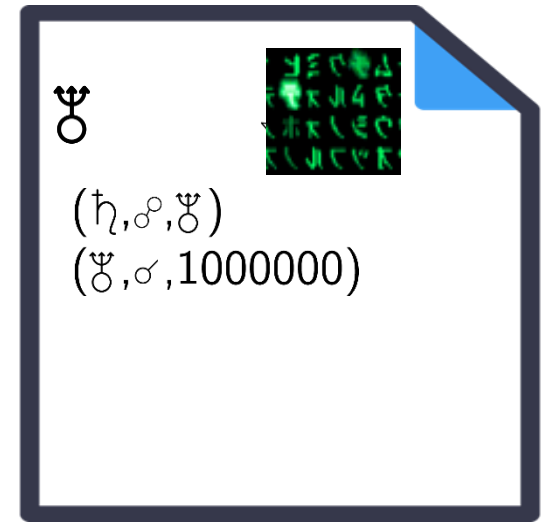


SEARLE'S CHINESE ROOM II

<http://ex.org/h>



<http://ex.org/♂>



RULE: “(b, ♂, a) → (a, ⊙, b)”

INPUT: “(x, ⊙, y)?”

... what should the output be?

OUTPUT: $\{(x \mapsto h, y \mapsto ㄥ), (x \mapsto ♂, y \mapsto h)\}$




SEARLE'S CHINESE ROOM II

<http://ex.org/Ireland>

Ireland 

(Ireland,partOf,Europe)
(Ireland,isA,Country)
(Ireland,capital,Dublin)

<http://ex.org/Dublin>

Dublin 

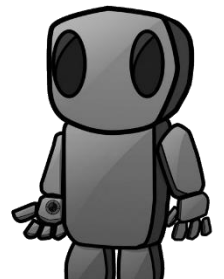
(Ireland,capital,Dublin)
(Dublin,population,1000000)

RULE: “ $(b, \text{capital}, a) \rightarrow (a, \text{partOf}, b)$ ”

INPUT: “ (x, partOf, y) ?”

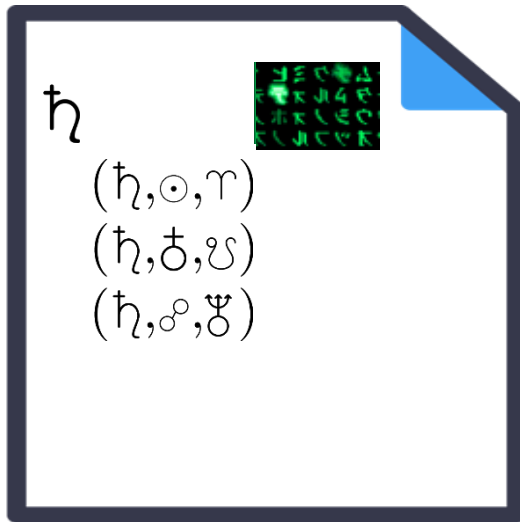
... what should the output be?

OUTPUT: $\{(x \mapsto \text{Ireland}, y \mapsto \text{Europe}),$
 $(x \mapsto \text{Dublin}, y \mapsto \text{Ireland})\}$
 $(x \mapsto \text{Dublin}, y \mapsto \text{Europe})?$

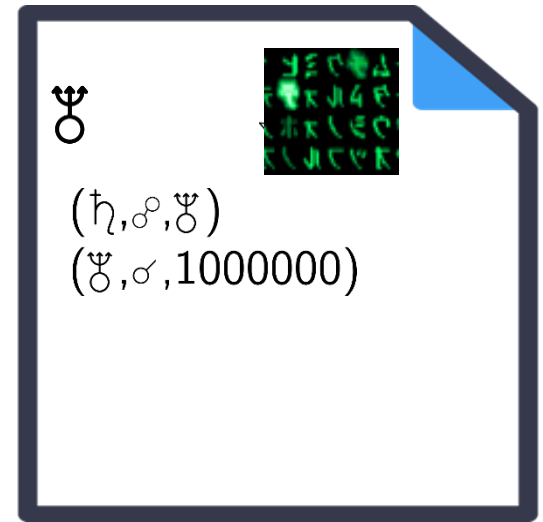


SEARLE'S CHINESE ROOM II

<http://ex.org/h>



<http://ex.org/y>



RULES: “(b, s, a) → (a, o, b)”
“(a, o, b), (b, o, c) → (a, o, c)”

INPUT: “(x, o, y)”


... what should the output be?

OUTPUT: $\{(x \mapsto h, y \mapsto r), (x \mapsto y, y \mapsto h), (x \mapsto y, y \mapsto r)\}$




SEARLE'S CHINESE ROOM II

<http://ex.org/Ireland>

Ireland 

(Ireland,partOf,Europe)
(Ireland,isA,Country)
(Ireland,capital,Dublin)

<http://ex.org/Dublin>

Dublin 

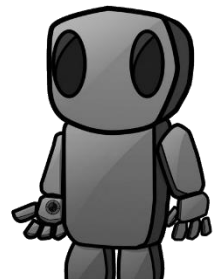
(Ireland,capital,Dublin)
(Dublin,population,1000000)

RULES: $(b, \text{capital}, a) \rightarrow (a, \text{partOf}, b)$
 $(a, \text{partOf}, b), (b, \text{partOf}, c) \rightarrow (a, \text{partOf}, c)$

INPUT: $(x, \text{partOf}, y) ?$

... what should the output be?

OUTPUT: $\{(x \mapsto \text{Ireland}, y \mapsto \text{Europe}),$
 $(x \mapsto \text{Dublin}, y \mapsto \text{Ireland}),$
 $(x \mapsto \text{Dublin}, y \mapsto \text{Europe})\}$



SEMANTIC WEB: DATA, LOGIC, QUERY

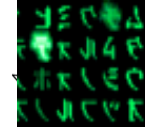
DATA:

Ireland



(Ireland,partOf,Europe)
 (Ireland,isA,Country)
 (Ireland,capital,Dublin)

Dublin



(Ireland,capital,Dublin)
 (Dublin,population,1000000)

LOGIC: $“(b, \text{capital}, a) \rightarrow (a, \text{partOf}, b)”$
 $“(a, \text{partOf}, b), (b, \text{partOf}, c) \rightarrow (a, \text{partOf}, c)”$

QUERY: $“(x, \text{partOf}, y)?”$

OUTPUT: $\{(x \mapsto \text{Ireland}, y \mapsto \text{Europe}),$
 $(x \mapsto \text{Dublin}, y \mapsto \text{Ireland}),$
 $(x \mapsto \text{Dublin}, y \mapsto \text{Europe})\}$



THE SEMANTIC WEB NOW?

THE SEMANTIC WEB IS NOW ABOUT 20 YEARS OLD



... so where is it then?

HIDDEN WITHIN THE WEB ...



WIKIDATA: A WIKIPEDIA FOR DATA

WHAT IS WIKIDATA?



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A network diagram with nodes and connecting lines in red, green, and blue. Some nodes are labeled with words like "open", "multilingual", "free", and "collaborative".

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the **free** knowledge base with **89,078,643** data items that anyone can edit.

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Want to help translate? [Translate the missing messages.](#)

A barcode icon.

Welcome!

A barcode icon.

Learn about data

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Main Page

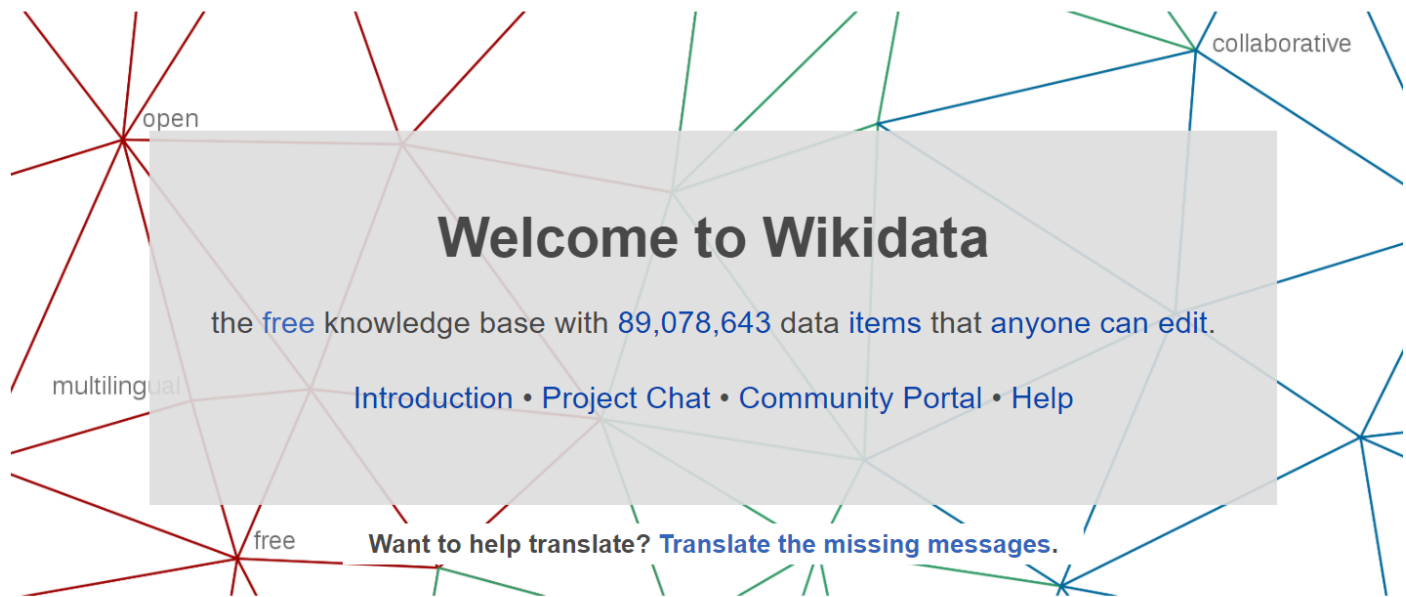
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PROBLEM 1: DIFFERENT LANGUAGE VERSIONS MANUALLY EDITED BY USERS

Alexis Sánchez



Sánchez with Chile in 2013

Personal information

Full name Alexis Alejandro Sánchez Sánchez^[1]
Date of birth 19 December 1988 (age 26)^{[1][2]}
Place of birth Tocopilla, Chile^{[3][2]}

National team[†]

2007	Chile U20	12	(2)
2006–	Chile	82	(26)

Alexis Sánchez



Datos personales

Nombre completo Alexis Alejandro Sánchez Sánchez

Carrera internacional

Selección  Chile
Part. (goles) 82 (26)
Debut 2006

Alexis



Alexis Sánchez im Dezember 2011

Spielerinformationen

Voller Name Alexis Alejandro Sánchez Sánchez
Geburtstag 19. Dezember 1988
Geburtsort Tocopilla, Chile

Nationalmannschaft²

2007	Chile U-20	
2006–	Chile	76 (25)

PROBLEM 2: COMPLEX LISTS OF THINGS

MANUALLY EDITED BY USERS



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Chile national football team

From Wikipedia, the free encyclopedia

Most capped players [\[edit\]](#)

As of September 1, 2016

*Players in **bold** are still active, at least at club level.*

Top goalscorers [\[edit\]](#)

As of September 1, 2016

*Players in **bold** are still active, at least at club level.*

#	Name	International Career	Caps	Goals	#	Name	International Career	Goals	Caps
1.	Claudio Bravo	2004 –	106	0	1.	Marcelo Salas	1994–2007	37	70
2.	Alexis Sánchez	2006 –	102	34	2.	Iván Zamorano	1987–2001	34	69
3.	Gary Medel	2007 –	96	7		Alexis Sánchez	2006 –	34	102
4.	Gonzalo Jara	2006 –	95	3	(list)				
						Eduardo			

ALEXIS SCORES A GOAL ...



Now an army of human editors has to manually update a bunch of articles: different languages, lists, ...



SOLUTION: WIKIDATA



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[Main Page](#)

[Discussion](#)

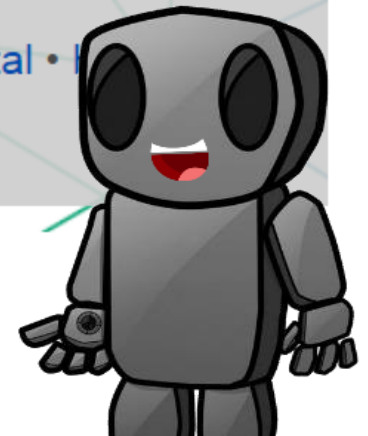
More ▾



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the **free** knowledge base with **50,290,536** data **items** that
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Alexis Alejandro Sánchez Sánchez (Q180553)

Chilean footballer

[edit](#)

Chiqui

[► In more languages](#)

Statements

sex or gender

male

[edit](#)

[► 1 reference](#)

[+ add](#)

member of sports team

Cobreloa

[edit](#)

[► 1 reference](#)

Udinese Calcio

[edit](#)

[► 1 reference](#)

Arsenal F.C

[edit](#)

[► 1 reference](#)

Club Atlético River Plate

[edit](#)

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 - [Cite this page](#)



Alexis Sánchez (Q180553)

futbolista chileno [editar](#)

Alexis Sánchez Sánchez | AS9 | Alexis Alejandro Sánchez Sánchez | AS7 | Alexis Alejandro Sánchez | Alexis Sánchez | Alexis Sanchez | Alexis Sanches

► [En más idiomas](#)

Declaraciones

sexo	<div>masculino editar</div> <div>► 1 referencia</div>
<div>+ añadir</div>	
miembro del equipo deportivo	<div>Club de Deportes Cobreloa editar</div> <div>► 1 referencia</div>
	<div>Udinese Calcio editar</div> <div>► 1 referencia</div>
	<div>Arsenal Football Club editar</div> <div>► 1 referencia</div>

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Alexis Sánchez (Q180553)

chilenischer Fußballspieler

[bearbeiten](#)

[Alexis Alejandro Sánchez Sánchez](#) | [Alexis Sanchez](#) | [Alexis Alejandro Sanchez Sanchez](#)

[▶ In weiteren Sprachen](#)

Aussagen

Geschlecht	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> männlich bearbeiten
	▶ 1 Fundstelle
	+ hinzufügen

Mitglied von Sportmannschaft oder -verein	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> CD Cobreloa bearbeiten
	▶ 1 Fundstelle
	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Udinese Calcio bearbeiten
	▶ 1 Fundstelle
	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> FC Arsenal bearbeiten
	▶ 1 Fundstelle
	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> CA River Plate bearbeiten

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История



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Описание не заполнено

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Алексис Санчес

[▶ На других языках](#)

Утверждения

пол	мужской редактировать
	▶ 1 источник
+ добавить	

член спортивной команды	Кобрелоа редактировать
	▶ 1 источник
	Удинезе редактировать
	▶ 1 источник
	Арсенал редактировать
	▶ 1 источник
	Ривер Плейт редактировать

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- [Цитировать страницу](#)



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- സാമൂഹികകവാടം
- Project chat
- പുതിയൊരു ഇനം സൃഷ്ടിക്കുക
- ഇനം തിരഞ്ഞെടുക്കാനുസരിച്ച്
- സമീപകാല മാറ്റങ്ങൾ
- ഏതെങ്കിലും താൾ സമീപസ്ഥം
- സഹായം
- സംഭാവന

- അച്ചടിയ്ക്കുക/കയറ്റുമതി ചെയ്യുക
- പുസ്തകം സൃഷ്ടിക്കുക
- PDF ആയി ഡൗൺലോഡ് ചെയ്യുക
- അച്ചടിയറുപം

- ഉപകരണങ്ങൾ
- ഈ താളിലേക്കുള്ള കണ്ണികൾ
- അനുബന്ധ മാറ്റങ്ങൾ
- പ്രത്യേക താളുകൾ
- സ്ഥിരകണ്ണി
- താളിന്റെ

ലേഖനം സംവാദം വായിക്കുക നാൽപ്പതികാണുക ☆ തിരയുക

അലക്സിസ് സാഞ്ചസ് (Q180553)

വിവരണമൊന്നും നിർവചിച്ചിട്ടില്ല ✎ തിരുത്തുക
 അപരനാമങ്ങളൊന്നും കണ്ടെത്താനായില്ല.

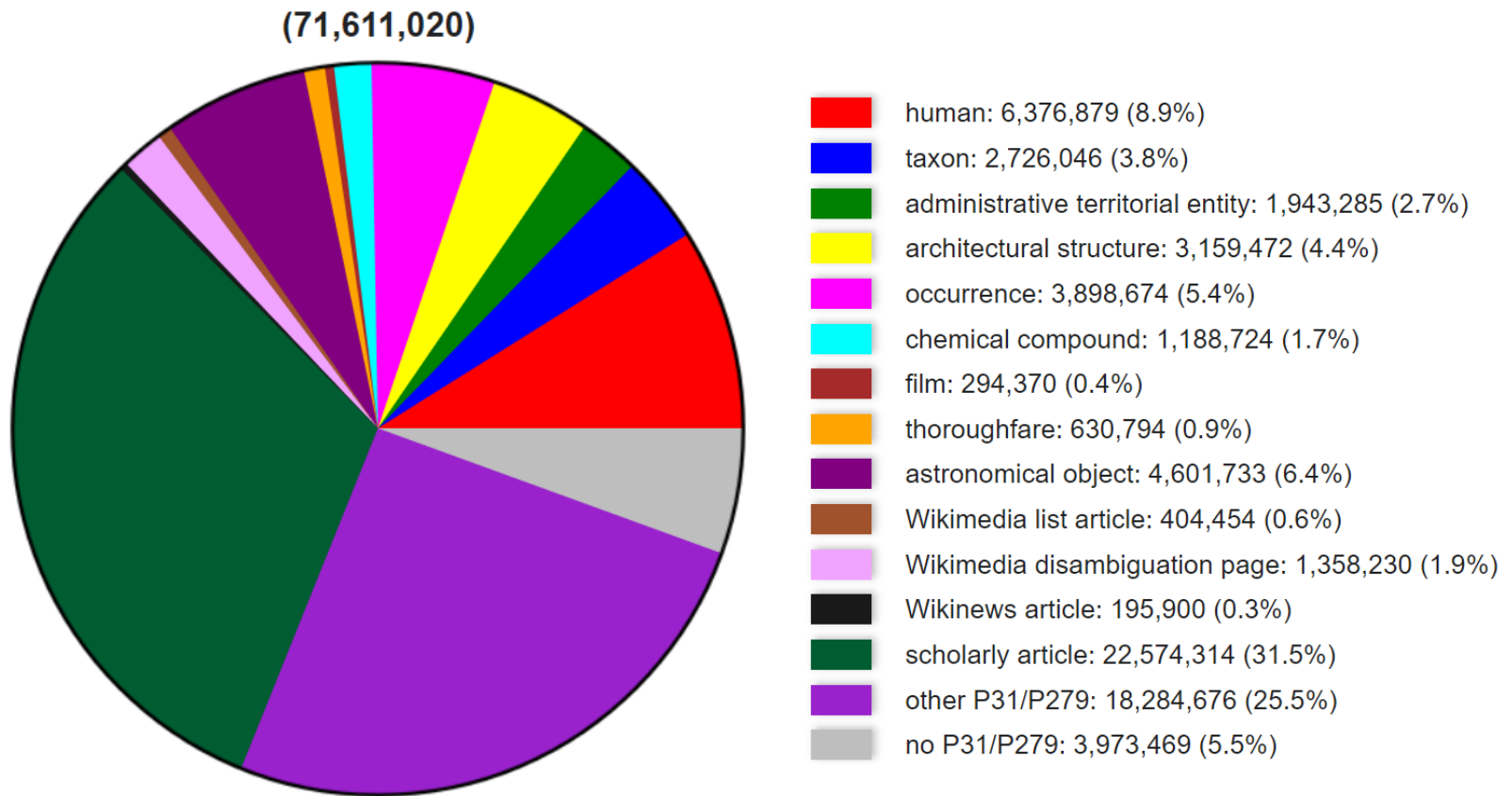
▶ കൂടുതൽ ഭാഷകളിൽ

Statements

ലിംഗം	<ul style="list-style-type: none"> പുരുഷൻ ▶ 1 സ്രോതസ്സ് 	✎ തിരുത്തുക
+ ചേർക്കുക		

member of sports team <i>ഇംഗ്ലീഷ്</i>	<ul style="list-style-type: none"> Cobreloa <i>ഇംഗ്ലീഷ്</i> ▶ 1 സ്രോതസ്സ് 	✎ തിരുത്തുക
	<ul style="list-style-type: none"> Udinese Calcio <i>ഇംഗ്ലീഷ്</i> ▶ 1 സ്രോതസ്സ് 	✎ തിരുത്തുക
	<ul style="list-style-type: none"> ആഴ്സണൽ എഫ്.സി. ▶ 1 സ്രോതസ്സ് 	✎ തിരുത്തുക
	<ul style="list-style-type: none"> Club Atlético River Plate <i>ഇംഗ്ലീഷ്</i> 	✎ തിരുത്തുക

WHAT DOES WIKIDATA DESCRIBE?



- 23,593 active users

USE-CASE: INFO-BOXES



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Atacama Pathfinder Experiment

From Wikipedia, the free encyclopedia

The **Atacama Pathfinder Experiment (APEX)** is a [radio telescope](#) 5,100 meters above sea level, at the [Llano de Chajnantor Observatory](#) in the [Atacama desert](#) in northern [Chile](#), 50 km east of [San Pedro de Atacama](#) built and operated by 3 European research institutes. The main dish has a diameter of 12 m and consists of 264 aluminium panels with an average surface accuracy of 17 micrometres (*rms*). The telescope was officially inaugurated on September 25, 2005.

The APEX telescope is a modified [ALMA](#) (Atacama Large Millimeter Array) prototype antenna and is at the site of the ALMA observatory. APEX is designed to work at sub-millimetre wavelengths, in the 0.2 to 1.5 mm range — between infrared light and radio waves — and to find targets that ALMA will be able to study in greater detail. Submillimetre astronomy provides a window into the cold, dusty and distant Universe, but the faint signals from space are heavily absorbed by water vapour in the Earth's atmosphere. [Chajnantor](#) was chosen as the location for such a telescope because the region is one of the driest on the planet and is more than 750


Atacama Pathfinder Experiment



The APEX telescope

Observatory	Llano de Chajnantor Observatory ✎
Location(s)	Atacama Desert, Chile ✎
Coordinates	23°00′21″S 67°45′33″W﻿ / ﻿23.00583°S 67.75917°W﻿ / -23.00583; -67.75917 ✎
Organization	<div><input type="text" value="Edit this at Wikidata"/> Observatory Max Planck Institute for Radio Astronomy Onsala Space Observatory ✎</div>
Altitude	5,100 m (16,700 ft) ✎
Wavelength	0.2, 1.5 mm (1.50, 0.20 THz)
First light	2004 ✎
Telescope style	Cassegrain reflector Cosmic microwave background experiment Radio telescope ✎

USE-CASE: INFO-BOXES



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Atacama Pathfinder Experiment

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Atacama Pathfinder Experiment (Q753076) EX

radio telescope at

[In more languages](#)

Statements

instance of	radio telescope edit 0 0 references + add reference
	Cassegrain reflector edit 0 0 references + add reference

Atacama Pathfinder Experiment



The APEX telescope

Observatory	Llano de Chajnantor Observatory edit
Location(s)	Atacama Desert, Chile edit
Coordinates	 23°00′21″S 67°45′33″W﻿ / ﻿23.00583°S 67.75917°W﻿ / -23.00583; -67.75917﻿ (-23.00583; -67.75917) edit
Organization	<input type="text" value="Edit this at Wikidata"/> Observatory Max Planck Institute for Radio Astronomy Onsala Space Observatory edit
Altitude	5,100 m (16,700 ft) edit
Wavelength	0.2, 1.5 mm (1.50, 0.20 THz)
First light	2004 edit
Telescope style	Cassegrain reflector Cosmic microwave background experiment Radio telescope edit



USE-CASE: QUALITY CHECKS

List of all person who do not have an age between 0 and 130. Update: 22:21, 10 September 2018 (UTC)

Item	Birth	Death	Age
Tuti Yusupova (Q1038827)	1880-07-01	2015-03-28	134
Karni Mata (Q1106783)	1387-10-02	1538-03-23	150
no label (Q11556831)	1185-01-01	1392-01-01	207
Minamoto no Chikayuki (Q11564306)	1185-01-01	1333-01-01	148
Bir Narayan Chaudhuri (Q11854281)	1857-00-00	1998-04-20	141
no label (Q12123094)	1091-00-00	1228-00-00	137
no label (Q12218744)	1819-00-00	1954-00-00	135
Maftai Pop (Q12734691)	1804-01-01	1952-03-15	148
Habib Miyan (Q1365575)	1868-05-20	2008-08-19	140
Egyō (Q1392070)	805-01-01	1185-01-01	380
Xu Xun (Q1428729)	239-01-01	374-01-01	135
Zaro Aga (Q148028)	1777-01-01	1934-06-29	157
Charles Étienne Guillaume Blandin de Chalain (Q15967550)	1740-06-07	1958-01-01	217
Javier Pereira (Q15999178)	1789-00-00	1958-00-00	169
Chen Jun (Q16077971)	881-00-00	1324-00-00	443
Jules Granier (Q16842647)	1770-01-01	1906-04-07	136
Genson (Q18115051)	1700-01-01	1950-01-01	250
Liutwin (Q18222784)	1200-01-01	1350-01-01	150
Salah (Q1827950)	-2068-00-00	-1635-00-00	433

USE-CASE: QUALITY CHECKS

List of all person who do not have an age between 0 and 130. Update: 22:21, 10 September 2018 (UTC)

Item	Birth	Death	Age	
Tuti Yusupova (Q1038827)	1880-07-01	2015-03-28	134	
Karni Mata (Q1106783)	1387-10-02	1538-03-23	150	
no label (Q11556831)	...	1185-01-01	1392-01-01	207
Minamoto no Chikayuki (Q11564306)	1185-01-01	1333-01-01	148	
Julius Fessler (Q55677113)	1982-05-04	1937-10-27	-45	
Max Hallbauer (Q55678777)	1851-12-04	1818-10-08	-34	
Ernst Keiter (Q55679293)	1943-10-28	1907-10-30	-36	
Franz Friedrich Theodor Steinhauer (Q55680095)	1849-12-25	1822-12-21	-28	
Johann Joseph Schoder (Q55680781)	1918-12-07	1884-12-12	-34	
Paul Kaspar Helbling (Q55681272)	2012-06-05	2011-06-20	-1	
Gustaf Bolinger (Q55683866)	1988-12-19	1957-07-16	-32	
Joseph Marcus Jaffé (Q55683961)	1867-03-11	1841-04-12	-26	
Johann Baptist Hau (Q55683983)	1782-08-14	1758-12-26	-24	
Wilhelm Klaubert (Q55684184)	1557-08-17	1526-10-03	-31	
Dieterich Johann Krüger (Q55684826)	1742-06-23	1726-08-22	-16	
Alfred Reichenbecher (Q55684894)	1884-01-26	1664-03-05	-220	
Johann Ludwig Winckler (Q55901640)	1963-05-08	1767-08-08	-196	
Johann Heremberck (Q55902890)	1811-01-01	1489-01-01	-322	
Salah (Q1827950)	-2068-00-00	-1635-00-00	433	

USE-CASE: QUERY SERVICE



Wikidata Query Service

<https://query.wikidata.org/#PREFIX%20wd%3A%20%3Chttp%3A%2F%2Fwww.wikidata.org%2Fentity%2F%33>

Wikidata Query Service Examples Prefixes Tools Help English

```
1 PREFIX wd: <http://www.wikidata.org/entity/>
2 PREFIX wdt: <http://www.wikidata.org/prop/direct/>
3 PREFIX p: <http://www.wikidata.org/prop/>
4 PREFIX ps: <http://www.wikidata.org/prop/statement/>
5 PREFIX pq: <http://www.wikidata.org/prop/qualifier/>
6 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
7
8 SELECT DISTINCT ?laureateName ?awardYear ?warName ?warYear
9 WHERE {
10   ?laureate p:P166 ?award .           # Winner of some prize
11   ?award ps:P166 wd:Q37922 .         # Prize is Nobel Pr. in Lit.
12   ?award pq:P585 ?awardDate .       # Get the date of the award
13   BIND(YEAR(?awardDate) as ?awardYear) # Get the year of the award
14   ?laureate wdt:P607 ?war .         # Find war(s) laureate was in
15   ?war rdfs:label ?warName .       # Get name(s) of war(s)
16   ?war wdt:P580 ?warStart .        # Get date the war started
17   BIND(YEAR(?warStart) as ?warYear) # Get year from date
18   ?laureate rdfs:label ?laureateName . # Get name of laureate
19   FILTER(lang(?warName)="en"      # Filter for English
20           && lang(?laureateName)="en") # ... names only
21 } ORDER BY ?awardYear              # Order by year
22
```

Find award received Nobel Prize in Literature

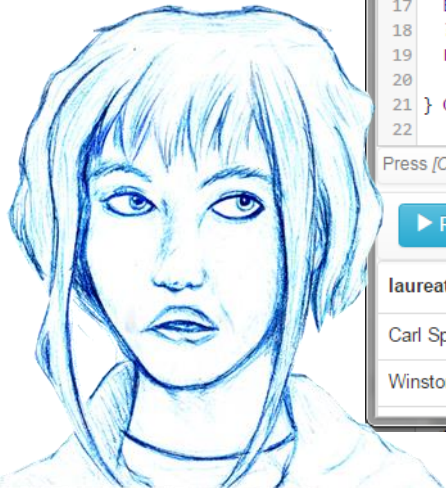
Show

Limit

Press [CTRL-SPACE] to activate auto completion. Data updated a few seconds ago

Run Clear 12 Results in 1589 ms Display Download Link

laureateName	awardYear	warName	warYear
Carl Spitteler	1919	World War I	1914
Winston Churchill	1953	World War I	1914



USE-CASE: QUERY SERVICE



Wikidata Query Service

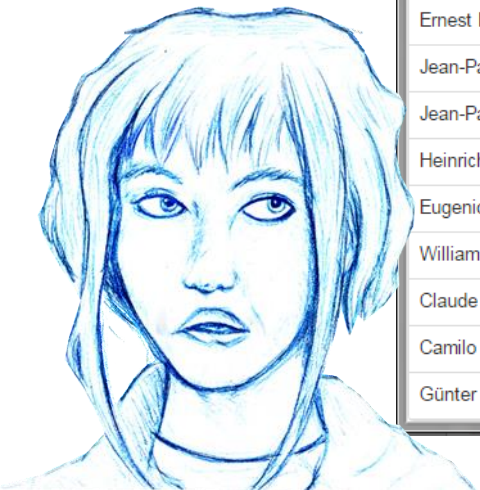
<https://query.wikidata.org/#PREFIX%20wd%3A%20%3Chttp%3A%2F%2Fwww.wikidata.org%2Fentity%2F%3>

```
16 ?war wdt:P580 ?warStart . # Get date the war started
17 BIND(YEAR(?warStart) as ?warYear) # Get year from date
18 ?laureate rdfs:label ?laureateName . # Get name of laureate
19 FILTER(lang(?warName)="en" # Filter for English
    && lang(?laureateName)="en") # ... names only
21 } ORDER BY ?awardYear # Order by year
22
```

Press [CTRL-SPACE] to activate auto completion. Data updated a few seconds ago

Run Clear 12 Results in 1589 ms Display Download Link

laureateName	awardYear	warName	warYear
Carl Spitteler	1919	World War I	1914
Winston Churchill	1953	World War I	1914
Ernest Hemingway	1954	World War I	1914
Ernest Hemingway	1954	World War II	1939
Jean-Paul Sartre	1964	Algerian War	1954
Jean-Paul Sartre	1964	World War II	1939
Heinrich Böll	1972	World War II	1939
Eugenio Montale	1975	World War I	1914
William Golding	1983	World War II	1939
Claude Simon	1985	Spanish Civil War	1936
Camilo José Cela	1989	Spanish Civil War	1936
Günter Grass	1999	World War II	1939



USED IN APPLICATIONS LIKE SIRI ...

Siri Erroneously Told People Stan Lee Was Dead



Beth Elderkin

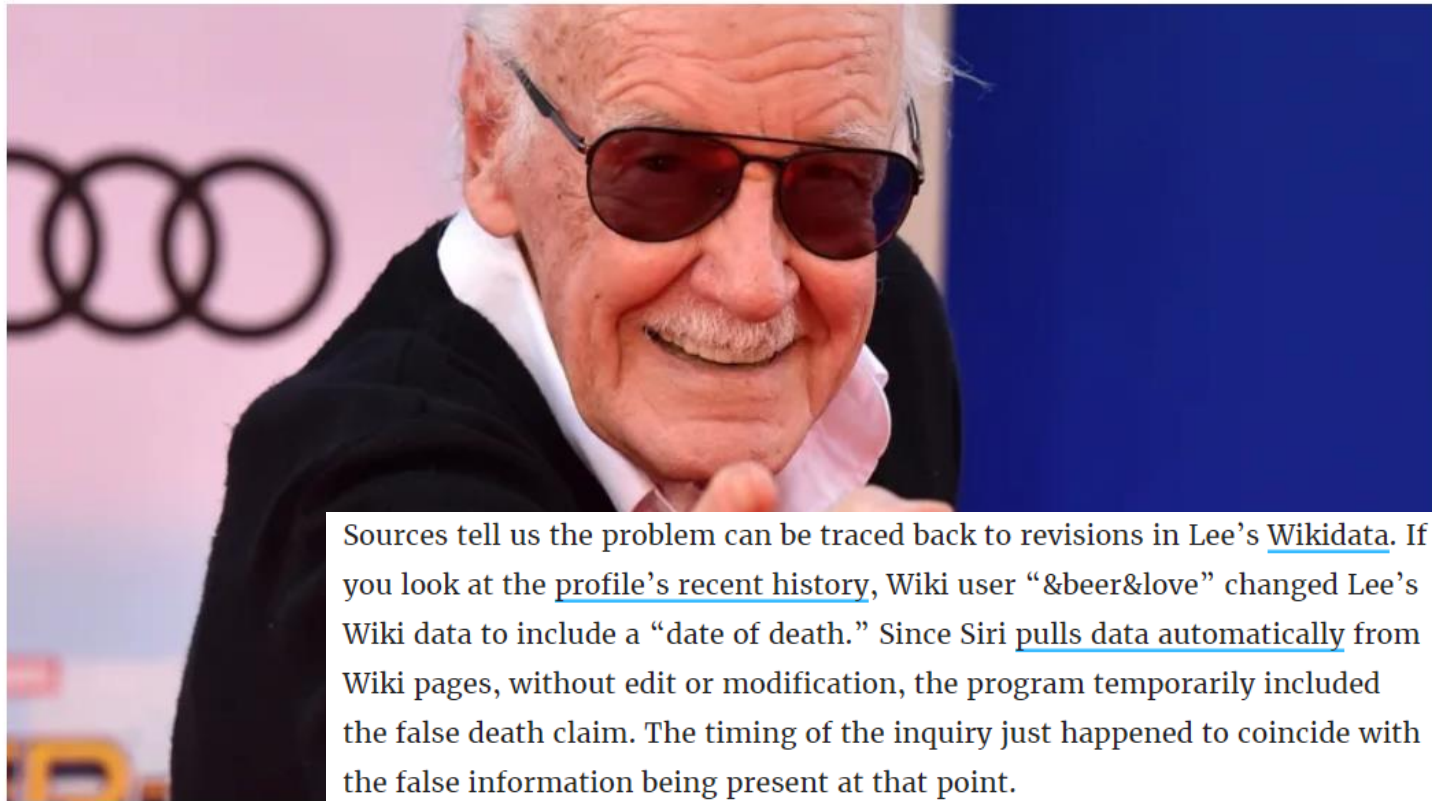
7/03/18 2:45pm • Filed to: STAN LEE ▾



17.4K

45

5



Sources tell us the problem can be traced back to revisions in Lee's [Wikidata](#). If you look at the [profile's recent history](#), Wiki user “&beer&love” changed Lee's Wiki data to include a “date of death.” Since Siri [pulls data automatically](#) from Wiki pages, without edit or modification, the program temporarily included the false death claim. The timing of the inquiry just happened to coincide with the false information being present at that point.

Stan Lee at the premiere of *Spider-Man: Homecoming*.

Photo: Alberto E. Rodriguez (Getty Images)

GOOGLE'S KNOWLEDGE GRAPH

GOOGLE'S KNOWLEDGE PANEL

The image shows a screenshot of a Google search for "sully prudhomme". The search results on the left include links to Wikipedia, the French Wikipedia, Biographical, Nobelprize.org, and Britannica.com. The Knowledge Panel on the right features a grid of portraits, the name "Sully Prudhomme", his profession "Poet", a brief biography, his birth and death dates, his books, awards, and a section for "People also search for" with portraits of Leconte de Lisle, Theodor Mommsen, Frédéric Mistral, Paul Verlaine, and Gabriel Fauré.

Sully Prudhomme - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/Sully_Prudhomme
René François Armand (Sully) Prudhomme was a French poet and essayist. He was the first ever winner of the Nobel Prize in Literature in 1901. Born in Paris ...
Early life · Writing · Nobel Prize · Death

Sully Prudhomme - Wikipedia, la enciclopedia libre
https://es.wikipedia.org/wiki/Sully_Prudhomme · Translate this page
René François Armand (Sully) Prudhomme también conocido como Sully Prudhomme (París, Francia, 16 de marzo de 1839 - Châtenay-Malabry, Francia, 6 de ...

Sully Prudhomme - Biographical - Nobelprize.org
www.nobelprize.org/nobel_prizes/literature/laureates/1901/prudhomme-bio.html
Rene Francois Armand Prudhomme (1839-1907) was the son of a French shopkeeper. ... Sully Prudhomme was a member of the «Conférence La Bruyère», ...

Sully Prudhomme - Nobelprize.org
https://www.nobelprize.org/nobel_prizes/literature/laureates/1901/
The Nobel Prize in Literature 1901 was awarded to Sully Prudhomme "in special recognition of his poetic composition, which gives evidence of lofty idealism, ...

Sully Prudhomme | French poet | Britannica.com
<https://www.britannica.com/biography/Sully-Prudhomme>
Sully Prudhomme, pseudonym of René-François-Armand Prudhomme (born March 16, 1839, Paris—died Sept. 7, 1907, Châtenay, France) French poet who ...

Sully Prudhomme - NNDB.com
www.nndb.com/people/297/000098003/
It was at this moment that the small circle of which Leconte de Lisle was the center were preparing the Parnasse, to which Sully Prudhomme contributed several ...

Sully Prudhomme | Definition of Sully Prudhomme by Merriam-Webster

Sully Prudhomme
Poet

René François Armand Prudhomme was a French poet and essayist. He was the first ever winner of the Nobel Prize in Literature in 1901.
[Wikipedia](#)

Born: March 16, 1839, Paris, France
Died: September 6, 1907, Châtenay-Malabry, France
Books: [Les vaines tendresses](#)
Awards: [Nobel Prize in Literature](#)

People also search for [View 10+ more](#)

[Leconte de Lisle](#) [Theodor Mommsen](#) [Frédéric Mistral](#) [Paul Verlaine](#) [Gabriel Fauré](#)

USING SEMANTIC WEB KNOWLEDGE-BASES

From Freebase to Wikidata: The Great Migration

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ABSTRACT

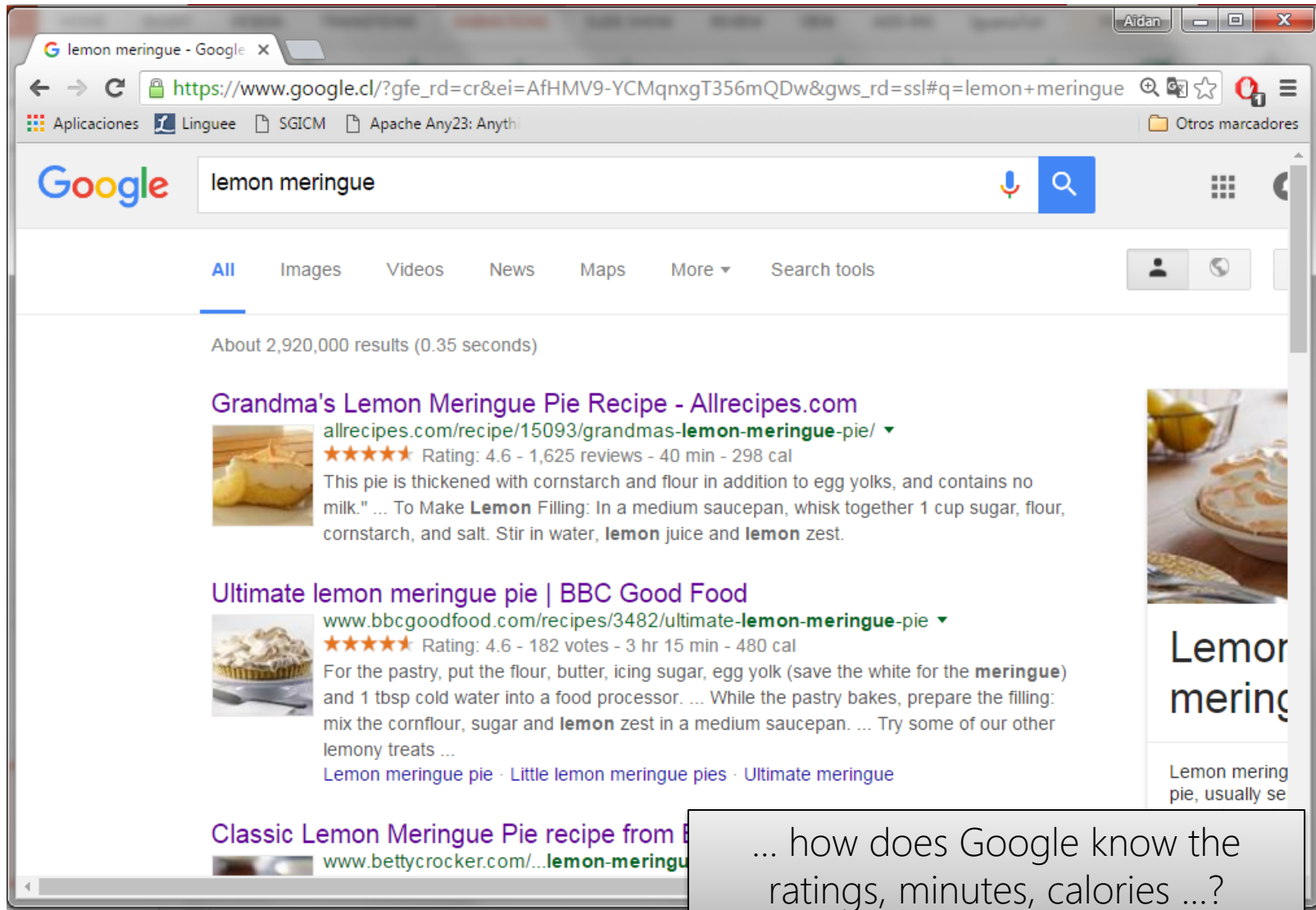
Collaborative knowledge bases that make their data freely available in a machine-readable form are central for the data strategy of many projects and organizations. The two major collaborative knowledge bases are Wikimedia's Wikidata and Google's Freebase. Due to the success of Wikidata, Google decided in 2014 to offer the content of Freebase to the Wikidata community. In this paper, we report on the ongoing transfer efforts and data mapping challenges, and provide an analysis of the effort so far. We describe the *Primary Sources Tool*, which aims to facilitate this and future data migrations. Throughout the migration, we have gained deep insights into both Wikidata and Freebase, and share and discuss detailed statistics on both knowledge bases.

One such collaborative knowledge base is Freebase, publicly launched by Metaweb in 2007 and acquired by Google in 2010. Another example is Wikidata, a collaborative knowledge base developed by Wikimedia Deutschland since 2012 and operated by the Wikimedia Foundation. Due to the success of Wikidata, Google announced in 2014 their intent to shut down Freebase and help the community with the transfer of Freebase content to Wikidata [10].

Moving data between two knowledge bases that do not share a similar design is usually a problematic task and requires the careful mapping between their structures. The migration from Freebase to Wikidata was no exception to this rule: we encountered a number of to-be-expected *structural* challenges. However, even more demanding was the *cultural* difference between the two involved communities.

GOOGLE'S RICH SNIPPETS

FANCY-LOOKING SEARCH RESULTS ...



The screenshot shows a Google search for "lemon meringue" in a browser window. The search results are displayed in a list format. The first result is "Grandma's Lemon Meringue Pie Recipe - Allrecipes.com" with a 4.6 rating from 1,625 reviews, a 40-minute cooking time, and 298 calories. The second result is "Ultimate lemon meringue pie | BBC Good Food" with a 4.6 rating from 182 votes, a 3-hour 15-minute cooking time, and 480 calories. The third result is "Classic Lemon Meringue Pie recipe from Betty Crocker" with a 4.6 rating from 1,625 reviews, a 40-minute cooking time, and 298 calories. A callout box at the bottom right asks, "... how does Google know the ratings, minutes, calories ...?".

lemon meringue - Google X

https://www.google.cl/?gfe_rd=cr&ei=AfHVMV9-YCMqnxgT356mQDw&gws_rd=ssl#q=lemon+meringue

Google lemon meringue

All Images Videos News Maps More Search tools

About 2,920,000 results (0.35 seconds)

Grandma's Lemon Meringue Pie Recipe - Allrecipes.com
allrecipes.com/recipe/15093/grandmas-lemon-meringue-pie/
★★★★★ Rating: 4.6 - 1,625 reviews - 40 min - 298 cal
This pie is thickened with cornstarch and flour in addition to egg yolks, and contains no milk." ... To Make **Lemon** Filling: In a medium saucepan, whisk together 1 cup sugar, flour, cornstarch, and salt. Stir in water, **lemon** juice and **lemon** zest.

Ultimate lemon meringue pie | BBC Good Food
www.bbcgoodfood.com/recipes/3482/ultimate-lemon-meringue-pie
★★★★★ Rating: 4.6 - 182 votes - 3 hr 15 min - 480 cal
For the pastry, put the flour, butter, icing sugar, egg yolk (save the white for the **meringue**) and 1 tsp cold water into a food processor. ... While the pastry bakes, prepare the filling: mix the cornflour, sugar and **lemon** zest in a medium saucepan. ... Try some of our other lemony treats ...
Lemon meringue pie · Little lemon meringue pies · Ultimate meringue

Classic Lemon Meringue Pie recipe from Betty Crocker
www.bettycrocker.com/...lemon-meringue
★★★★★ Rating: 4.6 - 1,625 reviews - 40 min - 298 cal

... how does Google know the ratings, minutes, calories ...?

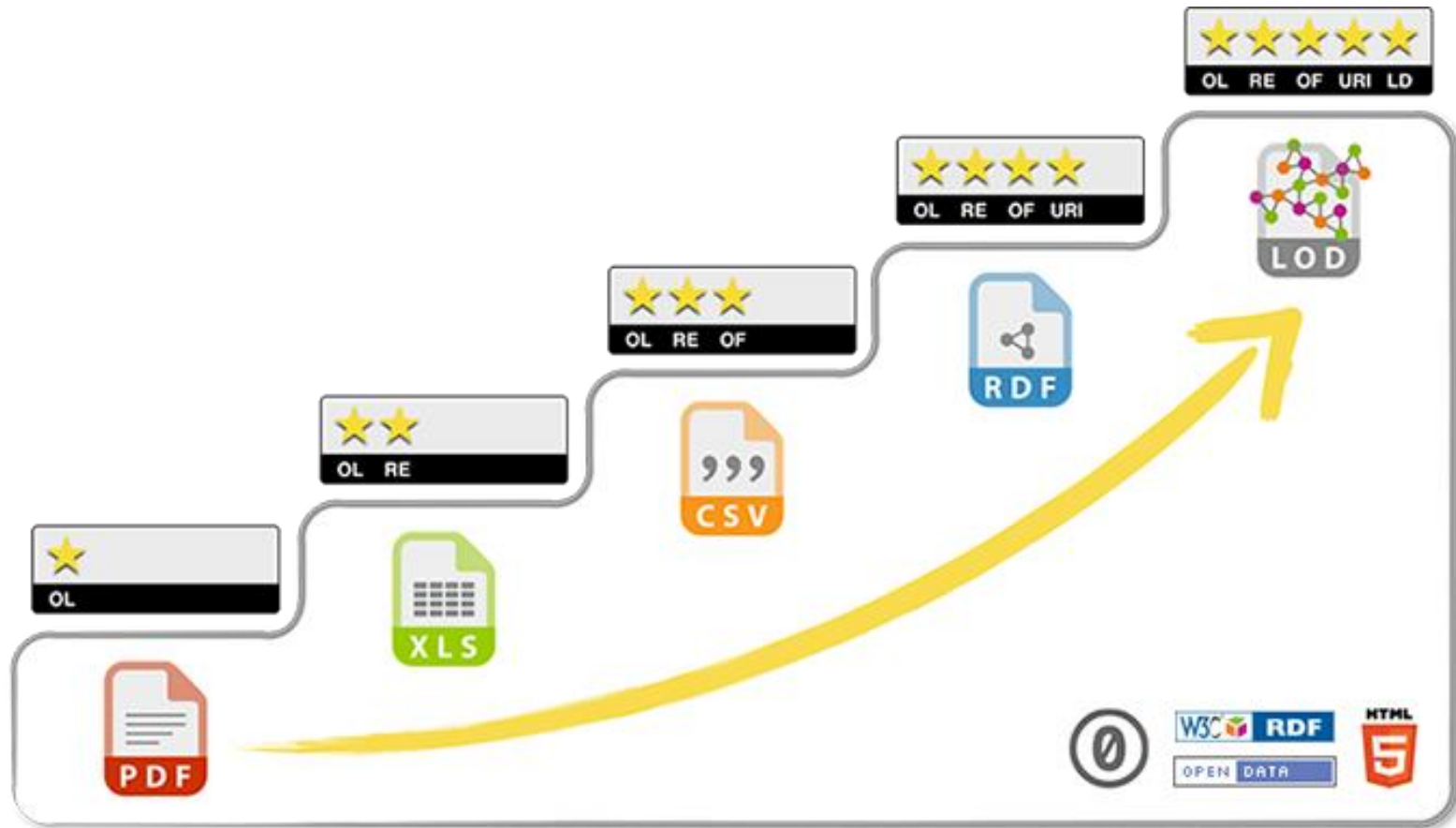
PUBLISHERS ADD STRUCTURED DATA!

```
<ul class="nutrition" itemprop="nutrition" itemscope
  itemtype="http://schema.org/NutritionInformation">
  <li>
    <span class="nutrition_label">kcal</span>
    <span class="nutrition_value" itemprop="calories">480</span>
    ...
  </li>
</ul>
```

- ✓ Publishers get more clicks on their results
- ✓ Google gets data to make fancy results

STANDARDS FOR OPEN DATA:
LINKED OPEN DATA

HOW TO PUBLISH OPEN DATA?



5-Star Linking Open Data Scheme

THE LINKED DATA CLOUD

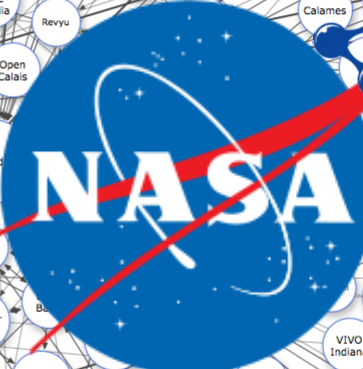


The New York Times

METAWEB



WIKIPEDIA
The Free Encyclopedia



Computer Science
Bibliography

HM Government

Sears

YAHOO!

ABOUT THE COURSE ...

TOPICS COVERED

- RDF (triple-based data model)
- RDFS/OWL (ontological languages)
- SPARQL (query language)
- Linked Data / Web of Data
- RDB2RDF (importing databases to Sem. Web.)
- Shapes (validating RDF data)

RESEARCH COURSE



STRUCTURE OF THE COURSE

- Each week:
 - Class on Monday (learn concepts)
 - Lab on Wednesday (see concepts in practice)
 - Auxiliar session on Friday (Q&A)
- Marking structure:
 - 70% labs
 - 20% project
 - 10% reading group

BIBLIOGRAPHY

Aidan Hogan

The Web of Data

This book concisely brings together the key standards and best practices relating to modelling, querying, validating and linking machine-readable data and semantics on the Web. Alongside practical examples and formal definitions, the book shows how these standards contribute to – and have been used thus far on – the “Web of Data”: a machine readable evolution of the Web marked by increased automation, enabling powerful Web applications capable of discovering, cross-referencing, and organising data from numerous websites in a matter of seconds.

The book is divided into nine chapters, the first of which highlights the fundamental shortcomings of the current Web that illustrate the need for increased machine readability. The next chapter outlines the core concepts of the “Web of Data”, discussing use-cases on the Web where they have already been deployed. “Resource Description Framework (RDF)” describes the graph-structured data model proposed by the Semantic Web community as a common data model for the Web. The chapter on “RDF Schema (RDFS) and Semantics” presents a lightweight ontology language used to define an initial semantics for RDF graphs. In turn, the chapter “Web Ontology Language (OWL)” elaborates on a much more expressive ontology language built upon RDFS. In “SPARQL Query Language” a language for querying and updating RDF graphs is described. “Shape Constraints and Expressions (SHACL/ShEx)” introduces two languages for describing the expected structure of – and expressing constraints over – RDF graphs for the purposes of validation. “Linked Data” discusses the principles and best practices by which interlinked (RDF) data can be published on the Web, and how they have been adopted. The final chapter highlights open problems and concludes with a general discussion on the future of the Web of Data.

The book is intended for students, researchers and advanced practitioners interested in learning more about the Web of Data, and about closely related topics such as the Semantic Web, Knowledge Graphs, Linked Data, Graph Databases, Ontologies, etc. Offering a range of accessible examples and exercises, it can be used as a textbook for students and other newcomers to the field. It can also serve as a reference handbook for researchers and developers, as it offers up-to-date details on key standards (RDF, RDFS, OWL, SPARQL, SHACL, ShEx, RDB2RDF, LDP), along with formal definitions and references to further literature. The associated website webofdatabook.org offers a wealth of complementary material, including solutions to the exercises, slides for classes, interactive examples, and a section for comments and questions.

Aidan Hogan



The Web of Data

Aidan Hogan

The Web of Data

OUTCOMES: LEARN ABOUT THE SEMANTIC WEB!

- An ongoing research topic here in the DCC
- Apply database, logic, AI, etc., to the Web
- Mix of theory and practical exercises
- The future of the Web?

QUESTIONS?

