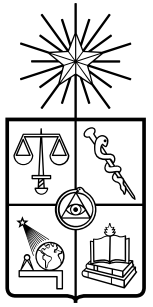

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SICCS 2023
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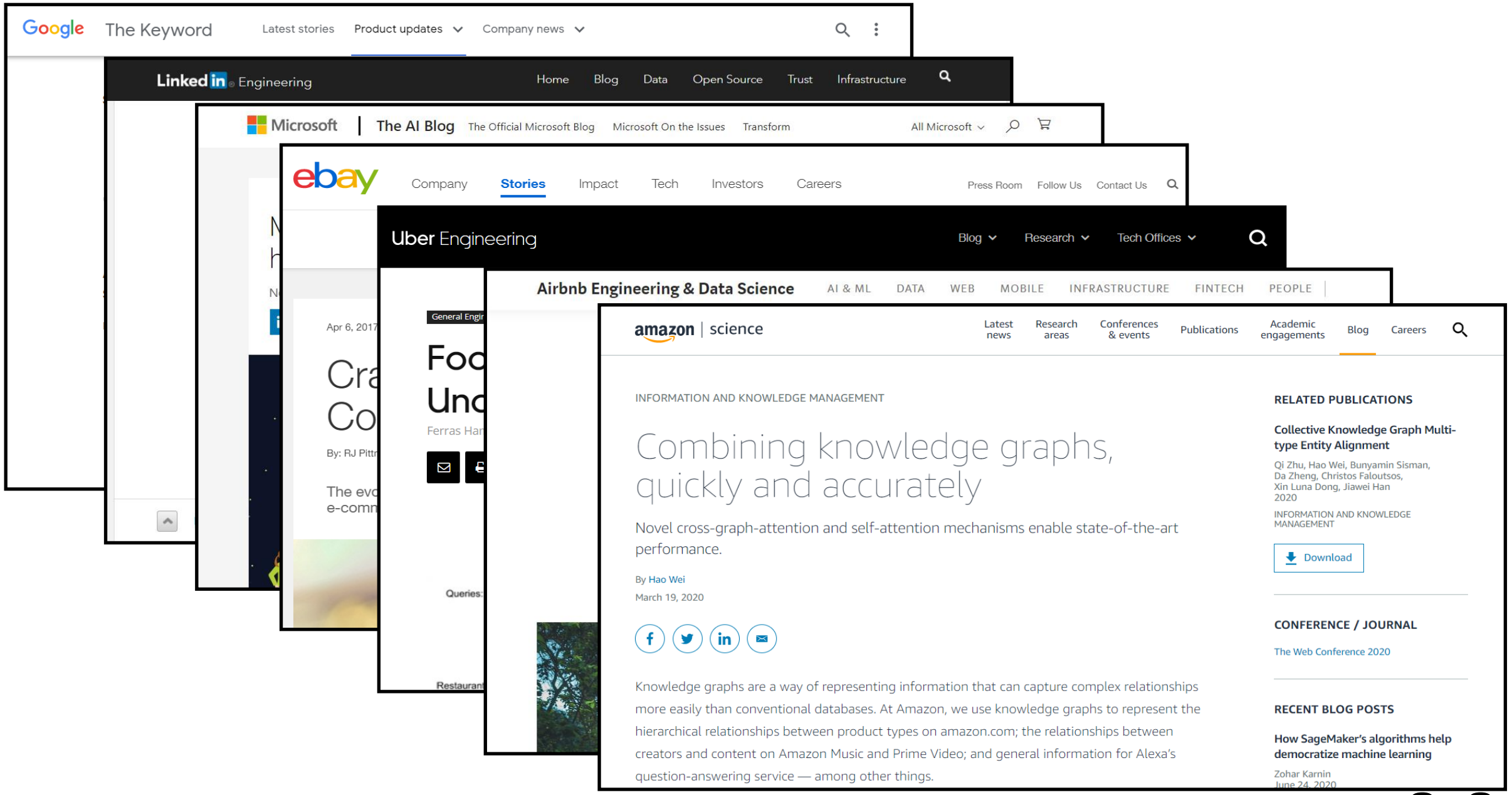
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By Hao Wei
March 19, 2020
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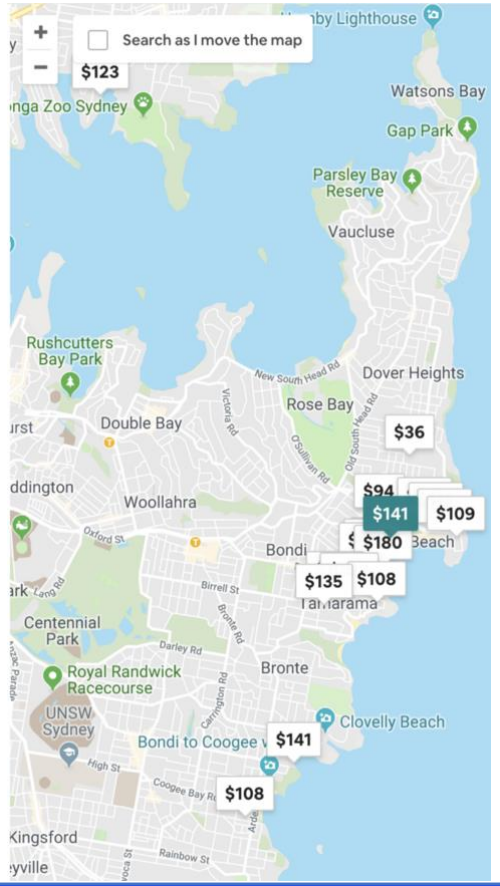
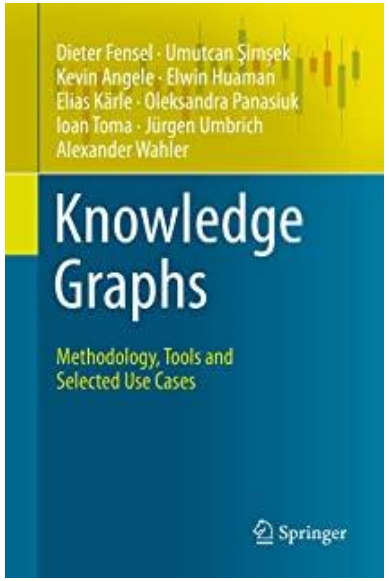


Knowledge Graph

The Knowledge Graph is a knowledge base used by Google and its services to enhance its search engine's results with information gathered from a variety of sources. The information is presented to users in an infobox next to the search results.
Wikipedia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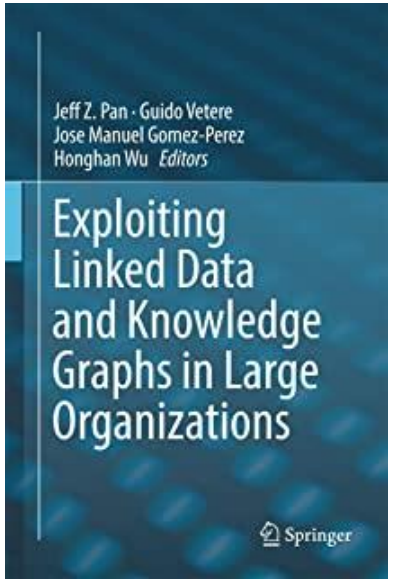
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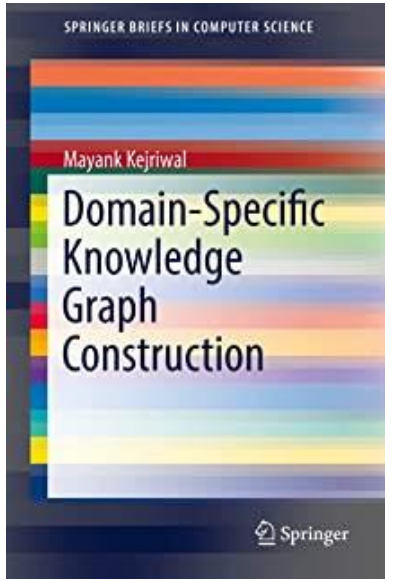
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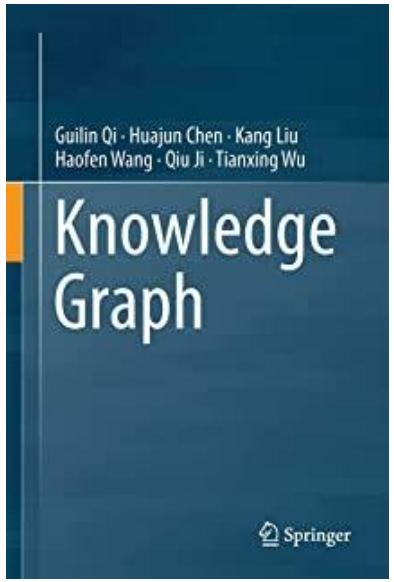
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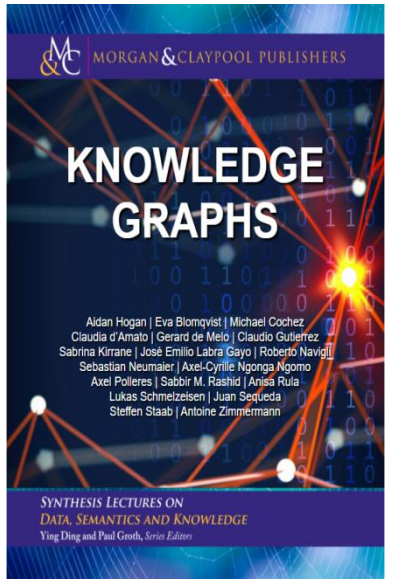
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¿Qué es un “grafo de conocimiento”?

Un grafo de conocimiento...

“es un grafo de multiples relaciones compuesto de entidades como nodos y relaciones como diferentes tipos de aristas”
[Wang et al. 2014]

Un grafo de conocimiento...

“es una base de conocimiento estructurada como un grafo”
[Nickel et al. 2016]

Un grafo de conocimiento…

“adquiere e integra información en una ontología y aplica un razonador”
[Ehrlinger & Wöß. 2016]

Un grafo de conocimiento...

“describe principalmente rentidades del muldo real y sus inter-relaciones, organizado en un grafo [Paulheim 2017]

Un grafo de conocimiento...

“es un modelo de datos semi-estructurado caracterizado por tres componentes:

(i) un componente extensional de base[...]

(ii) un componente intensional [...];

(iii) un componente extensional derivado”

[Bellomarini et al. 2019]

Un grafo de conocimiento…

“describe objectos de interés y las conexiones entre ellos” y “provee un sustrato común de conocimiento dentro de una organización”

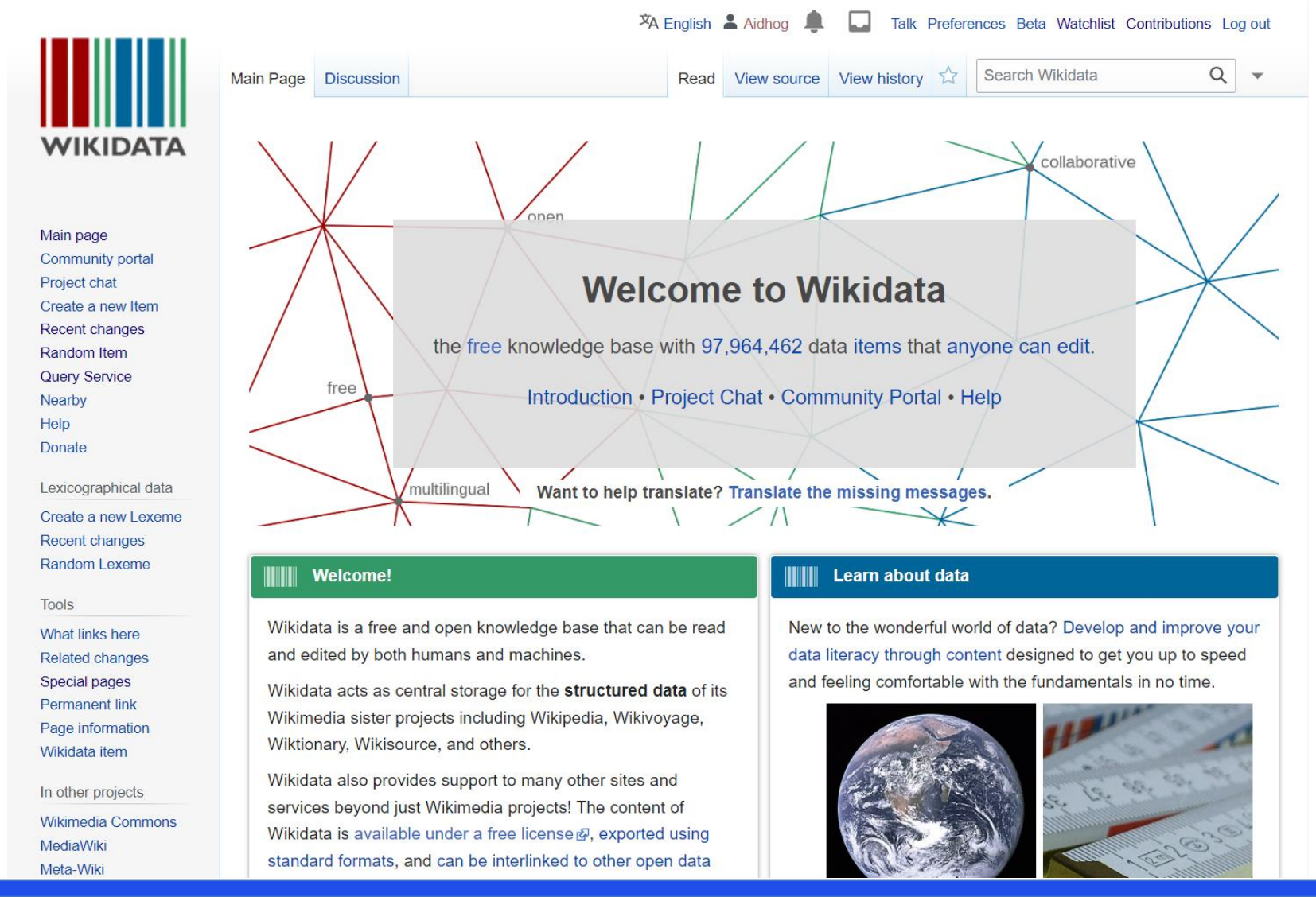
[Noy et al. 2019]

A knowledge graph …

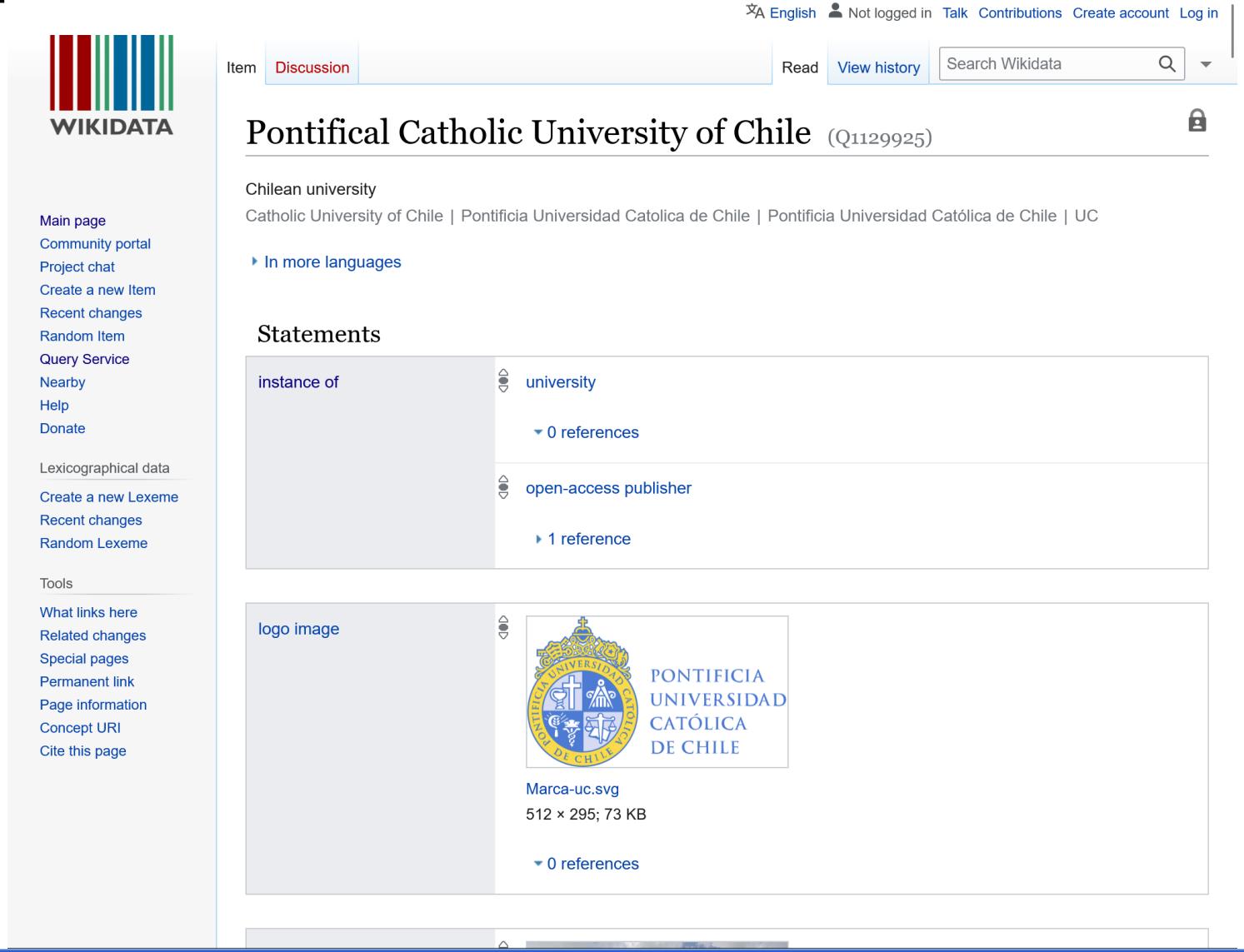
"is a graph of knowledge"
[Hogan 2022]

¿Ejemplos de "grafos de conocimiento"?

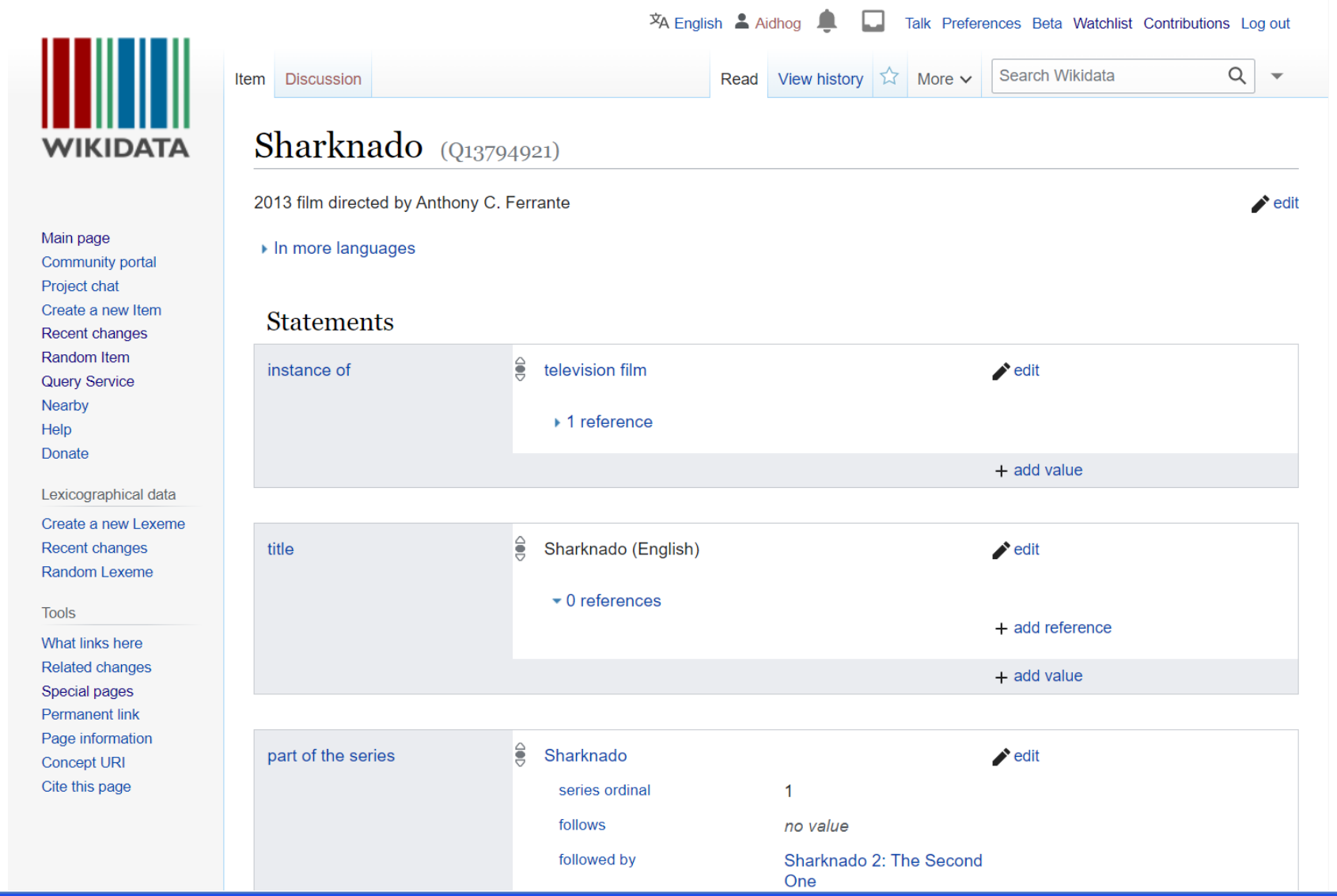
Wikidata: Wikipedia en un grafo



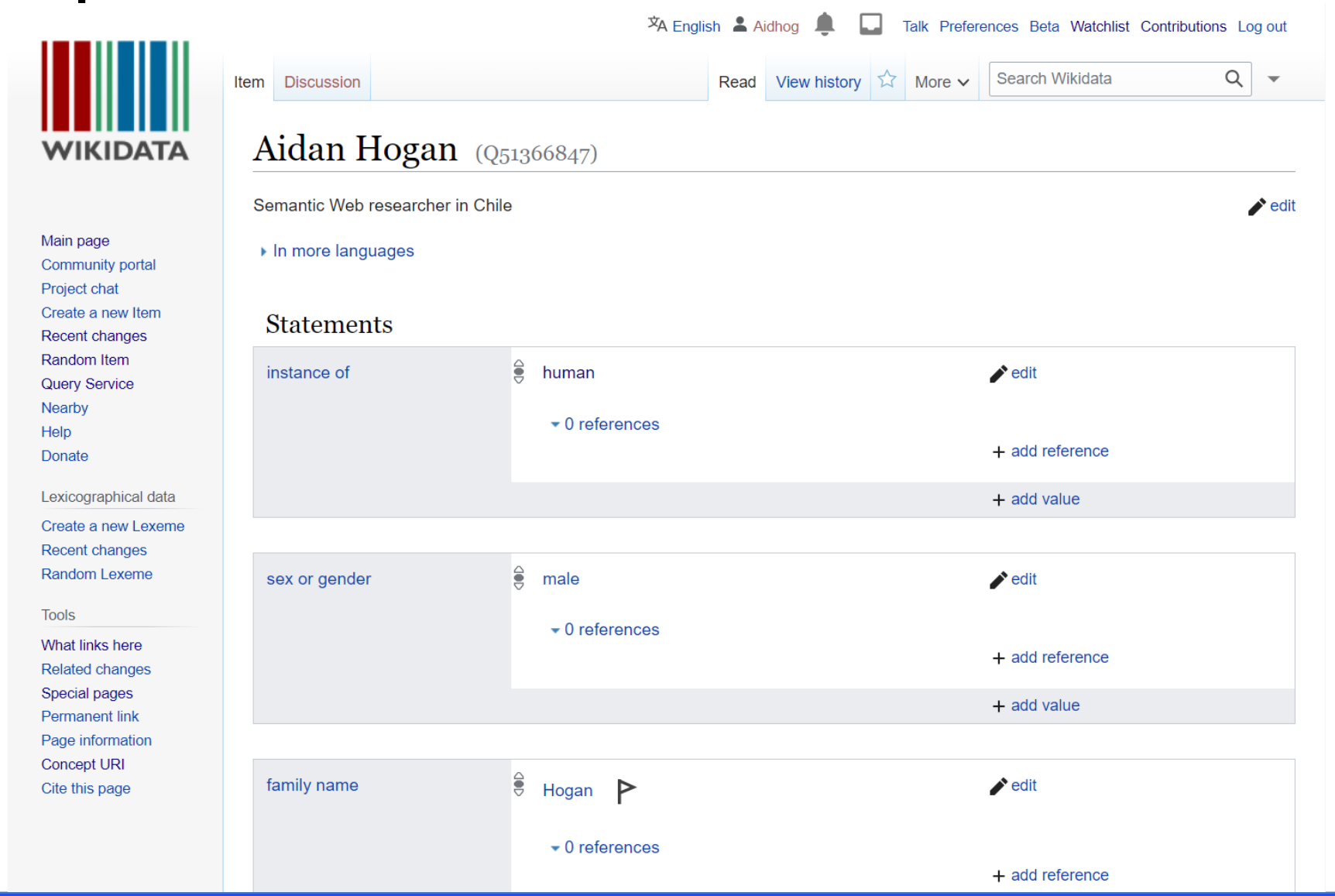
¿Qué tipos de entidades contiene?



¿Qué tipos de entidades contiene?



¿Qué tipos de entidades contiene?



¿Qué tipos de entidades contiene?

English Ferradest Talk Preferences Beta Watchlist Contributions Log out

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metro station in Santiago, Chile
San Joaquin metro station

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instance of	metro station 1 reference	edit
	+ add value	
transport network	Santiago Metro 1 reference	edit
	+ add value	
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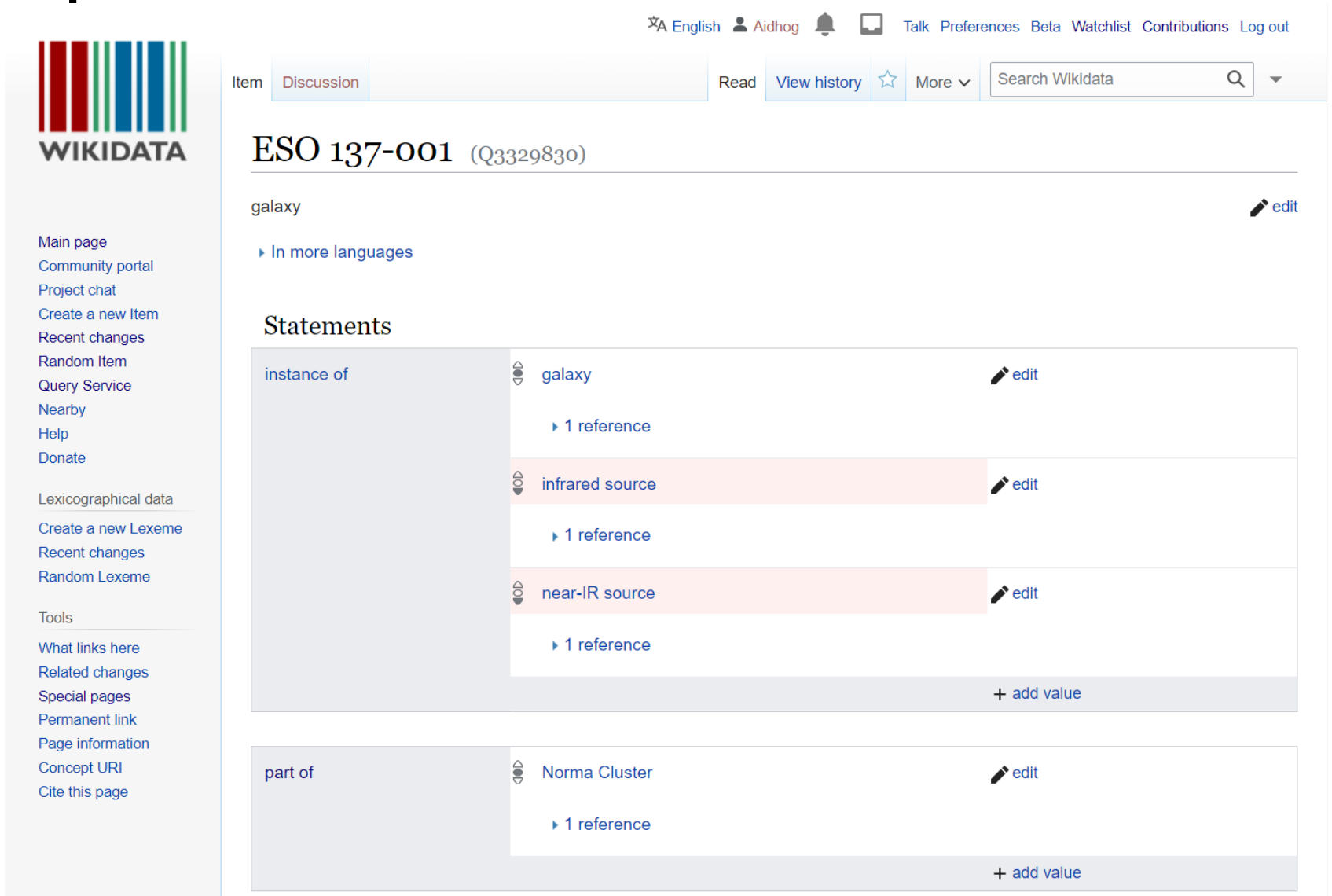
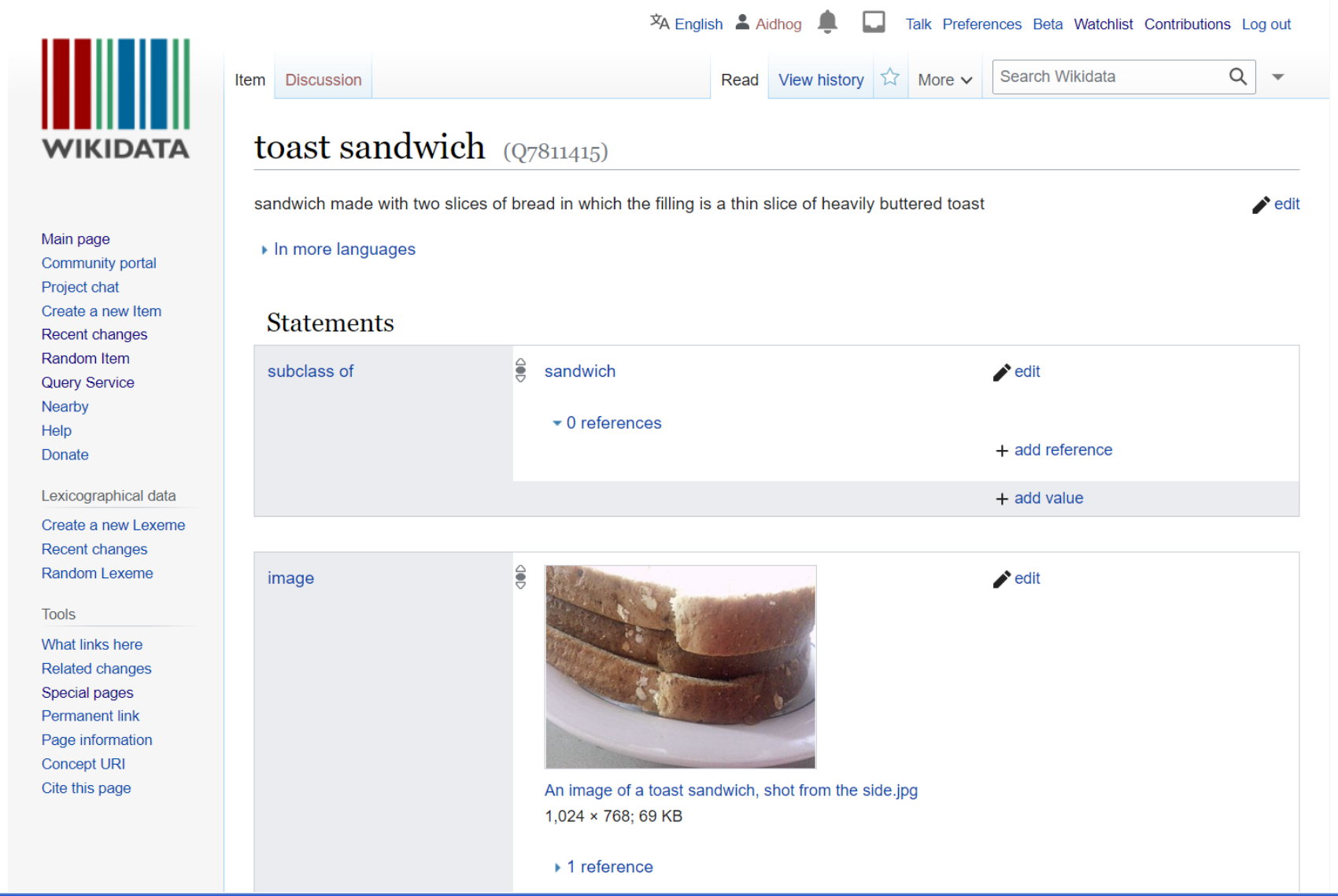
¿Qué tipos de entidades contiene?



¿Qué tipos de entidades contiene?



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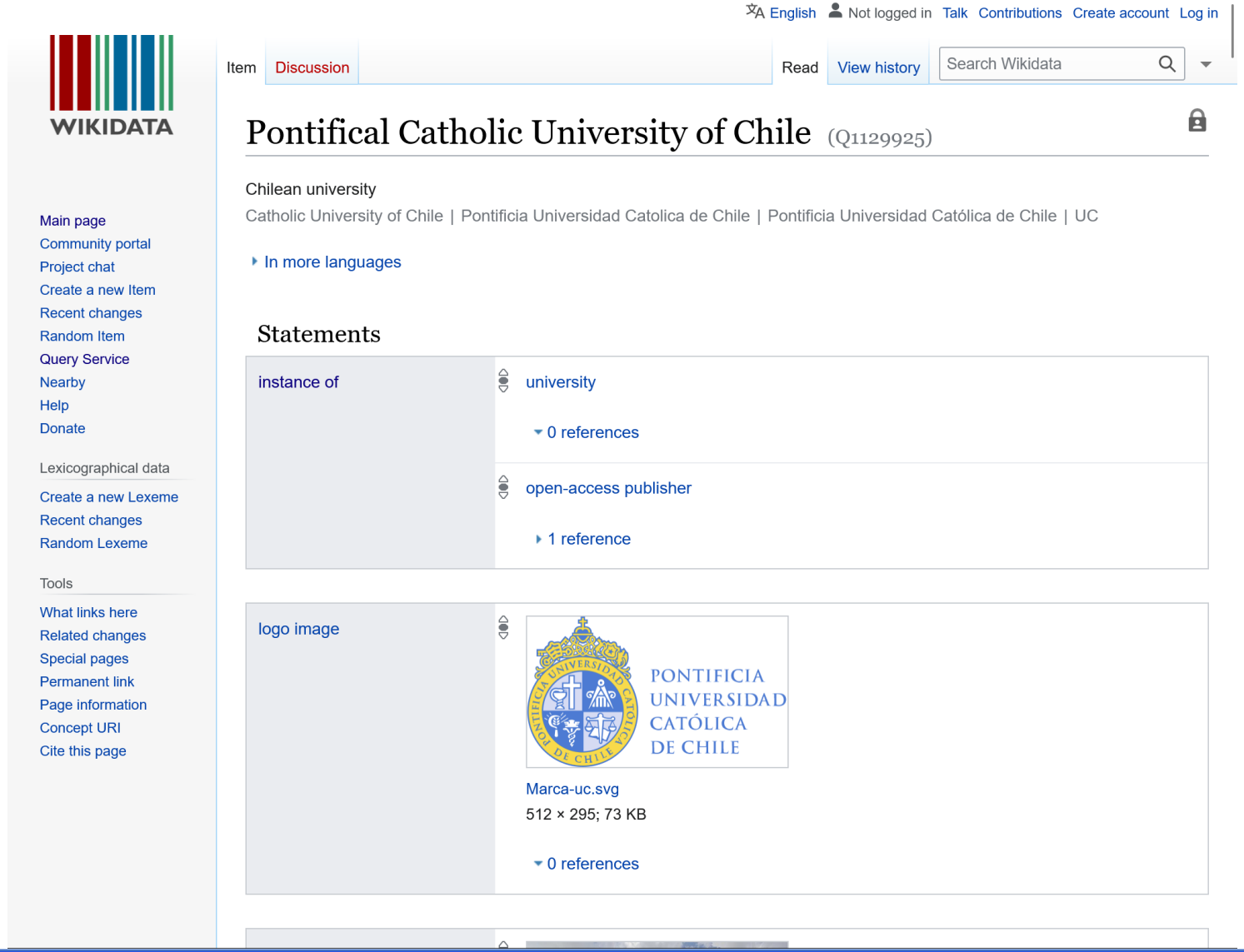

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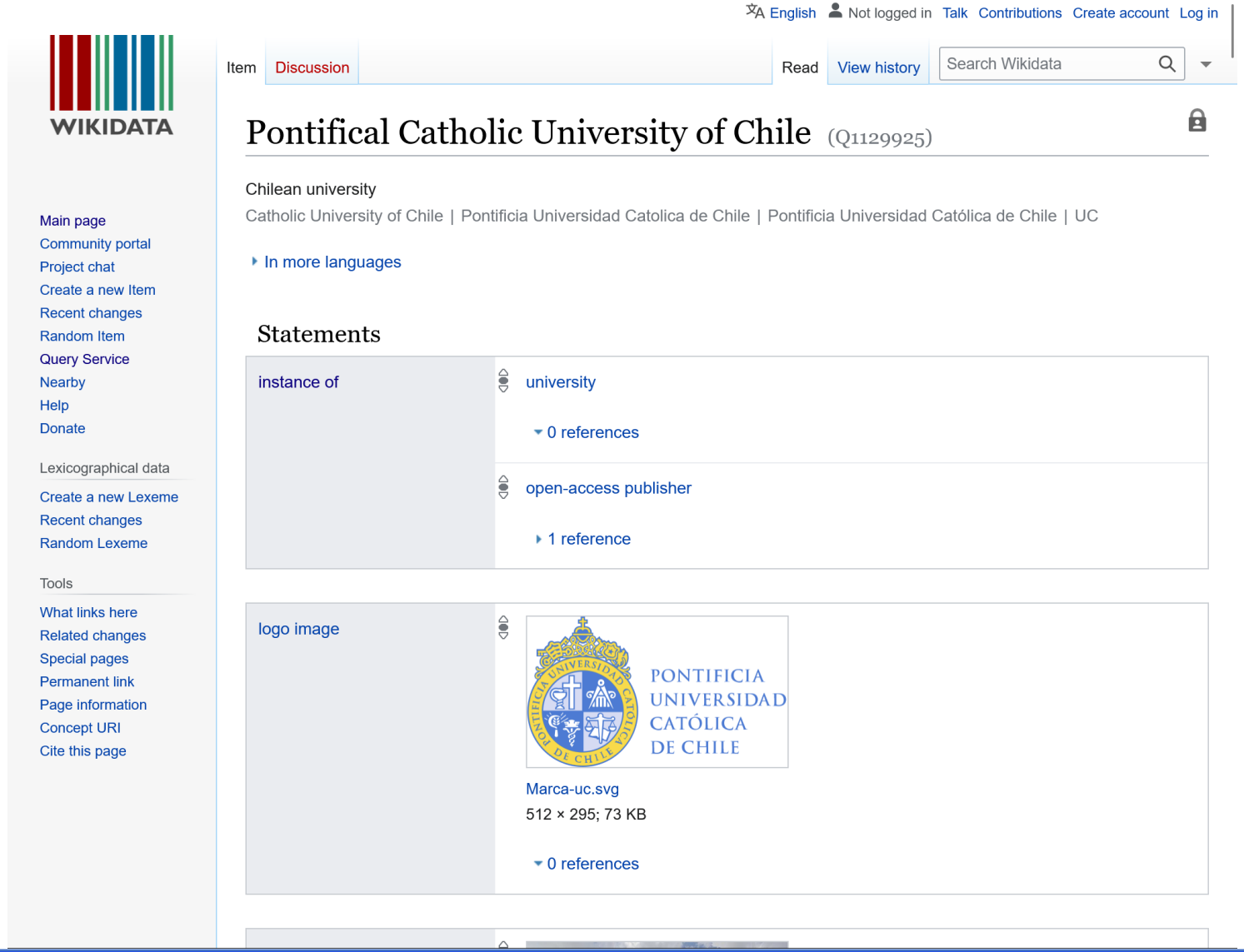
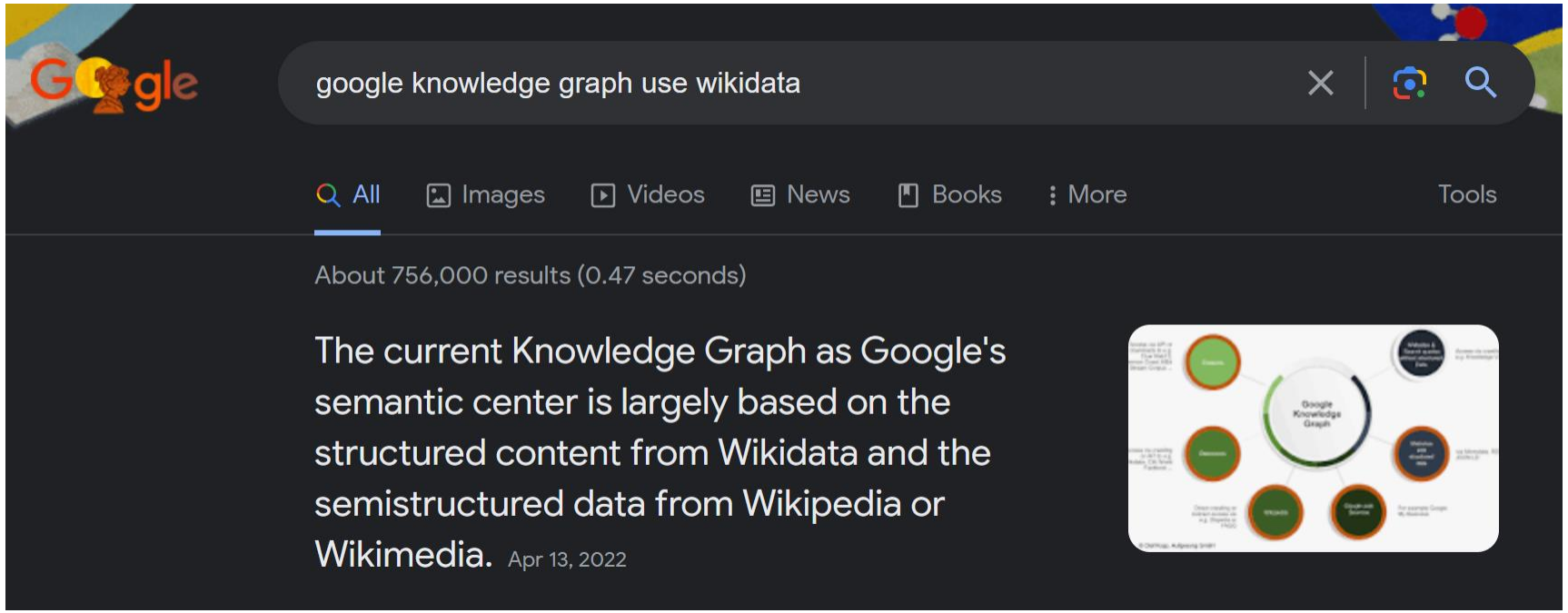


¿Por qué esto es un grafo de conocimiento?

¿Dónde se usa Wikidata?



¿Dónde se usa Wikidata?

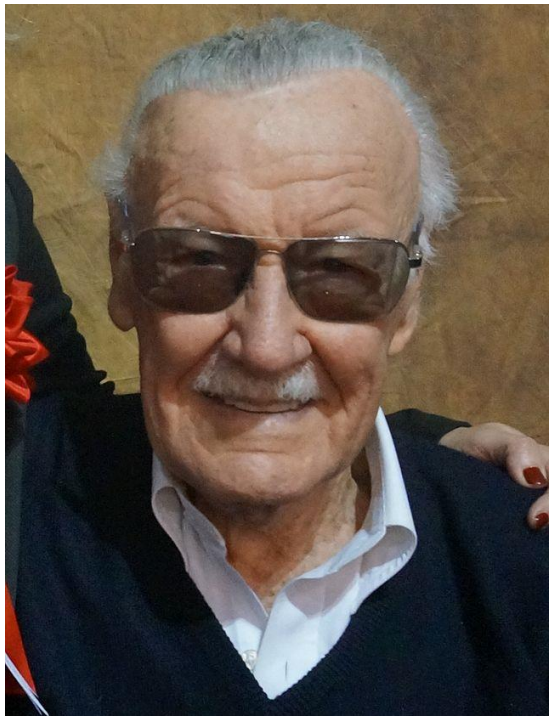
GIZMODO

Siri Erroneously Told People Stan Lee Was Dead

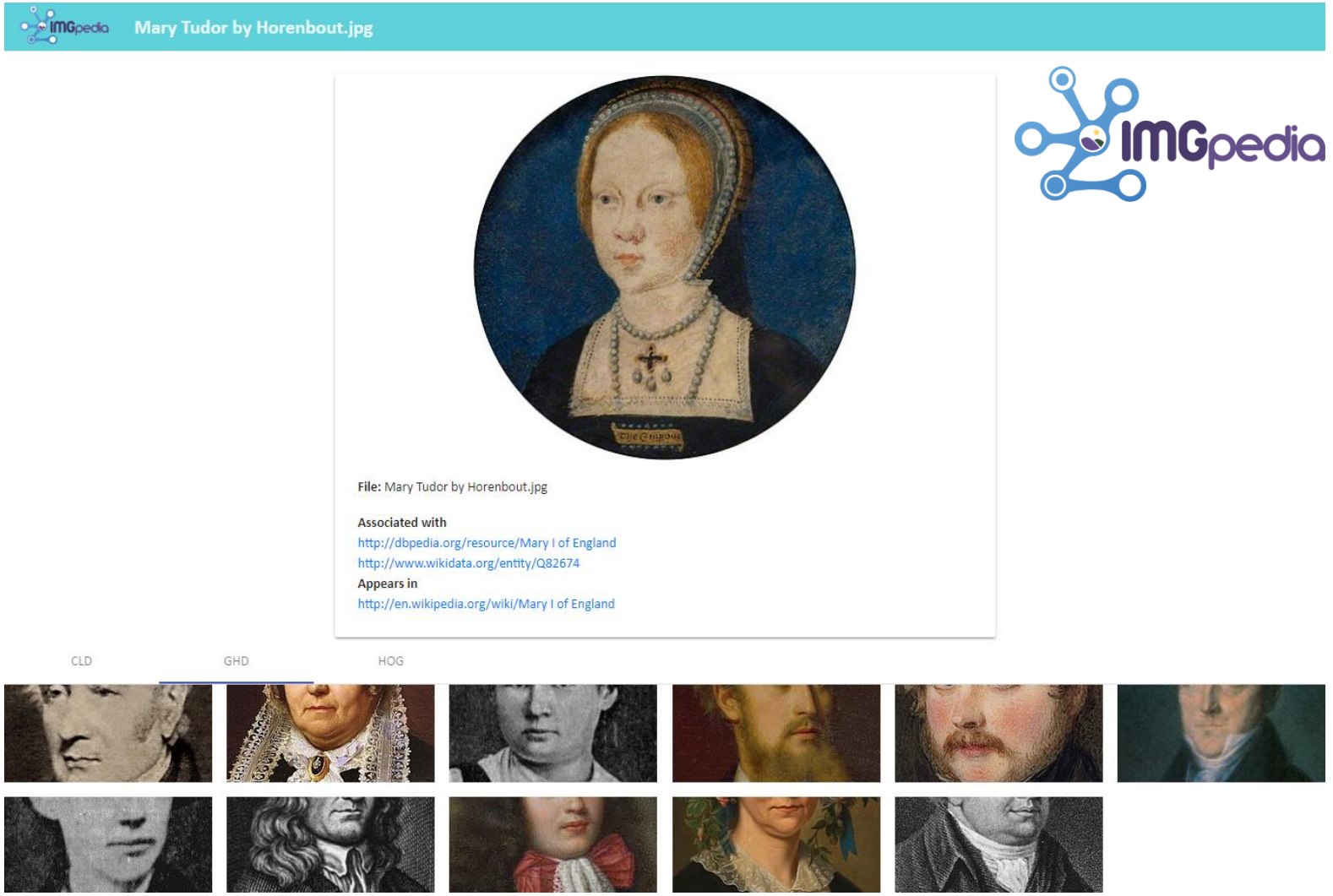
By Beth Elderkin | 7/03/18 2:45PM | Comments (45)

For a few brief moments, comic book fans around the world were shocked to hear some tragic news. But luckily, the panic didn't last long. As first reported by CinemaBlend, Siri spent a little time this week telling people that Stan Lee had died on July 2. Why would a computer program falsely report a famous figure's death? You can blame a Wiki user for that.

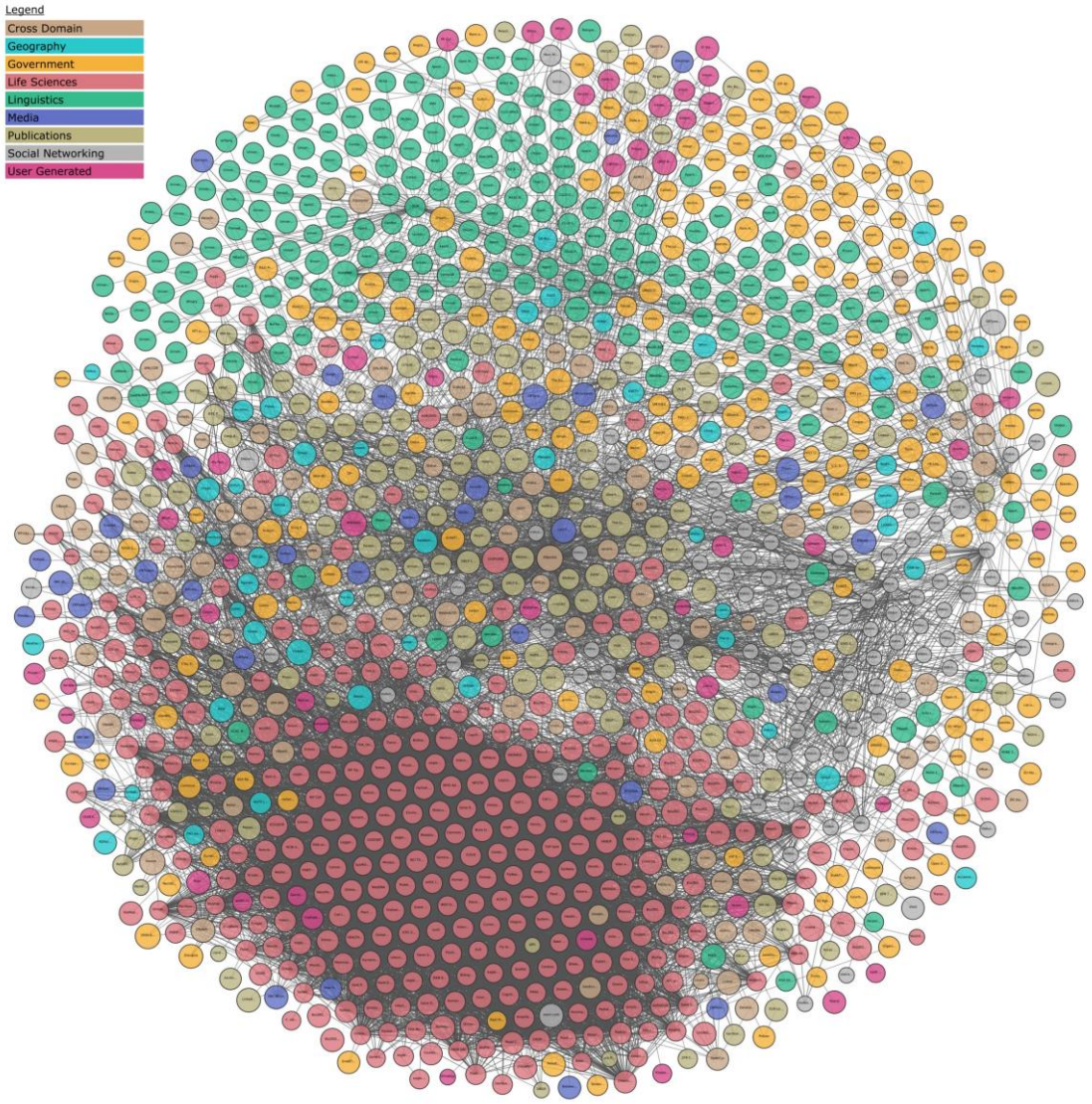
Sources tell us the problem can be traced back to revisions in Lee's Wikidata. If you look at the profile's recent history, Wiki user "&beer&love" changed Lee's Wiki data to include a "date of death." Since Siri pulls data automatically from Wiki pages, without edit or modification, the program temporarily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



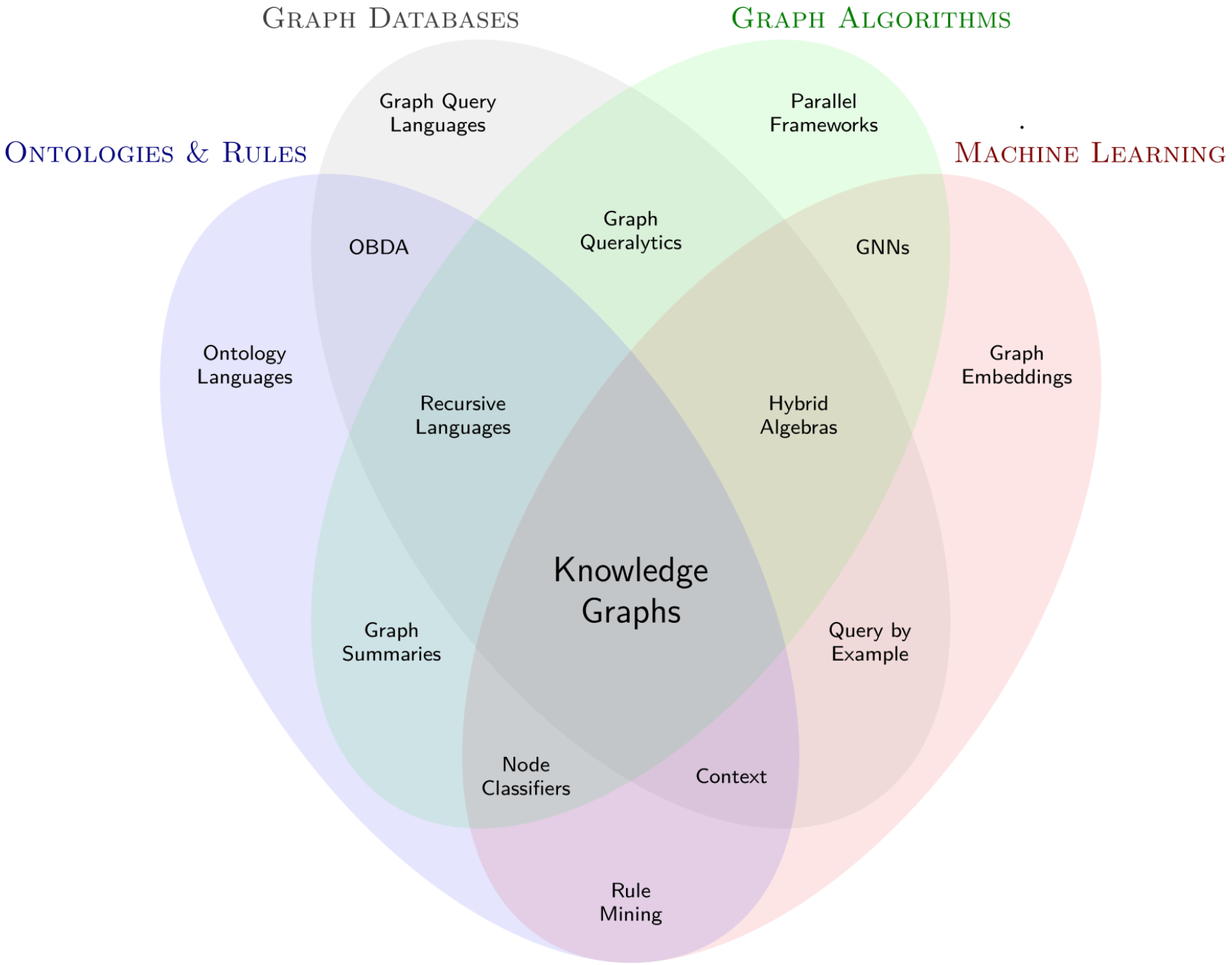
¿Dónde se usa Wikidata?



¿Dónde se usa Wikidata?



¿Qué tienen de novedoso los "grafos de conocimiento"?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¿Por qué grafos?

Bases de Datos Relacionales

Bases de Datos Relacionales

Debit

account	comment	date	time	amount	total	id
7873698669	Initial deposit	2020-21-01	20:02:02	300000	300000	TRCXGU8JSHD
7873698669	C0°0°L Designs	2020-02-06	09:15:33	50000	325000	TRCCIA2J8AO

Credit

account	comment	date	time	amount	total	id
7873698669	Electricity	2020-02-02	20:00:01	8200	291800	TRCJASJDA9A
7873698669	Heat	2020-02-02	20:00:02	600	291200	TRC81KAQWAS
7873698669	Moviestar	2020-02-02	20:00:03	16200	275000	TRCK8J7JA8D
7873698669	ATM	2020-02-08	16:05:02	100000	225000	TRCPM8A45AD

Account

number	rut	type	total_clp	total_usd
7873698669	32.000.273-K	Current	225000	344,94

Client

rut	name	phone	address
32.000.273-K	Kelvin	+56976698463	Campo de Hielo Sur, Depto 273

Exchange

c1	c2	value
CLP	USD	0,0001533
USD	CLP	652,2750000

Base de Datos Relacional de Planetas

Base de Datos Relacional de Planetas

Planet
name
Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune
Pluto

Base de Datos Relacional de Planetas

Planet

name	dist
Mercury	
Venus	
Earth	1.00
Mars	
Jupiter	
Saturn	
Uranus	
Neptune	
Pluto	

Base de Datos Relacional de Planetas

Planet

name	dist
Mercury	0.39
Venus	0.72
Earth	1.00
Mars	1.52
Jupiter	
Saturn	
Uranus	
Neptune	
Pluto	49.31

Base de Datos Relacional de Planetas

Planet

name	dist	radius
Mercury	0.39	0.38
Venus	0.72	
Earth	1.00	1.00
Mars	1.52	0.53
Jupiter		10.97
Saturn	9.54	
Uranus	19.19	3.98
Neptune		
Pluto	49.31	

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false
Earth	1.00	1.00	9.8	0.997	1.000	288	false
Mars	1.52	0.53	3.7	1.026	1.880	186	false
Jupiter	5.20	10.97	22.9	0.414	11.862	152	true
Saturn	9.54	9.14	9.1	0.444	29.447	134	true
Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false
Earth	1.00	1.00	9.8	0.997	1.000	288	false
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Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring	moon
Mercury	0.39	0.38	2.8	58.646	0.241	440	false	$\perp$
Venus	0.72	0.95	8.9	-243.019	0.615	730	false	$\perp$
Earth	1.00	1.00	9.8	0.997	1.000	288	false	Luna
Mars	1.52	0.53	3.7	1.026	1.880	186	false	Phobos, Deimos
Jupiter	5.20	10.97	22.9	0.414	11.862	152	true	Callisto, Ganymede, ...
Saturn	9.54	9.14	9.1	0.444	29.447	134	true	Titan, Rhea, ...
Uranus	19.19	3.98	7.8	-0.719	84.017	76	true	Oberon, Titania, ...
Neptune	30.07	3.86	11.0	0.671	164.791	53	true	Triton, ...
Pluto	49.31	0.19	0.063	6.39	248.000	44	false	Charon

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false
Earth	1.00	1.00	9.8	0.997	1.000	288	false
Mars	1.52	0.53	3.7	1.026	1.880	186	false
Jupiter	5.20	10.97	22.9	0.414	11.862	152	true
Saturn	9.54	9.14	9.1	0.444	29.447	134	true
Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	planet
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Terra
Oberon	Uranus
Charon	Pluto
...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false
Earth	1.00	1.00	9.8	0.997	1.000	288	false
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Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	planet	discoverer	year
Ganimedes	Jupiter	Galileo Galilei	1610
Calisto	Jupiter	Galileo Galilei	1610
Europa	Jupiter	Galileo Galilei	1610
Io	Jupiter	Galileo Galilei	1610
Titan	Saturn	Christiaan Huygens	1655
Triton	Neptune	William Lassell	1846
Luna	Terra	$\perp$	$\perp$
Oberon	Uranus	William Herschel	1787
Charon	Pluto	$\perp$	1978
...	...	...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false
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Mars	1.52	0.53	3.7	1.026	1.880	186	false
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Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	planet
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Terra
Oberon	Uranus
Charon	Pluto
...	...

MoonDiscoverer

name	discoverer
Ganimedes	Galileo Galilei
Calisto	Galileo Galilei
Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

MoonDiscYear

name	year
Ganimedes	1610
Calisto	1610
Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false
Earth	1.00	1.00	9.8	0.997	1.000	288	false
Mars	1.52	0.53	3.7	1.026	1.880	186	false
Jupiter	5.20	10.97	22.9	0.414	11.862	152	true
Saturn	9.54	9.14	9.1	0.444	29.447	134	true
Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	planet
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Terra
Oberon	Uranus
Charon	Pluto
...	...

MoonDiscoverer

name	discoverer
Ganimedes	Galileo Galilei
Calisto	Galileo Galilei
Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

MoonDiscYear

name	year
Ganimedes	1610
Calisto	1610
Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false
Earth	1.00	1.00	9.8	0.997	1.000	288	false
Mars	1.52	0.53	3.7	1.026	1.880	186	false
Jupiter	5.20	10.97	22.9	0.414	11.862	152	true
Saturn	9.54	9.14	9.1	0.444	29.447	134	true
Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	P.name
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Earth
Oberon	Uranus
Charon	Pluto
...	...

MoonDiscoverer

name	discoverer
Ganimedes	Galileo Galilei
Calisto	Galileo Galilei
Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

MoonDiscYear

name	year
Ganimedes	1610
Calisto	1610
Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false
Earth	1.00	1.00	9.8	0.997	1.000	288	false
Mars	1.52	0.53	3.7	1.026	1.880	186	false
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Saturn	9.54	9.14	9.1	0.444	29.447	134	true
Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	P.name
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Earth
Oberon	Uranus
Charon	Pluto
...	...

MoonDiscoverer

name	discoverer
Ganimedes	Galileo Galilei
Calisto	Galileo Galilei
Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

MoonDiscYear

name	year
Ganimedes	1610
Calisto	1610
Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
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Saturn	9.54	9.14	9.1	0.444	29.447	134	true
Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true

DwarfPlanet

name	dist	radius	grav	days	years	temp	ring
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	P.name
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Earth
Oberon	Uranus
Charon	Pluto
...	...

MoonDiscoverer

name	discoverer
Ganimedes	Galileo Galilei
Calisto	Galileo Galilei
Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

MoonDiscYear

name	year
Ganimedes	1610
Calisto	1610
Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
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Earth	1.00	1.00	9.8	0.997	1.000	288	false
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Saturn	9.54	9.14	9.1	0.444	29.447	134	true
Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true

DwarfPlanet

name	dist	radius	grav	days	years	temp	ring
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	P.name
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Earth
Oberon	Uranus
Charon	Pluto
...	...

MoonDiscoverer

name	discoverer
Ganimedes	Galileo Galilei
Calisto	Galileo Galilei
Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

MoonDiscYear

name	year
Ganimedes	1610
Calisto	1610
Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
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Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true

DwarfPlanet

name	dist	radius	grav	days	years	temp	ring
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	planet
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Earth
Oberon	Uranus
Charon	Pluto
...	...

MoonDiscoverer

name	discoverer
Ganimedes	Galileo Galilei
Calisto	Galileo Galilei
Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

MoonDiscYear

name	year
Ganimedes	1610
Calisto	1610
Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
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Venus	0.72	0.95	8.9	-243.019	0.615	730	false
Earth	1.00	1.00	9.8	0.997	1.000	288	false
Mars	1.52	0.53	3.7	1.026	1.880	186	false
Jupiter	5.20	10.97	22.9	0.414	11.862	152	true
Saturn	9.54	9.14	9.1	0.444	29.447	134	true
Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true

DwarfPlanet

name	dist	radius	grav	days	years	temp	ring
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	planet
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Earth
Oberon	Uranus
Charon	Pluto
...	...

MoonDiscoverer

name	discoverer
Ganimedes	Galileo Galilei
Calisto	Galileo Galilei
Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

MoonDiscYear

name	year
Ganimedes	1610
Calisto	1610
Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Base de Datos Relacional de Planetas

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false
Earth	1.00	1.00	9.8	0.997	1.000	288	false
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Jupiter	5.20	10.97	22.9	0.414	11.862	152	true
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Uranus	19.19	3.98	7.8	-0.719	84.017	76	true
Neptune	30.07	3.86	11.0	0.671	164.791	53	true

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DwarfPlanet

name	dist	radius	grav	days	years	temp	ring
Pluto	49.31	0.19	0.063	6.39	248.000	44	false

Moon

name	planet
Ganimedes	Jupiter
Calisto	Jupiter
Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Earth
Oberon	Uranus
Charon	Pluto
...	...

MoonDiscoverer

name	discoverer
Ganimedes	Galileo Galilei
Calisto	Galileo Galilei
Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

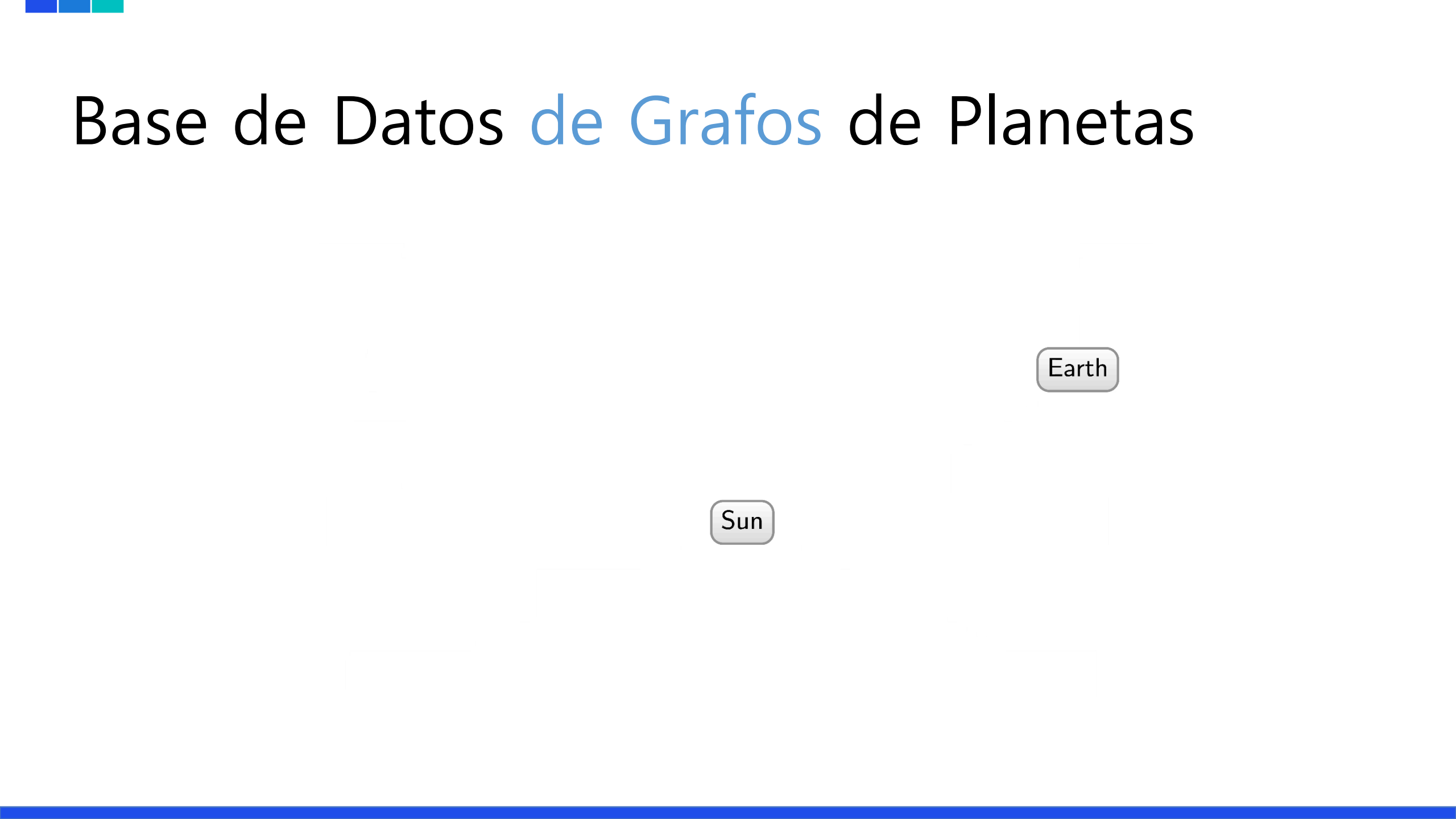
MoonDiscYear

name	year
Ganimedes	1610
Calisto	1610
Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Base de Datos de Grafos de Planetas

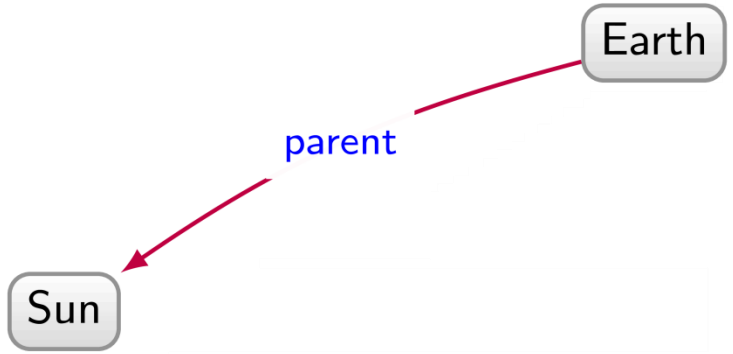
Base de Datos de Grafos de Planetas

Base de Datos de Grafos de Planetas

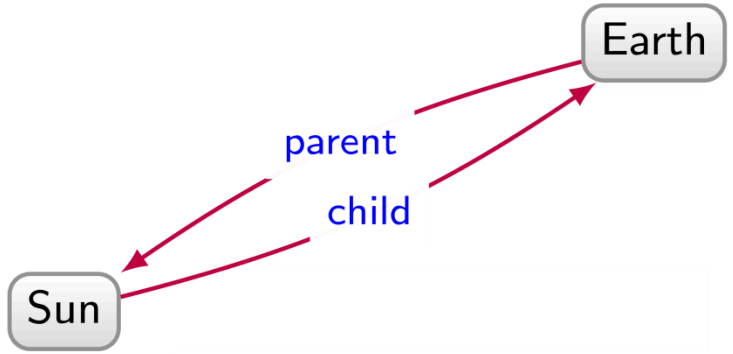


Base de Datos de Grafos de Planetas

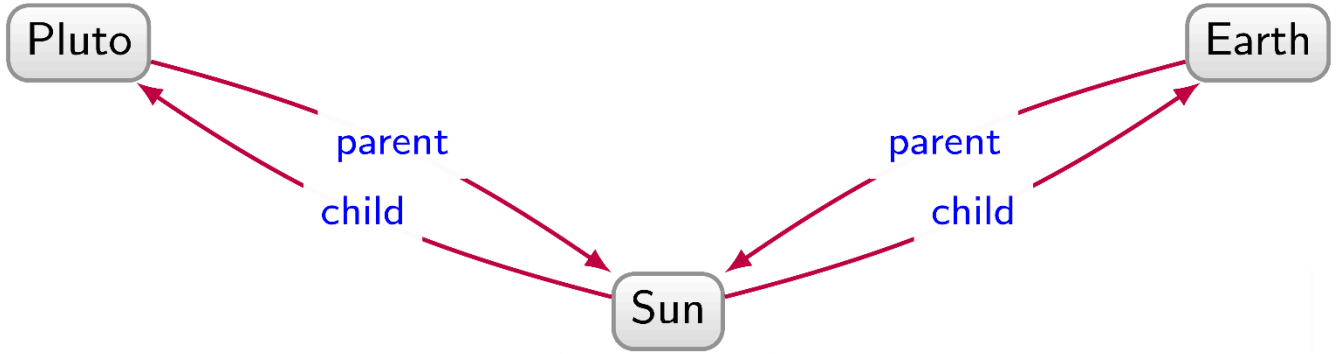
Base de Datos de Grafos de Planetas



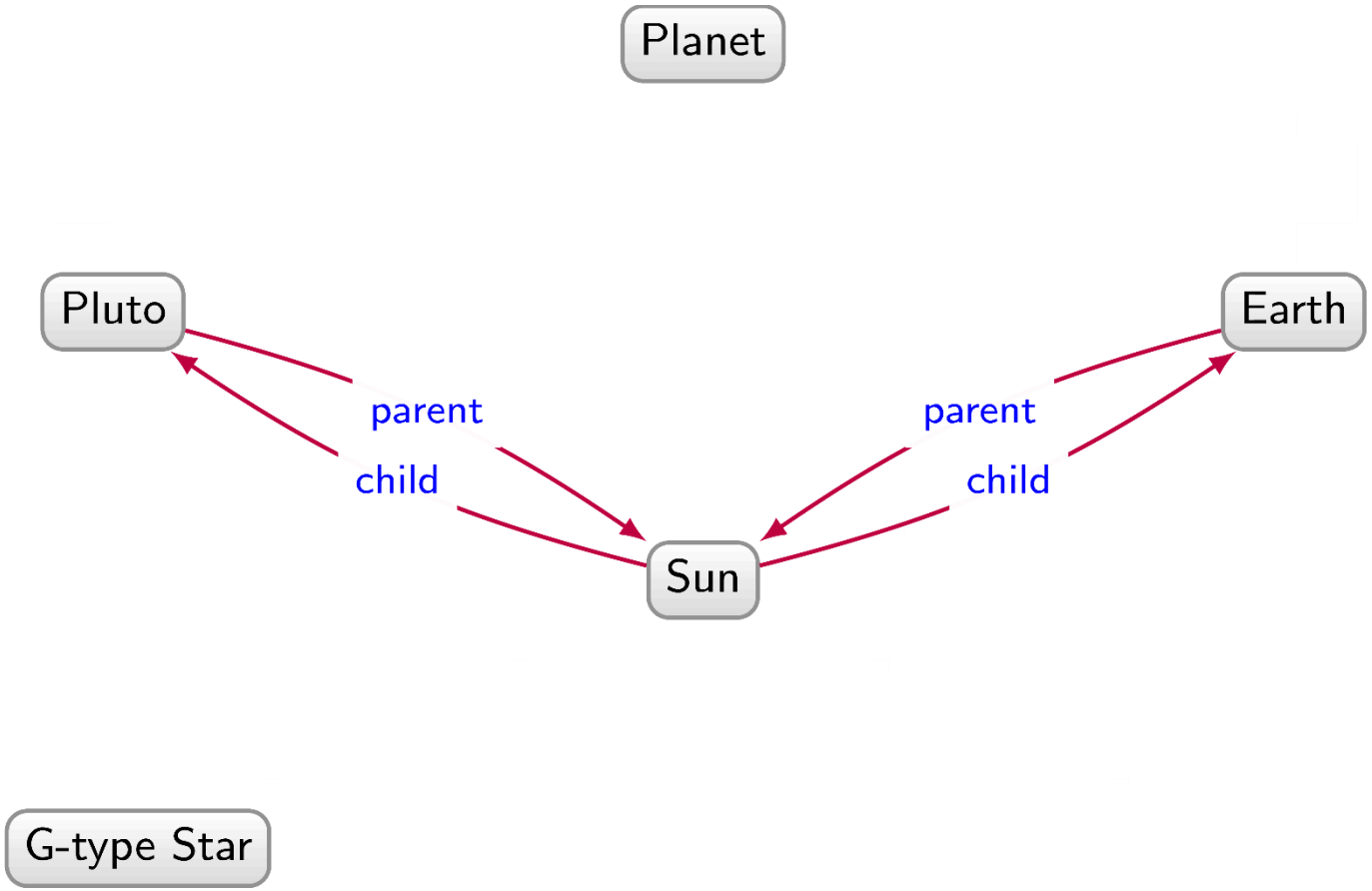
Base de Datos de Grafos de Planetas



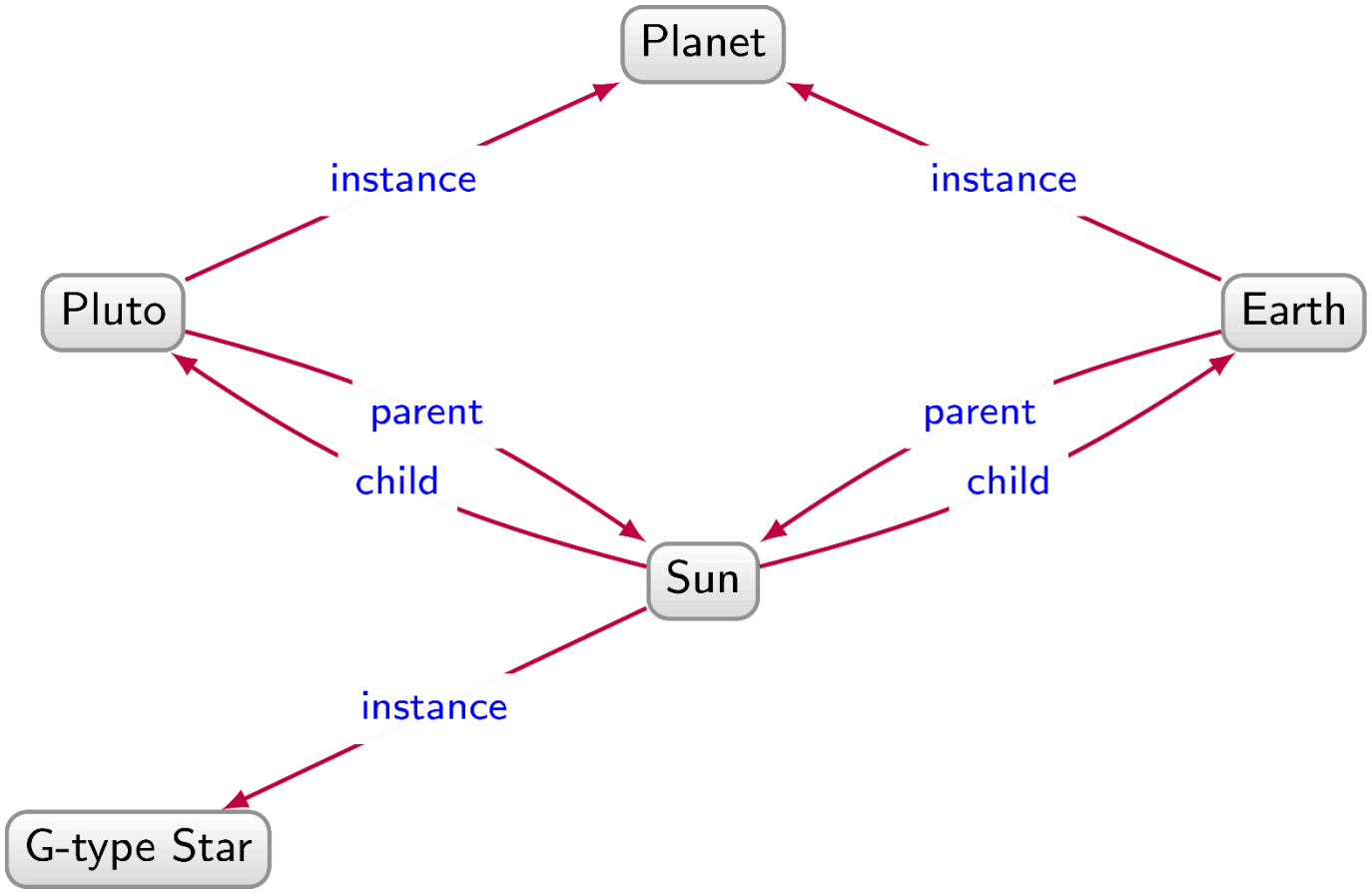
Base de Datos de Grafos de Planetas



Base de Datos de Grafos de Planetas



Base de Datos de Grafos de Planetas



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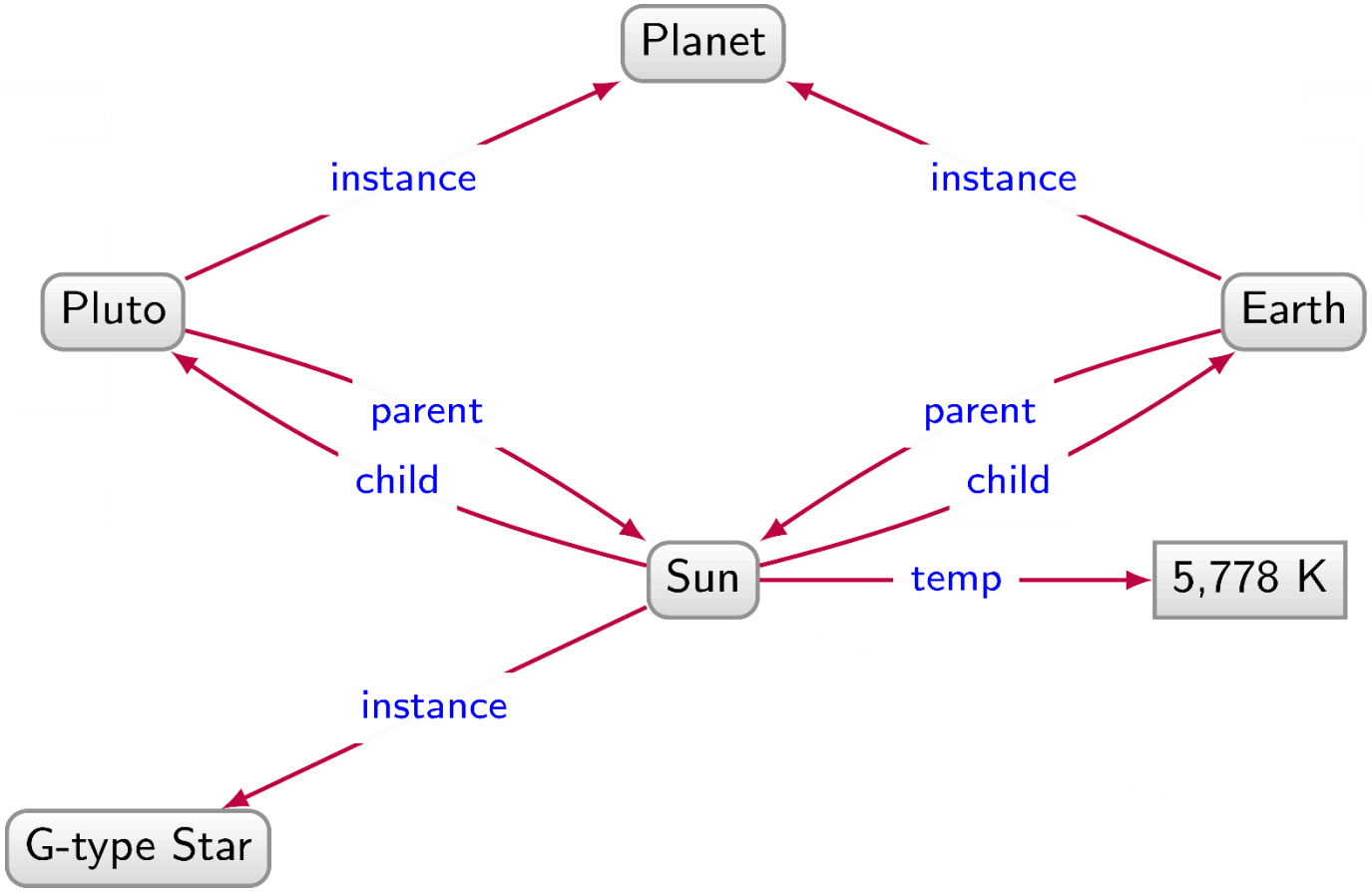

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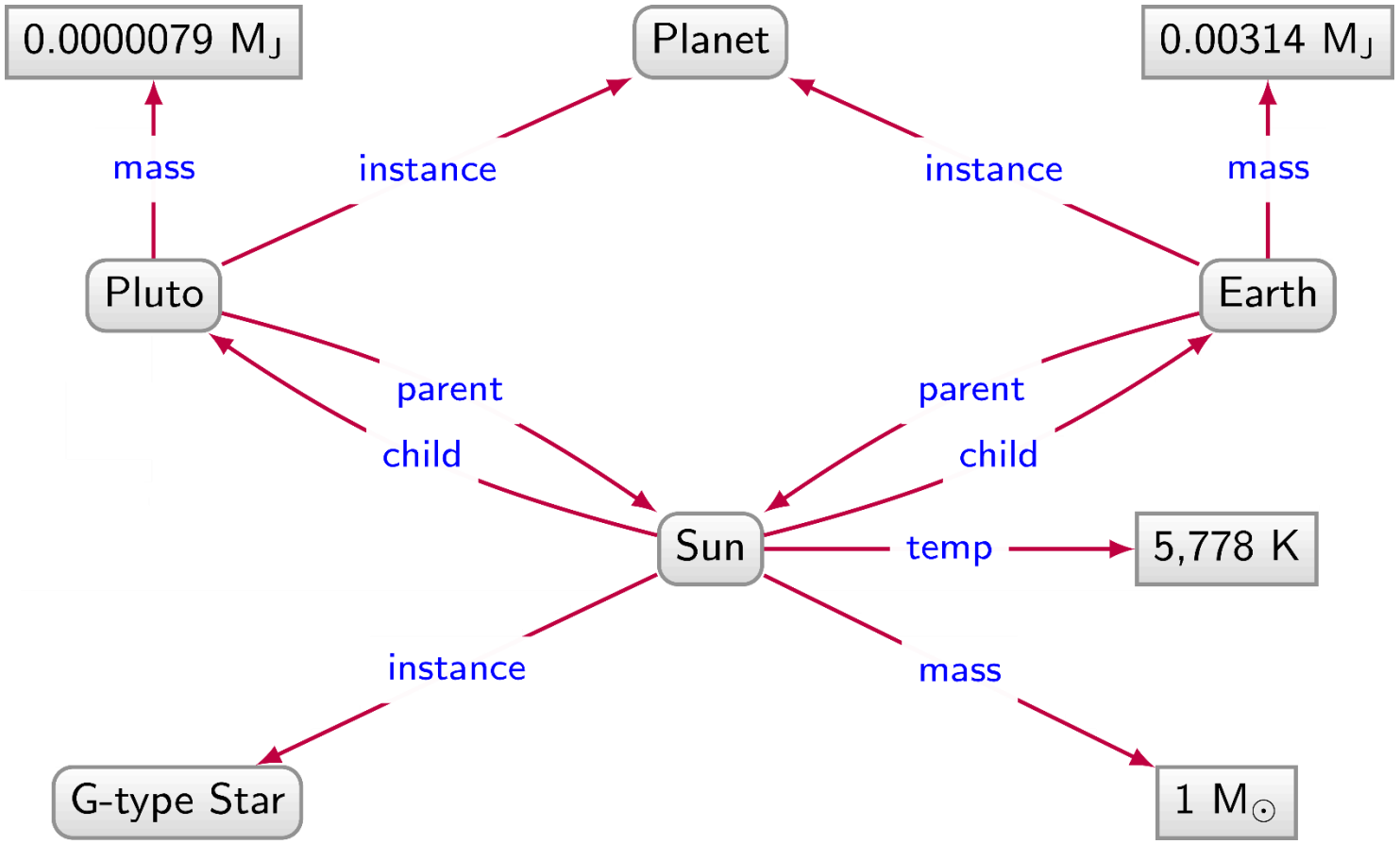
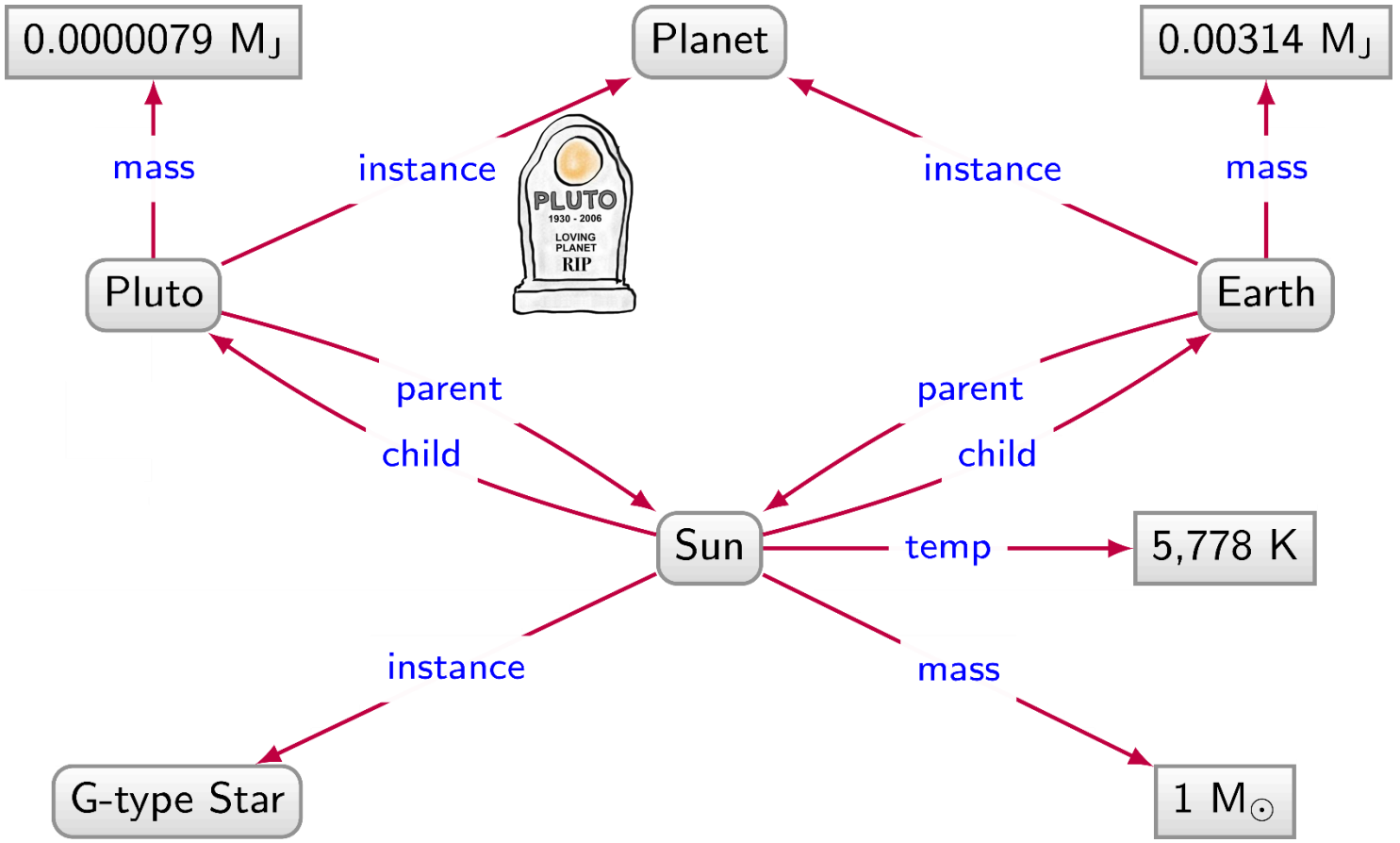
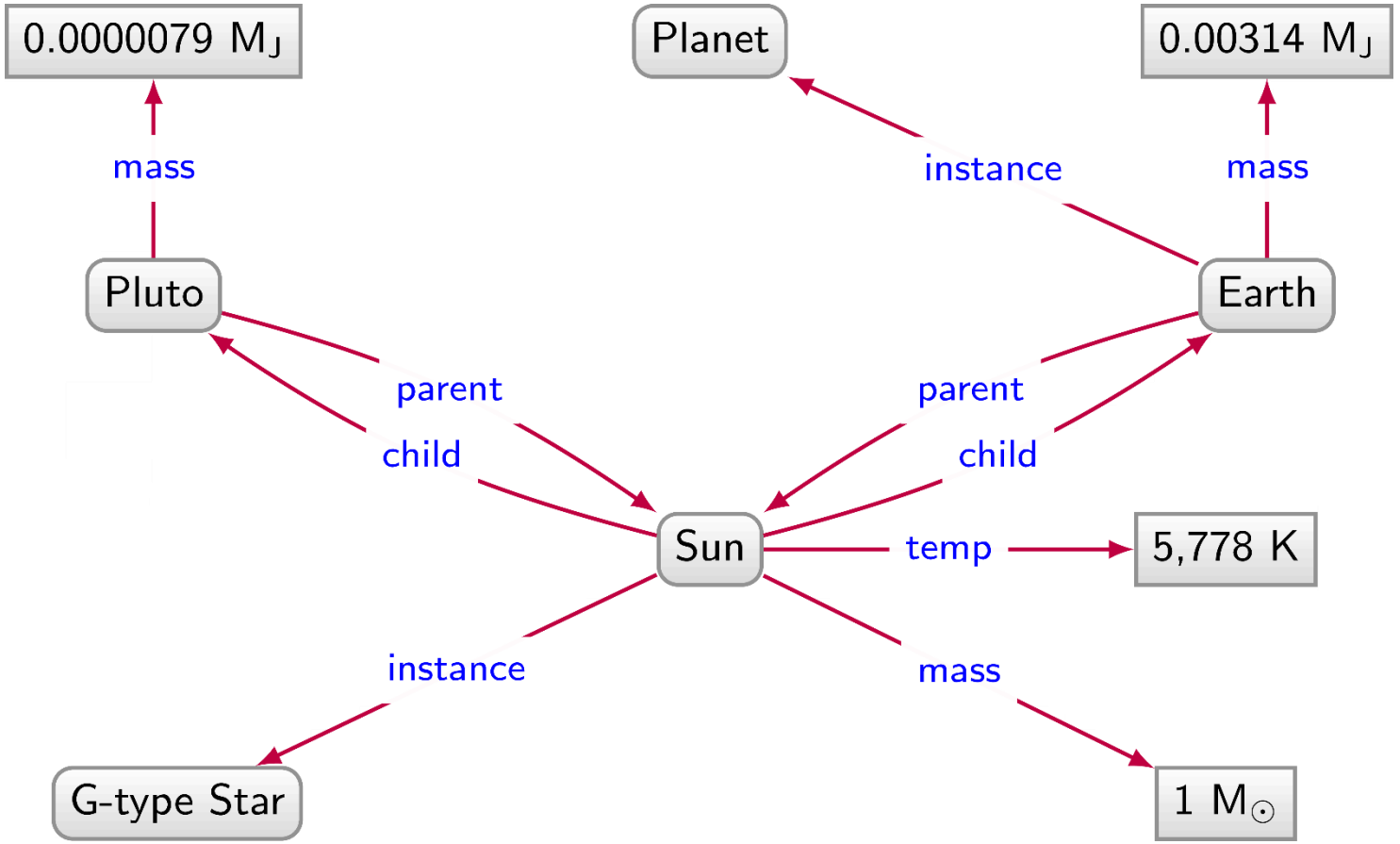


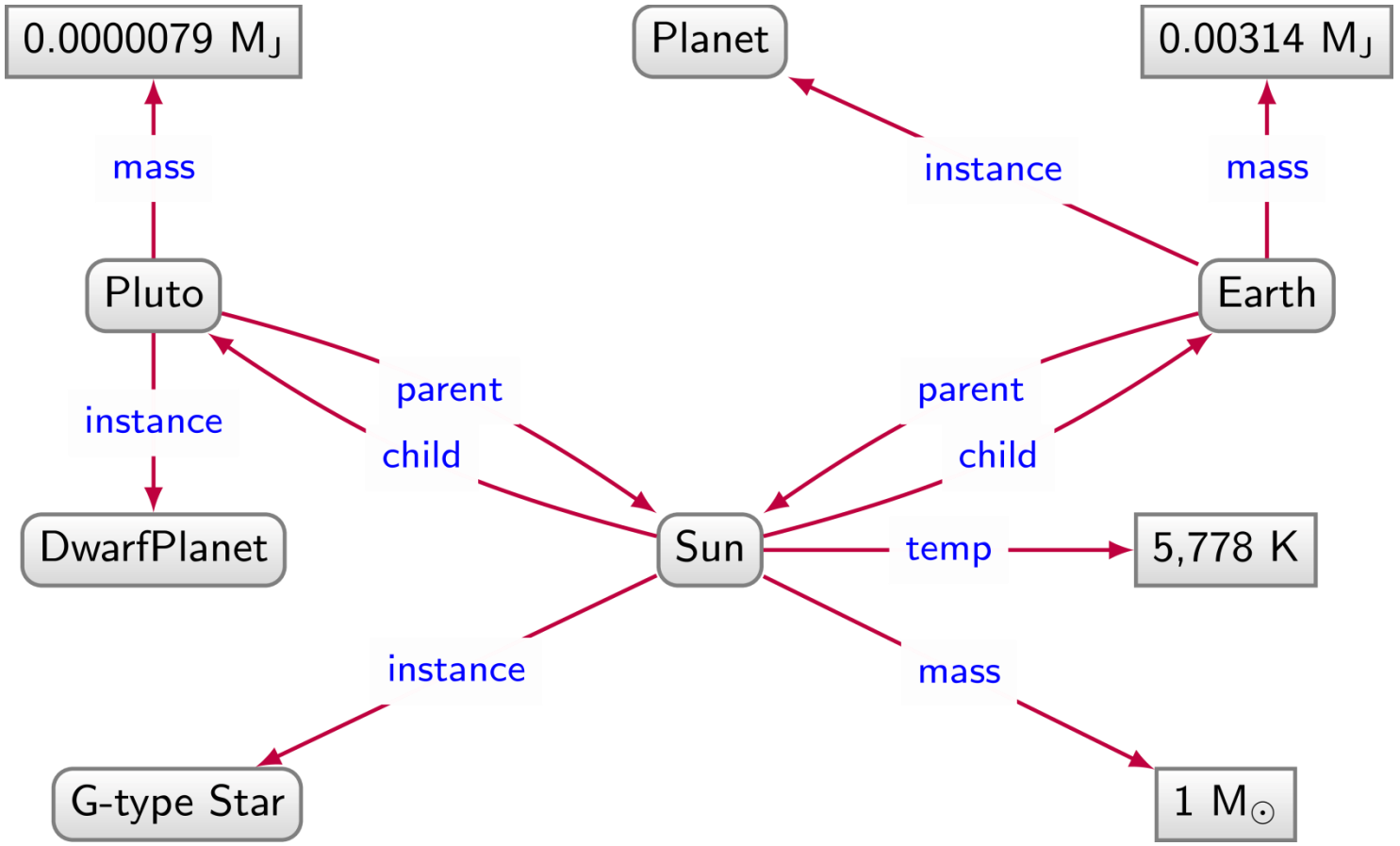
Base de Datos de Grafos de Planetas



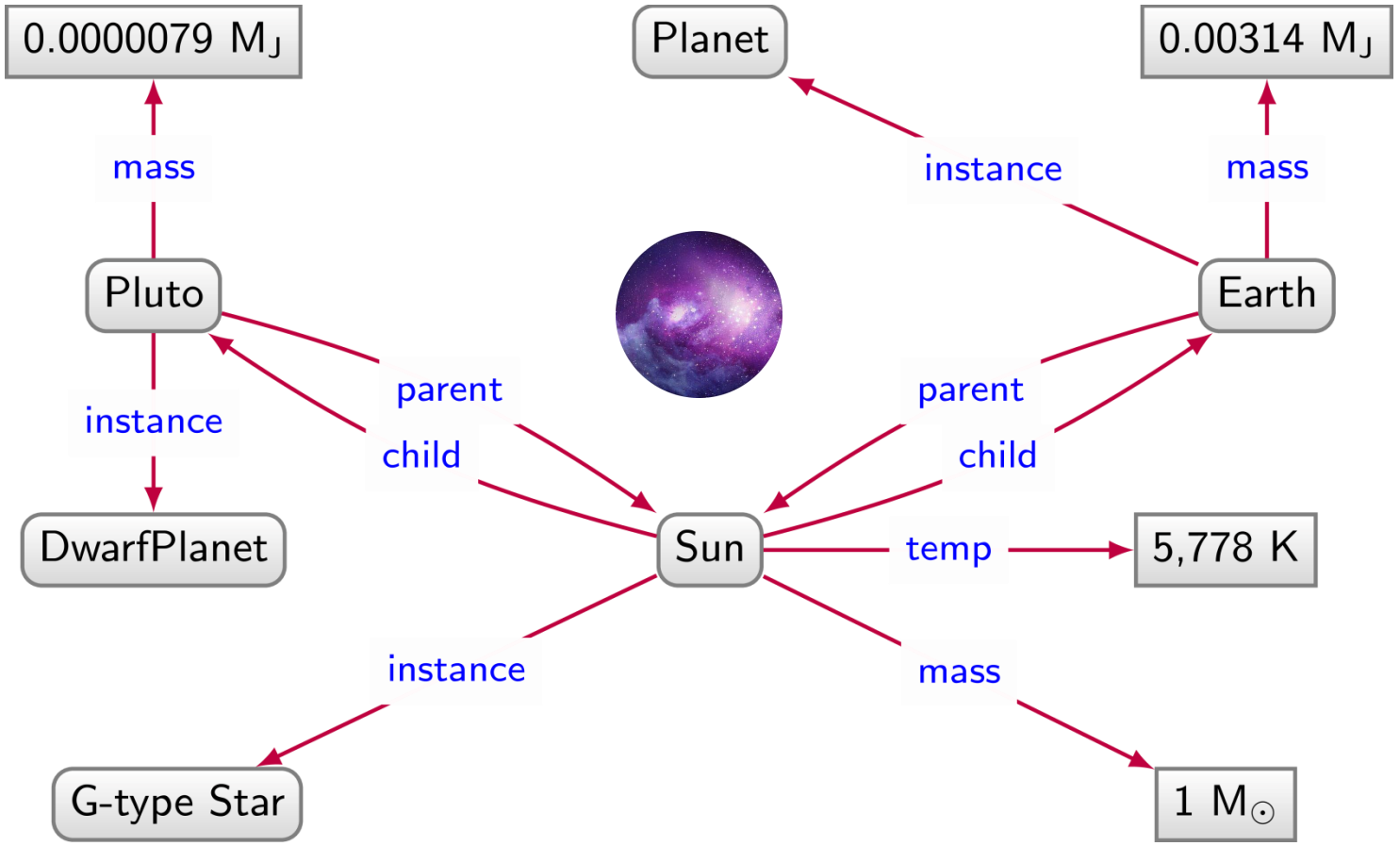
Base de Datos de Grafos de Planetas



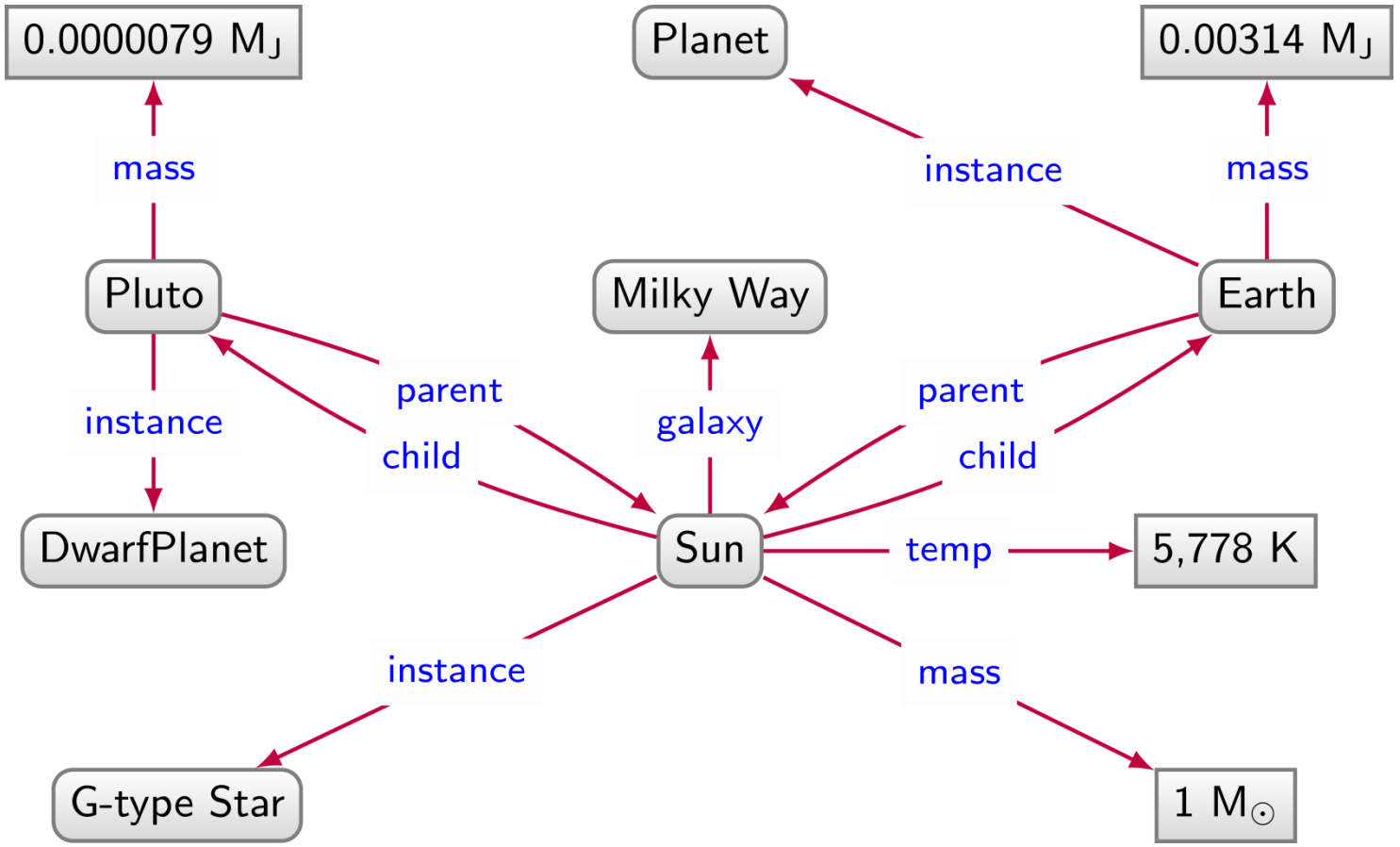
Base de Datos de Grafos de Planetas



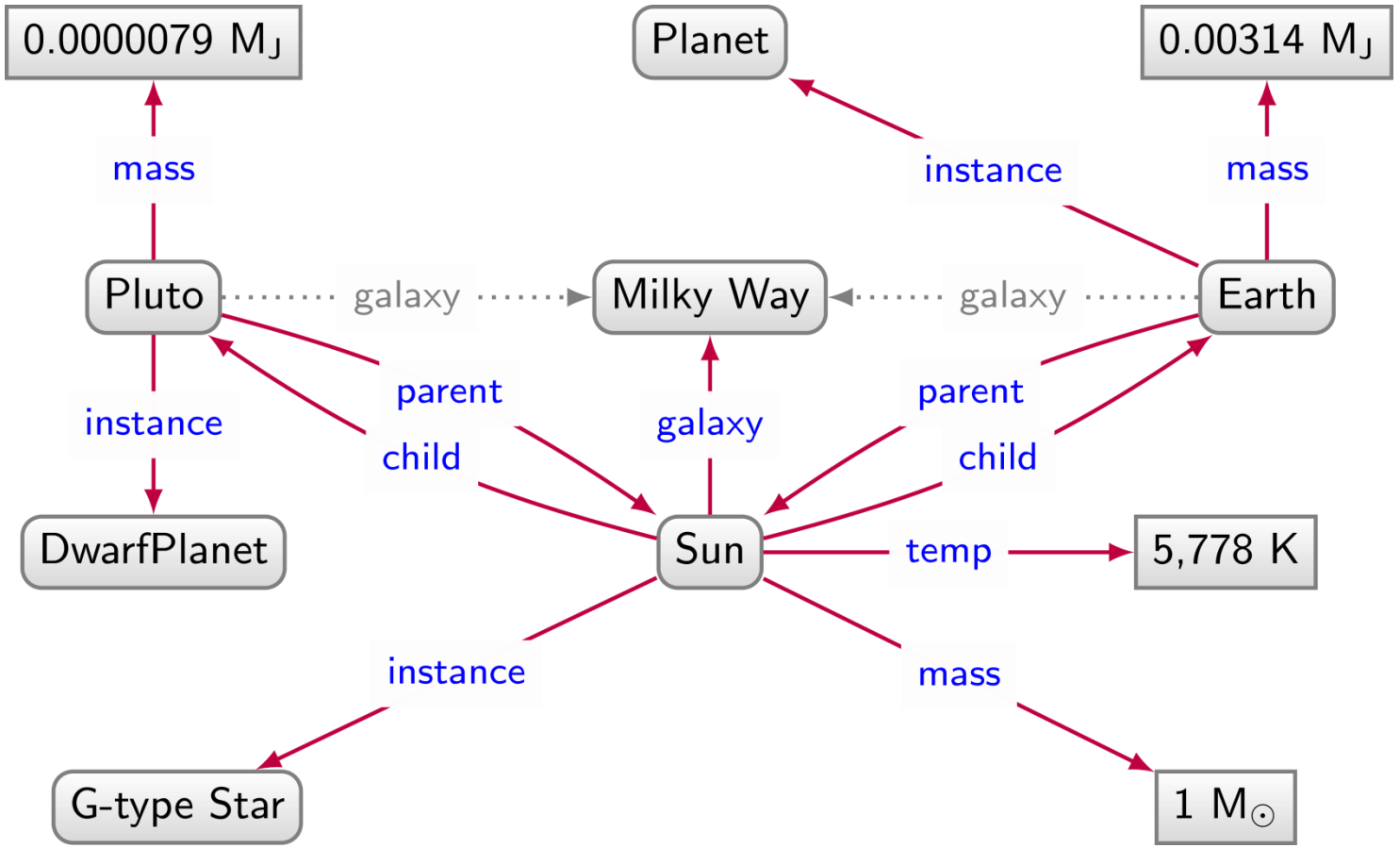
Base de Datos de Grafos de Planetas



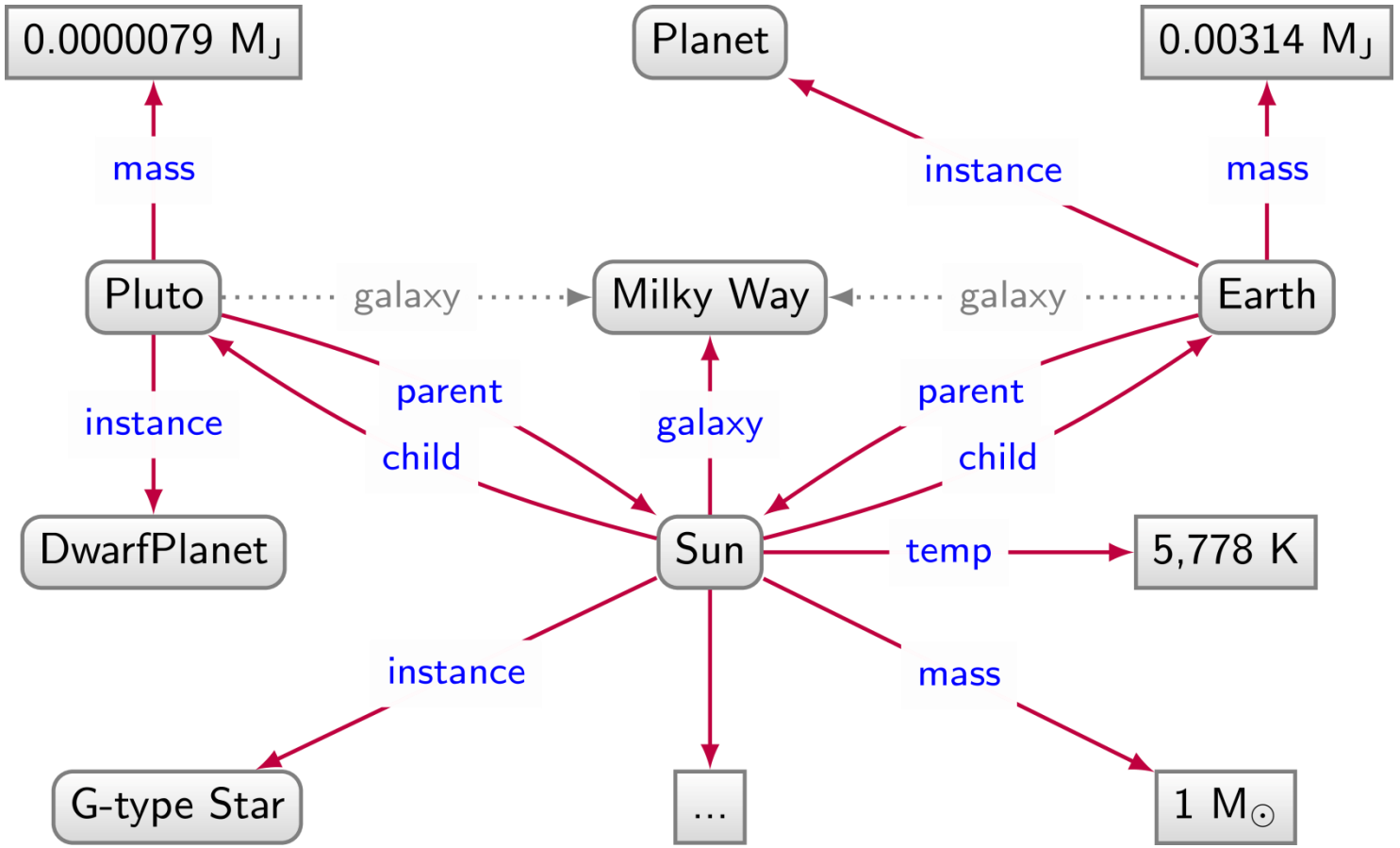
Base de Datos de Grafos de Planetas



Base de Datos de Grafos de Planetas



Base de Datos de Grafos de Planetas

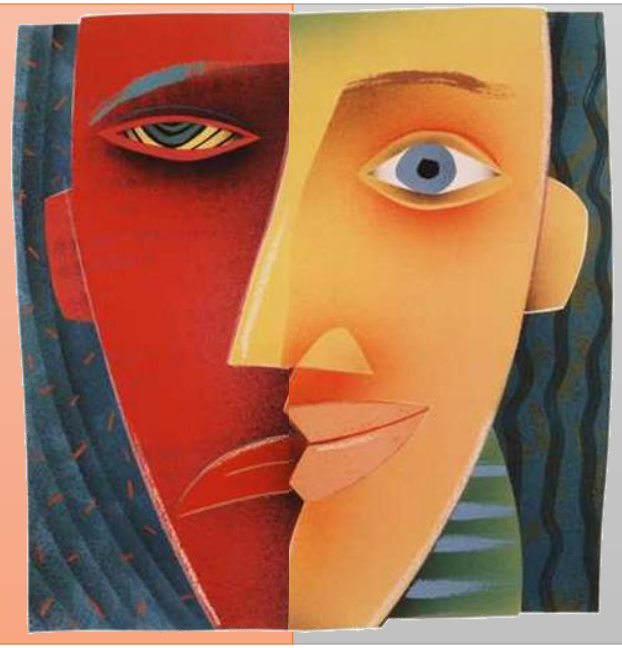


Bases de Datos Relacionales: pros y cons

Planet

name	dist	radius	grav	days	years	temp	ring
Mercury	0.39	0.38	2.8	58.646	0.241	440	false
Venus	0.72	0.95	8.9	-243.019	0.615	730	false

Necesitamos imponer
estructura (esquema)
desde el inicio



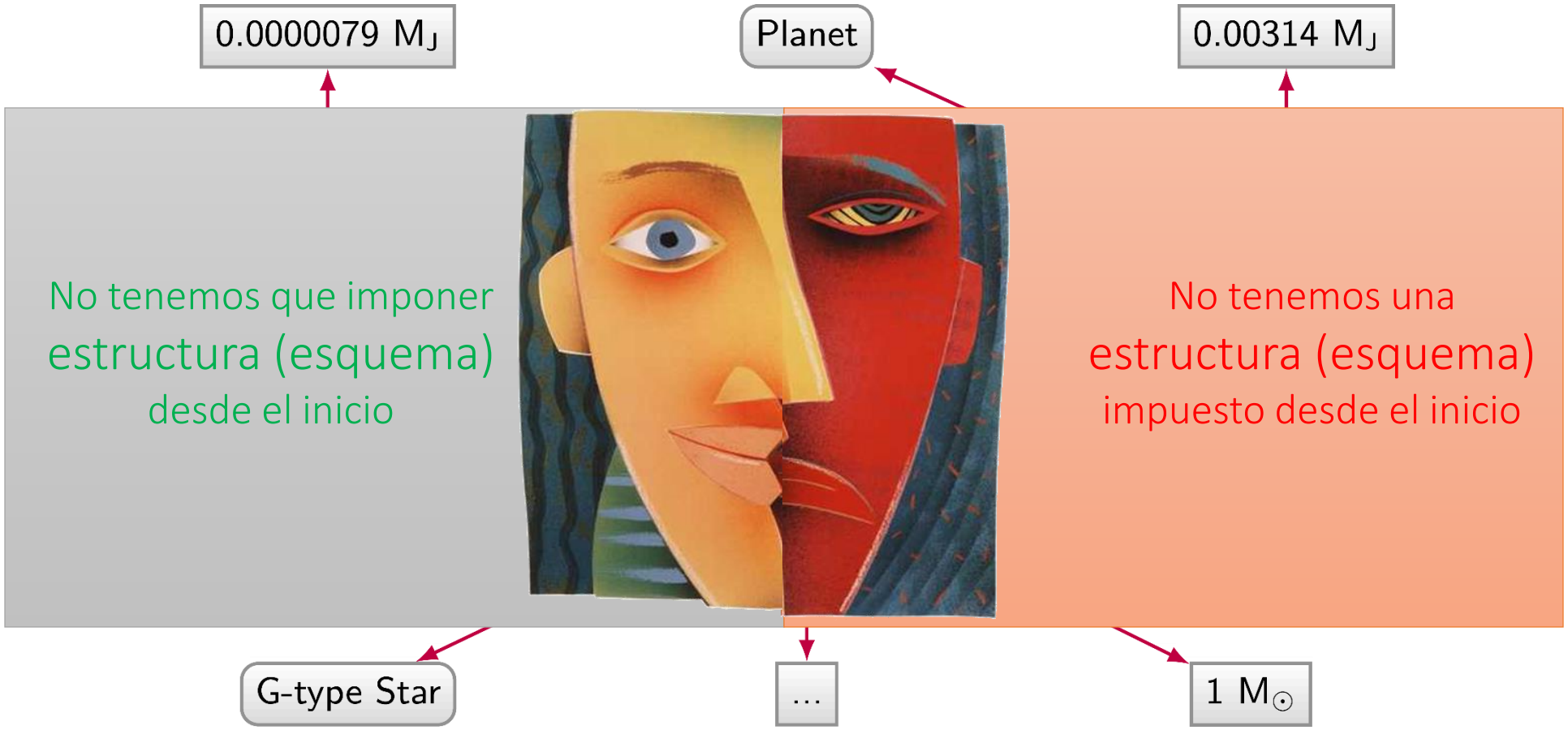
Tenemos una
estructura (esquema)
impuesto desde el inicio

Europa	Jupiter
Io	Jupiter
Titan	Saturn
Triton	Neptune
Luna	Earth
Oberon	Uranus
Charon	Pluto
...	...

Europa	Galileo Galilei
Io	Galileo Galilei
Titan	Christiaan Huygens
Triton	William Lassell
Oberon	William Herschel
...	...

Europa	1610
Io	1610
Titan	1655
Triton	1846
Oberon	1787
Charon	1978
...	...

Bases de Datos de Grafos: pros and cons



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Ignacio Sánchez
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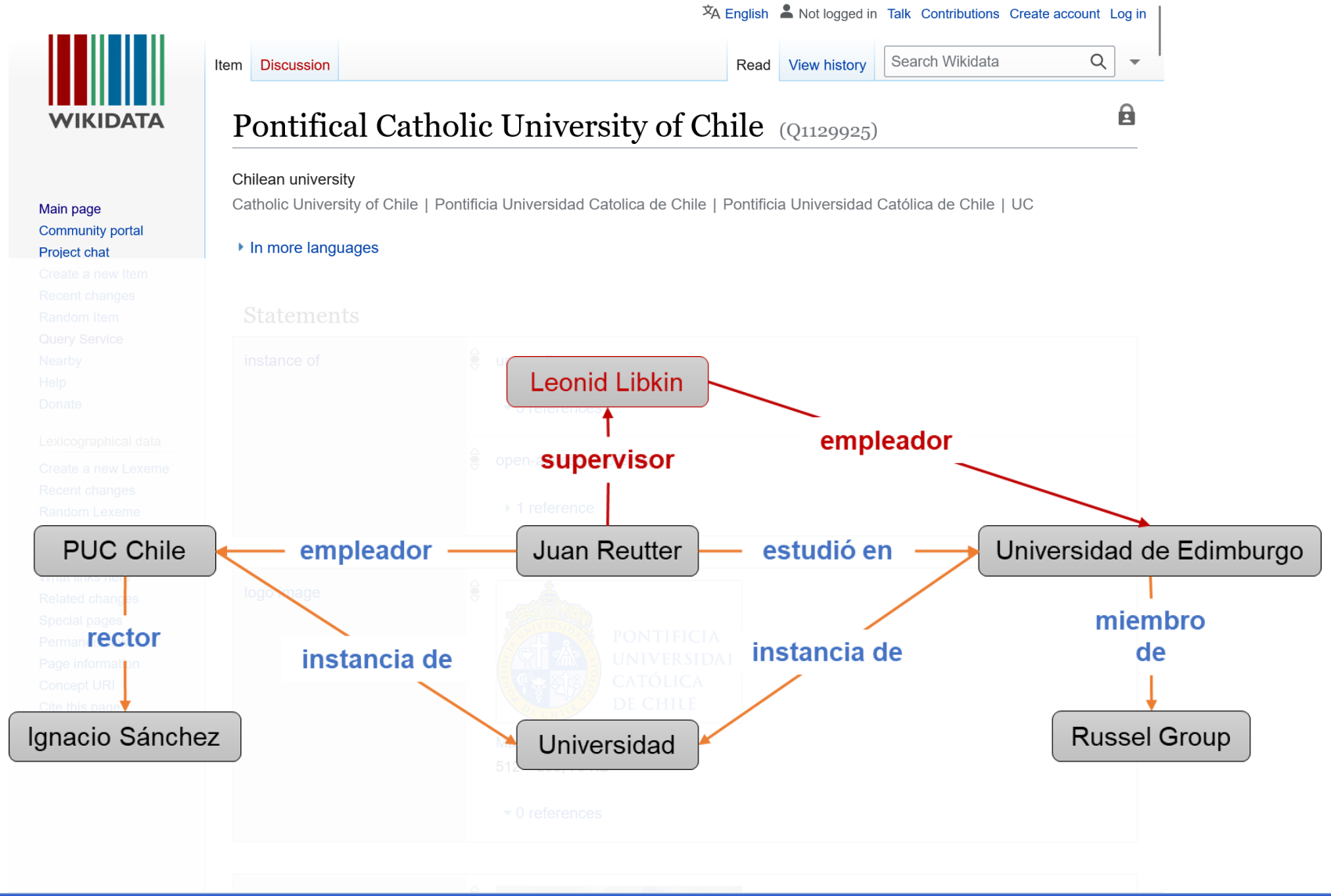
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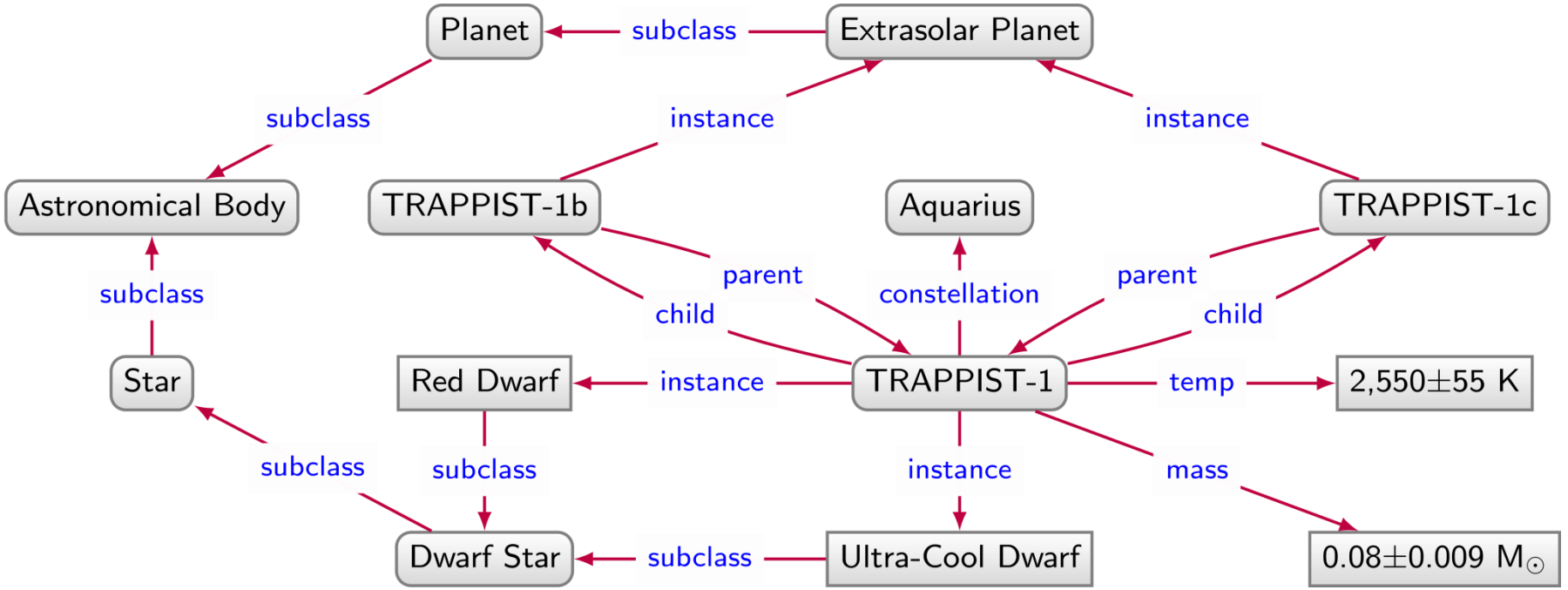
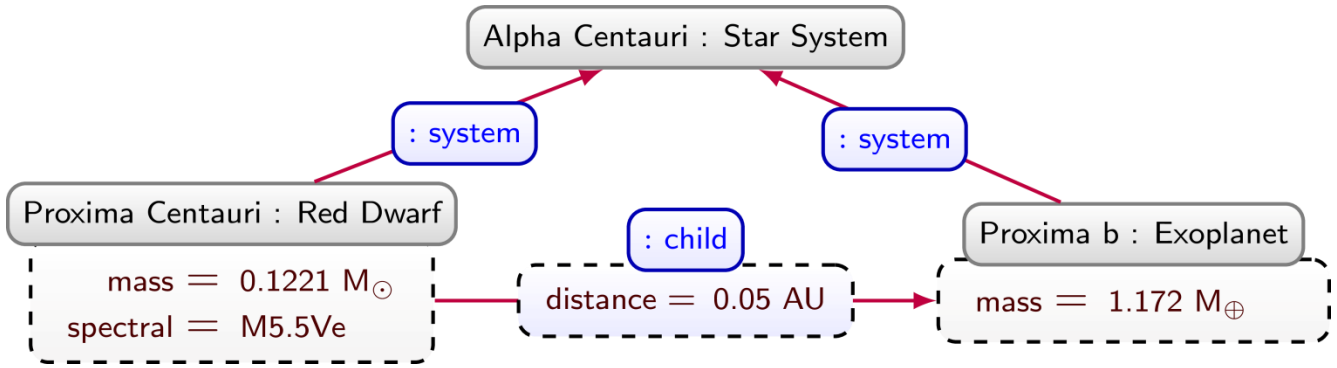
Leonid Libkin
supervisor
empleador
PUC Chile
empleador
Juan Reutter
estudió en
Universidad de Edimburgo
rector
instancia de
instancia de
miembro de
Ignacio Sánchez
Universidad
Russel Group

Modelos de Grafo

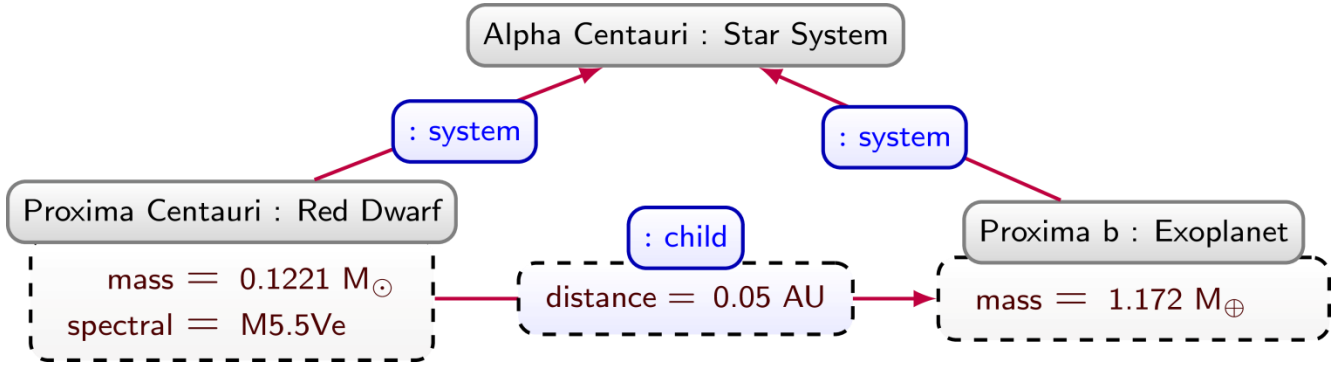
Grafo con Aristas Dirigidas y Etiquetadas
(DEL graph)

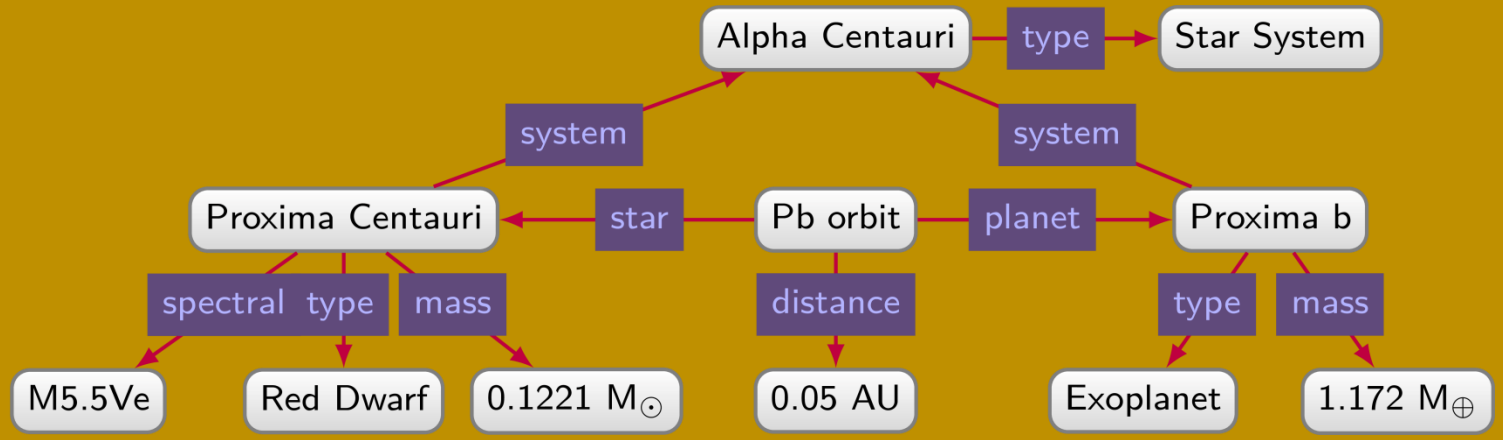


Grafo de Propiedades



Grafo de Propiedades



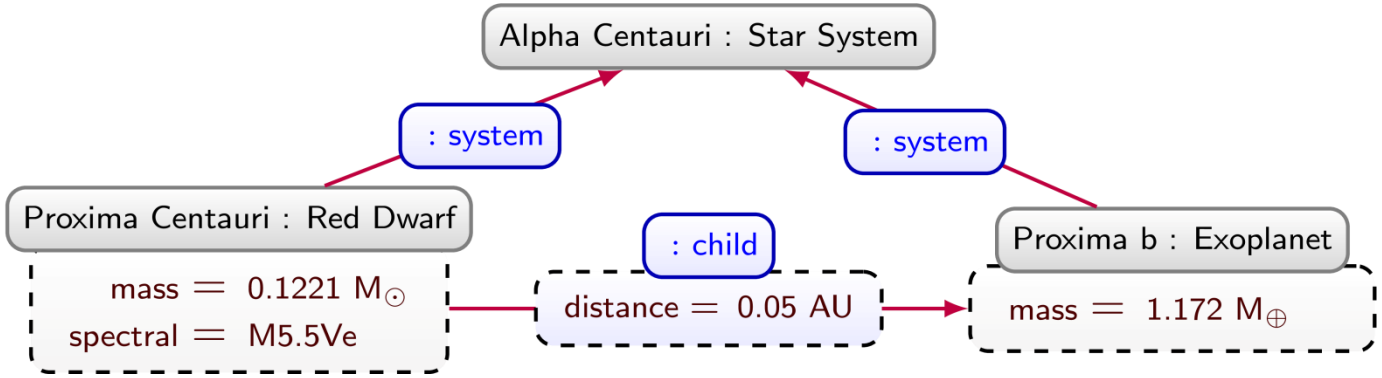


Del graph

1.- Semántica en Grafos de Propiedades

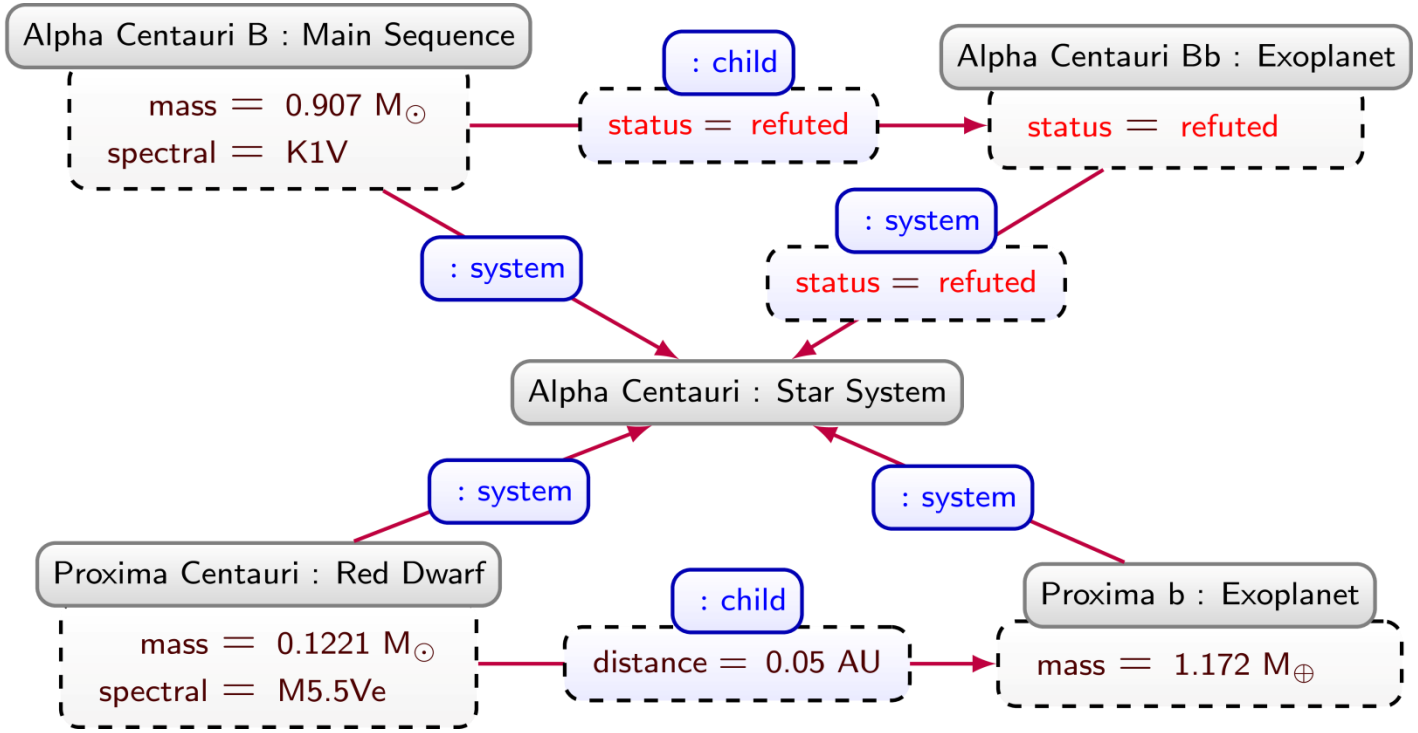
Property graph semantics

How should we define the semantics of property graphs?



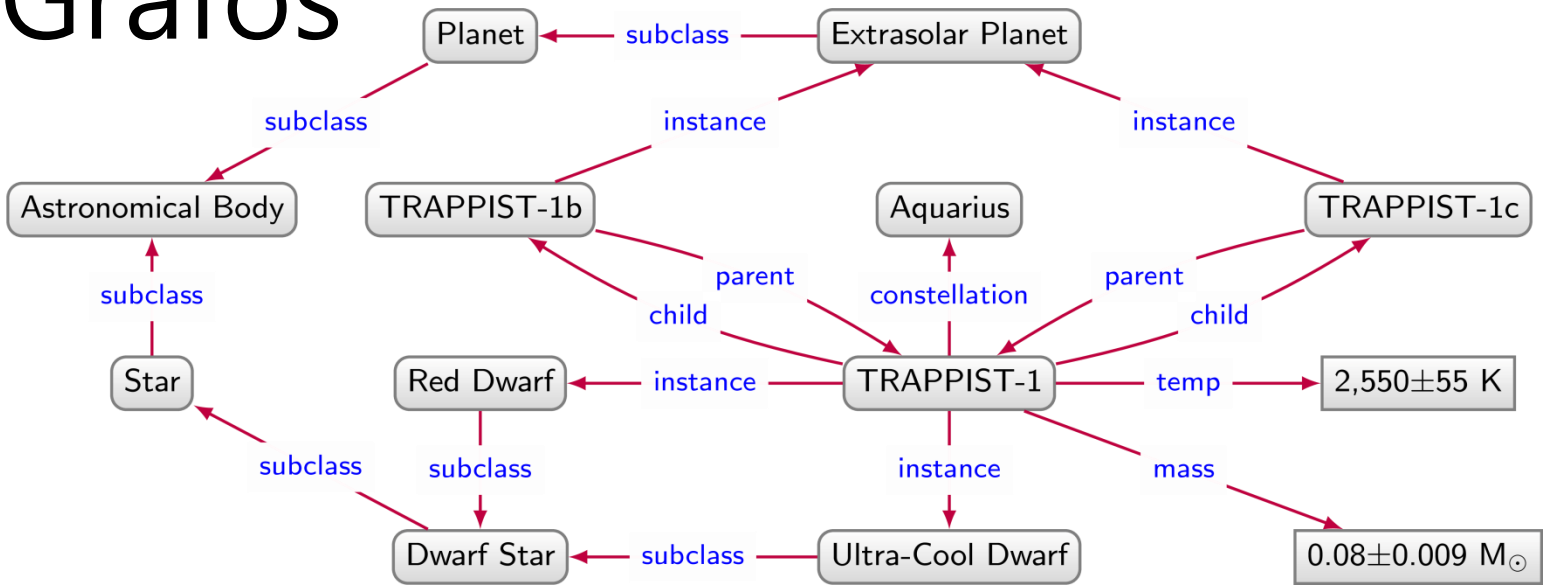
Property graph semantics

How should we define the semantics of property graphs?

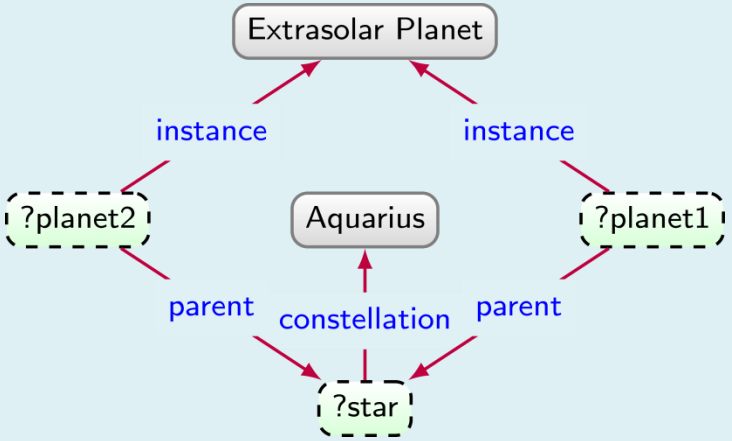


Graph Queries

Patrones de Grafos



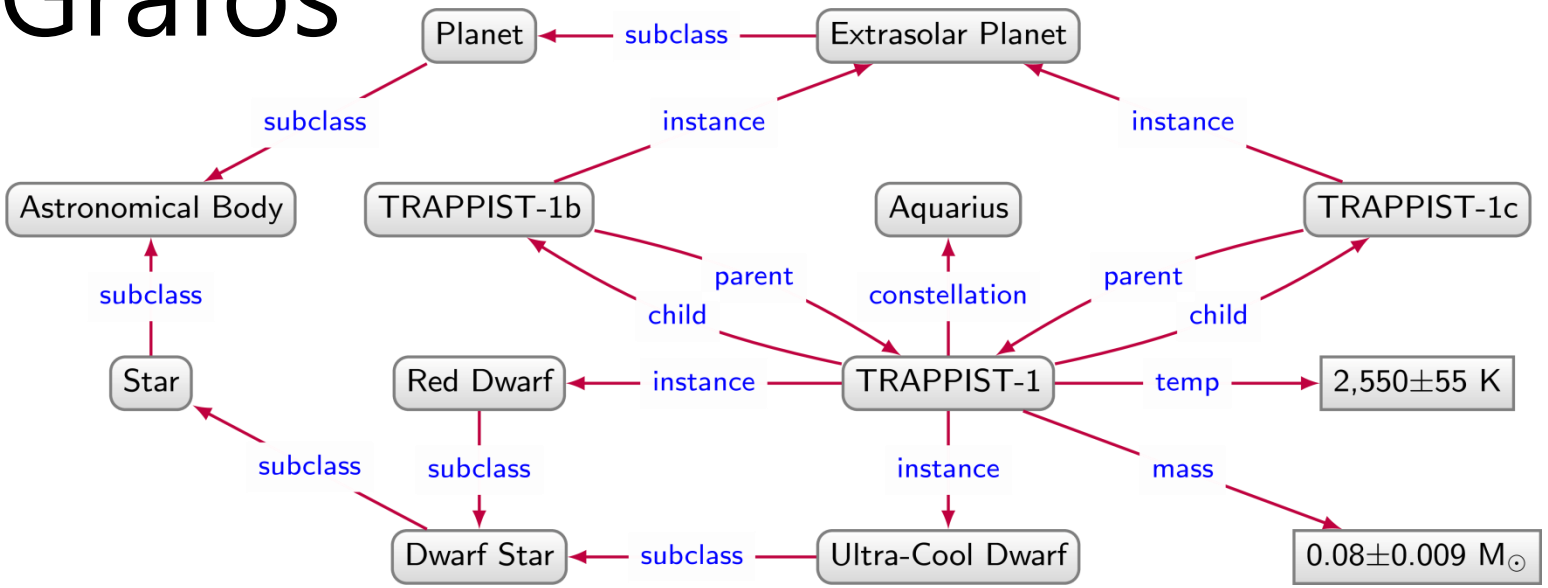
Encontrar pares de exoplanetas orbitando la misma estrella en Acuario



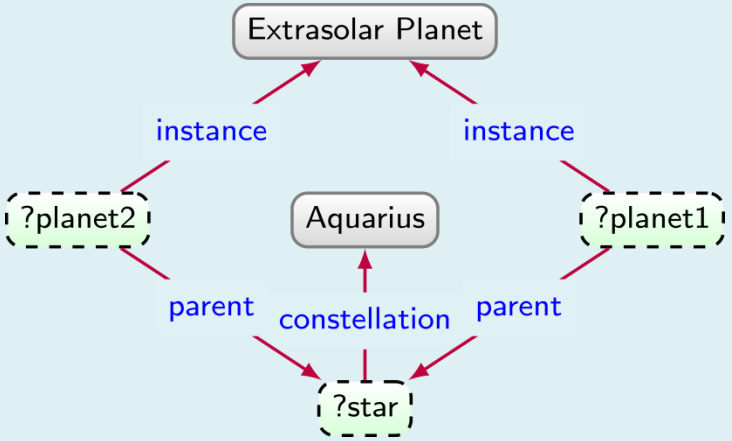
Semántica: Homomorfismo

?star	?planet1	?planet2
TRAPPIST-1	TRAPPIST-1b	TRAPPIST-1c
TRAPPIST-1	TRAPPIST-1b	TRAPPIST-1b
TRAPPIST-1	TRAPPIST-1c	TRAPPIST-1b
TRAPPIST-1	TRAPPIST-1c	TRAPPIST-1c

Patrones de Grafos



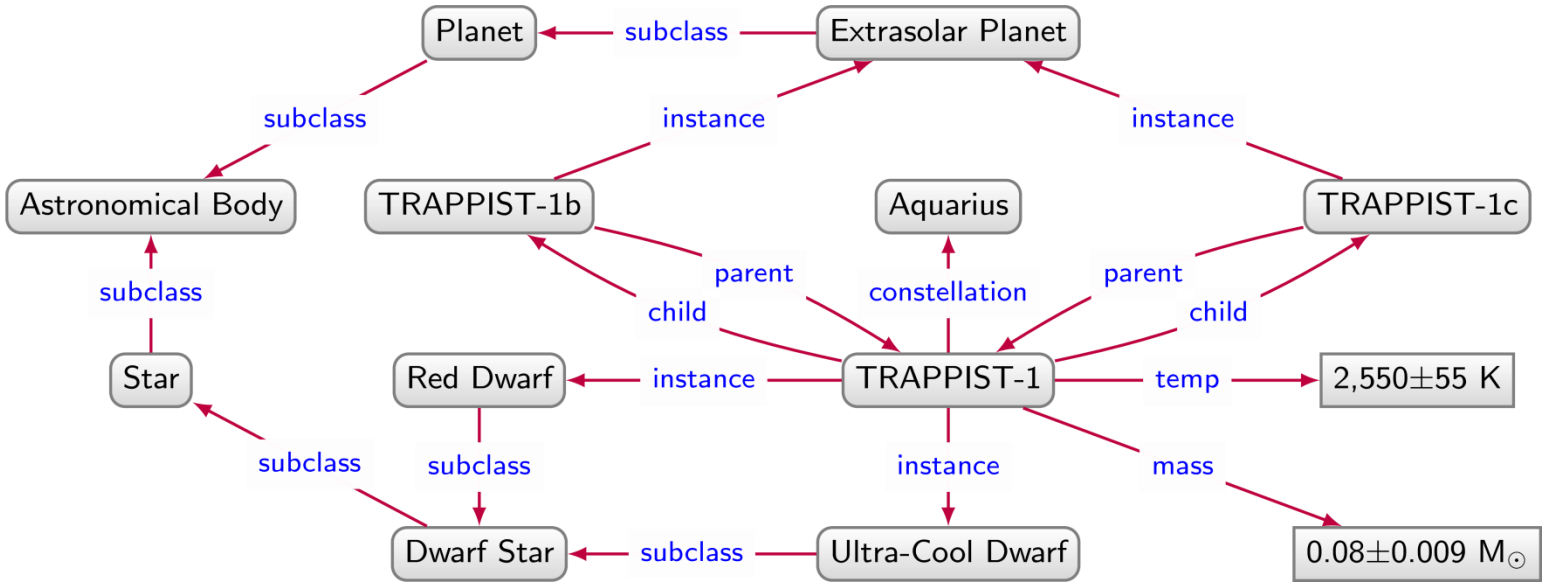
Encontrar pares de exoplanetas orbitando la misma estrella en Acuario



Semántica: Isomorfismo

?star	?planet1	?planet2
TRAPPIST-1	TRAPPIST-1b	TRAPPIST-1c
TRAPPIST-1	TRAPPIST-1b	TRAPPIST-1b
TRAPPIST-1	TRAPPIST-1c	TRAPPIST-1b
TRAPPIST-1	TRAPPIST-1c	TRAPPIST-1c

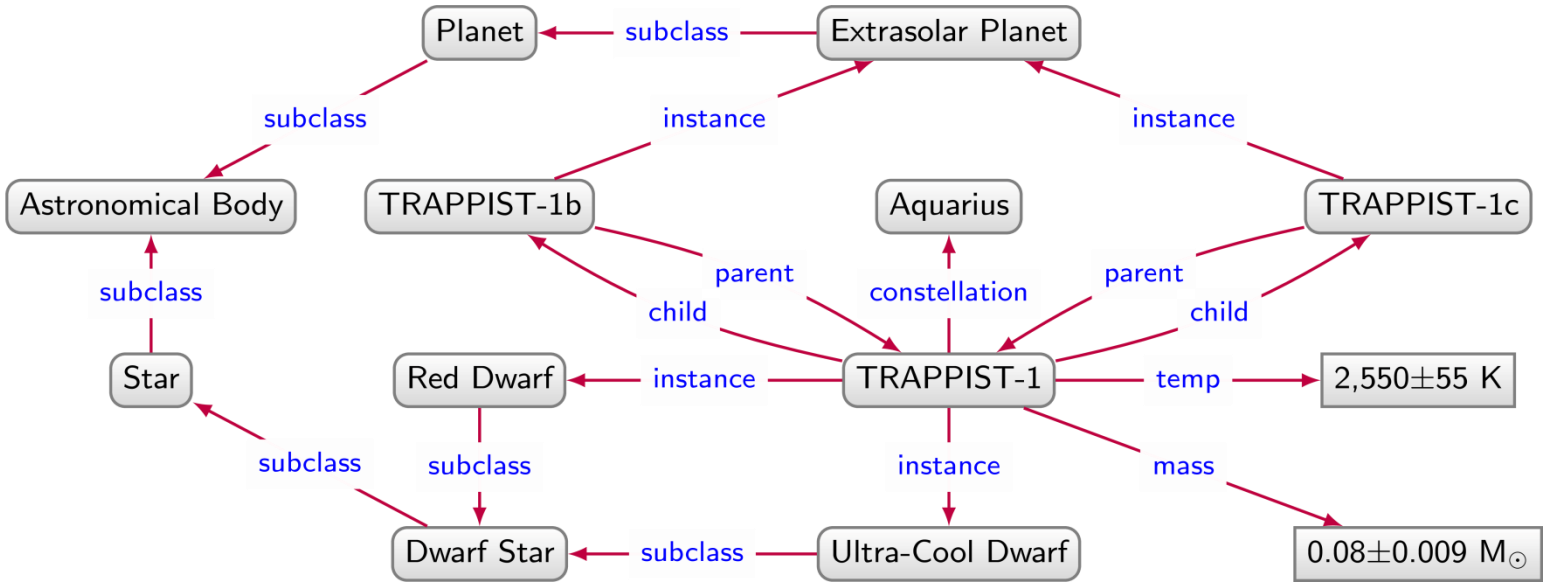
Patrones Complejos de Grafos



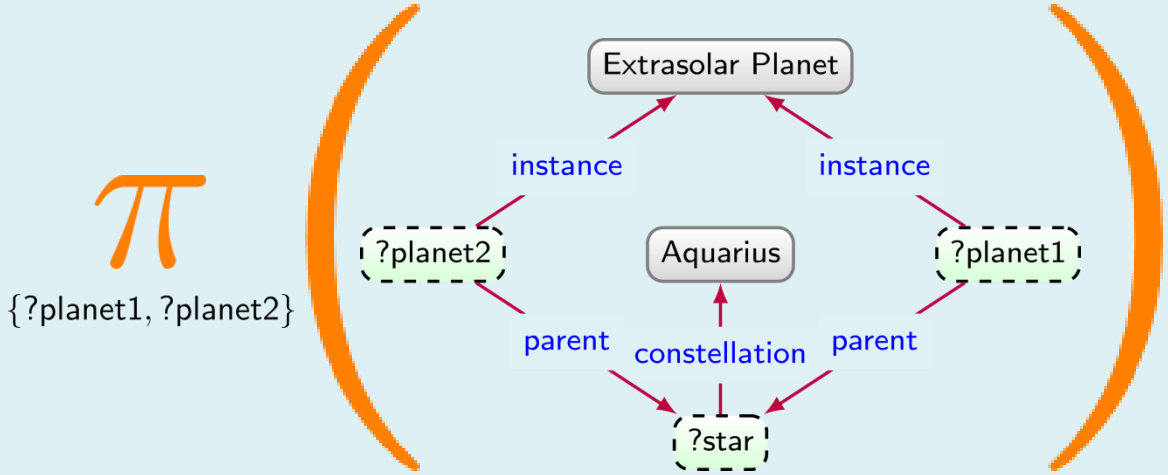
$\bowtie$ $\setminus$ σ π $\cup$

Patrones de Grafos + Álgebra Relacional

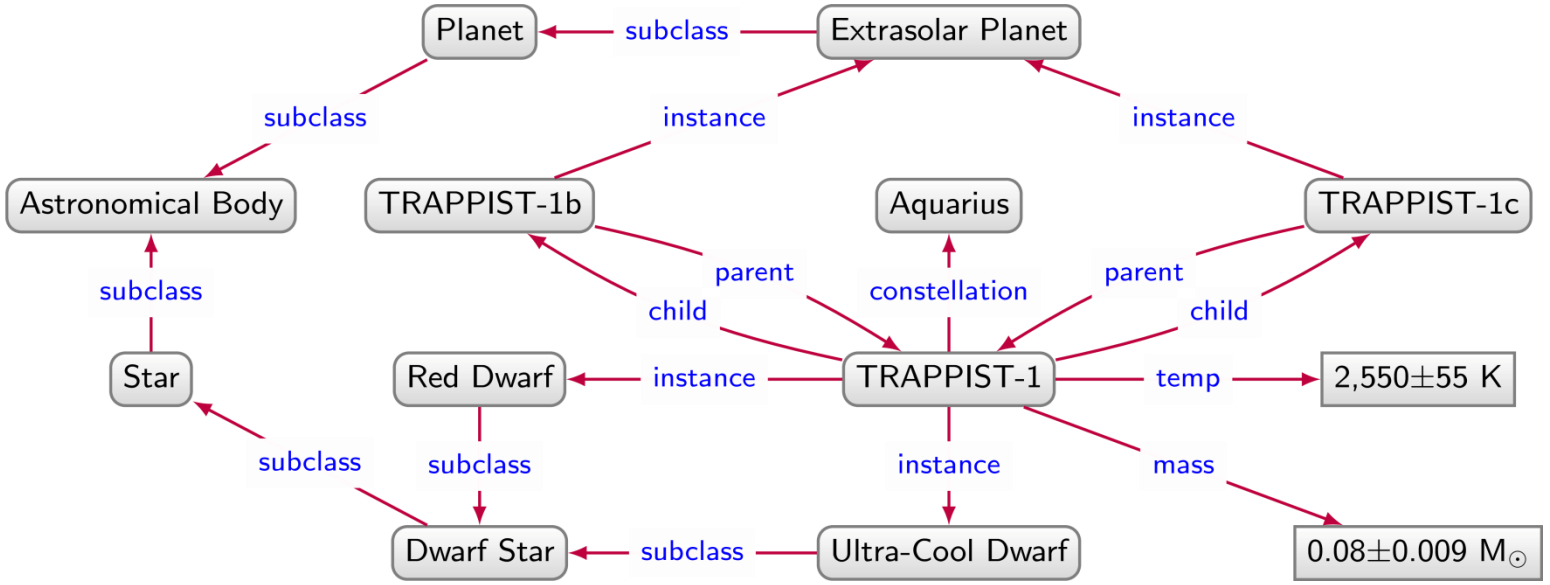
Patrones Complejos de Grafos



Encontrar pares de exoplanetas orbitando la misma estrella en Acuario



Patrones Complejos de Grafos



Encontrar pares de exoplanetas orbitando la misma estrella en Acuario

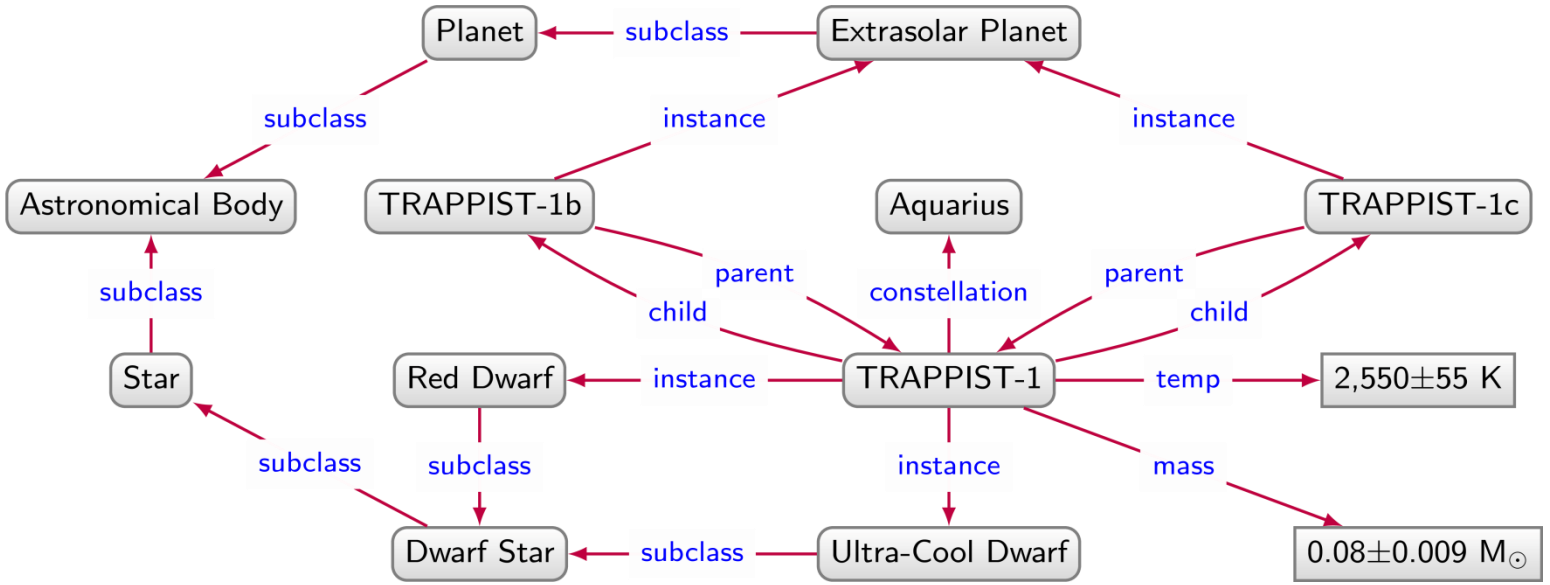
$\pi_{\{?planet1,\ ?planet2\}}$

?star	?planet1	?planet2
TRAPPIST-1	TRAPPIST-1b	TRAPPIST-1c
TRAPPIST-1	TRAPPIST-1b	TRAPPIST-1b
TRAPPIST-1	TRAPPIST-1c	TRAPPIST-1b
TRAPPIST-1	TRAPPIST-1c	TRAPPIST-1c

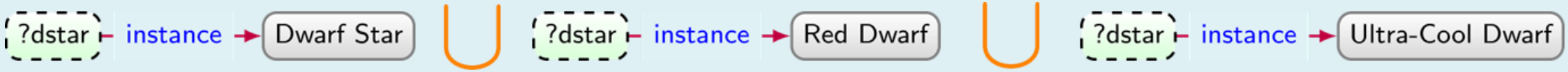
=

?planet1	?planet2
TRAPPIST-1b	TRAPPIST-1c
TRAPPIST-1b	TRAPPIST-1b
TRAPPIST-1c	TRAPPIST-1b
TRAPPIST-1c	TRAPPIST-1c

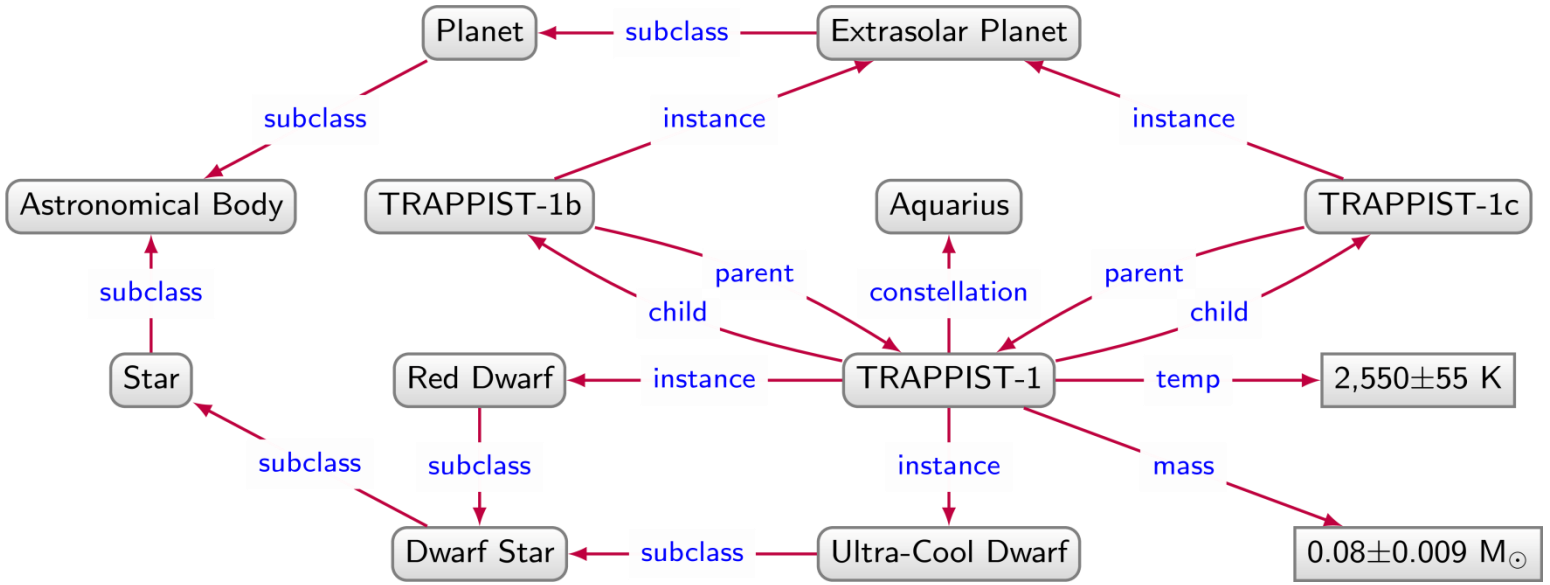
Patrones Complejos de Grafos



Encontrar instancias de Dwarf Star



Patrones Complejos de Grafos



Encontrar instancias de Dwarf Star

?dtar

∪

?dtar
TRAPPIST-1

∪

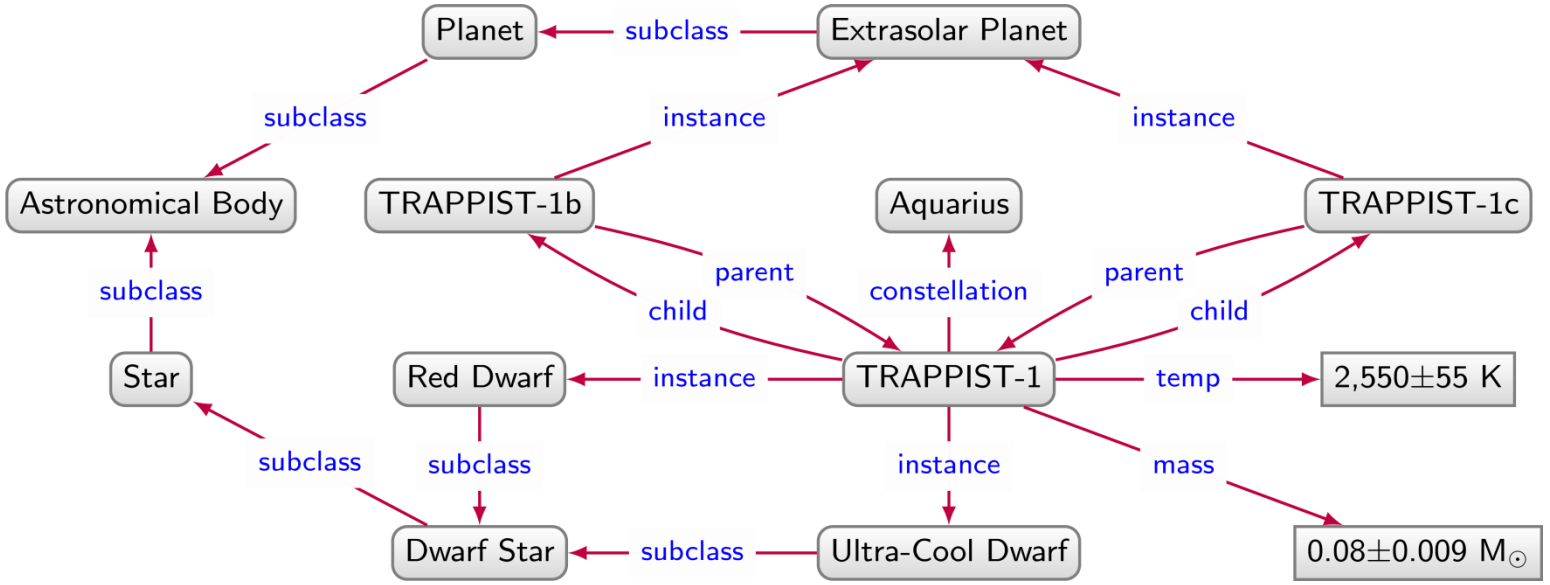
?dtar
TRAPPIST-1

=

?dtar
TRAPPIST-1
TRAPPIST-1

Semántica: Bag

Patrones Complejos de Grafos



Encontrar instancias de Dwarf Star

?dtar

∪

?dtar
TRAPPIST-1

∪

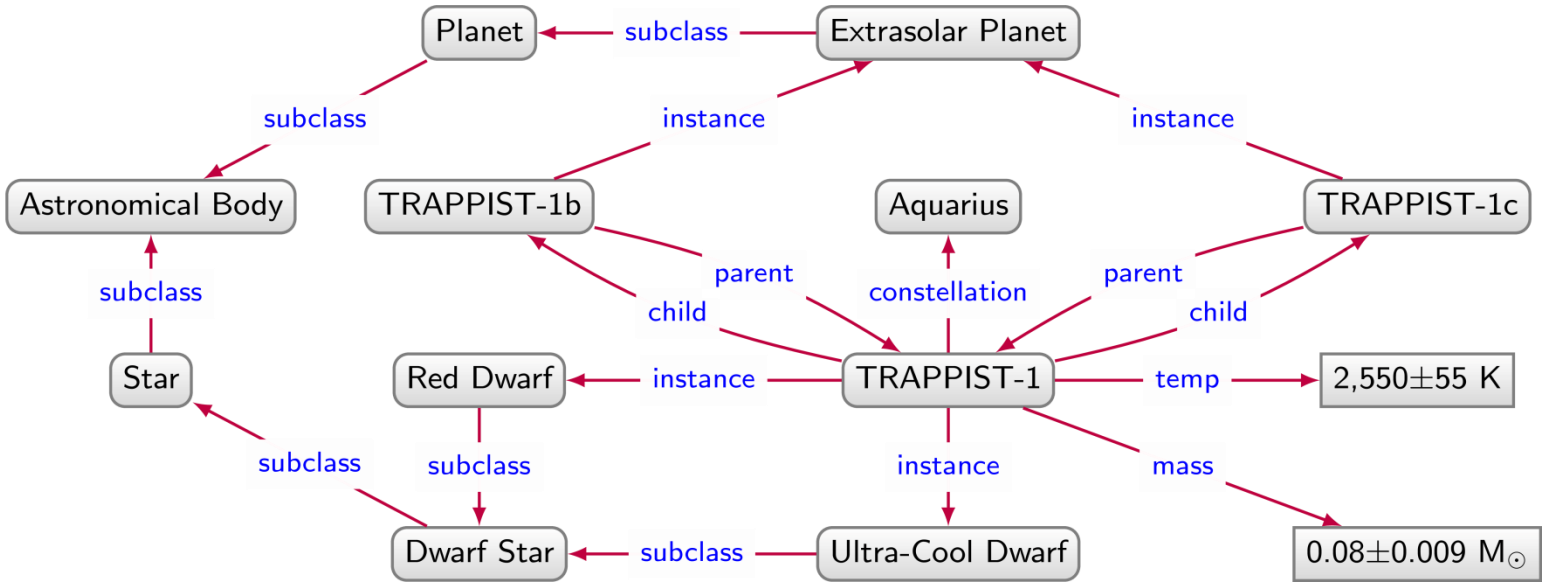
?dtar
TRAPPIST-1

=

?dtar
TRAPPIST-1
TRAPPIST-1

Semántica: Set

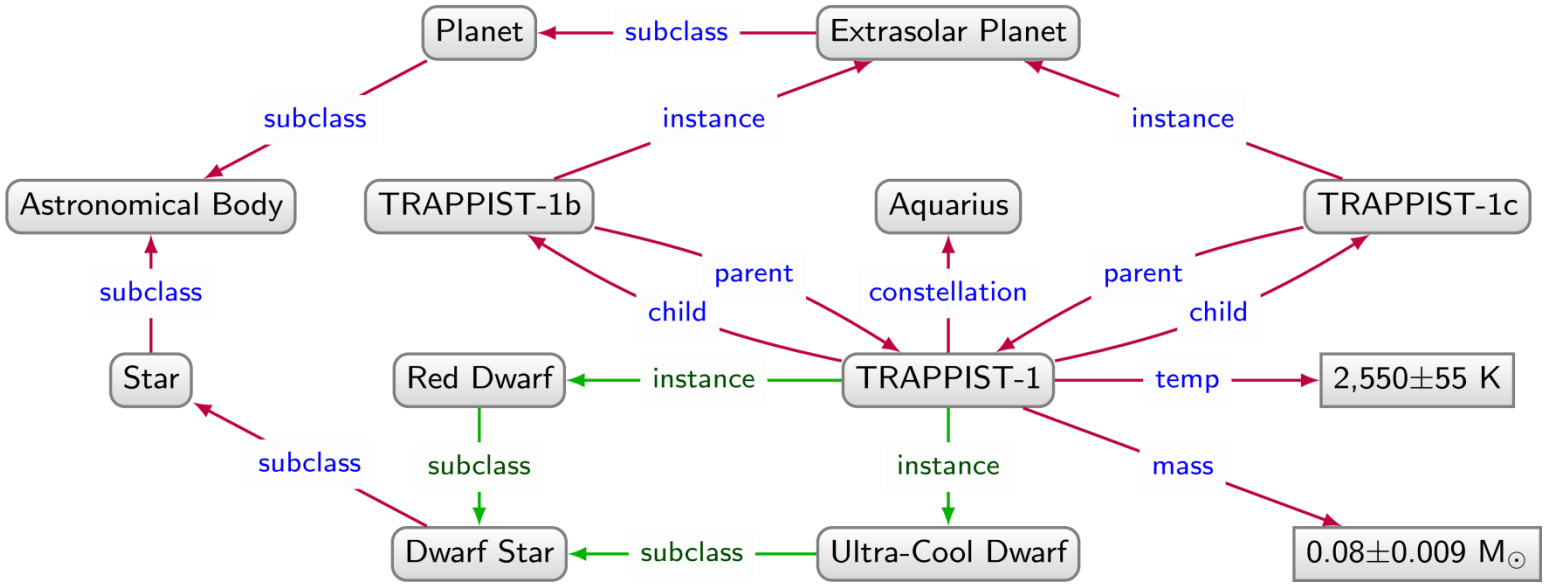
Patrones Navegacionales de Grafos



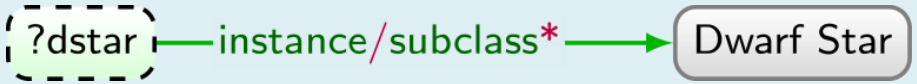
* | / —

Patrones de Grafos + Consultas Regulares de Caminos

Consultas Regulares de Caminos

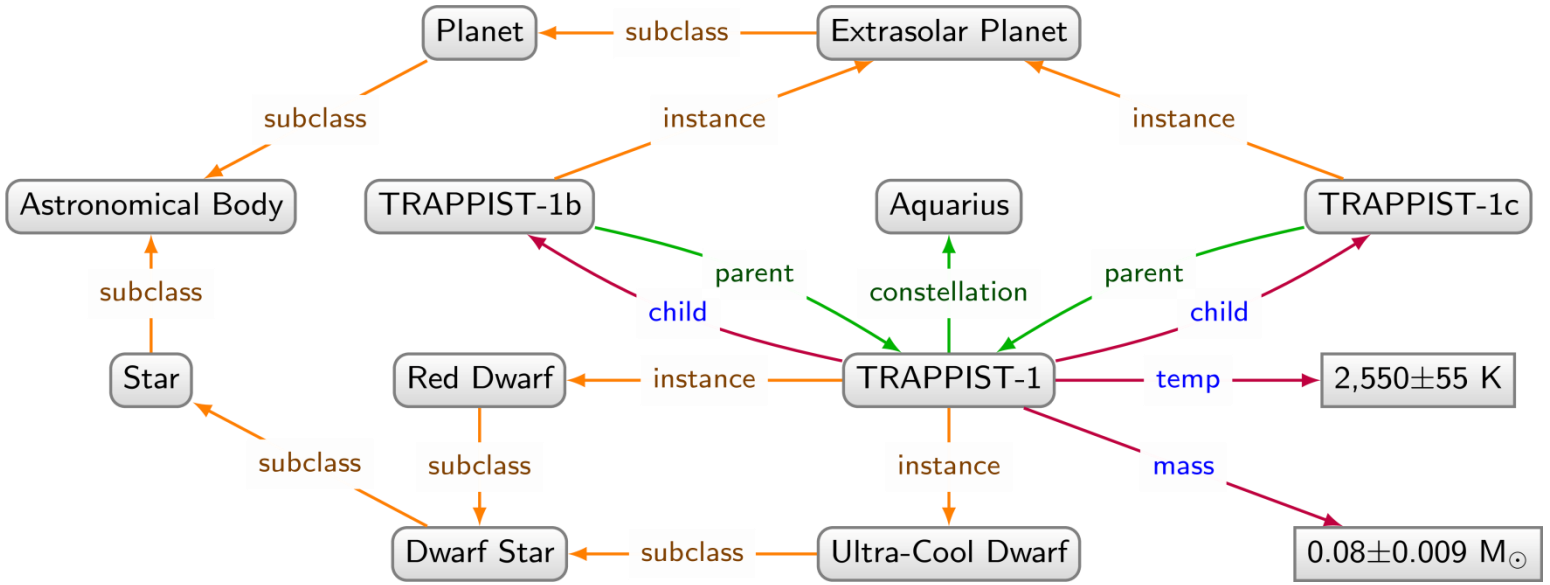


Encontrar instancias de Dwarf Star



?dtar
TRAPPIST-1

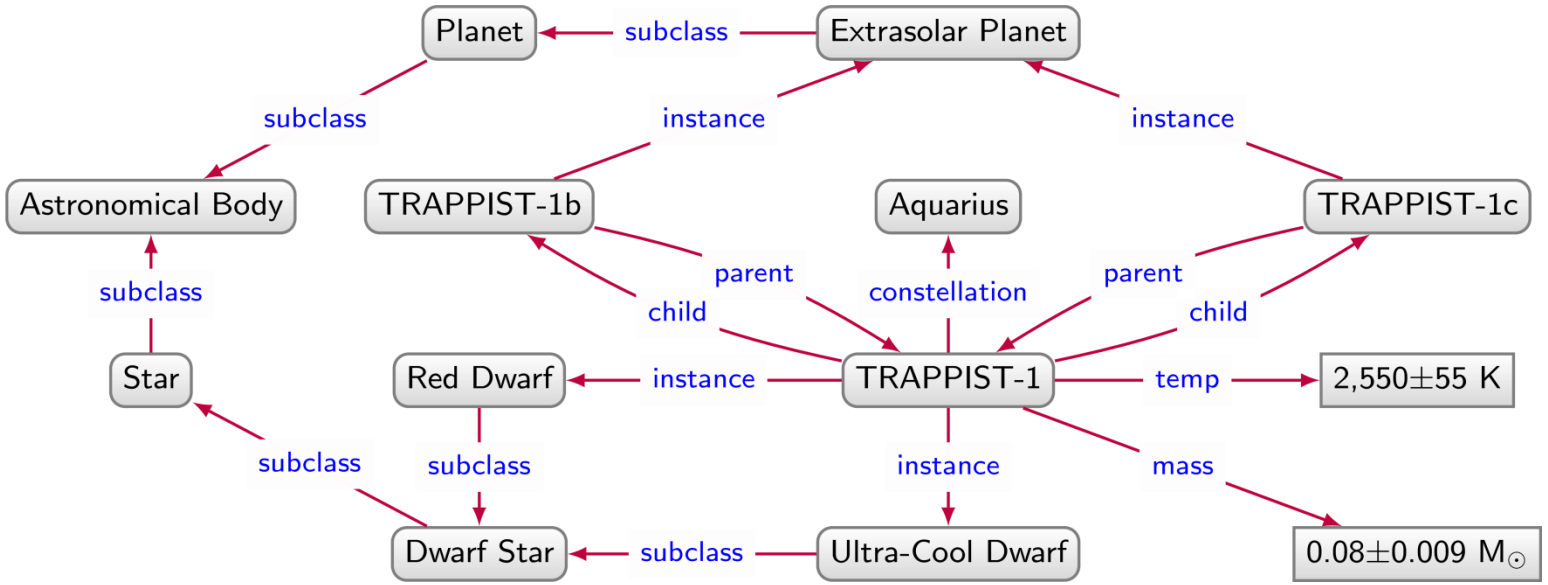
Patrones Navegacionales de Grafos



Encontrar Cuerpos Celestiales y su Constelación

?body	?con
TRAPPIST-1	Aquarius
TRAPPIST-1b	Aquarius
TRAPPIST-1c	Aquarius

Patrones Navegacionales y Complejos de Grafos



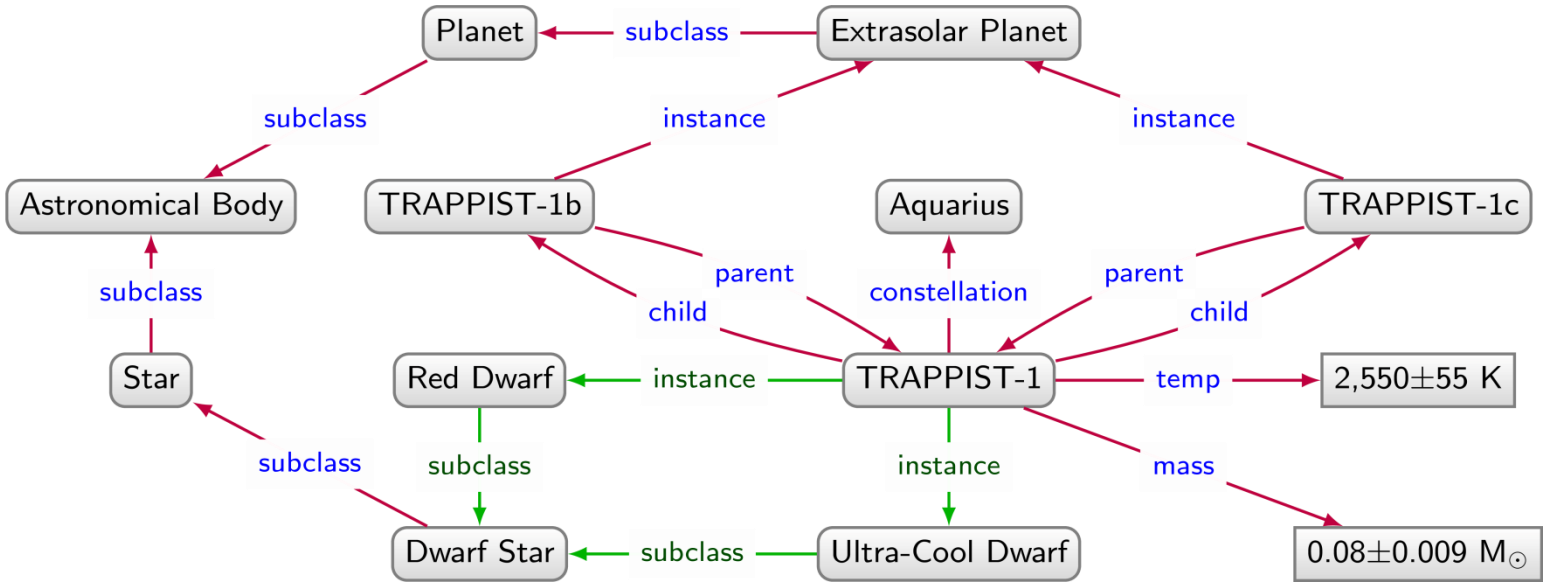
$\bowtie$ $\setminus$ σ π $\cup$

$*$ $|$ $/$ $-$

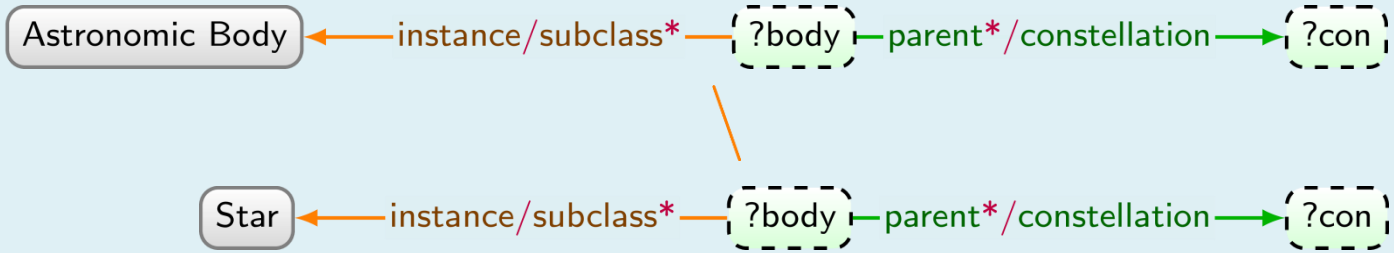
Patrones de Grafos + Álgebra Relacional

+ Consultas Regulares de Caminos

Patrones Navegacionales y Complejos de Grafos

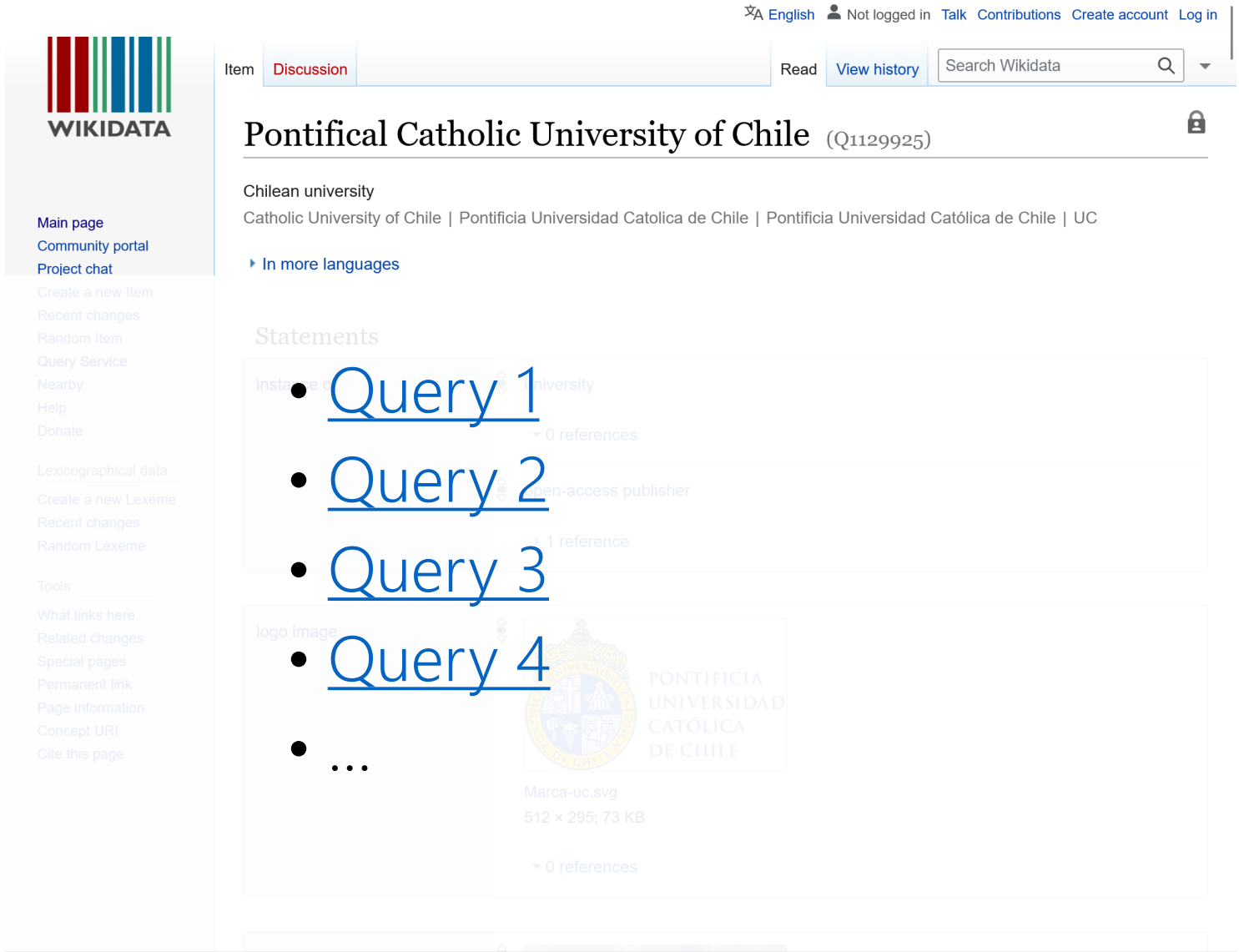


Encontrar cuerpos celestiales no estrelares y su constelación



?body	?con
TRAPPIST-1b	Aquarius
TRAPPIST-1c	Aquarius

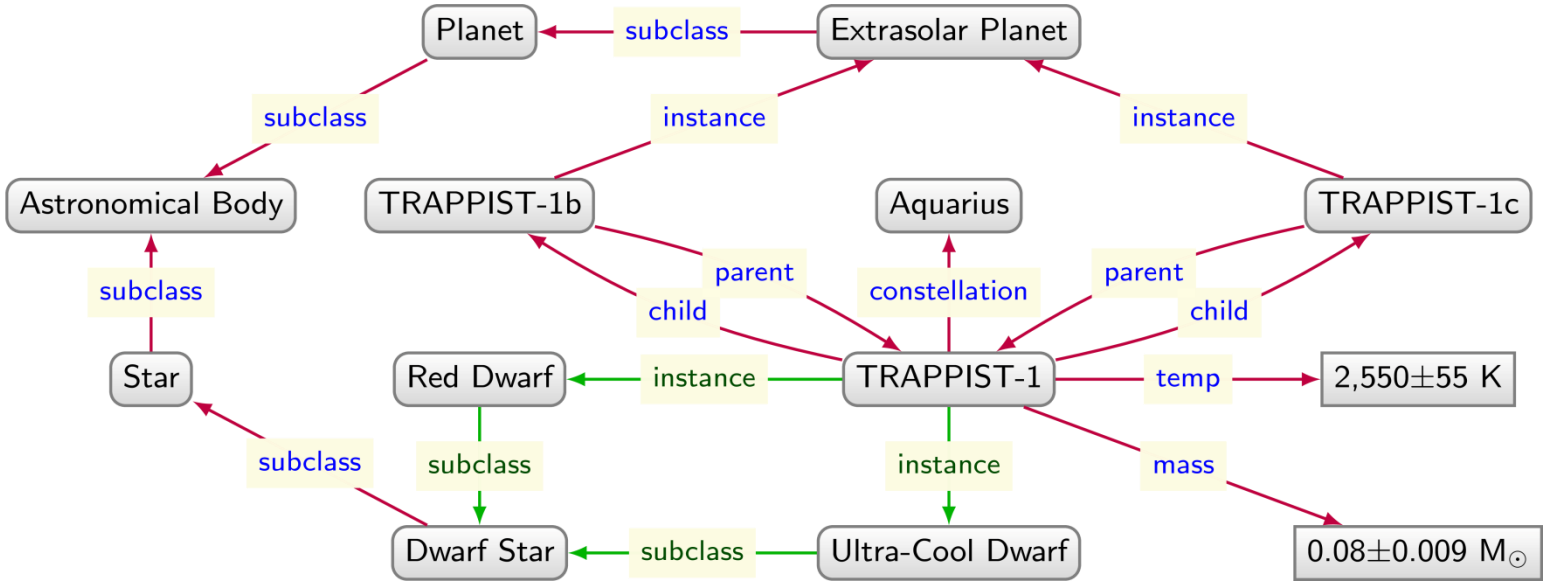
En Wikidata

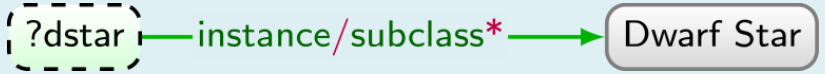


- Query 1
- Query 2
- Query 3
- Query 4
- …

2.- Consultas Nativas

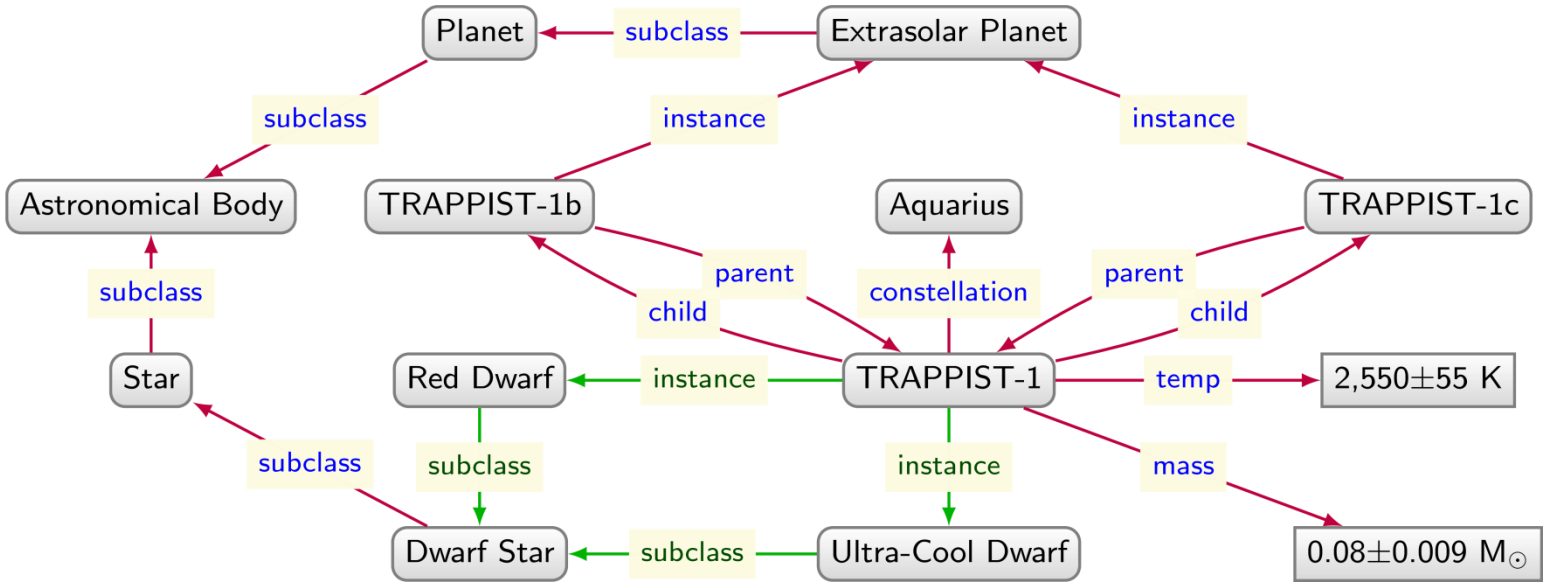
Retornar Caminos



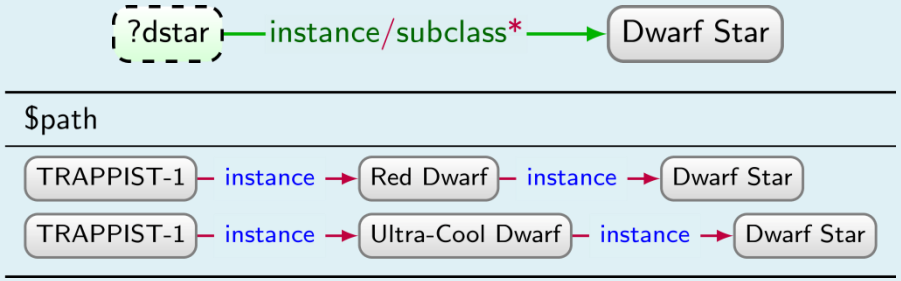


?dtar
TRAPPIST-1

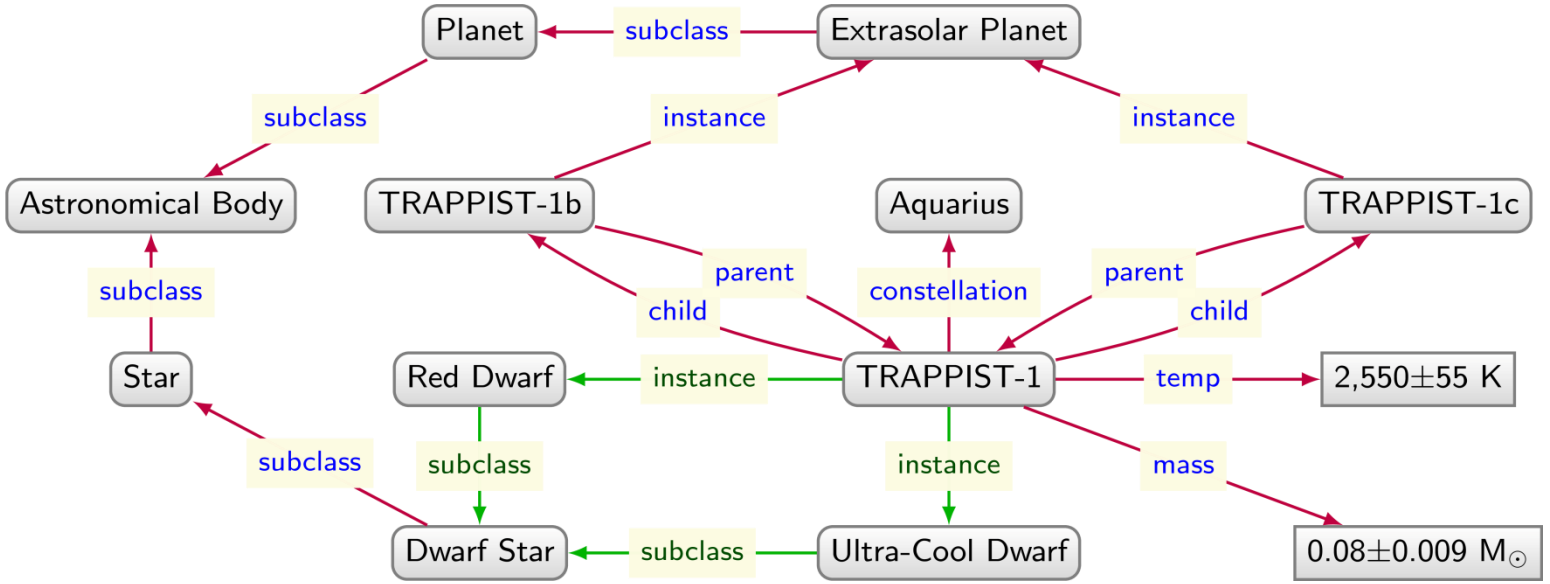
Retornar Caminos



¿Cómo se debería retornar y manejar caminos en los resultados?



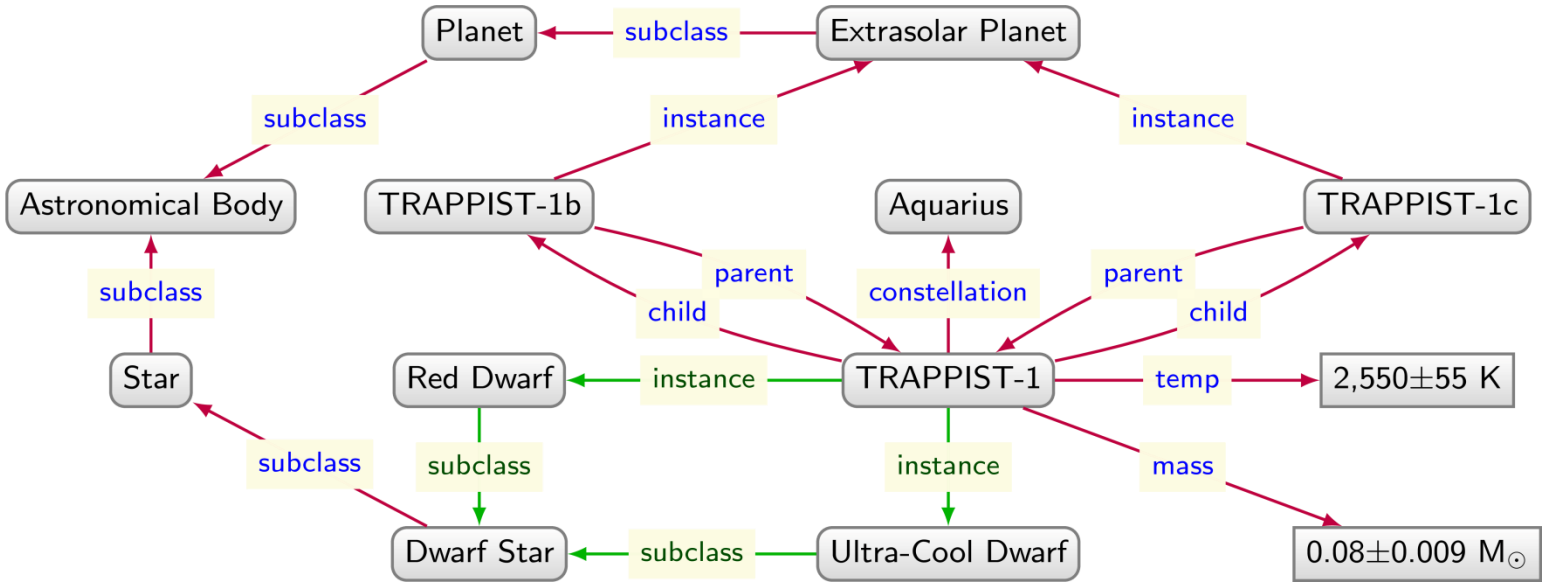
Retornar Grafos



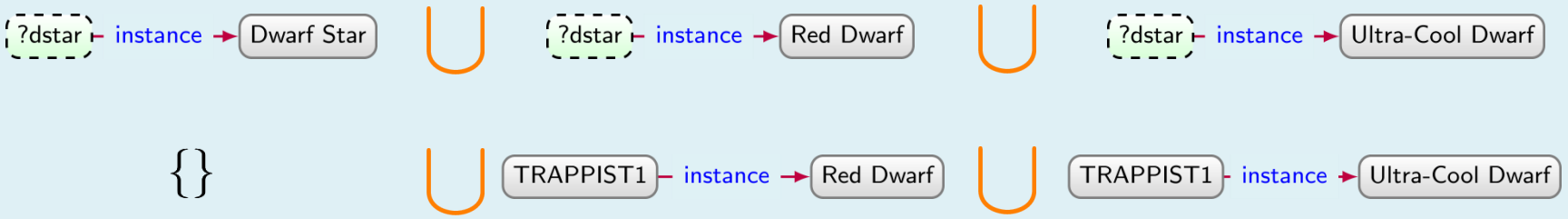
?dstar ⊢ instance → Dwarf Star ∪ ?dstar ⊢ instance → Red Dwarf ∪ ?dstar ⊢ instance → Ultra-Cool Dwarf

?dtar ∪ ?dtar / TRAPPIST-1 ∪ ?dtar / TRAPPIST-1

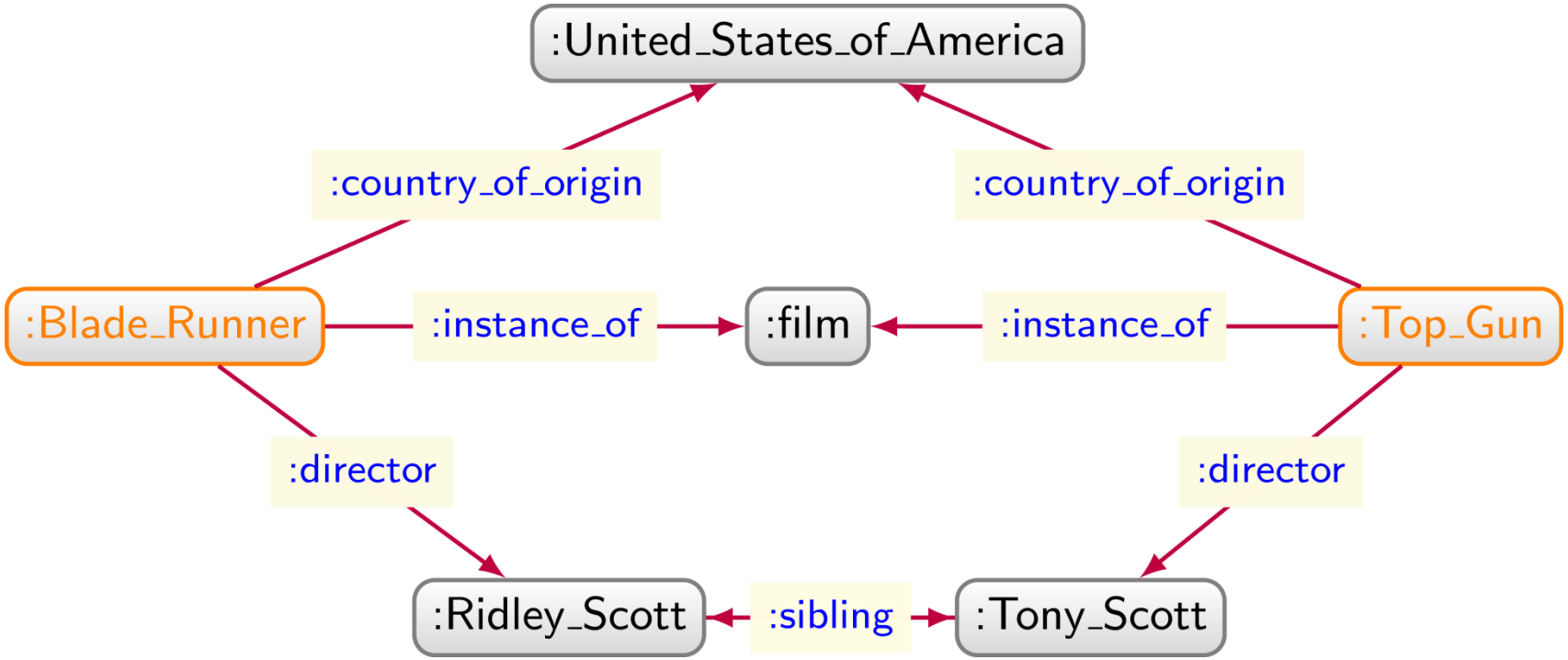
Retornar Grafos

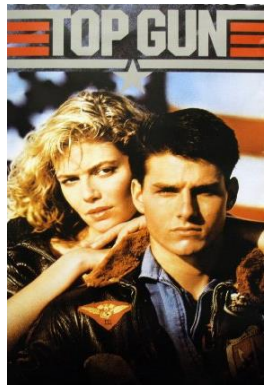


¿Se podrá definir un álgebra nativa ($\bowtie$, $\setminus$, σ, π, $\cup$) para grafos?

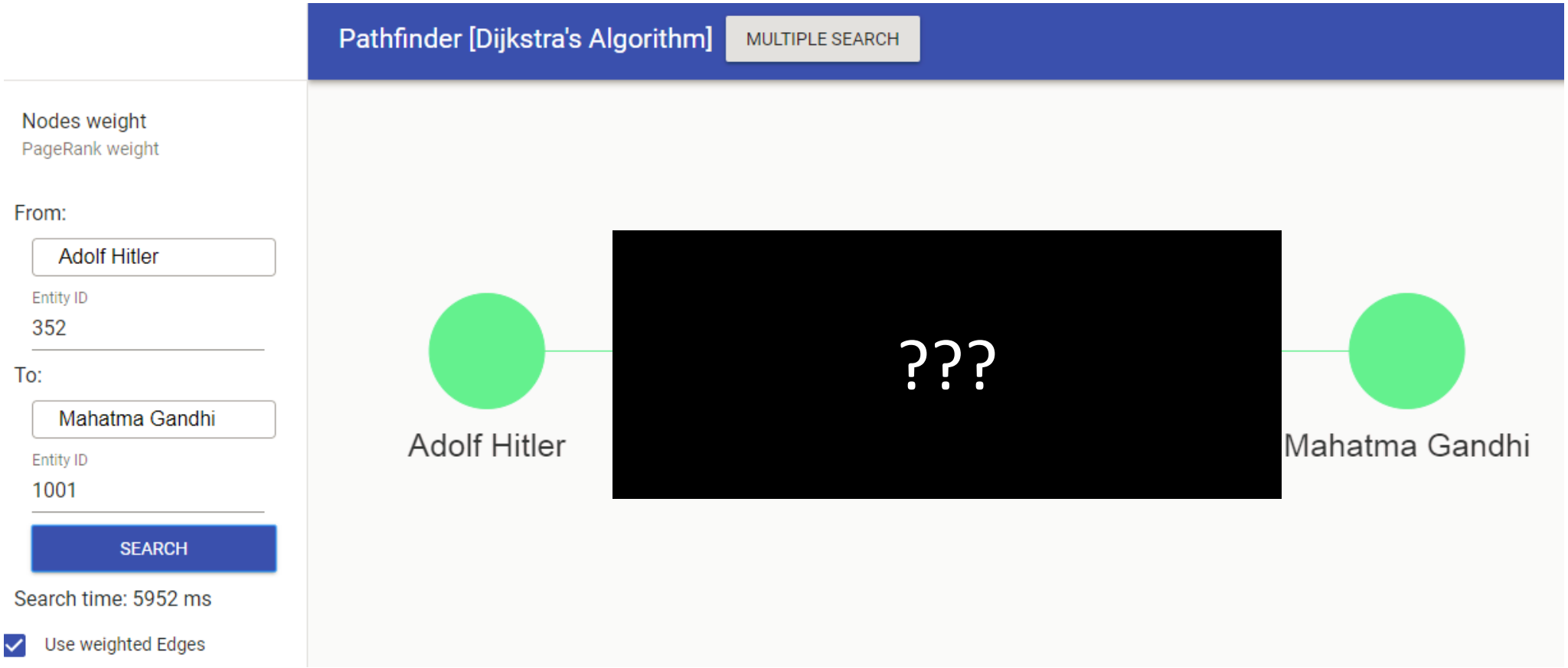


Encontrar Caminos *Interesantes*

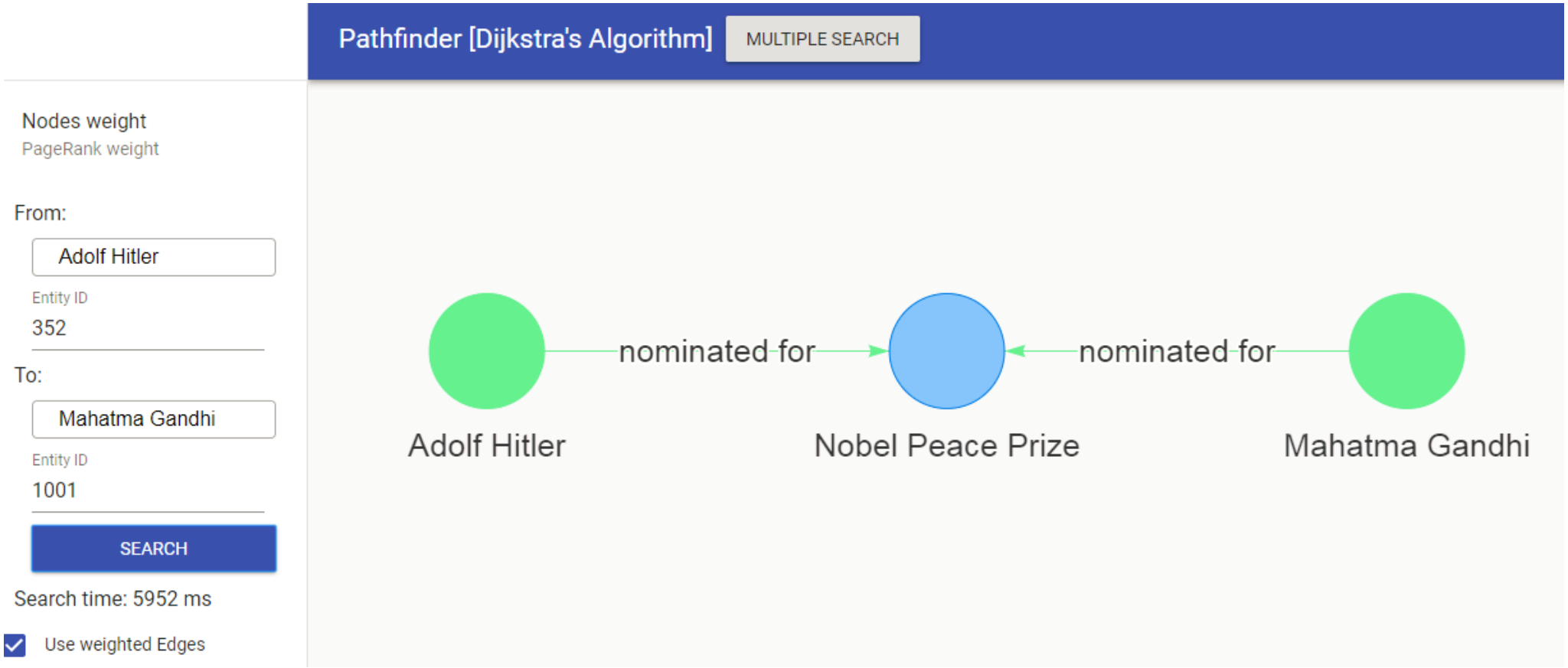




Encontrar Caminos *Interesantes*

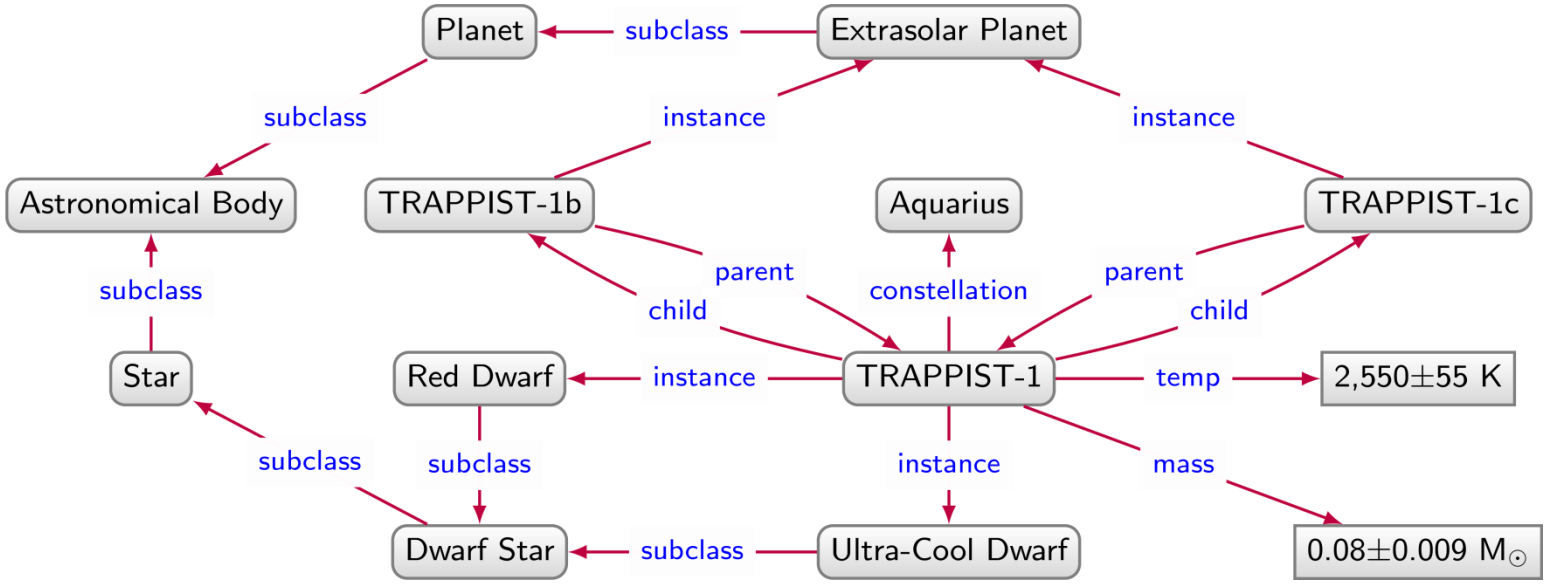


Encontrar Caminos *Interesantes*



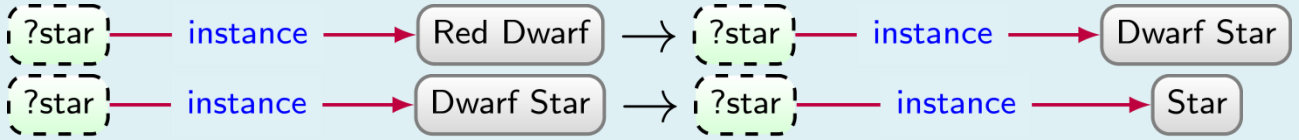
3.- Reglas y Ontologías

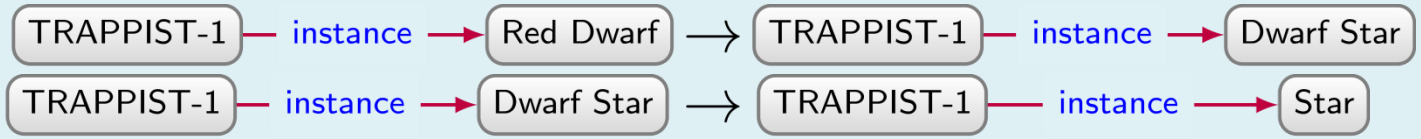
Reglas



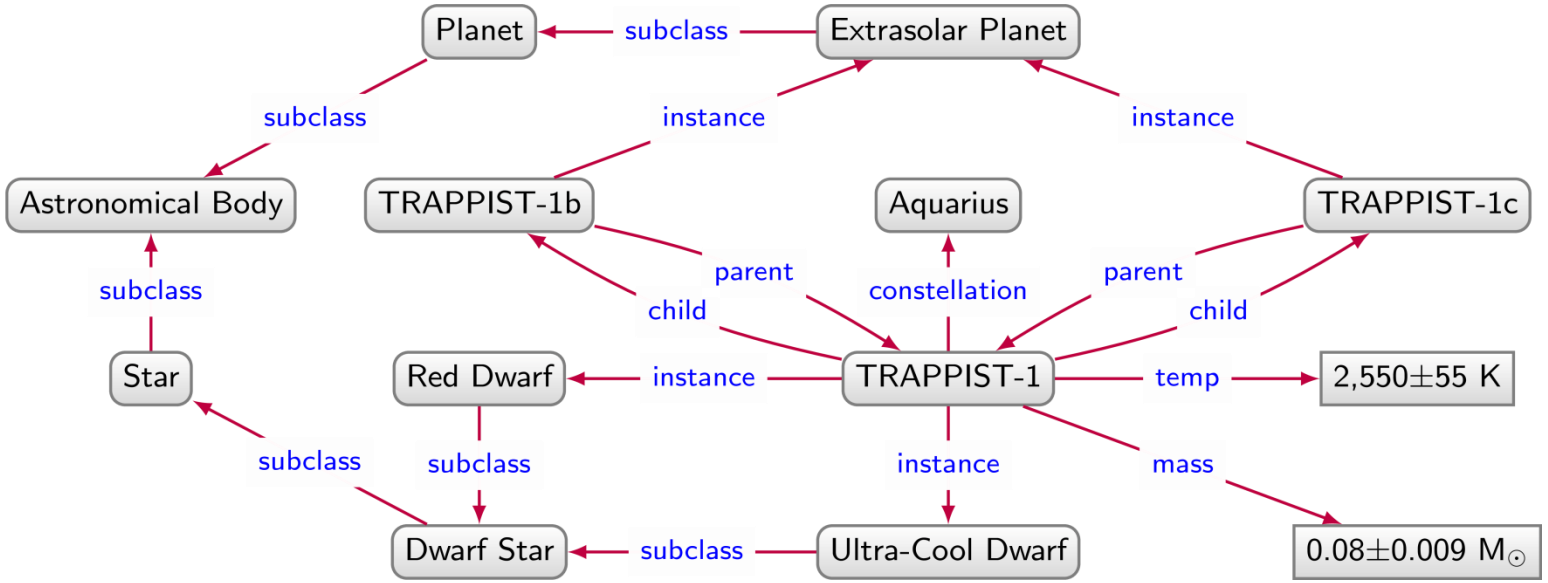
$\text{RedDwarf} \sqsubseteq \text{DwarfStar}$

$\text{DwarfStar} \sqsubseteq \text{Star}$





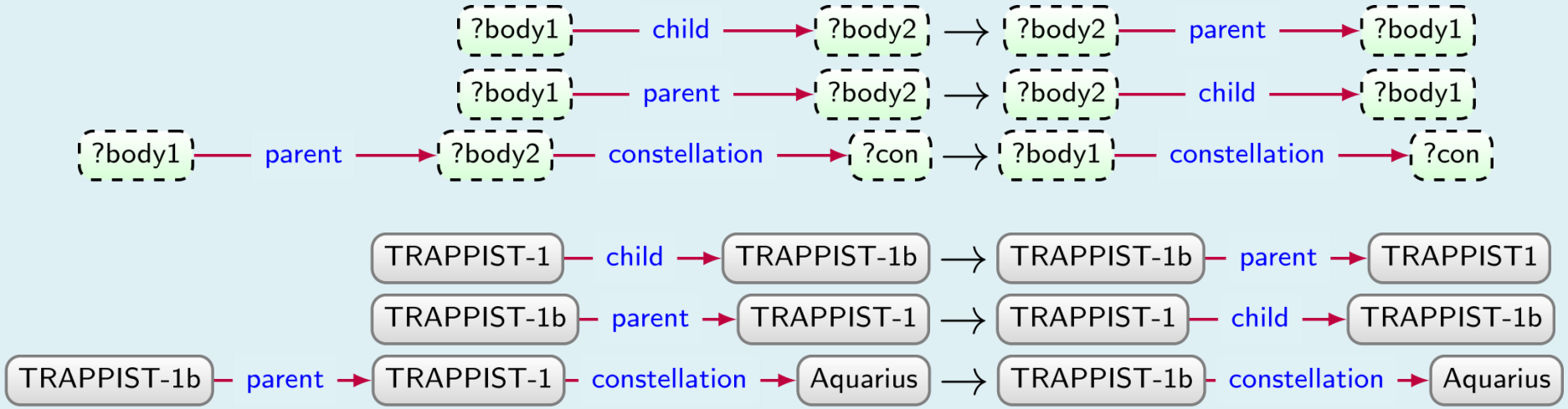
Reglas



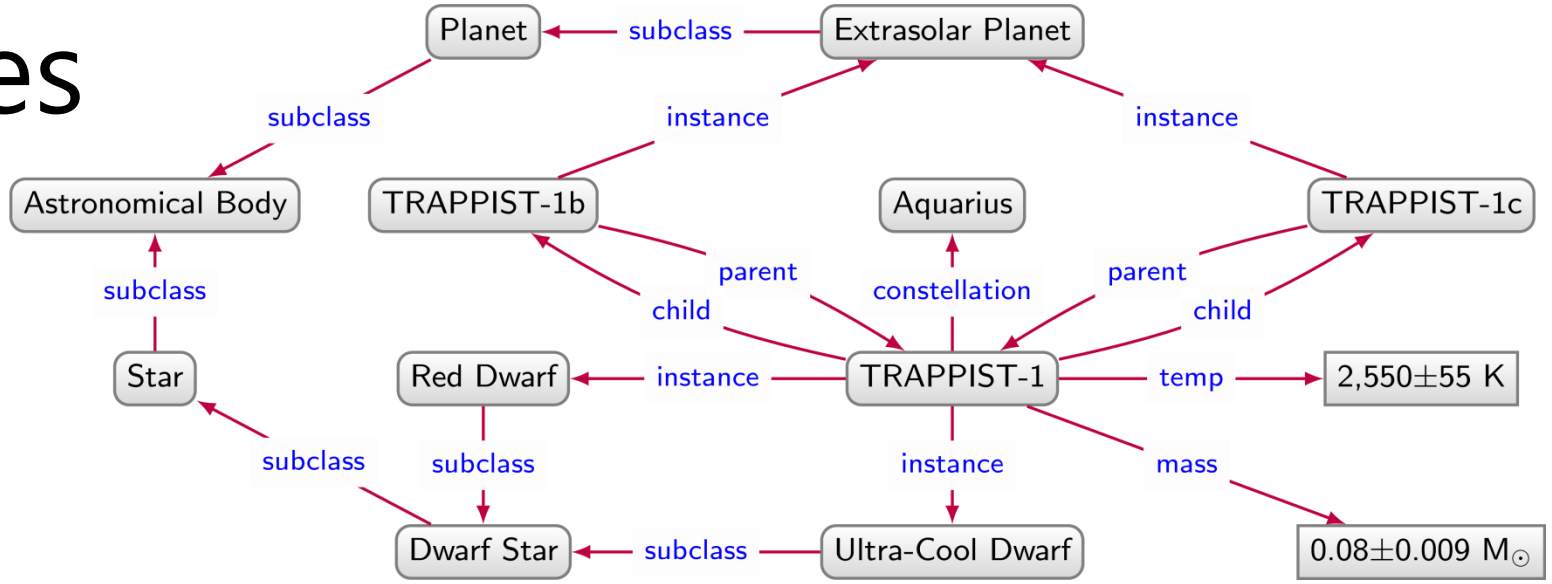
$\text{child} \sqsubseteq \text{parent}^-$

$\text{parent} \sqsubseteq \text{child}^-$

$\text{parent} \circ \text{constellation} \sqsubseteq \text{constellation}$

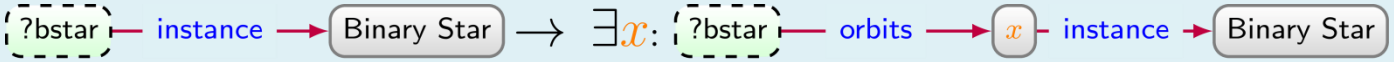


Reglas: disyunción y existenciales



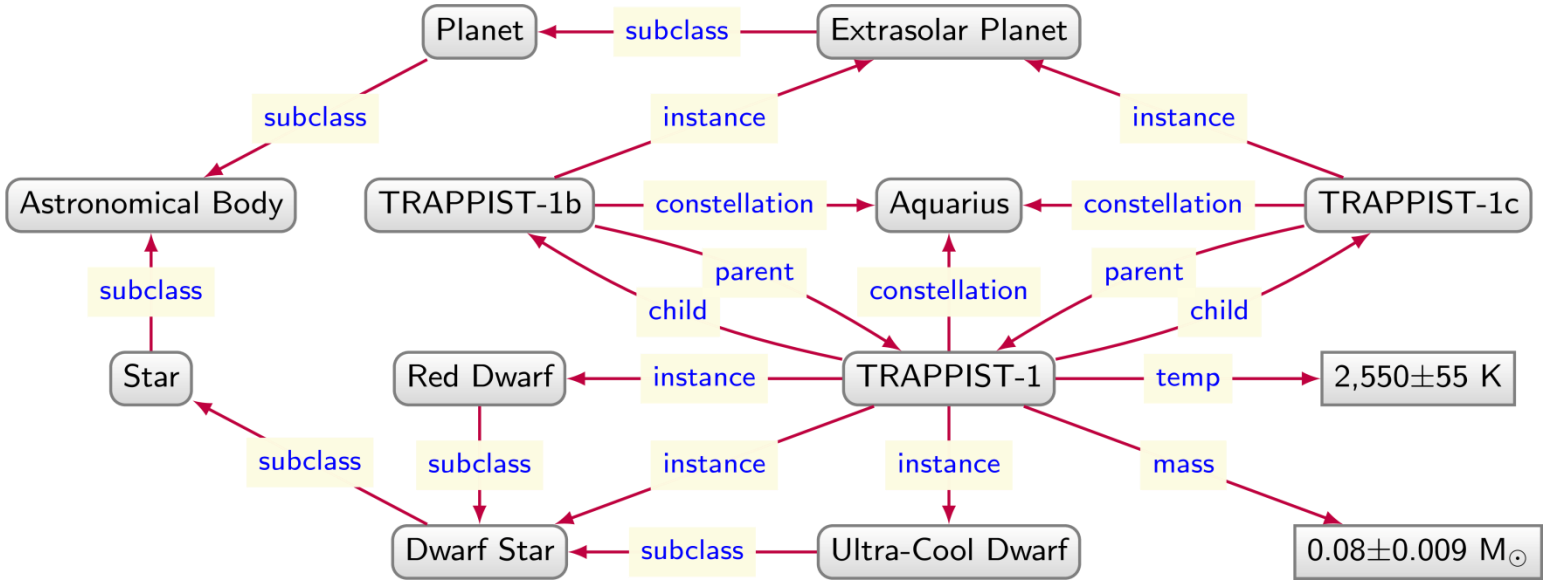
$\text{Planet} \sqsubseteq \text{ExtrasolarPlanet} \sqcup \text{SolarPlanet}$

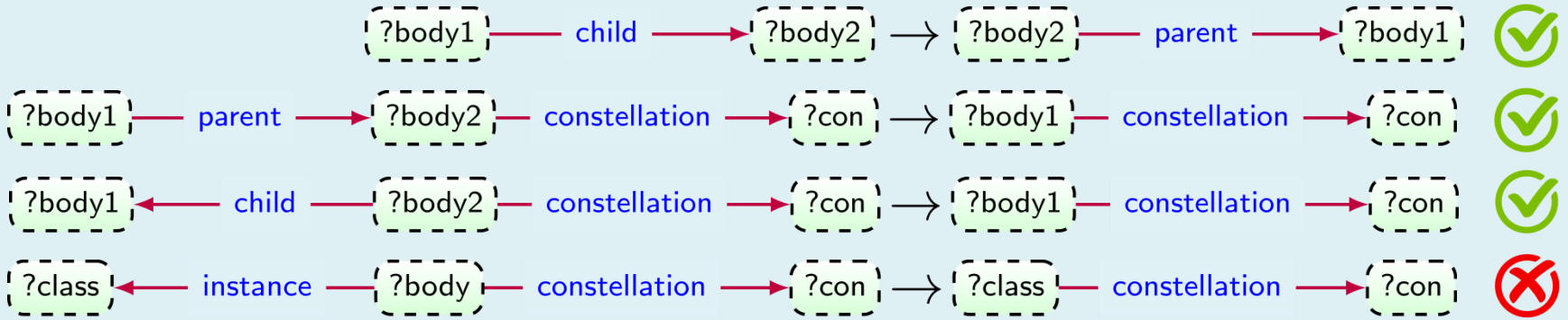
$\text{BinaryStar} \sqsubseteq \exists \text{orbits}.\text{BinaryStar} \sqcap \text{Star}$



Rule Mining

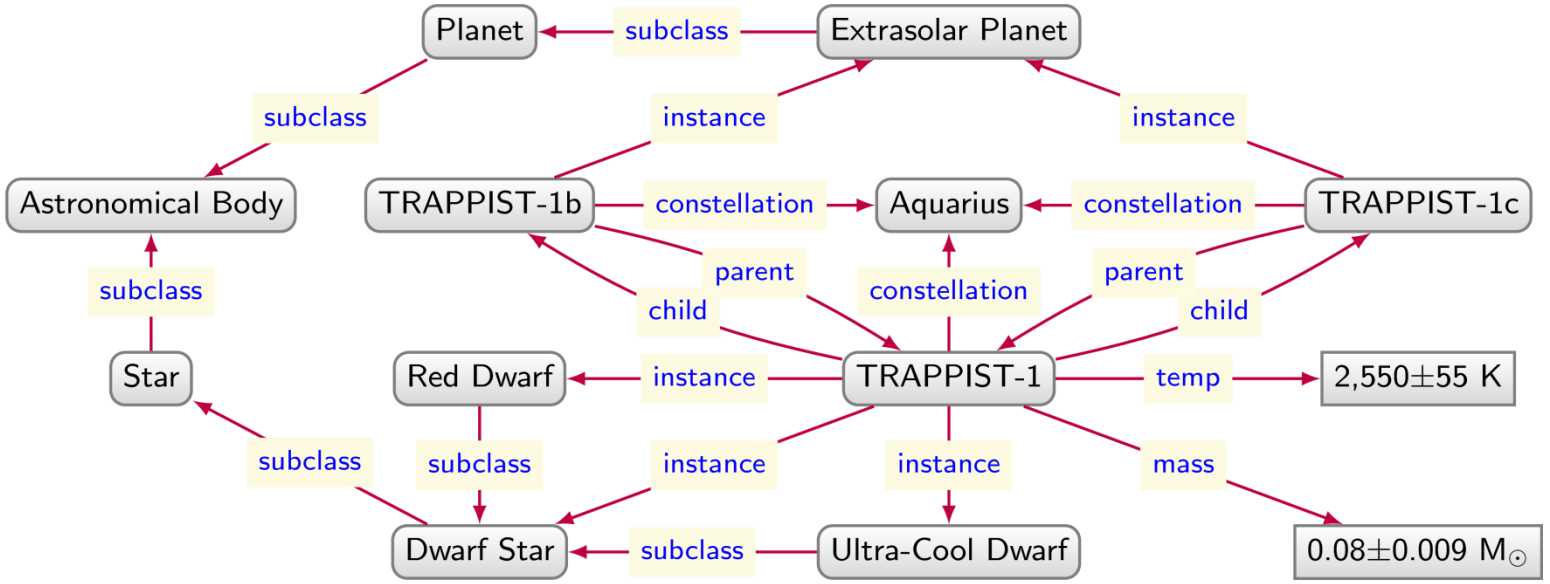
Rule Mining





[Galárraga et al. 2015]

Rule Mining



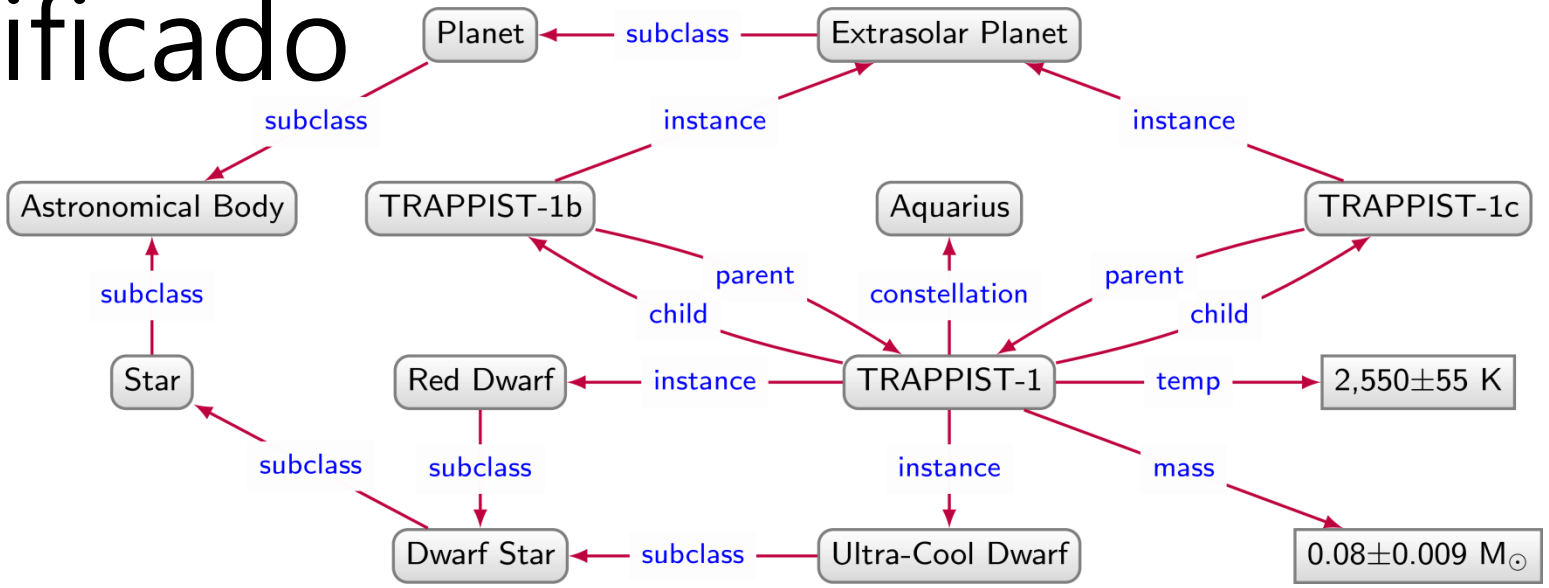
¿Podemos minar reglas disyuntivas y/o existenciales?

?dtar — instance → Dwarf Star ⟶ ?dstar — instance → Red Dwarf ⋁ ?planet — instance → Ultra-Cool Dwarf

?planet — instance → Extrasolar Planet ⟶ $\exists x$: ?planet — parent → x

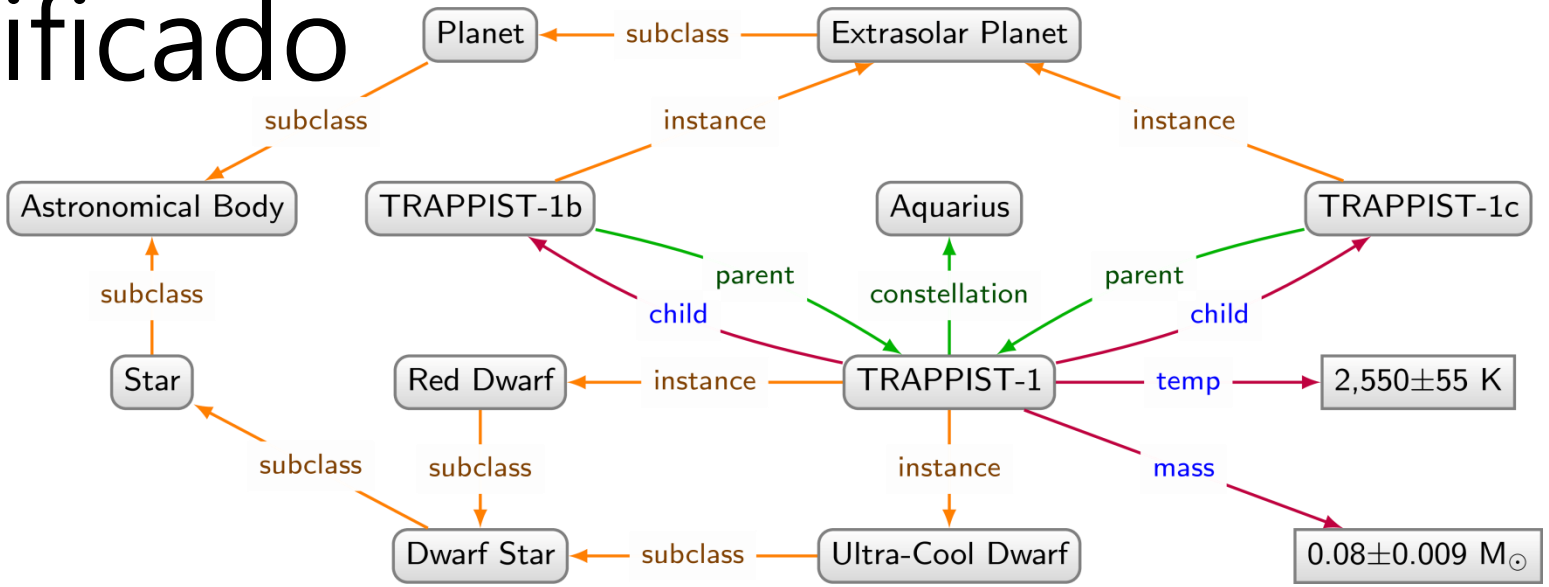
Ontologías

La necesidad de tener Semántica/Significado



Encontrar instancias de Dwarf Star

La necesidad de tener Semántica/Significado



Encontrar Cuerpos Astronómicos y su constelación

Description Logics: A-Box

A-Box

$\mathsf{child}(\mathsf{TRAPPIST\text{-}1}, \mathsf{TRAPPIST\text{-}1b})$

$\mathsf{constellation}(\mathsf{TRAPPIST\text{-}1}, \mathsf{Aquarius})$

$\mathsf{RedDwarf}(\mathsf{TRAPPIST\text{-}1})$

$\mathsf{BinaryStar}(\mathsf{AlphaCentauriB})$

Ontología

Name	**Syntax**	**Semantics** $(\cdot^I)$
	Assertional Definitions	
Individual	a	a^I (an element of Δ^I)
	Assertional Axioms (A-Box)	
Role Assertion	$\mathsf{R}(\mathsf{a}, \mathsf{b})$	$(\mathsf{a}^I, \mathsf{b}^I) \in \mathsf{R}^I$
Negative Role Assertion	$\neg\mathsf{R}(\mathsf{a}, \mathsf{b})$	$(\mathsf{a}^I, \mathsf{b}^I) \notin \mathsf{R}^I$
Concept Assertion	$\mathsf{C}(\mathsf{a})$	$\mathsf{a}^I \in \mathsf{C}^I$
Equality	$\mathsf{a} = \mathsf{b}$	$\mathsf{a}^I = \mathsf{b}^I$
Inequality	$\mathsf{a} \neq \mathsf{b}$	$\mathsf{a}^I \neq \mathsf{b}^I$

Description Logics: T-Box

A-Box

$\mathsf{child}(\mathsf{TRAPPIST\text{-}1}, \mathsf{TRAPPIST\text{-}1b})$

$\mathsf{constellation}(\mathsf{TRAPPIST\text{-}1}, \mathsf{Aquarius})$

$\mathsf{RedDwarf}(\mathsf{TRAPPIST\text{-}1})$

$\mathsf{BinaryStar}(\mathsf{AlphaCentauriB})$

T-Box

$\mathsf{RedDwarf} \sqsubseteq \mathsf{DwarfStar}$

$\mathsf{DwarfStar} \sqsubseteq \mathsf{Star}$

$\mathsf{Planet} \sqsubseteq \mathsf{ExtrasolarPlanet} \sqcup \mathsf{SolarPlanet}$

$\mathsf{BinaryStar} \sqsubseteq \exists \mathsf{orbits}.\mathsf{BinaryStar} \sqcap \mathsf{Star}$

Ontología

Name	**Syntax**	**Semantics** $(\cdot^I)$
	Concept Definitions	
Atomic Concept	A	A^I (a subset of Δ^I)
Top Concept	$\top$	Δ^I
Bottom Concept	$\bot$	$\emptyset$
Concept Negation	$\neg\mathsf{C}$	$\Delta^I \setminus \mathsf{C}^I$
Concept Intersection	$\mathsf{C} \sqcap \mathsf{D}$	$\mathsf{C}^I \cap \mathsf{D}^I$
Concept Union	$\mathsf{C} \sqcup \mathsf{D}$	$\mathsf{C}^I \cup \mathsf{D}^I$
Nominals	$\{\mathsf{a}\}$	$\{\mathsf{a}^I\}$
Existential Restriction	$\exists \mathsf{R}.\mathsf{C}$	$\{\mathsf{x} \mid \exists \mathsf{y} : (\mathsf{x},\mathsf{y}) \in \mathsf{R}^I \text{ and } \mathsf{y} \in \mathsf{C}^I\}$
Universal Restriction	$\forall \mathsf{R}.\mathsf{C}$	$\{\mathsf{x} \mid \forall \mathsf{y} : (\mathsf{x},\mathsf{y}) \in \mathsf{R}^I \text{ implies } \mathsf{y} \in \mathsf{C}^I\}$
Self Restriction	$\exists \mathsf{R}.\mathsf{Self}$	$\{\mathsf{x} \mid (\mathsf{x},\mathsf{x}) \in \mathsf{R}^I\}$
Number Restriction	$\star n\,\mathsf{R}$ (where $\star \in \{\geq, \leq, =\}$)	$\{\mathsf{x} \mid \#\{\mathsf{y} : (\mathsf{x},\mathsf{y}) \in \mathsf{R}^I\} \star n\}$
Qualified Number Restriction	$\star n\,\mathsf{R}.\mathsf{C}$ (where $\star \in \{\geq, \leq, =\}$)	$\{\mathsf{x} \mid \#\{\mathsf{y} : (\mathsf{x},\mathsf{y}) \in \mathsf{R}^I \text{ and } \mathsf{y} \in \mathsf{C}^I\} \star n\}$
	Concept Axioms (T-Box)	
Concept Inclusion	$\mathsf{C} \sqsubseteq \mathsf{D}$	$\mathsf{C}^I \subseteq \mathsf{D}^I$

Description Logics: R-Box

A-Box

$\mathsf{child}(\mathsf{TRAPPIST\text{-}1}, \mathsf{TRAPPIST\text{-}1b})$

$\mathsf{constellation}(\mathsf{TRAPPIST\text{-}1}, \mathsf{Aquarius})$

$\mathsf{RedDwarf}(\mathsf{TRAPPIST\text{-}1})$

$\mathsf{BinaryStar}(\mathsf{AlphaCentauriB})$

T-Box

$\mathsf{RedDwarf} \sqsubseteq \mathsf{DwarfStar}$

$\mathsf{DwarfStar} \sqsubseteq \mathsf{Star}$

$\mathsf{Planet} \sqsubseteq \mathsf{ExtrasolarPlanet} \sqcup \mathsf{SolarPlanet}$

$\mathsf{BinaryStar} \sqsubseteq \exists \mathsf{orbits}.\mathsf{BinaryStar} \sqcap \mathsf{Star}$

R-Box

$\mathsf{child} \sqsubseteq \mathsf{parent}^-$

$\mathsf{parent} \sqsubseteq \mathsf{child}^-$

$\mathsf{parent} \circ \mathsf{constellation} \sqsubseteq \mathsf{constellation}$

$\mathsf{Asym}(\mathsf{parent})$

Ontología

Name	**Syntax**	**Semantics** $(\cdot^I)$
	ROLE DEFINITIONS	
Role	R	R^I (a subset of $\Delta^I \times \Delta^I$)
Inverse Role	R^-	$\{(\mathsf{y},\mathsf{x}) \mid (\mathsf{x},\mathsf{y}) \in \mathsf{R}^I\}$
Universal Role	U	$\Delta^I \times \Delta^I$
	ROLE AXIOMS (R-Box)	
Role Inclusion	$\mathsf{R} \sqsubseteq \mathsf{S}$	$\mathsf{R}^I \subseteq \mathsf{S}^I$
Complex Role Inclusion	$\mathsf{R}_1 \circ \ldots \circ \mathsf{R}_n \sqsubseteq \mathsf{S}$	$\mathsf{R}_1^I \circ \ldots \circ \mathsf{R}_n^I \subseteq \mathsf{S}^I$
Transitive Roles	$\mathsf{Trans}(\mathsf{R})$	$\mathsf{R}^I \circ \mathsf{R}^I \subseteq \mathsf{R}^I$
Functional Roles	$\mathsf{Func}(\mathsf{R})$	$\{(\mathsf{x},\mathsf{y}),(\mathsf{x},\mathsf{z})\} \subseteq \mathsf{R}^I$ implies $\mathsf{y} = \mathsf{z}$
Reflexive Roles	$\mathsf{Ref}(\mathsf{R})$	for all $\mathsf{x} \in \Delta^I : (\mathsf{x},\mathsf{x}) \in \mathsf{R}^I$
Irreflexive Roles	$\mathsf{Irref}(\mathsf{R})$	for all $\mathsf{x} \in \Delta^I : (\mathsf{x},\mathsf{x}) \notin \mathsf{R}^I$
Symmetric Roles	$\mathsf{Sym}(\mathsf{R})$	$\mathsf{R}^I = (\mathsf{R}^-)^I$
Asymmetric Roles	$\mathsf{Asym}(\mathsf{R})$	$\mathsf{R}^I \cap (\mathsf{R}^-)^I = \emptyset$
Disjoint Roles	$\mathsf{Disj}(\mathsf{R},\mathsf{S})$	$\mathsf{R}^I \cap \mathsf{S}^I = \emptyset$

Description Logics: R-Box

A-Box

$$\mathsf{child}(\mathsf{TRAPPIST\text{-}1}, \mathsf{TRAPPIST\text{-}1b})$$
$$\mathsf{constellation}(\mathsf{TRAPPIST\text{-}1}, \mathsf{Aquarius})$$
$$\mathsf{RedDwarf}(\mathsf{TRAPPIST\text{-}1})$$
$$\mathsf{BinaryStar}(\mathsf{AlphaCentauriB})$$

T-Box

$$\mathsf{RedDwarf} \sqsubseteq \mathsf{DwarfStar}$$
$$\mathsf{DwarfStar} \sqsubseteq \mathsf{Star}$$
$$\mathsf{Planet} \sqsubseteq \mathsf{ExtrasolarPlanet} \sqcup \mathsf{SolarPlanet}$$
$$\mathsf{BinaryStar} \sqsubseteq \exists \mathsf{orbits}.\mathsf{BinaryStar} \sqcap \mathsf{Star}$$

R-Box

$$\mathsf{child} \sqsubseteq \mathsf{parent}^{-}$$
$$\mathsf{parent} \sqsubseteq \mathsf{child}^{-}$$
$$\mathsf{parent} \circ \mathsf{constellation} \sqsubseteq \mathsf{constellation}$$
$$\mathsf{Asym}(\mathsf{parent})$$

Ontología

A-Box

$$\mathsf{parent}(\mathsf{TRAPPIST\text{-}1b}, \mathsf{TRAPPIST\text{-}1})$$
$$\mathsf{constellation}(\mathsf{TRAPPIST\text{-}1b}, \mathsf{Aquarius})$$
$$\mathsf{DwarfStar}(\mathsf{TRAPPIST\text{-}1})$$
$$\mathsf{Star}(\mathsf{AlphaCentauriB})$$
$$\mathsf{orbits}(\mathsf{AlphaCentauriB}, x)$$
$$\mathsf{BinaryStar}(x)$$
$$\mathsf{orbits}(x, y)$$
$$\ldots$$

T-Box

$$\mathsf{RedDwarf} \sqsubseteq \mathsf{Star}$$
$$\mathsf{BinaryStar} \sqsubseteq \exists \mathsf{orbits}.\mathsf{BinaryStar}$$
$$\mathsf{BinaryStar} \sqsubseteq \exists \mathsf{orbits}.\mathsf{Star}$$
$$\mathsf{BinaryStar} \sqsubseteq \exists \mathsf{orbits}.\top$$
$$\mathsf{BinaryStar} \sqsubseteq \mathsf{Star}$$
$$\mathsf{RedDwarf} \sqsubseteq \top$$
$$\bot \sqsubseteq \mathsf{RedDwarf}$$
$$\ldots$$

R-Box

$$\mathsf{Irref}(\mathsf{parent})$$
$$\mathsf{Asym}(\mathsf{child})$$
$$\mathsf{Irref}(\mathsf{child})$$
$$\mathsf{Disj}(\mathsf{child}, \mathsf{parent})$$
$$\mathsf{Disj}(\mathsf{parent}, \mathsf{child})$$
$$\ldots$$

Implicaciones

Description Logics: grafos

A-Box

child(TRAPPIST-1, TRAPPIST-1b)

constellation(TRAPPIST-1, Aquarius)

RedDwarf(TRAPPIST-1)

...

T-Box

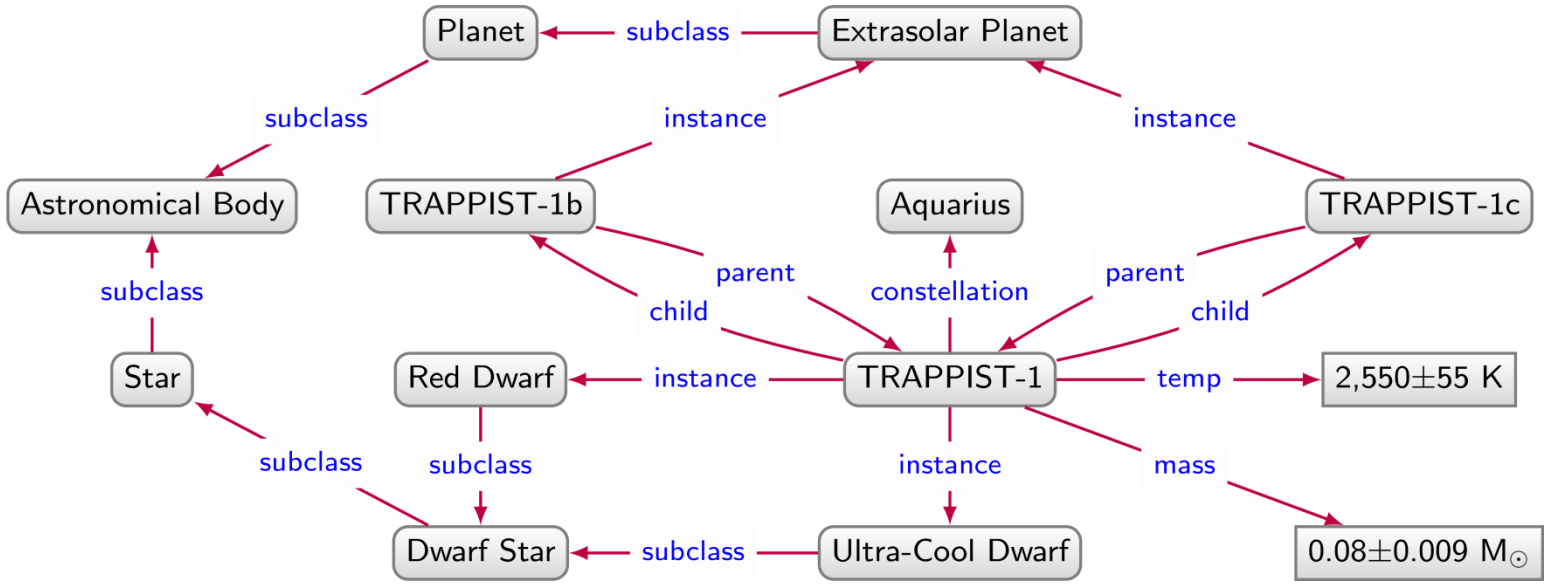
RedDwarf $\sqsubseteq$ DwarfStar

DwarfStar $\sqsubseteq$ Star

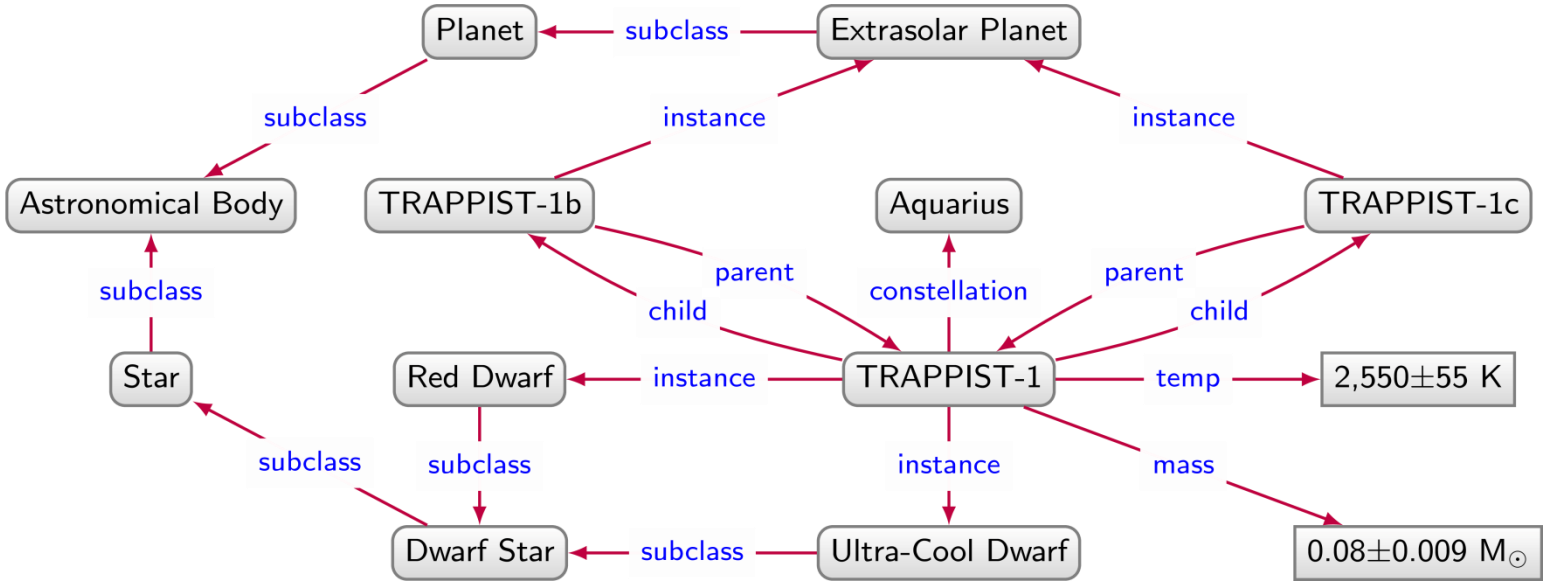
...

R-Box

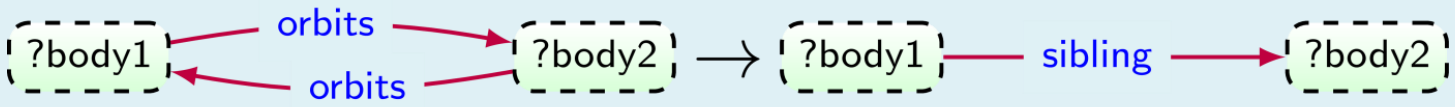
Ontología



Reglas: más allá de las ontologías

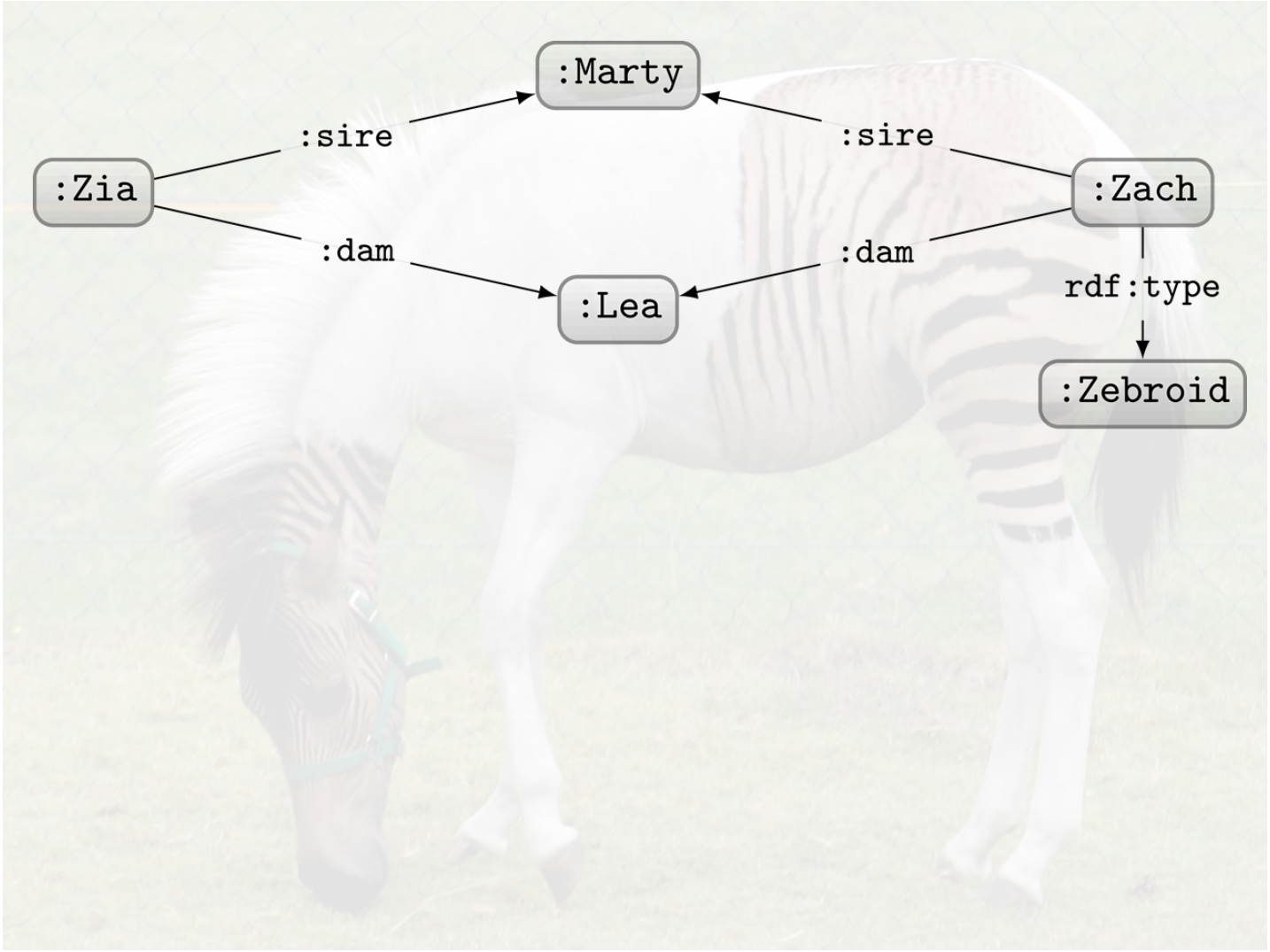


$\text{orbits} \sqcap \text{orbits}^- \sqsubseteq \text{sibling}$

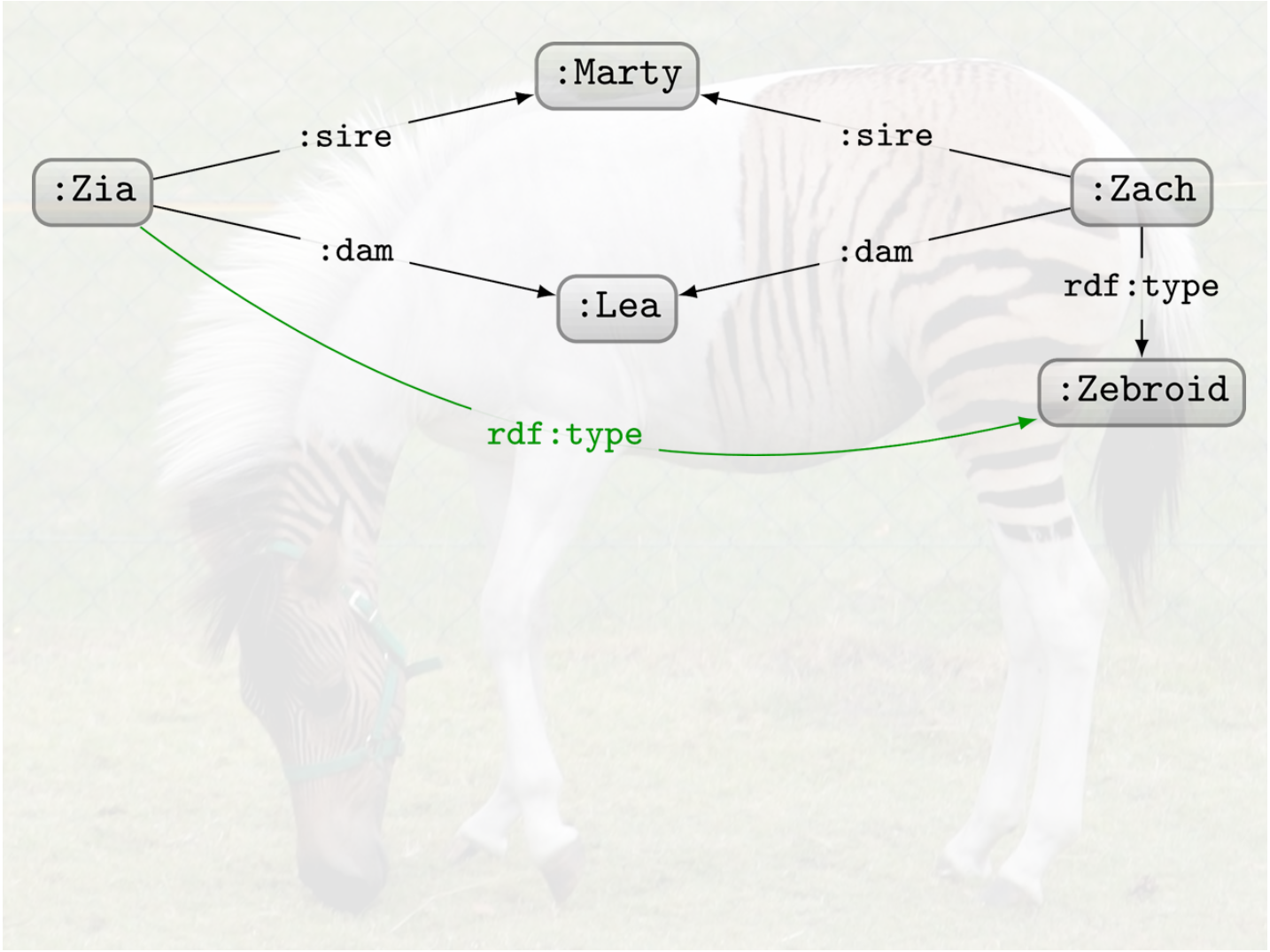


Ontologías: más que reglas

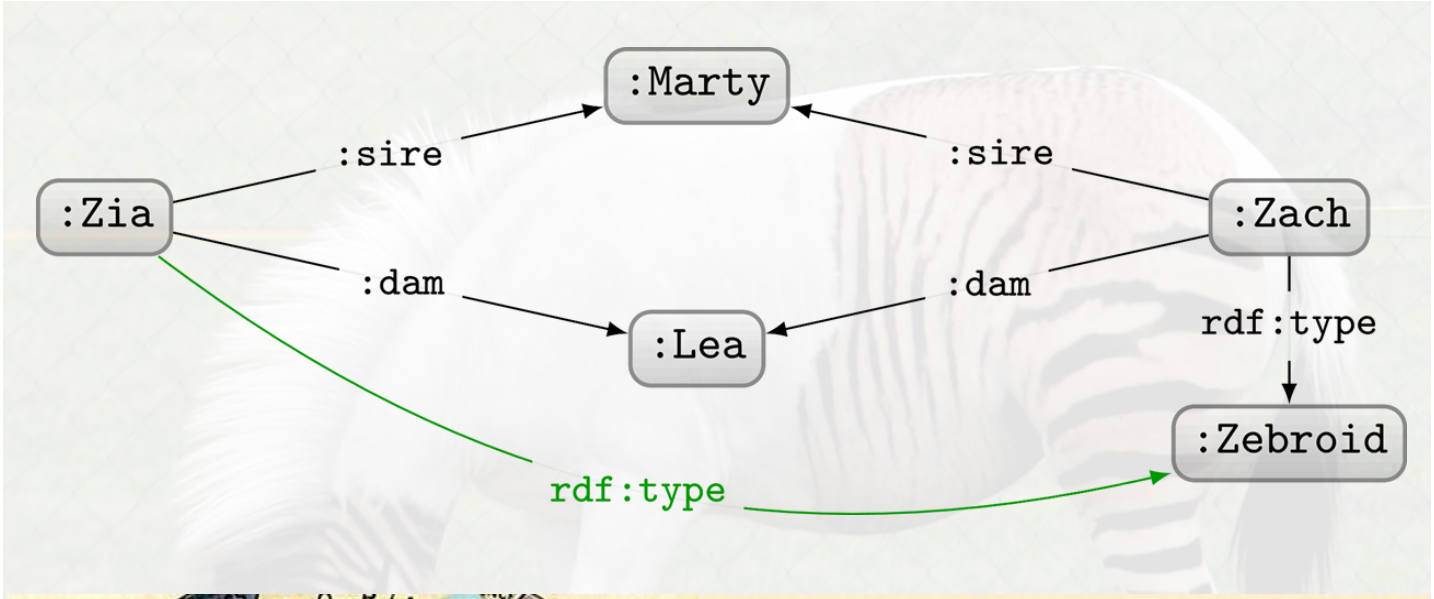
Ontologías: más que reglas



Ontologías: más que reglas

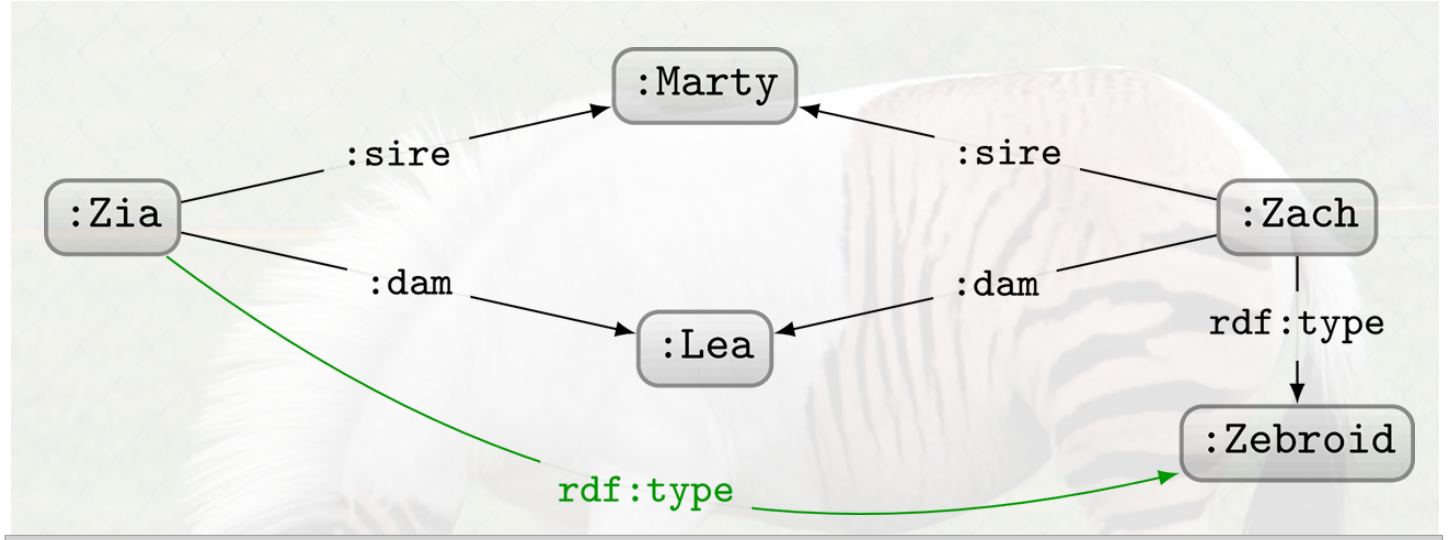


Ontologías: más que reglas



$(x, \texttt{:dam}, z_1)$, $(x, \texttt{:sire}, z_2)$,
$(y, \texttt{:dam}, z_1)$, $(y, \texttt{:sire}, z_2)$,
$(y, \texttt{rdf:type}, \texttt{:Zebroid})$
$\rightarrow (x, \texttt{rdf:type}, \texttt{:Zebroid})$

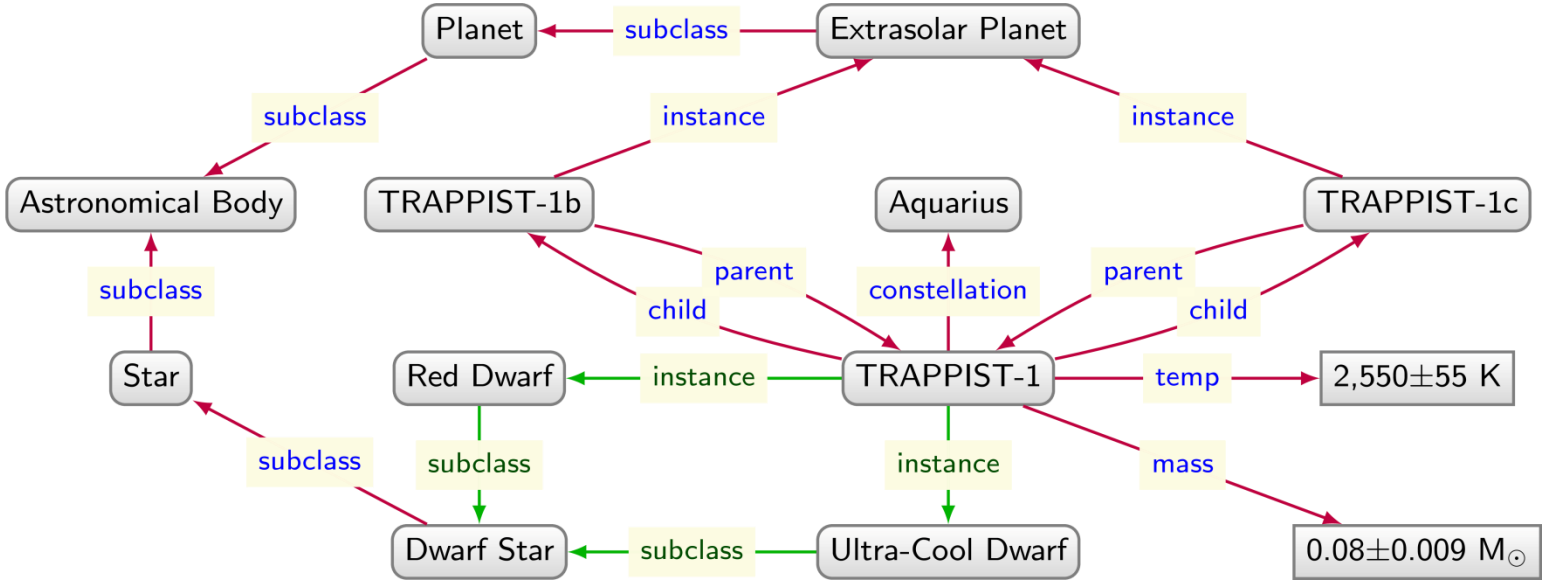
Ontologías: más que reglas



- `sire` es una sub-propiedad de `parent`
- `dam` es una sub-propiedad de `parent`
- Un `Zebroid` tiene exactamente un `parent` tipo `Zebra`
- Un `Zebroid` tiene exactamente un `parent` tipo (¬`Zebra` y `Equine`)
- Un `Zebroid` es una sub-clase de `Equine`
- Un `Equine` tiene exactamente dos `parents`
- dos cosas no pueden estar relacionadas por `sire` y `dam` al mismo tiempo

OBDA sobre grafos

OBDA: patrones complejos de grafos



Patrón de Grafo

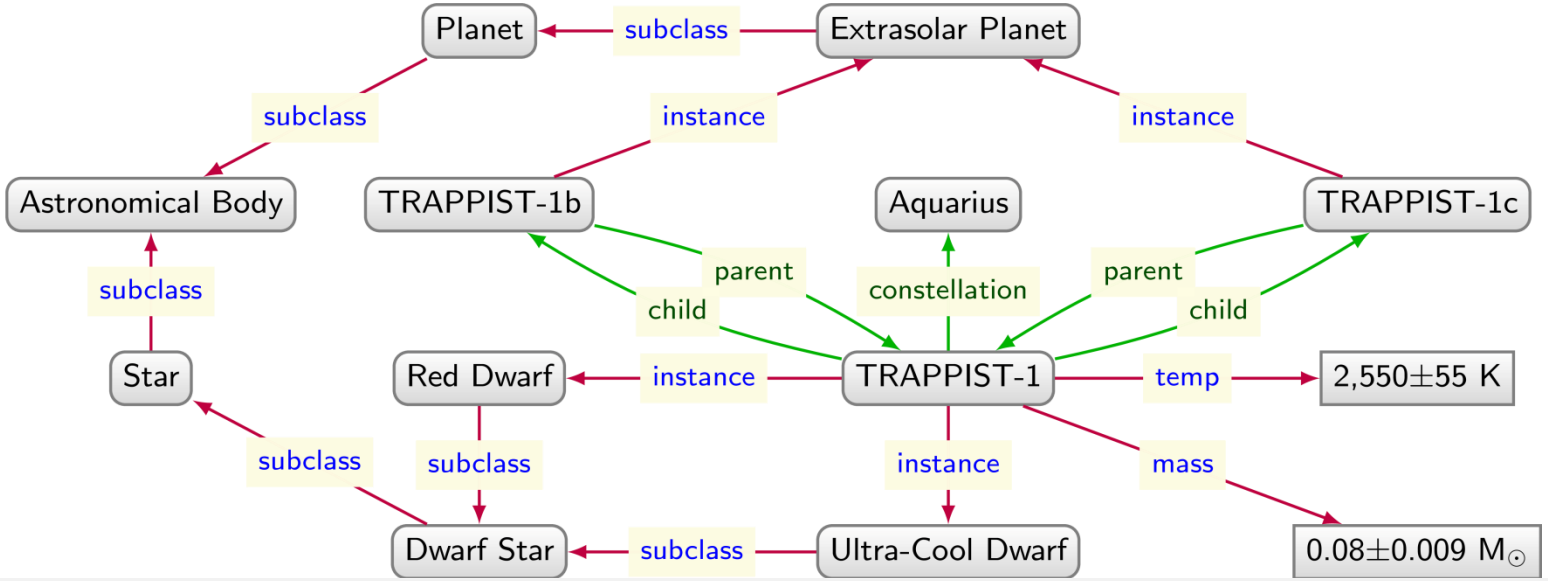
Q : ?dstar — instance → Dwarf Star

O : RedDwarf $\sqsubseteq$ DwarfStar
UltraCoolDwarf $\sqsubseteq$ DwarfStar
DwarfStar $\sqsubseteq$ Star
...

Patrón Complejo de Grafo

$O(Q)$: ?dstar — instance → Dwarf Star ∪
?dstar — instance → Red Dwarf ∪
?dstar — instance → Ultra-Cool Dwarf

OBDA: patrones complejos de grafos



¿Cómo soportar/utilizar caminos en OBDA?

Patrón de Grafo

Q : ?body — constellation → Aquarius

O :

$\text{child} \sqsubseteq \text{parent}^-$

$\text{parent} \sqsubseteq \text{child}^-$

$\text{parent} \circ \text{constellation} \sqsubseteq \text{constellation}$

...

Patrón Complejo Navegacional de Grafo

$O(Q)$:

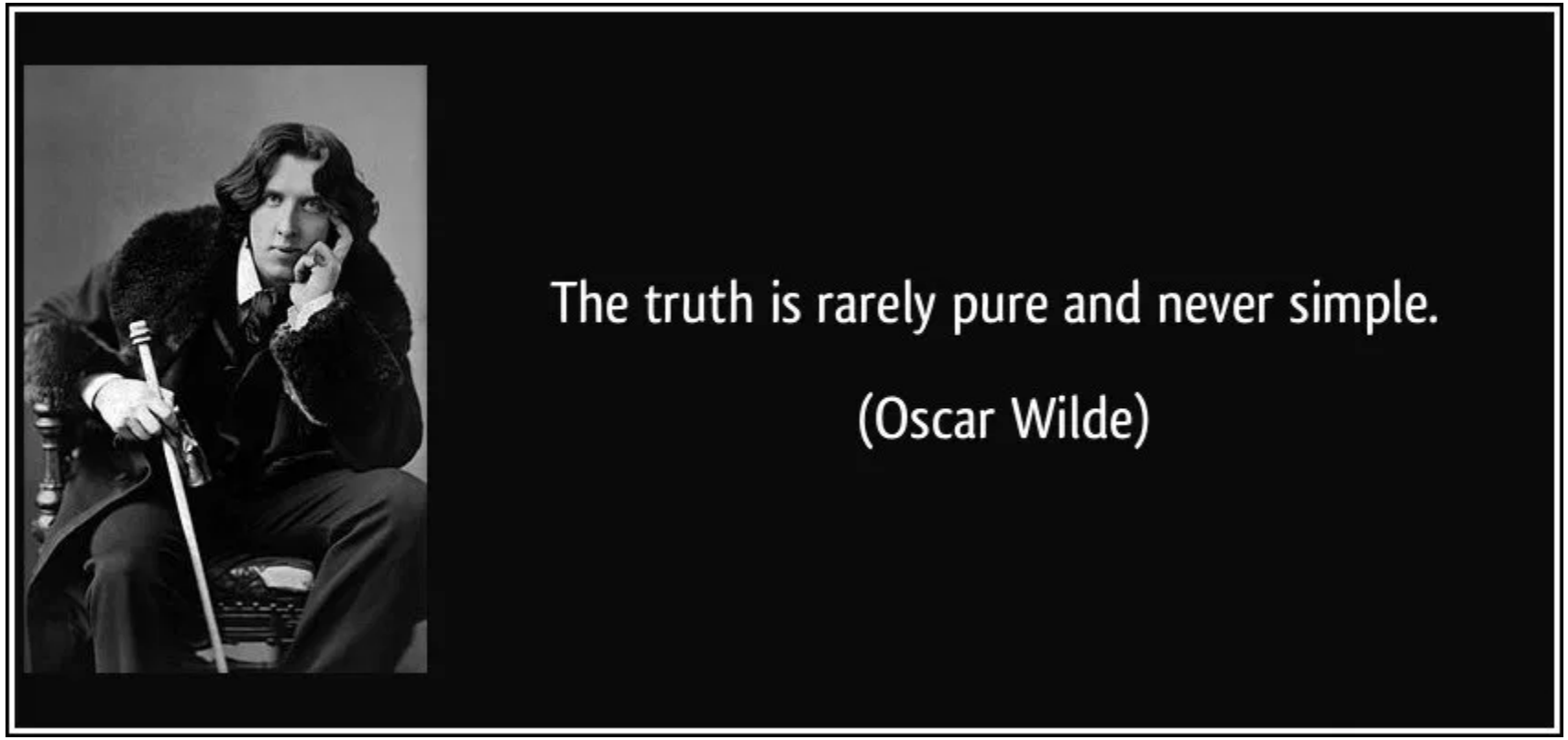
?body — constellation → Aquarius ∪

?body — parent*/constellation → Aquarius ∪

?body — $(\text{child}^-)^*$/constellation → Aquarius

4.- Contexto

La Verdad



Sin Contexto

Una proposición φ es verdadera.

- presidente(Clinton, US) es verdadera
- ilegal(Bitcoin) es verdadera
- nacidoEn(Obama, Kenia) es verdadera

Con Contexto

Una proposición φ es verdadera en un contexto c.

- presidente(Clinton, US) es verdadera
- ilegal(Bitcoin) es verdadera
- nacidoEn(Obama, Kenia) es verdadera

Con Contexto

Una proposición φ es verdadera en un contexto c.

- presidente(Clinton, US) es verdadera en el contexto `[1993, 2001]` (temporal)
- ilegal(Bitcoin) es verdadera
- nacidoEn(Obama, Kenia) es verdadera

Con Contexto

Una proposición φ es verdadera en un contexto c.

- presidente(Clinton, US) es verdadera en el contexto `[1993, 2001]` (temporal)
- Ilegal(Bitcoin) es verdadera en el contexto `Bolivia` (geográfico)
- nacidoEn(Obama, Kenia) es verdadera

Con Contexto

Una proposición φ es verdadera en un contexto c.

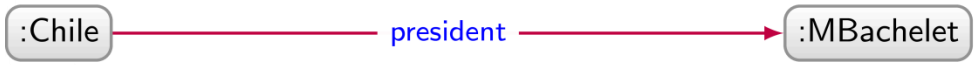
- presidente(Clinton, US) es verdadera en el contexto `[1993, 2001]` (temporal)
- Ilegal(Bitcoin) es verdadera en el contexto `Bolivia` (geográfico)
- nacidoEn(Obama, Kenia) es verdadera en el contexto `Breitbart` (procedencia)

Con Contexto

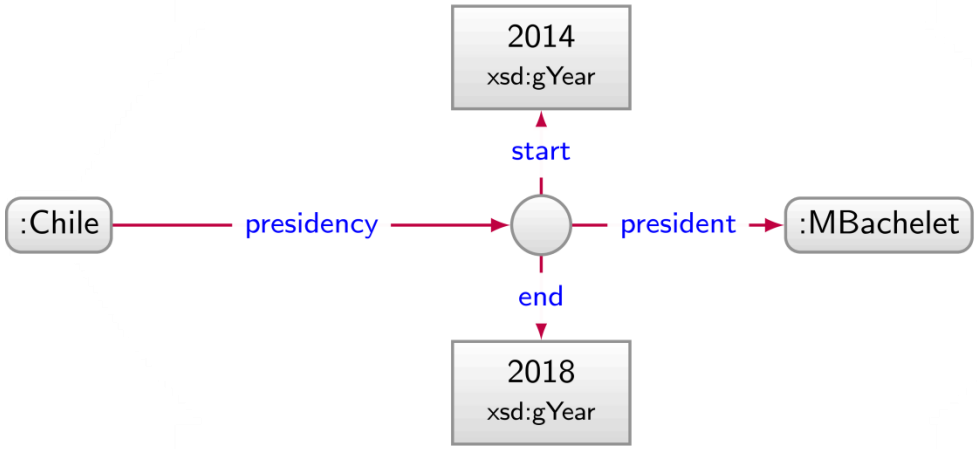
Una proposición φ es verdadera en un contexto c.

- presidente(Clinton, US) es verdadera en el contexto `[1993, 2001]` (temporal)
- Ilegal(Bitcoin) es verdadera en el contexto `Bolivia` (geográfico)
- nacidoEn(Obama, Kenia) es verdadera en el contexto `Breitbart` (procedencia)
- …

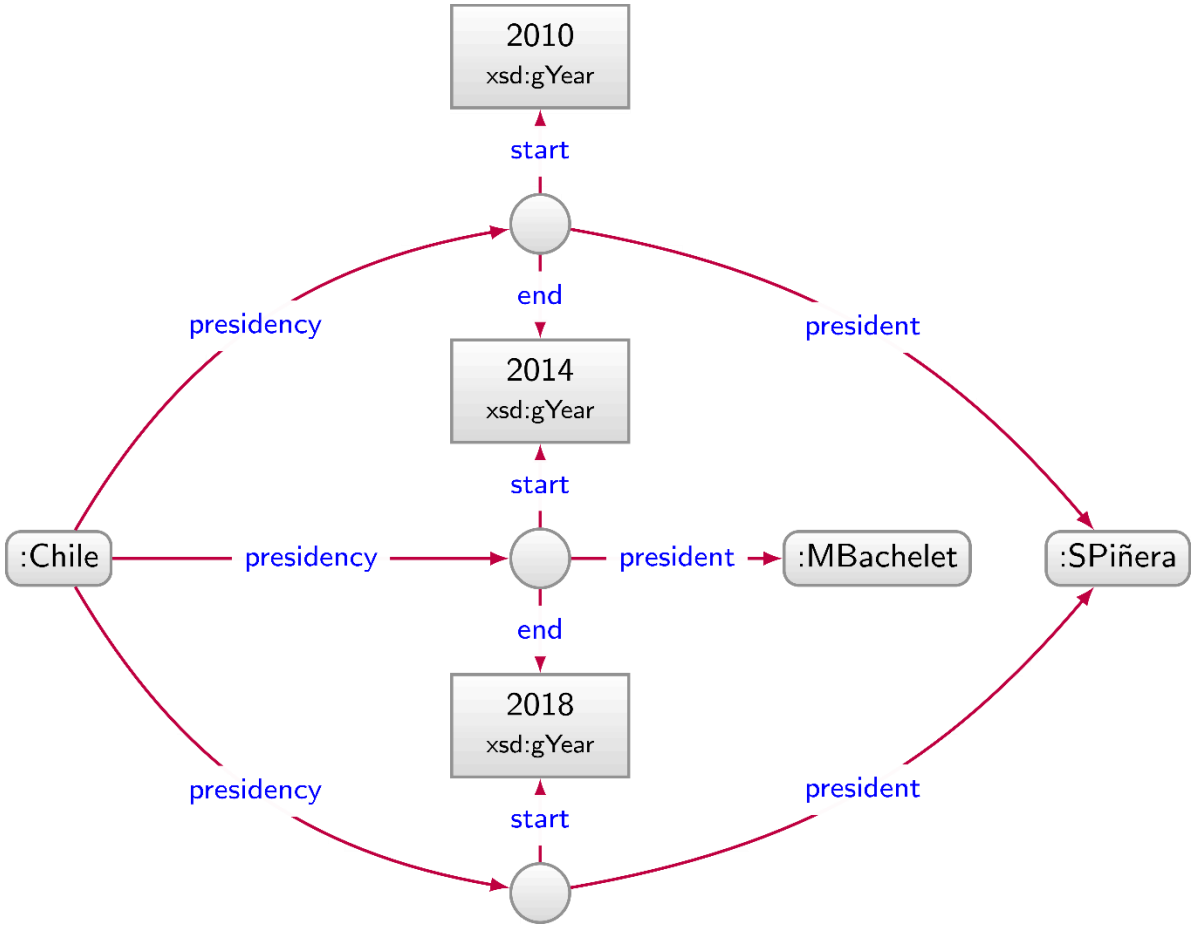
Contexto en grafos



Contexto en grafos



Contexto en grafos

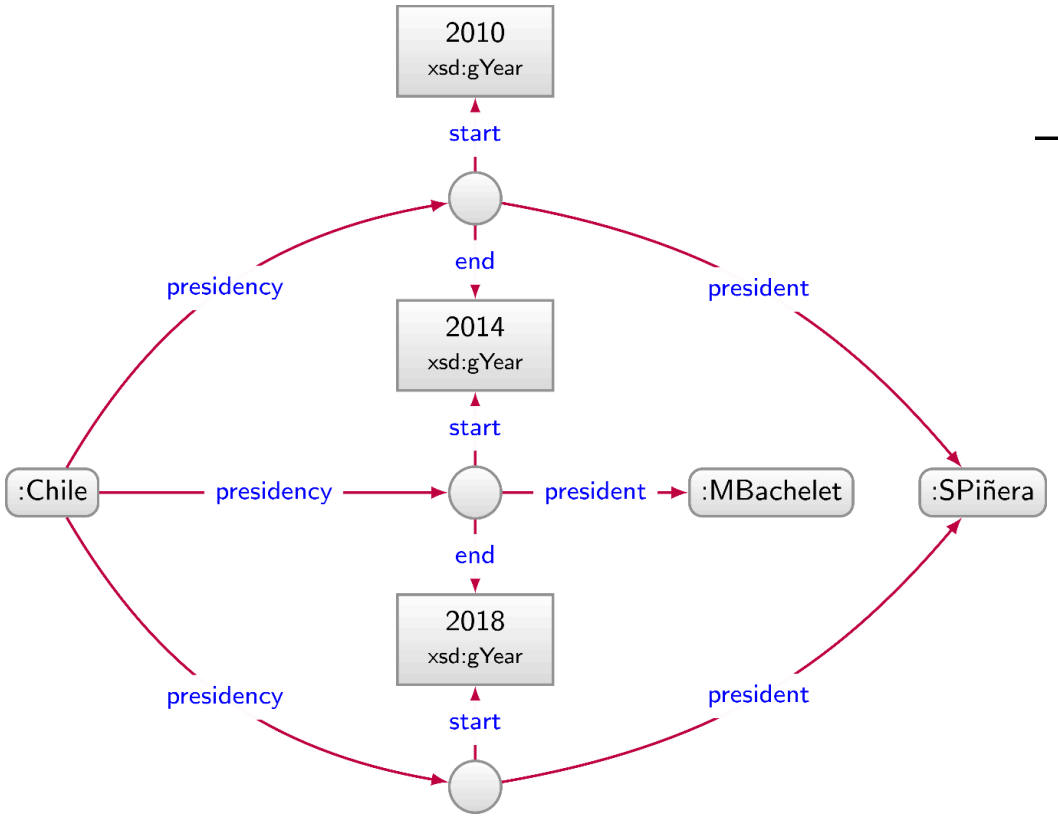


¿Es esto contexto? ¿son datos?

Representación de Contexto

S	P	O	E
:SPiñera	:president	:Chile	:E1
:SPiñera	:president	:Chile	:E2

E	Q	V
:E1	:start	"2010"^^xsd:gYear
:E1	:end	"2014"^^xsd:gYear
:E1	:replaces	:MBachelet
:E1	:replacedBy	:MBachelet
:E2	:replaces	:MBachelet
:E2	:start	"2018"^^xsd:gYear



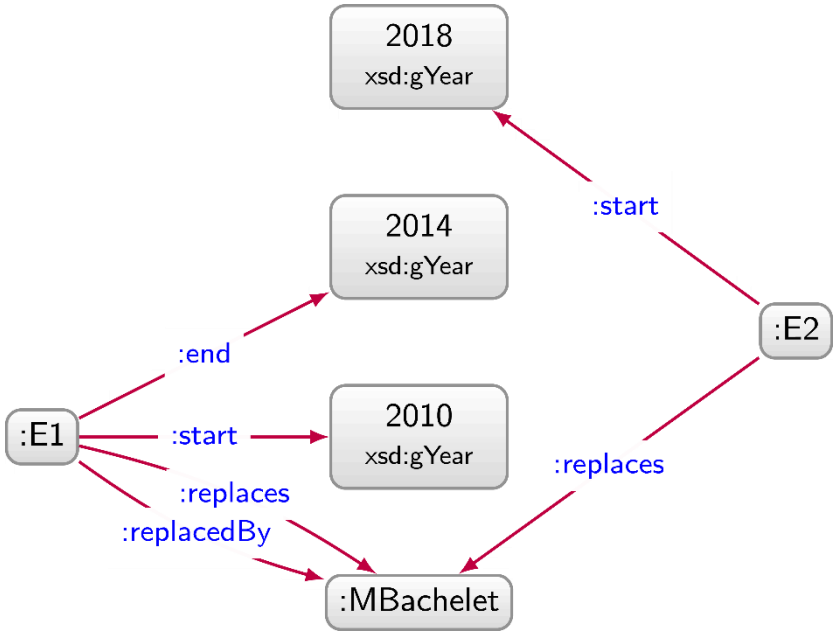
Representación de Contexto

S	P	O	E
:SPiñera	:president	:Chile	:E1
:SPiñera	:president	:Chile	:E2

¿Cómo representar esto como grafo?

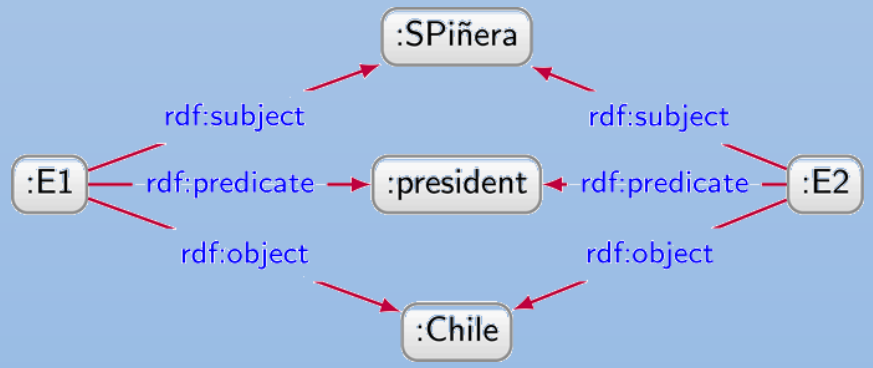
???

E	Q	V
:E1	:start	"2010"^^xsd:gYear
:E1	:end	"2014"^^xsd:gYear
:E1	:replaces	:MBachelet
:E1	:replacedBy	:MBachelet
:E2	:replaces	:MBachelet
:E2	:start	"2018"^^xsd:gYear

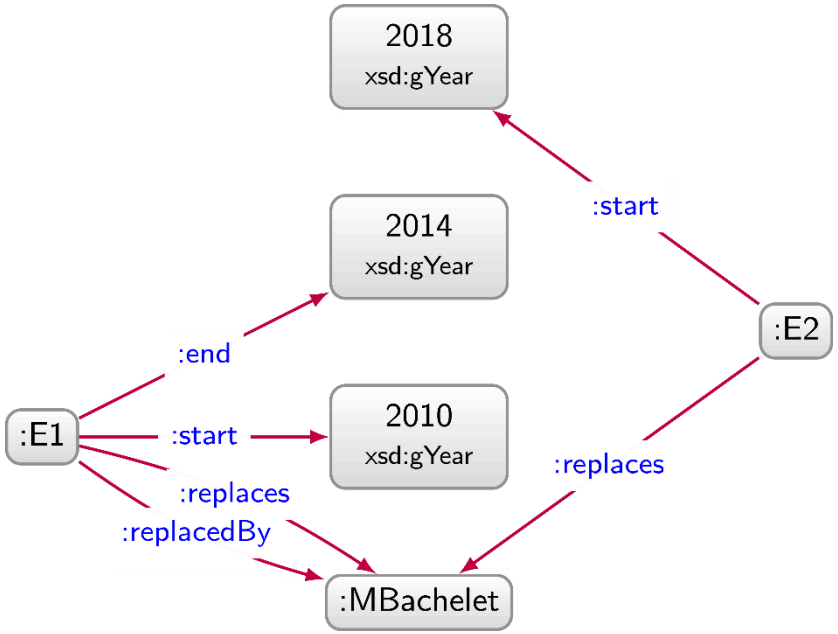


Reificación

S	P	O	E
:SPiñera	:president	:Chile	:E1
:SPiñera	:president	:Chile	:E2



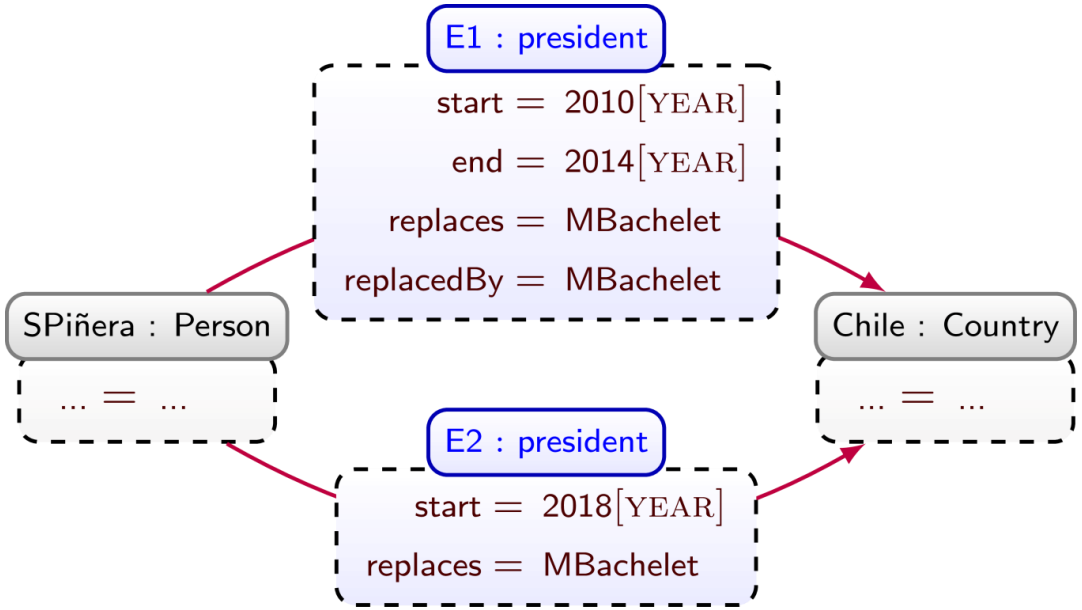
E	Q	V
:E1	:start	"2010"^^xsd:gYear
:E1	:end	"2014"^^xsd:gYear
:E1	:replaces	:MBachelet
:E1	:replacedBy	:MBachelet
:E2	:replaces	:MBachelet
:E2	:start	"2018"^^xsd:gYear



Grafos de Propiedades

S	P	O	E
:SPiñera	:president	:Chile	:E1
:SPiñera	:president	:Chile	:E2

E	Q	V
:E1	:start	"2010"^^xsd:gYear
:E1	:end	"2014"^^xsd:gYear
:E1	:replaces	:MBachelet
:E1	:replacedBy	:MBachelet
:E2	:replaces	:MBachelet
:E2	:start	"2018"^^xsd:gYear



RDF-star

S	P	O	E
:SPiñera	:president	:Chile	:E1
:SPiñera	:president	:Chile	:E2

E	Q	V
:E1	:start	"2010"^^xsd:gYear
:E1	:end	"2014"^^xsd:gYear
:E1	:replaces	:MBachelet
:E1	:replacedBy	:MBachelet
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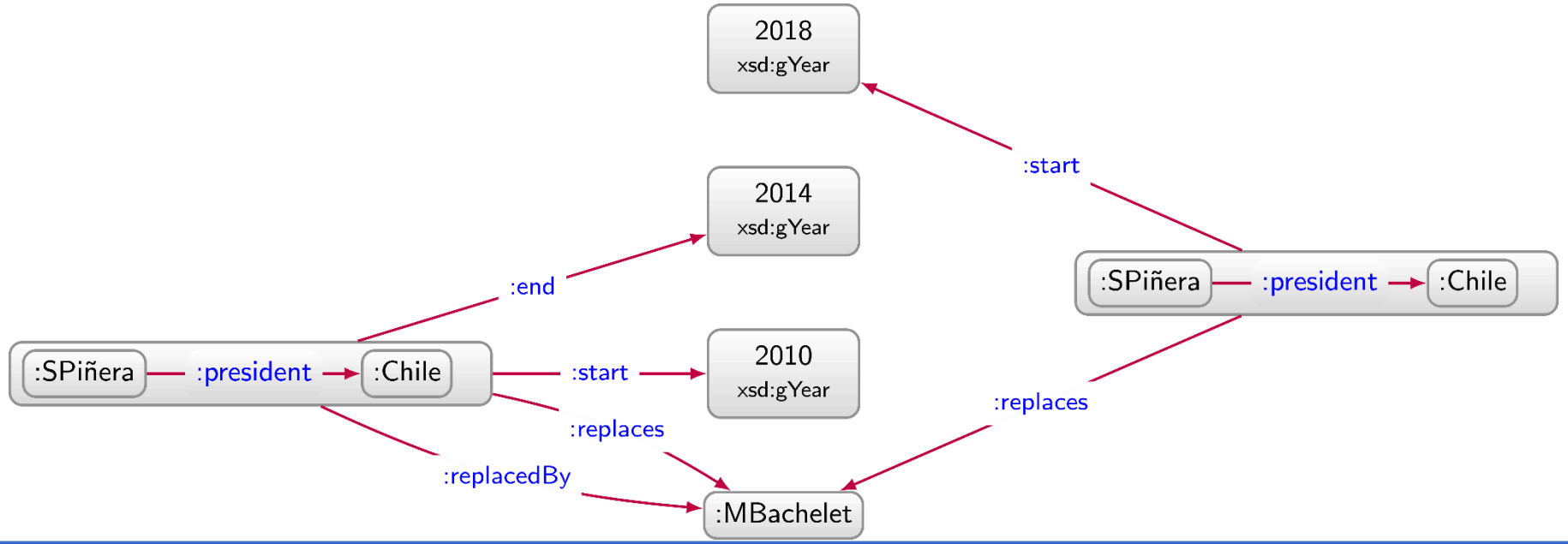
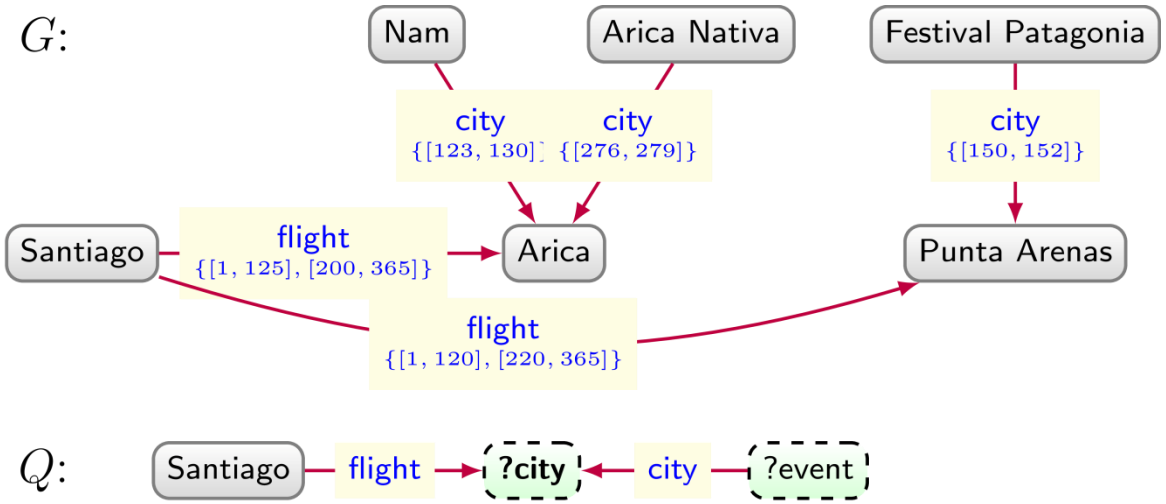


[Hartig 17]

Semántica Contextual Compleja

Semántica Contextual

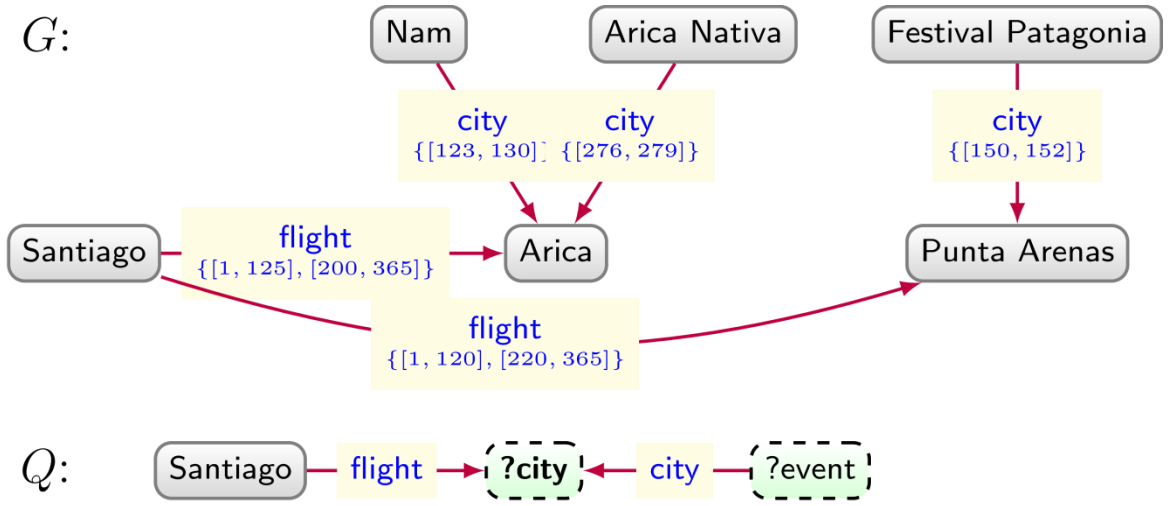


$Q(G)$:

?city	context
Arica	$\{[123, 125], [276, 279]\}$

[Zimmermann et al. 2012]

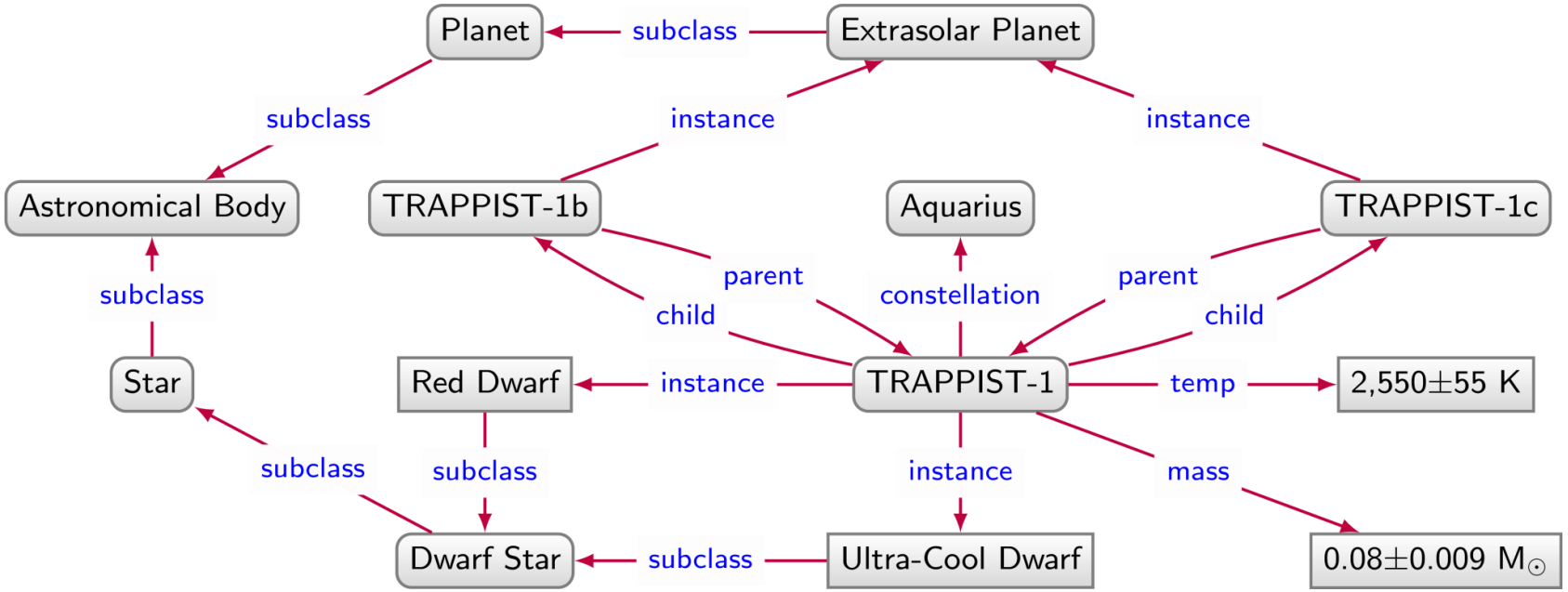
Semántica Contextual

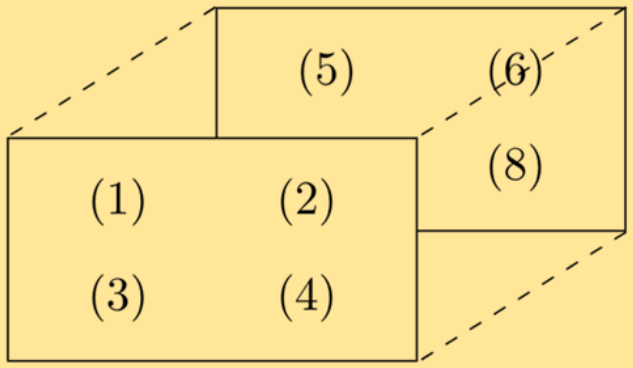


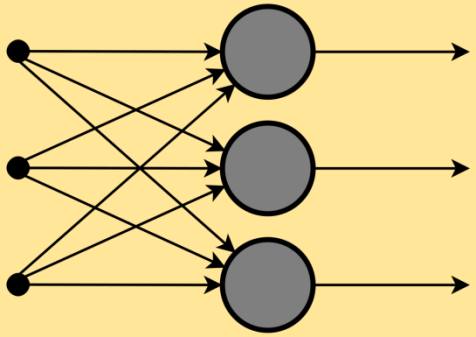
¿Cómo se puede manejar un contexto más complejo?

5.- Embeddings

Machine Learning en grafos

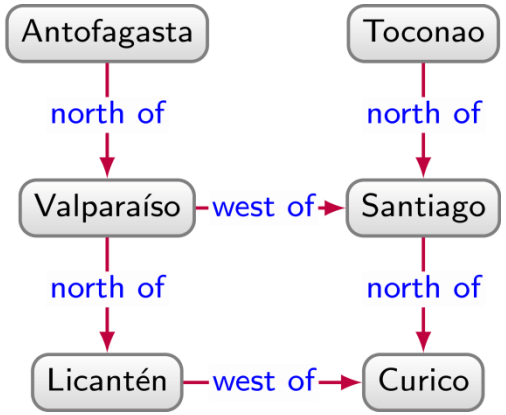




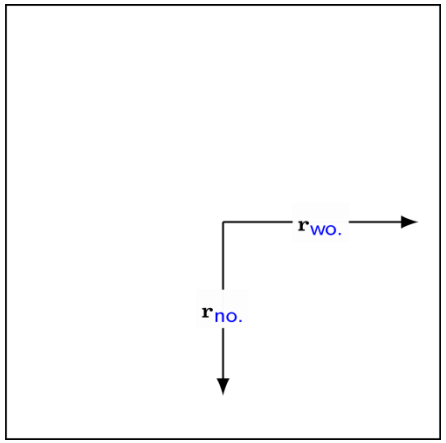


Embeddings Translacionales

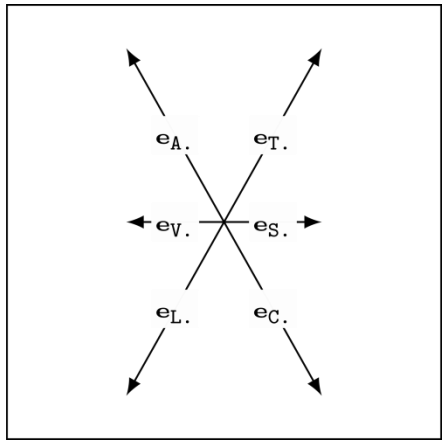
Grafo de Entrada



Embedding relaciones

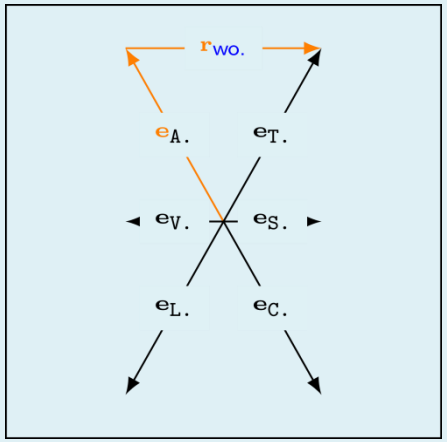


Embedding Entidades



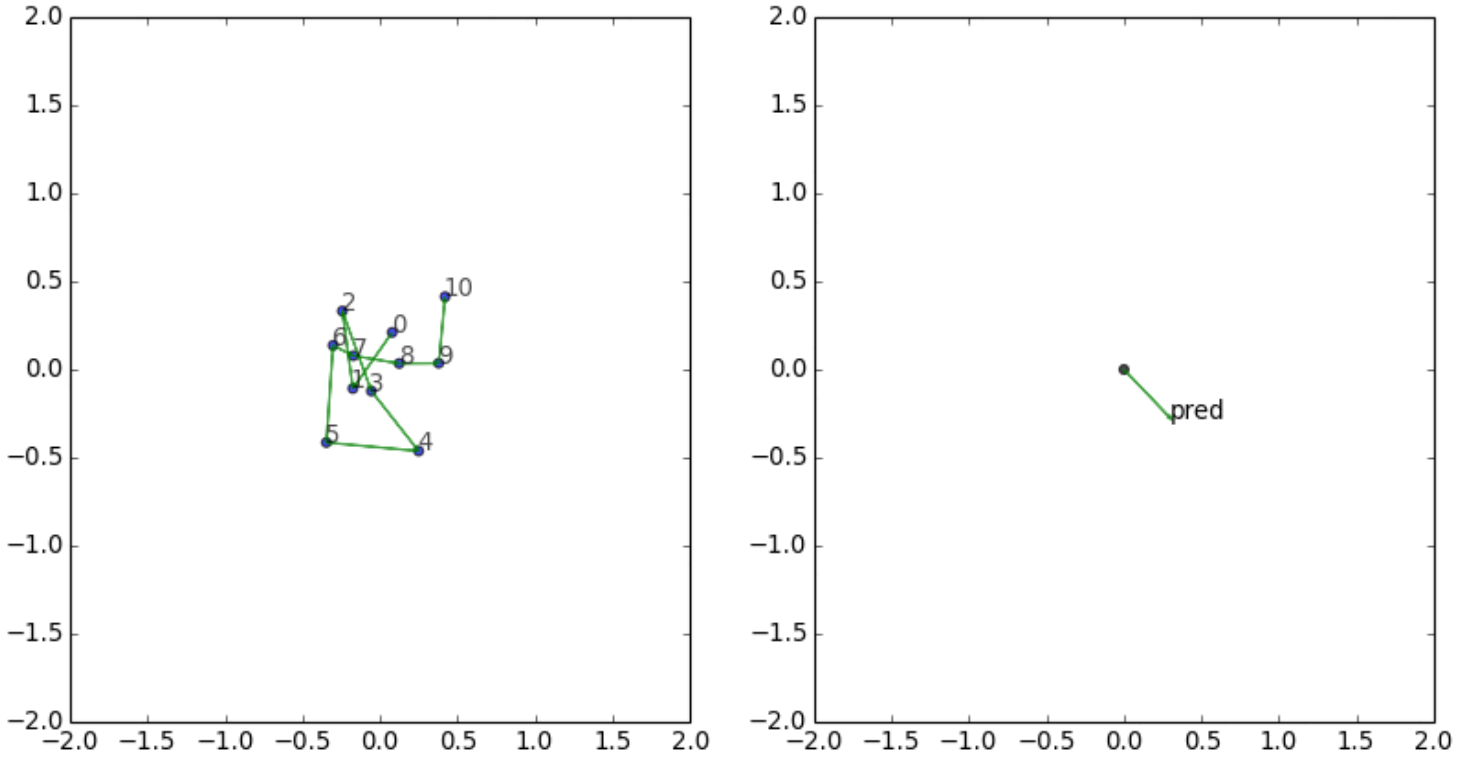
¿Qué está al este de Antofagasta?

Predicción de Links:



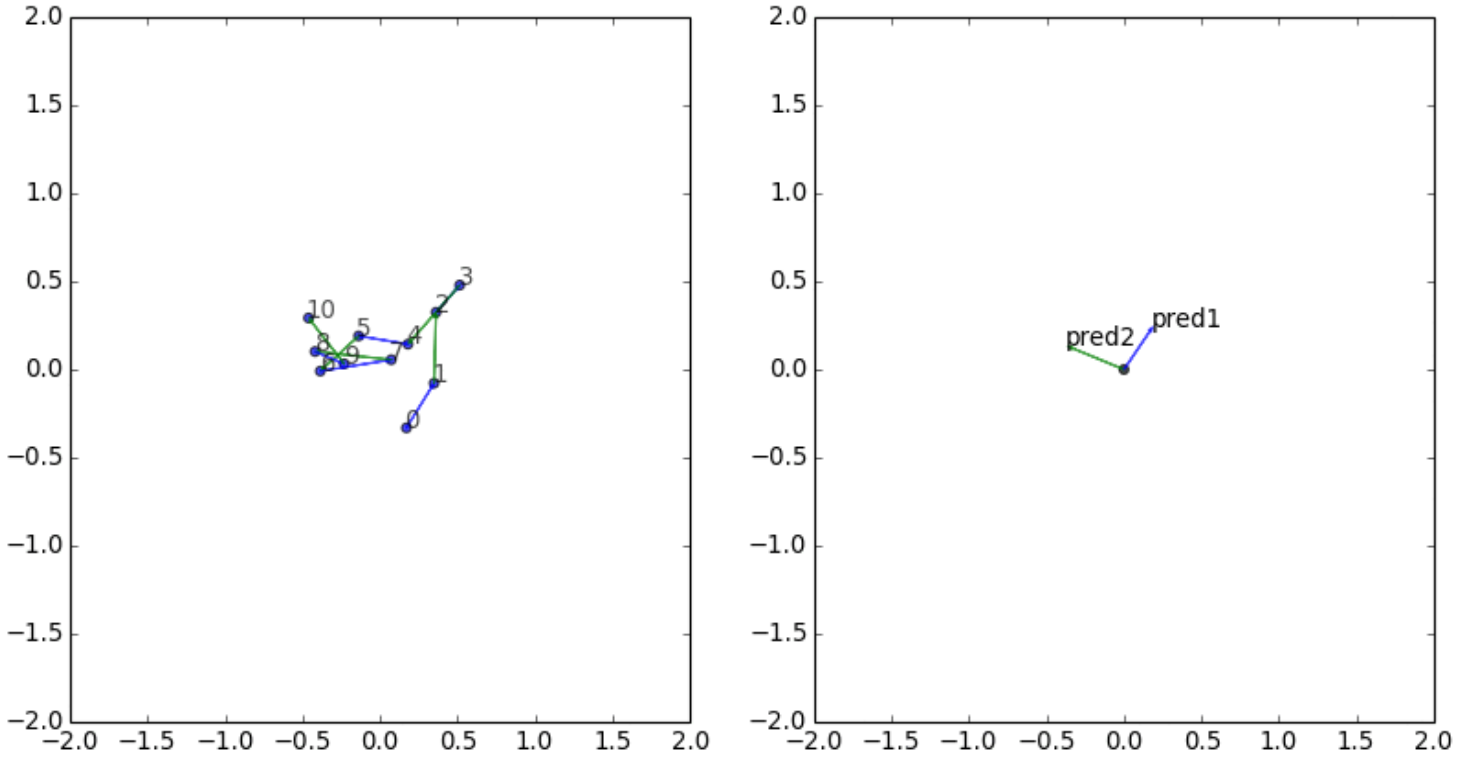
Mayor Viabilidad:

Embeddings Translacionales



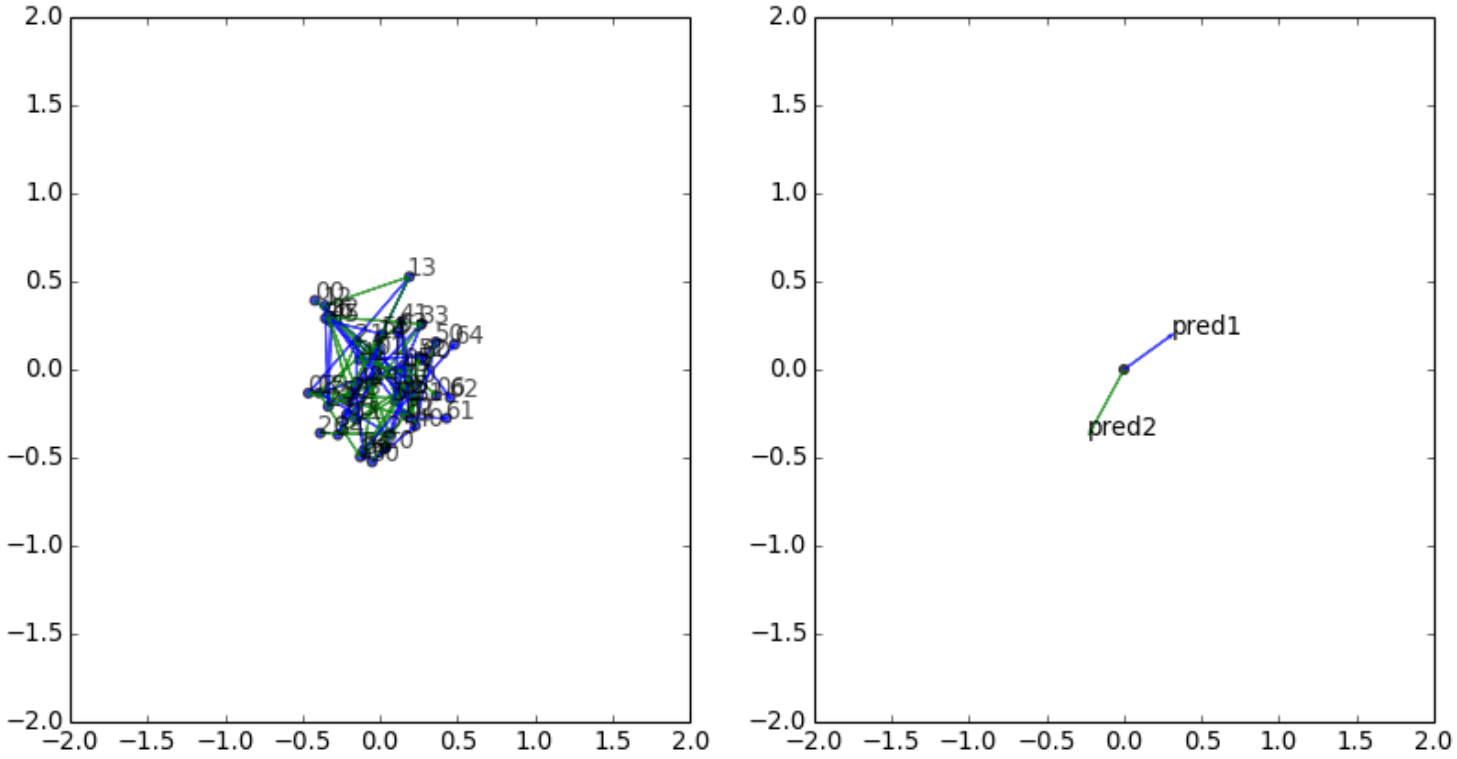
Dhand; https://www.ga-ccri.com/use-transe-effectively

Embeddings Translacionales



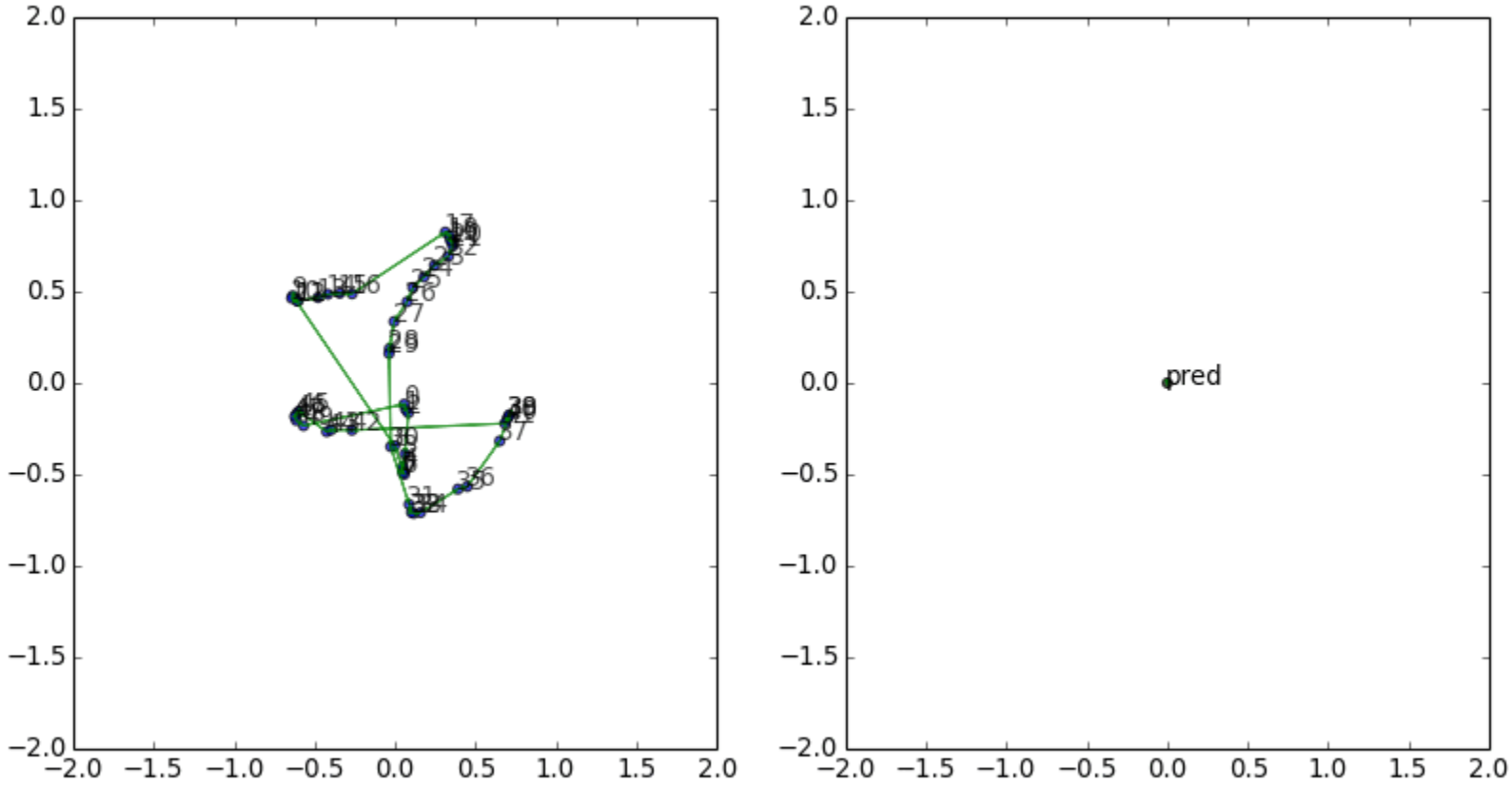
Dhand; https://www.ga-ccri.com/use-transe-effectively

Embeddings Translacionales



Dhand; https://www.ga-ccri.com/use-transe-effectively

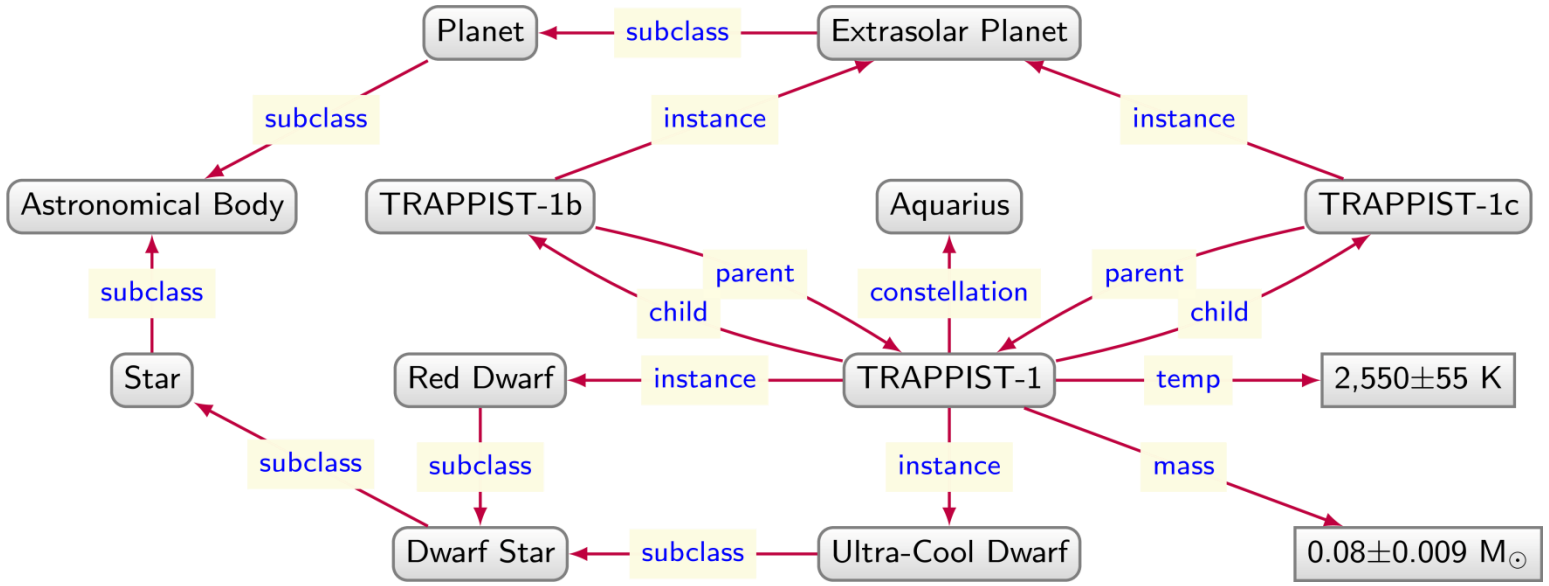
Embeddings Translacionales



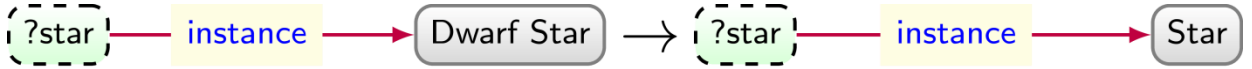
Dhand; https://www.ga-ccri.com/use-transe-effectively

Embeddings Semánticos

Viabilidad de triples implicados



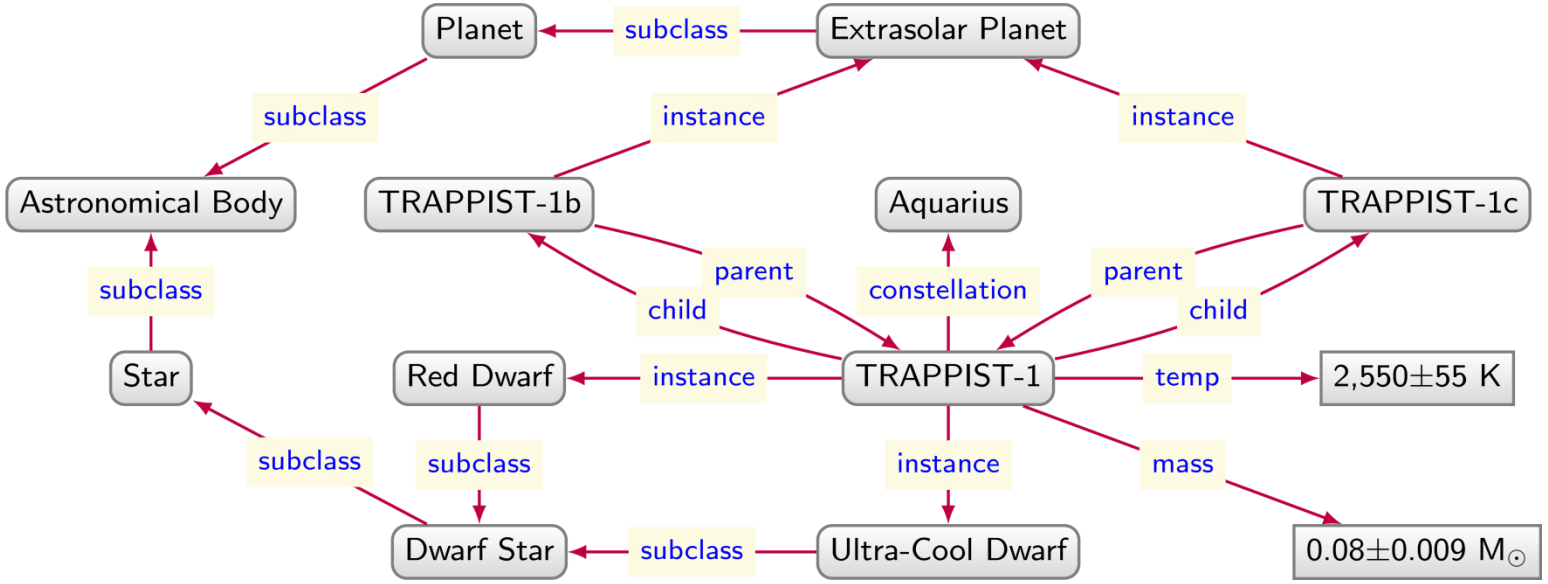
DwarfStar $\sqsubseteq$ Star



Debiera ser siempre más viable que:

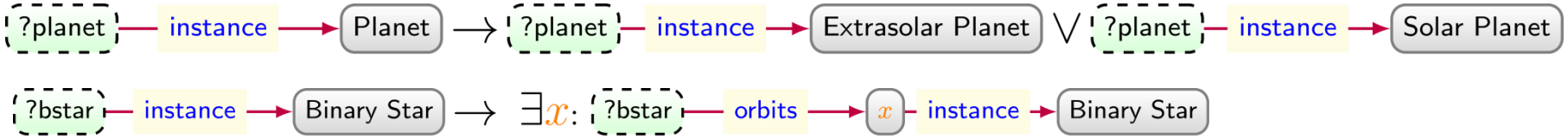
[Demeester et al. 2016]

Viabilidad de triples implicados



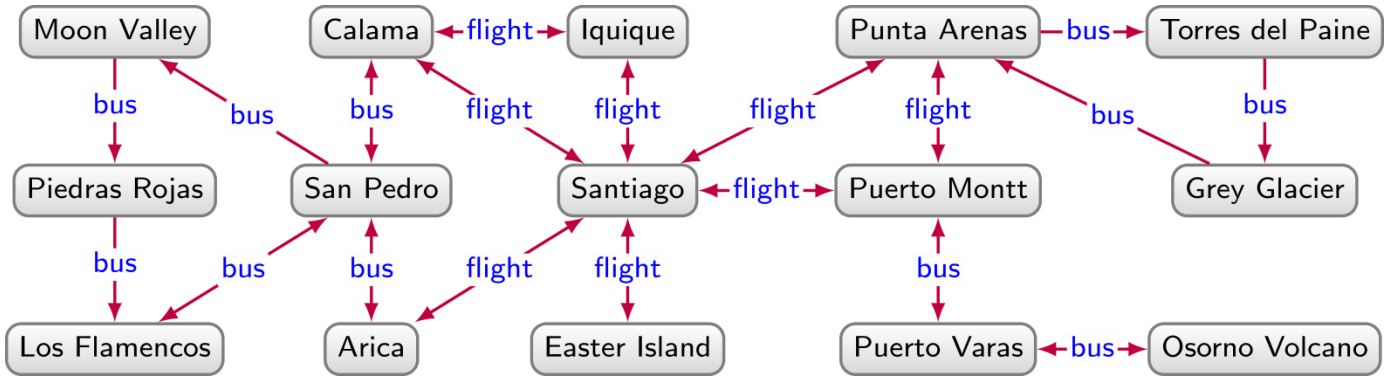
¿Reglas más complejas?

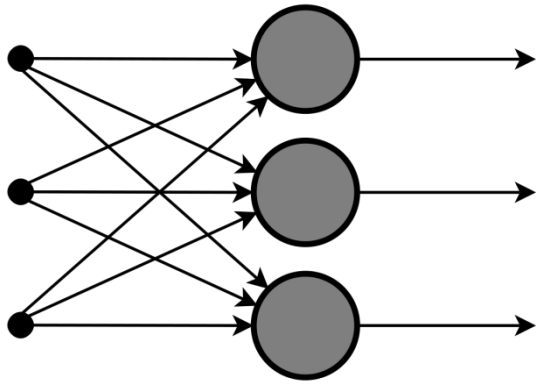
¿Reglas existenciales/disyuntivas?



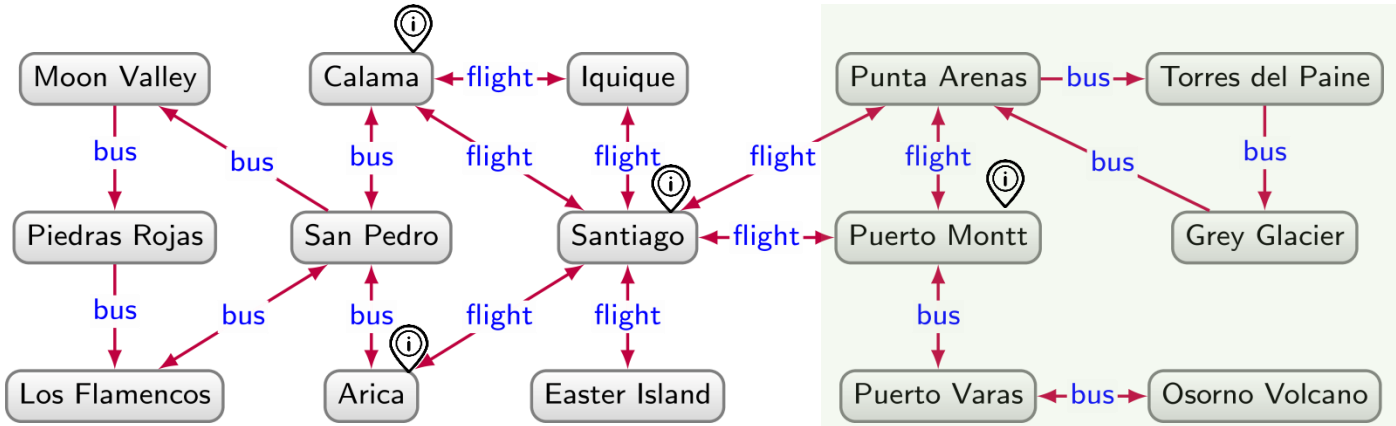
Graph Neural Networks

¡Las Redes Neuronales También son Grafos!

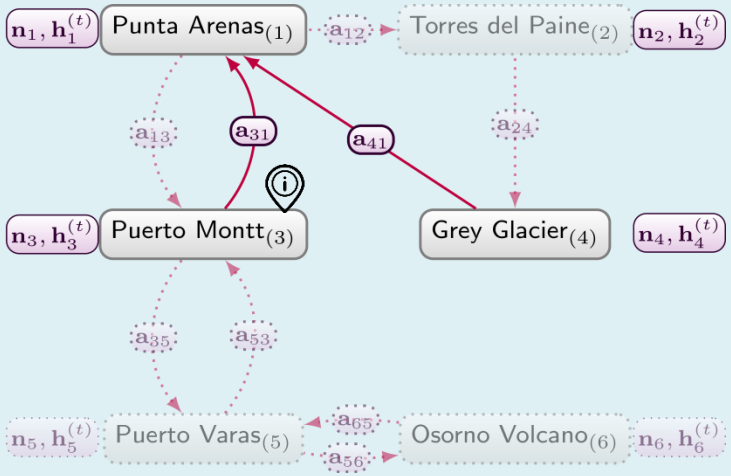




Recursive Graph Neural Networks



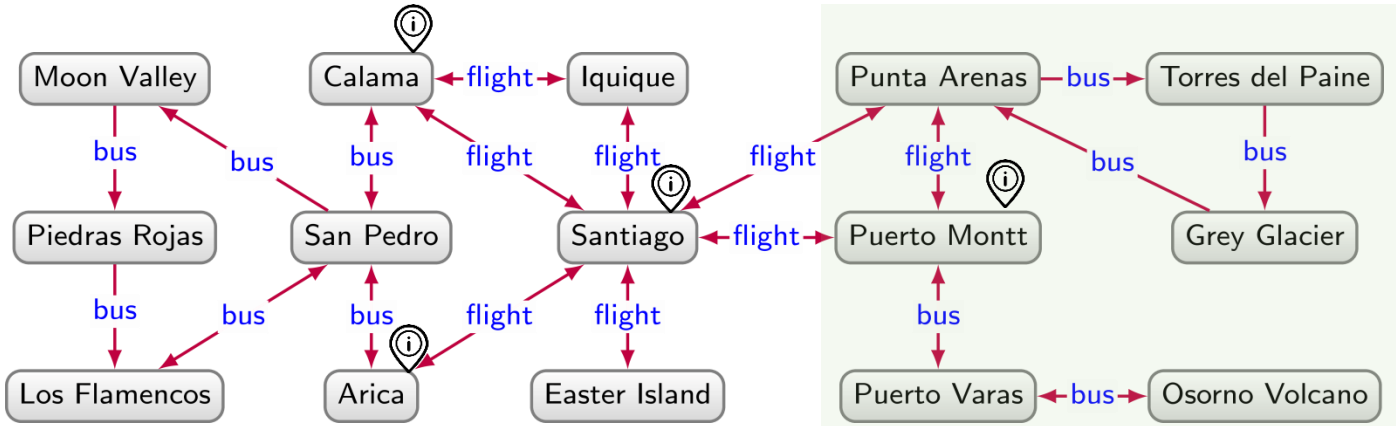
¿Dónde abrir la siguiente Oficina Turística?



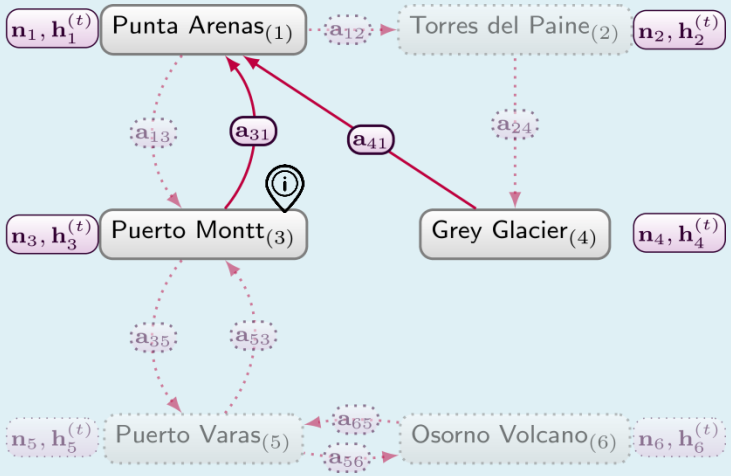
$$\mathbf{h}_x^{(t)} = \sum_{y \in \mathrm{N}(x)} f_{\mathbf{w}}(\mathbf{n}_x, \mathbf{n}_y, \mathbf{a}_{yx}, \mathbf{h}_y^{(t-1)})$$
$$\mathbf{o}_x^{(t)} = g_{\mathbf{w}'}(\mathbf{h}_x^{(t)}, \mathbf{n}_x)$$

[Scarselli et al. 2009]

Recursive Graph Neural Networks



¿Dónde abrir la siguiente Oficina Turística?

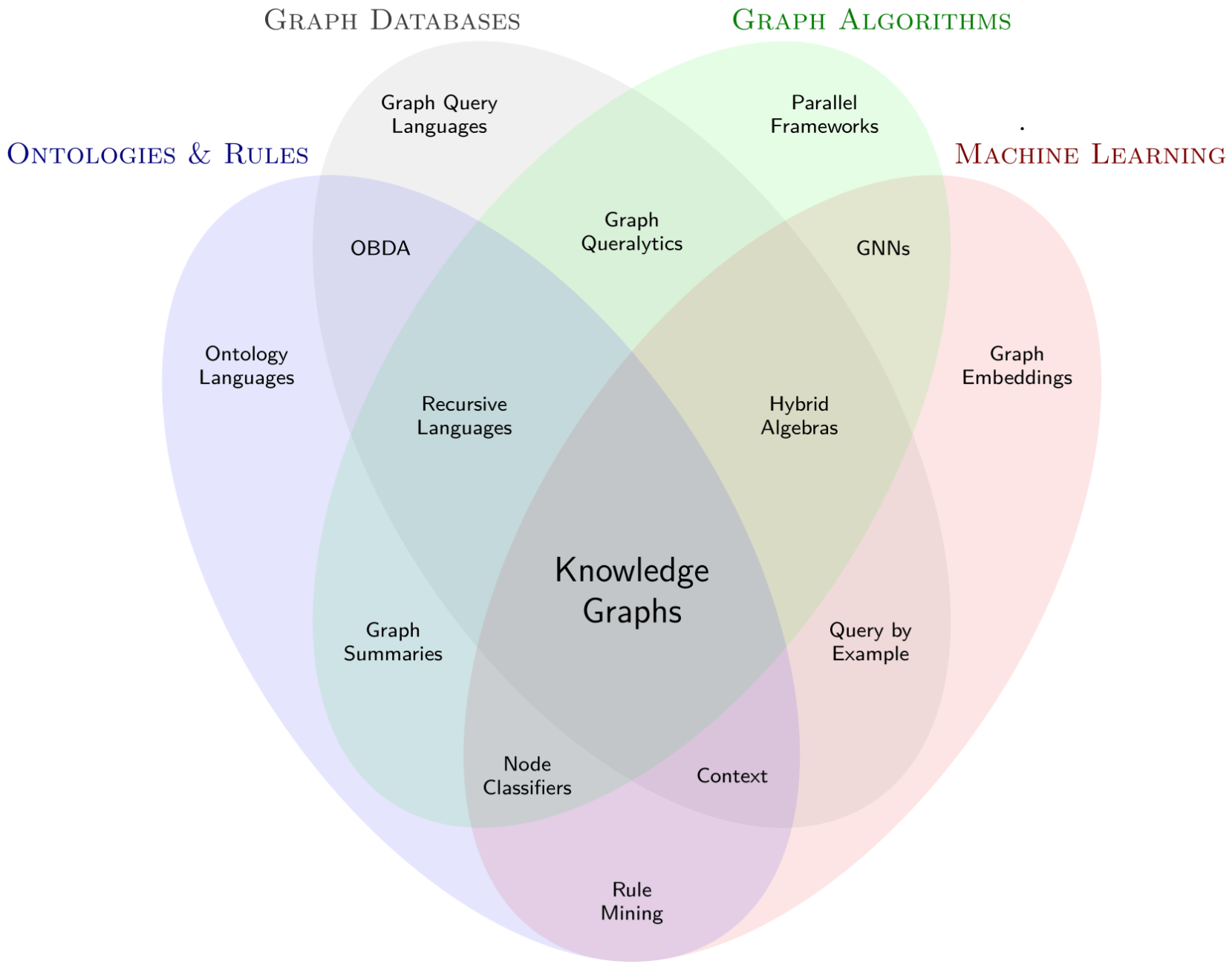


$$\mathbf{h}_x^{(t)} = \sum_{y \in \mathrm{N}(x)} f_{\mathbf{w}}(\mathbf{n}_x, \mathbf{n}_y, \mathbf{a}_{yx}, \mathbf{h}_y^{(t-1)})$$
$$\mathbf{o}_x^{(t)} = g_{\mathbf{w}'}(\mathbf{h}_x^{(t)}, \mathbf{n}_x)$$

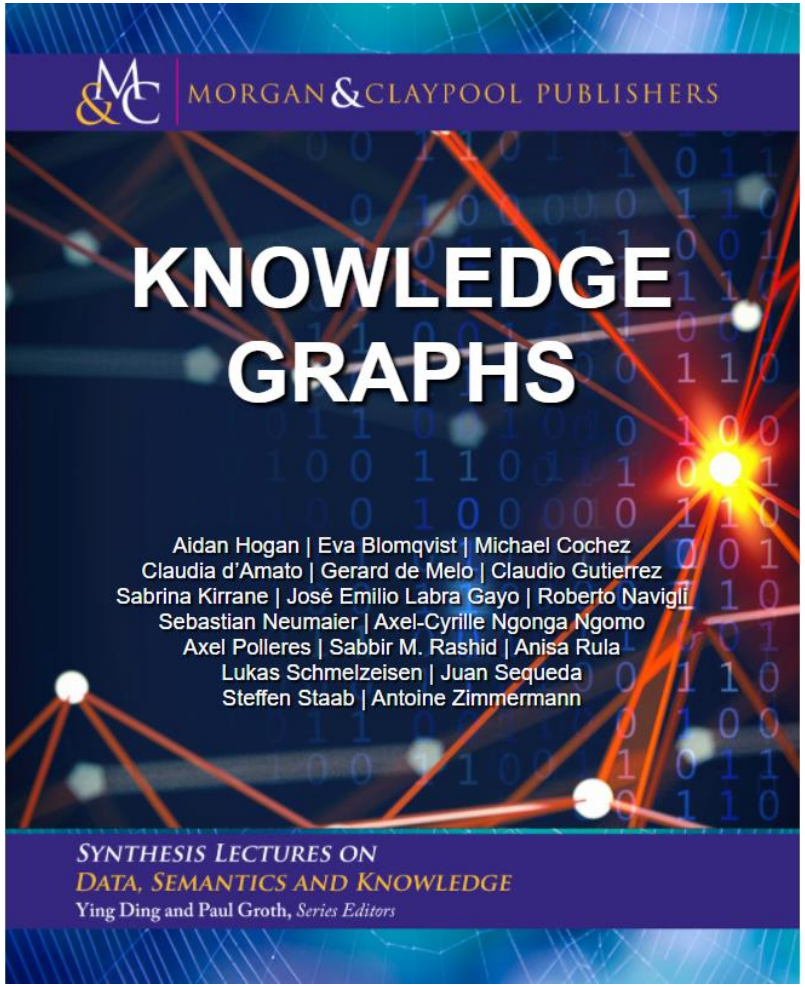
$$\mathbf{h}_1^{(t)} = f_{\mathbf{w}}(\mathbf{n}_1, \mathbf{n}_3, \mathbf{a}_{31}, \mathbf{h}_3^{(t-1)}) + f_{\mathbf{w}}(\mathbf{n}_1, \mathbf{n}_4, \mathbf{a}_{41}, \mathbf{h}_4^{(t-1)})$$
$$\mathbf{o}_1^{(t)} = g_{\mathbf{w}'}(\mathbf{h}_1^{(t)}, \mathbf{n}_1)$$
$$\ldots$$

[Scarselli et al. 2009]

Conclusión


Graph Databases
Graph Algorithms
Ontologies & Rules
Machine Learning
Graph Query Languages
Parallel Frameworks
OBDA
Graph Queralytics
GNNs
Ontology Languages
Graph Embeddings
Recursive Languages
Hybrid Algebras
Knowledge Graphs
Graph Summaries
Query by Example
Node Classifiers
Context
Rule Mining

Bibliografía Extra



http://kgbook.org/