

Introduction to Ontologies & Reasoning

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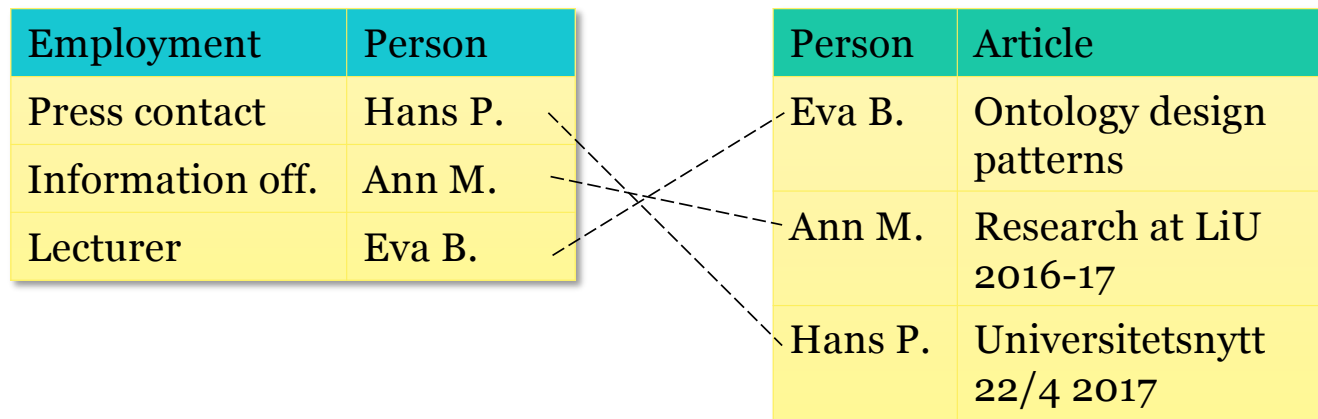
Outline

- Motivation
 - Knowledge graphs revisited – this time with an ontology
 - Data integration example with real-world open data
 - Tables to graph: Is any graph a good graph?
 - Vocabulary of the dataset
 - Going from vocabulary to ontology
- Ontologies
 - The building blocks of an ontology
 - What is reasoning?

(naive) Example

Relational data (tables) vs. Knowledge Graphs and ontology

We have a lot of data and want to be able to ask for all **research articles**



(naive) Example

Relational data (tables) vs. Knowledge Graphs and ontology

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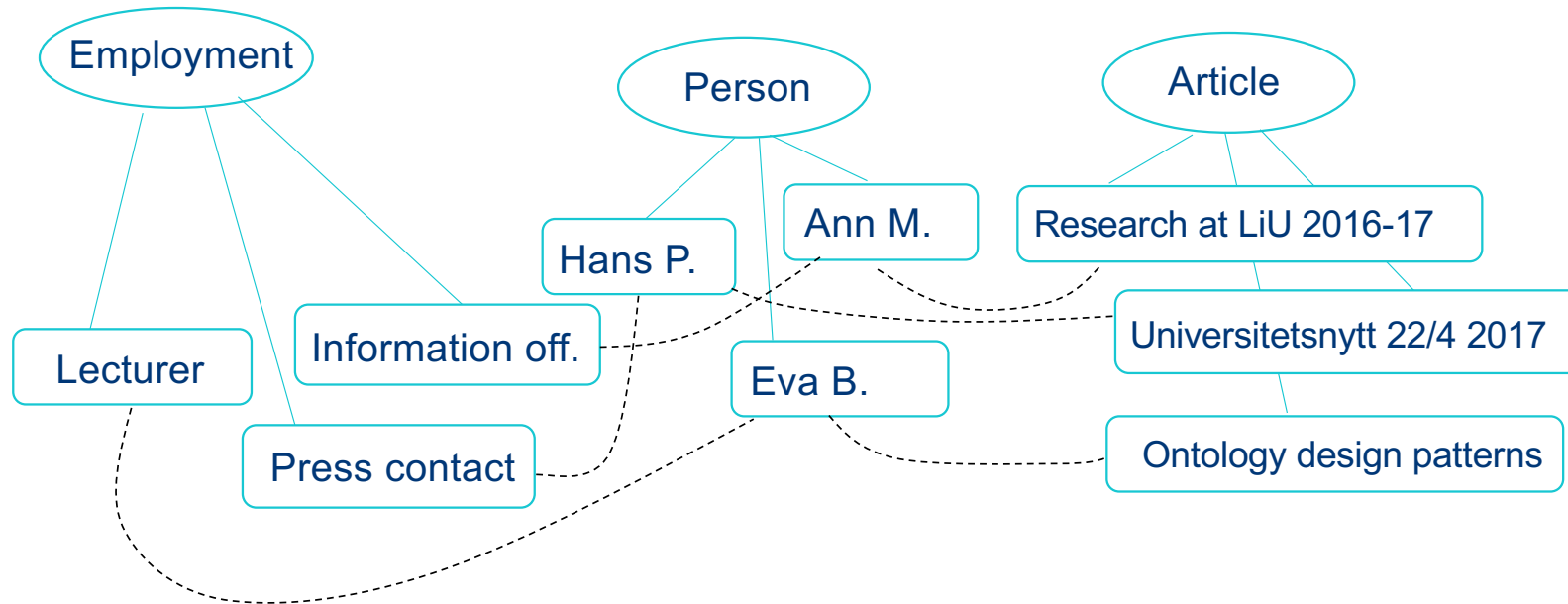
Employment	Person
Press contact	Hans P.
Information off.	Ann M.
Lecturer	Eva B.

Person	Article	Res. art.
Eva B.	Ontology design patterns	yes
Ann M.	Research at LiU 2016-17	no
Hans P.	Universitetsnytt 22/4 2017	no



(naive) Example

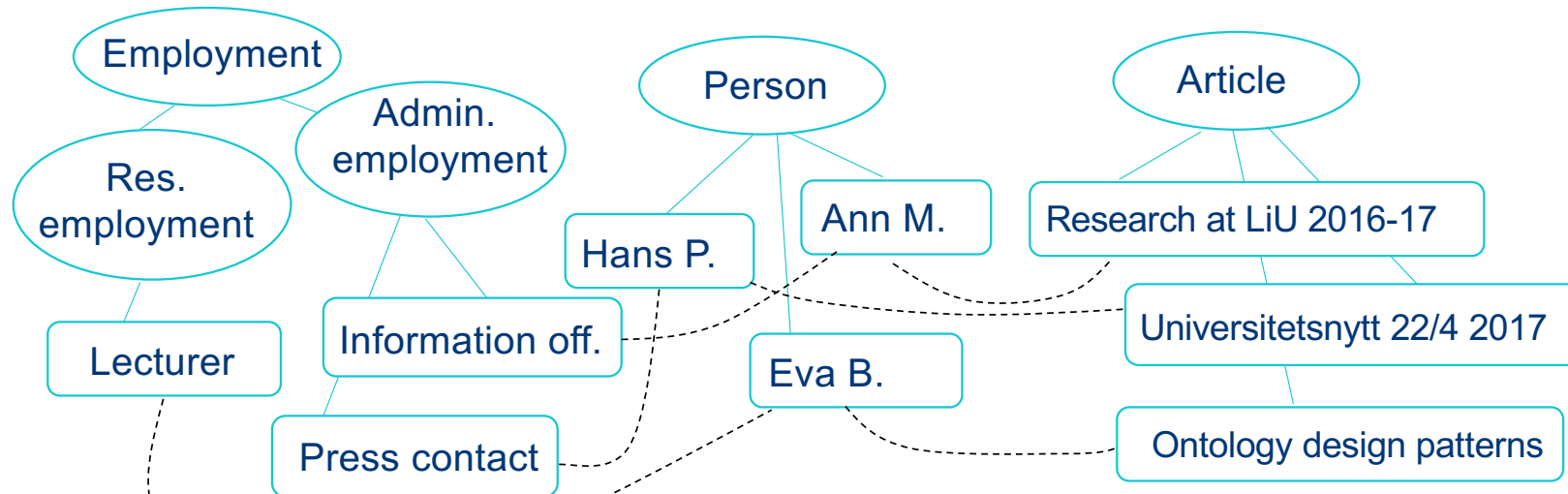
We have a lot of data and want to be able to ask for all **research articles**



(naive) Example



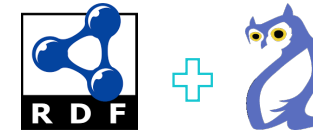
We have a lot of data and want to be able to ask for all **research articles**



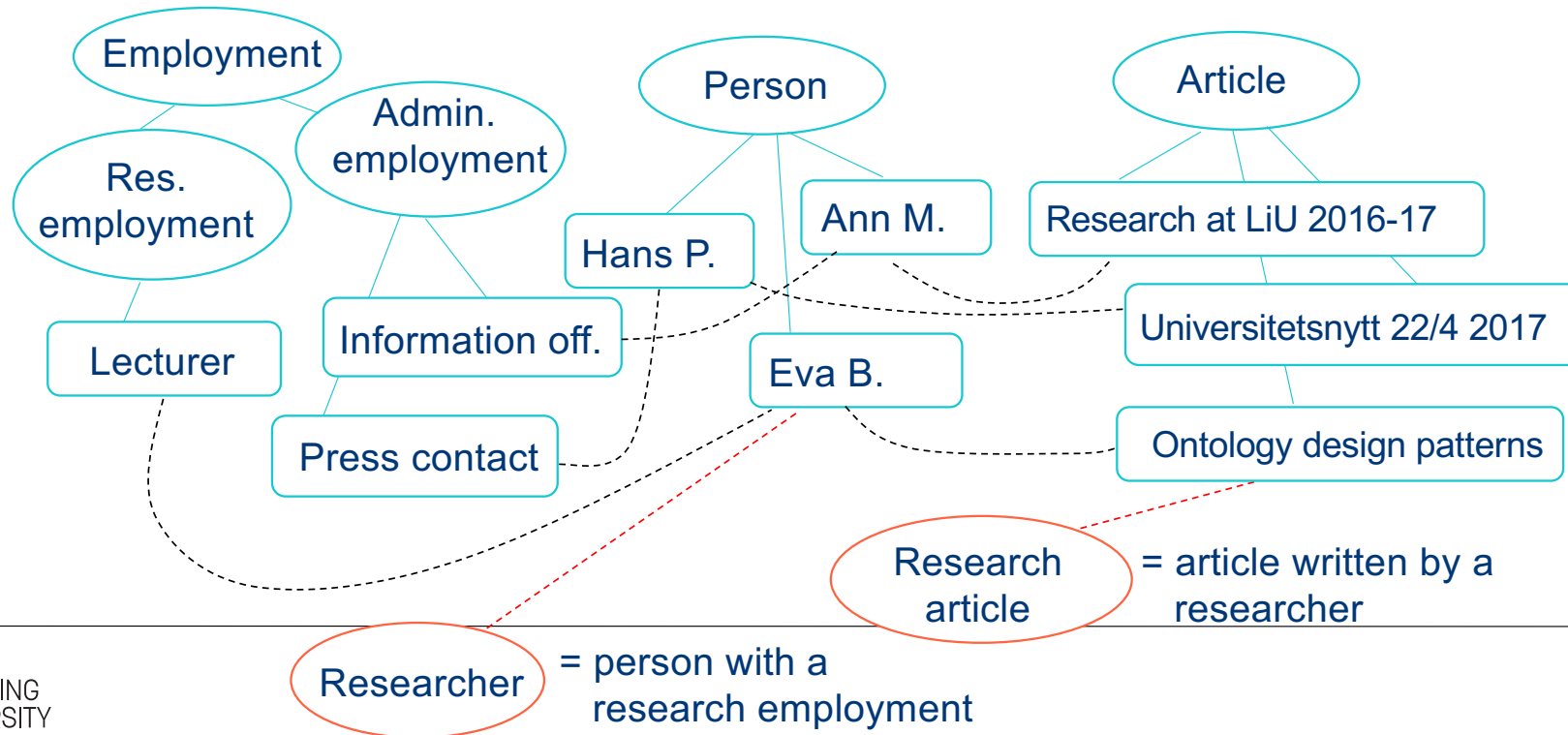
Research article = article written by a researcher

Researcher = person with a research employment

(naive) Example



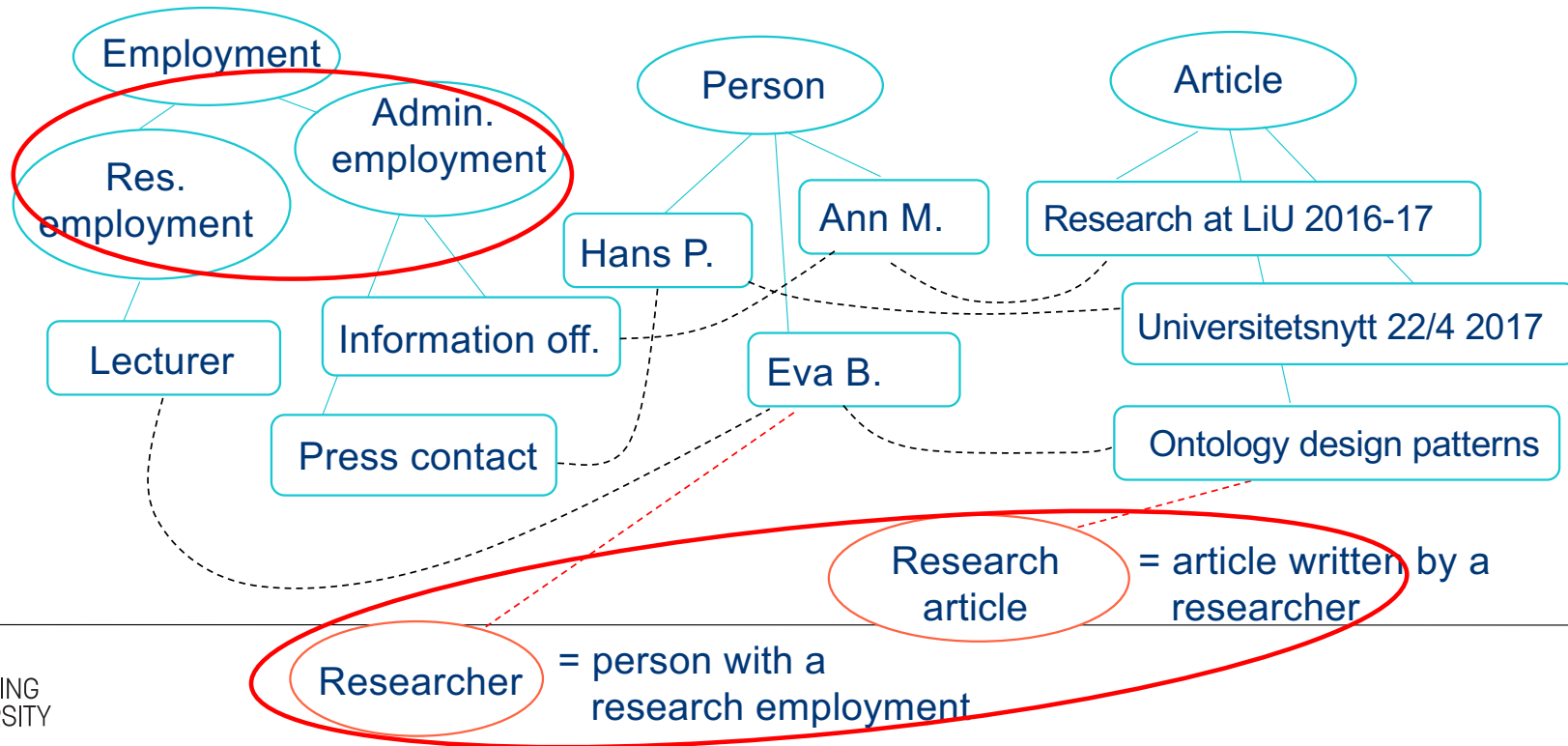
We have a lot of data and want to be able to ask for all **research articles**



(naive) Example



We have a lot of data and want to be able to ask for all **research articles**



Charging stations for electric cars - Helsingborg

laddpl

OBJECTID	Parkeringstyp	Namn	Agartyp	Antal_plats	Tid	Avgift	Automatnr	Publik	Status	Kommentar	Uppdaterat_datum
26	laddpl	Stortorget	hbg	4		ja		ja	oppen		20201021113600
1263	laddpl	Södra parkeringen laddplatser	hbg	4	0-24	ja		ja	avst		20180919123853
2863	laddpl	Gustav Adolfs torg	hbg	2	2 tim	ja		ja	oppen		20210225073120
2864	laddpl	Idrottens hus	hbg	2	2 tim	ja		ja	oppen		20210225073455
2865	laddpl	Nicolaiskolan	hbg	4		ja		ja	oppen		20210225073743

Charging stations for electric cars - Tomelilla

LADDSTATIONS NAMN	GATU NAMN	HUS- NUM- MER	POST- NUM- MER	GPS- POSITION LATITUD	GPS- POSITION LONGITUD	ÄGARE	ANTAL LADD- PUNKTER	PLATS- BESKRIV- NING	TILL- GÅNG- LIGHET	ÖPPET 24H	PARKE- RINGS- AVGIFT	TIDSBE- GRÄNS- NING	REALTIDS- INFORMA- TION	LADD- PUNKT 1	LADD- PUNKT 2	LADD- PUNKT 3
Tomelilla station	Tomelilla Station		273 80	55.546272	13.948694	Tomelilla Kommun		Tomelilla 2station	Ja	Ja	Nej	Nej	Nej	Semisnabblad dare	Semisnabbla ddare	
Laddstolpe på parkeringen vid Tomelilla kommunhus. Vid änden närmast Coop	Gustafs Torg	16	27380	55.542676	13.955116	Tomelilla Kommun		1Torget	Ja	Ja	Nej	Nej	Nej	Snabbladdare		
Svamparondellen	Svampako rset	11	27397	55.560043	13.912323	Tomelilla Kommun		Svamparo 2ndellen	Ja	Ja	Nej	Nej	Nej	socket:chade mo, 1 - socket:chade mo:output 50 kW	socket:type2_combo, 1 - socket:type2_combo:outp ut - 50 kW	
Brösarps torg	Brösarps Torg		27350	55.725459	14.101312	Tomelilla Kommun		Svamparo 1ndellen	Ja	Ja	Nej	Nej	Nej	Semisnabblad dare		
Skåne-Tranås Gästgivarevägen	Gästgivare vägen	2	27392	55.615042	13.996657	Tomelilla Kommun		Svamparo 1ndellen	Ja	Ja	Nej	Nej	Nej	Semisnabblad dare		
Smedstorps station	Smedstor p Station		27398	55.549668	14.116864	Tomelilla Kommun		Svamparo 1ndellen	Ja	Ja	Nej	Nej	Nej	Semisnabblad dare		

Charging stations for electric cars – integration?

LADDSTATIONS NAMN	GATU NAMN	HUS- NUM- MER	POST- NUM- MER	GPS- POSITION LATITUD	GPS- POSITION LONGITUD	ÄGARE	ANTAL LADD- PUNKTER	PLATS- BESKRIV- NING	TILL- GÅNG- LIGHET	ÖPPET 24H	PARKE- RINGS- AVGIFT	TIDSBE- GRÄNS- NING	REALTIDS- INFORMA- TION	LADD- PUNKT 1	LADD- PUNKT 2	LADD- PUNKT 3
Tomelilla station	Tomelilla Station		273 80	55.546272	13.948694	Tomelilla Kommun	2	station	Ja	Ja	Nej	Nej	Nej	Semisnabblad dare	Semisnabblad dare	
Laddstolpe på parkeringen vid Tomelilla kommunhus. Vid änden närmast Coop	Gustafs Torg	16	27380	55.542676	13.955116	Tomelilla Kommun	1	Torget	Ja	Ja	Nej	Nej	Nej	Snabbladdare		
Svamparondellen	Svamp rset													socket:chade mo, 1 -		
Brösarps torg	Brösarps torg															
Skåne-Tranås Gästgivarevägen	Gästgi vägen															
Smedstorps station	Smeds Station		27398	55.549668	14.116864	Kommun		indellen	Ja	Ja	Nej	Nej	Nej	dare		

OBJECTID	Parkeringstyp	Namn	Agartyp	Antal_plats	Tid	Avgift	Automatnr	Publik	Status	Kommentar	Uppdaterat_datum
26	laddpl	Stortorget	hbg	4		ja		ja	oppen		20201021113600
1263	laddpl	Södra parkeringen laddplatser	hbg	4	0-24	ja		ja	avst		20180919123853
2863	laddpl	Gustav Adolfs torg	hbg	2	2 tim	ja		ja	oppen		20210225073120
2864	laddpl	Idrottens hus	hbg	2	2 tim	ja		ja	oppen		20210225073455
2865	laddpl	Nicolaiskolan	hbg	4		ja		ja	oppen		20210225073743

Not present

Not present

Not present

Somehow related?

Implicit

Not present

Not present

Not present

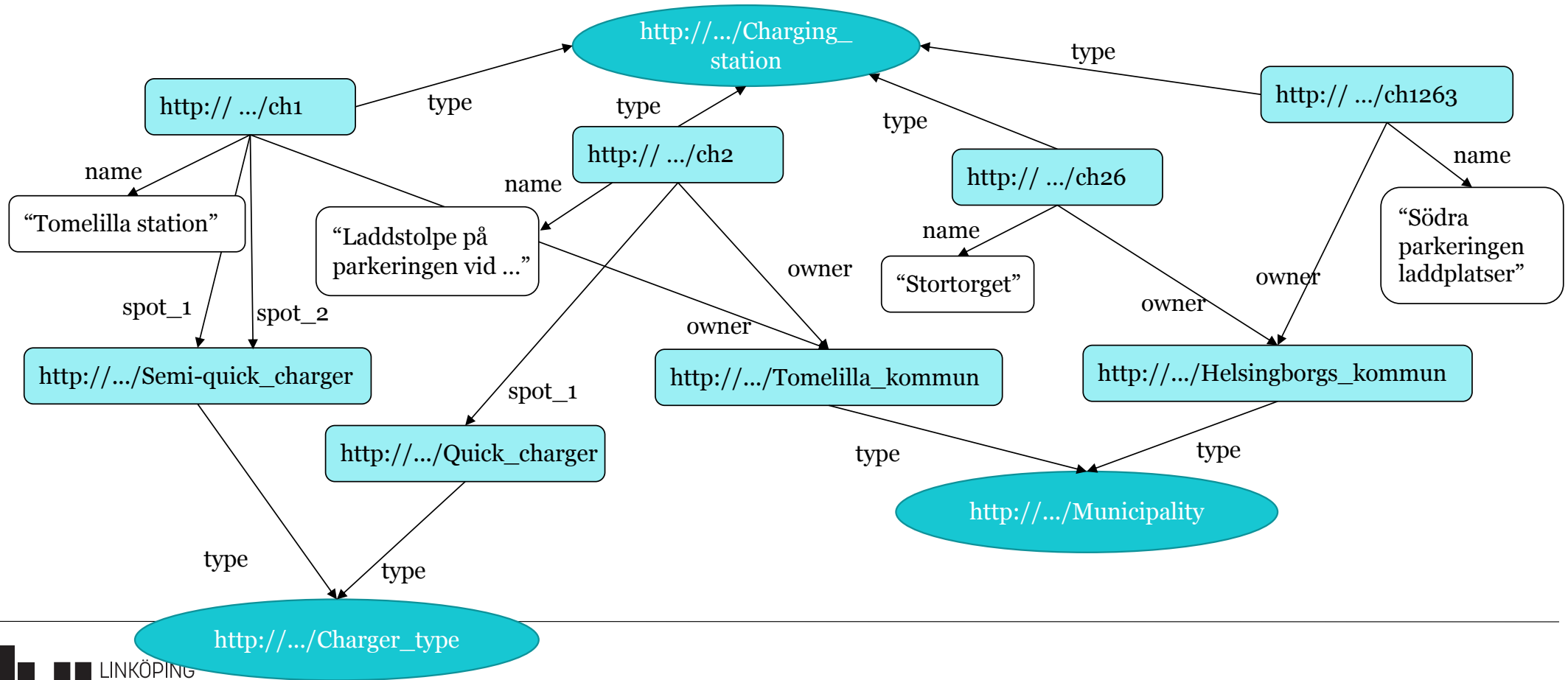
Tabular/relational integration (naïve)

ID	Name	Street	No	Zip	Lat	Long	Owner	Places	Desc	Public acc	24h acc	Time limit	Fee	Rt data	Status	Up-dated	Spot 1	Spot 2
	Tomelilla station			27380	55.5462724	13.94869	Tomelilla kommun	2	Tomelilla station	yes	yes	no	no	no			Semi-quick charger	Semi-quick charger
	Laddstolpe på parkeringen vid Tomelilla kommunhus. Vid änden närmast Coop	Gustafstorg	16	27380	55.542676	13.955116	Tomelilla kommun	1	Torget	yes	yes	no	no	no			Quick charger	
26	Stortorget						Hbg	4		yes			yes		Open	20201021113600		
1263	Södra parkeringen laddplatser						Hbg	4		yes		0-24	yes		Closed	20180919123853		

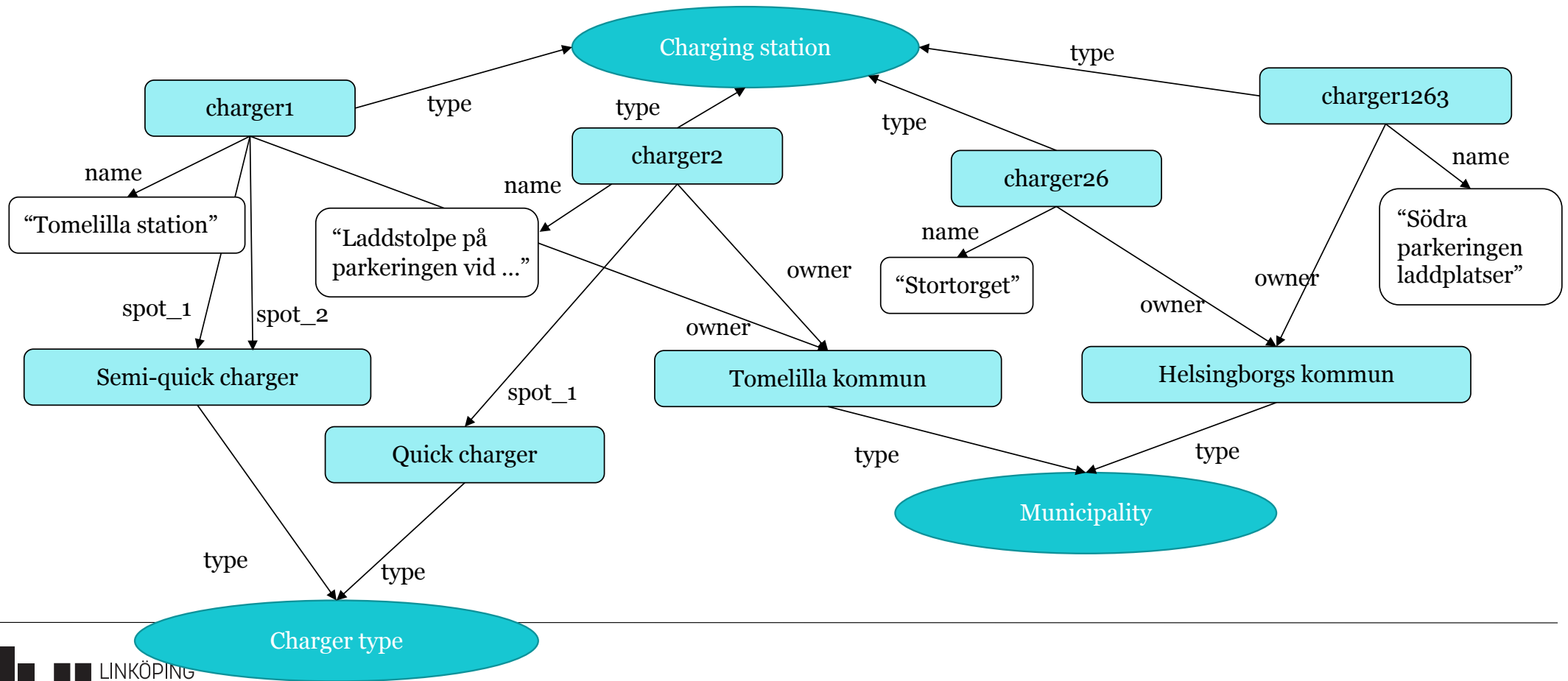
Tabular/relational integration (naïve)

ID	Name	Street	No	Zip	Lat	Long	Owner	Places	Desc	Public acc	24h acc	Time limit	Fee	Rt data	Status	Up-dated	Spot 1	Spot 2
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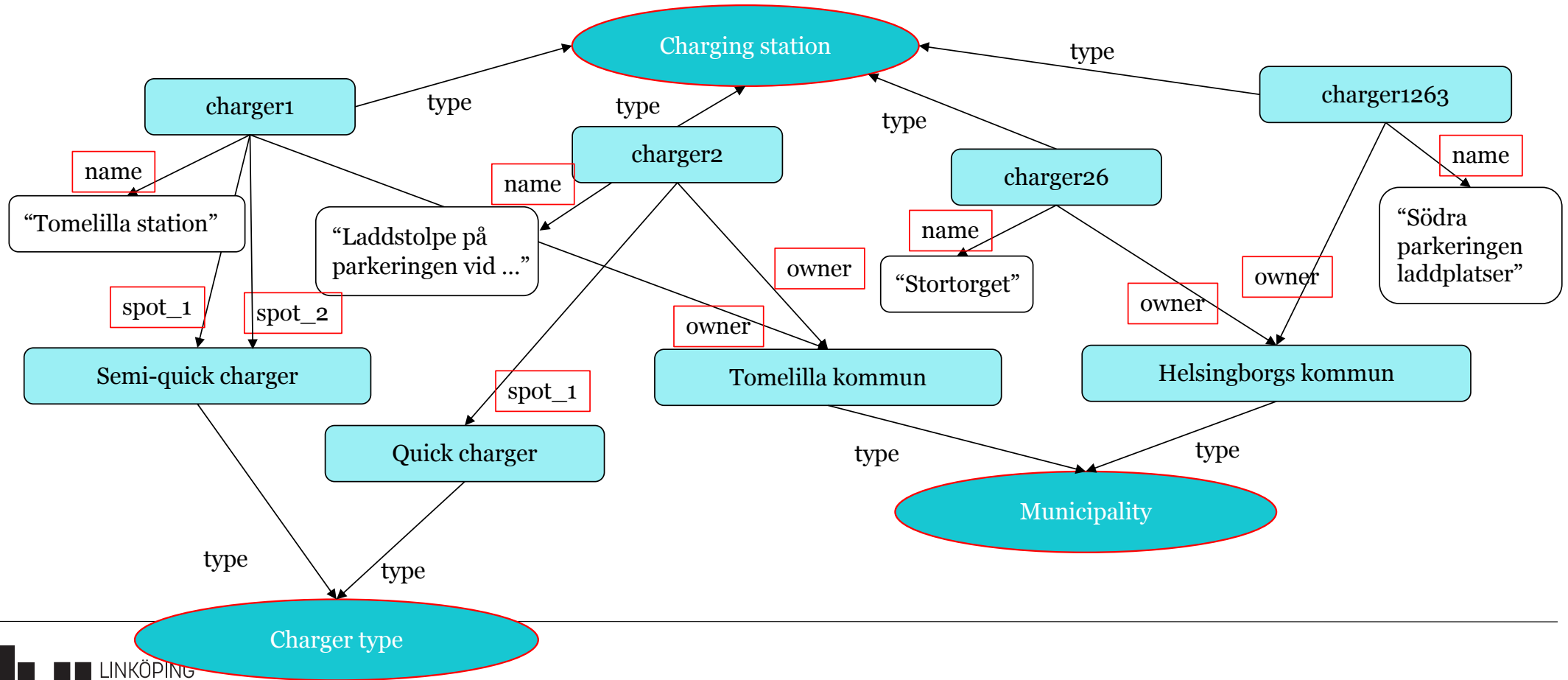
KG with types...



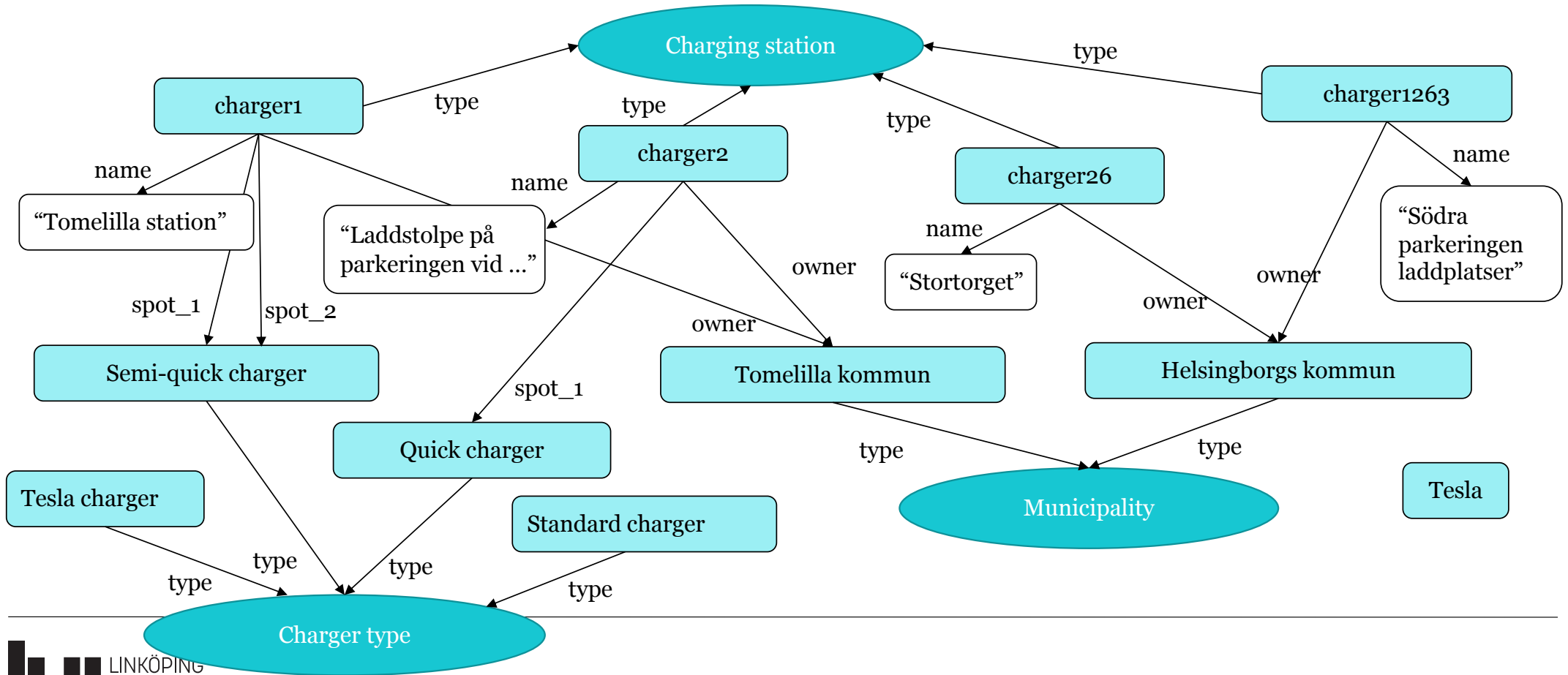
KG with types...



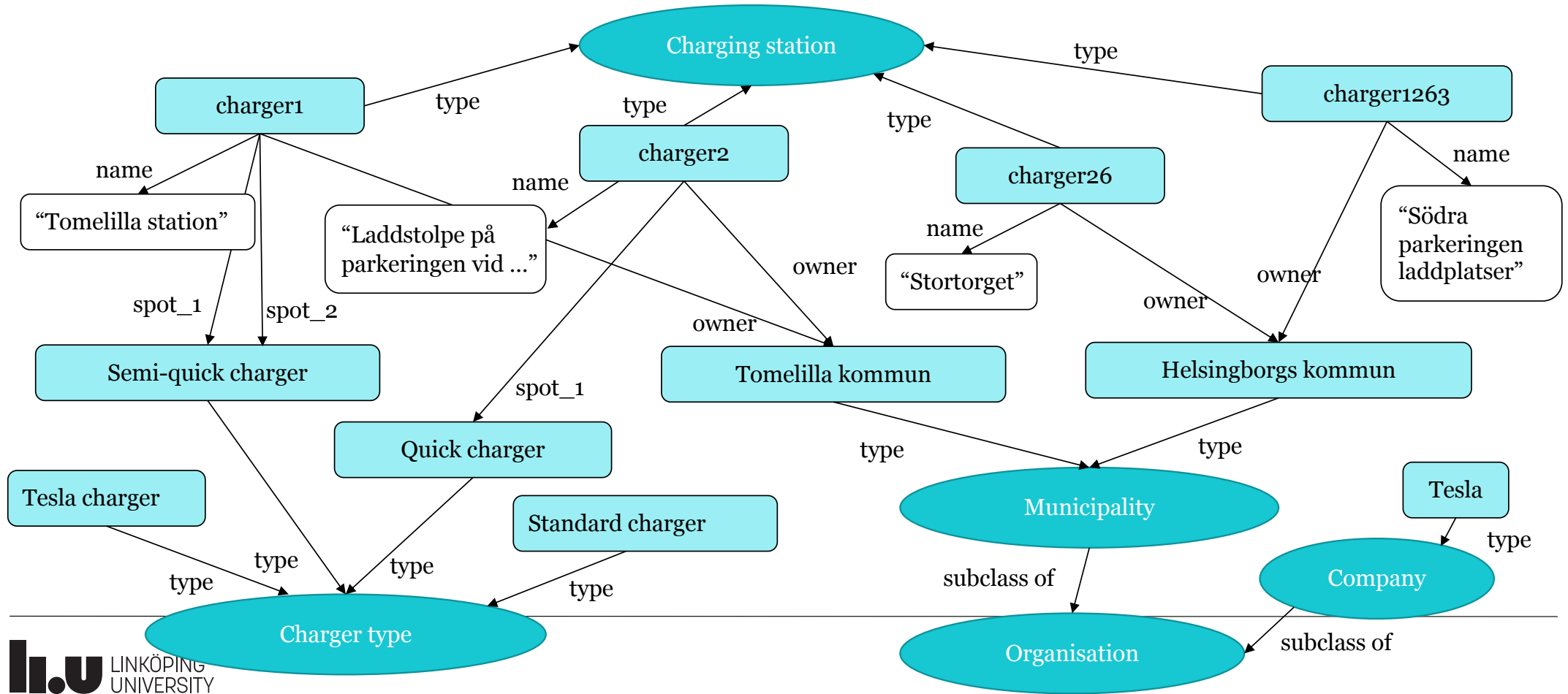
Vocabulary



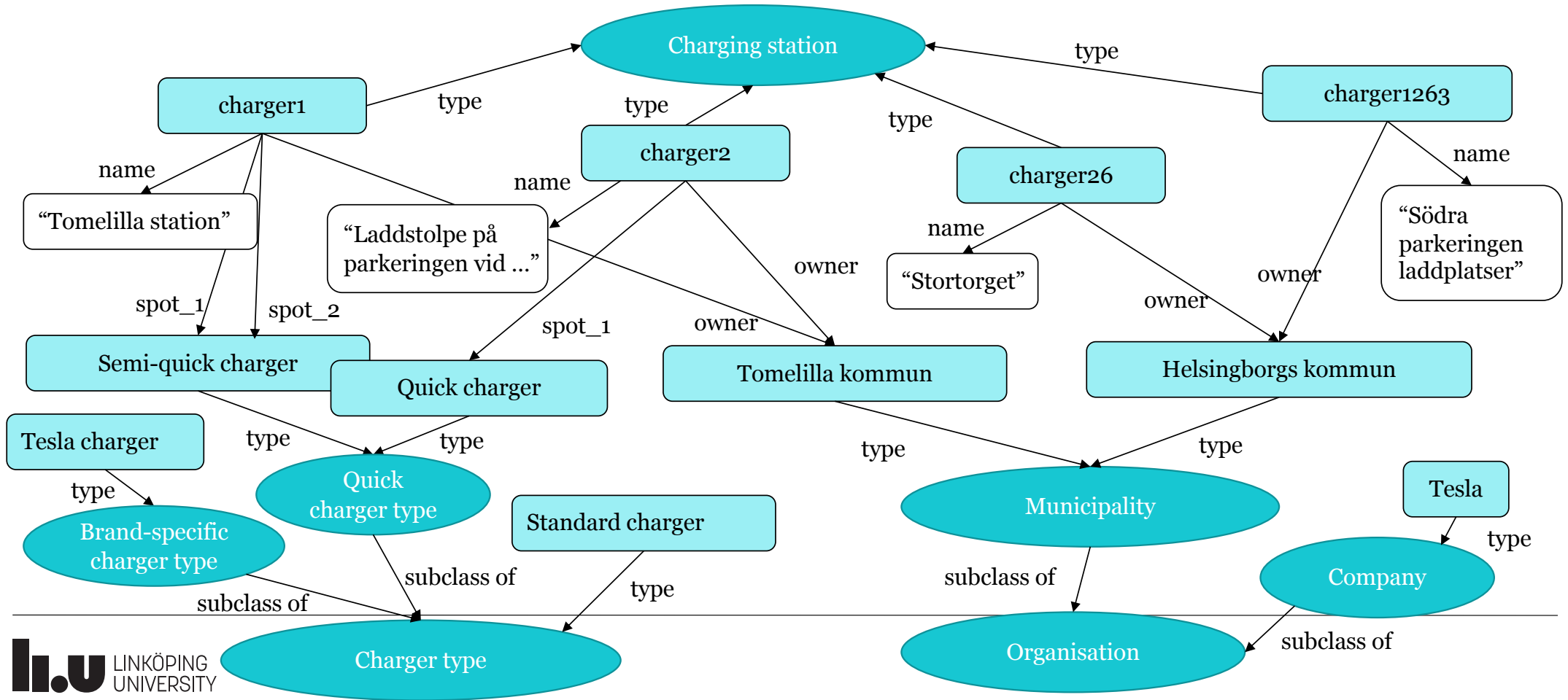
More data...



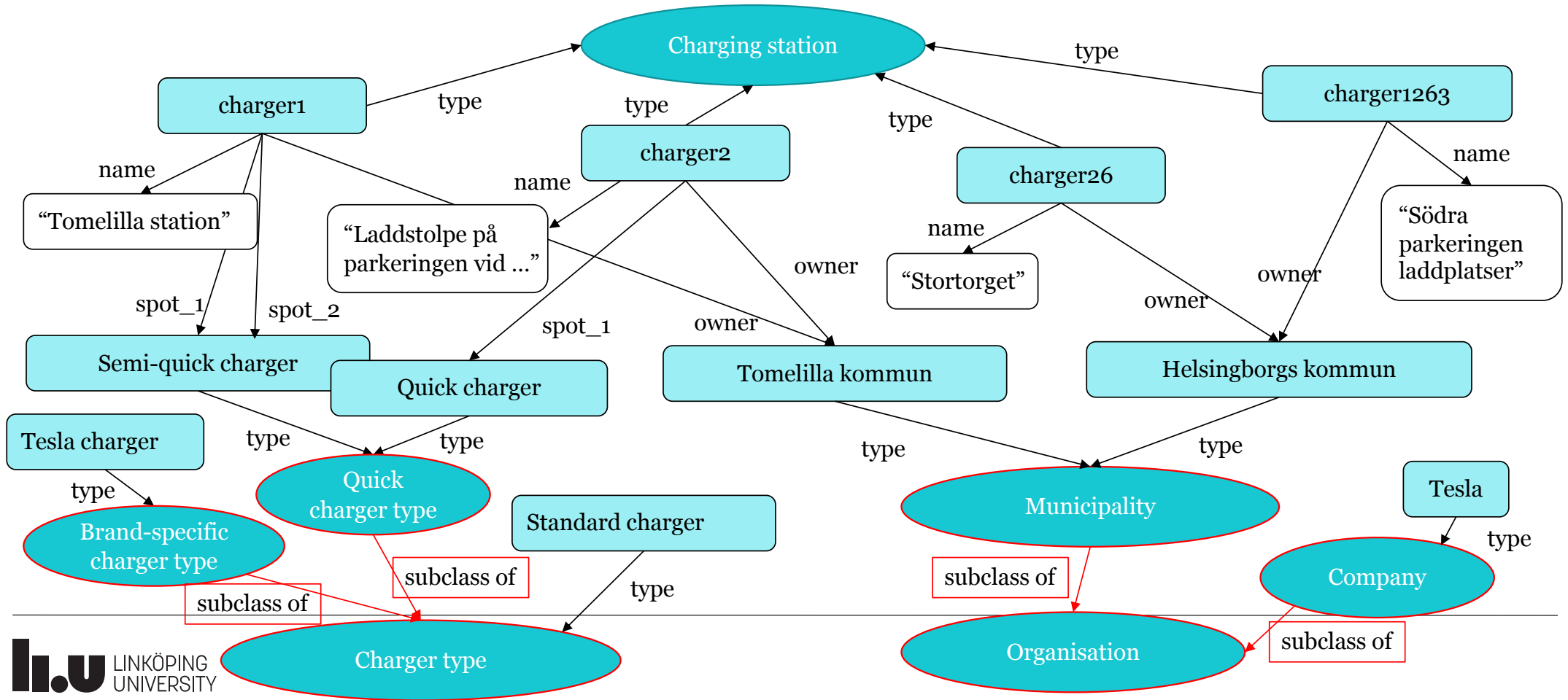
Modify the model...



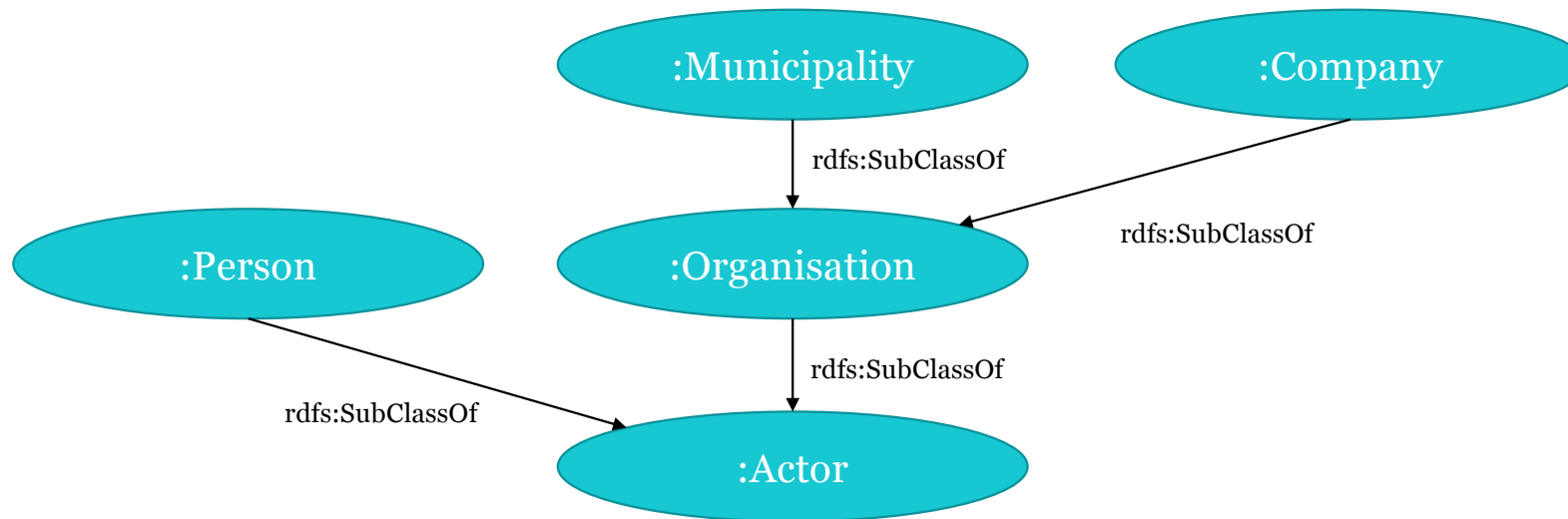
Modify the model...



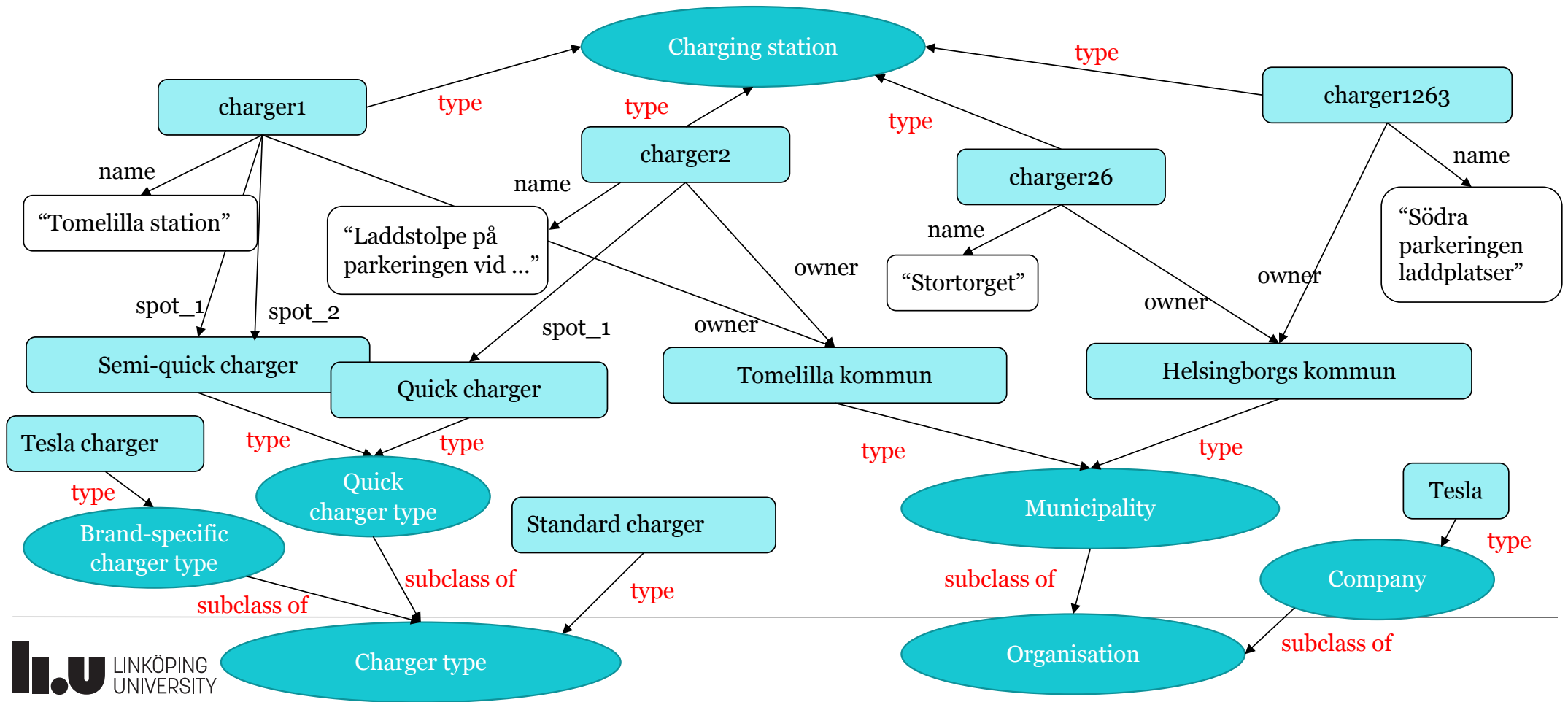
Taxonomy



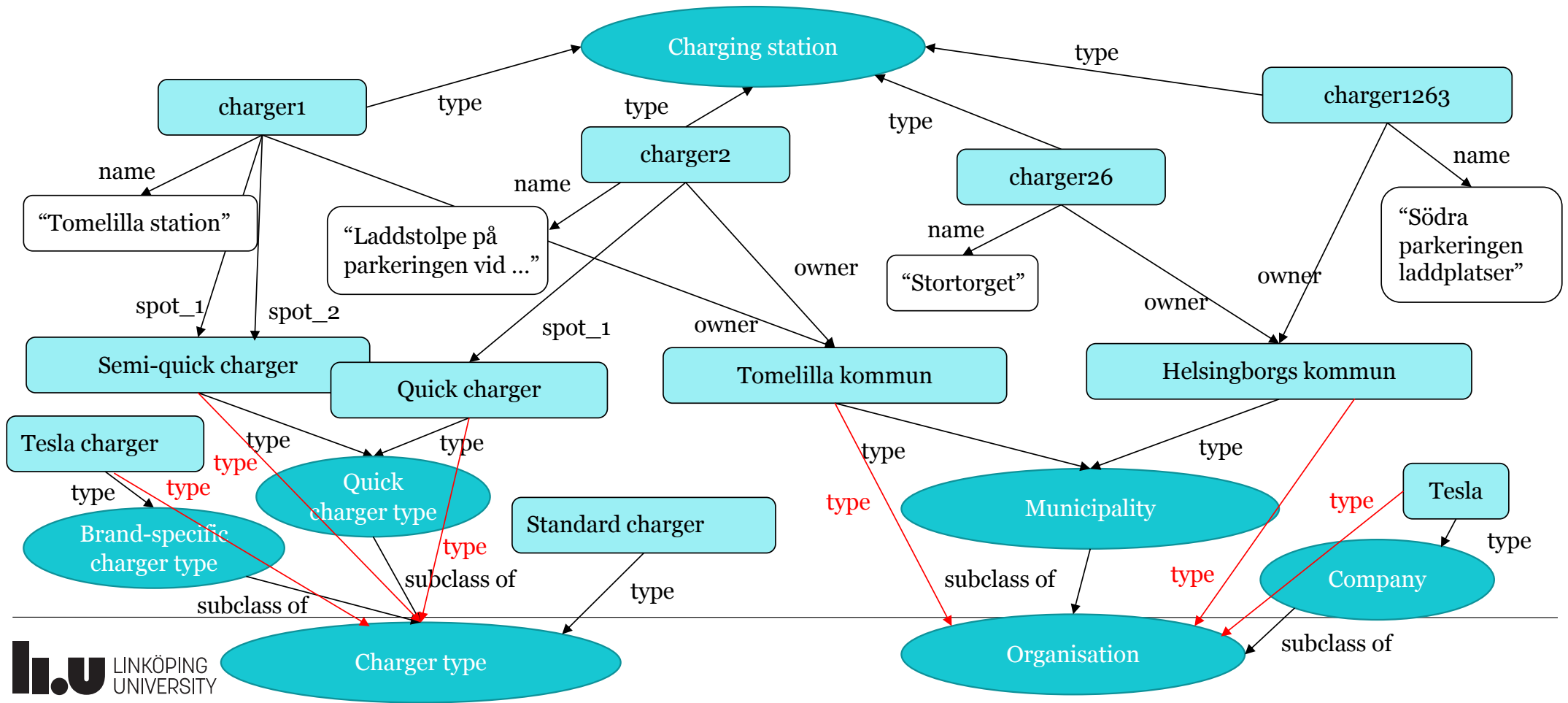
Taxonomy – the “backbone” of an ontology



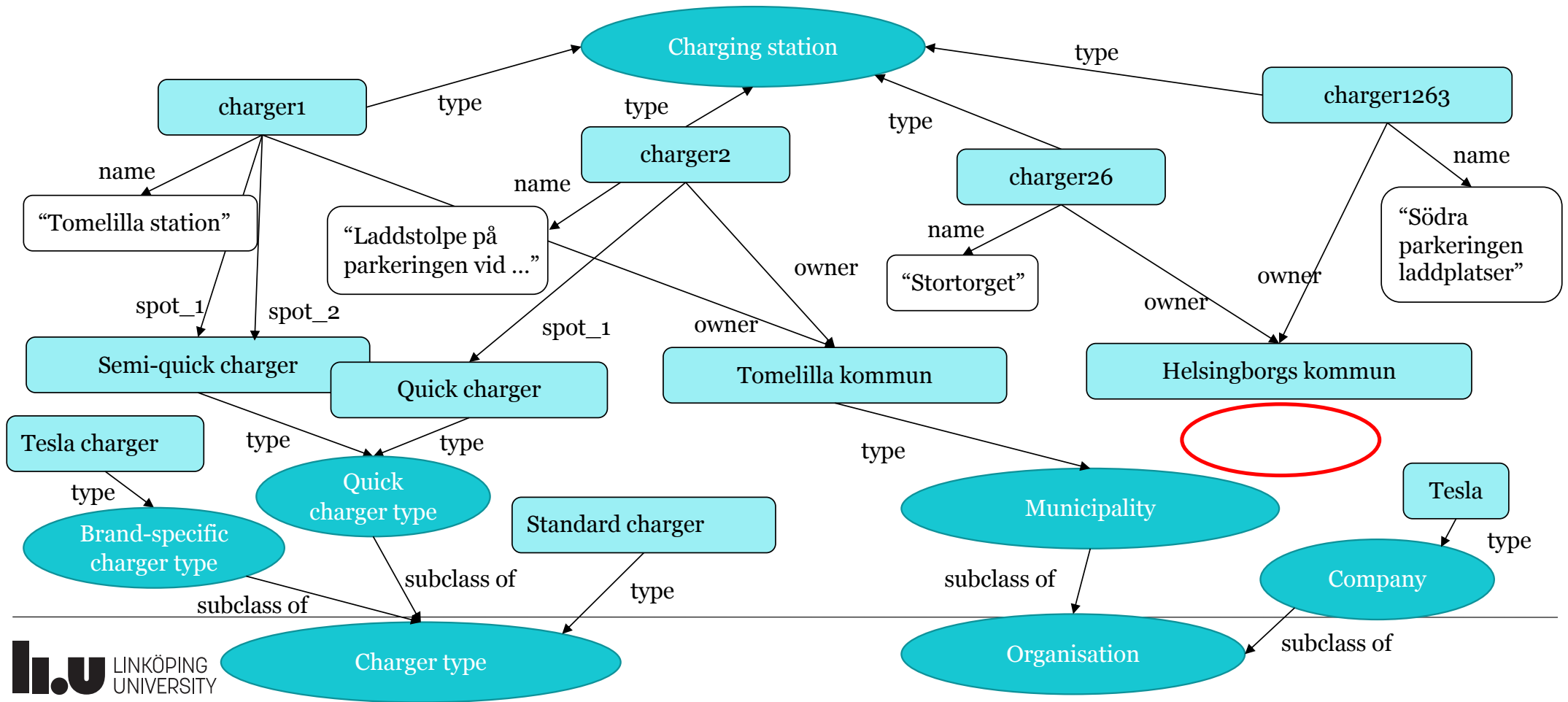
Reasoning...



Reasoning...

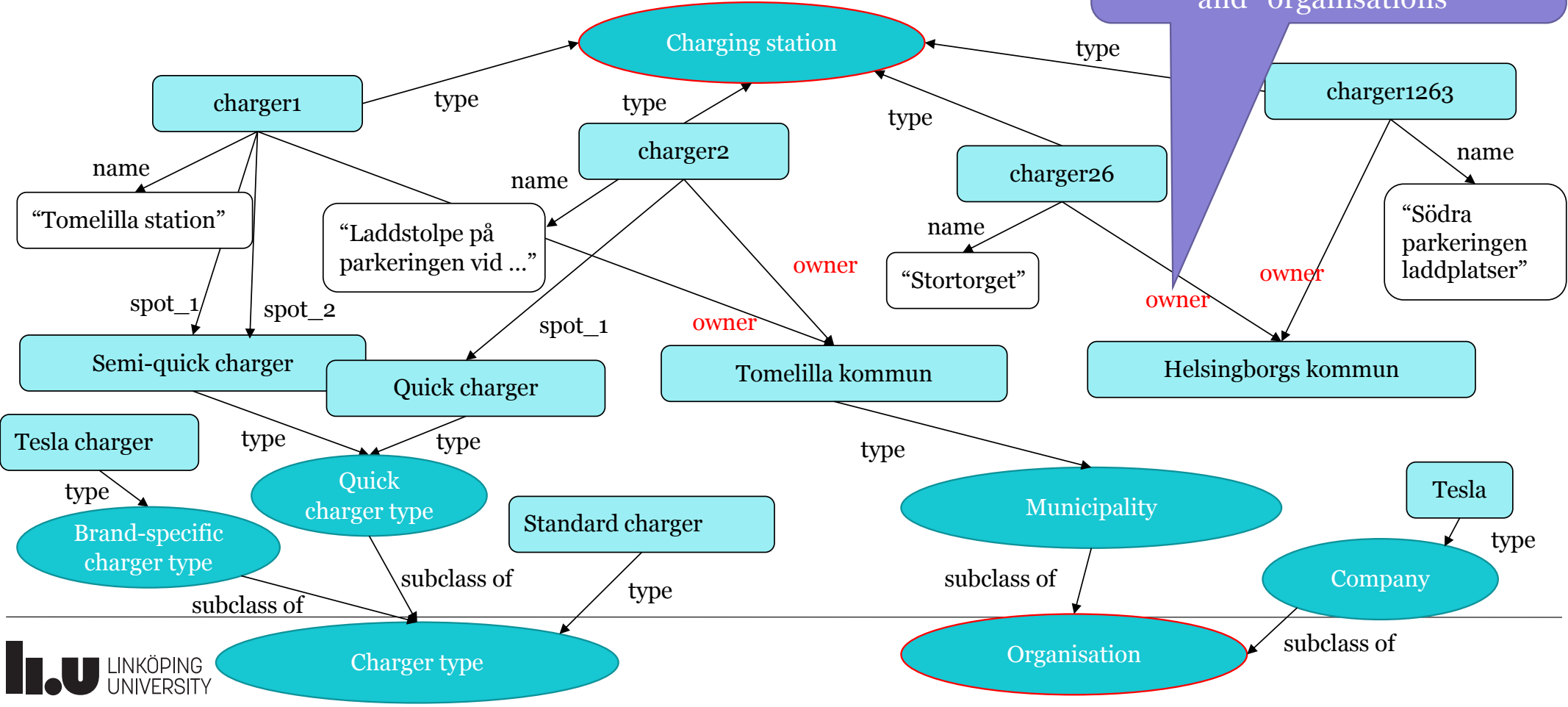


More reasoning...

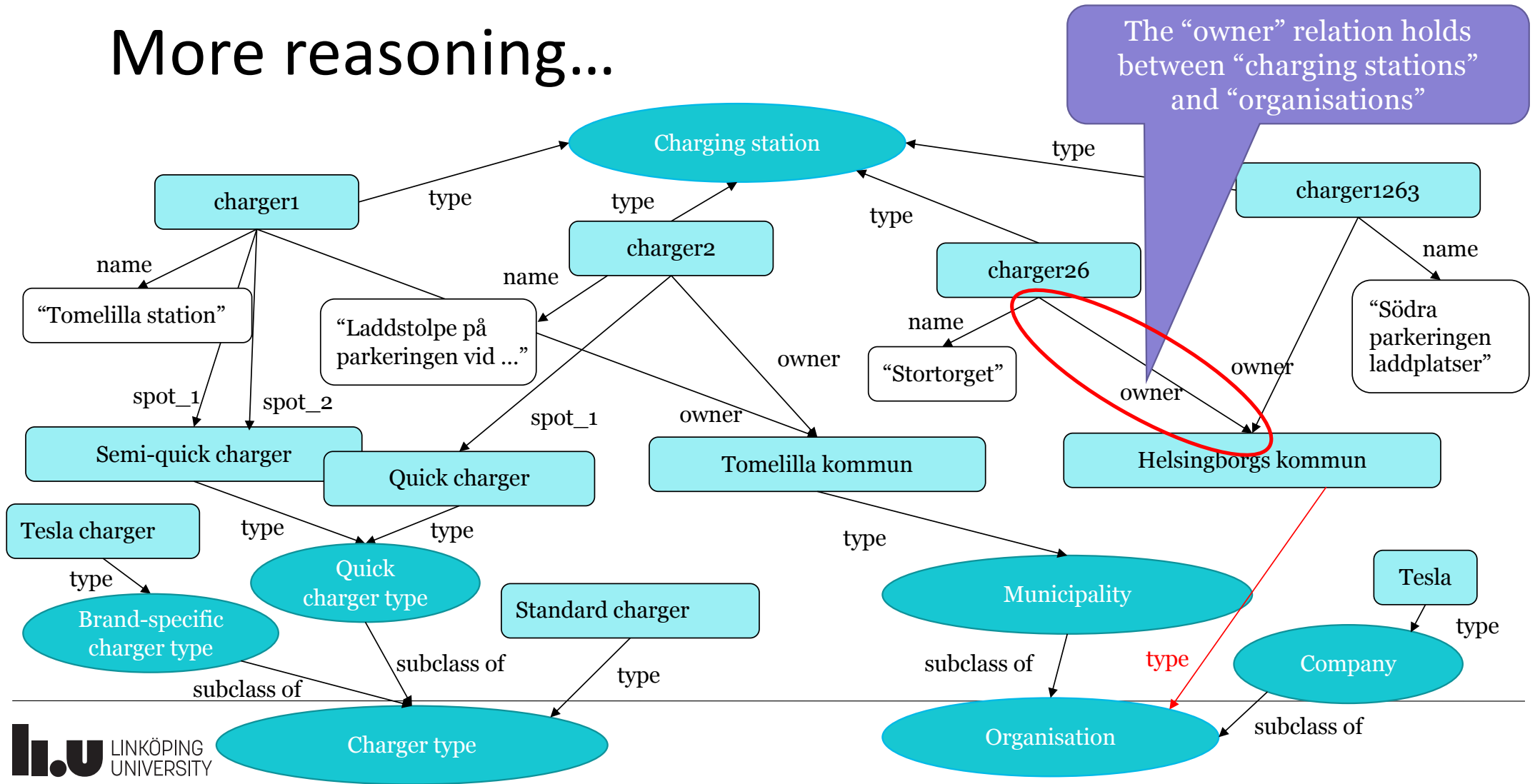


More reasoning...

The "owner" relation holds between "charging stations" and "organisations"



More reasoning...



Summary – What is an ontology?

- A model describing some part of the world (usually a dataset)
 - Ranging from a simple vocabulary, listing the concepts (types, or classes - nodes) and relations (predicates or properties - edges) used in our data...
 - ... via taxonomies...
 - ... to a set of complex logical axioms, used to do automated reasoning
- A way to make assumptions explicit, and break out some of the “logic” of our system into a knowledge model, instead of coding it into queries, source code etc.

Summary – Why an ontology?

- Describing data
 - What does our data look like? How can I query it?
 - What do the data elements mean and what are general characteristics of the types and properties in our data?
 - ... but only goes so far (grounding problem)
 - How does my data compare to other data? Can we align it? Generalise?
 - What conclusions (based on known “rules”) do I want to draw based on my input data?

How to make ontologies work in practice

- Ontologies are artefacts
 - Development and reuse
 - Quality assurance and testing
 - Documentation
 - Publishing and storage
 - Maintenance



Questions?