SUBTYPES IN ERM, PART 1

INTRODUCTION TO SUBTYPES IN ERM

- Business Rules (BRs) for special entities
- Ordinary modeling of these BRs
- Alternative modeling with subtypes
- Derivable subtypes
- Declarative subtypes
- Rules and recommendations

BUSINESS RULES FOR SPECIAL ENTITIES

A common kind of constraint:

We record […] <u>only</u> for […]

BRa: We record a bonus only for CEOs.

BRb: We record a guardian only for minors.

BRc: We record ink capacity only for inkjet printers.

In each case: a fact type is only recorded for a special subset (subtype) of an entity type.

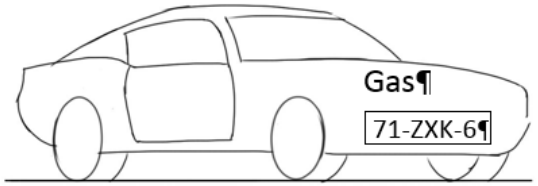
	Entity type	**Subtype**	**Fact type**
BRa	Employee	CEO	Bonus received
BRb	Person	Minor	Guardianship
BRc	Printer	Inkjet printer	Ink capacity

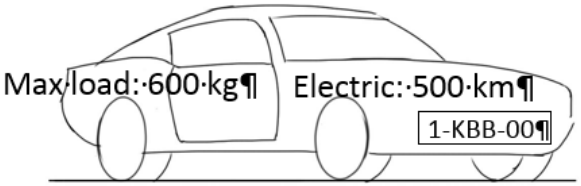
Such BRs can be modeled clearly in ERM and other techniques using the modeling concept of subtypes

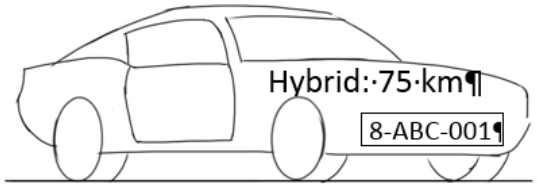
BUSINESS RULES FOR SPECIAL ENTITIES

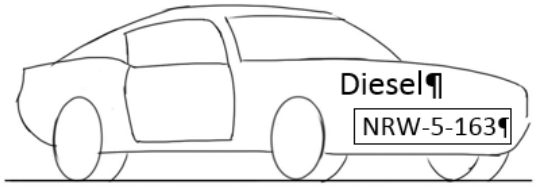
Small example to illustrate all subtype related modeling concepts in ERM

Example to illustrate how to model using subtypes:










```
FT1: The car with LPno 1-KBB-00 is an electric car.
FT2: The car with LPno 1-KBB-00 can drive 500 km on a full battery.
FT3: The car with LPno 1-KBB-00 can tow a load of at most 600 kg.
```

Domain expert:

BR1 Range is only to be recorded for all electric and hybrid cars..

BR2 Max_load is only to be recorded for cars with a tow hitch.

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ORDINARY MODELING OF THESE BRS

CAR			
License_plate	<pi>	LP_NO	<M>
Power_type		POWER_TYPE_NAME	<M>
Range		RANGE	
Max_load		LOAD	

FT1: The car with LPno <License_plate> is a <Power_type> car.
FT2: The car with LPno <License_plate> can drive <Range> kilometers on a full battery.
FT3: The car with LPno <License_plate> can tow a load of at most <Max_load> kg.

71-ZXK-6	1-KBB-00	8-ABC-001	NRW-5-163
Gas	Electric	Hybrid	Diesel
--	500	75	--
--	600	--	--

Note: many NULL_values. When is a value required or forbidden?

BRs modeled with constraints:

BR1 Range is only to be recorded for all electric and hybrid cars.
BR2 Max_load is only to be recorded for cars with a tow hitch.

C1a: For each entity of ET CAR:
IF Range has a value,
THEN Power_type must be 'Electric' or 'Hybrid'.
C1b: For each entity of ET CAR:
IF Power_type = 'Electric' or 'Hybrid'
THEN Range must have a value.
C2: ??

Consider BR1 and C1a+C1b first.
It is not easy to see C1a+C1b in the model.

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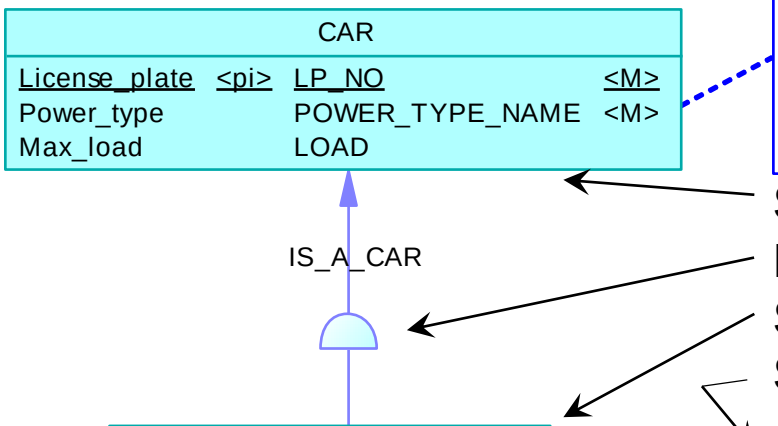
ALTERNATIVE MODELING WITH SUBTYPES



FT1: The car with LPno <License_plate> is a <Power_type> car.
FT3: The car with LPno <License_plate> can tow a load of at most <Max_load> kg.

71-ZXK-6	1-KBB-00	8-ABC-001	NRW-5-163
Gas	Electric	Hybrid	Diesel
--	600	--	--

Supertype

Inheritance link

Subtype: inherits <pi> from supertype

Subtype defining fact type: always present

FT4*(from SDR1): The car with LPNo <License_plate> is a car with electric power.
FT2: The car with LPno <License_plate> can drive <Range> kilometers on a full battery.

1-KBB-00	8-ABC-001
500	75

SDR1: x IN CAR_WITH_ELECTRIC_POWER
IF (x, 'Electric') OR (x, 'Hybrid')
IN CAR(License_plate, Power_type)

BR1 Range is only to be recorded for all electric and hybrid cars.

C1a: modeled by Att in subtype with SDR1. C1b: modeled by <M>.

BR1 modeled by Att in subtype: much easier to see.

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DERIVABLE SUBTYPES

How does the system ‘know’:
which entities belong to the subtype, and which don’t?

Subtype defining fact type

Explicit statements which entities are in the subtype.

Indispensible: this information is always needed.

Subtype defining fact type: better to always show it.

Usually: can be derived from other supertype facts.

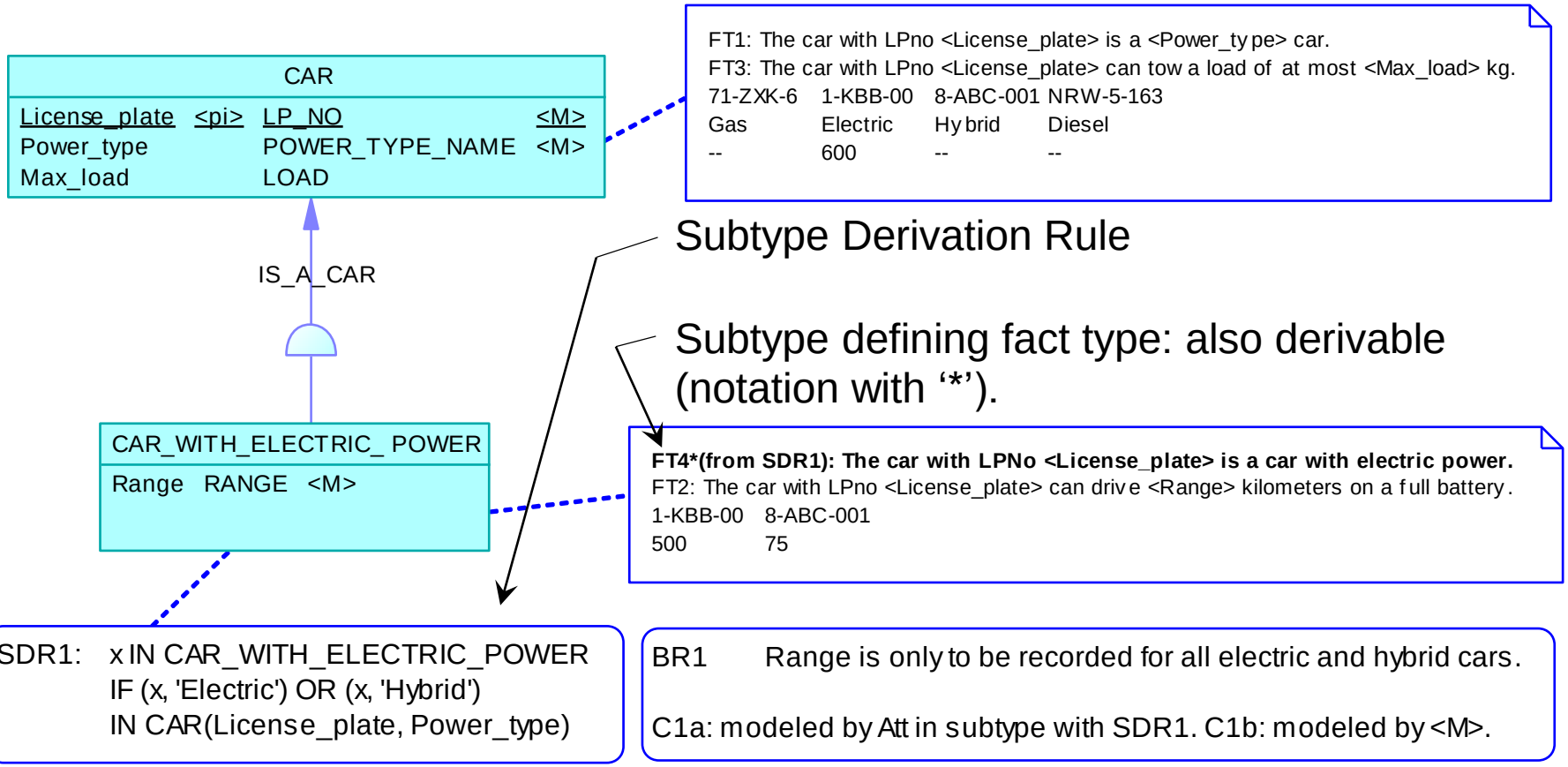
In that case: **derivable subtype**

If derivable:

Give Subtype Derivation Rule

- Give Subtype Derivation Rule
- Subtype defining fact type is derivable
  (still: even then better to show it explicitly)

DERIVABLE SUBTYPES

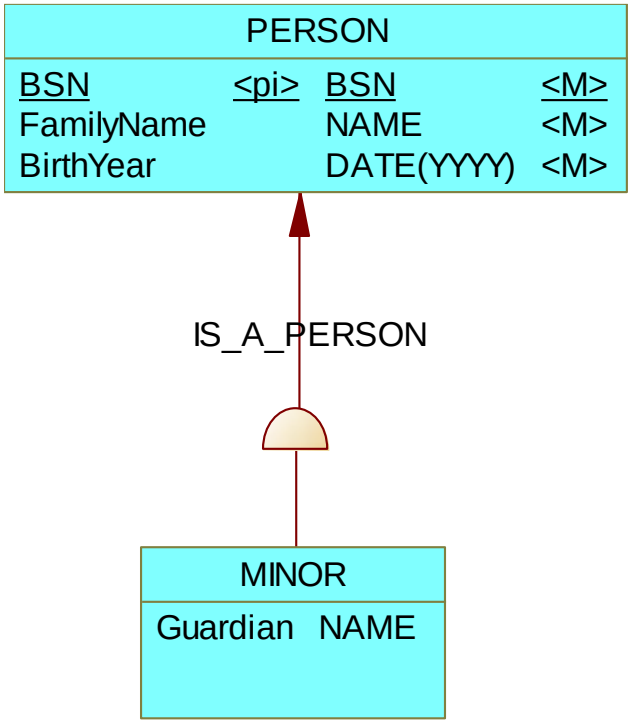


Most subtypes are derivable. Advice: include FT4 even if derivable.

SYNTAX OF SUBTYPE DERIVATION RULE

- Many formalisms to express **Business Rules (BRs)** exist e.g: SBVR (Semantics of Business Vocabulary and Rules), and their translations to
  - **Constraints (Cs)** in a **CDM**
  - **Integrity rules (IRs)** in a **PDM**
- In this course: only informal specifications
- BRs: in the language of the business
- Cs: refer to the relevant ETs/Atts/RTs in the CDM
- IRs: refer to the relevant Tables/Columns in the PDM

SYNTAX OF SUBTYPE DERIVATION RULE



Subtype derivation rule must make clear:
which entities of the supertype(s) also belong to the subtype

BR: A minor is a person under 18.

A certain entity x

Subtype

SR: x IN MINOR

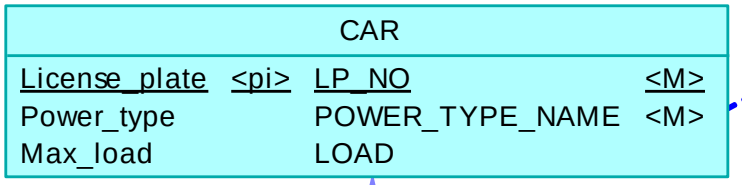
Atts of supertype

IF (x, BirthYear) IN PERSON

AND PresentYear-BirthYear < 18

System parameter?

ALTERNATIVE MODELING WITH SUBTYPES



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Gas	Electric	Hybrid	Diesel
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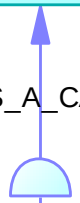

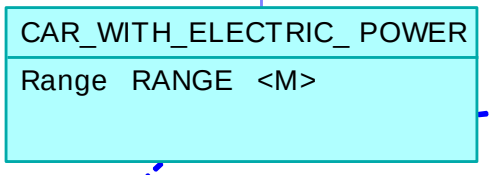

FT4*(from SDR1): The car with LPNo <License_plate> is a car with electric power.
FT2: The car with LPno <License_plate> can drive <Range> kilometers on a full battery.

1-KBB-00	8-ABC-001
500	75

A certain entity x

Subtype

SDR1: x IN CAR_WITH_ELECTRIC_POWER
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DECLARATIVE SUBTYPES

Subtype defining fact type: can also be non-derivable

Can BR2 be modeled in a similar way?

Yes, but not with a derivable subtype:

- There are cars with a tow hitch, but the value of the Max_load is not known. Which cars?
- The system (or we ourselves) cannot know which cars have a tow hitch: No facts about this.

Therefore we need to add this missing info explicitly:

FT5: The car with LPno NRW-5-163
is a car with a tow hitch.

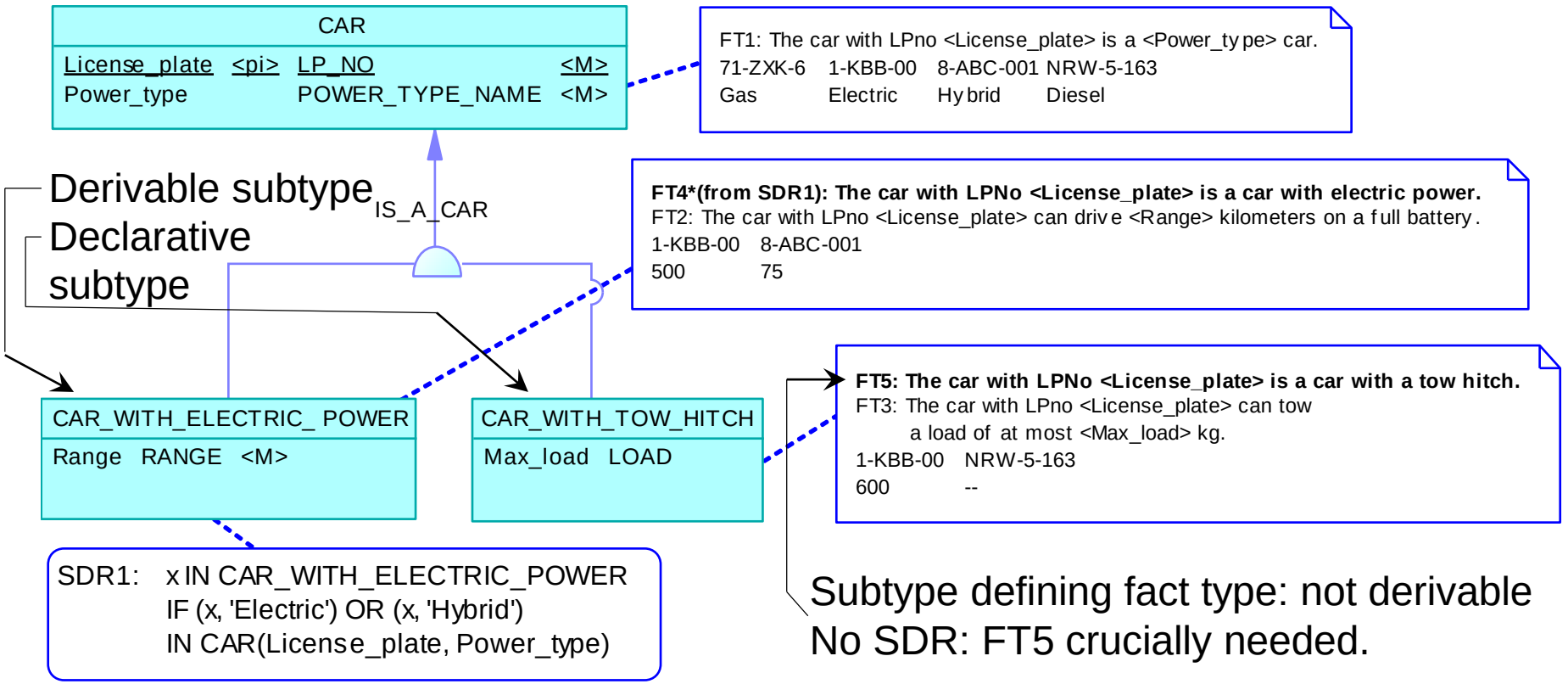
This is a subtype defining fact type, but not derivable.

Declarative subtype:

subtype with a non-derivable defining fact type

DECLARATIVE SUBTYPES

BR1 Range is only to be recorded for all electric and hybrid cars. Modeled by derivable subtype.
BR2 Max_load is only to be recorded for cars with a tow hitch. Modeled by declarative subtype.



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RULES AND RECOMMENDATIONS

Rules for using subtypes

Rule 1:

- Modeling a subtype always implies adding a subtype defining fact type.
- Every subtype must have such a fact type.

Rule 2:

- If possible, specify a Subtype Derivation Rule.
- A Subtype Derivation Rule can only refer to:
  - fact types from the supertype,
  - **not** to fact types from the subtype itself.

Recommendations for using subtypes

Recommendations (see also Subtypes part 2):

- Use derivable subtypes as much as possible, unless there is a good reason not to do so.
- Add extra attributes to change declarative subtypes into derivable ones if needed.