Interactive Model Derivation with External Constraints

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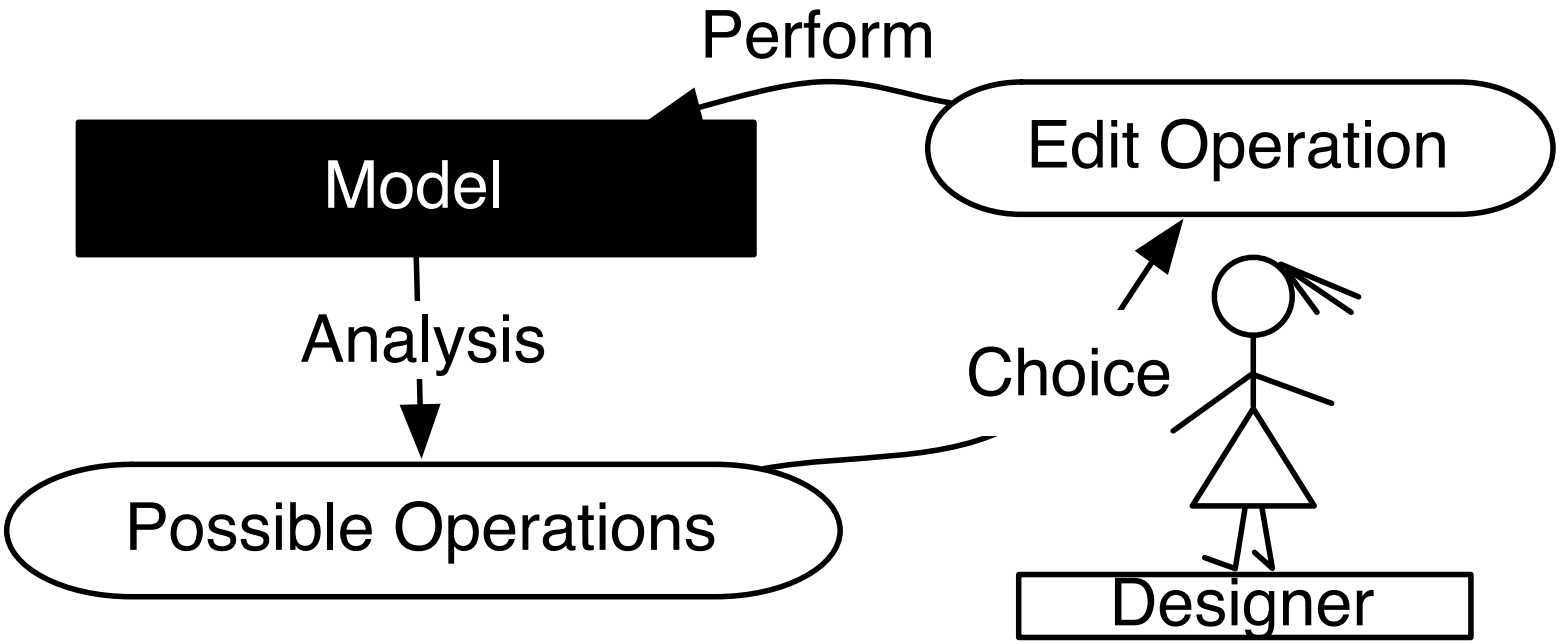
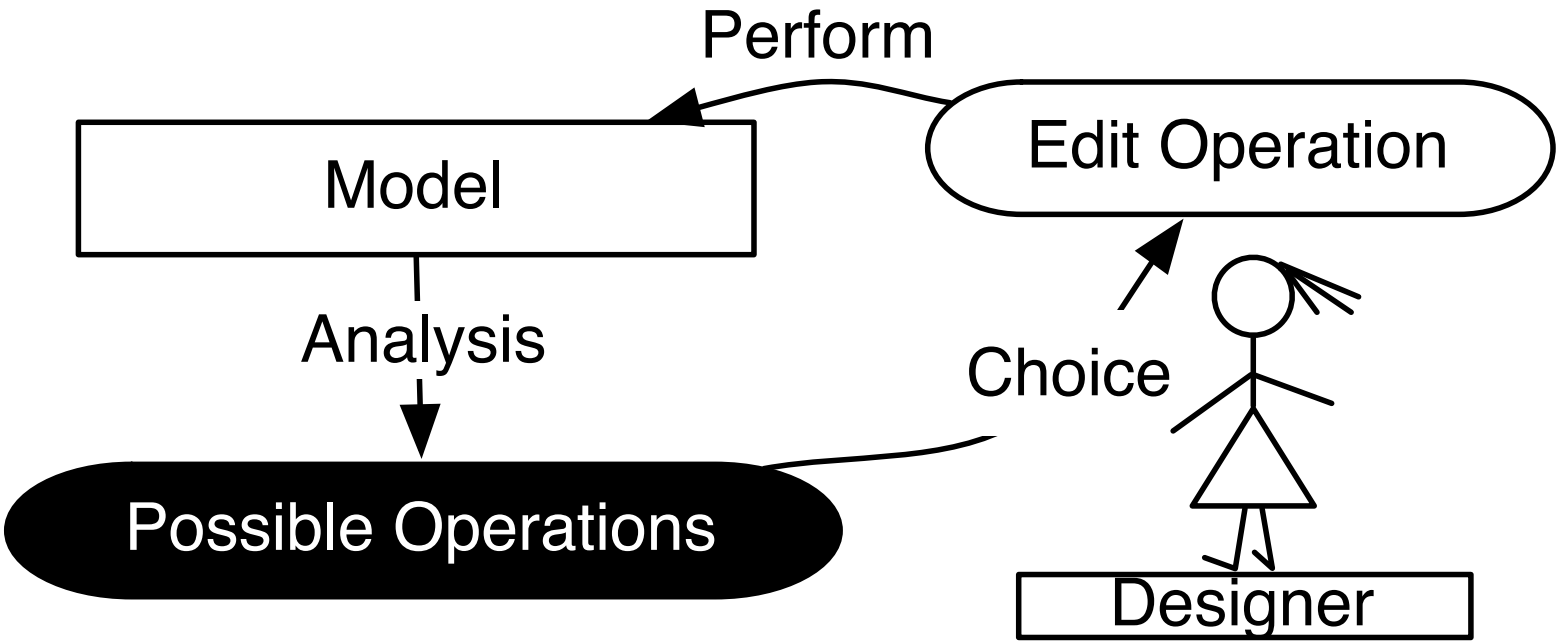
Inte


Perform
Edit Operation
Model
Analysis
Choice
Possible Operations
Designer

Inte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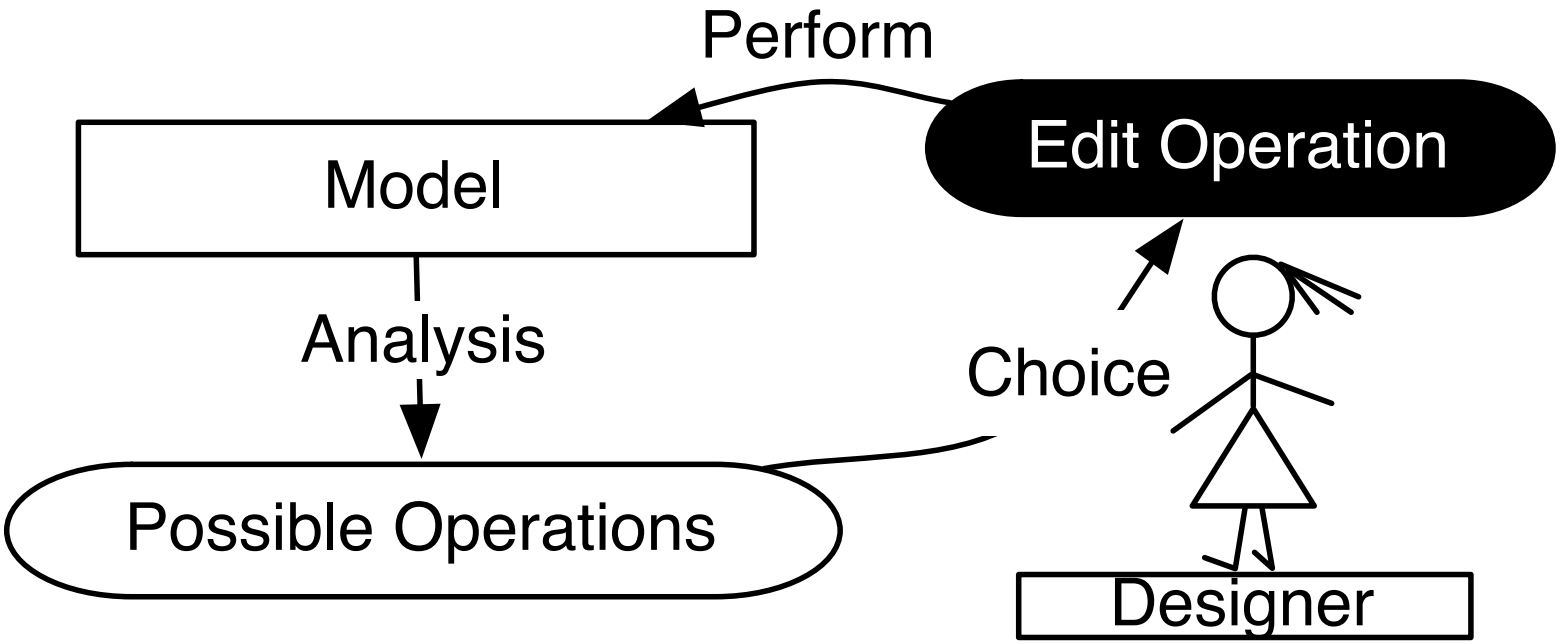
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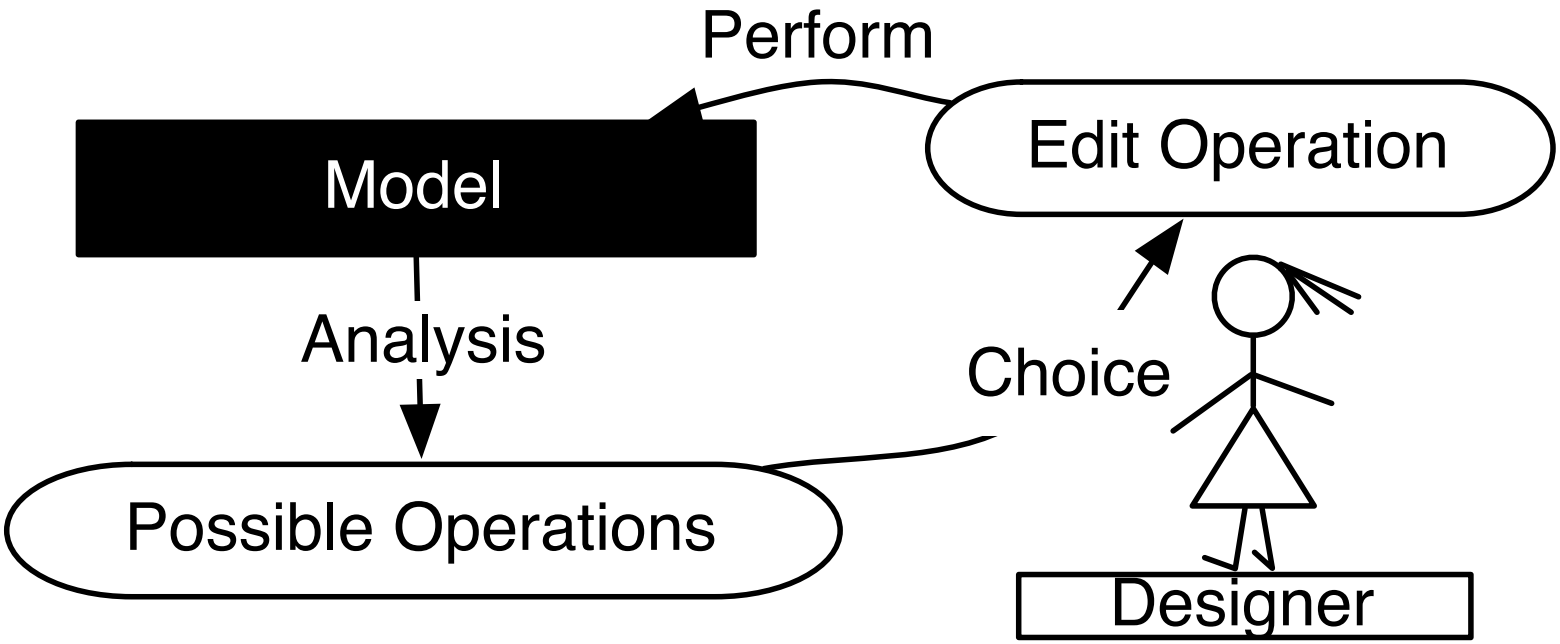
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- Soundness-preserving derivation seen in instance derivation
- Completeness-preserving derivation will be illustrated by a prototype for feature diagrams
- Semantics-preserving derivation will be illustrated by a prototype for feature models

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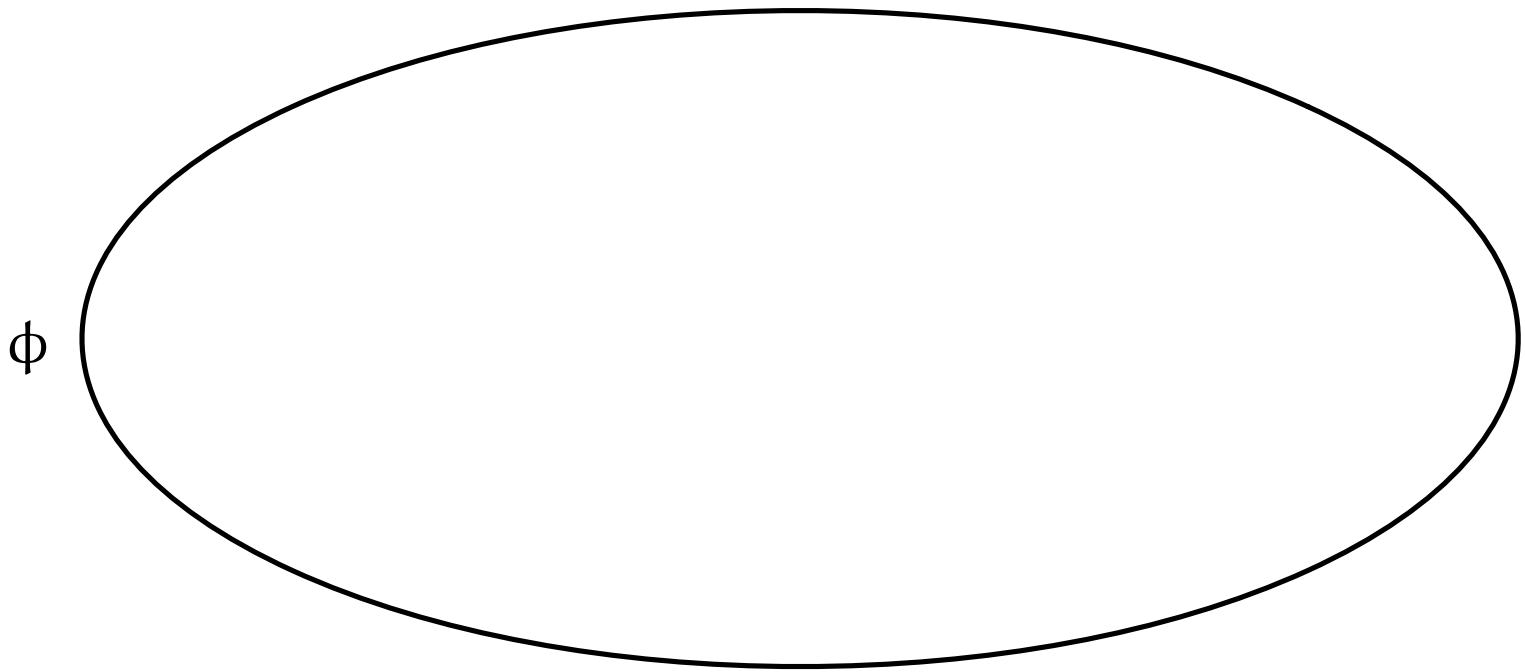
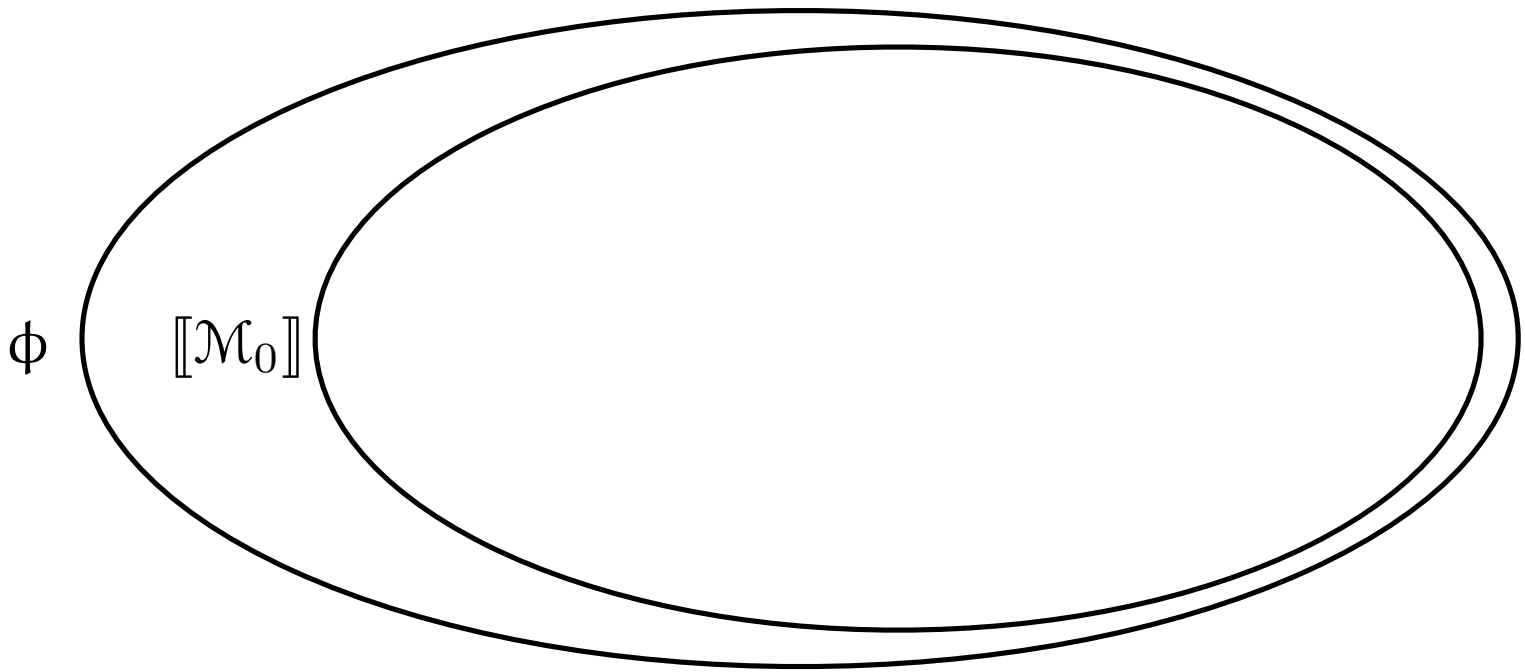
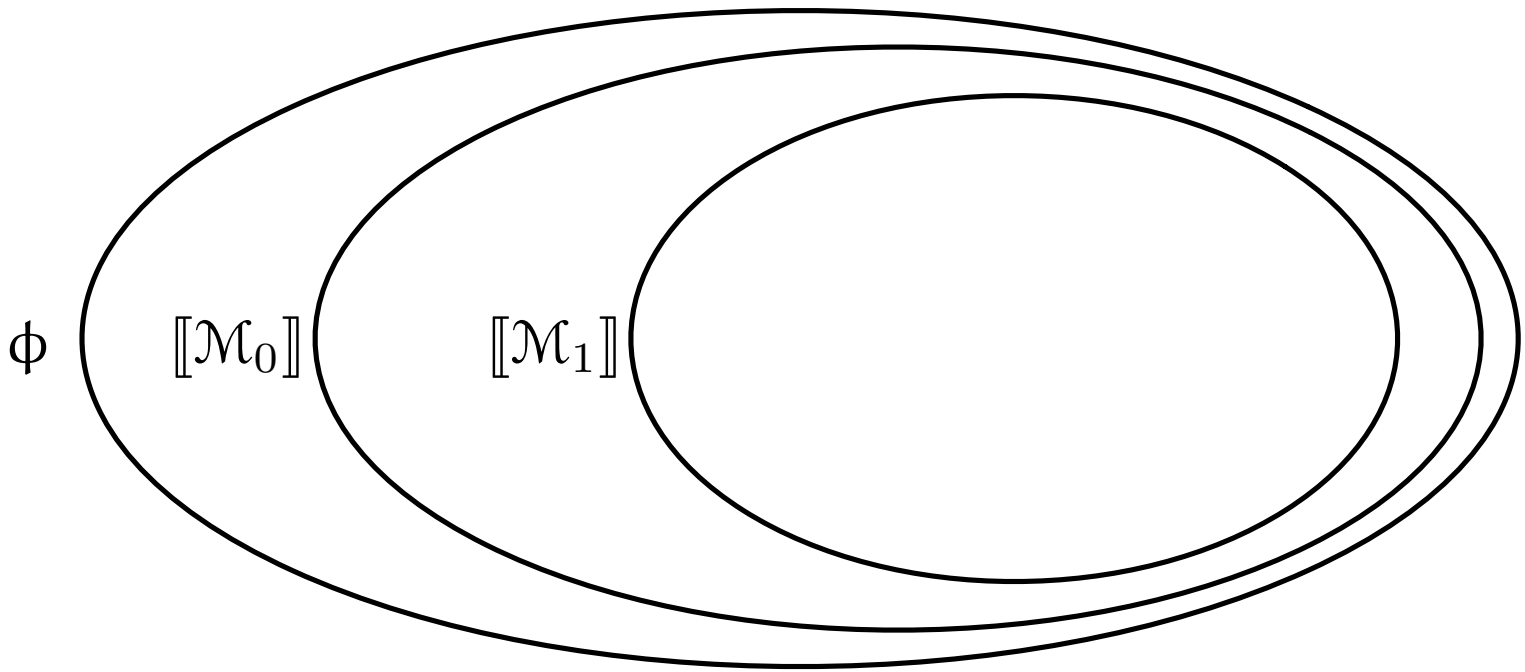


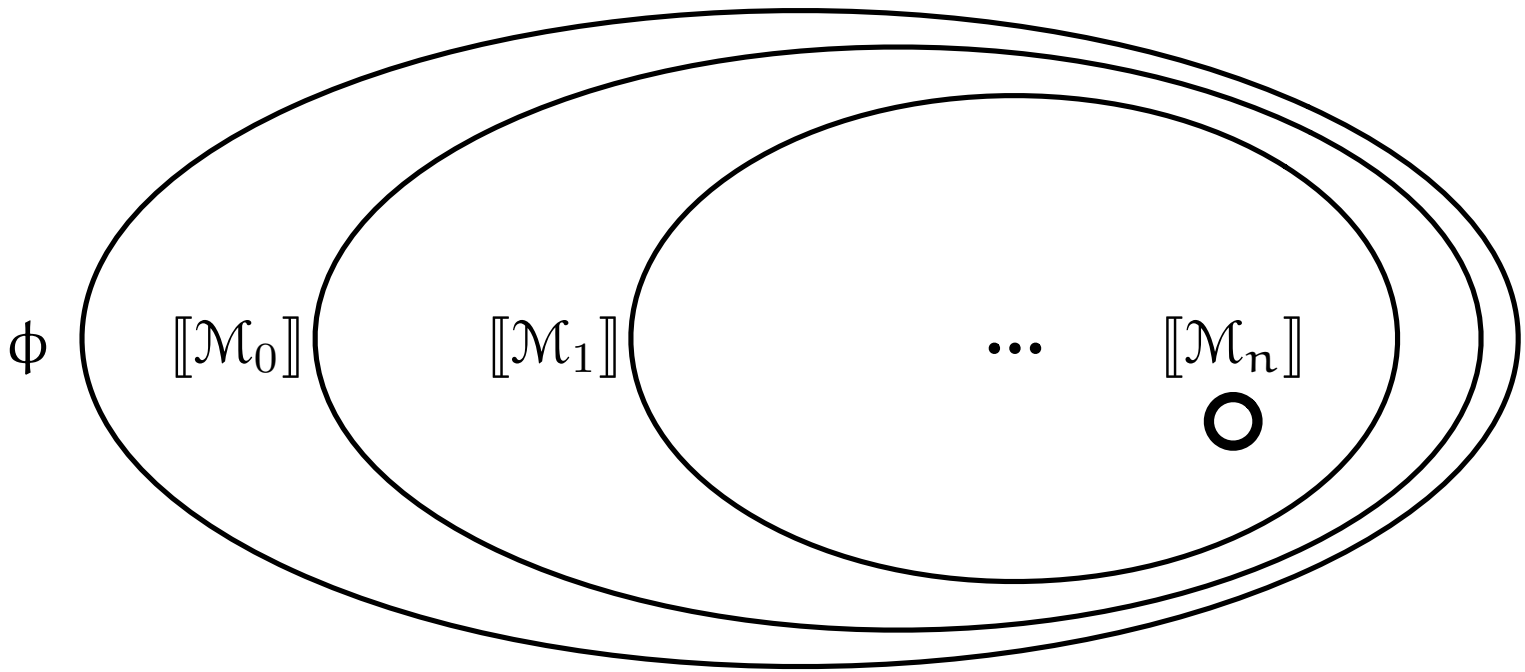
model $\rightarrow$ an instance



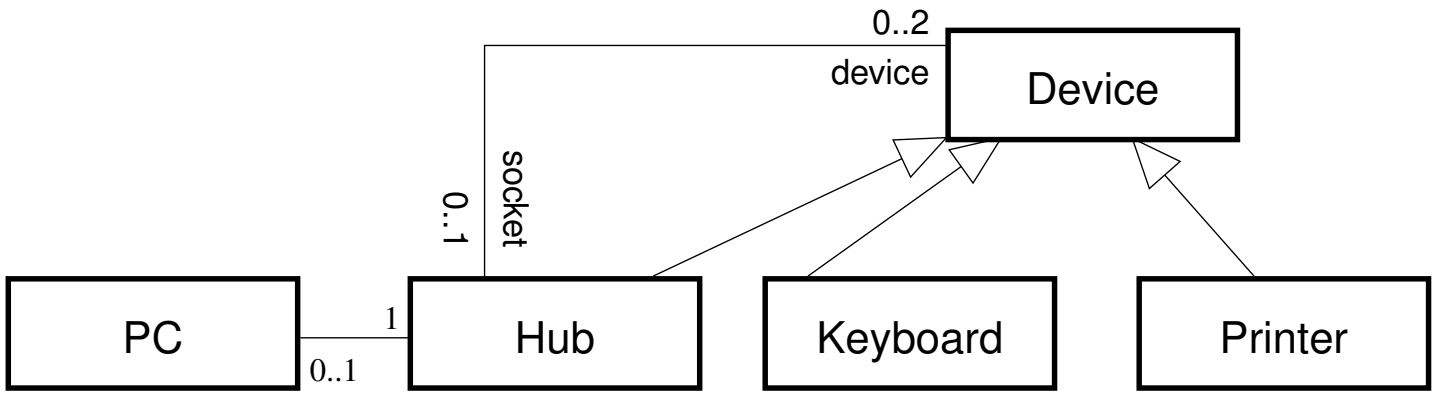
model $\rightarrow$ an instance



model $\rightarrow$ an instance



model $\rightarrow$ an instance

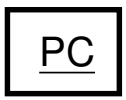


C1 Each USB must contain exactly one instance of PC.

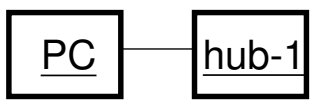
C2 Every device is connected to a port or to the PC instance.

C3 Every USB has a keyboard connected or a free port to connect one.

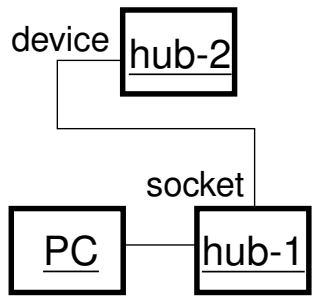
1.


PC

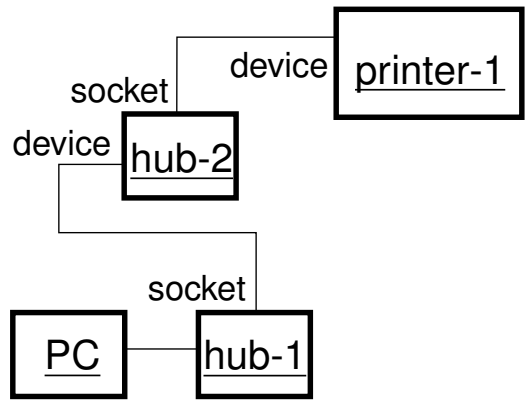
2.


PC
hub-1

3.

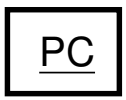

device
hub-2
socket
PC
hub-1

4.

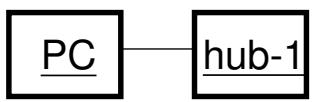

device
printer-1
socket
device
hub-2
socket
PC
hub-1

PC

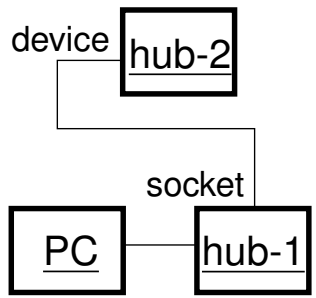
1.


PC

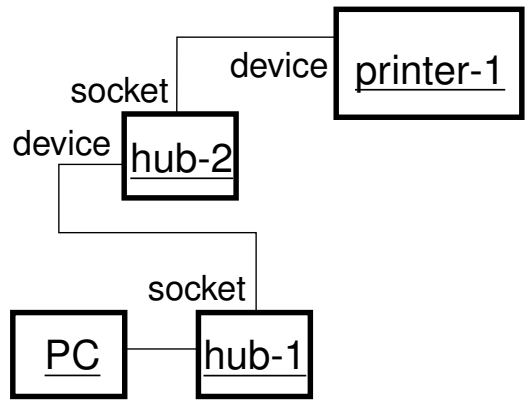
2.


PC
hub-1

3.

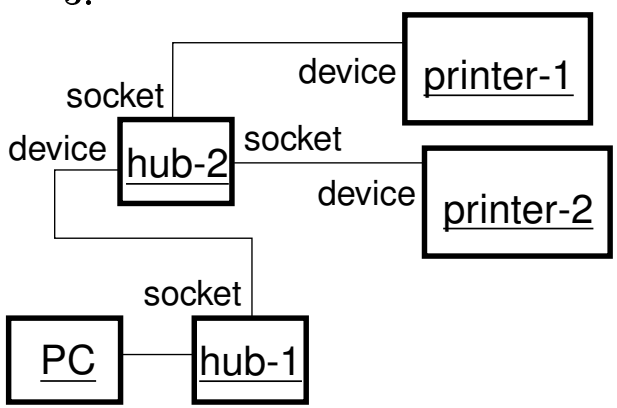

device
hub-2
socket
PC
hub-1

4.


device
printer-1
socket
device
hub-2
socket
PC
hub-1

PC

5.


device
printer-1
socket
device
hub-2
socket
device
printer-2
socket
PC
hub-1

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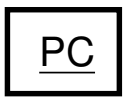
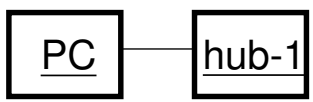
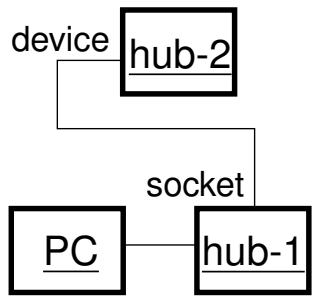

PC

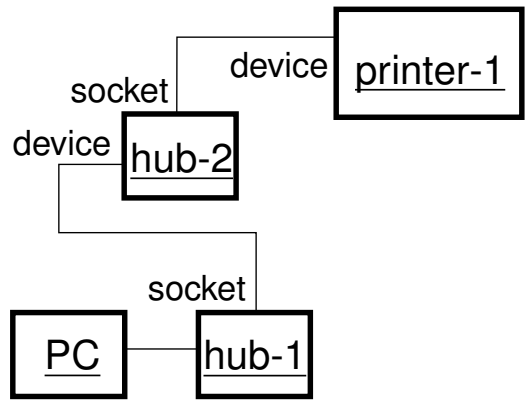
2.


PC
hub-1

3.


device
hub-2
socket
PC
hub-1

4.


device
printer-1
socket
device
hub-2
socket
PC
hub-1

PC

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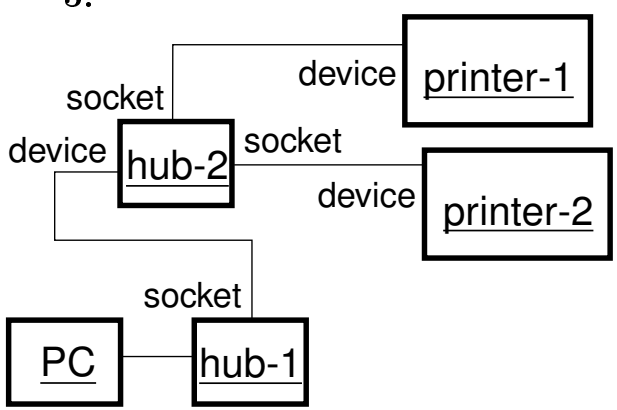
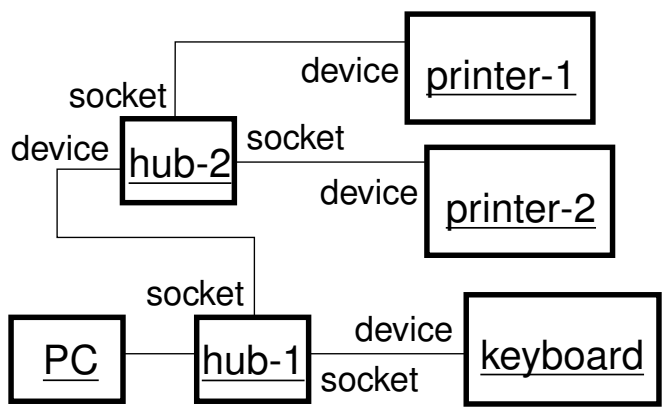

device
printer-1
socket
device
hub-2
socket
device
printer-2
socket
PC
hub-1


device
printer-1
socket
device
hub-2
socket
device
printer-2
socket
PC
hub-1
device
socket
keyboard

- **Validity of advice:** no sequence of operations leads to an invalid model
  - For the USB language: all derivable USBs satisfy the language constraints (the diagram and C1–C3)
- **Exhaustiveness of advice:** all conforming instances are derivable.
  - For the USB language: all legal USBs can be derived (*van der Meer* 2006)

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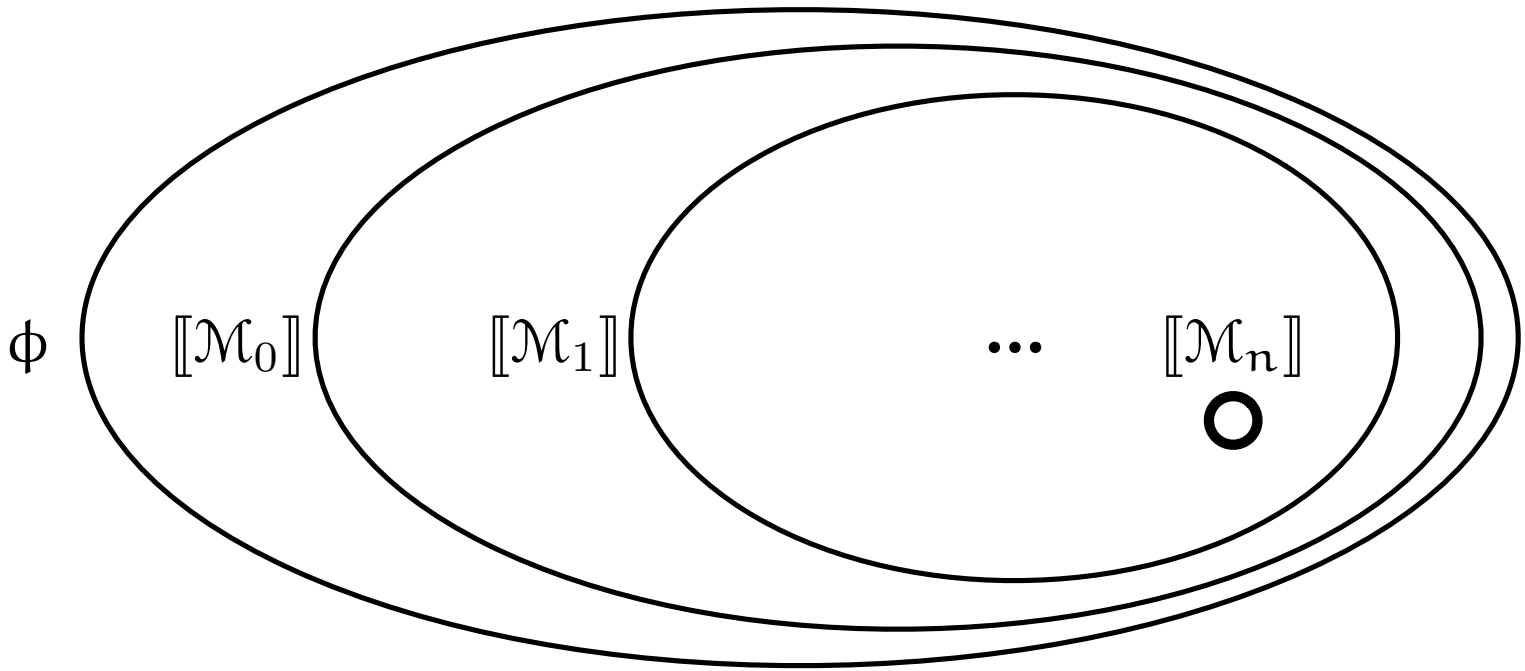
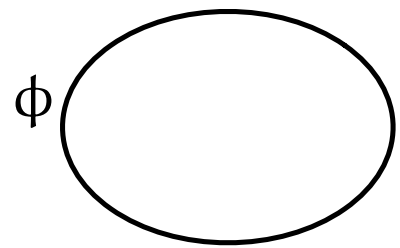
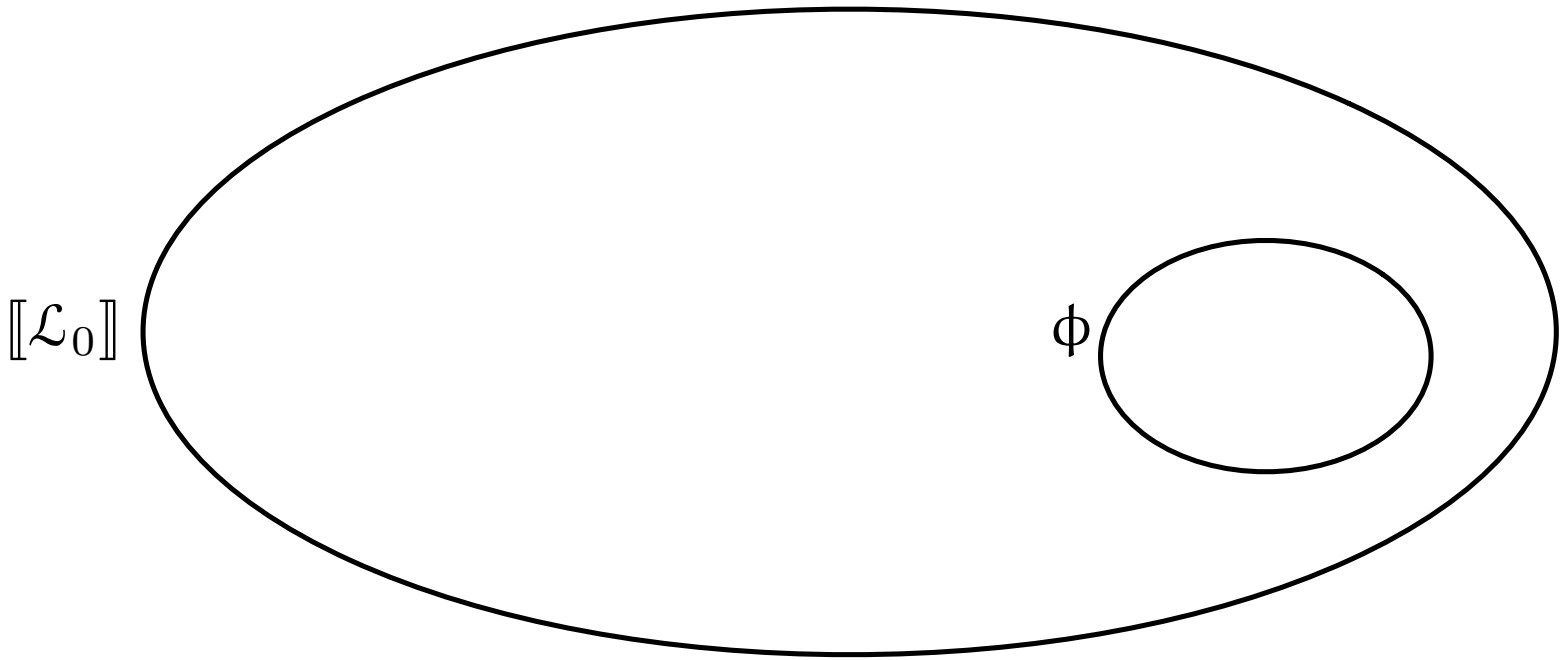
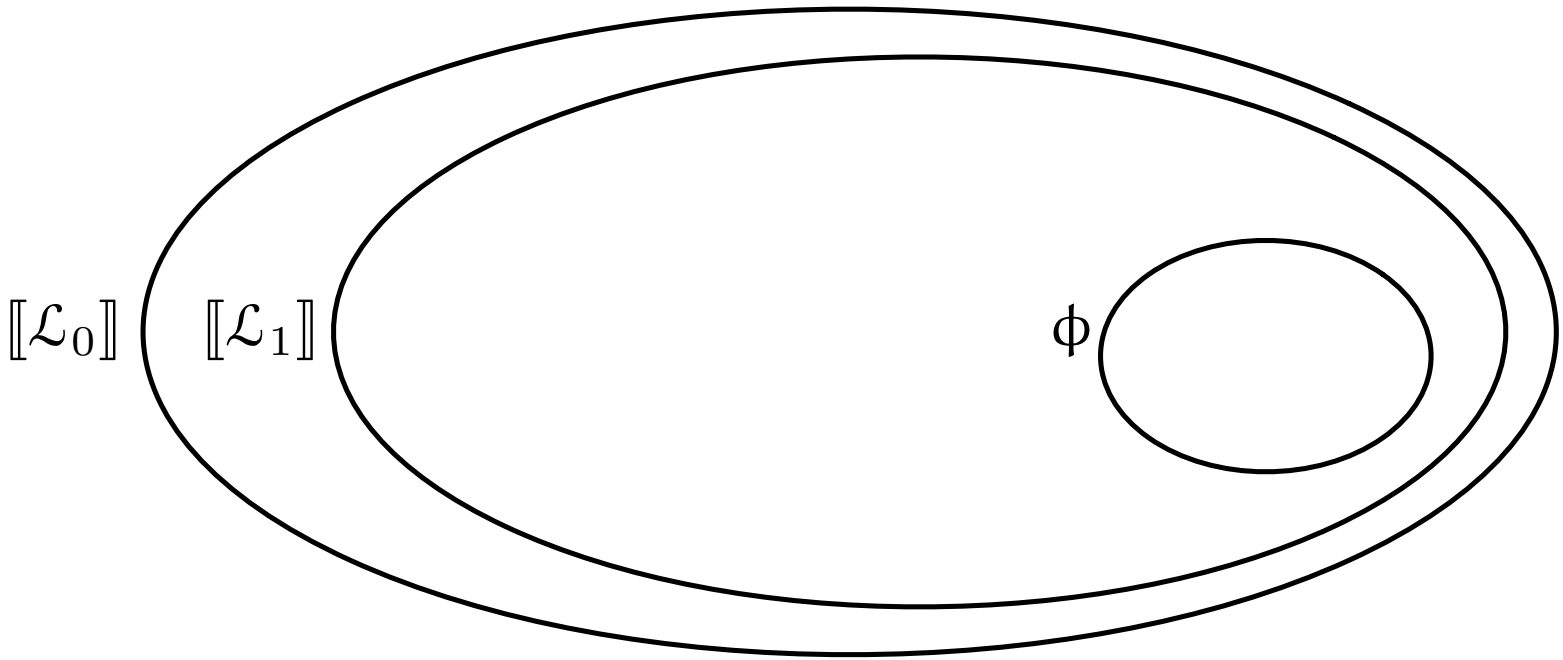
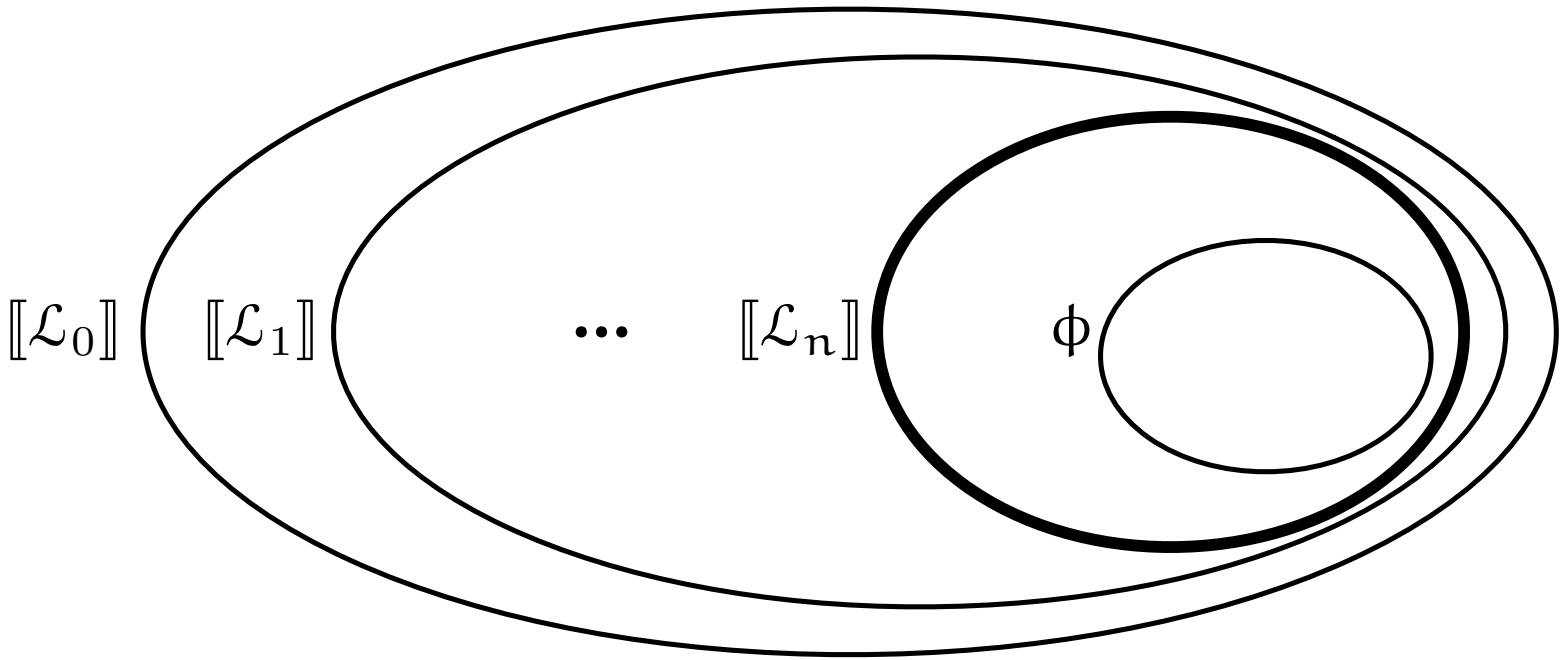


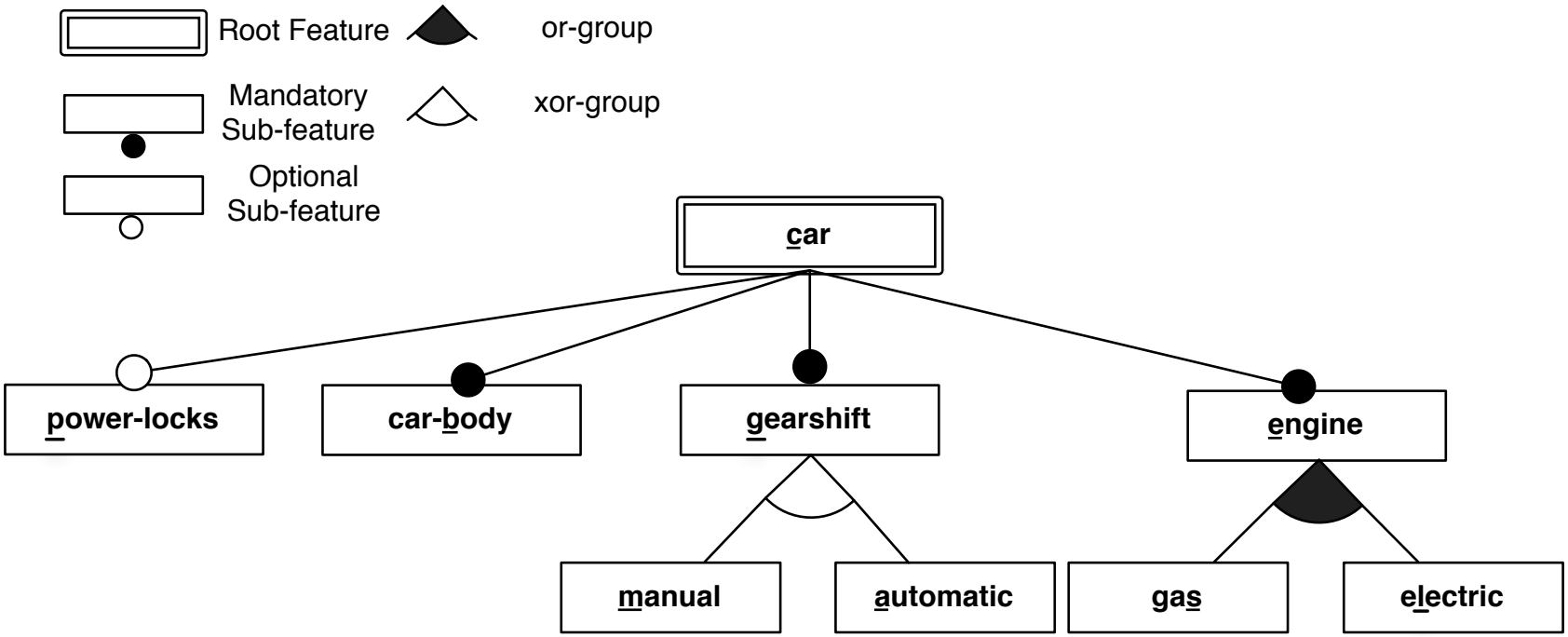
model $\rightarrow$ an instance


ϕ


$[\![\mathcal{L}_0]\!]$
ϕ

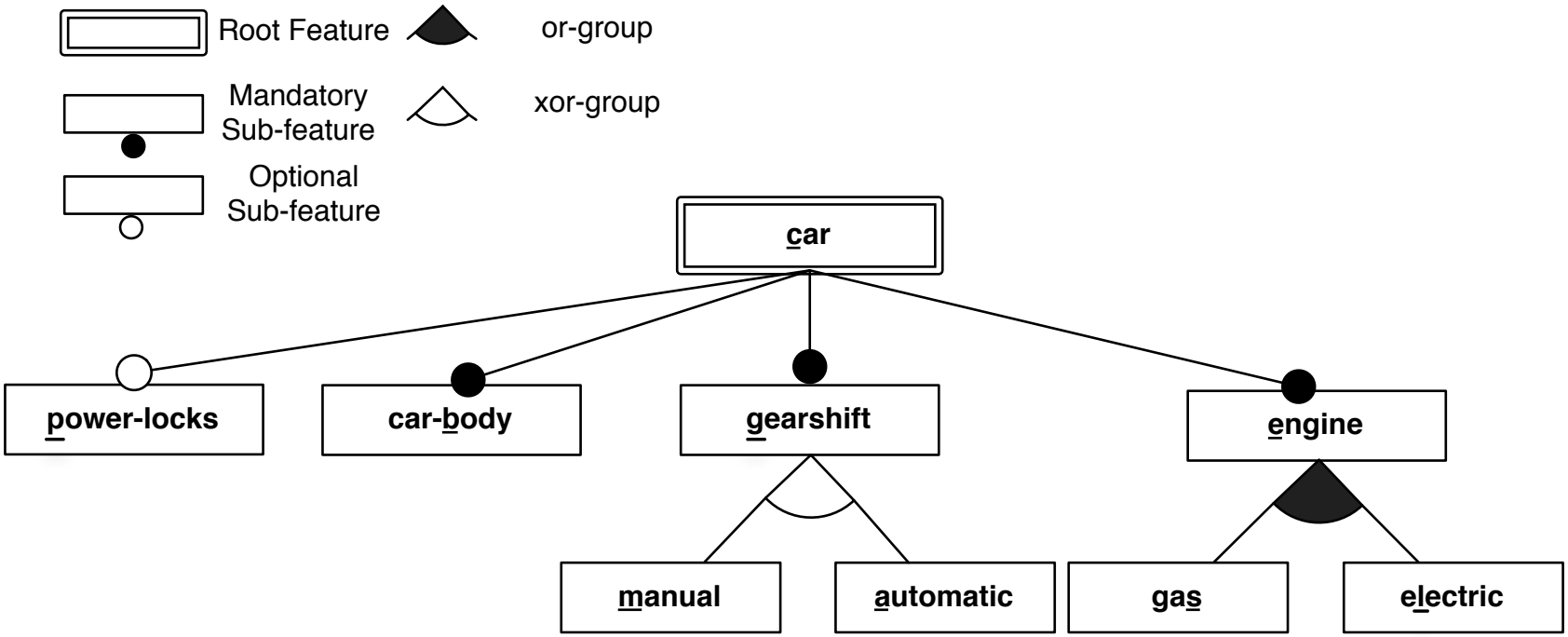

$[\![\mathcal{L}_0]\!]$
$[\![\mathcal{L}_1]\!]$
ϕ


$[\![\mathcal{L}_0]\!]$
$[\![\mathcal{L}_1]\!]$
$\cdots$
$[\![\mathcal{L}_n]\!]$
ϕ



additional constraint:

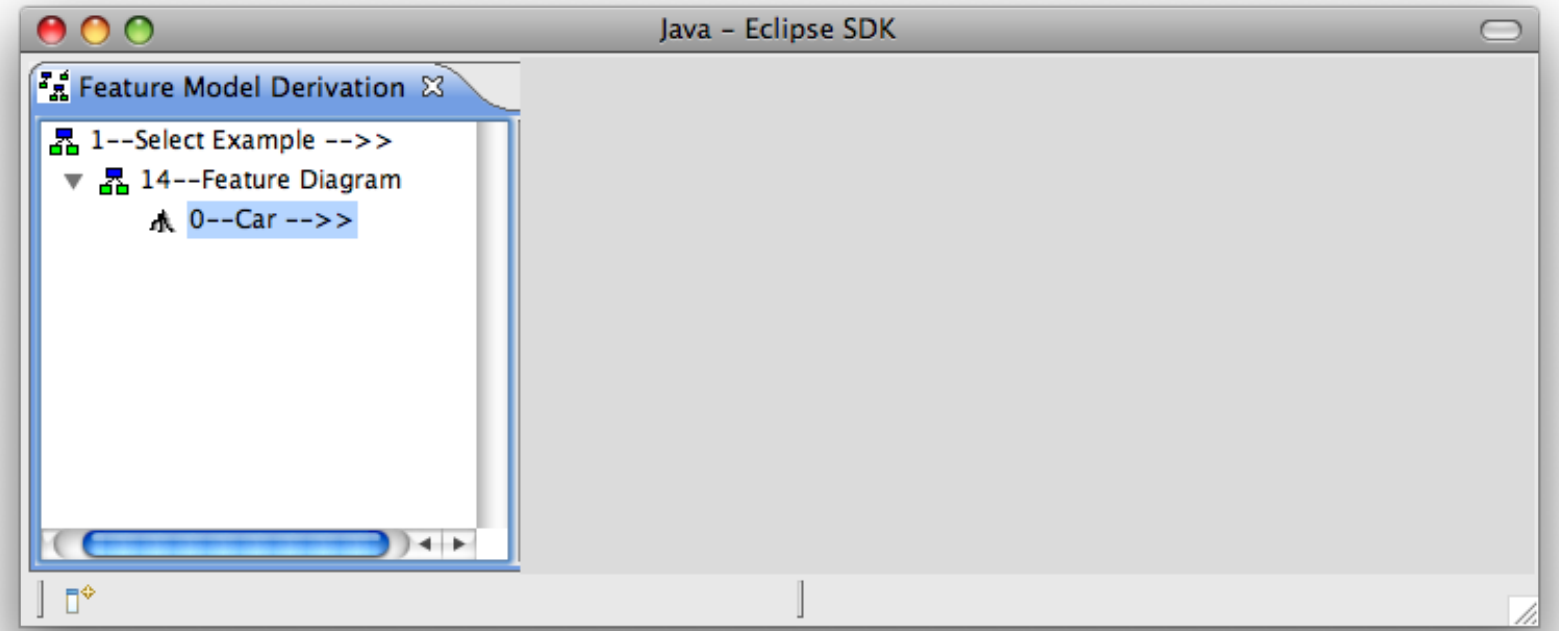
electric $\rightarrow$ automatic



additional constraint:

$$\text{electric} \rightarrow \text{automatic}$$

Feature Model approximating a constraint



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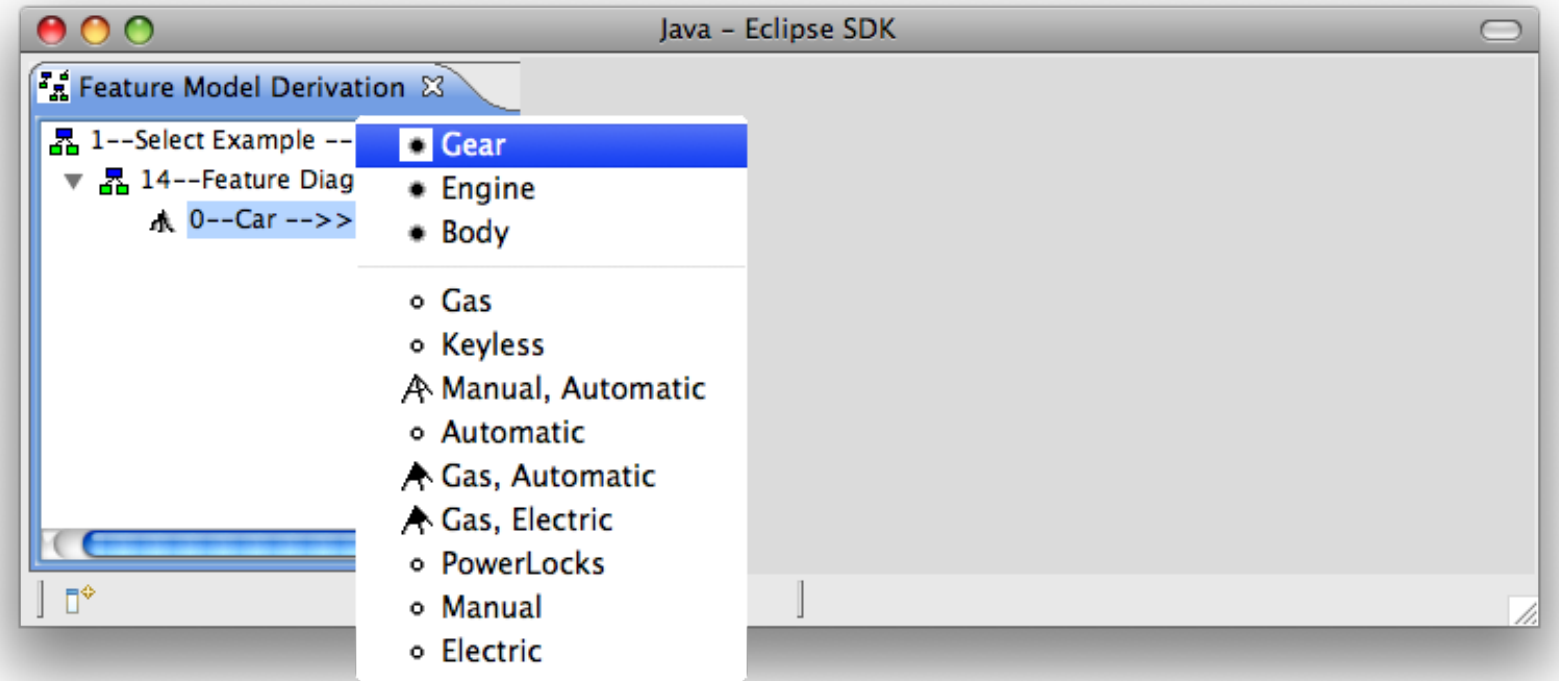

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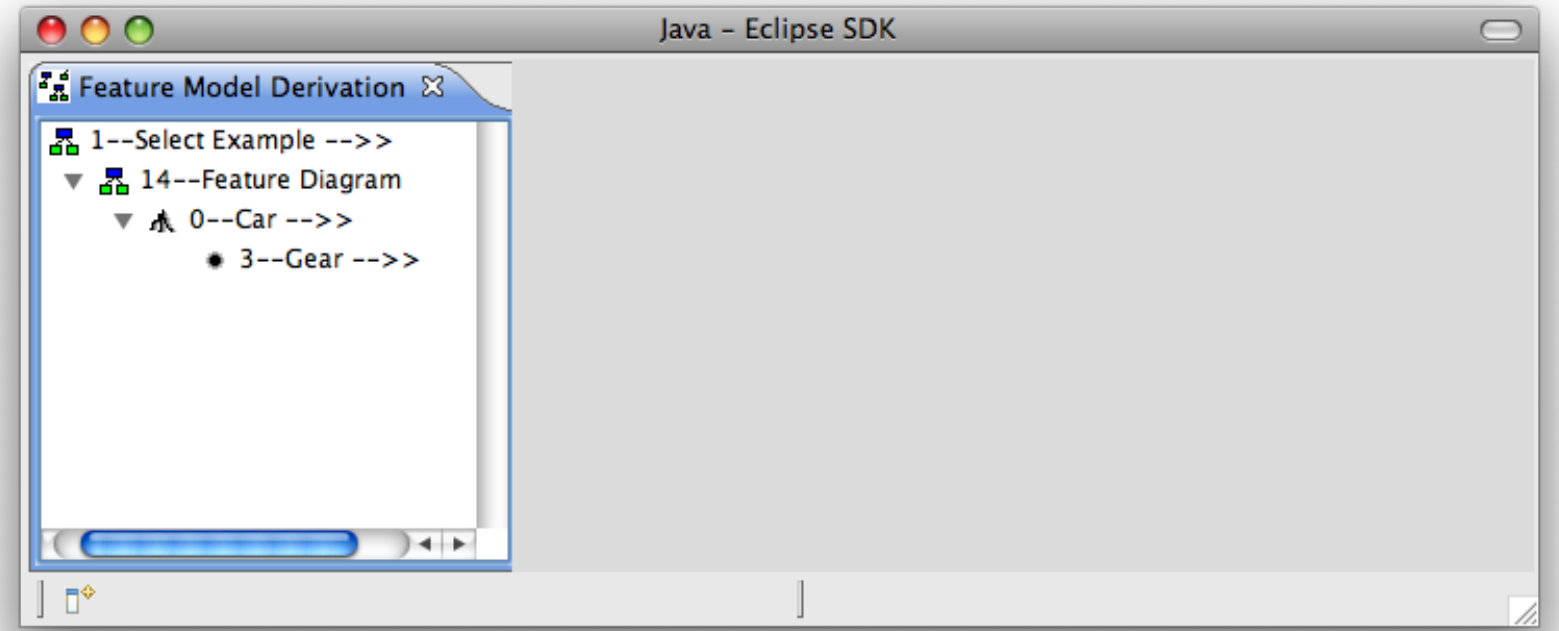
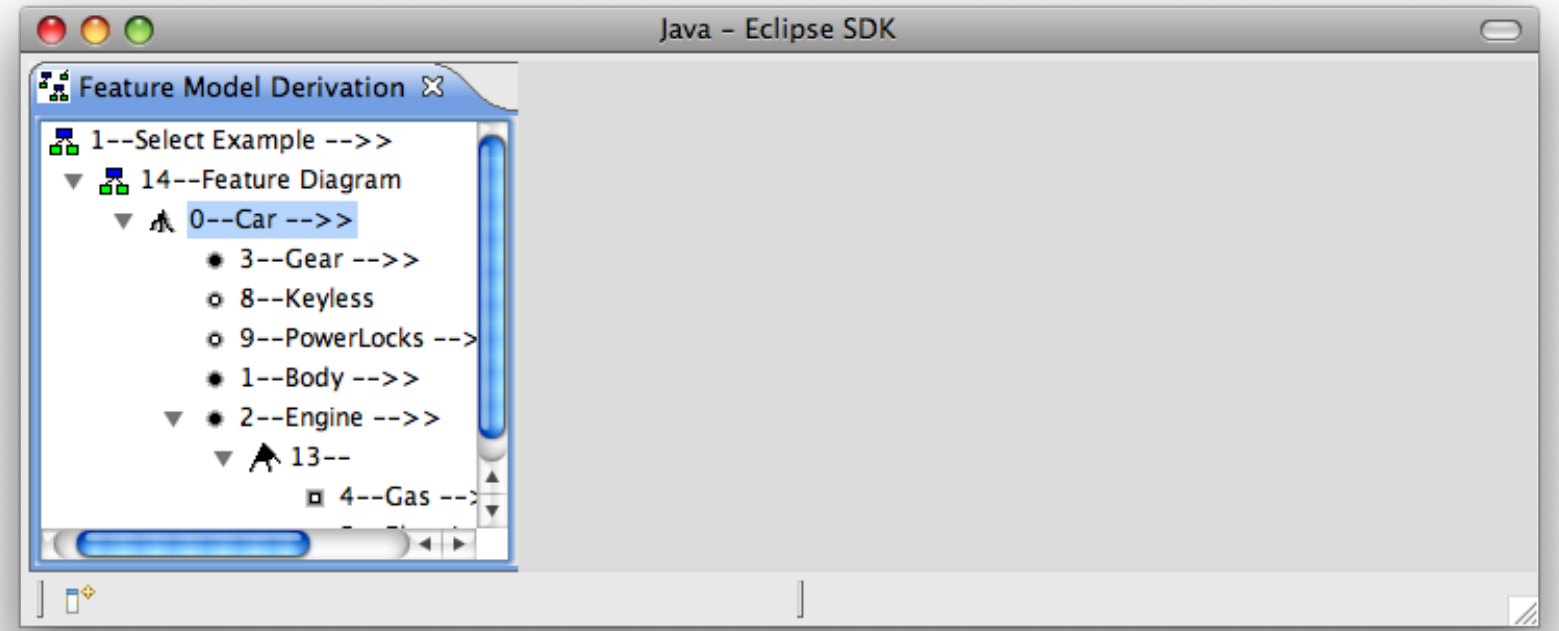
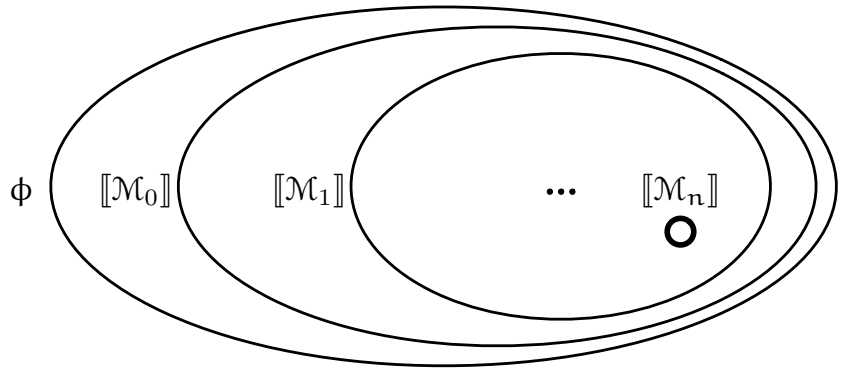
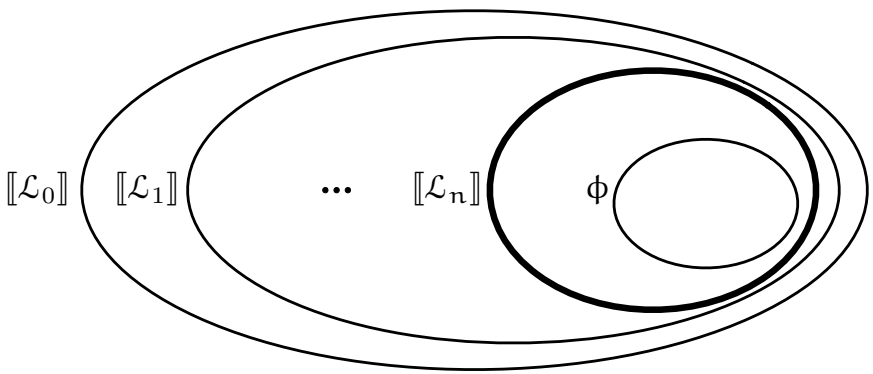


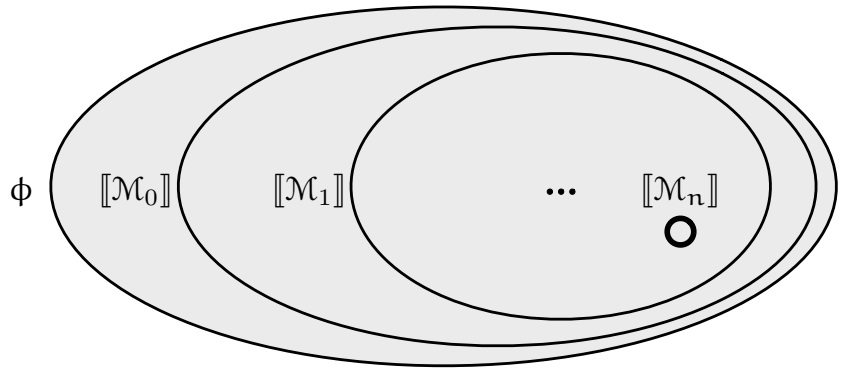
Feature Model approximating a constraint



- The algorithm has the properties of **validity** and **exhaustiveness** of advice.
- The algorithm is efficient compared to approaches based on Constraint Satisfaction or Logic Programming.


ϕ
$[\![\mathcal{M}_0]\!]$
$[\![\mathcal{M}_1]\!]$
$\cdots$
$[\![\mathcal{M}_n]\!]$


$[\![\mathcal{L}_0]\!]$
$[\![\mathcal{L}_1]\!]$
$\cdots$
$[\![\mathcal{L}_n]\!]$
ϕ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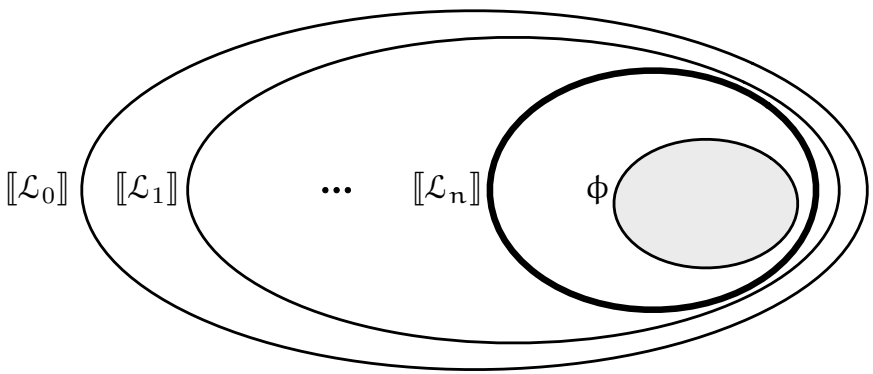
$\cdots$
$[\![\mathcal{M}_n]\!]$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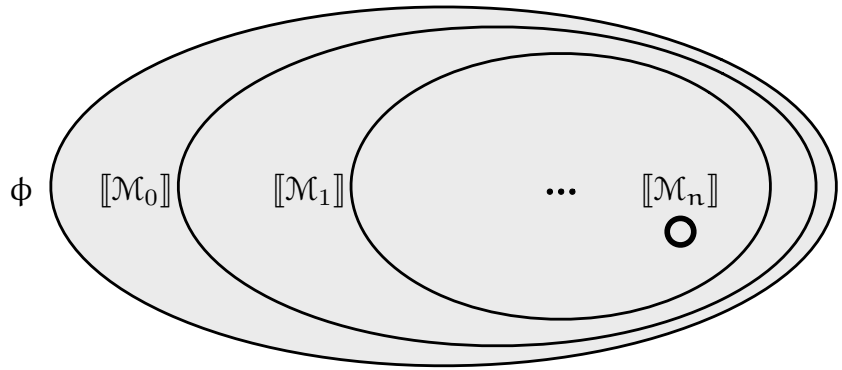
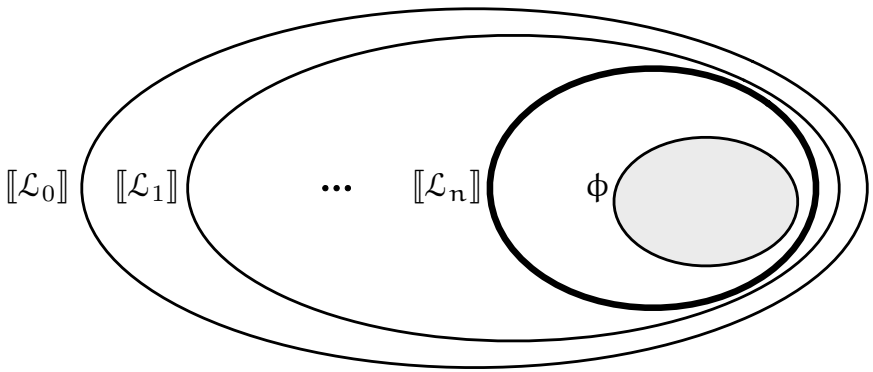
$\cdots$
$[\![\mathcal{L}_n]\!]$
ϕ



model $\rightarrow$ an instance



meta-model $\rightarrow$ model

semantics-preserving =

completeness-preserving

+ soundness-preserving

semantics-preserving =
completeness-preserving
+ soundness-preserving

Example: any refactoring

semantics-preserving =
completeness-preserving
+ soundness-preserving

Example: any refactoring
Example: feature **model** derivation

- the model comprises two components
  - feature diagram (M)
  - additional constraint (ψ)
- overall semantics must be preserved

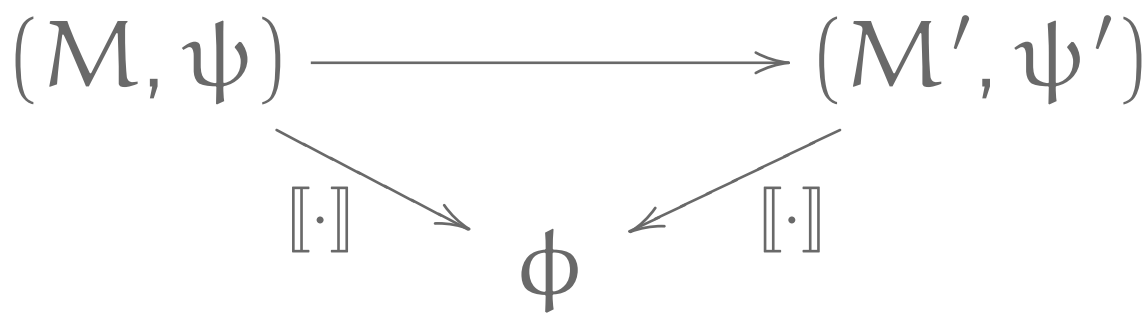
  "$M + \psi = M' + \psi'$"

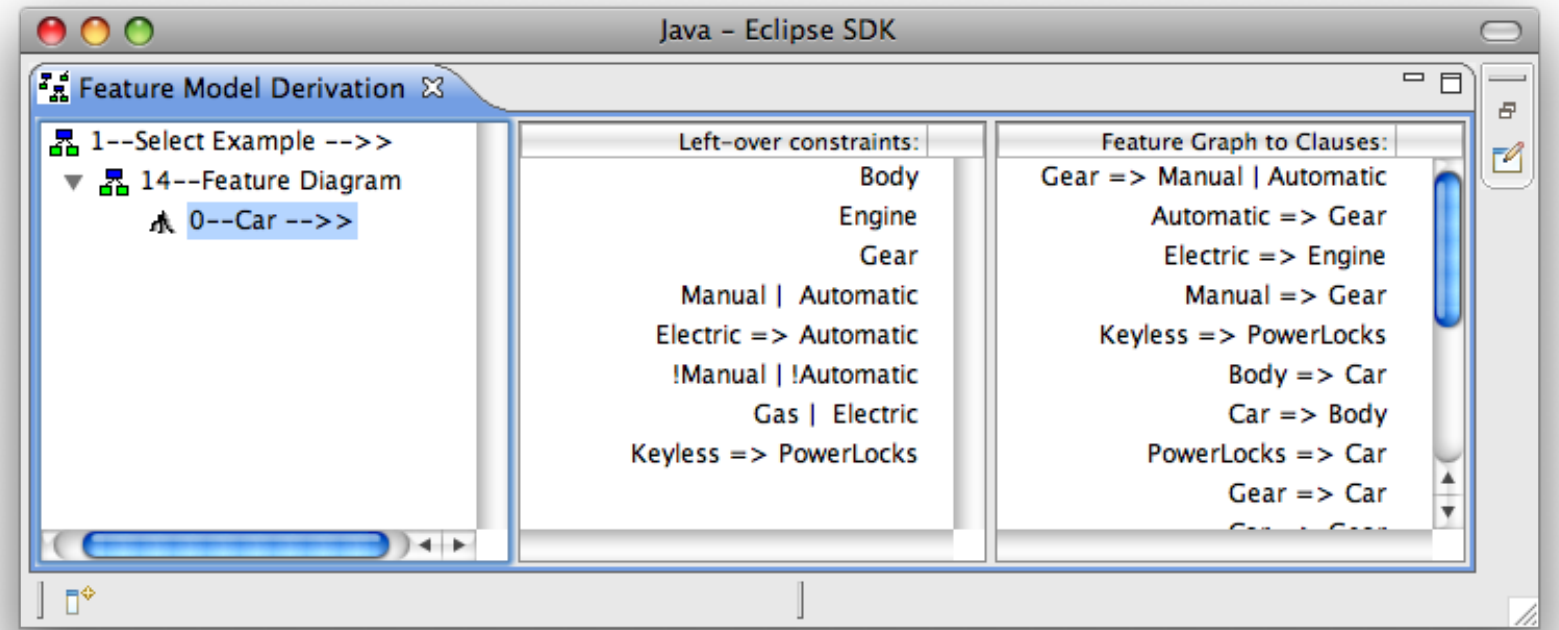
or

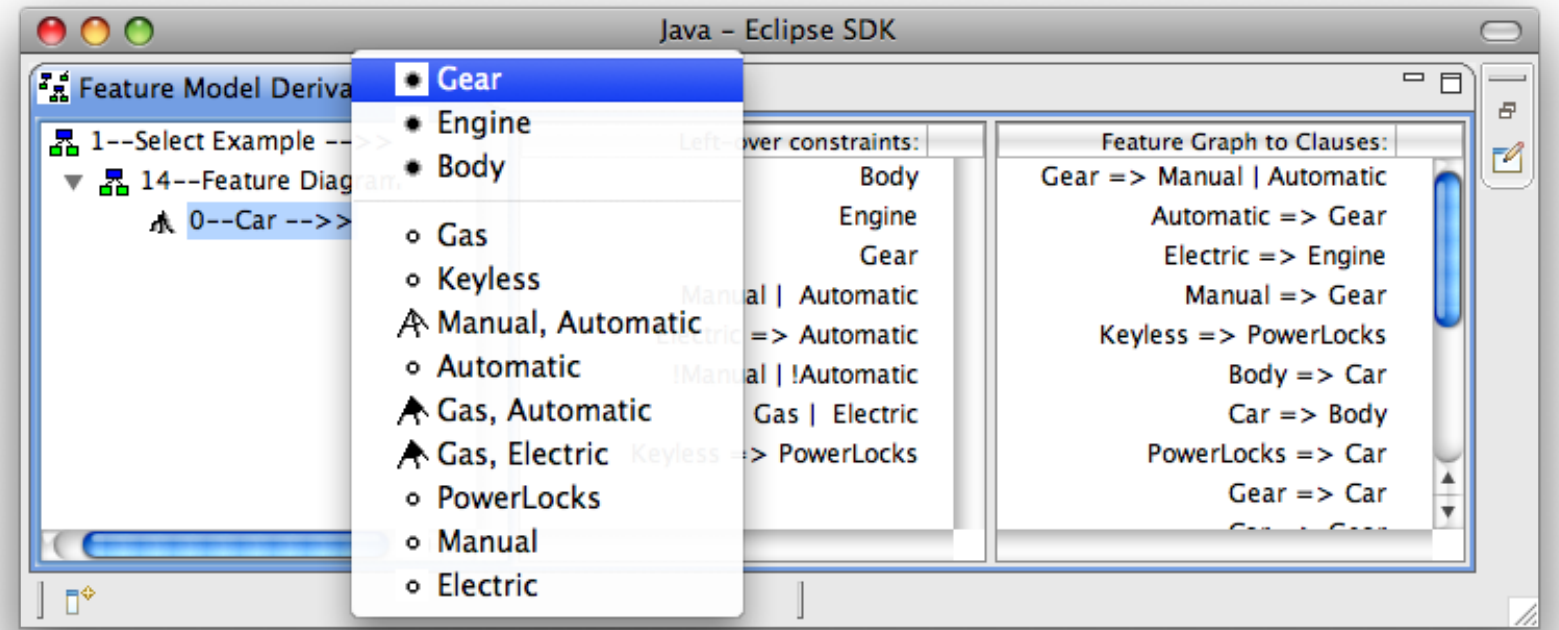
- the model comprises two components
  - feature diagram (M)
  - additional constraint (ψ)
- overall semantics must be preserved

$$\text{“ } M + \psi = M' + \psi' \text{”}$$

or




Java – Eclipse SDK
Feature Model Derivation
1--Select Example -->>
14--Feature Diagram
0--Car -->>
Left-over constraints:
Body
Engine
Gear
Manual | Automatic
Electric => Automatic
!Manual | !Automatic
Gas | Electric
Keyless => PowerLocks
Feature Graph to Clauses:
Gear => Manual | Automatic
Automatic => Gear
Electric => Engine
Manual => Gear
Keyless => PowerLocks
Body => Car
Car => Body
PowerLocks => Car
Gear => Car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Gear
Engine
Body
Gas
Keyless
Manual, Automatic
Automatic
Gas, Automatic
Gas, Electric
PowerLocks
Manual
Electric
ver constraints:
Body
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al | Automatic
=> Automatic
al | !Automatic
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> PowerLocks
Feature Graph to Clauses:
Gear => Manual | Automatic
Automatic => Gear
Electric => Engine
Manual => Gear
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Body => Car
Car => Body
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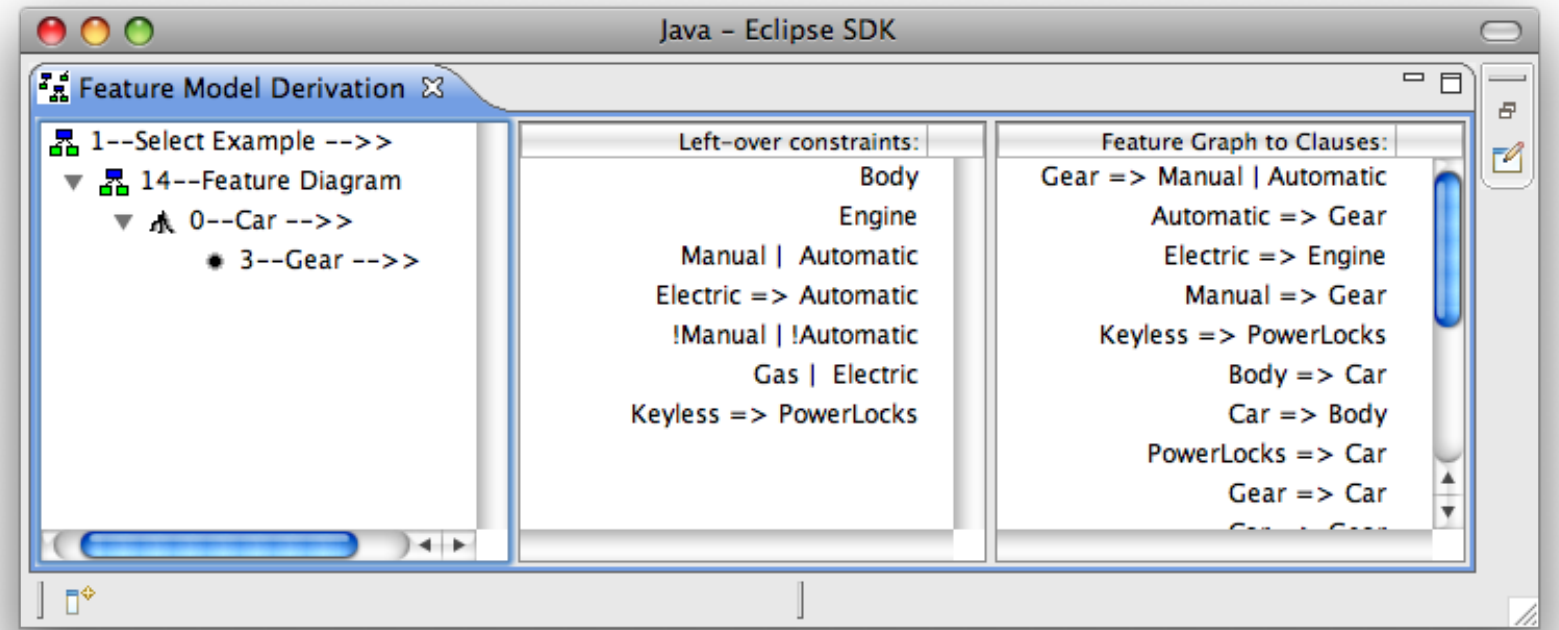
Gear => Car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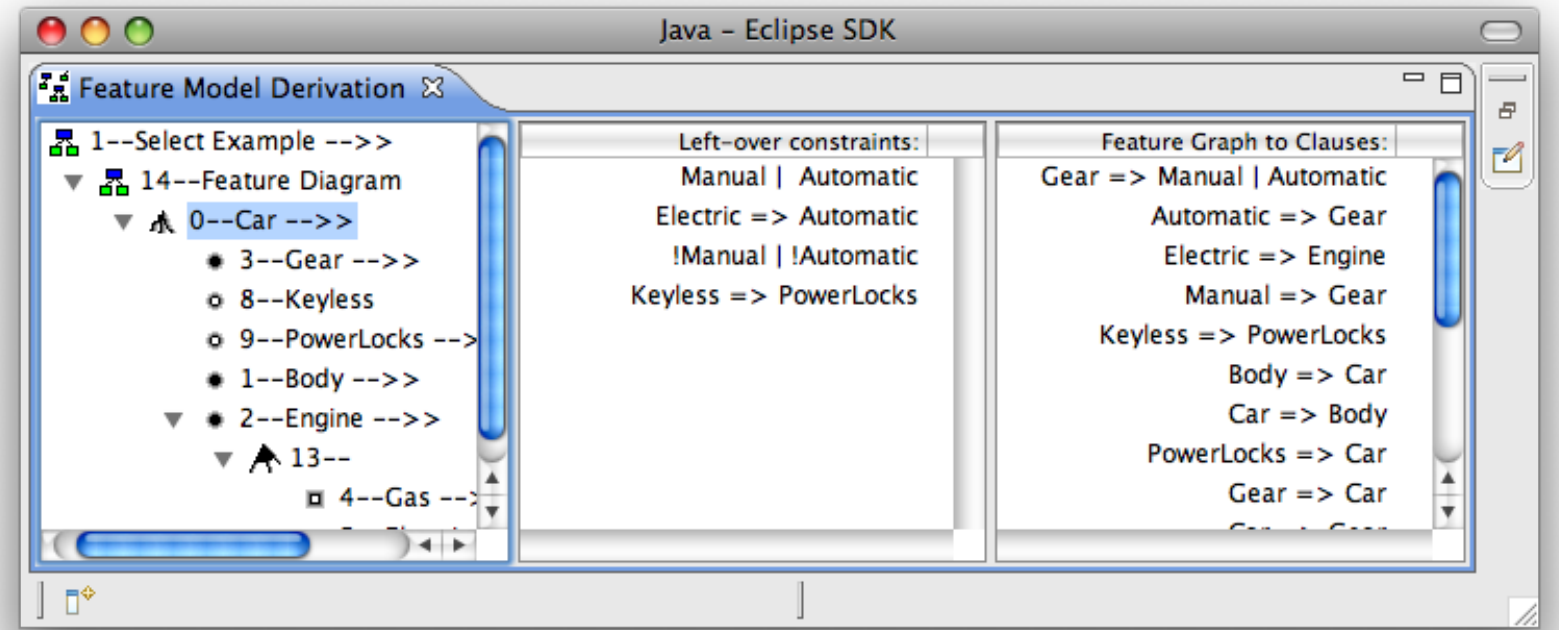
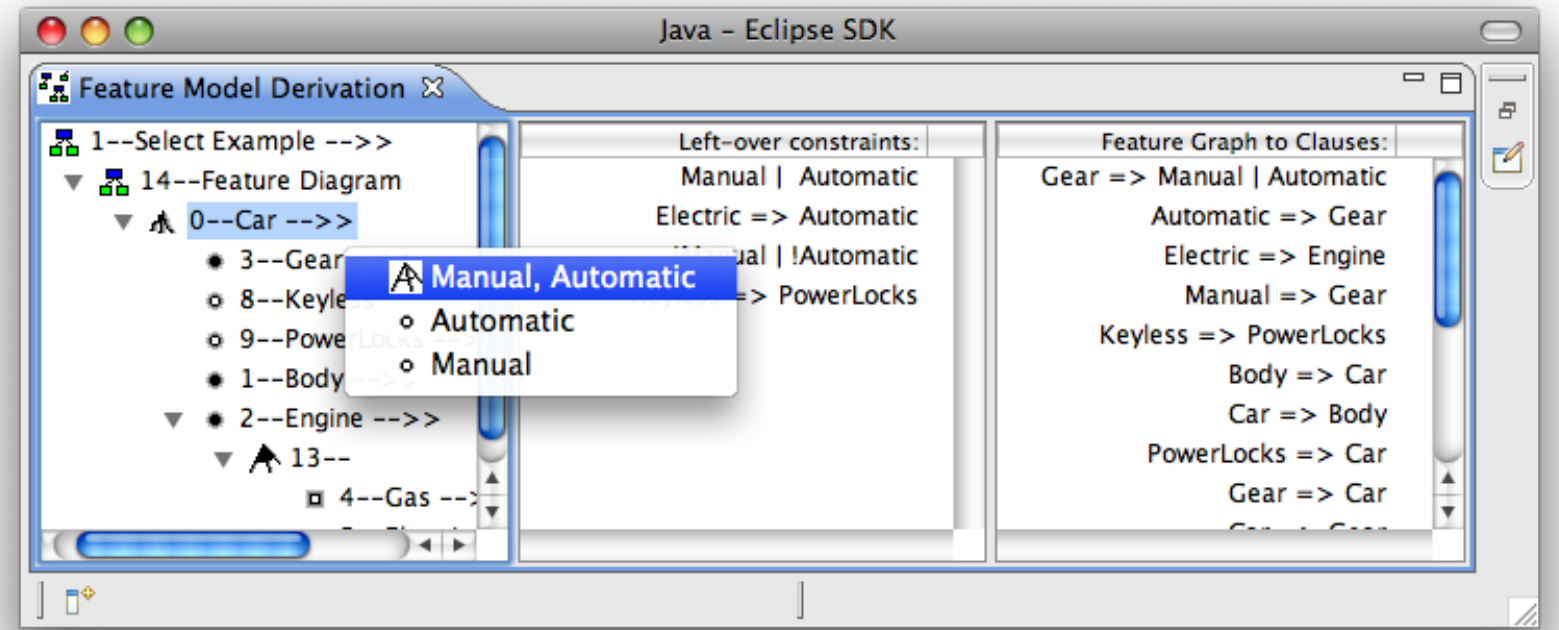
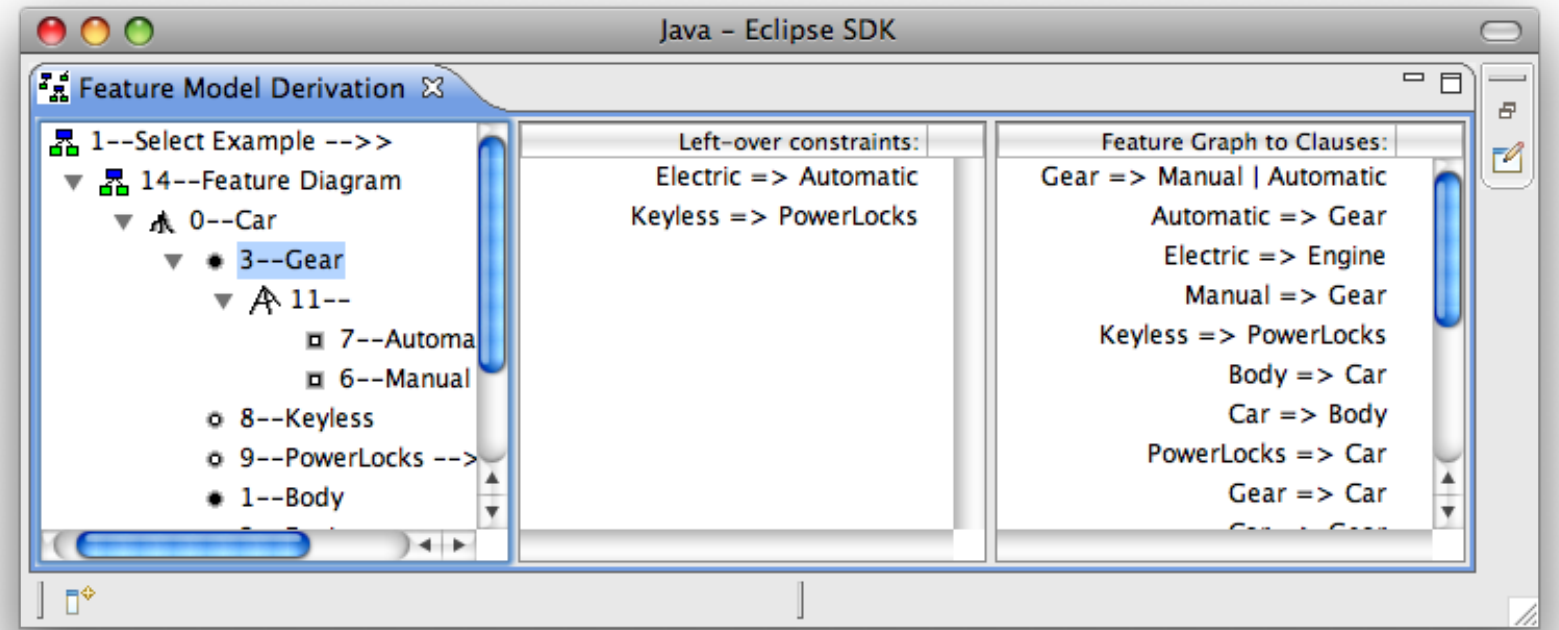
PowerLocks => Car
Gear => Car


Java – Eclipse SDK
Feature Model Derivation
1--Select Example -->>
14--Feature Diagram
0--Car -->>
3--Gear -->>
8--Keyless
9--PowerLocks -->
1--Body -->>
2--Engine -->>
13--
4--Gas -->
Left-over constraints:
Manual | Automatic
Electric => Automatic
!Manual | !Automatic
Keyless => PowerLocks
Feature Graph to Clauses:
Gear => Manual | Automatic
Automatic => Gear
Electric => Engine
Manual => Gear
Keyless => PowerLocks
Body => Car
Car => Body
PowerLocks => Car
Gear => Car


Java – Eclipse SDK
Feature Model Derivation
1--Select Example -->>
14--Feature Diagram
0--Car -->>
3--Gear
8--Keyle
9--Powe
1--Body
2--Engine -->>
13--
4--Gas -->
Manual, Automatic
Automatic
Manual
Left-over constraints:
Manual | Automatic
Electric => Automatic
ual | !Automatic
=> PowerLocks
Feature Graph to Clauses:
Gear => Manual | Automatic
Automatic => Gear
Electric => Engine
Manual => Gear
Keyless => PowerLocks
Body => Car
Car => Body
PowerLocks => Car
Gear => Car


Java – Eclipse SDK
Feature Model Derivation
1--Select Example -->>
14--Feature Diagram
0--Car
3--Gear
11--
7--Automa
6--Manual
8--Keyless
9--PowerLocks -->
1--Body
Left-over constraints:
Electric => Automatic
Keyless => PowerLocks
Feature Graph to Clauses:
Gear => Manual | Automatic
Automatic => Gear
Electric => Engine
Manual => Gear
Keyless => PowerLocks
Body => Car
Car => Body
PowerLocks => Car
Gear => Car

- **glossary**

  soundness-preserving derivation
  completeness-preserving derivation
  semantics-preserving derivation

  validity of advice
  exhaustiveness of advice

- Work this out for a rich subset of ECORE models, not only for Feature Models