Interactive **M**odel **D**erivation with **E**xternal **C**onstraints

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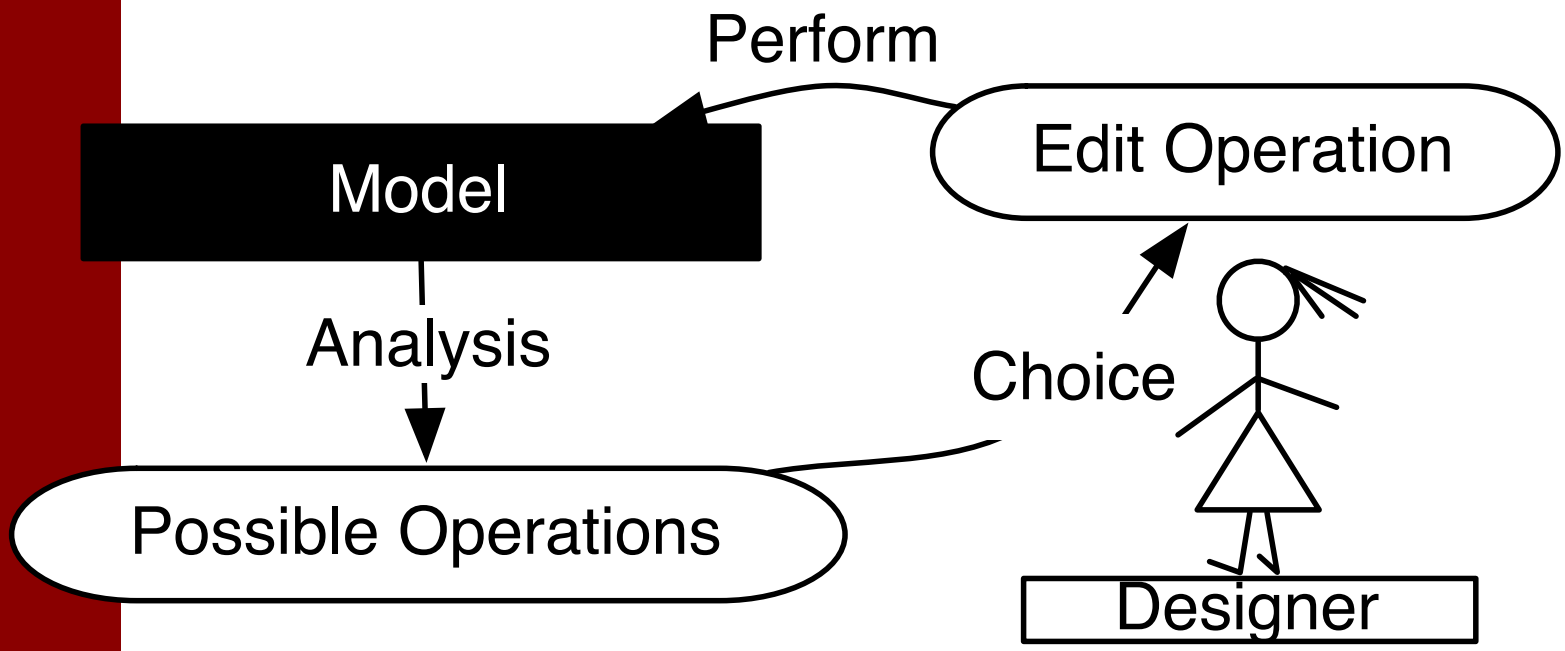
Interactive **M**odel **D**erivation



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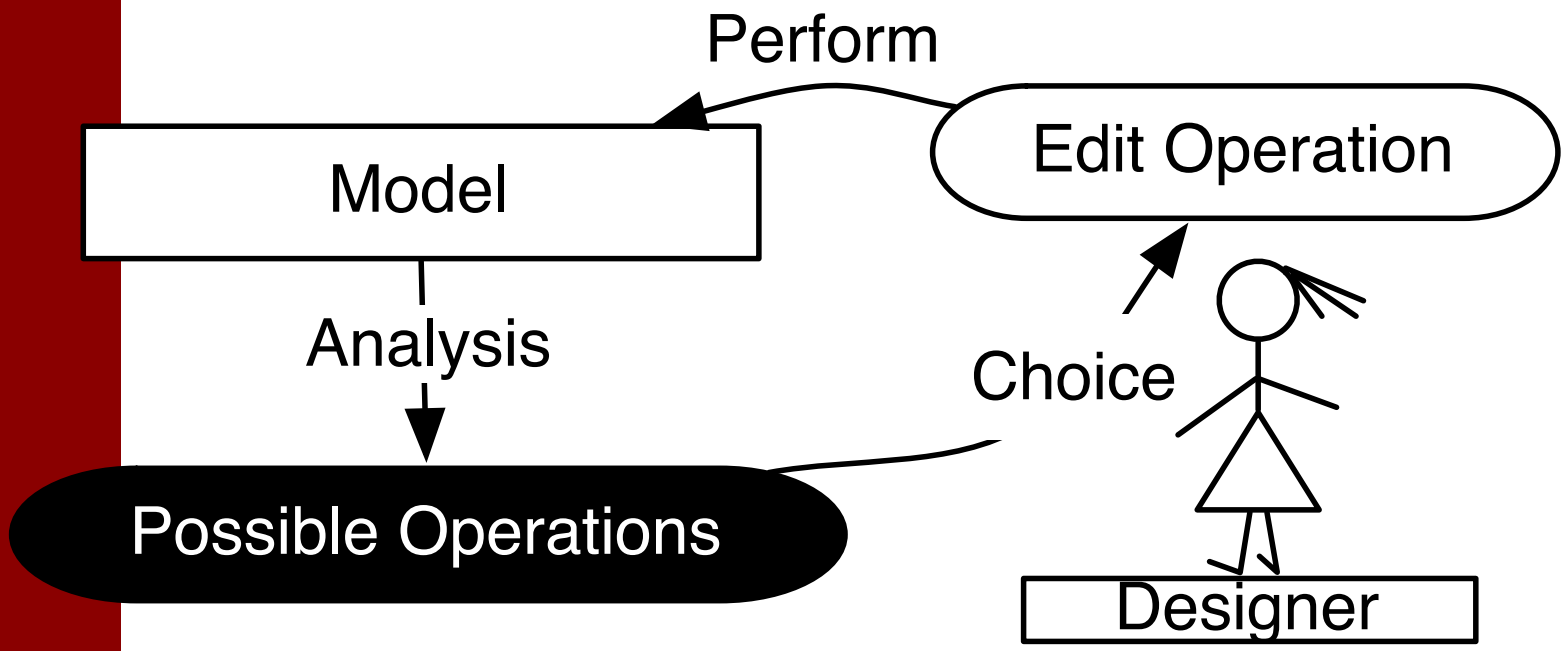
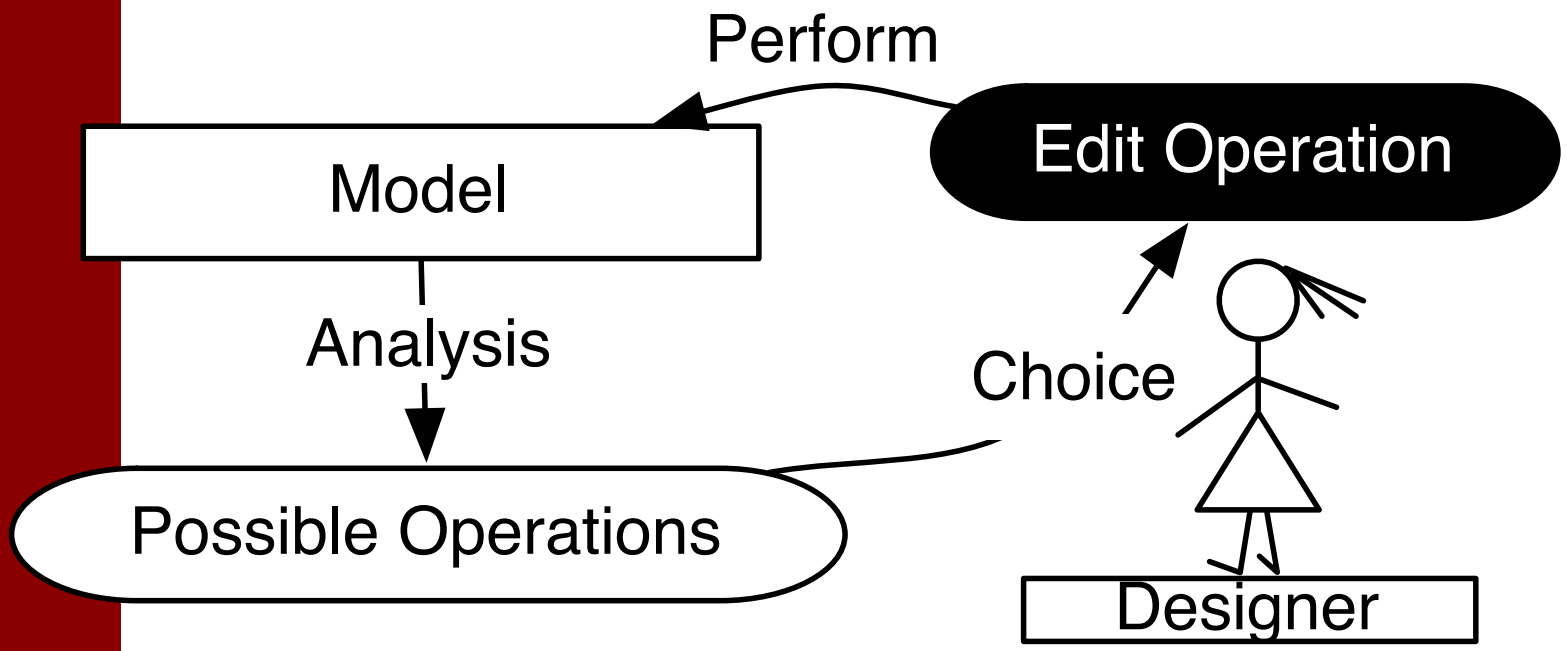


Interactive Model Derivation



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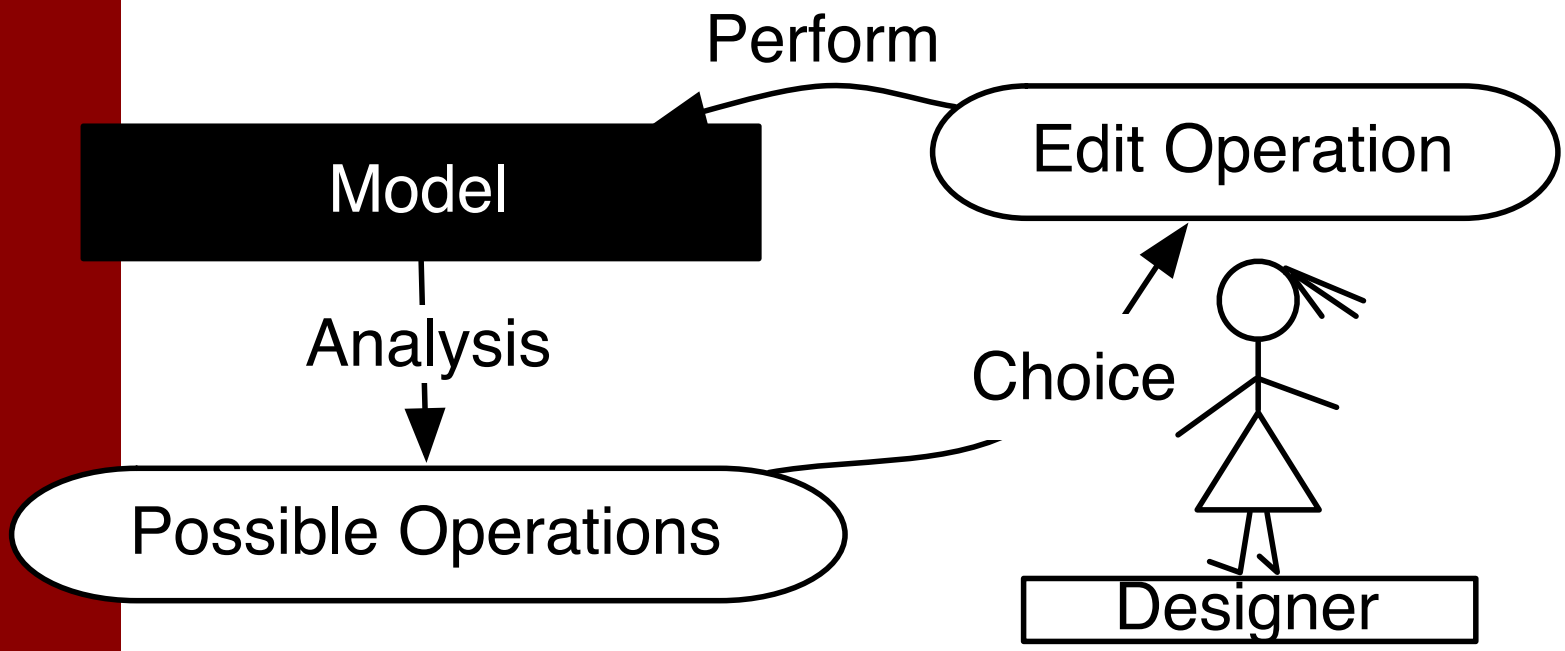

Model **C**arving

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Classification of **D**erivation

- *Soundness-preserving* derivation seen in instance derivation

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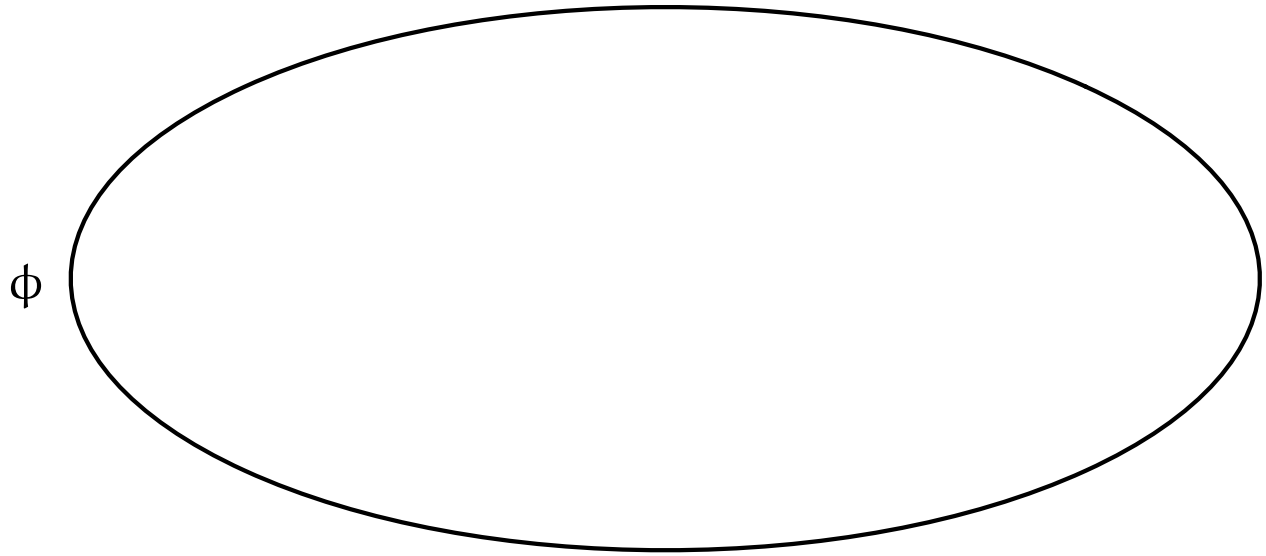
- *Completeness-preserving* derivation will be illustrated by a prototype for *feature diagrams*
- *Semantics-preserving* derivation will be illustrated by a prototype for *feature models*

Soundness-**P**reserving **D**erivation



model $\longrightarrow$ an instance

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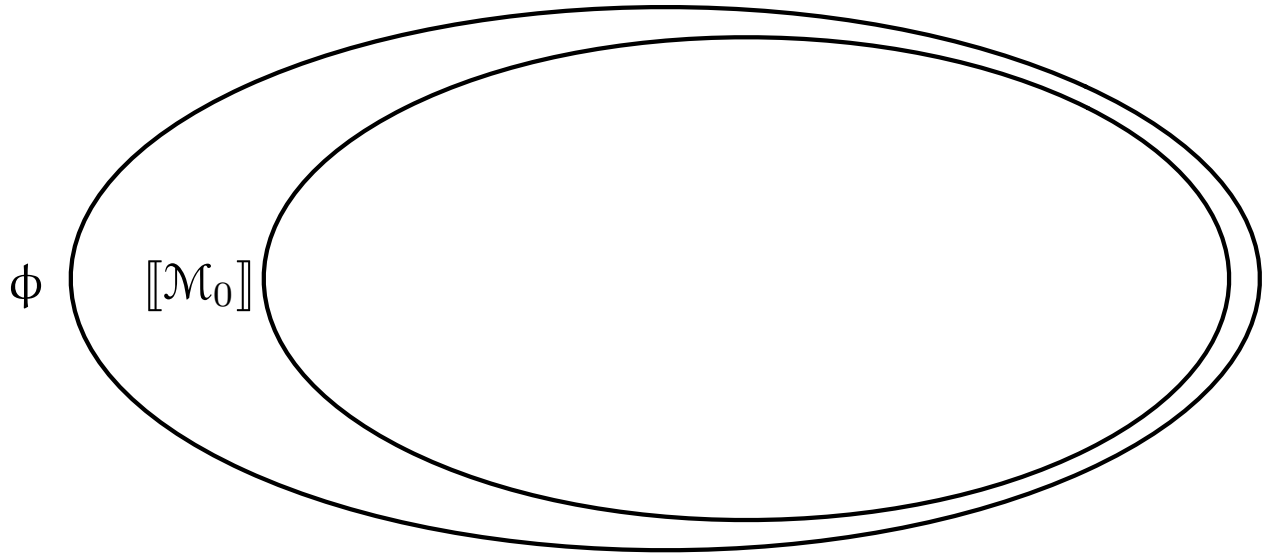

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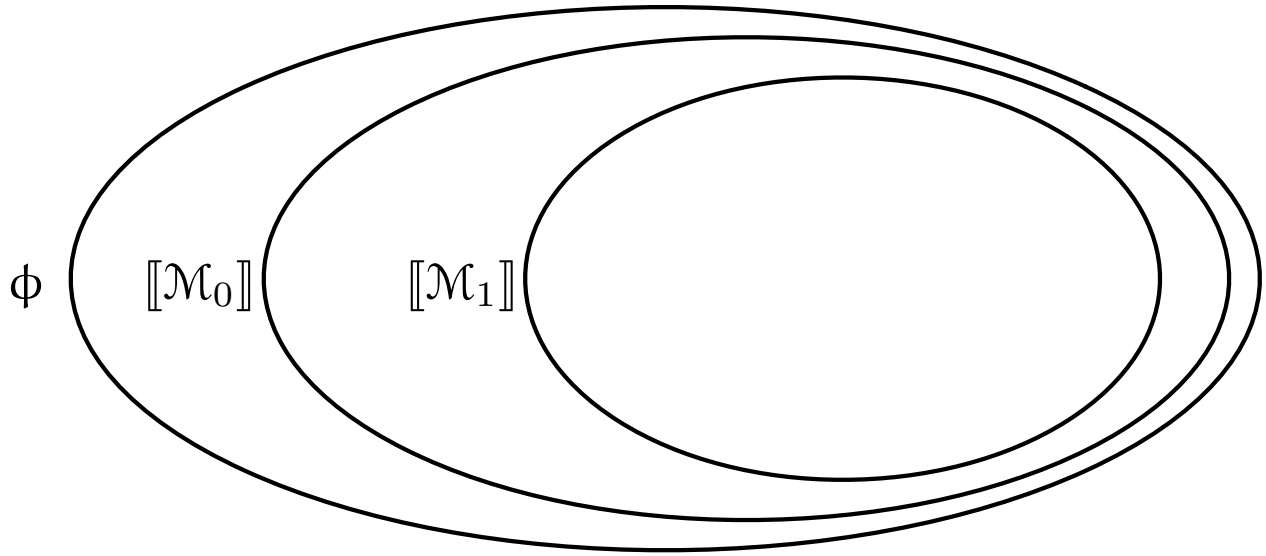

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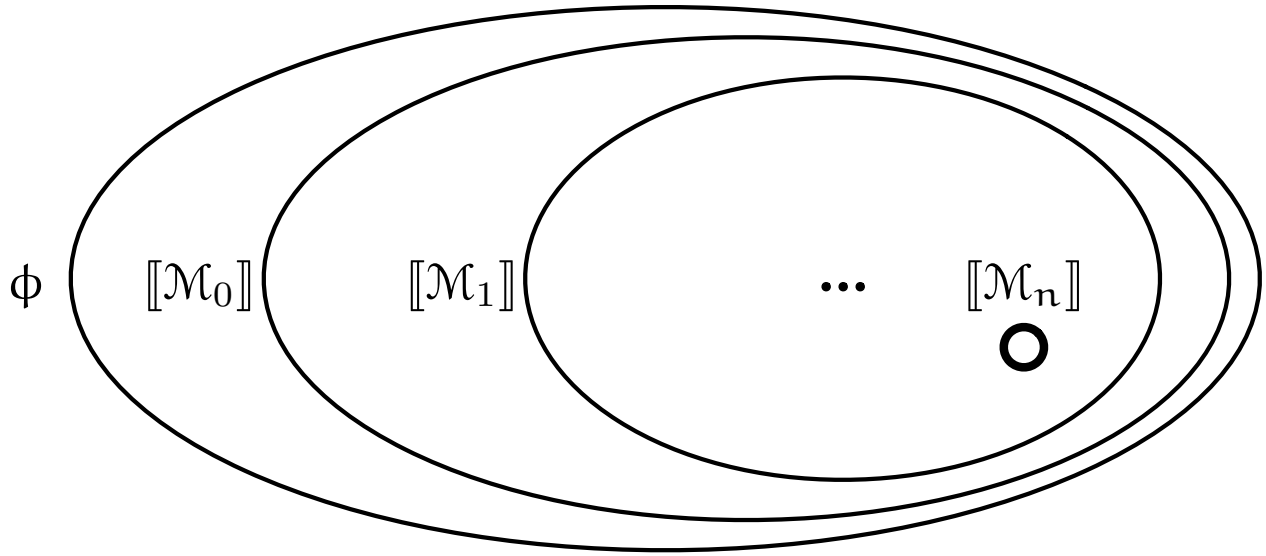

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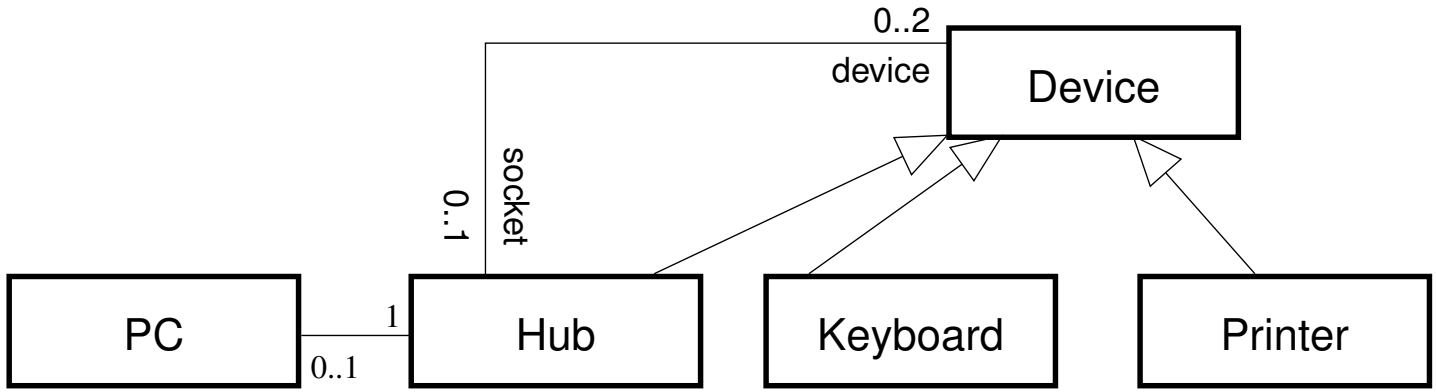
USB Language



C1 Each USB must contain exactly one instance of PC.

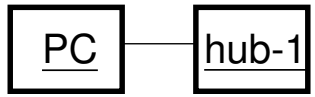
C2 Every device is connected to a port or to the PC instance.

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

Deriving a **USB**

1.

2.



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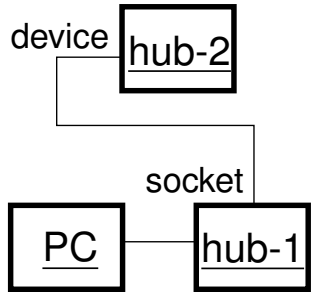
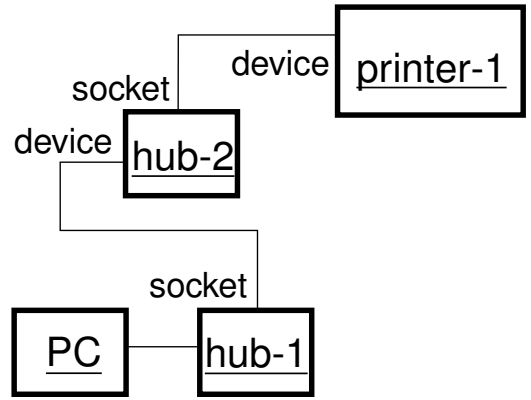


4.



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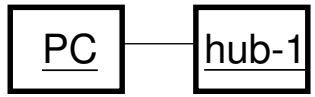

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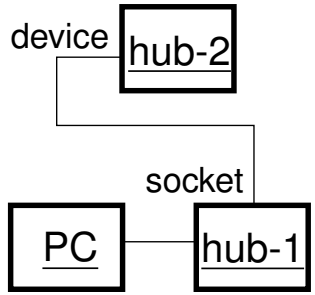

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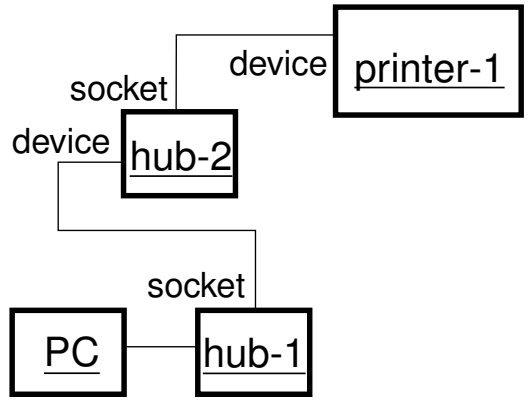

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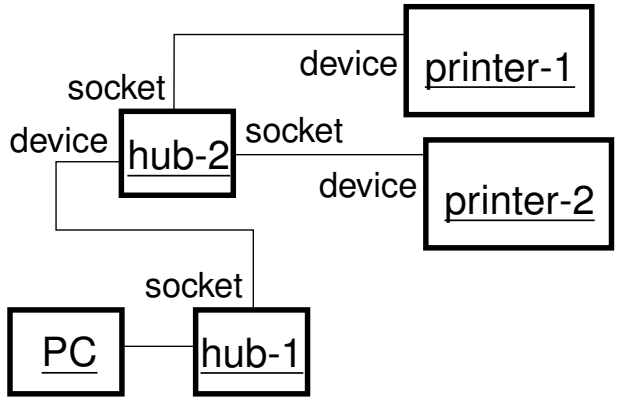

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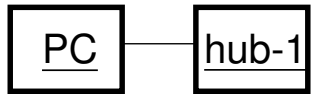

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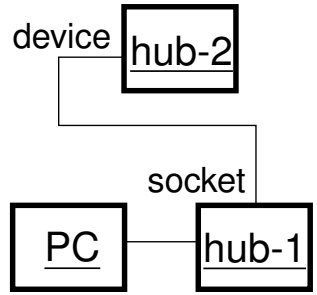

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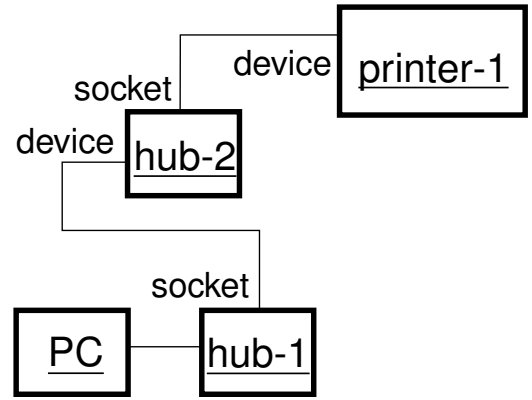

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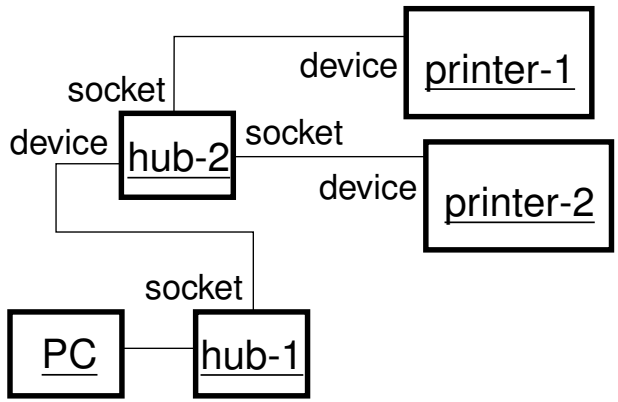

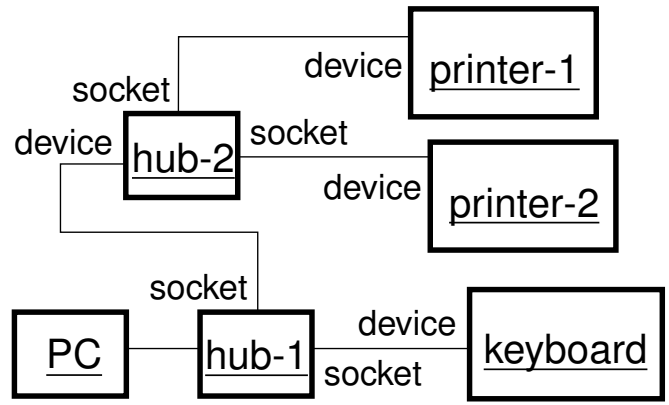

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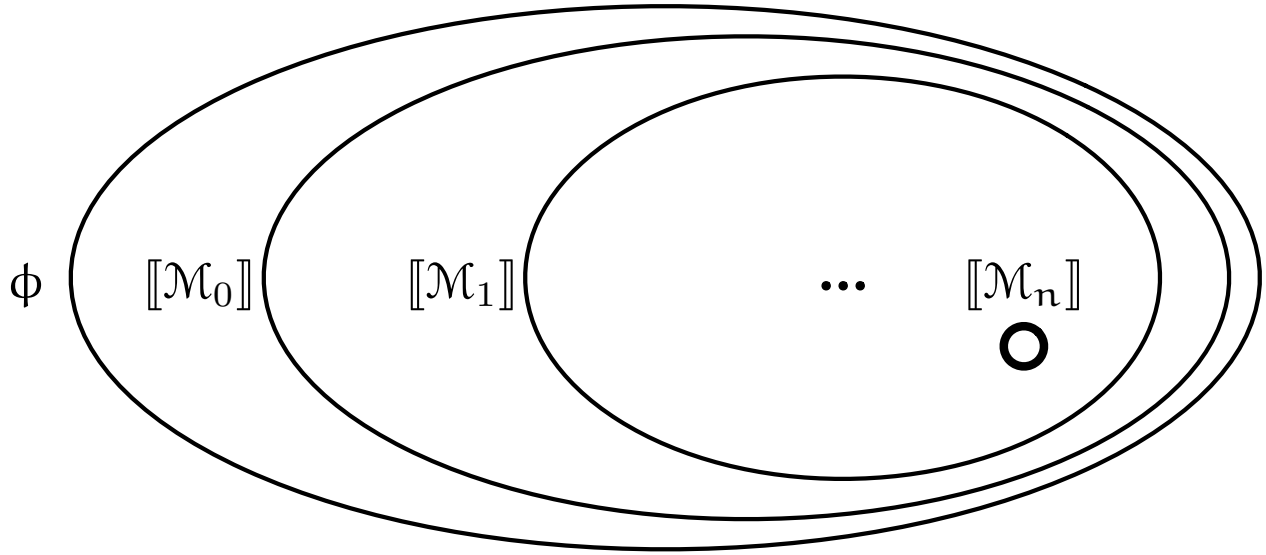
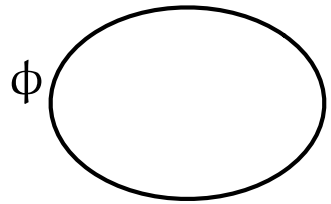
  - For the USB language: all derivable USBs satisfy the language constraints (the diagram and C1–C3)
- **Exhaustiveness of advice:** all conforming instances are derivable.
  - For the USB language: all legal USBs can be derived (*van der Meer* 2006)

Soundness-**P**reserving **D**erivation



model $\longrightarrow$ an instance

Completness-**P**reserving **D**erivation



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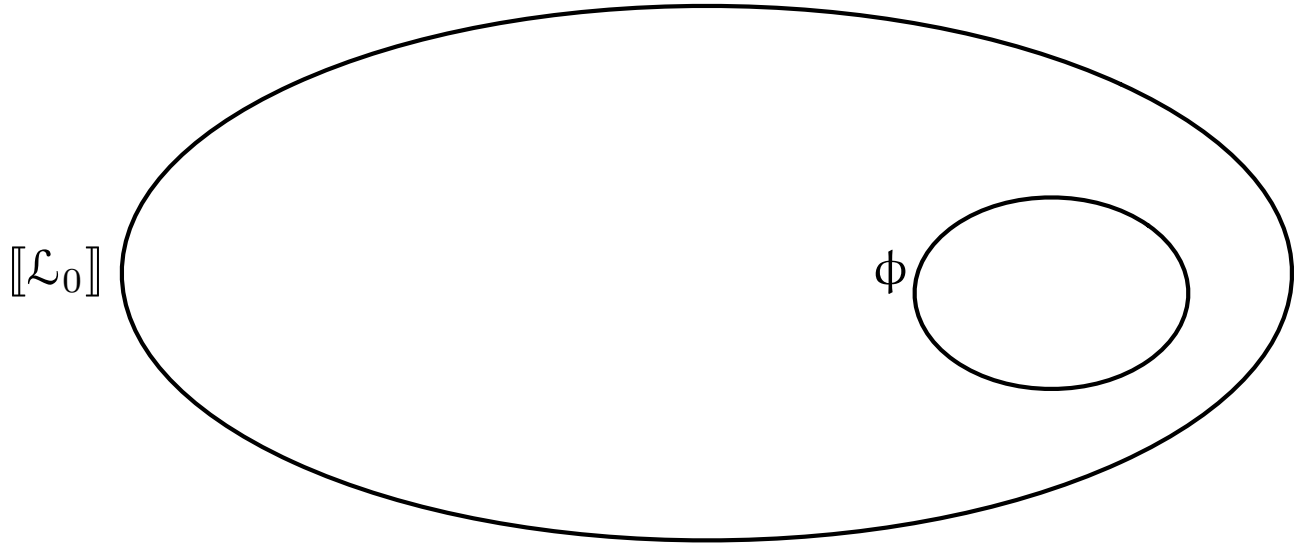

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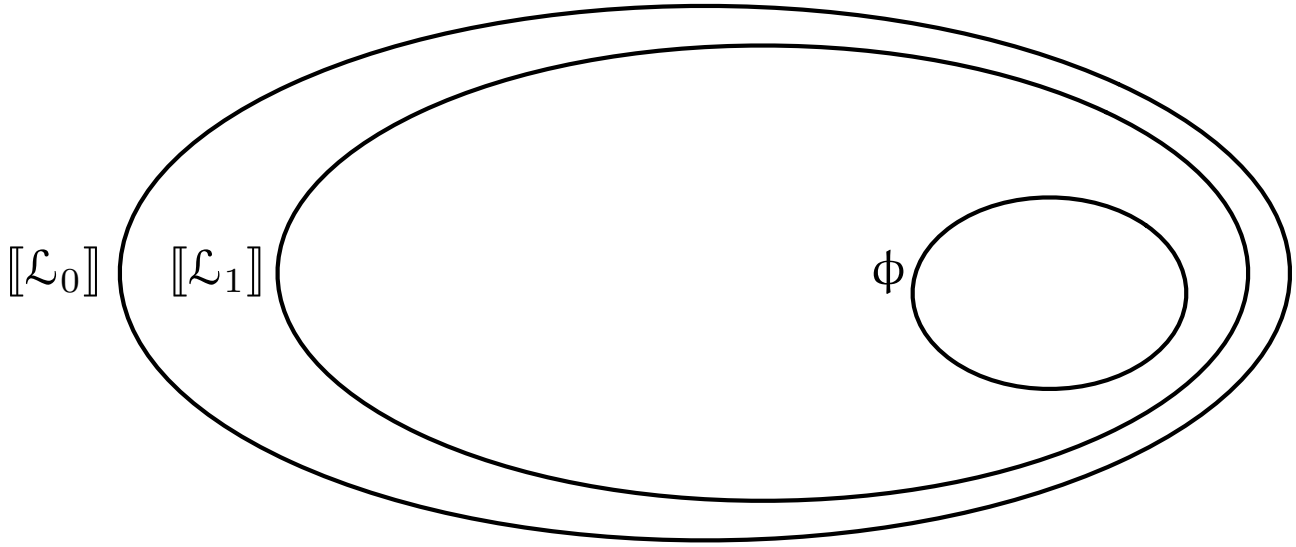

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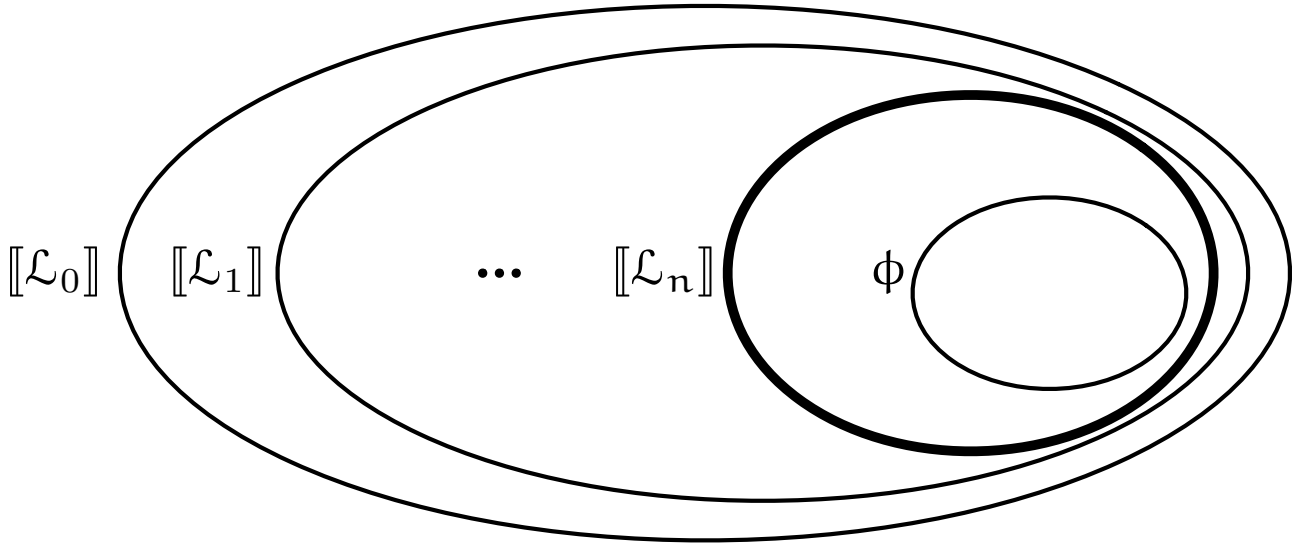
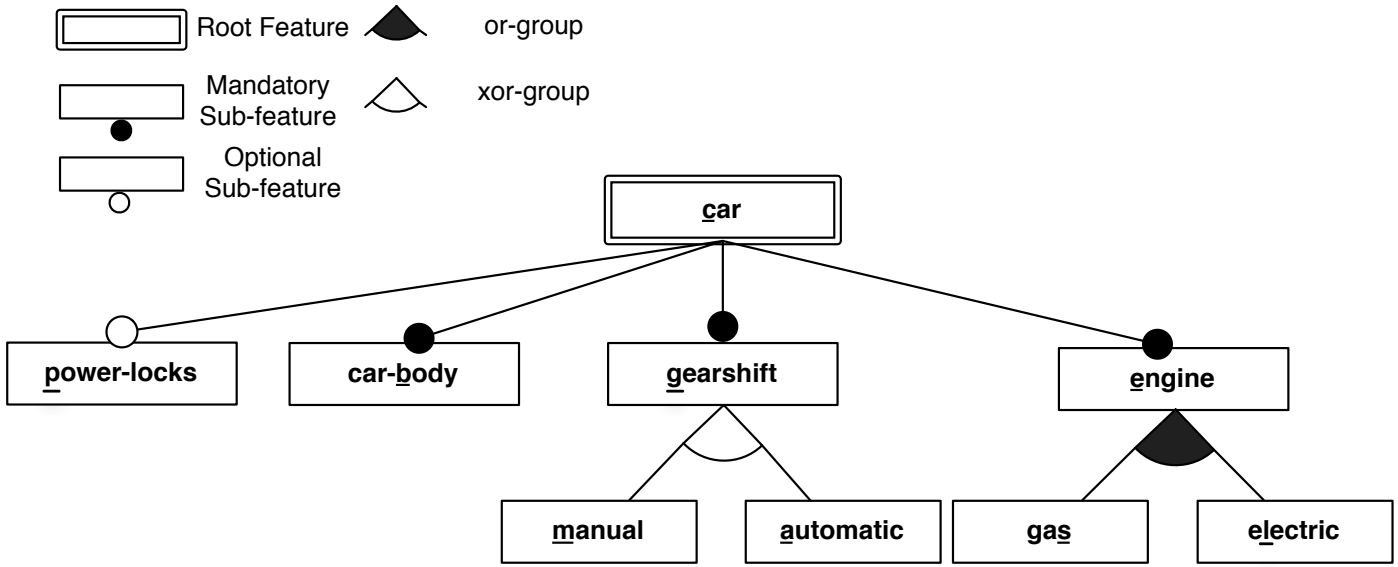


Feature Model Example



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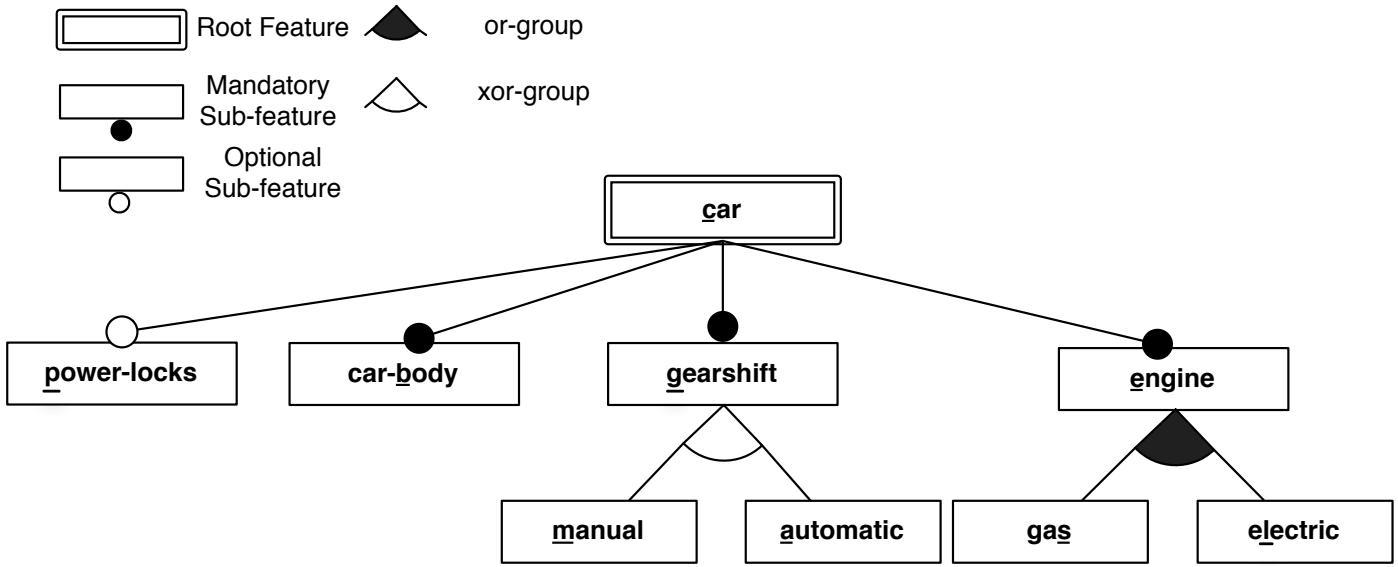
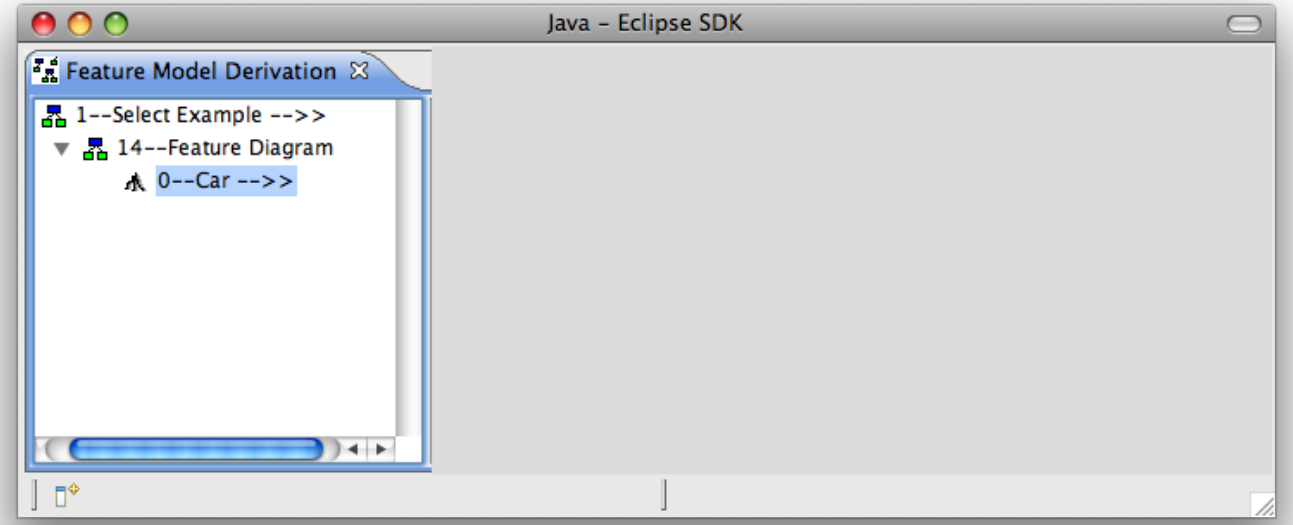


additional constraint:

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

Practically **S**peaking

Feature Model approximating a constraint



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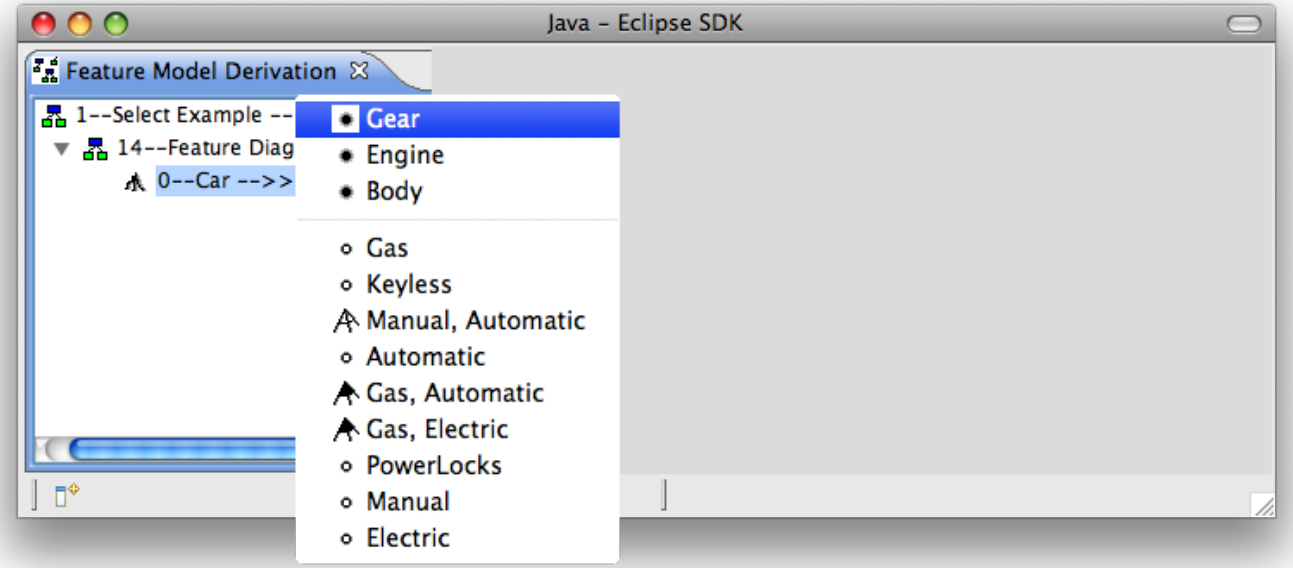

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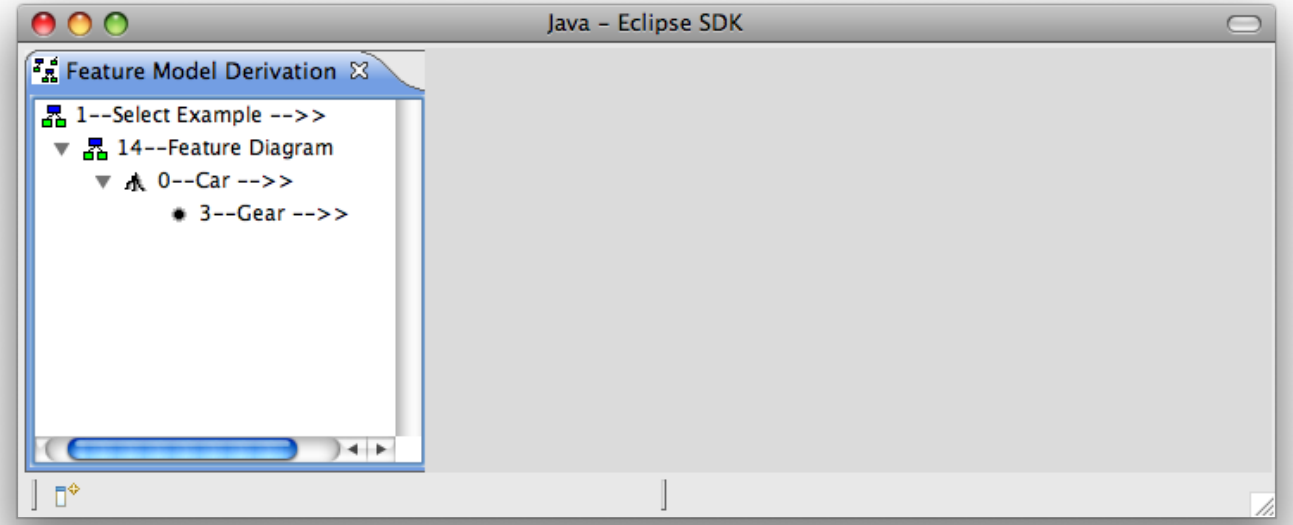

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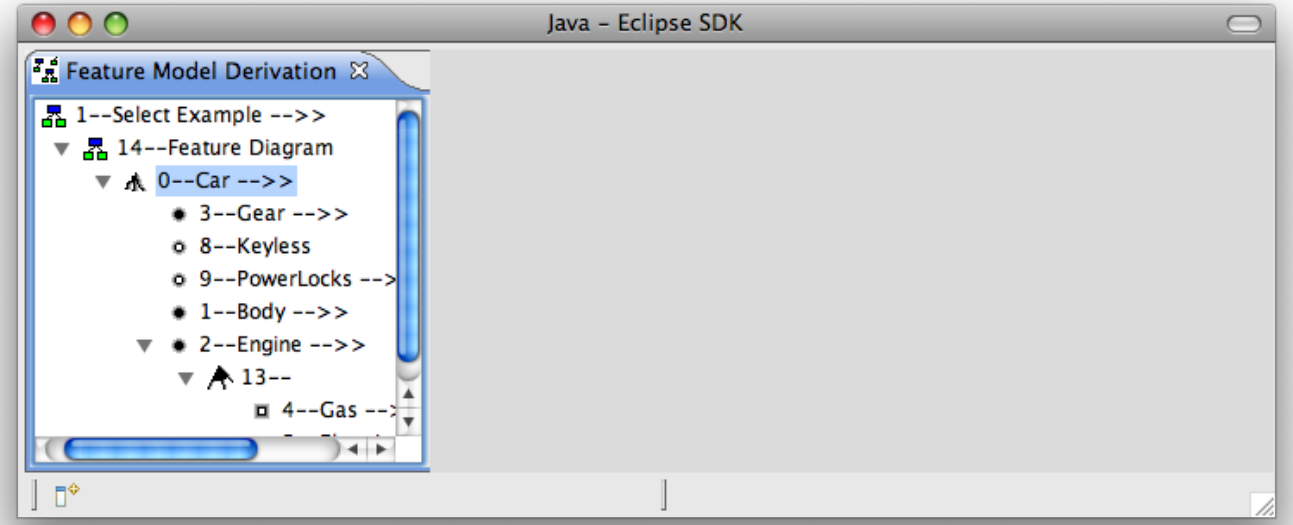
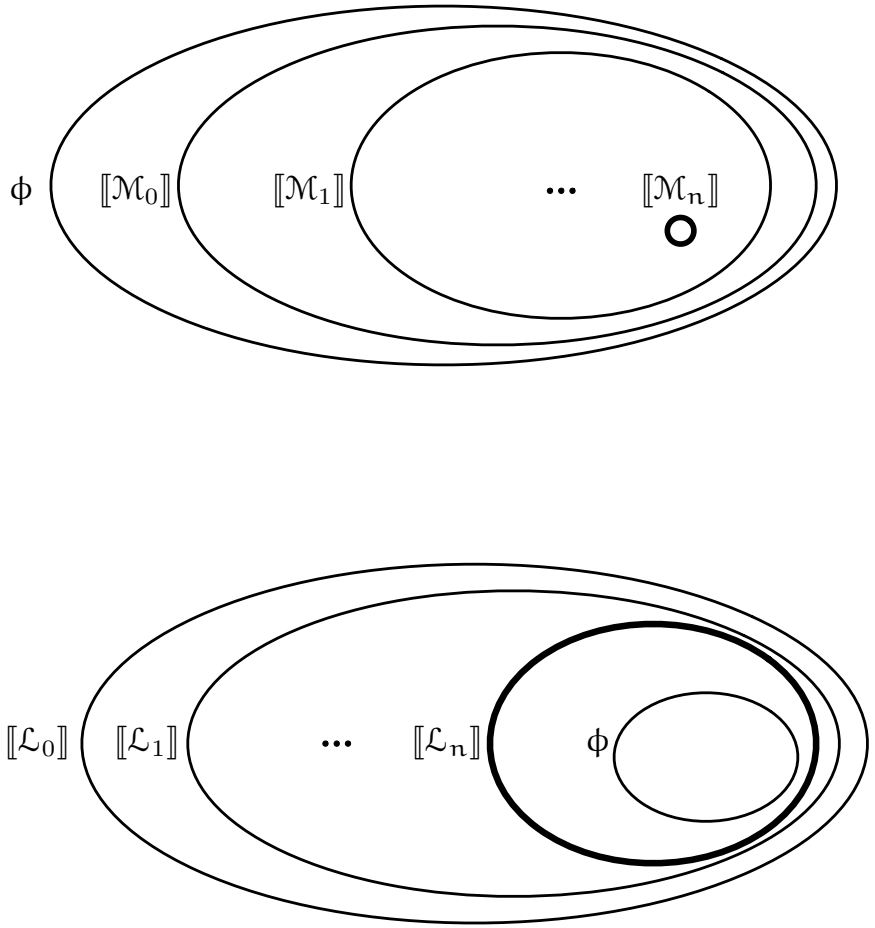


Claims

- 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.

Compl**e**teness-**P**reserving **D**erivation



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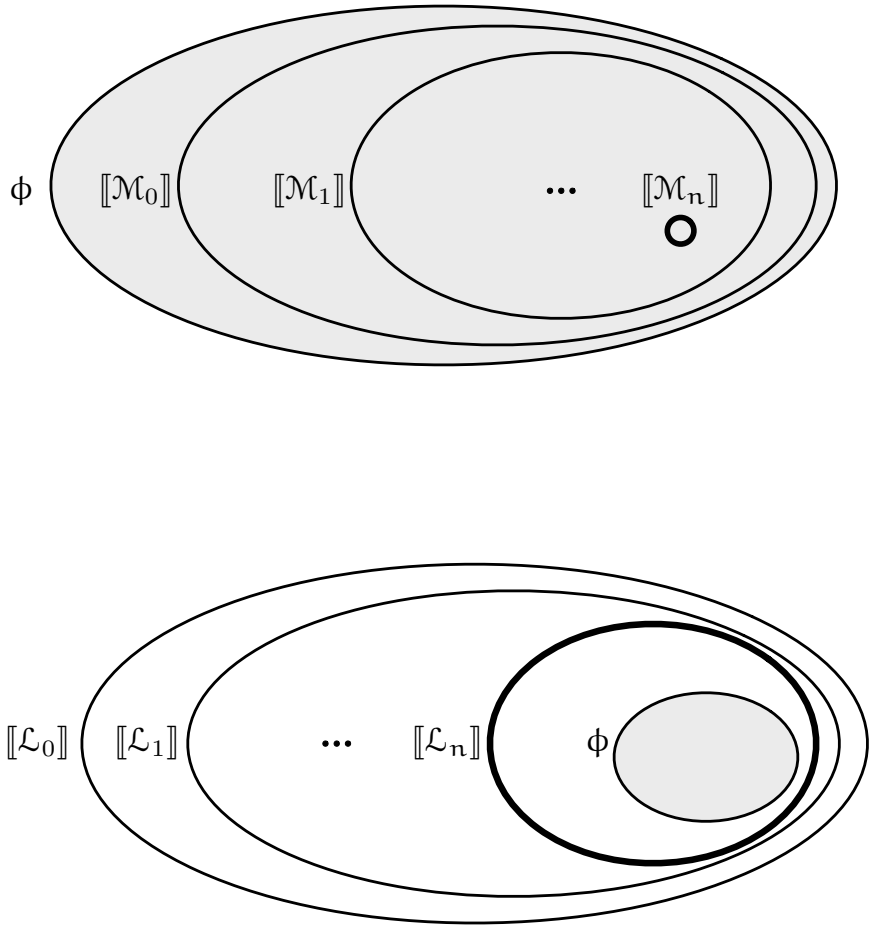
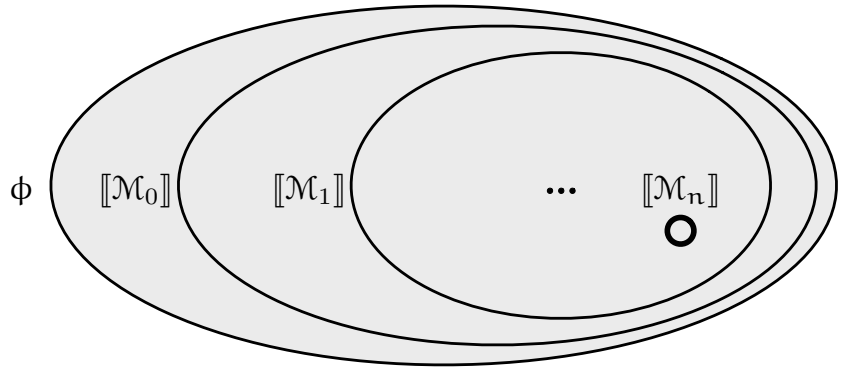


Completeness-Preserving Derivation



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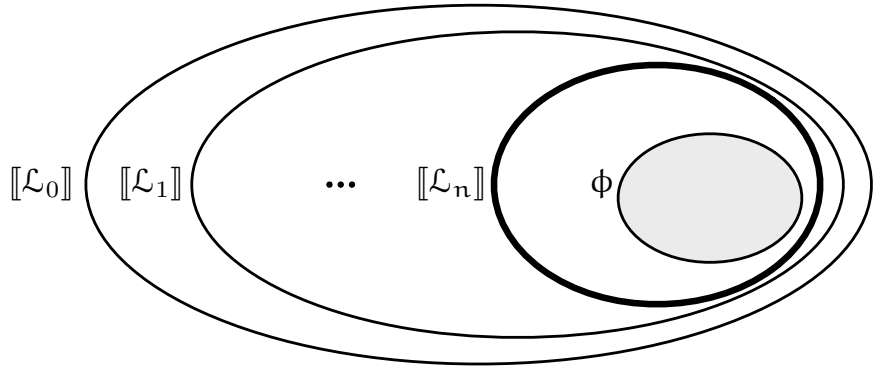

meta-model $\longrightarrow$ model

Semantics-**P**reserving **D**erivation

semantics-preserving =
completeness-preserving
+ soundness-preserving

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Example: any refactoring

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

Full **S**etup

- the model comprises two components
  - feature diagram (M)
  - additional constraint (ψ)
- overall semantics must be preserved
  - “ $\mathrm{M} + \psi = \mathrm{M}' + \psi'$”

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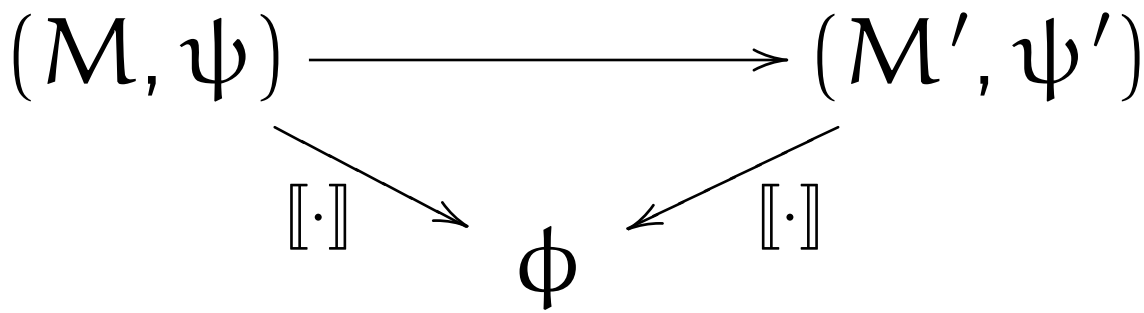
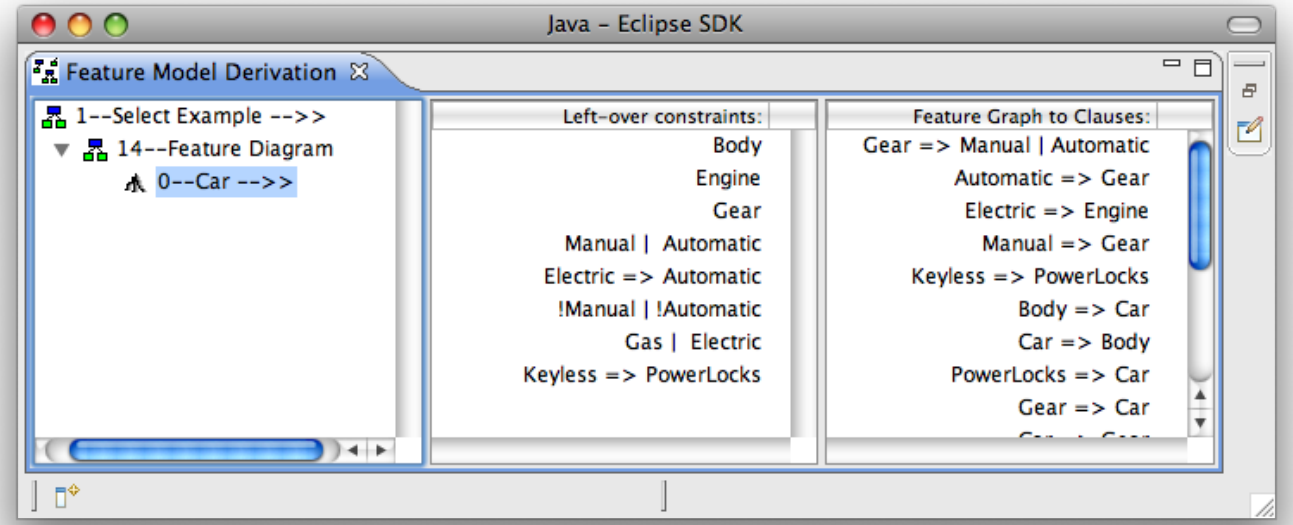
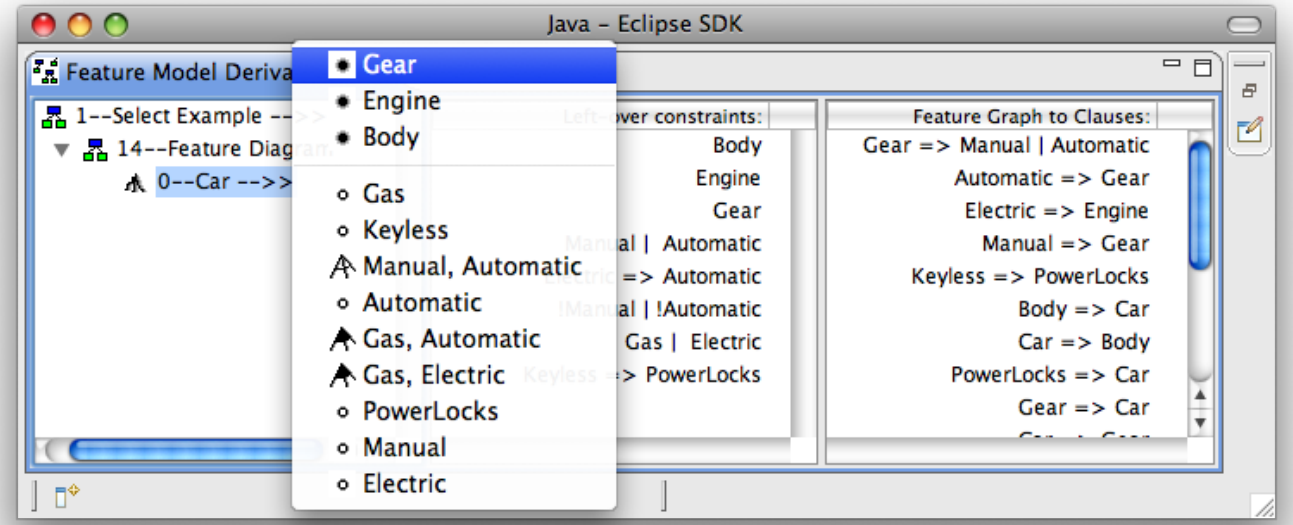


Practically **S**peaking



Practically Speaking



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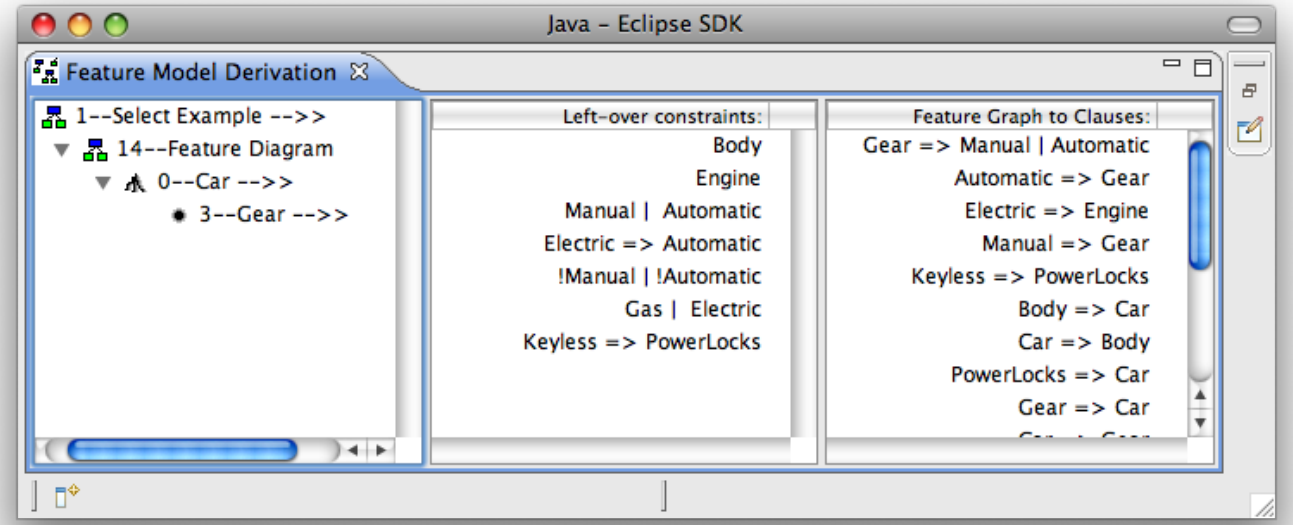

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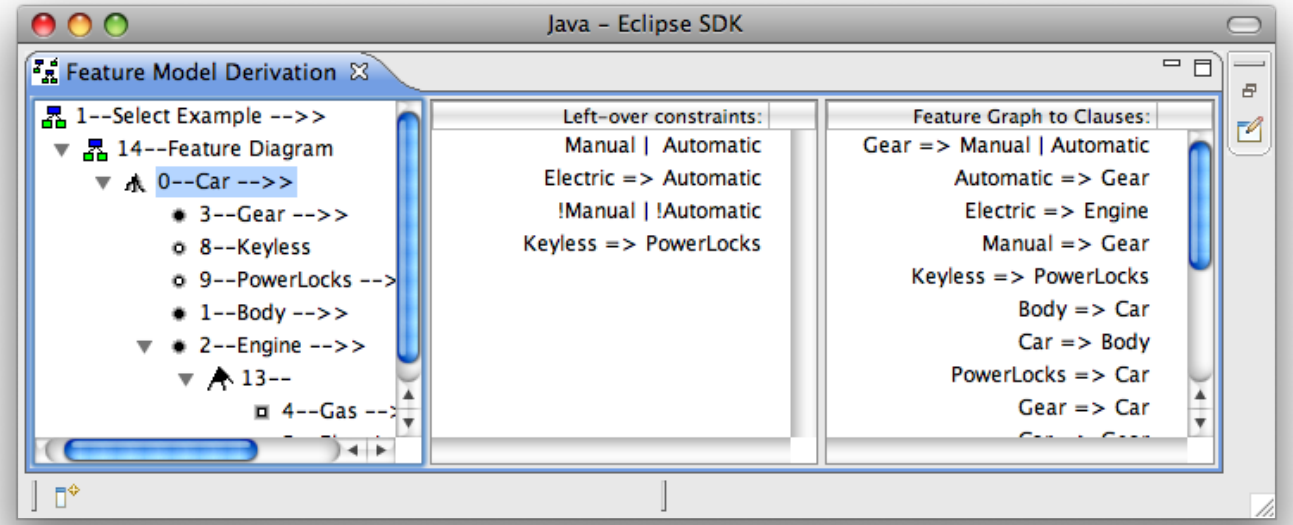

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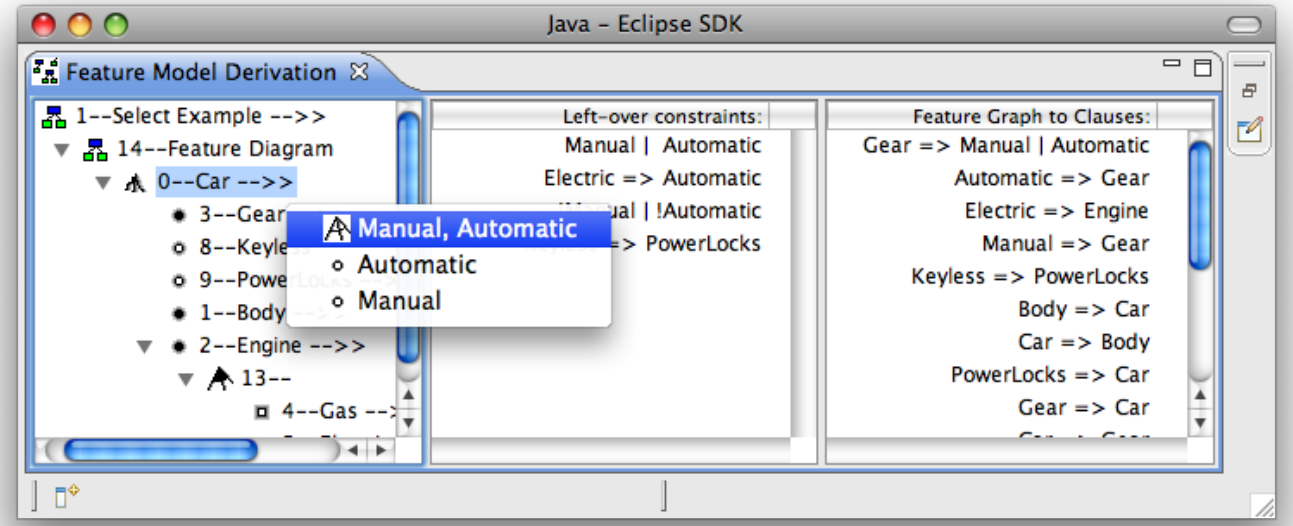

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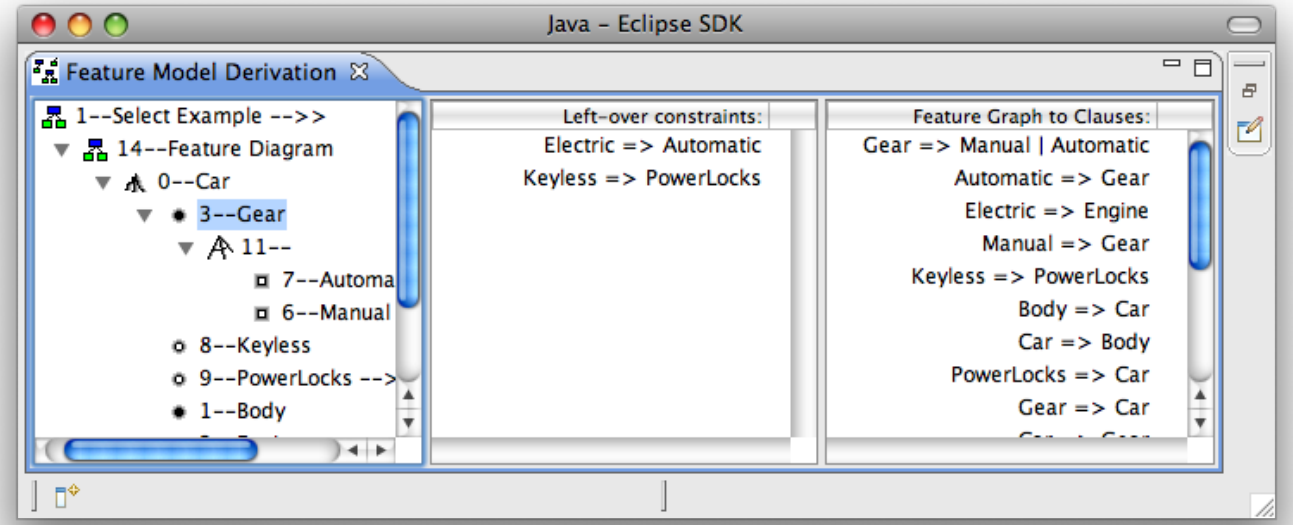


Summary and **C**hallenges **A**head

- **glossary**

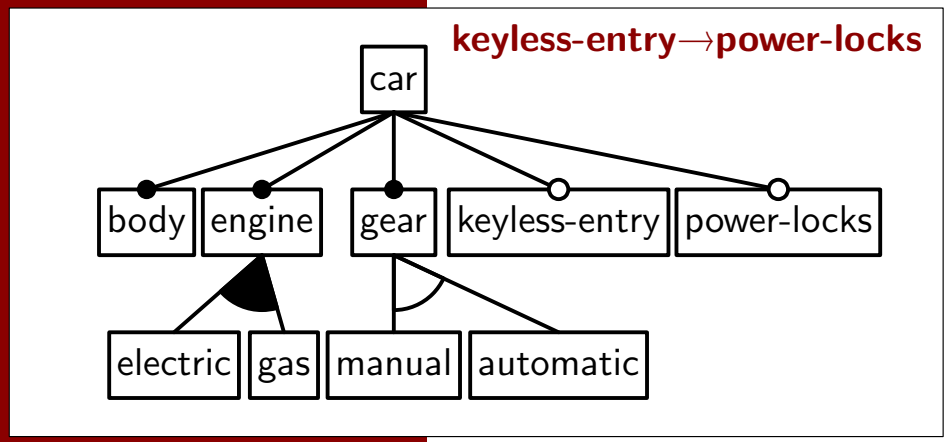
  soundness-preserving derivation
  completeness-preserving derivation
  semantics-preserving derivation

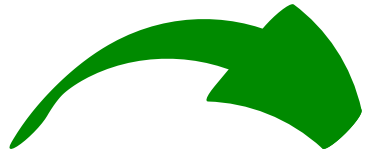
  validity of advice
  exhaustiveness of advice

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

Q&A

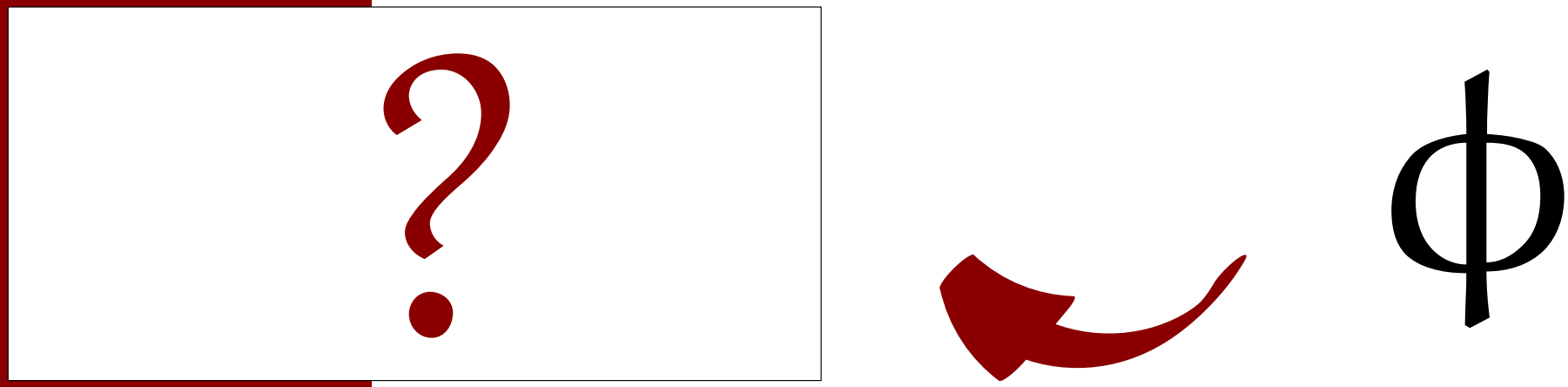
Semantics





ϕ

Reverse **E**ngineering **S**yntax



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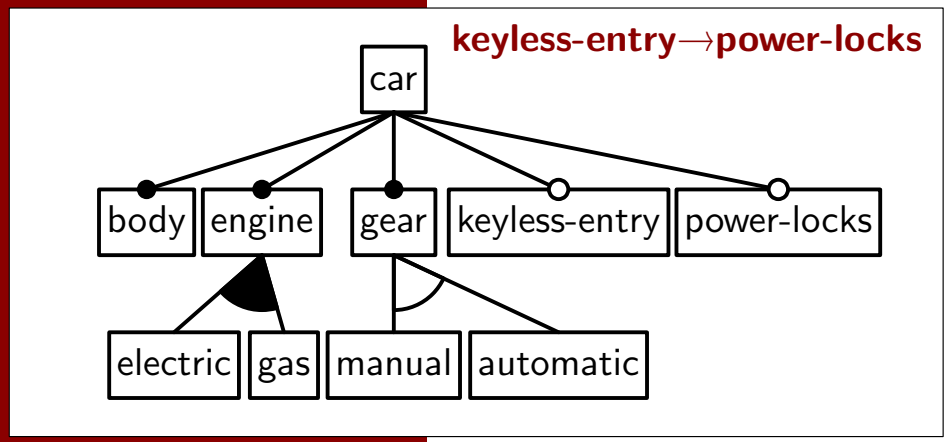

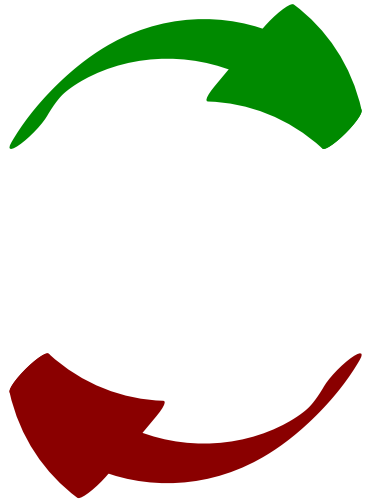

ϕ

Computing Valid-Operations for FMs

VALID-OPERATIONS(M, n, ϕ) : operation-set

$\triangleright$ M is a (partially constructed) feature diagram
$\triangleright$ n is a node in M, present iff M is nonempty

1 **if** M is empty
2 **then return** $\{\text{Root}(r) \mid \text{for each feature } c.\ \phi, M \models c \rightarrow r\}$
3 $solitary \leftarrow \{\text{Mandatory}(n, c) \mid \phi, M \models c \leftrightarrow n$ and c not instantiated in $M\}$
$\cup \{\text{Optional}(n, c) \mid \phi, M \models c \rightarrow n$ and c not instantiated in $M\}$
4 $groups \leftarrow \{\text{OrGroup}(n, m_1 \ldots m_k) \mid n \leftrightarrow \phi, M \models \bigvee_{i \in 1 \ldots k} m_i$, $k > 1$ and all m_i are not instantiated in $M\}$
$\cup \{\text{XorGroup}(n, m_1 \ldots m_k) \mid \phi, M \models n \leftrightarrow \bigvee_{i \in 1 \ldots k} m_i$ and $\bigwedge_{i \neq j} \neg(m_i \wedge m_j)$, $k > 1$ and all m_i are not instantiated in $M\}$
5 $refine \leftarrow \{\text{RefineOR-group}(n, m_1, \ldots, m_k) \mid \{m_1, \ldots, m_k\}$ is an or-group of p in M and $\phi, M \models \bigwedge_{i \neq j} \neg(m_i \wedge m_j)\}$
$\cup \{\text{RefineOptional}(n) \mid n$ is an optional child of p in M, and $\phi, M \models n \rightarrow p\}$
6 **return** $solitary \cup groups \cup refine$