Model Transformation

MT^2 Tutorial

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How many of you are familiar with MDE?

Overview of MDE

Model Transformation

Example

Overview of MDE

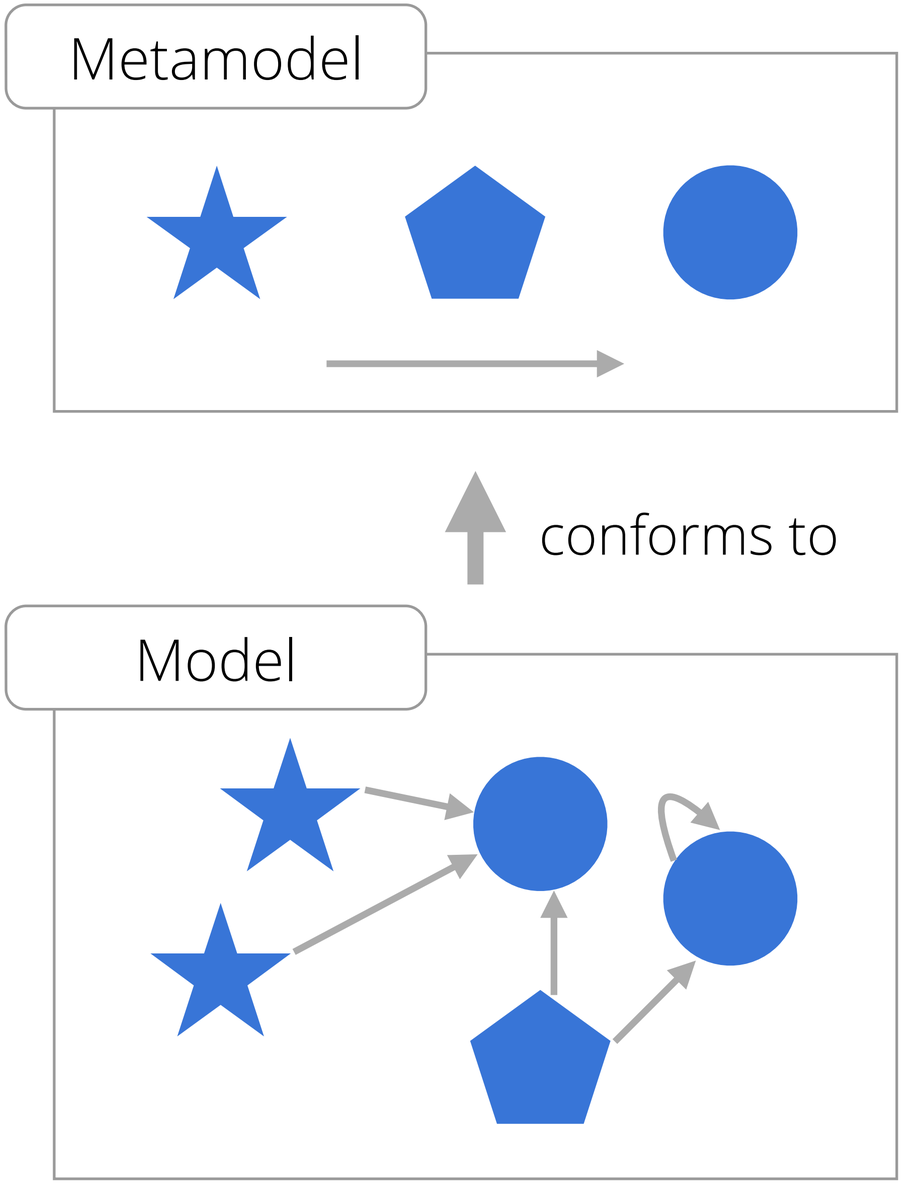
Model Transformation

Example

Model-Driven Engineering

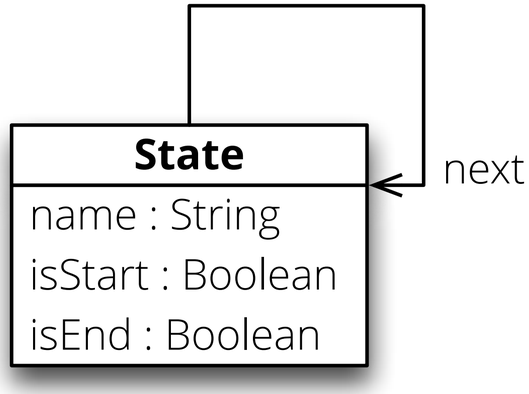
Treats **models** as first class artefacts in the development lifecycle.

Models are structured; amenable to automated processing.

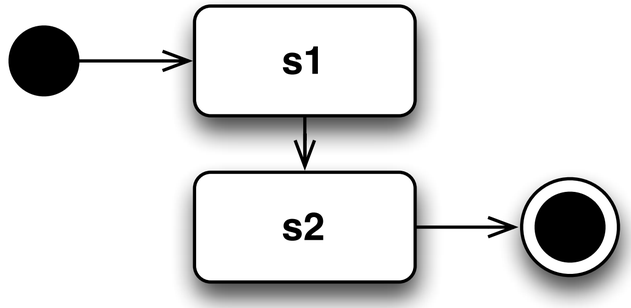


Domain-Specific Languages

Metamodels define domain-specific modelling languages.



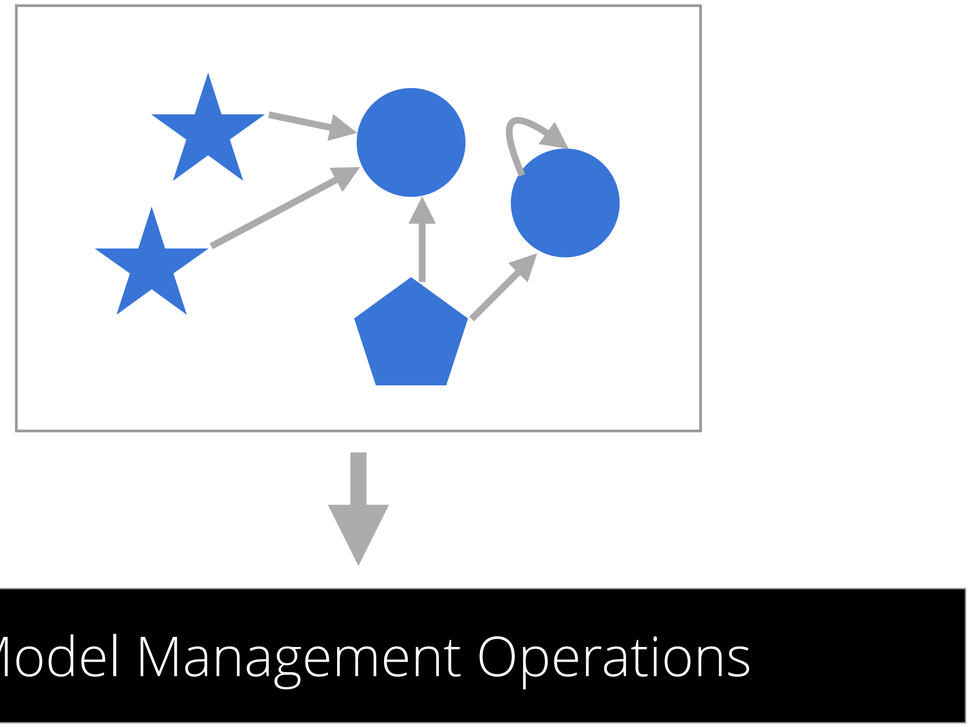

```
Start {
   next : s1
}

s1 : State {
   next : s2
}

s2 : State {
   next : End
}

End { }
```



Model Management

Programmatic management of models:

- validation
- transformation
- comparison
- merge
- analysis (e.g. pattern detection)



Overview of MDE

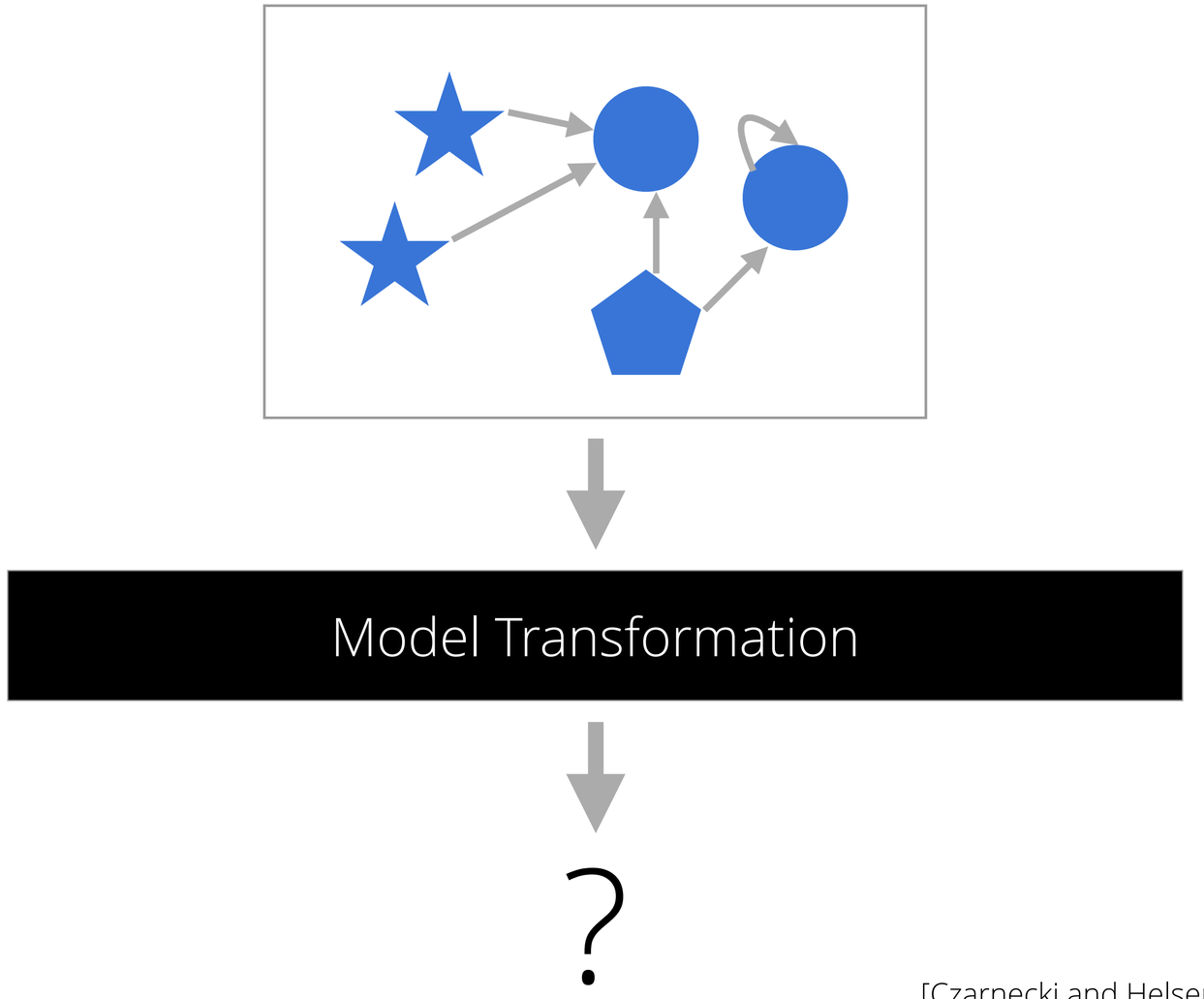
Model Transformation

Example

Model Transformation

Transforms a model into some other useful artefact.

Can have multiple inputs and multiple outputs.

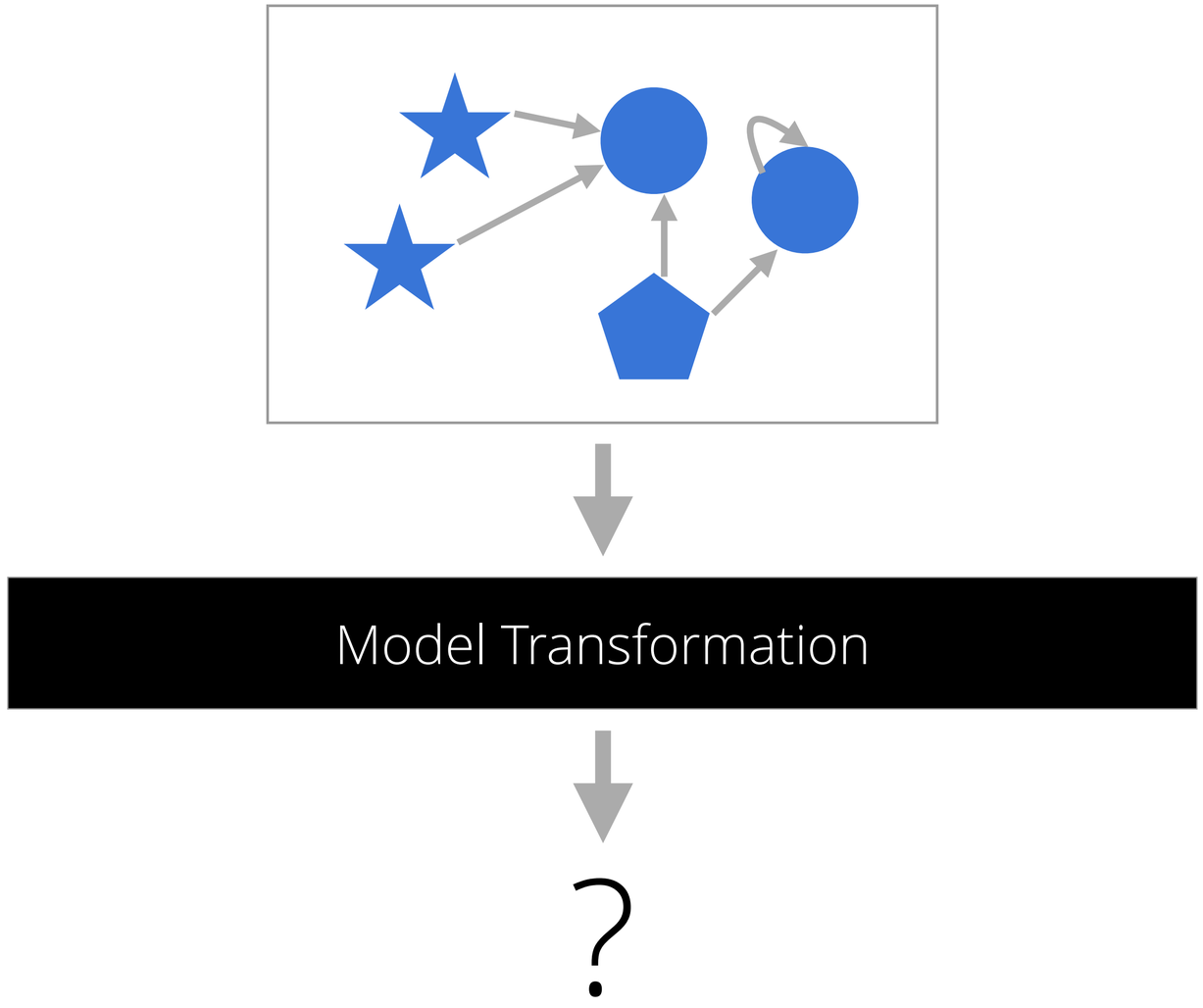


[Czarnecki and Helsen, 2006]

Model Transformation

Applications:

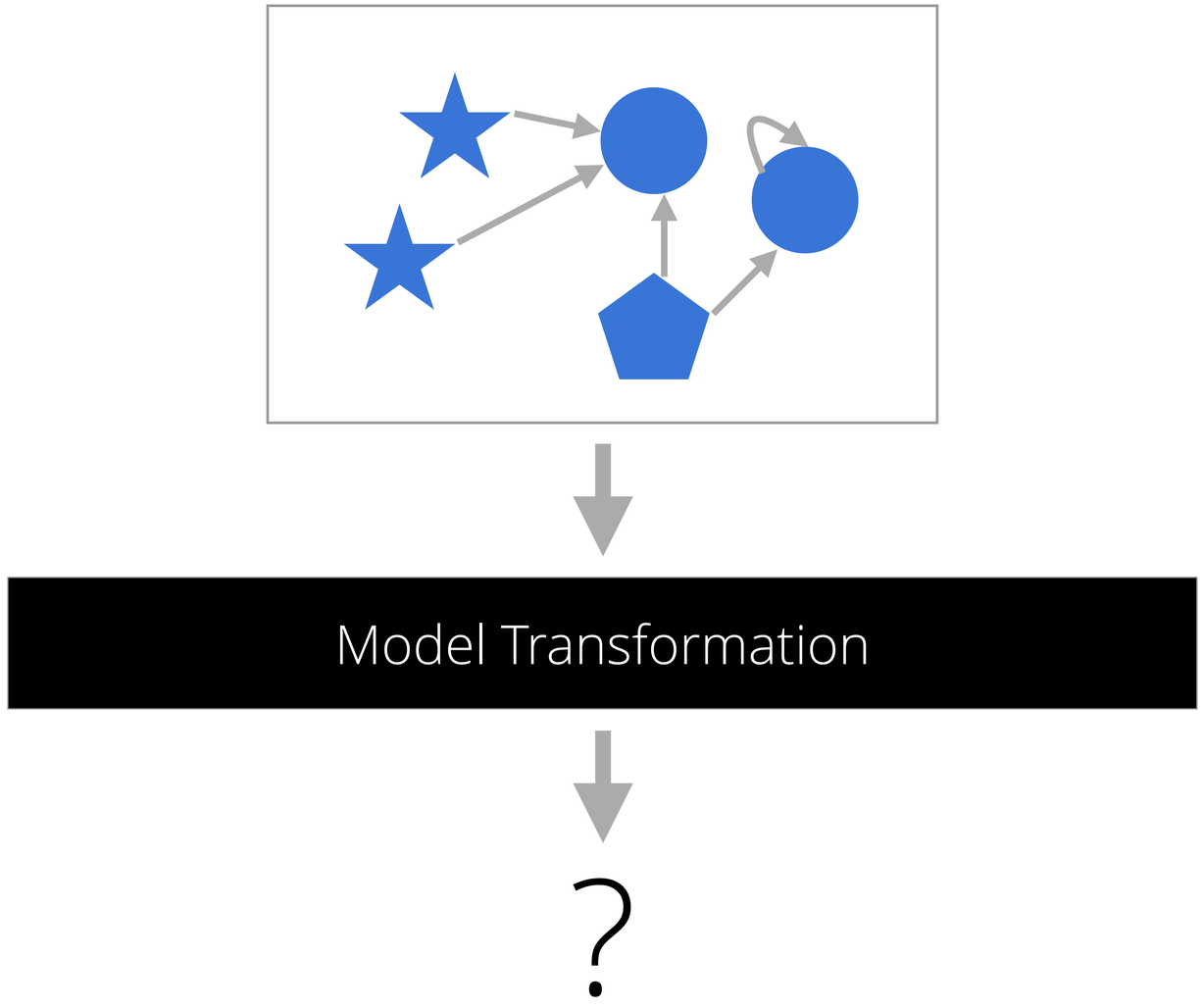
- Elaboration
- Synchronisation
- View creation
- Model evolution/refactoring
- Abstraction



Model Transformation

Transformations are not necessarily:

- semantic preserving
- refinements
- specified in a way that allows interesting properties to be checked



Transformation Languages

Numerous mature tools

- QVT
- VIATRA2
- Tefkat
- ETL
- ATL
- GReAT
- KerMeta
- ...

Transformation Languages

Much variety in implementation:

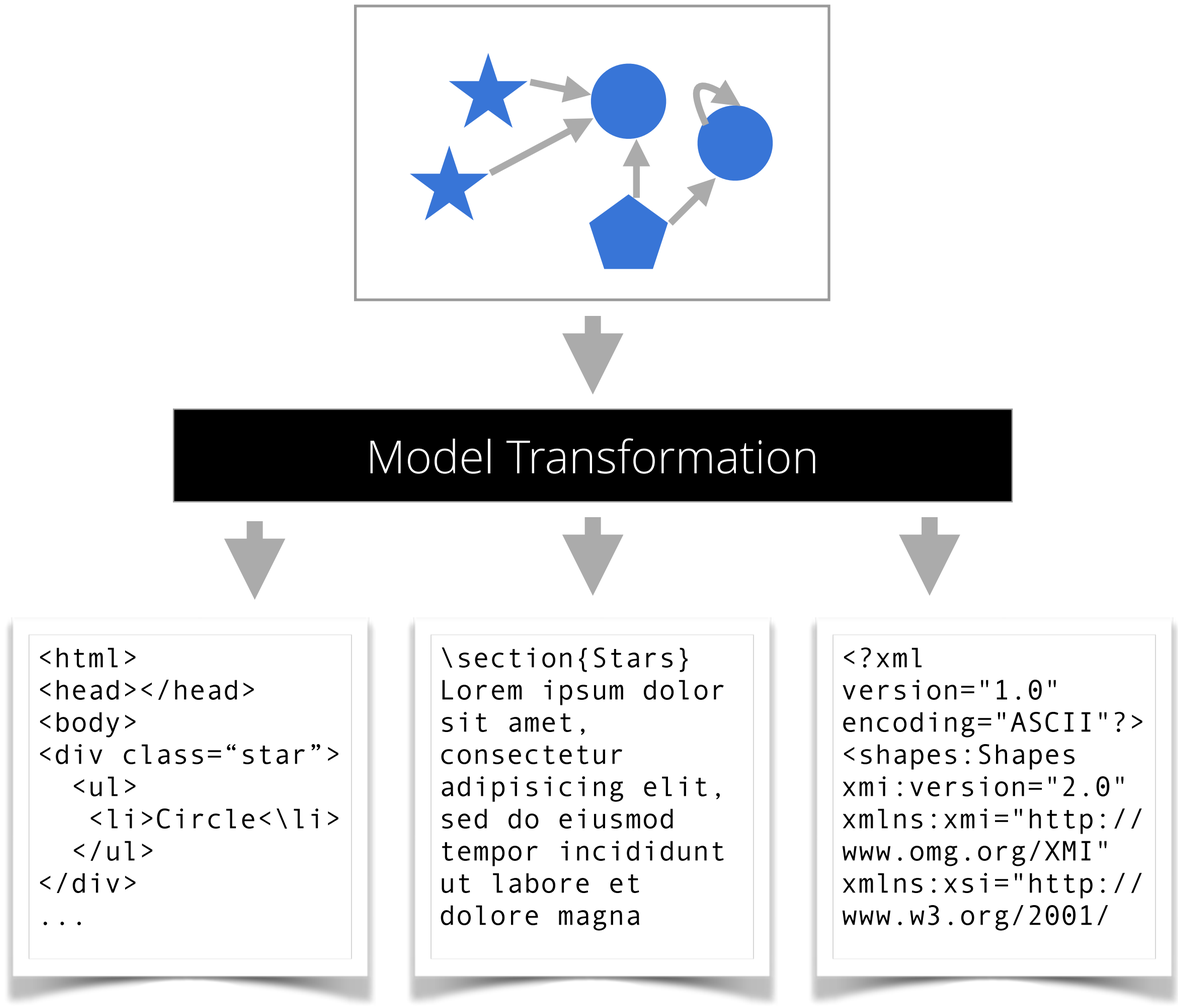
- APIs in GPLs
- Operational (procedural)
- Relational (declarative)
- Graph matching
- …

M2T / M2M

Model-to-Text Transformation

Output is a string.

e.g. source code, documentation (HTML, LaTeX, Markdown), visualise models (svg, dot), serialise models (JSON, XMI)



Model-to-Text Transformation

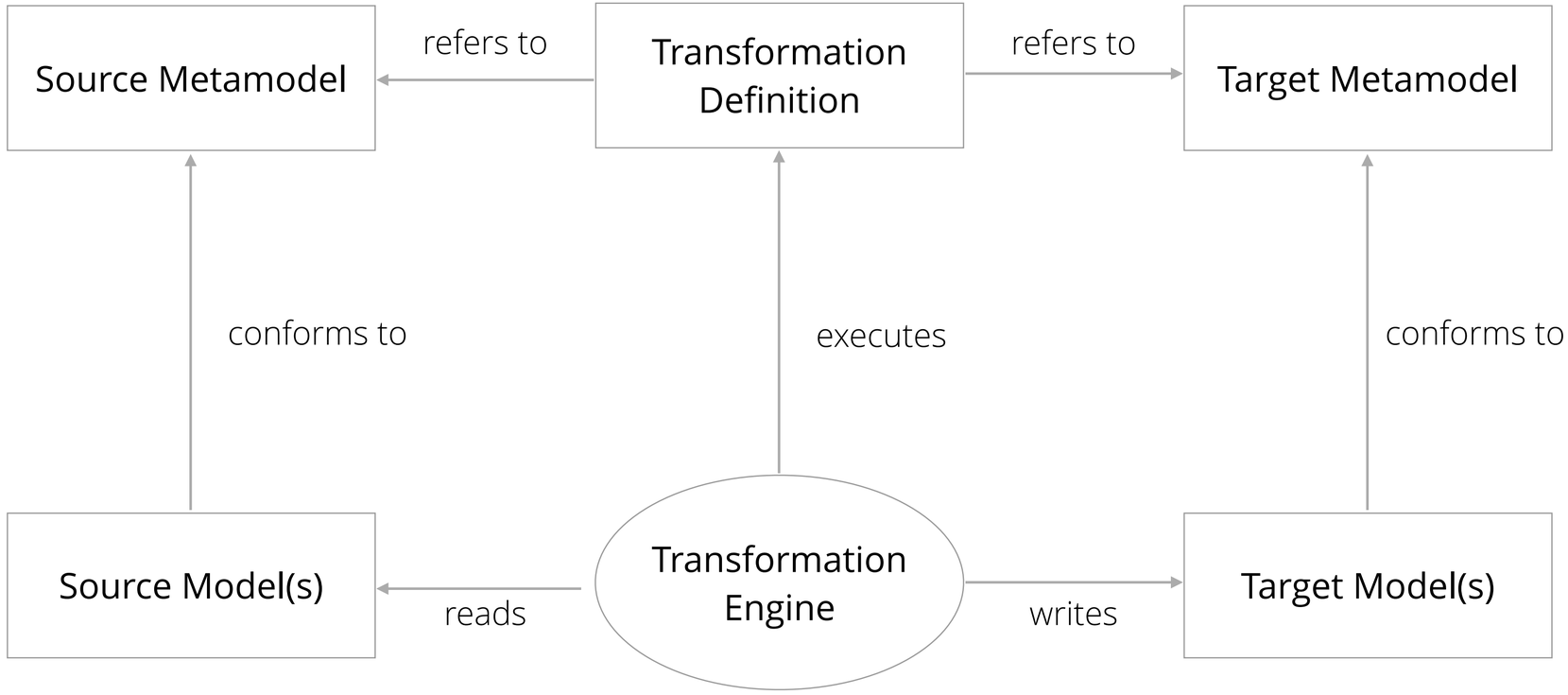
Approaches:

- Visitor-based
- Template-based

```
<html>
<head></head>
<body>

[% for (s in Stars.all) { %]
<div class="star">
  <ul>
[% for (c in s.circles) { %]
   <li>Circle<\li>
[% } %]
  </ul>
</div>
[% } %]
...
```

Model-to-Model Transformation

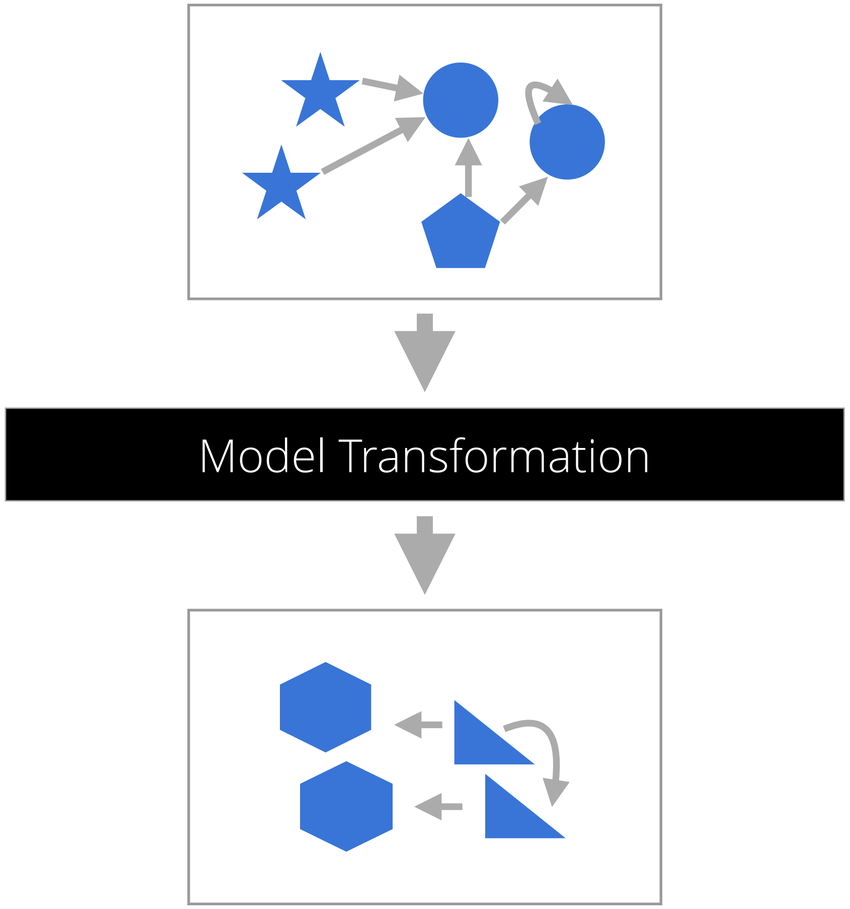
Generate a (set of) model(s) from a (set of) model(s).



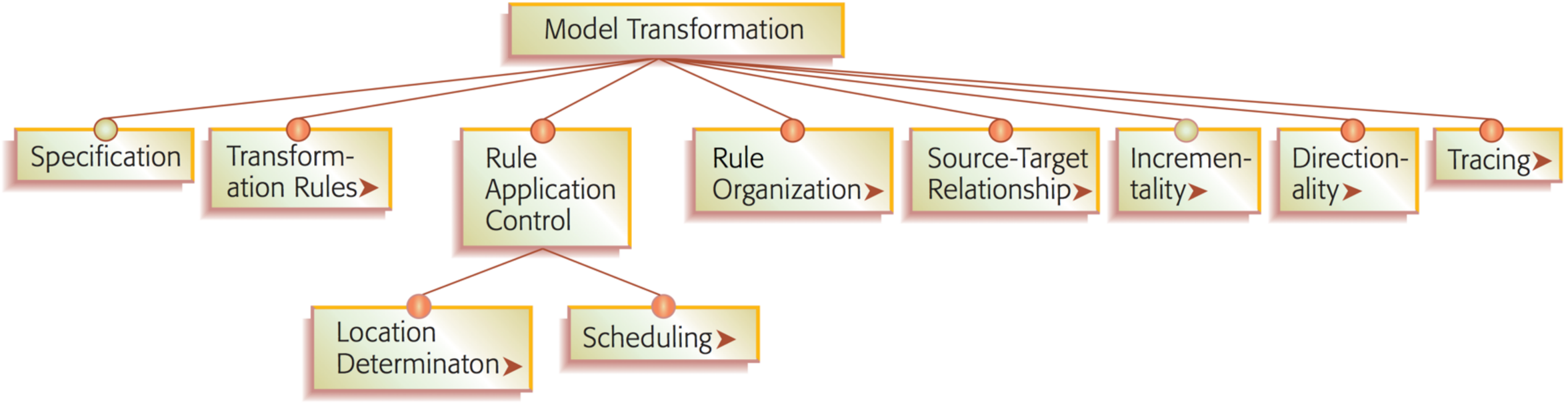
[Czarnecki and Helsen, 2006]

Model-to-Model Transformation

```
rule StarToHexagon
  transform star : Star
  to hex : Hexagon {

  // Describe process

}
```



Model-to-Model Transformation



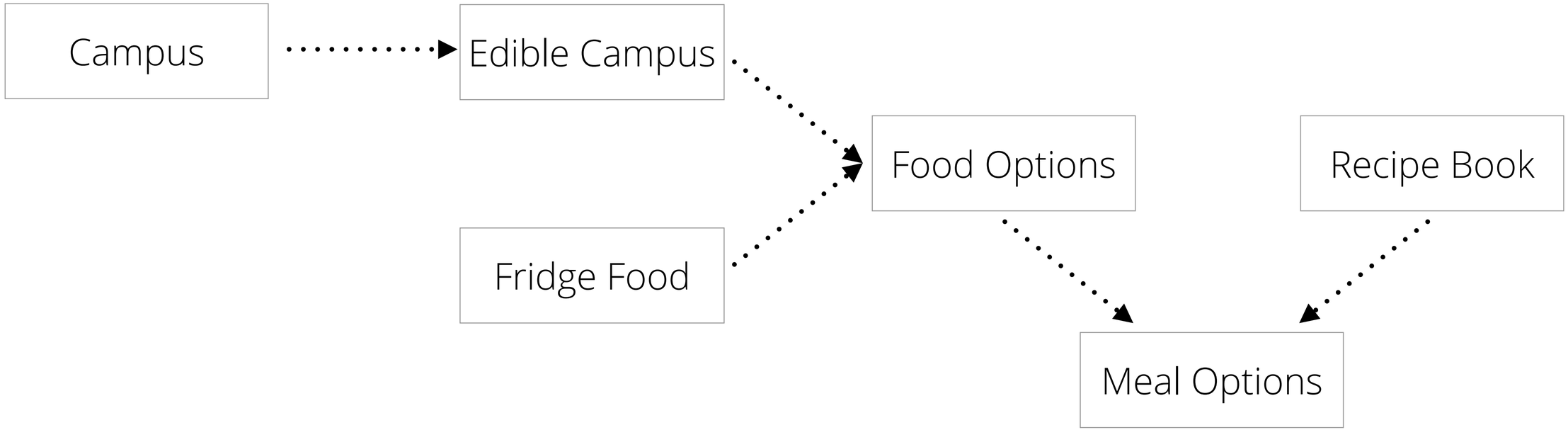
[Czarnecki and Helsen, 2006]

Overview
MDE+MT

M2M + M2T

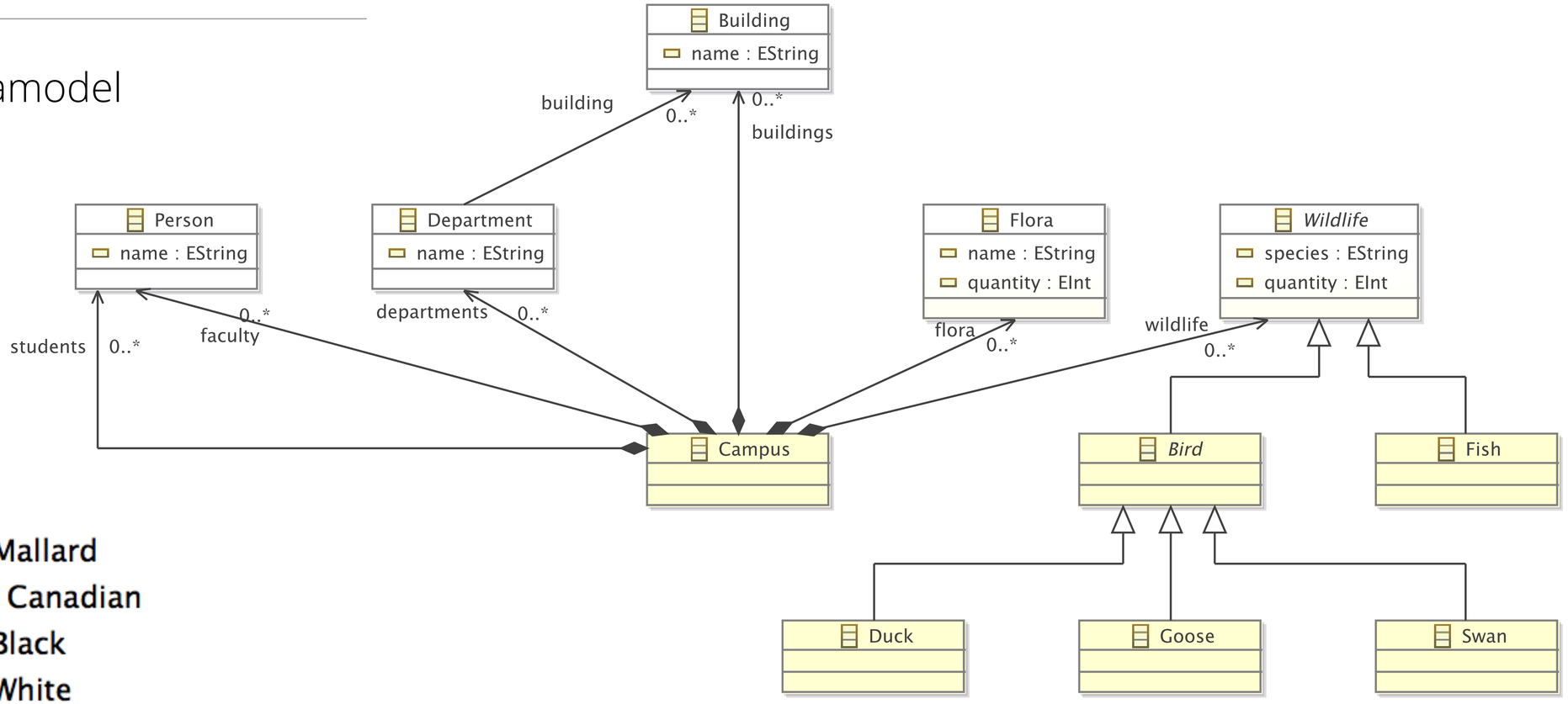
Example

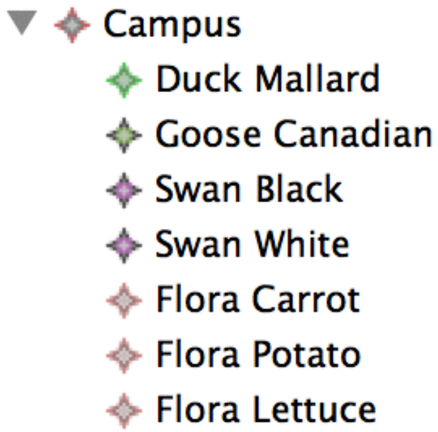
Example:
Campus Menu



Example:
Campus Menu

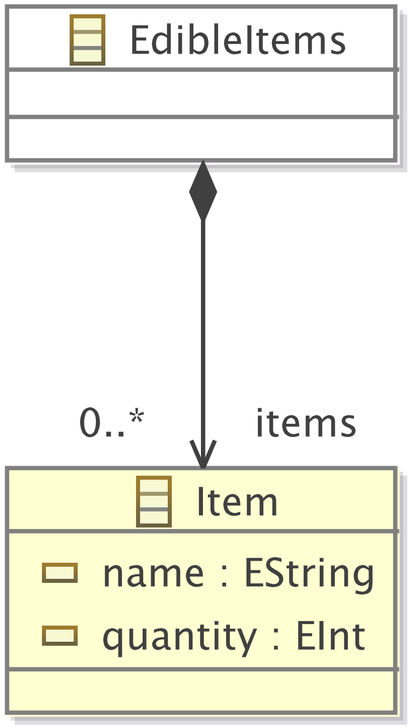
Campus metamodel



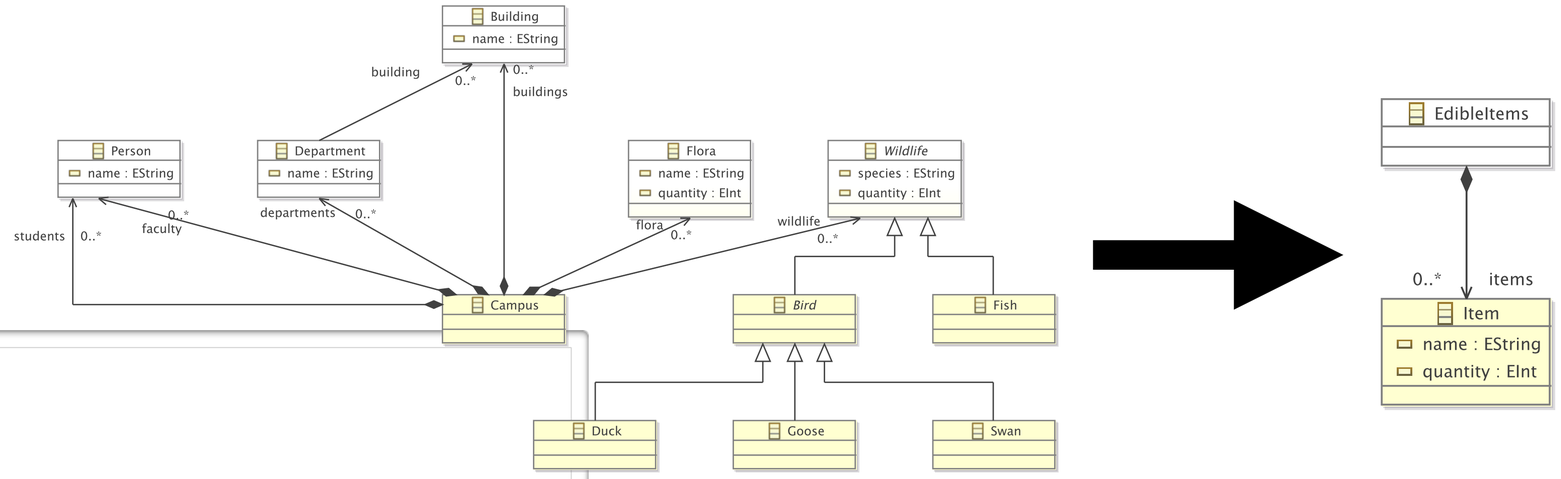


Example:
Campus Menu

Edible items metamodel



Example: Campus Menu



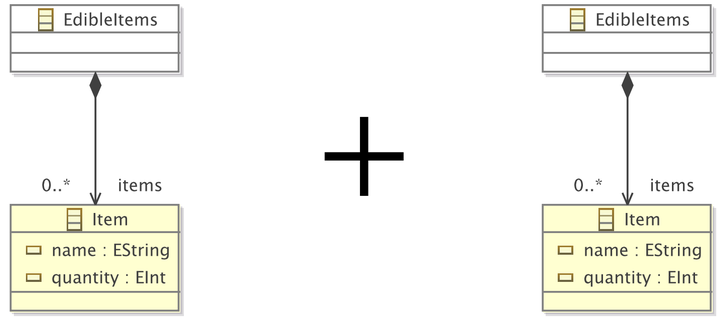

```
rule CampusToEdibleItems
  transform c : CAMPUS!Campus
  to e : FOOD!EdibleItems {

  e.items.addAll(c.wildlife.equivalents().flatten());
  e.items.addAll(c.flora.equivalents().flatten());

}
```

```
@greedy
rule WildlifeToEdible
  transform w : CAMPUS!Wildlife
  to e : FOOD!Item {

  guard : not w.isTypeOf(CAMPUS!Swan)

  e.name = w.eClass.name;
  e.quantity = w.quantity;
}
```

```
@lazy
rule FloraToEdible
  transform f : CAMPUS!Flora
  to e : FOOD!Item {

  e.name = f.name;
  e.quantity = f.quantity;
}
```

Example: Campus Menu

Merge the fridge food and edible campus food




```
var edibleItems = new OUT!EdibleItems;
edibleItems.items.addAll(FOOD!Item.all);
```

Example: Campus Menu

Print the available meals

```
[% var book = RECIPE!RecipeBook.all.first();
var rs = new Sequence;
for (recipe in book.recipes) {
   var canMake = true;
   for (item in recipe.items) {
      if (FOOD!Item.all.select(i | i.name == item.name and i.quantity >= item.quantity).size() == 0) {
         canMake = false;
         break;
      }
   }
   if (canMake) {
      rs.add(recipe);
   }
}
%]
<html>
<head>
   <title>Recipes</title>
</head>
<body>
[% if (rs.size() == 0) {%]
   <p>Sorry, you don't have enough food to make a meal! Maybe you should go shopping!</p>
[%} else {%]
   <p>Available recipes:</p>
   <ul>
[%for (r in rs) {%]
      <li>[%=r.name%]</li>
[%}%]
   </ul>
[%}%]
</body>
</html>
```

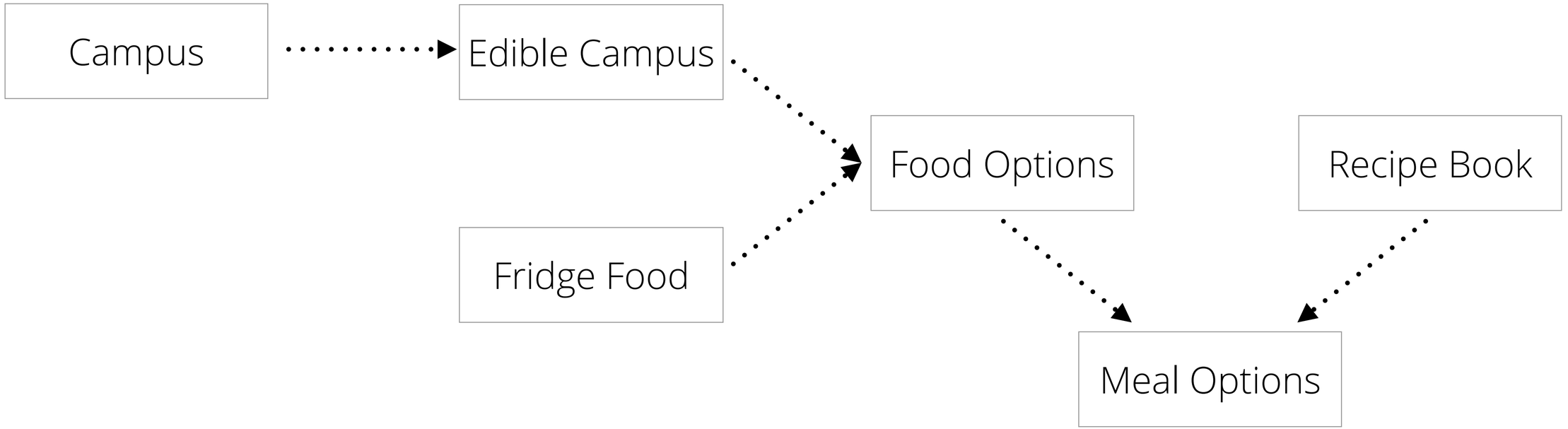
Example: Campus Menu

Print the available meals

```
<html>
<head>
   <title>Recipes</title>
</head>
<body>
   <p>Sorry, you don't have enough food to make
   a meal! Maybe you should go shopping!</p>

</body>
</html>
```

```
<html>
<head>
   <title>Recipes</title>
</head>
<body>
   <p>Available recipes:</p>
   <ul>
      <li>Duck Cassoulet</li>
   </ul>

</body>
</html>
```

Example:
Campus Menu



Code for example available at:
https://github.com/UOY-Enterprise/mt2-tutorial

Overview
MDE+MT

M2M + M2T

Example

Open Research Areas

Testing MTs [Baudry 2009]

- Oracle
- Test data
- Language heterogeneity
- Test coverage

- Incrementality
- Scalability

- Semantics

- “Learning” transformations from examples

Further Reading

Epsilon: www.eclipse.org/epsilon

Example code: https://github.com/UOY-Enterprise/mt2-tutorial

General overview: Marco Brambilla, Jordi Cabot, and Manuel Wimmer. *Model-Driven Software Engineering in Practice*. Morgan and Claypool, 2012.

Shane Sendall and Wojtek Kozaczynski. *Model transformation: The heart and soul of model-driven software development*. IEEE Software, pages 42–45, 2003.

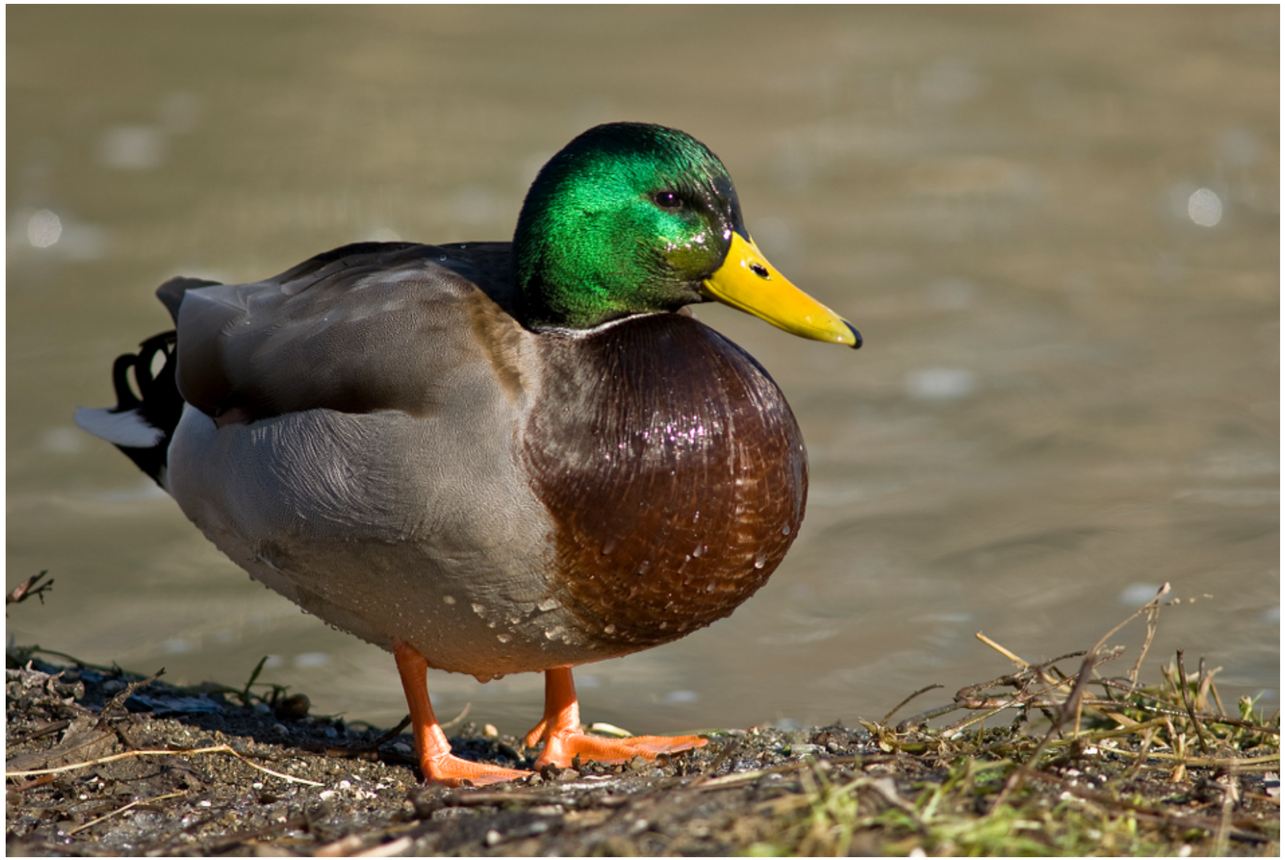
Czarnecki and Helsen, *Feature-based survey of model transformation approaches*, IBM Systems Journal, 45(3):621–645, 2006

B. Baudry, S. Ghosh, F. Fleurey, R. France, Y. La Traon, and J-M. Mottu. *Barriers to systematic model transformation testing*. Communications of the ACM, 53(6):139– 143, 2009.

Workshops and conferences: ICMT, VOLT, AMT, TTC, ...

Please Don’t Eat the Ducks

Thank you



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