Software Engineering

Models for Engineers

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Introduction

- Outline
  - MDE & Meta-Model
  - Meta-Modeling & EMF
- Application
  - Domain Model & Abstract Syntax
  - Concrete Syntax
    - Graphical
    - Textual

MODEL-DRIVEN ENGINEERING

Model-Driven Engineering

- Software Engineering
  - Build software useful to end-users to solve a particular problem
- **M**odel-**D**riven **E**ngineering
  - Build **models** to help software engineer to build faster, better software able to handle **more complex** problems
    - Generative approaches

Model-Driven Engineering

- Coping with complexity
  - Reduce *accidental complexity*
  - Help build tools to build software
- A **model** is a representation of a thing that highlights some of its properties
  - Focuses on a **specific** viewpoint/aspect
  - Serves a particular purpose
  - Evolves when the system evolves !
  - ➢ Is used to derive the code **automatically**

Model: an example

- Genealogy: *model of a family*
  - Focus: family relationships
  - Purpose: keep track of ancestors and siblings

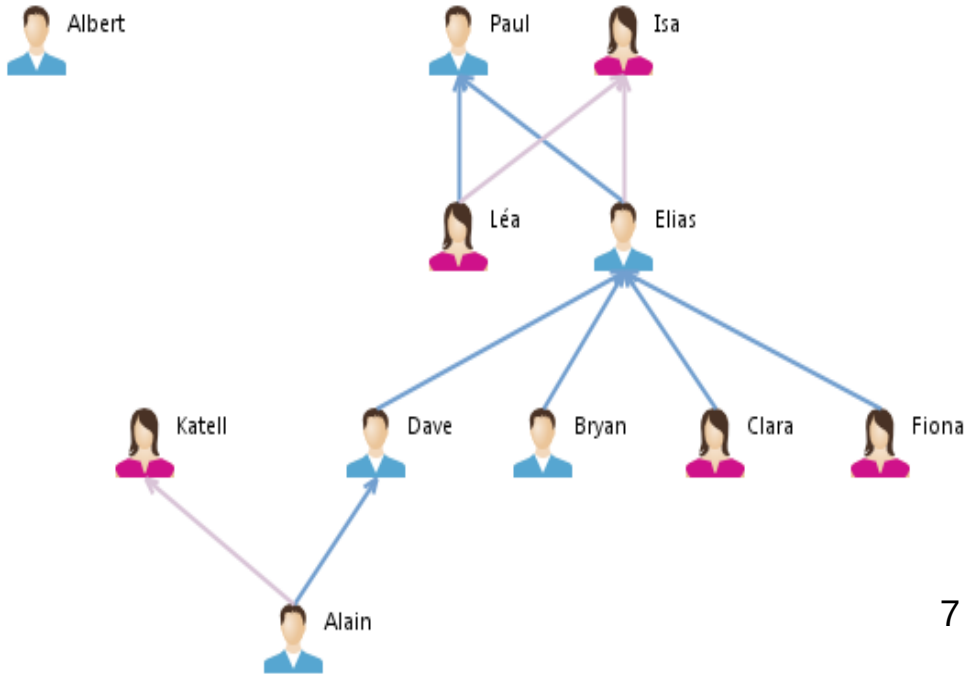
A Thing

Model: an example

- Genealogy: *model of a family*
  - Focus: family relationships
  - Purpose: keep track of ancestors and siblings

A *Thing*

A Model of the *Thing*

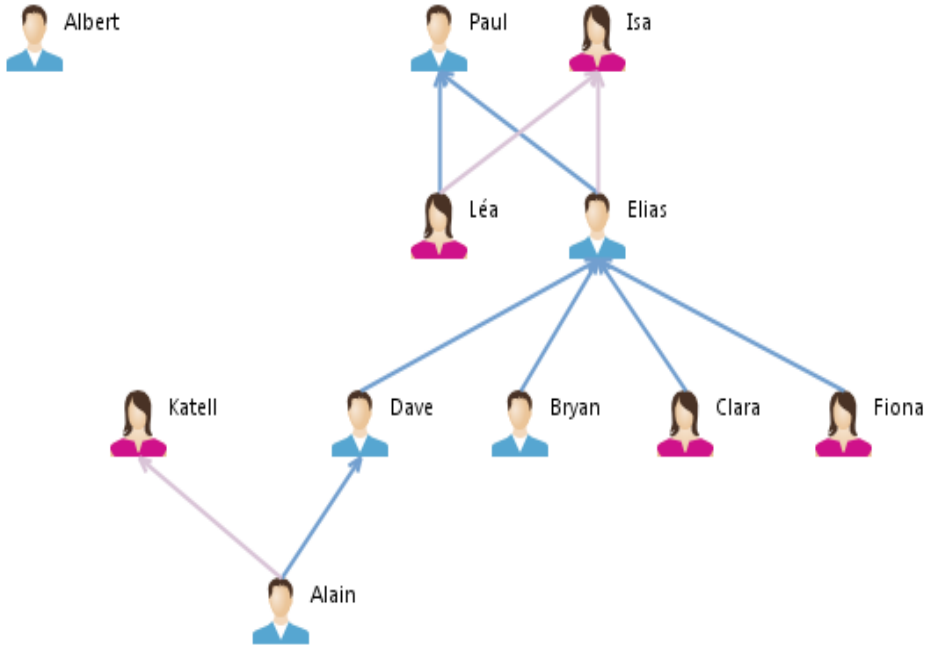


Meta-Model: A model of a Model

Metamodel of ANY family

- Family
  - Set of persons
- Person
  - Name
  - Set of children
  - 2 parents (father, mother)
- Man
  - Is-a person
- Women
  - Is-a person

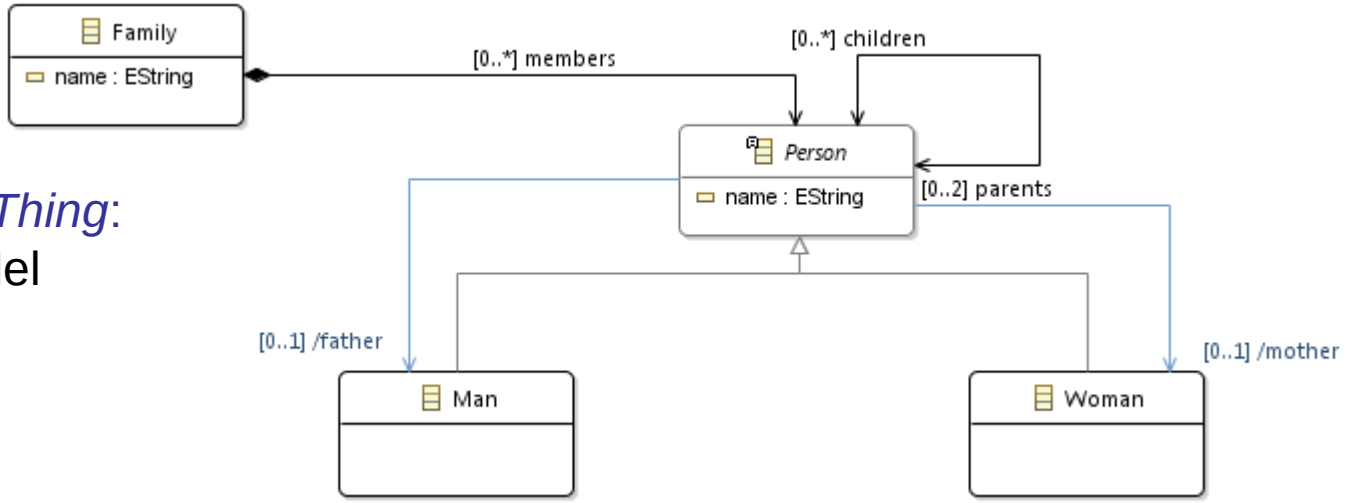
A model of ONE family



Meta-Model: A model of a Model

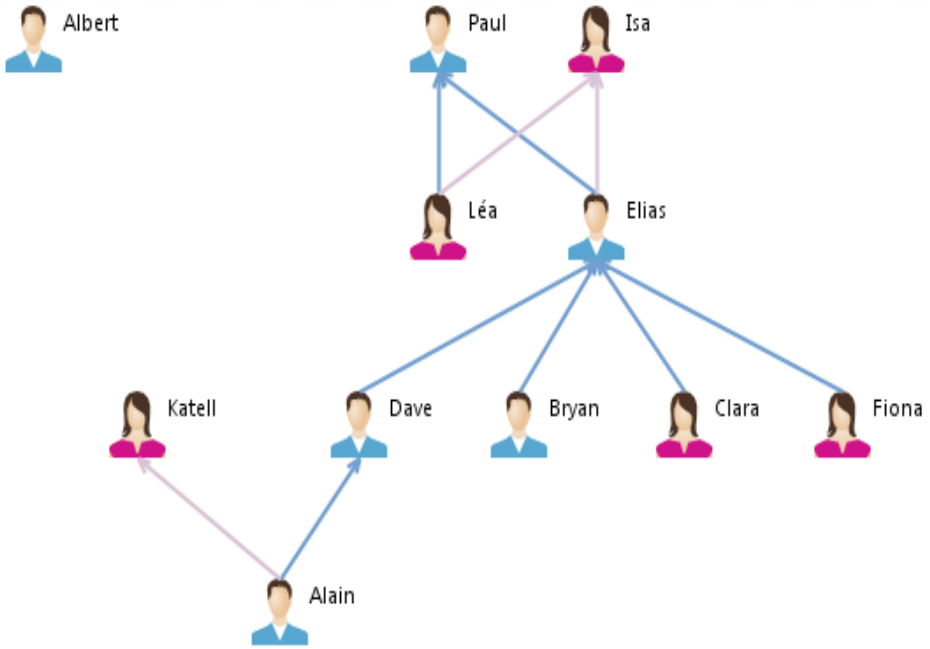
M2

A Model of the *Thing*:
A metamodel



M1

A *Thing:*
A model



Models for Computer Science

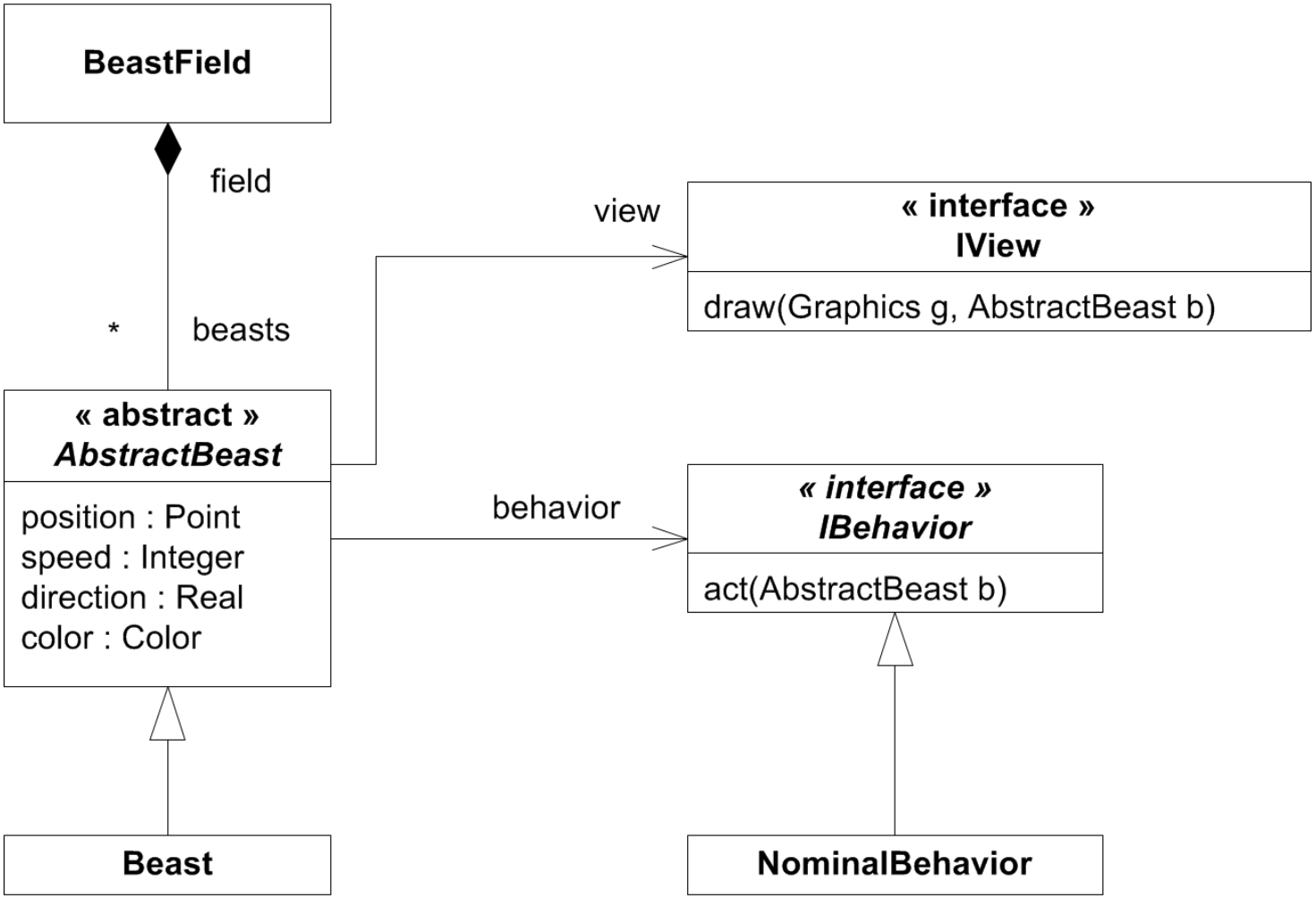
- What are the models in Computer Science?
  - A program is a model of a system (staff of a company, accounts in a bank, engine controller)
  - To reason about the programs, we need to build models of the programs
    - Models about the data structure: classes, fields and methods
    - Models about the behavior/algorithm: state machines, scenarios, data and control flows

M0 - A *Thing:* *a* Program

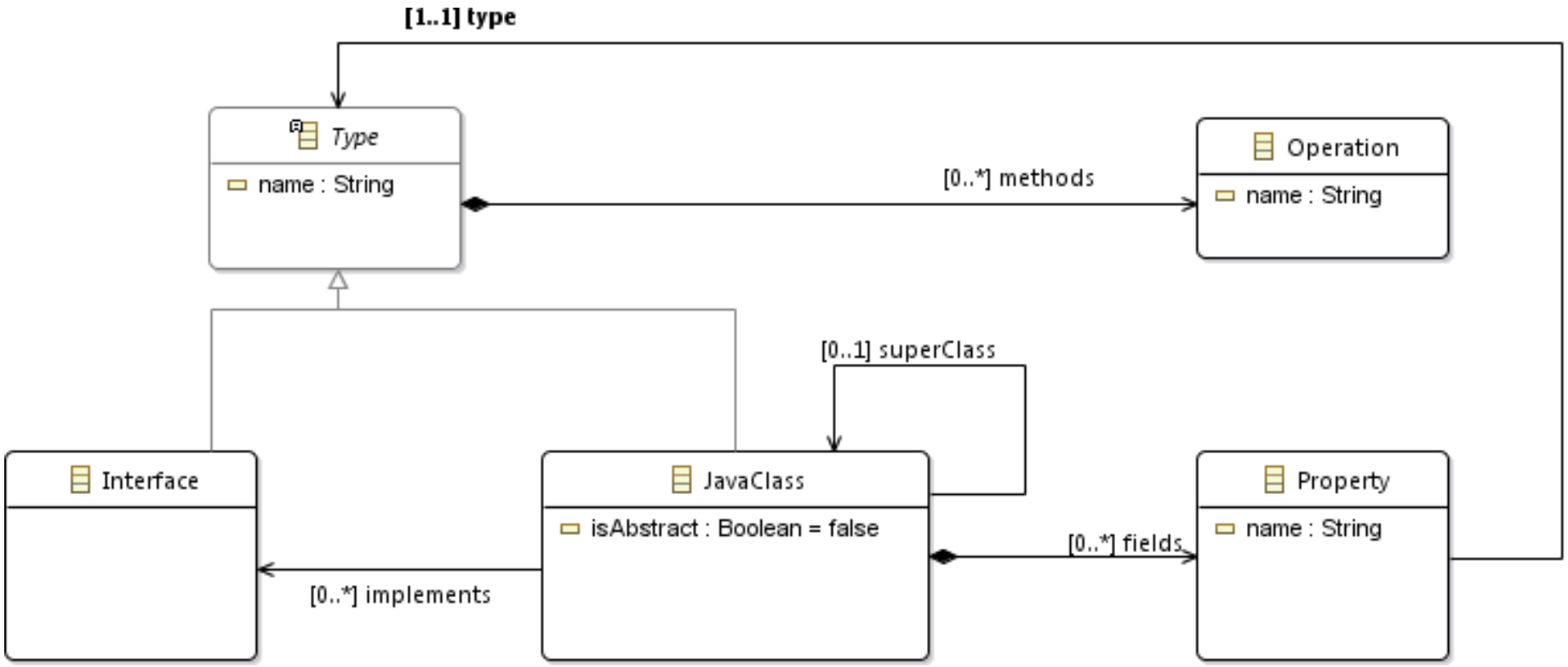
```
abstract class AbstractBeast {
    protected int x, y;              // position on the screen
    int speed;                       // speed [pix/s]
    double direction;                // radians [0 - 2 PI[
    protected Color color;           // Filling color
    protected BeastField field;      // the field
    static final int SIZE = 10;


    protected AbstractBeast(BeastField field, int x, int y, Color color) {
        this.field = field;
        this.x = x;
        this.y = y;
        this.color = color;

        Random gen = new Random();
        direction = gen.nextFloat() * 2 * Math.PI;
        speed = gen.nextInt(field.maxSpeed);
    }


    public abstract void act();


    protected IBehavior behavior;
```

```
    public boolean see(AbstractBeast b) {
        double angle = Math.atan2 (b.getY()-y, b.getX()-x);
        double diff = Math.abs(angle-direction)%(2*Math.PI);
        if (diff>Math.PI) diff=2*Math.PI-diff;
        return diff<champDeVue/2;
    }

    public double getDistance(IBeast b) {
        return distanceFromAPoint(b.getX(), b.getY());
    }


    double distanceFromAPoint(double x1, double y1){
          // @returns distance between the beast and a point
        return Math.sqrt((x1 - x)*(x1-x) + (y1 - y)*(y1 - y));
    }


    protected IView view = null;
    void drawYourself(Graphics g) {
        if (this.view != null)
            this.view.draw(g, this);
    }

    final public void translate(double dx, double dy) {
        this.x += dx;
        this.y += dy;
    }
}
```

M1 - A Model of the *Program*

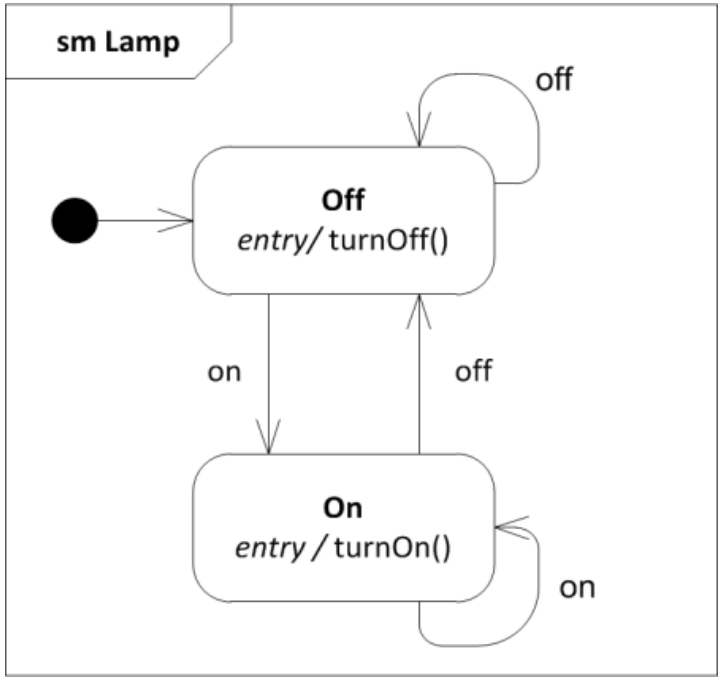


M2 - A Model of ANY *Program*



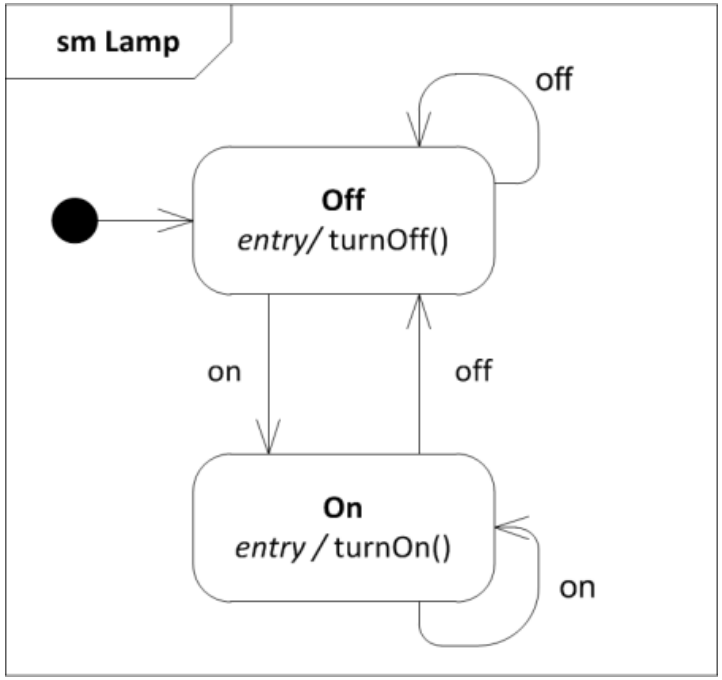
A MetaModel of *Java* Classes

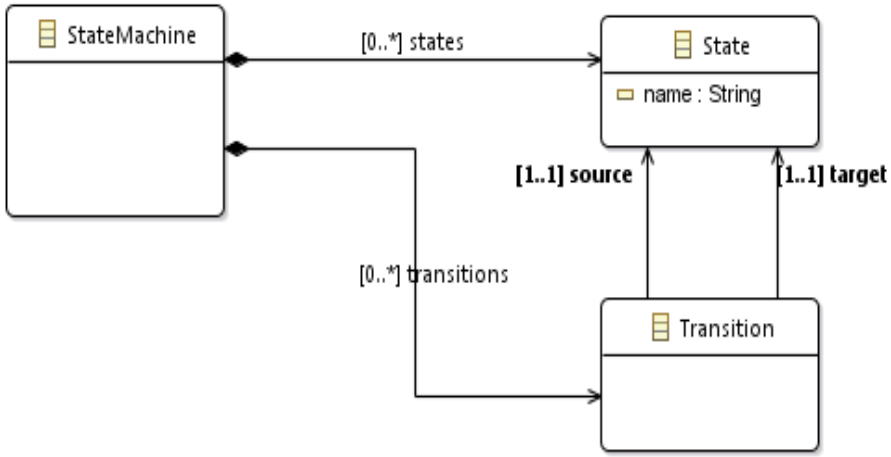
M1 – A(nother) Model of the *Program*



Metamodel ?

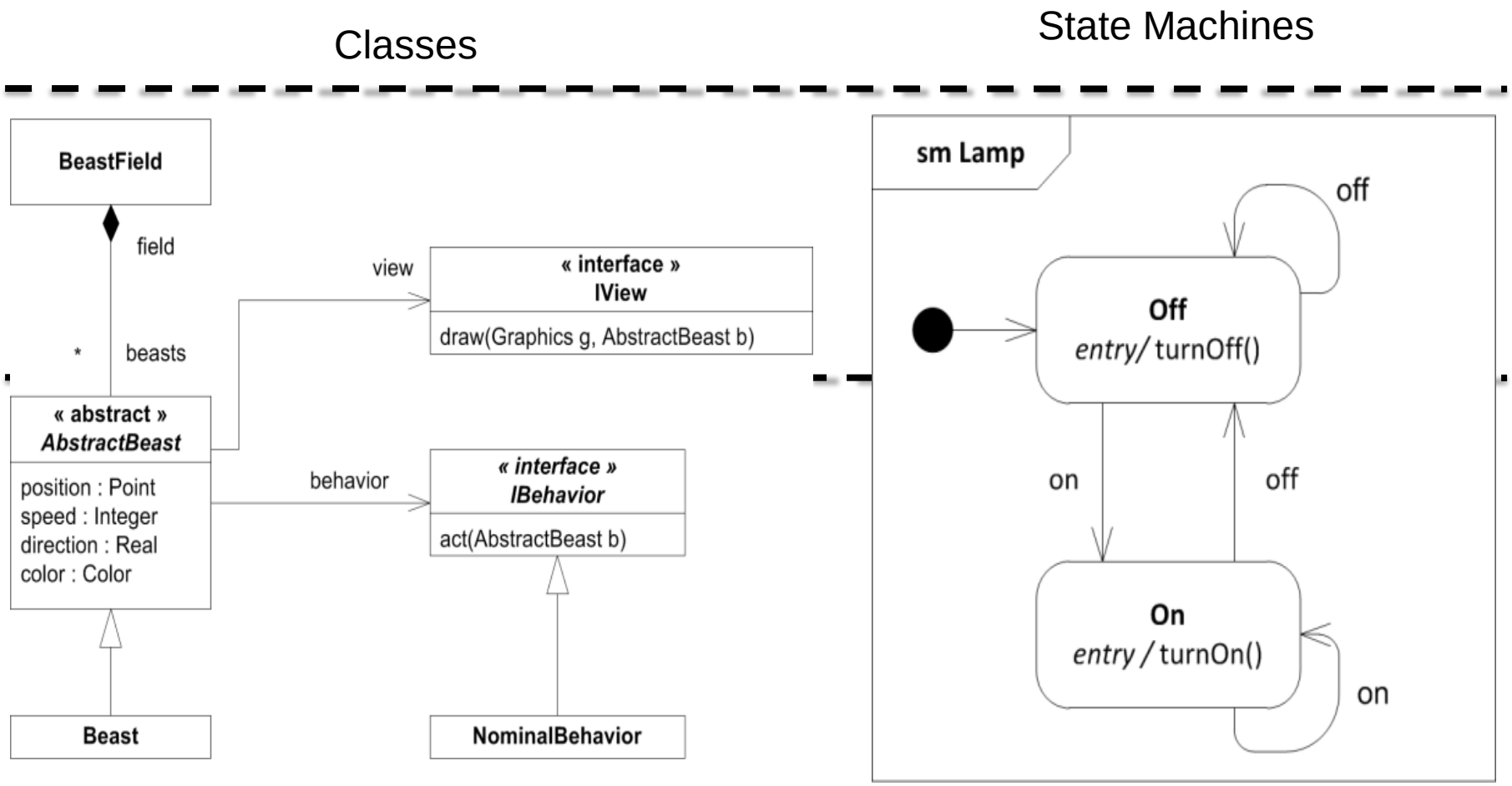
M2 - A Model of ANY *State Machine*



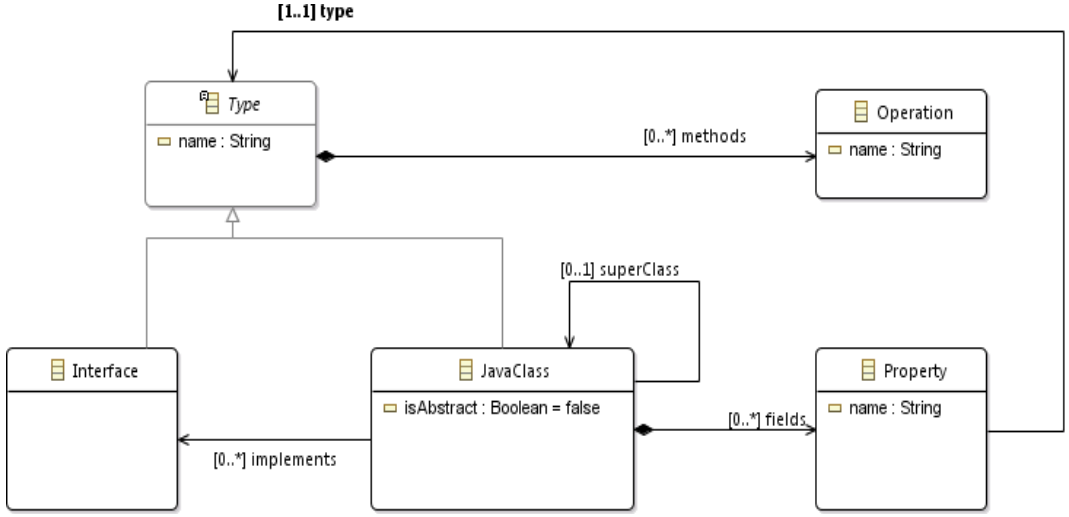


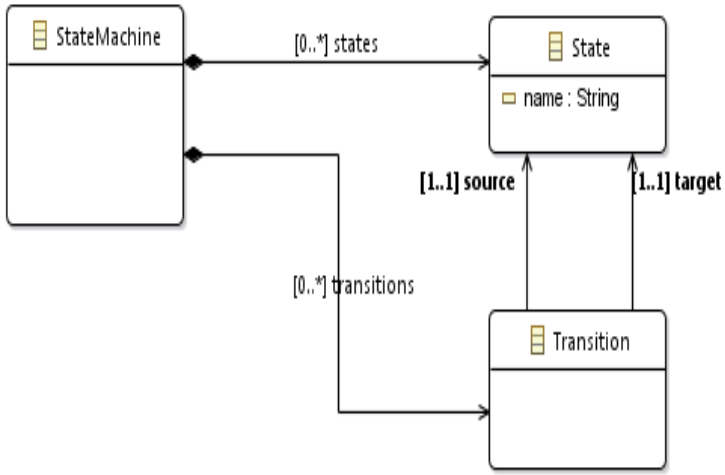
A MetaModel of the behavior of *Java* Classes

Modeling Hierarchy (M1)



Modeling Hierarchy (M2)

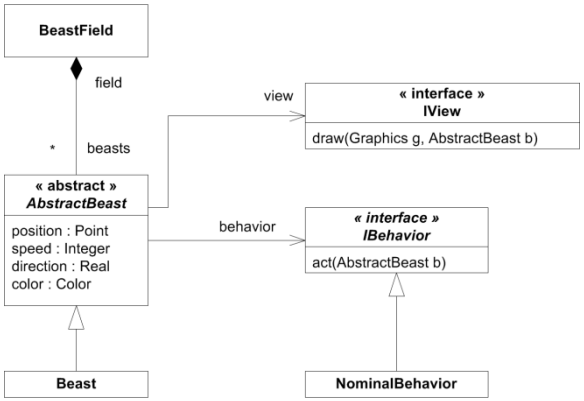


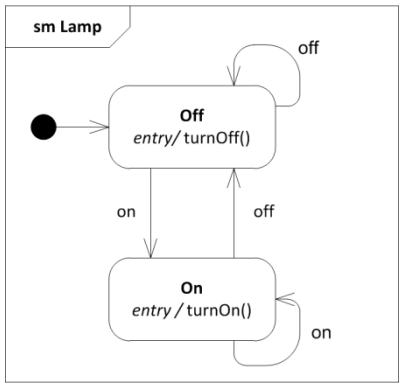


Classes

State Machines

M1



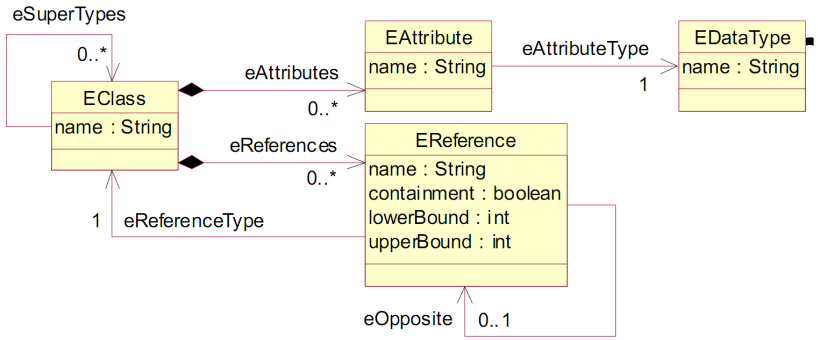


M0

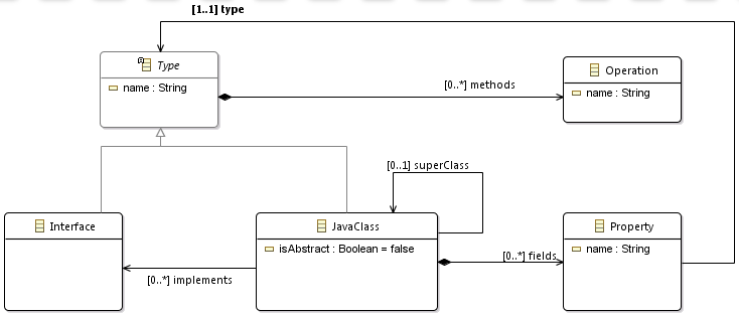
Program

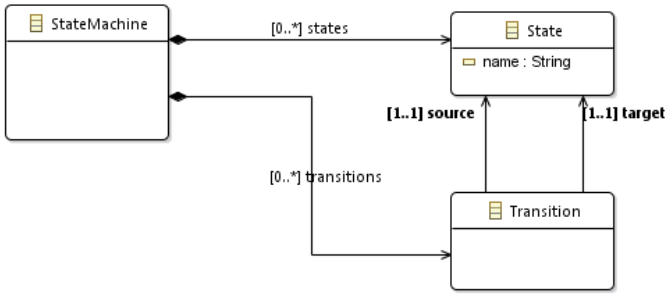
archy (M3)

M3



M2

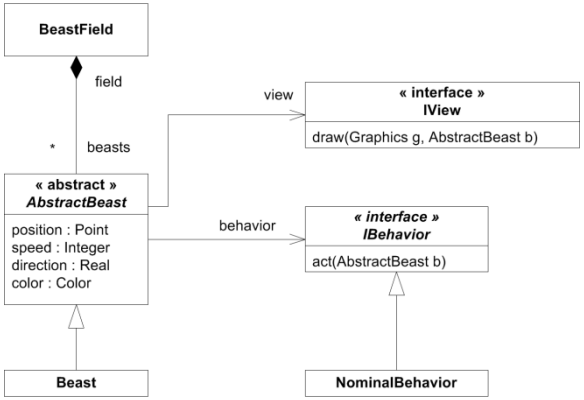


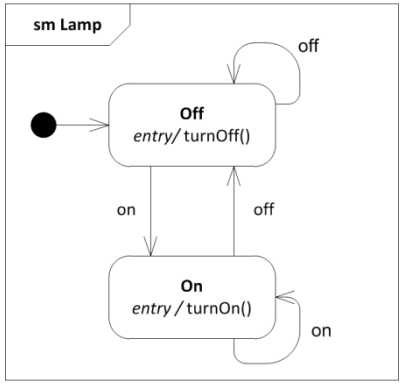


Classes

State Machines

M1

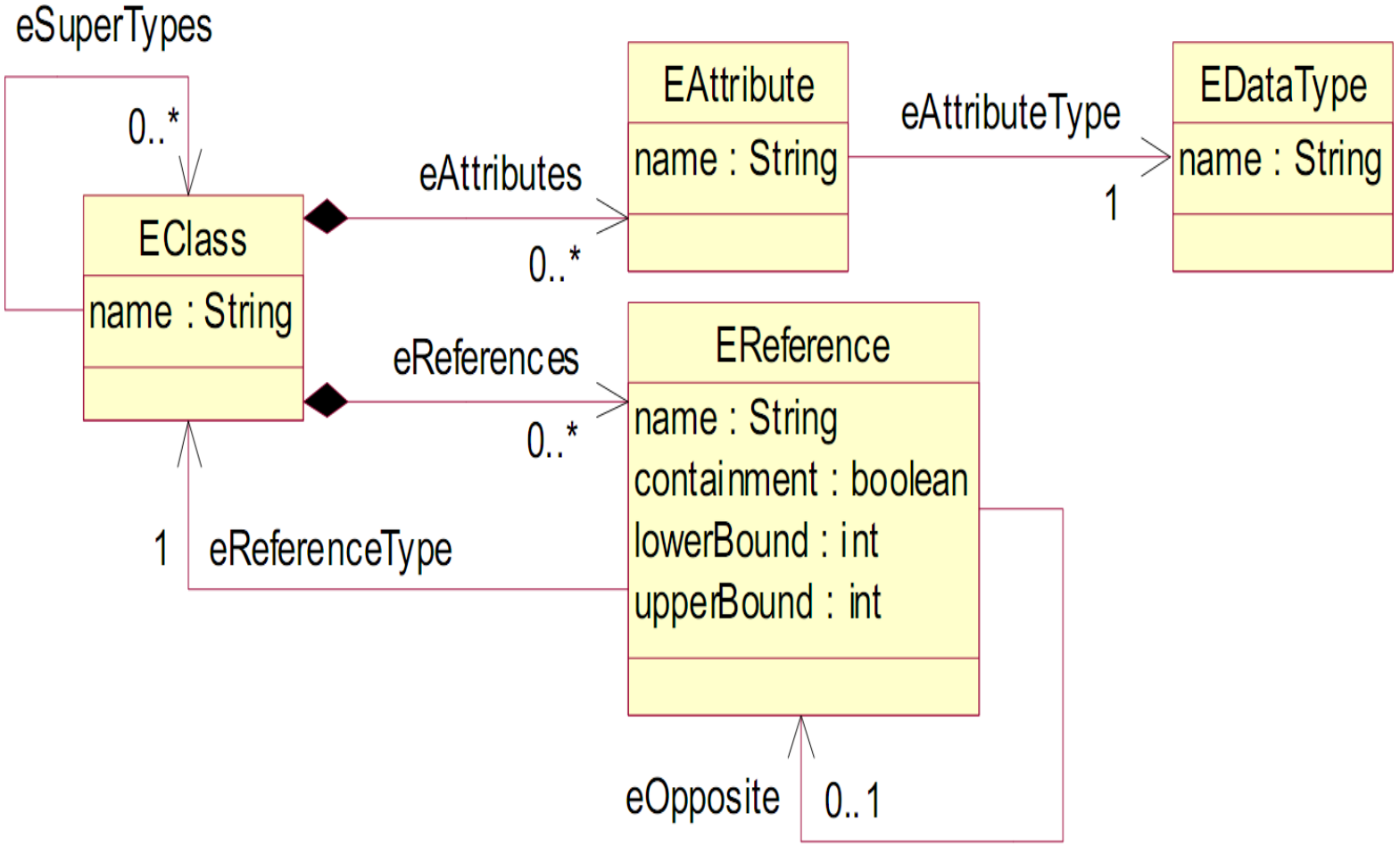




M0

Program

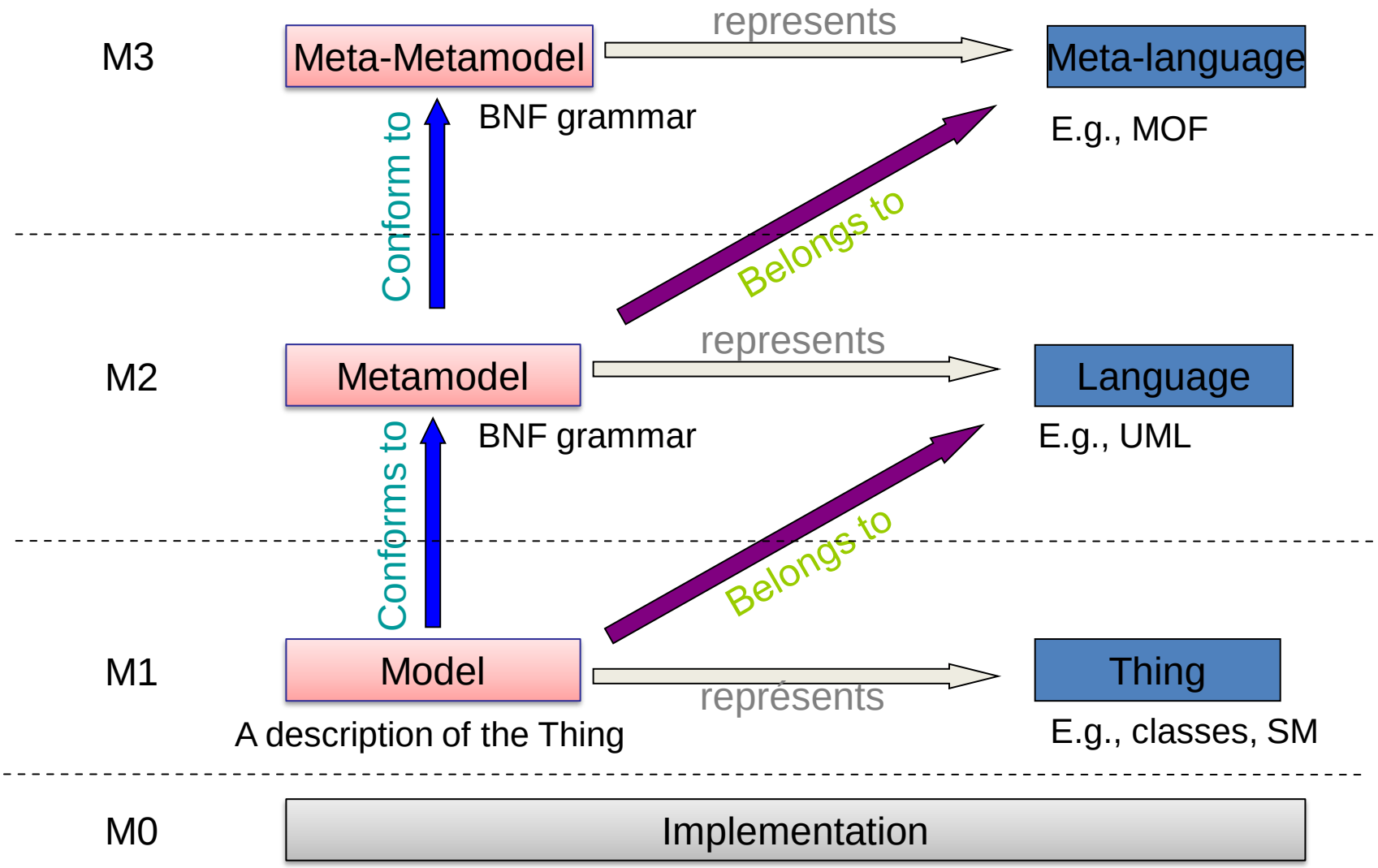
Modeling Hierarchy (M3)



M0

Program

Models/Metamodels/Languages



Summary

- Model-Driven Engineering
  - Attempts to replace programs by models
  - Useful when the code is generated from the models (~80%)