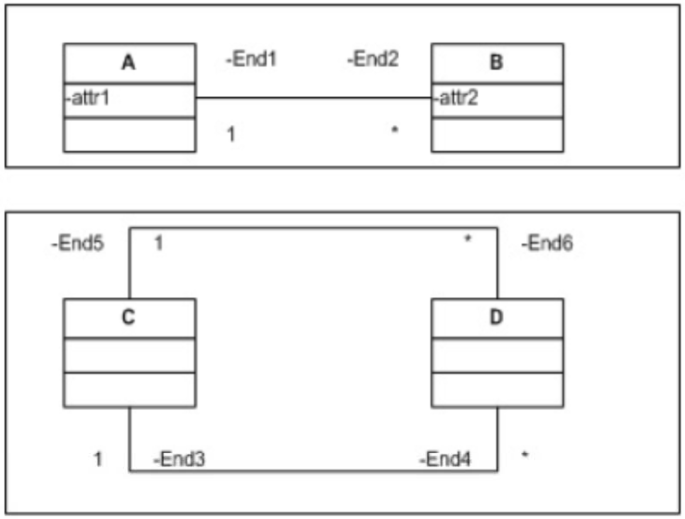
H3 SOLUTIONS

H3: Meta-Metamodels

Due: Wednesday, Sept 18, 10pm

Below, I show you two different graphs (a.k.a. UML class diagrams). They, and others like them, are simplified in that:

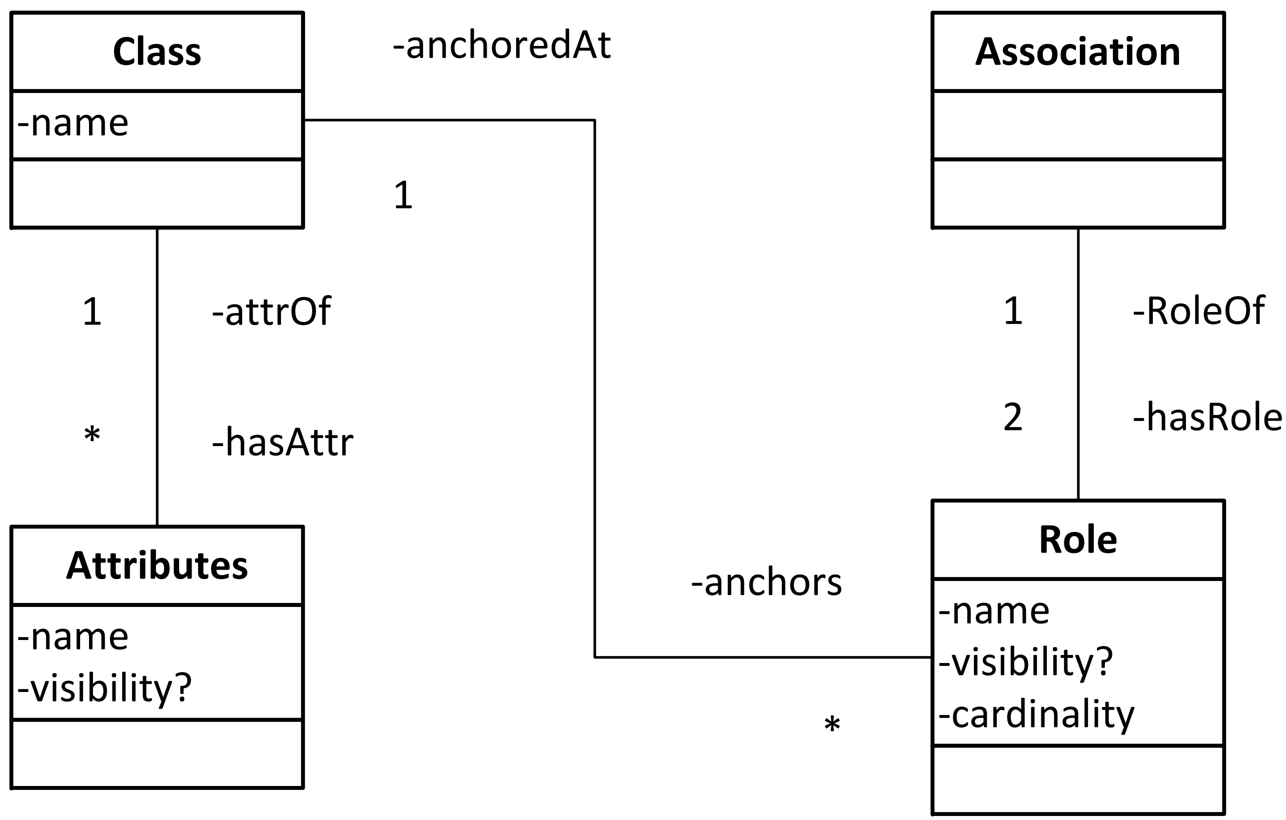
- there are no methods
- attributes have names (but no types)
- associations have role names, cardinalities, but no arrows
- there are no inheritance relationships



You have the following tasks:

1. create a metamodel whose instances include those above.
2. include with your metamodel a list of English constraints. Both instances above must conform to these constraints.
3. create tables from your metamodel and show that both instances can be expressed as rows in its tables.
4. now, show that your metamodel (in 1.) conforms to itself. You show this by (a) treating your answer in (1.) as an instance of itself, and (b) show that it could be expressed as rows in the tables you defined in (3.), and (c) that all constraints defined in (2.) are satisfied.

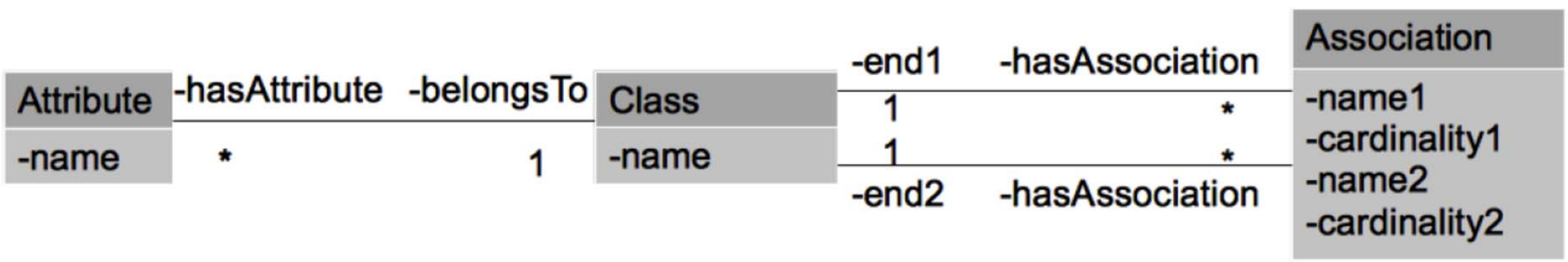
My Solution



Class
-name
-anchoredAt
1
Association
1
-attrOf
*
-hasAttr
1
-RoleOf
2
-hasRole
Attributes
-name
-visibility?
-anchors
*
Role
-name
-visibility?
-cardinality

Interesting Solution

- Is this equivalent to my solution?
- If so, how would you show it?



ANSWER: REFACTORINGS

A Refactoring

- is a semantics-preserving transformation that maps an input model to an output model
  - "behavior" of model is the same
  - structure should be cleaner or easier to understand or extend

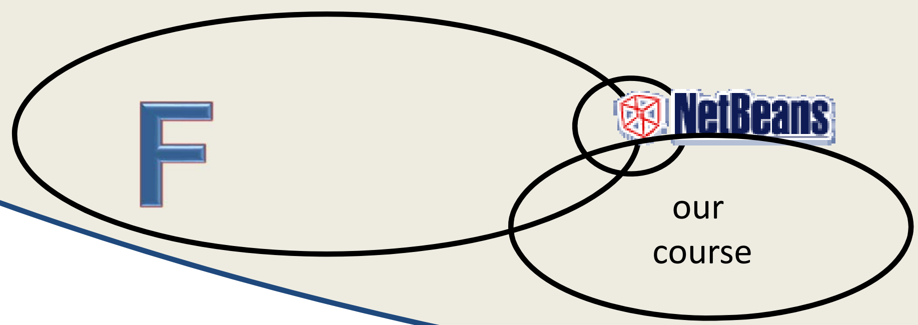
- Original motivation: to restructure OO programs
  - now known that refactorings apply to ***all*** program representations

  - other refactorings are only for State Charts, etc.
  - see examples of non-OO refactorings in parallel architectures lecture

Big Picture

- Refactorings with NetBeans are supported by NetBeans
- Refactorings with F are in Fowler's catalog

Venn Diagram:



in general

Mathematics Analogy

- Expressions are structures – create parse tree for this:

$$2(3\ + 4x) + \ x(x - 6) - 21$$

- Clear parentheses – use $\boldsymbol{a}(\boldsymbol{b} + \boldsymbol{c}) \ = \ \boldsymbol{ab} \ + \ \boldsymbol{ac}$ identity

$$6 + 8x\ + x^2 - 6x\ - 21$$

- Simplify

$$x^2 + 2x - 15$$

- Further (re)factoring to get a “clean” structure

$$(x + 5)(x - 3)$$

Mathematics Analogy

CALCULUS DERIVATIVES AND LIMITS

DERIVATIVE DEFINITION

$$\frac{d}{dx}(f(x)) = f'(x) = \lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$$

BASIC PROPERTIES

$$(cf(x))' = c(f'(x))$$

$$(f(x) \pm g(x))' = f'(x) \pm g'(x)$$

$$\frac{d}{dx}(c) = 0$$

MEAN VALUE THEOREM

If f is differentiable on the interval (a, b) and continuous at the end points there exists a c in (a,b) such that

$$f'(c) = \frac{f(b)-f(a)}{b-a}$$

PRODUCT RULE

$$(f(x)g(x))' = f(x)'g(x) + f(x)g(x)'$$

QUOTIENT RULE

$$\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right) = \frac{f'(x)g(x) - f(x)g'(x)}{[g(x)]^2}$$

POWER RULE

COMMON DERIVATIVES

$$\frac{d}{dx}(x) = 1$$

$$\frac{d}{dx}(\sin x) = \cos x$$

$$\frac{d}{dx}(\cos x) = -\sin x$$

$$\frac{d}{dx}(\tan x) = \sec^2 x$$

$$\frac{d}{dx}(\sec x) = \sec x \tan x$$

$$\frac{d}{dx}(\csc x) = -\csc x \cot x$$

$$\frac{d}{dx}(\cot x) = -\csc^2 x$$

$$\frac{d}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{1-x^2}}$$

$$\frac{d}{dx}(\cos^{-1} x) = -\frac{1}{\sqrt{1-x^2}}$$

$$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$$

$$\frac{d}{dx}(a^x) = a^x \ln(a)$$

$$\frac{d}{dx}(e^x) = e^x$$

CHAIN RULE AND OTHER EXAMPLES

$$\frac{d}{dx}([f(x)]^n) = n[f(x)]^{n-1}f'(x)$$

$$\frac{d}{dx}(e^{f(x)}) = f'(x)e^{f(x)}$$

$$\frac{d}{dx}(\ln[f(x)]) = \frac{f'(x)}{f(x)}$$

$$\frac{d}{dx}(\sin[f(x)]) = f'(x)\cos[f(x)]$$

$$\frac{d}{dx}(\cos[f(x)]) = -f'(x)\sin[f(x)]$$

$$\frac{d}{dx}(\tan[f(x)]) = f'(x)\sec^2[f(x)]$$

$$\frac{d}{dx}(\sec[f(x)]) = f'(x)\sec[f(x)]\tan[f(x)]$$

$$\frac{d}{dx}(\tan^{-1}[f(x)]) = \frac{f'(x)}{1+[f(x)]^2}$$

$$\frac{d}{dx}(f(x)^{g(x)}) = f(x)^{g(x)}\left(\frac{g(x)f'(x)}{f(x)} + \ln(f(x))\, g'(x)\right)$$

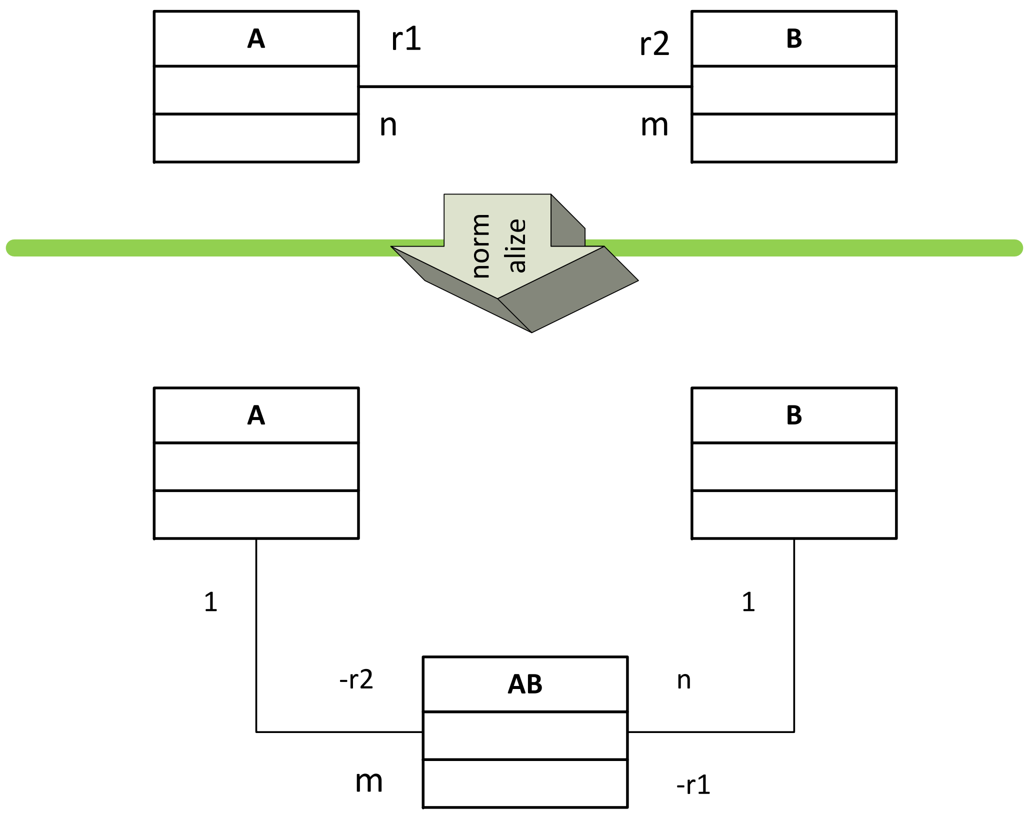
PROPERTIES OF LIMITS

These properties require that the limit of $f(x)$ and $g(x)$ exist

$$\lim_{x\to a}[cf(x)] = c\lim_{x\to a} f(x)$$

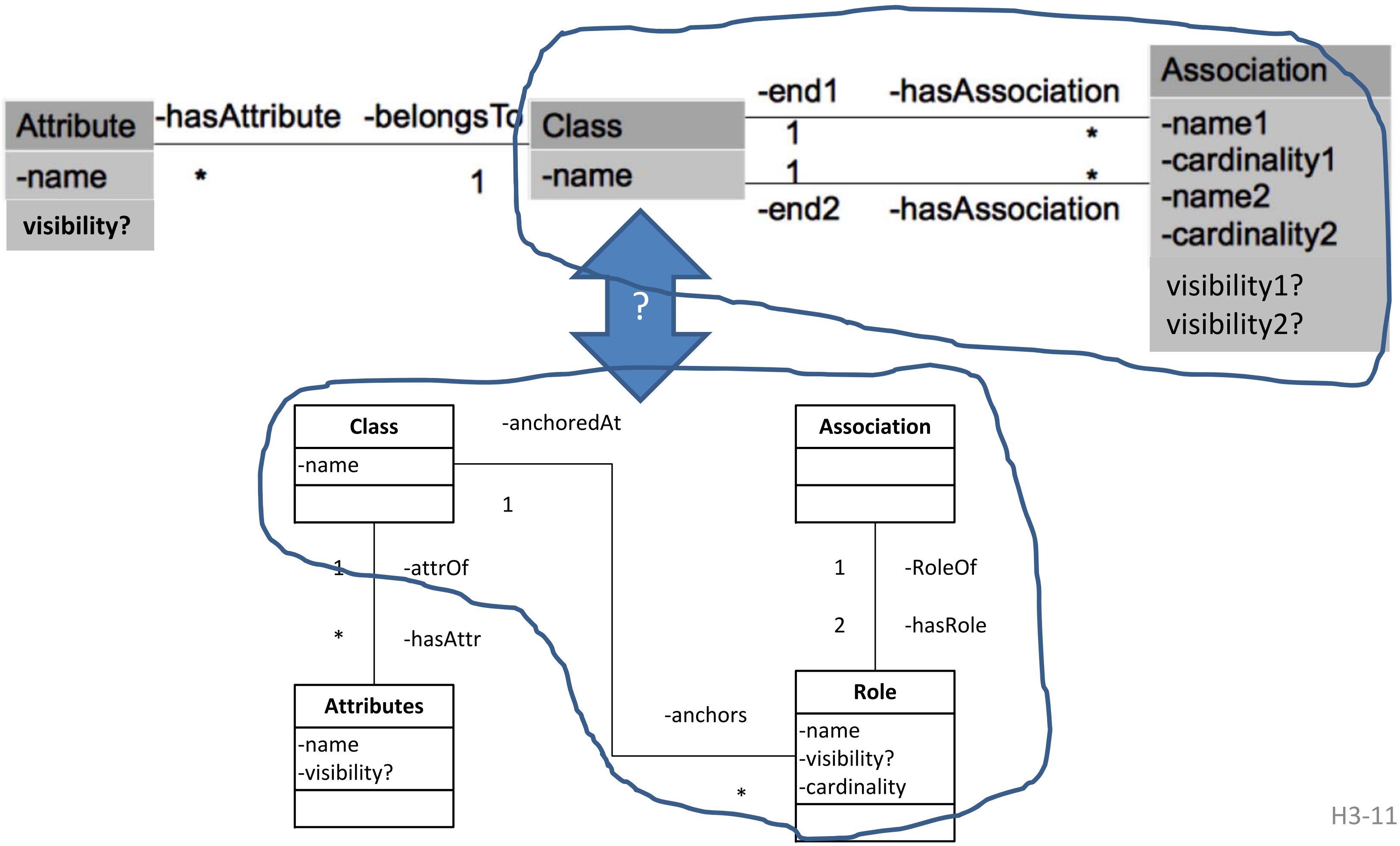
Example of Refactoring (Structural Equivalence)

- You've used this (or at least have seen this ☺) before



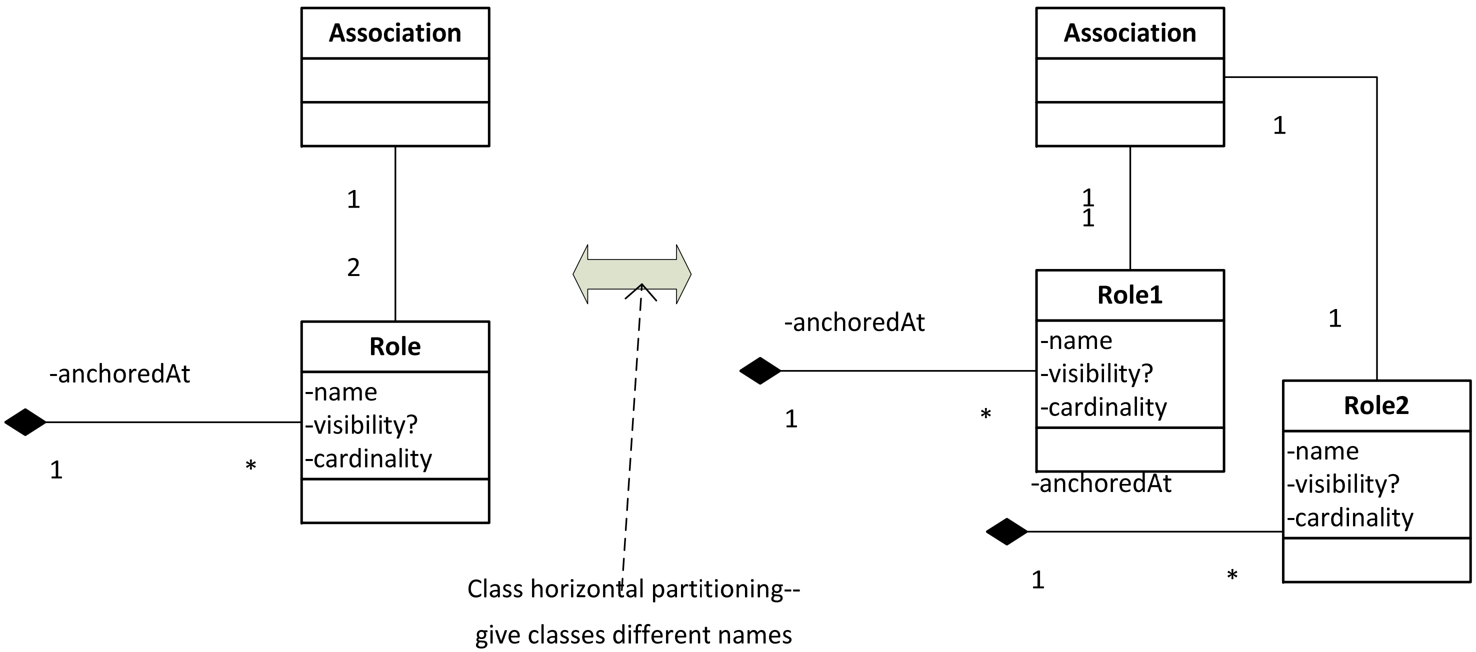
"Proof"

- Obviously not quite equivalent…



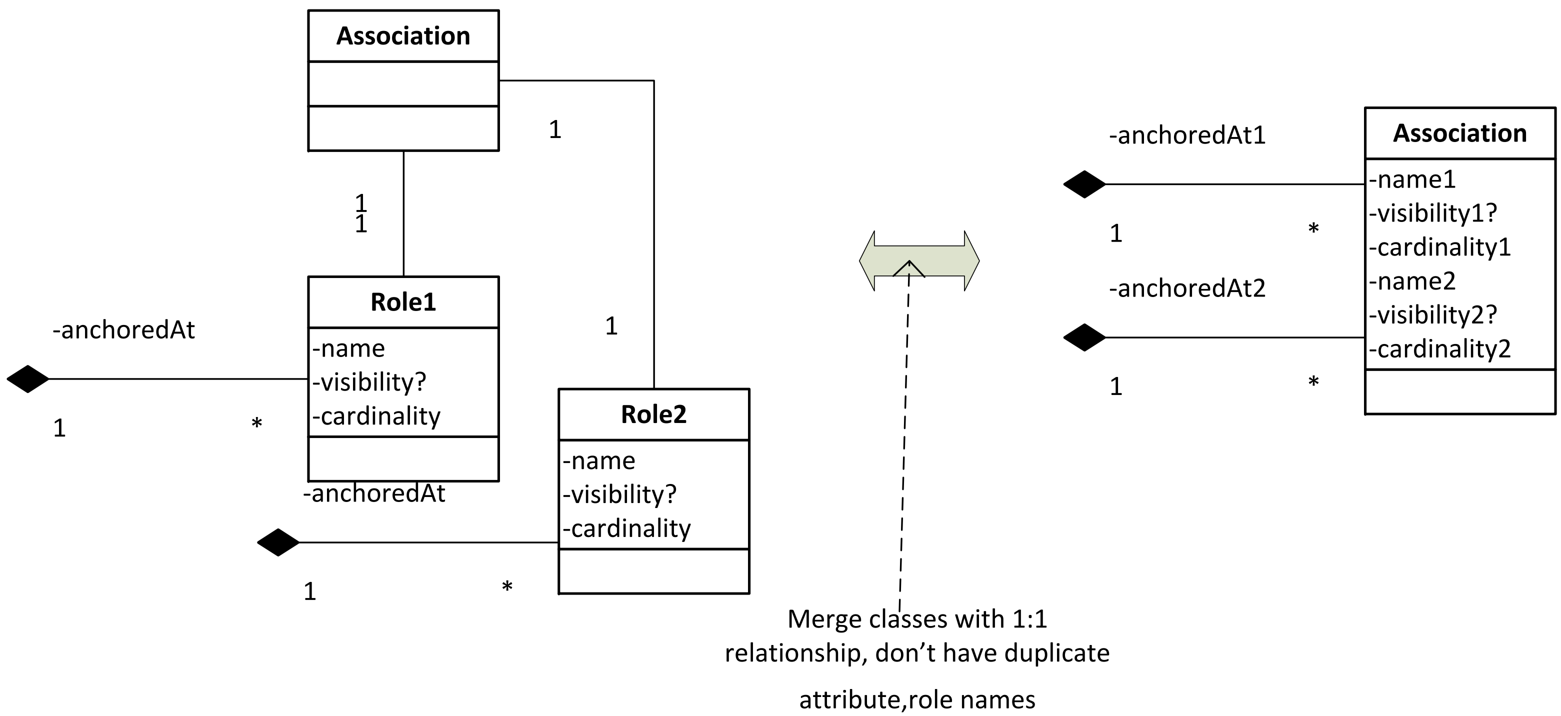
Proof Sketch – page 1

- partition Role table horizontally into 2 different (but schema-isomorphic) tables

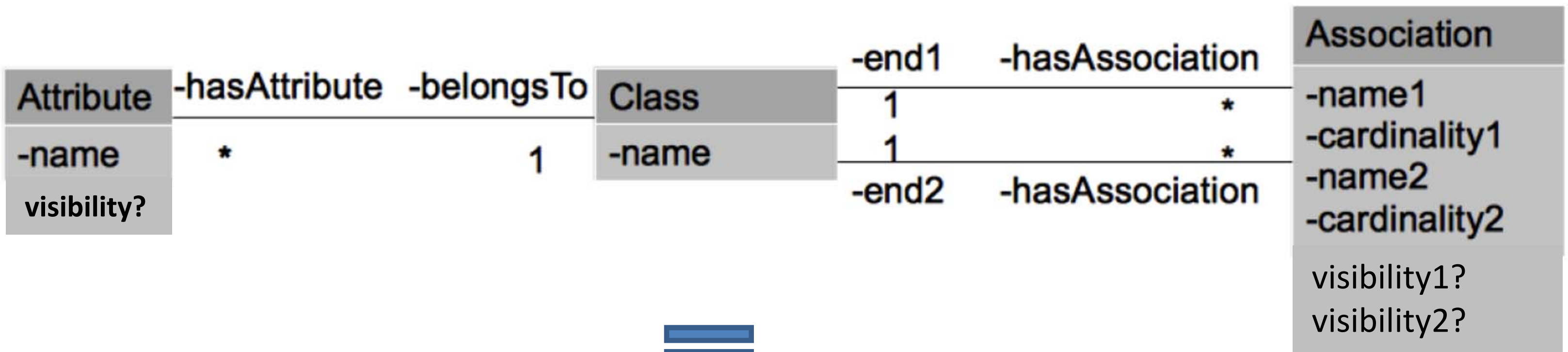


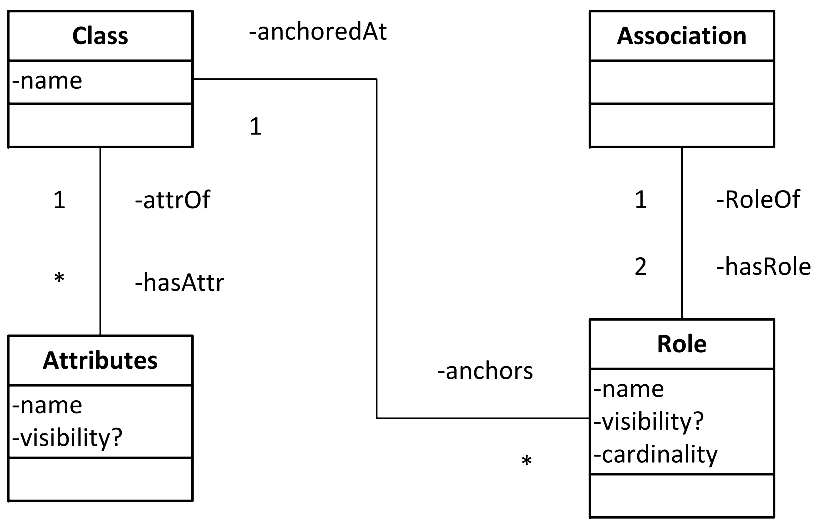
Proof Sketch – page 2

- Combine tables (classes) that are in 1:1 relationship, and make sure that attribute and role names are not duplicated

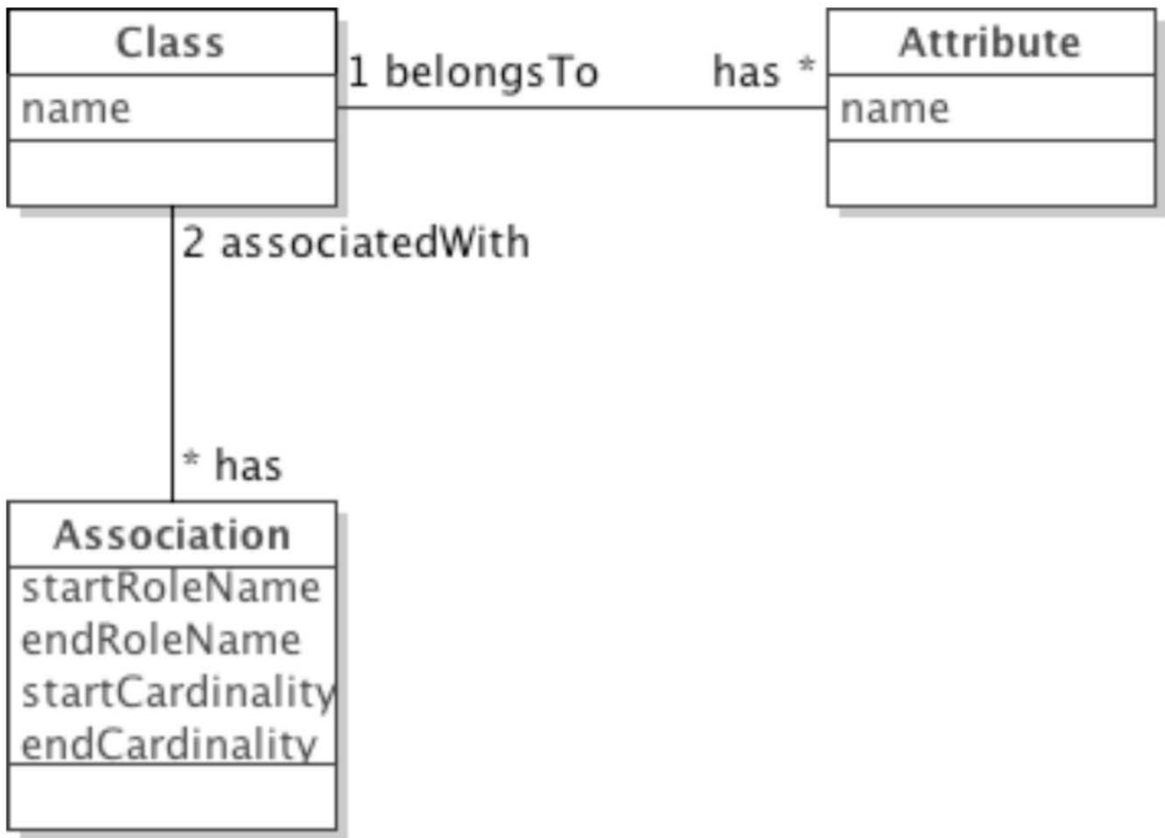


Summary


Attribute
-name
visibility?
-hasAttribute
-belongsTo
*
1
Class
-name
-end1
-hasAssociation
1
*
1
*
-end2
-hasAssociation
Association
-name1
-cardinality1
-name2
-cardinality2
visibility1?
visibility2?


Class
-name
-anchoredAt
1
1
-attrOf
*
-hasAttr
Attributes
-name
-visibility?
Association
1
-RoleOf
2
-hasRole
Role
-name
-visibility?
-cardinality
-anchors
*

Your Comments Please!



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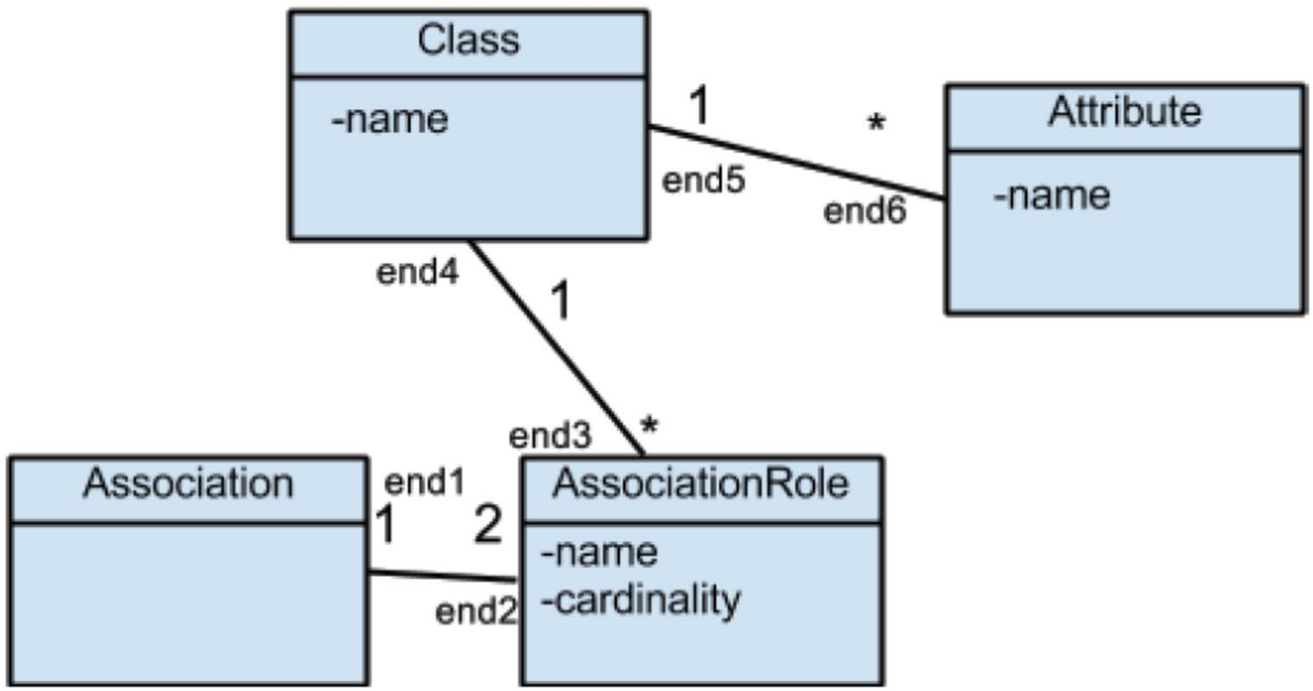

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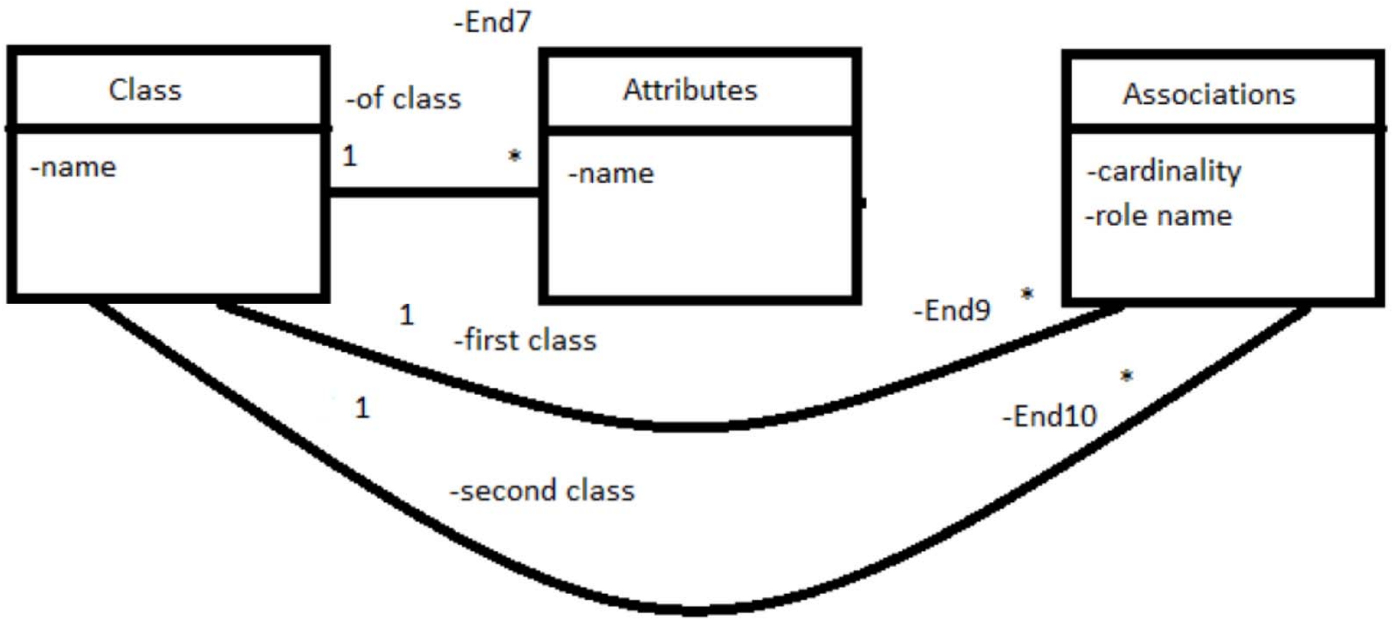

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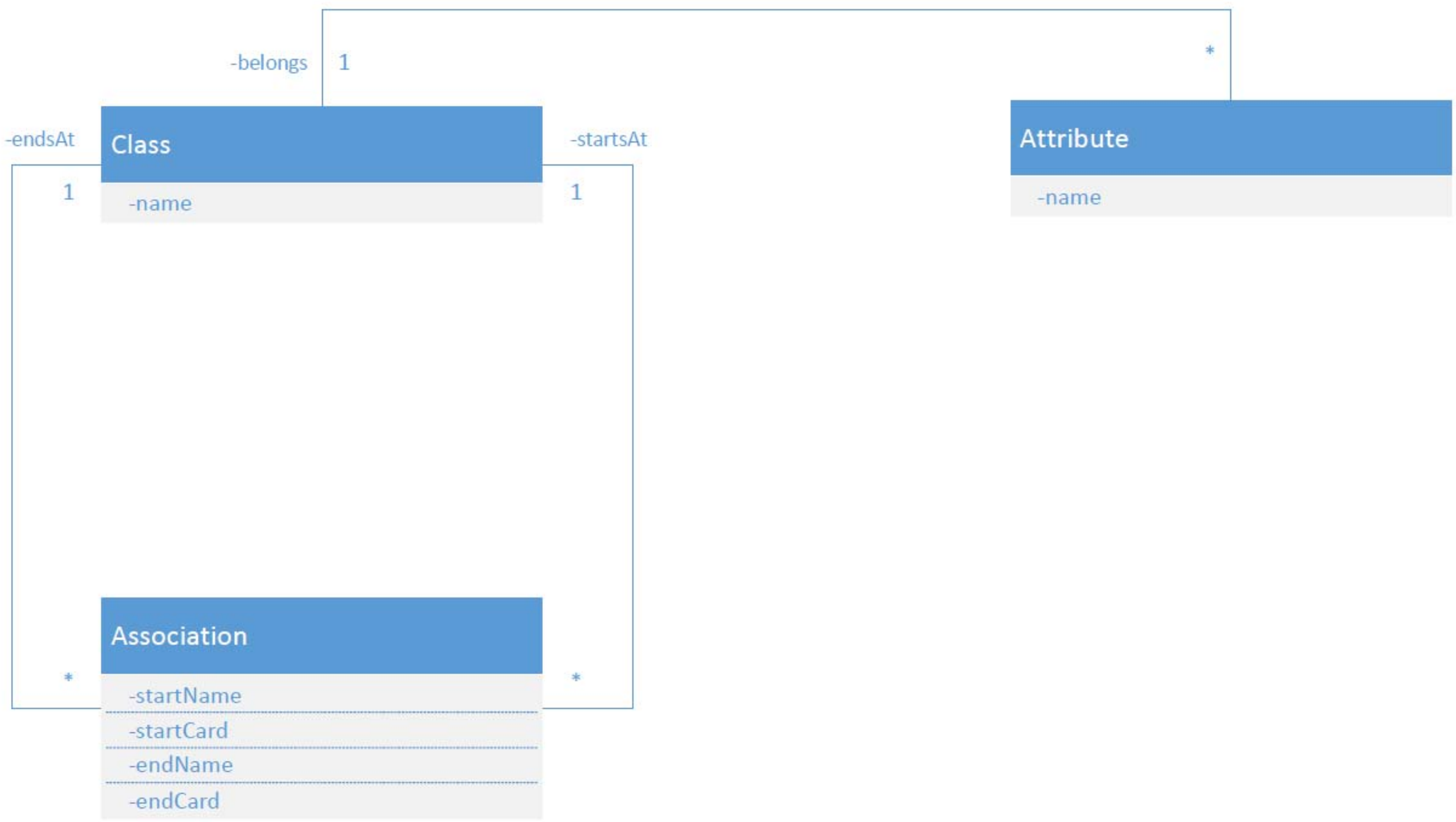

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