Midterm + Solutions Spring 2019

1 Here is the GUIDSL specification of the Graph Product Line.

```
// grammar

GPL   : Alg+ [Src] Wgt Gtp;
Gtp   : Directed | Undirected ;
Wgt   : Weighted | Unweighted ;
Src   : BFS | DFS ;
Alg   : Number | Connected | SC | Cycle | MSTPrim | MSTKruskal
        | ShortestPath ;
SC   : Transpose StronglyConnected;

%% // constraints

Number implies Gtp and Src;      // means a Gtp and Src must be selected
Connected implies Undirected and Src; // means a Src must be selected
StrongConnect implies Directed and DFS;
Cycle implies DFS;
MSTKruskal or MSTPrim implies Undirected and Weighted;
MSTKruskal or MSTPrim implies not (MSTKruskal and MSTPrim);
ShortestPath implies Directed and Weighted;
```

a) $(MSTKruskal, MSTPrim)$ ~~○ legal~~ ○ illegal

One excludes the other

b) $(Directed, Cycle)$ ○ legal ~~○ illegal~~

they are compatible

c) $(ShortestPath, StronglyConnect)$ ○ legal ~~○ illegal~~

they are compatible

Each of the questions below I start with no selected features. Then I select:

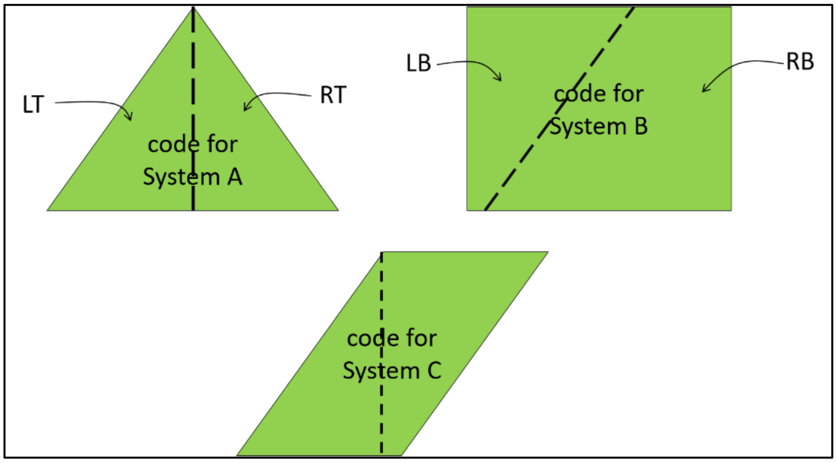
d) $(Undirected)$ what other assignments are selected or deselected for me?

directed,shortest path, stronglyConnect are deselected

e) (BFS)

DFS, Cycle, StronglyConnect are deselectedvi

2. Recall this slide from class lectures. I gave to one person the triangle and to another the rectangle and a pair of scissors to “modularize” their shapes. And then I tried to use these existing modules to produce the rhomboid below and couldn’t do it without serious hacking. I then “remodularized” the triangle and rectangle along the dashed lines below, showing that if I had chosen these modularities, I could build the rhomboid instantly at virtually no cost.



I have labeled my modules above (LT for **left triangle**, LB for **left box**, etc.).

Question: what is the feature model of this product line? You will:

(a) Provide a Feature diagram tree OR a GUIDSL context free grammar. You can not use A, B, C as labels or features. Only LT, RT, LB, RB as primitive tokens.
(b) Feature constraints (if none, say “none”).

This was **much, much harder** than I thought. Even I got it wrong (when designing the test). Anyone who proposed what I proposed got an A- (for this problem’s grade). Those who got it correct although I directed them away from the simplest answer got full credit 25pts (see below. For answers I couldn’t tell, I entered them into guidsl to see if they were correct. If so, they got 30pts (extra credit). I will announce the 2nd winner of the “TinkerToys award” for most elegant answer soon, with award. There are many solutions.

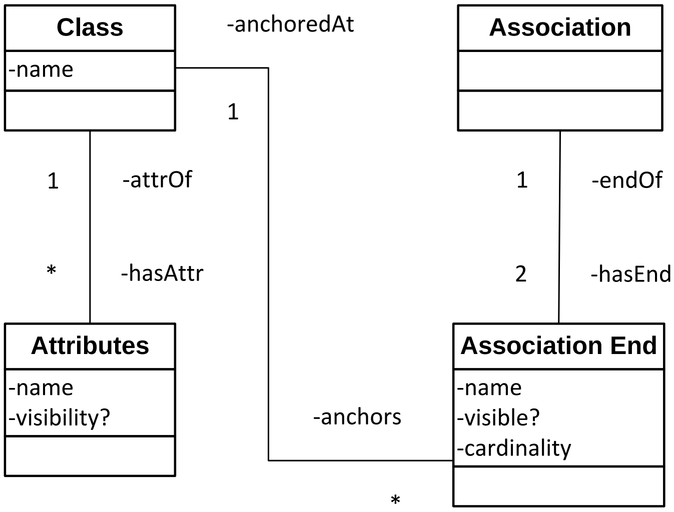
The simplest that I tried to direct you away from	Sol 1

SPL : Aprod | Bprod | Cprod;
Aprod : LT RT;
Bprod : LB RB;
Cprod : LT RB;
	SPL : [LT] [LB] [R];
	R: RT | RB;
	%%
	RT implies LT;
	BR implies LB;
	LT and LB implies not RT and not RB;

Sol2	Sol3

spl : [LT] [RT] [LB] [RB];
%%
choose1(LT,RB);
LT implies (choose1(RT,LB));
RB implies LB and not RT;
	spl : [LT] [RT] [LB] [RB];
	%%
	not(RT and RB);
	RT implies LT;
	RB implies LB;
	LT and LB implies not RT and not RB;

(3) 15 minutes max. Recall from lectures the metamodel of all class diagrams with associations and no inheritance. I do not list the constraints, but assume they are present.

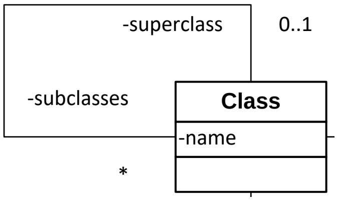


a) What is the **minimal addition** to this diagram and constraints that permits inheritance relationships among classes? Draw the revised diagram.

b) What additional constraints, **in English**, are needed to retain the sanity of such diagrams?

c) Does the original diagram (above) conform to your revised metamodel of b)? Yes or No + **briefly** explain why.

Answer: (3a)



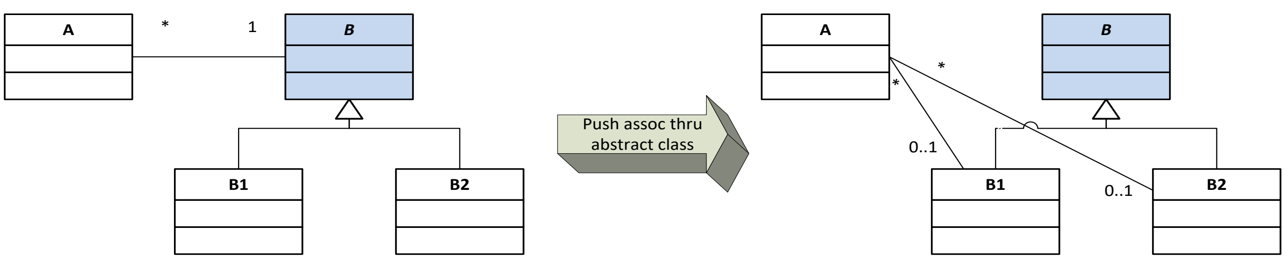
(3b) Additional constraints should be:

- No inheritance cycles is basically what I was looking for.

(3c) Yes it conforms. The original diagram just doesn't have inheritance relationships. The tabular representation of the modified diagram adds a field to the class table. This column would contain nulls for the original diagram.

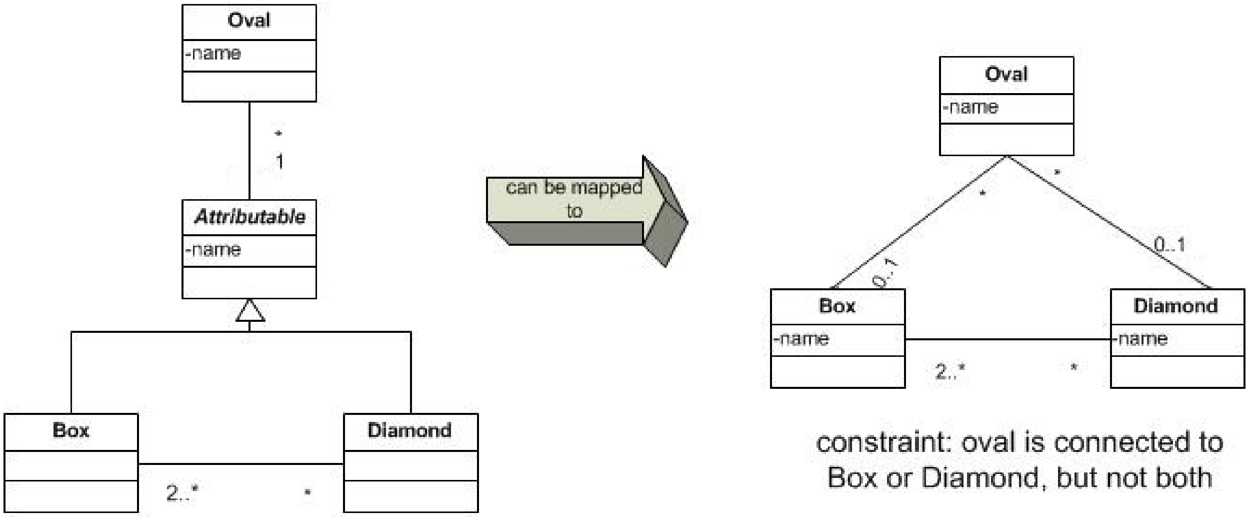
Note: there were other answers – like augmenting associations to indicate that they can now represent inheritance relationships. This answer, while "correct", is very invasive – lots of changes are needed to qualify association constraints from those that are inheritance constraints.

(3) 15 minutes max. A common refactoring pushes an association "through" an abstract class to its subclasses:

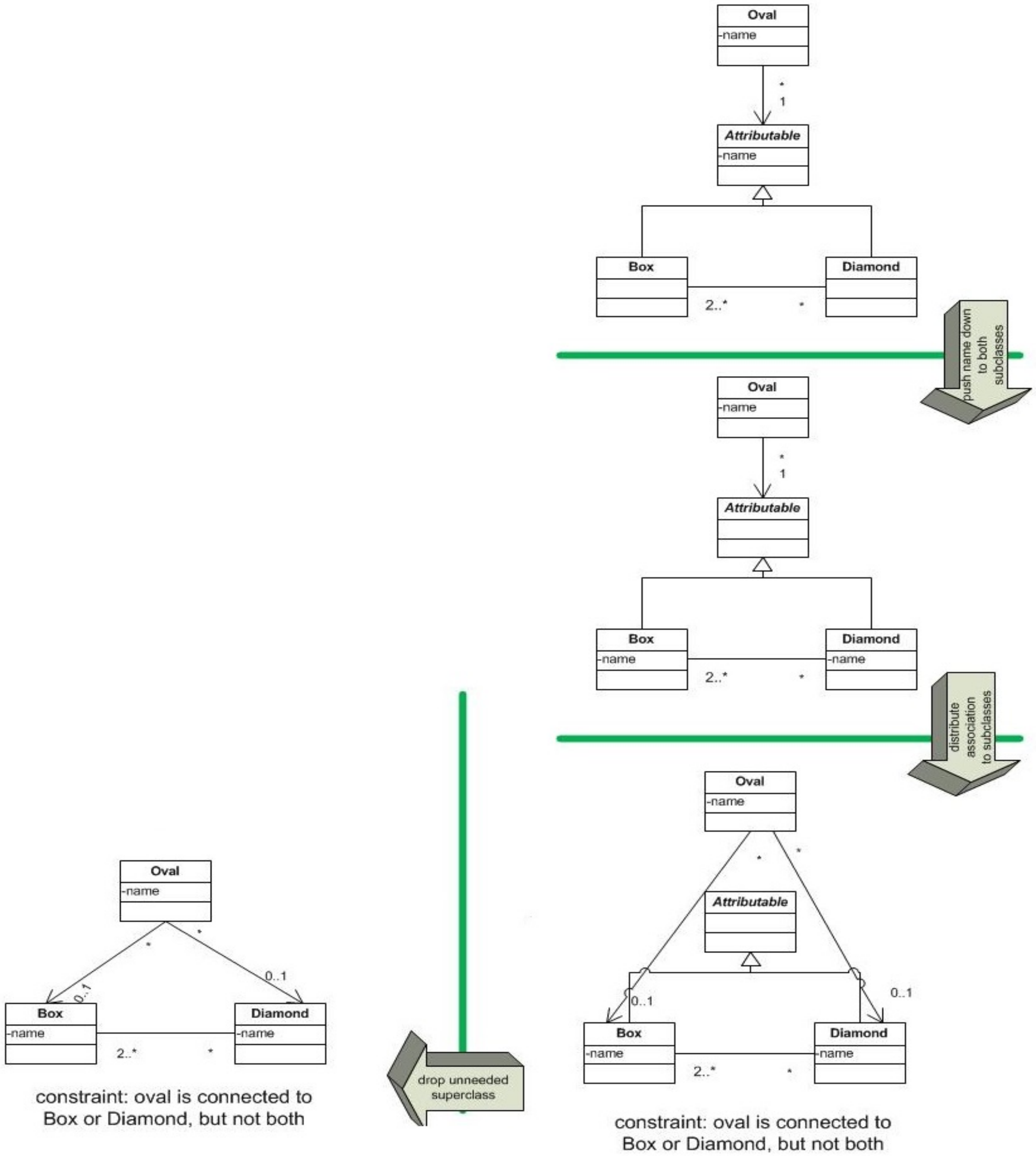


By making class A associations reference abstract class B's subclasses, a constraint must be added: each A instance is bound to a B1 or B2 instance, but never both.

Using the above refactoring and <u>any that we have discussed in class along with their **names**</u> – show that the left model can (or cannot) be mapped to the right model. STATE ANY CONSTRAINTS THAT MUST BE APPLIED AS YOU PROCEED.



constraint: oval is connected to Box or Diamond, but not both


Oval
-name
*
1
Attributable
-name
Box
Diamond
2..*
*
push name down to both subclasses
Oval
-name
*
1
Attributable
Box
-name
Diamond
-name
2..*
*
distribute association to subclasses
Oval
-name
*
*
Attributable
0..1
0..1
Box
-name
Diamond
-name
2..*
*
constraint: oval is connected to Box or Diamond, but not both
drop unneeded superclass
Oval
-name
*
*
0..1
0..1
Box
-name
Diamond
-name
2..*
*
constraint: oval is connected to Box or Diamond, but not both

4)