OODP 4: Minimize Dependencies

Today, we look at our fourth object-oriented design principle: **Minimize Dependencies**. We not only want to reduce the ***number*** of dependencies between our classes, but also desire to decrease the ***strength*** of the dependencies which we cannot remove without breaking functionality. Through several examples, we will see how and why to minimize dependencies.

Manager: Recorder:

Presenter: Reflector:

Content Learning Targets

After completing this activity, you should be able to say:

- I can identify and categorize dependencies between classes in both UML and code.
- I can explain the design goals of "tell, don't ask" and "avoid message chains".
- I can define coupling and cohesion in my own words.
- I can distinguish cohesion from encapsulation.
- I can apply coupling and cohesion to analyze the level and quality of dependencies in a UML design or code.

Process Skill Goals

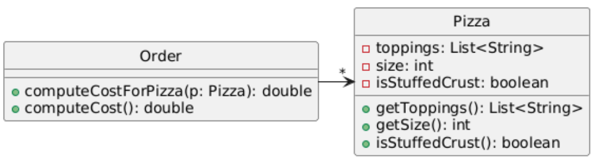
During the activity, you should make progress toward:

- Writing with technical detail using precise object-oriented design terminology. (Communication)
- Interpreting UML diagrams and imagining possible implementations. (Information Processing)

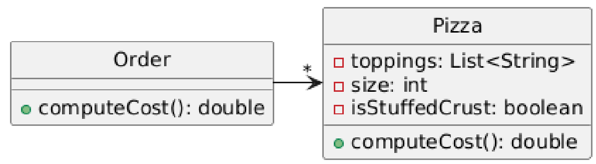
Model 1 Tell, Don't Ask

Recall the Pizza Restaurant design problem from a previous class, in which an Order consists of a list of Pizzas, and the cost of each Pizza depends on its toppings. Suppose that the restaurant adds different sizes (diameter, in inches) and a stuffed crust option, and both factors affect Pizza cost. Consider the two partial UML designs below. (Details not related to our current focus have been left out.)

Design A: (PlantUML source)



Design B: (PlantUML source)



Questions (30 min)

Start time:

1. The `computeCost()` method in Order will look very similar.

In Design A:

```
public double computeCost() {
    double cost = 0;
    for (Pizza p : this.pizzas) {
        cost += this.computeCostForPizza(p);
    }
    return cost;
}
```

In Design B:

```
public double computeCost() {
    double cost = 0;
    for (Pizza p : this.pizzas) {
        cost += p.computeCost();
    }
    return cost;
}
```

Where will the designs' differences appear in code, if not in Order's `computeCost()`?

2. Which design is better? Justify your choice.

The design principle of "Tell, Don't Ask" (see Fig. 1) encourages us to keep operations (methods) that operate on certain data with the class(es) containing that data. Instead of having Class A ask for Class B's internal data and then do something with it, possibly updating Class B's internal data afterward, we should have Class A ***tell*** Class B to perform that operation.

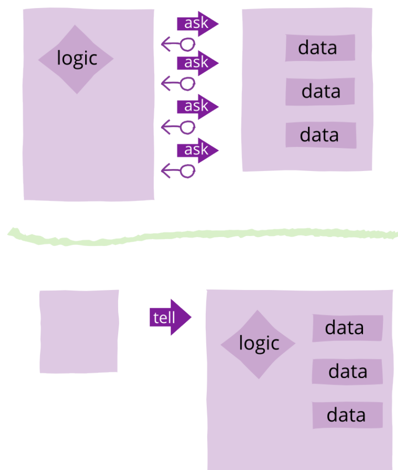


Figure 1: "Tell, Don't Ask" diagram by Martin Fowler.

3. Asking is especially poor design when you return some internal class that the caller would otherwise not know exists. For example, suppose we have a class called `AppRunner` with a field called `framework` of type `LogFramework`, which supports logging errors and user actions to files. One of our methods:

```
public LogFramework getLogFramework() {
    return this.framework;
}
```

One of our client's methods:

```
public void activateVerboseLogging() {
    LogFramework fw = this.appRunner.getLogFramework();
    fw.setLevel(5);
}
```

How could you refactor to "Tell, Don't Ask" and avoid exposing the `LogFramework` class to the client?

4. Based on the "Tell, Don't Ask" examples we've seen, list a few rules of thumb for avoiding asking, and/or red flags that suggest your design/code might be asking instead of telling.

Model 2 Message Chains

A ***message chain*** is code in the form

```
someObject.someMethod().otherMethod().stillOtherMethod();
```

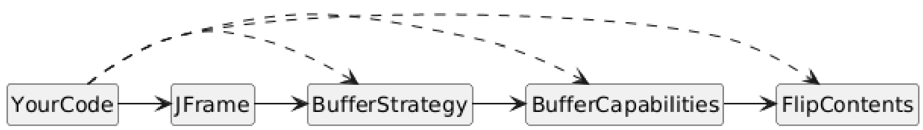
For example (this is taken from Java AWT/Swing; the details of these classes are not important), your code might have a line like

```
myFrame.getBufferStrategy().getCapabilities().getFlip().wait(17);
```

A rational programmer might split up this message chain by introducing intermediate variables:

```
BufferStrategy strategy = myFrame.getBufferStrategy();
BufferCapabilities capabilities = strategy.getCapabilities();
FlipContents flip = capabilities.getFlipContents();
flip.wait(17);
```

By splitting the message chain like this, the dependencies become even clearer, as we see in the UML diagram below. Your code knows details ***four levels deep*** in the called operations!



(PlantUML source)

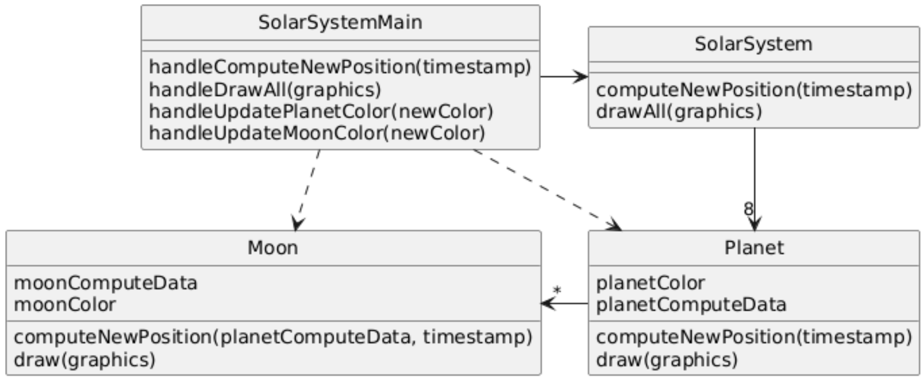
Questions (30 min) Start time:

5. If you could modify these classes however you wanted, how could you eliminate this message chain to reduce dependencies? Draw your updated design on a whiteboard, paper, or in PlantUML, and explain below.

Solar System Problem

System description: A Java program draws a minute-by-minute updated diagram of the solar system including all planets and moons. To update the moon's position, the moon's calculations must have the updated position of the planet it is orbiting. The diagram is colored—all planets are drawn the same color and all moons are drawn the same color. However, it needs to be possible to modify the planet color or the moon color.

6. Examine the UML diagram below of a possible design for this system. Which dependencies seem essential? Which seem like we might be able to weaken or eliminate them?



(PlantUML source)

7. Investigate the implementation of this design provided in the `src/solarSystem` package. For the seemingly unnecessary dependencies, where do they appear in the code? What principle(s) do these dependencies violate?

8. Improve the UML design by applying our standard procedure for handling the type of dependency you found. Use the PlantUML source linked above as a starting point, and paste your updated PlantUML link below. (Remember to click the "Decode URL" button after making changes.)

9. Revisit the system description. What do you notice about the color specifications that suggests a further design improvement?

10. Refactor the solar system project to match this design, which includes the improvement from the previous question. You may get help from GenAI tools. Looking at the methods where you previously saw evidence of unnecessary dependencies, what does the new implementation do? How does it avoid the bad dependencies of the original version?

Model 3 Coupling and Cohesion