

# AP Computer Science

OO design

# NullPointerException

- Before a variable of an object type is initialized with `new`, it holds a reference to `null` (nothing!)
- Calling a method on `null` gives a `NullPointerException`
- Make sure to initialize fields in your constructor

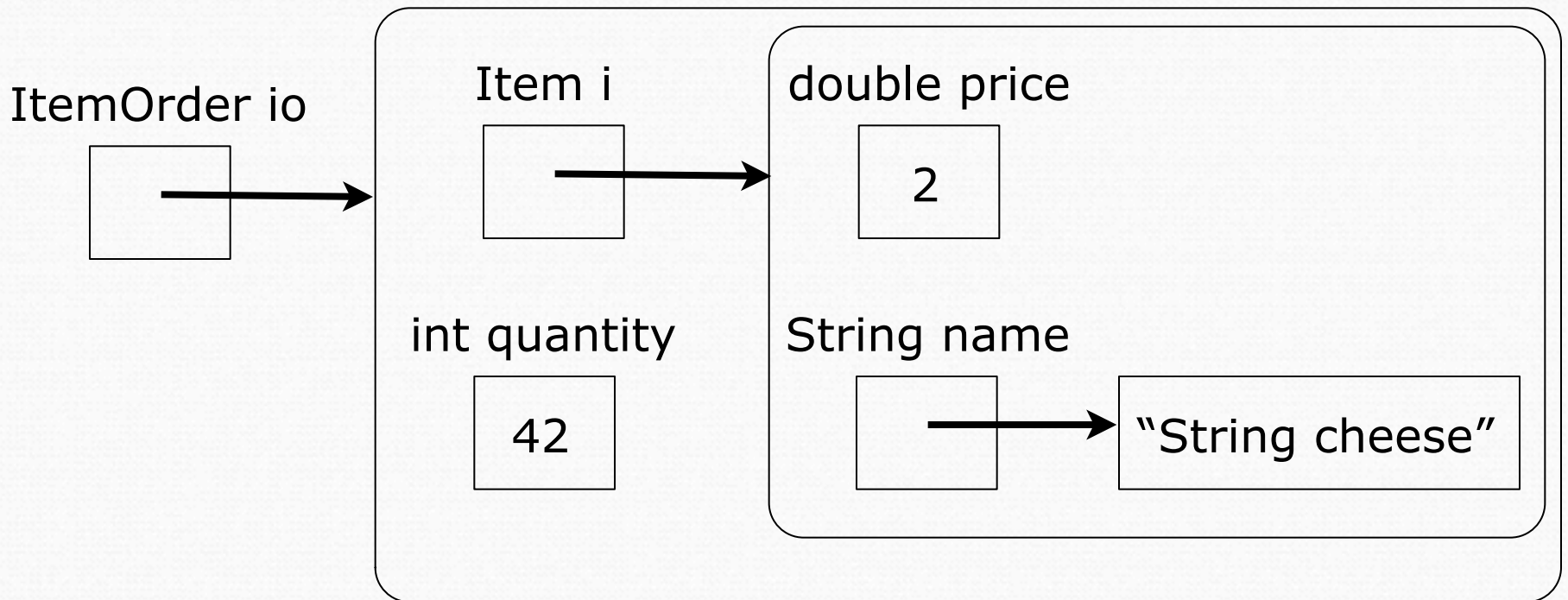
```
public class Student {
    private ArrayList<Integer> grades;

    public Student() {
        grades = new ArrayList<Integer>();
    }

    ...
}
```

# Reference to an object

- Variables don't directly hold objects, they hold the memory address of objects.

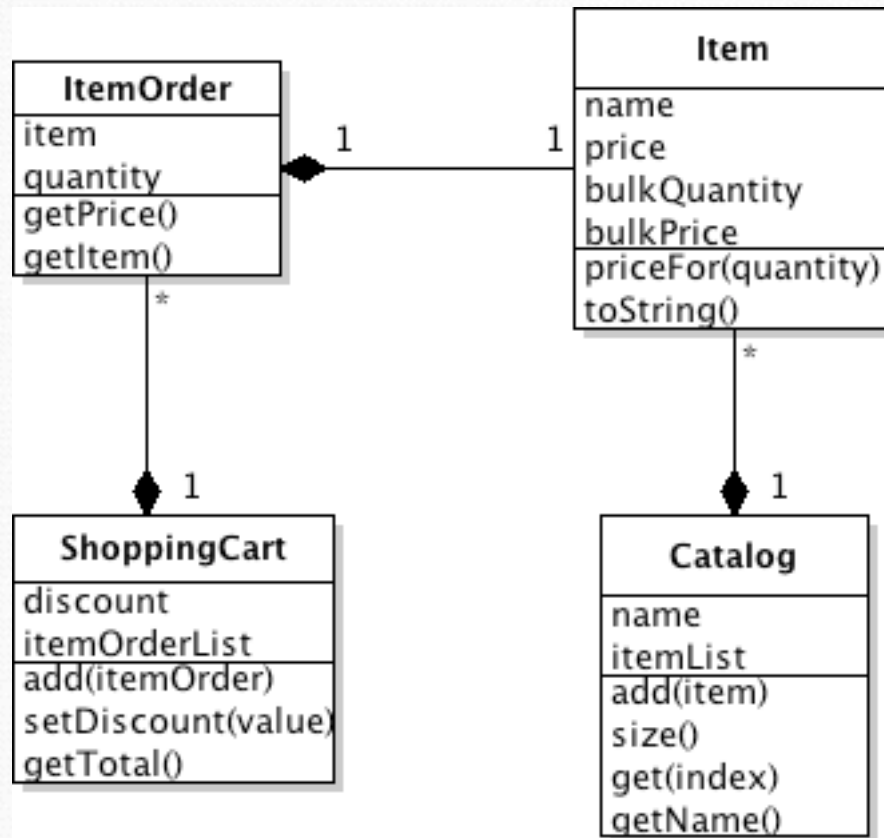


# Object-Oriented Design

- Design is critical in OO and often hardest part
- What are the nouns in the specification? (ex: item)
- Which responsibilities belong to which nouns?
- What are the relationships between nouns?

# Composition

- “Has-a” relationship
- An ItemOrder has an Item
- A ShoppingCart has many ItemOrders



# Bottom-up implementation

- Write the simplest classes without dependencies first
- Link simple system pieces into larger subsystems
- Test as you go to make sure you're not building off a bad foundation