

CSSE 220: Object Design

Part 1 of Many

Also Class Diagrams

Designing Classes

- Programs typically begin as abstract ideas
- These ideas form a set of requirements (i.e. what the user wants)
- We must take these requirements, and figure out an approach for our coding
- Usually the approach is not obvious
- So we propose designs, then iteratively refine them into something that might work (continued...)

- So we propose designs, then iteratively refine them into something that might work
 - Many bad ideas in the process
 - We don't want to go through the effort of implementing bad ideas in code
 - But we need a way to communicate/think concretely about these half-baked program approaches
- We need a diagram language!

Tools of the Trade

- Class Diagrams (UML)
- UML – Unified Modeling Language
 - Language **un**specific
 - Has a lot of different diagrams it provides specifications for – but the class diagram language is the most widely used

A little class diagram will get you a long way

ClassName
Field names
Method names

- 3 sections
- Not the final version of UML we will teach, but covers the main points

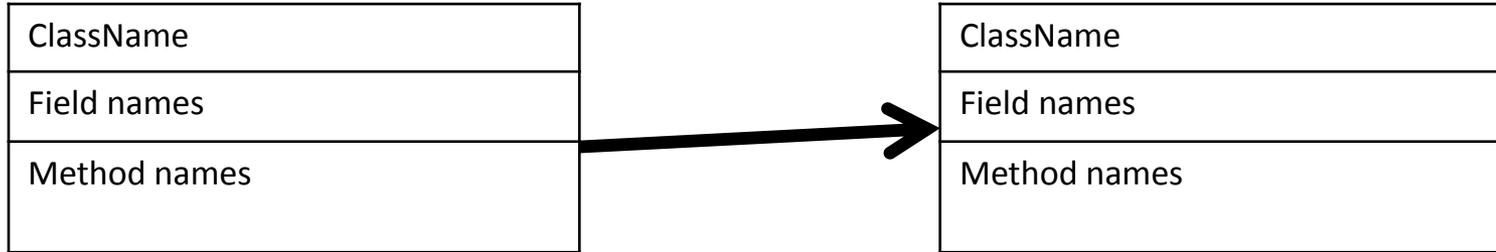
Example

Team
teamAverage name students
addGrade(grade) getTeamAverage()

Student
grades name
addGrade(grade)

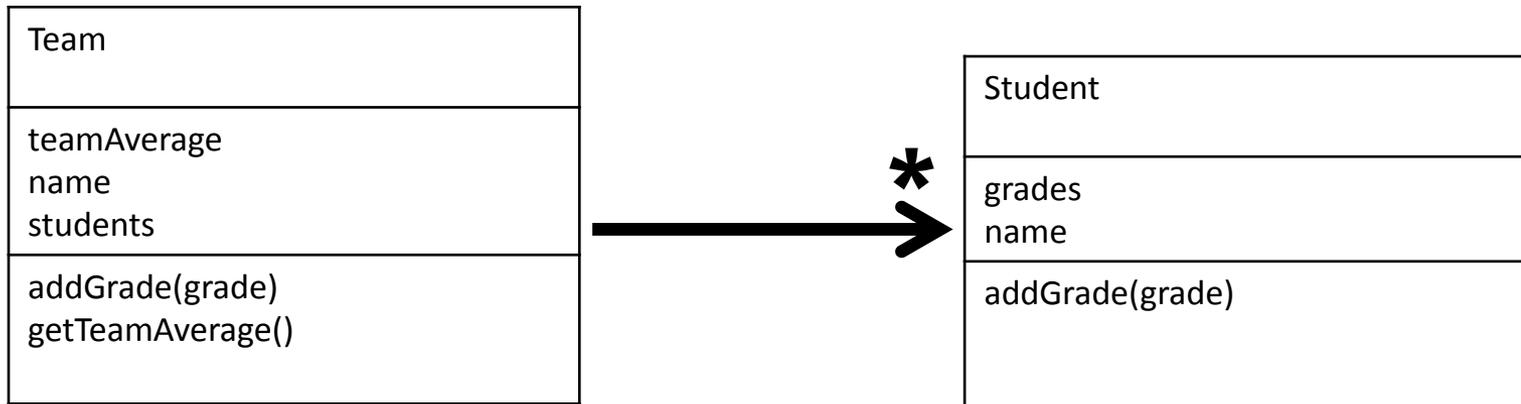
Lines

A has a B (field)



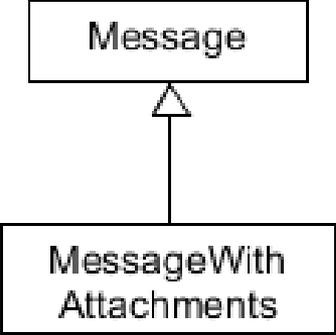
Example

Note the star means several... usually a list or collection.

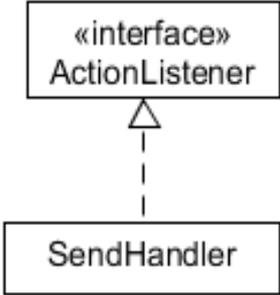


Summary of UML Class Diagram Arrows

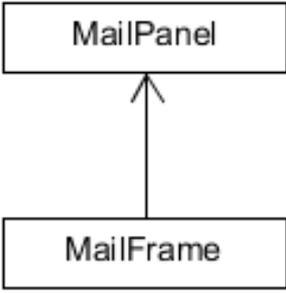
Inheritance
(is-a)



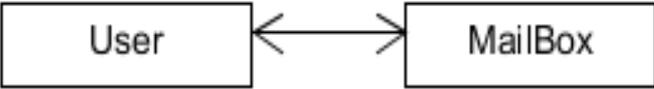
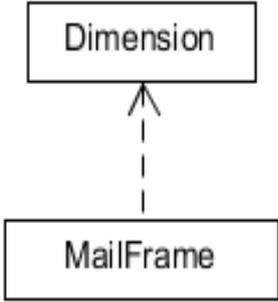
Interface Implementation
(is-a)



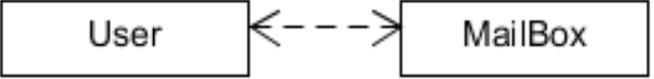
Association
(has-a-field)



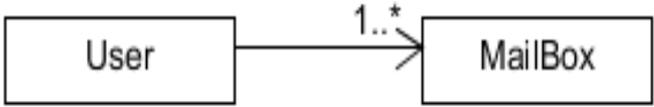
Dependency
(depends-on)



Two-way Association



Two-Way Dependency



Cardinality
(one-to-one, one-to-many)
One-to-many is shown on left

Principles of Design (for CSSE220)

1. Structure your program **around the data** that needs storing
 - Nouns become your classes, operations become their methods
2. Your structure needs to **function correctly**
 - Every class must have access (directly or indirectly) to the data it needs to complete its operations
 - Usually this means the problem must be modeled correctly
 - Data should also not be duplicated
3. Functionality should be **spread** throughout the system
 - No single part of the system should get too large
 - Each class should have a single responsibility it accomplishes
4. **Minimize dependencies** between objects when you can
 - Ask don't tell
 - Don't have message chains
5. **Don't duplicate** code
 - Similar "chunks" of code should be unified into functions
 - Classes with similar features should be given common interfaces
 - Classes with similar internals should be simplified using inheritance

Today's Focus

1. Structure your program around the data that needs storing

- Nouns become your classes, operations become their methods

2. Your structure needs to function correctly

- Every class must have access (directly or indirectly) to the data it needs to complete its operations
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For an object oriented design...

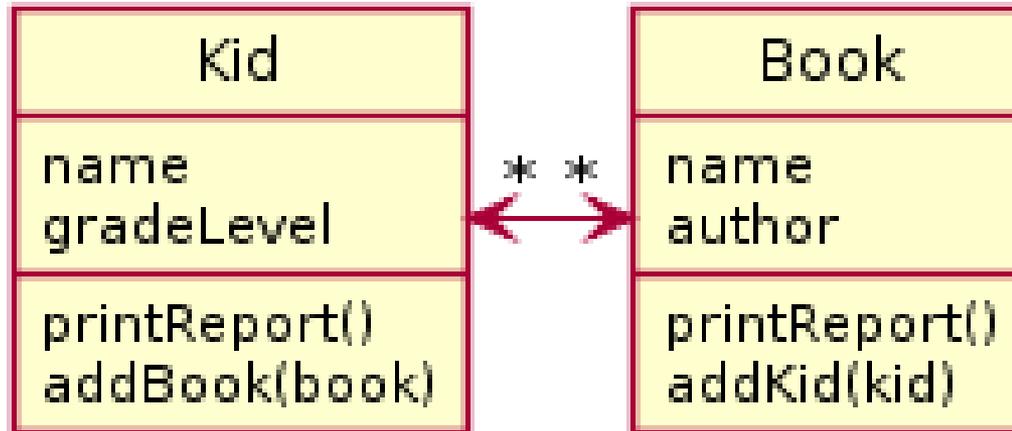
- Look for the nouns in your problem, consider making them classes
- Put the data you need to store as fields in your classes
- Add operations to the classes to accomplish what your need
- Avoid Plural Nouns

An Example Problem

A website tracks books and the kids that read them. For each book the system stores the name and author. For each kid the system stores name and grade level. The teacher enters when a kid reads a particular book. It should be possible to print a report on a book that includes all kids who have read a particular book. It should be possible to print a report on a kid that includes the books a particular kid has read.

Make a UML diagram of your proposed design for this system.

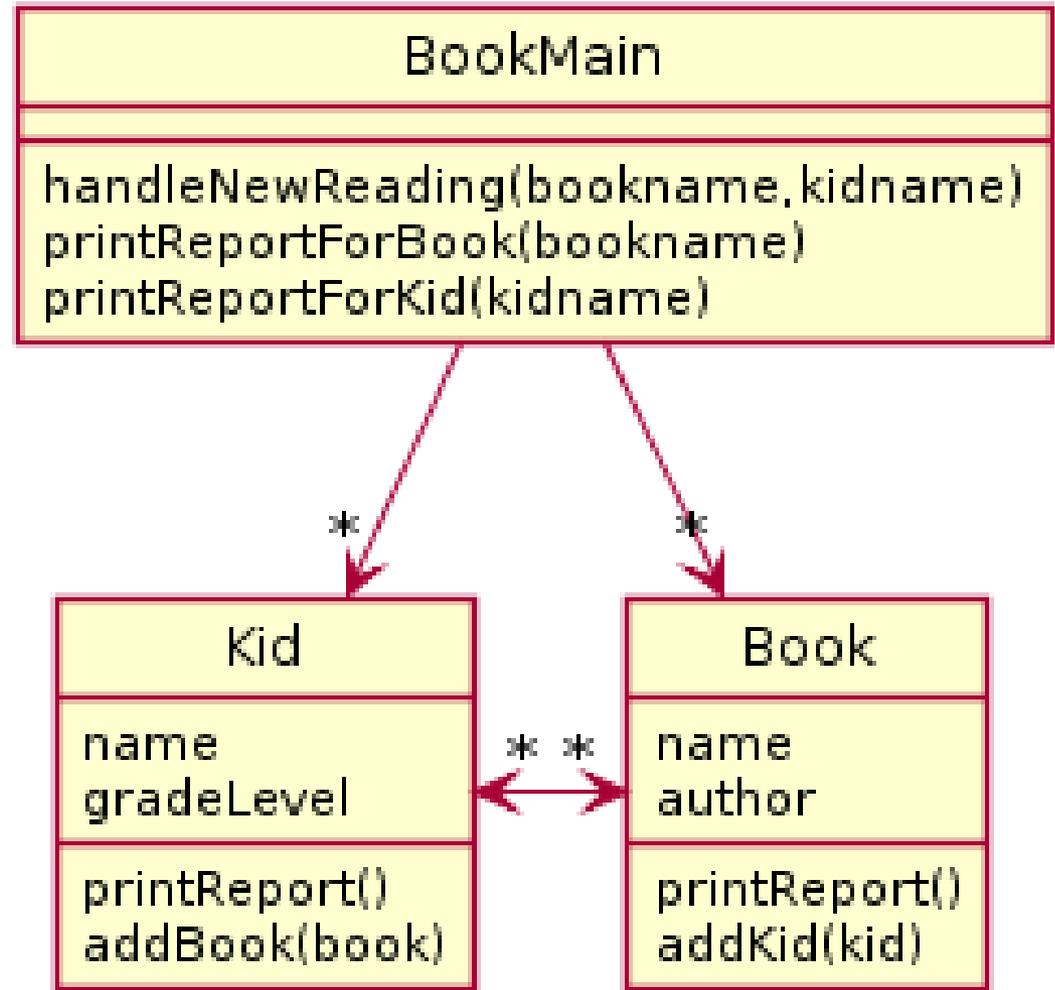
Basic solution



Note that `List<Book>` isn't listed by name as an instance variable of `Kid`, but the line from `Kid` to `Book` with the `*` implies that. Ditto for `List<Kid>` in `book`, since the arrow is double-ended with `*` on each end

Main class

- In really small programs, you could just have them as local variables in a static main
- But for larger programs, it's more usual for the class with main to be a real class with fields (also aids testing)
- In our very simple designs, this class also deals with user input
- Also be sure your design shows where things start and how use commands are handled



Today's Focus

1. Structure your program around the data that needs storing

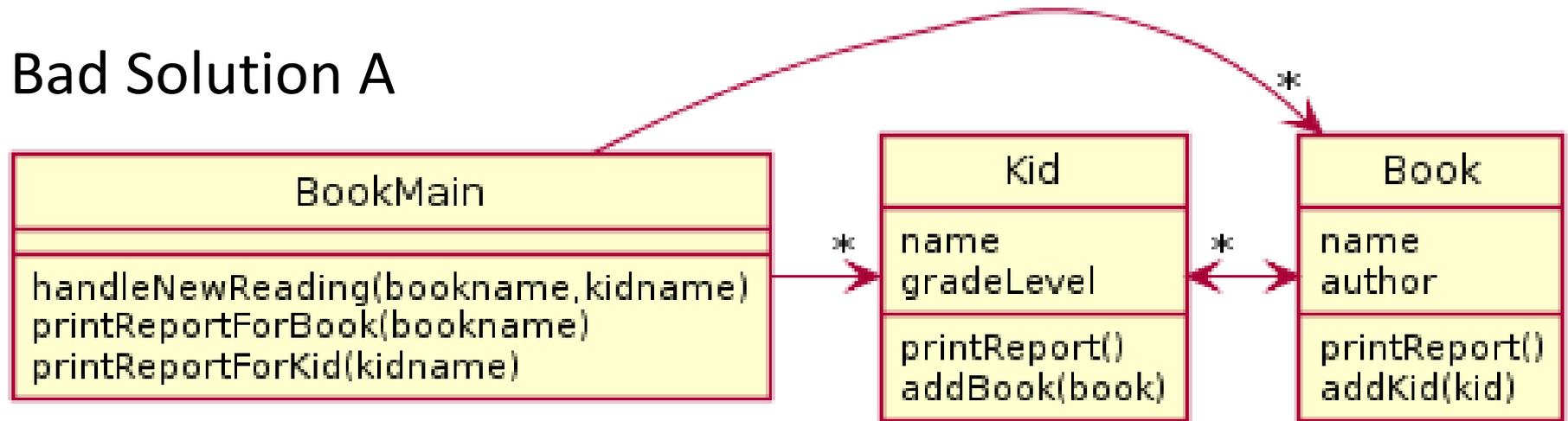
- Nouns become your classes, operations become their methods

2. Your structure needs to function correctly

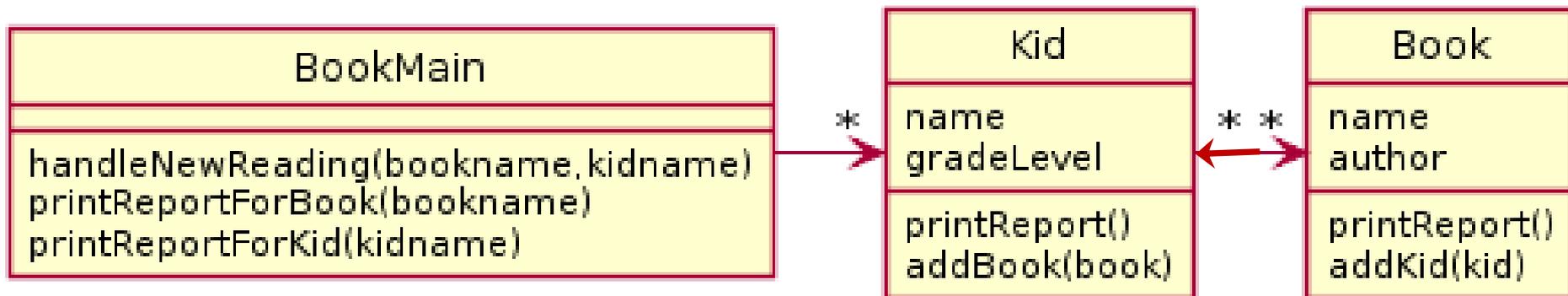
- Every class must have access (directly or indirectly) to the data it needs to complete its operations
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Consider

Bad Solution A



Bad Solution B

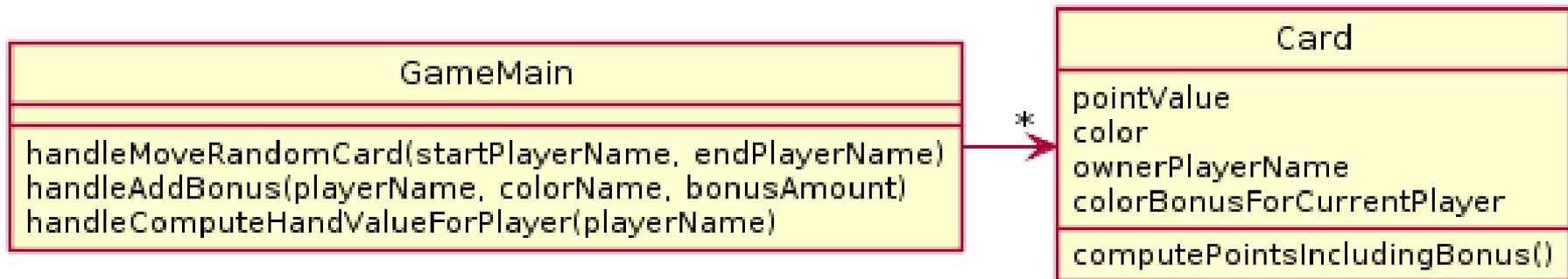


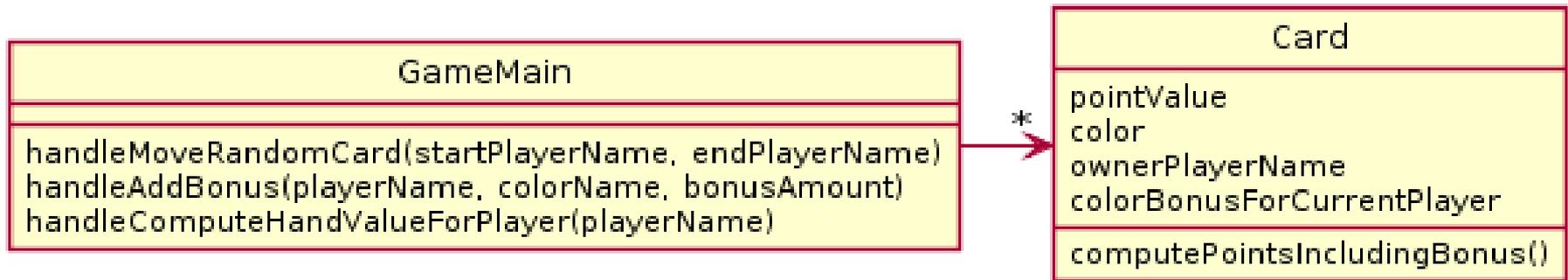
In most cases non-workable design is caused by...

- Not reading the problem carefully or not mapping it to design carefully (e.g. not noticing that each kid reads several books, not just one)
- Not thinking about how specific required features might be implemented (e.g. how can we print a book report if we don't have access to the book objects?)
- Duplicating data (e.g. what does it matter if we store a copy of the author and title for every kid that reads the book)

In a particular card game, players have hands of cards. Each card is worth some points and also has a color (red, blue, green). During play, players accrue bonuses that mean cards of a particular color are worth bonus points. During play, sometimes a random card is selected from one player's hand and moved to another player's hand. At the end of game, it is necessary to compute the total points for each player's hand.

What is wrong with this design? (Hint: look at and refer to your design principles by number). I see at least 2 separate categories violated.





My answer (in order of importance)

2a. The design does not function correctly

The player's color bonus cannot be preserved if he/she loses all their cards of a particular color

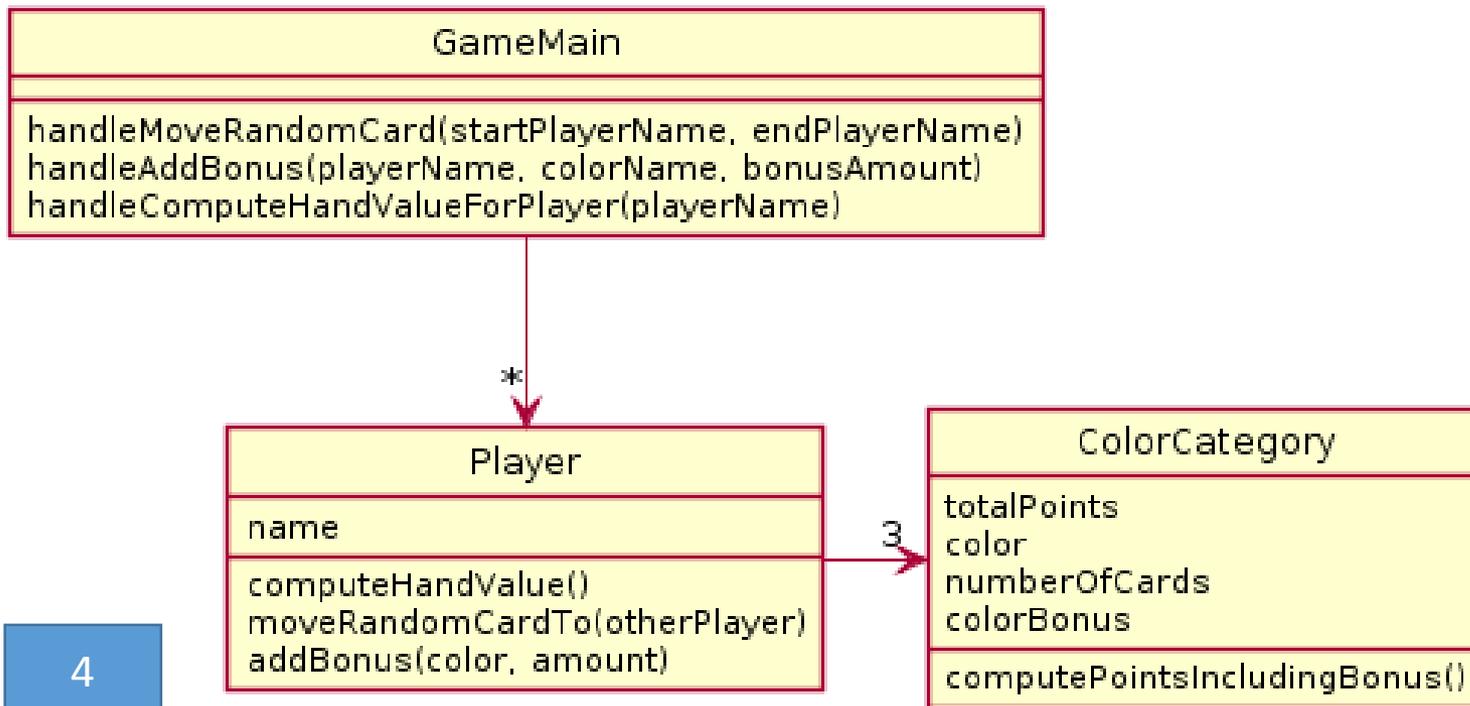
It requires iterating over all objects to get the full set of cards in the players hands to move cards or compute final total

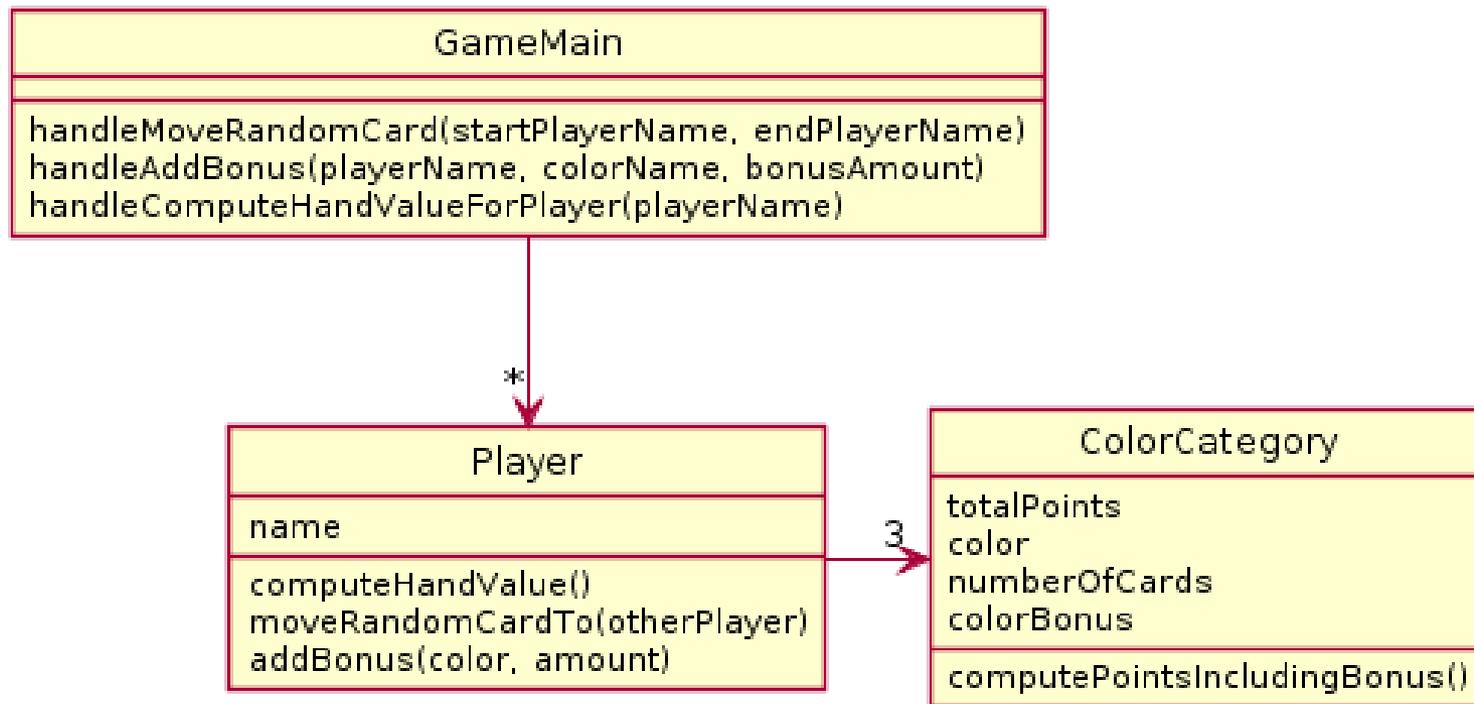
2c. Playername & player color bonus are duplicated across cards

1a. Player (common noun from problem) not represented

In a particular card game, players have hands of cards. Each card is worth some points and also has a color (red, blue, green). During play, players accrue bonuses that mean cards of a particular color are worth bonus points. During play, sometimes a random card is selected from one player's hand and moved to another player's hand. At the end of game, it is necessary to compute the total points for each player's hand.

What is wrong with this design? (Hint: look at and refer to your design guidelines). I see at least 2 separate categories violated.





My answer (in order of importance)

2a. The design does not function correctly

Once a card is added to a players hand, its specific point value is lost so the card cannot be randomly moved to another players hand

1a. Card (common noun from problem) not represented

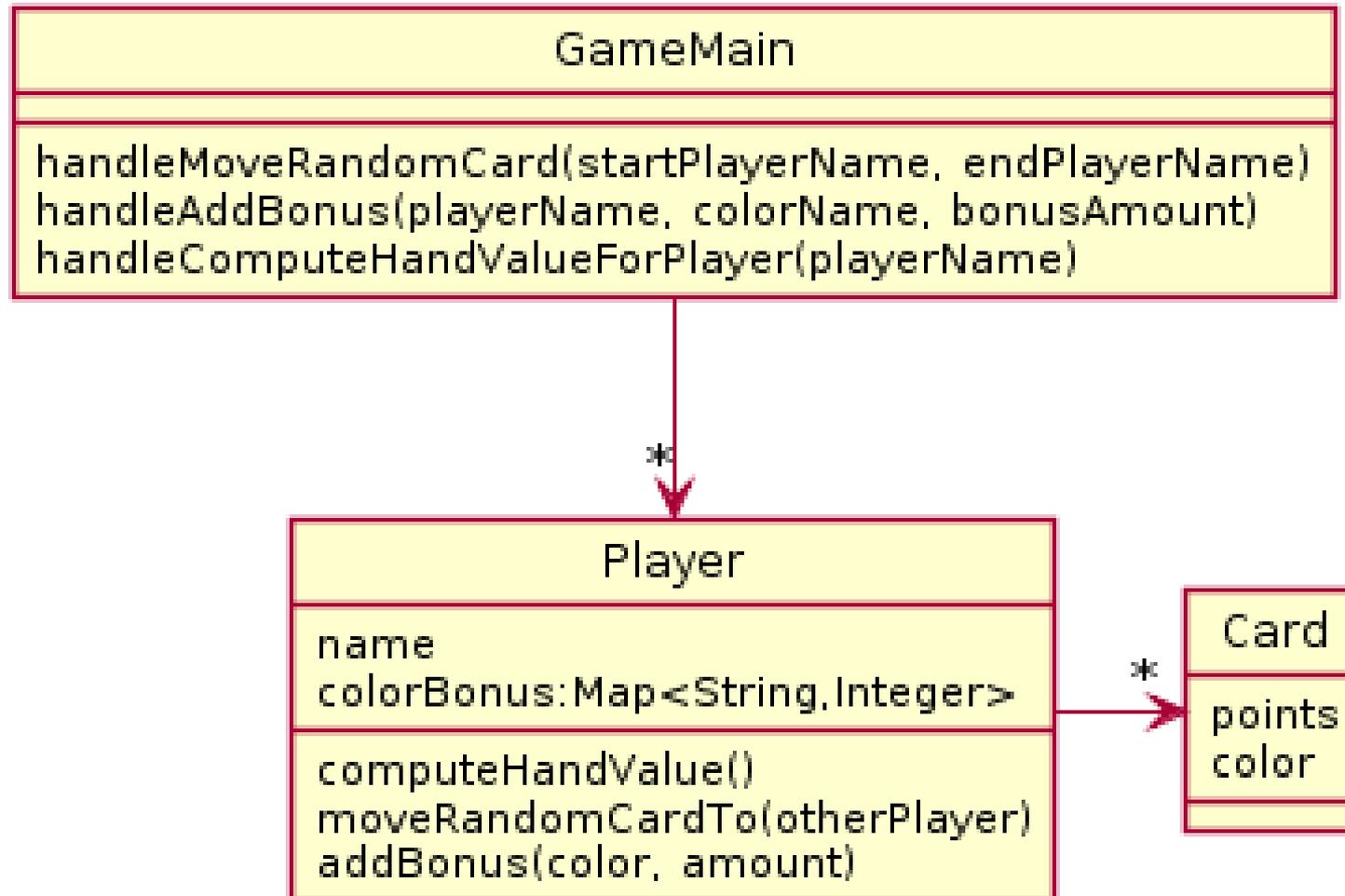
In a particular card game, players have hands of cards. Each card is worth some points and also has a color (red, blue, green). During play, players accrue bonuses that mean cards of a particular color are worth bonus points. During play, sometimes a random card is selected from one player's hand and moved to another player's hand. At the end of game, it is necessary to compute the total points for each player's hand.

Now design your solution that solves all problems.

GameMain

```
handleMoveRandomCard(startPlayerName, endPlayerName)  
handleAddBonus(playerName, colorName, bonusAmount)  
handleComputeHandValueForPlayer(playerName)
```

My Solution



A problem (if we have time)

A factory sells a small number of unique products. Each product has an id code, a description, price and quantity (the amount currently available at the factory). When a customer places an order, they buy a specific number of each product. The order needs to be stored in the system for future reference, with the customer's name and address.

At some point, the order should ship to the customer, and that date should also be recorded.

The main operation of the system is to add a new order and mark an order as shipped.

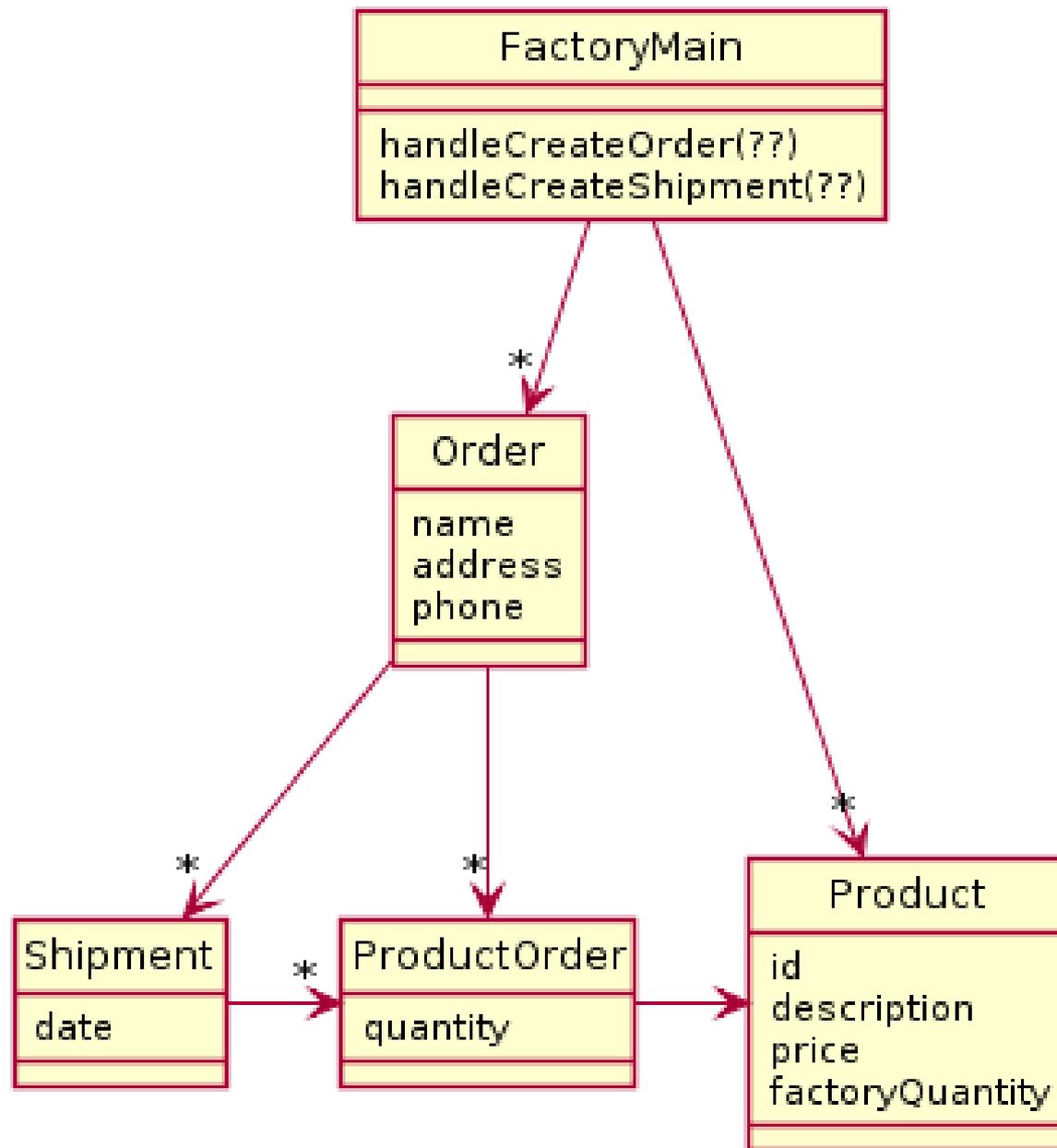
In a group of 2-3, make with an object design for this system and document it in UML (on paper).

A problem –revised

Now orders can be partially shipped – i.e. a single order might take several shipments to complete.

The main operation of the system is to add a new order and enter shipments for orders.

In a group of 2-3, revise your design to accommodate this new issue.



For Next Class

- Solve the 2 Design Problems in the handout
- Bring your solution to be collected **IN CLASS** Tuesday