AP Computer Science with Data Structures

Lab: Java Adventure Game

This lab was inspired by and adapted from both M. Kolling's Zork lab and MIT's 6.001 Adventure Game. In the first part of the lab, you'll implement simple changes to the adventure game. In the second part, you'll allow your programming and creative talents to run wild, expanding the game world in whatever way you choose. So start thinking about what sort of changes you'd like to make, and leave some time to implement them!

For this lab, you are expected to fully comment your code. Each new method must be commented before you implement it. You may find that your project is randomly checked to see that you are doing this. Then, in part 10, you must complete your design and have it checked off before you begin to code.

1. Putting Harker on the Map

Make a new directory for your work on this lab, and download the following files to it: Command.java, CommandWords.java, Game.java, Parser.java, Person.java, Room.java. Then compile and run the `Game` class. Try walking around the world. Draw a map showing all the "rooms" and how they're connected.

2. You Can Change the World

Here are some important questions about the game that you should answer for yourself, before going on.

A. Open up Room.java. What attributes does a `Room` have?

B. What happens when a `Room`'s `add` method is called?

C. Now open up Person.java. What attributes does a `Person` have?

D. Why does a `Person` need to know what `Room` they're in, when a `Room` already knows what people are in it? What potential danger is there in storing redundant information like this?

E. What happens when a `Person`'s `changeRoom` method is called? What would happen if the `changeRoom` method did not call any of `Room`'s methods?

Open up Game.java, and replace "YourNameHere" with your name.

Create a new room, and connect it to other rooms in the game in a consistent manner. (In other words, if you get there by going north from some room, you should leave it by going south back to the other room.) Be sure to add your room to the `rooms` list.

Create a new person, and have them start in your new room. Be sure to add your person to the `otherPeople` list. Test your changes before going on!

3. Who's There?

Wouldn't it be nice if, when a person entered a room, they greeted to all others in the room? First, we'll need to be able to ask a `Room` what people are in it, which is a more subtle problem than it sounds.

Suppose an instance of the class `Sender` sends a message to an instance of `Receiver`. It is often helpful to distinguish between the code inside `Receiver` that implements the method, and the code in `Sender` that calls it. We say that `Sender` is a *client* of `Receiver`, because it makes use of the functionality provided by `Receiver`. Whenever we implement a class (such as `Receiver`), we want to make sure that the data used by that class is *hidden* (in private instance variables), so that *client code* (like that found in `Sender`) cannot gain access to the internal workings of our class. The fancy word for this idea is *encapsulation*, and it is one of the most important concepts we'll study in AP Computer Science.

We want to be able to ask a `Room` what people are in it, so you'll need to go ahead and add a `getPeople` method to `Room`, which should return an `ArrayList` of the people in the `Room`. However, we don't want `Room` to grant the client access to *the* `ArrayList` it uses internally to store those people. (Otherwise, the client code could change what people are inside the room without calling the appropriate `add` and `remove` methods.) Therefore, your `getPeople` method should make a new `ArrayList`, copy all the people from the `Room`'s `ArrayList` into the new one, and return this new list.

4. Hi Everybody!

The `move` method is called to move a *robot* or *monster* (not the *hero*) into a new room. By changing the `move` method, we can make sure that robots and monsters say hi to any people *that were already in the room*. In this exercise, you will modify the move method so that robots greet all people in a room in a single line of output, as shown in the following example:

```
At Shah Hall Bamboozler says -- Hi MrPage MrNikoloff
```

(Combining strings is easy in Java. If `x` points to the `String` "AP", and `y` points to the `String` "PLE", then the expression `y + x` returns the new `String` "PLEAP".)

One of the holy grails of software development is code reuse. If we had just called `println`, we would have to write code to print "At Shah Hall Bamboozler says --". But the `say` method *already does this for us*, and we would prefer to reuse this functionality by simply calling `say`.

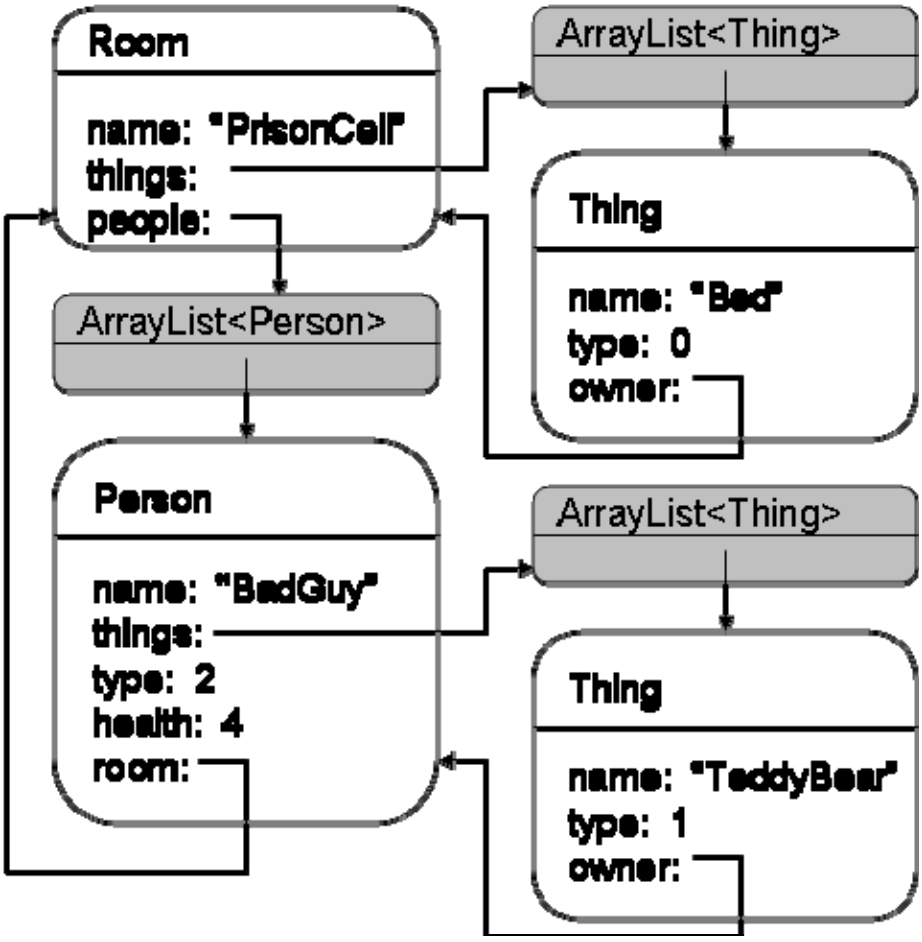
Make sure your people only say hi *when someone else is in the room*, and that they *don't say hi to themselves*. Make sure that your people only say hi when they actually move to a different room. Go test your code!

5. The Thing Is ...

It'd be nice if there were items in the rooms of our game. To this end, make a new `Thing` class, which might be used as follows.

```
Thing bed = new Thing("Bed", Thing.HEAVY);
bed.changeOwner(someRoom);
Thing bear = new Thing("TeddyBear", Thing.MOBILE);
bear.changeOwner(somePerson);
```

This code creates two instances of the `Thing` class. The following instance diagram shows a heavy `Thing` owned by a `Room` (because the "Bed" is located in the "PrisonCell") and a mobile `Thing` owned by a `Person` (because the "TeddyBear" is owned by the "BadGuy"). Knowing this, what type should you declare `Thing`'s `owner` instance variable to be?



There will be at least two types of things in our game: heavy things and mobile things. (Later, you may decide to add other kinds of things, such as food, etc.) We will note this by setting the `type` field to `0` for heavy things and `1` for mobile things. But *no one* wants to see `0`s and `1`s all over our code (except for your computer), or they wouldn't be able to read it! Therefore, we'll define some constants near the beginning of our class definition, as follows.

```
public static final int HEAVY  = 0;
public static final int MOBILE = 1;
```

(`public`, because other classes will need access to these variables. `static`, because these variables are attributes of the class—not of any particular instance. And `final`, because these variables are constant, and hence will never vary.)

Now we can (and should!) write `type = HEAVY`, rather than `type = 0`.

Our `Thing` class will need a constructor, which should take in a name and a type. The `owner` field should be initialized to `null`, indicating that no one owns this `Thing` yet.

Our class will also need the following methods.

- `getName`, which should return the name of the `Thing`.
- `isHeavy`, which will return *`true`* if this is a heavy `Thing`.
- `getOwner`, which will return the object that owns this `Thing`.
- `changeOwner`, which will change the owner to be the given new owner.

Go ahead and implement the `Thing` class.

6. Putting Your Things Away

When you have finished writing your `Thing` class, modify `Room` so as to keep track of an `ArrayList<Thing>` of things in that room. This list should initially be empty. Add a method called `add`, which takes in a `Thing` and adds it to the room. Note that this method has the same name as the one which adds a `Person` to the room. This is ok. Java has no trouble figuring out which method is being called, thanks to explicit types.

Likewise, add a corresponding `remove` method, for removing a `Thing` from the room.

Now let's go back to your `Thing` class and modify `changeOwner` so that the `Thing` is automatically removed from its old room and added to the new one. We can do this by modifying `changeOwner` to appear as follows. *Make sure you understand this code*, and then copy it into your `Thing` class.

```
public void changeOwner(Object newOwner)
{
   if (owner != null)
      //remove the thing from the old room
      ((Room)owner).remove(this);

   //change owner
   owner = newOwner;

   if (newOwner != null)
      //add the thing to the new room
      ((Room)newOwner).add(this);
}
```

(Notice again that we're storing redundant information in our objects. A `Thing` knows where it is, and its location knows what `Thing`s are there. We have chosen to make a `Thing` responsible for keeping this redundant data in sync, but it is not clear that this is the best solution. What else could we have done?)

In the `Game` class's `setup` method, add some `Thing`s (including at least one heavy and one mobile `Thing`) to the rooms of your game.

Finally, add a method `thingString` to `Room`, which should return a `String` listing all things in the room. (Should this method be `public` or `private`? A good rule of thumb is to declare each method as `private`, unless there is a good reason to grant other classes access to your method.) Be sure to return something helpful if there aren't any things in the room. Then modify `Room`'s `longDescription` method to use `thingString`. When you've made these changes, your game should behave something like this.

```
You are in The Edge.
Exits: east south west
No one is here.
There's nothing here.
> go south
You are in Dobbins Hall.
Exits: north south
People here: JavaMan
Things here: InflatableMethod
```

Be sure to test your changes!

7. Finders, Keepers

A person should be able to carry a bunch of things. Modify `Person` to keep track of what `Thing`s he/she is carrying. Implement the `add` method, which should take in a `Thing` and add it to the bunch of things your `Person` is carrying. You'll also need to implement the `remove` method, which should take in a `Thing` and remove it from the `Person`'s carried things. We'll see shortly how these methods will get called.

Upon encountering a room with a hat, type "take hat", and you'll get the following response.

```
I don't know what you mean...
```

This is because your game doesn't yet know about the "take" command you'll be adding now. At the top of the file CommandWords.java, add "take" to the mysterious array of valid commands.

Again, try taking something in the game, and this time you'll find that the error message has gone away, but nothing has taken its place. This is because you have not yet written code to handle your new command. Modify `Game`'s `processCommand` method to pass the `Command` to a new method in `Game` called `take`, whenever `commandWord.equals("take")`.

Now we'll add the `take` method to `Game`, which should take in a `Command` and have no return value. Temporarily, we'll just stick a `println` here to print out "in take method" (or similar), so that we can test now to see that it gets called when we type "take" in our game.

Having established that the `take` method is indeed being called, let's begin implementing it. First, we need a suitable error message when someone types "take", but doesn't indicate what to take. ("Take what?") Look at other methods in `Game`, and in the `Command` class to see how to test for this condition.

Our next problem is that, if the user typed "take hat" (for example), then all we'll have is the string "hat", and what we really need is the instance of `Thing` with that name. We can solve this by adding a method to `Room` called `getThing`, which will take in the name of a `Thing` and return the `Thing` itself (or `null` if it's not found). Go ahead and write `Room`'s `getThing` method. Note that you need to use the `equals` method to compare two `String`s (for example, `string1.equals(string2)`).

Now, let's go back to `Game`'s take method, and add code to find the `Thing` with the name the user typed. If there's no thing with that name in the room, print a suitable error message. ("It's not here!") Otherwise, let's pass the `Thing` to a new `take` method that we'll add to our `Person` class.

Open the `Person` class, and add a method called `take`, which takes in a `Thing` and does not return a value. If the `Thing` is heavy, the person should merely say "I try but cannot take BigJavaBook" (if BigJavaBook is a heavy thing in your game). Otherwise, the person should say where they're taking the object from, such as "I take Fork from The Edge". Be sure to modify the `Thing`'s owner to be the person taking it.

Go test your game now, including typing just "take", "take <some object that isn't here>", "take <some heavy object>", and "take <some mobile object>". Taking a mobile object will result in a `ClassCastException`, since your `Thing`'s `changeOwner` method assumes that an owner will only ever be a `Room`, and not a `Person`. We can fix this by testing if the owner is a `Room` (with the code `owner instanceof Room`) or a `Person` before casting to that type. You'll then need to modify `changeOwner` as follows. Make sure you understand what this code does. (You should find these changes to be somewhat unsettling. We'll learn a better approach to solve this problem later in the course.)

```
public void changeOwner(Object newOwner)
{
   if (owner != null)
   {
      //remove the thing from the old owner
      if (owner instanceof Room)
         ((Room)owner).remove(this);
      else
         ((Person)owner).remove(this);
   }

   //change owner
   owner = newOwner;

   if (newOwner != null)
   {
      //add the thing to the new owner
      if (owner instanceof Room)
         ((Room)newOwner).add(this);
      else
         ((Person)newOwner).add(this);
   }
}
```

When you've completed these changes, make sure that you can now take a mobile object from a room, and that when you return to that room, the object no longer appears there.

8. Kleptomania

It seems rather unfair that the hero can take things and robot people can't. In this exercise, we'll modify the robot people so that they'll be able to take things, too. First, we'll need to be able to ask a `Room` for a random thing.

Find the code that makes robots and monsters exit to a random room. There, you'll see the method `Game.random(int)` being called. Notice that we're calling this method *directly* on the `Game` class, and *not on a particular instance* of `Game`. (This should remind you of our use of `Thing.HEAVY` or `Person.MONSTER`, where we are somehow accessing an attribute of the class itself, rather than calling a method on a particular `Thing` or `Person`.) `Game`'s `random` method, like `HEAVY`, `MONSTER`, and `Game`'s `main` method, has been declared `static`, making it a feature of the class itself.

Use `Game`'s `random` method to implement a method `getRandomThing` in `Room`, which should return a random `Thing` from the `Room`, or `null` if the `Room` is empty.

Then modify `Person`'s `act` method, so that, after moving, robots (and only robots) will call a new method `takeSomething`, which will cause them to pick up a random item from their room. Be sure to make use of `Person`'s `take` method, rather than redoing all your hard work.

9. Stop! Thief!

In this exercise, we'll modify the game so that other people can steal things from you, and you can steal them back. Here's what you'll need to do.

Add a method `getThings` to `Person`, which should return a list of all the things that `Person` is carrying (a new list—not the `Person`'s secret list of things).

Add a helper method `getAllThings` to `Room`, which should return all the things in the `Room`, including the ones sitting around and the ones held by people in the `Room`.

Modify `Room`'s `getThing` and `getRandomThing` methods, so that they use your `getAllThings` method to look through all the things in the `Room`.

You can now start testing your changes by playing your game. Here are some additional changes you'll need to make.

When one person takes something from another person, they should announce whom they're taking from, rather than where they're taking from. Furthermore, the victim should announce what they are losing, and should throw a fit, as this example shows.

```
At the gym JavaMan says -- I take A+ from MrPage
At the gym MrPage says -- I lose A+
At the gym MrPage says -- Yaaaah!  I am upset!
```

Go ahead and test this change.

Unless you anticipated this problem, you'll probably notice that people are taking things from themselves! An easy (but questionable) way to fix this is to remove a person from the room before calling `getRandomThing`, and then adding the person right back. I'm certain you can come up with a better way. You do know what things you own and you should be able to check if you already have the thing returned by `getRandomThing.` Also make sure you print a suitable error message ("You're already carrying that!") when the Hero tries to take something they're already carrying.

Finally, when a person dies, all their stuff disappears with them. Modify your game so that when a person dies, their stuff remains in the room they died in. Be sure to test your changes.

10. Choose Your Own Adventure (To earn over 85%)

Now you've created a world full of things and thieves, but you can hardly call it a game yet. The time has come to let your creative juices run wild, and to design and implement your own adventure game. First, you should decide what the goal of your game is. It should be something along the lines of: You have to find some items and take them to a certain room (or a certain person?). Then you can get another item. If you take that to another room, you win.

For example: You have to get accepted at Stanford. But first you'll need to get an A in your Comp Sci class, which means picking up the textbook and then tracking down MrPage and answering a programming question. If you answer correctly, he gives you a RecommendationLetter, which you must mail with your CollegeApplication (if you can find it), and then stay alive long enough to pick up your acceptance letter. If you're not accepted within a certain time frame, you'll be condemned to spend four years at Harker Community College, a place even darker than the cave.

Or: You are lost in a dungeon. You meet a dwarf. If you find something to eat that you can give to the dwarf, then the dwarf tells you where to find a magic wand. If you use the magic wand in the big cave, the exit opens, you get out and win.

It can be anything, really. Think about the scenery you want to use (a dungeon, a city, a building, etc) and decide what your locations (rooms) are. Make it interesting, but don't make it too complicated.

Put objects in the scenery, maybe people, monsters, etc. Decide what task the player has to master.

Consider adding a way for the player to "win" your game.

Add at least two new commands. (You might need to extend the parser to recognize three-word commands. You could, for example, have a command "give bread dwarf" to give the bread you're carrying to the dwarf.)

Some other things you might try:

- Add a magic transporter room every time you enter it you are transported to a random room in your game.
- Add weapons to your game, so you can fight back against Grendel.
- Add healers to your game, who can increase a person's health who has been injured by Grendel.

For this section of the lab, you must produce a document that describes your game using complete sentences and paragraphs. Your document must contain a UML diagram showing all of the classes and their interactions except for the Game class,

CommandWords class, Command class and Parser (See part 5). The document will be submitted to Athena.

Then you must create the classes and add JavaDoc style comments before you start to code. You must get your design checked off before proceeding.

Your grade for this part depends on how well you use what you have already learned as well as how challenging your game is to create. Trivial extension to the existing game will not earn as many points as a complete game with non-trivial objectives and a clear way to win the game. You should try to reuse as much of your existing code as possible. You must be able to design and implement your game in 1 week or less.