

## CIT 590: Spring 2019

### Homework 8

HW deadline as per Canvas.

This homework is more detailed than previous assignments, so start as early as you can on it. It deals with the following topics:

- Abstract classes
- Inheritance
- 2-dimensional arrays

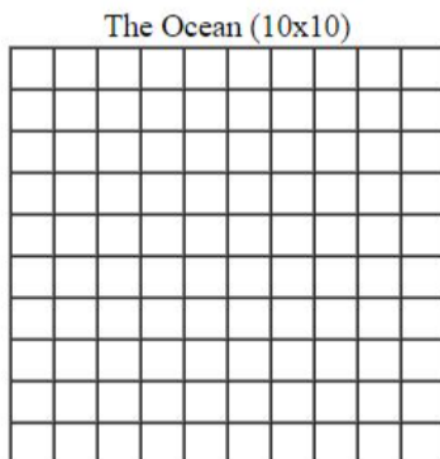
### Introduction

We are going to show you how to build a *simple* (only because there is no *graphical user interface* - GUI) version of the classic game [Battleship](#).

Battleship is usually a **two-player game**, where each player has a fleet of ships and an ocean (hidden from the other player), and tries to be the first to sink the other player's fleet.

We will be doing just a **one-player vs. computer version**, where the computer places the ships, and the human attempts to sink them.

We'll play this game on a 10x10 "ocean" and will be using the following ships ("the fleet"):



The Fleet

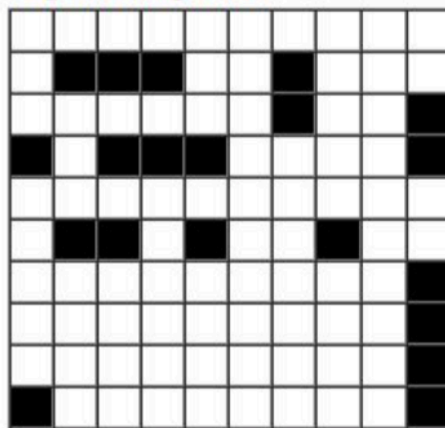
One battleship	■ ■ ■ ■ ■
Two cruisers	■ ■ ■ ■ ■ ■ ■ ■
Three destroyers	■ ■ ■ ■ ■ ■ ■ ■ ■
Four submarines	■ ■ ■ ■

## How to Play Battleship

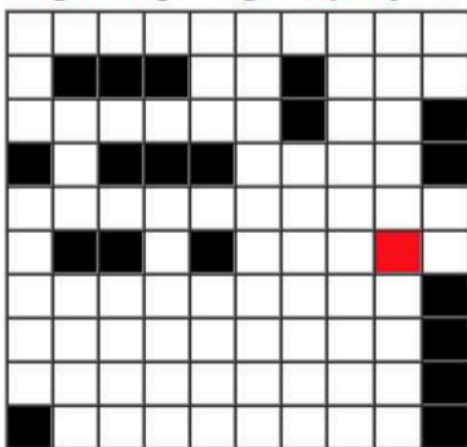
Please take a look at these rules *even if* you have played Battleship before in your life. Remember this is a **Human vs. Computer** version.

The computer places the **ten ships** on the ocean in such a way that no ships are immediately adjacent to each other, either horizontally, vertically, or diagonally. Take a look at the following diagrams for examples of legal and illegal placements:

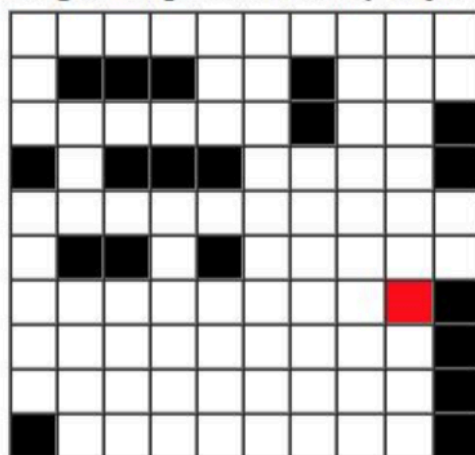
**Legal arrangement**



**Illegal--ships diagonally adjacent**



**Illegal--ships horizontally adjacent**



The human player does not know where the ships are. The initial display of the ocean to be printed to the console therefore shows a 10 by 10 array of '.' (see the description of the `Ocean` class' `print()` method below for more information on what subsequent

ocean displays will look like).

The human player tries to hit the ships, by indicating a specific row and column number (r,c). The computer responds with one bit of information saying, “hit” or “miss”.

When a ship is hit but not sunk, the program does not provide any information about what kind of a ship was hit. However, when a ship is hit and sinks, the program prints out a message “You just sank a ship - *(type)*.” After each shot, the computer re-displays the ocean with the new information.

A ship is “sunk” when every square of the ship has been hit. Thus, it takes four hits (in four different places) to sink a battleship, three to sink a cruiser, two for a destroyer, and one for a submarine.

The object is to sink the fleet with as few shots as possible; the best possible score would be 20 (lower scores are better.) When all ships have been sunk, the program prints out a message that the game is over, and tells how many shots were required.

## Details of Implementation

Name your **project** Battleship, and your **package** battleship.

Your program should have the following 8 classes:

- `class BattleshipGame`
  - This is the “main” class, containing the main method, which starts by creating an instance of `Ocean`
- `class Ocean`
  - This contains a 10x10 array of `Ships`, representing an “ocean”, and some methods to manipulate it
- `abstract class Ship`
  - This abstract class describes the characteristics common to *all* ships
  - It has **subclasses**:
    - `class Battleship extends Ship`
      - Describes a ship of length 4
    - `class Cruiser extends Ship`
      - Describes a ship of length 3
    - `class Destroyer extends Ship`

- Describes a ship of length 2
- `class Submarine extends Ship`
  - Describes a ship of length 1
- `class EmptySea extends Ship`
  - Describes a part of the ocean that doesn't have a ship in it. (It seems silly to have the lack of a ship be a type of ship, but this is a trick that simplifies a lot of things. This way, every location in the ocean contains a "ship" of some kind.)

### abstract class Ship

The abstract `Ship` class has the **instance variables** below.

Note: Fields should be declared private unless there is a good reason for not doing so. This is known as "encapsulation", which is the process of making the fields in a class private and providing access to the fields via public methods. If a field is declared private, it cannot be accessed by anyone outside the class, thereby hiding the fields within the class. "Encapsulation" is also referred to as data hiding.

Private variables also help prevent people from depending on certain parts of your code. You want users of your classes to not care how you implemented it, but rather just use the implementation through well-defined methods. The reason is that if no one is depending on your implementation, you can change it whenever you want.

- `private int bowRow`
  - The row that contains the bow (front part of the ship)
- `private int bowColumn`
  - The column that contains the bow (front part of the ship)
- `private int length`
  - The length of the ship
- `private boolean horizontal`
  - A boolean that represents whether the ship is going to be placed horizontally or vertically
- `private boolean[] hit`

- An array of 4 booleans that indicate whether that part of the ship has been hit or not

The default **constructor** for the `Ship` class is:

- `public Ship(int length)`
  - This constructor **sets the length property of the particular ship** and **initializes the hit array**

The **methods** in the `Ship` class are the following:

#### **Getters**

- `public int getLength()`
  - Returns the ship length
- `public int getBowRow()`
  - Returns the row corresponding to the position of the bow
- `public int getBowColumn()`
  - Returns the bow column location
- `public boolean[] getHit()`
  - Returns the hit array
- `public boolean isHorizontal()`
  - Returns whether the ship is horizontal or not

#### **Setters**

- `public void setBowRow(int row)`
  - Sets the value of `bowRow`
- `public void setBowColumn(int column)`
  - Sets the value of `bowColumn`
- `public void setHorizontal(boolean horizontal)`
  - Sets the value of the instance variable `horizontal`

## Abstract Methods

- `public abstract String getShipType()`
  - Returns the type of ship as a `String`. Every specific type of `Ship` (e.g. `BattleShip`, `Cruiser`, etc.) has to override and implement this method and return the corresponding ship type.

## Other Methods

- `boolean okToPlaceShipAt(int row, int column, boolean horizontal, Ocean ocean)`
  - Based on the given row, column, and orientation, returns true if it is okay to put a ship of this length with its bow in this location; false otherwise. The ship must not overlap another ship, or touch another ship (vertically, horizontally, or diagonally), and it must not "stick out" beyond the array. Does not actually change either the ship or the `Ocean` – it just says if it is legal to do so.
- `void placeShipAt(int row, int column, boolean horizontal, Ocean ocean)`
  - "Puts" the ship in the ocean. This involves giving values to the `bowRow`, `bowColumn`, and `horizontal` instance variables in the ship, and it also involves putting a reference to the ship in each of 1 or more locations (up to 4) in the ships array in the `Ocean` object. (Note: This will be as many as four identical references; you can't refer to a "part" of a ship, only to the whole ship.)
  - For placement consistency (although it doesn't really affect how you play the game), let's agree that **horizontal ships face East** (bow at right end) and **vertical ships face South** (bow at bottom end).
    - This means, if you place a horizontal battleship at location (9, 8) in the ocean, the bow is at location (9, 8) and the rest of the ship occupies locations: (9, 7), (9, 6), (9, 5).
    - If you place a vertical cruiser at location (4, 0) in the ocean, the bow is at location (4, 0) and the rest of the ship occupies locations: (3, 0), (2, 0).
- `boolean shootAt(int row, int column)`

- If a part of the ship occupies the given row and column, and the ship hasn't been sunk, mark that part of the ship as "hit" (in the hit array, index 0 indicates the bow) and return true; otherwise return false
- `boolean isSunk()`
  - Return true if every part of the ship has been hit, false otherwise
- `@Override`

```
public String toString()
```

  - Returns a single-character String to use in the Ocean's print method. This method should return "s" if the ship has been sunk and "x" if it has not been sunk. This method can be used to print out locations in the ocean that have been shot at; it should not be used to print locations that have not been shot at. Since `toString` behaves exactly the same for all ship types, it is placed here in the `Ship` class.

### class ShipTest

Test every non-private method in the `Ship` class. (Unfortunately, you can't test methods that are private because they are inaccessible outside of the class.)

Also test the methods in each subclass of `Ship`. You can do this here or in separate test classes (e.g. `CruiserTest`, `SubmarineTest`, etc.), if you wish.

### class BattleshipGame

The `BattleshipGame` class is the "main" class -- that is, it contains a `main` method. In this class you will set up the game; accept "shots" from the user; display the results; print final scores; and ask the user if he/she wants to play again. All input/output is done here (although some of it is done by calling a `print()` method in the `Ocean` class.) All computation will be done in the `Ocean` class and the various `Ship` classes.

To aid the user, row numbers should be displayed along the left edge of the array, and column numbers should be displayed along the top. Numbers should be **0 to 9**, not 1 to 10. The top left corner square should be 0, 0. Use different characters to indicate locations that contain a hit, locations that contain a miss, and locations that have never

been fired upon.

For example, here's a display of the ocean when the program first launches, and no shots have been fired.

```
  0 1 2 3 4 5 6 7 8 9
0 . . . . . . . . .
1 . . . . . . . . .
2 . . . . . . . . .
3 . . . . . . . . .
4 . . . . . . . . .
5 . . . . . . . . .
6 . . . . . . . . .
7 . . . . . . . . .
8 . . . . . . . . .
9 . . . . . . . . .
Enter row,column:
```

Use various sensible methods. Don't cram everything into one or two methods, but try to divide up the work into sensible parts with reasonable names.

### Extending abstract class `Ship`

Use the abstract `Ship` class as a parent class for every single ship type. Create the following classes and keep each class in a separate file.

- `class Battleship extends Ship`
- `class Cruiser extends Ship`
- `class Destroyer extends Ship`
- `class Submarine extends Ship`

Each of these classes has a public constructor, the purpose of which is to **set the length variable to the correct value**. Note: these types of hard-coded int values are good candidates for *static final* variables.

Aside from the constructor you have to override this method:



- @Override

```
public String getShipType()
```

- Returns one of the strings “battleship”, “cruiser”, “destroyer”, or “submarine”, as appropriate. Again, these types of hard-coded string values are good candidates for *static final* variables.
- This method can be useful for identifying what type of ship you are dealing with, at any given point in time, and eliminates the need to use instanceof

### class EmptySea extends Ship

You may wonder why “EmptySea” is a type of Ship. The answer is that the Ocean contains a Ship array, every location of which is (or can be) a reference to some Ship. If a particular location is empty, the obvious thing to do is to put a null in that location. But this obvious approach has the problem that, every time we look at some location in the array, we’d have to check if it is null. By putting a non-null value in empty locations, denoting the absence of a ship, we can save all that null checking.

The constructor for the EmptySea class is:

- public EmptySea()
  - This constructor sets the length variable to 1

The methods in the EmptySea class are the following:

- @Override
 

```
boolean shootAt(int row, int column)
```

  - This method overrides shootAt(int row, int column) that is inherited from Ship, and always returns false to indicate that nothing was hit
- @Override

```
boolean isSunk()
```

- This method overrides `isSunk()` that is inherited from `Ship`, and always returns `false` to indicate that you didn't sink anything

- `@Override`

```
public String toString()
```

- Returns the single-character “-” String to use in the `Ocean`'s print method. (Note, this is the character to be displayed if a shot has been fired, but nothing has been hit.)

- `@Override`

```
public String getShipType()
```

- This method just returns the string “empty”

## class Ocean

### Instance variables

- `private Ship[][] ships = new Ship[10][10]`
  - Used to quickly determine which ship is in any given location
- `private int shotsFired`
  - The total number of shots fired by the user
- `private int hitCount`
  - The number of times a shot hit a ship. If the user shoots the same part of a ship more than once, every hit is counted, even though additional “hits” don't do the user any good.
- `private int shipsSunk`
  - The number of ships sunk (10 ships in all)

### Constructor

- `public Ocean()`
  - Creates an "empty" ocean (and fills the ships array with `EmptySea` objects). You *could* create a private helper method to do this.
  - Also initializes any game variables, such as how many shots have been fired.

## Methods

- `void placeAllShipsRandomly()`
  - Place all ten ships randomly on the (initially empty) ocean. **Place larger ships before smaller ones**, or you may end up with no legal place to put a large ship. You will want to use the `Random` class in the `java.util` package, so look that up in the *Java API*.
- `boolean isOccupied(int row, int column)`
  - Returns true if the given location contains a ship, false if it does not
- `boolean shootAt(int row, int column)`
  - Returns true if the given location contains a "real" ship, still afloat, (not an `EmptySea`), false if it does not. In addition, this method updates the number of shots that have been fired, and the number of hits.
  - Note: If a location contains a "real" ship, `shootAt` should return true every time the user shoots at that same location. Once a ship has been "sunk", additional shots at its location should return false.
- `int getShotsFired()`
  - Returns the number of shots fired (in the game)
- `int getHitCount()`
  - Returns the number of hits recorded (in the game). All hits are counted, not just the first time a given square is hit.
- `int getShipsSunk()`
  - Returns the number of ships sunk (in the game)
- `boolean isGameOver()`
  - Returns true if all ships have been sunk, otherwise false
- `Ship[][] getShipArray()`
  - Returns the 10x10 array of Ships. The methods in the `Ship` class that take an `Ocean` parameter **need** to be able to look at the contents of this array; the `placeShipAt()` method even needs to modify it. While it is undesirable to allow methods in one class to directly access

instance variables in another class, sometimes there is just no good alternative.

- `void print()`
  - Prints the `Ocean`. To aid the user, row numbers should be displayed along the left edge of the array, and column numbers should be displayed along the top. Numbers should be 0 to 9, not 1 to 10.
  - The top left corner square should be 0, 0.
  - 'x': Use 'x' to indicate a location that you have fired upon and hit a (real) ship. (reference the description of `toString` in the `Ship` class)
  - '-': Use '-' to indicate a location that you have fired upon and found nothing there. (reference the description of `toString` in the `EmptySea` class)
  - 's': Use 's' to indicate a location containing a sunken ship. (reference the description of `toString` in the `Ship` class)
  - '.': and use '.' (a period) to indicate a location that you have never fired upon
  - This is the only method in the `Ocean` class that does any input/output, and it is never called from within the `Ocean` class (except possibly during debugging), only from the `BattleshipGame` class.

For example, here's a display of the ocean after 2 shots have missed.

[illegible]

And here's a display of the ocean after 2 shots have missed, and 1 has hit a (real) ship.

	0	1	2	3	4	5	6	7	8	9
0	.	.	.	.	.	.	.	.	.	.
1	.	.	.	.	.	.	.	.	.	.
2	.	.	.	.	.	.	X	.	.	.
3	.	.	.	-	-	.	.	.	.	.
4	.	.	.	.	.	.	.	.	.	.
5	.	.	.	.	.	.	.	.	.	.
6	.	.	.	.	.	.	.	.	.	.
7	.	.	.	.	.	.	.	.	.	.
8	.	.	.	.	.	.	.	.	.	.
9	.	.	.	.	.	.	.	.	.	.
Enter row, column:										

You are welcome to write additional methods of your own. Additional methods should have *default* access (accessible anywhere in the package) and be tested, if you think they have some usefulness outside of this class. If you don't think they have any use outside of this class, mark them as *private*.

### class OceanTest

This is a JUnit test class for `Ocean`. Test every required method for `Ocean`, including the constructor, but not including the `print()` method. If you create additional methods in the `Ocean` class, you must either make them private, **or** write tests for them. Test methods do not need comments, unless they do something non-obvious.

## Javadocs

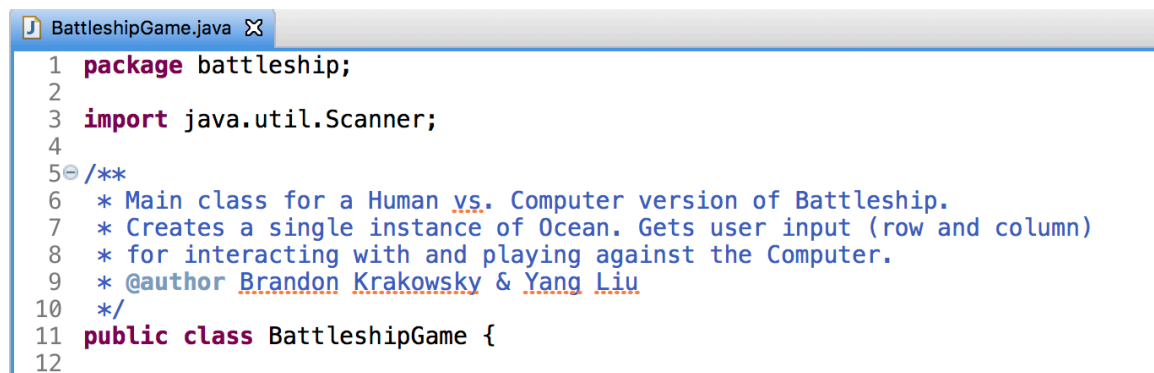
Create *API (Application Programming Interface)* documentation for your entire program. This can be extremely helpful for other programmers reading/running your code. Eclipse makes it very easy to generate HTML files directly from the Javadocs in your code. See the separate "Generating Javadocs.pdf" file for how to do this.

## What to Submit

Please submit your entire Java project in a .zip file. Make sure it includes your “src” folder with all of your code and a separate folder with all of your generated Javadoc HTML files.

If you’re working as part of a team, only one student from your team needs to submit the .zip file. Name it with your pennkey(s), separated by an underscore. For example, if Brandon was working with Yang, their submission would be *lbrandon\_liuya.zip*.

Also include the members of your team as part of the @author tag in the Javadocs for the BattleshipGame class. Again, if Brandon was working with Yang, their Javadocs and @author tag would look something like:



```
1 package battleship;
2
3 import java.util.Scanner;
4
5 /**
6  * Main class for a Human vs. Computer version of Battleship.
7  * Creates a single instance of Ocean. Gets user input (row and column)
8  * for interacting with and playing against the Computer.
9  * @author Brandon Krakowsky & Yang Liu
10 */
11 public class BattleshipGame {
12
```

## Evaluation

The TAs will grade you out of 45:

- **Style (5 pts total)**
  - This includes, but is not limited to:
    - Adding Javadocs to methods and variables, and comments to all non-trivial code
    - Indenting properly (Cmd+i or Ctrl+i) and using { brackets } correctly in loops and conditionals
    - Naming additional variables and methods descriptively with camelCase
- **Javadocs (5 pts total)**

- Be sure to write Javadocs for every method and variable
  - Generate HTML files from the Javadocs in your code using Eclipse
- **Game play (10 pts total)**
  - This comes down to whether or not a TA can play your game. The interface should be clear. If you have made some potentially unusual design choice, please make sure that you point that out very clearly. If you do not know what this means, it might be worth asking on piazza or during office hours. If you followed all the instructions to the letter, you are fine.
- **Unit testing (15 pts total)**
  - Please make sure you pass your own unit tests (10 pts)
  - Passing our own unit tests (5 pts)
  - Note, there are some methods which cannot be unit tested, such as a method that takes in user input. Similarly, a method that prints to the console (and does only that) cannot be unit tested.
- **Code writing (10 pts)**
  - Make sure you understand inheritance and correctly utilize overriding
  - Also, since there is no way for us to test the `placeShipsRandomly()` method, the TAs will have to read this part of your code and make sure that you are actually doing this correctly