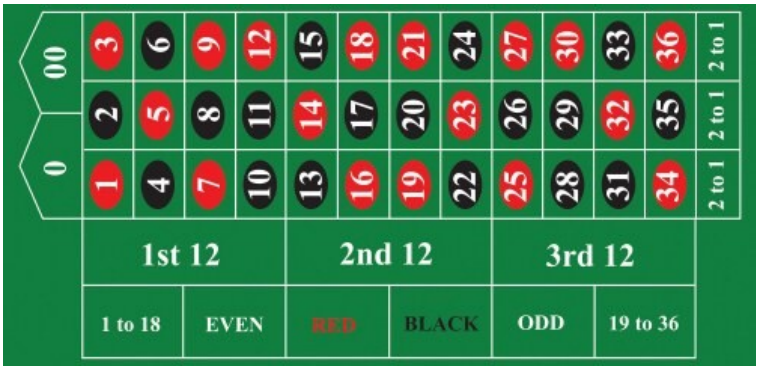
CS170 **Lab 11**
Fall 2012 **Abstract Data Types & Objects**

Due: Midnight tonight

- Introduction: Abstract Data Type (ADT)
  - An abstract data type is commonly known as a class of objects
  - An abstract data type in a program is used to represent (the behavior) of some class of object in the real world
  - In this lab, we will write the definition of an abstract data type (called `Roulette`) that represents Roulette tables in the real world and their behavior.
- Roulette Table
  - Note: A computer program will never be able to represent a real Roulette table. What a computer program can do is represent the functionality of a Roulette table. So we need to know how a Roulette table is used.
  - The Roulette Table:
    - Roulette consists of a wheel and a betting area:



  - How to play roulette:
    - People place bets in the betting area
    - The dealer spins the roulette wheel and place a ball on the wheel.
    - The ball will land on some number. Each number has an associated color.
    - The bets are checked if they match the outcome.
    - Bets are paid out differently depending on the chance of winning.
    - In this lab, we will write a class `Roulette` that can represent (ie simulate) spinning of the roulette wheel.

- **Preparation:**
  - Create your `~/cs170/lab10/`, and copy files by cutting and pasting these terminal commands:

```
mkdir ~/cs170/lab11
cp  ~cs170003/share/lab11/*.java  ~/cs170/lab11
cd ~/cs170/lab11
```

  - In this lab, we will use gedit and javac.
  - You should see 6 Java files in your directory:
    - `Roulette.java`: this file will contain the definition of the roulette table (it will contain: (1) variables to hold information on the roulette table, and (2) methods that make the program behave like a roulette table)
    - `Test1.java`, `Test2.java`, `Test3.java`, `Test4.java`, and `Test5.java`: test programs to check if you have implemented various aspects of the roulette table correctly.

- **Task 1: representing a roulette table**
  - The function of a roulette table is to produce one of the following 38 possible outcomes:

```
(0, Green)     (9, Red)         (18, Red)      (27, Red)       (36, Red)
(1, Red)       (10, Black)      (19, Red)      (28, Black)     (00, Green)
(2, Black)     (11, Black)      (20, Black)    (29, Black)
(3, Red)       (12, Red)        (21, Red)      (30, Red)
(4, Black)     (13, Black)      (22, Black)    (31, Black)
(5, Red)       (14, Red)        (23, Red)      (32, Red)
(6, Black)     (15, Black)      (24, Black)    (33, Black)
(7, Red)       (16, Red)        (25, Red)      (34, Red)
(8, Black)     (17, Black)      (26, Black)    (35, Black)
```

  - Notice that:
    - The "normal" outcomes are between 1 and 36, but there are 2 special outcomes: 0 and 00
    - Every outcome has a color associated with the outcome.
    - The "normal outcomes" (between 1 and 36) are either red or black
    - The "special outcomes" (0 and 00) are green.
  - We will need to store information to represent all these 38 outcomes
    We will use 2 arrays:

```
String[] value;
String[] color;
```

  - Take a look at these variables inside the `Roulette.java` program file:

```
public class Roulette {

    public String[] value;  // Variables to represent
    public String[] color;  // the Roullete table

    public int outcome;

    /* ================================================
       Task 1: write the constructor
       ================================================ */
    public Roulette( ) {
```

```
    }

    .... (other methods omitted)
}
```

- Note:
  - The `value` and `color` variables are currently declared as `public` variables so that you can run the test program `Test1.java`
    - We will change the access specifier from `public` to `private` later in the lab.
- Write the constructor method Roulette() that must perform the following:
  - The constructor method `Roulette()` must create (with the `new` operator !) an array of 38 elements for `value`: to store the 38 values "0", "1", "2", ..., "35", "36", "00"
  - The constructor method `Roulette()` must create (with the `new` operator !) an array of 38 elements for `color`: to store the 38 values "G", "R", "B", "R", "B", ... ("G" means green, "R" means red and "B" means black)
    - The entries `value[i]` and `color[i]` store the value and the color for the one outcome
    - So make sure that the value and color of the outcome are correct (example, the outcome "1" has the color "Red", don't store the wrong color with that value !)
  - The constructor method `Roulette()` must store the roulette table information in the array (the roulette information is given above.)
- Testing the program. After writing the constructor method `Roulette`, you can test it with the `Test1.java` program. Compile and run the `Test1.java` file. You should see:

```
Test1: constructor method in class Roulette

value[0] = 0 color[0] = G  value[1] = 1 color[1] = R
value[2] = 2 color[2] = B  value[3] = 3 color[3] = R
value[4] = 4 color[4] = B  value[5] = 5 color[5] = R
value[6] = 6 color[6] = B  value[7] = 7 color[7] = R
value[8] = 8 color[8] = B  value[9] = 9 color[9] = R
value[10] = 10 color[10] = B  value[11] = 11 color[11] = B
value[12] = 12 color[12] = R  value[13] = 13 color[13] = B
value[14] = 14 color[14] = R  value[15] = 15 color[15] = B
value[16] = 16 color[16] = R  value[17] = 17 color[17] = B
value[18] = 18 color[18] = R  value[19] = 19 color[19] = R
value[20] = 20 color[20] = B  value[21] = 21 color[21] = R
value[22] = 22 color[22] = B  value[23] = 23 color[23] = R
value[24] = 24 color[24] = B  value[25] = 25 color[25] = R
value[26] = 26 color[26] = B  value[27] = 27 color[27] = R
value[28] = 28 color[28] = B  value[29] = 29 color[29] = B
value[30] = 30 color[30] = R  value[31] = 31 color[31] = B
value[32] = 32 color[32] = R  value[33] = 33 color[33] = B
value[34] = 34 color[34] = R  value[35] = 35 color[35] = B
value[36] = 36 color[36] = R  value[37] = 00 color[37] = G
```

- **Task 2: define a `spin()` method that simulate a spin on the roulette wheel**
  - Recall that:
    - We have stored the 38 possible outcomes in the arrays `value` and `color`
    - Each one of the 38 entry of the arrays represents a outcome of a spin of the roulette wheel.

- Task 2: Write the method `spin()` that records the outcome of a spin of the roulette wheel in the variable `outcome`:

```
public class Roulette {

      public String[] value;
      public String[] color;

      public int outcome;        // Stores the outcome of a spin

      ....

      /* ================================================
         Task 2: write the spin() method
         ================================================ */
      public void spin() {

      }

      .... (other methods omitted)
}
```

- Note:
  - The method `spin()` does not return any value.
  - Instead, the method `spin()` records (= updates) the outcome of a spin using the variable `int outcome` (we can retrieve the result from this variable !)
- The outcome can be represented by a random (integer) value between 0 and 37. We will use the value in the variable `outcome` to find the outcome information using the arrays `value` and `color`!
- Hints:
  - If you forgot how to generate a random number, take a look at this webpage: click here
  - You will need to multiply the random value and truncate it to an `int` using casting
- Testing the program:
  - After writing the method `spin()`, you can test it with `Test2.java`. Compile and run the `Test2.java file`. It should print out:

```
Test2: spin method in class Roulette
```

followed by a lot of numbers (each one should be between 0 and 37)
You will see:

```
   Test was passed successfully !
```

if the numbers are correct and:

```
   Illegal result of spin(): ...
```

if you have a value that is < 0 or > 37
If there is no value 37, the test program will say:

```
   The outcome 37 was not found; run test again
```

- **Task 2b: changing instance variables from public to private**

- If your program has passed the `Test2.java` test, change the `public` access specifiers on the instance variables `value`, `color`, and `outcome` to `private`:
- Now, try re-compile the first 2 test programs, `Test1.java` and `Test2.java`:
  - You will get compilation errors, because the instance variables `value`, `color` and `outcome` can no longer be accessed from external classes.
  - Notice that before we made the change from `public` into `private`, the test programs `Test1.java` and `Test2.java` could access the variables `value`, `color` and `outcome`.
  - Therefore, we could make changes to these variables! In other words, we could ruin the correctness (for example, change the roulette table that will only spin the number 9!
  - After changing the access specifiers from `public` into `private`, this "trick" is no longer possible !)

- **Task 3: write the `value()` method that returns the value of the spin**
  - Complete the `value()` method in the `Roulette.java` program and make the method return the string that represents the outcome of the value of the spin:

```
public class Roulette {


   public String[] value;  // Store the values of all outcomes
   public String[] color;

   public int outcome;     // represents the current oucome

   ...

    /* ================================================
      Task 3: write the value() method
      ================================================ */
   public String value() {
         return "";   // This return statement is wrong, write a correct one.
   }
 }
```

  - Testing the program:
    - After writing the method `value()`, you can test it with `Test3.java`. Compile and run the `Test3.java` file.
    - The `Test3.java` program checks the number of times the roulette spin comes up with "13".
    - The frequency should be approximately 26 times. If your program spins the number 13 more than 36 times or less than 16 times, check for errors.
- **Task 4: write the color() method that returns the color of the spin**
  - Complete the `color()` method in the `Roulette.java` program and make the method return the string that represents the outcome of the color of the spin:

```
public class Roulette {
```

```
    public String[] value;
    public String[] color;  // Store colors of all outcomes

    public int outcome;     // represents the current oucome

    ...

    /* ================================================
       Task 4: write the color() method
       ================================================ */
    public String color() {
       return "";   // This return statement is wrong, write a correct one.
    }
    ...
}
```

- Testing the program:
  - After writing the method `color()`, you can test it with `Test4.java`. Compile and run the `Test4.java` file.
  - The Test4.java program checks the number of times the roulette spin results in a red color (“R”).
  - The frequency should be approximately 473 times.

- **Task 5: write the toString() method**
  - Take a look at the `Test5.java` program:

```
public class Test5  {
   public static void main( String[] args ) {
      int i;
      int win=0, N=0;

      Roulette x = new Roulette( );

      System.out.println("Test5: toString method in class Roulette\n");

      N = 10;
      for ( i = 1; i <= N; i++ ) {
         x.spin();
         System.out.println( "x = " + x );
              // Converts a Roulette object x to a String !!!
      }

      System.out.println();
      System.out.println("If you don't see '0 G' or '00 G', run again");
      System.out.println();
   }
}
```

  - The `Test5.java` program will print a Roulette object as a String
    We will show you how to control the printing of objects that you define as a class.
  - Enter the follow `toString()` method into the `Roulette.java` program:

```
/* ================================================
   Task 5: write the toString() method
   ================================================ */
public String toString() {  // Write this toString method....
```

```
    return "Hello World !";
  }
```

- Compile and run `Test5.java`
- How does the Roulette objects get printed ? (You should see 10 roulette objects printed, but the print out is "Hello World !" which is not very informative about a roulette object).
- Now write a `toString()` method inside `Roulette.java` that returns a String of the form:

```
"value-of-the-spin    color-of-the-spin"
```

- After you have written this method, compile and run `Test5.java`
- You should see an output like this:

```
Test5: toString method in class Roulette
 x = 17 B
 x = 5 R
 x = 3 R
 x = 34 R
 x = 17 B
 x = 00 G
 x = 22 B
 x = 0 G
 x = 18 R
 x = 34 R

 If you don't see '0 G' or '00 G', run again
```

- **Turn in**
  - You must turn in your work by enter these terminal commands:

```
cd ~/cs170/lab11
/home/cs170XXX/turnin-lab   Roulette.java   lab11
```