The Observer Design Pattern

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Sample code and document are modified from last version in 2019 (designed by Pan Chao)

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Executive Summary

In this lab exercise, you will gain experience in using the Observer design pattern, in this case in the specific context of Java's implementation of the Observer design pattern in Swing.

To complete this assignment, you're going to need to refactor original code to meet our requirements.

The Observer Pattern and Swing

The Observer pattern is often used in the development of Graphical User Interfaces (GUIs). When a user of the interface interacts with some widget in the graphical representation of the application, various objects within the application may need to be informed of the change so that they can update the application's internal state. Swing introduces a new term for such clients: listeners; applications associate (register) listeners with any GUI components the user may interact with. Any component may have as many registered listeners as the application desires.
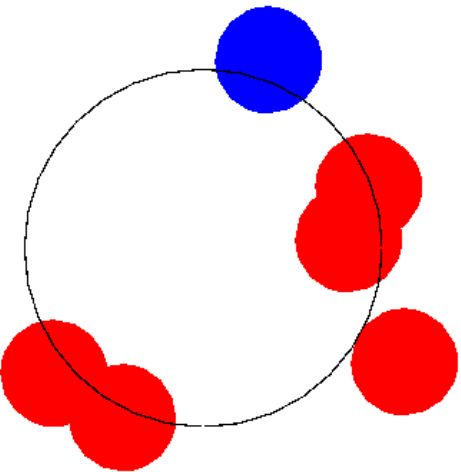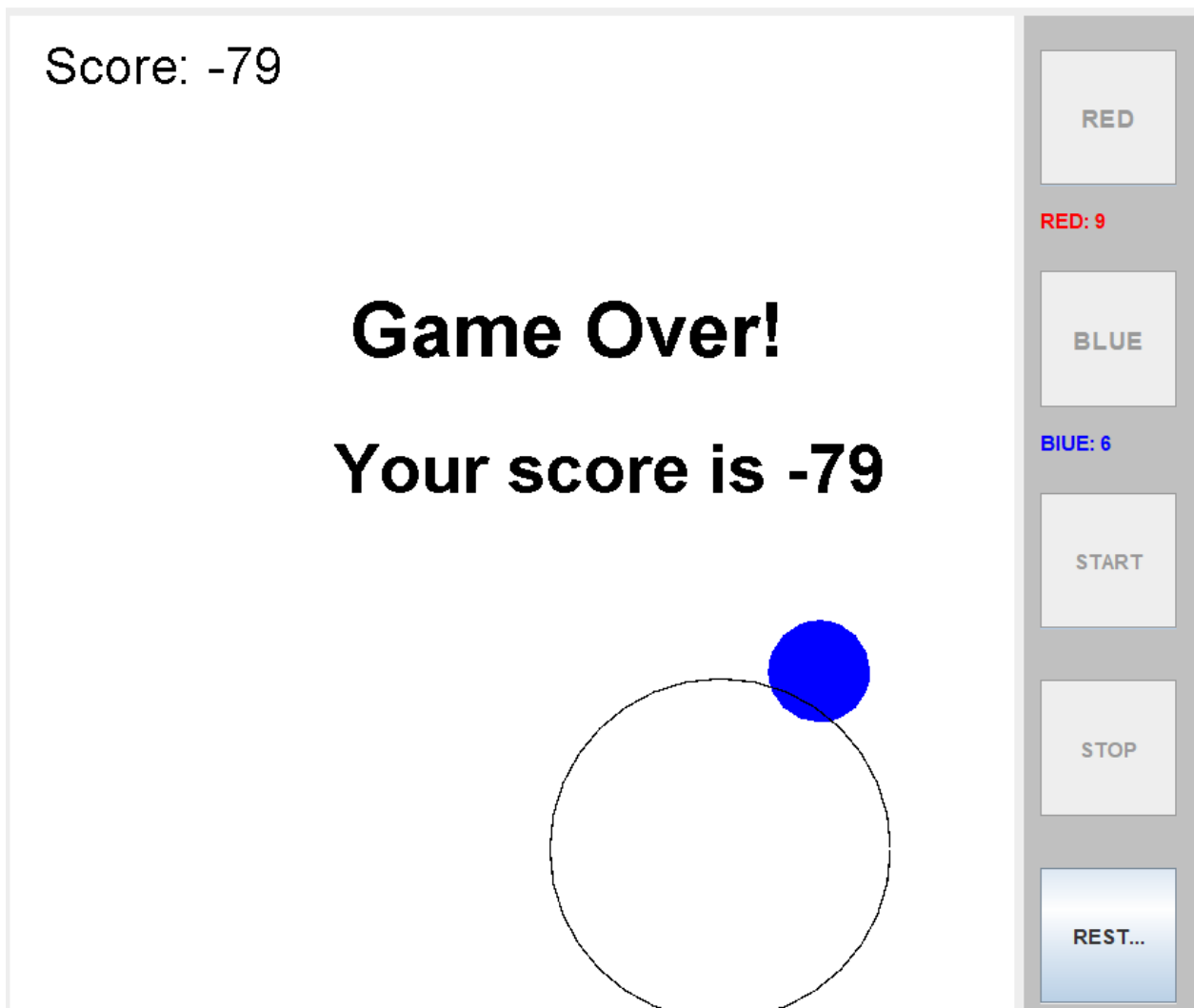
Game Rules:

Picture 1:
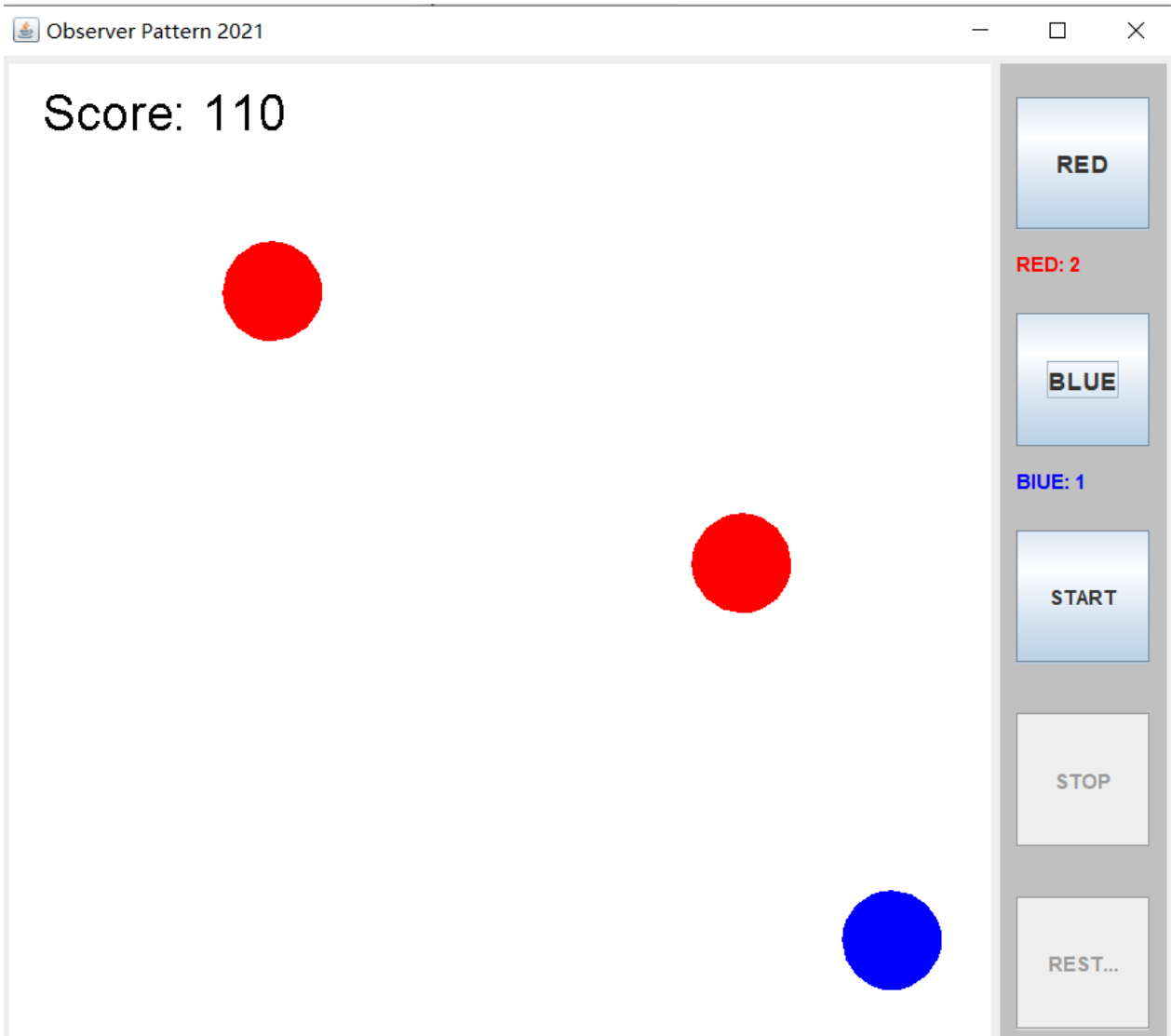
Picture 2:

Picture 3:

- This is a pretty simple game with only three type of balls (red, blue and white).
- Before starting the game, user can click **ADD** button to add red or blue balls. The initial score of this game is 100. Score would minus 10 while adding a red ball, plus 30 while adding a blue ball. All red and blue balls can be seen before the game starts. (Picture 1)
- When click start button, the game starts while the white ball appears, at the same time all three buttons in game frame can not be clicked anymore. (Picture 2)
- Score will continuously decrease after the game starts. User could control balls through the keyboard. Only ball that intersects with the white ball can be seen.
- The rules of keyboard:

Balls	Key to Action
White ball	a: xSpeed becomes -8 d: xSpeed becomes 8 w: ySpeed becomes -8 s: ySpeed becomes 8
Red ball	a: xSpeed becomes a negative random int d: xSpeed becomes a positive random int w: ySpeed becomes a negative random int s: ySpeed becomes a positive random int
Blue ball	All keys: change the direction of xSpeed, ySpeed respectively

- If user click stop button, the game will terminate. Score will be calculated by the amount of red and blue balls that white ball has caught. Score would plus 80 with each read ball and minus 80 with each blue ball. (Picture 3)

Task 1 (40 points)

So this isn't terrible code, and it's actually quite common to see. But it's not at all a real implementation of the observer pattern. The problem here is that the observed object is basically observing itself and then dispatching its observations to the clients, instead of letting those clients take care of their own observations.

First, let's create a new module named `observer`. Make a copy of the code you have in original inside of the src folder in `observer`. Now let's think about the changes we want to make.

To be consistent with the Observer pattern, each of the interested components should register itself to receive the keyboard's events. The question is, who is really the "client" in this interaction? If you answered " The Balls!" you would be exactly correct.

Hints

First, let's refactor our design. Provide a new class diagram depicting a design that allows each of the interested observers to register themselves to receive the keyboard's events.

There's a catch, though. I had to refactor the three type of balls into three different extensions of the same abstract base class `Ball` (I called them `RedBall`, `WhiteBall` and `BlueBall` if you want to follow my lead).

So, we can regard the `MainPanel` class as the implement class of `Subject` class, and regard three type of Ball classes (`RedBall`, `WhiteBall` and `Blueball`) that extends the Ball as the observer. So in the "Subject" class, you should design methods like `registerObserver()`, `notifyObservers()`, `removeObserver()` and `measurementsChanged()` (if you need). On the whole, no matter how you design your project, you should guarantee that, **when you press the keyboard, it will notice the three ball classes and finally the xSpeed and ySpeed of three type of ball classes would be changed accordingly.**

To do

All right, now fix the code to observer pattern to decouple the complex code in public void `keyPressed(KeyEvent keyEvent)` . Notice that do not change any rules of the game we have declared.

Task 2　(60 points)

It actually is. It can be succinctly described by the fact that the WhiteBall doesn't have to know anything about the existence of the BlueBall and RedBall at all! Fantastic.

Adding New Rules:

To make the game more interesting, adding news rules based on original rules:

- When `WhiteBall` intersect with `RedBall` and `BlueBall` , keep changing its speed
    - `RedBall` : same as the speed of `WhiteBall`
    - `BlueBall` : change the direction of xSpeed and ySpeed

Hints and To do

According to the rules declared above, we know **WhiteBall should notify its location to BlueBall and RedBall when it moves,** then the instance of `BlueBall` and the `RedBall` can **update** their speed automatically when the `WhiteBall` is intersected with them.

Could you understand in shifting process, which class can be the subject and which class can be observer? When to register observer and when to remove observer?

When notice white ball's location to BlueBall and RedBall.

Subject Interface Structure

```java
public interface Subject<T> {
    //when create a ball object, it is need to register the ball object into
observer list.
    public void registerObserver(T t);
    // when restart a new game, it is need to remove all observer from
paintinglist
    public void removeObserver(T t);
    // when clicked keyboard, it is need to notify all observers to update
their state
    public void notifyObservers(char keyChar);

    // For task 2: when white ball moved, it is need to notify all observers to
update their state
    public void notifyObservers();

    // or For task2   public void notifyObservers(int x, int y);
}
```

What to check

Finish all tasks above. And:

- Task 1 and 2 should to be implemented in the same module.
- Each `java` file should not have any package declaration

For example, if I were to turn in my current files, my directory would unpack like the following:

- Ball.java
- BlueBall.java
- RedBall.java
- WhiteBall.java
- Subject.java
- ButtonPanel.java
- MainPanel.java
- MainFrame.java
- Main.java
- may be other java files (if you think is necessary)