Engineering Workshop for HKUST Summer Camp 2017

**Topic:** Make an On Screen Piano to Play Your Favorite Music

30 June 2017 (Friday), Rm 4213

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Software

- In this workshop, you are going to use Greenfoot to construct an on-screen piano
  - Greenfoot is an interactive Java development environment for development of two-dimensional graphical applications, e.g., simulations and interactive games
  - Link to official site: https://www.greenfoot.org/
Website for the Workshop

http://www.cse.ust.hk/~desmond/piano-workshop

Engineering Workshop for HKUST Summer Camp 2017

Make an On Screen Piano to Play Your Favorite Music

- Date: 30 June, 2017 (Friday)
- Time: 9:30 - 12:30
- Venue: Rm 4213 (CS Lab 3)

Description:
In this workshop we use Greenfoot platform to animate a piano. First, the participants use the Greenfoot to construct a piano key in simple Java template. Then all white keys and black keys are in place. The keyboards are used to link with the keys to make sound note. Combining all sound note the participants can play their own music.

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Things to Do

1. Visit the Workshop Website
2. Download the Skeleton Code (middle icon)
3. Start Greenfoot (Please follow the verbal instructions)
4. Load up the code page:
   http://www.cse.ust.hk/~desmond/piano-workshop/code.html

Note

Please keep your browser open as you need to refer to the code from time to time
Goal: Make an On-Screen Piano to Play Music
How? Two Files: Piano.java and Key.java

A piano has a collection of keys (white and black keys)
Five Parts

I. Making a white key
II. Making two white keys
III. Making all white keys (12 in total)
IV. Making all black keys (8 in total)
V. Making a music player
Part I

Making a White Key
What is given?
What is given?

- Piano Class (Right-click Piano icon and select “Open editor”)

```
// (World, Actor, GreenfootImage, and Greenfoot)
import greenfoot.*;

public class Piano extends World {
    /*
     * Create the piano.
     */
    public Piano() {
        super(800, 340, 1)
    }
}
```
What is given?

- **Key Class** *(Right-click Key icon and select “Open editor”)*

```java
// (World, Actor, GreenfootImage, and Greenfoot)
import greenfoot.*;

class Key extends Actor {

/*
 * Create a new key.
 */
    public Key() {
    }

    /*
     * Do the action for this key.
     */
    public void act() {
    }
}
```
Run it

- Press "Run"
- Right-click the "Key" icon and select "new Key()"
Place the key on the piano

Problem
No response when we press keys! :(
Update the `act()` method of Key class with the following:

```java
// This method is called whenever
// the "Act' or 'Run' button gets
// pressed in the environment

public void act() {
    // Check if key "g" is pressed
    if(Greenfoot.isKeyDown("g")) {
        // change to gray image
        setImage("white-key-down.png");
    }
    else {
        // change to original image, i.e. white
        setImage("white-key.png");
    }
}
```
Oops...

Problem
Key always Down for First Press! :(  
(Some versions of Greenfoot may not have this problem)
Update the act() method of Key class again with the following:

```java
public void act() {
    // if( not is Down and "g" is down )
    if( !isDown && Greenfoot.isKeyDown("g") ) {
        setImage("white-key-down.png");
        isDown = true;
    }

    // if( isDown and "g" is not down )
    if( isDown && !Greenfoot.isKeyDown("g") ) {
        setImage("white-key.png");
        isDown = false;
    }
}
```

Run it again and press "g". It should work! :)

Problem
No sound! :(  

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The sounds folder has a collection of sound files, each of which contains the sounds for a single piano key.
Play the Note

- Add `play()` method to the `Key` class as follows

```java
// (World, Actor, GreenfootImage, and Greenfoot)
import greenfoot.*;

public class Key extends Actor {
    // ...

    /*
    * Play the note of this key.
    */
    // Add the following code to the "Key" class
    public void play() {
        Greenfoot.playSound("3a.wav");
    }
}
```
Play the Note if "g" is down

- Put `play();` after the line `setImage("white-key-down.png");`

```java
public void act() {
    // if( not is Down and "g" is down )
    if( !isDown && Greenfoot.isKeyDown("g") ) {
        setImage("white-key-down.png");

        // -----------------
        // Add play() here
        // -----------------
        play();

        isDown = true;
    }

    // if( isDown and "g" is not down )
    if( isDown && !Greenfoot.isKeyDown("g") ) {
        setImage("white-key.png");
        isDown = false;
    }
}
```

Run it again and press "g". It works! Perfect! :)

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Add More Keys

- Now, add two keys and see what happen

Problem
All keys react the same way > . <
Part II

Making Two White Keys
Make the Code of Key Class More Generic

- Add two more variables and update Key(...) method

```java
public class Key extends Actor {
    private boolean isDown;
    // Add two more variables
    private String key;
    private String sound;

    // Update the Key() method
    public Key(String keyName, String soundFile) {
        key = keyName;
        sound = soundFile;
    }

    public void act() {
        if(!isDown && Greenfoot.isKeyDown(key)) {
            setImage("white-key-down.png");
            play();
            isDown = true;
        }
        if(isDown && !Greenfoot.isKeyDown(key)) {
            setImage("white-key.png");
            isDown = false;
        }
        Greenfoot.playSound(sound);
    }
}
```
Try: Add First Key

- Right-click “Key” and select “new Key”
  - Enter “g” and “3a.wav”
  3a.wav is “Do” sound
Try: Add Second Key

- Right-click “Key” and select “new Key”
  - Enter “h” and “3b.wav”

3b.wav is “Rei” sound

Run it again. Press ”g” and ”h”.
Add a Key at Specified Position When the Program is Run

- **Use** `addObject` method provided by Greenfoot
- **The following statement** add a Key at (300, 180) and link it with key “g” and sound file “3a.wav”

```java
addObject(new Key("g", "3a.wav", 300, 180))
```

- **Update** `Piano()` of `Piano` class with the following

```java
public class Piano extends World {
    public Piano() {
        super(800, 340, 1);
        // Add the following line
        addObject( new Key("g", "3a.wav"), 300, 180 );
    }
}
```
Run It and See What Happen

Problem
Not in a nice position
Need Some Arithmetic!

The Key is 63 x 280
Therefore the Center of the Key
Would be 31 ½ x 140
- Update Piano() of Piano class again

```java
public class Piano extends World {
    public Piano() {
        super(800, 340, 1);
        // Add the following line
        addObject(new Key("g", "3a.wav"), 32, 140);
    }
}
```

- Run it and see
Add Another Key

- **Update** Piano() of Piano class again
  ```java
  public class Piano extends World {
      public Piano() {
          super(800, 340, 1);
          addObject( new Key("g", "3a.wav"), 32, 140 ); // First Key
          addObject( new Key("h", "3b.wav"), 32+63, 140 ); // Second Key
          // Shifted 63 units
      }
  }
  ```

- **Run it and see**

![Greenfoot Piano-AllWhiteKeys](image-url)
Part III

Making All White Keys
Add All 12 White Keys

- **Update** Piano() of Piano class as follows

```java
public class Piano extends World {
    public Piano() {
        super(800, 340, 1);
        for(int i=0; i<12; i++) // Repeat 12 times
            addObject( new Key("g", "3a.wav"), 32, 140);
    }
}
```
Problem

Oops... all overlapped
Add All 12 White Keys

- **Update Piano() of Piano class**

  ```java
  public class Piano extends World {
      public Piano() {
          super(800, 340, 1);
          for(int i=0; i<12; i++)
              addObject( new Key("g", "3a.wav"), 32 + i*63, 140);
      }
  }
  ```
Run It and See

Problem
Hmm... better, but not perfect!
Add All 12 White Keys

- **Update Piano() of Piano class**

```java
public class Piano extends World {
    public Piano() {
        super(800, 340, 1);
        // Width of piano: 800
        // Width of 12 keys: 12 * 63 = 756
        // Empty space = 800 - 756 = 44
        // Half the space on each side = 44 / 2 = 22
        for(int i=0; i<12; i++)
            addObject( new Key("g", "3a.wav"),
                        22 + 32 + i*63, 140 );
    }
}
```
Run It and See

Problem

Perfect! But ... all keys binded with "g" and with the same sound file
Make Each Key Different

String [] whiteKeys = { "a", "s", "d", "f", "g", "h", "j", "k", "l", ";", ",", "\"" };

// whiteKeys[3] contains the string "f"
// whiteKeys[6] contains the string "j"
// How about whiteKeys[10]?
How about Notes?

- We can do something similar

```java
String[] whiteKeys={"a","s","d","f","g","h","j","k","l",";","'","\""};

String[] whiteNotes={"3c","3d","3e","3f","3g","3a","3b","4c","4d","4e","4f","4g"};
```

- Update Piano class as follows:

```java
public class Piano extends World {

    private String[] whiteKeys = {"a", "s", "d", "f", "g", "h", "j", "k", "l", ";", ";", ";"};

    private String[] whiteNotes = {"3c", "3d", "3e", "3f", "3g", "3a", "3b", "4c", "4d", "4e", "4f", "4g"};

    public Piano() {
        super(800, 340, 1);
        for (int i = 0; i < 12; i++)
            addObject(new Key(whiteKeys[i], whiteNotes[i] + ".wav"),
                22 + 32 + i*63, 140);
    }
}
```
Run It and See

Your First Workable Piano. Play!! :D
Part IV

Making All Black Keys
Can Include Black Keys - Different Key Images

- First, **add two variables** and **update** `Key(...)` method as follows:

```java
public class Key extends Actor {
    private boolean isDown = false;
    private String key;
    private String sound;

    // Add two more variables below
    private String upImage;
    private String downImage;

    public Key(String keyName, String soundFile, String img1, String img2) {
        key = keyName;
        sound = soundFile;
        upImage = img1;
        downImage = img2;
        setImage(upImage);
    }
}
```
Next, update Piano class as follows:

```java
public class Piano extends World {
    private String[] whiteKeys = {"a", "s", "d", "f", "g", "h", "j", "k", "l", ",", ",", ","};
    private String[] whiteNotes = {"3c", "3d", "3e", "3f", "3g", "3a", "3b", "4c", "4d", "4e", "4f", "4g"};
    private String[] blackKeys = {"w", "e", ",", "t", "y", "u", ",", "o", "p", ",", ","};
    private String[] blackNotes = {"3c#", "3d#", ",", "3f#", "3g#", "3a#", ",", "4c#", "4d#", ",", "4f#"};
    public Piano() {
        super(800, 340, 1);
        for(int i=0; i<12; i++) {
            Key key = new Key(whiteKeys[i], whiteNotes[i]+".wav",
                              "white-key.png", "white-key-down.png");
            addObject(key, 22 + 32 + i*63, 140);
        }
        for(int i=0; i<12-1; i++) {
            Key key = new Key(blackKeys[i], blackNotes[i]+".wav",
                              "black-key.png", "black-key-down.png");
            addObject(key, 22 + (63/2) + 32 + i*63, 86);
        }
    }
}
```
Part V

Making a Music Player
Add whiteKeyDownUp and blackKeyDownUp methods to Key class

```java
public class Key extends Actor {
    // ...
    public void whiteKeyDownUp() {
        setImage("white-key-down.png");
        Greenfoot.playSound(sound);
        Greenfoot.delay(15);
        setImage("white-key.png");
    }

    public void blackKeyDownUp() {
        setImage("black-key-down.png");
        Greenfoot.playSound(sound);
        Greenfoot.delay(15);
        setImage("black-key.png");
    }
}
```
public class Piano extends World {
    private String[] whiteKeys = {"a", "s", "d", "f", "g", "h", "j", "k", "l", ";", "'", "\""};
    private String[] whiteNotes = {"3c", "3d", "3e", "3f", "3g", "3a", "3b", "4c", "4d", "4e", "4f", "4g"};
    private Key[] pianoWhiteKey = new Key[12];
    private String[] blackKeys = {"w", "e", ",", "t", "y", "u", ",", "o", "p", ",", "]"};
    private String[] blackNotes = {"3c#", "3d#", ",", "3f#", "3g#", "3a#", ",", "4c#", "4d#", ",", "4f#"};
    private Key[] pianoBlackKey = new Key[11];
    public Piano() {
        super(800, 340, 1);
        for(int i=0; i<12; i++) {
            pianoWhiteKey[i] = new Key(whiteKeys[i], whiteNotes[i] + ".wav",
                        "white-key.png", "white-key-down.png");
            addObject(pianoWhiteKey[i], 22 + 32 + i*63, 140);
        }
        for(int i=0; i<12-1; i++) {
            // Add another loop to create black keys
            if(!blackKeys[i].equals("")) {
                // If black key name is not empty
                pianoBlackKey[i] = new Key(blackKeys[i], blackNotes[i] + ".wav",
                                          "black-key.png", "black-key-down.png");
                addObject(pianoBlackKey[i], 22 + (63/2) + 32 + i*63, 86);
            } // Shifted by half-width of white key
        }
    }
}
Add pressKey and playSong Method to Piano Class

- Add `pressKey()` and `playSong()` method to Piano class as follows:

```java
public class Piano extends World {
    // ...
    private void pressKey(int i) {
        if (i >= 0 && i < 90) {
            if (i <= 20)
                pianoWhiteKey[i].whiteKeyDownUp(); // i <= 20 are for white keys
            if (i >= 50 && i != 52 && i != 56 && i != 59)
                pianoBlackKey[i-50].blackKeyDownUp(); // i >= 50: some are for black keys
        }
    }

    public void playSong() {
        // Sound of Music
        int[] notes = {
            1,1,2,3,99,1,3,1,3,99,2,3,4,4,3,2,4,99,3,4,5,99,3,
            5,3,5,99,4,5,6,6,5,4,6,99,5,99,1,2,3,4,5,6,99,6,
            99,2,3,54,5,6,7,99,7,99,3,54,55,6,7,8,99,8,7,56,6,
            4,7,5,8,5,3,2,0};

        int i = 0;
        while (notes[i] != 0) {
            if ((notes[i] >= 1 && notes[i] <= 12) || (notes[i] >= 51 && notes[i] <= 61))
                pressKey(notes[i]-1);
            else
                Greenfoot.delay(15);
            i++;
        }
    }
}
```
Other Songs

```java
int[] wedding =
{99,6,99,6,7,7,8,8,7,7,6,6,3,3,1,1,5,5,4,4,3,4,5,4,99,99,99,99,4,4,5,5,6,6,
 7,7,5,5,2,2,4,4,3,3,2,3,4,3,99,99,99,99,99,10,99,6,8,10,9,10,99,6,8,10,9,10,
99,6,8,11,10,11,99,6,8,11,10,11,99,4,3,4,5,5,99,5,6,5,6,3,99,99,99,99,10,
99,6,8,10,9,10,99,6,8,10,9,10,99,6,8,11,10,11,99,6,8,11,10,11,99,4,3,4,54,
5,99,5,6,5,6,3,99,99,99,99,99,0};

int[] jasmin =
{3,99,3,5,6,8,8,6,5,99,5,6,5,99,99,99,99,3,99,3,5,6,8,8,6,5,99,5,6,5,99,99,

int[] happyBirthday =
{99,5,5,6,5,8,7,99,5,5,6,5,9,8,99,5,5,12,10,8,7,6,13,99,11,11,10,8,9,8,99,0};

int[] ohSusanna =
{99,1,2,3,5,5,99,6,5,3,1,99,2,3,3,2,1,2,99,1,2,3,5,5,99,6,5,3,1,99,2,3,3,2,2,
 1,99,99,4,99,4,99,5,6,6,99,5,5,3,2,1,2,99,1,2,3,5,5,6,5,3,1,99,2,3,3,2,2,1,
99,0};

int[] ShanghaiBeach =
{3,5,6,99,3,5,2,99,3,5,6,8,6,5,1,3,2,99,2,3,5,99,2,3,6,6,1,2,3,2,7,6,5,1,99,
8,8,6,8,99,6,8,6,5,5,3,6,5,1,2,1,3,99,3,3,2,3,99,8,8,7,6,99,3,3,2,3,8,7,6,3,
5,99,3,5,6,99,3,5,2,99,3,5,6,8,6,5,1,3,2,99,2,3,5,2,3,6,99,6,1,2,3,2,7,6,5,
1,0};
```
That’s all!
Any questions?