Instructor

Dr. Desmond Yau-chat TSOI (Simply call me "Desmond" ;))

- Personal website: http://www.cse.ust.hk/~desmond
- E-mail: desmond@cse.ust.hk
- Office: Rm 3553 (Lift 27-28)

Student Helpers

- CHAN, Ho Ting
- CHIU, Chi Fun
- CHIU, Ka Ho
- CHIU, Ka Wa
- CHUNG, Pak Ho
- HE Jianle
- HEUNG, Shui Leung
- HUI, Yun Fung
- KRISHANDI, Hans
- LAM, Kwun Yuk
- LEUNG, Yiu San
- NI, Xiaoyuan
- PRATAMA, Nicky
- SEE, Cheuk Nam
- SUN, Yushi
- SUNG, Ka Ho
- WONG, Ka Yiu
- WU, Po Man
- YEUNG, Cheuk Man
- ZHANG, Chi
- ZHANG, Ziyan

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/info-day-workshop

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/info-day-workshop/code/

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?

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

```java
// (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.*;

public 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()”**

Image to Show the Key Down

- **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");
    }
}
```

Problem

No response when we press keys! :(

Place the key on the piano
Oops...

Problem
Key always Down for First Press! :( (Some versions of Greenfoot may not have this problem)

Change Once Only: boolean isDown

- 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! :(

Produce the Sound

- 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 isDown 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! :)

Add More Keys

- Now, add two keys and see what happen

```java
public class Key extends Actor {
    private boolean isDown;
    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;
        }
    }

    public void play() {
        Greenfoot.playSound(sound);
    }
}
```

Part II

Making Two White Keys

Problem

All keys react the same way > . <

Make the Code of Key Class More Generic

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

- Right-click "Key" and select "new Key"
  - Enter "g" and "3a.wav"
    3a.wav is "Do" 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"

```
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 \times 280
Therefore the Center of the Key
Would be 31 \frac{1}{2} \times 140

Add Another Key
• Update Piano() of Piano class again
  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

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 + i*63, 140);
    }
  }
  ```

Run It and See

- The white keys are overlapped.

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++) // Repeat 12 times
        addObject(new Key("g", "3a.wav"), 32 + i*63, 140);
    }
  }
  ```

Run It and See

- The white keys are improved but not perfect.

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

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"};
  ```

Make Each Key Different

- 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;

      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);
      }
  }
  ```
Can Include Black Keys - Different Key Images

- First, add two variables and update Key(...) and act() 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);
    }

    public void act() {
        if (!isDown && Greenfoot.isKeyDown(key)) {
            setImage(downImage); // Change this play();
            isDown = true;
        }
        if (isDown && !Greenfoot.isKeyDown(key)) {
            setImage(upImage); // Change this
            isDown = false;
        }
    }
}
```

- 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 = {
        "u", "e", ",", "t", "y", "u", ",", "o", "p", ",", ","]
    };
    private String[] blackNotes = {
        "3c#", "3d#", ",", "3f#", "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++) { // Add another loop to create black keys
            if (!blackKeys[i].equals("") {
                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); // Shifted by half-width of white key
            }
        }
    }
}
```
Add Methods to Control Key Up and Down

- 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");
    }
}
```

Update Piano Class

```java
public class Piano extends World {
    private String[] whiteKeys = {"a", "e", "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", "r", "t", "y", "u", ",", "i", "o", "p", ";", ";"};
    private String[] blackNotes = {"3c#", "3d#", "3e", "3f#", "3g#", "3a", "3b", "4c#", "4d#", "4f#", "4g#"};
    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; i++) {
            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);
        }
    }
}
```
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 = {1,1,2,3,99,1,3,1,3,99,2,3,4,4,3,2,4,99,3,4,5,99,3,5,3,99,4,5,6,6,5,4,6,99,5,99,1,2,3,4,6,99,6,99,2,3,5,4,5,6,7,99,7,99,3,5,4,5,6,7,8,99,8,7,5,6,6,4,7,5,6,5,2,0};

        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 = {99,6,99,6,7,7,8,8,7,7,6,6,3,3,1,1,5,5,4,4,3,4,5,4,99,99,99,99,99,99,4,4,5,5,6,6,7,7,5,5,2,2,4,4,3,3,2,3,4,3,99,99,99,99,10,99,6,8,10,9,10,9,99,6,8,10,9,10,99,6,8,11,10,11,99,6,8,11,10,11,99,4,3,4,5,5,99,5,6,6,3,99,99,99,99,10,99,6,8,10,9,10,99,6,8,10,9,10,99,6,8,11,10,11,99,6,8,11,10,11,99,4,3,4,5,5,99,5,6,6,3,99,99,99,99,99,0};


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

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

int[] ShanghaiBeach = {3,5,6,99,3,5,2,99,3,5,6,8,6,5,1,3,2,99,2,3,5,99,2,3,6,6,1,2,3,2,7,6,5,1,99,8,8,6,99,6,8,6,5,3,5,6,5,1,2,1,3,99,3,3,2,9,99,8,7,6,99,6,3,2,3,8,7,6,3,5,99,3,5,6,99,3,5,2,99,3,5,6,8,6,5,1,3,2,99,2,3,5,2,3,6,99,6,1,2,3,2,7,6,5,1,0};
```

That's all!

Any questions?

thank you!