JAVAFX - GRAPHIC

CONTENT

- Graphics
  - Canvas, GraphicsContext
- AnimationTimer
- Design
  - Shared Object, Drawing Part, Logic Part
- Handling User Input
  - Mouse, Keyboard
- Audio
- Export Jar
- Conclusion

Graphics

Drawing

- Where to draw ?
- How to draw ?

Canvas

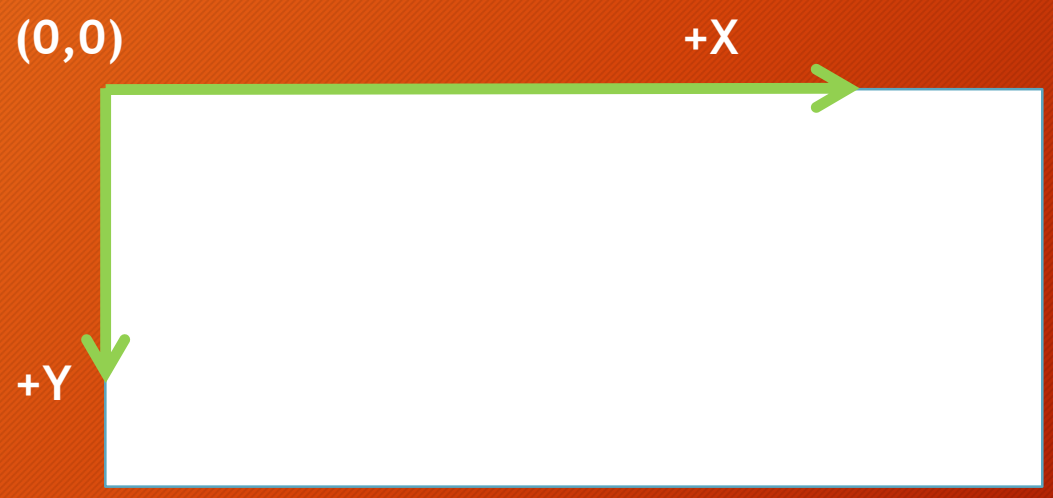
- Empty component
- See it as Paper **(Where to draw)**

- Can draw text, shapes, lines and images using a set of graphics commands provided by a GraphicsContext.

- Canvas has 2 constructors
  - Canvas canvas = new Canvas();
    - Create a Canvas of zero width and height
    - Can set width and height later
  - Canvas canvas = new Canvas(double width, double height);

Canvas - Coordinate system

- Vertically flipped version of real world



Example : *FxCanvasExample0.java*

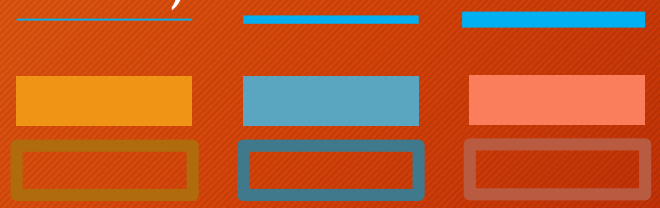

```java
@Override
public void start(Stage stage) {
    StackPane root = new StackPane();
    Scene scene = new Scene(root);
    stage.setScene(scene);
    stage.setTitle("Creation of a Canvas");

    Canvas canvas = new Canvas(400, 200);
    root.getChildren().add(canvas);

    stage.show();
}
```

GraphicsContext

- Drawing class
- See it as Pen, Pencil, Brush **(How to draw)**
- Contains a wealth of powerful customization abilities
- GraphicsContext gc = canvas.getGraphicsContext2D()
  - Get the graphics context of the canvas
- Drawings that fall outside the bounds of the Canvas are clipped

GraphicsContext

- setLineWidth(Double lw)
- setFill(Paint p)
- setStroke(Paint p)

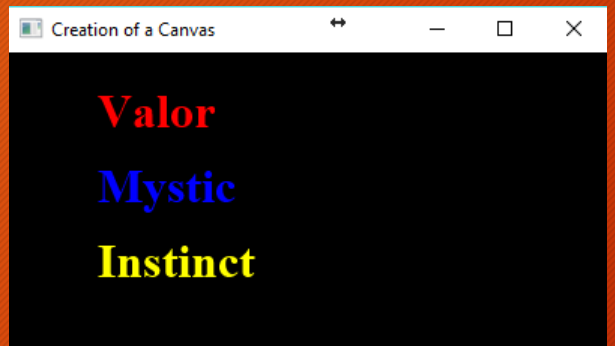


- restore()
  - Used to remove all properties from GraphicsContext

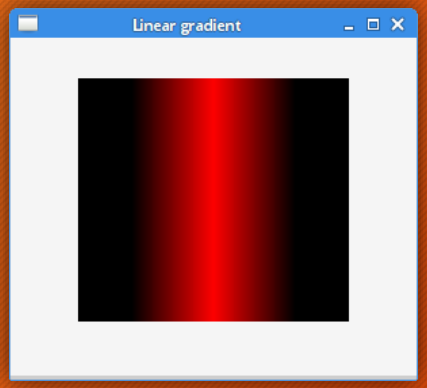
Example : *FxCanvasExample1.java*

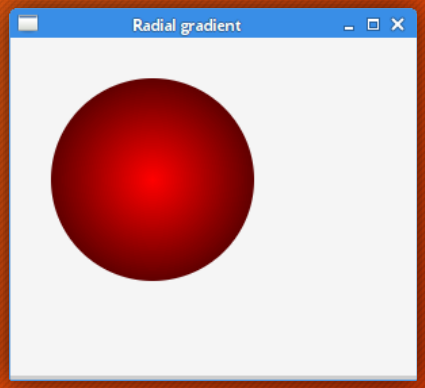

```java
@Override
public void start(Stage stage) {
    StackPane root = new StackPane();
    Scene scene = new Scene(root);
    stage.setScene(scene);
    stage.setTitle("Creation of a Canvas");

    Canvas canvas = new Canvas(400, 200);
    GraphicsContext gc = canvas.getGraphicsContext2D();
    root.getChildren().add(canvas);
    setBackGround(gc);
    drawString(gc);

    stage.show();
}
```

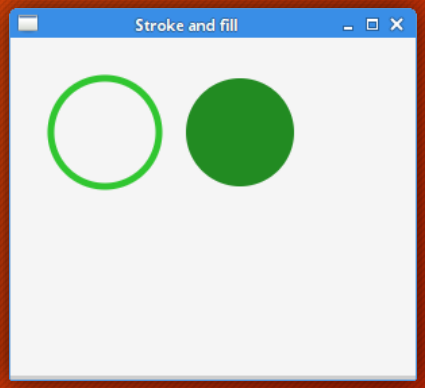
```java
public void setBackGround(GraphicsContext gc) {
    gc.setFill(Color.BLACK);
    gc.fillRect(0, 0, gc.getCanvas().getWidth(), gc.getCanvas().getHeight());
}

public void drawString(GraphicsContext gc) {
    Font theFont = Font.font("Times New Roman", FontWeight.BOLD, 32);
    gc.setFont(theFont);

    gc.setFill(Color.RED);
    gc.fillText("Valor", 60, 50);

    gc.setFill(Color.BLUE);
    gc.fillText("Mystic", 60, 100);

    gc.setFill(Color.YELLOW);
    gc.fillText("Instinct", 60, 150);
}
```

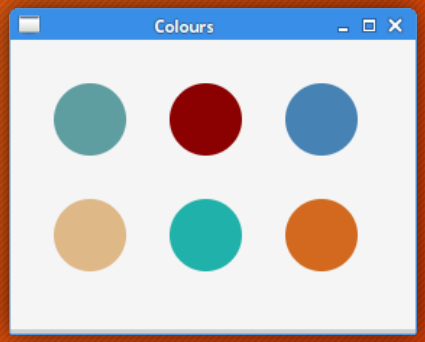


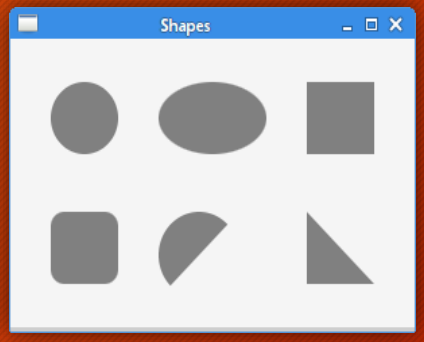
Drawing Example

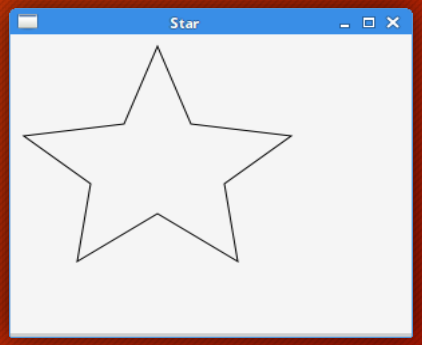












Drawing

- Basic shapes
- Text
- Paths
- Images
- Rotate

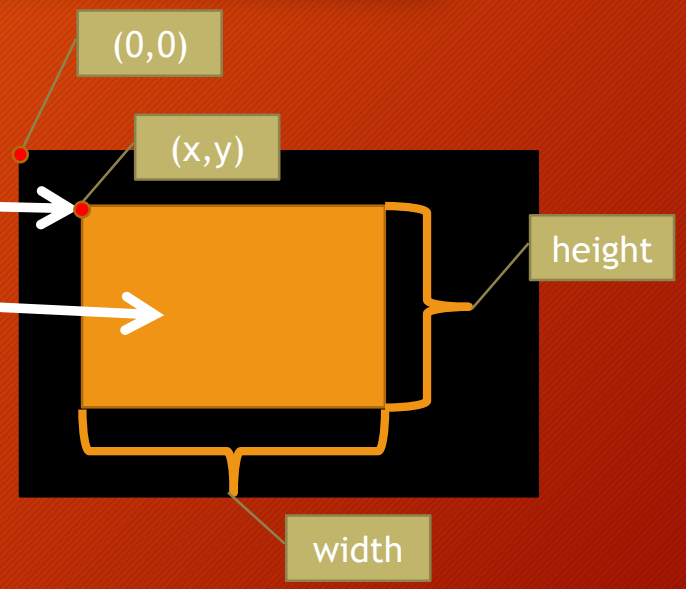
Drawing - Basic Shapes

- Basic Shapes
  - fillRect(), fillRoundRect(), fillOval(), fillArc()
  - strokeLine(), strokeRect(), strokeRoundRect(), strokeOval(), strokeArc()
  - clearRect()

  - fillPolygon()
  - strokePolygon(), strokePolyline()

Drawing 2D shapes

- Basic drawing methods
  - setStroke (the outline) // set property
  - setFill (the shape) // set property
  - FillRect // draw here
    - gc.fillRect(int x, int y, int width, int height)

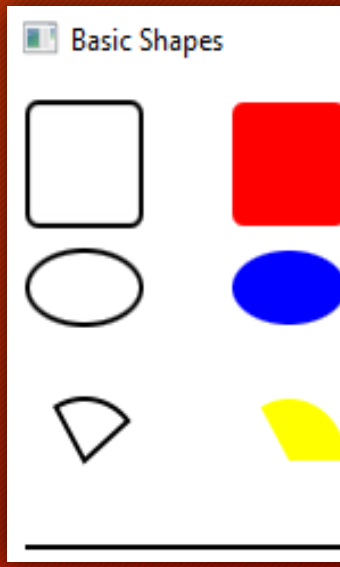


Example : *FxCanvasExample2.java*


```java
@Override
public void start(Stage stage) {
    StackPane root = new StackPane();
    Scene scene = new Scene(root);
    stage.setScene(scene);
    stage.setTitle("Basic Shapes");

    Canvas canvas = new Canvas(400, 200);
    GraphicsContext gc = canvas.getGraphicsContext2D();
    root.getChildren().add(canvas);
    drawRoundRect(gc);
    drawOval(gc);
    drawArc(gc);
    drawLine(gc);

    stage.show();
}
```

```java
public void drawRoundRect(GraphicsContext gc) {
    gc.setLineWidth(2.0);
    gc.setFill(Color.RED);
    // Draw a rounded Rectangle
    // x,y,w,h,arcWidth,arcHeight
    gc.strokeRoundRect(10, 10, 50, 50, 10, 10);
    // Draw a filled rounded Rectangle
    gc.fillRoundRect(100, 10, 50, 50, 10, 10);
}
```

```java
public void drawOval(GraphicsContext gc) {
    gc.setLineWidth(2.0);
    gc.setFill(Color.BLUE);
    // Draw an Oval
    // x,y,w,h
    gc.strokeOval(10, 70, 50, 30);
    // Draw a filled Oval
    gc.fillOval(100, 70, 50, 30);
}
```

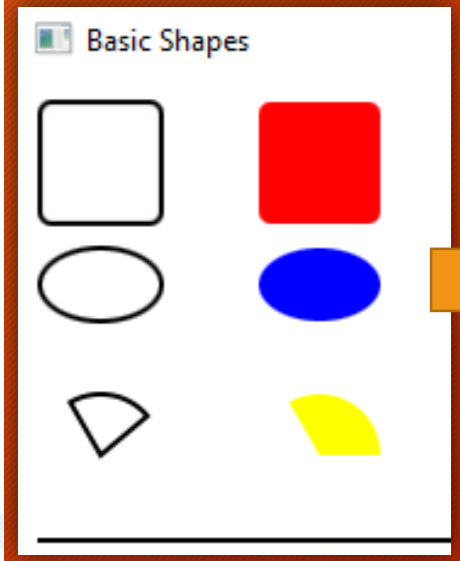


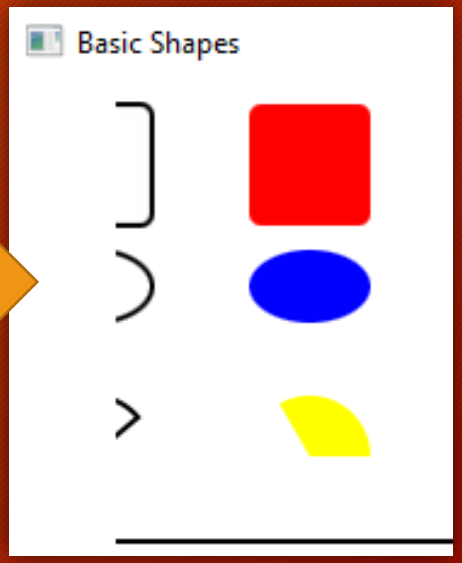

```java
public void drawLine(GraphicsContext gc) {
    gc.setLineWidth(2.0);
    gc.setFill(Color.BLACK);
    // Draw a Line
    // x1,y1,x2,y2
    gc.strokeLine(10, 190, 200, 190);
}
```

```java
public void drawArc(GraphicsContext gc) {
    gc.setLineWidth(2.0);
    gc.setFill(Color.YELLOW);
    // Draw an Arc
    //x,y,w,h,startAngle,arcExtent,closure
    gc.strokeArc(10, 130, 50, 50, 40, 80, ArcType.ROUND);
    // Draw a filled Arc
    gc.fillArc(100, 130, 50, 50, 00, 120, ArcType.ROUND);
}
```

Example : *FxCanvasExample2.java*


```java
@Override
public void start(Stage stage) {
    StackPane root = new StackPane();
    Scene scene = new Scene(root);
    stage.setScene(scene);
    stage.setTitle("Basic Shapes");

    Canvas canvas = new Canvas(400, 200);
    GraphicsContext gc = canvas.getGraphicsContext2D();
    root.getChildren().add(canvas);
    drawRoundRect(gc);
    drawOval(gc);
    drawArc(gc);
    drawLine(gc);

    clearRect(gc);

    stage.show();
}
```

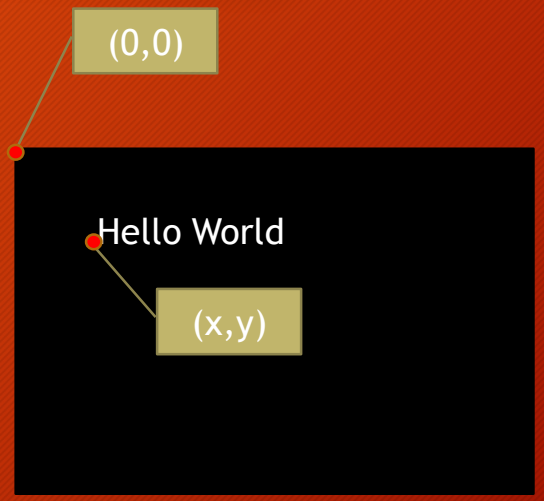





```java
public void clearRect(GraphicsContext gc) {
    gc.clearRect(0, 0, gc.getCanvas().getWidth() / 9, gc.getCanvas().getHeight());
}
```

Drawing - Text

- Text
  - setFont(Font f)
  - getFont()
  - fillText(Text t, int x, int y)
  - fillText(Text t, int x, int y, double maxWidth)
  - strokeText(Text t, int x, int y)
  - strokeText(Text t, int x, int y, double maxWidth)



- Font
  - Font.font(String family, FontWeight weight, FontPosture posture, int size)
  - More…

Example : *FxCanvasExample3.java*


```java
@Override
public void start(Stage stage) {
    StackPane root = new StackPane();
    Scene scene = new Scene(root);
    stage.setScene(scene);
    stage.setTitle("Drawing - Text");

    Canvas canvas = new Canvas(800, 400);
    GraphicsContext gc = canvas.getGraphicsContext2D();
    root.getChildren().add(canvas);

    drawFilledText(gc);
    drawStrokedText(gc);
    drawText(gc);

    stage.show();
}
```

```java
public void drawFilledText(GraphicsContext gc) {
    // Set line width
    gc.setLineWidth(2);
    // Set fill color
    gc.setFill(Color.RED);
    gc.setStroke(Color.BLACK);
    // set font
    Font theFont = Font.font("Times New Roman", FontWeight.LIGHT, 58);
    gc.setFont(theFont);

    // Draw a filled Text
    gc.fillText("This is a filled Text", 10, 75);
    gc.fillText("This is a filled Text with Max Width 300 px", 10, 150, 400);
    gc.fillText("This is a filled Text with Max Width 300 pxxxxxxxxxxxxxxxxxxxxxxxxx", 10, 225, 400);
}
```

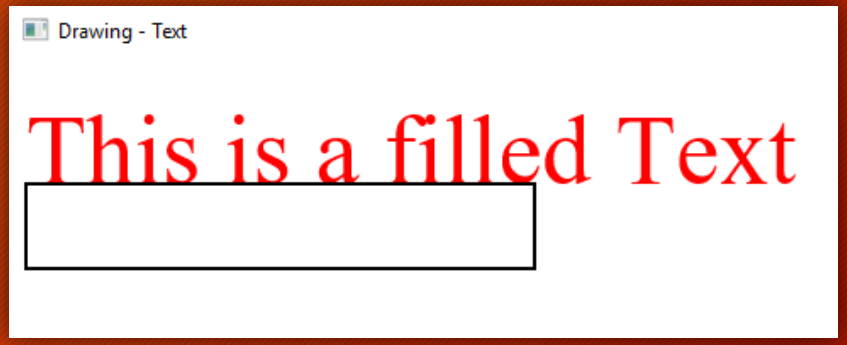
```java
public void drawText(GraphicsContext gc) {
    // Set line width
    gc.setLineWidth(2);
    // Set fill color
    gc.setFill(Color.RED);
    gc.setStroke(Color.BLUE);
    // set font
    Font theFont = Font.font("Times New Roman", FontWeight.LIGHT, 58);
    gc.setFont(theFont);

    // draw filled and stroked Text
    gc.fillText("This is a filled and stroked Text", 10, 375);
    gc.strokeText("This is a filled and stroked Text", 10, 375);
}
```

```java
public void drawStrokedText(GraphicsContext gc) {
    // Set line width
    gc.setLineWidth(2);
    // Set fill color
    gc.setFill(Color.RED);
    gc.setStroke(Color.BLUE);
    // set font
    Font theFont = Font.font("Times New Roman", FontWeight.LIGHT, 58);
    gc.setFont(theFont);

    // Draw a Text
    gc.strokeText("This is a stroked Text", 10, 300);
}
```

Example : *FxCanvasExample3_2.java*


```java
public void drawFilledText(GraphicsContext gc) {
    // Set line width
    gc.setLineWidth(2);
    // Set fill color
    gc.setFill(Color.RED);
    gc.setStroke(Color.BLACK);
    // set font
    Font theFont = Font.font("Times New Roman", FontWeight.LIGHT, 58);
    gc.setFont(theFont);

    // Draw a filled Text
    gc.fillText("This is a filled Text", 10, 75);

    gc.setLineWidth(2.0);
    gc.setFill(Color.RED);
    // Draw a rounded Rectangle
    gc.strokeRect(10, 75, 300, 50);
}
```

Look both have same position x,y



Drawing - Text

- How to draw Text in Rect?
  - We need to get text width and height
  - -> use FontLoader

Drawing - Text

- FontLoader fontLoader = Toolkit.getToolkit().getFontLoader();
- Width
  - double font_width = fontLoader.computeStringWidth("This is a filled Text", gc.getFont());
- Height
  - double font_height = fontLoader.getFontMetrics(gc.getFont()).getLineHeight();
  - For every text that use the same font will have same height

Example : *FxCanvasExample3_3.java*


```java
public void drawFilledText(GraphicsContext gc) {
    // Set line width
    gc.setLineWidth(2);
    // Set fill color
    gc.setFill(Color.RED);
    gc.setStroke(Color.BLACK);
    // set font
    Font theFont = Font.font("Times New Roman", FontWeight.LIGHT, 58);
    gc.setFont(theFont);

    // Draw a filled Text
    gc.fillText("This is a filled Text", 10, 75);

    gc.setLineWidth(2.0);
    gc.setFill(Color.RED);

    FontLoader fontLoader = Toolkit.getToolkit().getFontLoader();
    double font_width = fontLoader.computeStringWidth("This is a filled Text", gc.getFont())
    double font_height = fontLoader.getFontMetrics(gc.getFont()).getLineHeight();
    // Draw a rounded Rectangle
    gc.strokeRect(10, 75 - font_height, font_width, font_height);
}
```

Drawing - Paths

- Paths
  - A path consists of multiple subpaths
  - **beginPath()**
    - Resets the current path to empty
  - closePath()
    - Closes the path
  - moveTo() , lineTo(), quadraticCurveTo(), bezierCurveTo(), arc(), arcTo(), appendSVGPath(), rect()
  - stroke(), fill()
    - draw an outline or fill the path

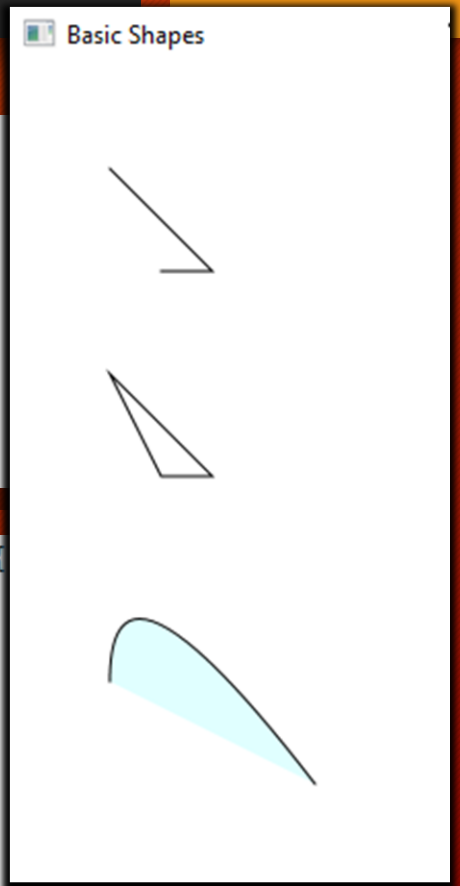
Example : *FxCanvasExample4.java*


```java
@Override
public void start(Stage stage) {
    StackPane root = new StackPane();
    Scene scene = new Scene(root);
    stage.setScene(scene);
    stage.setTitle("Drawing - Paths");

    Canvas canvas = new Canvas(400, 400);
    GraphicsContext gc = canvas.getGraphicsContext2D();
    root.getChildren().add(canvas);

    drawLine(gc);
    drawCloseLine(gc);
    drawCurve(gc);

    stage.show();
}
```

```java
public void drawLine(GraphicsContext gc) {
    // Start the Path
    gc.beginPath();
    // Make different Paths
    gc.moveTo(50, 50);
    gc.lineTo(100, 100);
    gc.lineTo(75, 100);
    // Draw the Path
    gc.stroke();
}
```

```java
public void drawCloseLine(GraphicsContext gc) {
    // Start the Path
    gc.beginPath();
    // Make different Paths
    gc.moveTo(50, 150);
    gc.lineTo(100, 200);
    gc.lineTo(75, 200);
    // End the Path
    gc.closePath();
    // Draw the Path
    gc.stroke();
```

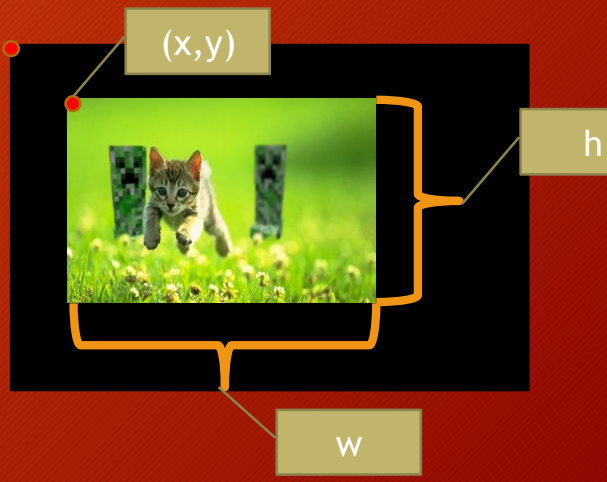
```java
public void drawCurve(GraphicsContext gc) {
    // Start the Path
    gc.setFill(Color.LIGHTCYAN);
    gc.beginPath();
    // Make different Paths
    gc.moveTo(50, 300);
    gc.quadraticCurveTo(50, 220, 150, 350);
    gc.fill();
    // End the Path
    gc.stroke();
}
```



Drawing - Images

- Can draw an Image on the Canvas using the drawImage() method
- Can draw the whole or part of the Image
- The drawn image can be stretched or shortened on the canvas

- void drawImage(Image img, double x, double y)
- void drawImage(Image img, double x, double y, double w, double h)



Drawing - Images

- Image
  - new Image(InputStream is)
  - new Image(String url)
    - url = image path in pc or web url
  - new Image(String url,
    double requestedWidth,
    double requestedHeight,
    boolean preserveRatio,
    boolean smooth)

Use this to resize image

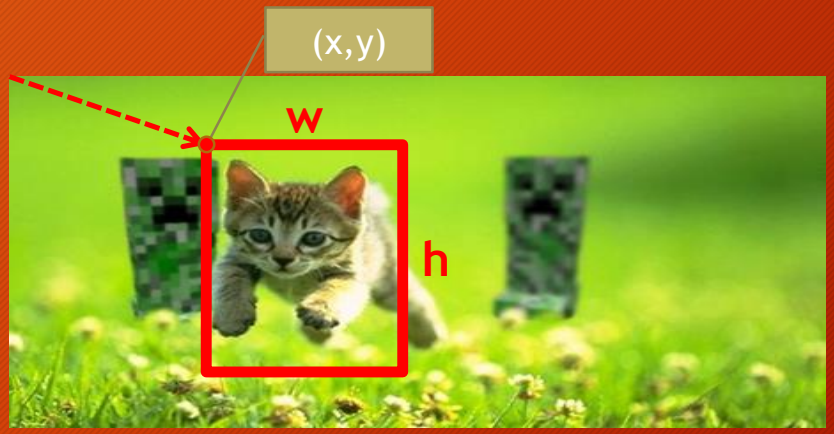
Example : *FxCanvasExample5.java*


```java
@Override
public void start(Stage stage) {
    StackPane root = new StackPane();
    Scene scene = new Scene(root);
    stage.setScene(scene);
    stage.setTitle("Drawing - Images");

    Canvas canvas = new Canvas(800, 800);
    GraphicsContext gc = canvas.getGraphicsContext2D();
    root.getChildren().add(canvas);

    setBackGround(gc);
    String image_path = "file:res/image/javafx_logo_color.jpg";
    drawImageFixSize(gc, image_path);
    drawImage(gc, image_path);

    stage.show();
}
```


```java
public void drawImage(GraphicsContext gc, String image_path) {
    System.out.println(image_path);
    Image javafx_logo = new Image(image_path);
    gc.drawImage(javafx_logo, 40, 250);
}

public void drawImageFixSize(GraphicsContext gc, String image_path) {
    System.out.println(image_path);
    Image javafx_logo = new Image(image_path);
    gc.drawImage(javafx_logo, 40, 40, 600, 200);
}
```

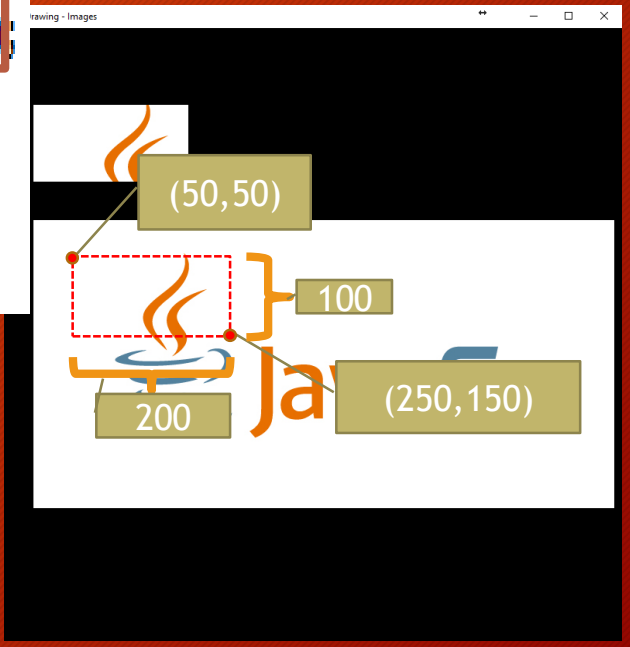
Drawing - Images

- SubImage
  - WritableImage croppedImage = **new WritableImage(image.getPixelReader(), x, y, h, w);**
  - (x,y) is the rectangle's top-left related to image's top-left



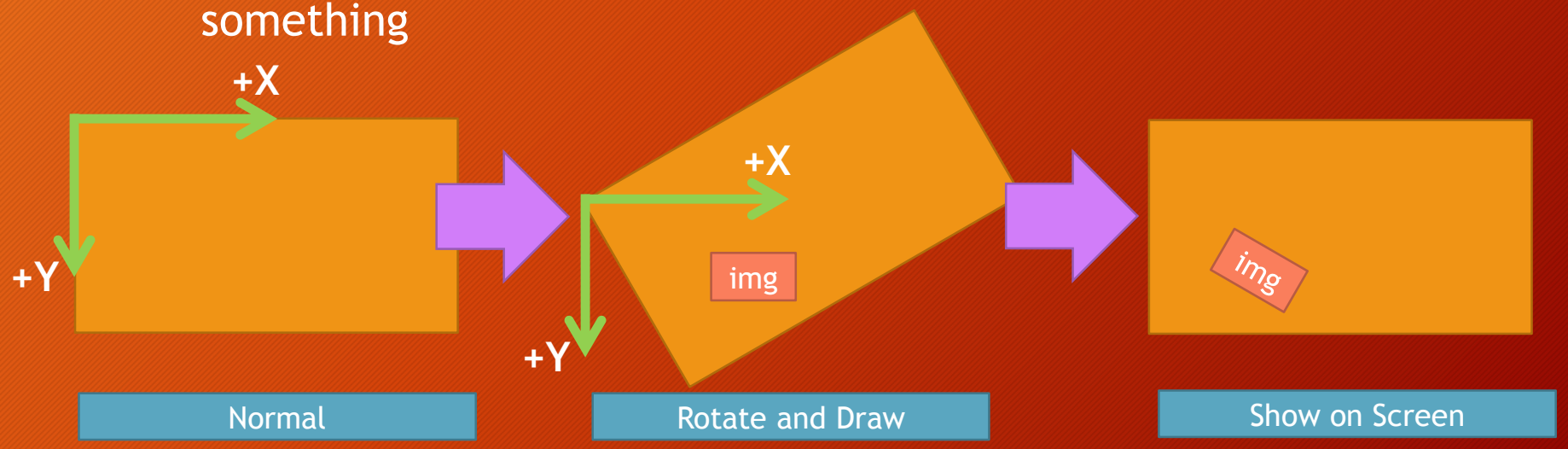
Example : *FxCanvasExample5_2.java*


```
public void drawCroppedImage(GraphicsContext gc, String image_path) {
    System.out.println(image_path);
    Image javafx_logo = new Image(image_path);
    WritableImage croppedImage = new WritableImage(javafx_logo.getPixelReader(), 50, 50, 200, 100);
    gc.drawImage(croppedImage, 40, 100);
    gc.drawImage(javafx_logo, 40, 250);
}
```

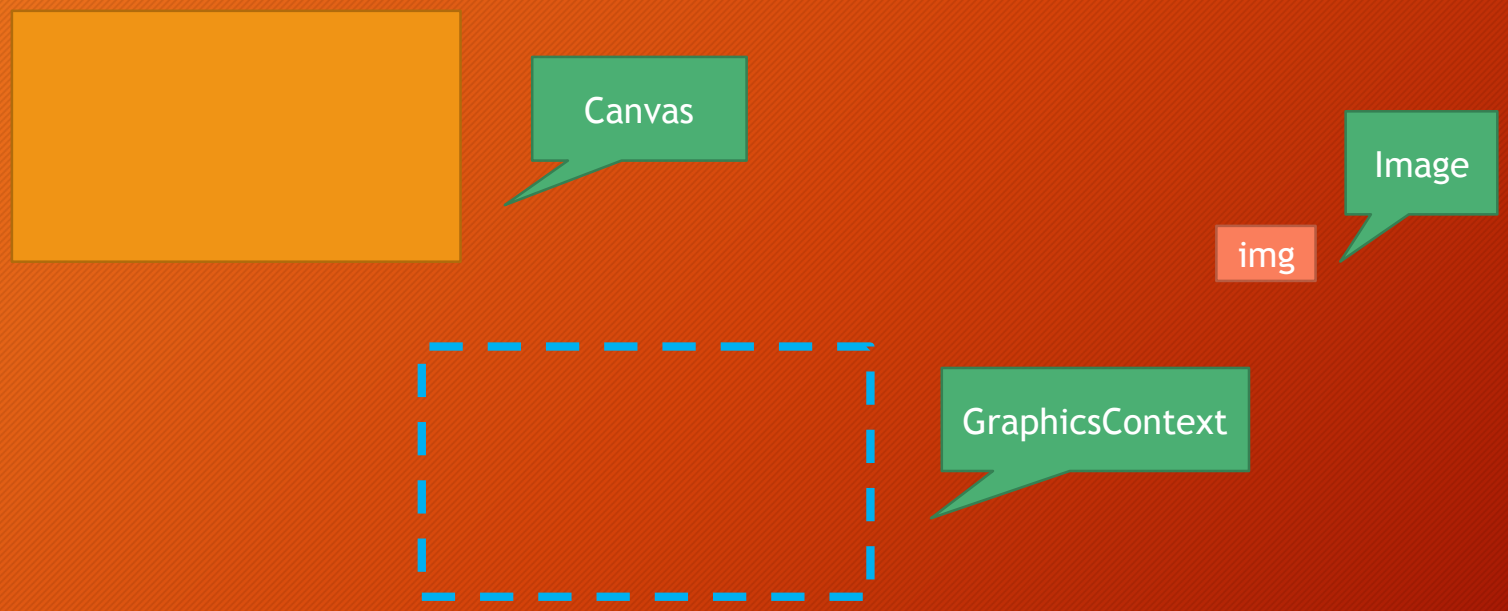


Other Topic - Rotate

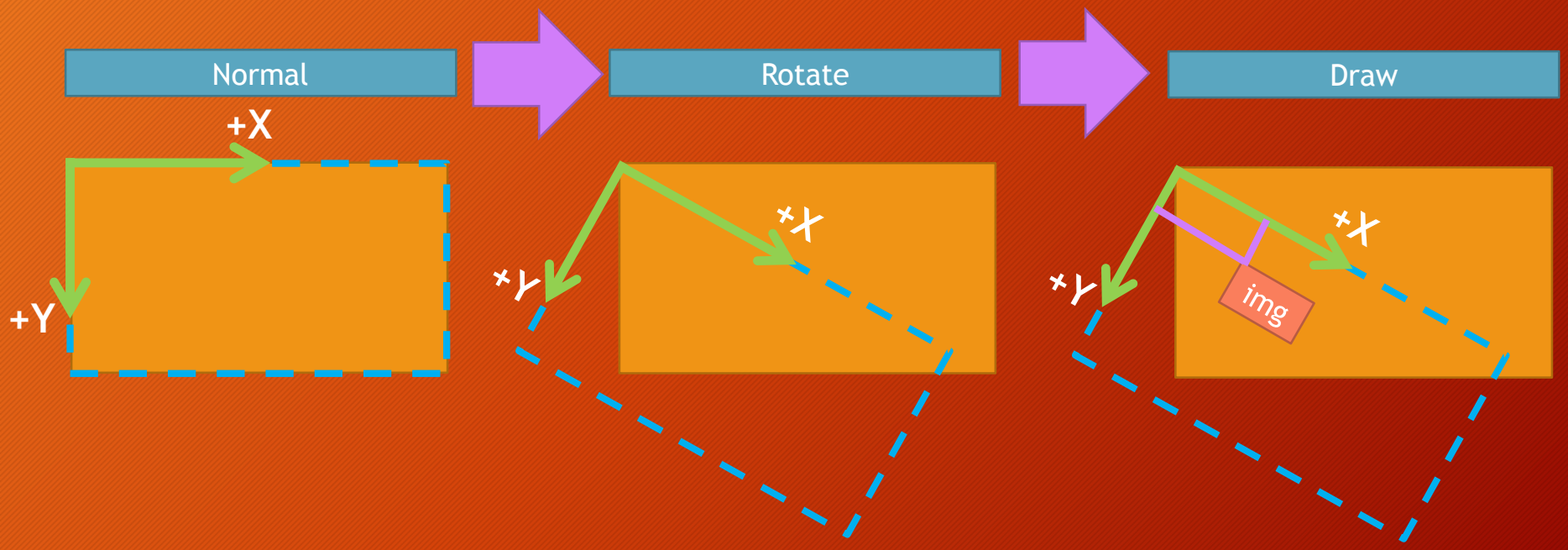
- Rotate
  - gc.rotate(double degrees)
  - gc.drawImage(image,100,50)
  - It seem like rotate paper(Canvas) then draw something



Other Topic - Rotate



Other Topic - Rotate



Example : FxCanvasExample8.java


```java
@Override
public void start(Stage stage) {
    StackPane root = new StackPane();
    Scene scene = new Scene(root);
    stage.setScene(scene);
    stage.setTitle("Drawing - Images");

    Canvas canvas = new Canvas(800, 800);
    GraphicsContext gc = canvas.getGraphicsContext2D();
    root.getChildren().add(canvas);

    setBackGround(gc);
    drawRotatedText(gc);

    stage.show();
}
```

```java
public void drawRotatedText(GraphicsContext gc) {
    gc.translate(gc.getCanvas().getWidth() / 2, gc.getCanvas().getHeight() / 2);
    gc.setFont(Font.font(50));
    gc.setFill(Color.RED);

    gc.fillOval(0, 0, 20, 20);


    int total_angle = 0;
    int angle = 30;
    while (total_angle < 360) {
        total_angle += angle;
        gc.rotate(angle);
        gc.fillText("" + total_angle, 150, 0);
    }
    gc.restore();

}
```

Example : JAVA_FX_TankGame - Tank


```java
public void update() {
    if (flashing) {
        if (flashCounter == 0) {
            this.visible = true;
            flashing = false;
        } else {
            if (flashDurationCounter > 0) {
                this.visible = flashCounter <= 5;
                flashDurationCounter--;
            } else {
                this.visible = true;
                flashDurationCounter = 10;
                flashCounter--;
            }
        }
    } else {
        this.visible = !InputUtility.getKeyPressed(KeyCode.SHIFT);
    }
    if (InputUtility.getKeyPressed(KeyCode.W)) {
        forward();
    }
    if (InputUtility.getKeyPressed(KeyCode.A)) {
        turn(true);
    } else if (InputUtility.getKeyPressed(KeyCode.D)) {
        turn(false);
    }
    if (InputUtility.isLeftClickTriggered()) {
        this.x = InputUtility.mouseX;
        this.y = InputUtility.mouseY;
    }
}
```

- This code receive input from user
- W -> go forward
- A -> turn left x degree
- D -> turn right x degree

```java
@Override
public void draw(GraphicsContext gc) {
    gc.setFill(Color.BLUE);
    gc.fillArc(x - radius, y - radius, radius * 2, radius * 2, 0, 360, ArcType.OPEN);
    gc.translate(x, y);
    gc.rotate(angle);
    gc.setFill(Color.YELLOW);

    int gunSize = radius / 5;
    gc.fillRect(0, -gunSize, radius * 3 / 2, gunSize * 2);
    gc.rotate(-angle);
    gc.translate(-x, -y);
}
```

AnimationTimer

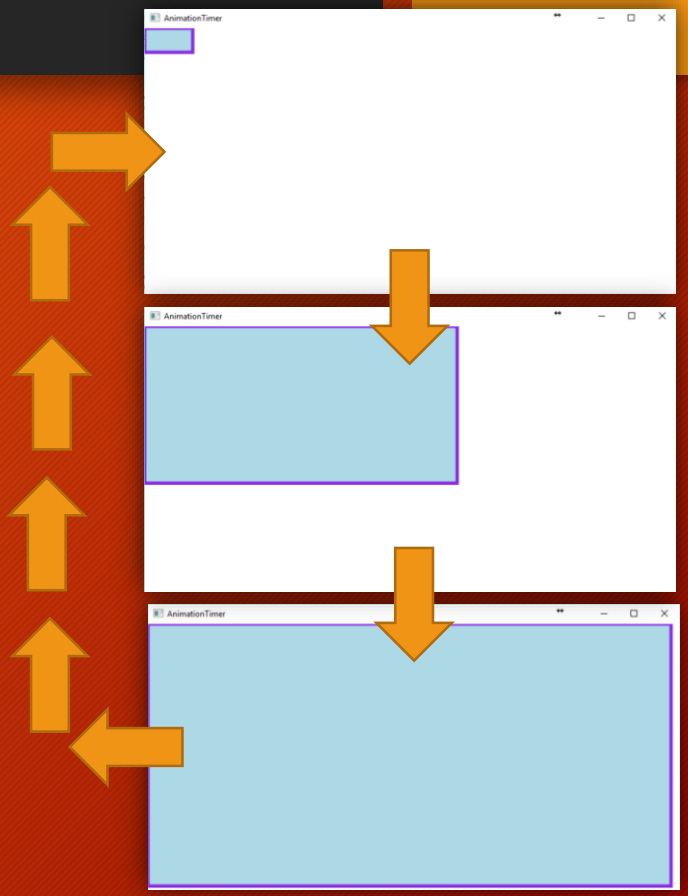
AnimationTimer

- make our programs *dynamic*, meaning that the game state changes over time
- implement a game loop: an infinite loop that updates the game objects and renders the scene to the screen
- AnimationTimer will be called at a rate of 60 times per second or as close to that rate as is possible

Example : *FxCanvasExample7.java*


```java
@Override
public void start(Stage stage) {
    StackPane root = new StackPane();
    Scene scene = new Scene(root);
    stage.setScene(scene);
    stage.setTitle("AnimationTimer");

    Canvas canvas = new Canvas(800, 400);
    GraphicsContext gc = canvas.getGraphicsContext2D();
    root.getChildren().add(canvas);

    drawScalableRectAnimation(gc);

    stage.show();
}
```

```java
public void drawScalableRectAnimation(GraphicsContext gc) {
    final long startNanoTime = System.nanoTime();
    new AnimationTimer() {
        double width = 0;
        double height = 0;

        public void handle(long currentNanoTime) {
            double t = ((currentNanoTime - startNanoTime) / 1000000000.0) % 3;
            width = gc.getCanvas().getWidth() * t / 3;
            height = gc.getCanvas().getHeight() * t / 3;

            gc.setFill(Color.LIGHTBLUE);
            gc.setStroke(Color.BLUEVIOLET);
            gc.setLineWidth(5);
            gc.clearRect(0, 0, gc.getCanvas().getWidth(), gc.getCanvas().getHeight());
            gc.fillRect(0, 0, width, height);
            gc.strokeRect(0, 0, width, height);
        }
    }.start();
}
```



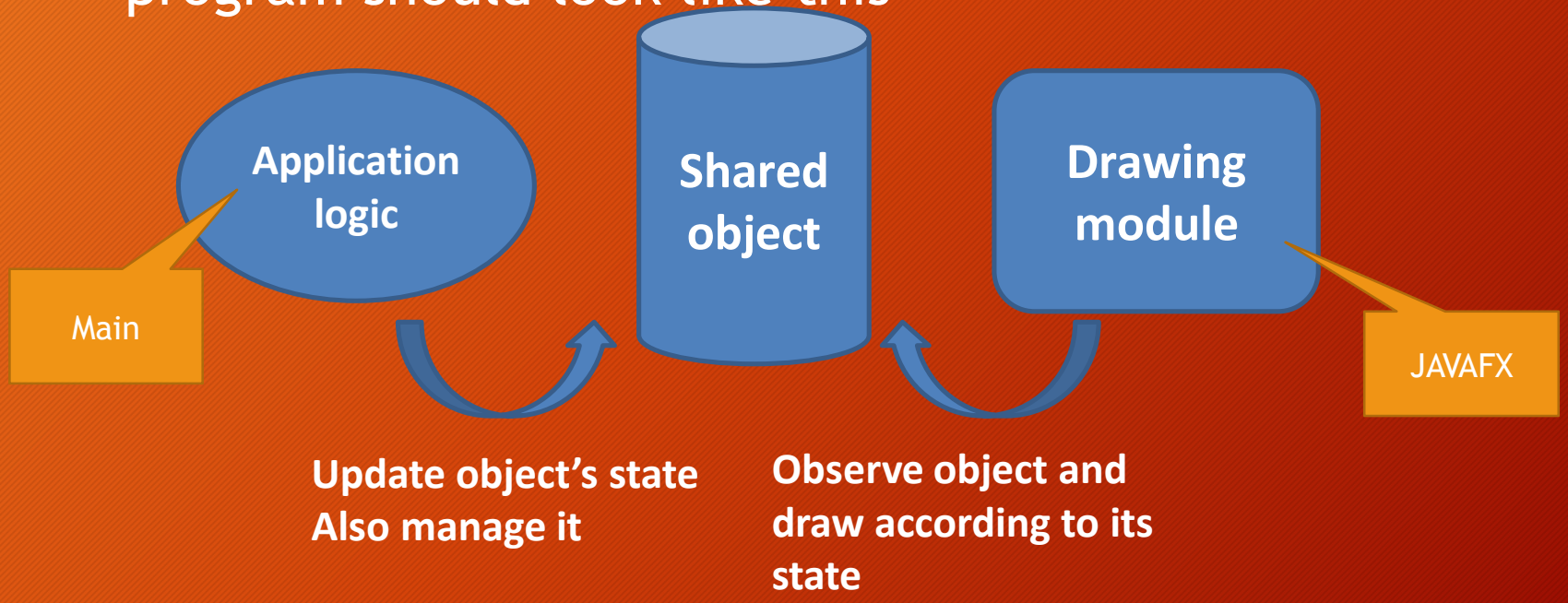
Design

Design

- Normally, we want to **draw** many **objects** on our screen
- Objects with different shapes should have different drawing methods
- At the same time, aside from drawing, we might want to **update** those objects' state

Design Component

- With requirements in the previous slide, the program should look like this



Design Component

- Shared Object
- Drawing Part
- Logic Part

Design Component

- **Shared Object**
- Drawing Part
- Logic Part

Shared Object - Requirement

- Back to our requirements
- Objects with different shapes should have different drawing methods **void draw(GraphicsContext gc)**
- Objects may overlap
  - We need "ordering" **int getZ()**
  - **Z=9 -> Foregound**
  - **Z=-999 -> Background**
- Add more capabilities to the object
  - Able to **hide/show boolean isVisible()**

Interface IRenderable

Shared Object - IRenderable

Polymorphism

```
public interface IRenderable {
        public int getZ();
        public void draw(GraphicsContext gc);
        public boolean isVisible();
}
```

Ordering

Draw

Hide/Show

Shared Object - RenderableHolder

- We want to draw **many objects** on our screen
- The application logic also access these objects

A *shared* Collection of generic interface (IRenderable)

For example:
- ArrayList<IRenderable>
- LinkedList<IRenderable>

Anything to keep track of “all” IRenderable

Shared Object - RenderableHolder

Collection

Constructor

```
public class RenderableHolder_Basic {
    private List<IRenderable> entities;

    public RenderableHolder_Basic() {
        entities = new ArrayList<IRenderable>();
    }
}
```

Shared Object – RenderableHolder - Sort

- RenderableHolder class
  - Any collection with <IRenderable> ArrayList<IRenderable>
  - Methods for accessing the collection

- The collection is used to keep track of objects that have to be drawn on the screen
- IRenderable in the collection **must be sorted by Z** (So you can just loop through the collection and draw the deepest one first)

Shared Object - RenderableHolder - Sort

- RenderableHolder class
  - Any collection with <IRenderable> ArrayList<IRenderable>
  - Methods for accessing the collection -> add(IRenderable)
  - -add(IRenderable)
    add new IRenderable object to the list and sort the list (according to Z)

Shared Object - RenderableHolder - Sort


```java
public class RenderableHolder {
    private List<IRenderable> entities;
    private Comparator<IRenderable> comparator;

    public RenderableHolder() {
        entities = new ArrayList<IRenderable>();
        comparator = (IRenderable o1, IRenderable o2) -> {
            if (o1.getZ() > o2.getZ())
                return 1;
            return -1;
        };
    }

    public void add(IRenderable entity) {
        entities.add(entity);
        // Sort our list by Z
        Collections.sort(entities, comparator);
    }
}
```

Use to sort IRenderable order by Z

Add Irenderable to ArrayList then sort using comparator

```java
public void update() {
    for (int i = entities.size() - 1; i >= 0; i--) {
        if (entities.get(i).isDestroyed())
            entities.remove(i);
    }
}
```

Shared Object – RenderableHolder - Singleton

- We can declare our shared collection as a field
- BUT:
  - According to our design, the collection does not belong to either the logic part (application logic) or the drawing part (drawing module)
  - We only need a single collection to store everything that must be drawn

- We encapsulate our collection in RenderableHolder class and use a **singleton pattern** to ensure that there is **only one instance of RenderableHolder**

Shared Object - RenderableHolder - Singleton

- Singleton pattern
  - A design pattern for a class that can be instantiated to only one object
  - Good when the program only need a single object shared across every part

```
private static final RenderableHolder instance = new RenderableHolder();
public static RenderableHolder getInstance(){
    return instance;
}
```

Shared Object - RenderableHolder - Singleton


```java
public class RenderableHolder_Singleton {
    private List<IRenderable> entities;
    private Comparator<IRenderable> comparator;
    private static final RenderableHolder instance = new RenderableHolder();

    public RenderableHolder_Singleton() {
        entities = new ArrayList<IRenderable>();
        comparator = (IRenderable o1, IRenderable o2) -> {
            if (o1.getZ() > o2.getZ())
                return 1;
            return -1;
        };
    }

    public void add(IRenderable entity) {
        entities.add(entity);
        // Sort our list by Z
        Collections.sort(entities, comparator);
    }

    public static RenderableHolder getInstance(){
        return instance;
    }
}
```

Example : JAVA_FC_TankGame - GameScreen

- This is how to use RenderableHolder from other Classes.

```
public class GameScreen extends Canvas {

    public GameScreen(double width, double height) {
        super(width, height);
        this.setVisible(true);
        addListerner();
    }

    public void addListerner() {

    public void paintComponent() {
        GraphicsContext gc = this.getGraphicsContext2D();
        gc.setFill(Color.BLACK);
        for (IRenderable entity : RenderableHolder.getInstance().getEntities()) {
            if (entity.isVisible() && !entity.isDestroyed()) {
                entity.draw(gc);
            }
        }
    }

}
```

This class wants to iterate all entities

Example : JAVA_FC_TankGame - GameLogic

This is how to use RenderableHolder from other Classes.

```java
public class GameLogic {
    private List<Entity> gameObjectContainer;

    private Tank tank;
    private Mine mine;

    public GameLogic(){
        this.gameObjectContainer = new ArrayList<Entity>();

        Field field = new Field();
        RenderableHolder.getInstance().add(field);
        tank = new Tank(320,240);
        mine = new Mine(100,100);
        addNewObject(tank);
        addNewObject(mine);
    }

    protected void addNewObject(Entity entity){
        gameObjectContainer.add(entity);
        RenderableHolder.getInstance().add(entity);
    }

    public void logicUpdate(){
        tank.update();
        if(!mine.isDestroyed() && tank.collideWith(mine)){
            mine.onCollision(tank);
        }
    }
}
```

This class wants to add entities

Shared Object - RenderableHolder - LoadResource

- Resource holder
  - Used to keep required resources in the memory
  - Resources are either pre-loaded or loaded on use
  - **uses static initializer to load all resources on the first use**

Shared Object - RenderableHolder - LoadResource


```java
public class RenderableHolder {
    private static final RenderableHolder instance = new RenderableHolder();

    private List<IRenderable> entities;
    private Comparator<IRenderable> comparator;
    public static Image mapSprite;
    public static Image mineSprite;
    public static AudioClip  explosionSound;

    static {
        loadResource();
    }

    public RenderableHolder() {

    public static RenderableHolder getInstance() {

    public static void loadResource() {
        ClassLoader loader = ClassLoader.getSystemClassLoader();
        mapSprite = new Image(loader.getResourceAsStream("res/Map.png"));
        mineSprite = new Image(loader.getResourceAsStream("res/Mine.png"));
        explosionSound = new AudioClip((loader.getResource("res/Explosion.wav")).toString());
    }

    public void add(IRenderable entity) {

    public void update() {

    public List<IRenderable> getEntities() {
}
```

Load Resource once
Then
Use Everywhere

Example : JAVA_FC_TankGame - RenderableHolder


```java
public class RenderableHolder {
    private static final RenderableHolder instance = new RenderableHolder();

    private List<IRenderable> entities;
    private Comparator<IRenderable> comparator;
    public static Image mapSprite;
    public static Image mineSprite;
    public static AudioClip  explosionSound;

    static {
        loadResource();
    }

    public RenderableHolder() {
        entities = new ArrayList<IRenderable>();
        comparator = (IRenderable o1, IRenderable o2) -> {
            if (o1.getZ() > o2.getZ())
                return 1;
            return -1;
        };
    }

    public static RenderableHolder getInstance() {
        return instance;
    }
```

Singleton

Load resource only 1 time

How to sort

```java
    public static void loadResource() {
        mapSprite = new Image("file:res/Map.png");
        mineSprite = new Image("file:res/Mine.png");
        explosionSound = new AudioClip("file:res/Explosion.wav");
    }

    public void add(IRenderable entity) {
        System.out.println("add");
        entities.add(entity);
        Collections.sort(entities, comparator);
    }

    public void update() {
        for (int i = entities.size() - 1; i >= 0; i--) {
            if (entities.get(i).isDestroyed())
                entities.remove(i);
        }
    }

    public List<IRenderable> getEntities() {
        return entities;
    }
}
```

Add entity and then sort

Remove dead entity

Design Component

- Shared Object
- **Drawing Part**
- Logic Part

Drawing Part

- Drawing Part
  - A simple subclass of Canvas that look at the shared collection and draw all objects

Example : JAVA_FC_TankGame - GameScreen


```java
public class GameScreen extends Canvas {

    public GameScreen(double width, double height) {
        super(width, height);
        this.setVisible(true);
        addListerner();
    }

    public void addListerner() {..

    public void paintComponent() {
        GraphicsContext gc = this.getGraphicsContext2D();
        gc.setFill(Color.BLACK);
        for (IRenderable entity : RenderableHolder.getInstance().getEntities()) {
            if (entity.isVisible() && !entity.isDestroyed()) {
                entity.draw(gc);
            }
        }
    }

}
```

Design Component

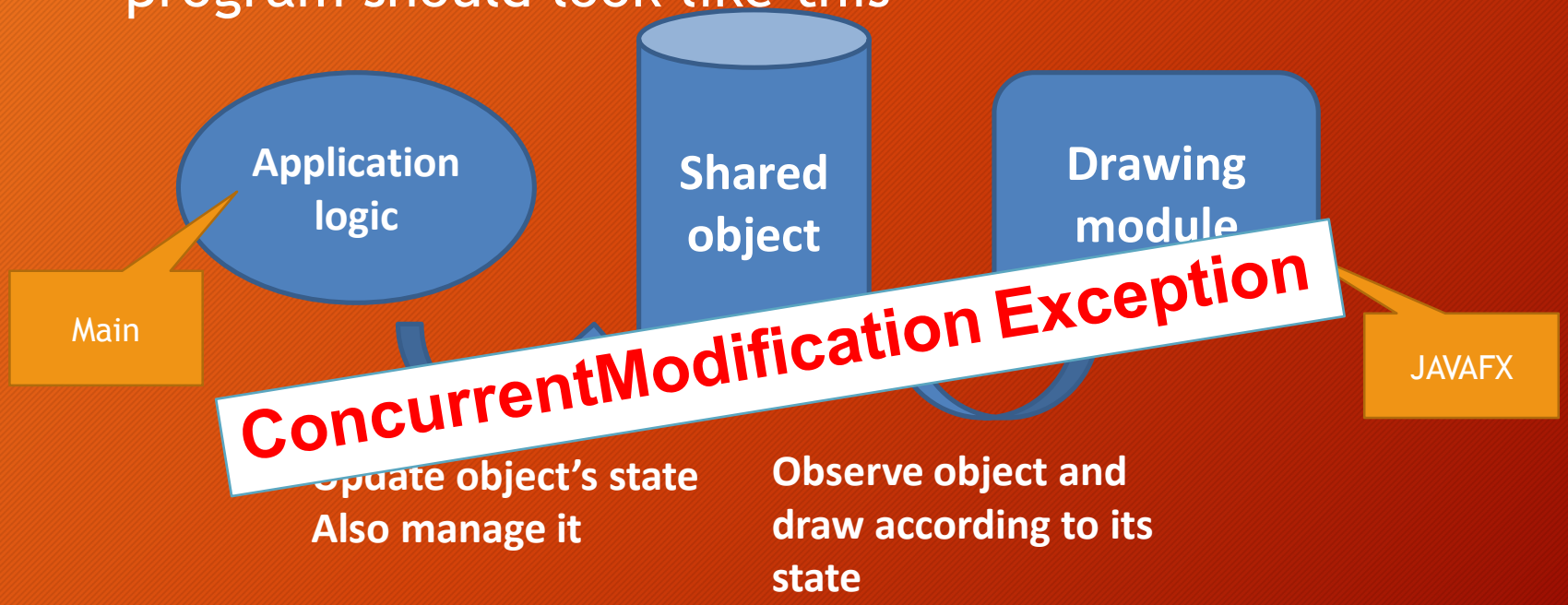
- Shared Object
- Drawing Part
- **Logic Part**

Logic Part

- Logic Part
  - This part is responsible for creating/removing objects and updating their state
  - When creating an object, if it must be drawn to the screen (that object is an IRenderable), add it to RenderableHolder
  - When removing an object, if it was added to RenderableHolder, don’t forget to remove it from the holder

Design Component

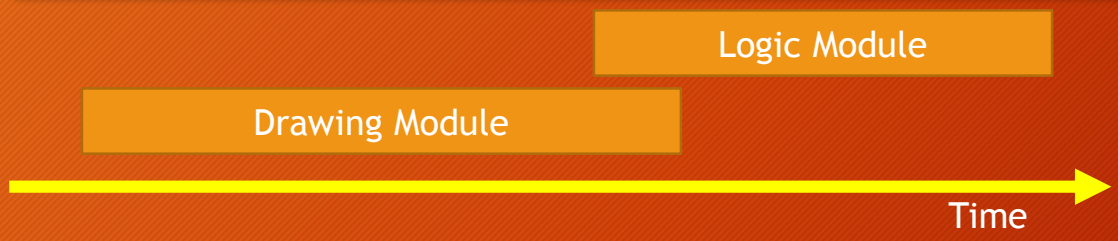
- With requirements in the previous slide, the program should look like this



Logic Part


```
AnimationTimer animation = new AnimationTimer() {
    public void handle(long now) {
        gameScreen.paintComponent();
        logic.logicUpdate();
        RenderableHolder.getInstance().update();
        InputUtility.updateInputState();
    }
};
animation.start();
```

- Drawing Module
  - Need to loop all Renderable.list to draw all object
- Logic Module
  - Need to loop all Renderable.list to update object
- Sometime, Logic Module access list while Drawing module have not finished draw all object
- This will cause Concurrent Modification Exception




```
public class ConcurrentModificationException
extends RuntimeException
```

This exception may be thrown by methods that have detected concurrent modification of an object when such modification is not permissible.

Logic Part

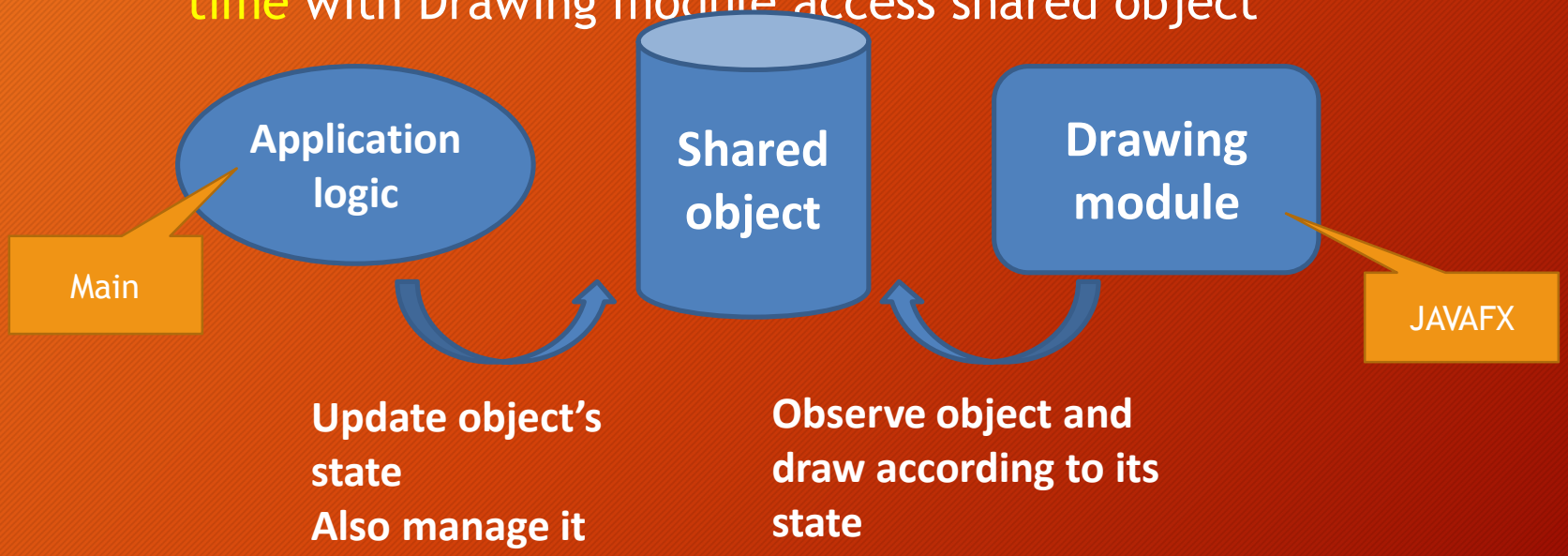
- To update objects that are added to the holder, there are 2 approaches:

1. Loop through all objects in the holder and update any object needed (casting required)

2. Cache local references of those objects and update through these references

Logic Part – Update Object

- **Approach 1 : Problem**
  - Application logic access shared object at the same time with Drawing module access shared object

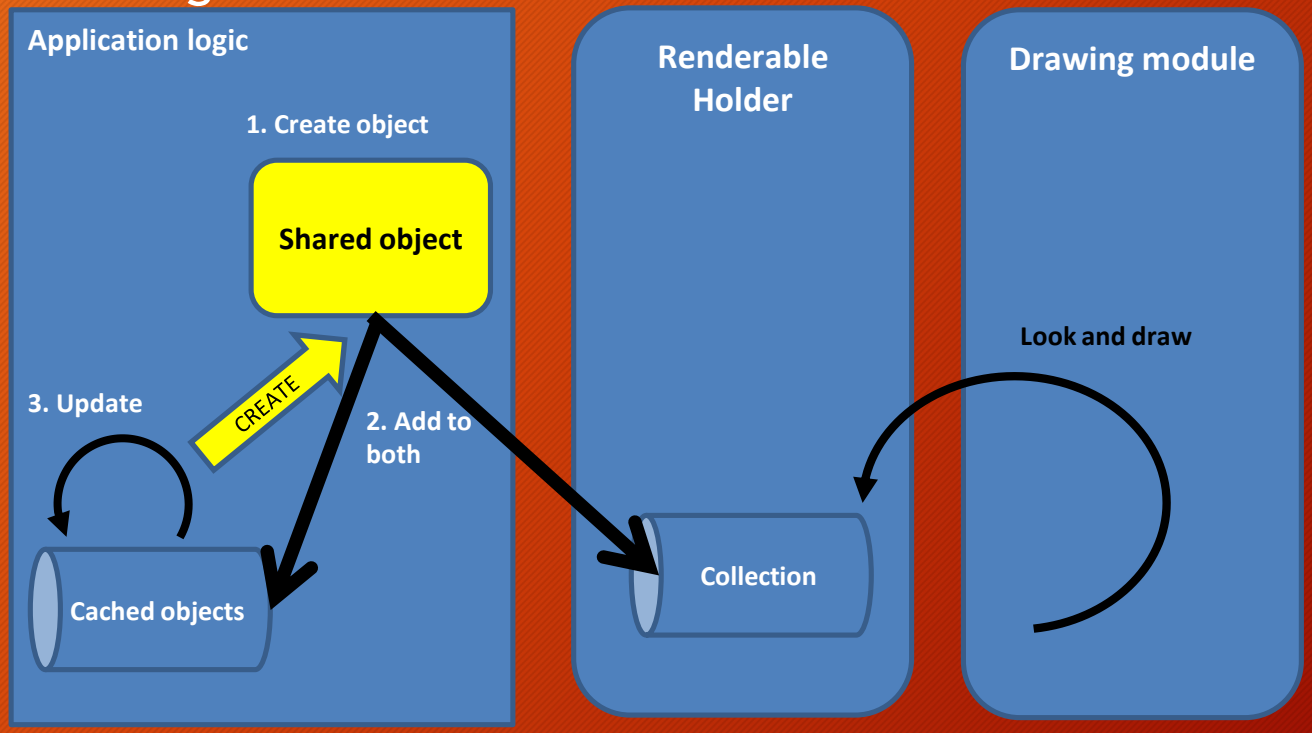


Logic Part – Update Object

- Approach 1 :
  - Loop through all objects in the holder and update any object needed
- Problem :
  - Application logic access shared object at the same time with Drawing module access shared object
- Solution :
  - using synchronize (Not in our scope!)

Logic Part – Update Object

- Approach 2 :
  - Cache local references of those objects and update through these references



Example : JAVA_FC_TankGame - GameLogic

- Create object
- Add same object in both Lists.

```java
public class GameLogic {
    private List<Entity> gameObjectContainer;

    private Tank tank;
    private Mine mine;

    public GameLogic(){
        this.gameObjectContainer = new ArrayList<Entity>();

        Field field = new Field();
        RenderableHolder.getInstance().add(field);
        tank = new Tank(320,240);
        mine = new Mine(100,100);
        addNewObject(tank);
        addNewObject(mine);
    }

    protected void addNewObject(Entity entity){
        gameObjectContainer.add(entity);
        RenderableHolder.getInstance().add(entity);
    }

    public void logicUpdate(){
        tank.update();
        if(!mine.isDestroyed() && tank.collideWith(mine)){
            mine.onCollision(tank);
        }
    }
}
```

Handling User Input

Handling User Input

- Detecting and processing user input in JavaFX is straightforward
- User actions that can be detected by the system, such as key presses and mouse clicks, are called *events*
- Any JavaFX class which implements the EventTarget class, such as a Scene, can "listen" for events and handle them

Handling User Input

- There are many methods that listen for handling different types of input from different sources
- setOnKey……() can assign an EventHandler that will activate when a key is ……
- setOnMouse…… () can assign an EventHandler that activates when a mouse button is ……
- The EventHandler class serves one purpose: to encapsulate a method (called handle()) that is called when the corresponding event occurs.

Handling User Input Example

- Example of Key Event

```
this.setOnKeyPressed((KeyEvent event) -> {
    InputUtility.setKeyPressed(event.getCode(), true);
});

this.setOnKeyReleased((KeyEvent event) -> {
    InputUtility.setKeyPressed(event.getCode(), false);
});
```

Handling User Input Example

- Example of Mouse Event

```
this.setOnMousePressed((MouseEvent event) -> {
    if (event.getButton() == MouseButton.PRIMARY)
        InputUtility.mouseLeftDown();
});

this.setOnMouseReleased((MouseEvent event) -> {
    if (event.getButton() == MouseButton.PRIMARY)
        InputUtility.mouseLeftRelease();
});
```

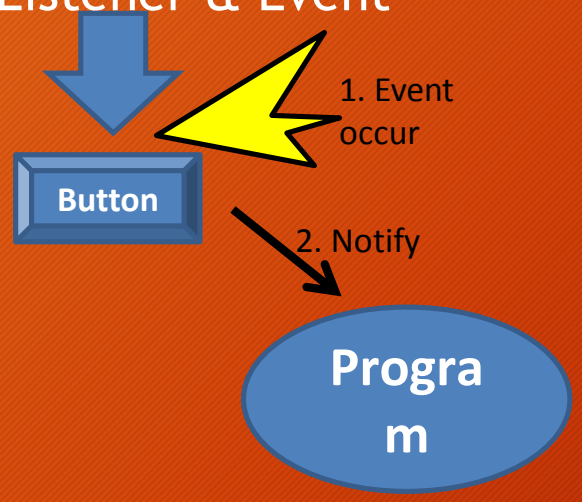
```
this.setOnMouseEntered((MouseEvent event) -> {
    InputUtility.mouseOnScreen = true;
});

this.setOnMouseExited((MouseEvent event) -> {
    InputUtility.mouseOnScreen = false;
});
```

```
this.setOnMouseMoved((MouseEvent event) -> {
    if (InputUtility.mouseOnScreen) {
        InputUtility.mouseX = event.getX();
        InputUtility.mouseY = event.getY();
    }
});

this.setOnMouseDragged((MouseEvent event) -> {
    if (InputUtility.mouseOnScreen) {
        InputUtility.mouseX = event.getX();
        InputUtility.mouseY = event.getY();
    }
});
```

Input handling

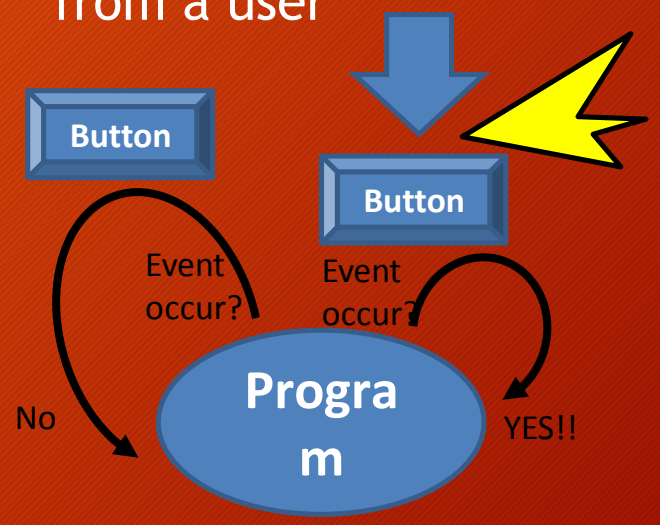
Event-driven

- A program handle an event immediately
- Listener & Event



Polling

- Periodically check if there is an input from a user



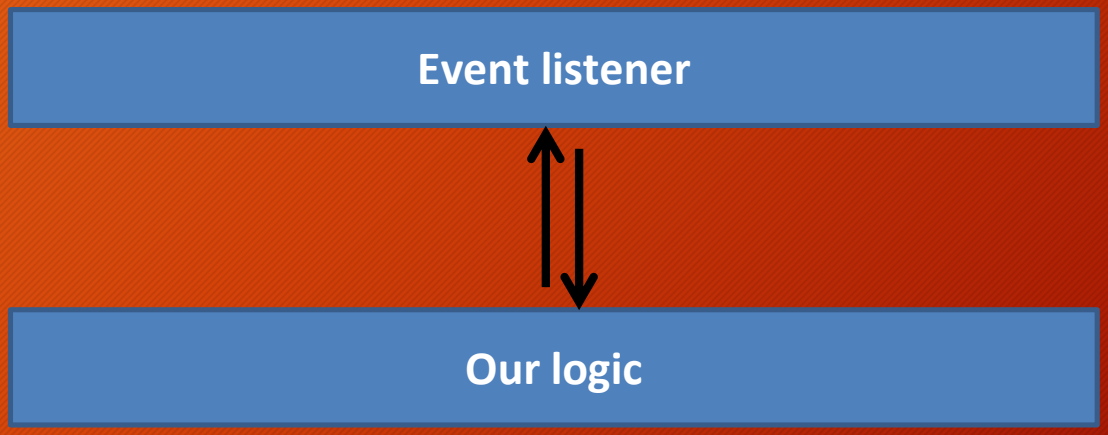
Input handling

- JVM provides user's input to JavaFX application via callback method in a listener which is an **event-driven method**
- This means we don't not know when the input is coming

- In contrast, the input checking code requires the exact time to operate!
- Therefore, it is required to poll the incoming event which is **polling method**

Input handling - Event-driven

- Event-driven
  - JVM provides user's input to JavaFX application via callback method in a listener
  - This means we don't not know when the input is coming



Example : JAVA_FX_InputHanding_Event_Driven

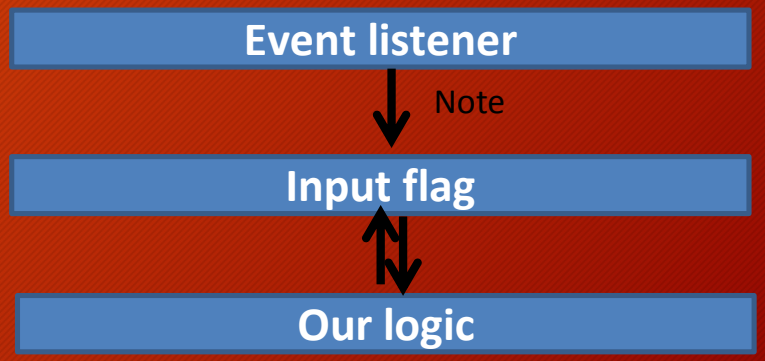

```java
public class Main extends Application {
    public static void main(String[] args) {
        Application.launch(args);
    }

    @Override
    public void start(Stage stage) {
        StackPane root = new StackPane();
        GameScreen gameScreen = new GameScreen(root);
        stage.setScene(gameScreen);
        stage.setTitle("Click click click");

        gameScreen.redraw("");
        stage.show();

        gameScreen.setOnKeyPressed((KeyEvent e) -> {
            String new_code = e.getCode().toString();
            gameScreen.redraw(new_code);
        });

    }
}
```

Trigger -> draw

```java
public class GameScreen extends Scene {
    private Canvas canvas;

    public GameScreen(Pane parent) {
        super(parent);

        canvas = new Canvas(420, 200);
        parent.getChildren().add(canvas);
    }

    public void redraw(String code){
        GraphicsContext gc = canvas.getGraphicsContext2D();
        gc.setFill(Color.BLACK);
        gc.setFont(Font.font(40));
        gc.clearRect(0, 0, canvas.getWidth(), canvas.getHeight());
        gc.fillText("TEST SetOnKeyPressed", 10, 50);
        gc.fillText(code, 200, 100);
    }
}
```

Input handling - Polling

- Polling
  - the input checking code requires the exact placement in the application code. Therefore, it is required to poll the incoming event
- The idea
  - When an event takes place, notes it down somewhere
  - Our logic polls the noted event



Input handling - Polling

- Polling example

```
While(true){
        Sleep for 20 ms
        Draw screen
        Update logic (poll the event here)
}
```

```
If (users press ENTER){
        Do action 1
}
If(users press SPACE){
        Do action 2
}
```

Example : JAVA_FX_InputHanding_Polling


```java
public class Main extends Application {
    public static void main(String[] args) {
        Application.launch(args);
    }

    @Override
    public void start(Stage stage) {
        StackPane root = new StackPane();
        GameScreen gameScreen = new GameScreen(root);
        stage.setScene(gameScreen);
        stage.setTitle("Click click click");

        gameScreen.redraw();
        stage.show();

        gameScreen.setOnKeyPressed((KeyEvent e) -> {
            String new_code = e.getCode().toString();
            CodeUtility.receiveInput(new_code);
        });

        new AnimationTimer() {
            public void handle(long now) {
                gameScreen.redraw();
            }
        }.start();
    }
}
```

Trigger -> store value

Loop to redraw

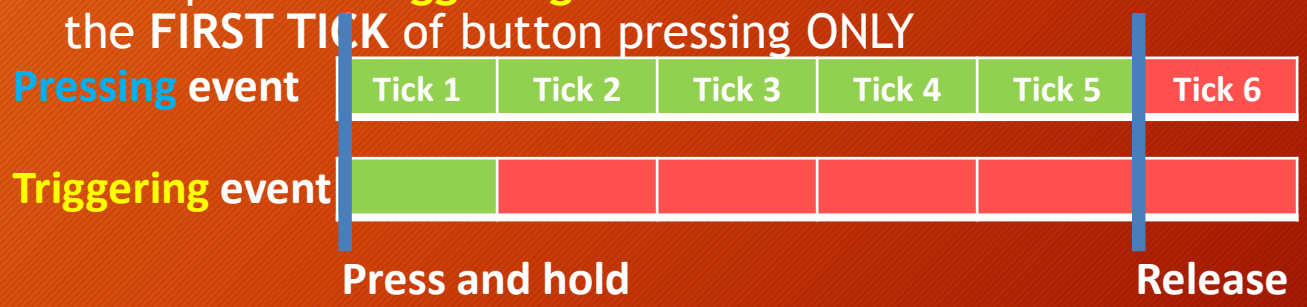
```java
public class CodeUtility {
    public static String code = "";
    public static int counter = 0;

    public static void receiveInput(String new_code){
        if(code.equalsIgnoreCase(new_code)) counter++;
        else counter = 1;
        code = new_code;
    }
}
```

Get code value

```java
public class GameScreen extends Scene {
    private Canvas canvas;

    public GameScreen(Pane parent) {
        super(parent);

        canvas = new Canvas(420, 200);
        parent.getChildren().add(canvas);
    }

    public void redraw(){
        GraphicsContext gc = canvas.getGraphicsContext2D();
        gc.setFill(Color.BLACK);
        gc.setFont(Font.font(40));
        gc.clearRect(0, 0, canvas.getWidth(), canvas.getHeight());
        gc.fillText("TEST SetOnKeyPressed", 10, 50);
        gc.fillText(CodeUtility.code, 200, 100);
    }
}
```

Input handling – Pressing VS Triggering

- Pressing VS Triggering
  - When user **press and hold** a button
    - If we poll for **pressing** event : it must remain TRUE until user releases the button
    - If we poll for **triggering** event : it must be TRUE on the **FIRST TICK** of button pressing ONLY



Example : JAVA_FX_Key


```java
public class Main extends Application {
    public static void main(String[] args) {
        Application.launch(args);
    }

    @Override
    public void start(Stage stage) {
        StackPane root = new StackPane();
        GameScreen gameScreen = new GameScreen(root);
        stage.setScene(gameScreen);
        stage.setTitle("Click click click");

        stage.show();

        gameScreen.setOnKeyPressed((KeyEvent e) -> {
            String new_code = e.getCode().toString();
            CodeUtility.receiveInput(new_code);
        });

        AnimationTimer timer = new AnimationTimer() {
            public void handle(long now) {
                gameScreen.redraw();
            }
        };
        timer.start();

    }
}
```

```java
public class CodeUtility {
    public static String code = "";
    public static int counter = 0;

    public static void receiveInput(String new_code){
        if(code.equalsIgnoreCase(new_code)) counter++;
        else counter = 1;
        code = new_code;
    }
}
```

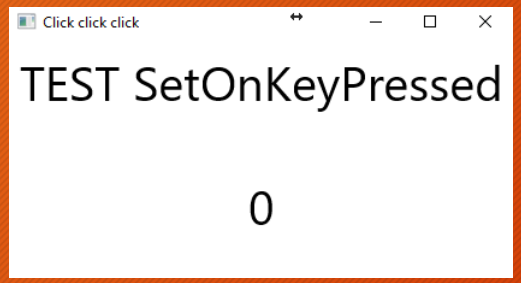
```java
public class GameScreen extends Scene {
    private Canvas canvas;

    public GameScreen(Pane parent) {
        super(parent);

        canvas = new Canvas(420, 200);
        parent.getChildren().add(canvas);
    }

    public void redraw(){
        GraphicsContext gc = canvas.getGraphicsContext2D();
        gc.setFill(Color.BLACK);
        gc.setFont(Font.font(40));
        gc.clearRect(0, 0, canvas.getWidth(), canvas.getHeight());
        gc.fillText("TEST SetOnKeyPressed", 10, 50);
        gc.fillText(CodeUtility.code + "\n" + CodeUtility.counter, 200, 100);
    }

}
```

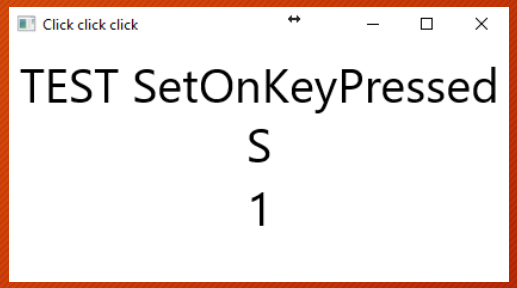
Example : JAVA_FX_Key

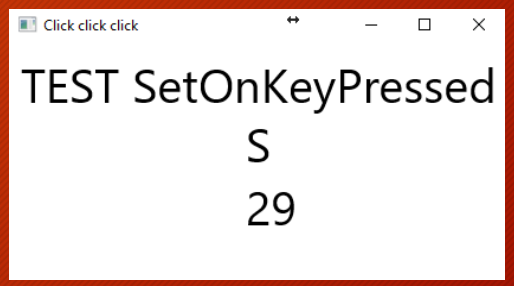
- This happens when we press “S” and hold

(1)

Start Program → Press S → Hold S







Input handling – Pressing VS Triggering

- Implementation to poll for pressing and triggering event
  - Take note of pressing and triggering event separately when “pressed” event happens
  - Pressing flag changes to FALSE on button releasing
  - Triggering flag changes to FALSE at the end of every tick

Example : JAVA_FX_KeyUpgrade


```java
public static void setPressed(boolean pressed) {
    if (pressed) {
        CodeUtility.pressed = true;
    } else {
        CodeUtility.pressed = false;
    }
}
```

```java
public static void setTriggered(String code, boolean pressed) {
    if (pressed) {
        CodeUtility.triggered = true;
        if (CodeUtility.code.equals(code))
            counter++;
        else {
            CodeUtility.code = code;
            counter = 1;
        }
    } else {
        CodeUtility.triggered = false;
    }
}
```

```java
public class Main extends Application {
    public static void main(String[] args) {
        Application.launch(args);
    }

    @Override
    public void start(Stage stage) {
        StackPane root = new StackPane();
        GameScreen gameScreen = new GameScreen(root);
        stage.setScene(gameScreen);
        stage.setTitle("Click click click");

        stage.show();

        gameScreen.setOnKeyPressed((KeyEvent event) -> {
            String new_code = event.getCode().toString();
            if (!CodeUtility.getPressed())
                CodeUtility.setTriggered(new_code, true);
            CodeUtility.setPressed(true);
        });

        gameScreen.setOnKeyReleased((KeyEvent event) -> {
            CodeUtility.setPressed(false);
        });

        AnimationTimer timer = new AnimationTimer() {
            public void handle(long now) {
                gameScreen.redraw();
                CodeUtility.postUpdate();
            }
        };
        timer.start();
    }
}
```

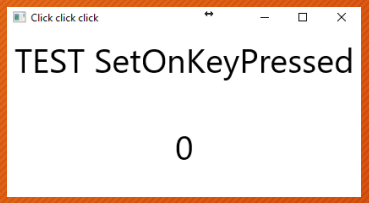
Example : JAVA_FX_KeyUpgrade

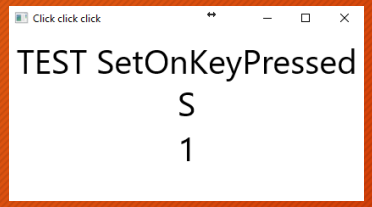
Action	Code	Counter	Pressed	Triggered
Start Program		0	False	False
Press S	S	1	True	True
CodeUtility.postUpdate()	S	1	True	False
Hold S	S	1	True	False
CodeUtility.postUpdate()	S	1	True	False
Release S	S	1	False	False
CodeUtility.postUpdate()	S	1	False	False
Press S	S	2	True	True
CodeUtility.postUpdate()	S	2	True	False

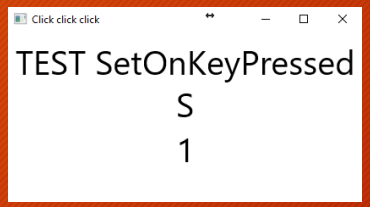
Example : JAVA_FX_KeyUpgrade

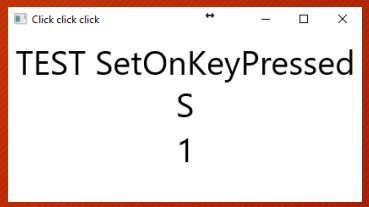
- This happens when we press “S” continuously

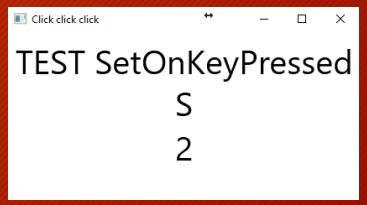
Start Program → Press S → Hold S → Release S → Press S











Input handling – Pressing VS Triggering

- When we have multiple input at the same time
- One way to accomplish this is by creating an ArrayList of String objects
- When a key is initially pressed, we add the String representation of the KeyEvent's KeyCode to the list
- When the key is released, we remove it from the list.

Input handling – Pressing VS Triggering

- Implement method
  - Getter and setter of keyPressed, KeyTriggered and KeyTriggerFlag yourself

(><)// wish u can do it by yourself

```
public class InputUtility {

    private static int mouseX, mouseY;
    private static boolean mouseLeftDown, mouseRightDown, mouseOnScreen;
    private static boolean mouseLeftLastDown, mouseRightLastDown;
    private static ArrayList<KeyCode> keyPressed = new ArrayList<>();
    private static ArrayList<KeyCode> keyTriggered = new ArrayList<>();
    private static ArrayList<KeyCode> keyTriggerFlag = new ArrayList<>();
```

Input handling – Pressing VS Triggering

- Triggering event: Keyboard VS Mouse
  - MouseListener fires “mousePressed” event only **once** when mouse button is pressed and held
  - KeyListener fires “keyPressed” event continuously (**<u>about</u> every tick**) as long as a button is pressed and held
    - Hold key? we only note down triggering event on the **first tick** of button **holding** : The tick that “pressed” flag change from FALSE to TRUE

Example : JAVA_FX_Mouse

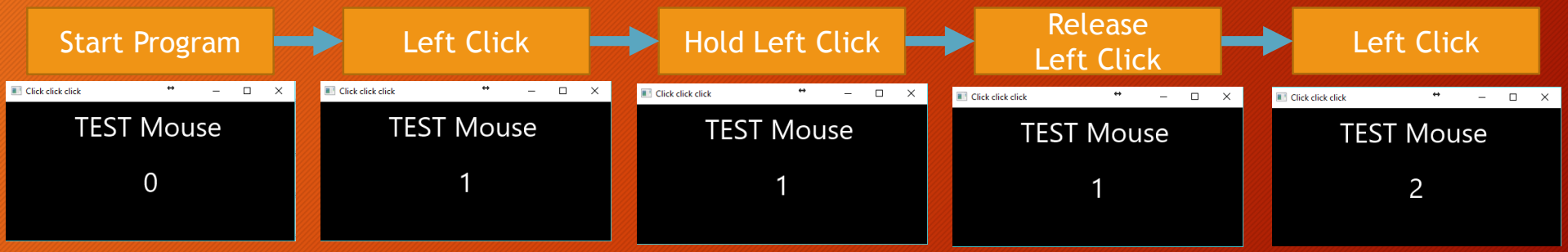
- Details of the program:
  - Click to increase the counter
  - Click & hold considers as “1 click”
  - The program should differentiate between “click” vs. “click & hold”

```
AnimationTimer timer = new AnimationTimer() {
    public void handle(long now) {
        gameScreen.redraw();
        if(MouseUtility.isLeftClickTriggered()){
            MouseUtility.counter++;
        }
        MouseUtility.postUpdate();
    }
};
timer.start();
```

```
gameScreen.setOnMouseClicked(new EventHandler<MouseEvent>() {
    public void handle(MouseEvent event) {
        if(event.getButton() == MouseButton.PRIMARY)
            MouseUtility.mouseLeftDown();
    }
});

gameScreen.setOnMouseReleased(new EventHandler<MouseEvent>() {
    public void handle(MouseEvent event) {
        if(event.getButton() == MouseButton.PRIMARY)
            MouseUtility.mouseLeftRelease();
    }
});
```

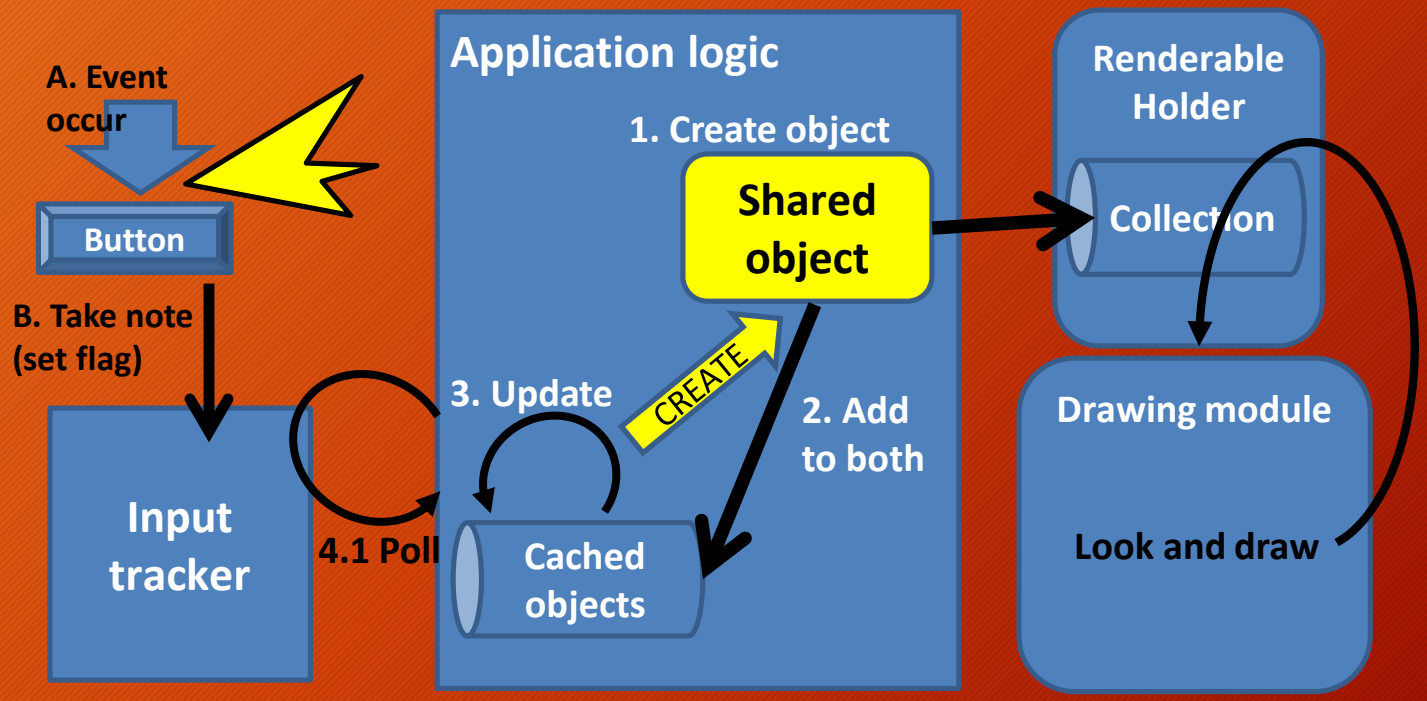
Input handling – Mouse

- This happens when we hold “left click”



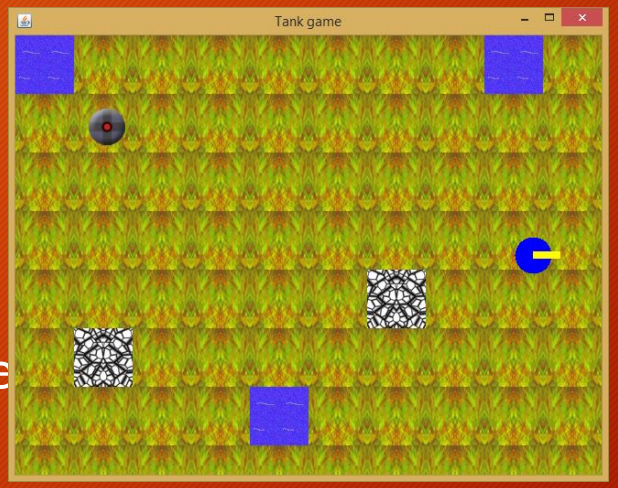
Graphics + Input

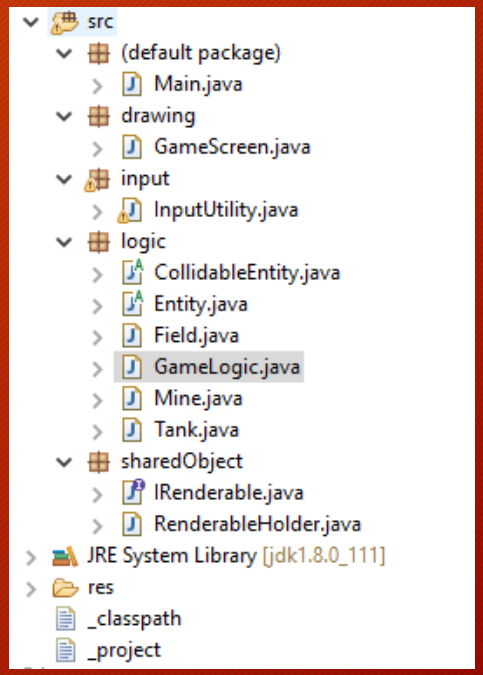
Put everything together



Put everything together

- Put everything together : JAVA_FX_TankGame
  - Controllable tank
    - W: Forward
    - A: Turn left
    - D: Turn right
    - Shift: Hide
    - Click: Warp
- The code
  - Drawing the battlefie
  - A moving tank





Input Handling – JAVA_FX_TankGame

- GameScreen Class

Key Event

```
this.setOnKeyPressed((KeyEvent event) -> {
    InputUtility.setKeyPressed(event.getCode(), true);
});

this.setOnKeyReleased((KeyEvent event) -> {
    InputUtility.setKeyPressed(event.getCode(), false);
});
```

Mouse Event

```
this.setOnMousePressed((MouseEvent event) -> {
    if (event.getButton() == MouseButton.PRIMARY)
        InputUtility.mouseLeftDown();
});

this.setOnMouseReleased((MouseEvent event) -> {
    if (event.getButton() == MouseButton.PRIMARY)
        InputUtility.mouseLeftRelease();
});

this.setOnMouseEntered((MouseEvent event) -> {
    InputUtility.mouseOnScreen = true;
});

this.setOnMouseExited((MouseEvent event) -> {
    InputUtility.mouseOnScreen = false;
});

this.setOnMouseMoved((MouseEvent event) -> {
    if (InputUtility.mouseOnScreen) {
        InputUtility.mouseX = event.getX();
        InputUtility.mouseY = event.getY();
    }
});

this.setOnMouseDragged((MouseEvent event) -> {
    if (InputUtility.mouseOnScreen) {
        InputUtility.mouseX = event.getX();
        InputUtility.mouseY = event.getY();
    }
});
```

Audio

Java sound

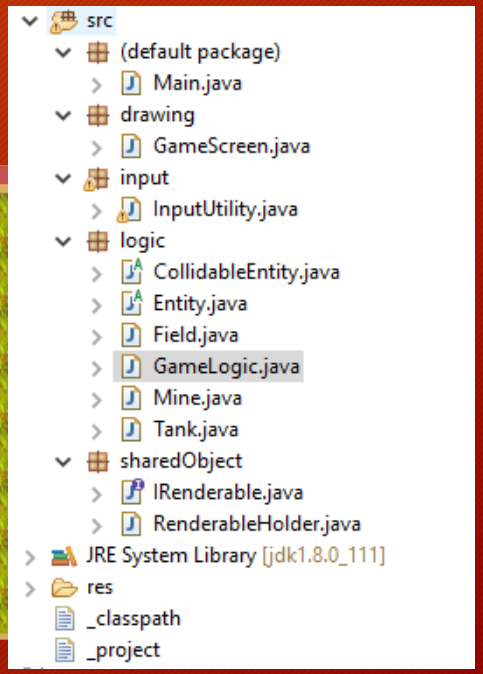
- New JAVA sound API in JavaFX
  - javafx.scene.media.AudioClip
- Constructor
  - AudioClip sound = new AudioClip(String source)
- Very easy to use
  - sound.play
  - sound.stop()
  - sound.setCycle()
  - sound.setVolume()

Example : JAVA_FX_Sound


```java
public class Main extends Application {
    public static void main(String[] args) {
        Application.launch(args);
    }

    @Override
    public void start(Stage stage) {
        StackPane root = new StackPane();
        Scene scene = new Scene(root);
        stage.setScene(scene);
        stage.setTitle("AnimationTimer");

        Canvas canvas = new Canvas(800, 400);
        GraphicsContext gc = canvas.getGraphicsContext2D();
        root.getChildren().add(canvas);

        gc.setFill(Color.BLACK);
        gc.fillRect(0, 0, canvas.getWidth(), canvas.getHeight());

        AudioClip sound = new AudioClip("file:res/audio/Meow.wav");

        scene.setOnMouseClicked(new EventHandler<MouseEvent>() {
            public void handle(MouseEvent event) {
                createCat(gc);
                createCat(gc);
                sound.play();
            }
        });

        stage.show();
    }

    public void createCat(GraphicsContext gc) {
        int random = (int) (Math.random() * 5 + 1);
        Image image = new Image("file:res/image/cat" + random + ".jpg", 100, 100, false, false);
        double width = Math.random() * gc.getCanvas().getWidth();
        double height = Math.random() * gc.getCanvas().getHeight();
        gc.drawImage(image,width, height);
    }
}
```

Put everything together

- Put everything together : JAVA_FX_TankGame
  - Move tank to the same position of mine
  - It will cause Explosion sound
- The code
  - Drawing the battlefield
  - A moving tank



Java sound – JAVA_FX_TankGame


```java
public class Mine extends CollidableEntity{

    public Mine(int x,int y){
        this.x = x;
        this.y = y;
        this.z = -100;
        this.radius = 20;
    }

    public void onCollision(Tank tank){
        tank.hitByMine();
        RenderableHolder.explosionSound.play();
        this.destroyed = true;
    }
```

```java
public class RenderableHolder {
    private static final RenderableHolder instance = new RenderableHolder();

    private List<IRenderable> entities;
    private Comparator<IRenderable> comparator;
    public static Image mapSprite;
    public static Image mineSprite;
    public static AudioClip  explosionSound;

    static {
        loadResource();
    }

    public RenderableHolder() {

    public static RenderableHolder getInstance() {

    public static void loadResource() {
        mapSprite = new Image(ClassLoader.getSystemResource("Map.png").toString());
        mineSprite = new Image(ClassLoader.getSystemResource("Mine.png").toString());
        explosionSound = new AudioClip(ClassLoader.getSystemResource("Explosion.wav").toString());
    }
```

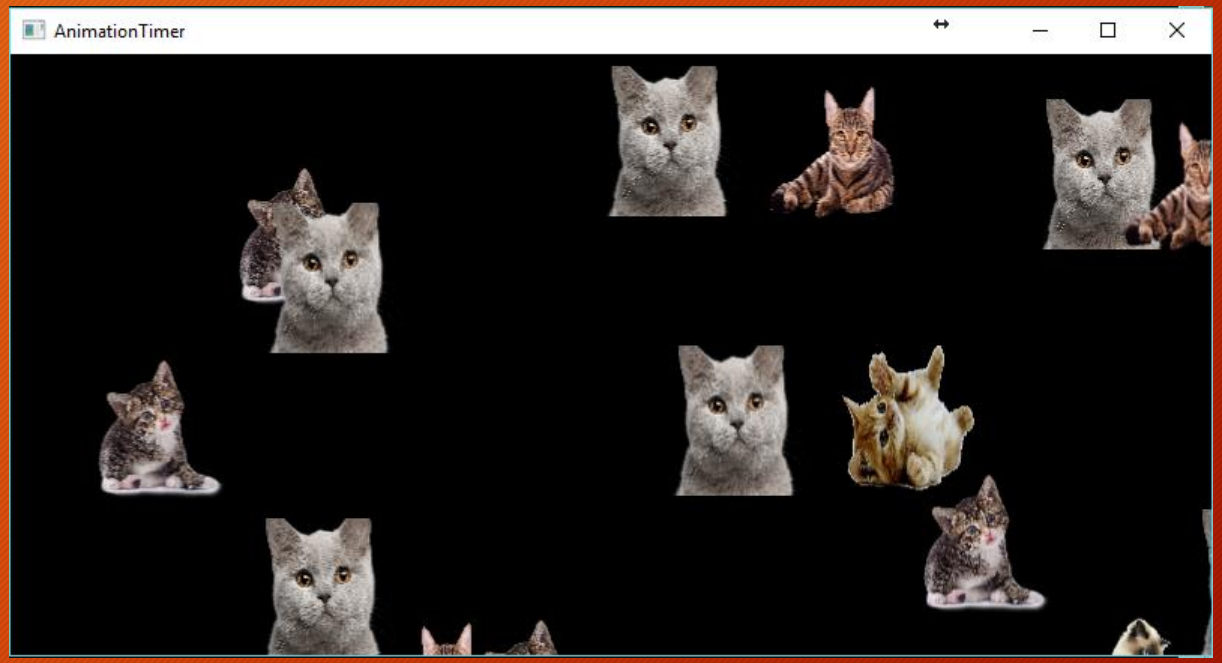
Export Jar

Publishing

- We've managed to draw something
- Let's try out our application as an executable JAR

Export Jar

- Run -> JAVA_FX_Sound/run.jar

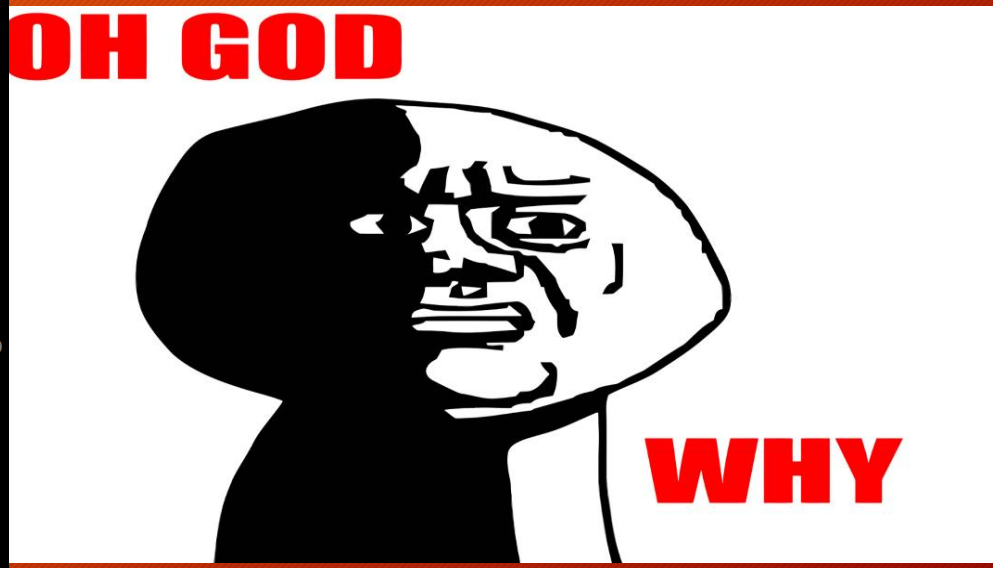


Export Jar

- Let copy our run.jar to somewhere
- Go to JAVA_FX_Sound/TestJar/1_only_jar/run.jar
- Run -> run.jar

Export Jar


```
[redacted]JAVA_FX_Sound\TestJar\1_only_jar>java -jar run.jar
Exception in Application start method
java.lang.reflect.InvocationTargetException
        at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
        at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
        at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
        at java.lang.reflect.Method.invoke(Method.java:498)
        at com.sun.javafx.application.LauncherImpl.launchApplicationWithArgs(LauncherImpl.java:389)
        at com.sun.javafx.application.LauncherImpl.launchApplication(LauncherImpl.java:328)
        at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
        at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
        at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
        at java.lang.reflect.Method.invoke(Method.java:498)
        at sun.launcher.LauncherHelper$FXHelper.main(LauncherHelper.java:767)
Caused by: java.lang.RuntimeException: Exception in Application start method
        at com.sun.javafx.application.LauncherImpl.launchApplication1(LauncherImpl.java:917)
        at com.sun.javafx.application.LauncherImpl.lambda$launchApplication$155(LauncherImpl.java:182)
        at java.lang.Thread.run(Thread.java:745)
Caused by: MediaException: MEDIA_UNAVAILABLE : res\audio\Meow.wav (The system cannot find the path specified)
        at javafx.scene.media.AudioClip.<init>(AudioClip.java:87)
        at Main.start(Main.java:33)
        at com.sun.javafx.application.LauncherImpl.lambda$launchApplication1$162(LauncherImpl.java:863)
        at com.sun.javafx.application.PlatformImpl.lambda$runAndWait$175(PlatformImpl.java:326)
        at com.sun.javafx.application.PlatformImpl.lambda$null$173(PlatformImpl.java:295)
        at java.security.AccessController.doPrivileged(Native Method)
        at com.sun.javafx.application.PlatformImpl.lambda$runLater$174(PlatformImpl.java:294)
        at com.sun.glass.ui.InvokeLaterDispatcher$Future.run(InvokeLaterDispatcher.java:95)
        at com.sun.glass.ui.win.WinApplication._runLoop(Native Method)
        at com.sun.glass.ui.win.WinApplication.lambda$null$148(WinApplication.java:191)
        ... 1 more
Exception running application Main
```



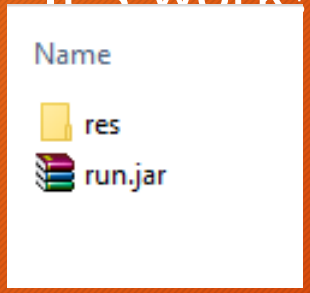
```
JAVA_FX_Sound\TestJar\1_only_jar>java -jar run.jar
Exception in Application start method
java.lang.reflect.InvocationTargetException
        at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
        at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
        at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
        at java.lang.reflect.Method.invoke(Method.java:498)
        at com.sun.javafx.application.LauncherImpl.launchApplicationWithArgs(LauncherImpl.java:389)
        at com.sun.javafx.application.LauncherImpl.launchApplication(LauncherImpl.java:328)
        at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
        at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
        at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
        at java.lang.reflect.Method.invoke(Method.java:498)
        at sun.launcher.LauncherHelper$FXHelper.main(LauncherHelper.java:767)
Caused by: java.lang.RuntimeException: Exception in Application start method
        at com.sun.javafx.application.LauncherImpl.launchApplication1(LauncherImpl.java:917)
        at com.sun.javafx.application.LauncherImpl.lambda$launchApplication$155(LauncherImpl.java:182)
        at java.lang.Thread.run(Thread.java:745)
Caused by: MediaException: MEDIA_UNAVAILABLE : res\audio\Meow.wav (The system cannot find the path specified
        at javafx.scene.media.AudioClip.<init>(AudioClip.java:87)
        at Main.start(Main.java:33)
        at com.sun.javafx.application.LauncherImpl.lambda$launchApplication1$162(LauncherImpl.java:863)
        at com.sun.javafx.application.PlatformImpl.lambda$runAndWait$175(PlatformImpl.java:326)
        at com.sun.javafx.application.PlatformImpl.lambda$null$173(PlatformImpl.java:295)
        at java.security.AccessController.doPrivileged(Native Method)
        at com.sun.javafx.application.PlatformImpl.lambda$runLater$174(PlatformImpl.java:294)
        at com.sun.glass.ui.InvokeLaterDispatcher$Future.run(InvokeLaterDispatcher.java:95)
        at com.sun.glass.ui.win.WinApplication._runLoop(Native Method)
        at com.sun.glass.ui.win.WinApplication.lambda$null$148(WinApplication.java:191)
        ... 1 more
Exception running application Main
```

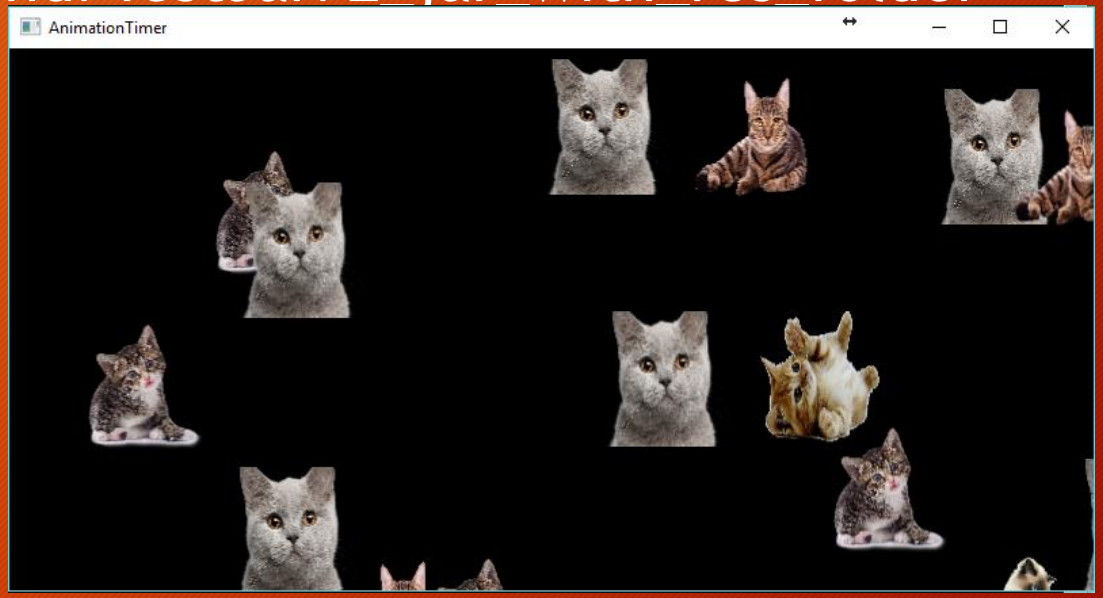
Export Jar – With res folder

- Let’s take a look at how we load our sound
  - AudioClip sound = new AudioClip("audio/Meow.wav");
- The image must be in the same directory as our JAR
  - Let’s try again

Export Jar – With res folder

- Run -> JAVA_FX_Sound/TestJar/2_jar_with_res_folder/run.jar
- It's work!!!



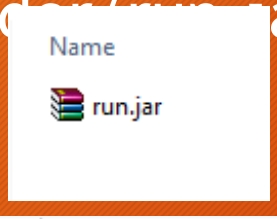


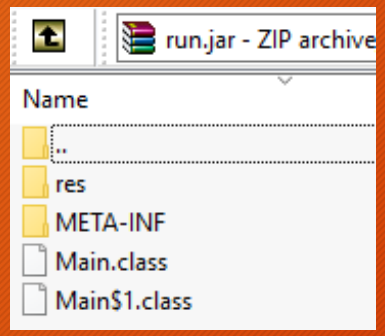
Export Jar – Contains res folder

- Keeping resource beside our JAR works
- But it would be better if we can store all our resources into our JAR

Export Jar – Contains res folder

- Run -> JAVA_FX_Sound/Test_Jar/3_jar_contain_res_folder/run.jar






```
JAVA_FX_Sound\TestJar\3_jar_contain_res_folder>java -jar run.jar
Exception in Application start method
java.lang.reflect.InvocationTargetException
        at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
        at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
        at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
        at java.lang.reflect.Method.invoke(Method.java:498)
        at com.sun.javafx.application.LauncherImpl.launchApplicationWithArgs(LauncherImpl.java:389)
        at com.sun.javafx.application.LauncherImpl.launchApplication(LauncherImpl.java:328)
        at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
        at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
        at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
        at java.lang.reflect.Method.invoke(Method.java:498)
        at sun.launcher.LauncherHelper$FXHelper.main(LauncherHelper.java:767)
Caused by: java.lang.RuntimeException: Exception in Application start method
        at com.sun.javafx.application.LauncherImpl.launchApplication1(LauncherImp
        at com.sun.javafx.application.LauncherImpl.lambda$launchApplication$155(Launche
        at java.lang.Thread.run(Thread.java:745)
Caused by: MediaException: MEDIA_UNAVAILABLE : res\audio\Meow.wav (The system cannot find the path specified)
        at javafx.scene.media.AudioClip.<init>(AudioClip.java:87)
        at Main.start(Main.java:33)
        at com.sun.javafx.application.LauncherImpl.lambda$launchApplication1$162(LauncherImpl.java:863)
        at com.sun.javafx.application.PlatformImpl.lambda$runAndWait$175(PlatformImpl.java:326)
        at com.sun.javafx.application.PlatformImpl.lambda$null$173(PlatformImpl.java:295)
        at java.security.AccessController.doPrivileged(Native Method)
        at com.sun.javafx.application.PlatformImpl.lambda$runLater$174(PlatformImpl.java:294)
        at com.sun.glass.ui.InvokeLaterDispatcher$Future.run(InvokeLaterDispatcher.java:95)
        at com.sun.glass.ui.win.WinApplication._runLoop(Native Method)
        at com.sun.glass.ui.win.WinApplication.lambda$null$148(WinApplication.java:191)
        ... 1 more
Exception running application Main
```

It's error again

Export Jar – Contains res folder

- Why?
  - Because AudioClip sound = new AudioClip("audio/Meow.wav");
  - Can get resource from file only
- How to fix it?

Export Jar – Contains res folder - ClassLoader

- Use ClassLoader to help loading our image
  - A path to our resource related to our .class file directory
- ClassLoader.*getSystemResource(String filePath)*
  - Return as URL

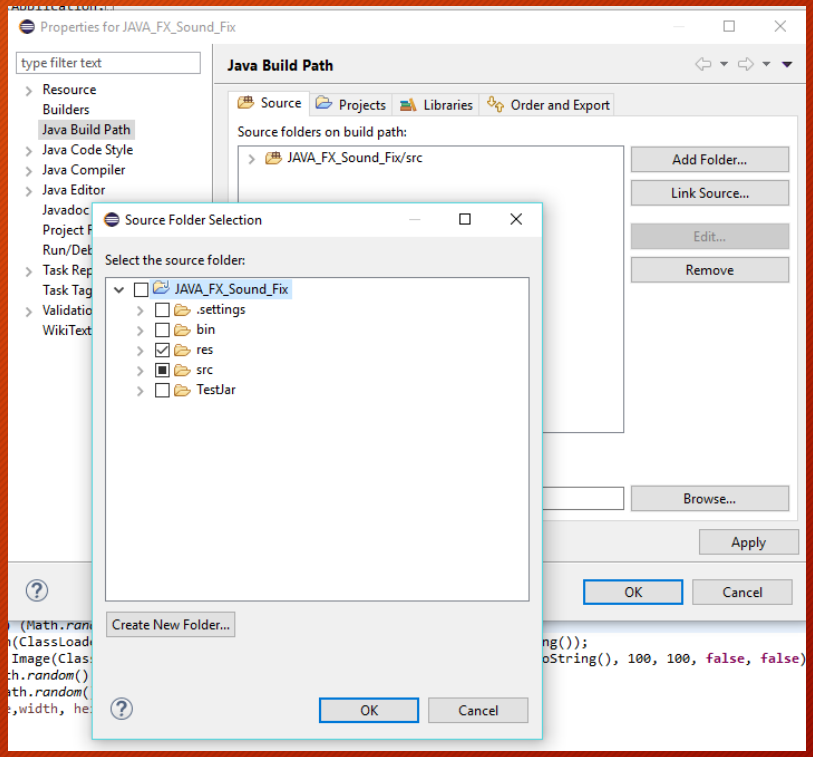
- Example:
  - String audio_path = **ClassLoader.*getSystemResource("audio/Meow.wav").toString()*;**
  - AudioClip sound = **new AudioClip(**audio_path**);**

Example : JAVA_FX_Sound_Fix - Main

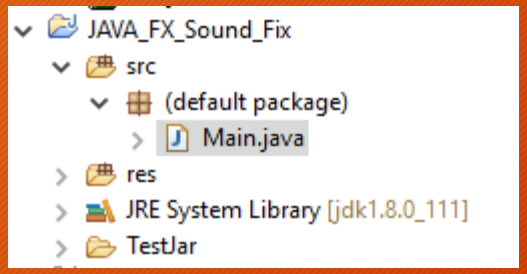

```java
public class Main extends Application {
    public static void main(String[] args) {
        Application.launch(args);
    }

    @Override
    public void start(Stage stage) {
        StackPane root = new StackPane();
        Scene scene = new Scene(root);
        stage.setScene(scene);
        stage.setTitle("AnimationTimer");

        Canvas canvas = new Canvas(800, 400);
        GraphicsContext gc = canvas.getGraphicsContext2D();
        root.getChildren().add(canvas);

        gc.setFill(Color.BLACK);
        gc.fillRect(0, 0, canvas.getWidth(), canvas.getHeight());

        System.out.println(ClassLoader.getSystemResource("audio/Meow.wav").toString());
        AudioClip sound = new AudioClip(ClassLoader.getSystemResource("audio/Meow.wav").toString());

        scene.setOnMouseClicked(new EventHandler<MouseEvent>() {
            public void handle(MouseEvent event) {
                createCat(gc);
                createCat(gc);
                createCat(gc);
                sound.play();
            }
        });

        stage.show();
    }

    public void createCat(GraphicsContext gc) {
        int random = (int) (Math.random() * 5 + 1);
        System.out.println(ClassLoader.getSystemResource("image/cat" + random + ".jpg").toString());
        Image image = new Image(ClassLoader.getSystemResource("image/cat" + random + ".jpg").toString(), 100, 100, false, false);
        double width = Math.random() * gc.getCanvas().getWidth();
        double height = Math.random() * gc.getCanvas().getHeight();
        gc.drawImage(image,width, height);
    }
}
```

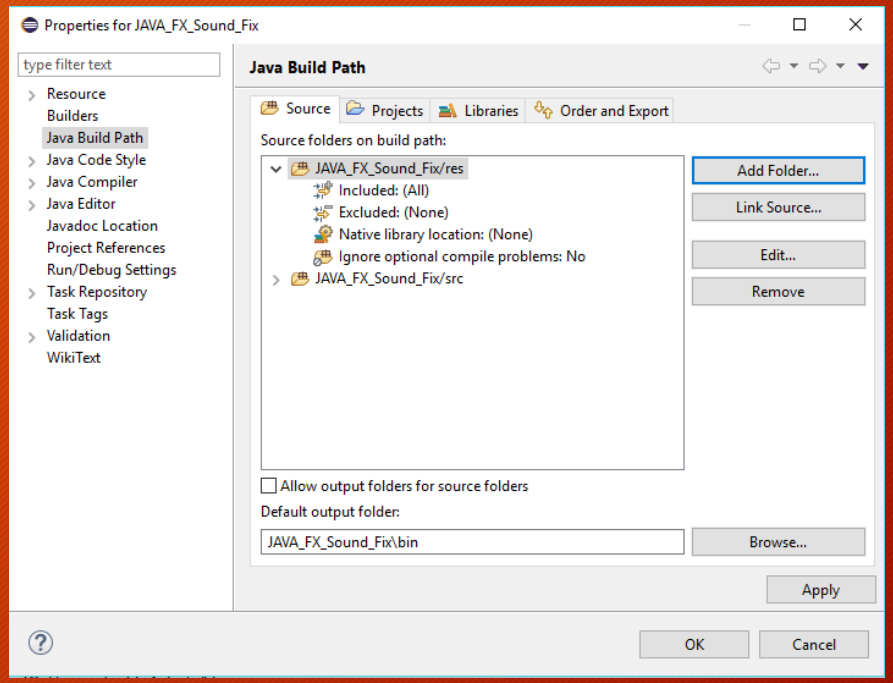
Export Jar – Contains res folder - BuildPath

- For add resoure folder, Build Path
- -> Configure Build Path
- -> Source (Tab)
- -> Add Folder
- -> Select Folder res



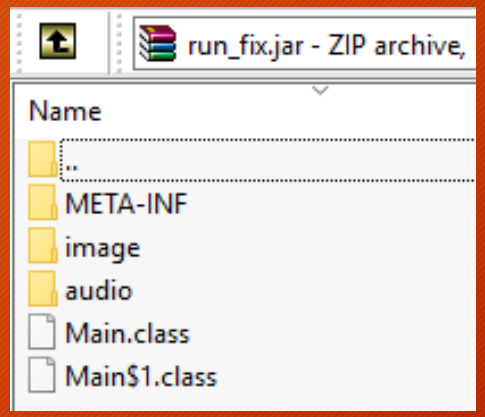
Export Jar – Contains res folder - BuildPath





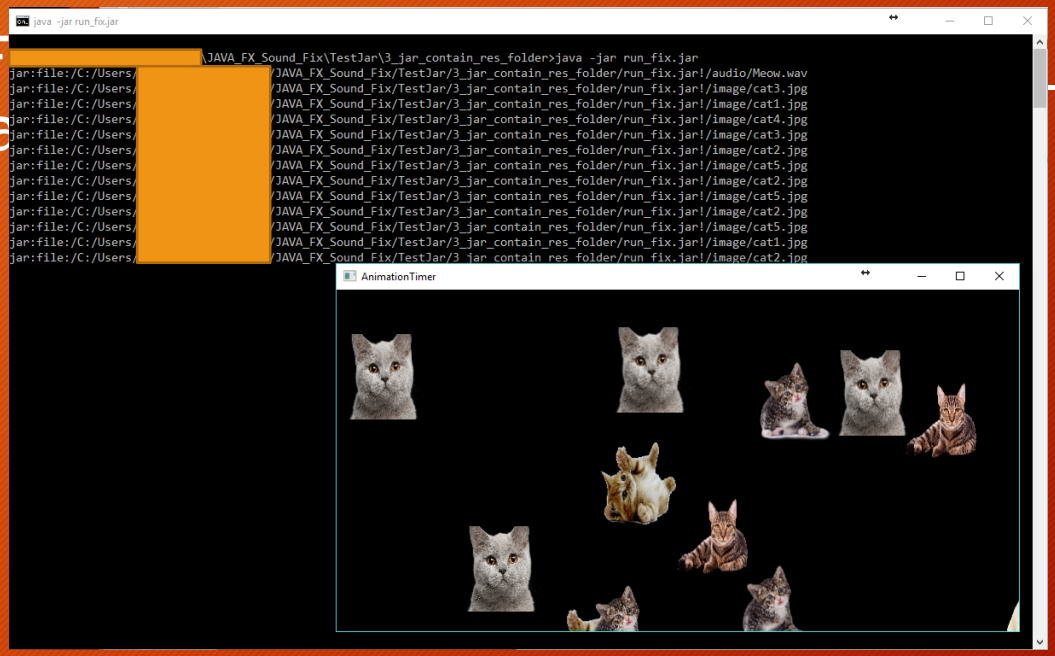
Export Jar – Contains res folder

- Let’s try to export runnable jar
- Our jar will contain res folder automatically
- No need to put our res folder in jar manually

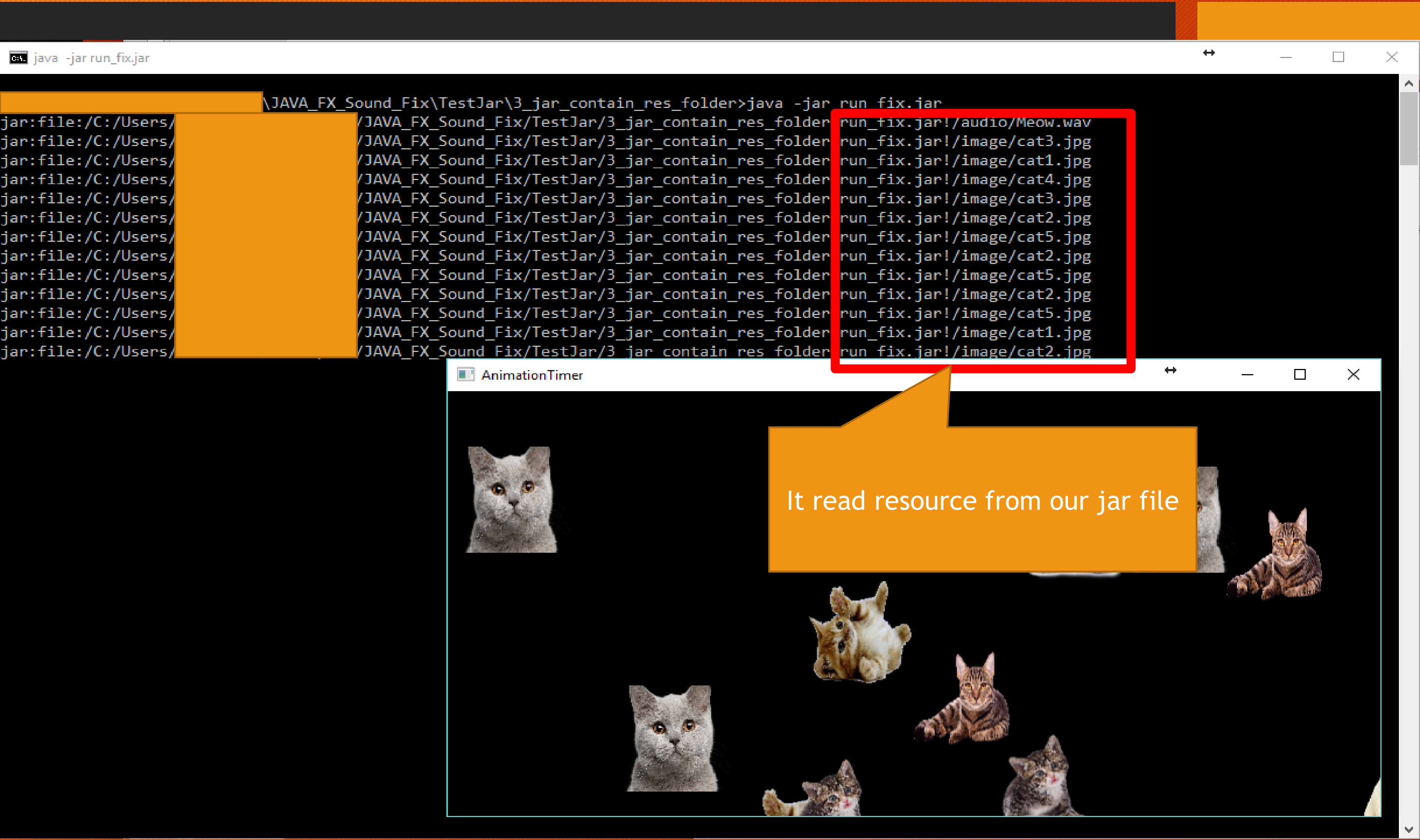


Export Jar – Contains res folder

- Run -> JAVA_F … _res_folder /run.ja



```
[redacted]\JAVA_FX_Sound_Fix\TestJar\3_jar_contain_res_folder>java -jar run_fix.jar
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/audio/Meow.wav
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat3.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat1.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat4.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat3.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat2.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat5.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat2.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat5.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat2.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat5.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat1.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder/run_fix.jar!/image/cat2.jpg
```



```
[redacted]\JAVA_FX_Sound_Fix\TestJar\3_jar_contain_res_folder>java -jar run_fix.jar
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/audio/Meow.wav
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat3.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat1.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat4.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat3.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat2.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat5.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat2.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat5.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat2.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat5.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat1.jpg
jar:file:/C:/Users/[redacted]/JAVA_FX_Sound_Fix/TestJar/3_jar_contain_res_folder run_fix.jar!/image/cat2.jpg
```

It read resource from our jar file

Export Jar

- Note
  - Some library can get resource from String : "audio/Meow.wav "
  - While some library can’t
- Using ClassLoader to get resource for all library is more stable

Conclusion

What you've learned

- Drawing on Canvas
- Input polling based on listener & event
- (Very simple) audio playback
- Application design pattern example

Last Suggestion

Google is your best friend

Credit

- https://docs.oracle.com/javase/8/javafx/api/javafx/scene/canvas/Canvas.html
- https://examples.javacodegeeks.com/desktop-java/javafx/javafx-canvas-example/
- http://docs.oracle.com/javase/8/javafx/api/javafx/scene/canvas/GraphicsContext.html
- http://zetcode.com/gui/javafx/canvas/
- http://docs.oracle.com/javafx/2/canvas/jfxpub-canvas.htm
- https://gamedevelopment.tutsplus.com/tutorials/introduction-to-javafx-for-game-development--cms-23835
- https://jaxenter.com/tutorial-a-glimpse-at-javafxs-canvas-api-105696.html