
# 5COSC019W – Object Oriented Programming
# Week 8

Dr. Barbara Villarini

b.villarini@westminster.ac.uk

# Summary

- Event Handling
- Implementing Event Handler
- File and Stream
- File handling

# What is an Event

- GUI components communicate with the rest of the applications through events.
- An event is an object that describes a state changes in a source
- An event occurs every time the user
  - Types a character or
  - Pushes a mouse button
- The source of an event is the component that causes that event to occur.
- The listener of an event is an object that receives the event and processes it appropriately.
- That object must:
  - Implement the appropriate interface
  - Be registered as an *event listener* on the appropriate *event source*.

# Delegation Event Handling Model

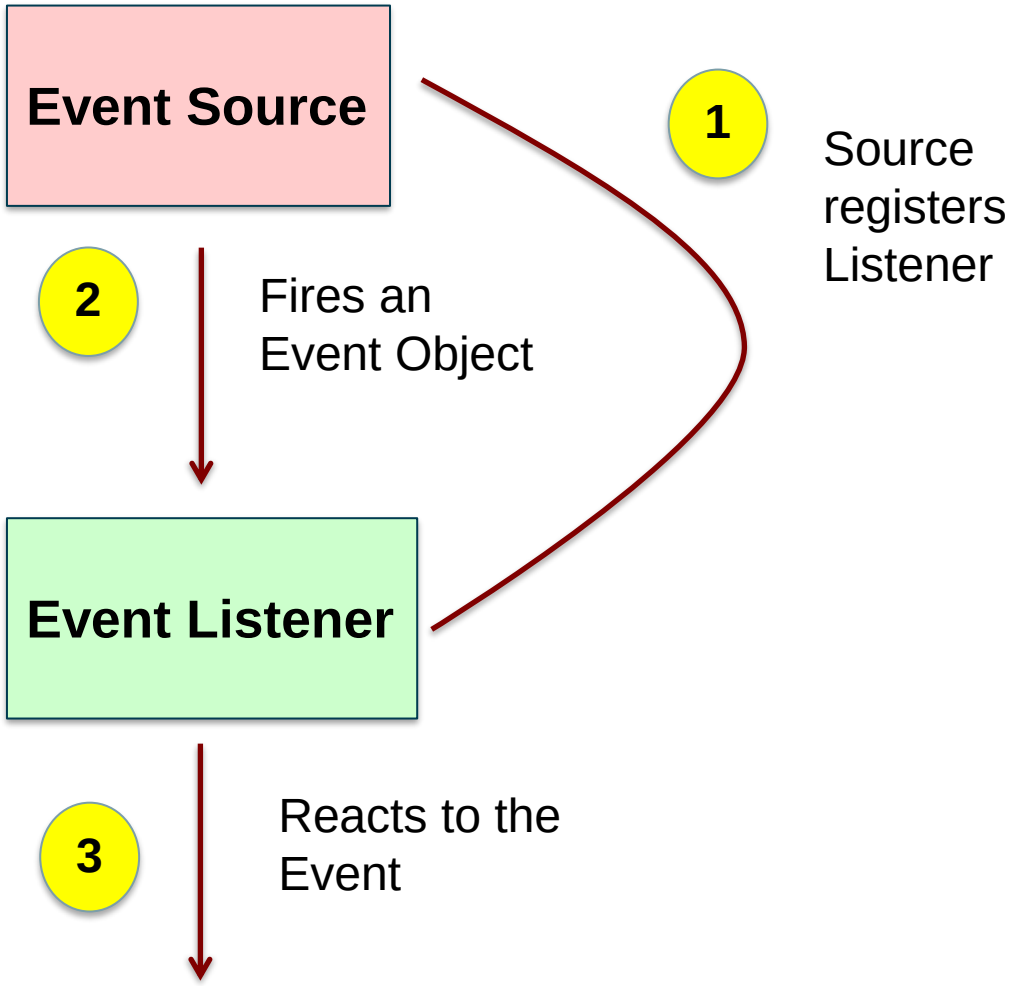
- Three parts
  - Event source
    - GUI component which user interacts with
  - Event object
    - Encapsulates information about event that occurred
  - Event listener
    - Receives event object when notified, then responds
- Programmer must perform two tasks
  1. **Register event listener for event source**
  2. **Implement event-handling method (event handler)**

# What is an Event Listener?

- An event listener is an object
  - It "listens" for events from a specific GUI component (itself an object)

- When an event is generated by the GUI component a method in the listener object is invoked to respond to the event

# Recap the Event Handling process



# Implement an Event Handler

Every event handler requires three bits of code:

1. Code that specifies that the class either
   1. Implements a listener interface or
   2. Extends a class that implements a listener interface.

```
public class MyClass implements ActionListener {…
```

2. Code that implements the methods in the listener interface.

```
public void actionPerformed(ActionEvent e)
{ ...//code that reacts to the action... }
```

3. Code that registers an instance of the event handler class as a listener upon one or more components.

```
someComponent.addActionListener(instanceOfMyClass);
```

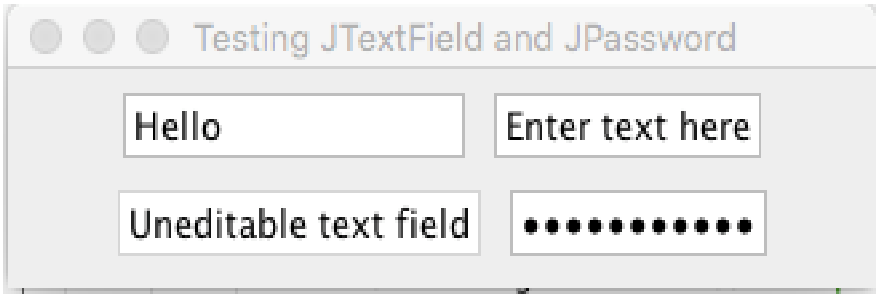
# Example using JTextField

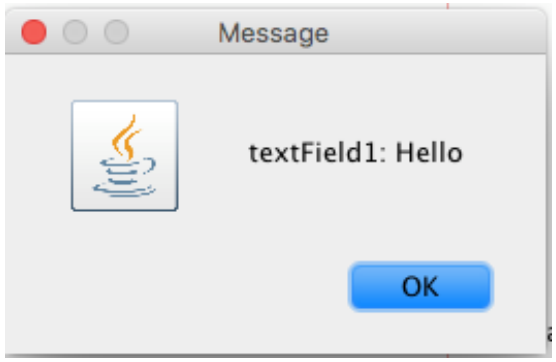
- **`JTextField`**
  - Single-line area in which user can enter text
- **`JPasswordField`**
  - Extends **`JTextField`**
  - Hides characters that user enters

# What we visualise:

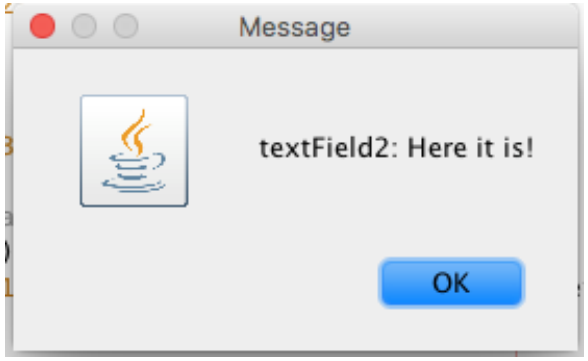
UNIVERSITY OF WESTMINSTER

If you enter “Hello!” in the text field 1 and press enter:

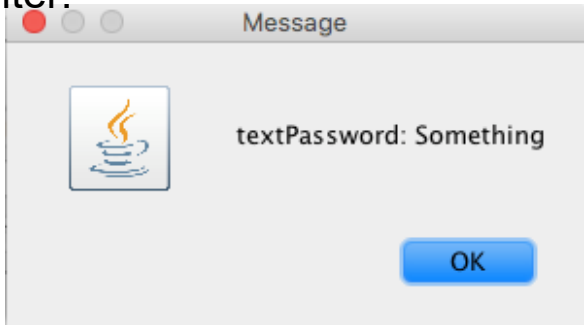



If you enter “Here it is!” in the text field 2 and press enter:


If you enter “Something” in the text Password and press enter:

# Part (1)

```
package textfieldframe;

import java.awt.FlowLayout;
import java.awt.event.ActionListener;
import java.awt.event.ActionEvent;
import javax.swing.JFrame;
import javax.swing.JTextField;
import javax.swing.JPasswordField;
import javax.swing.JOptionPane;

public class TextFieldFrame extends JFrame{

    private JTextField textField1;
    private JTextField textField2;
    private JTextField textField3;
    private JPasswordField passwordField;

    // TextFieldFrame constructor adds JTextFields to JFrame
    public TextFieldFrame()
    {
        super("Testing JTextField and JPassword");
        setLayout(new FlowLayout());

        // construct textfield with 10 coulumns
        textField1 = new JTextField(10);
        add(textField1); // add the textfield to JFrame

        // construct textfield with default text
        textField2 = new JTextField("Enter text here");
        add(textField2); // add the textfield to JFrame
```

Import Swing Packages

We define our class that extends JFrame

Constructor and we define the layout adding the components

# Part (2)

UNIVERSITY OF WESTMINSTER

```
    // construct textfield with default text and 21 columns
    textField3 = new JTextField("Uneditable text field");
    textField3.setEditable(false);
    add(textField3); // add the textfield to JFrame

    // construct passwordfield with the default text
    passwordField = new JPasswordField("Hidden text");
    add(passwordField);

    // register event handlers
    TextFieldHandler handler = new TextFieldHandler();
    textField1.addActionListener(handler);
    textField2.addActionListener(handler);
    textField3.addActionListener(handler);
    passwordField.addActionListener(handler);
} // End TextFieldFrame constructor

//private inner class for event handling
private class TextFieldHandler implements ActionListener
{
    // process text fiekd events
    public void actionPerformed(ActionEvent event)
    {
        String string = ""; // declare string to display

        // user pressed Enter in JTextField1
        if(event.getSource() == textField1)
            string = String.format("textField1: %s", event.getActionCommand());
```

textField3 will not be editable!

Register event handler to our components:
*addActionListener(handler)*

Class for event handling

Override actionPerformed(ActionEvent event)

getSource() is specified by the EventObject class that ActionEvent is a child of (via java.awt.AWTEvent)

**getActionCommand()** gives you a String representing the action command

# Part (3)

UNIVERSITY OF WESTMINSTER

```
        // user pressed Enter in JTextField2
        if(event.getSource() == textField2)
            string = String.format("textField2: %s", event.getActionCommand());

        // user pressed Enter in JTextField3
        if(event.getSource() == textField3)
            string = String.format("textField3: %s", event.getActionCommand());

        // user pressed Enter in JTextField passwordField
        if(event.getSource() == passwordField)
            string = String.format("textField1: %s", new String(passwordField.getPassword()));

        // display the string in a dialog box
        JOptionPane.showMessageDialog(null, string);
    }      // end method action Performed
} // end private inner class

public static void main(String[] args) {

    TextFieldFrame textFieldFrame = new TextFieldFrame();
    textFieldFrame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    textFieldFrame.setVisible(true);
    textFieldFrame.setSize(325,100);
}
}
```

Show the string in dialog box

# Steps required to set up and event handler

- Several coding steps are required for an application to respond to events
  - Create a class for the event handler
  - Implement an appropriate event-listener interface
  - Register the event handler

# Using a Nested Class to Implement an Event Handler

- Top-level classes
  - Not declared within another class
- Nested classes
  - Declared within another class
  - Non-static nested classes are called inner classes
    - Frequently used for event handling
- Note: An inner class is allowed to directly access its top-level class's variables and methods, even if they are private.

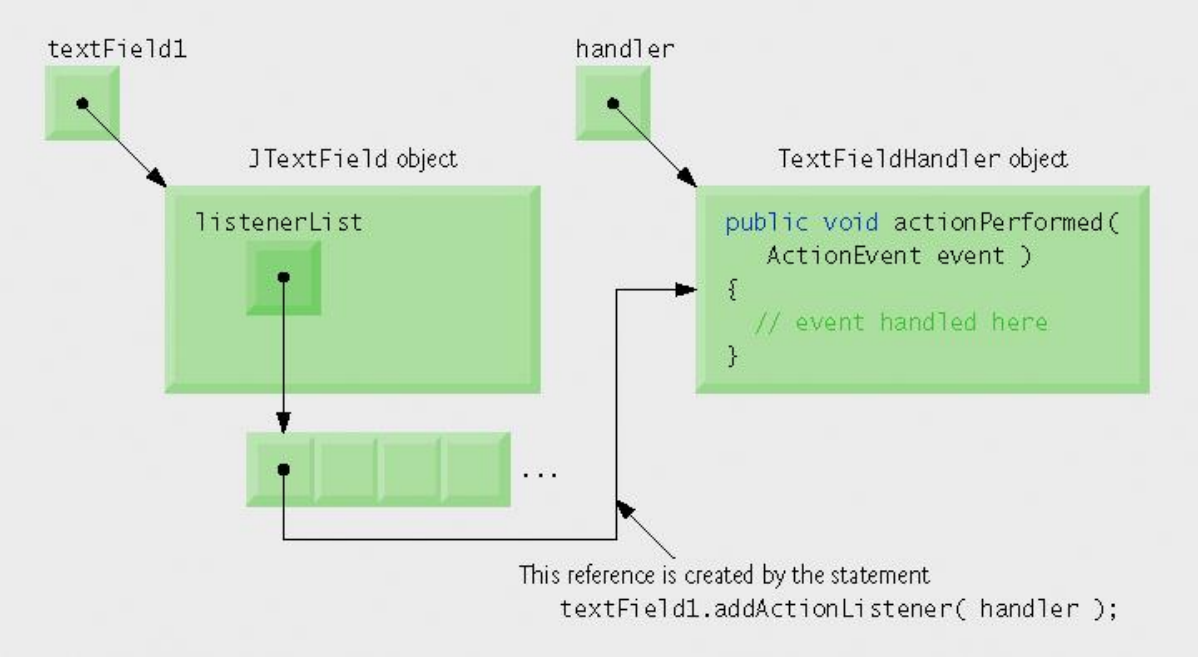
# Types of Event

| Act causing Event | Listener Type |
|---|---|
| User clicks a button, presses Enter, typing in text field | ActionListener |
| User closes a frame | WindowListener |
| Clicking a mouse button, while the cursor is over a component | MouseListener |
| User moving the mouse over a component | MouseMotionListener |
| Component becomes visible | ComponentListener |
| Table or list selection changes | ListSelectionListener |

# How Event Handler works

- How did the event handler get registered?
- How does the GUI component know to call actionPerformed rather than some other event-handling method?
- Every JComponent has instance variable listenerList

– Object of type EventListenerList
– Maintains references to all its registered listeners



# Mouse Event Handling

- Every time an action is performed using a mouse a MouseEvent object is created
- Handled by MouseListeners and MouseMotionListeners
- MouseInputListener combines the two interfaces
- Interface MouseWheelListener declares method mouseWheelMoved to handle MouseWheelEvents

# Mouse Events



## MouseListener and MouseMotionListener interface methods

*Methods of interface* ***MouseListener***

`public void mousePressed( MouseEvent event )`

**Called when a mouse button is pressed while the mouse cursor is on a component.**

`public void mouseClicked( MouseEvent event )`

**Called when a mouse button is pressed and released while the mouse cursor remains stationary on a component. This event is always preceded by a call to `mousePressed`.**

`public void mouseReleased( MouseEvent event )`

**Called when a mouse button is released after being pressed. This event is always preceded by a call to `mousePressed` and one or more calls to `mouseDragged`.**

`public void mouseEntered( MouseEvent event )`

**Called when the mouse cursor enters the bounds of a component.**

`public void mouseExited( MouseEvent event )`

**Called when the mouse cursor leaves the bounds of a component.**

*Methods of interface* ***MouseMotionListener***

`public void mouseDragged( MouseEvent event )`

**Called when the mouse button is pressed while the mouse cursor is on a component and the mouse is moved while the mouse button remains pressed. This event is always preceded by a call to `mousePressed`. All drag events are sent to the component on which the user began to drag the mouse.**

`public void mouseMoved( MouseEvent event )`

**Called when the mouse is moved when the mouse cursor is on a component. All move events are sent to the component over which the mouse is currently positioned.**

# Example – Part(1)

```
import java.awt.BorderLayout;
import java.awt.Color;
import java.awt.event.MouseListener;
import java.awt.event.MouseMotionListener;
import java.awt.event.MouseEvent;
import javax.swing.JFrame;
import javax.swing.JLabel;
import javax.swing.JPanel;

public class MouseTrackerFrame extends JFrame{

    private JPanel mousePanel; // panel in which mouse events will occur
    private JLabel statusBar; // label that displays event information

    // MouseTRakerFrame constructor sets up GUI and
    // registers mouse event handlers

    public MouseTrackerFrame()
    {
        super("Demonstarting Mouse Events");

        mousePanel = new JPanel(); // create panel
        mousePanel.setBackground(Color.white);
        add(mousePanel, BorderLayout.CENTER);

        statusBar = new JLabel("Mouse outside JPanel");
        add(statusBar, BorderLayout.SOUTH);
```

Create a panel and a label in MouseTrackerFrame

# Part (2)



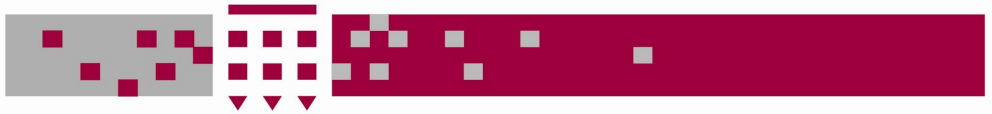
```
    // create and register listener for mouse and mouse motion events
    MouseHandler handler = new MouseHandler();
    mousePanel.addMouseListener(handler);
    mousePanel.addMouseMotionListener(handler);
} // end constructor

private class MouseHandler implements MouseListener,
        MouseMotionListener
{
    // MouseListener event handlers
    // handle event when mouse released immediatly after press
    public void mouseClicked(MouseEvent event)
    {
        statusBar.setText (String.format("Clicked at [%d, %d]",
                event.getX(), event.getY()));
    }

    // handle event when mouse pressed
    public void mousePressed(MouseEvent event)
    {
        statusBar.setText (String.format("Clicked at [%d, %d]",
                event.getX(), event.getY()));
    }

    //handle event when mouse released after dragging
    public void mouseReleased(MouseEvent event)
    {
        statusBar.setText (String.format("Clicked at [%d, %d]",
                event.getX(), event.getY()));
    }
```

Register listeners for mouse and mouse motion

Definition of our class MouseHandler

# Part (3)

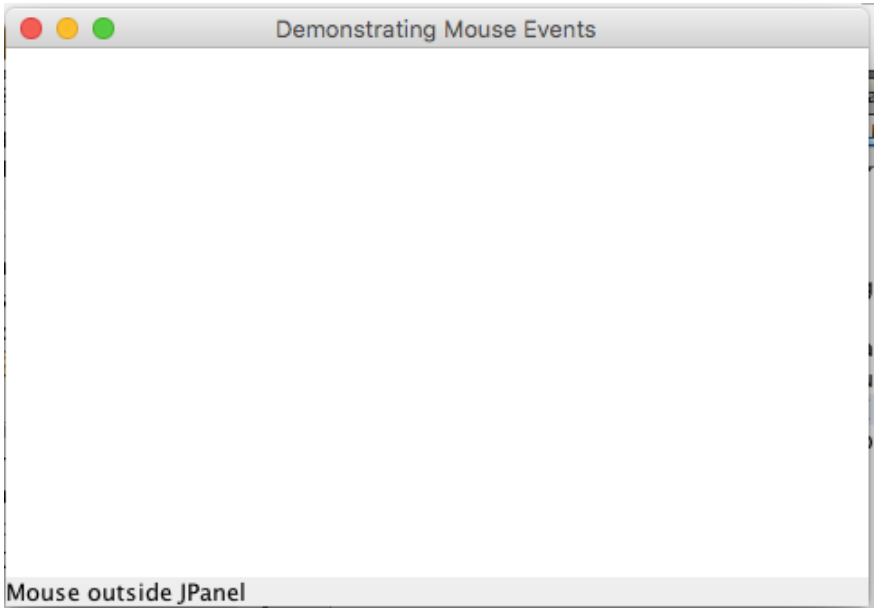


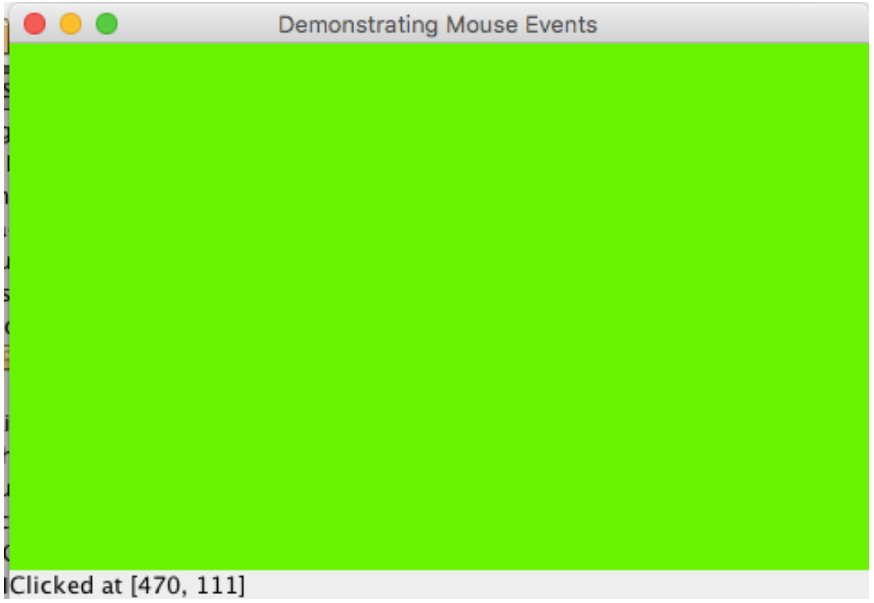


```
    // handle event when mouse enters area
    public void mouseEntered(MouseEvent event)
    {
        statusBar.setText (String.format("Clicked at [%d, %d]",
                event.getX(), event.getY()));
        mousePanel.setBackground(Color.green);
    }

    // handle event when mouse exits area
    public void mouseExited(MouseEvent event)
    {
        statusBar.setText ("Mouse outside JPanel");
        mousePanel.setBackground(Color.white);
    }

    @Override
    public void mouseDragged(MouseEvent e) {
        throw new UnsupportedOperationException("Not supported yet."); //To change body of generated
    }

    @Override
    public void mouseMoved(MouseEvent e) {
        throw new UnsupportedOperationException("Not supported yet."); //To change body of generated
    }
}
```

# Part (4)

```
    public static void main(String[] args) {

        MouseTrackerFrame mouseTrackerFrame = new MouseTrackerFrame();
        mouseTrackerFrame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        mouseTrackerFrame.setSize(300,100);
        mouseTrackerFrame.setVisible(true);
    }

}
```



# Listener Interface

- Suppose your class directly implements **`MouseListener`**,
  - Then you must implement all five **`MouseListener`** methods.
  - Even if you care only about mouse clicks
- Methods for those events you don't care about can have empty bodies.
  - Resulting collection of empty method bodies can make code harder to read and maintain

# Adapter Class

- Solution is to use adapter classes
- For example, the **`MouseAdapter`** class implements the **`MouseListener`** interface.
- An adapter class implements empty versions of all its interface's methods.
- To use an adapter
  - Create a subclass of it, instead of directly implementing a listener interface.
  - By extending **`MouseAdapter`**, your class inherits empty definitions of all five of the methods that **`MouseListener`** contains.

# Adapter Classes

- Characteristics of an adapter class
  - Implements interface
  - Provides default implementation of each interface method
  - Used when all methods in interface is not needed

| Event-adapter class in `java.awt.event` | Implements interface |
|---|---|
| `ComponentAdapter` | `ComponentListener` |
| `ContainerAdapter` | `ContainerListener` |
| `FocusAdapter` | `FocusListener` |
| `KeyAdapter` | `KeyListener` |
| `MouseAdapter` | `MouseListener` |
| `MouseMotionAdapter` | `MouseMotionListener` |
| `WindowAdapter` | `WindowListener` |

# Example - Part (1)

```
import java.awt.BorderLayout;
import java.awt.Graphics;
import java.awt.event.MouseAdapter;
import java.awt.event.MouseEvent;
import javax.swing.JFrame;
import javax.swing.JLabel;

public class MouseDetailsFrame extends JFrame{

    private String details; // string representing
    private JLabel statusBar; // Jlabel that appears at the bottom of the window

    // constructor sets title bar String and register mouse listener
    public MouseDetailsFrame()
    {
        super("Mouse clicks and buttons");

        statusBar = new JLabel ("Click the mouse");
        add(statusBar, BorderLayout.SOUTH);
        addMouseListener(new MouseClickHandler()); // add handler
    }
```

# Part (2)

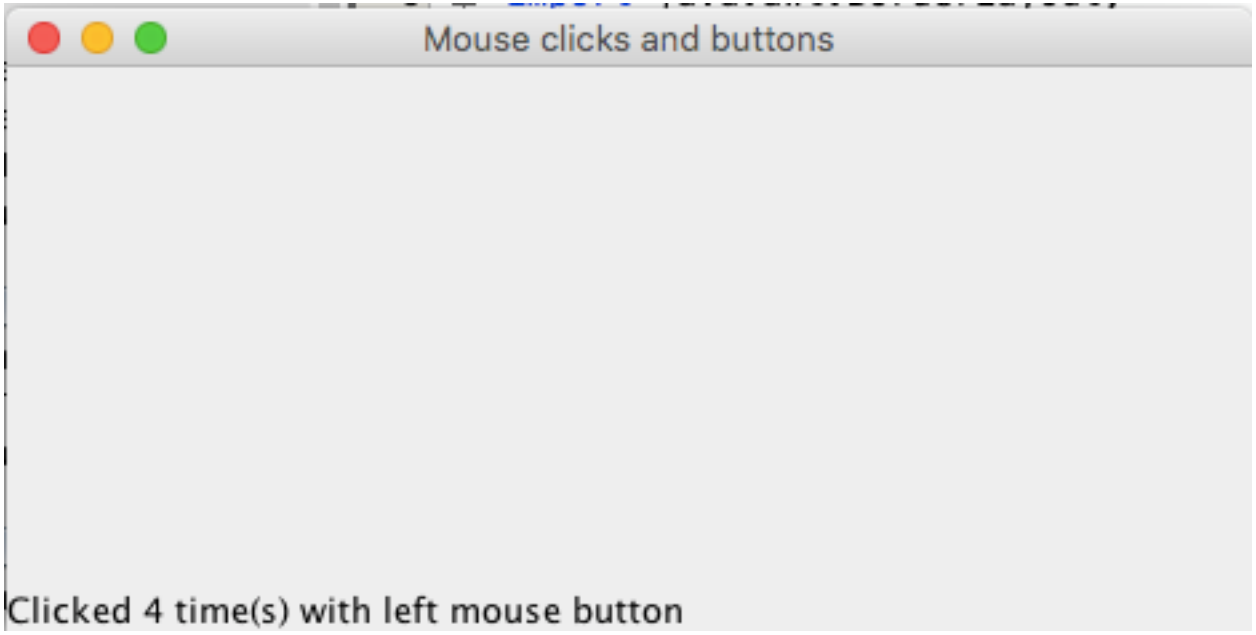
```
// inner class to handle mouse event
private class MouseClickHandler extends MouseAdapter
{
    public void mouseClicked(MouseEvent event)
    {
        int xPos = event.getX(); // get pos x of the mouse
        int yPos = event.getY(); // get pos y of the mouse

        details = String.format("Clicked %d time(s)",
                event.getClickCount());

        if(event.isMetaDown()) // right mouse button
            details += " with right mouse button";
        else if (event.isAltDown()) // middle mouse button
            details += " with center mouse button";
        else
            details += " with left mouse button";

        statusBar.setText(details);
    }
}
```

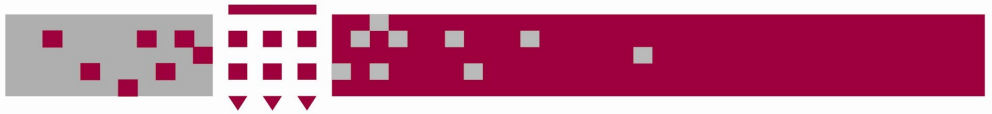
You don’t need to implement all the others methods!

Check if the event is right, left or center clicked

# Part (3)

```
    public static void main(String[] args) {

        MouseDetailsFrame mouseDetailsFrame = new MouseDetailsFrame();
        mouseDetailsFrame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        mouseDetailsFrame.setSize(400, 150);
        mouseDetailsFrame.setVisible(true);
    }

}
```





# FILE HANDLING

# Introduction

- Storage of data in variables and arrays is temporary
  - when the program is done running or when computer is turned off The data is gone!
- Files used for long-term retention of large amounts of data, even after the programs that created the data terminate
- Persistent data – exists beyond the duration of program execution
- Files stored on secondary storage devices (hard disks, CD-ROMs, etc.)
- Requirements information stored in  secondary memory
  - can be retrieved in the future
  - kept separate from other documents, programs, etc.

# Intro Example: Stock Market Analysis

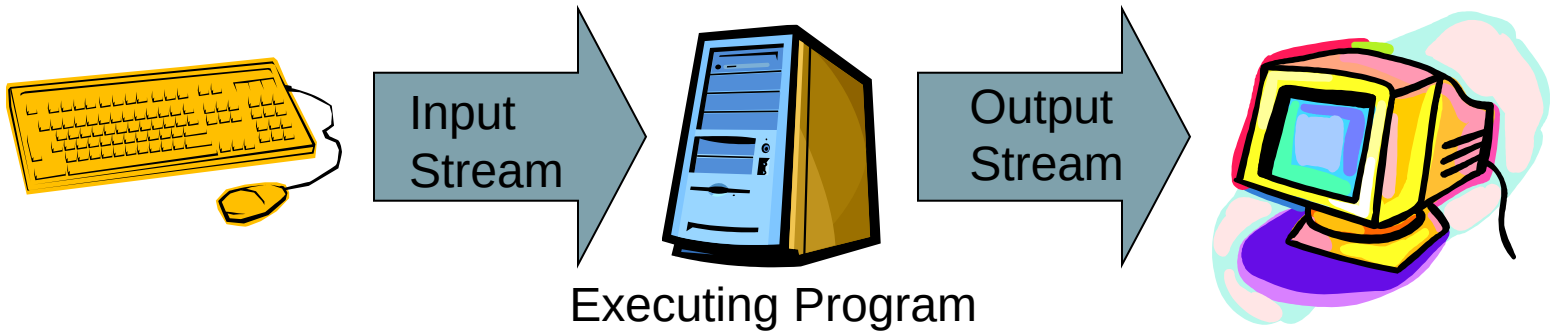
- Problem: large amounts of stock prices/indices are recorded and processed
  - taken every day
  - stored in a text file **`dataStockMarcket.dat`**

- Analyzing this data means find minimum, maximum, and average  of the data

- Data must be read from file, statistics calculated, results written to a text output file

# Java's I/O System

- All input and output in Java is accomplished by classes called streams
- The purpose of the stream abstraction is to keep program code independent from physical devices.



# Type of Stream

- There are 2 kinds of streams
  - byte streams: stores data in binary format
  - character streams: stores data as a sequence of characters
- Java opens file by creating an object and associating a stream with it
- Java libraries define a number of stream classes (`java.io` classes):

– Reader and Writer for dealing with character formatted data (e.g., unicode characters).

– InputStream and OutputStream for dealing with unformatted data (bytes)

Note that the classes **InputStream**, **OutputStream**, **Reader**, and **Writer** are *abstract* classes.

# Predefined Stream

- Three stream objects are automatically created for every application: `System.in`, `System.out`, and `System.err`.

- System.in
  - `InputStream` object, usually for the keyboard
- System.out
  - a buffered `PrintStream` object, usually the screen or an active window
- System.err
  - an unbuffered `PrintStream` object usually associated with the screen or console window

# `File` Class

- Useful for retrieving information about files and directories from disk
- Object of class File doesn't open the actual files/directories.
- It provides methods to operate on the files/directories named.

# Create a `File` object

Creating a File object specifies name/path only:

```
File myDirectory = new File("/Desktop/directory”);

File myFile = new File(“/Desktop/directorydataset.txt");

File myFile = new File("/Desktop/directory”, “dataset.txt");

File myFile = new File(myDirectory, “dataset.txt");
```

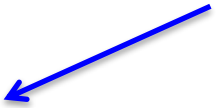
# Methods to manipulate Files and Directory

- `exists()`
- `isDirectory()`
- `isFile()`
- `canRead()`
- `canWrite()`
- `isHidden()`
- `getName()`
- `getPath()`
- `getAbsolutePath()`
- `getParent()`
- `list()`
- `length()`
- `renameTo( newPath )`
- `delete()`
- `mkdir()`
- `createNewFile()`

# Listing files

```
import java.io.*;
import java.util.*;

public class ListFile {

public static void main(String[] args) {
        File currentDirectory = new File(".");

        String[] contents = currentDirectory.list();

        for (int i = 0; i < contents.length; i++)
        {
                System.out.println(contents[i]); }
        }
}
```

It is considering the current directory, but you could pass any path



# FileReader

• FileReader opens file for reading and throws exception if open fails.

Constructors:

```
FileReader reader = new FileReader("filename");
FileReader reader = new FileReader(fileObject);
```

• Provides basic set of methods for reading:

– read character (mapped to character set).

– read array of characters.

• Also provides method to close stream.

# FileWriter

- FileWriter opens file for writing and throws exception if open fails
- Constructors:

```
FileWriter writer = new FileWriter("filename");
FileWriter writer = new FileWriter(fileObject);
```

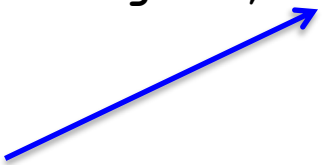
- Provides basic set of write methods:
  - write character.
  - write array of characters.
  - write String.
- Also provides method to close stream.
- If you don't close the file some data may not be written to file.

# Remember

- All FileReader/Writer methods throw exceptions. You should use try/catch blocks or write methods with a throws declaration.

- If you open an existing file for writing, you *delete* existing contents, unless append mode is selected:

```
FileWriter writer = new FileWriter(fileObject,true);
```



boolean append_to_file

# Example – Copying a text file

```
import java.io.*;

public class CopyTextFile {

public static void main(String[] args) throws IOException {

     File inputFile = new File("text.txt");
     File outputFile = new File("text_copy.txt");

     FileReader in = new FileReader(inputFile);
     FileWriter out = new FileWriter(outputFile);

     int c;
     while ((c = in.read()) != -1)
     {
          out.write(c);
     }
     in.close();
     out.close();
}
}
```

Copy one character at a time. read() returns -1 when no more data.

Reading

Writing

# Reading/writing files using Byte Streams

- Java methods to read and write bytes from and to a file:
  - FileInputStream
  - FileOutputStream
- Create an object of one of these classes to open a file
- Specify the name of the file as argument to the constructor.
- Once the file is open you can read/write it

# Example – copy a file as bytes

```
import java.io.*;

public class CopyBytesFile {
     public static void main(String[] args) throws IOException {

          File inputFile = new File("Text.txt");
          File outputFile = new File("Text_copy.txt");

          FileInputStream in = new FileInputStream(inputFile);
          FileOutputStream out = new FileOutputStream(outputFile);

          int c;
          while ((c = in.read()) != -1) {
               out.write(c);
          }
          in.close();
          out.close();
}
}
```

Type int used to store byte.

Copy one byte at a time.

# BufferedReader and BufferedWriter Class

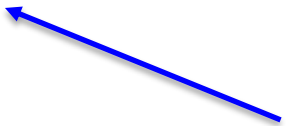
- An object of these classes reads/writes an entire line of text into a buffer
- The constructor take as parameter an object of type Reader
- It provides a **`readLine`** method to read complete line into a String

```
BufferedReader in = new BufferedReader(new FileReader("data.txt"));
String s = in.readLine();
```

- String can then be converted to other types (int, double, etc.)

# Example – Copying a file

```
import java.io.*;

public class ReadString{
    public static void main(String[] args) throws IOException {

    FileReader in = new FileReader("File1.txt");
    BufferedReader br = new BufferedReader(in);

    FileWriter out = new FileWriter("File2.txt", true);
    BufferedWriter bw = new BufferedWriter(out);

    String line = br.readLine();
    while(line != null){
        bw.write(line);
        bw.newLine();
        line = br.readLine();
    }
    in.close();
    br.close();
    bw.close();
    out.close();

}
}
```



Use readLine() from BufferReader to read a line of text

# Other Reader/Writers

- **`StringReader`**, **`StringWriter`**: read/write to/from strings rather than files or writers.
- **`InputStreamReader:`** Convert from stream to reader.
- **`OutputStreamWriter:`** Convert from writer to stream.

Plus a family of InputStream and OutputStream classes.

# Summary

- We saw file handling in Java
- Remember that it is important to save data in files and permanent storage.
- Reading and writing data from and to a file is a must for a good developer!