Basics of programming 3

Java GUI and SWING

GUI basics

GUI basics

- Mostly window-based applications
- Typically based on widgets
  - small parts (buttons, scrollbars, etc)
  - built on a windowing framework
- Abundance of frameworks
  - AWT, SWING, SWT, etc
- Logic is to be defined
- GUI builders help

Abstract Windowing Toolkit

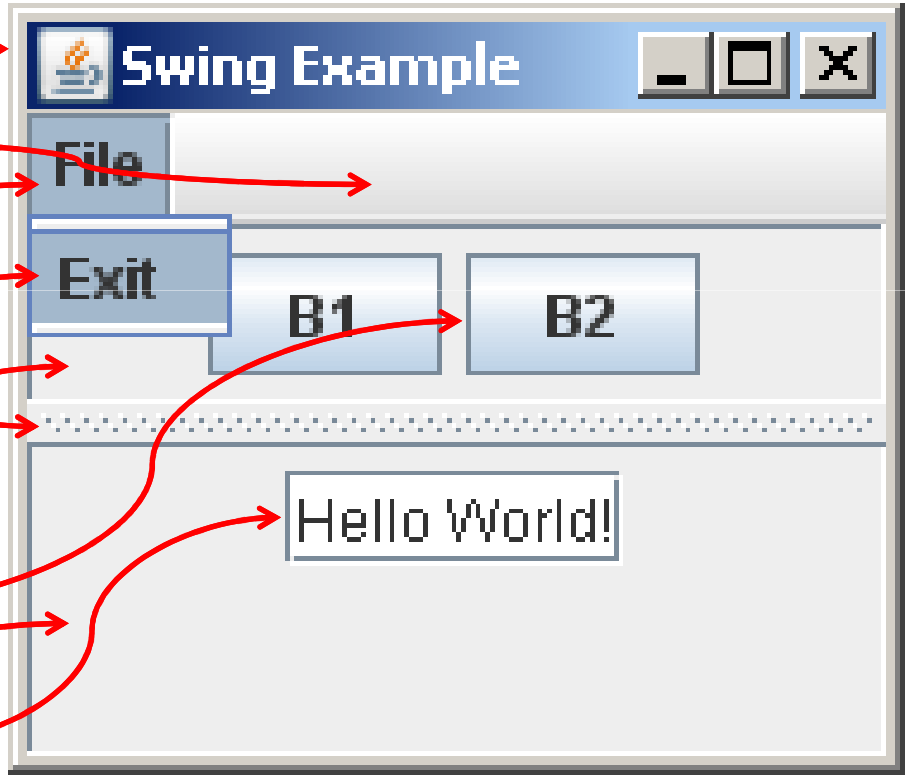
- Heavy-weight widgets
  - relies on OS features
- Abstract facade
  - same look and feel on all platforms
- Different implementations
  - incompatibility issues
- Most features still in use
  - events, layoutmanagement, etc
- `java.awt.*`

SWING

- Rich set of GUI elements
  - light-weight widgets
  - implemented in Java
- Heavy use of model-view-controller pattern
  - complex widgets have separate model classes
  - parts of rendering is implemented separately
- Configurable look and feel
  - via new classes, config files and config parameters
- `javax.swing.*`

Basic window architecture

- JFrame
  - JMenuBar
    - JMenu
      - JMenuItem
  - JSplitPane
    - JPanel
      - JButton
      - JButton
    - JPanel
      - JTextField



Window Application Lifecycle

- Build up window
  - create JFrame or other window
  - put on containers and components
- Register event handlers
  - separate objects for handling user events
- Make it visible
  - window is shown and can be used
- Close window
  - release resources

Components and containers

Components and containers

- Basic widgets
  - **JButton**
  - **JTextField**
  - JPanel
  - **JFrame**
- Complex widgets
  - MVC
  - JList + JScrollPane

Widget basics

- Rendering is automatic
- Common functionality
  - size (minimum, maximum, preferred)
  - visibility
  - enabled/disabled
  - event handling
- Can be added to a container
- Containers are also widgets
  - component-hierarchy

Simple widgets: JButton

- Classic button
  - can be clicked
  - *event handling later*
- Text and image can be set
- Size is calculated automatically
  - shrinks and grows as the container asks
- Important methods
  - `setEnabled(boolean)`
  - `get/setText()`

Simple widgets: JTextField

- Classic textfield
  - textual input can be entered
- Initial text and size can be set
- Size is calculated automatically if needed
  - shrinks and grows as the container asks
- Important methods
  - `setEditable(boolean)`
  - `get/setText(String)`
  - `setCaretPosition(int)`
  - `setSelectionStart/End(int)`

Simple widgets: JPanel

- Basic container
  - components can be put on it
- Responsible for layout of components
- Size is calculated automatically if needed
  - shrinks and grows as the parent container asks
- Important methods
  - `add(Component[, param])`
  - `setLayout(LayoutManager)`
  - `getComponentAt(int,int)`

Basic window: JFrame

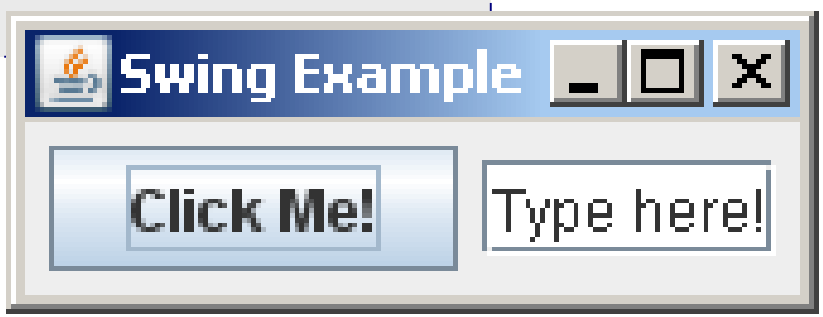
- Basic window with frame and title
- All window operations are supported
  - some has to be explicitly enabled
- Size is calculated automatically
  - based on the size of its contents
- Important methods
  - `add(Component, int where)`
  - `pack()`
  - `setVisible(boolean)`
  - `setDefaultCloseOperation(`*`JFrame.EXIT_ON_CLOSE`*`)`

Example: building a GUI

```
JFrame f = new JFrame(”Swing Example”);
JPanel p = new JPanel();
JButton b = new JButton(”Click Me!”);
JTextField t = new JTextField(”Type here!”);

p.add(b);
p.add(t);
f.add(p, BorderLayout.NORTH);

f.pack();
f.setDefaultCloseOperation(f.EXIT_ON_CLOSE);
f.setVisible(true);
```



Event handling

Event handling basics

- Listener (observer) pattern
  - two roles: *listener* and *subject*
    - subject receives event ...
    - ... and forwards it to all registered listeners
- Event types for all kinds of events
    - `java.util.EventObject`
    - `java.awt.AWTEvent`
    - `java.awt.event.MouseEvent`
    - `java.awt.event.WindowEvent`
- Events and listeners can be separated
  - responsibility can be dedicated

Event handling interfaces

- *XEvent* → *X*`Listener`
  - interface (implementation is needed)
  - implementation has to be registered at the component
    - `add`*X*`Listener(`*X*`Listener el)`
  - *XEvent* must be processed
    - `MouseEvent, KeyEvent, AdjustmentEvent, FocusEvent` stb.
  - it is usual to use anonymous inner classes
    - looks convenient but is hardly maintainable

Event handling adapters

- *X*`Adapter`
  - default implementation of *X*`Listener`
    - empty methods
  - convenience class
    - if only a subset of methods is to be implemented
  - use them for a clearer looking code
  - consider single inheritance!

Event handling example

- Modify previous example:
  - when pressing button, put current time in textfield!
- An `ActionListener` implementation is needed
  - new class, take care of visibility
  - *`actionPerformed(ActionEvent ae)`* method
- How to identify the button
  - ActionEvent's *`getSource`* → Component
  - ActionEvent's *`getActionCommand`* → String
    - name of button or set by *`setActionCommand(String c)`*

Event handling example

```
final class MyActionListener implements ActionListener {
  JTextField t;
  public MyActionListener(JTextField tt) { t = tt;}
  public void actionPerformed(ActionEvent ae) {
    if (ae.getActionCommand().equals("date")) {
      t.setText((new Date()).toString());
    }
 }
}
```

```
...
JButton b = new JButton("Click Me!");
b.setActionCommand("date");
ActionListener al = new MyActionListener(t);
b.addActionListener(al);
...
```

Layout handling

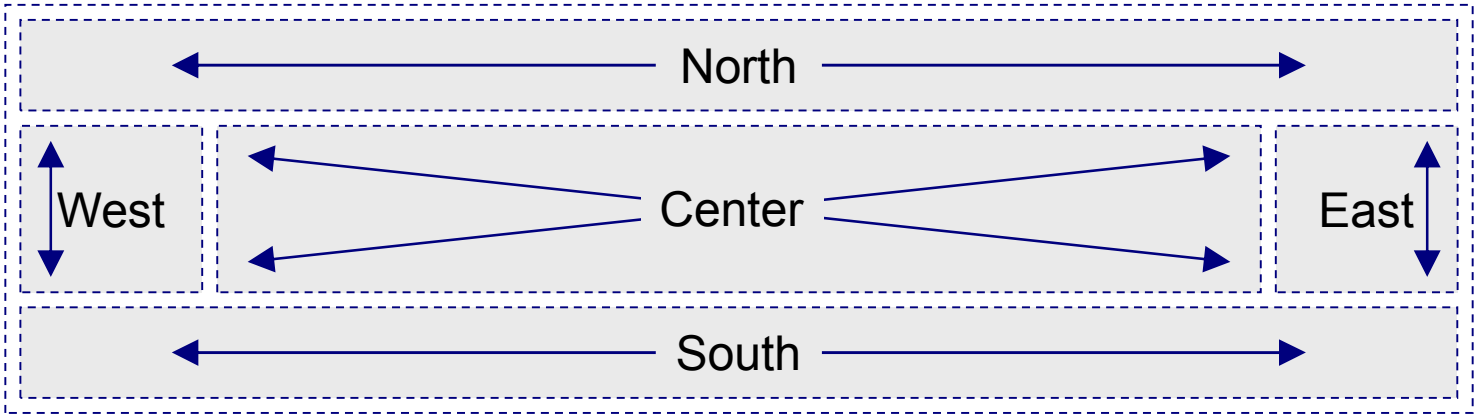
Where are components placed?

- Problems
  - positioning
    - *this page is optimized for 800x600 resolution*
  - what happens when resizing
- Solution: Layout Managers
  - every container has a default layout manager
  - layout maganers can be changed (setLayoutManager)
  - responsible for placement
  - recursive calculation
  - when resizing recalculation occurs

Layout Managers

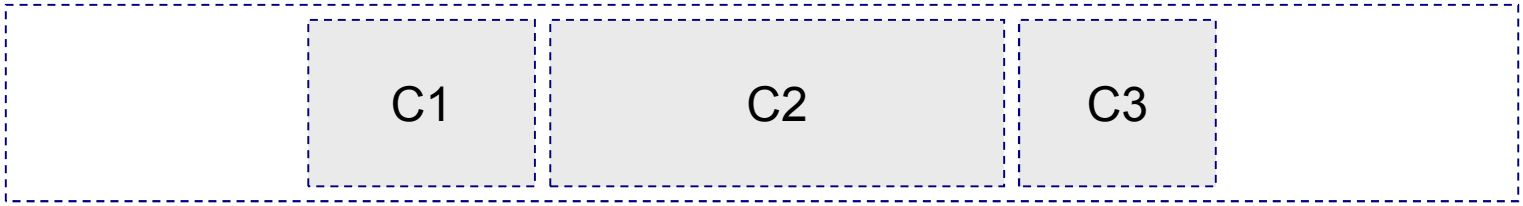
- `Container`
  - `void setLayout(LayoutManager mgr)`
  - `LayoutManager getLayout()`
  - `void validate()`
    - recalculates placement and arranges components (recursive)
  - `Component add(Component comp` *`[,int index]`*`)`
  - `void add(Component c, Object constraint, int index)`
    - adds the component to the container
    - optional parameter specifies special placement demands
- `LayoutManager`
  - long story...

BorderLayout



- Five fields
  - north, south, west, east, center
- Default layout for `JFrames`
- Resize in the arrows' direction possible
- One field – one component

FlowLayout

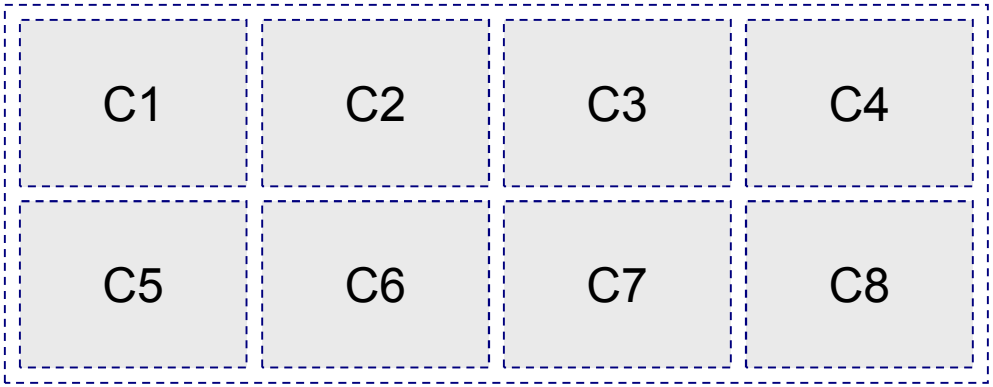


- Default layout for `JPanel`
- Puts components beside each other
  - if there is no more place, starts new row
- Does not resize them individually
- Direction depends on container
  - **`ComponentOrientation.LEFT_TO_RIGHT, RIGHT_TO_LEFT`**
- Alignment can be set:
  - **`LEFT, RIGHT, CENTER, LEADING, TRAILING`**

CardLayout

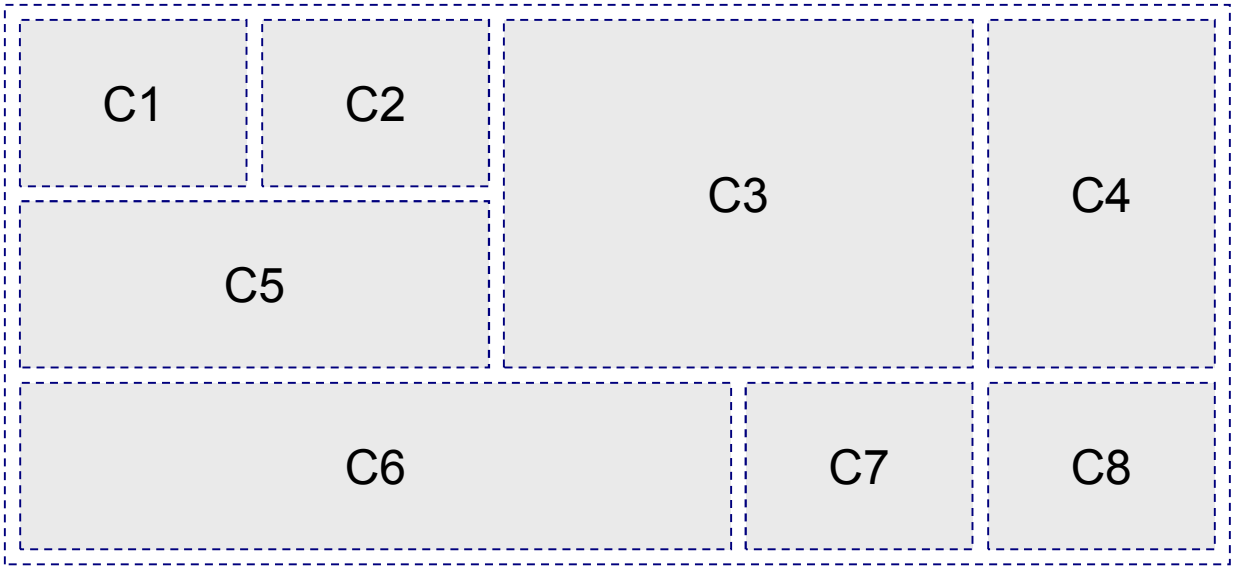
- Components are placed below each other
  - like a deck of cards
  - one comoponent – one card
- Always the topmost is visible
- Deck can be reordered by methods of the managers
- Components can be named for faster access

GridLayout



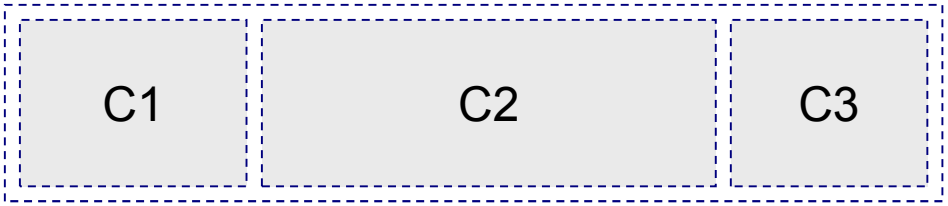
- Components are put into an NxM grid
- Every component has the same size
  - resize if needed
- Direction depends on the container
  - `LEFT_TO_RIGHT - RIGHT_TO_LEFT`
- If number of rows is fixed, new columns can be added

GridBagLayout



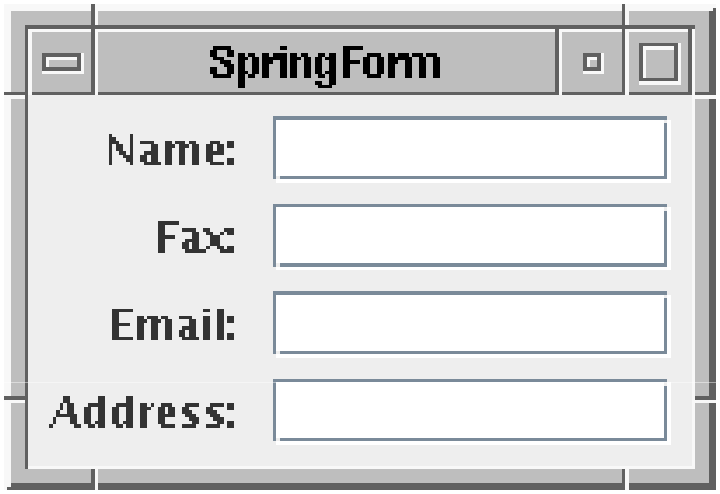
- Advanced variant of *GridLayout*
- Components can occupy more than one square
- *GridBagConstraint* specifies occupancy rules

BoxLayout



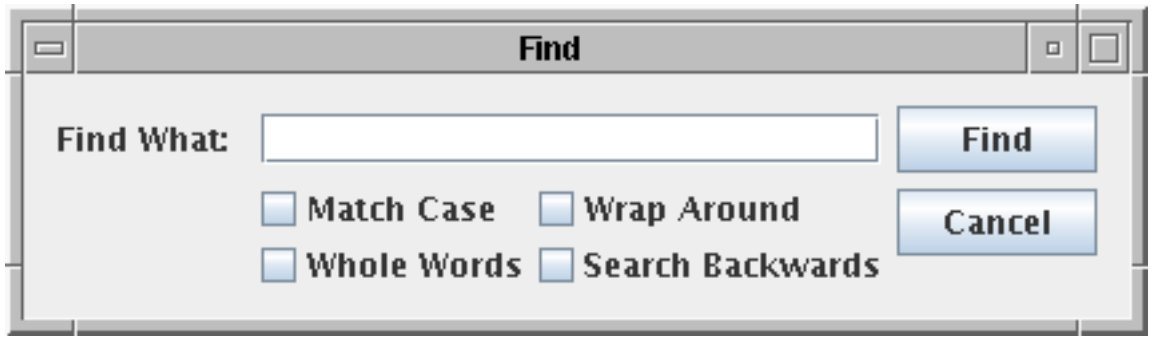
- Vertical or horizontal placement of components
- No new line when full
- Four kinds of directions
  - **`X_AXIS`** – **`Y_AXIS`**: horizontal or vertical
  - **`LINE_AXIS`** – **`PAGE_AXIS`**: considers also **`ComponentOrientation`**

SpringLayout



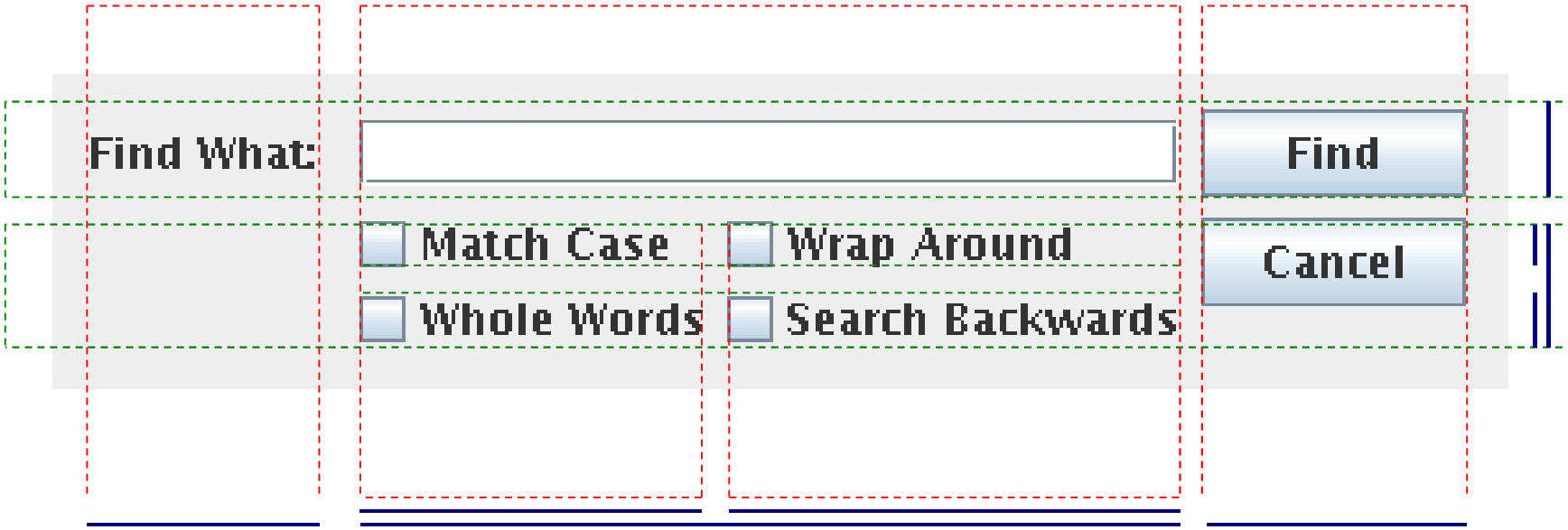
- For flexible table-like layout
- Basically the connection between components' edges must be defined
- Only for GUI builders (designers)
  - hard to program manually

GroupLayout



- Independent specification of horizontal and vertical dimensions
  - each component is added twice
- Hierarchical: groups are placed into each other
- Sequential or parallel placement
- Replacing a component:
  - `void replace(Component oldc, Component newc)`

GroupLayout (swing) 2



GroupLayout (swing) 3

```
layout.setHorizontalGroup(layout.createSequentialGroup()
  .addComponent(label)
  .addGroup(layout.createParallelGroup(LEADING)
     .addComponent(textField)
     .addGroup(layout.createSequentialGroup()
        .addGroup(layout.createParallelGroup(LEADING)
           .addComponent(caseCheckBox)
           .addComponent(wholeCheckBox))
        .addGroup(layout.createParallelGroup(LEADING)
           .addComponent(wrapCheckBox)
           .addComponent(backCheckBox))))
  .addGroup(layout.createParallelGroup(LEADING)
    .addComponent(findButton)
    .addComponent(cancelButton))
);
```

GroupLayout (swing) 4

```
layout.setVerticalGroup(layout.createSequentialGroup()
  .addGroup(layout.createParallelGroup(BASELINE)
    .addComponent(label)
    .addComponent(textField)
    .addComponent(findButton))
  .addGroup(layout.createParallelGroup(LEADING)
    .addGroup(layout.createSequentialGroup()
      .addGroup(layout.createParallelGroup(BASELINE)
        .addComponent(caseCheckBox)
        .addComponent(wrapCheckBox))
      .addGroup(layout.createParallelGroup(BASELINE)
        .addComponent(wholeCheckBox)
        .addComponent(backCheckBox)))
    .addComponent(cancelButton)))
);
```

Inner classes

- Defined within a class
  - outside or inside methods
  - as a parameter when calling a method *(nasty!!!)*
- No limit on nesting
- Has access to members of nesting class
  - methods
  - *final* parameters and *final* local variables only
- Goal: encapsulation
  - e.g. small helper class in a big one: *Map – Map.Entry*

Member class

- has a name
- can be accessed outside of nesting class
  - depending on visibility
- declared in class block (not inside a method)

```
class In1 {
  int k;
  class In2 {int x = k;}
  void bar() {
    In2 i2 = new In2();
    k = i2.x++;
  }
}
```

```
...
In1 i1 = new In1();
i1.k++;
In1.In2 i3 =
       new In1().new In2();
...
```

Local class

- has name
- declared inside a block
  - used in the block

```
public class Test {
  int i = 10;
  void xxx() { i++; }
  void foo(final int a) {
    class In1 {
      int k = a;
      int j = i;
      void bar() {
        k = i++;
        xxx();
      }
    }
    In1 i1 = new In1();
    i1.j++;
  }
}
```

Combined example

```
public class Test {
  int i = 10;
  void xxx() { i++; }
  void foo(final int a) {
    class In1 {
      int k = a;
      int j = i;
      class In2 {
        int x = k;
        int y = i;
        int z = a;
      }
      void bar() {
        In2 i2 = new In2();
        k = i2.z++;
        xxx();
      }
    }
    In1 i1 = new In1();
    i1.j++;
    In1.In2 i3 =
      new In1().new In2();
  }
}
```

Anonymous class

- never *abstract*, never *static*, always *final*
- has no declared constructor

```
public class MyFrame extends JFrame {
  MyFrame() {
    super("MyFrame");
    addWindowListener(new WindowListener() {
        public void windowClosing(WindowEvent e) {
          System.ext(0);
        }
        ... // other methods
      }
    );
  }
}
```