25 Object Serialization

- Motivation
  - objects must be independent from application life time
  - objects must be exchanged between applications

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

25.1 Object Streams

- Object streams can read/write objects from/to a byte stream
- Class **`java.io.ObjectOutputStream`**
  - **`void writeObject(Object o)`**: transitive serialization of an object
- Class **`java.io.ObjectInputStream`**
  - **`Object readObject()`**: reading a serialized object

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

25.2 Example

- Save a String and a **`Date`** object

```
FileOutputStream f = new FileOutputStream("/tmp/objects");
ObjectOutput s = new  ObjectOutputStream(f);
s.writeObject("Today");
s.writeObject(new Date());
s.flush();
```

- Read the objects

```
FileInputStream in = new FileInputStream("/tmp/objects");
ObjectInputStream s = new ObjectInputStream(in);
String today = (String)s.readObject();
Date date = (Date)s.readObject();
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

25.3 Interfaces

- Marker interface **`java.io.Serializable`**:
  - Instance variables are saved automatically
  - declare variable as **`transient`** to exclude it from saving
- Interface **`java.io.Externalizable`**:
  - Object can control its serialization
  - contains methods
    - **`writeExternal(ObjectOutput out)`**
    - **`readExternal(ObjectInput in)`**

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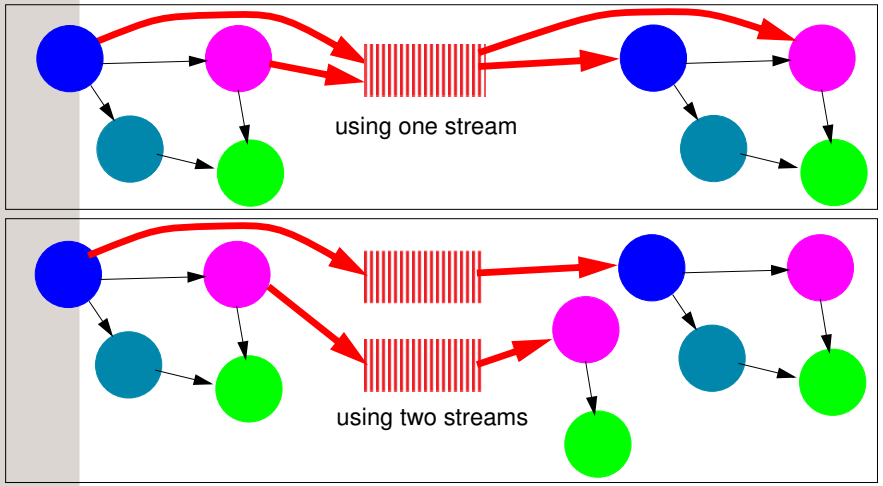
25.4 Problems

- write all related objects to the same stream, otherwise objects are duplicated when read in



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25.4 Problems / Hints

- to preserve the exact state: write object graph atomically
- to write the new state: clone the object or reset the object stream
- classes are not saved: they must be available if you later read in the object
- statics are not saved

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

25.5 Version Control of Classes

- serialized objects must be read with the "right" class
- serialized object contains a class reference that contains the class name and a version number
- version number is created by hashing over class name, interfaces, names of instance variables and methods
- Problem: small changes at the class make old serialized objects unreadable
- Solution
  - a class may contain its version number:
    ```
    static final long serialVersionUID =
    1164397251093340429L;
    ```
  - version number can be computed using **`serialver`**
  - ⇒ change version number only after incompatible changes

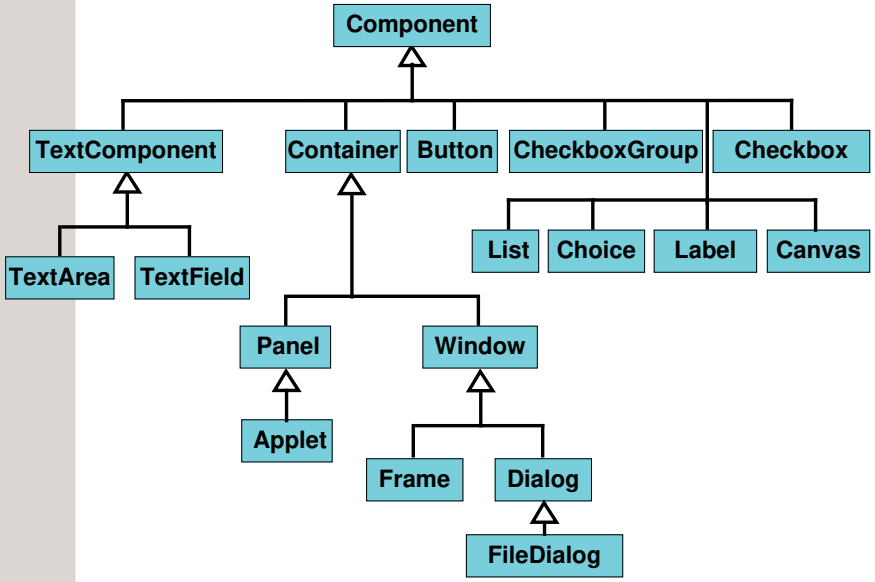
Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26 Abstract Window Toolkit (AWT)

- Contains classes to construct graphical user interfaces (GUIs)
- Classes are arranged in
  - a platform-independent package (**`java.awt.*`**)
  - a platform-dependent package (**`java.awt.peer.*`**)
- Use only classes from **`java.awt.*`** !
  - Button
  - List
  - Label
  - TextField
  - ...

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26.1 AWT Class Diagram



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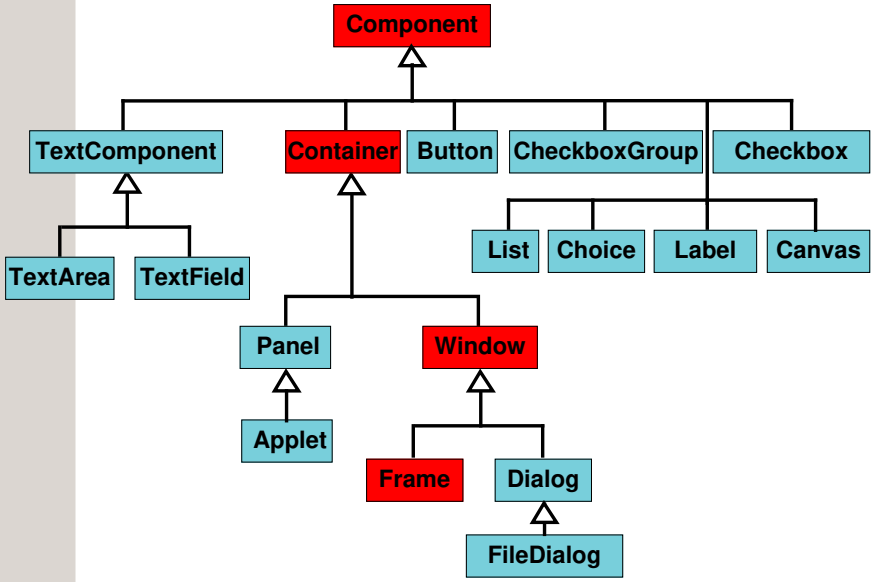
26.2 Container - Window - Frame

- `Container` is subclass of `Component`
  - contains `Component` objects
  - `add(Component c)`: adds a component to the container
- `Window` is subclass of `Container`
  - `pack()`: resize + validate
  - `show()`: show the window
  - `Window` is not used directly
- `Frame` is subclass of `Window`
  - used for top-level windows

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26.1 AWT Class Diagram



Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26.3 Example: Frame with Button

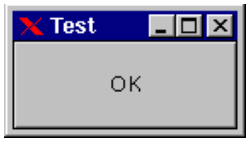
```
import java.awt.*;

public class Simple extends Frame {
  public Simple(String title) {
    super(title);
    Button b = new Button("OK");
    add(b);
    pack();
    show();
  }

  public static void main(String a[]) {
    Simple s = new Simple("Test");
  }
}
```

button label

window title



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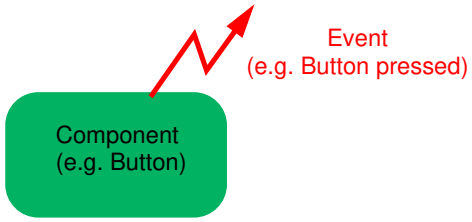
26.4 Events (JDK 1.1)

- User actions generate events (mouse movements, keyboard input, etc.)
- Every component can fire an event



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26.4 Event Handling

- Events are defined in package **`java.awt.event`**
- Two kinds of events
  - High Level (push button, input text, ...)
  - Low Level (move mouse, press key, ...)

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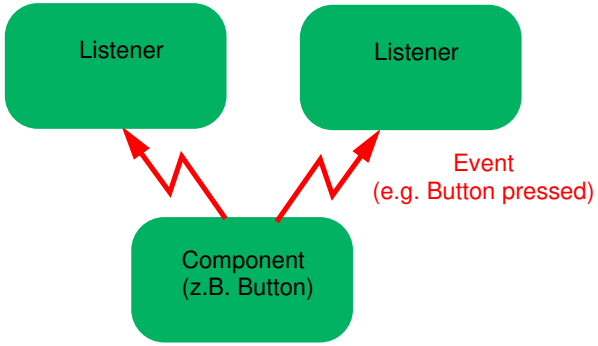
26.4 Events

- Every object can be registered as an event receiver *if it implements a Listener interface*



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26.5 Events Example

```
import java.awt.*;
import java.awt.event.*;

public class SimpleEvt extends Frame {
  public SimpleEvt(String title) {
    super(title);
    Button b = new Button("OK");
    add(b);
    OKListener l = new OKListener();
    b.addActionListener(l);

    pack();
    show();
  }
  public static void main(String a[]) {
    SimpleEvt s = new SimpleEvt("Test");
  }
}
class OKListener implements ActionListener {
  public void actionPerformed(ActionEvent e) {
    System.out.println("OK was pressed.");
  }
}
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26.6 High-Level Events

- **ActionEvent**: User interacts with component
- **AdjustmentEvent**: User moves scrollbar slider
- **ItemEvent**: User selects component
- **TextEvent**: Contents of text component changed

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26.7 Low-level Events

- **ComponentEvent**: component moved, resized, ...
- **FocusEvent**: component got/lost input focus
- **InputEvent**: abstract superclass of KeyEvent and MouseEvent
  - **KeyEvent**: Key was pressed, released, etc.
  - **MouseEvent**: Mouse was moved, mouse button pressed, etc.
- **ContainerEvent**: state of container changed
- **WindowEvent**: Window opened, closed, iconized, etc.

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26.8 Events Example with Inner Class

```
import java.awt.*;
import java.awt.event.*;

public class SimpleEvt extends Frame {
  public SimpleEvt(String title) {
    super(title);
    Button b = new Button("OK");
    add(b);
    OKListener l = new OKListener();
    b.addActionListener(l);

    pack();
    show();
  }
  public static void main(String a[]) {
    SimpleEvt s = new SimpleEvt("Test");
  }

  class OKListener implements ActionListener {
    public void actionPerformed(ActionEvent e) {
      System.out.println("OK was pressed.");
    }
  }
}
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26.9 Events Example with Anonymous Inner Class

```
import java.awt.*;
import java.awt.event.*;

public class SimpleEvt extends Frame {
  public SimpleEvt(String title) {
    super(title);
    Button b = new Button("OK");
    add(b);

    ActionListener l = new ActionListener() {
       public void actionPerformed(ActionEvent e) {
         System.out.println("OK was pressed.");
       }
    };

    b.addActionListener(l);

    pack();
    show();
  }

  public static void main(String a[]) {
    SimpleEvt s = new SimpleEvt("Test");
  }
}
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26.10 Events Example with Anonymous Inner Class

```
import java.awt.*;
import java.awt.event.*;

public class SimpleEvt extends Frame {
  public SimpleEvt(String title) {
    super(title);
    Button b = new Button("OK");
    add(b);

    b.addActionListener(new ActionListener() {
       public void actionPerformed(ActionEvent e) {
          System.out.println("OK was pressed.");
       }
    });

    pack();
    show();
  }

  public static void main(String a[]) {
    SimpleEvt s = new SimpleEvt("Test");
  }
}
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

26.11 Event Adpaters

- Event Adapters can be used to map an event to an arbitrary method invokation
- Useful for:
  - event queues
  - event filters
  - demultiplexing of multiple event sources to one listener
- **`java.awt.event`** package provides some simple adapters:
  - **`MouseAdapter`**, **`ComponentAdapter`**, ...
  - contain empty handlers
  - subclass these adapters and override some of the handler methods

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26.12 Mouse Handling

- MouseListener, MouseMotionListener, MouseEvent, MouseAdapter, MouseMotionAdapter
- MouseListener is used to react to mouse buttons
- MouseMotionListener is used to react to mouse movements
- the MouseEvent object contains information about
  - the mouse position (**`getX()`**, **`getY()`**)
  - whether some modifier keys are pressed (**`isShiftDown()`**, **`isControlDown()`**, ...)

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

27 Layoutmanager

- Problem: Arranging components in a container
- Solution #1: absolute positioning
  - Problem: User cannot change window size
- Solution #2: using a layout manager
- Principle:
  - A rectangular container contains components and other containers.
  - Every container has a layout manager.
  - The layout manager is responsible for computing the component positions.
- The most simple container is **`Panel`** with layout manager **`FlowLayout`**.

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

27.1 Layoutmanager

- FlowLayout (from left to right, line by line)
- GridLayout (aligned in a grid)
- BorderLayout (aligned at the container borders)
- CardLayout (components are cards)
- GridBagLayout (constraints for layout in the grid)

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

27.2 FlowLayout

- Default LayoutManager of **`Panel`** and **`Applet`**
- Similar to a text processor with word wrap

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

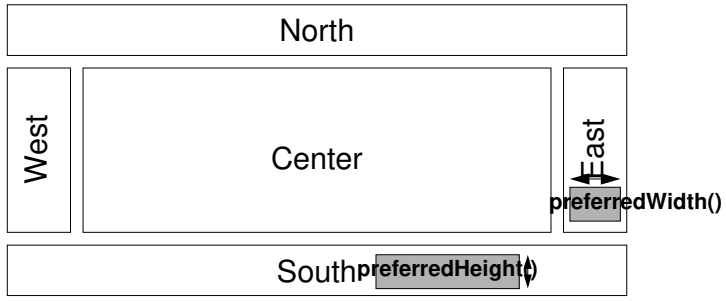
27.3 FlowLayout Example

```
import java.awt.*;

public class Flow extends Frame {
  public Flow(String title) {
    super(title);

    setLayout(new FlowLayout());

    add(new Button("Ja"));
    add(new Button("Nein"));
    add(new Button("Weiss nicht"));
    add(new Button("Kann sein"));

    pack();
    show();
  }

  public static void main(String a[]) {
    new Flow("Test");
  }
}
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

27.4 BorderLayout

- Default LayoutManager of **`Frame`**
- 5 Components:



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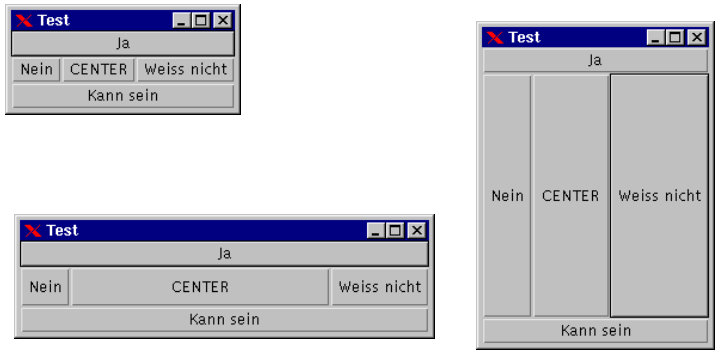
27.5 BorderLayout Example



Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

27.6 BorderLayout Example

```
import java.awt.*;

public class Border extends Frame {
  public Border(String title) {
    super(title);

    setLayout(new BorderLayout());

    add(new Button("Ja"), BorderLayout.NORTH);
    add(new Button("Nein"), BorderLayout.WEST);
    add(new Button("Weiss nicht"), BorderLayout.EAST);
    add(new Button("Kann sein"), BorderLayout.SOUTH);

    add(new Button("CENTER"), BorderLayout.CENTER);

    pack();
    show();
  }

  public static void main(String a[]) {
    new Border("Test");
  }
}
```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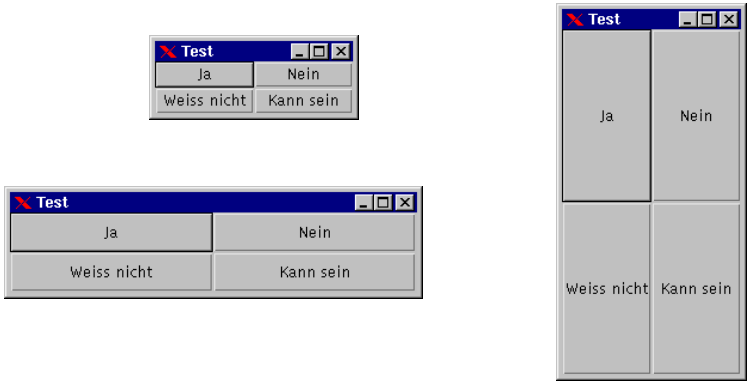
27.7 GridLayout

- Alignes components in a grid



Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

27.8 GridLayout Example

```
import java.awt.*;

public class Grid extends Frame {
  public Grid(String title) {
    super(title);

    setLayout(new GridLayout(2,2));

    add(new Button("Ja"));
    add(new Button("Nein"));
    add(new Button("Weiss nicht"));
    add(new Button("Kann sein"));

    pack();
    show();
  }

  public static void main(String a[]) {
    new Grid("Test");
  }
}
```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27.9 CardLayout

- only one component is visible at a time
- normally components are containers
- **`CardLayout`** is used to create a slide-show effect
- **`show(Container parent, String name)`**: show component with **`name`** in Container **`parent`**
- Methods **`first, next, previous, last`** iterate through the container

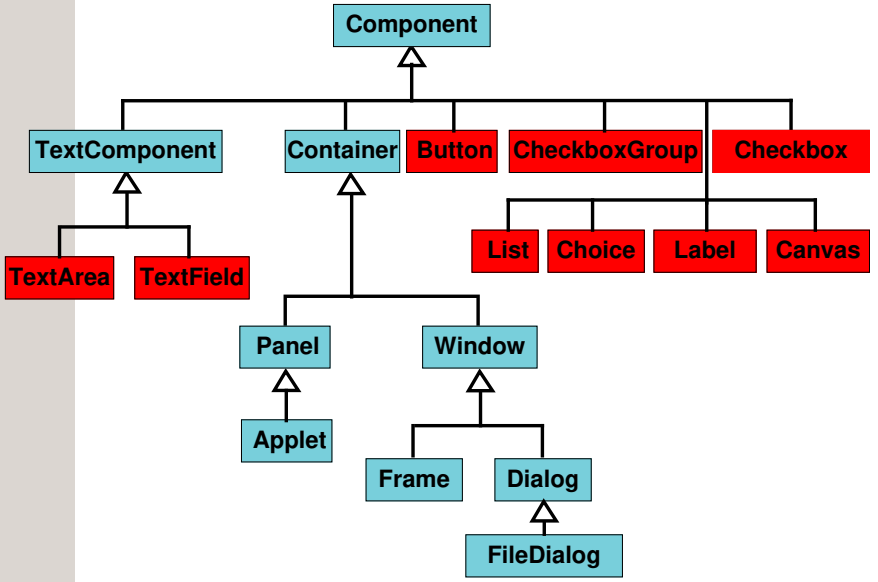
Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

27.10 CardLayout Example

```
import java.awt.*;
import java.awt.event.*;

public class Card extends Frame {
  public Card(String title) {
    super(title);

    final CardLayout cardLayout = new CardLayout();
    setLayout(cardLayout);

    Button button = new Button("Go");
    add("Card1", button);
    button.addActionListener(new ActionListener() {
      public void actionPerformed(ActionEvent e) {
        cardLayout.show(this, "Card2");
      }
    });

    ...
  }
}
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

28 AWT Components



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28.1 Some important components

- **`Button`**: normally used together with ActionListener

```
Button b = new Button("OK");
b.addActionListener(new ActionListener() {
        public void actionPerformed() {...  }
};
```

- **`TextField`**: used to get user input, normally used together with Button (as trigger)

```
TextField t = new TextField();
...
String s = t.getText();
```

- **`Canvas`**: used for drawing, normally subclassed

```
class MyDrawingClass extends Canvas {
        public void paint(Graphics g) { ... }
}
```


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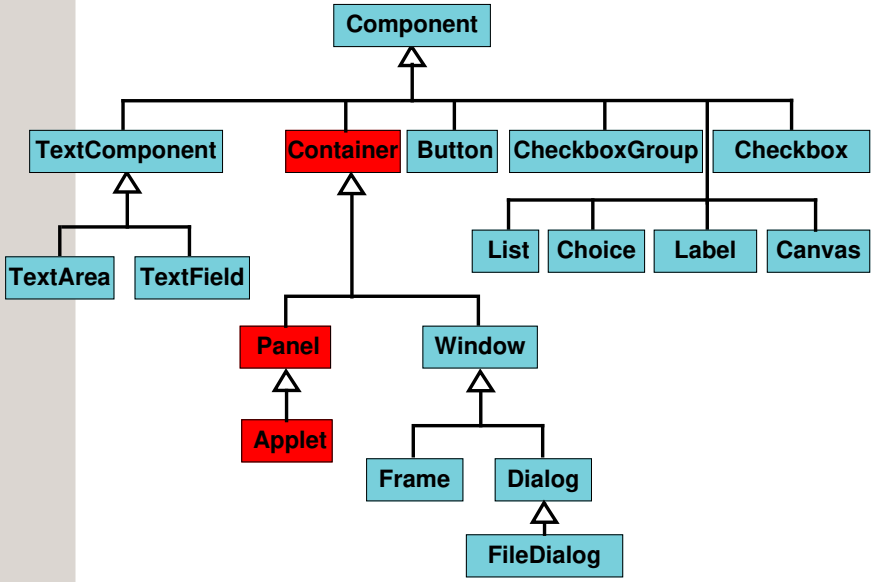
28.2 Using Container Components



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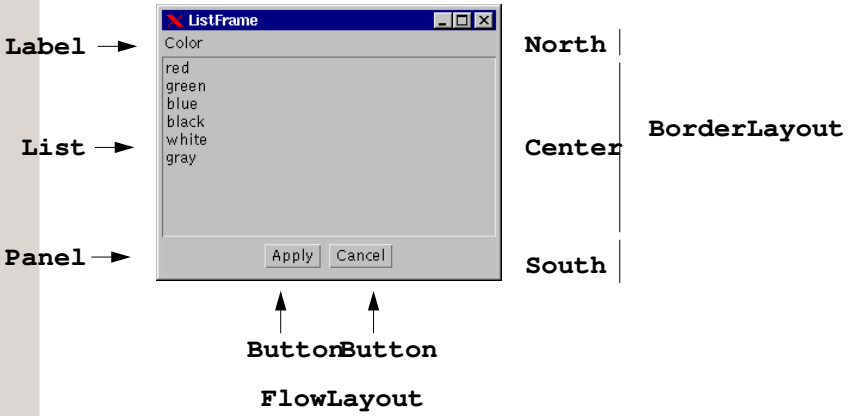
28.3 Composing Panels

- Combine a panel from other panels



Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

28.4 Composing Panels

```
import java.awt.*;
public class ListFrame extends Frame {
  List list;
  public ListFrame(String name) {
    super(name);                                  // Frame constructor
    setLayout(new BorderLayout());               // new frame layout manager
    list = new List(3,true);                      // create a List
    add(new Label("Color"),BorderLayout.NORTH); // Label in north area
    Panel ctrlPanel=new Panel();                  // create control panel
    ctrlPanel.setLayout(new FlowLayout()); // new Panel layout manager
    ctrlPanel.add(new Button("Apply"));     // add Apply and Cancel
    ctrlPanel.add(new Button("Cancel"));    // buttons to control panel
    add(ctrlPanel, BorderLayout.SOUTH);     // control panel at south
    add(list, BorderLayout.CENTER);          // List at center
    pack();                                       // compute positions
    show();                                       // show frame
  }
  public static void main(String a[]) {
    ListFrame frame = new ListFrame("ListFrame");
    frame.list.addItem("red");
    ...
  }
}
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

29 AWT Graphics

- Drawing
- Images

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

29.1 Drawing

- `java.awt.Graphics` has methods to draw
- is passed to the `paint` method

```
import java.awt.*;

public class DrawTest extends java.applet.Applet {
  public void paint(Graphics g) {
    g.setColor(Color.red);
    g.drawOval(10,10,70,100);
  }
}
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

29.2 Images

- a `Image` object contains a GIF, JPEG, etc.
- you can draw images using the `drawImage` method of `Graphics`

```
import java.awt.*;

public class ImageTest extends java.applet.Applet {
  Image image;
  public void init() {
    image = getImage(getDocumentBase(), "image.gif");
  }
  public void paint(Graphics g) {
    g.drawImage(image,10,10,this);
  }
}
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

29.3 Images

- Load and show images
- Consider World-Wide-Web problems
  - slow connections
  - load asynchronously: All images are loaded in parallel.
- Principle:
  - `Image` objects contain a partially/completely loaded image
  - `Applet.getImage()` returns immediately, image starts loading if `drawImage` is called
  - `MediaTracker` object controls image loading

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

29.4 MediaTracker

`void addImage(Image image, int id)`
Control `image` loading. `id` can be used to group images.

`void waitForID(int id)`
Wait for medium with `id`.

`boolean checkAll()`
Returns `true` if all images/media are loaded.

`boolean checkAll(boolean force)`
Returns true if all images are loaded. If `force=true` stat image loading.

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

30 AWT Design Patterns

- AWT employs many design patterns
- understand the AWT looking at these patterns
- Patterns:
  - *Composite*: Component management in a Container
  - *Strategy*: Separating layout strategy from Container objects
  - *Bridge*: Separating platform independent from platform dependent AWT objects
  - *AbstractFactory*: Creating peer objects
  - *Singleton*: the abstract factory that creates peer objects
  - *Observer*: the listener mechanism

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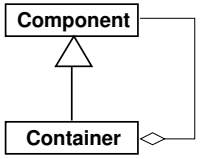
30.1 Composite Pattern

- Class diagram



- Roles
  - Component: supplies GUI service
  - Container: is composite, manages components(children), computes position

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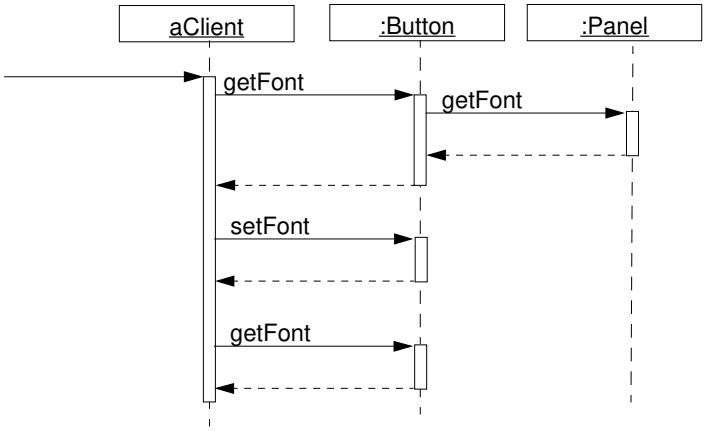
30.1.1 Interactionen during getFont

- Which font is used for a newly created button?



- Propagation of the font property from the parents to the children

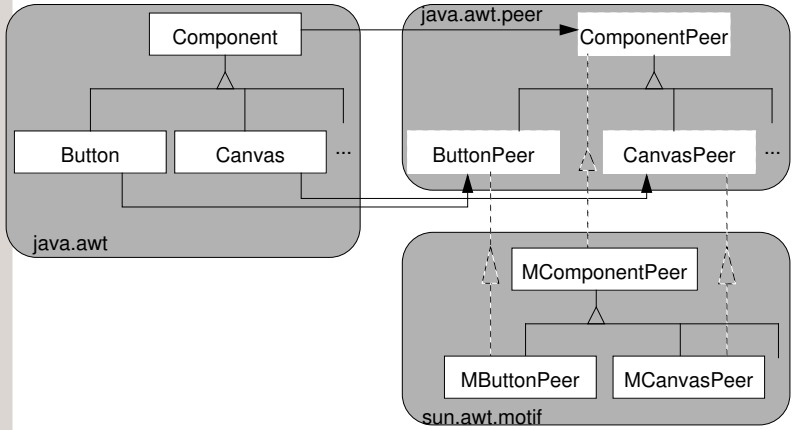
Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

30.2 Bridge Pattern

- Motivation
  - platform-independent user interface
- Roles:
  - *Component*: platform-independent visual component
  - *ComponentPeer*: platform specific component

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

30.2.1 Peers - Class Diagram



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30.3 Factory

- Problem: Instantiation ties to a specific GUI

```
ButtonPeer b = new MButtonPeer();
ScrollbarPeer s = new MScrollbarPeer();
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

30.3 Factory

- Problem: Instantiation ties to a specific GUI

```
ButtonPeer b = new MButtonPeer();
ScrollbarPeer s = new MScrollbarPeer();
```

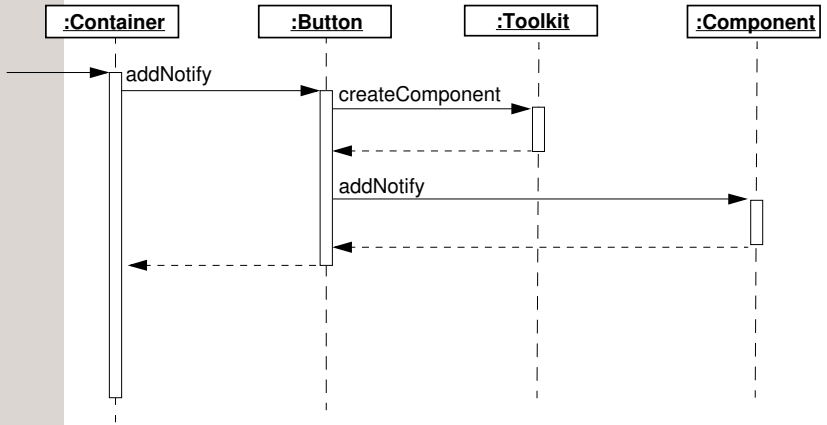
- Solution: Use a factory (Toolkit)

```
Button button = new Button();
ButtonPeer buttonPeer = toolkit.createButton(button);
```


Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

30.3 Factory

- Sequence diagram: making a button visible



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30.4 Singleton

- Motivation
  - only one instance of Toolkit should be allowed
  - the class name is given as a property

```
abstract class Toolkit {
    Toolkit instance;

    private Toolkit() {}

    public Toolkit getDefaultToolkit() {
        if (instance == null) {
            Class tClass =Class.forName(toolkitName);
            instance = tClass.newInstance();
        }
        return instance;
    }
    ...
}
```

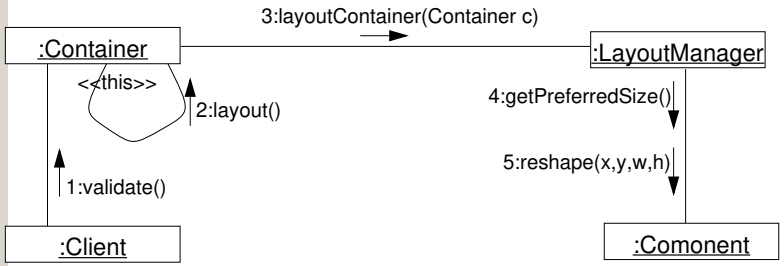

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

30.5 Strategy

- Separation of container and layout strategy
- Roles:
  - **`Container`**: wants to layout a component
  - **`LayoutManager`**: provides layout algorithm
  - **`Component`**: provides size information and is positioned

Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

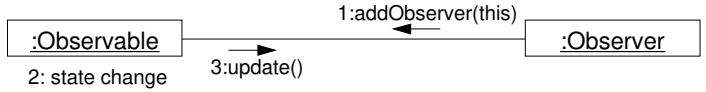
30.5.1 LayoutManager - Collaboration Diagram



Reproduktion jeder Art oder Verwendung dieser Unterlage bedarf der Zustimmung des Autors.

30.6 Observer

- Example
  - Listener mechanism
  - **`Observer`**/**`Observable`** from **`java.util`**
- Observ *Subject* and react



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