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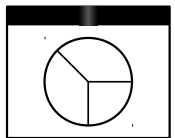
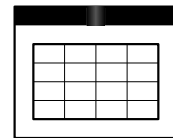
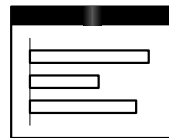
## • MVC and Android

Slides originally by Ken Wong

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## • Model/View/Controller

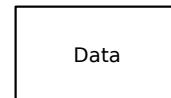
views



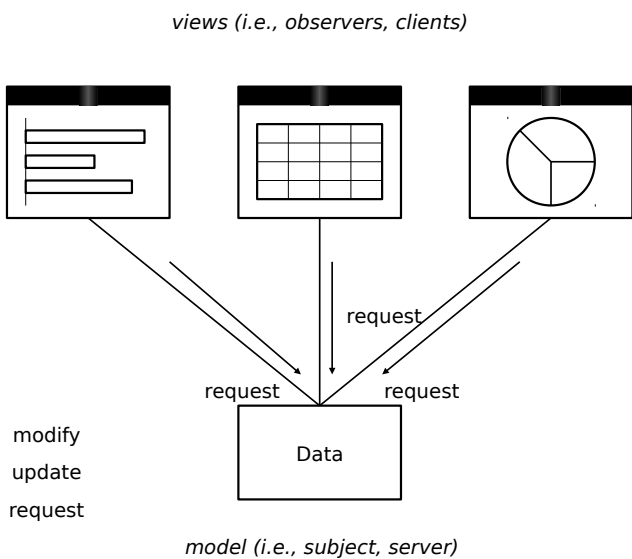
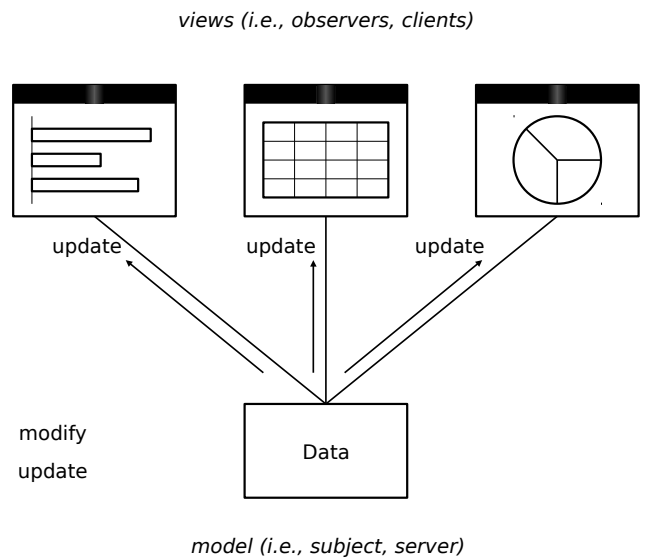
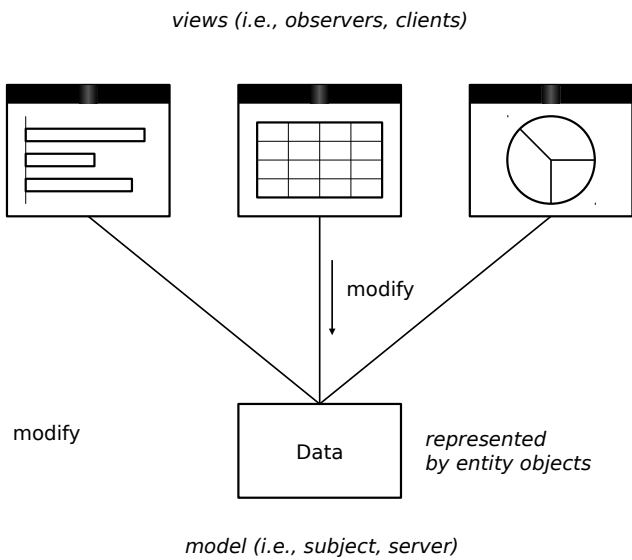
*need to maintain consistency in the views*

*want clear, separate responsibilities for presentation, interaction, computation, and representation*

*need to update multiple views of the common data model*



model



## Model/View/Controller Roles

- **Model:**
  - entity layer
    - ▢ complete, self-contained representation of the data managed by the application
    - ▢ provides services to manipulate this data
    - ▢ “the back end”
  - main responsibilities
    - ▢ representation and computation issues
    - ▢ sometimes persistence

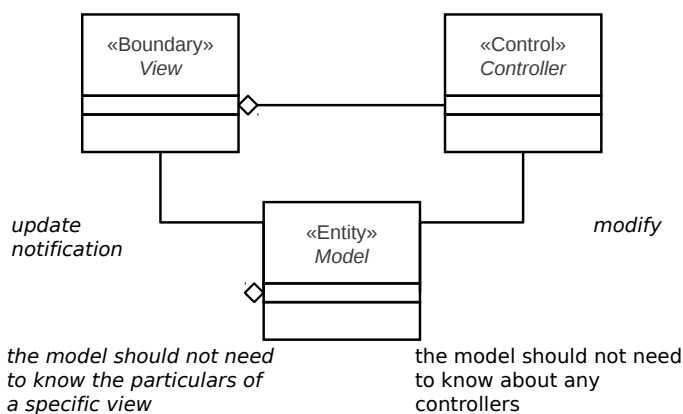
## MVC Roles

- View:
  - boundary layer
    - set of user interface components
    - determines what is needed for a particular perspective of the data
    - “the front end”
  - main responsibility
    - presentation issues

## MVC Roles

- Controller:
  - control layer
    - handles events and uses appropriate information from user interface components to modify the model
  - main responsibility
    - interaction issues

can create new, specific types of views without changing the model



## MVC Design Issues

- Swing dependent part:
  - views contain Swing components
  - controllers are Swing listeners
- Swing independent part:
  - the model should be as Swing free as possible
    - e.g., not using Swing types in entity classes

## “MV” Design

- Generalization:
  - use “model” superclass and “view” interface
    - all models keep track of their views
    - when changed, all models notify their views to update
    - all views update themselves when notified
  - have application-specific model and view classes

## Java Observer

- java.util.Observer interface
- ```
public interface Observer {  
    public void update( Observable s, Object arg );  
}
```

## Java Observer

- java.util.Observable superclass
- ```
public class Observable {  
    ...  
    public Observable() { ... }  
  
    // "all models keep track of their views"  
    public void addObserver( Observer o ) { ... }  
    public void deleteObserver( Observer o ) { ... }  
  
    // "all models notify their views to update"  
    public void notifyObservers() { ... }  
    public void notifyObservers( Object arg ) { ... }  
  
    // note whether the model has changed  
    public boolean hasChanged() { ... }  
    protected void clearChanged() { ... }  
    protected void setChanged() { ... }  
    ...  
}
```

## Java Observer

- ```
// MyModel.java  
import java.util.*;  
  
public class MyModel extends Observable {  
    private String message;  
  
    public MyModel() {  
        message = "";  
    }  
    public String getMessage() {  
        return message;  
    }  
    public void setMessage( String message ) {  
        this.message = message;  
        setChanged();  
        notifyObservers(); // clears changed flag  
    }  
}
```

## Java Observer

- `// MyView.java`  
`import java.util.*;`  
  
`public class MyView implements Observer {`  
    `public void update( Observable s, Object arg ) {`  
        `System.out.println(`  
            `((MyModel) s).getMessage()`  
        `);`  
    `}`  
`}`

## Java Observer

- `// MyApp.java`  
  
`public class MyApp {`  
    `public static void main( String args[] ) {`  
  
        `MyModel theModel = new MyModel();`  
        `MyView aView = new MyView();`  
        `MyView anotherView = new MyView();`  
  
        `theModel.addObserver( aView );`  
        `theModel.addObserver( anotherView );`  
  
        `theModel.setMessage( "hello" );`  
    `}`  
`}`

## Observer using Java Generics

- `// TView.java`  
`public interface TView<M> {`  
    `public void update( M model );`  
`}`

## Observer using Java Generics

- `// TModel.java`  
`import java.util.*;`  
  
`public class TModel<V extends TView> {`  
    `private ArrayList<V> views;`  
  
    `public TModel() {`  
        `views = new ArrayList<V>();`  
    `}`  
  
    `public void addView( V view ) {`  
        `if (! views.contains( view )) {`  
            `views.add( view );`  
        `}`  
    `}`  
  
    `...`

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## Observer using Java Generics

- ```

public void deleteView( V view ) {
    views.remove( view );
}

public void notifyViews() {
    for ( V view : views ) {
        view.update( this );
    }
}
...
}

```

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## Observer using Java Generics

- ```

// MyView.java
import java.util.*;

public class MyView implements TView<MyModel> {
    public void update( MyModel model ) {
        System.out.println( model.getMessage() );
    }
}

```

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## Observer using Java Generics

- ```

// MyModel.java
public class MyModel extends TModel<TView> {
    private String message;

    public MyModel() {
        message = "";
    }
    public String getMessage() {
        return message;
    }
    public void setMessage( String message ) {
        this.message = message;
        notifyViews();
    }
}

```

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## Observer using Java Generics

- ```

// MyApp.java

public class MyApp {

    public static void main( String args[] ) {

        MyModel theModel = new MyModel();
        MyView aView = new MyView();
        MyView anotherView = new MyView();

        theModel.addView( aView );
        theModel.addView( anotherView );

        theModel.setMessage( "hello" );

    }
}

```

## MVC Design

- Approach:
  - use a framework that supports MVC to help structure an interactive application
  - framework is a set of cooperating classes that forms a reusable design in a particular domain
  - reusable design *and* code

## Who is in Control?

- Class library reuse
  - application developers:
    - write the main body of the application
    - reuse library code by calling it
- Framework reuse
  - application developers:
    - reuse the main body of the application
    - write code that the framework calls
    - reuse library code by calling it

## ● MVC Framework

## Framework

- Separation of concerns:
  - framework
    - skeletal application code
    - general superclasses and interfaces
  - your “customizations”
    - specific subclasses and implementations

## Exercise

- Design an MVC framework for building interactive applications.

## Generic View

- `// TView.java`  

```
public interface TView<M> {
    public void update( M model );
}
```

## Generic Model

- `// TModel.java`  

```
...

public abstract class TModel<V extends TView> {
    private ArrayList<V> views;

    protected TModel() {
        views = new ArrayList<V>();
    }

    public void addView( V view ) {
        if (! views.contains( view )) {
            views.add( view );
        }
    }
}
```

## Generic Model

- ```
public void deleteView( V view ) {
    views.remove( view );
}

public void notifyViews() {
    for (V view : views) {
        view.update( this );
    }
}
```



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## General Command

- `// TCommand.java`  
...

```
public class TCommand {
    public void execute((ActionEvent event) {
    }
    public void execute( ItemEvent event ) {
    }
}
```

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## “Code Reuse”

- <http://www.dilbert.com/strips/comic/1996-01-31/>

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## General Controller

- `// TController.java`  
...

```
public abstract class TController implements
    ActionListener, ItemListener {

    private JComponent component;
    private TCommand command;

    protected TController(
        JComponent component, TCommand command ) {

        this.component = component;
        this.command = command;
    }
}
```

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## General Controller

- ```
public JComponent getComponent() {
    return component;
}
public TCommand getCommand() {
    return command;
}

public void actionPerformed(
   (ActionEvent event) {

    TCommand command = getCommand();
    if (command != null) {
        command.execute( event );
    }
}
...
}
```

## General Button Controller

- // TButtonController.java
- ...

```
public class TButtonController extends TController {
    public TButtonController(
        JButton button, TCommand command ) {
        super( button, command );
        button.addActionListener( this );
    }
}
```

## General Menu Item Controller

- // TMenuItemController.java
- ...

```
public class TMenuItemController extends TController
{
    public TMenuItemController(
        JMenuItem menuItem, TCommand command ) {
        super( menuItem, command );
        menuItem.addActionListener( this );
    }
}
```

## Generic Application

- // TApp.java
- ...

```
public abstract class TApp<M> {
    private static TApp theApp = null;
    public static TApp getApp() {
        return theApp;
    }
    private M model;
    public M getModel() {
        return model;
    }
}
```

## Generic Application

- 

```
private JFrame frame;
private JPanel content;
public JFrame getFrame() {
    return frame;
}
public JPanel getContent() {
    return content;
}
```

## Generic Application

```
protected TApp( String title, M model ) {
    if (theApp != null) {
        return;
    }
    theApp = this;

    this.model = model;

    makeWindow( title );
}
```

## Generic Application

```
private void makeWindow( String title ) {
    frame = new JFrame( title );

    content = new JPanel();
    frame.setContentPane( content );
}

public void show() {
    frame.pack();
    frame.setVisible( true );
}

public void addToContent(
    JComponent component ) {
    content.add( component );
}
```

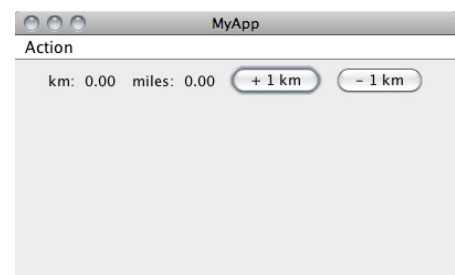
## Generic Application

```
private JMenuBar menubar = null;

public void makeMenuBar() {
    menubar = new JMenuBar();
    frame.setJMenuBar( menubar );
}

public void addToMenuBar( JMenu menu ) {
    if (menubar == null) {
        return;
    }
    menubar.add( menu );
}
}
```

## Example Custom Application



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## Custom View

- `// MyLabelView.java`  
...

```
public class MyLabelView implements TView<MyModel>
{
    private static DecimalFormat twoPlaces =
        new DecimalFormat( "0.00" );

    private JPanel panel;
    private JLabel labelLabel;
    private JLabel valueLabel;
    private double multiplier;

```

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## Custom View

- ```
public MyLabelView(
    String labelText, double multiplier ) {

    panel = new JPanel();
    labelLabel = new JLabel( labelText );
    panel.add( labelLabel );
    valueLabel = new JLabel( " " );
    panel.add( valueLabel );
    this.multiplier = multiplier;
}

public JComponent getComponent() {
    return panel;
}

```

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## Custom View

- ```
public void update( MyModel model ) {
    double value =
        model.getValue() * multiplier;

    valueLabel.setText(
        twoPlaces.format( value )
    );
}

```

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## Custom Model

- `// MyModel.java`

```
public class MyModel extends TModel<TView> {
    private int value;

    public MyModel() {
        value = 0;
    }
    public int getValue() {
        return value;
    }
    public void setValue( int value ) {
        if (value < 0) {
            value = 0;
        }
        this.value = value;
        notifyViews();
    }
}

```

## Custom Application

- `// MyApp.java`  
...

```
public class MyApp extends TApp<MyModel> {

    public MyApp(
        String title, MyModel model ) {

        super( title, model );

        // create the UI
        MyMainView myMainView =
            new MyMainView( this, model );
        model.addView( myMainView );
    }
}
```

## Custom Application

- 

```
public static void main( String args[] ) {
    MyModel model = new MyModel();
    MyApp app = new MyApp( "MyApp", model );

    model.notifyViews();

    app.getContent().setPreferredSize(
        new Dimension( 400, 200 )
    );
    app.show();
}
}
```

## Custom User Interface

- `// MyMainView.java`  
...

```
public class MyMainView implements TView<MyModel> {

    private MyLabelView kmView;
    private MyLabelView milesView;

    private TCommand incrCommand;
    private TCommand decrCommand;

    private JMenu menu;

    private JMenuItem incrMenuItem;
    private JMenuItem decrMenuItem;

    private JButton incrButton;
    private JButton decrButton;
}
```

## Custom User Interface

- 

```
public MyMainView(
    MyApp app, final MyModel model ) {

    // create views
    kmView = new MyLabelView(
        "km: ", 1.0
    );
    milesView = new MyLabelView(
        "miles: ", 0.621371192
    );

    // register views with model
    model.addView( kmView );
    model.addView( milesView );
}
```

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## Custom User Interface

- ```

// create commands that modify the model
incrCommand = new TCommand() {
    public void execute(
        ActionEvent event ) {

        model.setValue(
            model.getValue() + 1
        );
    }
};
decrCommand = new TCommand() {
    public void execute(
        ActionEvent event ) {

        model.setValue(
            model.getValue() - 1
        );
    }
};

```

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## Custom User Interface

- ```

// views
app.addToContent( kmView.getComponent() );
app.addToContent( milesView.getComponent() );

// controls
incrButton = new JButton( "+ 1 km" );
app.addToContent( incrButton );

decrButton = new JButton( "- 1 km" );
app.addToContent( decrButton );

// associate components to commands
new TMenuItemController(
    incrMenuItem, incrCommand );
new TMenuItemController(
    decrMenuItem, decrCommand );
new TButtonController(
    incrButton, incrCommand );
new TButtonController(
    decrButton, decrCommand );

```

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## Custom User Interface

- ```

public void update( MyModel model ) {
    // nothing to do
}

```

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## Exercise

- Draw a UML sequence diagram for the behavior when a button is clicked in the example application.