CS193j, Stanford Handout #23
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MVC Table

Model / View / Controller

Design
- A decomposition strategy where "presentation" is separated from data maintenance
- Smalltalk idea
- Controller is often combined with View, so have Model and View / Controller

Web Version
- Shopping cart model is on the server
- The view is the HTML in front of you
- Form submit = send transaction to the model, it computes the new state, sends you back a new view

Model -- aka Data Model

"data model"
Storage, not presentation
Knows data, not pixels
Isolate data model operations
- cut / copy / paste, File Saving, undo, networked data -- these can be expressed just on the model which simplifies things

View

Presentation
Gets all data from model
Edits events piped to model
- Edit events happen in the view (keyboard, mouse gestures) -- these get messaged to the model which does the actual data maintenance

Controller

The logic that glues things together.
Manage the relationship between the model and view
Usually, the controller is implemented in the view.

Model Role

Respond to getters methods to provide data
Respond to setters to change data
Manage a list of listeners
When receiving a setData() to change the data, notify the listeners of the change (fireXXXChanged)
- Change notifications express the different changes possible on the model. (cell edited, row deleted, ...)

Iterate through the listeners and notify each about the change.

View Role

Have pointer to model
Don't store any data
Send getData() to model to get data as needed
User edit operations (clicking, typing) in the UI map to setData() messages sent to model
Register as a listener to the model(respond to listener notifications)
On change notification, consider doing a getData() to get the new values.

Swing Table Classes

JTable -- view

Uses a TableModel for storage

TableModel -- Interface

The messages the define a table model -- the abstraction is a rectangular area of cells.
getValueAt(), setValueAt, getRowCount(), getColumnCount(), ...

TableModelListener -- Interface

Defines the one method tableChanged()
If you want to listen to a TableModel to hear about its changes, implement this interface.

```
public interface TableModelListener extends java.util.EventListener
{
    /**
     * This fine grain notification tells listeners the exact range
     * of cells, rows, or columns that changed.
     */
    public void tableChanged(TableModelEvent e);
}
```

AbstractTableModel

Implements TableModel 50%
Provides helper utilities for things not directly related to storage
    addTableModelListener(), removeTableModelListener(), ...
fireXXXChanged() convenience methods
    These iterate over the listeners and send the appropriate notification
    fireTableCellUpdated(row, col)
    fireTableRowDeleted(row)
    etc.
getValueAt() and setValueAt() are missing

DefaultTableModel

extends AbstractTableModel
Complete implementation with Vector

BasicTableModel Code Points

A complete implementation of TableModel using ArrayList
getValueAt()
    Pulls data out of the ArrayList of ArrayList implementation
setValueAt()
    Changes the data model and uses fireTableXXX (below) to notify the listeners
AbstractTableModel
    Has routine code in it to manage listeners -- add and remove.
    Has fireTableXXX() methods that notify the listeners -- BasicTableModel uses these to tell the listeners about changes.

1. Passive Example

1. Table View points to model
2. View does model.getXXX to get data to display

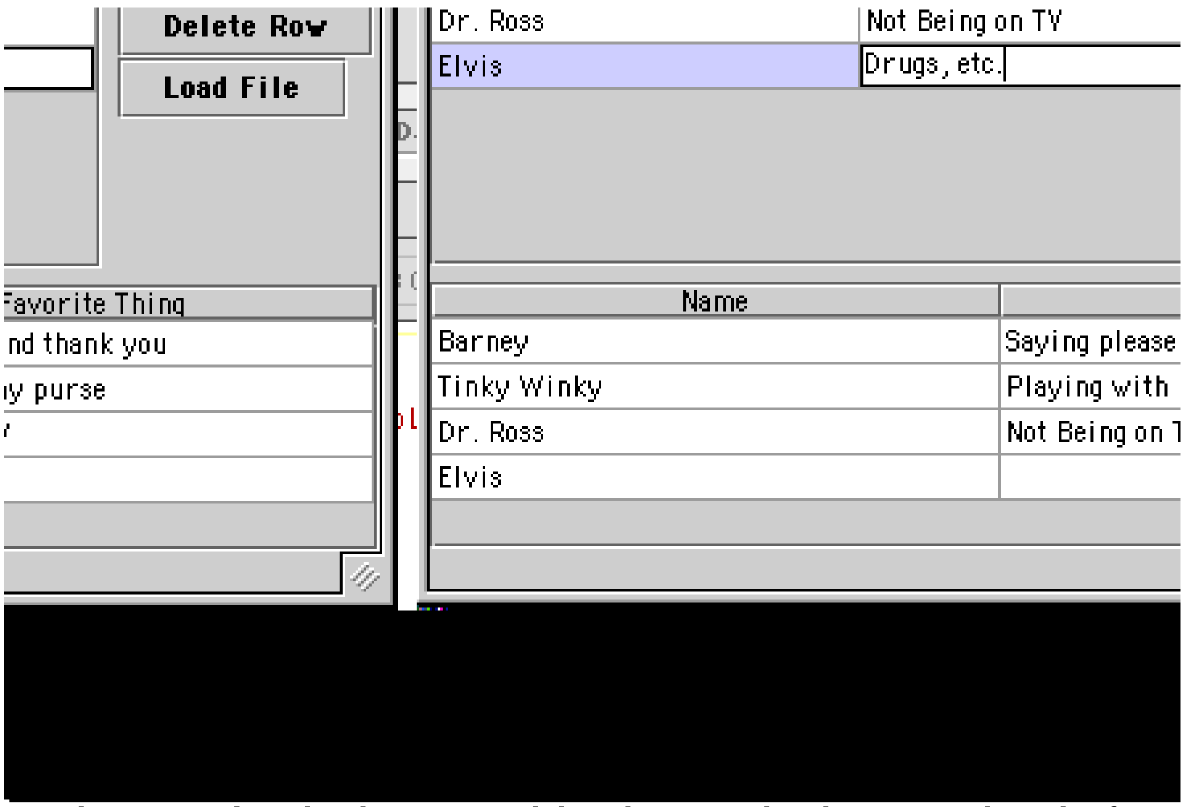
2. Row Add Example

1. Add row button wired to the model
2. Model changes its state
3. Model does fireRowAdded() which sends notification to each listener
4. Listeners get the notification, call getData() as needed

3. Edit Example

1. Table View1 points to model for its data and listens for changes
2. Table View2 also points to the model and listens for changes
3. User clicks/edits data in View1
4. View1 does a model.setXXX to make the change
5. Model does a fireDataChanged() -- notifies both listeners
6. Both views get the notification of change, update their display (getXXX) if necessary

View2 can be smart if View1 changes a row that View2 is not currently scrolled to see.



Dr. Ross	Not Being on TV
Elvis	Drugs, etc.

Favorite Thing
nd thank you
y purse

Name	
Barney	Saying please
Tinky Winky	Playing with
Dr. Ross	Not Being on T
Elvis	

In this case, "Elvis" has been entered, but the return key has not yet been hit for the "Sex, drugs, etc." entry

BasicTableModel

Demonstrates a complete implementation of TableModel -- stores the data and generates fireXXXChanged() notifications where necessary.

```
// BasicTableModel.java

/*
 Demonstrate a basic table model implementation
 using ArrayList.

 A row may be shorter than the number of columns
 which complicates the data handling a bit.
*/
import java.awt.*;
import javax.swing.*;

import javax.swing.table.*;

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

```
class BasicTableModel extends AbstractTableModel {
   private ArrayList names;   // the label strings
   private ArrayList data;    // arraylist of arraylists


   public BasicTableModel() {
      super();

      names = new ArrayList();
      data = new ArrayList();
   }


   // Basic Model overrides
   public String getColumnName(int col) {
      return (String) names.get(col);
   }
   public int getColumnCount() { return(names.size()); }
   public int getRowCount() { return(data.size()); }
   public Object getValueAt(int row, int col) {
      ArrayList rowList = (ArrayList) data.get(row);
      String result = null;
      if (col<rowList.size()) {
         result = (String)rowList.get(col);
      }

      // _apparently_ it's ok to return null for a "blank" cell
      return(result);
   }


   // Support writing
   public boolean isCellEditable(int row, int col) { return true; }
   public void setValueAt(Object value, int row, int col) {
      ArrayList rowList = (ArrayList) data.get(row);

      // make this row long enough
      if (col>=rowList.size()) {
         while (col>=rowList.size()) rowList.add(null);
      }

      rowList.set(col, value);

      // notify model listeners of cell change
      fireTableCellUpdated(row, col);
   }

   // Adds the given column to the right hand side of the model
   public void addColumn(String name) {
      names.add(name);
      fireTableStructureChanged();
      /*
       At present, TableModelListener does not have a more specific
       notification for changing the number of columns.
      */
   }
```

```
// Adds an empty row, returns the new row index
public int addRow() {
   // Create a new row with nothing in it
   ArrayList row = new ArrayList();
   return(addRow(row));
}

// Adds the given row, returns the new row index
public int addRow(ArrayList row) {
   data.add(row);
   fireTableRowsInserted(data.size()-1, data.size()-1);
   return(data.size() -1);
}

// Deletes the given row
public void deleteRow(int row) {
   if (row == -1) return;

   data.remove(row);
   fireTableRowsDeleted(row, row);
}


/*
 Utility.
 Change a tab-delimited line into an ArrayList.
 It's strange to me that this code is as complex as it is,
 but this is the best I could figure out.
 It seems like the StringTok docs could be better.
*/
private static ArrayList stringToList(String string) {
   StringTokenizer tokenizer = new StringTokenizer(string, "\t", true);
   ArrayList row = new ArrayList();
   String elem = null;
   String last = null;
   while(tokenizer.hasMoreTokens()) {
      last = elem;
      elem = tokenizer.nextToken();
      if (!elem.equals("\t")) row.add(elem);
      else if (last.equals("\t")) row.add("");
   }
   if (elem.equals("\t")) row.add("");

   return(row);
}



/*
 Load the whole model from a file.
*/
public void loadFile(File file) {
   try {
      FileReader fileReader = new FileReader(file);
      BufferedReader bufferedReader = new BufferedReader(fileReader);

      ArrayList first = stringToList(bufferedReader.readLine());
      names = first;
```

```
         String line;
         data = new ArrayList();
         while ((line = bufferedReader.readLine()) != null) {
            data.add(stringToList(line));
         }

         fireTableStructureChanged();
      }
      catch (IOException e) {
         System.err.println(e.getMessage());
      }
   }

}
```

Table Client Code

```
// TableFrame.java
/*
 Demonstrate a couple tables using one table model.
*/

import java.awt.*;
import javax.swing.*;
import java.util.*;

import java.awt.event.*;
import javax.swing.event.*;

import com.sun.java.util.collections.*;

class TableFrame extends JFrame {
   private BasicTableModel model;

   private JTable table;
   private JTable table2;

   JButton columnButton;
   JButton rowButton;
   JButton deleteButton;
   JButton loadButton;
   JButton saveButton;
   JComponent container;

   public TableFrame(String title) {
      super(title);
      container = (JComponent)getContentPane();
      container.setLayout(new BorderLayout(6,6));

      // make a model
      model = new BasicTableModel();

      // Make a table on the model
      table = new JTable(model);
      // there are many options for col resize strategy
      table.setAutoResizeMode(JTable.AUTO_RESIZE_ALL_COLUMNS);

      JScrollPane scrollpane = new JScrollPane(table);
      scrollpane.setPreferredSize(new Dimension(300,200));
      container.add(scrollpane, BorderLayout.CENTER);

      // Make a second table
      JTable table2 = new JTable(model);
      scrollpane = new JScrollPane(table2);
      scrollpane.setPreferredSize(new Dimension(300,100));
      container.add(scrollpane, BorderLayout.SOUTH);

      Box panel = new Box(BoxLayout.Y_AXIS );
      container.add(panel, BorderLayout.EAST);

      rowButton = new JButton("Add Row");
      panel.add(rowButton);
      rowButton.addActionListener(
         new ActionListener() {
            public void actionPerformed(ActionEvent e) {
               int i = model.addRow();
               table.clearSelection();
               table.addRowSelectionInterval(i, i);
            }
         }
      );

      columnButton = new JButton("Add Column");
      panel.add(columnButton);
      columnButton.addActionListener(
         new ActionListener() {
            public void actionPerformed(ActionEvent e) {
               String result = JOptionPane.showInputDialog("What name for the new
column?");
               if (result != null) {
                  model.addColumn(result);
               }
            }
         }
      );

      deleteButton = new JButton("Delete Row");
      panel.add(deleteButton);
      deleteButton.addActionListener(
         new ActionListener() {
            public void actionPerformed(ActionEvent e) {
               int row = table.getSelectedRow();
               if (row!=-1) model.deleteRow(row);
            }
         }
      );

      ...
```

...

MVC Summary

MVC is used in Swing in many places, and it is also a pattern you will see in other systems.

1. Data model -- storage
   Deals with storage. Algorithmic code can send messages to the model to get, modify, and write back the data
2. View -- presentation
   Gets data from the model and presents it. Translates user actions in the view into getters/setters sent to model
3. Listener logic
   A design used in Swing: Model/view use a listener system to update the view(s) about changes in the model.

Advantage: Modularity

2 small problems vs. 1 big problem

Provides a natural decomposition "pattern"

You will get used to the MVC decomposition. Other Java programmers will also. It ends up providing a common, understood language.

Isolate coding problems in a smaller domain

Can solve GUI problems just in the GUI domain, the storage etc. is all quite separate. e.g. don't worry about file saving when implementing scrolling.

Networking / Mult Views

The abstraction between the model and view works well for a networked version: the model is on the central machine, the view is on the client machine.

The abstraction between the model and view can support multiple views all looking at one model (on one machine, or with some views over the network).

Use 50% Off The Shelf

The Model and View are both already written -- can customize one or the other

e.g. Substitute, say, your own Model, but use the off the shelf View.

e.g. File Save, or Undo

File save can be implemented/debugged just against the model. If the view worked before, it should still work.

undo() can just be implemented on the model -- it has to interact with far fewer lines of code than if it were implemented on top of some sort of combined model+view system

e.g. Web Site

Suppose you are implementing a calendaring web site.

model -- complex data relationships of people, times, events

view -- web pages, javascript, etc. that present parts of the model

Need to support multiple views simultaneously, and perhaps different types of view -- web page, PDF, IM message, ...

MVC: the data model team and the view team should be separate as much as possible -- don't want choices about pixels to interfere which choices of whether to store events in a hash map vs. a binary tree.

This is what the modern Servlet/JSP style does. The servlet does the data model "business logic", and the JSP just sends getter messages and formulates the results in to HTML or whatever.

e.g. Model Substitution

Have some 2-d data. Want to present it in a 2-d GUI. Wrap your data up so that it responds to getColumnCount(), getDataAt(), etc....

Build a JTable, passing it pointer to your object as the data model and voila. The scrolling, the GUI, etc. etc. is all done by JTable.

e.g. Wrap Database

Similar example -- suppose you have a table in an SQL database. Wrap it in TableModel class that makes the data appear to be in row/col format. getValueAt() requests are translated into queries on the database. Note that the JTable is insulated from knowing how you get the data, so long as you respond to the TableModel messages -- that's a nice use of OOP modularity.