Assignment #6—NameSurfer

The NameSurfer assignment was created by Nick Parlante, who also wrote parts of this handout.

Due: Monday, December 11

This assignment has two primary goals. The first is to give you an opportunity to use Java interactors to create an application that looks more like a modern interactive program complete with buttons, text fields, and a resizable graphical display. The second goal is to pull together the various facilities you have learned about so far to create an interesting application that—unlike Breakout, Hangman, Yahtzee, and Adventure—is not a game but rather a useful program that enables you to think about sociological questions.

Overview of the NameSurfer project

Against all bureaucratic stereotypes, the Social Security Administration, provides a neat web site showing the distribution of names chosen for kids over the last 100 years in the United States (**`http://www.ssa.gov/OACT/babynames/`**). Every 10 years, the data gives the 1000 most popular boy and girl names for children. The data can be boiled down to a single text file that looks something like this:

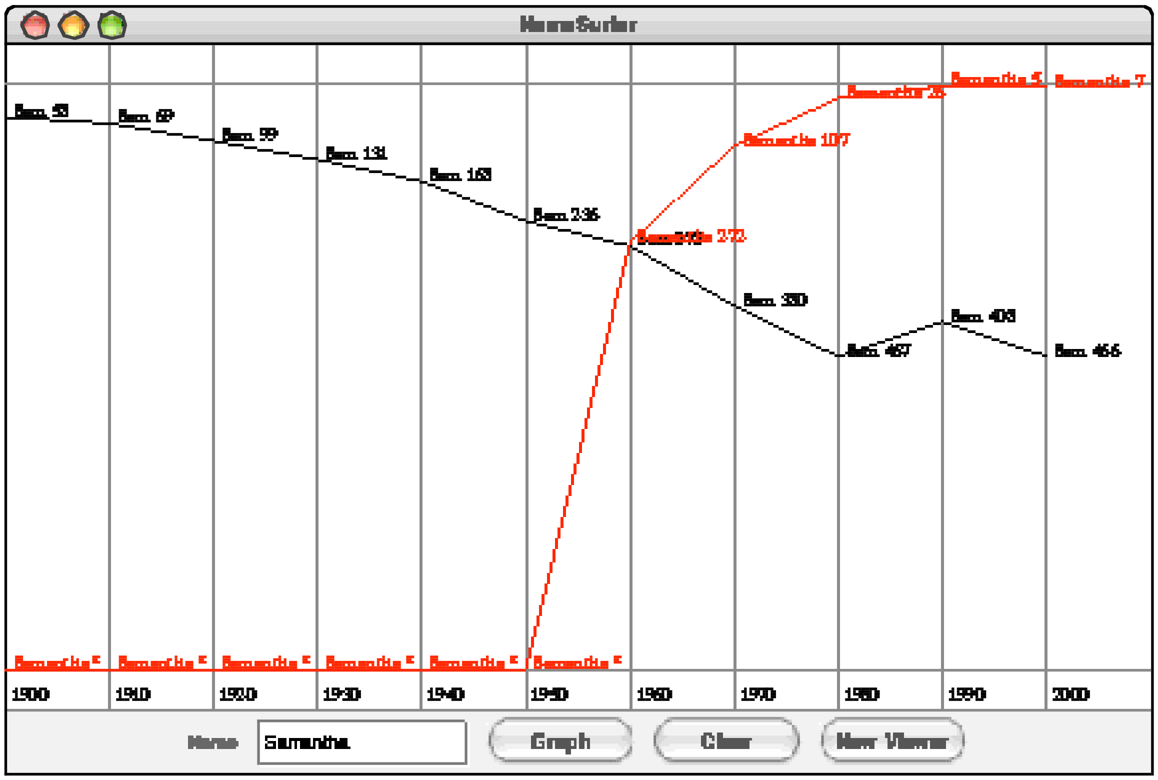
`names-data.txt`

```
. . .
Sam 58 69 99 131 168 236 278 380 467 408 466
Samantha 0 0 0 0 0 0 272 107 26 5 7
Samara 0 0 0 0 0 0 0 0 0 0 886
Samir 0 0 0 0 0 0 0 0 920 0 798
Sammie 537 545 351 325 333 396 565 772 930 0 0
Sammy 0 887 544 299 202 262 321 395 575 639 755
Samson 0 0 0 0 0 0 0 0 0 0 915
Samuel 31 41 46 60 61 71 83 61 52 35 28
Sandi 0 0 0 0 704 864 621 695 0 0 0
Sandra 0 942 606 50 6 12 11 39 94 168 257
. . .
```

Each line of the file begins with the name, followed by the rank of that name in each of the 11 decades since 1900, counting the current one: 1900, 1910, 1920, and so on up to 2000. A rank of 1 indicates the most popular name that year, while a rank of 997 indicates a name that is not popular at all. A 0 entry means the name did not appear in the top 1000 names for that year and therefore indicates a name that is even less popular. The elements on each line are separated from each other by a single space. The lines happen to be in alphabetical order, but nothing in the assignment depends on that fact.

As you can see from the small excerpt from the file, the name Sam was #58 in the first decade of the 1900s and is slowly moving down. Samantha popped on the scene in the 1960s (possibly because *Bewitched* ran on television during those years) and is moving up strong to #7. Samir barely appears in the 1980s, but by the current decade is up to #798. The database counts children born in the United States, so trends in particular names tend to reflect the evolution of ethnic communities over the years.

Figure 1. Sample run of the NameSurfer program



The goal of this assignment is to create a program that graphs these names over time, as shown in the sample run in Figure 1. In this diagram, the user has just typed **`Samantha`** into the box marked “Name” and then clicked on the “Graph” button, having earlier done exactly the same thing for the name **`Sam`**. Whenever the user enters a name, the **`NameSurfer`** program creates a new plot line showing how that name has fared over the decades. Clicking on the “Clear” button removes all the plot lines from the graph so that the user can enter more names without all the old names cluttering up the display.

To give you more experience working with classes that interact with one another, the **`NameSurfer`** application as a whole is broken down into several separate class files, as follows:

- **`NameSurfer`**—This is the main program class that ties together the application. It has the responsibility for creating the other objects and for responding to the buttons at the bottom of the window, but only to the point of redirecting those events to the objects represented by the other classes.
- **`NameSurferConstants`**—This interface is provided for you and defines a set of constants that you can use in the rest of the program simply by having your classes implement the **`NameSurferConstants`** interface, as they do in the starter files. The **`NameSurferConstants`** interface therefore has the same role that **`YahtzeeConstants`** did in Assignment #5.
- **`NameSurferEntry`**—This class ties together all the information for a particular name. Given a **`NameSurferEntry`** object, you can find out what name it corresponds to and what its popularity rank was in each decade.

- `NameSurferDataBase`—This class keeps track of all the information stored in the data files, but is completely separate from the user interface. It is responsible for reading in the data and for locating the data associated with a particular name.
- `NameSurferModel`—This class keeps track of what names are currently on the display but does not actually display them. Adding names with the "Graph" button or taking them all away with the "Clear" button updates the `NameSurferModel` object, which then sends a message to a `NameSurferViewer` object to update the display.
- `NameSurferViewer`—This class is a subclass of `GCanvas` that displays the graph of the various names by arranging the appropriate `GLine` and `GLabel` objects on the screen, just as with the various graphical programs you've written this quarter.

Even though the class structure sounds complicated, the `NameSurfer` application is about the same size as `Yahtzee`. In my implementation, the source files for `NameSurfer` contain a few more lines, but the code for `Yahtzee` is actually about 10% larger in terms of the total number of character, not counting comments. Even if the scale of the project is comparable to the last assignment, the wise course is to start on the assignment soon and keep up with the milestones described in this handout.

Milestone 1: Assemble the GUI interactors

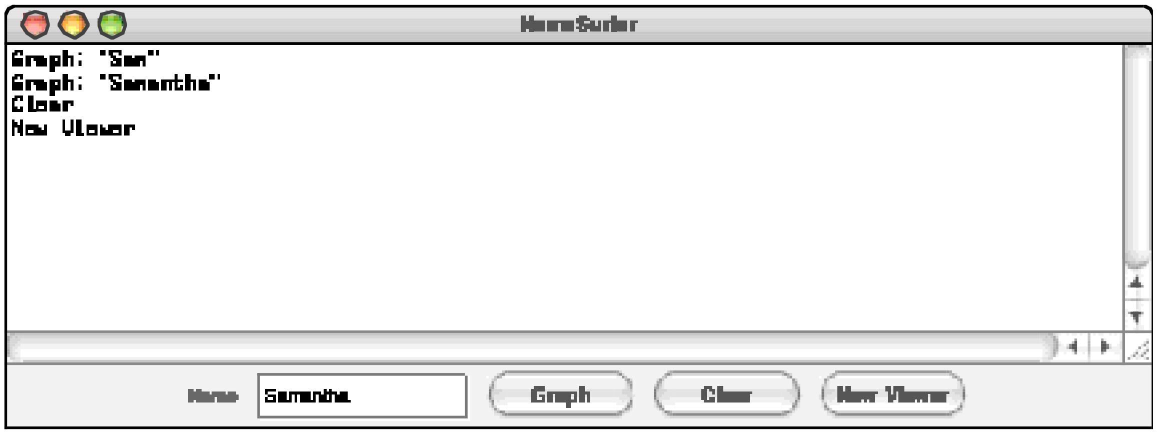
If you look at the bottom of Figure 1, you will see that the region along the `SOUTH` edge of the window contains several interactors: a `JLabel`, a `JTextField`, and three `JButton`s. Since putting up interactors is a new idea, you probably want to work on this step before it becomes complicated with all the other parts of the assignment. Thus, your first milestone is simply to add the interactors to the window and create an implementation for the `actionPerformed` method that allows you to check whether you can detect button clicks and read what's in the text field.

The simplest strategy to check whether your program is working is to change the definition of the `NameSurfer` class so that it extends `ConsoleProgram` instead of `Program`, at least for the moment. You can always change it back later. Once you have made that change, you can then use the console to record what's happening in terms of the interactors to make sure that you've got them right. For example, Figure 2 shows a possible transcript of the commands used to generate the output from Figure 1, in which the user has just completed the following actions:

1. Entered the name `Sam` in the text field and clicked the "Graph" button.
2. Entered the name `Samantha` in the text field and then typed the ENTER key.
3. Clicked the "Clear" button.
4. Clicked the "New Viewer" button.

The hard part about reaching this milestone is understand how interactors work. Once you do, writing the code is quite straightforward. All you need is something on the order of 15 to 20 lines of code.

Figure 2. Illustration of Milestone 1



```
Graph: "Sam"
Graph: "Samantha"
Clear
New Viewer
```

Milestone 2: Implement the `NameSurferEntry` class

The starter file for the **`NameSurferEntry`** class appears in full as Figure 3 on the following page. As with the other files supplied with this assignment, the starter file includes definitions for all of the public methods we expect you to define. The method definitions in the starter files, however, do nothing useful, although they occasionally include a **`return`** statement that gives back a default value of the required type. In Figure 3, for example, the **`getRank`** method always returns 0 to satisfy the requirement that the method returns an **`int`** as defined in its header line.

Methods that will eventually become part of the program structure but that are temporarily unimplemented are called **stubs**. Stubs play a very important role in program development because they allow you to set out the structure of a program even before you write most of the code. As you implement the program, you can go through the code and replace stubs with real code as you need it.

The **`NameSurferEntry`** class encapsulates the information pertaining to one name in the database. That information consists of two parts:

1. The name itself, such as "**`Sam`**" or "**`Samantha`**"
2. A list of 11 values indicating the rank of that name in each of the decades from 1900 to 2000, inclusive

The class definition begins with a constructor that creates an entry from the line of data that appears in the **`names-data.txt`** file. For example, the entry for **`Sam`** looks like this:

```
Sam 58 69 99 131 168 236 278 380 467 408 466
```

The idea behind the design of this constructor is that it should be possible to read a line of data from the file and then create a new entry for it using code that looks more or less like this:

```
String line = rd.readLine();
NameSurferEntry entry = new NameSurferEntry(line);
```

The implementation of the constructor has to divide up the line at the spaces, convert the digit strings to integers (using **`Integer.parseInt`** as in various class examples), and then store all of this information as the private state of the object in such a way that it is easy for the **`getName`** and **`getRank`** methods to return the appropriate values.

The last method in the starter implementation of **`NameSurferEntry`** is a **`toString`** method whose role is to return a human-readable representation of the data stored in the entry. For example, if the variable **`entry`** contains the **`NameSurferEntry`** data for **`Sam`**, you might want **`entry.toString()`** to return a string like this:

```
"Sam [58 69 99 131 168 236 278 380 467 408 466]"
```

Defining **`toString`** for a class has the wonderful advantage that it makes it possible to print out objects of that class using **`println`**, just as you do for primitive values. Whenever Java needs to convert an object to a string, it always calls its **`toString`** method to do the job. The default definition of **toString** in the **Object** class doesn't supply much useful information, and you will find that your debugging sessions get much easier if you can look easily at the values of your objects.

To show that you've got **NameSurferEntry** implemented correctly, you might want to write a very simple test program that creates an entry from a specific string and then verifies that the other methods work as they are supposed to.

Figure 3. Starter file for the NameSurferEntry class

```
/*
 * File: NameSurferEntry.java
 * --------------------------
 * This class represents a single entry in the database.  Each
 * NameSurferEntry contains a name and a list giving the popularity
 * of that name for each decade stretching back to 1900.
 */

import acm.util.*;
import java.util.*;

public class NameSurferEntry implements NameSurferConstants {

/* Constructor: NameSurferEntry(line) */
/**
 * Creates a new NameSurferEntry from a data line as it appears
 * in the data file.  Each line begins with the name, which is
 * followed by integers giving the rank of that name for each
 * decade.
 */
   public NameSurferEntry(String line) {
      // You fill this in //
   }

/* Method: getName() */
/**
 * Returns the name associated with this entry.
 */
   public String getName() {
      // You need to turn this stub into a real implementation //
      return null;
   }

/* Method: getRank(decade) */
/**
 * Returns the rank associated with an entry for a particular
 * decade.  The decade value is an integer indicating how many
 * decades have passed since the first year in the database,
 * which is given by the constant START_DECADE.  If a name does
 * not appear in a decade, the rank value is 0.
 */
   public int getRank(int decade) {
      // You need to turn this stub into a real implementation //
      return 0;
   }

/* Method: toString() */
/**
 * Returns a string that makes it easy to see the value of a
 * NameSurferEntry.
 */
   public String toString() {
      // You need to turn this stub into a real implementation //
      return "";
   }
}
```

Milestone 3: Implement the `NameSurferDataBase` class

The next step in the process is to implement the **`NameSurferDataBase`** class, which contains two public entries:

- A constructor that takes the name of a data file and uses that to read in the entire set of data from the file into internal data structures that allow the class to keep track of all the records as a database.
- A **`findEntry`** method that takes a name, looks it up in the stored database, and returns the **`NameSurferEntry`** for that name, or **`null`** if that name does not appear.

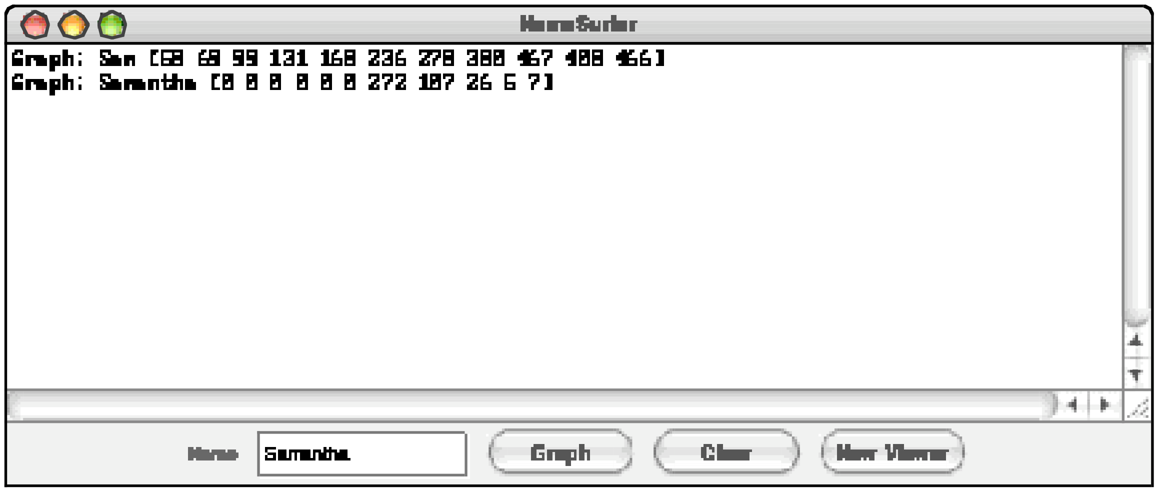
The code for this part of the assignment is not particularly difficult. The challenging part lies in figuring out how you want to represent the data so that you can implement the **`findEntry`** method as simply and as efficiently as possible.

To test this part of the program, you can add a line of code or two to the **`NameSurfer`** program so that it creates the **`NameSurferDataBase`** and then change the code for the button handlers so that clicking the "Graph" button looks up the current name in the data base and then displays the corresponding entry, as shown in Figure 4.

Milestone 4: Implement the `NameSurferModel` class

The next step in the process is to begin the implementation of the model/view/controller pattern by building the underlying model. As described in Handout #45, the point of the model/view/controller pattern is to provide a flexible structure that makes it have multiple views (or multiple controllers, although we won't need that functionality for this

Figure 4. Illustration of Milestone 3



```
Graph: Sam [58 69 99 131 168 236 278 380 467 408 466]
Graph: Samantha [0 0 0 0 0 0 272 107 26 6 7]
```

assignment) to work with a single underlying model of the data structure. In the NameSurfer application, the model and view aspects of the pattern are implemented using the following two classes:

- The **`NameSurferModel`** class keeps track of what is on the display at the current time but does not actually display anything or worry about any of the details like coordinates and fonts that are necessary to create graphical displays.
- The **`NameSurferViewer`** class (which is introduced in Milestone 5) handles the details for displaying information on the screen but doesn't actually store any data on its own. When the **`NameSurferViewer`** class needs to update the screen image, it goes to the **`NameSurferModel`** for all of the necessary information.

Conceptually, the **`NameSurferModel`** class has two basic functions:

1. It keeps track of a list of entries that are to be graphed on the display. Clicking the "Graph" button needs to send a message to the model that adds a new entry; clicking the "Clear" button sends a message that deletes all of the existing entries.
2. It keeps track of a list of viewers that present the state of the model. Whenever the state of the model changes, the code needs to go through the list of viewers and send an update message to each one by calling its **`update`** method.

The starter code for the **`NameSurferModel`** class appears in Figure 5. Given that the model is not responsible for any of the graphical displays or interactors, the required code is much simpler than that of most of the other classes. Each of the methods is at most a couple of lines long. Figuring out what state you need to store and how best to represent that state are the important challenges.

The fact that the model does not have a graphical representation of its own, however, makes it more difficult to test this class in isolation. Even so, it is a good idea to think hard about how you might test it even before you have a chance to write the **`NameSurferViewer`** class. Writing it all first and then trying to debug the whole thing is a dangerous—and usually unproductive—strategy. You should therefore design a test program for this milestone that will allow you to see if you have it working.

Milestone 5: Create the background image in the `NameSurferViewer` class

Once you have created the model, it is now time to turn your attention to the viewer. The starter code for the **`NameSurferViewer`** class appears in Figure 6. There are a couple of important differences in this starter file that are worth noting:

1. This class extends **`GCanvas`**, which means that every **`NameSurferViewer`** object is not only a **`GCanvas`** but also an instance of the classes that **`GCanvas`** itself extends. **`GCanvas`** is a subclass of **`Component`** in the standard **`java.awt`** package and therefore is part of the hierarchy of classes that can be added to the display area of a program.
2. The starter file includes a tiny bit of code that monitors the size of the viewer and calls **`update`** whenever the size changes. This code requires only a couple of lines to implement, but would be hard to explain well enough for you to implement on your

own. Writing a page of description so that you could add a couple of lines seemed like overkill, particularly given that the strategy is easiest to learn by example.

To start the process of adding the viewer code, go back to the **`NameSurfer`** class and change its definition so that it extends **`Program`** rather than the temporary expedient of extending **`ConsoleProgram`**. At the same time, you should remove the various **`println`** calls that allowed you to trace the operation of the interactors in the earlier milestones. Finally, change the constructor so that it creates a **`NameSurferViewer`** for the model you created in Milestone 4, and then add that viewer object to the display.

If you run the program with only these changes, it won't actually display anything on the screen. To create the graph, you need to implement the **`update`** method, which will almost certainly involve defining private helper methods as well. As a first step, write the code to create the background grid for the graph, which consists of the vertical line separating each decade, the horizontal lines that provide space for the top and bottom borders (which are there to ensure that the text labels stay within the window bounds), and the labels for the decades. As with all the graphical applications you've written, the lines and labels are represented using **`GLine`** and **`GLabel`** objects, which you add to the viewer in the appropriate positions.

Figure 5. Starter file for the `NameSurferModel` class

```
/*
 * File: NameSurferModel.java
 * --------------------------
 * This class keeps track of what names are displayed on the
 * screen but is not responsible for the actual display.
 */

public class NameSurferModel implements NameSurferConstants {

/* Constructor: NameSurferModel() */
/**
 * Creates a new NameSurferModel with no entries and no viewers.
 */
   public NameSurferModel() {
      // You fill this in //
   }

/* Method: addViewer(viewer) */
/**
 * Adds a viewer to the list of viewers for this model.
 */
   public void addViewer(NameSurferViewer viewer) {
      // You fill this in //
   }

/* Method: addEntry(entry) */
/**
 * Adds an entry to the list of entries for the model.
 */
   public void addEntry(NameSurferEntry entry) {
      // You fill this in //
   }

/* Method: clear() */
/**
 * Remove all entries from the model.
 */
   public void clear() {
      // You fill this in //
   }

/* Method: getEntryCount() */
/**
 * Returns the number of entries.
 */
   public int getEntryCount() {
      // You need to turn this stub into a real implementation //
      return 0;
   }

/* Method: getEntry(index) */
/**
 * Returns the entry at the specified index.
 */
   public NameSurferEntry getEntry(int index) {
      // You need to turn this stub into a real implementation //
      return null;
   }
```

Figure 6. Starter file for the `NameSurferViewer` class

```
/*
 * File: NameSurferViewer.java
 * ---------------------------
 * This class represents a viewer that responds to changes in the
 * corresponding NameSurferModel or changes in the viewer size.
 */

import acm.graphics.*;

import java.awt.event.*;

public class NameSurferViewer extends GCanvas
    implements NameSurferConstants, ComponentListener {

/* Constructor: NameSurferViewer(model) */
/**
 * Creates a new NameSurferViewer that watches the model and responds
 * to changes in its structure.
 */
   public NameSurferViewer(NameSurferModel model) {
      addComponentListener(this);
      // You fill in the rest //
   }

/* Method: update() */
/**
 * Updates the display image by deleting all the graphical objects
 * from the canvas and then reassembling the display as specified
 * by the model.  This method is called automatically by the model
 * whenever it needs to signal that the state has changed.  It is
 * also called whenever the size of the canvas changes as
 * specified by the implementation of componentResized below.
 */
   public void update() {
      // You fill this in //
   }

/* Implementation of the ComponentListener interface */

   public void componentHidden(ComponentEvent e) { }
   public void componentMoved(ComponentEvent e) { }
   public void componentResized(ComponentEvent e) { update(); }
   public void componentShown(ComponentEvent e) { }

}
```

```
}
```

The other important piece of the application that you need to add for Milestone 5 is the ability to create multiple viewers. The "New Viewer" button on the control strip at the bottom of the program window is intended to open up a new window that contains a viewer that is independent of the one in the main program window. To do so, you need to create a new Java window frame and add a new viewer to it, which requires the following five lines of code:

```
JFrame frame = new JFrame("NameSurfer");
NameSurferViewer view = new NameSurferViewer(model);
frame.getContentPane().add(view, BorderLayout.CENTER);
frame.setSize(APPLICATION_WIDTH, APPLICATION_HEIGHT);
frame.setVisible(true);
```

You shouldn't worry about the details of this code, which is not the important issue. What matters here is whether your program supports multiple views. If you click on the "New Viewer" button, your program should pop up a whole new viewer window that looks exactly like the original except that it is missing the buttons along the bottom. Moreover, you should be able to resize the two windows independently and have them scale the background appropriately.

Milestone 6: Complete the implementation of `NameSurferViewer` class

In addition to creating the background grid, the `update` method in `NameSurferViewer` also has to plot the actual data values. The viewer has access to the model, because the model was provided as an argument to the constructor. The model knows what entries are supposed to be on the screen, so the viewer can simply ask the model to determine which entries it has to plot. As with the grid, the lines and text strings that appear in the graph are simply `GLine` and `GLabel` objects; the interesting part of this phase of the project is calculating where to put them from the data in each `NameSurferEntry`.

There are several points that you should keep in mind while implementing this part of the program:

- The code to create the display happens in the `update` method, along with any helper method it calls. The `update` method is invoked from two places. First, it is called (assuming you've coded Milestone 5 correctly) whenever the model changes in response to the user clicking the "Graph" or "Clear" button. Second, it is called from the `sizeChanged` method in the `NameSurferViewer` class itself whenever the size of the component changes. Remember that the code to detect the size change is given to you as part of the starter file, and you shouldn't need to change the code for the four listener methods—three of which are empty and one of which just calls `update`.
- Before you add any graphical objects to the window in `update`, you need to remove any objects that were there from the last time around. In the ACM libraries, a `GObject` sticks around once it has been added to a `GCanvas` until it is explicitly removed.
- To make the data easier to read, the lines on the graph are shown in different colors. In the sample applet on the web site, the first data entry is plotted in black, the second in red, the third in blue, and the fourth in magenta. After that, the colors cycle around again through the same sequence.
- The fact that rank 1 is at the top of the window and rank 1000 is at the bottom means that it can sometimes seem confusing that rank 0—which means that the name does not appear in the top 1000 values for that year—appears at the bottom. To reduce the apparent discontinuity between rank 1 and rank 0, the entries for names that are absent from the data for a decade are listed with an asterisk instead of a numeric rank. You can see several examples of this convention in the data for `Samantha` in Figure 1.

Possible extensions

There are a lot of things that you could do to make this program more interesting. Here are just a few possibilities:

- *Add features to the display.* The current display contains only lines and labels, but could easily be extended to make it more readable. You could, for example, put a dot at each of the data points on the graph. Even better, however, would be to choose different symbols for each line so that the data would be easily distinguishable even in a black-and-white copy. For example, you could use little circles for the first entry, squares for the second, triangles for the third, diamonds for the fourth, and so on. You might also figure out what the top rank for a name is over the years and set the label for that data point in boldface.
- *Allow deletion as well as addition.* Because the screen quickly becomes cluttered as you graph lots of names, it would be convenient if there were some way to delete entries individually, as opposed to clearing the entire display and then adding back the ones you wanted. The obvious strategy would be to add a "Delete" button that eliminated the entry corresponding to the value in the "Name" box. That approach, however, has a minor drawback given the design so far. If you added a bunch of entries to the graph and then deleted the early ones, the colors of the later entries would shift, which might prove disconcerting. Can you redesign the color-selection strategy so that displayed entries retain their color even if other entries are removed?
- *Try to minimize the overprinting problem.* If the popularity of a name is improving slowly, the graph for that name will cross the label for that point making it harder to read. You could reduce this problem by positioning the label more intelligently. If a name were increasing in popularity, you could display the label below the point; conversely, for names that are falling in popularity, you could place the label above the point. An even more challenging task is to try to reduce the problem of having labels for different names collide, as they do for **`Sam`** and **`Samantha`** in Figure 1.
- *Adjust the font size as the application size changes.* One of the wonderful features of this program is that it redraws itself to fill the available space if you change the size of the window. If you make it too small, however, the labels run together and become unreadable. You could eliminate this problem by choosing a font size that allowed each label to fit in the space available.
- *Support different views of the data.* In the NameSurfer application as defined in this assignment, the "New Viewer" button brings up a new viewing window that is identical in structure to the first. One of the advantages of the model/view/controller pattern is that it supports different views of the same model. You could add a "Table" button to the application that created a new viewer object that displayed the results in tabular rather than graphical form.