

## 1 Project Instructions

- Create a folder named **p3**.
- Copy all your **.java** source code files to **p3**. Do not copy the **.class** files or any testing files.
- Compress the **p3** folder creating a **zip archive** file named **p3.zip**.
- Upload **p3.zip** to the Programming Project 3 (P3) submission page in Gradescope.
- The project deadline may be found in the *Course Schedule* section of the Syllabus.
- Consult the Syllabus for the late submission and academic integrity policies.

## 2 Learning Objectives

1. Complete all of the learning objects of the previous projects.
2. To implement a GUI interface and respond to action events.
3. To implement and use the binary search algorithm.
4. To implement and use the quick sort algorithm.
5. To implement the *java.lang.Comparable<T>* interface.

## 3 Background

This project shall implement a program which stores grade information for students in a class and allows that grade information to be edited. The data shall be stored in a database file named *gradebook.dat*. There shall be one student record per line, where the format of a student record is:

*last-name first-name ex1 ex2 ex3 hw1 hw2 hw3 hw4 hw5*

where:

<i>last-name</i>	The student's last name. A contiguous string of one or more characters, with no spaces.
<i>first-name</i>	The student's first name. A contiguous string of one or more characters, with no spaces.
<i>ex1, ex2, ex3</i>	The student's scores on three exams, may be zeros. Each exam is worth 100 pts.
<i>hw1-hw5</i>	The student's scores on five homework assignments, may be zeros. Each assignment is worth 25 pts.

Here is an example *gradebook.dat* file which you may use for testing if you wish:

```
Sample gradebook.dat
Simpson Lisa 100 100 100 25 25 25 25 25
Flintstone Fred 80 60 40 15 17 22 18 23
Jetson George 70 83 81 20 21 22 23 25
Explosion Nathan 7 6 5 4 3 2 1 0
Muntz Nelson 60 70 50 20 15 10 5 8
Terwilliger Robert 80 90 95 23 21 19 17 23
Flanders Ned 85 95 75 12 14 17 23 16
Bouvier Selma 16 16 16 16 16 16 16 16
Spuckler Cletus 1 2 3 4 5 6 7 8
Wiggum Clancy 18 16 14 12 10 8 4 2
Skinner Seymour 78 83 99 19 23 21 24 18
```

## 3 Software Requirements

- ✓ 1. The GUI shall be implemented in a class named *View*. When the program starts the *View* frame shall appear as shown in Fig. 1.
- ✓ 2. The View frame shall be 525 pixels wide and 225 pixels high.
- ✓ 3. The program shall display the program name in the title bar. You may change the name of the program to anything you wish.
- ✓ 4. The X close button in the title bar shall be disabled, i.e., when it is clicked the program shall not exit and the *View* shall remain unchanged.

Figure 1: The View Frame

- ✓ 5. The student records shall be stored in a gradebook database in a file named *gradebook.dat*.
- ✓ 6. When the program starts, if the *gradebook.dat* file cannot be opened for reading, the program shall display an error message dialog (using the *JOptionPane.showMessageDialog()* method) informing the user that the gradebook database could not be opened for reading and that the program will terminate. When the user clicks the OK button the program shall terminate. See SR 27.
- ✗ 7. When the program exits, if the *gradebook.dat* file cannot be opened for writing, the program shall display an error message dialog (using the *JOptionPane.showMessageDialog()* method) informing the user that the gradebook database could not be opened for writing and that clicking the dialog's OK button will cause the program to terminate without updating the gradebook database. When the user clicks the OK button the program shall terminate. See SR 27.
- ✓ 8. When the program starts, no student record shall be displayed and the text fields shall be empty. See SR 1.
- ✓ 9. The last names of the students in the gradebook database shall be unique (because the last name is the key when searching the database).
- ✓ 10. When the program starts, it shall read the contents of the gradebook database from *gradebook.dat* and shall sort the list of students into ascending order by last name (per the Software Design requirements, it shall sort using the quick sort sorting algorithm). The sort is performed so that the program may search the database in memory for a specific student record using the binary search algorithm.
- ✓ 11. If the student record for a student who's last name is "Simpson" is being displayed, Fig. 2 shows how the View shall appear, displaying the student's full name, homework scores, and exam scores. See SR's 12–14.

Figure 2: The View Displaying a Student's Grades

- ✓ 12. When a student record is being edited, the full name of the student shall be displayed in the *Student Name* text field.
- ✓ 13. When a student record is being edited, the student's homework 1–5 scores shall be displayed from left to right in the *Homework* text fields.
- ✓ 14. When a student record is being edited, the student's exam 1–3 scores shall be displayed from left to right in the *Exam* text fields.

- ✓ 15. When the *Search* button is clicked, if there are values being displayed in the homework and exam fields, then those fields shall be cleared, i.e., set to empty, before the search begins.
- ✓ 16. When the user clicks the *Search* button and the *Student Name* text field is empty, an error message dialog shall be displayed, requesting that the user enter a student's last name. The *Student Name* and numeric text fields shall all remain empty.
- ✗ 17. When the user enters a name in the *Student Name* text field and then clicks the *Search* button, the gradebook database in memory shall be searched for a student whose last name matches the name in the text field. Per the Software Design requirements, the search function shall be implemented either using either iterative binary search or recursive binary search.
- ✗ 18. If the search discussed in SR 17 fails because there are no students whose last name matches the name in the *Student Name* text field, then an error message dialog shall be displayed informing the user that a student with that last name could not be found in the gradebook. After the user clicks OK to close the dialog, the *Student Name* text field shall be cleared and the numeric text fields shall remain empty.
- ✓ 19. If the search discussed in SR 17 succeeds, then the *Homework* and *Exam* text fields shall be updated with the student's homework and exam scores. The *Student Name* text field shall continue to display the student's full name per SR 12.
- ✓ 20. When the user is editing the homework and/or exam scores for a student and then clicks the *Save* button, the student record in memory shall be updated with the new scores.
- ✓ 21. See SR 20. These changes shall remain stored in memory and shall not be written to the gradebook database until the program exits.
- ✓ 22. When no student record is being edited (the homework and exam text fields are empty) and the user clicks the *Save* button, nothing shall happen.
- ✓ 23. When the user is editing the information for a student and clicks the *Clear* button, without first clicking the *Save* button, then the student record in memory shall not be updated even if the homework and/or exam text fields had been modified.
- ✓ 24. When no student information is being displayed or edited, and the user clicks the *Clear* button, then nothing shall happen.
- ✓ 25. When the user is editing and has modified the information for a student and then clicks the *Exit* button, the student record (and all of the other student records) shall be written to the gradebook database before the program terminates. See SR 7 for how write failures are handled.
- ✓ 26. Whether the user is editing student information or not, when the *Exit* button is clicked, all of the student records shall be written to the gradebook database and then the program shall terminate.
- ✓ 27. Any error message dialogs shall be displayed centered within the View frame and display a message and one button labeled OK.

#### 4 Software Design Requirements



1. We recommend placing all the classes in a package named *proj3* but this is not critical.
2. The UML class diagram in UMLet format can be found in the project archive's *uml* folder. The *img* folder contains the class diagram in PNG format. Your program shall implement all of the classes (including methods, declaring instance and class variables, and so on) of this design.
3. Class *Main*. A template source code file for *Main* is included in the project archive. The *Main* class shall contain the *main()* method which shall instantiate an object of the *Main* class and then call *run()* on that object. You shall complete the code by reading the comments and implementing the pseudocode, while using the UML class diagram for *Main* as a guide.

*Main.run()* shall catch the *FileNotFoundException* which may get thrown by *GradebookReader.readGradebook()* and shall terminate the program by displaying an error message dialog which informs the user that the gradebook database could not be opened for reading; it shall then terminate the program. See SR 6.

*Main.exit()* shall catch the *FileNotFoundException* which may be thrown by *GradebookWriter.writeGradebook()* when the gradebook database cannot be opened for writing; the handler shall display an error message dialog informing the user that the gradebook database file could not be opened for writing and that the gradebook will not be updated; it shall then terminate the program. See SR 7.

The parameter to *Main.search()* is the last name of a student and *search()* shall call *Roster.getStudent()* to search the *Roster* for a student with that last name. If the student is found, it will return a *Student* object which *search()* shall return.

There are five homework assignments, so *Main.getNumHomeworks()* is a class method which shall return the class constant *NUM\_HOMEWORKS* which is declared in *Main* and is equivalent to 5. Similarly, *Main.getNumExams()* shall return the class constant *NUM\_EXAMS* which is declared in *Main* and is equivalent to 3. The remainder of the methods in *Main* are accessor/ mutator methods for various data members.

4. Class *GradebookReader*. The constructor of this class creates a *Scanner* object which is used to read the gradebook database (the *Scanner* object is stored in instance variable *mIn* so that it may be used in the various read methods). Since the file open may fail, this constructor shall throw the *FileNotFoundException* to *Main.run()* which shall catch the exception.

This class reads the gradebook information from the gradebook database file *gradebook.dat* when *readGradebook()* is called. It then calls *readRoster()* to read each student record from the input file and then returns the created *Roster* object.

The *readRoster()* method first instantiates a *Roster* object, then uses a while loop to read student records from the input file. For each student record, it reads the student's last and first names from the input file, creates a *Student* object, passing the last name and first name to the *Student* constructor, and then calls *readHomework()* and *readExam()* to read the student's homework and exam scores. Then it calls *Roster.addStudent()* to add the *Student* object to the *Roster*. Finally, it returns the *Roster* object that was created, back to *readGradebook()*, which then returns the *Roster* back to *Main.run()* which called *readGradebook()* in the first place.

Note that after reading the *Roster* but before returning the *Roster* to *Main.run()*, *readGradebook()* calls *Roster.sortRoster()* to sort the *Roster*.

5. Class *GradebookWriter*. This class writes the gradebook information to *gradebook.dat* before the program exits. It is a subclass of *java.io.PrintWriter* so the *GradebookWriter* constructor must call the *PrintWriter* constructor to open the file for writing. Since the open may fail, *PrintWriter* will return the *FileNotFoundException* to *GradebookWriter()* which will throw it back to *Main.exit()* which will catch and handle it.

The gradebook database is written when *writeGradebook()* is called. This is a very simple method which just iterates over the *Roster*, writing each *Student* object to the file.

6. Class *Roster*. The class roster is implemented as an *ArrayList* of *Student* objects. *addStudent()* is called from *GradebookReader.readRoster()* to add a *Student* to the *Roster*'s *ArrayList*.

*getStudent()* is called from *Main.search()*, which is called by *View.actionPerformed()* when the user clicks the *Search* button in the *View*. *getStudent()* calls *Searcher.search()*, passing the *Student*'s last name as the key; *search()* searches the *ArrayList* for the student with a matching last name using the binary search algorithm. You shall implement either the iterative or recursive version of the algorithm. If a *Student* with matching last name is found, then *getStudent()* returns the *Student* object; otherwise, it returns -1 which represents the "not found" condition.

*sortRoster()* is called from *GradebookReader*, see that class for a discussion. *sortRoster()* calls the class method *Sorter.sort()* passing the *ArrayList* of *Students* as the parameter. Upon return, the *ArrayList* will have been sorted.

Note that *Roster* overrides the inherited *toString()* method and it returns a *String* representation of the *Roster*. The string representation is just the string representation of each *Student* in the *ArrayList*, which is formed by calling *Student.toString()* on each *Student* object. *Roster.toString()* is primarily implemented for use as a useful method to call to print out the *Roster* during debugging. *Roster.getStudentList()* and *Roster.setStudentList()* are accessor/mutator methods for the *mStudentList* instance variable.

7. Class *Searcher*. This class shall implement one public class method *int search(ArrayList<Student> pList, String pKey)* which searches the *Roster* for a student with the specified last name stored in *pKey*. Since the roster is sorted into ascending order by last name, you shall implement either the iterative or recursive binary search algorithm. The method returns the index of the student in the list or -1 if the student is not found. Template not provided; use the UML class diagram as a guide and the binary search lecture notes.
8. Class *Sorter*. A class which implements the quicksort algorithm. All of the method are static and *sort(ArrayList <Student> pList)* is the only public method and calls private *quickSort(pList, 0, pList.size() - 1)* to sort the list. Template not provided; use the UML class diagram and the quicksort lecture notes.
9. Class *Student*. The *Student* class stores the information for one student. Read the comments and implement the pseudocode. See the comments for *Student.toString()* and make sure to implement this method correctly. It is called while writing the gradebook database to write out each *Student* record. During grading, we will be using the Linux **diff** command to compare your output files to our output files to check for differences. If there are mismatches, that are more than minor formatting issues, then if the method does not correctly output the *Student* information, then **diff** will fail and the test case will fail which will cause you to lose points.
10. Class *View*. The *View* implements the GUI. Read the comments and implement the pseudocode.

## 5 Additional Project Requirements

1. Format your code neatly. Use proper indentation and spacing. Study the examples in the book and the examples the instructor presents in the lectures and posts on the course website.
2. Put a comment header block at the top of each method formatted thusly:

```
/**
 * A brief description of what the method does.
 */
```

3. Put a comment header block at the top of each source code file containing this information:

```
/*
 * CLASS: ClassName (ClassName.java)
 *
 * DESCRIPTION
 * A description of the contents of this file.
 *
 * COURSE AND PROJECT INFORMATION
 * CSE205 Object Oriented Programming and Data Structures, semester and year
 * Project Number: project-number
 *
 * AUTHOR: your-name, your-asuriteid, your-email-addr    ** Note: Include 2nd and 3rd author lines
 * AUTHOR: your-name, your-asuriteid, your-email-addr    if you work with a partner **
 */
```

This PNG image may be found in the `cse205-p3/img` subdirectory of the Project 3 zip archive. The UMLet class diagram file can be found in the `cse205-p3/uml` subdirectory.

