

# Assignment

Here in project #03 we're going to put your GradeUtil functions to work as part of a Grade Analysis console application. The input file will be grade data for a particular college and semester. The application will input the data, parse, and then accept commands from the user to search and analyze this data. In particular, the application will support the following 6 commands:

1. Summary of a department or college
2. Search by course # or instructor prefix
3. List of courses with grading type of satisfactory
4. List of courses by DFW rate
5. List of courses by percentage of B letter grades
6. List of courses by average GPA.

## Input Files

All input files are CSV files that contains two header rows followed by 1 or more rows of data. Here's the start of the "fall-2018.csv" file that is provided on the course web page:

### **Engineering, Fall, 2018**

#### **Dept, Number, Section, Title, A, B, C, D, F, I, NR, S, U, W, Instructor**

```
CS,377,1,Communication and Ethics,93,48,2,0,0,0,0,0,0,3,Burton
ME,308,1,Mechanical Vibrations,16,26,21,9,3,0,0,0,0,0,Szwalek
ME,599,1,PhD Thesis Research,0,0,0,0,0,0,11,0,0,0,Shahbazian-Yassar
ME,211,2,Fluid Mechanics 1,3,9,8,9,3,1,0,0,0,0,Mirbod
ECE,559,1,Neural Networks,29,46,2,0,0,0,0,0,0,0,Koyuncu
.
.
.
CME,211,1,Fluid Mechanics and Hydraulics,20,21,4,3,0,0,0,0,0,1,Vitousek
```

The first line consists of three values: college name, semester, and year. The second line consists of the column headers, and can be ignored. The remaining lines are data rows, each with 15 values. "I" refers to the

# of incompletes, “W” the # of withdrawals, and “NR” the # of “no reports” --- e.g. students who never attended class and thus no grade could be reported. More commonly, grades of NR occur when grades are not submitted before the end of semester deadline; in this case all grades for the course are in the form of NRs. **Note:** the format of a data row matches the format of the string accepted by the **ParseCourse()** function.

## Assignment Details

The program starts by inputting the name of the input file from the keyboard, parsing this data, and then outputting a college-level summary of this data. For example, here’s what we get for “fall-2018.csv”:

```
fall-2018.csv ←
** College of Engineering, Fall 2018 **
# of courses taught: 247
# of students taught: 13715
grade distribution (A-F): 44.62%, 31.28%, 14.89%, 5.33%, 3.89%
DFW rate: 12.78%

Enter a command>
```

Note that we will be auto-grading using Gradescope, so your output must match what you see *exactly*. Any space you see will be exactly 1 blank character, and that’s a blank line between “DFW rate” and “Enter”. All real numbers are output with 2 digits to the right of the decimal point. This is obtained by `#include <iomanip>` and executing these 2 lines at the start of `main()`:

```
cout << std::fixed;
cout << std::setprecision(2);
```

When computing the # of students taught, simply sum the # of students in each course; the `Course` class contains a method that returns the # of students. The # of courses taught includes all types of courses (Letter, Satisfactory, and Unknown).

Once the summary is output, the program prompts the user to input a command. The user can input commands in any order, and can input any number of commands. The “#” command ends the program. There are 6 commands: “summary”, “search”, “satisfactory”, “dfw”, “letterB”, and “average”. Commands are case-sensitive, and any other input should result in the output “\*\*unknown command”. Here’s an example:

```
Enter a command> help ←
**unknown command
Enter a command> SUMMARY ←
**unknown command
Enter a command> search ←
dept name, or all? CS ←
course # or instructor prefix? 499 ←
CS 499 (section 1): Hummel
# students: 84
course type: satisfactory
grade distribution (A-F): 0.00%, 0.00%, 0.00%, 0.00%, 0.00%
DFW rate: 0.00%
Enter a command> # ←
```

## 1. summary

The summary command outputs a college-wide summary, or a departmental summary. The user is prompted for a department name, e.g. "CS", or "all" which means the college. The input is case-sensitive. Here's a departmental summary:

```
Enter a command> summary
dept name, or all? CS
CS:
# courses taught: 56
# students taught: 4298
grade distribution (A-F): 39.99%, 32.94%, 14.95%, 6.07%, 6.05%
DFW rate: 17.64%
Enter a command>
```

Here's a college-wide summary, note the departments are listed in alphabetical order by name:

```
Enter a command> summary
dept name, or all? all
BIOE:
# courses taught: 23
# students taught: 786
grade distribution (A-F): 55.16%, 29.37%, 10.32%, 3.58%, 1.58%
DFW rate: 7.80%
CHE:
# courses taught: 16
# students taught: 550
grade distribution (A-F): 51.12%, 33.13%, 10.84%, 3.27%, 1.64%
DFW rate: 7.92%
```

```
.
. // more departments in alphabetical order by department name
.
```

```
IT:
# courses taught: 1
# students taught: 24
grade distribution (A-F): 33.33%, 20.83%, 16.67%, 12.50%, 16.67%
DFW rate: 45.16%
ME:
# courses taught: 39
# students taught: 2154
grade distribution (A-F): 45.75%, 28.01%, 18.34%, 5.58%, 2.32%
DFW rate: 9.60%
Enter a command>
```

## 2. search

The search command performs a department or college-wide search by course number or instructor prefix. The user is first prompted for a department name, e.g. "CS", or "all" which means the college. The user is then prompted to enter a course number or instructor prefix. All input is case-sensitive. Here's a departmental search for CS 341:

```
Enter a command> search
dept name, or all? CS
course # or instructor prefix? 341
CS 341 (section 1): Grad Asst
# students: 16
course type: letter
grade distribution (A-F): 50.00%, 35.71%, 7.14%, 0.00%, 7.14%
DFW rate: 7.14%
CS 341 (section 2): Hummel
# students: 134
course type: letter
grade distribution (A-F): 33.33%, 40.15%, 16.67%, 7.58%, 2.27%
DFW rate: 11.19%
Enter a command>
```

And a departmental search by instructor prefix "Bel":

```
Enter a command> search
dept name, or all? CS
course # or instructor prefix? Bel
CS 151 (section 1): Bello Lander
# students: 269
course type: letter
grade distribution (A-F): 39.93%, 27.24%, 17.16%, 7.09%, 8.58%
DFW rate: 19.86%
CS 342 (section 1): Bell
# students: 164
course type: letter
grade distribution (A-F): 31.29%, 55.21%, 10.43%, 1.23%, 1.84%
DFW rate: 9.20%
CS 418 (section 1): Bello Lander
# students: 59
course type: letter
grade distribution (A-F): 88.14%, 8.47%, 3.39%, 0.00%, 0.00%
DFW rate: 1.67%
CS 440 (section 1): Bell
# students: 114
course type: letter
grade distribution (A-F): 48.67%, 34.51%, 10.62%, 5.31%, 0.88%
DFW rate: 6.19%
Enter a command>
```

Notice in both cases the output is by course #, then section #. Since the user can enter a course number or an instructor prefix, your app needs to determine whether the input is numeric (and convert if so). There are various way to do this, here's one approach using the C++ **stringstream** class. First, you need to #include <string> and <sstream>. Then

```

string instructorPrefix;
int    courseNum;

cout << "course # or instructor prefix? ";
cin >> instructorPrefix;

stringstream ss(instructorPrefix); // create stringstream object
ss >> courseNum; // try to convert input to a course #:

if ( ss.fail() )
    // conversion failed, input is not numeric
else
    // conversion worked, courseNum contains numeric value

```

Here are college-wide searches by course number and instructor prefix. Note that for college-wide searches, the output is sorted first by department, then course #, then section.

```

Enter a command> search
dept name, or all? all
course # or instructor prefix? 599
CS 599 (section 1): Yu
# students: 16
course type: satisfactory
grade distribution (A-F): 0.00%, 0.00%, 0.00%, 0.00%, 0.00%
DFW rate: 0.00%
ME 599 (section 1): Shahbazian-Yassar
# students: 11
course type: unknown
grade distribution (A-F): 0.00%, 0.00%, 0.00%, 0.00%, 0.00%
DFW rate: 0.00%
Enter a command>

```

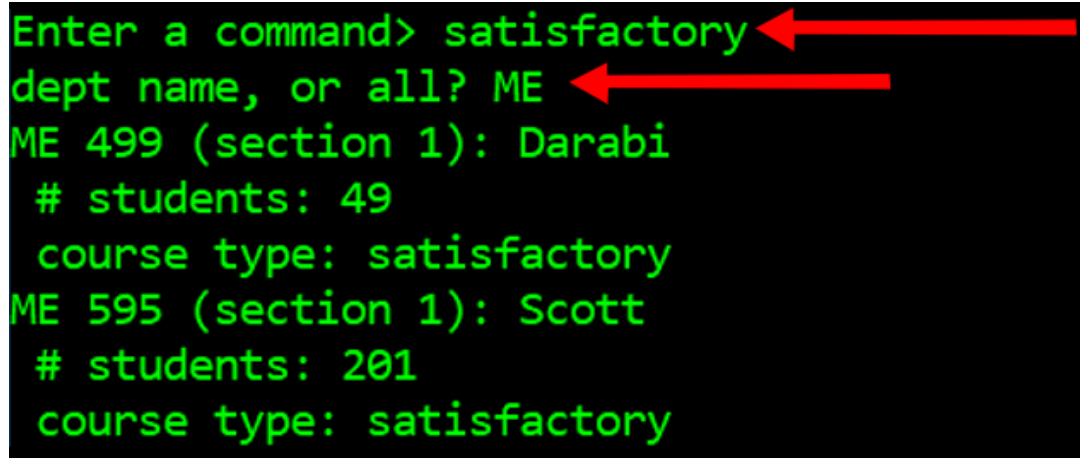
```

Enter a command> search
dept name, or all? all
course # or instructor prefix? Ha
CS 111 (section 2): Hayes
# students: 99
course type: letter
grade distribution (A-F): 44.09%, 36.56%, 10.75%, 4.30%, 4.30%
DFW rate: 10.53%
ECE 451 (section 1): Han
# students: 30
course type: letter
grade distribution (A-F): 33.33%, 36.67%, 16.67%, 6.67%, 6.67%
DFW rate: 23.53%
IT 202 (section 1): Hayes
# students: 24
course type: letter
grade distribution (A-F): 33.33%, 20.83%, 16.67%, 12.50%, 16.67%
DFW rate: 45.16%

```

### 3. satisfactory

The satisfactory command performs a department or college-wide search for all courses whose Grading type is Course::Satisfactory. The user is prompted for a department name, e.g. "CS", or "all" which means the college. Here are the satisfactory courses for the ME department (output ordered by course #, then section #):



```
Enter a command> satisfactory
dept name, or all? ME
ME 499 (section 1): Darabi
# students: 49
course type: satisfactory
ME 595 (section 1): Scott
# students: 201
course type: satisfactory
```

On the next page is a subset (the first page) of the satisfactory courses college-wide (output is ordered by dept name, course #, section #):

Enter a command> satisfactory

dept name, or all? all

BIOE 595 (section 1): Khetani

# students: 23

course type: satisfactory

CHE 499 (section 1): Zdunek

# students: 60

course type: satisfactory

CS 499 (section 1): Hummel

# students: 84

course type: satisfactory

CS 598 (section 1): Kenyon

# students: 24

course type: satisfactory

CS 599 (section 1): Yu

# students: 16

course type: satisfactory

ECE 499 (section 1): Devroye

# students: 55

course type: satisfactory

ECE 595 (section 1): Smida

# students: 71

course type: satisfactory

ENGR 100 (section 1): Narubin

# students: 489

course type: satisfactory

ENGR 100 (section 2): Narubin

# students: 448

#### 4. dfw

The dfw command performs a department or college-wide search for all courses whose DFW rate exceeds a threshold input by the user. Here's an example for the CS department with a threshold of 40.0%, notice the output is in descending order by DFW rate:

```
Enter a command> dfw
dept name, or all? CS
dfw threshold? 40.0
CS 251 (section 1): Lillis
# students: 170
course type: letter
grade distribution (A-F): 17.65%, 12.94%, 24.12%, 11.18%, 34.12%
DFW rate: 51.56%
CS 425 (section 1): Kenyon
# students: 22
course type: letter
grade distribution (A-F): 15.79%, 26.32%, 26.32%, 21.05%, 10.53%
DFW rate: 48.00%
CS 251 (section 2): Troy
# students: 108
course type: letter
grade distribution (A-F): 18.52%, 28.70%, 17.59%, 6.48%, 28.70%
DFW rate: 40.68%
Enter a command>
```

If 2 courses have the same DFW rate, the output is then ordered by dept, course #, section # (all in ascending order). Here's a college-wide search for courses with a DFW rate above 40.0%:



```
Enter a command> dfw
dept name, or all? all
dfw threshold? 40.0
CS 251 (section 1): Lillis
# students: 170
course type: letter
grade distribution (A-F): 17.65%, 12.94%, 24.12%, 11.18%, 34.12%
DFW rate: 51.56%
CME 201 (section 1): Ataei
# students: 143
course type: letter
grade distribution (A-F): 17.02%, 18.44%, 19.86%, 21.28%, 23.40%
DFW rate: 48.00%
CS 425 (section 1): Kenyon
# students: 22
course type: letter
grade distribution (A-F): 15.79%, 26.32%, 26.32%, 21.05%, 10.53%
DFW rate: 48.00%
IT 202 (section 1): Hayes
# students: 24
course type: letter
grade distribution (A-F): 33.33%, 20.83%, 16.67%, 12.50%, 16.67%
DFW rate: 45.16%
ECE 465 (section 1): Dutt
# students: 17
course type: letter
grade distribution (A-F): 25.00%, 31.25%, 25.00%, 18.75%, 0.00%
DFW rate: 40.91%
CS 251 (section 2): Troy
# students: 108
course type: letter
grade distribution (A-F): 18.52%, 28.70%, 17.59%, 6.48%, 28.70%
DFW rate: 40.68%
Enter a command>
```

## 5. letterB

The letterB command performs a department or college-wide search for all courses whose percentage of letter B grades exceeds a threshold input by the user. Here's an example for the CS department with a letter B threshold of 50.0%. Notice the output is in descending order the percentage of B grades, where if 2 courses have the same percentage, the output is then ordered by dept, course #, section # (all in ascending order)

```
Enter a command> letterB
dept name, or all? CS
letter B threshold? 50
CS 491 (section 3): Kenyon
# students: 88
course type: letter
grade distribution (A-F): 0.00%, 98.86%, 0.00%, 0.00%, 1.14%
DFW rate: 1.14%
CS 491 (section 1): Lillis
# students: 13
course type: letter
grade distribution (A-F): 23.08%, 76.92%, 0.00%, 0.00%, 0.00%
DFW rate: 7.14%
CS 450 (section 1): Vamanan
# students: 51
course type: letter
grade distribution (A-F): 17.65%, 68.63%, 11.76%, 0.00%, 1.96%
DFW rate: 5.66%
CS 342 (section 1): Bell
# students: 164
course type: letter
grade distribution (A-F): 31.29%, 55.21%, 10.43%, 1.23%, 1.84%
DFW rate: 9.20%
Enter a command>
```

Continued on the next page...

Here's an example of a college-wide search for courses above 60.0%. Note that they are sorted in descending order by Percentage of BS, the sorting by Department is coincidental with this data set.

```
Enter a command> letterB
dept name, or all? all
letter B threshold? 60
CS 491 (section 3): Kenyon
# students: 88
course type: letter
grade distribution (A-F): 0.00%, 98.86%, 0.00%, 0.00%, 1.14%
DFW rate: 1.14%
CS 491 (section 1): Lillis
# students: 13
course type: letter
grade distribution (A-F): 23.08%, 76.92%, 0.00%, 0.00%, 0.00%
DFW rate: 7.14%
CS 450 (section 1): Vamanan
# students: 51
course type: letter
grade distribution (A-F): 17.65%, 68.63%, 11.76%, 0.00%, 1.96%
DFW rate: 5.66%
CHE 501 (section 1): Kim
# students: 23
course type: letter
grade distribution (A-F): 26.09%, 65.22%, 8.70%, 0.00%, 0.00%
DFW rate: 0.00%
IE 461 (section 1): Williams
# students: 31
course type: letter
grade distribution (A-F): 32.26%, 64.52%, 3.23%, 0.00%, 0.00%
DFW rate: 3.13%
ME 518 (section 1): Paoli
# students: 11
course type: letter
grade distribution (A-F): 27.27%, 63.64%, 9.09%, 0.00%, 0.00%
DFW rate: 0.00%
Enter a command>
```

## 6. average

The average command performs a department or college-wide sort by average GPA. If all departments is chosen, the departments in the college are listed in descending order by average GPA, determined by taking the average of the average GPAs per course. If a specific department is chosen, the courses in that department are listed in descending order of average GPA. If 2 courses or departments have the same percentage, the output is then ordered by dept, course #, section # (all in ascending order)

Here's an example of the departments being listed.

```
Enter a command> average  
dept name, or all? all  
Overall GPA for ENGR : 3.75  
Overall GPA for ENER : 3.61  
Overall GPA for BIOE : 3.37  
Overall GPA for CHE : 3.31  
Overall GPA for CME : 3.31  
Overall GPA for ECE : 3.28  
Overall GPA for ME : 3.21  
Overall GPA for IE : 3.17  
Overall GPA for CS : 3.14  
Overall GPA for IT : 2.42
```

Here's an example for the ENGR department.

```
Enter a command> average  
dept name, or all? ENGR  
Overall GPA for ENGR 194(1) : 4.00  
Overall GPA for ENGR 194(2) : 4.00  
Overall GPA for ENGR 294(1) : 3.91  
Overall GPA for ENGR 194(3) : 3.10
```

## Getting started...

As always, build the program slowly, one feature at a time. Note that one of the requirements will be to build on the GradeUtil functions developed in project 02 --- these functions will do most of the work needed in this program. That said, feel free to extend the GradeUtil classes and functions as needed. For example, you may find it helpful to add methods to the Dept and College classes, such as **getNumClasses()**.

If you did not complete project 02, our solution is being provided in box and in codio: look under “Projects”, “project02-solution”:

The input file shown in the screenshots, “fall-2018.csv”, is also provided in box and in codio: look under “Projects”, “project03-files”:

Just in case you’re curious, the provided data is the actual data from the College of Engineering for Fall, 2018.

In terms of programming environment, you are free to work in the environment of your choice. If you prefer, you can also continue to use Codio and the “project02” workspace. If you plan to use Codio, I would recommend creating a sub-directory and then moving all your files into that sub-directory for safe-keeping:

```
mkdir backup
mv * ./backup
```

This way you start with an empty workspace. You can copy files from the backup folder up into your workspace to get started, such as gradeutil.h and gradeutil.cpp:

```
cd backup
cp gradeutil.* ..
cd ..
```

Now create a new “main.cpp” file for your app, and a makefile to compile and run. Remember that when creating a makefile, you must indent using TABs, not spaces --- in Codio’s View menu, uncheck “Soft Tabs” when editing your makefile so Codio does not turn your TABs into spaces.

As is the case with all assignments in CS 341, how you solve the problem is just as important as simply getting the correct answers. You are required to solve the problem the “proper” way, which in this case means using modern C++ techniques: classes, objects, built-in algorithms and data structures, lambda expressions, etc. It’s too easy to fall back on existing habits to just “get the assignment done.”

In this assignment, your solution is required to do the following:

- Use the **GradeUtil** functions developed in project 02; use your own functions or the ones we have provided.
- All sorting must be done using **std::sort** (or another built-in sort). No explicit sorting.
- Use **ifstream** to open / close the input file for you. Be sure to check that the file was opened successfully since C++ does not check for you; if (!file.good()) is one approach.
- Use **range-based for** loops (“foreach”), there’s no reason to use C-style index-based loops in this assignment.
- Define at least **10 functions** of your own design, and call them. These are in addition to the functions in the GradeUtil library. Nothing fancy required, just practice **modular** development. For example, you might give each command its own function to make it easy to add, remove, or modify the functionality of your application.
- Use **standard C++** only; no third-party libraries.
- **No global variables**; use parameter passing to/from your functions.
- **No explicit pointers**; use references and iterators as appropriate.

For online documentation, I typically use the site <http://www.cplusplus.com/reference/>. Another way is to google with the prefix **std::**, which refers to the C++ standard library. Example: for information about the C++ string class, google “std::string”. For the vector class, google “std::vector”.

