Problem Definition:

1. Open the dataset file and extract the respective observation data point (x_1, y_1), (x_2, y_2), (x_3, y_3)…($x_{10,000}$, $y_{10,000}$) into array set.
2. Write a function to perform a linear regression analysis and fits a straight line equation in the form of y = mx + c to the set of observations (x_1, y_1), (x_2, y_2), (x_3, y_3)…($x_{10,000}$, $y_{10,000}$). It should also compute the correlation coefficient, the coefficient of determination and the standard error of the estimate.
3. The output program should plot the 10,000 points in the x, y plane and draw the estimated straight-line equation that will superimpose on these 10,000 points. The output program shall also print the results of the equation of the estimated straight line, correlation coefficient, coefficient of determination and standard error of the estimate.

Problem Analysis

1. To find the slope of the line, m, the equation is $m = \frac{N\,\Sigma(xy) - \Sigma x\,\Sigma y}{N\,\Sigma(x^2) - (\Sigma x)^2}$ where N is the number of pairs (x,y) in this case it is 10,000.
2. To find the y-intercept, c, the equation is $c = \frac{\Sigma y - m\,\Sigma x}{N}$
3. To find the Estimated Straight Line, the equation is $y = mx + c$
4. To find the Correlation Coefficient, r, the equation is $r = \frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$
5. To find the Coefficient of Determination, the equation is r^2
6. Assuming this dataset is a sample size, to find the Standard Error of Estimate, s, the equation is $s = \sqrt{(\frac{\Sigma(y - y')^2}{N-2})}$

Input Variable

Reading the 10,000 pairs of (x,y) from the dataset file by opening and extract it into the elements, coordinates (float coordinates[])

Process Variable

1. The summation of all data $x_1 \ldots x_{10,000}$, $sumX$ ($float\ sumX$)
2. The summation of all data $y_1 \ldots y_{10,000}$, $sumY$ ($float\ sumY$)
3. The summation of all data $x_1^2 \ldots x_{10,000}^2$, $sumXX$ ($float\ sumXX$)
4. The summation of all data $y_1^2 \ldots y_{10,000}^2$, $sumYY$($float\ sumYY$)
5. The summation of all data $xy_1 \ldots xy_{10,000}$, $sumXY$ ($float\ sumXY$)
6. The summation of all data $y_1 - y_1' \ldots y_{10,000} - y_{10,000}'$, $yyPrimeDiffSum$ ($float\ yyPrimeDiffSum$)

Output Variable

1. The Estimated Straight Line, Correlation Coefficient, Coefficient of Determination, Standard Error of Estimate, y = mx + c, r, rr, $standErrOfEstimate$ (float $m,\ c,\ r, rr, standErrOfEstimate$)
2. Plotting of the 10,000 points, (x,y) and Estimated Straight-Line using CMD and/or GNU plot

Source Code

This assignment is written in ANSI C(C89).
All source files (.c .h) in ./src/ folder are originally written by the team.
They contain the algorithms for calculating the regression line equation, file operations, plotting graph as ASCII art on the console as well as an optional feature to open and plot the graph on a additional program called Gnuplot.

Main entry point: regression.c

Dependencies

- C Standard Library
- C Maths Library
- unistd
- Gnuplot (Optional)

Compiling

This is compiled and tested using GCC.
Open terminal in this directory:

```
gcc ./src/*.c -o regression -lm
```

Platforms Supported

- Windows
- MAC OS
- Raspbian (Raspberry PI)

Operating the Program

The program by default requires a data input file of 10000 lines of comma seperated value tuple named Group1_8.txt (Assigned by the Lecturer) in the same directory as the regression executable.

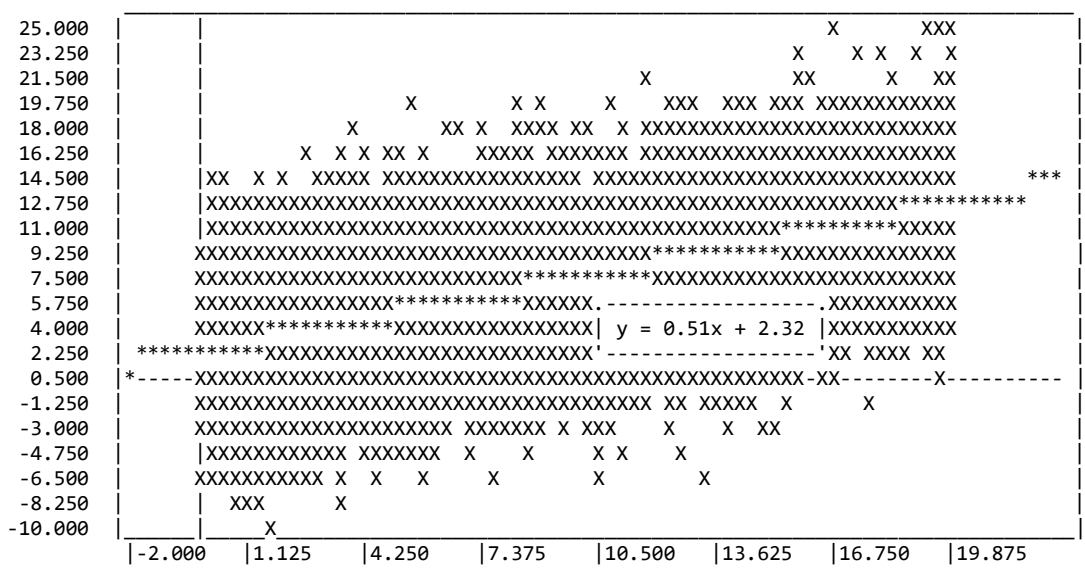
Executing the program with default configuration on command line

Run the executable in this directory:

./regression

Expected Output on Standard Out

```
File: Group1_8.txt, Lines: 10000, Console Plot Height: 20, Console Plot Width: 80
-h to display command line options
Min Y: -9.626100 , Max Y: 25.362000
y = 0.514091 x + 2.315605
Correlation coefficient: 0.596192
Coefficient of determination: 35.544506 %
Standard error of estimate: 3.996875
```




```
Type < > ^ v + - to pan and zoom the graph. Current scaling: 1.00

_
Entering a combination of < > ^ v + - can be used to control the plot view.
```

Command Line Arguments

This program accepts command line options to configure how it runs, such as using a different data file, changing the console display height and width of the ASCII art plotting.

Option	Description	Type	Example	Default value
-f	Name of the data file	string	-f Group9_15.txt	Group1_8.txt
-l	Amount of lines to scan in the data file	int	-l 1000	10000
-c	Columns of the console for the ASCII plotting	int	-c 200	60
-r	Rows of the console for the ASCII plotting	int	-r 40	20

So for example to execute the program with the data file Group9_15.txt with a maximised console which gives about 200 columns and 50 rows of spacing to plot the ASCII graph:

```
./regression -f Group9_15.txt -c 200 -r 50
```

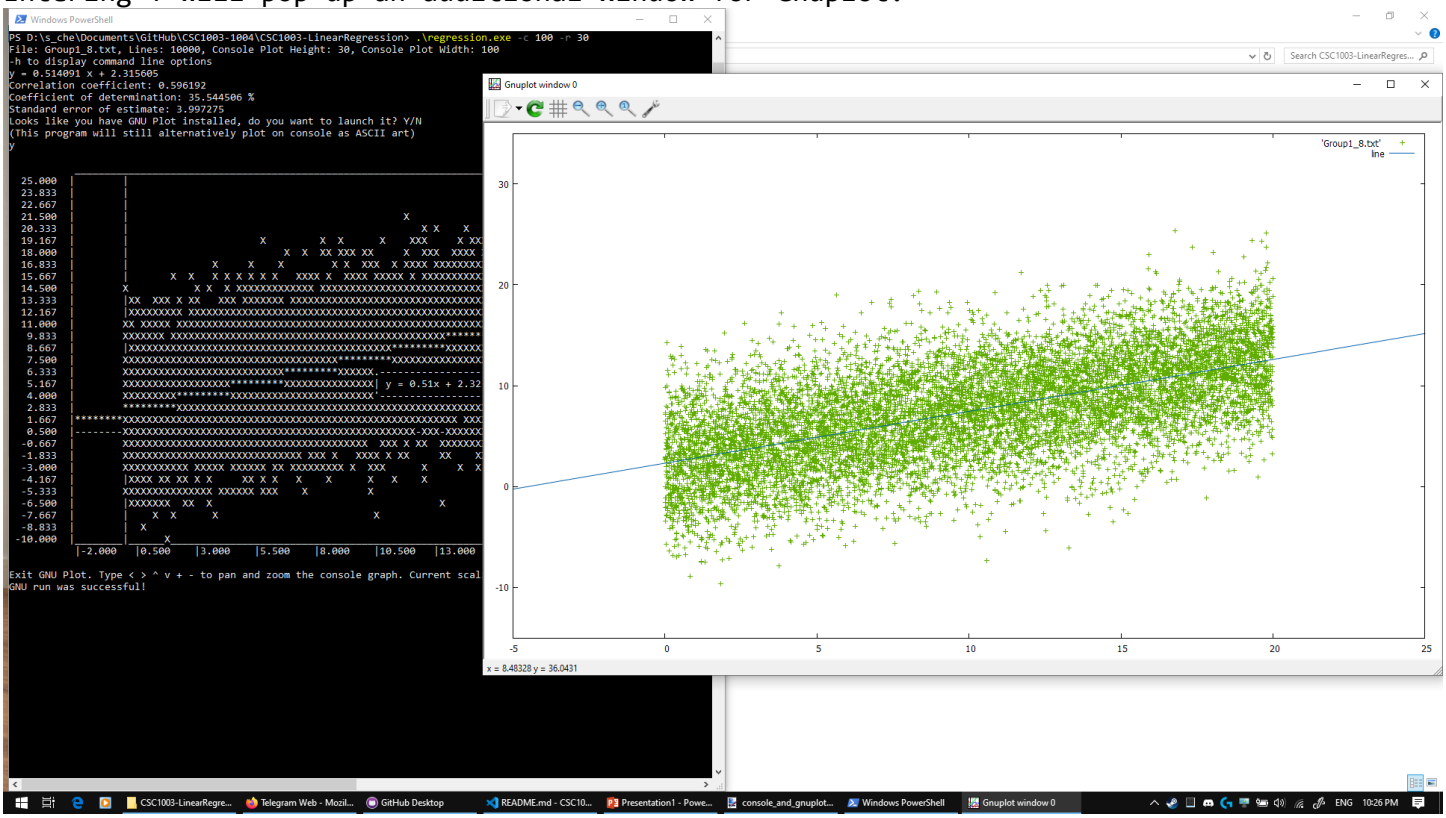
Additional Feature - Launching Gnuplot

If the user has Gnuplot installed and added to the environment PATH, this program will automatically ask the user whether to launch Gnuplot to display the graph.

Executing the program with Gnuplot installed

```
File: Group1_8.txt, Lines: 10000, Console Plot Height: 20, Console Plot Width: 100
-h to display command line options
Min Y: -9.626100 , Max Y: 25.362000
y = 0.514091 x + 2.315605
Correlation coefficient: 0.596192
Coefficient of determination: 35.544506 %
Standard error of estimate: 3.996875
Looks like you have Gnuplot installed, do you want to open it? Y/N
(This program will still alternatively plot on console as ASCII art)
```

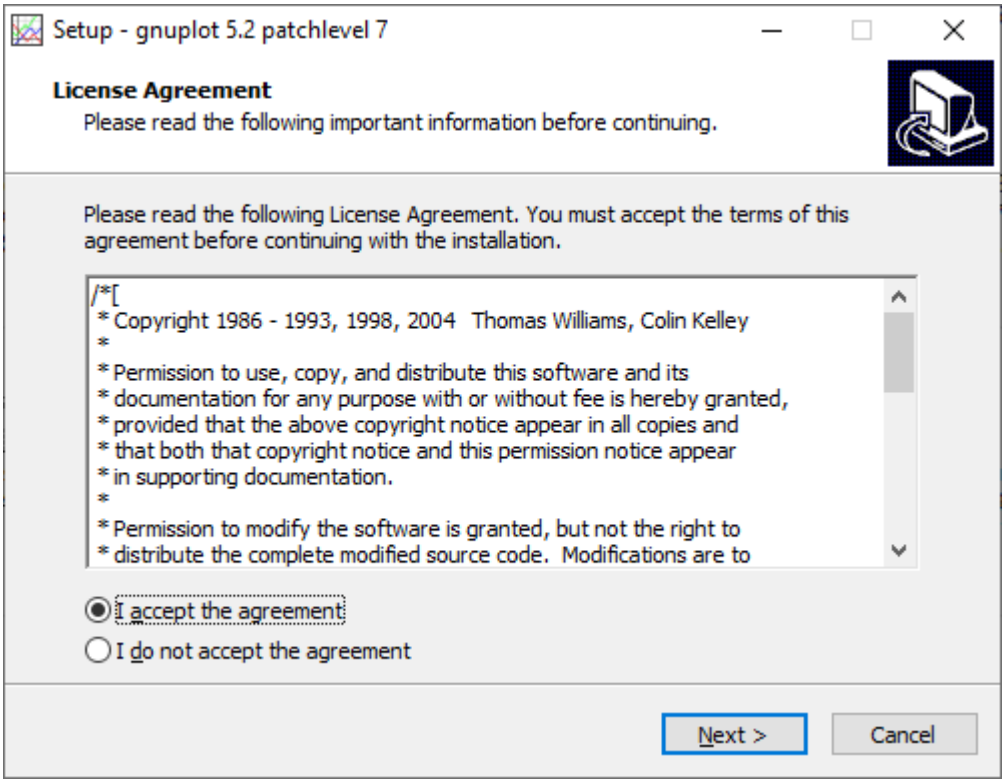
Entering Y will pop up an additional Window for Gnuplot.



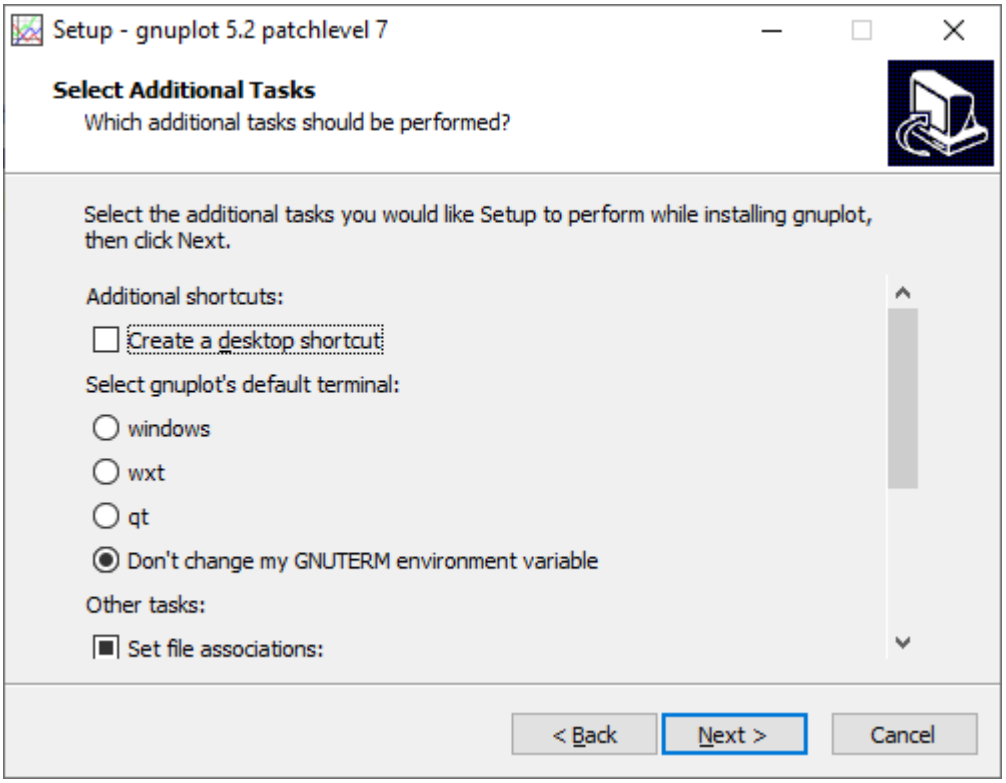
Installing Gnuplot

Windows

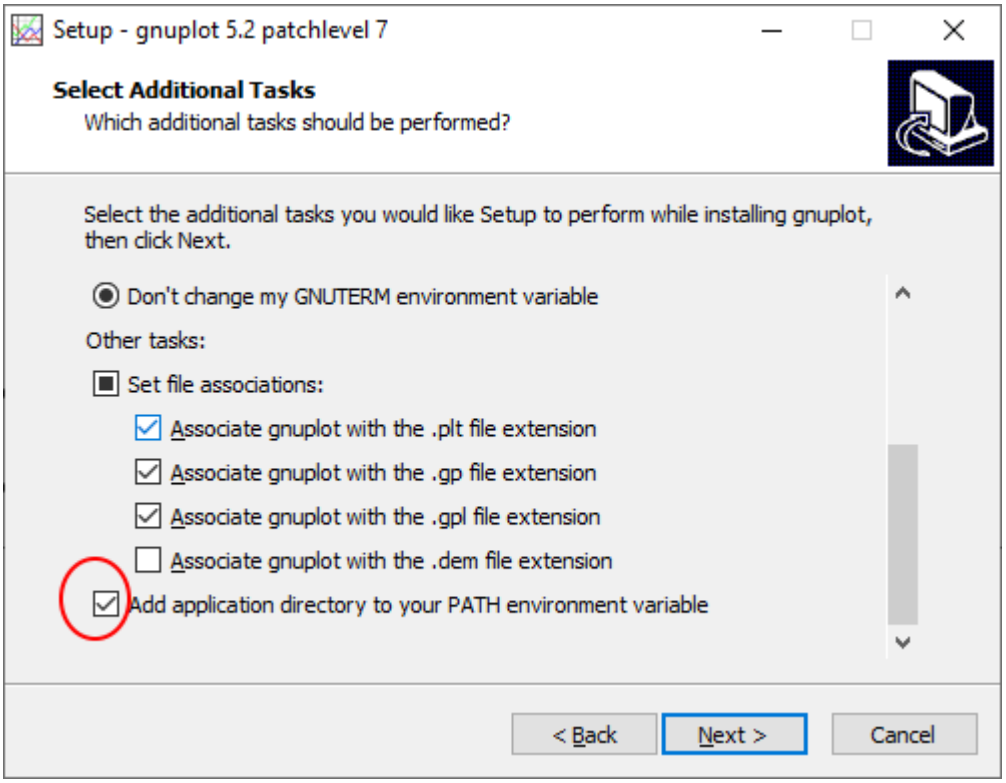
1. Download the Gnuplot Installer at https://sourceforge.net/projects/gnuplot/files/
2. Before installing, close all applications especially those have close interaction with the system shell, such as Command Prompt and code editors.
3. Double click the Gnuplot installer.



4. Read accept the agreement and click next with default options until **Select Additional Tasks** section.



5. Scroll down and tick "Add application directory to your PATH environment variable".



6. Click next and then complete the installation.

After installation, open a terminal such as Command Prompt.
Run:

gnuplot

Expected output:

```
          G N U P L O T
        Version 5.2 patchlevel 7    last modified 2019-05-29

        Copyright (C) 1986-1993, 1998, 2004, 2007-2018
        Thomas Williams, Colin Kelley and many others

        gnuplot home:     http://www.gnuplot.info
        faq, bugs, etc:   type "help FAQ"
        immediate help:   type "help"  (plot window: hit 'h')

Terminal type is now 'wxt'
Encoding set to 'cp1252'.
gnuplot>_
```

This shows that the Gnuplot has properly installed and added to the system path variable.

If command is not recognised, restart Windows. If persists, install again make sure step 5 is performed.

MAC OS

Press Command+Space and type Terminal and press enter/return key.

If the user already have brew in his/her OS, the user may skip this process.

Run in Terminal app:

```
ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)" < /dev/null 2> /dev/null
```

and press enter/return key.

If the screen prompts you to enter a password, please enter your Mac's user password to continue. When you type the password, it won't

be displayed on screen, but the system would accept it. So just type your password and press ENTER/RETURN key. Then wait for the command to finish.

Run:

```
brew install gnuplot
```

Additional Project Facts

C89 Compliance

The source code is warning free with ANSI C and strict checking compiler flags.

```
gcc ./src/*.c -o regression -lm -ansi -Wall -Wextra -Werror -pedantic
```

Version Control

The team used git and GitHub for collaboration and version control.

Debug in VS Code

Configered tasks in .vscode folder. F5 to debug with break points works on any file.

Terminal Tweaks

Terminal can be tweaked to display smaller font size and more character buffers.
On Windows PowserShell, set screen width buffer to 1000 and font size of 5, then maximise window.

Run the regression with options (type carefully as the font size is very small to see):

```
./regression -r 200 -c 900
```

Expected output