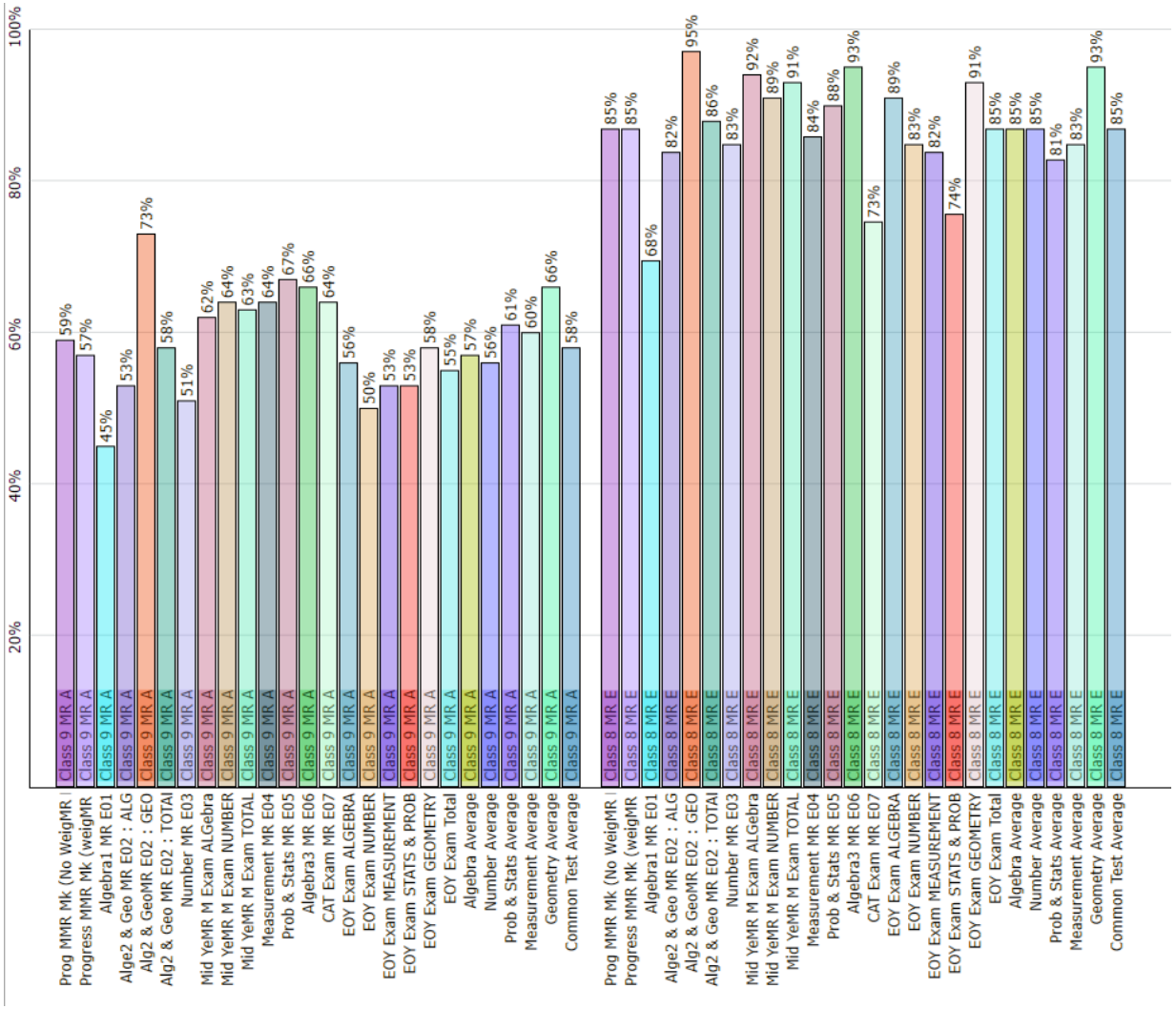
# Customised Graphing and Filtering Program

A Windows program developed for graphing and filtering a specific set of data

https://github.com/uilymmot/HBHSMathGrapher



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***Project Disclaimer and Copyright notice:***
***All data shown and used in example graphs of this program is not actual student data but randomly generated data, any true test data used in this project had all unique markers which could lead to identification of individuals or groups removed before it was given to myself in order to maintain the confidentiality of student marks.***

# Introduction

In recent years there has been a shift from paper based systems into electronic based systems, there have been issues with this in the transitional speed and accessibility to many non ‘tech-savvy’ people, for this purpose many of them require solutions to problems which have arisen caused by this rapid shifting and culture.
In the light of these better technological practice and the availability of computing power it is possible to fulfil tasks at much faster rates than previously resulting in an overall increase in productivity.

My school is one such school affected by this drastic technological upheaval, a school is responsible for managing, storing and reviewing vast amounts of physical and electronic copies of results each year.

My client and calculus teacher, (Mr) Charlton Thompson who is the head of the Mathematics Department at Hamilton Boys High School has requested a program which can automate and speed up the process of generating graphs from year 9 and 10 data so that their results can be compared and analysed as to provide feedback to teachers and to be used in evidence based reviews.
My client as the head of the Mathematics Faculty is responsible for carrying out evidence based reviews upon faculty members and the graphs of year 9 and 10 results are one such piece of evidence in the analysis.
Furthermore he has requested a method of sorting and filtering out student marks to determine which courses they are eligible for in the following year.

My client has come to me as he has been unable to find any specialised program that is better than his current solution and that his current solution of using Excel to manually filter and select data to graph using Excel's graphing function is far too slow and is taking up too much of his valuable time.

# Existing Solutions to my Client's Problem

Upon hearing my clients' problem, I wondered if there were any other existing solutions that already exist because I imagined that the creation of graphs would be relatively easy and commonplace, only after some research did I realise how much that we take graphs for granted.

Firstly, I went and attempted to use his current solution: Excel, after stumbling around with some random data sets I came to the conclusion that: Excel is a very flexible program for creating graphs and charts, however it has the drawback of taking a long time to make each individual graph as you must manually select and filter out data to plot on the graph and their labels, along with this Excel favours functionality over aesthetics resulting in some rather unwieldy and ugly graphs. I realised how long my client must spend working on this if a single graph using a relatively small dataset took as long as it did me.

## Other Programs that may fulfil some of the needs

After investigating excel I did some searching around, I firstly created a questionnaire which I sent out to my classmates asking them of what graphing solutions that they know of.
From my questionnaire I received the following answers: Excel, iNZight, Google Sheets and manually drawing the graphs, I decided to investigate each of these solutions.

- Google Spreadsheets suffers from the same problem as that of Excel in that it is too slow, its method if graph generation is much similar to Excel's
- iNZight is a data analysis tool, not a spreadsheet/graphing tool, it creates graphs one at a time and is very inflexible in what can be drawn
- Manually drawing graphs has a large number of drawbacks including: having to actually manually calculate data then, having to scan and upload them and it's actually quite hard to draw good looking graphs without taking a long time.

So after investigating these solutions I went and did some further research using google and the internet looking for graphing and charting tools, I found the following two websites:

- (As of Mar 2016)http://www.datacopia.com/ Is a website that seems to be able to create the graphs and charts specified by my client however it is not very flexible, this website is still in development, I had issues uploading my test .csv file and detecting datasets and groups from my uploaded test data.
- (As of Mar 2016)http://www.onlinecharttool.com/ is another website that is used to create graphs, from testing using my testing .csv file it seems to have few problems and is relatively flexible and simple to use however it would not fulfil my client's specifications as would not be efficient or much better than his current solution is it requires each graph to be individually created.
- (As of Aug 2016)https://nces.ed.gov/nceskids/createagraph/ Is yet another website that hosts services that allow for graphs to be created, upon loading in and selecting a bar chart I was overwhelmed with over 3 pages of options that had to be selected in order to generate the desired graphs, along with this data entry is a slight problem as it does not allow files to be uploaded.

All of the websites I have found were most definitely not an improvement over my client's current method and in some cases worse. The primary issue with possible solutions is that because of the nature of the task, data will have to be manually selected because each graph must be in a specific format in a specific layout for the purposes of my client.

Feedback from online sources: “If you’re looking to quickly create a set of specific graphs, it might be a better idea to make your own system”.

# Brief

My (Tommy Liu) client and calculus teacher, (Mr) Charlton Thompson has requested a program which can be used to organize and present year 9 and 10 student mathematics test results in a suitable format (preferably graphs), so that these results can be compared and analysed as to provide feedback to teachers in the form of evidence based reviews furthermore he has requested a method of sorting and filtering out student marks to determine which courses they are eligible for in the following year. My client has come to me as he does not know any specialised programs that suit his needs and his current solution to his problems are not optimal.

Mr Charlton Thompson is the HOF(Head of Faculty) of the Mathematics department at Hamilton Boys High School and as such is the responsibility of overseeing student and staff progress and results throughout the year.

## Proposed Solution

For this project I propose a customised program that I will design and create in order to fulfil my client's needs using my programming knowledge and skills. I will write a conceptual brief and create a conceptual design which includes visuals, UI and design, then a functional prototype which can be used by my client to solve his issue.

Throughout this process I shall document the processes that I go through, and manage my time accordingly to complete the project on time (or as early as possible).

# Initial Research into Resources and Constraints

## Resources

I believe that the only resource that I will need for this project is access to a computer and subsequently the Development environment I will be using and the internet/programming resources that I will need in order to learn any skills that I do not have

## Constraints

The primary constraint for this project is that of time, I have a limited time throughout this year in order to complete the project (the year of 2016), thus I must manage my time appropriately and efficiently in order to meet major deadlines, for this I will manage my time using suitable project management tools.

Another constraint is that of skill, I do not have the required programming skill in order to create this program thus throughout the course of this year I will be building upon my programming skills in order to slowly build this program from the ground up.

## Time-project Management

For management of time and this project I will use a combination of a project log and the project management website: Trello.com.
My project log will keep track of what progress and major events that have occurred and trello will allow me to manage upcoming deadlines and key dates, I will compile this log into a calendar for easy visual overview.

Trello is a web based project management website that is designed to replace other forms of management such as sticky notes, it uses boards to represents projects which contains lists tasks which contain cards for specific tasks.
Along with these tools I will create a visual calendar detailing my progress on tasks throughout the year.

# Legal and Ethical

The resources and ideas that I use for the project must be legal, that is, I must not infringe upon any Intellectual Property (Such as copyright and trademarks).

I have researched some forms of Intellectual property, I will have to take these into consideration when creating elements of my program and looking at other sources for inspiration or help.

One resource that I shall use extensively is Stackoverflow, this is a programming website which people can post questions and answers with examples of code, I will look at some of this code found on Stackoverflow and occasionally copy sections of it.
I will have to comply with the Stackoverflow terms and conditions of service and the MIT license which Stackoverflow operates under, this license states that any resource found in Stackoverflow is free to use and distribute as long as it is referenced back to its original work or is also licensed under the MIT license.

Along with this, since I will be writing this program in Visual Studios I will have to comply with Microsoft Visual Studios terms of use, these terms are quite loose with few restrictions, the main condition that concerns me is that all work must be legal in that I do not infringe upon any intellectual property, other than this Microsoft Visual Studios does not have many other terms that I must be too concerned with.

Another resource I plan to be using to manage my project and to move it between home and school is Github, Github is a free service that allows for files to be uploaded and downloaded from various locations and has integration into Visual Studios using add-ons.

The data that this program will be working with, that is, the test results of all year 9 and 10 students will be sensitive, thus I must take this into consideration, the program must be secure as test scores are confidential information.

# Stakeholders:

I have identified the stakeholders for this project as follows:

## Key Stakeholders

The primary stakeholder would be my client himself as he is the one who wishes for this program to be made, he will be the primary person using this program and hence the primary person benefiting from this program.
I myself would be a stakeholder as I will be the one most involved in overseeing and developing this program over the course of this year, this project also has value to me as it is part of my final grades for the year.

## Stakeholders

The teachers at Hamilton Boys High School(primarily in the Maths department) will be stakeholders as they will be the ones who are presented the end result of the program (that is, the graphs created). These teaching staff will be the ones who will be able to compare their results and be subject to the end of year evidence based reviews.
The class of 13IA (My IT class) will also be stakeholders as I will be asking them for feedback; programming help, general advice and feedback.
Mr Erceg, the teacher of 13IA will also be a stakeholder as he is the one overseeing myself, I will be able to ask him for advice when I need help.

## Wider Community Stakeholders

The student body of Hamilton Boys and their parents will be wider community stakeholders, this program will be used by my client and shown to teachers, these teachers will be able to work on areas they are weak at teaching or areas students are weak in, this my program would indirectly benefit the student body, along with this any flaws/faults in my program would be reflected in the end resultant graphs.

# Client Consultation

This is a record of any questions asked by myself or the client in the initial stages of developing an idea for the design and functionality of the brief.

## Initial Consultation with Client

My client initially proposed this idea to me on the 17/02/19, I interviewed him the following day with these questions.

**What sort of program do you need?**

“Something to create some graphs based on data exported out of KAMAR and filter data and determine what courses a student is eligible for, something that I can just put data in and does all the work and spits out what I’m looking for”

**What is this program going to be used for?**

“I’m going to use these graphs in evidence based reviews throughout the year and to make my life easier in determining what courses students are eligible for”

**Who is this program for?**

“I’m gonna be using this program myself, and showing it to other teachers in the maths department, possibly this project could be expanded to be used across all departments throughout the whole school”

**Why do you need such a program? What have you been using before?**

“I’ve previously used excel and filtered data groups and manually create graphs on this data, I want a program to make this process easier, using excel takes too much time valuable and effort”

### Further Consultation with Client

#### Project Extension

21/06 My client mentioned to me the possibility of adding to this project, he wanted a method to filter and detect course eligibility for student data.

8/07 My client decided to fully incorporate this filtering of student data in the project, I again asked the same questions as I did for the initial consultation:

- “Something that sorts my data and spits out what courses students are eligible for”

- “It’s just to make my life easier so that I don’t have to spend so much time on this”
- “Most likely just myself and whoever else might be doing course selections next year.”
- “Again, I did this in excel manually before, looking over each student's results takes a lot of valuable time and effort”

## Specifications

From developing the brief and speaking with my client I have come up with a list of specifications for this project.

| | **Key Factor Addressed** | **Justification** | **Comments** |
|---|---|---|---|
| The program must accept a .csv file exported from KAMAR. | Cross program (KAMAR and this program) compatibility and resource management. | A CSV or comma separated variables file is a text file with rows of variables separated by either commas or tabs, it is an industry standard for non program specific files. | I know no other suitable file formats which I have the skill or knowledge to work with. |
| It must create graphs of comparisons of data of different fields. | Design and User interface/interaction | The purpose of this program is to create graphs for my client in order to be used as comparisons thus this program must fulfil that. | I along with my classmates believe that graphs are one of the best methods of comparing different datasets. |

| | | | |
|---|---|---|---|
| All source code in this project must be legal and not infringe upon any intellectual property. | Legal and Ethical | This program will be used in the school, it must not include any illegal content which may result in any negative consequences. | While infringing upon copyrights will likely not result in any major consequences as this program will be internally used, it would be unethical. |
| I must frequently gather feedback and consult with my stakeholders | Stakeholder feedback and consultation | The main client for this project is not myself, because this program is intended for an audience other than myself, I must gather feedback and advice from those who may be using it | My personal opinion on functionality and looks may differ from someone else's and thus I must accommodate their needs above mine. |
| The graphs created must be exportable/printable, along with this, these graphs must be designed well. | Physical, Formality and Appropriateness. | The graphs must look acceptable and be able to be printed by my client, these graphs will be used by my client to review other teachers and therefore must be suitable for a business environment. | |
| It must be faster and better than my client’s current solution (excel). | Physical, Time | The reason why my client has requested this program is that his current solution is too slow therefore this solution must be better than his current one. | The program will automate what my client is manually trying to do, if this automated process is slower then this program will be a failure. |

| | | | |
|---|---|---|---|
| The project must be completed on time (within the year) in order for my client to use. | Time Project Management | My client wishes to use this program next year (and possibly this year) to replace his current solution, along with this I will have left high school by the end of this year and will not have easy access to my client. | My client specified that it should be completed as soon as possible and as such I should begin work as soon as possible. |
| It must in a suitable manner filter out students and the courses they are eligible for | Design and User Interface, Ease of Use | My program should make my clients work easier. | |
| The project should be simple to use and feature a simple user interface. | Accessibility and stakeholder feedback | My client is not the most technologically inept person and thus this program would have to be easy to use for this an appropriate user interface and controls should be used | A classmate commented that this program should be easy to use so that is user friendly to my client. |

# Research into Methods of Development

Here I researched some possible methods to develop a solution and their environments.

## Possible methods of creating the program/solution

### The .Net Framework C#

The .Net framework is a comprehensive set of tools developed by microsoft that aids in the development of programs and applications in a Windows based environment.

#### Windows Presentation Foundation


Windows Presentation Foundation or WPF is a Graphical User Interface(GUI) class library subsystem which is used for rendering programs in the Windows Runtime Environment. WPF is run out of the Microsoft Visual Studio's Integrated Developer Environment(IDE) the source code can be written in either Visual C# or Visual Basic. WPF features a drag and drop and a programmatic system to allow the customisation of a window.

WPF was developed to replace Windows Forms, it is more flexible and customisable than Windows Forms but as a result is more difficult to use and requires more work in doing what may be simple in other systems such as Windows Forms. WPF uses a combination of XAML and C#/Visual Basic in order to achieve desired results, unlike Windows forms which controls are built into the library, XAML creates a ‘button’ and C# events and actions give these buttons functionality.

## Windows Forms

Windows Forms is another Graphical User Interface class library, it is included in the .NET Framework 2.0 specification and overhauled in the .Net 3.0 specification and was the main method of creating programs for a windows runtime environment before Microsoft developed WPF.
Windows forms is like WPF based in Microsoft Visual Studios, like WPF the source code can be written in Visual C# or Visual basic but is much easier to use as most actions and controls (like buttons) have specific actions associated with them unlike WPF.


## Java

Java is a general purpose programming language meaning that it has a variety of uses, it is similar to C# in that is is object oriented and it can run on all operating systems on a Java Virtual Machine using the Java Runtime Environment (JRE).

Using Java I would be able to make a program much the same way as windows forms however I have no prior experience using Java as a language.

## HTML, CSS and Javascript


I could make this program in the form of a website using the following languages

- HTML (HyperText Markup Language) is a markup language that is used as the backbone of most websites.
- CSS (Cascading Style Sheets) is a stylesheet language that is used to format and style websites, it is used in conjunction with HTML to give visual appeal to websites.
- Javascript is a scripting language that is used to build logic, actions and user interaction in websites.

The advantage of making this project as a website is that printing functionality is integrated and updating the website would be relatively simple. The disadvantage would be paying for hosting and accessibility to everyone who has internet.

## Conceptual Statement

For this project, I will plan and design a program that will create graphs from a .csv file for my client, along with this I will concurrently develop a program which filters data according to my clients specification;, I will pre write down the specific graphs that my client wishes to make so that it is all automated; I will write a conceptual brief and create a conceptual design which includes visuals, UI and design, then a prototype of both programs. I will then integrate both programs so that they can be considered one program with multiple functionalities.

Throughout this process I shall document the processes that I go through, and manage my time accordingly to complete the project on time (or as early as possible).

Initially I proposed that I will make both these programs in Windows Forms using C#, this is the solution I have the most experience with compared to other methods that I have researched, after working on the concept design and receiving stakeholder feedback I decided that I would use Windows Presentation Foundation(WPF) instead of Windows Forms, this is because WPF is more customisable in its aesthetics and functionality.

# Initial Time Project Management plan for the year

| | Term 1 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Week 10 | Week 11 | Week 12 | Term 1 holidays |
| Monday | | | | Identify problem and consult client, write up initial brief | | Refine initial brief gathering feedback from classmates/teachers/stakeholders | | Write up final specifications and hand in Final brief | | Hand in and get feedback on brief and fix up any issues, consult with stakeholder on brief | Begin Concept design writeup, research into conceptual design methods | | Continue working on conceptual design writeup |
| Tuesday | | | | | | | | | | | | | |
| Wednesday | | | | | | | | | | | | | |
| Thursday | | | | | | | | | | | | | |
| Friday | | | | | | | | | | | | | |
| Saturday | | | | | | | | | | | | | |
| Sunday | | | | | | | | | | | | | |
| | Term 2 | | | | | | | | | | | | |
| | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Week 10 | Term 2 Holidays | | |
| Monday | Create models of concepts and gather feedback | Create final concept to be further developed using chosen tool/development environment | | Senior Mid Year Exams | Create final concept to be further developed using chosen tool/development environment | | Hand in and gather feedback for concept design writeup, consult with stakeholders and test final concept | Begin prototype writeup and research into development techniques | | Begin development of prototype using final concept as base | busy overseas | | |
| Tuesday | | | | | | | | | | | | | |
| Wednesday | | | | | | | | | | | | | |
| Thursday | | | | | | | | | | | | | |
| Friday | | | | | | | | | | | | | |
| Saturday | | | | | | | | | | | | | |
| Sunday | | | | | | | | | | | | | |
| | Term 3 | | | | | | | | | | | | |
| | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Term 3 Holidays | | | |
| Monday | Work on prototype | | | Senior End of Year Exams | | Work on and refined prototype according to stakeholder feedback, complete prototype writeup | Consult and show stakeholder program, get feedback and any other additions to be added to program | Work on and refined prototype according to stakeholder feedback, complete prototype writeup | Reflect upon development process and tehniques and Hand in prototype writeup | Do exam study, begin scholarship writeup | | | |
| Tuesday | | | | | | | | | | | | | |
| Wednesday | | | | | | | | | | | | | |
| Thursday | | | | | | | | | | | | | |
| Friday | | | | | | | | | | | | | |
| Saturday | | | | | | | | | | | | | |
| Sunday | | | | | | | | | | | | | |
| | Term 4 | | | | | | | | | | | | |
| | Week 1 | Week 2 | Week 3 | Week 4 | | | | | | | | | |
| Monday | Compile and write up scholarship portfolio | | | | | | | | | | | | |
| Tuesday | | | | Scholarship Portfolio Due | | | | | | | | | |
| Wednesday | | | | | | | | | | | | | |
| Thursday | | | | Study Leave for Exams begins | | | | | | | | | |
| Friday | | | | | | | | | | | | | |
| Saturday | | | | | | | | | | | | | |
| Sunday | | | | | | | | | | | | | |

# Conceptual Development

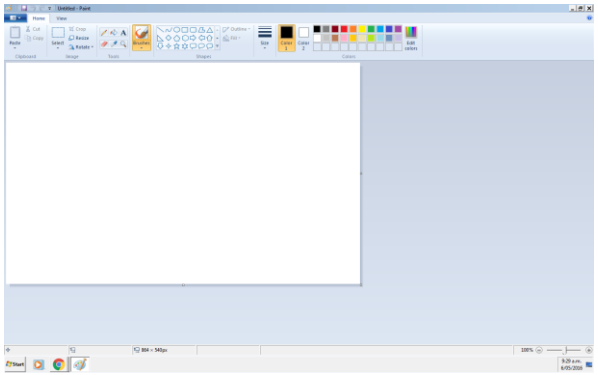
After writing a conceptual statement, I began working on designing a visual concept and began researching ways that I could do so, in this process I gathered and integrated stakeholder feedback into my design process.

## Exploration of Concept Development tools

**Pen and paper** can be used in concept design to plan the look and layout of the program, this is versatile and there a few constraints on what the program can be drawn to look like in order to satisfy the specifications of the program.
The problem with drawing it manually is that going through many iterations may take a significant amount of time and resources (paper) and that some elements visualised may be difficult to translate into programming.
**Artistic/drawing programs** such as Microsoft paint, these programs are essentially like drawing on pen and paper except it is done electronically the benefit of this is that it requires far less resources (no paper required), is still easily portable and can be coloured in order to better reflect the actual program. The drawbacks of using such programs is that it may take longer and require more actions (restricted by tools available in the program).
**Specialised Planning Tools** such as the program Pencil and the website wireframe.cc, these programs were developed for the purpose of developing concepts of programs, these programs have very specific things they can easily create (such as buttons).

## Specific tools

Microsoft Paint is a drawing program built into the Windows operating system, it features a simple design with tools on a toolbar above the drawing area.

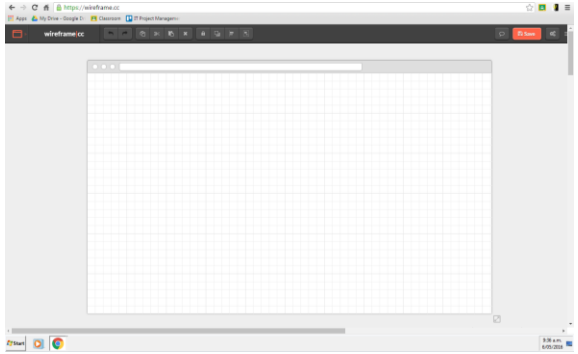


Pros:

- Is extremely easy to use
- Very flexible

Cons;

- May be time consuming as it was not designed for such tasks
- Is largely frowned upon by most people



https://wireframe.cc/ is a planning website designed for website concept development however can easily be used for other purposes.

Pros:

- Easy and flexible to use after getting used to it
- Free to use
- Has a ‘pleasant’ user interface

Cons:

- May be confusing at first and take some getting used to
- Is “too simple” and has problems with complex tasks

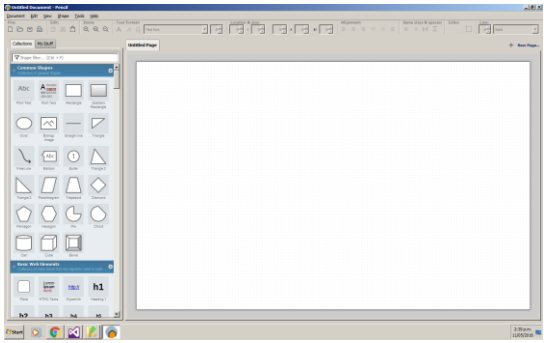
Pencil built for the purpose of providing a free and open-source GUI prototyping tool that people can easily install and use to create mockups in popular desktop platforms.

Pros:

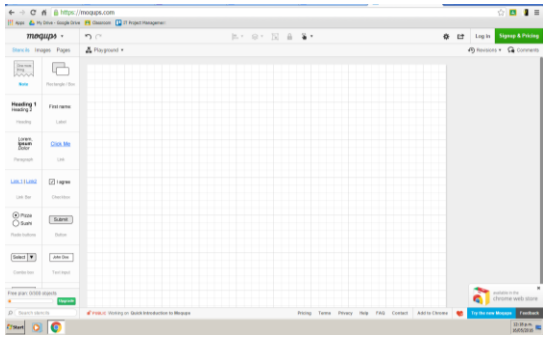
- Is a free open source downloadable program
- Has an overwhelming amount of tools for flexibility

Cons:

- Has quite an unappealing design and UI
- May seem overwhelming with the amount of features/tools



https://moqups.com/ is another planning and prototyping website for concept development, it lies somewhere between Pencil with all the specific design tools and wireframe.cc with a relatively minimalistic UI and design and Pencil which has a large amount of specific tools.



Pros:

- Is quite easy to use

Cons:

- Advertisements
- Not the most flexible

## Exploration of keeping program up to date

Initially I planned on making this program as a standalone, fit for the purposes specified by my client however both my client and I realised that needs and requirements change over the years and that my program needs to be able to adapt to these changes or be updated by myself, for that I need to plan suitable methods of doing so.

I researched some methods of keeping the program up to date, this research led me to the source control GitHub.

Github is a free to use hosting service (source control), it features repositories which users can ‘push’ and ‘pull’ versions and updates, using this I could publish any updated versions of the program to github, notify my client and he would be able to obtain the most any updates I put into the program.

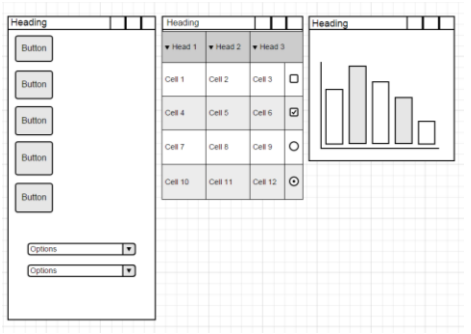
My stakeholders thoughts of updating the program: *“Yeah it would be nice to know how to update the program as specifications for the maths department change over time”*

# Design, Layout and UI

*“What is good design? “Good design is honest and long lasting, it is user oriented, unobtrusive and thorough down to the last detail. Good design is always the simplest working solution with as little design as possible and engages through focus and intrinsic motivation.” - Google*

I asked my client what his thoughts on good design were and he replied with the following: *“I think something well designed should be easy for me to use and navigate and that it shouldn’t be so ugly that I don’t want to use it even if it makes my life easier”.*

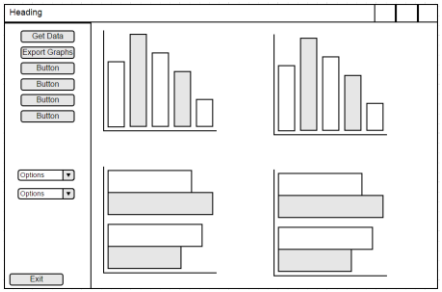
## Design Concepts




### First Concept: Made in Moqups

The design to the right is my first initial design concept, when the program is opened, only the first menu (left most) shows up, the user can then load the data using one of the buttons and upon doing so will load the data on a grid (middle form), the user can then select variables to create charts/graphs with and export/add these graphs to a file.

This provides a segregated interface where the user can specify and select what to use at any given time.




### Second concept: Made in Moqups

This design features an integrated user interface with a vertical bar menu with all the options with a ‘display area’ to show graphs and any data structures. This design

contrasts with the first concept in that all controls are integrated into one window and there is no grid showing the data to minimise clutter.

### Stakeholder Feedback for Design Concepts based on Questionnaire - 5/24/2016 - 5/25/2016

*"The second design looks more cohesive than the first one"*

*"As it subdivides the content design 1 is better"*

*"It's like three different windows that are all different sizes and that's dumb."*

*" I prefer design 2 because it like all of the information in one window."*

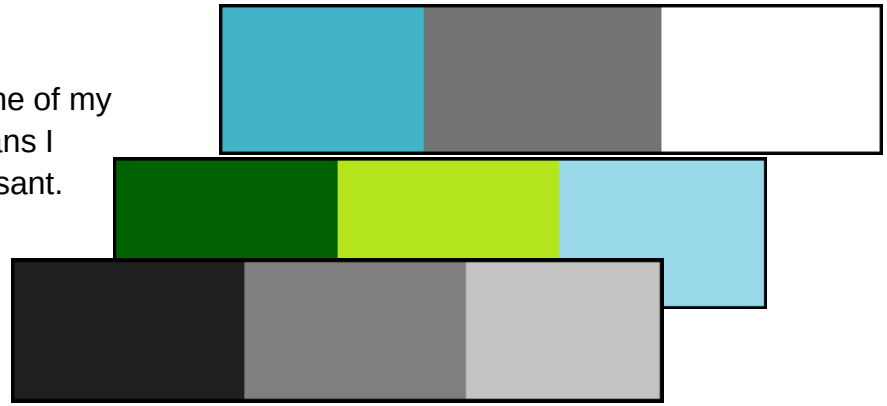
*"Lots of windows create confusion and make it harder to manage (see iNZight)"*

After sending out a questionnaire and receiving feedback it seems that people believe that having multiple windows and a degregated interface is a bad choice. One stakeholder mentioned that multiple windows makes it harder to manage and that iNZight was an example of this bad design choice.
My stakeholder stated that *"iNZight looks horrible and is horrible to work with as it is full of bugs, the interface is unintuitive and hard to navigate".*

## Colour design

A good program must feature good color design along with this one of my specifications is for my program to be visually appealing, this means I will have to properly design the colors to be coordinated and pleasant.

I have created several color schemes to the right which I could apply to my program, I chose only up to 3 light and easy to look at colors to make the program as simple as possible.



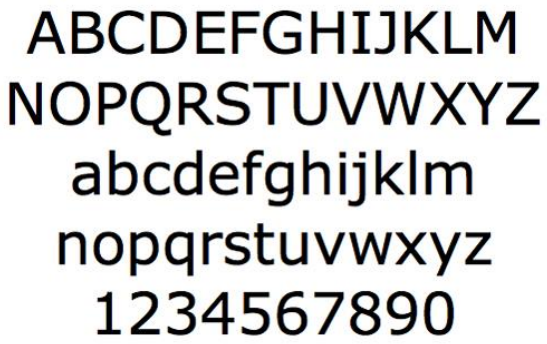
### Stakeholder Feedback for Color Design based on Questionnaire - 24/5/2016 - 25/5//2016

*"I like the first colour scheme the most because the colours in the second scheme clash and the third colour scheme does not have enough colour"*

*"the first two options don't look very nice. The blue/grey/white is weird and the green/green/blue looks like the default Windows XP desktop background."*

From my questionnaire, the second color scheme was not well received, the most liked color scheme appeared to be the first, thus for my color scheme I will use a combination of light blues and grays.

## Fonts and Formatting




The program must feature easy to read and legible text thus I must choose a suitable font to use for this program.
Research shows that sans-serif fonts are the best to use for reading on a monitor/digitalised screen and serif[1].

From my questionnaire I gathered that people most prefered Verdana.
Verdana is a sans-serif font designed for Microsoft Corporation and released in 1996. *"The counters and apertures are wide, to keep strokes clearly separate from one another, and similarly-shaped are designed to appear clearly different to increase legibility for body text. The bold weight is thicker than would be normal with fonts for print use, suiting the limitations of on screen display. Carter has described spacing as an area he particularly worked on during the design process"*[2].

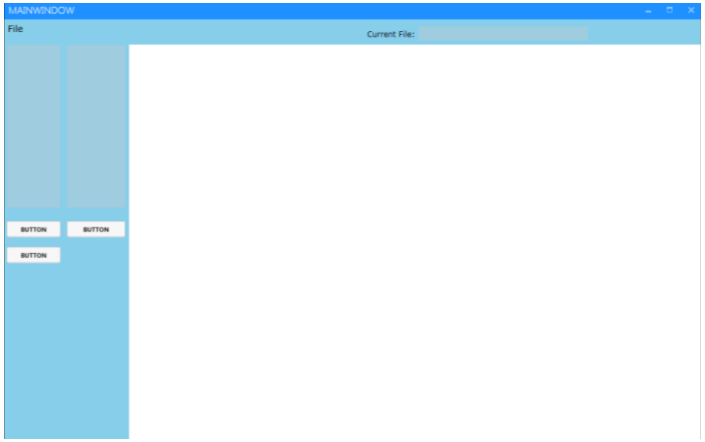
[1] http://www.betterwritingskills.com/tip-w017.html
[2]Directly quoted from https://en.wikipedia.org/wiki/Verdana

Thus for my program I shall use Verdana as the main reading font as it has been suggested by feedback that it is the most pleasant and readable font to use. My stakeholder has stated that: *“I don’t particularly mind about what fonts I have to read as long as it is legible”.*

## Creating a Visual Prototype Concept

From my gathered feedback I began compiling and integrating these ideas into a prototype design using WPF with specific colors and arrangement

# Initial Concept




I created an initial concept in WPF forms based on my specifications and can be seen to the right, it features a light color scheme accentuated with blue colors and a simple layout.

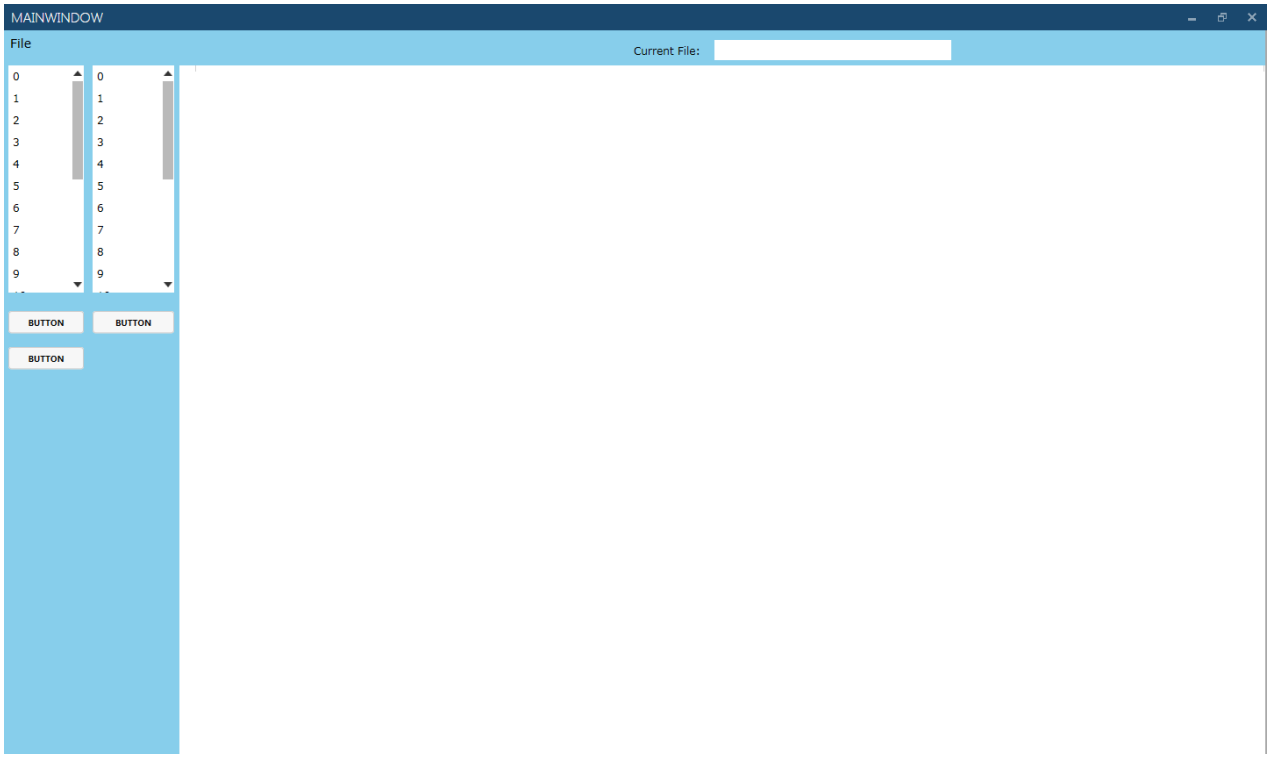
As seen there is a horizontal bar across the top containing a file menu and a display of the currently used file, a vertical bar with controls to manipulate data and create the graphs and a datagrid to store and display the file so that things can be selected and highlighted.

### Stakeholder feedback on Final concept

***Hamish Weren*** *13/06: “I think the two blues may clash a little bit but other than that the colours are good with the design, it's nice and uncomplicated so it is simple to use but other than that it seems literally like iNZight”*
***Ian Chen*** *20/06: “looks perfectly fine, it's really simple and there's not really much I can add to that”*
***Cameron Salisbury*** *20/06: “The gray of the listbox and textbox is ugly and makes me want to puke, I feel that it should be a more standard white as it is a widespread convention”*

***Jordyn Coxhead*** *20/06: "It looks very 'windowsy', it fits quite well into the windows theme although I'm not sure how much I like like the windows theme, I think it looks plenty simple, even incredibly technologically incompetent people would be able to navigate clearly labeled buttons".*

## Final Concept




After taking into account some advice from stakeholders, I modified the color scheme but kept the layout and design due to the positive responses to them. This is also the concept that I presented to my client
As seen the top bar has a slightly darker shade and which is more contrasting and pleasant to look at, along with this the backgrounds for the listboxes and textboxes are a normal white.

***Jordyn Coxhead*** *20/06: "Much better than before, I like that because it definitely feels sharper than before"*

***James Weren*** *20/06: "I feel that looks much better, it's a lot easier on the eyes that before"*

This is the final concept that I have modified based on feedback from several people and thus this is the design I will further develop into a working prototype that shall fulfil my client’s specifications.

## Feedback from Client on Final Concept

On the 4/08 I met up again with my client and showed him my final concept.

*“This program is really pretty but not particularly what I had in mind when I asked for this project, I was thinking you would just make a program that does the things for me minimalistically, I didn’t really have something like this in mind, but now that you’ve made it, I really appreciate you going the extra mile and making it good looking and you might as well keep developing the program like this” - From this I think there might have been some slight miscommunication between me and my client initially with the specifications but now that I have this concept, he seems to really like and appreciate this extra work.*

*“This looks amazing and I can see that a lot of effort would have gone into making it, I think aesthetically this is very pleasing and although there is no functionality as of present, I can feel that in the future when it does, it will be very useful tool and will be pleasant to use.”*

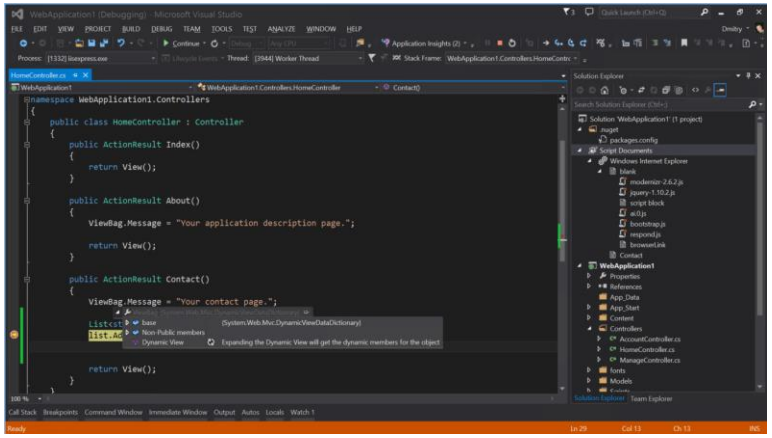
*“It seems that the buttons and file menu would be simple for me to navigate and there doesn’t seem to be too many complicated features which may trip me up”*

# Development of a Prototype

After designing a Visually pleasing concept that I was happy with, the next step was the develop it into a functioning prototype.

## Materials/Tools for Development

### Microsoft Visual Studios 2015



Microsoft Visual Studios Community 2015 is Microsoft's latest free iteration of their Visual Studios software development environment. Microsoft Visual Studios provides an environment which is very powerful which has Intellisense, error detection, integrated libraries, team solutions, extensive documentation and more which help ease the development process.

In MVS there are several ‘project’ type programs that can be developed including: Console applications; Windows Presentation Foundation applications; Windows Forms applications; XNA game programs  and many more. Each of these types of projects feature a different implementation of visuals and user interface to create different forms of programs.

## Brief Overview of Project Types

A Console application is a program that is command line meaning it is text only and has no user interface, it is generally only used for logic based programs.
A Windows Forms Application was Microsoft's earlier implementation of a program that can be customised to work with user inputs, it features a “Form” which contains the program like a wrapper and contains “Controls” which have “Actions” associated with them when users interact in certain ways with the program.
A Windows Presentation Foundation Application is Microsoft’s successor to Windows Forms, It builds on the ideas of Windows Forms where there are controls and actions but allows for far more customisation as the visual and controls side is handed by XAML (A markup language much like HTML) and is then associated with code by actions.

For my project I have chosen to use a Windows Presentation Foundation Application in Visual Studios based in C# for several reasons:

- I require flexibility and customisation and for this WPF is a good tool to use as it was built with these things in mind. Although I have prior experience in Windows Forms, I feel that it is too limited for the purposes of developing a truly aesthetic program and fulfilling all my specifications
- C# is a language which I have a fair amount of previous experience using, this means I can focus on working on my specifications instead of spending time trying to learn new things.
- I have prior experience working in Microsoft Visual Studios and it is the go-to solution for working in C# and I consider it the best tool for the job. There are other environments to work in C# such as http://www.icsharpcode.net/ and http://www.monodevelop.com/ however I am the most familiar and confident with Visual Studios.

## C# (C Sharp)

Is a programming language that first appeared in the year 2000 and is developed by Microsoft as part of the .NET infrastructure/framework, it is a general purpose (meaning that there was no special goal in the development and can be applied to a range of problems) language and is object oriented (meaning that the program works with “objects” which store properties).

C# is the first language that I have learned to use and write programs with and to date is the only language I know how to semi-competently use.

## XAML (Extensible Application Markup Language)

XAML is markup language developed by Microsoft and is based off XML and in turn HTML. XAML is responsible for the core visuals, controls and arrangement of items in a Windows Presentation Foundation. It works very much like HTML with opening, closing tags and properties the major difference with HTML is in the layout and format. There are no alternatives to XAML when making a WPF program.

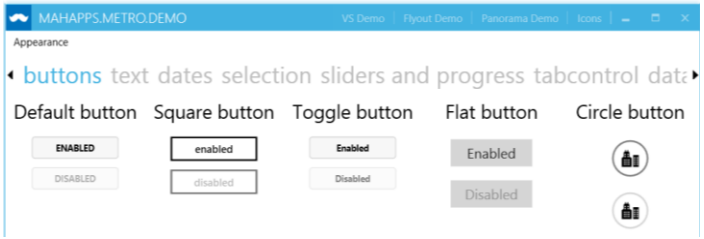
```
    </Grid.RowDefinitions>
    <Grid.ColumnDefinitions>
        <ColumnDefinition Width="200" />
        <ColumnDefinition Width="*" x:Name="col2"/>
        <ColumnDefinition Width="0" x:Name="col3"/>
    </Grid.ColumnDefinitions>

        <DockPanel Background="SkyBlue" Grid.Column="0" Grid.Row="0">
            <Menu DockPanel.Dock="Top" Margin="0,0,0,0" Background="SkyBlue">
                <MenuItem Header="_File" Background="SkyBlue" FontFamily="Verdana">
                    <MenuItem x:Name="OpenFile" Header="_Open" Click="OpenFile_Click"/>
                    <MenuItem x:Name="ExportData" Header="_Export"/>
                    <MenuItem x:Name="FilterChanger" Header="_Filter Program" Click="FilterChanger_Click"/>
                    <MenuItem x:Name="GraphProgram" Header="Graph Program" Click="GraphProgram_Click"/>
                    <Separator />
                    <Separator />
                    <MenuItem x:Name="ExitProgram" Header="_Close" Click="ExitProgram_Click"/>
                </MenuItem>
            </Menu>
        </DockPanel>

    <Grid x:Name="GraphProg" Background="SkyBlue" Grid.Row="1" Grid.Column="0" Panel.ZIndex="0">
        <Grid.ColumnDefinitions>
            <ColumnDefinition/>
        </Grid.ColumnDefinitions>
        <Button x:Name="DrawGraphButton" Content="Draw Graph" HorizontalAlignment="Left" Margin="101,350,0,0" VerticalAlignment="Top" Width="93" Click="DrawGraphButton_C
        <Button x:Name="ViewDataButton" Content="View Data" HorizontalAlignment="Left" Margin="101,328,0,0" VerticalAlignment="Top" Width="93" RenderTransformOrigin="0.2
        <ListBox x:Name="GroupResultsListBox" HorizontalAlignment="Left" SelectionMode="Multiple" Height="275" Background="White" Margin="5,19,0,0" VerticalAlignment="To
        <Button x:Name="AutoGenerateButton" Content="AutoGenerate" HorizontalAlignment="Left" Margin="97,590,0,0" VerticalAlignment="Top" Width="93"/>
        <ListBox x:Name="GroupByListBox" HorizontalAlignment="Left" SelectionMode="Multiple" Height="275" Margin="101,19,0,0" VerticalAlignment="Top" Width="89"/>
        <Label x:Name="label11" Content="Group Results:" HorizontalAlignment="Left" Margin="5,-7,0,0" VerticalAlignment="Top"/>
        <Label x:Name="label12" Content="By" HorizontalAlignment="Left" Margin="101,-7,0,0" VerticalAlignment="Top"/>
```

## Development Environment - Operating system

While there are other desktop operating systems such as Apple and Linux, I will choose to use and develop exclusively for Microsoft Windows, this is because this is what my client uses on the school computers and does not have much/any experience using other forms of operating systems therefore it would inconducive to develop for alternate systems. Along with this I don't have much experience or ease of access with the other operating systems.

## Mahapps

Mahapps is a project started in 2011 by Paul Jenkins as a means to make the metro style user interface available to use in a Windows Presentation Foundation program. It is a community project meaning many people in the community work and contribute to it and as a result is open sourced meaning that everyone has access to the



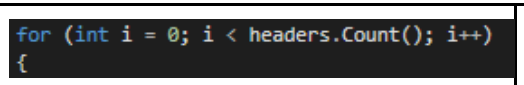
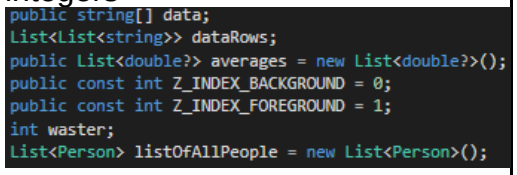
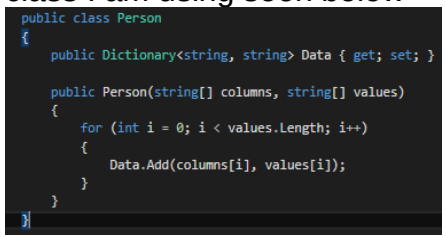
source code.
Mahapps comes in the form of a custom C# library, it overrides some default WPF controls and brings several new controls in. I stumbled upon this as I was looking for a way to aesthetically modify my program and was recommended this library from a friend.
There are many other libraries for WPF that allow the customisation of the visuals of a program however Mahapps is the only library that I have found that is built for a Windows 'Metro' style UI.

# Components and Techniques:

## C#/Programming Techniques

A brief overview of techniques and components in the development of a C# program

| **C# Techniques/Components** | **Examples** | **Purpose** |
|---|---|---|
| Variables | Strings (string), Integers (int32, int64), Double precision floating point integers (double). | Stores into memory values that can be used later. Each variable type has its own purposes and advantages for example, int32 is good for general number use without decimal values. |
| Arrays and Lists | List of Ints(List<Int>), Array of strings (string[])<br>`public string[] data;`<br>`List<string> columnHeaders = new List<string>();`<br>`public List<double?> averages = new List<double?>();` | Groups together many variables of the same type so that they can be accessed easily and dynamically. |
| Loops | For loops (for(int i; i<count;  i++), while loops (while(true)). | Allows for commands and things to be carried out consecutively/many times and can save amount of code required. |

| | | |
|---|---|---|
| |  | |
| Objects | | *"Supports all classes in the .NET Framework class hierarchy and provides low-level services to derived classes. This is the ultimate base class of all classes in the .NET Framework; it is the root of the type hierarchy."*<br>Essentially objects are the central basis of a C# program. |
| Types | Variables such as strings and integers<br>  | *"The information stored in a type can include the following:*<br>• *The storage space that a variable of the type requires.*<br>• *The maximum and minimum values that it can represent.*<br>• *The members (methods, fields, events, and so on) that it contains.*<br>• *The base type it inherits from.*<br>• *The location where the memory for variables will be allocated at run time.*<br>• *The kinds of operations that are permitted."*<br>Types define things about objects. |
| Classes | Custom classes - The person class I am using seen below<br>  | Constructs that are 'blueprints' which can have groups of specific variables |
| Objects | Custom Objects - Person objects | Instances of objects are blocks of memory with properties specified by a 'blueprint' |

| | | |
|---|---|---|
| Namespaces | MainWindow<br>`public partial class MainWindow : MetroWindow` | Scopes that contains collections of related objects |
| Libraries | Mahapps (Mahapps.Metro.Controls)<br>`using System.Data;`<br>`using System.Threading;`<br>`using System.Windows.Forms;` | Contains classes, namespaces, interfaces, and value types that comprises foundations of programs such as the WPF Framework |
| Events | ButtonClick_Events | Are particular methods which are carried out when particular events/actions occur such as when a button is clicked. |
| Conditional Statements | If statements<br>`if (int.TryParse(ite.Data[columnHeaders[i]], out temp) \|\| i` | Allows for the program to change or selectively carry out code if certain conditions are true or false. |
| Concatenation, splitting and appending | string.Split(), array.Split(), string.Split(). file.append | Allows for one variable to be split into multiple smaller variables, this is essential to my program when reading my .csv file as I must split according to commas. |
| Methods | Private void fillListView(string[] data)<br>`private void DrawABarChart(List<int> dataToDraw)` | Methods allows for a group/collection of code to be called and executed, methods can be void which means it is purely an action performing set of code or return types which means it performs a set of operations and got a type (variable) out of it. |
| **Empty Cell** | | |

## Namespaces, Libraries and Assemblies(Using)

Overview of Namespaces, libraries and assemblies used referenced/used in my program and how they are used.

| **Library Name** | **Purpose and Explanation** |
|---|---|
| System.IO | This namespace contains types that are used in reading and writing to files outside the |

| | |
|---|---|
| | scope of the application itself. I need this in order to read the .csv file that my client generates in order to use it. |
| System.Windows.Forms | This namespace contains all the Windows Forms Controls, of which I use a ListView in order to display data in an “excel-like” manner. |
| System | *“The System namespace contains fundamental classes and base classes that define commonly-used value and reference data types, events and event handlers, interfaces, attributes, and processing exceptions.”* - **Microsoft Developer Network (MSDN)** - Basically this namespace contains the core of which most programs are based upon. |
| System.Generic.Collections | Contains and defines generic collections, that is the generic forms of lists and arrays, I use many forms of arrays and lists including lists of strings, arrays of strings, list of integers and more. |
| System.Windows | Contains several core elements of the WPF framework including event handlers |
| System.Windows.Media | Provides types that allow for the usage of media such as pictures, drawings and colors. |
| System.Data | This namespaces allows for the management and efficient usage of data |
| MahApps.Metro.Controls | This library contains additional Mahapps controls and some things that override default WPF settings, it allows for a Metro style interface using WPF. |
| System.Windows.Media.Imaging | Contains types and methods used in the manipulation and creation of bitmap images - these are to be used in order to copy my graphs onto the clipboard which then can be pasted somewhere else. |
| System.Windows.Controls | Contains the controls of the application such as the textbox types which allow user interaction. |
| System.Drawing | Provides basic commands in order to interact with and use GDI+ (bitmaps) |

| | |
|---|---|
| System.Drawing.Imaging | Provides more advanced functions on top of what System.Drawing programs to interact with GDI+. |

## Variables and Objects used

Overview of the variable and object types used in my program and brief explanations and examples of what they are used for.

| **Variable and Declaration + Exmaples** | **Explanation and Usage** |
|---|---|
| String s = “”;<br>`string value = typeItem.Content.ToSt` | Strings contain any Unicode characters in a specific sequence, these are used in a large number of situations ranging from storing values to checking if stored strings match a hard coded value. |
| Random rand = new Random();<br>`private Random rand = new Random();` | Creates a new instance of a random object called random, this random object allows me to generate variables of type int randomly, I use this in generating and assigning colors to bars inside the ColorDictionary |
| Dictionary<String, Color> ColorDictionary = new Dictionary<String, Color>();<br><br>Dictionary<String, String> Data = new Dictionary<String, String>();<br>`private Dictionary<string` | Dictionaries allow for two or more variables to be stored which have variables assigned to each other, for example the stored value in ColorDictionary for “timetable” could be the color blue. I use the ColorDictionary to store and be consistent with the coloring with bars and the Data dictionary is part of a person object which stores its information for example the value assigned to “Timetable” in a person objects data dictionary is “911”. |
| List<string> columnHeaders = new List<string>(); | Lists are like dictionaries but instead of values, it is stored in an index, for example the first item with an index of 0 in the columnHeaders list is “Teacher”. I use lists of strings |

| | |
|---|---|
| `List<string> columnHeaders` | for many different tasks including: storing the Column Headers in the dataset, storing the selected items to graph and storing the labels to be used for the bars. |
| Int temp = 15;<br>`private int distanceFromLeft = 40;` | Integer variables store whole numbers, these are used in a variety of situations such as: storing how wide to draw each bar of the graphs. |
| Double averages = 0;<br>Double waster;<br>`double waster;` | Double variables store numbers with more precision than int and can work with decimal values in the form of floating point integers, these are used when int cannot be used such as calculating averages as they would usually be decimal values. |
| Person tempPerson = new Person(); | Person objects are a custom object that I created, the variable 'tempPerson' stores temporary data about a person in order to be added to a list of all people later on. |
| New GridLength(0, GridUnitType.Pixel);<br>`GridLength(1, GridUnitType.Star);`<br>`GridLength(0, GridUnitType.Pixel);` | A GridLength variable is one that stores data about the lengths of items in XAML terms, in this case this gridlength specifies that it has a value of 0 and type pixel meaning 0 pixels long. |
| ComboBoxItem typeItem; | A ComboBoxItem is a variable stored in a selected item inside a combobox, I use a combobox to allow the user to select the desired width of bars to be drawn. |
| Rectangle yAxis<br>`Rectangle bar` | Rectangle objects store a series of points, the properties of the rectangle can be specified in the declaration, I use rectangles as the basis of drawing my graphs, in this situation, the yAxis rectangle has a height of 1, is black and drawn horizontally in order to be the y-axis in any graph that is to be drawn. |
| TextBlock labelForBar<br>`labelsForYAxix.Add(new TextBlock{`<br>`RenderTransform = new RotateTransform(270),`<br>`Text = $"{i * 20 + 20}%",`<br>`});` | Textblock objects are like rectangles but they are more versatile in working with text, I use Textblocks in order to make labels for my bars in each graph. |

| | |
|---|---|
| MainWindow newWindow = new MainWindow();<br>`MainWindow newWindow = new MainWindow();` | MainWindow is the name of the entire project, creating a new object MainWindow creates another copy of the program, this is used when restarting the program and the old MainWindow is closed. |
| Bitmap ImageFromCanvas<br>`System.Drawing.Bitmap bmp;` | A bitmap object is an object that inherits from Image, this means the bitmap object is essentially an image object with slightly more and different properties, I use the bitmap object to copy an image to the windows clipboard and to save an image to a file. |
| new MemoryStream();<br>`MemoryStream outStream = new MemoryS` | A MemoryStream is a stream which allows for the transfer of data and bytes which is backed into memory, I use this to transfer my bitmap to memory in order to save it. |

## Controls

An overview of the controls that I have chosen to use as part of the user interface/interaction of this program

| **Control type/name** | **Library** | **Explanation and Usage** |
|---|---|---|
| Button | WPF/XAML | Performs actions when buttons are clicked |
| ListView | Forms/WPF | Holds and displays the .csv file in grids and columns so that it is easily viewable |
| Menu | WPF/XAML | A dropdown menu is a standard for many programs to have settings and controls |
| Menu Item | WPF/XAML | Controls/options within a menu |
| Grid | WPF/XAML | Grids are the building blocks of a XAML application, they act like wrappers from HTML and hold other controls and elements. |
| Label | WPF/XAML | Contains text to provide information, a label is usually read-only and cannot be interacted with by the user. |
| WindowsFormsH | WPF/XAML | Allows a Windows Forms control to be hosted in a WPF application, for my program I |

| | | |
|---|---|---|
| ost | | use a WindowsFormsHost to host a ListView |
| Canvas | WPF/XAML | Is a grid with graphics options built in and allows for ‘children’ objects to be added to create images and graphics. |
| ComboBox | WPF/XAML | Allows for a selection from a set range of “combo” options, I use this to allow the size/width of each bar on the graph to be changed. |
| FileDialog | Forms/WPF | Opens a windows file dialog which one can select a file to open. |
| SaveFileDialog | Forms/WPF | Opens a windows save dialog which one can set a name and target to save the image file to. |

## Notable Properties of XAML controls

Brief overview of notable properties that are essential to the design and layout of the program

| **Property and Example** | **Attribution** | **Explanation** |
|---|---|---|
| Margin | XAML | `Margin="0,0,0,0"`<br>Defines how much of a margin the top, bottom, left and right of a control has to another, this means that this dictates the distance and positioning of a control to others |
| x:name | XAML | `x:Name="label1"`<br>`x:Name="label2"`<br>Names a control so that it can be referenced in program code, defines its name property, without this I would not be able to access controls using C# code. |
| Multiselect | Windows Forms - C# | Allows multiple items to be selected inside a listview, this is used to allow multiple items to be graphed at a time, without this I wouldn’t be able to allow the user to select multiple items and hence draw multiple items. |

| | | |
|---|---|---|
| FullRowSelect | Windows Forms - C# | Allows for an entire row to be selected and highlighted by a user instead of a single row item within a listview, whilst not necessary is a part of making the User experience a bit better to give a more organised feel to the program |
| Grid.Row/Grid.Column | XAML | `Grid.Column="0" Grid.Row="1"`<br>`<ColumnDefinition Width="200" />`<br>`<ColumnDefinition Width="*" x:Name="col2"/>`<br>`<ColumnDefinition Width="0" x:Name="col3"/>`<br>Sets the alignment and size of vertical and horizontal planes of an item to a set value previously declared, this is like margins but able to dynamically update and change, this is essential when resizing a window. |
| Click=”Name” | XAML | `am" Click="FilterChanger_Click"/>`<br>`Click="GraphProgram_Click"/>`<br>Sets it so that the method called Name in C# is called when control is clicked, this is essential in binding the logic/code to user interface elements in a WPF application. |

## Color Resources

In my program I use colours to make the visuals more appealing, in my program I use all three of the following color resources as they each have different advantages.

| **Type** | **Example** | **Explanation** |
|---|---|---|
| Hexadecimal | #FFFFFF | Hexadecimal uses 16 different alphanumerical variables in a 6 or 8 digit string to represent different colors, is useful if you want a definitive well defined color. |
| Word/Index based | Color.Red, Color.Black, Color.Blue | There are predefined colors in C# which are part of the System.Drawing library, these can be used as part of a program using Color.<Color> are colors predefined in the System.Windows.Media library, the advantage of these is that it is simple and quick to use however are not very flexible as it cannot match or |

| | | |
|---|---|---|
| | | get specific shades of colors. |
| RGB (Red, Green Blue) | Color.FromARGB(0, 255, 255, 255) | RGB is a type of color system which defines how much red, green and blue is seen in a color, differing amounts of each color results in different colors for example, 0 red, 0 green and 255 blue results in pure blue. C# using the Color.FromARGB method allows a color using the RGB system to be drawn/displayed/used. |

## Source control: GitHub Notes

Originally I had planned on using GitHub as a source control in order to manage my project, however due to several factors such as the fact that Github.io requires quite a lot of workarounds in order to make work on school computers, therefore overall I decided to not use Github overall.

Me method of source control and file sharing is the usage of archiving and uploading to google docs. Every time I make an update or change to my project, I duplicate my project and rename it, this means I have every historical revision of my project, the downside of this is that I end up with a large number of archived files.

However in the future I will create a Github project and upload my program to it, this is to allow for my client to download any updated versions in the future.

# Notable Features/Techniques, Trialling and Core Development Notes

### Reading data from file and loading data into rows/columns to be displayed

My input data is in the form of a .csv file, there are several ways in C# that one could read data from such a file type including: DataTable objects, custom libraries and manual reading.

I initially chose to use a custom library, http://www.stellman-greene.com/CSVReader/ as it was easy to use and loaded data in a suitable format to prepare for data binding to a Datagrid.

There are many controls that can be used in a C# program that allows for the display of data including: Forms Listview, Datagrid, WPF Listview, grids and more. These each have their own advantages and disadvantages.
Initially I decided to use a Datagrid as it seemed to be the most logically named and easiest to use however I ran into many problems in attempting to do so, while I used a custom library to load the data from file, it was loaded in a format which was not optimal for me to work with due to the fact that I did not have any experience using the said data format before and thus progress was slow.
Therefore after some deliberation and struggle to use the Datagrid I decided to stop using both a Datagrid and the custom library and chose to manually read the data and use a Windows Forms Listview.

```
data = File.ReadAllLines(openfiledialog1.FileName);
```

| Class | Teac... | Algebra | Geom... | Trigo... | Calcu... |
|---|---|---|---|---|---|
| 1012 | RR | 75 | 66 | 48 | 44 |
| 1012 | RR | 35 | 69 | 35 | 43 |
| 1012 | RR | 33 | 75 | 48 | 30 |
| 1012 | RR | 52 | 42 | 36 | 55 |
| 1012 | RR | 31 | 45 | 41 | 49 |
| 1012 | RR | 20 | 74 | 27 | 39 |
| 1012 | RR | 56 | 47 | 40 | 72 |
| 1012 | RR | 23 | 80 | 34 | 67 |
| 1012 | RR | 50 | 74 | 57 | 33 |
| 1013 | MZ | 67 | 49 | 69 | 49 |
| 1013 | MZ | 54 | 58 | 62 | 64 |
| 1013 | MZ | 55 | 32 | 71 | 68 |
| 1013 | MZ | 32 | 33 | 58 | 49 |
| 1013 | MZ | 63 | 39 | 52 | 63 |
| 1013 | MZ | 54 | 47 | 73 | 33 |
| 1013 | MZ | 54 | 31 | 75 | 34 |
| 1013 | MZ | 68 | 47 | 50 | 67 |
| 1013 | MZ | 35 | 46 | 61 | 56 |

In manually reading the data, I used the C# method File.ReadAllLines(<Target File>), this method reads each line of a file and writes it to an array of strings (string[]), this exacerbated my reasons to use a Windows Forms ListView as data in a string array is especially easy to load and that I had done it before.
To use a Windows Forms Listview in WPF (as they are different program structures) I used a WindowFormsHost control which allows a Windows Forms control to be hosted in a WPF project. An image of the listview displaying data can be seen to the right.

## Filtering Data

One major specification of my project is to filter data, to do so I used a long series of If statements, looking back at this I feel that this was not an optimal method, I could have used LINQ statements which could have shortened the amount of code required many fold.
However I will not go back and change it all to make use of more LINQ statements as it would require quite a bit of work and at this time I am quite constrained by the factor of time, therefore even though there are better solutions that I know

of, I will not go back and rework my program since it works even if it is not the best method the achieve the specified outcome. However some I have changed some of the easier to change lines of code to make use of the Enumerable.Range() method which cut down the required amount of code by about 6 lines.

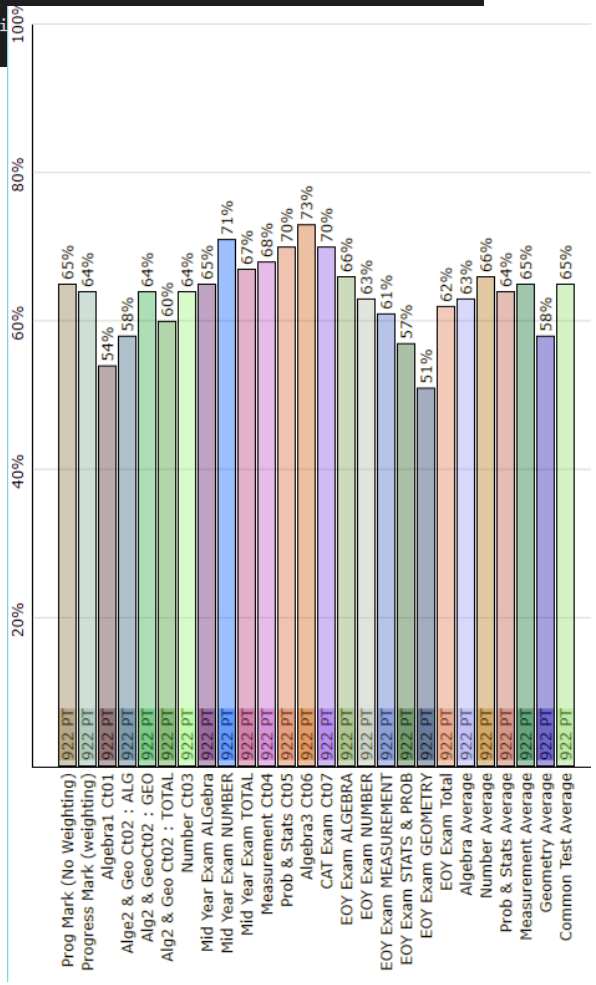
```
Rectangle bar = new Rectangle
{
    Width = wiidth,
    Height = ((canvas1.ActualHeight - 199 - 20) / 100) * heightOfBar,
    Fill = new SolidColorBrush(ColorDictionary[cols[i]]),
    Stroke = Brushes.Black,
    ToolTip = cols[i].ToString() + " " + dataToDraw[i].ToString(),
};
Canvas.SetLeft(bar, ri
Canvas.SetBottom(bar,
```

## The Drawing of Graphs

Here I had two main choices, use a custom graph drawing library or to manually draw graphs, after researching into the usage and documentation of several WPF charting libraries I decided that it would be too difficult to use as I did not understand much of the documentation and felt that progress would be too slow and therefore I would manually draw the graphs - something which I had done before.

```
if (heightOfBar != 0)
{
    TextBlock LabelOnGraphlForBars = new TextBlock
    {
        Text = $"{labelForBars[i]}" ,
        Background = new SolidColorBrush(ColorDictionary[cols[i]]),
        Foreground = Brushes.Black,
        RenderTransform = new RotateTransform(270),
        Height = wiidth,
    };

    Canvas.SetLeft(LabelOnGraphlForBars, right);
    Canvas.SetBottom(LabelOnGraphlForBars, 190);
    canvas1.Children.Add(LabelOnGraphlForBars);

}
```

The process of drawing graphs has a few major markers, the first was that addition of “Person” object to my program, after receiving consultation and programming advice (from one Jacob Cheatley), Person objects contained data about that person (row), this allowed for the usage of LINQ statements to easily search and filter through data contained in said objects to be manipulated for graphing.




My method of manually drawing graphs involves the usage of Rectangle and Textblock objects which are added to a Canvas. The properties and sizes of the children objects inside a Canvas are decided by data which is filtered and

manipulated. The bar width is manually set and can be selected by the user and the height is determined by the height of the window in relation to the percentage average, this means bigger graphs will be drawn the larger the program window is.

## Copying Graphs to Clipboard

The Windows Clipboard refers to the series of functions which all applications running on Windows has access to.

```
private void CopyToClipBoard_Click(object sender, RoutedEventArgs e)
{
    System.Windows.Forms.Clipboard.SetImage(BitmapFromWriteableBitmap(SaveAsWriteableBitmap(canvas1)));
    canvas1.Children.Clear();
    right = 40;
    col2.Width = new GridLength(1, GridUnitType.Star);
    col3.Width = new GridLength(0, GridUnitType.Pixel);
}
```

Copying something to clipboard means that it can be transferred onto other projects and applications such Microsoft Paint or Documents, this is done after a graph has been drawn by creating an Image Object based on what objects are seen inside the Canvas at the time - there is an issue here which means that objects that cannot be seen, which extend outside the bounds of the monitor/program would not be copied, this is a limitation that I attempted to find workarounds for however after not managing to solve by myself, had a friend help out by suggesting to put the entire canvas inside a scrollviewer and after tweaking a few other dependency features managed to get it working.

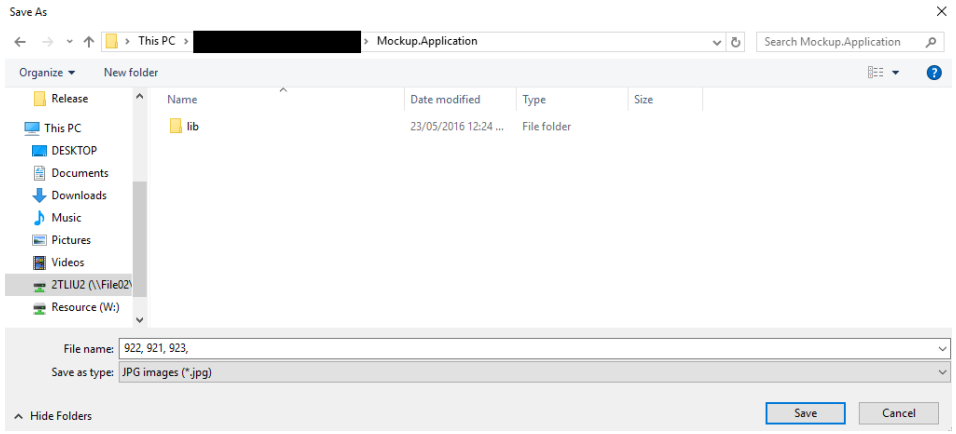
The method of creating the image is as follows: the target (the canvas) is sent to the method ‘SaveAsWriteableBitmap’ which measures, scales and converts all elements into the form of a writeable bitmap, which is in turn passed to a method which converts the writable bitmap into a bitmap, I spend a while figuring this out as this conversion process was quite obscure and non-intuitive. The image is passed out as a Bitmap object (this inherits from the ‘Image’ object) which is then set to the clipboard using the C# Clipboard.SetImage method which is present in the System.Windows.Forms assembly.

```
private void SameImageButton_Click(object sender, RoutedEventArgs e)
{
    string nameOfSave = "";
    foreach (var item in groupByCategories)
    {
        nameOfSave += $"{item.ToString()}, ";
    }

    System.Drawing.Bitmap imageFromCanvasToSave = BitmapFromWriteableBitmap(SaveAsWriteableBitmap(canvas1));

    System.Windows.Forms.SaveFileDialog saveDialog = new System.Windows.Forms.SaveFileDialog();
    saveDialog.DefaultExt = "jpg";
    saveDialog.Filter = "JPG images (*.jpg)|*.jpg";
    saveDialog.FileName = nameOfSave;

    if (saveDialog.ShowDialog() == System.Windows.Forms.DialogResult.OK)
    {
        IntPtr hBitmap = imageFromCanvasToSave.GetHbitmap();
        System.Drawing.Image bmp = System.Drawing.Image.FromHbitmap(hBitmap);

        using (var bitMapStream = new MemoryStream())
        {
            bmp.Save(saveDialog.FileName, ImageFormat.Jpeg);
        }
        bmp.Dispose();

        col2.Width = new GridLength(1, GridUnitType.Star);
        col3.Width = new GridLength(0, GridUnitType.Pixel);
    }
}
```

## Saving Graphs to File

In order for the graphs to be stored and used later they are saved in the form of a .Jpeg file using the built in C# command Image.Save(Image) in the assembly System.Drawing. I chose to use the Jpeg format it is a generic form that takes relatively little space, has relatively decent quality and has good compatibility with the Image object I am using.
This uses the same method as saving to clipboard in order to get the image by capturing the entire canvas and converting it to an image.

In line with saving like any other windows application, a Windows SaveFileDialog browser is used to allow the user to select target location to save to and name the file.

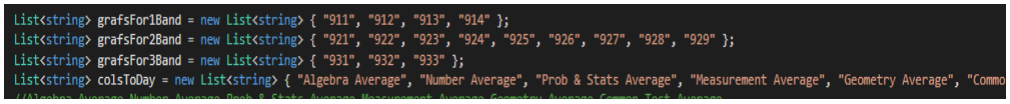



I encountered an issue when first attempting to make the program save in the form of a “Generic Error occured in GDI+”, it took several hours to solve this problem as the error message was not very useful in diagnosing what went wrong, I eventually solved it by sending the image to a MemoryStream then saving the image from the MemoryStream.

## Autogeneration

To make my clients work infinitely easier, I hard-coded a set of graphs to be generated and saved to file. This means I will have to hard-code the variables to draw into my code
The hard coded variable are hard coded and saved into the file, because they are hard coded and the nature of my data filtering method, the input data must be in the correct form with not even a single character differences.
This auto generation of graphs was relatively easy as all had to do was create the hard coded variables and call the other methods of my program in order to graph them.

Issues I ran into here were:
Due to the nature of my method of converting the drawn graphs which requires the canvas to be visible, I had to quickly 'flash' the canvas into focus in order to actually save the drawn graphs. This was repeated for each graph to be drawn, this means this feature quickly does a series of flashes which may not be good for photosensitive people, however because it is flashed so quickly ~10 milliseconds between each graph drawn, there is only 1 flash because this 10 (30 millisecond) overall window is greater than the refresh rate of most monitors.




Due to the nature of changing the visibility states inside a thread, you cannot just set a value and allow the target to be automatically updated, this was the case for my canvas, this took a few hours to figure out properly and in the end I realised that every time a value is updated you must force the target to be updated, in this case I had to use the Canvas.UpdateLayout() method after each update to values

This feature is honestly not the most useful as it requires hard coding variables and items to graph, this means the data and columns formatting and text must be the same every year and according to my client these things can change every year although it is possible for him to manually change it back, it would however require additional work on his part.

# Stakeholder feedback on Prototype

- Jacob Cheatley 14/09/16

    - "You should probably change the workings of the program and use person objects with attached dictionaries as it would make your data manipulation to much easier and it would mean that you could have much less code"
        - Integrated Person objects with Dictionaries into my program
- Hamish Weren 10/10/16
    - "I think the percentage mark should be displayed on the bar because if it's going to be copied to another program the tooltip obviously wouldn't be visible"
        - Added percentages to the top of every bar
- Cameron Salisbury 17/10/16
    - "I dislike your error handling, your usage of empty try-catches provides no information to the user on the nature of the error, along with this you could fix some design limitations such as putting your canvas into a scrollviewer"
    - "That's Poor design if you draw the x and y axis over and over again"
        - Updated try-catches to show error messages and fixed canvas design limitation, did not really notice any actual problems with drawing the x and y axes multiple times.
- Jayesh Dullabh 18/10/16
    - "Everything looks fine, it feels like a normal windows program in Windows 10, one thing I noticed is that loading data when already loaded causes problems"
        - Was aware of the issue already but I actually don't have a solution to this program, my current workaround involves restarting the entire program
- Cameron Paul 22/10
    - "That's really cool, I feel that you have a lot of code from what I've seen is quite redundant, perhaps you should work on that a bit, other than that I feel that the positioning of buttons could have been better"
        - Overhauled project and unnecessary code

## Client Consultation on Late Stage Prototype:

19/10 - On this day I gave my client a revised copy of my program after getting another dataset, this was his feedback:
“This is basically all that I would have wished for, this is gonna make my life much easier, you have no idea how much time I’m gonna save, honestly I’m happy with it as it is really, I wouldn’t mind some tweaks but it works as it is now and it's great.”
My client asked some questions about the usage of the program and the answers from myself are as follows:
**Does your program only accept input in the form of a .csv file?**
“Yes, this program only takes .csv files, they can easily be created from any excel file, along with this there is a filter on the filedialog meaning only .csv files can be selected”
**Do the column headers have to be the same or in the same order every time?**
“No, as long as the column headers exist and don't contain certain keywords such as “Name” and “Ethnicity” they will be added to the right hand column in order to be used, the order doesn’t matter because everything is added and can be selected from therein.”
**How can I take these graphs and images to other programs in order to print them?**
“The program has 2 built in methods of doing this, you can copy to clipboard which allows for it to be pasted into other programs such as word or you can save it to a .png image file.
**About the colors, will they always be consistent?**
“The colors are auto generated and assigned to a column upon the loading of a file, this means as long as you don’t restart or close the program the colors for each column/header will be the same for every bar even across different graphs.”
**Client**: “That's so great, it's all I wanted It’ll make my work so much easier and I’m gonna use it this year as soon as the year 9’s and 10’s finish their end of year exams, but also see here in this booklet, I sort of would like the band names and class to be grouped together because a teacher could teach more than one class, along with this I would like to be able to group by entire bands because that's just the way we like to do things”.
“About the filtering program, I don’t really need it anymore, I’ve discovered some other methods whilst slow, I wouldn’t want to bother you with a heavy workload because our needs for entrance into the classes can change each year and we have to decide the same things for the year 11 classes as well so it’s probably just too much of a hassle”

## Further Development of Additional Features Requested by Client

To group band/teacher together I simply added another variable into the dictionary when loading the people objects named “TeacherBand” and the value assigned to it was the combination of the value stored in the “Timetable” and “Teacher”, along with this I set the value to label each bar to be taken from this “TeacherBand”.

```
        List<string> data1 = data.Skip(1).ToList<string>();
        string[] columnHeaders = data[0].Split(',');
        List<string> colHeaders = columnHeaders.ToList<string>();

        for (int i = 0; i < data1.Count; i++)
        {

            Person tempPerson = new Person(columnHeaders, data1[i].Split(','));
            tempPerson.Data.Add("TeacherBand", $"{tempPerson.Data["Timetable"]} {tempPerson.Data["Teacher"]}");
            listOfAllPeople.Add(tempPerson);
        }
    }
```

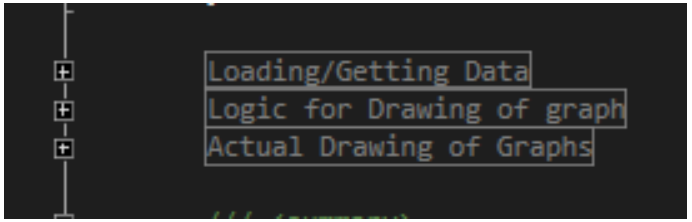
Implementing the drawing of whole bands together was bit of a struggle, this is because of the nature of my filtering method, my filtering method involves being passed 1 string variable (the band or teacher code) and selecting values from the listOfAllPeople, this does not allow for multiple bands to be passed to it in order to get the entries bands dataset.

As a result of this I had to copy paste and rewrite a few things in my filtering method and I implemented the drawing of whole bands (1,2,3 band) into 3 distinct buttons instead of adding them to the listbox selection of items to graph because the nature of drawing these bands was different. The result of creating these buttons to draw entire bands was a mess, it required around 400 extra lines of code, most of which was redundant and copy pasted, although it would have been better and possible to write a new method which is capable of parsing whole bands, this copy pasting was easier due to time constraints.

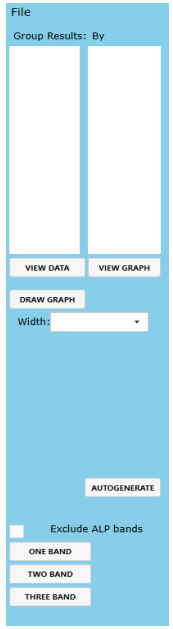
Along with this I removed the filtering section of my program according to my clients suggestion, this required cutting out several lines of code and controls from the program, it did not however take very long to tidy this up.

# Streamlining the Final Program

Firstly, I tidied up variable names - the names I used such as wiidth etc are fine for single person project of this nature where I am the only person working on it however it is not suitable if people are to edit/change the code in the future. This is a sustainability factor, whilst this is not an official specification, it would be good if the program were to be able to use for a long time to come and be adapted whether by myself, other people or my client himself. Thus, in this process I changed variable names to ones such that they explain themselves such as ‘right’ -> ‘distanceFromLeft’ and ‘wiidth’ -> ‘widthOfBars”.




I then removed any and all unnecessary lines of code from my project and cut down the total number of lines of code from 950 to around 840 lines, along with this I added spacings where necessary to allow for easier reading of code. I split the program into separate regions which contain whole methods used for related tasks, for example, all the physical graphing of items is in one region called “Actual Drawing of Graphs” this allows for easy access and finding of specific components of the program.




I then changed my XAML so that more controls/elements were aligned with each other and gave the entire collection of the program a more ordered feel.

## Critical Reflection

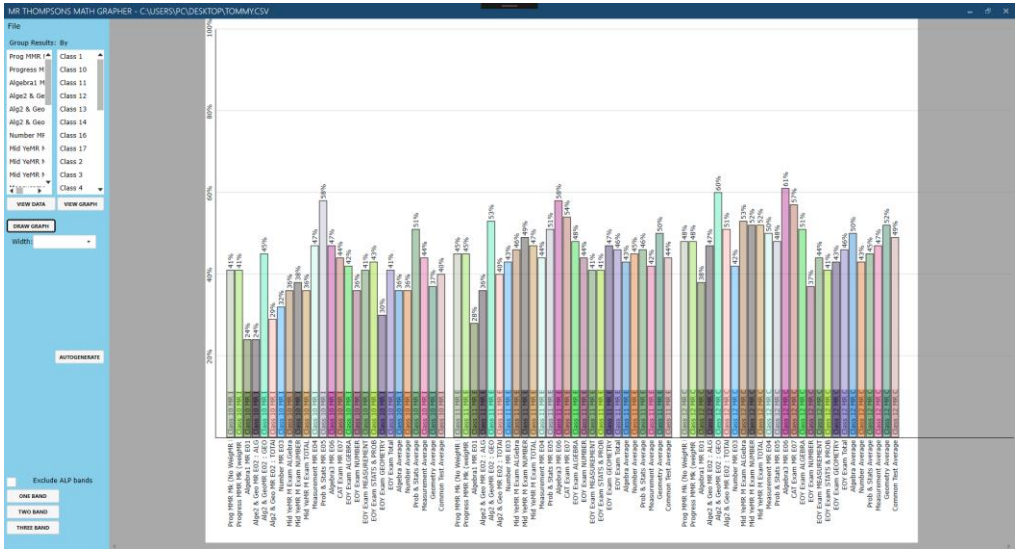
Honestly though, If I actually followed good programming conventions, I would not have to do much in this section, while writing code and the program, I fall into the bad habit of “I’ll just use random names and deal with it later” resulting in difficulty understanding code and having to go back and spend time changing names and formatting, I am more critically aware of this after spending about an hour during this streamlining process.

# The Final Program


The final user interface of the program can be seen to the left, many changes have been made to it since the creation of my final concept during the conceptual development stage. It has evolved alongside my needs and methods of solving problems throughout the development of this project.

This final version features far more controls than the final concept, this was not unexpected since the three buttons in the final concept were merely placeholders, a listbox or drop-down box has been added which controls the width of bars drawn.

The top row has also been removed so that the graph/data grid's width is the entire window, the file location textblock was moved into the header of the window and is a much more efficient usage of space.



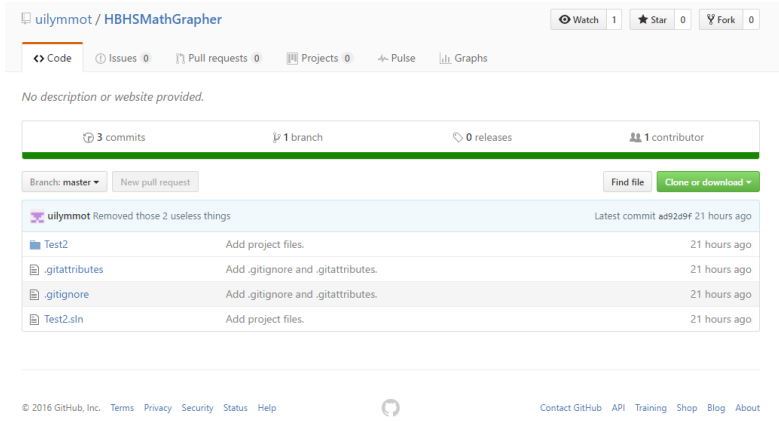

The graphs drawn seen to the left are drawn on the canvas which is shown upon drawing a graph, two buttons allow for changing from viewing the data grid to viewing the canvas.

The canvas (white background) is only large enough to encapsulate whatever graphs are drawn, any resulting free space is filled with a grey background, this gives the graphs more focus so that they stand out more.

This final version (which I call Release 1.0) is basically my final completed program which my client will be using.

For a name for this program I asked my classmates and got the name of “Mr Thompsons Math Grapher” and hence is the name of my program which can be seen in the header of the program.

I also have taken steps to upload this version into a repository on GitHub so that my client can remotely download it. The repository can be seen to the right and can be found at the address on the title page of this project.




Codewise, this final program is 868 + 20 lines of C# and 85 lines of XAML and all names and variable names are chosen in such a manner that is self-explanatory in what its purpose is so that if anyone wished to edit/work on/change features in my

program it would be quick and easy. In obscure and unintuitive areas, comments were added to describe what function the lines of code performed.

## Fitness for Purpose

| | |
|---|---|
| The program must accept a .csv file exported from KAMAR. | This program does accept a .csv file, in fact .csv is the only file type that it really does accept. |
| It must create graphs of comparisons of data of different fields. | Graphs are created by the program and can be visualised. |
| All source code in this project must be legal and not infringe upon any intellectual property. | To my knowledge, all source code is legal and does not infringe upon any intellectual property as most of it is original code. |
| I must frequently gather feedback and consult with my stakeholders | Feedback was frequently gathered on design choices and decisions from stakeholders. |
| The graphs created must be exportable/printable, along with this, these graphs must be designed well. | The program is capable of both saving and copying the images to the windows clipboard and according to feedback said graphs look good aesthetically. |
| It must be faster and better than my client's current solution (excel). | It only takes about 10 minutes to generate all the graphs that my client wishes to make compared to hours previously using Excel. |
| The project must be completed on time (within the year) in order for my client to use. | It has officially been completed on the 29/10/2016 on time. |

| | |
|---|---|
| It must in a suitable manner filter out students and the courses they are eligible for | This specification is not relevant anymore due to the removal of the filtering program according to client feedback. |
| The project should be simple to use and feature a simple user interface. | According to feedback, the interface is relatively easy to use and intuitive. |

According to user/stakeholder/client feedback, the program and user interface was well designed in a manner that is easy to use, it is simple and intuitive, and my client easily adapted to using it, and along with this my client is clearly happy in that my program is better and easier to use than his previous solution of using Microsoft excel.

The graphs themselves are nothing too special, they are however more aesthetically pleasing than Excel's graphing solutions if a less versatile, they look fine and get the relevant information and points across in a suitable manner, my client is perfectly happy with the condition of these graphs and I received no major complaints from any stakeholders.

Most of the program code was written by myself, some lines/methods were taken directly from Stackoverflow.com, in the situations the code was copied the original thread was referenced inside a XML comment header. My code is licensed under the MIT license and overall, I do not detect any infringements on copyright/Intellectual property in my project code.

In this I believe that I have satisfied all my specifications initially laid out in my brief.

## Time management: Term 1 and 2 - Keeping track

| | Term 1 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Week 10 | Week 11 | Week 12 | Term 1 Holidays |
| Monday | | | | | Writing of initial brief | Working on initial brief | Completed initial brief | Created a questionnaire to gather stakeholder feedback from class on design choices | Finishing writeup of refined brief | Started work on final brief | Final brief writeup | -Began working on some concept designs -met up again with client | Planning out concept designs and layouts |
| Tuesday | | | | | | | Started work on refined brief | Gathering of stakeholder feedback | | | | | |
| Wednesday | | | | First brief proposal due date | | | | | | Final brief writeup | | Finishing of final brief writeup | |
| Thursday | | | | -Began keeping a log book and keeping track of events -Initial consultation with stakeholder | | | Refined brief writeup | Met again with client, more discussions about specifications and details | | | | | |
| Friday | | | | -More detailed discussion with stakeholder | Initial Brief due date - Incomplete due to other school factors | | Refined brief due date - Incomplete due to late start on initial brief | Integrating specifications into brief | Completed refined brief | Final brief initial due date - pushed out to 15/04 due to the vast majority of class unfinished | Project management checkpoint 1 | Completed final brief | |
| Saturday | | | | -Started initial brief | | | | | | | | | |
| Sunday | | | | | | | | | | | | | |

| | Term 2 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Week 10 | Term 1 Holidays |
| Monday | Began work on conceptual design | Working on concepts research and writeup | Working on touching up/rewriting/fixing brief | Working on color schemes and design | Began working on final concept in WPF | Finishing aesthetics of final concept | Finishing concept design writeup | Finishing concept writup | Completed and handed in final concept designs | Researching and testing tools found online for prototype development | Away |
| Tuesday | | | | | Working on final concept | | | Began 3.4 Prototype development | Research for tools to use for prototype | | |
| Wednesday | | | Creating visual concepts and layout using concept tools | Gathering feedback on possible design choices using questionnaires and direct approach | | Gathering feedback on final concept | | | | | |
| Thursday | | | | | | | | Stakeholder suggested additions to the program, updated brief | | | |
| Friday | Concept design checkpoint 1 | Got feedback on brief | | Concept design checkpoint 2 | | Concept design writeup | | | | | |
| Saturday | | | | | | | | | | | |
| Sunday | | | | | | | | | | | |

| | Term 3 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Term 3 Holidays |
| Monday | Got feedback for concept writeup | Working on early stage coding for prototype | Found some things out that did not work, code quickly became to cluttered, decided to erase code and start again | Senior exams | Senior exams | Handed in updated concepts writeup | Coding prototype logic | Coding Prototype logic | Working on coding of user interface and drawing methods | Studying for other subjects, working on compiling writeups into scholarship report, writing and testing program - got the making of graphs and all the layout working |
| Tuesday | Fixing and rewriting portions of concept design | | | | | Coding prototype logic | | | | |
| Wednesday | | | Began prototype writeup | | | | Another client consultation | Received some feedback from stakeholders in writing code | | |
| Thursday | | | | | | | Coding Prototype logic | Integrating stakeholder feedback into program logic | | |
| Friday | Consulting with stakeholder on further proceeding with project | | Project management checkpoint 3 | | Coding Prototype logic | | -Project management checkpoint 4 -Prototype design checkpoint 1 | | | |
| Saturday | | | | | | | | | | |
| Sunday | | | | | | | | | | |

| | Term 4 | | | | |
|---|---|---|---|---|---|
| | Week 1 | Week 2 | Week 3 | Week 4 | |
| Monday | Client consultation, showing of program | Fixing design limitations, gathering final feedback and refining program efficiency and bug fixes for program | Handed in prototype writeup | Final touches on report and teacher feedback on report | Study leave for exams |
| Tuesday | Gathering stakeholder feedback from classmates | | Writing scholarship report and critically analysing the processes that I have undergone in this project | Scholarship report due date | |
| Wednesday | integrating feedback into project | | | Senior prizegiving | |
| Thursday | More speaking with client | Finishing off prototype writeup, reflecting on design principles | | Study leave for exams | |
| Friday | More speaking with client, got additional data sets to test program | | | | |
| Saturday | | | | | |
| Sunday | | | | | |

Time Management: Term 3 and 4 - Keeping track

# Reflection on Project

My usage of project management and keeping track has keep my critically away of what I must do at all times during the year, My project management tools include: Trello - a project management website, a logbook/doc which keeps track of the years activities and a projected timeline.
With the usage of Trello I was able to manage specific due dates and logging all my actions I was aware of how much extra work/behind I was on meeting deadlines/how far behind the projected schedule I was.

From looking at my projected and actual timelines, I can see that I was behind schedule in the end, whilst I began working on the prototype earlier than projected, the development process stretched on longer than projected and in the end the scholarship report was delayed and had to be rushed in the end. I feel that perhaps I wasted too much time initially developing and researching C# only to restart my project and ignore everything gained from this research.

In the end however I feel that I have learned much about programming, myself and the development process during the development of this project.
In programming the project, I have learnt many new C# and programming techniques such as Linq (Language Integrated Query), the usage of Dictionaries and the relation of C# to the wider Windows Interface.
In time project management and the writeup of the Brief, Conceptual Document and Prototype Writeup I have learnt more about the development process, whereby each step of development must be documented and planned out.

Overall, I am quite happy with my project as a whole and my client is satisfied with program making his life as Head of Faculty easier.