Team Profile

Team Name

Our team name is ***Memeiacs*** with the prefix “meme” that originally meant “an element of culture or system of behavior that is considered to be passed down from one individual to another”. Since the beginning of the 21st century, the word has adopted a new meaning to be “a humorous image, video, piece of text, etc. that is copied and spread rapidly by internet users” (Oxford Dictionary n.d.). Team members at Memeiacs are very up-to-date with newest memes and are always eager to lighten up stressful working hours for others. We are aware it will come to the attention of potential employers and we hope they can see our goofy, bright personality through the name.

Personal information

- ➔ **Project Leader:** My name is Mai Duc Minh and my student number is s3681447 and I am honored to be elected as the project leader. I have studied Software Engineering for 6 semesters in RMIT. I usually play video games and listen to music in my free time. Sports are not counted as hobbies for me because I play sports for physical and mental training. I have some IoT experience with Arduino and household networking. I am interested in Python and have a long term plan which aims at machine learning in the medical aspect.
- ➔ **Secretary:** My name is Vu Quoc Gia Quan, and I have the student ID s3927120. I am currently our team's secretary. I am an IT major, and this is my first semester at RMIT. My hobbies include creating small DIY projects, reading manga, researching random topics, and so on. I do not have much IT knowledge because this is my first time learning programming and IT.
- ➔ **Project Designer:** They call me Ethan and my full name is Dang Hoang Anh Khoa. My student ID is s3836606. I got the designer position for my team project and I’m happy with that although I'm the oldest member. In my leisure time, I like listening to music, playing video games and learning new things from Youtube or external sources are my hobbies. Especially coding something fun such as Microbit and websites. This is my second semester in this school so my academic knowledge is limited. I’ve experienced some interesting languages such as Python, Css, HTML and a bit about JavaScript.
- ➔ **Project Manager:** My name is Nguyen Thu Thuy, my student number is s3870273 and I am the project manager in the team. I am a Digital Marketing major and this is my fifth semester at RMIT. My hobbies include reading,

painting, and writing stories. I like coding although I am still in the learning stage but I am familiar with Python and a little bit of other coding languages.

Group processes

Our group worked and continues to work extremely well and efficiently together. Every member of the group is proactive in their work and meets the group deadlines on their part of the assignment. Every two weeks, we commence a meeting through calls to better understand each person’s process. Whenever one member is done with their section, they actively report back and propose the next part to work on. Aside from work-related topics, the group also shares aspects of their personal life to better understand the people they are working with. Especially, as memers, each takes turns to share memes relating to school and life which brings laughter and lightens up our mood. Furthermore, the leader encourages hard work by promising a group treat if our assignments are returned with 90+.

The project is an ever-evolving work, thus, there will always be improvement or changes. During meetings, we continuously challenge the previous designs and come up with new features to see whether it fits with the objective. At an early stage, the project will be kept simple and feasible. After the first steps are completed, we will be able to implement and introduce an updated design.

Career Plans

Each position has its own set of qualifications for applicants. Some will appear vague, while others, such as Thuy's ideal job, will contain a very specific description of what it will entail. Most other occupations require at least a few years of experience in the same function, or the experience of someone who has worked in that position for a long time. Every profession necessitates a thorough understanding of its respective fields, as well as specialization in what the job entails. All four of our positions offer reasonable compensation, provide adequate insurance, and, in certain cases, provide employees with a monthly stipend. All of the job postings promote a variety of recreational activities as well as a professional working environment.

Everyone is qualified for occupations based on their present skills and abilities, as well as their hobbies. Khoa prefers to work for a company that encourages them to promote themselves through online methods in order to maximize their profits. This is most likely related to his interest in and anticipation of the online working environment. Thuy's job path differs from ours in that she works in marketing. This is most likely due to her preference for working with others rather than doing desk work such as IT. She may just enjoy interacting with others. Minh 's career path is currently unclear because he happened to stumble across his choice of job by pure chance. I believe he is more than capable, but he may choose jobs that require electrical engineering because he enjoys spending time researching circuitry. Finally, unlike my

teammates, my career path is not as clear as theirs. I know that I enjoy working with AI and solving problems with logic, but the only career that comes to me right now is that of an AI engineer. So, if other options become available in the future, I may reconsider my decision.

As previously stated, everyone has different plans and goals for their profession. And, because everyone's work is unique, so is everyone's career path. There isn't much we have in common. Khoa and Thuy appear to have made up their minds about what they want to do in the future.But I and Minh are still undecided about our options. My plan is still in the works, so there isn't much to discuss or compare to other people's plans.

Minh's job allows him to work from home and offers him free in-house entertainment and food. Khoa's profession allows him to work on-site abroad, allowing him to gather valuable experience that will serve him well in the future. Thuy's job is likely to be the most difficult of all of our teams' ideal occupations. Her job necessitates a slew of criteria just to receive an interview and a shot at the job. Based on the job description and requirements, Quan's job appears to be fairly simple, but whether this is true or not is questionable.

Quan, Minh, and Khoa are all likely to be junior engineers; however, Thuy's position is likely to be higher, such as senior engineer or technical lead. Because we all work in diverse fields of information technology, our professional trajectories will undoubtedly diverge. To satisfy our demands and earn the relevant certification for the position, we will have many self-development strategies in place.

Tools

This link takes you to our group's published webpage.

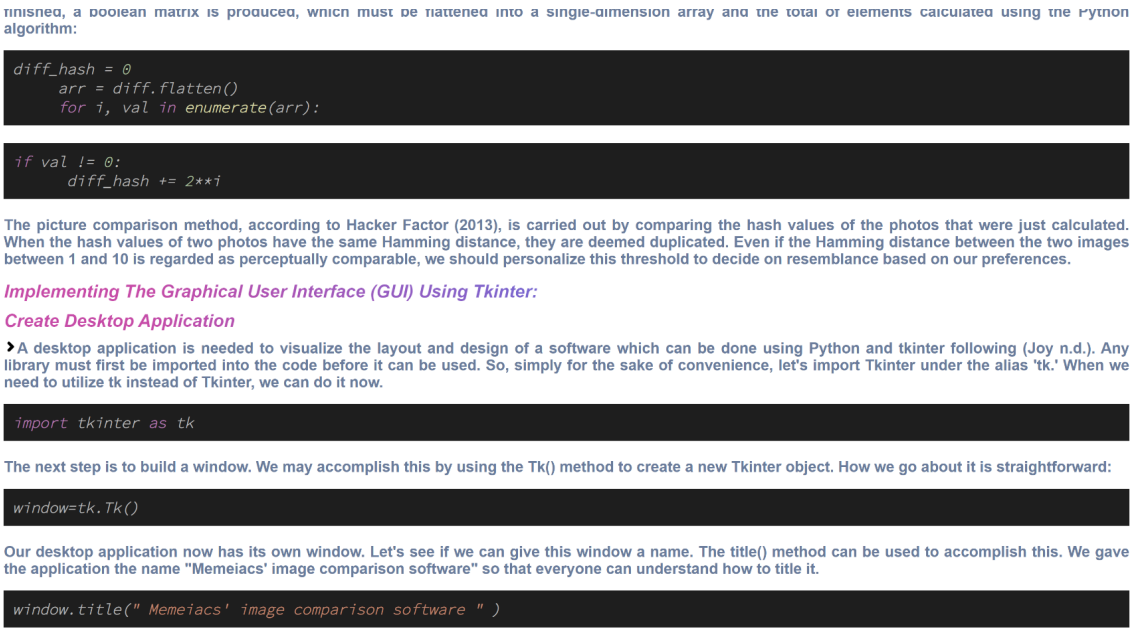
Our team's website is a condensed version of the report, but it still has all of the necessary information. As we show you on our website, the homepage includes a navigation bar containing the group's self-designed Mememiacs logo; a Drop down menu to choose how to display information about each group member; the center shows the Project section which leads to the most dedicated part from our team - details about the idea of creating an image comparison tool; the other sections contain the content of IT Work and IT Technologies sections; on the left sill is the content of IT Work and IT Technologies sections. We also added more information about what Assignment 3 requires such as Group Processes, Career Plan, Group Reflection into project sections to make this website fully finished.

The homepage's material includes the definition of the group's name as well as its slogan. The Git repository containing the website's content may be accessed by clicking on the picture positioning on the left of the motto.

As of assignment 2, the navigation bar is always on top when traveling to another page of the website to make it easier for the user to move between pages and totally return to the homepage by clicking on the Mememiacs logo on the left of the navigation bar.

Under terms of the content of the pages in each member's Profile tab, it shows the member's function in the group as well as individual information from Assignment 1 about interests, test results from online tests, and claims about its correctness.

About project ideas, this page shows deeply additional information that our team tried to make this project become reality by algorithms and formulas throughout the python language.


finished, a boolean matrix is produced, which must be flattened into a single-dimension array and the total of elements calculated using the Python algorithm:

```
diff_hash = 0
    arr = diff.flatten()
    for i, val in enumerate(arr):
```

```
if val != 0:
     diff_hash += 2**i
```

The picture comparison method, according to Hacker Factor (2013), is carried out by comparing the hash values of the photos that were just calculated. When the hash values of two photos have the same Hamming distance, they are deemed duplicated. Even if the Hamming distance between the two images between 1 and 10 is regarded as perceptually comparable, we should personalize this threshold to decide on resemblance based on our preferences.

Implementing The Graphical User Interface (GUI) Using Tkinter:

Create Desktop Application

A desktop application is needed to visualize the layout and design of a software which can be done using Python and tkinter following (Joy n.d.). Any library must first be imported into the code before it can be used. So, simply for the sake of convenience, let's import Tkinter under the alias 'tk.' When we need to utilize tk instead of Tkinter, we can do it now.

```
import tkinter as tk
```

The next step is to build a window. We may accomplish this by using the Tk() method to create a new Tkinter object. How we go about it is straightforward:

```
window=tk.Tk()
```

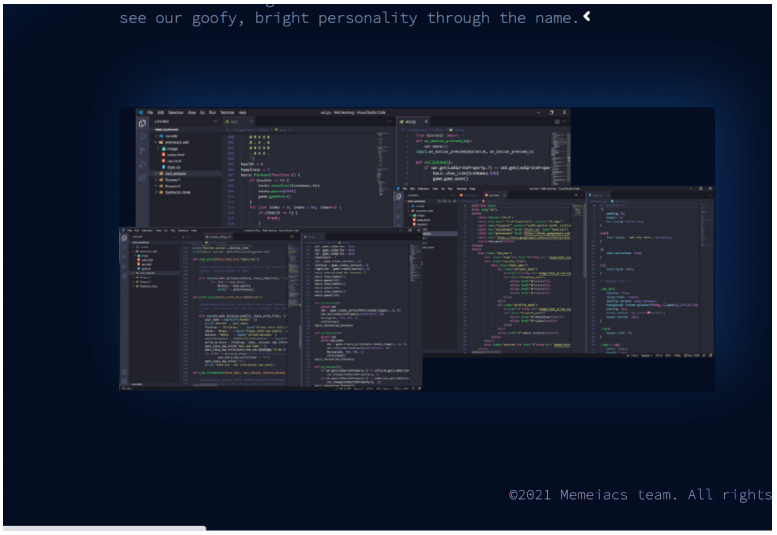
Our desktop application now has its own window. Let's see if we can give this window a name. The title() method can be used to accomplish this. We gave the application the name "Memeiacs' image comparison software" so that everyone can understand how to title it.

```
window.title(" Memeiacs' image comparison software " )
```

Image of some algorithms

This link will take you to the Git repository for Assignment 3's contents.

While the team was working on Assignment 3, extra content was stored in this repository. Every meeting includes a Meeting Minutes folder that contains all of the information of what the team has discussed or reported progress on assigned tasks. Furthermore, there is an Asm3 Mock Views folder that contains all of the mock design of the project idea's user interface in both PNG and PDF format. Additionally, we recorded a video as well as created a demo.txt that contains a link to our video for demo how to run those Python code.



Another way that you can access our repository is clicking this image on our website.

This link will take you to the Git repository for our group's website.

The GitHub demonstrates how the team worked collaboratively to create the website. As you can see, just two persons are responsible for all of the labor, although every member has actively contributed to the website design. First and foremost, our team's working procedures must be explained in order to minimize misunderstandings. Before beginning cooperation, the entire group met and decided that each member would be accountable for a different aspect of the project. To put it another way, each member serves as both a follower and a leader to guide the others.

To finish the personal part, each member must prepare their own personal details as soon as feasible. The website will be designed by the project designer, while the project manager and secretary will be in charge of the exterior portions. As a result, project ideas will be the responsibility of the group leader. The person in charge's job is to learn and lead the remaining members in completing the portion they've been given. Returning to everyone's participation to the website, the project manager and secretary are the main contributors to the content, followed by the project designer, who develops the website according to the team's agreed-upon design and has also contributed directly to the Git repository. Furthermore, in the final two weeks before submitting, the project leader assisted in the support and correction of the website's flaws, as well as the finalization and publication of the website. Therefore, the collaboration was harmonious.

Project Description

Overview

Topic

Memeiacs' Image Comparison Tool is a newly developed project, with first steps planned out and soon to be implemented. This project targets anyone able to take photos and have trouble organizing their photos.

Since the birth of cameras, and more importantly, affordable cameras, humanity is able to capture unlimited shots of their surroundings, memories, and time. With built-in cameras on smartphones, photo-taking is becoming a part of life, not just a luxury which was only possible at photography stores before. With such progression, less thought is put into taking the perfect shot at once, leading to an overwhelming pile of unorganized photos that would be time-consuming to manually sort. By continuously clicking the photo-taking button, people are left with a lot of similar photos only seconds apart from each other.

In this project, our Image Comparison Tool would work as a photo sorting program for easier access to groups of similar photos which leads to an easier process of choosing the best one.

Motivation

The project began with our leader sending a proposal, or rather a pitch, to the whole team, asking for opinions. He hooked each member into becoming a part of the early-stage development team by expressing his love for photography and proposing a way to solve some common issues faced in this hobby, which have been elaborated above. This project is interesting because it is so relevant to everyday life, and saves a large sum of time. Current IT trends point to solving specific problems that would benefit society as a whole, whether it's to further push humanity into a digitized world or to improve quality of life, and our motivation is consistent with the latter. To a future employer, this project shows that we are detailed, diligent, patient and especially, efficient.

Landscape

The market for image comparison tools is large but there are not a lot of providers. A similar system currently available is Bolide Software Image Comparer. This tool belongs to Bolide Software, which offers other types of programs such as duplicate video search and track books and movies, etc. The Image Comparer is only one of them which offers users ease in finding duplicate images and with one button, delete all of the duplicates. With extra steps, it is also possible to specify which images to keep, manage, or delete. The pricing for this tool is $34.95 and it is only supported on

Windows. The difference between other systems on the market and our Image Comparison Tool is the range of device compatibility from IOS - Android apps to Linux, Mac, and Windows.

Detailed Description

Aims

Our team's goal for the project is to use Python to construct an image comparison tool that will help us review photos. To accomplish this, the application must first be able to compare photos and identify those with comparable features using automatic comparison. This is made feasible by the code of the project, which will be demonstrated below.

Our team had designed a graphical user interface (GUI) from the ground up to enhance the program's usability. This is done to help the user visualize what is going on and to make it easier to use than CLI. This is arguably the most noticeable feature.

There is also a collection feature that allows us to create and delete collections. This will allow us to modify a collection on the fly. When we select a file, the application displays all of the photographs contained within it. We can then add the photos to a collection after comparing them. This will allow us to better organize our work, making it more efficient.

We have manual comparison in addition to automatic comparison. This will allow us to more precisely choose and make modifications based on our preferences. Our leader has also come up with a number of functions and features to assist us in manually comparing images and selecting the one that best meets our requirements.

Plans and Progress

1. **Planning System**

Image Comparison Process:

The software should read two directories: one from the "selected" image (the one we want to identify other images that are similar to), and the other from the image gallery (each image in the gallery is labeled "candidate"). The time it takes for the software to provide a list of perceptually comparable photographs in the gallery depends on the speed of our computers, but it should only take a few minutes (1 or 2 minutes) so that we can begin the manual evaluation.

The Difference Hashing technique is at the heart of our picture comparison program, and the principle of the process may be read here (Rosebrock 2017).Using the Difference Hashing algorithm, the two input photos (the "selected" and "candidate") are hashed into a string of values depending on their visual appearance. When two

images have "similar" hash values, they are classified as duplicated or perceptually similar. "Similar" hashes are precisely the same or within a given Hamming Distance range (Coskun, et al. 2007).

The Difference Hashing Procedure is Broken Down into 4 Steps:

Step 1: Blurring the Image

Firstly, the image is blurred using the Average Blurring approach from (Coskun, et al. 2006). Due to the influence of nearby pixels, the difference between the corresponding pixels of the "selected" and "candidate" should be as little as possible. To calculate the mean values with the central pixel, the neighboring pixels are taken into the filter. The average value replaces the current value of the center pixel after the mean value is calculated. This method has been run for all of the pixels, indicating that the image has been blurred.

Step 2: Converting the colored image into Grayscale

Python supports the OpenCV Library, which may be found from Hacker Factor (2021). The cv2.imread() method converts the input colored image to grayscale. Every pixel's three-channel colors are transformed to a single gray channel when it is converted to grayscale. As a result, the hashing process is faster, and the comparison process benefits since minor differences in color hues are ignored, and the photos are compared only on the basis of comparable patterns.

Step 3: Resizing the image

After the image has been converted to a single grayscale color, it must be rescaled to exactly 8 * 9 pixels, regardless of the image's original resolution. To begin, scaling the photographs makes those of various sizes become the same size, making it easy to compare patterns. Second, we want to construct a 64-bit hashcode for each image so that we can compare them. Because 8 * 8 = 64 bits, we must scale to an 8*9-dimension because we will have 8 differences if we compare each of the 8 pixels in one column with the neighboring pixels in that row (total of 9 pixels in a row) (the comparison is executed with 2 different pixels, a pixel cannot compare to itself). Therefore, 8 column * 8 differences = 64-bit hashcode.

Step 4: Hashcode difference computation

Each pixel in an image is compared to the neighboring pixels in this process, and True is returned if the concurrent pixel has a higher value than the following pixel. If the concurrent pixel has a smaller value than the succeeding pixel, however, the output will return False. When the pixel comparison is finished, a boolean matrix is produced, which must be flattened into a single-dimension array and the total of elements calculated using the Python algorithm:

```
diff_hash = 0
```

```
    arr = diff.flatten()
    for i, val in enumerate(arr):
        if val != 0:
            diff_hash += 2**i
```

The picture comparison method, according to Hacker Factor (2013), is carried out by comparing the hash values of the photos that were just calculated. When the hash values of two photos have the same Hamming distance, they are deemed duplicated. Even if the Hamming distance between the two images between 1 and 10 is regarded as perceptually comparable, we should personalize this threshold to decide on resemblance based on our preferences.

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import tkinter as tk
```

The next step is to build a window. We may accomplish this by using the Tk() method to create a new Tkinter object. How we go about it is straightforward:

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Our desktop application now has its own window. Let's see if we can give this window a name. The title() method can be used to accomplish this. We gave the application the name "Memeiacs' image comparison software" so that everyone can understand how to title it.

```
window.title(" Memeiacs' image comparison software ")
```

Let's define the app window's geometry for now. This refers to the width and height of the space. We can use the geometry() method to accomplish this. Let's say the width is 800 pixels and the height is 600 pixels.

```
window.geometry("600x800")
```

The window is now ready. For testing, let's print something on this window. We'll be shamelessly promoting our project once more. As a result, we will say, " Trust and use our image comparison tool, you will not regret seeing how it can wind up your image review day". tkinter's Label() method can be used to add text. The 'text' option should be filled with the string you want to display. We put everything into a variable called "newlabel".

```
newlabel = tk.Label(text = " Trust and use our image comparison tool,
you will not regret seeing how it can wind up your image review day ")
```

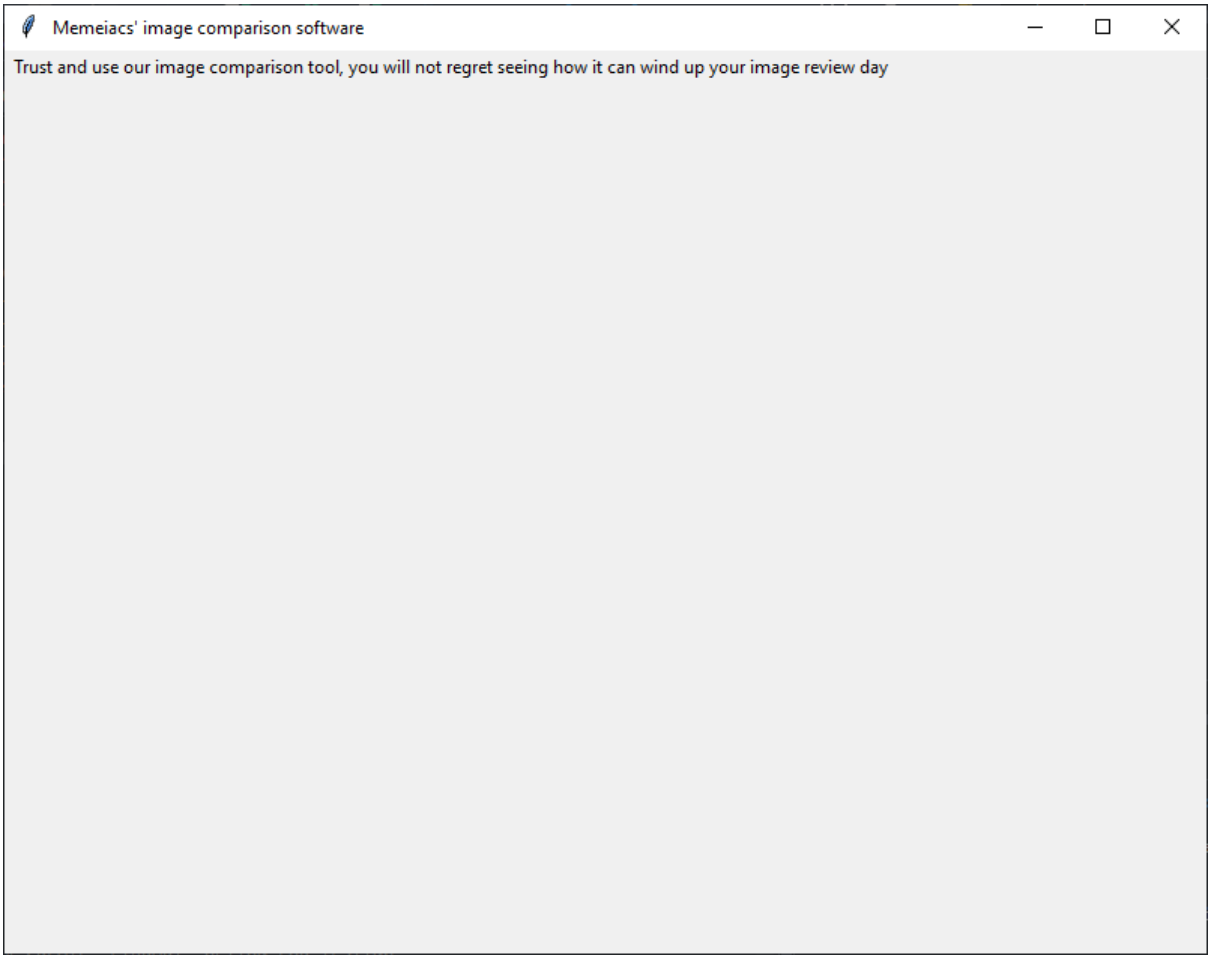
Let's put this label on a grid now. Multiple grids are used to split the tkinter window. Let's put it in the top-left corner of the grid (0,0).

```
newlabel.grid(column=0,row=0)
```

Almost everything has been completed. Finally, we must call the mainloop() method before running any tkinter program. It's the same as calling the main() program if you're familiar with the C programming language. Everything we've written above is executed by this main program. Let's call this loop the mainloop().

```
window.mainloop()
```

Our teeny-tiny desktop application is up and running. Let's put the software to the test in the Spyder IDE.



Create menu bar

The tkinter Menu bar is used to offer menu items that can provide additional functionality to an application, which is quite prevalent in software and applications following (here). Any library must first be imported into the code before it can be used. So, simply for the sake of convenience, let's import Tkinter under the alias 'tk.' When we need to utilize tk instead of Tkinter, we can do it now. Then, we import the ‘messagebox’ module from tkinter.

```
import tkinter as tk
from tkinter import *
from tkinter import messagebox
```

Instantiate the menu bar object using the following code:

```
menubar = Menu(window)
```

We start to create the options sequentially such as File, Edit, Library, Tool, View on the menu bar using this code:

```
file = Menu(menubar, tearoff=1)
edit = Menu(menubar, tearoff=0)
library = Menu(menubar, tearoff=0)
tool = Menu(menubar, tearoff=0)
view = Menu(menubar, tearoff=0)
```

We can think of adding the functionalities in each option later but let's having some selections in the 'File':

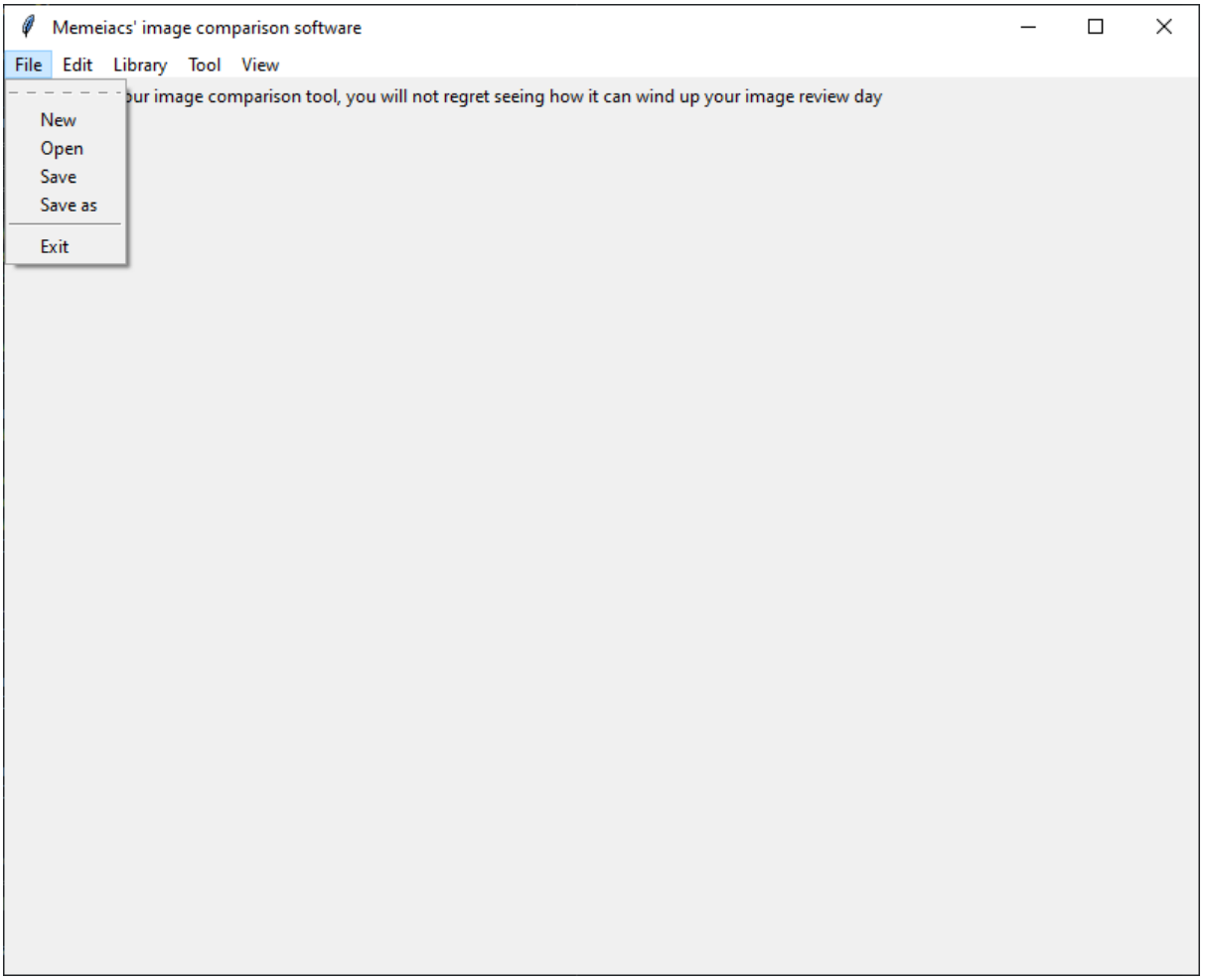
```
file.add_command(label="New")
file.add_command(label="Open")
file.add_command(label="Save")
file.add_command(label="Save as")
file.add_command(label="Exit", command=window.quit)
menubar.add_cascade(label="File", menu=file)
```

Further functionalities will be researched later but we firstly focusing on displaying the interface and only concern the functional Exit option that can properly work

To get the menu bar displaying up and running, we config the menu with the window.config() method and call mainloop():

```
window.config(menu=menubar)
window.mainloop()
```

Our teeny-tiny desktop application is up and running with the menu bar displayed. Let's put the software to the test in the Spyder IDE.



Create comboboxes

A combobox is a widget that combines an Entry and a Listbox widget. A combobox widget lets you pick one value from a list of options. It also allows you to specify a custom value. Further implementation to get the actual values in the hard drive of computer and display on the software will be later discussed when the project has been funded and given more time; Therefore, we will focus on how to create a combobox with predefined values following the tutorial from (here). Any library must first be imported into the code before it can be used. So, simply for the sake of convenience, let's import Tkinter under the alias 'tk.' When we need to utilize Tkinter, we can go ‘tk’ instead. Please note that we need to further import the ‘ttk’ widget from the ‘tkinter’ library and it is different from the alias ‘tk’ we use above. Moreover, we need to import the showinfo() method from the messagebox extension.

```
import tkinter as tk

from tkinter import ttk

from tkinter.messagebox import showinfo
```

The ttk.Combobox() constructor is used to create a combobox widget. The code below generates a combobox widget and associates it with a string variable:

```
current_var = tk.StringVar()
combobox = ttk.combobox(container, textvariable=current_var)
```

The container is the window or frame on which the combobox widget will be shown. The textvariable argument connects a variable current var to the combobox's current value. You can use the current var variable to get the presently selected value:

```
current_value = current_var.get()
```

Instead, you can utilize the combobox object's get() method:

```
current_value = combobox.get()
```

The 'current var' variable or the set() method of the combobox object are used to set the current value:

```
current_value.set(new_value)
combobox.set(new_value)
```

The 'values' property of the combobox allows you to assign a list of values to it, as shown below:

```
combobox['values'] = ('value1', 'value2', 'value3')
```

You can input a custom value in the combobox by default. Set the state option to 'readonly' if you do not want to, following this code:

```
combobox['state'] = 'readonly'
```

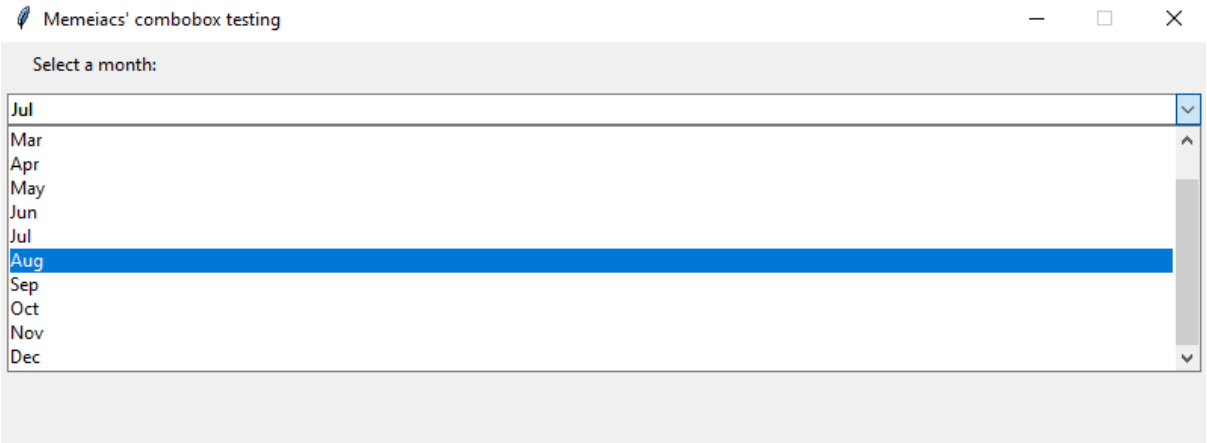
OR if you want to re-enable editing the combobox, set this:

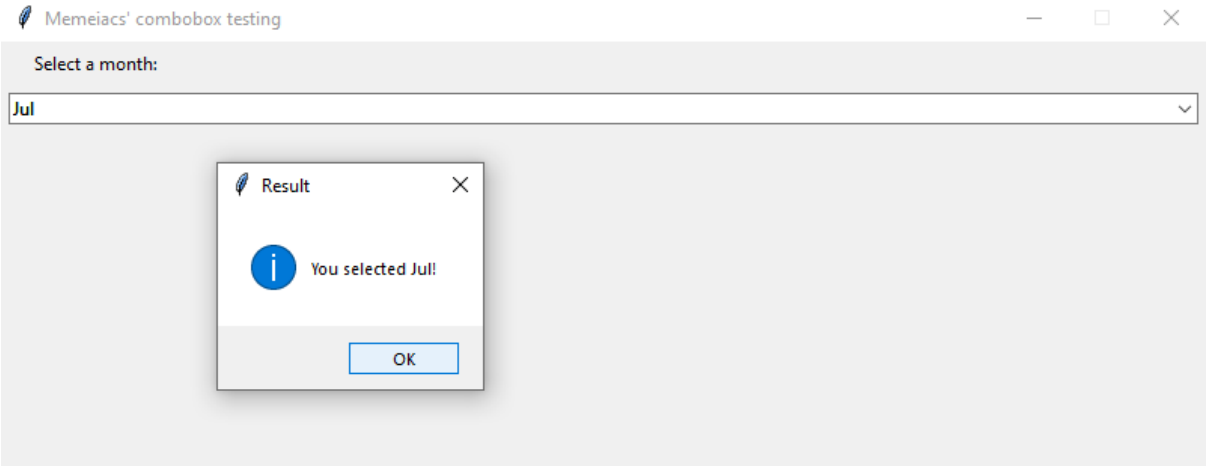
```
combobox['state'] = 'normal'
```

The combobox widget generates a 'ComboboxSelected>>' virtual event when a select value changes. You can use the bind() method to handle the event as follows:

```
combobox.bind('<<ComboboxSelected>>', callback)
```

Which ‘callback’ here is the function that will execute when the selected value of the combobox changes.





View list of images

When it comes to a Graphical User Interface (GUI) program, the image(s) are quite important. The PhotoImage class is used in the tkinter package, which is available at (here), to display photos in labels, buttons, canvases, and text widgets, from the application icon to animation.

Using the PhotoImage() function to return an image object is all it takes to display an image in Python. However, the PhotoImage class only supports GIF and PGM/PPM formats, which is a concern. JPEG/JPG and PNG are the most widely used formats. ImageTk and Image classes from the PIL(Photo Image Library) package are required to open and display those formats. We can load photos in over 30 formats and transform them to image objects using PIL (Photo Imaging Library), including base64-encoded GIF files from strings.

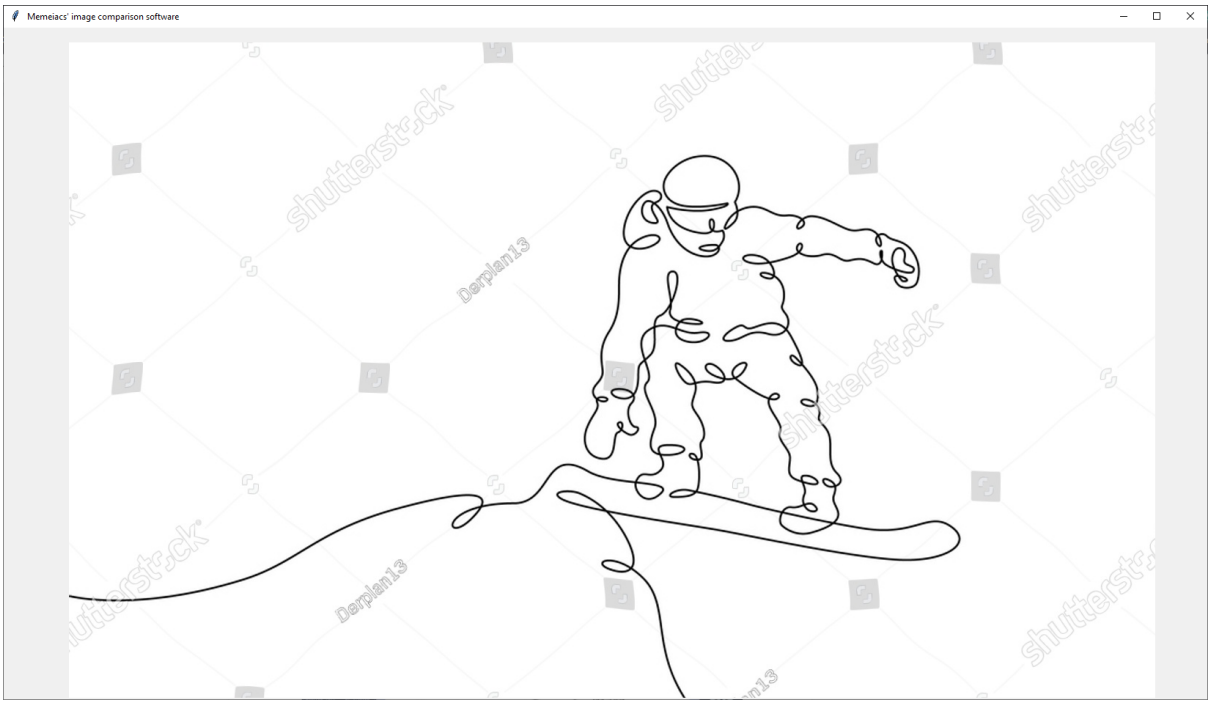
```
canvas = Canvas(window, width = 1500, height = 1600)
canvas.pack()

img = ImageTk.PhotoImage(Image.open
    ("snow3.jpg"))  # Paste in the directory,
  # example: C:/Users/MDM/Downloads/collection/snow3.jpg

canvas.create_image(20, 20, anchor=NW, image=img)
window.mainloop()
```

The Image class contains an attribute "open()" that will open image formats that are not natively supported, and we can use it with "ImageTk.PhotoImage()" to return and use the image object.

If we want to display an image inside a function, make sure to keep track of it in your Python program by putting it in a global variable or attaching it to another object.



Mock views of the software's GUI:

Homepage view

The software's layout will be designed as shown in the mock view above in order to give a user-friendly interface for the following features:

➔ In a scrolling list view, show a list of images.

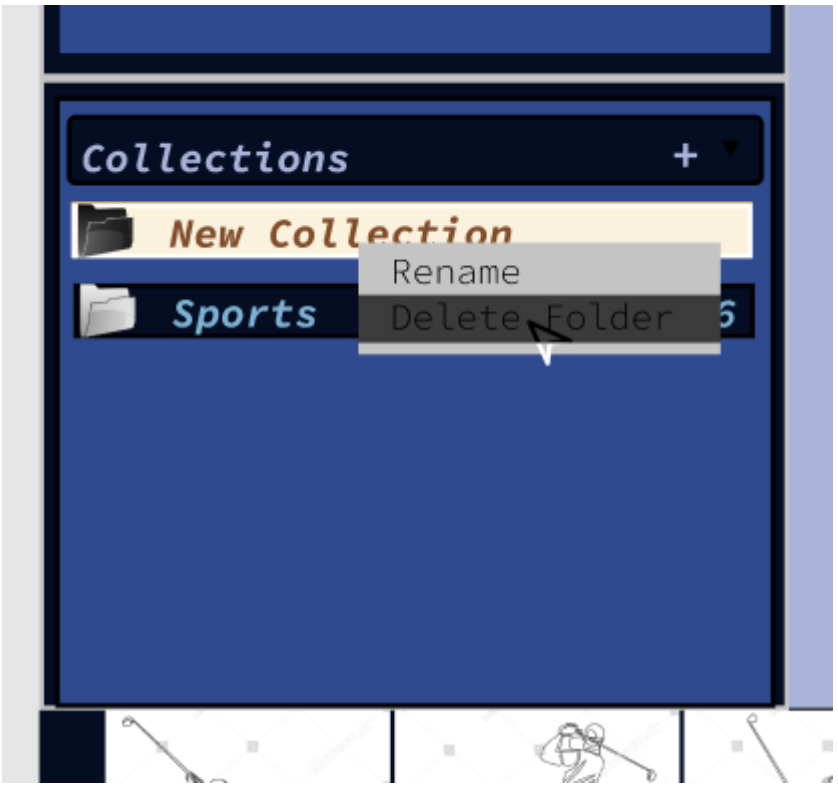
After we choose a folder, all of the images inside that folder will be displayed in the list view at the bottom of the software, and they can be scrolled using the backward and forward arrows or use the scrolling wheel of your mouse to scroll through them.

➔ To create/delete a collection, follow these steps:

To make a new collection, go to the lower left side of the screen and click the "+" icon in the Collection frame to make a new one, then rename it by left-clicking on the "New Collection" default name.

Create a new collection

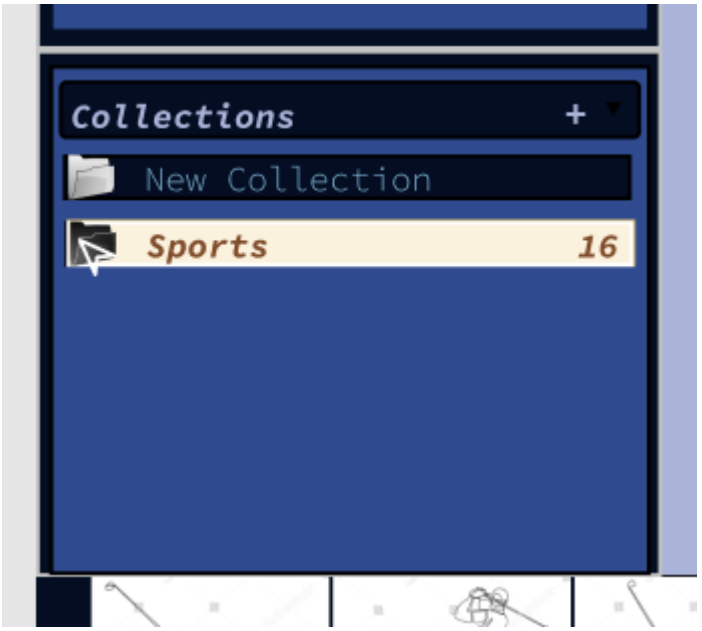
To delete a collection, go to the lower left side of the screen, to the Collection frame, then right-click on the collection you wish to delete, then select “Delete Collection”.



Delete a collection

➔ Choose an existing collection

To select an existing collection, go to the Collection frame and use your cursor to left-click on the collection you wish to select.



Choose an existing collection

➔ Right-click on numerous images then select an option (the options provided are: duplicate, delete, rename, view resolution, compare with current "selected" image).

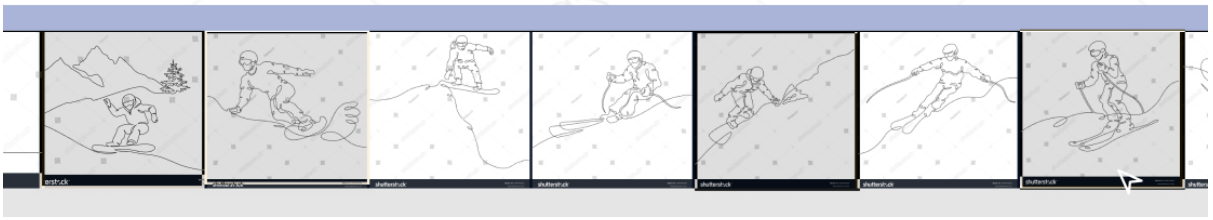
There are two possibilities for selecting numerous images:

+ To choose continuous photos, first click on the beginning image, then hold down the "Shift" key while clicking on the destination image in the image scroll list.

Multiple and continuous images selected in List view

+ Holding the "Ctrl" key on the keyboard and clicking on the images you want to pick on the image scroll list will select several but not continuous images.

We may duplicate, remove, rename, view resolution, and compare with the current "chosen" image by right-clicking on the selected images.



Multiple but not continuous images selected in List view

➔ To add files and folders to the collection, drag and drop them.

Choose a "selected" image by navigating to the image list at the bottom of the interface, then selecting, dragging, and dropping the image into the Navigator frame on the upper left with the mouse. The image displayed in the frame is now the current "chosen" image, as we can see.

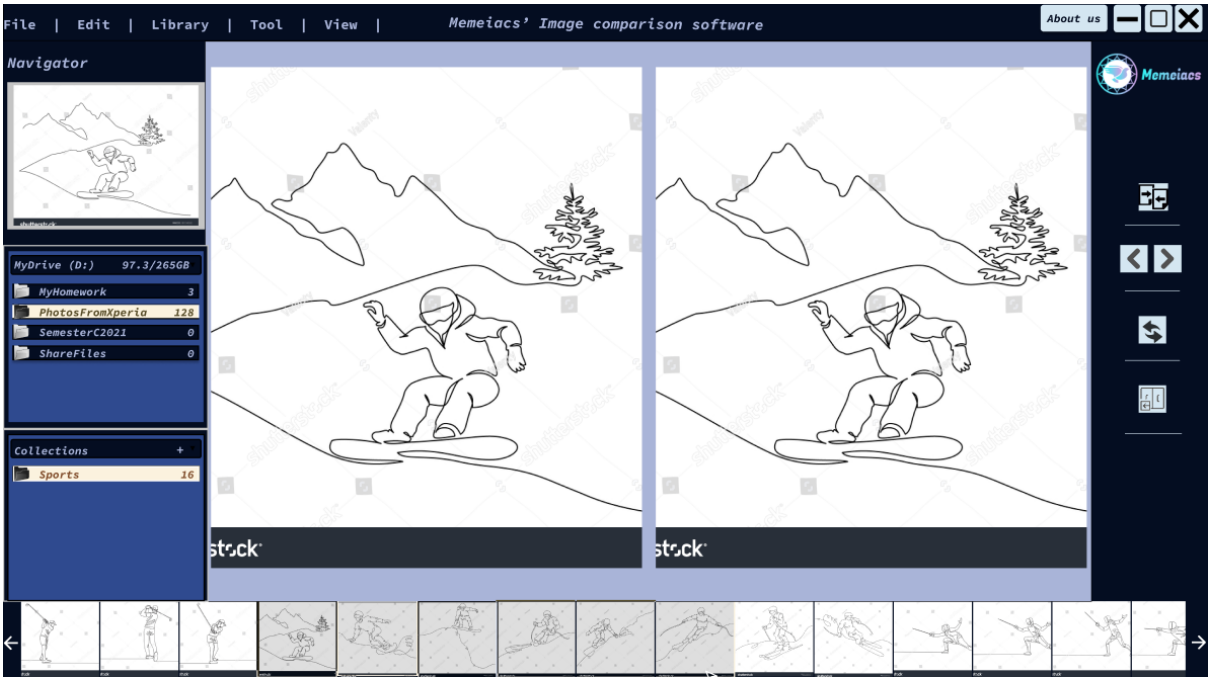
➔ Activate automatic comparison

To compare with images in the currently selected folder, go to the Navigator frame, right-click on the "selected" image, and select "Compare with images in the currently selected folder." The similar photos will be presented on the list view at the bottom of the interface once the comparison is complete.

Activate automatic comparison

➔ Activate manual comparison (Show “selected” and “candidate” next to each other)

After automatic image comparison, manual image comparison is usually performed so that users can select the best photographs from the group depending on their preferences by clicking on the  icon located on the right side. The "selected" image and the "candidate" image will be displayed side by side when manual comparison is enabled.

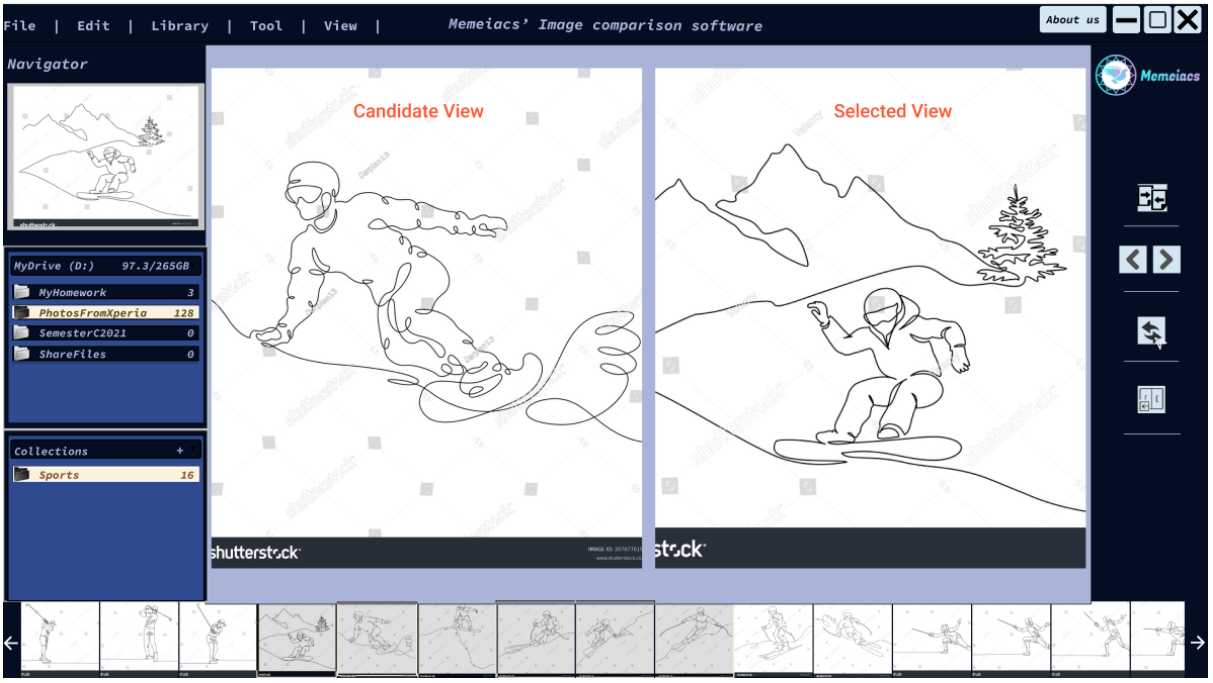


Activate manual comparison

Functionalities provided in manual comparison

➔ Using the arrow icons to navigate through the "candidate" images: 

➔ By clicking on the  icon, you can change the view side of the "chosen" and "candidate" images. The "selected" image is displayed on the left side by default.



Swap "candidate" and "selected" view side

➔ By clicking on the  icon on the right side, you can replace the "selected" image with the current "candidate" image. When the user finds a "candidate" that is better than the "selected," the user replaces the "selected" with the "candidate" and continues looking for a better "candidate". May not worry because this feature does not delete any of your original images.

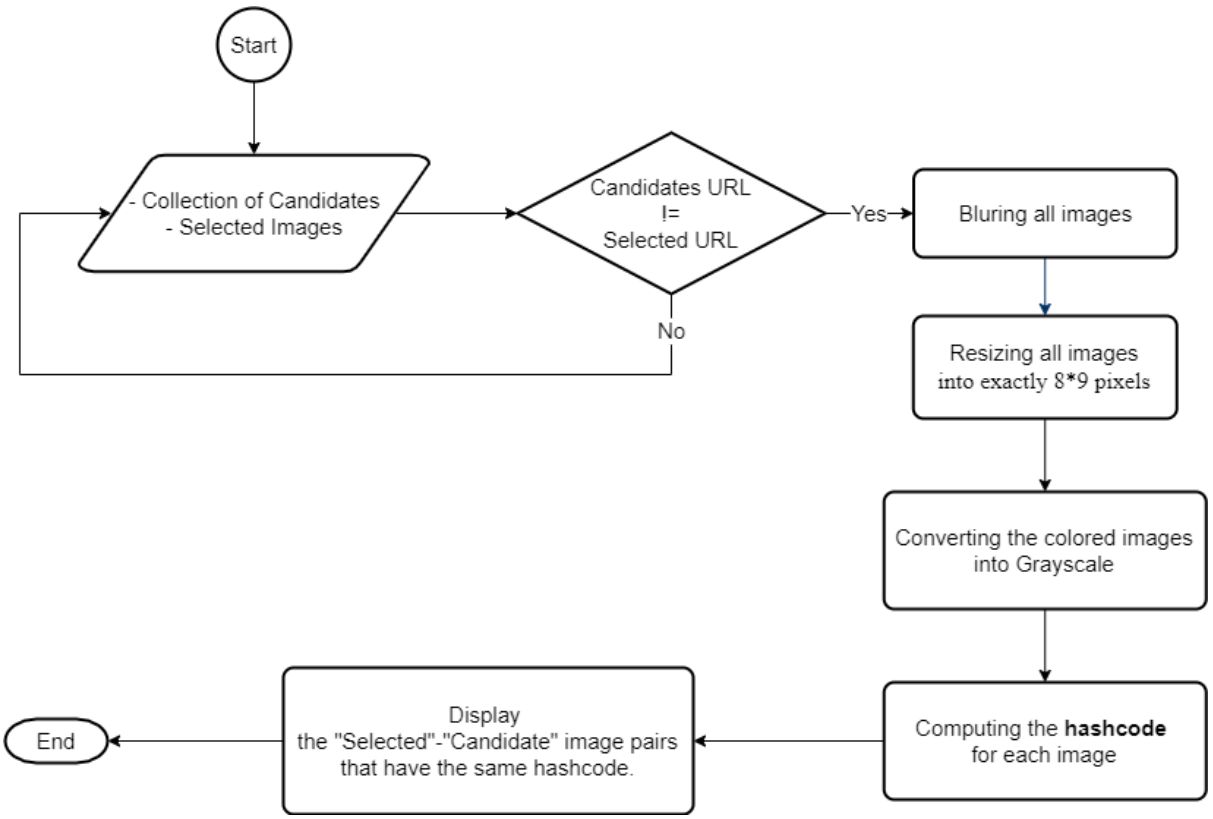
2. Working Progress

The project idea has come in firstly before the team was fully formed together as this is the idea of the project leader. Since there were only 3 people in the team, we have discussed to choose between developing a chatbot and different training programs that fits the scenario of each company and industry, an application that can connect multiple sale channels for easy management or an image comparison tool that can find not only the duplicated photos but also the perceptual similar ones. After several days of discussion, the team finalised the project idea with the image comparison tool due to its not only being an amazing, feasible idea but also the team can make use of the product to benefit personal needs. Feasibility was measured by how well each member of the team prepared the content, techniques and project scope evaluation that can fit in the timeframe of the project. Even though at the end of the course, the project might not be completed but the product can be used for demonstration and meets the personal needs of the team members.

The image comparison software's scope started with only implementing the Difference Hash algorithm into the image comparison process. The proposed idea

was initially rejected due to the fact that the scope was not large enough for an approximate project lifecycle of 3 to 4 months after the first assignment. At that time, a meeting was held for the team to redecide to keep following the current idea or not. It was a hard time for the team leader to defend his proposal of continuing with the idea. Even though it is the project leader's idea, all members understand his desire to support him in enlarging the project scope as well as reviewing the timeframe. It took a few days for the team to find the feasibility in the image comparison project idea again since the scope has been broadened with more features and more stuff to catch the attention of the audience on demonstration day. We tend to add a user interface so that users can interact with our software in a more friendly way, if not people need to learn using the software on Terminal. We also implement manual comparison mode for the user to choose their favourite images on preference. The manual is not a difficult feature to be implemented but it appears to meet the slight demand of our user to be independent of the technology when selecting their favourite moment.

So far, there has been only one month to demonstrate the project to the audience. Due to time constraints, we can only finish constructing the image comparison algorithm - the heart of the software - which can be broken down into a few step using the flowchart below:



Roles

Since our team had already decided on team roles for assignment 2, we would use the same ones for assignment 3. The positions are: project leader, project designer, project manager, and secretary. Each job plays a critical role in the team project. We make certain that everyone has a role in order for everyone to contribute to the team.

Minh is the project manager. He is in charge of the project's conception and execution. He has been at the center of the project's development since its inception. He is in charge of the picture recognition tool's major features and basic logic. He is also the one who writes the report portion of the project proposal for assignment 2.

Thuy is the project manager for our team. She is in charge of reviewing and ensuring that everything in the team's report is up to quality. She also conducts research with the secretary in order to complete everything required for the project report. She will also ensure that the squad stays on track.

Khoa is our project designer. He is in charge of the team website as well as the team GitHub page. He created the website from the ground up and worked with his team to ensure that it was presentable. He also ensures that everything is in order and well organized. His most significant contributions to the team are the building of the team website and managing of the team's GitHub page.

Finally, Quan is our secretary. He does not have a definite duty to fulfill, yet he assists everyone in their work. He makes an effort to assist everyone with their tasks in order to lessen everyone's workload while also reminding everyone of the team's progress. The majority of the time, he does research and writes the team report. His most important contribution is probably the interview of an IT professional.

Scope and Limits

In this part we are going to define clearly what we are going to do, which functionality can be extended if the development is ahead of the project schedule and which cannot. The scope needs to be defined as clearly as we can in order not to have any issue with the stakeholders/clients during the development and the team can focus fully on what has been planned so far.

User Interface of the software will include some fundamental functionalities:

+ Minimize, maximize, close button located on the upper right corner, following the general convention of application.
+ Menu bar containing the following commands: File, Edit, Library, Tool, View.
+ The Navigator Frame displays the “Selected” image that can be activated in the automatic comparison mode to search for duplicated and perceptually similar images.

+ The Folder Frame displays the default hard drive where the software is installed. It scans for the folders and displays the number of images currently in those folders.
+ Under the Folder Frame is the Collection Frame which displays any collection created by the users, by default, the frame will be left blank because there is no collection yet. The collections can be renamed or deleted by right clicking to choose either the options.
+ At the bottom of the interface displaying a list of “Candidates”. By default, before activating the “automatic comparison” mode, the view will list out all images in the current collection. If there is no image in the current collection or no similar image is found after comparison, the list will be left blanked. In case the images are listed in the list after the “automatic comparison” process is finished, users can select multiple of those images either continuously or discontinuously for “manual comparison” mode. Moreover, the list of images can be scrolled forward and backward by navigating the mouse to the list and scrolling the middle mouse. Please note that currently we do not implement the feature of removing those images out of the list. In order to remove the image out of the list, you need to navigate the image in its original storage and delete it because users may remove those images unintentionally and leave unwanted redundant files in their computer.

Automatic comparison mode will function exactly what we are going to list out below:

+ The inputs of the algorithm includes 2 directories: One is for the “Selected” image and the other is for the “Candidate” collection. In order to input multiple “Selected” images, those images must be stored in a folder and the directory of that folder is inputted to the algorithm.
+ During the comparison process, the images are hashed and compared to identify which are the similar images. Currently, the software does not identify which image has been hashed previously. Therefore, based on the number of the “Candidates”, the comparison process might take time because all images are hashed again.

Manual comparison mode will function exactly what we are going to list out below:

+ Click on the  button on the right side of the UI to activate “manual comparison” mode. When the mode is activated, the “Selected” view and the “Candidate” view will display side by side.
+ A list of “Candidates” images can be swiped backward or forward using the arrow buttons  while the “Selected” view remains the same image for the user to compare.

+ By default, when the “manual comparison” mode is activated, the “Selected” view will display on the left side and the “Candidate” view will display on the right side. By clicking on  button, the “Selected” view and the “Candidate” view will swap their position, which means if the “Selected” view previously stays on the left side, it will now stay on the right side and vice versa, same principle applies to “Candidate” view.

+ By clicking the  button, the current “Selected” image will be assigned with the current “Candidate” image. If only the user browses to the next “Candidate” image, the “Selected” view and “Candidate” view will have the same image.

Tools and Technologies

Python: a computer language that is extremely popular right now due to its ease of use when compared to other programming languages. Many typical activities, such as reading a website, processing text or data formats like JSON, or crunching statistics, need less lines of code with Python. Python is also powerful enough to be used to construct enterprise-grade software. Companies like Pinterest, Dropbox, and Quora use Python to build their offerings and handle automation. Installing Python on your PC is simple thanks to the instructions provided in this link.

- *Experience:* Our team has agreed to build the software using Python because we all have some experience in this programming language. Specifically, our project leader is a Software Engineering student who has more than 2 years of programming and he has just learned Python in the previous semester; although our project designer and secretary are quite new to university but both has been learning Python continuously for a few months; Lastly, our project manager seems to be a highlight of the team as she has learnt Python since high school and built some personal projects such as visual novel, game of numbers, killer 13 card game. Throughout the project lifecycle, the team has supported each other efficiently during debug sessions so that the tool can be built successfully for testing.

Integrated Development Environment (IDE): Our team decided to use Spyder, an open source environment built for developing Python programs and giving a robust debugging tool, for this project. Spyder can be downloaded by following the steps outlined in this link.

- *Experience:* We use Spyder via Anaconda distribution platform during the project lifecycle. It is a good python IDE that gives you a very much like inclination when a Python client just moved from Pycharm to Spyder. The IDE

permits clients to run code line by line and make the troubleshooting work a lot simpler than doing it straightforwardly. The advantages of this IDE are: it is an open-source programming language so no license is required, gives line-by-line troubleshooting and the connection point is easy to understand for somebody who has just come from Pycharm. In any case, the disadvantages are: the UI is very old and it just helps Python while Pycharm can work with many programming dialects. All in all, as we have utilized Pycharm to work with Python and MySQL, we would suggest Spyder is reasonable for organizations that either do not have a significant spending plan.

OpenCV: Abbreviation for OpenSource Computer Vision, one of the most popular open source libraries for computer vision and image processing tasks in the C ++, Java, or MATLAB community, as well as Python. OpenCV can be installed using the steps in this link.

- *Experience:* Although the team does not have much experience on OpenCV since only the team leader who has worked on one computer vision project using OpenCV before, the library is recommended to have best support on image comparison procedure by many people around us.
- *Hardware requirement:* OpenCV will run on anything. Indeed, even on a Raspberry Pi 1 (single-core CPU 700MHz, 256Mb of RAM). As long as your operating system is Windows or Linux, you are generally OK to use that device. Then, everything relies upon the handling needs of each user, if we do not determine how large is the image collection that we are going to compare, as powerful the CPU as possible is recommended. Same for the memory: handling a 640x480 pixel picture needs little memory, while handling a 4K video will fill your RAM. Moreover, it is essential to note that programming the software to process on GPU is very hard, the code will run generally on a CPU, so the video card is superfluous.

Difference hash is one of the choices of hashing algorithm when it comes to perceptually comparing photographs output exactly the same or only a few different bits of hashcode, this hashing algorithm is well recognized for its use in comparing images (Currier 2019).

tkinter is a standard library for creating graphical user interfaces for Python programs. 'tkinter' is considered by Python developers to be the simplest and fastest way to design a user interface. It's worth noting that 'tkinter' and 'Tkinter' are two separate libraries that support different Python versions. The 'tkinter' module is only compatible with Python 2.x, while the 'tkinter' module is only compatible with Python 3.x and higher. Because our team has decided to utilize Python 3.8 for this project, the instructions for installing tkinter can be found in this link.

Figma: Figma is a graphics editing and user interface design program that runs on the browser. It can be used for everything from wireframing websites to building mobile app interfaces, prototyping designs, crafting social media posts, and everything in between. It is not like other graphics editing software. Mostly because it operates completely within your browser. This means you can access your projects and begin designing from any computer or platform without purchasing numerous licenses or installing software. In terms of teamwork, it clearly outperforms Sketch. Figma, like Google Docs, allows numerous designers to work on the same document at the same time.

- Experience: Despite the fact that our team has no experience with UI design, we were advised to use Figma. Some of its most noticeable advantages are: real-time collaboration, browser-based, free, and simple to use. All of this makes it simple for newcomers to pick it up and utilize it.

Testing

One of the most fundamental processes of application development is testing. We divide the test process into 2 phases:

1. **Development testing**

   At the beginning of the development process, the image comparison is implemented gradually step by step in the following steps:

   + Blur the image: A formula is constructed to receive a 2-d matrix which shows colors of the pixels under hex value and output the resulting image into a file so that we can see that the image has been blurred or not with our own eyes.
   + Resize the image: A formula is constructed to receive a 2-d matrix which shows colors of the pixels under hex value and output the resulting image into a file that has exactly 8*9 pixels so that we can see that the image has been rescaled or not with our own eyes.
   + Convert the colored image to grayscale: A formula is constructed to receive a 2-d matrix which has the size of 8*9 pixels and output the resulting image into a file so that we can see that the image has been converted to single grayscale color or not with our own eyes.
   + Compute the hash value: A formula is constructed to receive a 2-d matrix which has the size of grayscale-colored 8*9 pixels then it is flattened into a single dimensional string

After the image comparison has been developed and tested successfully, the test data has to be prepared for the team to test the accuracy of the algorithm. Firstly, the set of low resolution images (under 1000 pixels on each side) is found and downloaded from the Internet. Secondly, some of the images are taken out for slight modification at different levels using Paint 3D software. Those modified images will be the “Selected” and the whole image set will be the “Candidate”. The test process is tested by inputting the “Selected” images to

see how heavily modified the “Selected” is which makes the software unable to find its original in the “Candidate” set. Please note that the algorithm can be tuned with some simple variables so the test process can help the development team tune the exact value that fits the certain accuracy of the algorithm.

There are several modifications that can be made to the test data such as changes in color, erase some of the parts of the object in the image, crop the image, display just part of the image. Therefore, we found out that the algorithm currently has drawbacks in certain cases:

1. Unable to find the perceptually similar images: If the “candidate” image is cropped or moved just one line/column of pixels, the algorithm cannot detect that “Candidate” image based on the “Selected” anymore
2. Performance issue: Each comparison command scans through and hashes all images in the directory which might take a certain time if the size is too big. As we all know the golden rule is we should not let users wait for more than 3 seconds (here). The software cannot detect the images that has been scanned through in previous command so it has to hash again

2. User testing

Taking advantage of user testing is one of the fastest methods to finish an application optimally. The plan for finding user testing for Memeiacs image comparison tool:

- Currently, technology website platforms create more opportunities for netizens to give their reports as well as assessments about technology products. Especially Reddit, usertesting(but with income). Beside those platforms, applications are integrated underground softwares that allow users to create reports whenever the application goes strange or not responsible(bugs) to resend to company’s developer sections.

    + Updating tool beta to social media (tech groups) or Reddit without any fee with hope to get assessments from netizens. Beside the internet, surrounding people(classmates, family members) is another source to exploit their experience when trying the tool.

    + Publishing fee for testing the tool through finding work websites(ex. Career building). This is fair because users give us experience and time when we can take advantage of this to improve the tool perfectly.

    + Integrating feedback section and underground testing program into the tool that allow users to write their feedback as well as report about bugs when using the tool.
- The number of users: approximately 4 users
    + First user: testing the display of the comparison tool. We will collect the data about how the tool is friendly with the user.
    + Second user: opening every feature once. We will summarize what features are wrong when running.
    + Third user: testing deeply every feature one more time. We will find out exactly the bugs to save it for fixing the tool and repairing fixed patches.
    + The fourth user: This user will be the important one. Testing sides of every feature such as algorithms, results and logics when continuously giving random input to get results from the tools.
- Maybe the application needs more than 4 test users to finish this tool to become able to run. But the estimated number the tool needs to be fixed for first deployment is approximate 4.

Timeframe

REPORTED PHASE		
Week	**Description**	**When**
1	_ First meeting to define the scope of the project. _ Project manager and secretary set up the report template and do research about information of any relevant softwares for reference. _ Project leader started researching the image comparison method. _ Project designer started to design the layout of new pages to prepare for additional information provided in the project.	Tuesday of Week 9
2	_ Beside technical work, the project team started documenting the project report by filling up the reused information that has been provided in the previous report. _ Project manager acted as a product owner, investigating the feedback of surrounding people and discussed with the team for evaluation. She also looked for sample images for testing. _ Project secretary started designing the Mock views for the user interface based on the features that have been agreed. _ Project leader and designer finished the image comparison algorithm and started testing	Monday of Week 10
3	_ The whole team started testing the accuracy of the image comparison algorithm, identifying and fixing any bug found during testing. _ Project leader researched how to design a layout of the UI.	Tuesday of Week 11

	_ Project manager and secretary started documenting the progress into the report. _ Project designer keeps up with generating sample images for testing.	
4	_ First demonstration pitch of the project to the stakeholders. _ Project leader keeps up with designing the complete layout of the Homepage. _ Project designer finalized the published web page reporting the current progress _ Project manager and secretary finalized the report of current progress.	Wednesday of Week 12
PLANNED PHASE		
5	_ Update the progress of each task: designing the mock-up view, implementing functionalities to the UI, generating testing data, researching about the consumer taste. _ The team has a meeting about proposing the first complete design of the homepage, not including basic functionalities in the menu bar. _ Project designer and secretary evaluate/adjust the design of the homepage. _ Project manager and leader starts designing the mock-up for different functionalities of the software.	Week 1
6	_ Update the progress of each task: designing the mock-up view, implementing functionalities to the UI, generating testing data, researching about the consumer taste. _ Project designer starts designing the menu bar and adds needed options to prepare for implementing the functionalities. _	Week 2
7	_ Update the progress of each task: designing the mock-up view, implementing functionalities to the UI, generating testing data, researching about the consumer taste. _ Project secretary and project leader start to implement functionalities in the menu bar. _	Week 3
8	_ Update the progress of each task: designing the mock-up view, implementing functionalities to the UI, generating testing data, research about the consumer taste. _ Project secretary and project leader continue to implement the functionalities in the menu bar. _ Project designer and manager starts implementing the “Add collection” feature.	Week 4
9	_ Update the progress of each task: designing the mock-up view, implementing functionalities to the UI, generating testing data, researching about the consumer taste. _ The team works together to combine the “Add collection” and “Menu bar functionalities” into the software.	Week 5
10	_ Update the progress of each task: finalizing all the designs of	Week 6

	the mock-up view, implementing functionalities to the UI, generating testing data, researching about the consumer taste. _ Project designer and secretary start implementing “automatic image comparison” feature. _ Project leader and manager design start asking for participants in the user testing phase.	
11	_ Update the progress of each task: implementing functionalities to the UI, generating testing data, and starting the marketing campaign. _ Project designer and secretary continue to implement “automatic image comparison” feature. _ Project leader starts implementing drag and drop images in the “add collection” feature.	Week 7
12	_ Update the progress of each task: implementing functionalities to the UI, get the tool ready for user testing, continue with the marketing campaign. _ Project designer and secretary test the “automatic image comparison” feature when implementing the tool. _ Project leader and manager start implementing the “manual comparison” feature.	Week 8
13	_ Update the progress of each task: implementing functionalities to the UI, getting the tool ready for user testing and gathering feedback, continue with the marketing campaign. _ Project leader, secretary and designer continue to implement the unfinished features (manual and automatic comparison). _ Project manager reviews the feedback from testers.	Week 9
14	_ Update the progress of each task: implementing functionalities to the UI, getting the tool ready for user testing and gathering feedback, continue with the marketing campaign. _ The whole team has a meeting to evaluate the testers’ feedback and make adjustments.	Week 10
15	_ Update the progress of each task: implementing functionalities to the UI, conclude the user testing and gathering feedback process, update the marketing campaign and announce accurately the publish date. _ The whole team works together to combine the “automatic comparison” and “manual comparison” features into the tool.	Week 11
16	_ Finalize the tool with some brief tests overall of the features. _ Prepare a presentation on the publish date.	Week 12

Risks Management

Risk Management	**Introduction to IT**		**COSC2083**	
	Project:		Memeiacs's image comparison software	
	Participants:		Memeiacs' project team members	
Task		*Description*	*Severity*	*Solutions*
Scope	Requirements and scope mismatch	The scope established by the project team does not meet the requirements of the stakeholders (lecturer).	Critical	Discuss the present project's process with stakeholders and, if necessary, amend the requirements.
	Potential scope void	Changes in project requirements that were not anticipated	Moderate	Discuss the present project's process with stakeholders and, if necessary, amend the requirements.

	Scope creep	Newly discovered information or ideas in an effort to improve project deliverables during project lifecycle	Moderate	Discuss the present project's process within the team. If no conclusion is found, the team should discuss with the stakeholders.
	Defects in Scope while Integration	Integration fails due to lack of knowledge and experience during the development	Serious	Be proactive to deeply research about the feasibility and assess the team's ability before the project has been started.
	Implemented approach failure	Integration fails due to wrong approach chosen during the development	Moderate	Always tackle a problem with at least two ideas and have backup plans in place for each task while it is being implemented.

Time	Project deadline overdue	Due to several issues, the project time exceeded the deadline	Critical	Everyone of the team focuses on solving the difficulties or coming up with alternate solutions, and then the timeframe is re-planned accordingly. Discuss with the stakeholders and, if possible, extend the deadline.
Technical	Application malfunction or low-accurate algorithm	After any algorithm/ formula is constructed or the application is finished, they do not work normally as expected, may cause crashes	Moderate	After any algorithm/ formula is constructed, the development team has to conduct the testing before it is implemented into the application.
Test and feedback	Wrong	Wrong data (image) prepared	Ser	Specify clearly the criteria to

	test ing an d fee db ack pro ces s set up	during development process and too few user testing	i o u s	generate suitable data at different levels . Each team member should invite at least 10 people to participate in a user testing program for gathering feedback.

Group processes and communications

Group meetings will be held twice a week and will be scheduled simultaneously at the same time every week. These meetings will surely be held, no matter how many things need to be discussed and participation is obligatory. A plan will be conveyed and sent out to every member by the project leader, usually one day before the meeting. The meeting will likewise be added as a post in the task schedule. The group members are relied upon to go to the gathering completely ready, in view of the plan. Additional meetings can be set up on the off chance that it is viewed as vital. Assuming the case of participants cannot think of a mandatory issue, yet participation is relied upon if nothing else is on his/her timetable.

1. **Communication plan with the lecturer.**

A communication plan is a continuous activity that connects the project team with the stakeholders for each project. The goal, purpose, message, and tools may change during implementation, but the most important thing is to maintain relationships with essential people. It also gives the project team a clear plan and ensures that all essential stakeholders are included in the right areas. It also guarantees that project participants continue to engage and deliver by reporting updates and progress.

Lectu	Mr. Nguyen Minh Long

rer	
Purpose	Asking for advice on the action plans and requesting clarification of the project's requirements.
Frequency	Approximately 2 - 3 times per week.
Communication channel	Microsoft Teams, Canvas, face-to-face (in Room 2.4.44)

Communication suggestion:

* Electronic communication:

- Create a set of common guidelines for successful email communication between team members and the lecturer. For instance:

+ Instead of pasting text into the body of emails, use bullet points to break up long communications.

+ Use bold font format to emphasize crucial points.

+ Implement important documents with attachment for downloading instead of writing long text in the email body.

- The lecturer should create a Team Group to make contact with all project groups easier and to keep track of all messages in one spot.

* Working Method:

- Meetings:

+ While 2 (choose between face-to-face or online) meetings per week are sufficient, small meetings for problem solving or urgency are still required. Using online tools like Google Calendar, it's simple to find meeting dates that are convenient for each team member.

+ Have members who are unable to attend meetings create a back-up meeting. A list of three to five objectives, as well as any specific decisions that must be made, should always be included in the meeting.

+ Any talks, activities, or decisions should be documented so that they can be carried out. After that, summarize the memo and distribute it to others.

+ To improve participant participation, consider a rotating schedule for sharing responsibility for idea expression. Finally, the team leader would be held accountable for the final outcomes.

+ It is critical to review all of the major issues and conclusions of the meetings in order to recall each member and reaffirm agreements.

2. Communication plan between team members:

Project Team	Memeiacs
Purpose	Keep frequent contact, make sure all members understand the current plans and processes in depth, which helps make decisions easier.
Frequency	2 meetings per week guaranteed, extra small meetings can be held to solve problems.
Communication channel	Messenger (Facebook), email, face-to-face (on SGS campus)

Communication suggestion:

** Electronic communication:*

- Create a set of common guidelines for successful communication between team members. For example:

+ Instead of pasting text into the body of emails, use bullet points to break up long communications.

+ Use bold font format to emphasize crucial points.

+ Uploading files to Google Drive and notify the team of the latest update on Messenger.

- The team opted to use Messenger as our primary informal communication method because Facebook is the most widely used social media platform and should be simple to use for all members. The team leader should create a Messenger Group to enable communication with the entire group and to keep track of all messages in one spot.

** Knowledge Administration:*

- Create a central online repository for important project documents. We utilize Google Drive to be more specific.

- Make folders for various project components, meetings, and references.

- Establish knowledge management methods and agreement on each member's duties and responsibilities.

- When updating the newest edition, use naming and dating conventions to prevent misunderstandings.

- Make a spreadsheet to track members' monthly progress, including challenges and plans for the future. Create a task table where members can fill in their sections.

** Working Method:*

- Meetings:

+ Because it is not always possible to accommodate each member's schedule, ask absent members to obtain all information that was not provided at the meeting. However, strive to include as many people as possible in group sessions, as this will help to strengthen team bonds and establish trust.

+ Using an online application like Google Calendar, it's simple to find meeting times that are convenient for each team member.

+ Google Calendar recommends available times and dates, and each participant can check their availability. This will make it easier for the team leader to see the best dates and times for the group.

+ Weekly reports and any challenges should be on the agendas of group meetings.

+ It is critical to go through all of the key issues and conclusions at the end of the meeting to remember everyone and reinforce agreements.

+ Finally, a brief note should be included in the meeting's output that includes all bullet points, revisions, and any choices made. Share it with the online group to ensure that any people who are unable to attend receive all of the material.

- Build consensus:

+ Create a project timeline for each work with a specific deadline.

+ Use Google Docs for online collaboration, allowing everyone to make revisions or track and comment on progress.

+ Present the writings or any coding experiments to the group, then debate and receive feedback on the process.

Skills and Jobs

As a growing technology start-up company, it is necessary to have large funds to help the project reach new heights. To promise a group of venture capitalists the most successful future for the tool, we need to assemble a group of four prominent young people that can take Memeiacs Comparison Tool into the next phase.

- ➔ **Developer:** A designer is in charge of all aspects of coding or IT related business. They should have at least 3 years of experience in similar fields as well as interpersonal skills to communicate with designers to make the project more proper.
- ➔ **Designer:** They are responsible for the creative aspect of the project, from designing the website to the view inside the tool. Designers are proficient in color theory and have an adequate amount of experience in portraying the right feeling from colors.
- ➔ **Marketer:** They are an important part of the team as their efforts rake in money from customers or other businesses that need it. With appropriate marketing, the image comparison tool will be able to make a big profit, which can satisfy the venture capitalists and guarantee more funds. Marketers need innovative thinking and experience in making a start-up company big.
- ➔ **Testers:** They may not sound as important but are very helpful in debugging - a very tedious part of developing softwares or websites - and quickens the pace of the project. By pushing for a shorter time, the project can be fixed to be more complete and successful. Testers need to have some understanding of the software and can make intelligent predictions about what is often the problem in a newly built software.

Group Reflection

Personal perspective

Minh's perspective: I am so honored to be a part of this team and to guide the project to its excellence today. I have created this idea and shared it with my teammates, which I call friends now, and they were all supportive and on board with my idea. We worked endlessly together to complete parts of the project, writing Python codes, getting the marketing department ready and building websites to make it more whole. Right now, I'm happy where we're at and where we stand with the project. This class has opened up opportunities that were previously unimaginable, that allowed me to meet the best people for the team and work on an idea I knew I wanted to start but didn't know where to start. And the dream team helped me achieve it. After this class ends, I wonder where we'll be next, whether it's finishing up the project and putting it on the market or scrapping this to start anew. I think anything would sound appealing with a team like this, and I'm so happy and honored to be a part of this. Together, we set sail for the sea to find copper, and like Columbus, when reaching our destination, what we found wasn't just copper– it was gold, and of course, the gold is the friendship that was formed along the way.

Thuy's perspective: I honestly really enjoyed my time with the group and I'm sad it has to end. This class was an unexpectedly good journey where I've learned the basics and so much more about Information Technology. My semester here with my teammates was surprising and unforgettable. The bond we've created both inside and outside of the classroom is amazing, where our whole team treated each other less like work partners and more like friends. As this is my first semester on this campus, I have received so much support from fellow Memeiacs that helped make this campus feel like home. As for working together, I believe we were the most efficient we could be. Each team member contributed a little of their time and skills to make this journey work and work successfully. The idea of creating an image comparison tool is frankly quite interesting and new, and the team made it happen. I learned so much from each friend, and received not only excellent feedback or help on work but also life, laughs, and memes. My teammates are pearls found in the sea. There are people who can work together perfectly, there are people who click together on a personal level and I'm so glad to find those that can be both.

Khoa's perspective: This is the first time I have met an amazing team with brilliant members. I was really confused when they finished their sections suddenly after the release date was just 4 days. Because of this, we got many chances to modify and finish our work as well as possible. Although the time with memeiacs is limited, we still contact each other with the hope that we can cooperate in some fields in the near future. The things I regret are that I could not create a better web with many effects

that could raise our score to a higher level. Web design is a different field which I coped with for days before the due day of assignment 2. Beside web design difficulties, I would not spend much time with the team even outside and box chat to make our project more interesting. But our cooperation is still consolidated to touch the final purpose for assignment 3 that is getting HD points and creating real results with visible source code. The idea with the image comparison tool was quite strange to me for the first time when hearing but I suddenly agreed because I trusted my team and recognized it may bring real value to people in the visual era. During cooperation time, I have learnt many things about time management, problem solving and academic knowledge not just from external sources but our teammates. Finally, I enjoy the time with Memeiacs.

Quan's perspective: Personally, I believe that this is one of the best teams with which I have ever had the pleasure of working. Everyone takes great pride in their work and takes great responsibility for it. Fortunately, we did not encounter many difficulties along the route. Everything went off without a hiccup. All of the people are pleasant and courteous. Our shared interest in memes is quite unexpected, considering how many of us are on the internet. If there is one thing I would change about the project, it would be the way the time is being managed. I wanted it finished sooner rather than later so that we would have more time to make any necessary revisions. Assignment 2 also had some late personal deadline dates that may have been better, but as a result of this, we were able to put together an outline for assignment 3. As a result, we have little to no problems with assignment 3, but it is completed at the expense of spending far too much time on assignment 2 in the process. Aside from the fact that I am delighted with the way we collaborated, there isn't anything to be unhappy about. Overall, I am pleased to work with everyone.

Group perspective

- ➔ **What went well:** We were able to accomplish much by working together. We are all putting in our best efforts to complete the team project. Time management and team advancement went better than expected, which was surprising to me. We were successful in creating a program that functions well and operates in the manner in which we desire. When we were working together, there wasn't much conflict. Our crew is always able to meet our deadlines and complete the tasks to the best of their abilities.
- ➔ **What could be improved:** Despite the fact that the group has performed admirably in terms of teamwork, there is clearly space for improvement. We could have done a better job with time management, but nevertheless, working around the schedules of each member was a significant hurdle that we had to overcome. We could achieve our goal more quickly and efficiently if we were better at managing our time and resources. If this had been done, the

ultimate product would have been better, with fewer problems and far more features. It is possible that if we had all learned how to code in this exact manner, we could have all made a greater contribution to the overall development of the project and reduced the amount of work placed on our team leader's shoulders.

- ➔ **At least one thing that was surprising:** The code was executed smoothly and flawlessly, demonstrating that our knowledge and preparation were well worth the time and effort. We were successful in making our program function properly. Everyone was really polite and conscientious about managing their own and the team's time as well. In fact, we had already begun planning for tasks of Assignment 3 while we were working on Assignment 2. The idea worked out quite nicely, and we had little to no trouble when assignment 3 came. As a result, we will have a significant amount of time to enhance and perfect our work in the future. This is most likely the best result we could have achieved in the time frame of approximately one month.
- ➔ **At least one thing that you have learned about groups:** We enjoy memes, we enjoy collaborating with one another and meeting deadlines, and we enjoy our work. The group has been extremely productive as a result of each member contributing a portion of their work that reflects their finest abilities. Everyone was jovial, courteous, and considerate of others. These are the characteristics that, in our opinion, are most important in a teammate. Everyone had their own responsibilities to fulfill, and they all did it brilliantly and without fail. There isn't much more that can be asked of a group of people.

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