



## **GRADUATE CERTIFICATE INTELLIGENT REASONING SYSTEM (IRS)**

### **Intelligent Album Generator**

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## 1. Introduction

The Intelligent Album Generator is set to revolutionize the manner in which we organize and cherish our memories. With the world becoming increasingly digital and our photo collections expanding there is a growing need, for a personalized solution to create photo albums. Our project addresses this need by introducing a system that can automatically generate albums customized to preferences. Users can effortlessly upload photos. Select preferences to craft albums that resonate with their experiences and emotions.

### 1.1 Background

In today's paced era the sheer volume of personal photos often results in chaos. Numerous memories waiting to be organized. Sorting through hundreds or even thousands of images to create personalized photo albums can be a time-consuming task. Understanding this challenge, we present the Intelligent Album Generator as a solution. This project aligns with trends such as mobile solutions, automation, intelligence and integration with social media platforms enabling users to easily import photos from their social accounts. Renowned industry players like Google, Mixbook and Shutterfly have already made progress in this field.

However, our project aims to provide an one clicks system for generating albums in formats (PDF and Open XML) with advanced AI driven features. It employs learning and machine learning techniques to analyze photo content identify objects, for layout design and intelligently sort and enhance photos based on time, location and theme to elevate the visual appeal of the album.

Additionally, there are limitations that we need to address for the project. These include concerns, about protecting privacy ensuring efficient image recognition maintaining high quality data and avoiding errors when converting output formats. We will need to consider these challenges and come up with solutions as we move forward.

### 1.2 Significance of the Project

The Intelligent Album Generator is more than a tool for organizing photos; it enhances our lives. It simplifies the task of creating personalized photo albums offering a time saving, efficient and emotionally influential solution. It enables users to relive their moments in a way that holds deep meaning for them personally. This project goes beyond automation; it represents an advancement, in how we engage with our memories and connect with those who share those special moments with us.

### 1.3 Project Objectives

Our project's main objective is to develop a user Intelligent Album Generator that simplifies the processes of uploading photos adding descriptions and creating albums. The system prioritizes photo management while incorporating robust machine learning algorithms to generate visually appealing and personalized albums.

The project aims to develop a smart photo album generation system with the following functions:

#### 1. User-friendly interface

Provides an intuitive user interface that allows users to easily upload multiple photos.

#### 2. Automated photo album generation

Use deep learning and image processing technology to automatically create the layout, style and theme of the photo album.

#### 3. Intelligent editing

Identify the main color, background and shooting time in the photo, and combine the size suitability of the photo and the template to optimize the visual effect.

#### 4. PDF output format

Supports generating photo albums in PDF format, making it easy for users to share and print.

#### 5. Efficiency and speed

The system should generate photo albums in a short time to improve user experience.

## 2. Problem Description and Market Analysis

### 2.1 Problem Statement

#### 2.1.1 Difficulty

1. In real life, users often upload similar pictures. For this situation, how does the system identify the similarity of images and retain only one image among similar images. During this process, we need to prevent the system from excessively deleting photos.
2. How to create a smart photo album generation system that allows users to upload multiple photos and automatically generate a photo album to meet users' needs for photo organization and sharing.
3. When the system generates photo albums based on photos uploaded by users, what basis should we use to allow the system to classify pictures and what basis should we use to layout the album.

#### 2.1.2 Stakeholders

1. End users  
Those who want to easily create beautiful photo albums.
2. Potential partners  
Enterprises with relevant resources who are interested in cooperating with us to launch products such as photo printing service providers and Advertisers.

#### 2.1.3 Limitations

1. Privacy protection  
The privacy and security of photos uploaded by users and generated album data need to be ensured.
2. Data Quality  
System performance may be limited by the quality of photos uploaded by users.
3. Technical challenges  
Technical challenges in deep learning and image recognition need to be overcome.

#### 2.1.4 Success signs

The system can quickly generate high-quality photo albums. Besides, we can evaluate the success of the system based on user satisfaction and feedback.

## 2.2 Business Model and Solution

### 2.2.1 Market and user demand

The market demands personalized customization functions, allowing users to choose specific styles, layouts and themes. Users need a wide variety of templates and styles to choose from to meet different occasions and preferences. At the same time, they need a simple and intuitive interface and easy-to-use operations so they can create beautiful photo albums without professional design skills.

### 2.2.2 Target customers

Mainly for individual users who want to easily create beautiful photo albums to save and share special moments.

### 2.2.3 Cost structure

#### 1. Research and development costs

The cost of developing and maintaining a smart photo album generation system.

#### 2. Servers costs

The cost of servers and infrastructure required to host and run the system.

#### 3. Operations, maintenance and advocacy costs

The costs of providing promotional advertising, maintaining systems and continuous improvement.

### 2.2.4 Source of income

#### 1. Transaction mode

Users can purchase specific and more beautiful photo album templates.

#### 2. Subscription model

Basic and advanced subscription models are available.

#### 3. Partner revenue sharing

Partner with photo printing service providers to share revenue from printing services. Cooperate with advertising promoters to reduce advertising space promotion costs.

### 2.2.5 Solution

Our smart photo album generation system will solve users' pain points, allowing them to easily create beautiful photo albums and share precious memories. Through smart automation and smart editing, our system will provide high-quality photo albums to meet different user needs. The core of this business model is to provide convenient and high-quality smart photo album generation services, obtain revenue in the form of

subscription and transaction models, and increase revenue and expand the market through partnerships. By continuously improving the system and attracting users and partners, our goal is to help users capture the fleeting moment and achieve business growth and profitability.

## 2.3 Market Research

### 2.3.1 Development Trend

#### 1. Mobile terminal development

With the popularity of smart terminals, users are more inclined to use mobile devices to create photo albums. Mobile optimization is a current trend.

#### 2. Automation and intelligence

The photo album generation system will tend to be automated and intelligent, using AI and machine learning technology to identify photo content, intelligent layout, and improve user experience.

#### 3. Social medialization

Integrate social media platforms, allowing users to directly import photos and content from social accounts to improve user experience.

### 2.3.2 Current market analysis

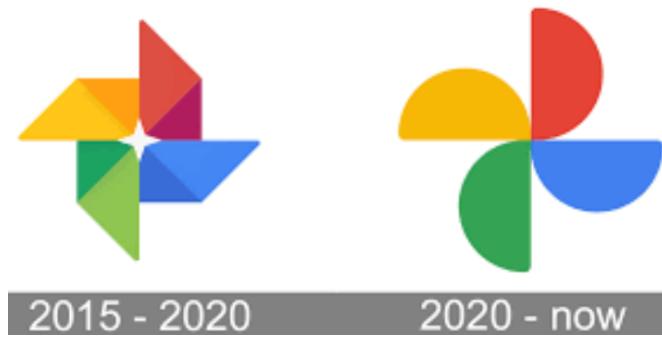
As users' demand for digital photo processing continues to increase, the market for smart photo album generation systems has broad prospects. The smart photo album generation system is a product of the digital age, which can help users automatically organize multiple photos into an album. There are currently different levels of photo album generation services on the market.

### 2.3.3 Potential opportunities

Use AI technology to improve the automation, intelligence and personalization of photo album production, providing users with a more perfect experience. At the same time, developers can create an ecosystem that integrates functions such as photo cloud storage, photo album production and generation, and sharing to social media into the same platform to increase user experience and attract more users.

## 2.4 Competitors Analysis

- (1) Google Photos – The home for your memories

*Fig 1. Google Photos Trademark*

Google Photos provides users with a powerful tool for storing, managing and sharing their photos and videos, and its intelligent search and classification capabilities make it easy to find the media content they need.

1. Free storage and syncing  
Allows users to store their photos and videos in the cloud, and storage space is initially free.
2. Intelligent search and classification  
Uses advanced image recognition technology to automatically identify objects, places, people and other information in photos. Users can use keyword searches to find photos, such as searching for specific places, animals, colors, etc.
3. Albums and Sharing  
Users can create photo albums, organize photos into collections, and share them with friends and family. Sharing can occur via link, email, social media.
4. Automatic backup and sync  
Can automatically back up users' photos and videos, ensuring they are not lost if the device is damaged or lost.
5. Smart editing tools  
Provides some simple image editing tools, such as adjusting brightness, contrast, cropping, filters, to improve photo quality.
6. Sharing and collaboration  
Multiple people can collaboratively edit and add photos to the same album.

(2) Mixbook -- Who knew creating photo books could be so much fun

*Fig 2. Mixbook Trademark*

Mixbook provides users with a powerful tool for creating personalized photo books and

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other printable to capture and share cherished memories or make special gifts. It is an online service and platform that provides personalized photo books, cards, posters and other photo printing products.

### 1. Personalized Design

A core feature of Mixbook is that it allows users to create fully personalized photo books, cards, posters and other printable based on their needs and preferences. Users can choose from different themes, layouts, fonts and backgrounds to create unique creations.

### 2. A variety of printing products

Provides a variety of different types of printing products, including photo books (such as wedding albums, family memory books, travel memory books), greeting cards, posters, calendars, photo frames, puzzles, etc. Users can choose the appropriate product based on a specific occasion or purpose.

### 3. Online editing tools

Provides easy-to-use online editing tools, allowing users to upload photos and layout, edit and design them in templates. These tools allow users to incorporate their creativity into print.

### 4. High-quality printing

Pays attention to the quality of prints and provides high-resolution print output to ensure that photos and design effects are clear and precise.

### 5. Order customization

Allows users to choose different covers, paper quality, sizes and binding methods to ensure that the print meets their specific needs.

### (3) Shutterfly -- Make Personalized Products



*Fig 3. Shutterfly Trademark*

Shutterfly is a well-known online photo printing and personalized gift making service provider founded in 1999. The company provides users with a variety of services and products to help them transform digital photos into personalized prints and gifts. Shutterfly is known for its user-friendly interface, high-quality prints, and diverse options.

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## 1. Photo printing service

Allows users to upload their digital photos and then choose to print them on different types of prints, including photo books, greeting cards, photo frames, posters, calendars, and more. Users can choose from different sizes, paper qualities and styles to meet their specific needs.

## 2. Personalized design tools

Offers online editing and design tools that enable users to customize their photo books, greeting cards, and other printed matter. Users can choose from different themes, layouts, fonts and backgrounds to create unique creations.

## 3. Special occasion prints

Offers a variety of prints for special occasions, such as wedding photo books, graduation albums, baby photo albums, holiday cards, and more. These prints can be designed according to different occasions and themes.

## 4. Gift making

In addition to printed matter, Shutterfly also provides a range of personalized gift options, such as cups, tableware, pillows, Rubik's cubes, mobile phone cases, etc. These gifts can be used to celebrate special occasions or given to friends and family.

## 5. Mobile Apps

Offers mobile apps that enable users to upload, edit and design photos on their phone or tablet and access their Shutterfly account at any time.

## 6. Online Preview

Users can preview their designs online to ensure satisfactory results.

### 3. System Architecture and Modeling

#### 3.1 System Architecture

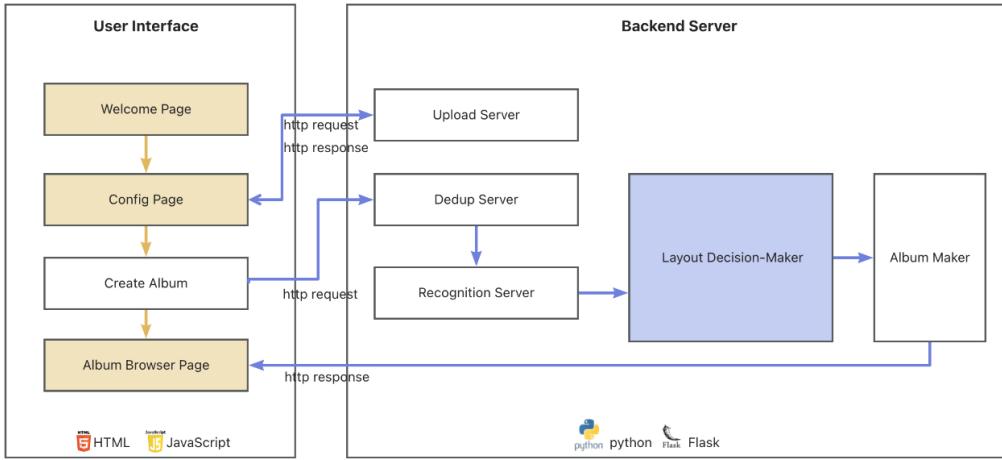


Fig 4. System Architecture Diagram

##### 1. User Interface

Users interact with the system through the web page, upload photos, set parameters and receive generated photo albums.

##### 2. Frontend Server

The front-end server accepts requests from the user interface, processes user input and displays the results. We use three front-end technologies: HTML, CSS, and JavaScript to build the user interface. HTML is used to define the structure and content of web pages, including text, images, and links. It describes each part in the form of tags. CSS is used to control the appearance and style of web pages, including colors, fonts, and layout. It is one of the key technologies for building the appearance and layout of web pages. It is used together with HTML. JavaScript is used to add interactivity, dynamic behavior, and handle user input. It is a scripting language that can be run in the browser.

##### 3. Backend Server

The backend server is the core of the system and is responsible for handling all business logic and image processing. It accepts requests from front-end servers and calls deep learning models, image processing engines. We use the Flask framework to build web applications. Flask is a lightweight Python web framework for building web applications and APIs.

##### 4. Deep Learning Model

This is the system's intelligence engine, which uses deep learning technology to identify the background in photos. Places365 is the latest subset of Places2 Database. There are two versions of Places365: Places365-Standard and Places365-Challenge. The train set of Places365-Standard has about 1.8 million images from 365 scene categories, where there are at most 5000 images per category. Meanwhile, the train set of Places365-

Challenge has extra 6.2 million images along with all the images of Places365-Standard (so totally about 8 million images), where there are at most 40,000 images per category.

## 5. Optimization Model

Following this, the system invokes the Layout Decision-Maker module. Leveraging the information obtained from the Recognition Server, it arranges similar photos on the same page, optimizing the visual appeal of the album. Layout Decision-Maker uses genetic algorithms to obtain better layout results. Lastly, guided by the Layout Decision-Maker's output, the system selects the most appropriate layout.

## 6. Output Generation

The generated photo album is output in PDF format and provided for users to download or print.

## 7. Monitoring and Logging

Systems need to implement monitoring and logging to track performance, identify problems, and support maintenance.

### 3.2 Hash Decision Automation

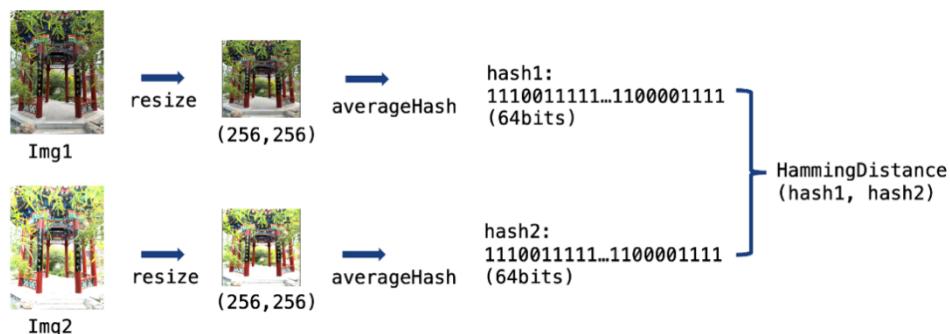


Fig 5. Hash Value Schematic

To output a beautiful photo album, we need to perform similarity detection on the photos uploaded by users and delete photos with high similarity. For this purpose, we introduce the hash value parameter. Using hashes to identify similar images is a common image processing and retrieval method. The overall process we designed mainly includes the following steps.

#### 1. Initialize image and feature hash

Convert image features into hash codes. A hash code is a fixed-length binary string, usually composed of 0s and 1s. The hashing method can be local sensitive hashing (LSH), perceptual hashing (pHash) or average hashing (aHash), etc. In this project we plan to use the average hashing (aHash) method. The purpose of hashing is to map the complex features of an image into a compact representation that can be compared.

## 2. Hash code comparison

Compare the generated hash code with hash codes of other images in the database. Hamming distance is usually used to measure the difference between two hash codes. Hamming distance refers to the number of different positions between two strings of equal length. A smaller Hamming distance usually indicates that two images are more similar.

## 3. Threshold setting

Define a threshold to determine when two images are considered similar. If the Hamming distance is less than or equal to the threshold, then the two images are considered similar.

## 4. Delete similar photos

Delete the remaining similar photos identified.

### 3.3 K-means Clustering

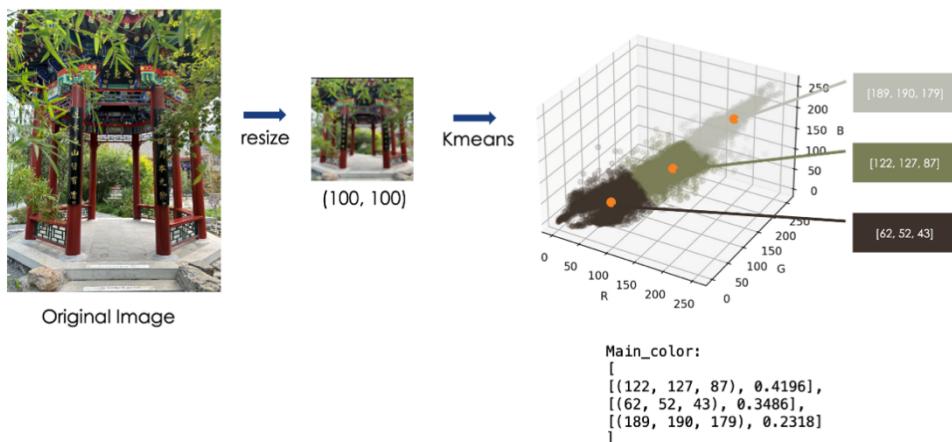


Fig 6. K-means Algorithm to Extract the Main Color

To effectively classify the photos uploaded by users, we need to identify the main color of the photos. In this project we plan to use the K-means Clustering method to extract the main colors of the image. K-means clustering algorithm is the most popular clustering tool used in scientific and industrial applications[1][2]. It is one of the most popular and simple unsupervised algorithms. For all data points scattered in n-dimensional space, it will group the data points with certain similarities into a cluster. After randomly initializing K cluster centroids, the algorithm iteratively performs two steps: cluster assignment, assigning point to the cluster with which the distance of the item is the least [3] ; moving the centroid, and calculating the distribution of all points in the cluster. Data points are reassigned to clusters based on their new centroid locations. Its core idea is to achieve data clustering by minimizing the distance between the data points in each cluster and the center point (centroid) of the cluster to which it belongs. The principal process of K-Means clustering algorithm is as follows.

1. Determine the K value and cluster into K clusters (K equals 3 in default).
2. Randomly select (or in some way) K data points from the data as the centers of the initial classification.
3. Calculate the distance from each point in the data to each center and divide each point into the class closest to the center.
4. After each center has divided some points, found the mean value of each class and select a new center.
5. Compare the new center with the previous center. If the distance between the new center and the previous center is less than a certain threshold, or the number of iterations exceeds a certain threshold, the clustering is considered to have converged and terminated.
6. Otherwise, continue to iteratively execute steps three to five until step five is satisfied.

In this project, we use the K-means Clustering algorithm to extract the main RGB colors. The logic of this program is to convert the image into a long list of pixels. Use K-means clustering to determine the dominant color in these pixels. Output these main colors and their proportions in the image. In this way, the code can effectively identify and extract the main colors in the image.

### 3.4 Genetic Algorithm

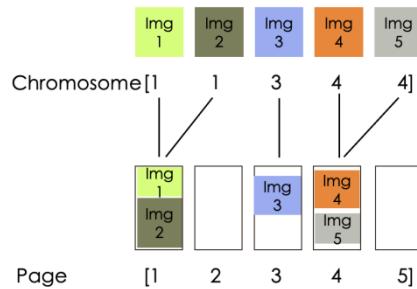
Genetic algorithm is a search algorithm used to solve optimization problems in computational mathematics and is a type of evolutionary algorithm. the genetic algorithm has become a common method due to its high solution accuracy, fast convergence speed, and strong robustness among the positioning algorithms.[4] [5] [6] [7] [8] Evolutionary algorithms were originally developed based on some phenomena in evolutionary biology. Genetic algorithms are usually implemented as a computer simulation. For an optimization problem, a certain number of candidate solutions can be abstractly represented as chromosomes, allowing the population to evolve toward better solutions.

We chose to use a genetic algorithm for the search of the optimal layout solution because it goes beyond the simple task of clustering similar photos. It involves determining which photos go in a particular version, selecting the appropriate template, and specifying the exact positioning of each photo. Using a genetic algorithm allows for an efficient and straightforward discovery of superior solutions.

To implement a specific genetic algorithm, there are six key aspects to address: defining the chromosome structure, determining the fitness function, establishing selection criteria, devising crossover methods, planning mutation strategies, and integrating these components to complete the iterative optimization process. Drawing inspiration from genetic algorithms used to solve the Traveling Salesman Problem (TSP), we have innovatively proposed a genetic algorithm tailored to the layout of images.

### 3.4.1 Defining the Chromosome Structure

The chromosome represents the page numbers in which the photos are placed within the album. For instance, chromosome [1, 1, 3, 4, 4] indicates that photo 1 and photo 2 are placed on the first page of the album, photo 3 is on the third page, and photos 4 and 5 are on the fourth page. The second page of the album is left blank and will be removed in a subsequent step.



*Fig 7. Chromosome Structure*

Hence, the chromosome length equals the number of photos to be arranged, as in the extreme case where each page accommodates only one photo. The permissible numerical range within the chromosome is [1, the number of photos]. During the generation process, numbers can be repeated, signifying that multiple photos are placed on the same page.

### 3.4.2 Fitness Function

When designing optimization objectives, it is essential to consider what type of album meets the user's needs. Based on user surveys, some users prefer layouts that are not too crowded, meaning there should be a limit on the number of photos per page. Users often want photos from the same event to be grouped as closely as possible. Currently, we assess photo relevance by factors such as the photo's capture time, background, and color composition; the closer these factors are, the higher the probability of photos being related. Therefore, we strive to arrange photos on the same page with similar capture times, backgrounds, and colors.

We also need to consider the compatibility of photo sizes and templates. We have 14 different templates, and for example, there are three variations of templates with two photos on a single page. After determining that a page should have two photos, we need to further decide which specific template to use. When selecting a specific template, we aim to minimize cropping and stretching of photos by choosing the template with an aspect ratio closest to the original image.

So, in the end, we need to consider five factors: the number of photos on one page, the match between the original image and the template, the difference in capture time of photos on the same page, the difference in colors of photos on the same page, and the difference in backgrounds of photos on the same page. The specific calculation methods and weights are detailed in the table below.

*Table 1. Optimization Goal Indicator*

| Description                       | optimize | weight | Calculation in one page   |
|-----------------------------------|----------|--------|---|
| Dismatch of ratio in template     | minimize | 1      | Calculate the mean of abs(img_ratio - template_ratio)                     |
| Difference of colors in one page  | minimize | 1      | Calculate color distributions in one page, and calculate the std of the v |
| Difference of picture taking time | minimize | 5      | Calculate the std of taking times of images in one page                   |
| Difference of picture background  | minimize | 1      | Calculate the gini coefficient  |
| Number of pictures in one page    | maximize | 4      | Calculate the num of images in one page                                   |

The constraint of maximizing the number of photos per page is introduced to prevent a situation where the optimal solution would be having one photo per page. To address this, we increase the weight assigned to this factor, encouraging the organization of related photos on a single page.

Given the need to consider multiple factors, the fitness function is designed as follows: `dismatch_ratio + diff_color + 5 * diff_shooting_time + diff_background - 4 * num_pic_in_one_page`, with higher-weighted factors prioritized in the evaluation process. When calculating the fitness of a chromosome, the results for each page are averaged.

### 3.4.3 Selection Criteria

During chromosome generation, a roulette wheel selection method is employed, where the probability of selection is determined by the fitness. Lower fitness values have a higher probability of being chosen. To calculate the selection probabilities, the inverse of the fitness is first computed, and then the SoftMax function is applied. The specific formula for calculation is as follows:

$$Prob_i = \frac{e^{-fitness(chromosome_i)}}{\sum e^{-fitness(chromosome_j)}} \text{ for all } j$$

This formula ensures that chromosomes with lower fitness values have a higher probability of being selected.

### 3.4.4 Crossover

In the context of the layout problem, crossover involves merging genetic information from both parents. We start by randomly selecting page numbers and retain the father's chromosome's layout for those pages. For photos that have not been assigned a layout on those pages, we inherit their positions from the mother's chromosome. When inheriting from the mother's chromosome, there is a detail to consider: we only care about which photos are on the same page, not their specific order on the page. Therefore, the page number sequence can be arbitrarily changed. In practical operations, for the purpose of smoothly merging chromosome segments from both parents, we need to reindex the mother's chromosome to ensure that there are no page numbers that overlap with the father's segments. After obtaining genetic segments from both parents, they are merged to create the genetic makeup of the next generation.

### 3.4.5 Mutate

Mutation is carried out using a random swap method. With a certain mutation probability, two numbers within the chromosome are randomly exchanged, resulting in a new chromosome. You can refer to the example in the following diagram.

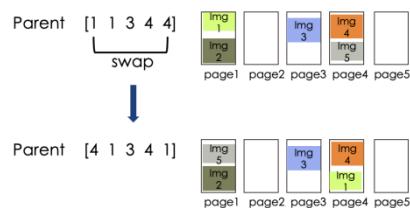


Fig 8. Mutation

### 3.4.6 Evolution

The complete evolutionary process involves initializing the population, computing the fitness of each chromosome, selecting, crossovering, and mutating based on fitness to generate offspring genes, completing one iteration. To strike a balance between user waiting time and search effectiveness, a total of 50 iterations are set. After completing the iterations, the layout of the photos is determined. Finally, the pages are sorted in ascending order based on their capture time for the final album layout.

## 4. Solution Implementation

### 4.1 Prototype Design

We have crafted a sleek, user-centric, and intuitive system prototype for the Smart Album Generator System, designed to enhance the presentation of our products to users and offer top-notch Smart Album Generation services.

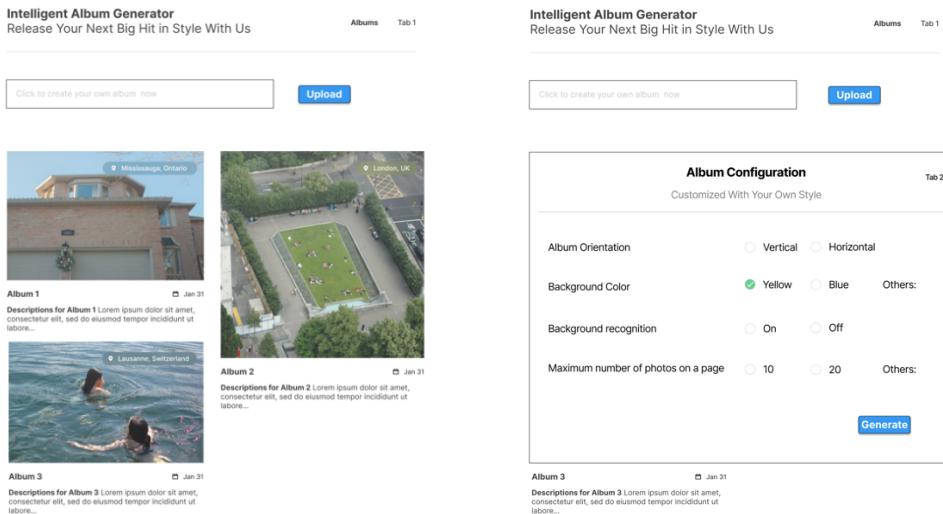


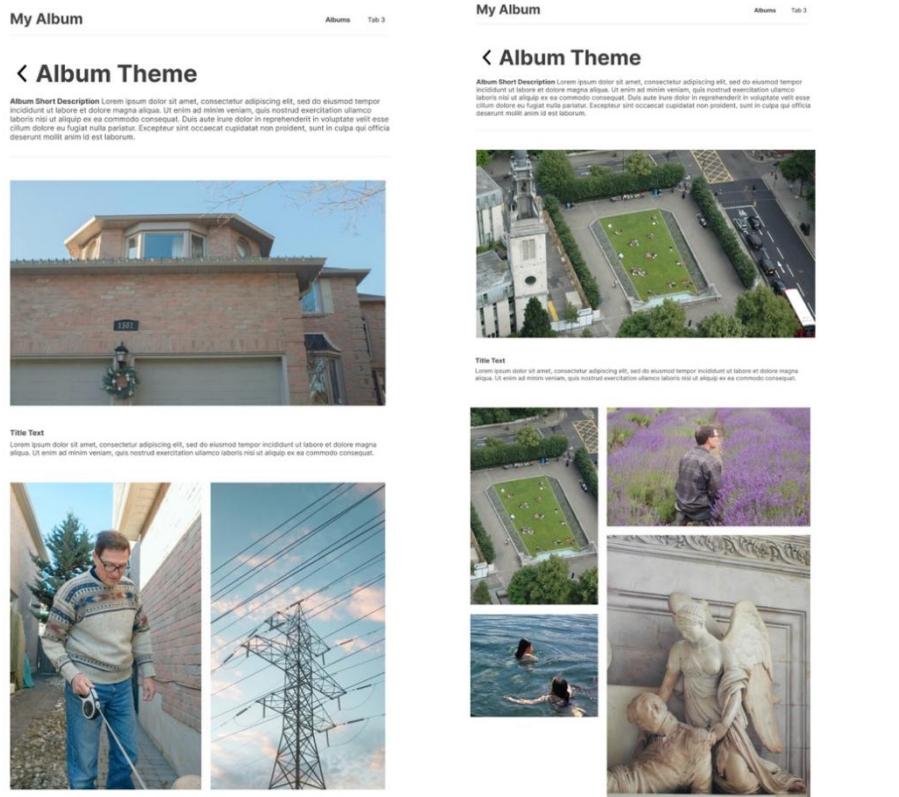
Fig 9. Album Home Page and Configure Page

#### 1. Homepage

On the homepage, user will find the Smart Album Generator system's logo and slogan in the top left corner. Albums generated by the system are showcased at the bottom of the page, and users can simply click the "Upload" button to access the configuration page and upload photos from their local storage.

#### 2. Configuration Page

Within the configuration page, users enjoy the freedom to customize their album generation experience. They can choose the album's orientation, select a background color, opt to employ the image background recognition model, and specify the number of photos to include on each page of the album.



*Fig 10. Album Browsing*

### 3. Album Browsing Page

The Album Browsing Page is the visual culmination of the Smart Album Generator System, where users can delight in the fruits of their configuration and photo uploads. Users have the convenience of downloading their albums for digital archiving or printing. High-quality PDF downloads ensure that the memories captured in the album are preserved in the best possible format.

## 4.2 Overall Design

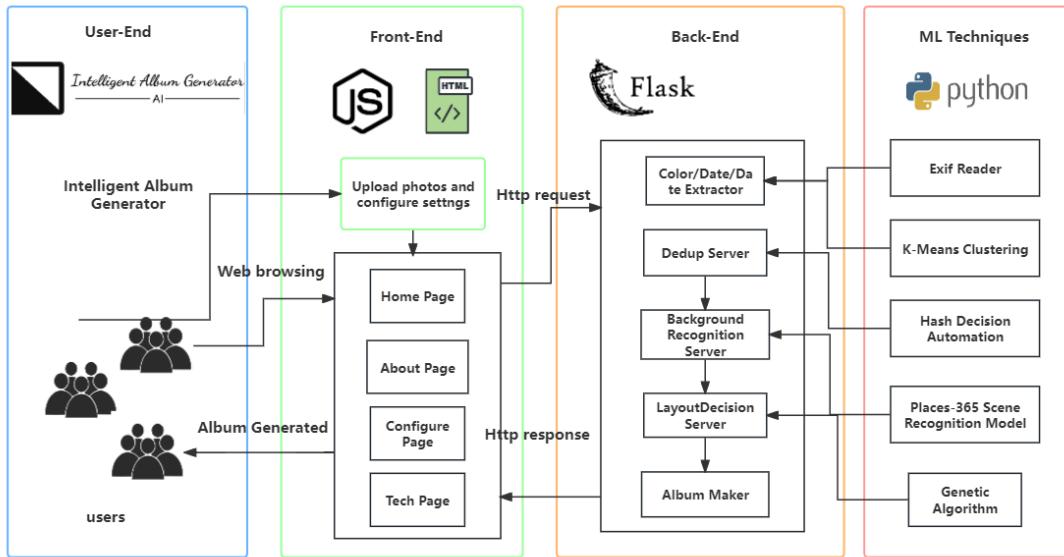


Fig 11. System Overall Design

The intelligent album generator system is designed to facilitate the creation of PDF photo albums through a seamless interconnection between front-end and back-end components via API interfaces.

It comprises three essential front-end pages: the photo upload page, the album configuration page, and the album browsing page, which allows users to view the final PDF album. On the back-end, the system leverages four key components encapsulated within Docker containers: the Deduplication Server, Recognition Server, Layout Decision-Maker, and Album Maker.

### Back-end Services Collaboration

#### 1. Deduplication Server

Identifies and removes duplicate photos to ensure album uniqueness using image information extraction and hash function.

#### 2. Recognition Server

Analyzes photos, extracting vital features such as capture time, location, and predominant colors. Multiple models are internally called in parallel for this analysis.

#### 3. Layout Decision-Maker

Utilizes information from the Recognition Server to arrange similar photos on the same page, optimizing the album's visual appeal through genetic algorithms and page-based chromosome representation.

#### 4. Album Maker

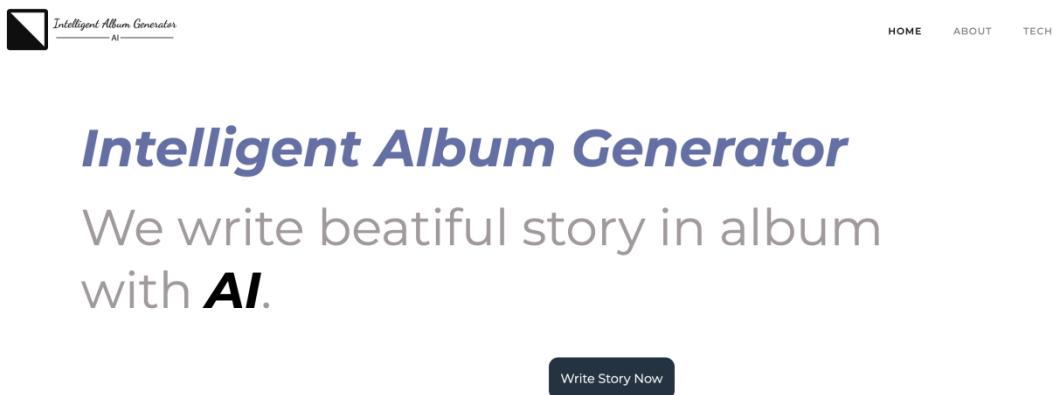
IRS-Intelligent-Reasoning-Systems-Practice-Project-Group17  
Based on the Layout Decision-Maker's output, selects the most suitable layout and assembles the final PDF album.

#### 4.3 Front-End Construction



Fig 12. Intelligent Album Generator Logo

Our logo features a sophisticated black and white photo album icon on the left, accompanied by the elegant typography of "Intelligent Album Generator" and the subtle inclusion of the "AI" symbol on the right. This composition encapsulates the perfect fusion of classic aesthetics and cutting-edge AI technology, symbolizing our commitment to seamlessly blending tradition with innovation in the world of album creation.

The screenshot shows the homepage of the "Intelligent Album Generator". At the top left is the logo. To its right is the text "Intelligent Album Generator" and "AI". On the far right are three navigation links: "HOME", "ABOUT", and "TECH". The main title "Intelligent Album Generator" is centered in a large, bold, blue font. Below it, a subtitle "We write beatiful story in album with AI." is displayed in a smaller, gray font. A dark blue button labeled "Write Story Now" is located at the bottom right of the main content area.

*Layout multiple photo albums at once!*

Fig 13. System Home Page

At the pinnacle of our homepage, in the leftmost corner, lies our logo, a symbol of traditional album generation and AI innovation. To the right, an array of three distinguished links beckon: "Home," "About," and "Tech." The "About" link opens a gateway to unveil the prowess of our dedicated team, while "Tech" unveils the intricate gears of our technological marvel. The "Write Story" button becomes a portal to unleash the creative power of our system, promising to weave captivating narratives and unforgettable memories into every album.

Want to get in touch?  
Drop me a line!

Customers are very satisfied with customer service, and they will definitely get customer services.

NAME

EMAIL ADDRESS

FORM LABEL  
Enter your message

SUBMIT

Fig 14. Online Query Design

Our meticulously crafted query interface stands as a gateway to foster meaningful connections with our users. With an emphasis on both user engagement and business value, this feature empowers individuals to seamlessly reach out to our team, forging a direct link between their queries and our solutions.

Through the elegance of this interface, users can share their identity, including their name and email address, while articulating their inquiries. This exchange, in turn, not only enriches our understanding of our users' needs but also positions us to deliver tailored and responsive support.

### Our Team

Build an AI photo album layout system.



Xiang Yi



Yin Siyuan



Yan Fu



Tang Haoran



Ren Jianan

Fig 15. About Team Members

Our Team Introduction page is a gallery of the masterminds behind this visionary project, where the faces and names of our talented team members take center stage.



INTELLIGENT ALBUM GENERATOR

How do we arrange the album?

Read information from Exif

*Fig 16. Tech Page*

Our Feature Introduction page is a captivating showcase of the technological prowess that underpins the very foundation of this AI intelligent album project. Within this digital sanctuary, we unveil the intricate web of cutting-edge AI technologies and methodologies that power the magic behind the scenes.

#### 4.4 System Backend and Model

The system's backend infrastructure and the integration of deep learning models are pivotal components that empower the core functionality of generating high-quality photo albums. The detailed part of the backend development is covered in chapter 3.

#### 4.5 System Usability Testing

##### 4.5.1 Method

We apply the method to send the questionnaire with our application to obtain feedback. The type of questionnaire is System Usability Scale (SUS). According to John Brooke's industrial experience in Digital Equipment Corporation, this 10-statement survey is short and reliable, so user can answer all questions patiently, and the data to assess subjective reactions to system usability will be sufficient. This questionnaire is suitable for the situations where we want to get quick and reliable results.

##### 4.5.2 Participants

Twelve people participated in the questionnaire survey whose ages are ranged around 25 years old. Before each participant filled in the questionnaire, we briefly introduced the intelligent album generator about the system functions to them and set 5 minutes

#### 4.5.3 Results

To evaluate the SUS responses, we look at the mean and standard deviations. Since the odd-number questions are asked from a positive perspective, and even-number questions are asked from a negative perspective. We map the score of all questions into positive nature to ensure consistency. In addition, we apply the color representation to help visualize the results. The figure of mapping rules is as follow.

*Table 2. SUS Evaluation*

| Odd-number question score | Even-number question score | SUS score | Adjective rating | Indicating color  |
|---------------------------|----------------------------|-----------|------------------|---|
| 5                         | 1                          | 80.3-100  | Excellent        |  |
| 4                         | 2                          | 68-80.3   | Good             |  |
| 3                         | 3                          | 68        | Acceptable       |  |
| 2                         | 4                          | 51-68     | Poor             |  |
| 1                         | 5                          | 0-51      | Not acceptable   |  |

The next figure presents the data we have obtained which is already converted according to the mapping table. According to the average scoring, the system is rating as a Good level.

|             | Question 1 | Q 2  | Q 3  | Q 4  | Q 5  | Q 6  | Q 7  | Q 8  | Q 9  | Q 10 | Scoring |
|-------------|------------|------|------|------|------|------|------|------|------|------|---------|
| Evaluation1 | 4          | 3    | 5    | 3    | 5    | 2    | 5    | 3    | 5    | 1    | 80      |
| E 2         | 5          | 1    | 5    | 4    | 4    | 2    | 3    | 1    | 5    | 4    | 75      |
| E 3         | 5          | 3    | 5    | 3    | 5    | 5    | 4    | 1    | 1    | 1    | 67.5    |
| E 4         | 4          | 2    | 4    | 2    | 4    | 2    | 3    | 2    | 4    | 2    | 72.5    |
| E 5         | 3          | 3    | 5    | 1    | 4    | 3    | 4    | 3    | 5    | 2    | 72.5    |
| E 6         | 1          | 1    | 4    | 1    | 1    | 1    | 2    | 3    | 2    | 3    | 52.5    |
| E 7         | 4          | 1    | 5    | 1    | 3    | 2    | 5    | 2    | 4    | 1    | 85      |
| E 8         | 3          | 3    | 4    | 2    | 3    | 4    | 4    | 4    | 3    | 3    | 78.5    |
| E 9         | 5          | 4    | 5    | 4    | 4    | 2    | 2    | 4    | 4    | 4    | 80      |
| E 10        | 5          | 1    | 4    | 1    | 4    | 1    | 5    | 3    | 5    | 1    | 90      |
| E 11        | 5          | 3    | 3    | 3    | 4    | 4    | 3    | 3    | 5    | 4    | 57.5    |
| E 12        | 4          | 3    | 4    | 1    | 3    | 4    | 4    | 4    | 4    | 2    | 62.5    |
| Average     | 4          | 2.33 | 4.42 | 2.17 | 3.67 | 2.67 | 3.67 | 2.75 | 3.92 | 2.33 | 75.4    |

## 5. Conclusion

### 5.1 Summary

The main goal of the Intelligent Album Generator was to create a user mobile friendly solution that seamlessly integrates with social media accounts. Its purpose is to make it easier for users to create albums that align with their preferences and memories. This system uses learning and machine learning techniques to analyze the content of photos. It can identify objects, for layout design, categorize content. Generate relevant titles. By focusing on photo sorting and editing based on factors like time, location and theme our project aims to enhance the appeal of each album and provide a more satisfying user experience.

In terms of system design both the end and back-end components have been carefully crafted to work together smoothly. The front end allows users to upload photos configure albums and view them seamlessly through API interfaces. On the back-end side four core components. Deduplication Server, Recognition Server, Layout Decision Maker and Album Maker. Work collaboratively to generate the PDF album. The Deduplication Server ensures that each album is unique by identifying and removing photos. The Recognition Server analyzes features of photos while the Layout Decision Maker utilizes algorithms, for better layout results. Finally, the Album Maker assembles all these components together into a PDF album.

Our process, for collecting and preparing data integrates models like Place365 for recognizing scenes, color classifiers and logically organizing photos based on factors such as time, scene, subject and color combinations. We have also developed a set of guidelines to ensure that the photo album generation process produces visually appealing and harmonious results.

### 5.2 Limitation

However, it is important to acknowledge that our project has some limitations. We are mindful of privacy concerns. Recognize the need for enhancements to safeguard user data. Additionally, we anticipate challenges in improving the accuracy and efficiency of image recognition managing data quality and addressing formatting errors in output formats.

### 5.3 Future Plan

Looking ahead we plan to extend our project to address these limitations gradually. Our focus will be on offering choices and diverse options that cater to user preferences and providing previews to ensure user satisfaction. Continuously refining our image classification and sorting algorithms will be crucial as we aim to enhance the systems adaptability and user friendliness.

In conclusion the Intelligent Album Generator represents an advancement, in how we treasure and revisit our memories.

Our project is built on a base. Has a focus, on future enhancements. It is set to offer lasting advantages to users by giving them a customized means to relive their most treasured memories.

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## 7. Appendix

### Appendix A: Project Proposal

|  |
|--|
| <b>Date of proposal:</b> October 28, 2023  |
| <b>Project Title:</b> Intelligent Album Generator  |
| <b>Group ID (As Enrolled in Canvas Class Groups): Group 17</b>   |
| <b>Group Members (name, Student ID):</b>   |
| XIANG YI, A0285838J<br>YAN FU, A0286045B<br>YIN SIYUAN, A0286060H<br>REN JIANAN, A0285879Y<br>TANG HAORAN, A0285856J   |
| <b>Sponsor/Client:</b> ( <i>Company Name, Address and Contact Name, Email, if any</i> )<br>Institute of Systems Science (ISS) at 25 Heng Mui Keng Terrace, Singapore<br>NATIONAL UNIVERSITY OF SINGAPORE (NUS)   |
| <b>Background/Aims/Objectives:</b><br><p>The Intelligent Album Generator is poised to transform how we manage and treasure our memories. As the globe shifts more towards digitalization and our photo repositories grow, there emerges a pressing demand for a tailored approach to curate photo albums. Our initiative meets this demand by unveiling a mechanism that autonomously crafts albums tailored to individual tastes. Users can seamlessly upload pictures and furnish narratives to shape albums that echo their personal journeys and feelings.</p> <p>Our project is geared towards crafting an Intelligent Album Creator that streamlines the steps of uploading photos, inputting descriptions, and forming albums. This system emphasizes photo organization, harnessing advanced machine learning techniques to produce aesthetically pleasing and tailored albums.</p> <p>The endeavor is focused on creating a sophisticated photo album builder with these features:</p> <ol style="list-style-type: none"><li>1. Intuitive Design: An interface designed for ease, enabling users to upload a multitude of photos effortlessly.</li><li>2. Album Automation: Leveraging deep learning and image analysis to autonomously determine the album's layout, aesthetic, and theme.</li></ol> |

3. Smart Adjustments: Detects the dominant color, backdrop, and time of capture in photos. It also matches the photo's dimensions with optimal templates to enhance visual appeal.

4. PDF Album Export: Offers the capability to render albums in PDF format, facilitating easy sharing and printing for users.

5. Quick Turnaround: Prioritizes swift album generation to enhance the overall user experience.

The Intelligent Album Generator is not just a mechanism for sorting photos; it enriches our existence. It streamlines the process of crafting bespoke photo collections, offering a solution that's not only efficient and time-conserving but also deeply evocative. It allows individuals to revisit their memories in a manner that resonates profoundly with them. This initiative transcends mere automation; it signifies a leap forward in the way we interact with our past and bond with those who have been part of those cherished times.

### **Project Descriptions:**

#### **Problem Statement**

Our project strives to offer a single-click solution for producing albums in the PDF format, powered by state-of-the-art AI capabilities. It harnesses deep learning and machine learning methodologies to scrutinize photo contents, pinpoint objects, craft layouts, and smartly organize and amplify images according to timestamp, locale, and theme, thereby enhancing the album's aesthetics. Moreover, we acknowledge specific hurdles we must overcome, such as safeguarding user privacy, ensuring precise image detection, preserving top-tier data quality, and circumventing conversion-related errors. We'll need to deliberate on these issues and devise strategies as we progress.

The following are some difficulties for our project:

1. In real life, users often upload similar pictures. For this situation, how does the system identify the similarity of images and retain only one image among similar images. During this process, we need to prevent the system from excessively deleting photos.
2. How to create a smart photo album generation system that allows users to upload multiple photos and automatically generate a photo album to meet users' needs for photo organization and sharing.
3. When the system generates photo albums based on photos uploaded by users, what basis should we use to allow the system to classify pictures and what basis should we use to layout the album.

At the same time, system performance may be limited by the quality of photos uploaded by users. The privacy and security of photos uploaded by users and generated album data need to be ensured. And technical challenges in deep learning and image recognition need to be overcome.

### **Market Research**

With the growing user demand for digital photo services, there's a promising future for intelligent photo album creation systems. Born from the digital era, these systems assist users in auto-organizing numerous pictures into albums. The market currently offers varying grades of album creation services. Leveraging AI enhances the system's automation, intelligence, and customization, offering users an enriched experience. Moreover, developers can craft an integrated ecosystem that combines features like cloud photo storage, album crafting, and social media sharing, elevating the user experience and drawing in a larger audience.

### **Market Needs and User Preferences**

The market is leaning towards tailored customization features, with users desiring the flexibility to select styles, layouts, and themes. They seek a diverse array of templates catering to various occasions and tastes. Moreover, an intuitive and straightforward interface is essential, enabling users to craft exquisite photo albums sans professional design expertise.

### **Target Audience**

Primarily tailored for individuals aiming to effortlessly construct stunning photo albums to memorialize and disseminate unique moments.

### **Expenditure Breakdown**

Funds channeled into crafting and updating the intelligent photo album creation system. Costs associated with the necessary servers and foundational setup to support and operate the system. Outlays for advertising, system upkeep, and ongoing enhancements.

### **Revenue Streams**

Users have the option to buy premium and intricate photo album designs. Tiered subscriptions, both basic and premium, are offered. Forming alliances with photo print service providers for a slice of the printing profits and engaging with advertisers to curtail advertising promotional expenditures.

### **Proposed Solution**

Our advanced photo album creation tool addresses user challenges, facilitating the effortless design of captivating albums to immortalize cherished memories. With adept automation and intelligent editing, we ensure top-tier albums that resonate with diverse user inclinations. The essence of our business blueprint is to deliver accessible and premium album creation services, generate income via subscription

and pay-per-use models, and augment revenue and market footprint through collaborations. Our commitment to incessantly refine our system and draw both users and partners is steered by our mission to encapsulate ephemeral moments, propelling business expansion and profitability.

## System Architecture

### 1. Interaction Platform

Via the online portal, users can engage with the system, upload their photographs, adjust settings, and obtain their personalized photo albums.

### 2. Client-side Server

This server manages requests from the interactive platform, processes user inputs, and showcases the outcomes.

### 3. Core Server

Acting as the system's nucleus, the backend server supervises all essential logic and photo manipulation tasks. It processes requests from the client-side server, invoking deep learning algorithms and imaging engines.

### 4. Advanced Learning Mechanism

This component is the brain of the system, harnessing deep learning to recognize photographic backgrounds. The Places365 dataset, a modern subset of the Places2 Database, is instrumental here.

### 5. Refinement Algorithm

After the initial processing, the Layout Decision-Maker module springs into action. With insights from the Recognition Server, it clusters similar photos for unified page placement, amplifying the album's aesthetic quotient.

### 6. Final Production

Users are presented with their customized photo album in a downloadable or printable PDF format.

### 7. Performance Tracking and Documentation

For optimal functionality, it's essential to incorporate performance tracking measures and maintain detailed logs, ensuring prompt issue identification and streamlined system upkeep.

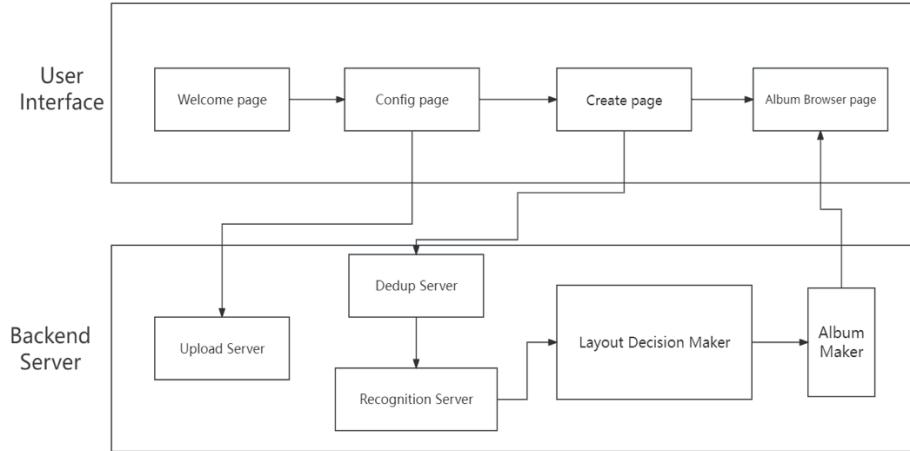


Fig 1. System Architecture Diagram

### Hash-Based Photo Filtering

To produce a unique photo album, it's essential to eliminate highly similar images. We employ hash values for this task, a prevalent technique in image processing. Here's a streamlined outline of our process: Convert image features to hash codes, which are fixed-length binary strings. Match the newly generated hash with existing ones using Hamming distance, which counts the differing positions between two equal-length strings. A smaller distance suggests greater image similarity. Set a benchmark Hamming distance. If two images fall within or below this distance, they're deemed similar. Elimination of Similarities: Remove identified similar images from the collection.

### K-means Clustering

In this endeavor, we employ the K-means Clustering technique to pinpoint dominant RGB hues. The essence of our approach is to transform the image into an extensive pixel array. By leveraging K-means clustering, we ascertain the prevailing colors from this array. The outcome presents these primary shades along with their relative presence in the image. Through this method, the system adeptly discerns and isolates the principal colors of the picture.

### Genetic Algorithm

For the execution of a particular genetic algorithm, six critical elements must be tackled: the formulation of the chromosome framework, the identification of the fitness function, the setting of selection parameters, the creation of crossover techniques, the orchestration of mutation approaches, and the amalgamation of these facets for the continuous optimization cycle. Inspired by genetic algorithms employed in addressing the Traveling Salesman Problem (TSP), we've uniquely crafted a genetic algorithm bespoke to image layout.

### Experiment Outline

Experiments are conducted by the following device.

**Table 1. Experiment Device**

| Hardware   |
|--|
| CPU: 11th Gen Intel(R) Core(TM) i7-11800H                  |
| GPU: NVIDIA GeForce RTX 3050 Ti Laptop GPU with 4GB memory |
| Memory: 16GB RAM   |
| Disk: NV900-1TB  |

### Timeline

The project officially begins in the end of September 2023 and is expected to end on 29 October, for approximately 1 month. The following table will map out the timeline of this project in detail.

**Table 2. Project Timeline**

| Programme  | completion date   |
|--|-------------------|
| <b>Project research and overall planning</b>                   | <b>2023/10/1</b>  |
| <b>Image recognition such as main colour recognition, etc.</b> | <b>2023/10/8</b>  |
| <b>Genetic Algorithm Design</b>                                | <b>2023/10/15</b> |
| <b>Similar Image Recognition and Image Typography</b>          | <b>2023/10/19</b> |
| <b>Front-end design and development</b>                        | <b>2023/10/24</b> |
| <b>Overall adaptation and testing</b>                          | <b>2023/10/27</b> |
| <b>Report &amp; video Generated</b>                            | <b>2023/10/29</b> |

### Conclusion

The primary objective of our Intelligent Album Generator is to offer a mobile-optimized solution that effortlessly syncs with social media platforms. It aims to simplify the album creation process for users, ensuring the output resonates with their personal tastes and cherished moments. This platform employs advanced learning

and machine learning methods to delve into photo content. It's adept at recognizing objects, designing layouts, categorizing visuals, and suggesting apt titles. By emphasizing photo organization and refinement based on parameters like timing, location, and theme, our endeavor is to augment the allure of each album, delivering an enriched user journey.

From a systems perspective, we've meticulously designed both frontend and backend elements to function in unison. The frontend facilitates hassle-free photo uploads, album adjustments, and visualization through APIs. The backend boasts four pivotal components: the Deduplication Server, Recognition Server, Layout Decision Maker, and Album Maker. These units collaboratively craft the final PDF album. The Deduplication Server ensures album distinctiveness by detecting and omitting redundant images. Meanwhile, the Recognition Server probes into photo traits, and the Layout Decision Maker employs algorithms to optimize layout quality. Conclusively, the Album Maker consolidates everything into a polished PDF album.

Our data assembly and refinement approach incorporate models like Place365 for scene detection, alongside color classifiers. This helps in judiciously arranging photos by criteria like timing, ambiance, main subject, and color schemes. Furthermore, we've established a comprehensive guideline framework to guarantee that the album creation journey yields visually captivating and coherent outcomes.

## Appendix B: Techniques and Skills

In the pursuit of creating intelligent and aesthetically pleasing photo albums, our module blends the principles of Machine Reasoning, Reasoning Systems, and Cognitive Systems. This comprehensive approach empowers us to harness the power of artificial intelligence, deep learning, and optimization techniques, ensuring that every photo album generated is a work of art. The detailed mapped system functionalities table is as follows.

| Module Courses           | Knowledge and Skills  |
|--------------------------|---|
| <b>Machine Reasoning</b> | <p><b>K-means Clustering</b></p> <ul style="list-style-type: none"> <li>➤ Proficiency in K-means Clustering algorithm.</li> <li>➤ Skill in clustering data points in n-dimensional space.</li> <li>➤ Expertise in identifying the main colors in images.</li> <li>➤ Understanding of color distribution and analysis.</li> </ul> <p><b>Hashing Methods</b></p> <ul style="list-style-type: none"> <li>➤ Knowledge of various hashing methods (aHash, LSH, pHash)</li> <li>➤ Ability to convert image features into hash codes.</li> <li>➤ Skill in comparing hash codes and using Hamming distance.</li> <li>➤ Setting thresholds to identify similar images.</li> </ul> <p><b>Deep Learning</b></p> <ul style="list-style-type: none"> <li>➤ Understanding of deep learning models and architectures.</li> <li>➤ Knowledge of neural networks and their applications.</li> <li>➤ Ability to train and use deep learning models.</li> <li>➤ Familiarity with Places365 dataset</li> </ul> |

|                          |  |
|--------------------------|--|
|                          | and scene categories.  |
| <b>Reasoning Systems</b> | <p><b>Genetic Algorithms</b></p> <ul style="list-style-type: none"> <li>➤ Understanding genetic algorithm concepts and principles.</li> <li>➤ Knowledge of chromosome structure and fitness functions.</li> <li>➤ Proficiency in selection, crossover, and mutation processes.</li> <li>➤ Skill in implementing genetic algorithms for optimization.</li> <li>➤ Ability to optimize photo album layouts based on multiple factors.</li> </ul> <p><b>Optimization Models</b></p> <ul style="list-style-type: none"> <li>➤ Ability to design optimization models for layout decisions.</li> <li>➤ Skill in selecting appropriate templates and photo arrangements.</li> <li>➤ Knowledge of layout factors, such as photo relevance and size.</li> <li>➤ Understanding of user preferences and aesthetics in layout.</li> </ul> |
| <b>Cognitive Systems</b> | <p><b>User Interface</b></p> <ul style="list-style-type: none"> <li>➤ Proficiency in web development technologies (HTML, CSS, JavaScript)</li> <li>➤ Skill in creating user-friendly interfaces for photo album generation.</li> <li>➤ Understanding of human &amp; computer interaction in AI related project.</li> <li>➤ Ability to present results to users effectively through the UI.</li> </ul> <p><b>Backend Server</b></p> <ul style="list-style-type: none"> <li>➤ Knowledge of web application development with Flask framework.</li> </ul>  |

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|  |  |
|--|--|
|  | <ul style="list-style-type: none"><li>➤ Skill in handling user requests and business logic processing.</li><li>➤ Understanding of server-side architecture and components.</li></ul> |
|--|--|

## Appendix C: Installation and User Guide

### 1 Getting Started

#### 1.1 Quick Start

For a quick start, a demo system has been deployed on the Tencent Cloud Server, and the only system requirement is a modern web browser. You can also access it from your mobile phone.

Steps:

Launch your web browser and visit <http://43.134.45.203/>.

Note:

The cloud server is rented for one month, and it will expire on 2023-11-24. If the server becomes inaccessible, you can try installing the system on your local computer.

#### 1.2 Full Installation

##### System Requirements

The Intelligent Album Generator can only be run on macOS or Linux systems. This is because we use a python package called pyheif to read HEIC image formats, which is compatible only with macOS and Linux.

##### Dependencies

- Anaconda
- A modern web browser

##### Pre-requisites

- Clone or download project source code from GitHub repository.

##### Starting the System

1. Navigate to the backend code in your local copy of the GitHub repository at `\\system\_code\\backend`. You can check the current path using command `pwd`.

```
(base) stacy@Stacylittle-MacBook-Pro backend % pwd  
/Users/stacy/ice/5001project_code/system_code/backend
```

2. Open the terminal and install the followings packages.

```
`conda create -n album python=3.11`  
`conda activate album`
```

```
(base) stacy@Stacylittle-MacBook-Pro 5001project_code % conda activate album  
[album] stacy@Stacylittle-MacBook-Pro 5001project_code %
```

After running these commands, your conda environment should be set to “album”.

3. Install the required Python project dependencies:

```
`pip install -r requirements.txt`
```

4. Run app.py by entering the following command in the console to start the backend

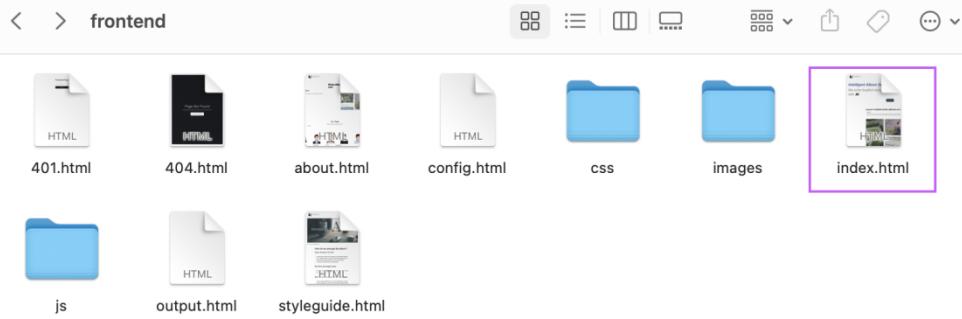
server:

```
`python -m flask run --host=0.0.0.0`
```

If console displays the following message, the backend server has starts successfully.

```
(album) stacy@Stacylittle-MacBook-Pro backend % python -m flask run --host=0.0.0.0
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/layout_decision_maker/templates_manager.py:load the template files successfully
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/layout_decision_maker/templates_manager.py:load 14 files
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/album.py:initiate successfully
* Debug mode: off
INFO:werkzeug:WARNING: This is a development server. Do not use it in a production deployment.
Use a production WSGI server instead.
* Running on all addresses (0.0.0.0)
* Running on http://127.0.0.1:5000
* Running on http://172.17.24.112:5000
INFO:werkzeug:Press CTRL+C to quit
```

5. Navigate to the frontend path to open `index.html` to join the system immediately.



## 2 User Guide

### 2.1 Generate Your First Album

When you double-click `index.html` file in the frontend document, you can explore our website. The website consists of three main pages: Home, About and Tech. You can create your first album on the home page. If you have any questions about using the system, you can contact us on the About page. The Tech page provides technical details about the system.

To create your first album, follow these steps:

1. Click on the “Write Story now” button on the home page. You will be redirected to the configuration page where you can upload your images and adjust your settings.

## Intelligent Album Generator

We write beatiful story in album  
with **AI**.

[Write Story Now](#)

- After you've filled in all the options, click the "submit" button to generate your album. If you choose "Yes" in the background recognition option, it may take a bit longer as the system will run a background recognition model to get the background features, which requires some time.

```
● ● ●  backend --root@VM-0-6-centos:~-- python -m flask run --host=0.0.0.0 --port=100x9
INFO:User@VM-0-6-centos:~/Desktop/Project_code/system_code/backend/album/layout_decision_maker/template_main.py:10
gen.load_template_file()
INFO:User@VM-0-6-centos:~/Desktop/Project_code/system_code/backend/album/layout_decision_maker/template_main.py:11
gen.load_template_file()
INFO:User@VM-0-6-centos:~/Desktop/Project_code/system_code/backend/album/layout_decision_maker/template_main.py:12
gen.load_template_file()
INFO:User@VM-0-6-centos:~/Desktop/Project_code/system_code/backend/album/layout_decision_maker/0A.payload is
on file /Users/stacy/lss/508lprproject_code/system_code/workspace/2023.10.28_16.09.59/2023.10.28_16.14
.2023.10.28_16.09.59.res.json
INFO:DNA String successfully
subf_DNA_String
generation_idx: 0 best_fitness: 4.09 -0.98908843277
generation_idx: 1 best_fitness: -3.416556243374538
generation_idx: 2 best_fitness: -3.416556243374538
generation_idx: 3 best_fitness: -3.416556243374538
generation_idx: 4 best_fitness: -3.416556243374538
generation_idx: 5 best_fitness: -3.416556243374538
generation_idx: 6 best_fitness: -3.416556243374538
generation_idx: 7 best_fitness: -3.416556243374538
generation_idx: 8 best_fitness: -3.416556243374538
generation_idx: 9 best_fitness: -3.416556243374538
generation_idx: 10 best_fitness: -3.416556243374538
generation_idx: 11 best_fitness: -4.83879432374538
generation_idx: 12 best_fitness: -4.83879432374538
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generation_idx: 31 best_fitness: -4.376882539467813
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generation_idx: 37 best_fitness: -4.376882539467813
generation_idx: 38 best_fitness: -4.376882539467813
generation_idx: 39 best_fitness: -4.376882539467813
```

Create your photo album!

Maximum number of photos on a page

Background Color

CHOOSE THE COLOR YOU WANT:

Image Upload

UPLOAD YOUR IMAGES

CHOOSE YOUR IMAGES

Images uploaded successfully!

Background Recognition

Yes

Submit

- You can also monitor the process in the console. After 50 iterations of genetic algorithm, the system will determine the optimal layout plan and generate the album as a PDF file. You can find local path to the PDF in the console, and the website will automatically jump to PDF browsing page.

## IRS-Intelligent-Reasoning-Systems-Practice-Project-Group17

backend - root@VM-0-6-centos:~ -- python -m flask run --host=0.0.0.0 --port=82...

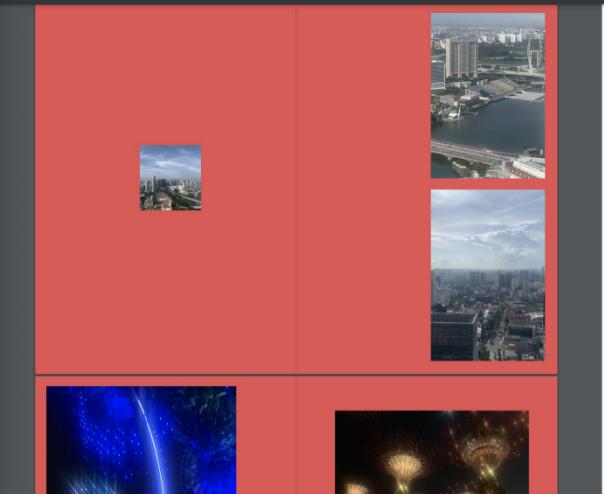
```

generation idx: 21 best_fitness: -3.41656243374538
generation idx: 22 best_fitness: -3.41656243374538
generation idx: 23 best_fitness: -3.41656243374538
generation idx: 24 best_fitness: -3.41656243374538
generation idx: 25 best_fitness: -3.41656243374538
generation idx: 26 best_fitness: -3.41656243374538
generation idx: 27 best_fitness: -3.41656243374538
generation idx: 28 best_fitness: -3.41656243374538
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generation idx: 31 best_fitness: -3.376882539467813
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generation idx: 41 best_fitness: -3.376882539467813
generation idx: 42 best_fitness: -3.376882539467813
generation idx: 43 best_fitness: -3.376882539467813
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generation idx: 45 best_fitness: -3.376882539467813
generation idx: 46 best_fitness: -3.376882539467813
generation idx: 47 best_fitness: -3.376882539467813
generation idx: 48 best_fitness: -3.376882539467813
generation idx: 49 best_fitness: -3.376882539467813
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/layout_decision_maker/layout_decision_maker.py:layout decision making part
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/layout_decision_maker/layout_decision_maker.py:output path: /Users/stacy/iss/5001project_code/system_code/workspace/2023.10.28.16.09.59/2023.10.28.16.33/layout/res.json
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/album.py:layout decision process success
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/album_maker/album_maker.py:generate album pdf successfull
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/album_maker/album_maker.py:album pdf path: /Users/stacy/iss/5001project_code/system_code/workspace/2023.10.28.16.09.59/2023.10.28.16.33/album.pdf
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/album.py:album maker process success
INFO:/Users/stacy/iss/5001project_code/system_code/backend/album/album.py:album path: /Users/stacy/iss/5001project_code/system_code/workspace/2023.10.28.16.09.59/2023.10.28.16.33/album.pdf
INFO:/Users/stacy/iss/5001project_code/system_code/backend/app.py:finish
INFO:wertzeug:127.0.0.1 - [28/Oct/2023 16:14:43] "POST /album HTTP/1.1" 200 -

```

album.pdf

1 / 4    33%    +    :   



## Appendix D: Individual Reports

**Name:** Xiang Yi

**Matriculation Number:** A0285838J

### Personal contribution to group project:

In the development of the project, I primarily focused on three areas:

#### 1. Backend Development

I designed and developed the backend framework code based on the project requirements. The framework proved to be immensely useful for our team, as it allowed each team member to understand the input and output formats for their respective parts, enabling individual testing. Additionally, it only took a little time for us to integrate our code.

Developing the genetic algorithm and album maker code was my work. This involved understanding how to apply the genetic algorithm to address specific problem. I made innovative adjustment to the genetic algorithm to suit our needs. Additionally, I utilized packages such as PyPDF2 and Pillow to generate a complete album based on the layout result.

#### 2. System Deployment

Working together with Ren jianan, we deployed our system on a commercial server, making it easier for uses to access. This deployment also facilitated the connection between the backend and frontend.

#### 3. Video and Report

I documented my work in the project report and created a system architecture introduction video with my teammates.

### What learnt is most useful for you:

This is the first time for me to use genetic algorithm to solve a specific problem. I've gained a lot about how to use a genetic algorithm to solve specific issues, going beyond its fundamental concepts. Genetic algorithms are no longer abstract and mysterious to me. The process of learning and innovatively adapting existing algorithms to suit to specific problem are beneficial for me.

Integrating all the code and connecting the frontend and backend were challenging tasks. It took both me and my teammate a lot of time to pinpoint the reasons for the frontend and backend communication issues. This process honed our patience, communication skills and the fundamental computer skills.

**How you can apply the knowledge and skills in other situations or your workplaces:**

When I encounter some optimization questions like the traveling salesman problem, I will consider using a genetic algorithm to address. It is an intuitive, effective and flexible method that can tackle complex and challenging questions. I am so curious about different evaluation strategies and enjoy trying them out to achieve optimal results.

|  |  |
|--|--|
| <b>Name:</b> Ren Jianan  | <b>Matriculation Number:</b> A0285879Y |
| <b>Personal contribution to group project:</b>   |  |
| In this project, I play multiple roles, including front-end development engineer, back-end development engineer and multimedia editor.   |  |
| 1. Front-end work:<br><br>Web application development: I used VS Code to complete the writing of HTML, CSS and JavaScript code, creating a modern web application interface to ensure that users can use and navigate easily. I designed and implemented the front-end logic and functions of the web application, including home page, configuration page, introduction page, about us.<br><br>Responsive design: I ensure that the web app displays and responds well to user actions on a variety of devices. |  |
| 2. Back-end work:<br><br>I implemented image processing functions, including extracting time information and aspect ratio, designing album background color, and extracting main colors. I called the Place365 scene recognition model API so that the web application can automatically recognize scenes in images, which is very important for content classification.   |  |
| 3. Multimedia editor:<br><br>I am responsible for producing the advertising video for the project. This includes video editing, adding special effects, and audio processing to create an engaging ad for promoting your web app.  |  |
| <b>What learnt is most useful for you:</b>   |  |
| 1. This project gave me a deeper understanding and more experience in genetic algorithms. The most useful thing I learned was how to apply genetic algorithms to real-world scenarios to solve optimization problems.<br><br>2. I also tried to train a color recognition model through supervised learning, using labeled color pictures. It helped me master some skills and experience.   |  |

**How you can apply the knowledge and skills in other situations or your workplaces:**

I am very interested in genetic algorithms. After checking the information, I found that he is interested in path planning: In autonomous driving, robot navigation and logistics, genetic algorithms can be used to determine the best path, considering various factors, such as traffic, terrain, and resource allocation. It just so happens that I really want to be an autonomous driving engineer, and I plan to study related fields in my spare time.

|  |                                 |
|--|---------------------------------|
| Name: Tang Haoran  | Matriculation Number: A0285856J |
| <b>Personal contribution to group project:</b>   |                                 |
| I contribute to three parts of this project:   |                                 |
| 1. System design: Participate in system hierarchy design, detailed function design and machine learning algorithm selection. Present creative ideas during the group discussion. For example, come up with a practical idea about recommending strategy -- analyze photos and produce appropriate recommendation based on colour of photos and entities in their content.  |                                 |
| 2. Python development: Complete filtering out duplicate or parlous similar picture tasks by using the library to generate hashes, for each image and establish a similarity threshold to determine whether images are duplicates. The process involves analyzing the hashes of all the images in a folder identifying pairs with hash differences below the threshold as similar. Additionally, it calculates similarity scores to provide a measure of likeness. Furthermore, for each pair of images it calculates the similarity score. Selects one image while excluding the other effectively removing duplicates, from the image collection while retaining any remaining unique images. |                                 |
| 3. Report: Participate in the writing of project reports, summarize the project background, project characteristics and target user groups, etc., and show the specific details of the project to interested investors in a clear report format. Finally, the content of the project is summarized, the shortcomings of the project are reflected in depth, and a feasible and creative future improvement plan is proposed.   |                                 |
| <b>What learnt is most useful for you:</b>   |                                 |
| Throughout this project I've had the opportunity to develop a range of skills and expand my knowledge in important areas. I gained experience in tasks such, as collecting and organizing data preparing it for analysis and training both Machine Learning and Deep Learning models. This journey has deepened my understanding of object detection including the models commonly used how they work, and the techniques employed to evaluate and optimize their performance. Additionally, I have made progress in Python programming skills allowing me to effectively implement data driven solutions and build ML/DL models.  |                                 |
| <b>How you can apply the knowledge and skills in other situations or your workplaces:</b>  |                                 |
| As I get ready, for my future, in computer vision after graduating the practical knowledge and skills I have gained in this field are incredibly important. The expertise I have acquired in object detection holds a value. When faced with challenges related to object detection, I can use the knowledge and experience I have gained to suggest and implement systems more efficiently which makes finding effective solutions easier.  |                                 |

|                  |                                 |
|------------------|---------------------------------|
| Name: Yin Siyuan | Matriculation Number: A0286060H |
|------------------|---------------------------------|

**Personal contribution to group project:**

Throughout the course of this project, I undertook multiple roles and responsibilities that contributed significantly to the group's success. My primary contributions can be summarized as follows:

1. System Prototype Development: I played a pivotal role in the development of the prototype for the Intelligent Album Generator system. This involved implementing and refining key features and functionalities, ensuring that the system aligned with our project objectives and user requirements.
2. Project Initiation and Organization: I actively participated in the inception of the project, where we brainstormed and conceptualized the project idea. I also organized and facilitated group meetings, recorded meeting minutes, and managed project progress. This ensured that our project stayed on track and met key milestones.
3. Report Task Division and Compilation: I was responsible for dividing tasks related to the project report and played a key role in its composition. This included creating essential components of the report, such as system architecture diagrams, front and back-end modules, and detailed descriptions of the techniques and skills used.

**What learnt is most useful for you:**

The knowledge gained from algorithms like genetic algorithms and clustering techniques is transferable and highly relevant in my future role as an AI Product Manager. This expertise equips me to understand the technical intricacies involved in AI product development, allowing me to effectively communicate and collaborate with technical teams, align expectations, and make informed product decisions.

**How you can apply the knowledge and skills in other situations or your workplaces:**

My deepened understanding of technical solutions like different algorithms and project management gained from this experience positions me as a more effective AI Product Manager. It enables me to navigate the complexities of AI product development with a heightened technical acumen, fostering improved collaboration between teams, and ensuring projects are efficiently executed, timelines are met, and AI-driven products are successfully brought to market.

|  |  |
|--|--|
| <b>Name: Yan Fu</b>  | <b>Matriculation Number: A0286045B</b> |
| <b>Personal contribution to group project:</b>   |  |
| <p>Following are my contributions in Intelligent Album Generator, IRS project:</p> <ol style="list-style-type: none"> <li>1. Project selection and system design: In the early stage of determining the theme of the project, I proposed some project themes for the team members to choose based on the market background and project difficulty. In the specific function design stage, I proposed some novel function design suggestions after market research, such as automatic deletion of similar photos and multiple format options for output albums. I also Participate in system hierarchy design, detailed function design and machine learning algorithm selection.</li> <li>2. Project development using python: Design and development of algorithms for recognition and deletion of duplicate photos, later improved to algorithms for recognition and deletion of similar photos. I was inspired by image fingerprinting techniques, used the related library to generate the hash value of images uploaded by the user, set a suitable similarity threshold to determine whether the images are similar or not, and completed the task of filtering duplicate and similar images. Also included are algorithms for calculating similarity scores to provide a measure of similarity. Only one photo in the similarity threshold is retained. In addition, I also took on part of the development task of arranging the processed images into albums.</li> <li>3. Report writing, PowerPoint production and reporting: I wrote up the second section of the project report 'Problem Description and Market Analysis', the third section 'System Architecture and Modelling' and the Project Proposal, showing the specific details of the project in a clear report format. I also took part in the PowerPoint presentation and reporting, Showing the highlights of our group projects.</li> </ol> |  |
| <b>What learnt is most useful for you:</b> <p>During this project, I've honed various developing skills and deepened my understanding in crucial domains. This project experience deepened my understanding of the image recognition direction, including how it works, the development methodology and the techniques used to optimize its performance. This was the first time I used image fingerprint recognition techniques to solve a specific problem. I am now proficient in dealing with the problem of detecting similar photos. Additionally, I have progressed in my Python programming skills and basic computer skills, enabling me to efficiently process data and build appropriate machine learning models.</p> <p>Although I didn't undertake specific front-end development tasks in this project, I gained a more specific and detailed understanding of front-end design through discussions with my teammates and writing reports. In addition, it has enhanced my patience, communication and co-operation skills.</p>  |  |

**How you can apply the knowledge and skills in other situations or your workplaces:**

When I encounter problems such as piracy detection, image duplicate detection and image search, I consider using image fingerprinting techniques to solve them. It is an efficient and flexible method that can be utilized in many industries such as social media monitoring, advertisement monitoring, etc. This project experience has allowed me to use the experience I have gained to develop and implement systems more efficiently and find more effective solutions when faced with challenges related to object detection. It also prepares me for my future work in the field of computer vision, and the hands-on experience and skills I gained this time are very important.