

# Hw2: Genetic Algorithm

TA mail: [nckummcvlab@gmail.com](mailto:nckummcvlab@gmail.com)

---

## Introduction

National Cheng Kung University (NCKU) is a comprehensive university known for its proactive innovation, complete range of disciplines, and strong academic prowess. It boasts world-class laboratories, a distinguished faculty, and consistently ranks among the top in multiple international rankings. The university's advanced technological capabilities span various academic fields, attracting talented students from around the world.

However, despite its strong academic foundation, students at NCKU still face some challenging issues in their daily academic life. For instance, when they need to collaborate on group assignments, it is common for some members to not fully participate due to various reasons, resulting in an uneven distribution of work and some individuals shouldering a disproportionate workload.

To address this issue in group collaborations, the faculty and students at NCKU have decided to implement an advanced genetic algorithm to automate the assignment of tasks within group projects. This approach aims to ensure a balanced workload for every student, allocate tasks according to each member's expertise, and prevent scenarios where some members do not contribute or others are overburdened.

## Problem definition

In a class, the professor assigns students to work on group presentations. Each group consists of  $M$  students, and the presentation requires completing  $N$  different tasks. Each task has a varying time requirement—some tasks take longer to complete, while others are relatively simple. Additionally, each student has different strengths for various tasks; some are skilled in writing reports, while others excel in creating slides or delivering presentations.

The professor's objectives are:

1. **Every student must be assigned at least one task**, ensuring that all members contribute to the preparation process.
2. **Assign each task to the most suitable student**, minimizing the overall time required for the group to complete the entire project.

## Methodology

Modify the TODO sections in the provided template to complete the genetic algorithm for task assignment. You can use a different programming language if you prefer, but make sure that the output file `answer.txt` is in the **correct format**. If the format is incorrect and the computer cannot read it, you may receive a score of 0!

## Example

### Question

In a course on Charisma Studies, Shinny and Jack are team members grouped according to their MBTI types, both being ENTJs. ENTJs are natural-born leaders who exude charisma and confidence, projecting an aura of authority and rallying people toward a common goal. For their final project on Charisma Studies, they plan to demonstrate how to confidently approach strangers without creating an awkward situation. Therefore, they have divided the work into three tasks: approaching strangers, filming and editing the video, and creating the report.

Shinny, being lively and outgoing, is not afraid to approach strangers, so it only takes her 3 hours to complete this task. Jack, on the other hand, is a bit shy and reserved, needing 5 hours for the same task. However, Jack has a passion for photography and can efficiently handle filming and editing in just 2 hours, while Shinny, in contrast, would need 8 hours. When it comes to creating the report, Shinny is more adept and can produce a high-quality report in just 6 hours, which is 1 hour less than Jack would need to complete the same task.

### Solution

According to the problem statement, there are a total of two students and three tasks. Each student requires different amounts of time to complete each task.

Therefore, it can be represented as follows:

```
m = 2, n = 3

# matrix format example
# task    1  2  3
cost = [[3, 8, 6], # Shinny
        [5, 2, 7]] # Jack
```

After calculating using the genetic algorithm, the following results were obtained:

```
total_time = 11
answer = [1, 2, 1]
```

This indicates that assigning Shinny to approach strangers and create the report, while Jack handles filming and editing, can minimize the total time required, completing all tasks in just 11 hours! This also illustrates the saying, "the capable should take on more responsibility."

## Assignment Description

1. Use genetic algorithms to complete the following ten problems (Q1~Q10)
2. Use any programming language you are comfortable with; however, a Python template has been provided for your convenience. Ensure that the format of the final `answer.txt` file is **CORRECT**.
3. **Incorrect formatting that prevents the computer from parsing will result in a score of 0.**
4. The format of `answer.txt` is that each line corresponds to one question, resulting in a total of 10 lines for the 10 questions. The answer for each question should be written in the format: `Total time = {total_time}`, where `{total_time}` represents the result obtained for that question using the genetic algorithm.

```
# an example of answer.txt

Total time = 16
Total time = 354
Total time = 69
Total time = 12
...

# There will be a total of 10 lines.
```

1. Do not use additional libraries.
2. Write meaningful variable names in the code and include comments.
3. Plagiarism is strictly prohibited. If found, the score will be zero.
4. **Submission format:** Compress the code and output results into a `.zip` file and name it as `student_id.zip`.

```
P12345678.zip
| ga.py
| answer.txt
```

## Q1:

During the preparation for a concert, there are two sound technicians: Tom and Jerry. They are responsible for three tasks: sound setup, lighting adjustment, and live testing. Find the optimal task assignment that minimizes the total working time.

- **Sound Setup:**
  - Tom requires 3 hours
  - Jerry requires 4 hours
- **Lighting Adjustment:**

- Tom requires 2 hours
- Jerry requires 3 hours
- **Live Testing:**
  - Tom requires 4 hours
  - Jerry requires 2 hours

## Q2:

In a technology project team, there are four members: Alice, Bob, Charlie, and Diana. They need to complete four tasks: requirements analysis, system design, coding, and testing. Find the optimal task assignment that minimizes the total working time.

Name	Alice	Bob	Charlie	Diana
requirements analysis	5	4	6	3
system design	6	5	4	2
coding	7	6	5	4
testing	4	3	2	5

## Q3:

```
M, N = 8, 9
cost = [[90, 100, 60, 5, 50, 1, 100, 80, 70],
        [100, 5, 90, 100, 50, 70, 60, 90, 100],
        [50, 1, 100, 70, 90, 60, 80, 100, 4],
        [60, 100, 1, 80, 70, 90, 100, 50, 100],
        [70, 90, 50, 100, 100, 4, 1, 60, 80],
        [100, 60, 100, 90, 80, 5, 70, 100, 50],
        [100, 4, 80, 100, 90, 70, 50, 1, 60],
        [1, 90, 100, 50, 60, 80, 100, 70, 5]]
```

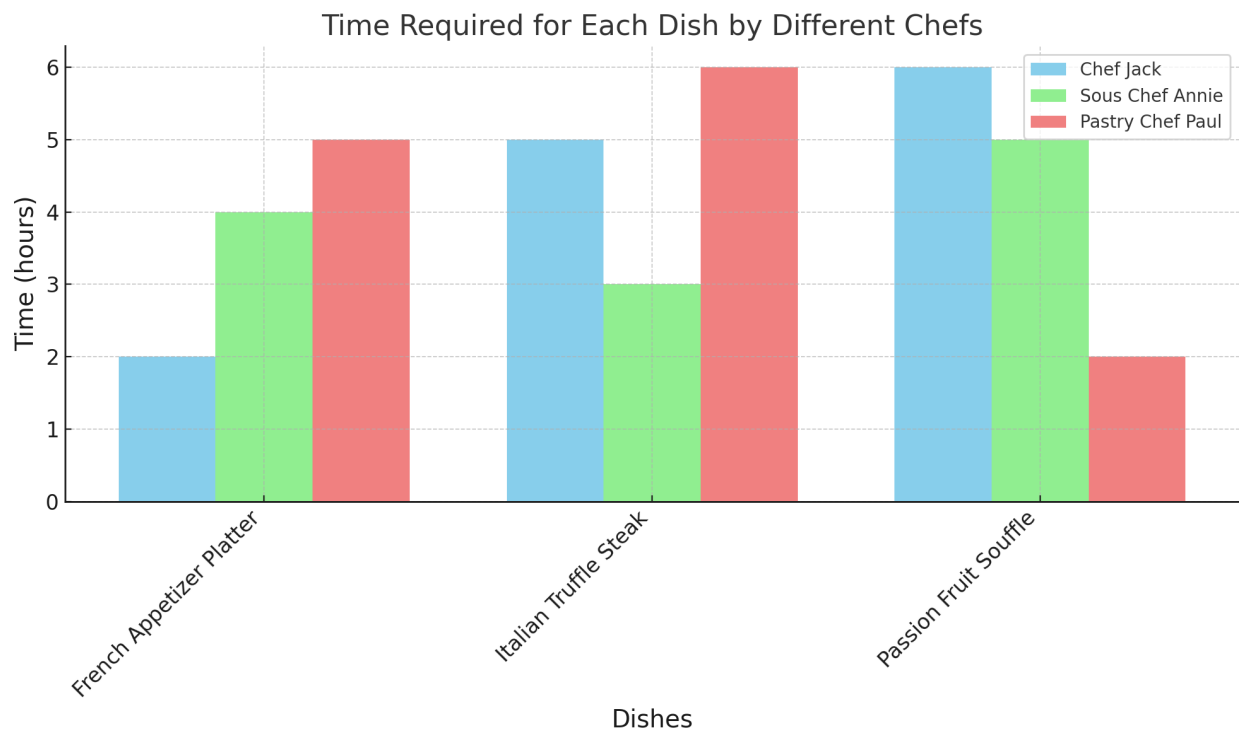
## Q4:

In the renowned Michelin 3-star restaurant "Gourmet Chef," there are three chefs: Head Chef Jack, Sous Chef Annie, and Pastry Chef Paul. Recently, the restaurant received a large banquet order, requiring them to collaborate according to their individual culinary strengths. They need to prepare the following three dishes, aiming to complete all preparations before the banquet begins.

The three dishes are:

1. **French Appetizer Platter:** A sophisticated and elegant dish that emphasizes knife skills and exquisite plating.
2. **Italian Truffle Steak:** A main course that requires precise control of heat and harmonious ingredient blending.
3. **Passion Fruit Soufflé:** A dessert that focuses on fermentation time and sweetness balance.

Based on the chart below, help them arrange the tasks to find the optimal assignment that minimizes total preparation time.

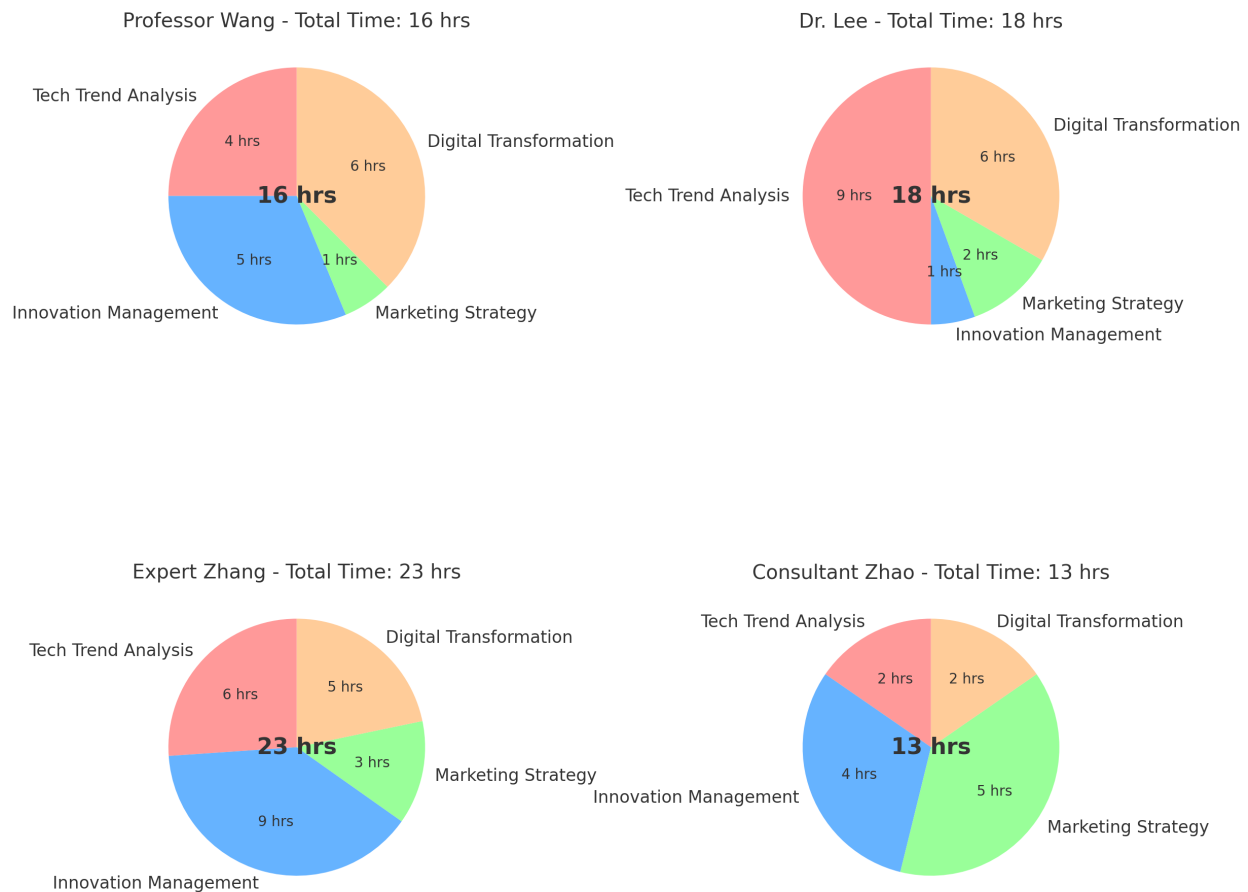


## Q5:

At a summit event, there are four speakers: Professor Wang, Dr. Lee, Expert Zhang, and Consultant Zhao. Each of them has different specialties: technology trend analysis, innovation management, marketing strategy, and digital transformation. According to the event requirements, each speaker needs to be assigned a different topic for their speech. However, the preparation time for each topic varies depending on their familiarity with the subject.

Based on the chart provided, find the optimal task assignment that minimizes the total preparation time for all speakers.

Adjusted Time Distribution for Different Speech Topics by Each Speaker



## Q6:

You are a curator at a renowned art museum and are responsible for planning the annual large-scale exhibition, "The Intersection of Art and Time." To ensure the success of the exhibition, you need to allocate four artists to different exhibition halls, each showcasing their signature works. The styles of the artists vary greatly, so it's crucial to assign them to the most suitable exhibition halls.

### Exhibition Halls:

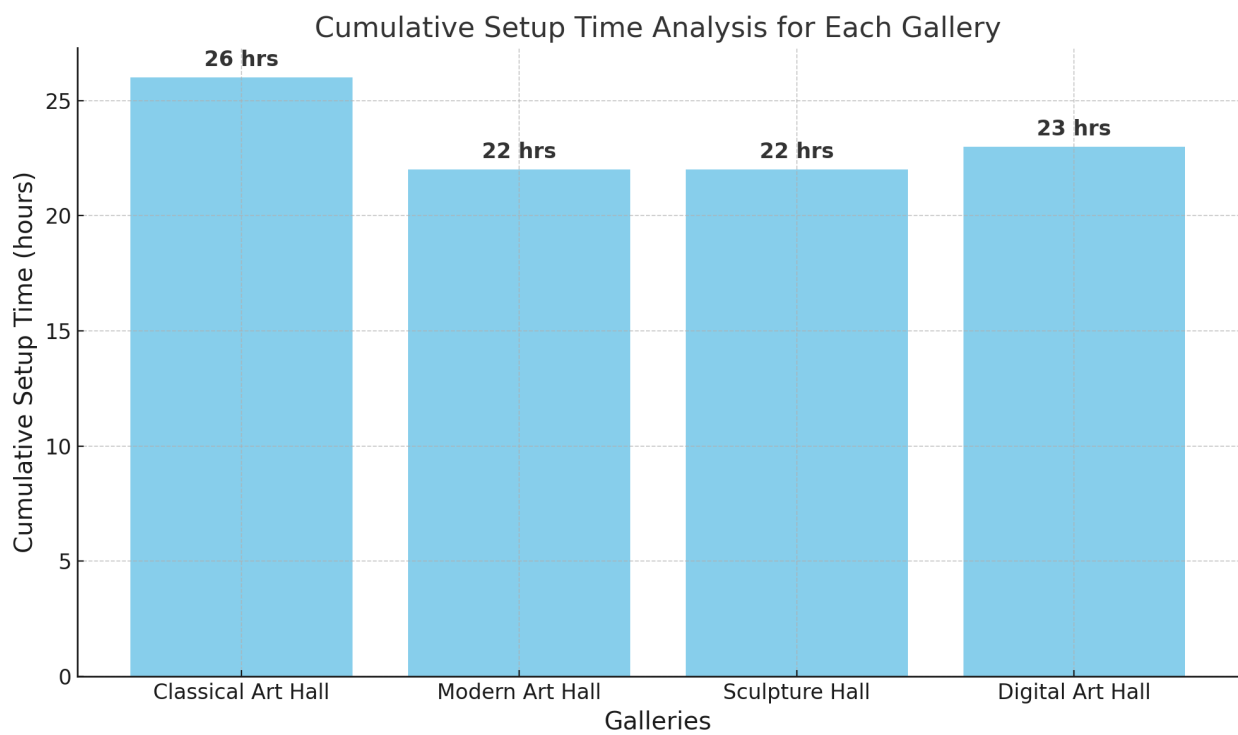
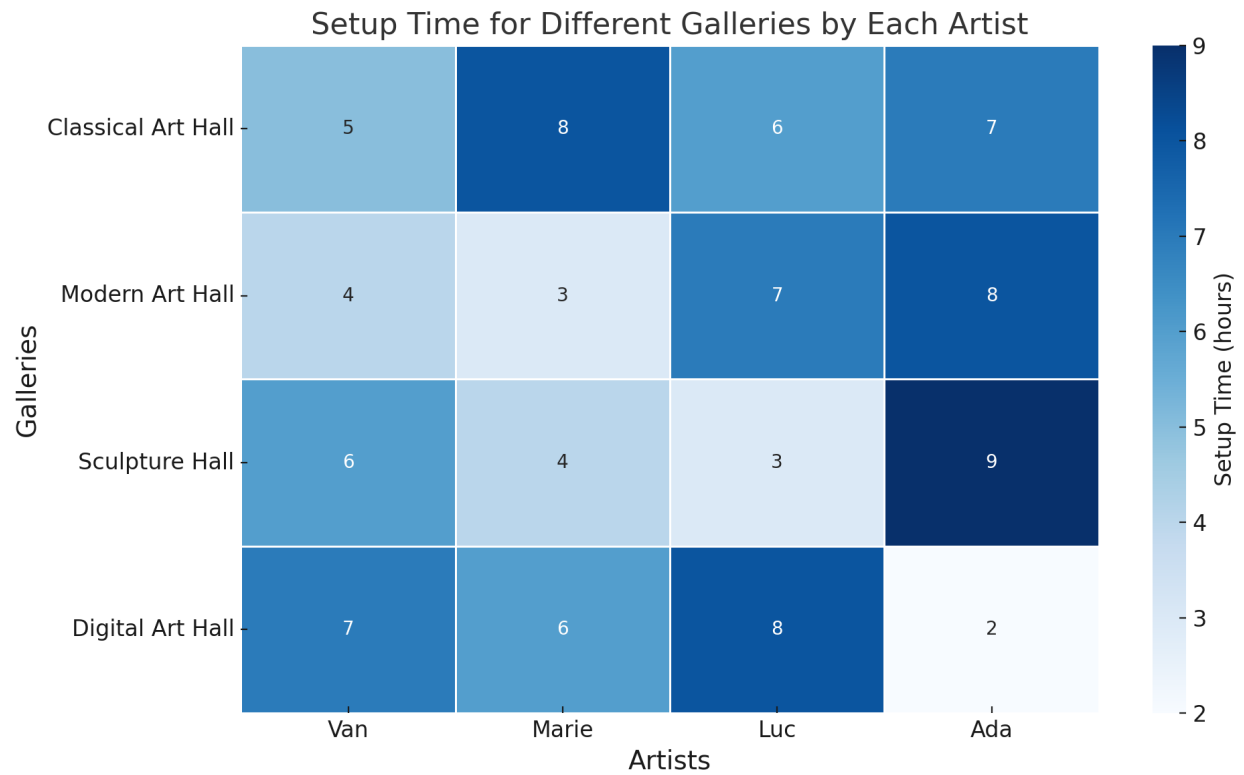
1. **Classical Art Hall:** Focused on classical paintings and sculptures, highlighting technique and historical context.
2. **Modern Art Hall:** A space for innovative and experimental modern art.
3. **Sculpture Hall:** A dedicated area for sculptures, emphasizing spatial perception and structural design.
4. **Digital Art Hall:** A showcase space for digital artworks combined with technology.

### Artists:

- **Van:** Specializes in classical paintings but has a strong understanding of modern art.
- **Marie:** Known for her modern and abstract paintings, with strong skills in sculpture as well.
- **Luc:** A renowned sculptor, but also has expertise in classical themes.
- **Ada:** A pioneer in digital art who is well-versed in the technological requirements of various exhibition halls.

The preparation time for each artist in different exhibition halls (in hours) is shown in the chart. Determine the optimal task assignment to minimize the total setup time for the exhibition.





**Q7:**

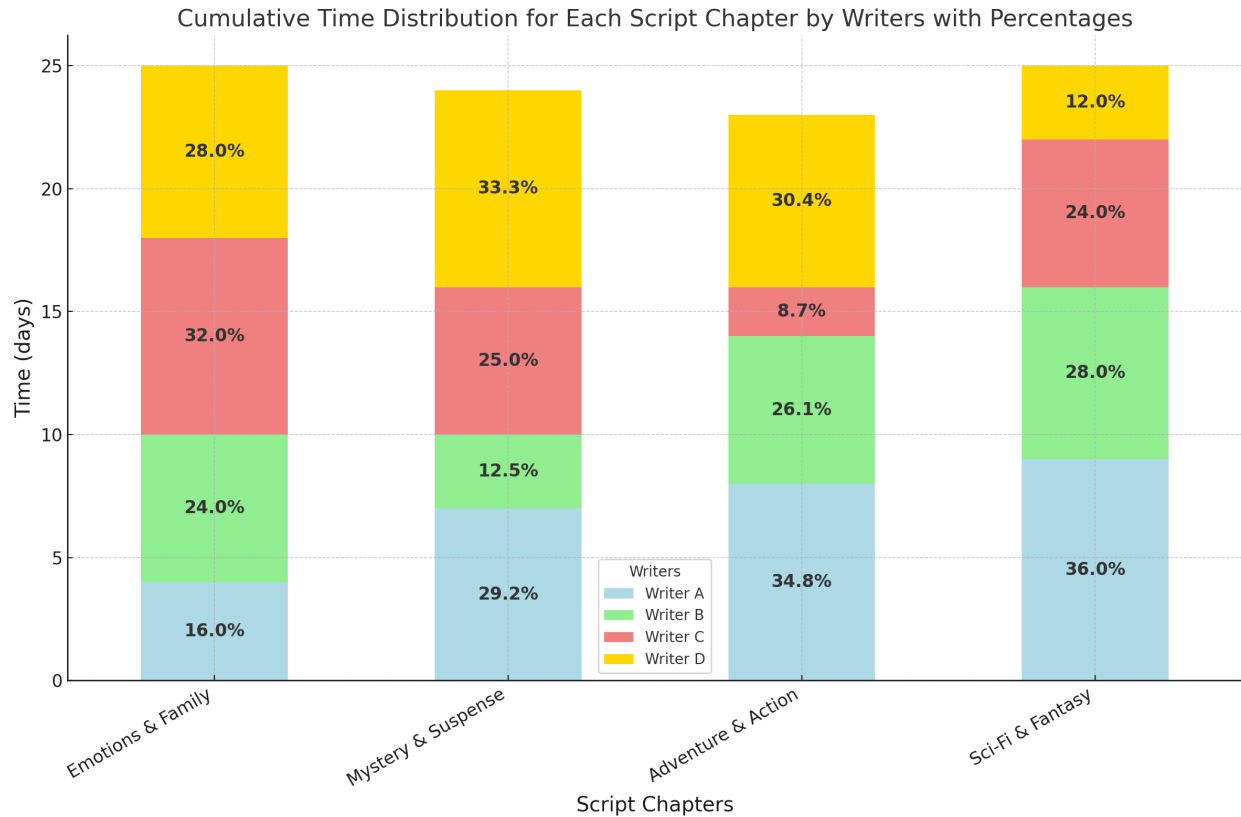
A team of four screenwriters is working on the creation of a large-scale film script. Each screenwriter has a different area of expertise and focus when it comes to writing different genres of scripts. Determine the optimal task assignment that minimizes the total writing time. The chapters they need to be assigned to are as follows:

1. **Chapter A: Romance and Family**
2. **Chapter B: Mystery and Suspense**
3. **Chapter C: Adventure and Action**
4. **Chapter D: Science Fiction and Fantasy**

**Screenwriters:**

- **Screenwriter A:** Specializes in writing emotionally rich family dramas but struggles with sci-fi elements.
- **Screenwriter B:** Known for mystery and suspense scripts, with some experience in adventure genres.
- **Screenwriter C:** Expert in action and adventure scripts but is unfamiliar with romance genres.
- **Screenwriter D:** A specialist in science fiction and fantasy scripts.

The following table shows the number of days (as whole integers) required by each screenwriter to complete the first draft for each chapter. Find the optimal assignment that minimizes the total writing time for the script.



## Q8:

An international technology conference is about to take place, and the organizing committee needs to allocate lecture topics based on each speaker's area of expertise and adjust the budget accordingly. The speakers come from different countries and have unique specialties and budget requirements. If they are assigned a topic outside of their expertise, they will charge three times the usual price to cover the additional preparation time. Determine the optimal task assignment that minimizes the total budget and ensures the most effective speaker-topic matching.

### Lecture Topics:

1. Trends in Artificial Intelligence Development (AI)
2. Applications of Blockchain Technology
3. IoT and Smart Cities (IoT)
4. The Future of Quantum Computing

## 5. The Social Impact of Emerging Technologies (Emerging Tech)

Find the best assignment strategy to minimize the total cost while ensuring each speaker is assigned to a suitable topic whenever possible.

	Lecturer Name	Country	Expertise Topics	Cost (thousand USD)
0	Dr. Smith	USA	AI, Blockchain	8
1	Prof. Chen	China	IoT, AI	6
2	Dr. Muller	Germany	Blockchain, Quantum Computing	10
3	Prof. Singh	India	Quantum Computing, Emerging Tech	7
4	Dr. Nakamura	Japan	Emerging Tech, IoT	9

## Q9:

A multinational company is drafting a new market strategy and plans to assign different strategic projects to regional managers based on the specific needs of each market. Each manager has varying efficiency levels for handling these projects, and each strategy project requires alignment with the manager's expertise to ensure successful execution. Determine the optimal task assignment that minimizes the total working time while maximizing project success.

Find the most efficient allocation of strategy projects to regional managers to minimize overall working hours and optimize project outcomes.

Regional Manager	Region	Expertise	Execution Time (Days)
Alice	North America	Social Media Strategy, Brand Management	10
Bob	Europe	Brand Management, Customer Relationship Management	12
Charlie	Asia	Social Media Strategy, Market Expansion	15
Diana	South America	Market Expansion, Brand Management	11

Regional Manager	Region	Expertise	Execution Time (Days)
Evelyn	Africa	Customer Relationship Management, Social Media Strategy	14

Project Name	Project Type
Global Brand Enhancement	Brand Management
Social Media Expansion	Social Media Strategy
Asia Market Expansion	Market Expansion
Africa Customer Maintenance	Customer Relationship Management
Europe Customer Relationship Management	Customer Relationship Management

## Q10:

```

M, N = 9, 10
cost = [[1, 90, 100, 50, 70, 20, 100, 60, 80, 90],
        [100, 10, 1, 100, 60, 80, 70, 100, 50, 90],
        [90, 50, 70, 1, 100, 100, 60, 90, 80, 100],
        [70, 100, 90, 5, 10, 60, 100, 80, 90, 50],
        [50, 100, 100, 90, 20, 4, 80, 70, 60, 100],
        [100, 5, 80, 70, 90, 100, 4, 50, 1, 60],
        [90, 60, 50, 4, 100, 90, 100, 5, 10, 80],
        [100, 70, 90, 100, 4, 60, 1, 90, 100, 5],
        [80, 100, 5, 60, 50, 90, 70, 100, 4, 1]]

```