Designing, developing and testing solutions for the London Underground system

Group work:
This coursework requires collaborative team efforts, making effective communication among team members essential for success. The demonstration of teamwork accounts for up to 20% of the overall coursework grade. This portion of the grade can be easily achieved, irrespective of the actual coursework completion. Securing this 20% could be pivotal for students on the cusp of passing. Documentation of weekly communications between the team members, detailing the accumulated contribution percentage of each member is required. If a member contributes fully (100%), his/her individual grade matches the group's overall grade. Members with contributions under 100% will receive a corresponding percentage of the grade. Any disagreements concerning contribution percentages or other issues should be resolved within the team, with the resolution process potentially included in the final report. Further instructions and guidelines will be provided in due course.

Data:
The London Underground is an intricate network of stations spanning the London region. A standard map of this system, sourced from the Transport for London (TFL) website at https://tfl.gov.uk/maps/track/tube, is available in PDF form. Additionally, an Excel spreadsheet titled "London Underground Data.xlsx" provides the travel durations (in minutes) between consecutive stations, derived from earlier data collection. Note that:

1. This data may have inaccuracies or missing information. It's up to you to determine how to address and report these issues in your study.
2. The dataset excludes durations associated with waiting times at stations and the process of passengers boarding or alighting.

COMPULSORY Usage of Library Code:

- For certain subtasks to be indicated later in the coursework specification, you should use the Python (library) code available at https://mitp-content-server.mit.edu/books/content/sectbyfn/books_pres_0/11599/clrsPython.zip.
- For instance, if you need the binary search algorithm for those subtasks, in your application code, you need to use/call the binary search function/code from the library code.
- This library is structured according to the chapter numbers from the recommended course textbook, "Introduction to Algorithms" (4th edition). You can easily navigate and identify code for specific algorithms within the library using the table of contents, available at https://mitp-content-server.mit.edu/books/content/sectbyfn/books_pres_0/11599/4e_toc.pdf, which lists chapters and sections.
- Using other (library) code (including your own code) for these subtasks is prohibited.
- Note: Failing to comply with the requirement might limit your maximum score to 50%.
- The mandatory use stems from the School's directive, requiring coursework designs to limit potential AI misuse or other challenges. Otherwise, the coursework specification would not be approved during the moderation process.

- In software projects, using pre-existing libraries for data structures and algorithms is typical, leading to quicker, more dependable results. The focus should be on choosing appropriate data structures and algorithms for a project.

TASKS

Task 1:

(1a)

[For this specific subtask, utilize the previously mentioned Python library by calling/using its functions within your application code.]

Your team is tasked with developing a software model for the London Underground tube system's route planner intended for public use. The model should ascertain the shortest journey duration **in minutes** between a specified starting and destination station. Emphasis should be placed on thoughtful design, robust implementation, and thorough testing of the software.

For an underground system user, your solution should offer:

1. A functionality to swiftly gather route information from the traveller.
2. A detailed list of stations indicating the journey from the initial station (x) to the final destination (y).
3. The total duration of the journey in minutes.

(1b)

Your team must also produce a histogram of the journey times (in minutes) between every station pair, utilizing the calculations from the prior subtask (1a).

Task 2:

(2a)

[For this specific subtask, utilize the previously mentioned Python library by calling/using its functions within your application code.]

Your team is assigned to revise subtask (1a). Rather than denoting the journey duration in minutes, it should now reflect **the count of stations or stops** between the starting point and the destination. Please utilize the same library code from subtask (1a) for this purpose.

(2b)

Your team must also produce a histogram of the journey times (in the count of stations or stops) between every station pair, utilizing the calculations from the previous subtask (2a).

Task 3:

(3a)

[For this specific subtask, utilize the previously mentioned Python library by calling/using its functions within your application code.]

Perform the actions outlined in subtask (2a), but utilize a different algorithm library code than the one used in both subtasks (1a) and (2a).

(3b)

Your team must also produce a histogram of the journey times (in the count of stations or stops) between every station pair, utilising the calculations from the previous subtask (3a).

Task 4:

(4a)

[For this specific subtask, utilize the previously mentioned Python library by calling/using its functions within your application code.]

For specific reasons, the government is contemplating shutting down as many tube lines between adjacent stations as feasible. However, they must adhere to the following requirement:

1. Travel between any two stations must remain viable. For example, even if the connection between adjacent stations like Piccadilly Circus and Green Park is severed, commuting between them (and any station pair) should remain feasible.

Your team is tasked with creating a prototype software to guide the government in their decision-making:

1. If it's infeasible to meet the closure conditions, provide a reasoned justification.
2. If the closure can be executed, list the affected routes by naming the adjacent stations on each line; for instance, if the segment between Piccadilly Circus and Green Park is shut down, specify it as "Piccadilly Circus -- Green Park".

(4b)

Your team is also required to analyse the effects of the shutdown on the journey times between each station pair, both in terms of minutes and the count of intermediary stations, as outlined in subtasks (1a), (2a), and (3a). For example, by contrasting the histograms pre- and post-closure, you can draw specific insights or determinations.