CSE 102 Spring 2025 – Computer Programming Assignment 4

Due on April 2, 2025 at 23:59

You have been hired as a junior aerospace engineer at a space research center. Your team is developing a small rocket that will be launched to a test altitude. Your job is to analyze its trajectory by modeling the rocket's flight using a quadratic equation and visualizing its path on a 2D graph.

In this assignment, you will develop a C program that:

1. Accepts launch parameters (initial velocity, gravity effects, and launch height).
2. Simulates the rocket's flight trajectory using a quadratic equation.
3. Plots the rocket's trajectory on a graph in text format.
4. Exports the trajectory graph to a file for further analysis.

Part 0: Simulation Menu (5 pts)

The program should have a menu system that allows the user to:

1. Enter rocket launch parameters.
2. Simulate and graph the rocket's trajectory.
3. Display and save the trajectory data.
4. Exit the program.

If an invalid input is provided, the program should issue a warning.

Part 1: Entering Rocket Launch Parameters (10 pts)

- The program should prompt the user to enter:
  - Initial launch velocity V_0 *(m/s)*.
  - Gravity effect g *(m/s²)* (default: Earth's gravity, 9.8 m/s²).
  - Initial launch height h *(meters)*.
- The rocket's vertical height over time follows a quadratic equation:

$$h(t) = -\frac{1}{2}gt^2 + V_0t + h$$

where:

- *h(t)* is the rocket's height at time t.
- V_0 is the initial velocity.
- *g* is the gravity constant.
- *h* is the initial launch height.

The program should store these parameters in a text file (rocket_data.txt).

Part 2: Graphing the Rocket's Trajectory (75 pts)

- The program should read the stored parameters from rocket_data.txt and simulate the rocket's flight.
- The graph should be printed line by line, with:
  - X-axis representing time (seconds).
  - Y-axis representing rocket altitude (meters).
  - # representing the rocket's path.
  - | and - representing the Y and X axes.
- The program should calculate the maximum altitude and time to impact (when h=0).
- Graphing range:
  - X-axis (time): 0 to estimated landing time.
  - Y-axis (height): 0 to the maximum height.

Part 3: Exporting Rocket Trajectory Data (10 pts)

- The graph should be saved in trajectory.txt.
- The rocket's maximum altitude and total flight duration should be printed and saved.

- Maximum altitude is calculated by: $$h_{\max} = \frac{V_0^2}{2g} + h_0$$

  Total flight duration is calculated by: $$t_{\text{flight}} = \frac{V_0 + \sqrt{V_0^2 + 2gh_0}}{g}$$

Example Execution

User Enters Rocket Parameters

```
Welcome to the Rocket Launch Simulator!

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1. Enter launch parameters

2. Simulate rocket trajectory

3. Save trajectory data

4. Exit

Choice: 1


Enter initial velocity (m/s): 50

Enter gravity (m/s², default 9.8): 9.8

Enter launch height (m): 10

Rocket parameters saved to rocket_data.txt!
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User Runs the Simulation

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1. Enter launch parameters

2. Simulate rocket trajectory

3. Save trajectory data

4. Exit

Choice: 2

Reading rocket parameters from file...

Equation: h(t) = -4.9 * t^2 + 50 * t + 10

Simulating trajectory...
```

```
100 |
 90 |
 80 |
 70 |             #
 60 |           #
 50 |         #
 40 |       #
 30 |     #
 20 |   #
 10 | #
  0 |---|---|---|---|---|---|---|---|---|---
     0   2   4   6   8   10   12   14   16
```

User Saves the Data

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1. Enter launch parameters

2. Simulate rocket trajectory

3. Save trajectory data

4. Exit

Choice: 3

Saving trajectory data...

Maximum altitude: 135.20 meters

Total flight duration: 10.30 seconds

Graph saved to trajectory.txt!
```

CONSTRAINTS:

- Arrays are not permitted; only basic variables should be used.
- The code must be structured using functions, and all logic should be broken into reusable components instead of writing everything in main().
- The program must handle invalid inputs and prevent crashes due to non-numeric or incorrect user input.
- All necessary data, including rocket parameters and trajectory information, must be read from and written to rocket_data.txt and trajectory.txt.
- The program should visualize the rocket's trajectory using ASCII characters and cannot use any graphical libraries.
- Only structured control flow constructs like for, while, and if-else are allowed, while goto statements are prohibited.
- The quadratic equation for the rocket's trajectory must be computed dynamically based on user input, not hardcoded.
- The use of global variables is not allowed; all variables should be declared within functions and passed as parameters.

IMPORTANT NOTES:

- Submit your homework as a zip file named as your name_surname id (name_surname.zip) and this file should include:
  - name_surname.c file
- name_surname.pdf file which includes, screenshots of your generated outputs and given C code as an input.
- Programs with compilation errors will get 0.
- The output format must be as given, do not change it.
- Compile your work with given command "gcc --ansi your_program.c -o your_program".
- Your work will be evaluated using gcc version 11.4.0.