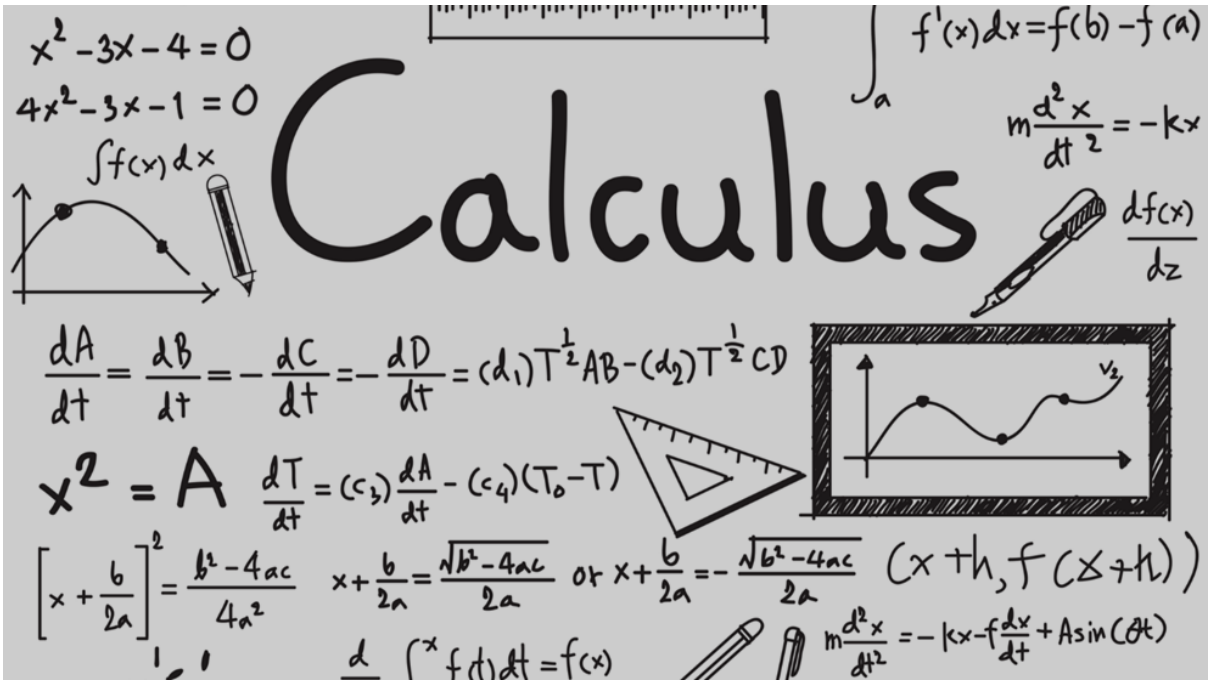
Calculus Project



Project Title : Pollen Analysis

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Student IDs : 23I-0696, 23I-0653, 23I-0732

Class Section : CS-E

Course Name : Calculus

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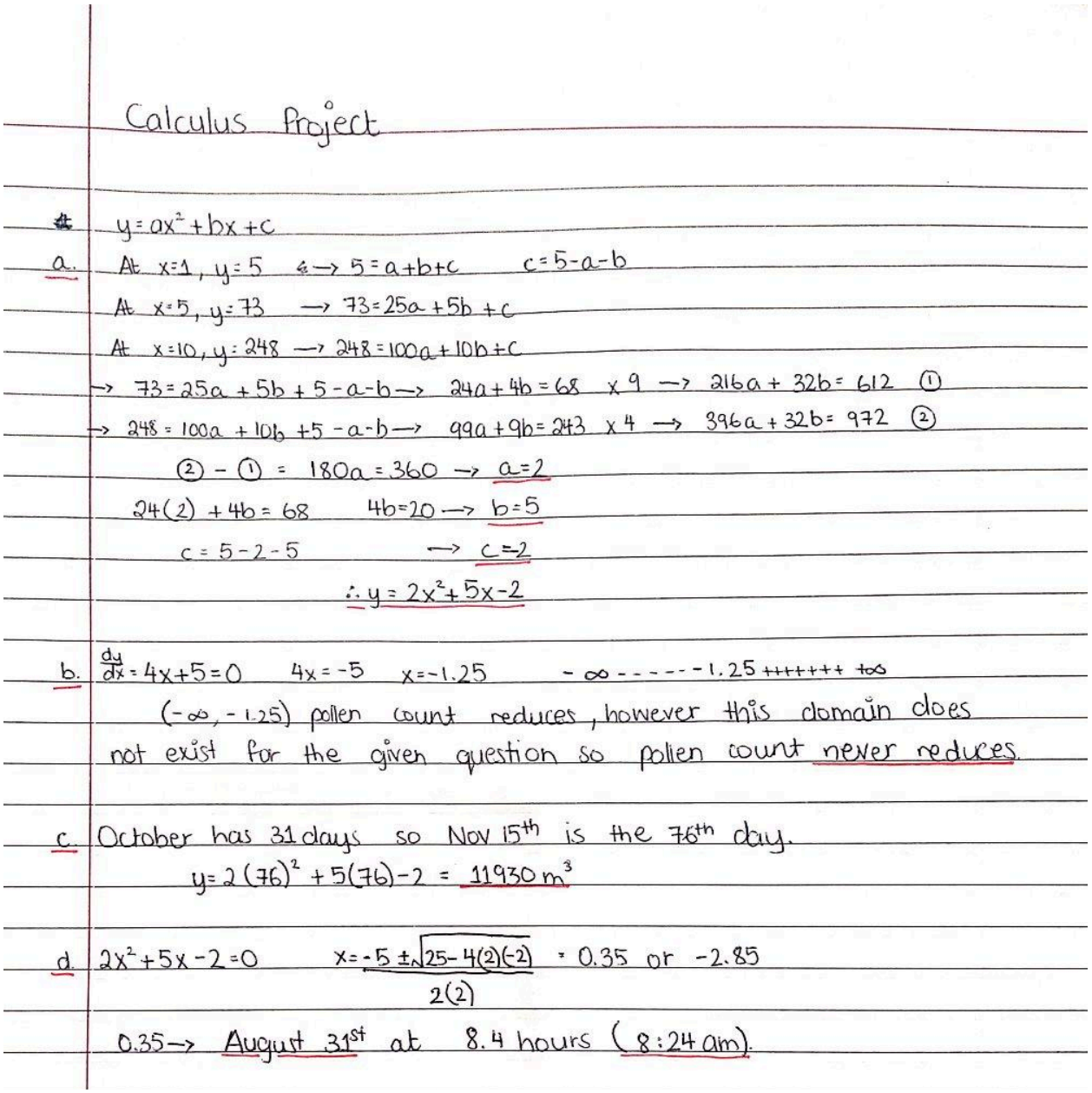
Objective of the problem

The objective is to analyze Islamabad's daily pollen count (1st Sep - 30th Oct). Tasks include fitting a quadratic curve to depict trends, using calculus to identify pollen reduction days, predicting 15th Nov pollen count, and determining, if possible, the day when pollen becomes zero. Insights aid in environmental and health planning.

By hand solution of the problem



Calculus Project

* $y = ax^2 + bx + c$

a. At $x=1, y=5 \rightarrow 5 = a+b+c \quad c = 5-a-b$

At $x=5, y=73 \rightarrow 73 = 25a+5b+c$

At $x=10, y=248 \rightarrow 248 = 100a+10b+c$

$\rightarrow 73 = 25a+5b+5-a-b \rightarrow 24a+4b=68 \times 9 \rightarrow 216a+32b=612$ ①

$\rightarrow 248 = 100a+10b+5-a-b \rightarrow 99a+9b=243 \times 4 \rightarrow 396a+32b=972$ ②

② − ① = $180a = 360 \rightarrow a=2$

$24(2)+4b=68 \quad 4b=20 \rightarrow b=5$

$c = 5-2-5 \rightarrow c=-2$

$\therefore y = 2x^2+5x-2$

b. $\frac{dy}{dx} = 4x+5=0 \quad 4x=-5 \quad x=-1.25 \quad -\infty \text{ ------ } -1.25 \text{ +++++++ } \infty$

$(-\infty, -1.25)$ pollen count reduces, however this domain does not exist for the given question so pollen count never reduces.

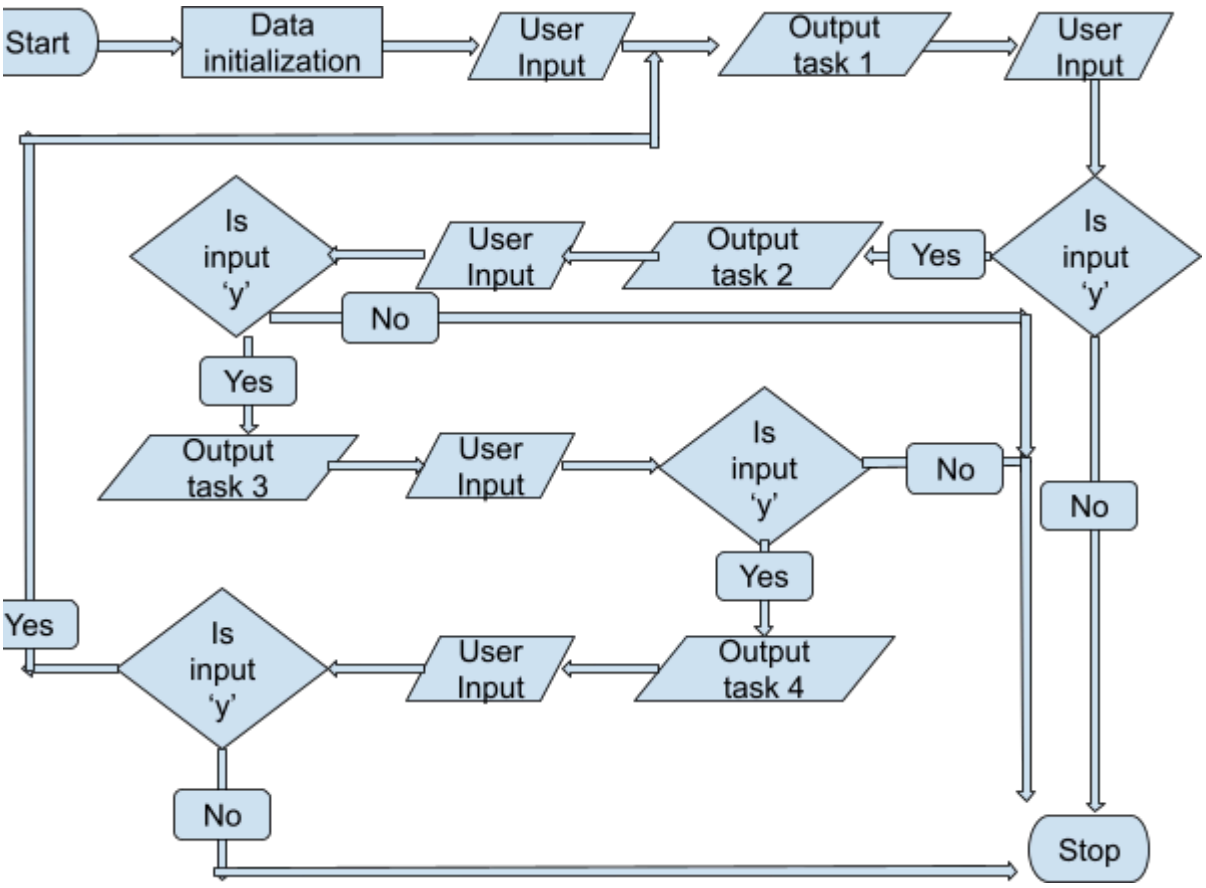
c. October has 31 days so Nov 15th is the 76th day.

$y = 2(76)^2 + 5(76) - 2 = 11930\ m^3$

d. $2x^2+5x-2=0 \quad x = \frac{-5 \pm \sqrt{25-4(2)(-2)}}{2(2)} = 0.35 \text{ or } -2.85$

0.35 → August 31st at 8.4 hours (8:24 am).

Flowchart



Explanation of MATLAB commands

- **disp**: This command is used to display text or the value of an expression in the command window.
- **polyfit**: Fits a polynomial to the data using the least-squares method.
- **figure**: Creates a new figure window for plotting.
- **plot**: Plots the actual data points ('r-') on the graph.
- **xlabel and ylabel:** These functions are used to label the x-axis and y-axis of the plot, respectively.
- **diff**: Computes the symbolic derivative.
- **poly2sym**: Converts the coefficients to a symbolic expression.
- **solve**: Finds symbolic roots.
- **polyval**: Evaluates the quadratic polynomial at the specified day (Nov_15)
- **roots:** This function calculates the roots of a polynomial. It is used to find the roots of the quadratic equation, representing when the pollen count becomes zero

A detailed example to run the program and detailed results section

*****WRITE THE CODE FILE NAME IN THE COMMAND WINDOW TO RUN THE CODE*****

Program Start:

- Run the MATLAB program.
- The program will display the names and student IDs of the team members.

Task 1: Fit a Quadratic Curve:

- The program will fit a quadratic curve to the given pollen count data.
- Displayed coefficients of the quadratic curve.

Graph Plotting:

- A graph will be plotted showing the actual pollen count data points along with the fitted quadratic curve.

User Input:

- The program will prompt you to press any key to continue.

Task 2: Find When Pollen Count Starts Decreasing:

- The program will calculate the derivative of the quadratic equation and find its roots.
- Displayed the number of days when the pollen count starts decreasing.

User Input:

- The program will ask if you wish to run another task (y/n).
- If 'y', it will proceed to the next task; if 'n', the program will terminate.

Task 3: Predict Pollen Count on 15th November:

- The program will predict the pollen count on 15th November using the fitted quadratic curve.
- Displayed the predicted pollen count.

User Input:

- The program will again ask if you wish to run another task (y/n).
- If 'y', it will proceed to the next task; if 'n', the program will terminate.

Task 4: Find Day When Pollen Count Is Zero:

- The program will find the roots of the quadratic equation and round to the nearest integer.
- Displayed the day when the pollen count is expected to be zero (if possible).

User Input:

- The program will once again ask if you wish to run another task (y/n).
- If 'y', it will repeat the loop; if 'n', the program will terminate.

Program Termination:

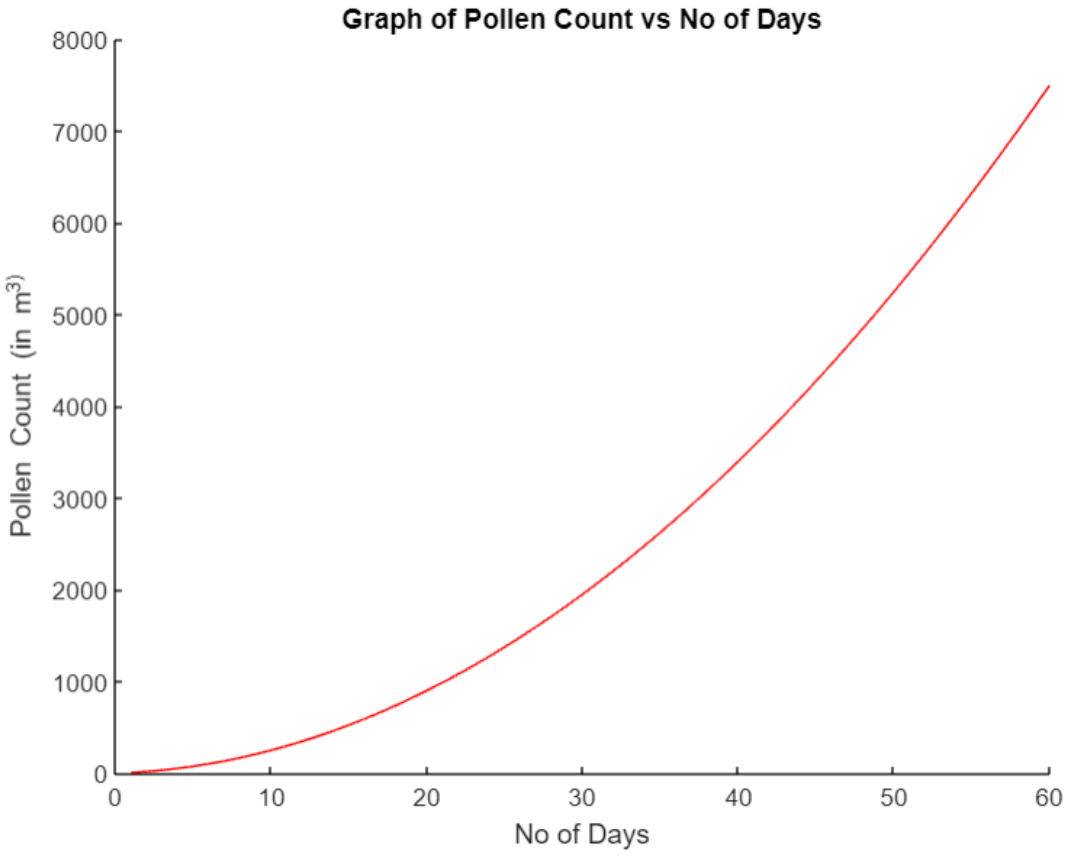
- If you choose 'n', the program will display a termination message and end.

```
>> pollen_count_analysis
Names: Eshaal Malik(23I-0732) , Fatima Ishtiaq(23I-0696) , Maimoona Imran(23I-0653)
Press any key to continue.
Task 1:
The Coefficients of the Quadratic Curve are:
    2.0000    5.0000   -2.0000

Do you wish to run another task? (y/n):
y
Task 2:
The pollen count does not get reduced within the given 60 day range.
Do you wish to run another task? (y/n):
y
Task 3:
Pollen count on 15th November (Day 76):
   1.1930e+04

Do you wish to run another task? (y/n):
y
Task 4:
Day when Pollen Count in air becomes 0 (if possible): 31-Aug-23
Do you wish to run another task? (y/n):
n
Terminating Program
>>
```

2D or other plots



Conclusions and analysis of the problem

The MATLAB script processes 60 days of pollen data, employing quadratic curve fitting, root finding, and derivative calculations. Automation enhances efficiency and reduces potential errors in mathematical operations. The script's visualizations aid in understanding data patterns.

Compared to manual solutions, the computational approach provides quicker, more reliable results, showcasing the utility of MATLAB's functions in complex data analysis and mathematical modeling. The choice of a quadratic model assumes a suitable fit for the given dataset.

Contribution

Maimoona Imran (23I-0653)
Fatima Ishtiaq (23I-0696)
Eshaal Malik (23I-0732)

Difficulties faced during this project

1. Understanding mathematical concepts was challenging and was overcome by investing time in learning, leverage online resources.

2. Programming errors arose so debugging tools were used along with the internet and AI.

3. Time was a significant hurdle: it was overcome by pulling an all-nighter.

4. Understanding the language used in the project along with the grammatical concerns was perhaps the biggest obstacle that was faced. It was overcome by the use of instinct.

Annexure A

```
% team info
disp('Names: Eshaal Malik(23I-0732) , Fatima Ishtiaq(23I-0696) , Maimoona
Imran(23I-0653)');
% program termination
end_task = false;
while ~end_task
   % user input to continue
   disp('Press any key to continue.');
   pause;
   % given data
   days = 1:60;
    pollen = [5, 16, 31, 50, 73, 100, 131, 166, 205, 248, 295, 346, 401, 460,
523, 590, 661, 736, 815, 898, 985, 1076, 1171, 1270, 1373, 1480, 1591, 1706,
1825, 1948, 2075, 2206, 2341, 2480, 2623, 2770, 2921, 3076, 3235, 3398, 3565,
3736, 3911, 4090, 4273, 4460, 4651, 4846, 5045, 5248, 5455, 5666, 5881, 6100,
6323, 6550, 6781, 7016, 7255, 7498];
   % task 1
   disp('Task 1: ');
   equation = polyfit(days, pollen, 2);
   disp('The Coefficients of the Quadratic Curve are:');
   disp(equation);
   % plot graph
   figure;
   hold on;
   plot(days, pollen, 'r-');
   xlabel('No of Days');
   ylabel('Pollen Count (in m^3)');
   title('Graph of Pollen Count vs No of Days');
   % ask if the user wishes to run another query or terminate the program
   input_query = input('Do you wish to run another task? (y/n): ', 's');
   if strcmpi(input_query, 'n')
       end_task = true;
       disp('Terminating Program');
   end
   % task 2
   if ~end_task
       disp('Task 2: ');
       % derivative of the quadratic equation
       syms x;
       der = diff(poly2sym(equation, x));
       roots_der = solve(der, x);

       % find the roots of the equation
       roots_der = double(roots_der(imag(roots_der) == 0 & real(roots_der) >=
1 & real(roots_der) <= 60));

       if ~isempty(roots_der)
           disp('Number of Days when pollen count in the air is reduced:');
           disp(roots_der);
```

```
        else
              disp('The pollen count does not get reduced within the given 60
day range.');
        end
       % ask if the user wishes to run another query or terminate the program
        input_query = input('Do you wish to run another task? (y/n): ', 's');
        if strcmpi(input_query, 'n')
            end_task = true;
            disp('Terminating Program');
        end
    end
    % task 3
    if ~end_task
        disp('Task 3: ');
         Nov_15 = 76; % October has 31 days so November 15th becomes the 76th
day
        pollen_Nov_15 = polyval(equation, Nov_15);
        disp(['Pollen count on 15th November (Day ', num2str(Nov_15), '):']);
        disp(pollen_Nov_15);
        % ask if the user wishes to run another query or terminate the program
        input_query = input('Do you wish to run another task? (y/n): ', 's');
        if strcmpi(input_query, 'n')
            end_task = true;
            disp('Terminating Program');
        end
    end
    % task 4
    if ~end_task
        disp('Task 4: ');
        roots_equation = roots(equation);
         no_pollen = round(roots_equation(roots_equation >= 0 & roots_equation
<= 60));

        % display the day when pollen count in air becomes 0
        if ~isempty(no_pollen)
            day_no_pollen = date_from_day(no_pollen);
              disp(['Day when Pollen Count in air becomes 0 (if possible): ',
day_no_pollen]);
        else
            disp('Pollen Count in air is never 0');
        end
    end
        % ask if the user wishes to run another query or terminate the program
        input_query = input('Do you wish to run another task? (y/n): ', 's');
        if strcmpi(input_query, 'n')
            end_task = true;
            disp('Terminating Program');
        end
end
% function to convert day number to date and month
function day = date_from_day(day_number)
    % the year starts on September 1
    start_day = datetime('01-Sep-2023');
```

```
    pollen_zero_day = start_day + days(day_number - 1);
    day = datestr(pollen_zero_day, 'dd-mmm-yy');
end
```