MM2090 : Introduction to Scientific Computing

Apr-Jun-2021

Final Evaluation

You are welcome to use any programming paradigm you are comfortable to attempt the following questions. Your submission will be a zip file that contains your report and any code that goes with the work. Don't forget to provide your name, roll number and question number on the first page of each report. Make a zip of your stuff, name it with your roll number (eg., ME20B001-final.zip) and upload on moodle.

You can attempt any 3 out of the 6 questions given below. Each question carries 10 marks each. The remaining 5 marks is for attribution of sources used, neat layout and overall presentation of the reports.

[1] Generate 10 random numbers y_i between -1 and +1. Use these as points (x_i, y_i) where x_i=i and show them as a scatter plot. Fit a higher order polynomial over these points to generate a pattern of how a random noise would look like. Sample the polynomial to generate about 100 points in the interval x_1 to x_{10}. Superpose a plot of this data along with original points (x_i, y_i). Identify the peaks (location and height) programmatically. Print them out and confirm those with the plot.

[2] Consider the following sample images.

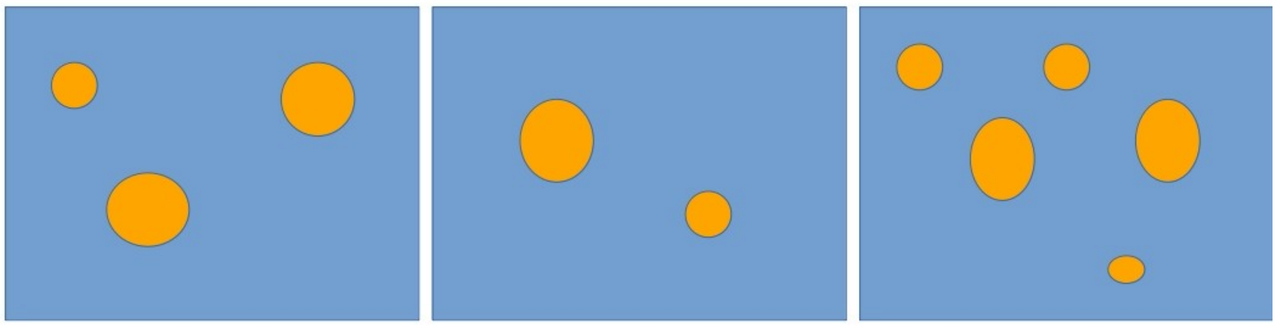


Image-1 Image-2 Image-3

Visually you can count that the number of objects in the images are 3, 2 and 5, respectively. Write a program that can take these images as inputs and report the number of objects as output. Assume that the objects are colored uniformly but different from the background which is also uniform. Do not assume the objects to be of same size or shape.

[3] Consider a temperature sensor placed near a valuable asset in a highly secure space. It records the local temperature every 5 seconds and writes it to a stream. The temperature data is flushed such that it keeps the data of only one hour. That is, you can view a window of only 720 data points at a time. Each new data point entering the window flushes the oldest data point out. Write two programs that do the following tasks.

(a) Program-A when executed will continuously send temperature data that looks almost flat (say, room temperature with a small random noise within 0.5 Kelvin). This is to simulate the data coming from the temperature sensor. At predetermined instance, introduce a spike (sudden increase of temperature by 10 K) for 10 seconds and revert back to room temperature. This spike is caused due to the presence of an intruder.

(b) Program-B keeps reading the incoming data, detects the spike and reports the instance when it took place. Verify if the detection is accurate.

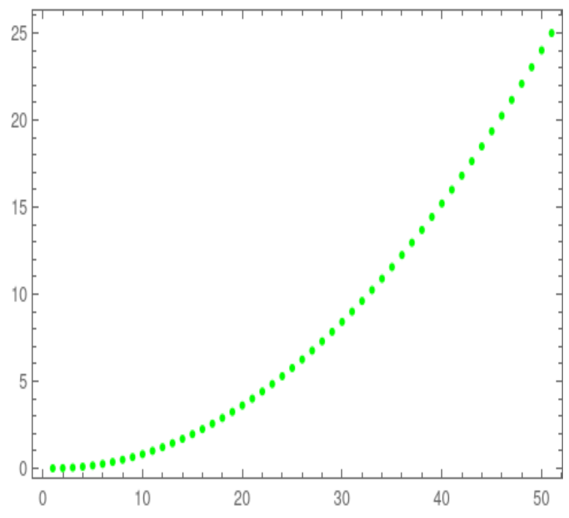
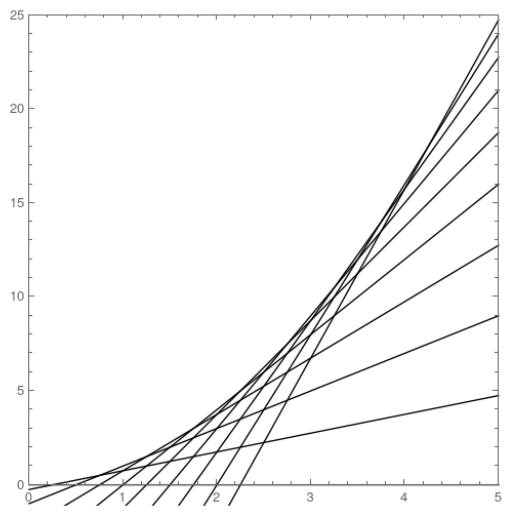
Think of the output from Program-A being piped to Program-B to perform this check. The stderr from both the programs about the spike should match. The stdout of Program-A contains the temperature data. You should submit a report on how this is made along with the two codes.

PS: If you need help imagine the situation, think about Ethan Hunt stealing the asset in one of the Mission Impossible series of movies.

[4] Simulate the Langton's ant. Look up wikipedia about what this problem is. Make sure you provide the formulation, program implementation and sample images to verify the behaviour of the ant motion in the box. Consider a box of size 64 * 64 for your problem.

[5] Seam carving is a special image manipulation. Look it up on Wikipedia to understand what it means. You are free to assumptions to simplify the problem defintion as you require. Choose an image that contains two objects of interest separated by large distance and illustrate how your implementation of seam carving works on it.

[6] Consider a transformation by which a function $y_i(x_i)$ is transformed to another function $m_i(c_i)$ where m and c are slope and intercept of the original curve at different points on the curve represented by y as function of x. The envelope of lines of slope m drawn at each value of c has the same shape as that of the curve drawn using the points (x,y). This is illustrated a parabola as shown in the figures below. Write a program that converts a function given as y(x) to the new form either graphically or analytically. Make sure your process works even when the function y(x) is changed to any other smooth and well behaved function.

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