MM2090 : Introduction to Scientific Computing
Apr-Jun-2021

Assignment – 5

Instructions for submission remain same as for first assignment. Don't forget to provide your name, roll number and assignment number on the first page of the PDF you are uploading. All the problems in this assignment should be done using sagemath. Make a zip of your stuff, name it with your roll number and assignment number (eg., ME20B001-assn5.zip) and upload on moodle.

[1] Consider a set A containing the range of integers between 1 and 225. What is the maximum number of elements in a set B, a subset of A such that the difference between any pair of elements is not a perfect square. [2 marks]

Output required: The sagemath code, list of elements of B and the size of the list B.

Application: Graphs come of use in asserting relations between nodes and then querying on them.

[2] Draw a circle with a radius r and (p,0) as origin. Rotate this circle about the origin by angles given by $2\pi j/14$ where $0 \leq j \leq 14$. Color each of these circles differently. Vary r and p between 1 and 3. Create a map of patterns in the parametric space of r and p. [3 marks].

Output required: The sagemath code, a 2D pallet of patterns mapped against the values of r and p.

Application: Rotations of objects in space and their tragectories allow for evaluation of possible overlap with surrounding structure. Analysis of such overlaps help in path planning of moving objects.

[3] Determine the (complex) roots of a polynomial such as $f(x) = x^6 -5*x+1$. Plot the roots as points in the complex plane and identify the circle within which all the roots like. Change the coefficients and see if you can generalize the solution. [3 marks]

Output required: The sagemath code, a plot of roots as points in the complex plane.

Application: This concept applies to the eigen values of a matrix and helps analyse several concepts in continuum mechanics. *Hint: Gerschgorin*

[4] A rectangular region of width A and breadth B needs to be segmented into smaller portions for certain calculation. Using random number generation split up the region into N triangles that are numbered and colored different from its neighbors. Your code should take the size A*B and the number of triangles N as input. For each triangle, generate a list of its vertices. Generate a list of edges shared by the triangles. [5 marks]

Output required: The sagemath code, a plot of domain showing the triangulation, output showing the lists asked for.

Application: Discretization of domain into smaller regions of certain shape is part of performing calculations to solve partial differential equations. Hint: *Delauney & Voronoi*

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