COMPUTER SCIENCE AND ENGINEERING
Indian Institute of Technology Palakkad
CS5016: Computational Methods and Applications
Mid Semester Exam

22 Feb 2024

Time: 14:00 — 17:00 hrs Max Marks: 100

A few instructions

- Codes should be compatible with *Python3* and should run on Ubuntu.
- Codes should be sufficiently commented.
- Code for each question should be placed in a separate stand-alone files.
- Create a folder with your name and roll no. in the **Documents** directory, and place the final code in the created folder.

1. Suppose we have a floor made of parallel strips of wood, each the same width t, and we drop a needle of length l onto the floor. If $l < t$, then the probability that the needle will lie across a line between two strips is $2l/\pi t$ — *Buffon's needle* problem.

   Write a Python program that uses the above idea and Monte Carlo method to estimate π. Your program should also visually illustrate convergence of the estimate. [20]

2. Consider a graph $G = (V, E)$ and a set of nodes $U \subseteq V$. Write a Python program to compute, for any node $v \in U$, the function $d(v) = \min_{u \in U} d(u, v)$, where $d(u, v)$ is the shortest distance between nodes u and v in G. **Do not use any Python libraries/modules.** [20]

3. Write a Python program to visualize, as a function of u, area under the curve $y(x) = \cos\theta \cdot e^{\sin\theta}$ in the interval $[0, u]$ computed using various integration functions available in Python's `scipy.integrate` module. In the figure, also indicate the actual area under the curve. [20]

4. Create a Python class `Polynomial`, representing a algebraic polynomial, such that [40]

   - It is possible to create a polynomial by specifying its coefficients.
   - It is possible to `print` it.
   - It is possible to add (subtract resp.) two polynomial using the + (- resp.) operators.
   - It is possible to pre-multiply the polynomial by a real number using the * operator.
   - It is possible to multiple two polynomials using the * operator.
   - It is possible to evaluate the polynomial at any real number using the [] operator.
   - It is possible to visualize the polynomial in any interval of the type $[a, b]$
   - It should have a method `fitViaLagrangePoly` that computes the *Lagrange polynomial* for the points passed as argument to this method. This method should display a plot with the given points and the computed polynomial. **Use the `Polynomial` class along with the overloaded operators + and * to compute the Lagrange polynomial.**

End of exam