MTH 308: Numerical Analysis & Scientific Computing I
Department of Mathematics and Statistics
Indian Institute of Technology - Kanpur March 30, 2019

Mini Project 2

The following problem is due **Thursday, April 18** at **5:00 PM**.
Steps you should follow :

1. While submitting, all of your programs should be arranged as follows: main directory should be called MP2-ID where ID stands for your roll number. For example, if your roll number is 12345, then the directory name will be MP2-12345; if your roll number is 123456, then the directory name will be MP2-123456.

2. The directory should contain three files, (i) a function called discreteData that takes as inputs the size of the grid to be used for approximation and the function to be approximated and returns `xGrid`, your choice of grid of the given size to be used for approximation of the given function and the function data `fGrid`, the function values on the chosen grid, that is, `fGrid = f(xGrid)`, (ii) a function file called `approxFuntion.m` that implements an approximation procedure to approximately evaluate the function from the given data (the approximation problem is described more formally at the end this document) and (iii) a script file named `main.m` that reads as follows:

```
% the script file for testing the code

% the interval of approximations
a = aValue;   % the value of the left end-point of the interval
b = bValue;   % the value of the right end-point of the interval

% the function to be approximated
f = @(x) f(x); % function description for f, e.g., f = @(x) x.*x

% approximation grid size
nGrid = nGridValue;   % size of the grid to be used for approximation
[xGrid, fGrid] = discreteData(nGrid, a, b, f);

% the number of test evaluation points
nEval = nEvalValue;
xEval = a + (b-a).*rand(1,nEval); % evaluation grid to be used for testing

tic;

exact = f(xEval);
approx = approxFunction(xEval, xGrid, fGrid);
```

```
maxExact = max(abs(exact)); %  the max norm of f
maxError = max(abs(approx-exact));  % the max norm of error

toc;

maxError/maxExact
```

3. Upon completion of the work, once you are ready for submission, go to the directory that contains the directory MP2-ID and compress it using following command at the xterm/terminal command prompt

   $ tar cvfz MP2-ID.tgz MP2-ID

   which will create a file called MP2-ID.tgz .

4. Attach this file in an email with subject MP2-ID and send it to akasha@iitk.ac.in by 5.00 pm on April 23. The supporting short report (not more than two pages) should also be submitted by 5:00 pm in hard or soft-copy. Late submission will not get any credit.

For given $a, b \in \mathbb{R}$ $(a < b)$ and a positive integer n, choose a discrete computational grid $X_{grid} = \{x_j\}_{j=1}^n$ with $x_j \in [a, b], j = 1, \ldots, n$, and $x_i \neq x_j$ for $i \neq j$. Let $F_{grid} = \{f(x_j)\}_{j=1}^n$ be the function data obtained by evaluating a given infinitely differentiable functions $f : [a, b] \to \mathbb{R}$ that satisfies $f^{(k)}(a) = f^{(k)}(b) = 0$ for $k = 0, 1, \ldots, 10$ and $f^{(11)}(a) \neq f^{(11)}(b)$.

Design and implement (in MATLAB) an approximation $f_n[a, b] \to \mathbb{R}$ to f based on the discrete data (X_{grid}, F_{grid}).