Rutgers CS323 (04), Spring 2017, Homework 5

Due at 11:55pm on April 7, 2017, submitted via Sakai

Legendre Polynomials and Chebyshev Polynomials

You are asked to submit the following five functions:

```
1. function y = f(x)
2. function P = Pn(X,x,y)
3. function y = LegPoly(n,x)
4. function L = LegPolyApprox(X,n)
5. function TestPoly(n)
```

The first function f.m should be

```
function y = f(x)
    y = exp(sin(x*5));
end
```

The second function Pn.m can be copied from homework 3 solution.

1 Overall Requirements

We will run your code from matlab console by typing

```
>> TestPoly(5)

err =
    0.6476    0.4001    0.2753    0.1912
```

In addition to these numbers, we expect to see two figures which should be essentially the same as Figure 1. We will test the code for any $2 \leq n \leq 100$. In order to encourage students write reasonably efficient code, the program should not take more than 1 minute (which is much more than necessary).

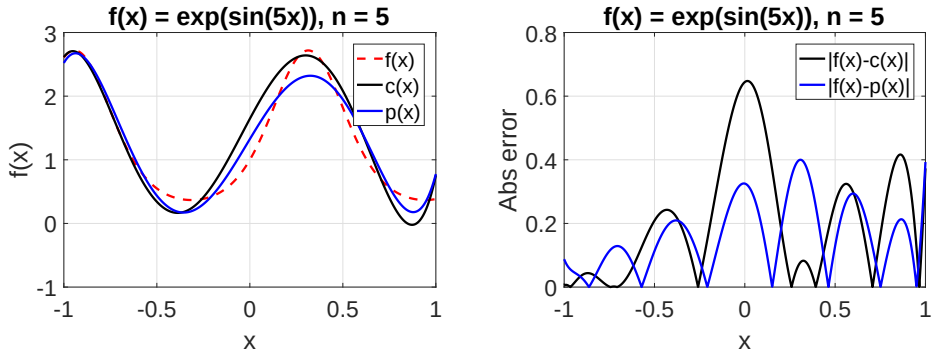

Figure 1: Left panel: Legendre approximation $p(x)$ and Chebyshev approximation $c(x)$ to $f(x)$. Right panel: absolute approximate errors.

Figure 2 is another run for $n = 40$.

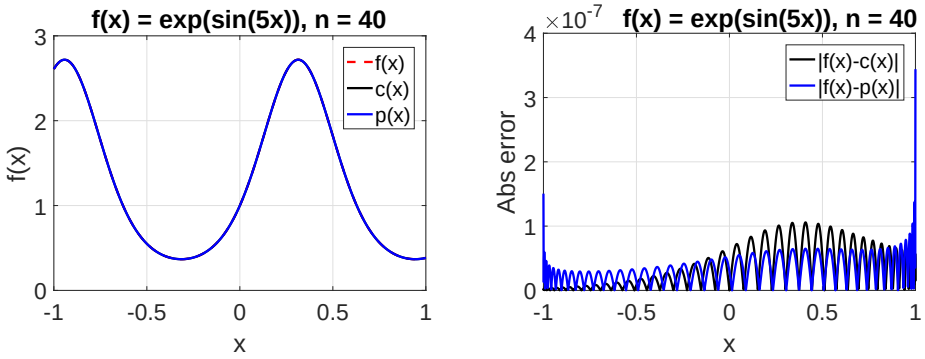

Figure 2: Left panel: Legendre approximation $p(x)$ and Chebyshev approximation $c(x)$ to $f(x)$. Right panel: absolute approximate errors.

2 Specific Instructions

TestPoly.m is something like the following:

```
function TestPoly(n)

X = -1:0.001:1;

% compute x and y

C = Pn(X,x,y);
L = LegPolyApprox(X,n);

% plot two figures

err = [max(abs(f(X)-C)) max(abs(f(X)-L)) sqrt(mean((f(X)-C).^2)) sqrt(mean((f(X)-L).^2))]
% keep this line as it is
```

LegPoly.m computes Legendre polynomials for any n and x. Note that the function will run fast for a vector x. One can not use recursion (at least not the naive version), otherwise the computation would be impossible once n is large (e.g., 40).

LegPolyApprox.m provides the Legendre approximation. Note that for this assignment, you can use matlab numerical integration tool "integral" function to compute (f, P_i).

3 Submission Instruction

Your submission should include the required five matlab files to Sakai in one zipped file.