Lab Session 6

MA581: Numerical Computations Lab S. Bora September 7, 2022

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1. Write a MATLAB function program `w = gaussweightslegendre(n)` to generate $n+1$ weights for Gauss quadrature rule in the interval $[-1, 1]$ from the roots of the Legendre polynomial. Use the following commands to find roots of the Legendre polynomial
   ```
   >> syms x
   >> roots = vpasolve(legendreP(n+1,x) == 0);
   ```
   and generate the weights by the method of undetermined coefficients.

2. Write a MATLAB function program `y = gaussquad(f,a,b,n)` that computes $\int_a^b f(x)dx$ via n-point Gauss quadrature rule with $n+1$ Legendre nodes. Your program should call `w = gaussweightslegendre(n)`.

3. Write a function program `[int,k] = adaptiveT(f,a,b,tol)` to implement adaptive trapezoid rule for approximating $\int_a^b f(x)dx$, `tol` being the amount of error you are willing to tolerate in the approximation. The output `int` should record the computed value of the integral and the output `k` should be the number of sub-intervals of $[a, b]$ created in the process.

   You may make your own program or use the function program provided on page 271 of *Numerical Analysis by Timothy Sauer.*

4. The intensity of diffracted light near a straight edge is determined by the values of the Fresnel integrals

   $$C(x) := \int_0^x \cos\left(\frac{\pi t^2}{2}\right) dt \quad \text{and} \quad S(x) := \int_0^x \sin\left(\frac{\pi t^2}{2}\right) dt.$$

   Use Gauss quadrature and adaptive trapezoid routines to evaluate these integrals for enough values of x to draw a smooth plot of $C(x)$ and $S(x)$ over the range $0 \le x \le 5$.

Submit a livescript program that contains all comments, answers and codes necessary to produce the required output. Ensure that the answers are correctly numbered. The filename of the livescript program should be Your-rollnumber-MA581-Lab6.mlx

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