Course Assignments for CSCE/Math 441

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Note: Unless otherwise stated, it is always permissible to use the course software (Matlab, Octave) for calculations. Also, Maple is acceptible for some tasks such as checking (or doing) your algebraic calculations. As a general rule, you are expected to show your work. In particular, if you use software to solve a problem, you are expected to provide a transcript or some output and paste it into a document. If an exercise is a programming problem, provide some sample output to show the correctness of your program. Typed documents are preferred; hand written copy will be accepted if it is *neatly* written. Unless otherwise stated, hardcopy is the rule. It is expected that co-collaborators and other sources for the homework will be duly acknowledged. Problems that are to be worked by individuals without collaboration will be marked "(I)". Each assignment will be worth about 40 points.

Assignment 1

Points: 35
Due: Friday, September 11

Do Exercises 1-8 in the file VectorSpaces441.pdf which can be found in the Course Materials folder.

Assignment Closed

Assignment 2

Points: 35
Due: Friday, October 2

Do Exercises 1.5, 2.7, 3.9 and 4.8 from textbook. Do these non-text exercises:

N1: With the assumptions and notation of Theorem 3.1 in the text, if one has a good estimate of of $d^*(f)$, one can find a lower bound for $\|X\|$. Show this lower bound. Then assume that Chebyshev interpolation gives a good estimate to the best approximation to $f \in C[-5,5]$ from $\mathcal{B} = \mathcal{P}_{20}$ and estimate $d^*(f)$ for $f = 1/(1+x^2)$ and one other function of your choice. Use these to give lower bounds for $\|X\|$, where X is the interpolation operator using 12 equally spaced interpolation points.

N2: Write a Matlab function with calling form Lnorm(a,b,x), where inputs a and b are left and right endpoints of an interval containing the coordinates of the input vector x, and the output is an approximation to the norm of the Lagrange interpolation operator with interpolation points in the vector x.

Assignment Closed

Assignment 3

Points: 40
Due: Friday, October 16

Do Exercises 5.5, 5.8, 6.2 from textbook. Do these non-text exercises:

N3: Write a Matlab function with the calling form HCpp(x,f,fp), where this function returns a PP structure representing the Hermite cubic p.p. with node row vector x, corresponding function values in the row vector f and derivative values in the row vector fp. You should follow the guidelines of the file PPfcns.m that is found in Course Materials. Validate with some calculations with the Runge's example and several choices of knots and include printout for the case of three knots.

N4: It is claimed in the notes that the error of Hermite p.p. interpolation is $\mathcal{O}\left(h^4\right)$, where h is the largest distance between knots, so that, if the error estimate is reasonably sharp, halving h should reduce the error by a factor of about 16. Verify this with Runge's example on the interval $[0,5]$ and equally spaced knots with $h=1$, $h=1/2$ and $h=1/4$.

Assignment Closed

Assignment 4

Points: 40

Due: Tuesday, November 17

Do Exercise 12.2 from textbook. (Note that for this exercise you must find the first three orthogonal polynomials with respect to the weight function $w(x)=x$ on the interval $[0,1]$. Then find the zeros of the quadratic for the nodes x_0, x_1 and use Formula (12.11) in the text to compute the weights w_0, w_1.)

N5: Calculate a Pade approximation for $f(x)=e^x$ of total degree $3=N=n+m$, with $n=2$ and $m=1$. (See the ClassroomNotes441.pdf file for an explanation of the notation.) Next find the best cubic approximation to $f(x)$ on $[-1,1]$. Find the (approximate) max norm of the error with Matlab. Which is better? (See our ClasroomNotes file for more information on Pade approximations.)

N6: Determine by Matlab experiment how many function evaluations are required to approximate $\int_{-1}^{1} e^x \sin(\pi x)\,dx$ to an accuracy as good as one obtains with a 7 point Gaussian quadrature method, if one uses a trapezoidal method with equally spaced nodes. (Exact answer: $\left((e-1/e)/(\pi+1/\pi)\right)$.)

Assignment Closed