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Math128B: Numerical Analysis

Programming Assignment #2, Due March 18

There are three separate, but related components of this project:

1. Develop a matlab program to perform "mixed radix" fft and inverse fft. Assume that the given problem size n is the product of prime numbers not to exceed 7 (for example, $n = 490 = 2*5*7*7$. This can be computed using the matlab `factor` command.) Your program should be able to do the fft whose stages use those factors as radices. Compare the amount of CPU time required by your program and the built-in matlab fft and inverse fft functions for $n = 1000, 5000, 10000$.

2. Develop a matlab program to multiply two given polynomials using the matlab built-in fft and inverse fft. Also develop a matlab program to multiply two given polynomials using direct coefficient formulas. Compare the amount of CPU time required by these programs for $n = 1000, 5000, 10000$.

3. The Toepliz matrix is a matrix whose entries remain constant along each diagoanl. For example, the following is a 4×4 Toepliz matrix

$$T_4 = \begin{pmatrix} a_0 & a_1 & a_2 & a_3 \\ a_{-1} & a_0 & a_1 & a_2 \\ a_{-2} & a_{-1} & a_0 & a_1 \\ a_{-3} & a_{-2} & a_{-1} & a_0 \end{pmatrix}.$$

   Let T be an $n \times n$ Toepliz matrix and let x be an n-dimensional vector. Develop a matlab program to compute Tx in $O(n \log n)$ operations using the matlab built-in fft and inverse fft. Compare the amount of CPU time required by your program with direct computation of Tx as a matrix-vector product for $n = 1000, 5000, 10000$.

You should:

1. Write a report to summarize these comparisons in three separate tables.

2. Email both your report and your matlab code to Scott by 11:59PM, March 18.