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MA222 - Computational Linear Algebra
Problem Sheet - 1

Basic Algorithms and Notation

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1. Suppose $A \in \mathbb{R}^{n\times n}$ and $x \in \mathbb{R}^r$ are given. Give a saxpy algorithm for computing the first column of $M = (A - x_1 I)\cdots(A - x_r I)$.

2. In the conventional 2-by-2 matrix multiplication $C = AB$, there are eight multiplications: $a_{11}a_{11}, a_{11}b_{12}, a_{21}b_{11}, a_{21}b_{12}, a_{12}b_{21}, a_{12}b_{22}, a_{22}b_{21}$, and $a_{22}b_{22}$. Make a table that indicates the order that these multiplications are performed for the ijk, jik, kij, ikj, jki, and kji matrix multiply algorithms.

3. Give an algorithm for computing $C = (xy^T)^k$ where x and y are n-vectors.

4. Specify an algorithm for computing $(XY^T)^k$ where $X, Y \in \mathbb{R}^{n\times 2}$.

5. Formulate an outer product algorithm for the update $C = AB^T + C$ where $A \in \mathbb{R}^{m\times r}$, $b \in \mathbb{R}^{n\times r}$, and $C \in \mathbb{R}^{m\times n}$.

6. Suppose we have real n-by-n matrices C, D, E, and F. Show how to compute real n-by-n matrices A and B with just three real n-by-n matrix multiplications so that $(A + iB) = (C + iD)(E + iF)$. Hint: Compute $W = (C + D)(E - F)$.

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