Math 228B, Fall 2004
Paper

You will work in a group of 3 or 4 on a paper on a linear algebra topic which we will not have time to cover in the course. The paper must explain the mathematics in a way which convinces me that the entire group has understood the topic. It must include a discussion of the theory, with at least two references; it may include examples from references, examples worked out by the group, or computer projects, and/or applications. Please keep in mind that the audience (me) may not know much about the specific topic. Grading will take into account the correctness, thoroughness and exposition. There are some suggestions for topics below, with at least one possible reference for each. If your group is interested in a topic not on the list, please discuss it with me.

Due dates

- Wednesday, October 13—Each group submits a list of the members of the group and the group's topic.
- Wednesday, November 3—Each group submits a brief outline of what it plans to include in the paper.
- Wednesday, November 17—Papers are due.

Suggestions for topics

- Computer graphics. How are four dimensional linear transformations used to show three dimensional objects? (Strang ILA §8.6, Shifrin and Adams, §7.2, ATLAST §5.2.2)
- Condition numbers. How do you measure whether small changes in $\mathbf{b}$ or A lead to large changes in solutions of $A\mathbf{x} = \mathbf{b}$ and, in particular, to large computer roundoff errors. Or, what happened when you asked Matlab to compute the inverse of the Hilbert matrix in problem 39 of §2.5? (Strang ILA, §9.2, Strang LAA, §7.2)
- Fast Fourier transform. This is very important in digital signal processing. (Strang LAA, §3.5)
- Fast matrix multiplication. How can you multiply two $n \times n$ matrices with fewer than n^3 multiplications? (See the paragraph in Strang beginning at the bottom of page 57.) (Lax, Appendix 6)
- Fibonacci numbers (Franklin, §4.2, esp. problem 2, Shifrin and Adams)
- Iteration for finding the dominant eigenvalue. This is a numerical method for finding eigenvalues. (ATLAST, Franklin, §7.9)

- The minimax principle for finding eigenvalues of real symmetric matrices (Franklin, §6.2-6.3, Lax, p. 89 Theorem 10, Strang LAA, §6.4)
- Pascal matrices. You saw a bit about these in the worked examples in §2.4. (Adelman and Strang)
- Positive matrices. In Math 225 you learned a test for max and min of functions of several variables. Where does the test come from? (Strang ILA, §6.5, Strang LAA, §6.1-6.2)
- The QR algorithm for computing eigenvalues. How can you use QR factorization to compute eigenvalues? (Franklin §7.15)
- The Simplex method and Karmarkar's algorithm. How can you minimize linear inequalities? (Strang ILA, §8.4, Strang LAA §8.2)
- Singular value decomposition. This is a way of "diagonalizing" any matrix (not even necessarily square), with applications to computer images. (Koranyi, ATLAST §8.2)
- Stochastic matrices (Friedberg, Insel and Spence, §5.3, Shifrin and Adams, §6.3.1, p. 368 #10-12)

References

ATLAST Computer Exercises for Linear Algebra

Adelman and Strang, "Pascal Matrices," *American Math. Monthly*, 111 (2004) 189–197.

Friedberg, Insel and Spense, *Linear Algebra*

Franklin, *Matrix Theory*

Koranyi, "Around the finite-dimensional spectral theorem," *Amer. Math. Monthly* 108 (2001), 120–125.

Lax, *Linear Algebra*

Shifrin and Adams, *Linear Algebra, A Geometric Approach*

Strang ILA, *Introduction to Linear Algebra* 3rd ed. (the textbook)

Strang LAA, *Linear Algebra and Its Applications*, 3rd ed.

Note: All of the books on this list except for Strang LAA are on reserve in the Mathematics Library. Strang LAA is on reserve in the Engineering Library.