The Traveling Salesman Problem...

(Continued from page 1)

to camp, sequence of motions of a robot arm in working on a job, etc.

The TSP offers opportunities to study algorithms, to look at different kinds of distance, to use enumeration methods, to investigate mathematical modelling, and even to allow grade schoolers to practice arithmetic.

The Wall Street Journal article cited below gives an account of some new ideas developed by two employees of Dupont to solve the assymetric TSP. The New York Times article is concerned with recent work on TSP problems which involve a very large number of sites; it has little overlap with the other article. An elementary treatment of the TSP can be found in Chapter 2 of the book cited at (4). A history of the TSP can be found in the first article (by A. Hoffman and P. Wolfe) of the book cited at (5); this book consists of many excellent survey articles, parts of which are accessible to all readers.

Bibliography:

(1) *Mathematicians Find New Key to Old Puzzle*, The Wall Street Journal, February 15, 1991, pp. b1,b2.

(2) Kolata, Gina, *Math Problem, Long Baffling, Slowly Yields*, The New York Times, March 12, 1991, pp. c1,c7.

(3) Miller, D. L., and Pekny, J. F., *Exact Solution of Large Asymmetric Traveling Salesman Problems*, Science, 251 (1991) 754-761. (This is the article on which the Wall Street Journal article is based.)

(4) Steen, L., (ed.), *For All Practical Purposes*, (2nd edition), W. H. Freeman, New York, 1991.

(5) Lawler, E. L., et al., eds., *The Traveling Salesman Problem*, John Wiley, New York, 1985.

Topics... What the Computer *Can* and *Cannot* Do

(Continued from page 5)

"Is this a long or a short period of time?" My students are not sure. We calculate that there are approximately 3.15×10^7 seconds per year and so the job will require $(7 \times 10^{13}/3.15 \times 10^7) = 2 \times 10^6$ or *2 million years* to complete, and that's a conservative figure.

Student reactions ranged from a simple "Wow!!" to "I wouldn't want to pay that electric bill!". And the response I was looking for -- "What do we do now?". The following sessions covered short-cut algorithms, including dynamic programming (see reference cited above). And no one in class lost sight of the fact that time efficiency was a crucial element in any algorithm we analyzed.

Another good example of "computational explosion" or "computational infeasibility" is given in *Number Theory and Public-Key Cryptography*, Mathematics Teacher, January 1991. Here the time required for a computer to factor the product of two 100 digit primes is 3.8 billion years, making this cryptosystem reasonably secure.

Ask a Discrete Question...

Dear Euler, Having read the article on page 5 on the limitations of computers, I understand that building a computer which runs twice as fast will only cut the time in half. But one of my students suggested that if each year computers double in speed, then the "computation explosion" will eventually catch up with the "combinatorial explosion". Is that true? *Perplexed.*

Dear Perplexed, First of all, that's a very big "if." Secondly, eventually can be a long time. If you remain perplexed, I suggested you seek out a mathematical counselor.

Illustration... Maps and Graphs

(Continued from article on page 3)

Is it possible for the Paris bridge sweepers to leave their depot on Citadel Island, sweep each bridge just once and return to their depot?

A huge potato spill has resulted in the closing of bridges 1 and 2. Can the sweepteam now start at the depot, sweep bridges 3-15 and return to their depot without repeating a bridge? Draw a graph and explain your answers.