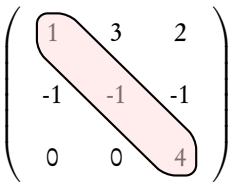
MAT 305: Final assignment

Due 5 May, 2014

Remark. As usual, try to organize the computational cells in your worksheet under text cells that separate problems, parts of problems, add commentary, etc. *Everything you need to manipulate matrices for this problem was discussed in class.*

1. The **trace** of a matrix is the sum of the elements on the main diagonal. For example, the trace of the matrix below is 4, and the main diagonal is circled.



   (a) Write pseudocode to compute the trace of a matrix. Format your pseudocode properly. Your pseudocode can assume that the matrix is square.

   (b) Write a program whose input is a matrix, and whose output is the trace of the matrix. Keep in mind that:
   - Your program should be able to handle any $n \times n$ matrix, where $n = 1, 2, 3, \ldots$.
   - If the matrix is not square, then your program should indicate this somehow. At the very least, it should print a message, but it would be better to raise an exception.

2. (a) It is impossible to simplify $\int e^{-x^2} dx$ to elementary functions. Use a loop to estimate $\int_0^\infty e^{-x^2} dx$.

   (b) Previously, we wrote a program to approximate $\int_a^b f(x) dx$ using Left Endpoints. Adapt this to a function to approximate $\int_a^b f(x) dx$ using Midpoints: For the height of the i-th rectangle on the interval $\left[x_{i-1}, x_i\right]$, use the value $f\left(m_i\right)$, where $m_i = \left(x_{i-1} + x_i\right)/2$.

   (c) *(Extra Credit)* Write an interactive Sage application that has
   - input boxes for a function f, and endpoints $a, b \in \mathbb{R}$,
   - a slider to choose the number of approximation points N from 1 to 10,
   - a selector for either Left Endpoint or Midpoint method,

   then computes an approximation of $\int_a^b f(x) dx$.