Announcements:
- Project 3 will be posted this weekend, due Thurs after break
- Prelim 1 solutions:
  - Check it out if you made minor mistakes
  - Don't read the solution to a particular question if you had significant errors! Instead, try to re-do it and/or come to office hr to work with a staff member to really learn the material.

Previous Lecture:
- Easy plots in MATLAB
- 1-d array of characters—string

Today's Lecture:
- 2-d array—matrix

Reading:
- CFile: Chapter 9 Sec 9.1, 9.2

2-d array: matrix
- An array is a named collection of like data organized into rows and columns
- A 2-d array is a table, called a matrix
- Two indices identify the position of a value in a matrix, e.g., \( \text{mat}(r,c) \) refers to the cell in row \( r \), column \( c \) of matrix \( \text{mat} \)
- Array index starts at 1

Creating a matrix
- Built-in functions: ones, zeros, rand
  - E.g., \( \text{ones}(2,3) \) gives a 2-by-3 matrix of 1s
  - "Build" a matrix using square brackets, \([\ ]\):
    - \([x \ y]\) puts \( y \) to the right of \( x \)
    - \([x; y]\) puts \( y \) below \( x \)
  - What are the dimensions of a matrix \( M \)?
    - \([nr, nc] = \text{size}(M)\) % \( nr \) is # of rows, \( nc \) is # of columns
    - \( nr=\text{size}(M, 1) \) % # of rows
    - \( nc=\text{size}(M, 2) \) % # of columns

Example:
```matlab
A = [1 1]
A = [A' ones(2,1)]
A = [1 1 1 1; A A A]
```
- Error in 2nd statement
- Error in 3rd statement
- A is 3-by-4 matrix
- A is 4-by-3 matrix
- A is vector of length 12

Example: min value in a matrix
```matlab
function val = minInMatrix(M)
% val is the lowest value in matrix M
```

% val is the lowest value in matrix M
Pattern for traversing a matrix \( M \)

\[
\begin{align*}
[nr, nc] &= \text{size}(M) \\
&\text{for } r = 1: nr \\
&\quad \text{for } c = 1: nc \\
&\quad \quad \text{do something with } M(r,c) \ldots \\
&\quad \text{end}
&\text{end}
\end{align*}
\]

% Given an \( nr \)-by-\( nc \) matrix \( M \)
\[
\begin{align*}
&\text{for } r = 1: nr \\
&\quad \text{for } c = 1: nc \\
&\quad \quad A(c,r) = M(r,c); \\
&\quad \text{end}
&\text{end}
\end{align*}
\]

a. \( A \) is \( M \) with the columns in reverse order
b. \( A \) is \( M \) with the rows in reverse order
c. \( A \) is the transpose of \( M \)
d. \( A \) and \( M \) are the same

% Given an \( n \)-by-\( m \) matrix \( A \)
\[
\begin{align*}
&\text{for } g = 1: n \\
&\quad \text{for } h = 1: \text{floor}(m/2) \\
&\quad \quad A(g,h) = A(g, m-h+1); \\
&\quad \text{end}
&\text{end}
\end{align*}
\]

a. Reflect the right half of \( A \) onto the left half
b. Reflect the bottom half of \( A \) onto the top half

Local minimum in a neighborhood

\[
\begin{array}{ccc}
2 & -1 & 5 \\
3 & 8 & 6 \\
5 & -3 & 9 \\
52 & 81 & 5 \\
\end{array}
\]

Cell (2,3)

Neighborhood of cell (2,3)

Local minimum in a neighborhood

Write a function \texttt{minInNeighborhood}

Input parameters:
- \( M \): matrix of numeric values
- \texttt{loc}: location of the middle of the neighborhood
  \( \text{loc}(1), \text{loc}(2) \) are the row, column numbers

Output parameter: \texttt{minVal}
  The minimum value of the neighborhood
Ask yourself leading questions!
- Can you find the min of a (sub)matrix?
  - Yes! Our function \( \text{minInMatrix}(A) \)
- Given the indices \( r, c \) (representing cell \( M(r,c) \)), is it easy to define the neighborhood?
  - Yes, for the general case the neighborhood is \( M(r-1:r+1, c-1:c+1) \)
  - But the “border cases” add complexity
- Can we get rid of the border cases?

Local minimum in a neighborhood

\[
\begin{array}{cccc}
2 & 1 & 5 & 0 \\
3 & 8 & 6 & \text{?} \\
5 & \text{?} & 8 & 5 \\
52 & 81 & 5 & 7 \\
\end{array}
\]

Want to be able to use the general case, \( M(r-1:r+1, c-1:c+1) \)