Components of Scientific Programming

• Definition of problem
• Physical/mathematical formulation
• Development of computer code (Focus today)
  ▪ Development of logic (e.g., flowchart)
  ▪ Assembly of correct lines of code
  ▪ Testing and troubleshooting
  ▪ Visualization of results
  ▪ Optimization of code
• Analysis of results
• Synthesis
Definition of problem (Sorting a row array)

• Sort through row array A of random numbers, and organize them from left to right by increasing numerical value in array B

• Example
  ▪ A = rand(1,4)
  ▪ A =
    0.7621  0.4565  0.0185  0.8214
  ▪ B =
    0.0185  0.4565  0.7621  0.8214
Searching an Array

\[ j=1 \quad j=2 \quad j=3 \quad j=4 \quad j=5 \quad j=6 \quad j=7 \quad j=8 \quad j=9 \]

\[ x_1 \quad x_2 \quad x_3 \quad x_4 \quad x_5 \quad x_6 \quad x_7 \quad x_8 \quad x_9 \]

Here, the column number is “j”
Development of logic (first try)

Start

Create array A of length n

Make copy array B

For j = 1:n-1

B(j) = C

B(j+1) = B(j)

C = B(j+1)

Is B(j) > B(j+1)?

Yes

No

Stop
Assembly of correct lines of code (a)

function [A,B] = gg250_lab_06_try(n)
% function [A,B] = gg250_lab_try(n)
% Partially sorts the elements in a vector array
% of n-elements on a single pass through the array.
% Input parameters
% n = input array
% Output parameters
% A = Unsorted array
% B = Partially sorted array
% Example
% [A,B] = gg250_lab_06_try(5)
Assembly of correct lines of code (b)

```matlab
% Make copies of the input array
A = rand(n,1);
B = A;

% Find the number of elements in the array
n = length(A);

% Step through the elements one-by-one, switching
% consecutive elements such that the lower element
% comes before the higher element
for j = 1:(n-1)
    if B(j) > B(j+1)
        C = B(j+1);
        B(j+1) = B(j);
        B(j) = C;
    end
end
```
Testing and troubleshooting
Visualization of results

• Can plot the values of the elements vs. their position in the array by including the command
  plot B
Optimization of code

- See Matlab's sort command
Searching a Grid

Here, the row number is “i” and the column number is “j”
Searching a Grid

\[ U = \text{rand}(5,9); \quad [n,m] = \text{size}(U); \]

\[
\begin{array}{c}
\text{for } i = 1:n \\
\quad \text{for } j = 1:m \\
\quad \quad \text{if } i == 3 \text{ } \& \text{ } j == 2; \quad U(i,j) = 1; \text{end} \\
\quad \text{end} \\
\text{end}
\end{array}
\]

\[
\begin{array}{c}
\text{Alternatives} \\
U(3,2) = 2; \quad \text{Or search a column vector form of } U \\
T = U(:); \quad T((2-1). \ast n + 3) = 3; \quad T = \text{reshape}(T,n,m)
\end{array}
\]