Array Creation

ENGR 1187
MATLAB 2
Today’s Topics

- Arrays: What are they?
- Vectors
- Matrices
- Creating Arrays
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Arrays: What are they?

- Before we answer that, let’s think about how a computer stores and organizes data.
  - In computer science, a *data structure* is a particular way of organizing data in a computer so that it can be used efficiently.
  - MATLAB has its own data structure (way of organizing data).
- An *array* is a data structure that contains a group of elements of the same *data type*. 
Arrays: What are they?

- In this class we’re going to work with one-dimensional & two-dimensional arrays.

- We can refer to the size of arrays as an M x N array.
  - M = number of rows.
  - N = number of columns.

- For example:
  - >> x = 5; % Enter this in the command window
  - The variable x is now a 1 x 1 scalar array.

- We can take advantage of MATLABs ability to easily create and manipulate various sizes of arrays to analyze large data sets.
Civil engineers store seismic data in arrays to analyze plate tectonics as well as fault patterns. These sets of data are critical to structural design in areas like California where earthquakes are prevalent and dangerous in number of occurrences and magnitude.
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What is a vector?

- A vector is an array that contains multiple elements in either a single row OR a single column.
- A vector is referred to as a one-dimensional array.
- For example:

  Row Vector: 1 Row by 4 Columns

  Column Vector: 4 Rows by 1 Column
Row Vectors vs. Column Vectors

- When creating a vector you need to choose which type to create.

- This will depend on the type of calculations you need to do.
  - i.e., Compute \( \sin(x) \) where \( x \) goes from 0 to 360 degrees.
    - \( \gg x = 0 : 360; \) % Generate a row vector using colon operator
    - \( \gg y = \text{sind}(x); \) % Remember, in degrees we use “sind”, not “sin”
    - \( \gg \text{plot}(x,y); \) % We’ll learn more about visualization later in the semester.
Row Vectors vs. Column Vectors

- Note: Because x is a row vector MATLAB will return y as a row vector as well.
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What is a matrix?

- A matrix is a two-dimensional, rectangular array of numbers.

- For example:

```
2  4  6  8
1  2  3  4
```

2 Rows

4 Columns

```
17  24  1  8  15
23  5  7  14  16
4   6  13 20  22
10  12 19 21  3
11  18 25  2  9
```

5 Rows

5 Columns
What is a matrix?

- There are many ways matrices can be used to represent data.

- For example:
  - We have attendance data for number of absences of three students over 4 months. We can create this as a matrix:

<table>
<thead>
<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student A</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Student B</td>
<td>9</td>
<td>7</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Student C</td>
<td>7</td>
<td>10</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

Attendance =
What is a matrix?

- Another Example: Using multiple matrices for a 3D representation of the earth’s surface (Digital Elevation Models).

- Requires 3 two-dimensional matrices
  - 1 matrix for all longitudinal coordinates (i.e., X)
  - 1 matrix for all latitude coordinates (i.e., Y)
  - 1 matrix for all elevation values (in feet or meters) (i.e., Z)
Yellowstone DEM

Google Earth Image

MATLAB Display of DEM
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Basic Approach (for small arrays): Row Vectors

- We could make a *row* vector that consists of even numbers from 2 to 10:
  - \( \gg x = [2 \ 4 \ 6 \ 8 \ 10]; \) % Without commas
  - OR
  - \( \gg x = [2,4,6,8,10]; \) % With commas

- Vectors can only be created using “[ ]” brackets.

- Elements can be separated by spaces OR commas.
Basic Approach (for small arrays): Column Vectors

- We could make a column vector that contains average temperature data for four months: \([28 \ 33 \ 42 \ 51]\) :
  - \(\gg x = [28; 33; 42; 51]; \) % With semi-colons
- Must use “[ ]” brackets.
- Elements can be separated by semi-colons OR using by an 'enter‘.
The most basic approach for creating a matrix is combining row and column vector syntax.

- For example:

  
  ```
  >> mat = [ 1 2 3 4; 4 3 2 1; 5 6 7 8]
  ```

<table>
<thead>
<tr>
<th>Row 1</th>
<th>Row 2</th>
<th>Row 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4</td>
<td>4 3 2 1</td>
<td>5 6 7 8</td>
</tr>
</tbody>
</table>
MATLAB Operators

- Larger arrays can be created easily in MATLAB using the colon ("::") operator.
  
  • Syntax:
    - \( x = \text{first}_\text{value} : \text{last}_\text{value}; \) (i.e., >> \( x = 1 : 10; \))
      - Assumes a spacing of 1
    - \( y = \text{first}_\text{value} : \text{spacing} : \text{last}_\text{value}; \) (i.e., >> \( y = 2 : 2 : 10; \))
      - Specify the spacing between elements
  
  • Note: This always produces a row vector!
MATLAB Operators

- How can we easily create a column vector? The transpose operator ( Denoted by an apostrophe ‘ ’).
  - Syntax:
    - >> x = ( 1 : 10 )’ ;
    - >> y = ( 2 : 2 : 10 )’ ;
  - Parenthesis are required for the transpose operator to work correctly.
- The transpose operator can be used more generally on either type of vector ( Can be used on matrices too ).
MATLAB Functions

- MATLAB has built-in functions for creating arrays.

  - **linspace**: Generates linearly spaced vectors
    - Syntax: \( y = \text{linspace}(x_1, x_2, N) \)
    - \( x_1 = \) start value; \( x_2 = \) end value; \( N = \) number of element

  - **zeros**: Generates an array of all zeros
    - Syntax: \( X = \text{zeros}(m,n) \)
      - \( m = \) number of rows; \( n = \) number of columns
      - **NOTE**: Other input options are available >> help zeros

  - **ones**: Generates an array of all ones
    - Syntax: \( X = \text{ones}(m,n) \)
      - \( m = \) number of rows; \( n = \) number of columns
      - **NOTE**: Other input options are available >> help ones
Recap

- Given the following array creations what is the size of each array?
  - `>> v1 = [2 4 6 8]`
    - Row vector of size [1 x 4]
  - `>> v2 = linspace(0 , 10 , 15)'
    - Column vector of size [15 x 1]
  - `>> v3 = [2 4 6 8 ; linspace(0 , 1 , 4) ]`
    - Matrix of size [2 x 4]
Preview of Next Class

- Array Accessing and Strings
  - Vector addressing and the use of an index
  - Vector functions
  - Addressing a range of elements in a vector
  - Matrix addressing
  - Extracting elements and sets of elements from a matrix
What’s Next?

- Review today’s Quiz #02
- Open the in-class activity from the EEIC website and we will go through it together.
- Then, start working on MAT-02 homework.
- Before next class, you will read about accessing arrays and how MATLAB recognizes strings of text.