

# SESSION 1: MATLAB BASICS

<http://uiuc-cse.github.io/matlab-sp17/>

# OUTLINE

- Introduction - MATLAB, programming, GUI
- Variables - scalar, vector, matrices & Operators
- Replicating vectors & Reshaping matrices
- Functions
  - Area of a circle & volume of a sphere
  - Fahrenheit/Celsius & plotting
- Matrix Definition
  - Falling ballistic object example
- Element-wise & matrix operators : Truss forces example
- Control Flow – Loop, If Else

# INTRODUCTION

- MATLAB Introduction
  - Tool for Linear Algebra
  - Functionality – tool box
- What is programming
  - Commands
  - Data or variables
  - Logic
- MATLAB GUI
  - Workspace
  - Command window
    - Command line
    - Script file - .m file

# VARIABLES - SCALAR, VECTOR

- Variable

- Scalar:

`x=2    y=3    x+y    x*y    x/y    x^y`

- Vector:

`V1 = [0 2 4 6 8]    V2 = 0:2:8`

`1:2:7    % row vector`

`(1:2:7)'    % column vector`

`1:6`

`linspace(0,10,5)    % row vector`

`linspace(0,10,5)'.    % column vector`

- Accessing element

Index in MATLAB starts from 1 (not 0).

`V1(3)    M1(2,3)    M1(:,2)    M1(1,:)`

# VARIABLES - MATRICES

- Matrices

- $A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$   $B = \begin{bmatrix} 7 & 8 \\ 9 & 10 \\ 11 & 12 \end{bmatrix}$
- $A * B$        $A'$        $A * A$        $A .* A$
- $V = [1 \ 3 \ 4 \ 2]$        $V'$        $V * V'$        $V .* V$        $\text{eye}(3)$        $\text{zeros}(3)$
- $C = \text{ones}(3)$        $D = \text{rand}(3)$        $C * D$        $C .* D$        $C^2$        $C.^2$
- $A(2,2) = 100;$        $V(5) = 1;$        $B(1:2) = 1;$   
 $B(:,2) = 3;$        $B(4,4) = 4;$        $B(2,:) = 5;$

# REPLICATING & RESHAPING

- Replicating elements in vectors
  - Example :  $N = 3$ ;  $A = [4\ 5]$   
Create  $N$  copies of each element in  $A$ , so  $B = [4\ 4\ 4\ 5\ 5\ 5]$   
Use **kron**:  $K = \text{kron}(X,Y)$  returns the Kronecker tensor product of  $X$  and  $Y$   
`>> kron(A,[1 1 1])`
- Reshaping arrays:
  - Example:  
Reshape a 3-by-4 matrix into a 2-by-6 matrix.  
 $A = [1\ 4\ 7\ 10; 2\ 5\ 8\ 11; 3\ 6\ 9\ 12]$   
 $B = \text{reshape}(A,2,6)$  or  $B = \text{reshape}(A,2,[])$

# EXAMPLE: AREA OF A CIRCLE & VOLUME OF A SPHERE (FUNCTIONS)

- $A(r) = \pi r^2$                        $r$  : radius
- To make it reproducible, use a function
- Try it on 1:1:5
- Create a new function, `volOfSphere`, and make it work:  
    `function [V] = volOfSphere(r)`  
    .....

# EXAMPLE: FAHRENHEIT/CELSIUS (FUNCTIONS)

- $T_F(T_C) = T_C \frac{180}{100} + 32$
- Write a function that performs this conversion:  
function Tf = TempC2F(Tc)  
...  
• Take Tc as vector:
  - 1:2:200
  - linspace(0, 200, 101)
- Save the results in a file:  
fileName = fopen('file name.txt','w')  
fprintf(fileName, 'header1 header2\n');  
fprintf(fileName, '%f %f\n', row vector)  
fclose(fileName)



# EXAMPLE: FALLING BALLISTIC OBJECT (VECTORIZATION, FUNCTIONS)

- $y(t) = \frac{1}{2}at^2 + v_0t + y_0$   
 $a = g = -9.81 \quad v_0=2.5 \quad y_0=0 \quad t=1$
- Vectorize:  
`t=linspace(0,5,101);`  
Try: `y=a*t^2+v*t+x0;`  
Not working? Why?
- Plot the `t` and `y` - `plot(t,y)`
- Create a function: `function [y] = a_fall(t,v,x0)`
- Modify the function to not yield `y`-values less than zero.

# EXAMPLE: TRUSS FORCES (ELEMENT-WISE & MATRIX OPERATORS)

- $T \cdot x = f \Rightarrow x = T^{-1} \cdot f$
- Let  $f_1 = 10$  and  $f_2 = 20$
- Define  $T$  and  $f$  using MATLAB new variable or load it from truss-matrix.mat.
- Solve the matrix using function 'inv' & using '\'
- Compare the speed of two method using tic and toc

# CONTROL FLOW(LOOP, IF ELSE) & MATRIX DEFINITION

- for loop :  
    *for i=1:n or linspace(1,n,n)*  
        *do something*  
    *end*
- Conditional statement:  
    *if condition 1*  
        *do something*  
    *elseif condition 2*  
        *do something different*  
    *else*  
        *do this rest of time*  
    *end*
- Example: define matrix using for loop and if-elseif-else