MATLAB for beginners

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MATLAB Tutorial II

• Functions for matrix analysis

i) For creating a vector of evenly spaced entries.

```
u = 1:20

u = linspace(1,20,20)

v = 0:20:100

v = linspace(0,100,6)
```

ii) For $\vec{\mathbf{v}} \in R^{n\times 1}$, $||\vec{\mathbf{v}}|| = \sqrt{v_1^2 + v_2^2 + \cdots + v_n^2}$

```
norm(v)

sqrt(v'*v)
```

iii) For creating $X \in R^{3\times 2}$ of all zeros:

```
X = [0 0;0 0;0 0]

X = zeros(3,2)
```

iv) For creating $X \in R^{3\times 2}$ of all ones:

```
X = [1 1;1 1;1 1]

X = ones(3,2)
```

v) For creating $X \in R^{3\times 2}$ of random values sampled from a uniform distribution of the interval [0 1]:

```
X = rand(3,2)

X = 2*rand(3,2) % random values sampled from a uniform distribution of the interval [0 2]
```

vi) For creating diagonal matrix X whose diagonal elements are [1 2 3]:

```
X = [1 0 0;0 2 0;0 0 3]

X = diag([1 2 3])

X = diag([1;2;3])
```

vii) For getting diagonal elements from a square matrix X:

```
[X(1,1); X(2,2); X(3,3)]
```

```
diag(X)
```

viii) For creating identity matrix $I_{3\times 3}$:

```
I = [1 0 0;0 1 0;0 0 1]
```

```
I = eye(3)
```

ix) Sum of diagonal elements:

```
X(1,1)+X(2,2)+X(3,3)
```

```
trace(X)
```

x) For computing the inverse of a square matrix X: *(we will learn the concept of matrix inverse in next class)*

```
Y = 1/(X(1,1)*X(2,2)-X(1,2)*X(2,1)) * [X(2,2) -X(1,2); -X(2,1) X(1,1)] % only when X is 2 by 2 matrix
```

```
Y = inv(X)
```

xi) For computing the determinant of a square matrix X:

```
d = X(1,1)*X(2,2)-X(1,2)*X(2,1) % only when X is 2 by 2 matrix
```

```
d = det(X)
```

- **Conditional statements**

======== Syntax ========

if *expression (e.g. $x > 2$)*

statements (e.g. $y = 3$)

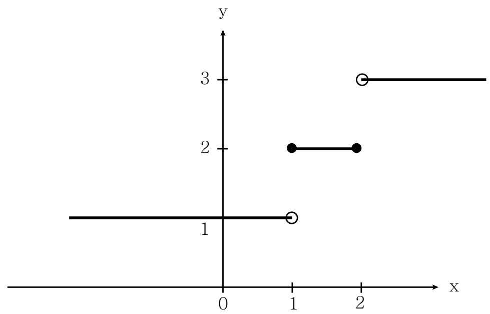
elseif *expression (e.g. $x < 1$)*

statements (e.g. $y = 1$)

else

statements (e.g. $y = 2$)

end



- **Exercise: conditional statements**

```
% Assign two row vectors [1 2] and [3 4[ to u and v, and write a matlab code that performs
% the addition of the two vectors if a conditional variable 'cond' is equal to 1,
% or that performs the inner (dot) product of them.
u = [1 2];
v = [3 4];
cond = 0; % 'cond' needs to be pre-assigned by a value. You can try many different values.
if cond == 1
    u + v
else
    u*v'
end
```

• Loop control statements

i) **for** statements loop a specific number of times, and keep track of each iteration with an incrementing/decrementing index variable.

```
x(1) = 0;
x(2) = 1;
for n = 3:10 % the following statement is executed until n becomes 10 by incrementing 3 in step of 1
    x(n) = x(n-1)+x(n-2)
end
```

ii) **while** statements loop as long as a condition remains true.

```
x(1) = 0;
x(2) = 1;
n = 3;
while n <= 10 % the following statements are executed as long as n is less than or equal to 10
    x(n) = x(n-1)+x(n-2)
    n = n + 1;
end
```

The above two examples i) and ii) generate Fibonacci numbers.

• Loop vs. Vectorization

MATLAB is optimized for operations involving matrices and vectors. The process of revising loop-based, scalar-oriented code to use MATLAB matrix and vector operations is called vectorization. Vectorizing your code is worthwhile for several reasons:[*doc vectorization*]

i) *Appearance:* Vectorized mathematical code appears more like the mathematical expressions found in textbooks, making the code easier to understand.

ii) *Less Error Prone:* Without loops, vectorized code is often shorter. Fewer lines of code mean fewer opportunities to introduce programming errors.

iii) *Performance:* Vectorized code often runs much faster than the corresponding code containing loops.

```
% Create a vector of one cycle of a sine wave (t from 0 to 2*pi in step of 0.001)
% by using for-loop and vectorized form.

% For loop form
tic; % tic starts a stopwatch timer to measure the internal time at execution of the tic command
n = 1;
for t = 0:0.001:2*pi;
    x(n,1) = sin(t);
    n = n + 1;
end
toc; % toc reads the elapsed time from the stopwatch timer started by the tic function

% Vectorized form
tic;
t = 0:0.001:2*pi;
y = sin(t);
toc;
```

• **Q: Construct 3 by 3 identity matrix in the following four different ways:**

i) *for* loop

ii) *while* loop

ii) *diag* and *ones*

iii) *eye*

==========================

i) *for* loop

```
X = zeros(3,3);
for n = 1:3
    X(n,n) = 1;
end
```

ii) *while* loop

```
X = zeros(3,3);
n = 1;
while n <= 3
    X(n,n) = 1;
    n = n + 1;
end
```

iii) *diag* and *ones*

```
X = diag(ones(3,1));
% OR
X = diag(ones(1,3));
```

iv) *eye*

```
X = eye(3);
```