Lecture 02: MATLAB FUNDAMENTALS

Reading:

The MATLAB Environment

- Computational Software

From The MathWorks:
www.mathworks.com

- MATrix LABoratory
- Algorithm Development Environment

Three Primary Windows

- **Command Window**

  Used to enter commands and data
- **Graphic Window**

  Used to display plots and graphs
- **Edit Window**

  Used to create and edit M-files

Variables

- Begin with an alphabetic character: a
- Case sensitive: a, A
- No data typing: a=5; a='ok'; a=1.3
- Default output variable: ans
- Built-in constants: **pi Inf**
- **clear removes variables**
- **who lists variables**
- Special characters

  [ ] ( ) { } ; % : = .

  ... @

Operators

- Arithmetic operators
  + - * / ^ \
- Relational operators
  < > <= >= == ~=
- Logical operators
  || **&&** **true** **false**
- Operator precedence
  () {} [] -> **Arithmetic** -> **Relational** -> **Logical**
- Do not use special characters, operators, or keywords in variable names.

Vectors

- **Row vector**

  >> R1 = **[1 6 3 8 5]**

  >> R2 = **[1 : 5]**

  >> R3 = **[-pi : pi/3 : pi]**

- **Column vector**

  >> C1 = **[1; 2; 3; 4; 5]**

  >> C2 = R2'

Matrices

- **Creating a matrix**

  >> A = **[1 2.5 5 0; 1 1.3 pi 4]**

  >> A = **[R1; R2]**

- **Accessing elements**

  >> A**(1, 1)**

  >> A**(1:2, 2:4)**

  >> A**(:, 2)**

Matrix Operations

- Operators + **and** -

```
>> X = [x1 x2 x3];
>> Y = [y1 y2 y3];
>> A = X + Y
      A = x1+y1 x2+y2 x3+y3
```

- Operators *, /, **and** ^

```
>> Ainv = A^-1
```

Matrix math is default!

Element-Wise Operations

- Operators .*, ./, **and .^**

```
>> Z = [z1   z2     z3]'
>> B = [Z.^2              Z      ones(3,1)]
```

B =

$$\begin{bmatrix} z_1^2 & z_1 & 1 \\ z_2^2 & z_2 & 1 \\ z_3^2 & z_3 & 1 \end{bmatrix}$$

Graphics

- **2D linear plots: plot**

```
>> plot (X, Y, 'r-')
```

Colors: b, r, g, y, m, c, k, w

Markers: o, *, ., +, x, d

Line styles: -, --, -., :

- **Multiple datasets on a plot**

>> p1 = **plot(xcurve, ycurve)**

>> **hold on**

>> p2 = **plot(Xpoints, Ypoints, 'ro')**

>> **hold off**

Customizing Graphs

- Annotating graphs

  >> **plot (X, Y, 'ro')**

  >> **legend ('Points')**

  >> **title ('Coordinates')**

  >> **xlabel ('X')**

  >> **ylabel ('Y')**
- Plot Edit mode: icon in Figure Editor
- Property Editor: View->Property Editor
- **Saving figures:** File->Save As

Build-in Functions

- The linspace and logspace Function

  linspace (x1, x2, n) : generate n points between x1 and x2. n=100 by default

logspace(x1, x2, n): generate a row vector that is logarithmically equally spaced.

- Matrices & Vectors: size, length, ones, zeros…
- Descriptive Statistics: mean, std…

Help → function browser…

MATLAB Programming

- Predict the fall velocity of a bungee jumper:

$$\frac{dv}{dt} = g - \frac{c_d v}{m}$$

- Analytical Solution:

$$v = \frac{gm}{c_d}\left(1 - e^{-\frac{c_d}{m}t}\right)$$

- Euler's Method:

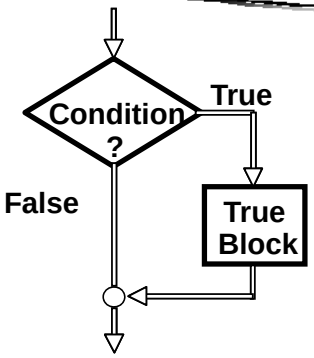
$$v_{i+1} = v_i + \frac{dv_i}{dt}\Delta t$$

Structured Programming

- ***Sequence***
- ***Selection (Decisions)***
- ***Repetition (Loops)***

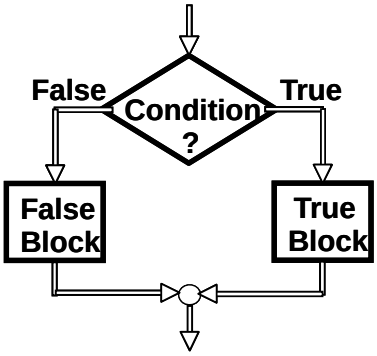
DECISIONS: If Statements

a) Single-alternative If structure (If/Then)




```
if a < 0
  a = -a
end
```

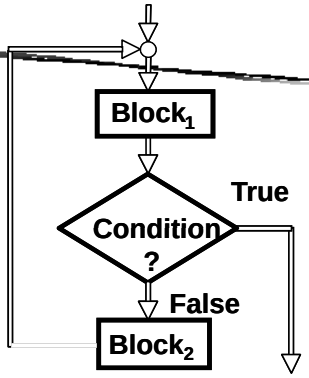
b) Double-alternative If structure (If/Then/Else)




```
if score >= 60
 disp (‘pass’);
else
  disp (‘fail’);
end
```

REPETITION: Loops

If/Exit Loop →

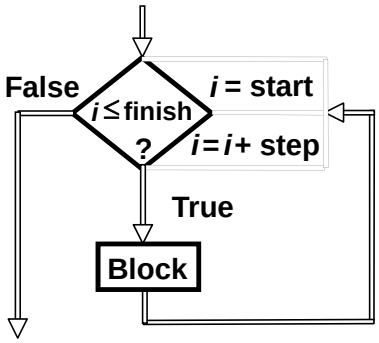


Flowchart

```
x = 10;
while (x > 0)
   x = x - 1
    i = i + 1;
end
```

MATLAB

For-Next Loop



Flowchart

```
fac = 1;
for i = 1 : 10
  fac = fac * i;
end
```

MATLAB

PARACHUTIST ALGORITHM

1. ***Get values from the user***
2. ***Perform the calculation***
3. ***Display the results***

M-files

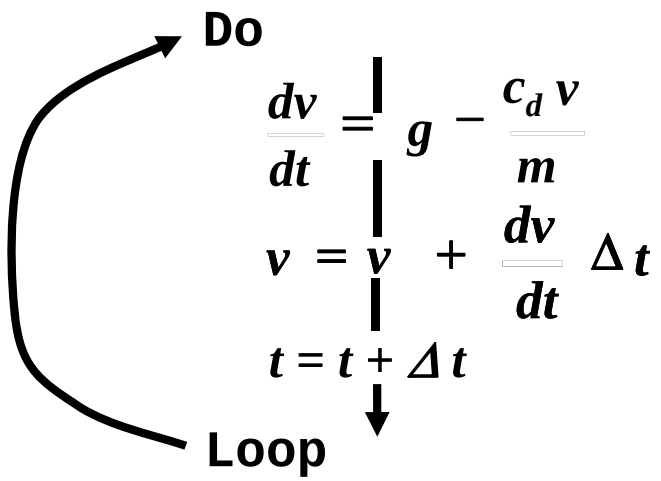
- File → New→ M-File
- Script File
- Function File
  - Learn to use 'help', 'lookfor'
  - Use subfunctions
- Input-Output
  - Input, fprintf…

Analytical Solution

- parachutistScript
- parachutistVel
- parachutistVelsubfunc

Numerical Solution

a. Basic algorithm:



Numerical Solution

b. How do you stop?

For i = 1 To n → $\frac{tf - ti}{dt}$

$$\frac{dv}{dt} = g - \frac{c_d v}{m}$$

$$v = v + \frac{dv}{dt} \Delta t$$

$$t = t + \Delta t$$

Next i

Example 1:

ti = 0
tf = 20
dt = 1

n = (20 - 0)/1 = 20

Example 2:

ti = 2
tf = 50
dt = 2

n = (50 - 2)/2 = 24

MATALB EXAMPLE

- parachutistNUM