Array multiplicⁿ A.*B

Matrix multiplicⁿ A*B

Array division < A./B a/b
A.\B b/a

Matrix Division complicated A/B
A\B

Array exponentiation 2^3 $\underset{\text{matrix}}{X}$.^$\underset{\text{matrix}}{N}$

Precedure

0 High - Parenthesis

1 - Exponentiation & Transposition '

2 +,- - Unary+, Unary-

3 - mult. & Div. (Array & matrix)

4 - Addition & subtraction

5 low - Colon operator :

6 Relational operators < <= > >= == ~=

7. Element-wise logical "and" : &

8. Element wise logical "or" : |

9. logical "and" : &&

10. logical "or" : ||

To continue a command to next line ... 3 dots

Functions

```
>> rand(3,4) ← stored function
```

creates a random (3,4) matrix with all numbers b/w 0 & 1

use help (or) doc

→ range can be changed as

```
>> 1 + rand(3,4)*9
```

so no.s are now b/w [1 & 10)

to get in other doc

To create our own function.

sin( ) sind( ) ↑ degree

→ we need to open editor

```
>>edit
```

In editor create your own fncⁿ & save it as a file (*.m)

```
>> function myRand
     a = 1 + rand(3,4)*9
   end  ← (local variable)
```

↳ Now this fncⁿ can be used

↳ The value of a variable remains only till function is running

→ so some changes to use the value in MATLAB.

x(2,end)

x(end,2)

x([2 3])

```
function a = myRand
    a = 1 + rand(3,4)*9;
end
```

Now in Matlab b = myRand

scope: set of fncⁿ that can access a variables

↳ You can also give input to function

```
function a = myRand(low, high)
    a = low + rand(3,4)*(high-low);
end
```

```
>> a = myRand(2,5);
```

↳ Can get more than 1 Outputs

```
function [a, s] = myRand(low,high)
    a = low + rand(3,4)*(high-low);
    v = a(:); ← get all element of a in a single column vector
    s = sum(v);
end
```

```
>> [a ss] = myRand[2,5);
```

To know about which ~~built in~~ functions exist

```
>> help exist
```

Sub functions

In same editor

main fncⁿ → function → first functⁿ & only fncⁿ that can be called from outside

=

subfncs — function

=

↓

can be called only by fncns within same editor file

To Make a variable in FUNCTION GLOBAL before that variable type global

| global v; ← Need to define (seperately)

Script

It is also written in editor, but does not accept values.

→ what is there in script is outputted to Matlab commandWindow

>> edit endlesson

creates & opens script.

```
fprintf ("concludes lesson");
pause(5); ← waits 5 secs b4 next command)
quit;
```

Polymorphism (output changes with input format)

sqrt(1) → 1

sqrt [1 4] → [1 2]

sum [1 2 3 4] → 10

sum $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$ → [3 7]

zeros(1, 2) → [0 0]

zeros(2) → $\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

ones(1, 2) → $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$

5* ones(2) → $\begin{bmatrix} 5 & 5 \\ 5 & 5 \end{bmatrix}$

diag(7 3 9)

$\begin{bmatrix} 7 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 9 \end{bmatrix}$

randi (10, 5, 4) ← (5, 4 matrix) if replaced by 5 it will take it as 5,5

↑ random ↑ integers ← (1 to 10)

randi ([5,10] 5, 4]

↑ integers from 5 to 10

randn (5) → [5x5 with stand devn. = 1] mean = 0

↑ normal/standard/Gaussian distribution

rng(0)

↑ sets the random numbers to initial

rng('shuffle')

↳ actually shuffles using microsec clock

Input /Output

In a function.

x= input('Gimme a number');

fprintf('This concludes lesson 3 \n')

fprintf ('%d items %.2f each\nTotal = $%5.2f\n', n, price, total);

→ %d → whole numbers (scientific notations except for) ↳ conversion character (format specifier); ampersent sign

→ %.2f → ↳ 2 digits after decimal

→ \n → escape character new line

%5.2f → fixedprint notations

↳ print using atleast 5 spaces ↳ - sign; digits b4 decimal; after decimal; decimal point

blanks b4 number ←

↳ How to write %

↳ %%

↳ \ ↳ \\

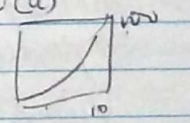
↳ ' ↳ ''

Recycling format while printing

Plotting

a=(1:10).^2

plot(a)



plot (a, b) ↑ horizontal → vertical

Two plots on same figure

↳ plot(x₁, y₁, x₂, y₂)

plot(x1, y1, 'r', x2, y2, 'k':')
↑ red ↑ black dotted
(:) → only the points

>> doc color

→ If in a figure, you don't want replace earlier plot,

>> hold on

to replace earlier plots

>> hold off

>> grid → to on

> grid → again to off

>> title(' ')

>> xlabel(' ')

>> ylabel(' ')

> legend('graph1', 'graph2')

--- bin
— wing

→ box on right side top to denote type of line & representing graph)

to turn off axis
axis off

>> axis(a b c d)
left-right range, bottom top range

Debugging.

(syntax error
└ Matlab catches this
semantic errors

⇒ Matlab has built-in debugger

In function
⇒ click - it turns to red to hold for debugging step by step

x left lim, x right lim → y
axis([0, 12, -10, 20])
to change the range of axis

imread()
to read .jpg as no.
← to see image → image()

lec-5.

Selection if / elseif / else | return to quit the function

If statement

if else statement .

function - -
└ if (condition)
block 1
else
block 2
~~else~~ elseif

⇒ end after completion

Relational operators

== is equal to

⇒ ~= is not equal to

> greater than

< lesses than

>= greaterthanequal to

<= less than equal to

(anything other than 0 is true) (2==3-1) → Answer =1 ⇒ True (else 0 for false)

» [4 -1 7 5 3] > [5 -9 6 5 -3]

① └→ [0 1 1 0 1]

» [4 -1 7 5 3] <= 4

② └→ [1 1 0 0 1]

logical operators

> logical values

Non-zero : true
zero : false

Matlab returns 1 for true.

logical operators:

&& and
|| or
~ not (one operand)

[1 -3 0] && [pi 0 0]
└→ error

→ [1 -3 0] & [pi 0 0]

array version (only single 1 or &) no need for , too
(b/w vectors
└→ [1 0 0]

Polymorphic functions.

functions that behave differently based on

1. → No. of input or output arg.

2. → Type of input or output arguments

Many built in fncs are Poly. fn
eg. (sqrt, max, size, plot, etc)

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How to Make our function POLYMORPHIC

Two built in fncns

nargin → # of actual input argument that fnc was called with

nargout → # ~~~ that function caller requested

ROBUSTness

→ A fncn is robust if it handles erroneous input and output arguments, and → provides a meaningful error message

comments

following %

* anything as comments in a function can be brought down to command screen using help function.

* Persistent Variables

Local Variable, BUT its value persists from one call of the fncn to the next

→ Relatively Rarely used. None of BAD side effects of global variables

FOR — While

Loops

```
loop { for n = 1:N   - control statement
     {   ~~~~        } body of loop
     { end
```

1:N → Doesn't have to be a scalar → can be any array

```
     { while total < limit     → condition / control statement
loop { body { n=n+1            → increment / decr
     {      { total = total+n;
     { end
```

Break ; Continue

*. Logical Indexing

eg: w = v(v>0) ⟶ All positive values of v will be stored in w.

(v>0) → logical values.

selects only those values of v which have logical value true.

eg :- v = [-1 0 2]

d = (v>=0) / d = v>=0

= [0 1 1]

v(d) = [illegible]

[0 2]

Logical indexing can be SIMULTANEOUSLY be done on left & right side of '='

for a vector

For an array → L.I on right changes dimension

on left assigns value without changing dimension

Logically using L.I on both sides of array can still retain indexing dimensions.

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Eg; toc
time for running the program

Preallocation (it's good to allocate a matrix with a size so that it saves time for reallocation of earlier row/colum before adding another element.)

$\boxed{A = zeros(N, N);}$

Datatypes

class( ) → double
  ↳ char
  ↳ logical

whos( )

double - DEFAULT type in MATLAB
- floating point representation
  64-bits (8 bytes)

single - 32-bits floating point

$2 \times 4 = 8$

Integer types - signed
  ↳ unsigned (non-negative)
  (8-, 16-, 32-, 64- bit long)

Inf → Infinite

NaN → Not-a-Number

Functions →
- class
- isa(x, 'double') - true or false.
- range check
- intmax, intmin, realmax, realmin

Strings **ASCII charcode** (0-127)

char( )
↳ gives the char at that particular number

fprintf('%s', 10)
↑ print as string

String functions

char, str2num( ), num2str( )

sprintf → assigns the value
NOT like fprintf

Structures

variables with variable.

r.name = 'mohit'

class(r) → 'struct'

class(name) → char

struct can hold arrays & arrays can hold struct.

isfield(account, 'owner')
checks if there is a field owner in ~~field~~ struct account.

rmfield(account, 'owner')
→ removes the field.

Cells

uses Pointers (i.e. stores address ~~of~~)
powerful to store heterogeneous data.
(Used more frequently than struct).

NEW SYNTAX
use: { }

⇒ Cell Arrays also exist

(In MATLAB, 2 cells pointers can ~~NOT~~ point to same location)

change something in string
strrep string replace

File Input / Output

pwd - present working directory
cd - change directory
ls - list in directory
mkdir - makes new foldes
rmdir - removes only empty folder

→ save everything in command window
using
>> save (saved as matlab.m)

or >> save mohit.m (saved as)

→ to load save file
> load
or >> load mohit.m

Excel files

xlsread
xlswrite

[num, txt, raw] = xlsread(.xls)

smallest rectangles in spreadsheet are copied

xls write → replaces only the part of existing files being written in.

text files

> Opening fid = fopen(filename, permission)
Closing fclose(fid).

fid → unique file identifier

permissions, rt, wt, at, r+t, w+t, a+t
↑
text

fgets( ) → gets one line at a time
& in loop automatically goes to next line
→ if no new text return (-1)
hence while printing lines start with ischar("line")
fwrite

In text files

parsing ~~string~~ to get numerical data is much harder.

Hence ~~[illegible]~~ Binary files are suited for numerical data

Binary file

permissions, r, w, a, r+, w+, a+.

n = fread(fid, data name type, datatype)
↓
returns ~~column~~ vectors
↳ & always in double

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