Notes

Notes

123, -345, 0

Matlab variable types

integer

123, -345, 0

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- real or float

 - 12.2344
 5.445454
 engineering notation
 - 4.2323e-9 = 4.2323 × 10⁻⁹

Notes

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Matlab variable types

integer

- 123, -345, 0
- real or float
 - 12.2344
 - 5.445454
 - engineering notation
 - 4.2323e-9 = 4.2323 × 10⁻⁹
- complex
 - $i = \sqrt{-1} = 1i$
 - 34.23+21.21i
 - (1+1i) * (1-1i) = 2

. ∂• Eugeniy Mikhailov (W&M) Practical Computing Lecture 02 0/05 Matlab variable types Notes integer 123, -345, 0 real or float • 12.2344 • 5.445454 engineering notation • 4.2323e-9 = 4.2323 × 10⁻⁹ • complex • $i = \sqrt{-1} = 1i$ • 34.23+21.21i • (1+1i) * (1-1i) = 2 • strings (put your words inside apostrophes) • handy for file names and messages • 'programming is fun' • s='Williamsburg' Eugeniy Mikhailov (W&M) Practical Computing Lecture 02 2/25 Some built in constants and functions Notes • $\pi = 3.141592653589793238462643383279502 \cdots$ • use pi • trigonometry functions By default angle is in radians But can be done in degrees • sin, cos, tan, cot • sind, cosd, tand, cotd • asin, acos, atan, acot • asind, acosd, atand, acotd sin(pi/2)=1 sind(90)=1 • hyperbolic functions • sinh, cosh, tanh, coth \bullet asinh, acosh, atanh, acoth logarithms natural log • base of 10 log10 o power • x^y use x^y or alternatively power (x, y) • e^y use exp (y) Eugeniy Mikhailov (W&M) Practical Computing Lecture 02 Assignment operator Notes

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x = 1.2 + 3.4

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Assignment operator

x = 1.2 + 3.4

Despite the look = is not an equality operator. = is an assignment operator.

Notes

Notes

x = 1.2 + 3.4

Despite the look = is not an equality operator.

= is an assignment operator.

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Assignment operator

The expression above should be read as

• evaluate expression at the right hand side of equality symbol

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- assign the result of the RHS to the variable on the left hand sign
- now variable x holds the value 4.6

We are free to use the value of the variable \times in any further expressions

> x + 4.2 ans = 8.8

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Efficient editing - Tab-completition

Notes

Once you typed some expressions in "Command window"

- type couple of first symbols of variable or function name
- hit tab and you will get

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- either fully typed name (if it is uniq)
- or little chart with choices
 - use <up> or <down> arrows to choose
 - alternatively <Ctrl-p>, <Ctrl-n>
 - then hit <enter> to make your choise

Help related commands

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Notes

These are the most important commands

- \bullet docsearch word
 - will search for word in the help files and show up matched help files
 example: docsearch trigonometry

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- help name
 - output short help text into "Command window" about
 - function/method named name
 - example: help sin
- doc name
 - show a reference page about function/method named name in the help vrowser
 - usually has more information compare to help name
 - example: doc sin

Operator Precedence

Look at the following Matlab expression

-2^4*5 + tan(pi/8+pi/8)^2

Guess the answer.

		() <	→ (E) E	୬୯୯
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Operator Preceder	nce			

Look at the following Matlab expression

-2^4*5 + tan(pi/8+pi/8)^2

Guess the answer.

- (2^4)*5 + (tan((pi/8+pi/8)))^2

Operator Precedence

Look at the following Matlab expression

-2^4*5 + tan(pi/8+pi/8)^2

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Guess the answer.

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```
- (2^4)*5 + (tan( (pi/8+pi/8) ))^2
```

```
-(16)*5+(tan((pi/4)))^2
```

Eugeniy Mikhailov (W&M) Practical Computing Lecture 02 **Operator Precedence** Look at the following Matlab expression -2^4*5 + tan(pi/8+pi/8)^2 Guess the answer.

-
$$(2^4) \times 5$$
 + $(\tan((pi/8+pi/8)))^2$

Lecture 02

Notes



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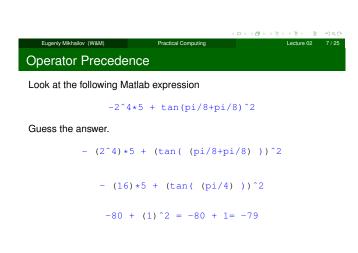
Operator Precedence

Look at the following Matlab expression

-2^4*5 + tan(pi/8+pi/8)^2

Guess the answer.

- $(2^4) * 5 + (tan((pi/8+pi/8)))^2$
 - $(16) * 5 + (tan((pi/4)))^2$
 - $-80 + (1)^2 = -80 + 1$



Operator Precedence

Look at the following Matlab expression

-2^4*5 + tan(pi/8+pi/8)^2

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Guess the answer.

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- (2^4)*5 + (tan((pi/8+pi/8)))^2

 $-(16)*5+(tan((pi/4)))^2$

 $-80 + (1)^2 = -80 + 1 = -79$

Rule of thumb: if not sure use extra parentheses ()

Operator Precedence

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Look at the following Matlab expression

 $-2^{4}+5 + \tan(pi/8+pi/8)^{2}$

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Guess the answer.

- $(2^4) * 5 + (tan((pi/8+pi/8)))^2$

$$-(16)*5+(tan((pi/4)))^2$$

 $-80 + (1)^2 = -80 + 1 = -79$

Rule of thumb: if not sure use extra parentheses ()

- Read more by executing doc precedence
- or searching for 'precedence' in the help browser.

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Matrices

Recall that Matlab stands for Matrix Laboratory

- So deep inside everything is a matrix (array)
- \bullet a number is the case of 1 \times 1 matrix

Notes

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Lecture 02

Recall that Matlab stands for Matrix Laboratory

- So deep inside everything is a matrix (array)
- $\bullet\,$ a number is the case of 1 \times 1 matrix

Let's create a 3×5 matrix (3 rows and 5 columns)

>>	Mz=zeros(3,5)								
Mz	=								
0	0	0	0	0					
0	0	0	0	0					
0	0	0	0	0					

This is not the only way, but it is one which make sure that matrix is filled with zeros

Note: it is possible to have more than 2 dimensional arrays.

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Matrix elements assignment	
>> Mz(2,4)=1 % 2nd row, 4th column	
Mz =	
0 0 0 0	
0 0 0 1 0	
0 0 0 0 0	

Notes

Notes

Matrix elements assignment

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>>	Mz(2,4)=1	olo	2nd row,	4th	column		
Mz	=						
0 0 0	0 0 0	0 0 0	0 1 0	0 0 0			
	Mz(3,5)=4	olo	3rd row,	5th	column		
Mz							
0	0	0	0	0			
0	0	0	1	0			
0	0	0	0	4			
					4		୬୯୯
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Alternative way to assign a matrix

• comma separates column elements

• semicolon separates row elements

>>	Mz=	= [
Ο,	Ο,	Ο,	Ο,	0;						
Ο,	Ο,	Ο,	1,	0;						
Ο,	Ο,	Ο,	Ο,	4]						
Mz	=									
0		0		0	0	0				
0		0		0	1	0				
0		0		0	0	4				

Notice $\cdots\,$ mark, which means that input continues on the next line

		10110	지수는 지수가 문제 문제	*) Q (*
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Strength of Matlab				

Native matrix operations

Mz =					
0 0 0 0 0	>> Mz-	+5			
0 0 0 1 0	ans =				
0 0 0 0 4	5	5	5	5	5
	5	5	5	6	5
	5	5	5	5	9

		+ = > + (10) > + (2) > + (2) >	₹ •9¢@
lov (W&M)	Practical Computing	Lecture 02	11 / 25
of Matlab			

Native matrix operations

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Eugeniy Mikhai

5	5	5	5	5
5	5	5	6	5
5	5	5	5	9
>> Mz*	2			
ans =				
0	0	0	0	0
0	0	0	2	0
0	0	0	0	8

0

Lecture 02

More example on matrices operations

>> Mz+5 ans =

Mz =	>> Mz+Mz						
0 0 0 0 0	ans =						
0 0 0 1 0	0	0	0	0	0		
0 0 0 0 4	0	0	0	2	0		
	0	0	0	0	8		

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More example on matrices operations

Mz =	>> Mz+Mz
0 0 0 0 0	ans =
0 0 0 1 0	0 0 0 0 0
0 0 0 0 4	0 0 0 2 0
	0 0 0 8
	algebra rules
	Matrix multiplication according to the linear algebra rules
	>> Mz*Mz'
	ans =
	0 0 0
	0 1 0
	0 0 16
	Here Mz' corresponds to transposed matrix Mz, i.e. $Mz'(i, j) = Mz(j, i)$
	(日)(間)(日)(日)(日)(日)(日)(日)(日)(日)(日)(日)(日)(日)(日)

Matrix as a function argument

A function can take a matrix as the function argument, it will evaluate the value of the function for each matrix element

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Mz =	>> sin(Mz)			
0 0 0 0 0	ans =				
0 0 0 1 0	0	0	0	0	0
0 0 0 0 4	0	0	0	0.8415	0
	0	0	0	0	-0.7568

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Vectors and column vector

A special case of the matrix is it has only one dimension. Such matrices generally called vectors

• $m \times 1$ column vector

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• $1 \times m$ just a vector

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Vectors and column vector

A special case of the matrix is it has only one dimension. Such matrices generally called vectors

- $m \times 1$ column vector
- $1 \times m$ just a vector

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To create a vector

>> % use comma to separate column elements >> v=[1, 2, 3, 4, 5, 6, 7, 8] v = 1 2 3 4 5 6 7 8 >> % alternatively you can use spaces >> v=[1 2 3 4 5 6 7 8]; >> % or mix of these two notations (NOT RECOMMENDED) >> v=[1 2 3, 4, 5, 6 7 8] v 3 4 5 6 7 1 2 8 $\partial \rightarrow$ Eugeniy Mikhailov (W&M) Lecture 02 14 / 25

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Construction of column vector

>> vc=[1; 2; 3]		
% use semicolon	to separate	row elements
VC =		
ve		
T		
2		
3		

		$(\Box \rightarrow (\Box \rightarrow (\Box \rightarrow (\Xi \rightarrow (\Xi \rightarrow (\Box \rightarrow (\Box \rightarrow (\Box \rightarrow $	8) - 8	Д
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Yet one more way	to create matrix			
If you have prearrange	d vectors or column vec	tors you can us	e thei	n
>> vc=[1; 2; 3]; >> % note that ; >> Mc=[vc, vc, vc	after a statement	suppresses	outr	put

~ ~	110	1,001	00,	v C]
Мс	=			
1		1	1	
2		2	2	
3		3	3	

Practical Computing Lecture 02 Yet one more way to create matrix

If you have prearranged vectors or column vectors you can use them

>>	vc=[1;	2; 3	;						
>>	% note	that	; after	a sta	tement	suppr	esses	outp	ut
>>	Mc=[vc,	, vc,	vc]						
Мc	=								
1	1	1							
2	2	2							
3	3	3							
v =	=								
1	2	3	4	5	6	7	8		
>>	Mv = [v;	2*v;	3*v]						
Mv	=								
1	2	3	4	5	6	7	8		
2	4	6	8	10	12	14	16		
3	6	9	12	15	18	21	24		
						< 🗆 > < 🗗	+ ≥ > + 3		୬୯୯
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Colon (:) operator

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The : operator is extremely useful to create vectors or matrix indexes It usually take form start:increment:stop and creates a vector with following values

[start, start+increment, ... , start+m*increment]

where

 $\min(\text{start}, \text{stop}) \leq \text{m*increment} \leq \max(\text{start}, \text{stop})$

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Colon (:) operator

The : operator is extremely useful to create vectors or matrix indexes It usually take form start:increment:stop and creates a vector with following values

. د الله

[start,	<pre>start+increment,</pre>	 ,	<pre>start+m*increment]</pre>
wh	ere			

 $\min(\text{start}, \text{stop}) \leq \text{m} \star \text{increment} \leq \max(\text{start}, \text{stop})$ >> v=5:2:11

v = 5 7 9 11

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Colon (:) operato	r		
	emely useful to create art:increment:sto vith following values		œs
[start, start+i	ncrement, ,	start+m*incremer	ıt]
where			
min(start,stop)	\leq m*increment \leq 1	max(start,stop)	
>> v=5:2:11			
v = 5 7	9 11		
It is also possible to ha	ave negative increme	nt	
>> v2=12:-3:1			
v2 = 12 9	6 3		C.
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Colon (:) operato	r continued		
	stop in this case inc	rement = 1	
>> v1=1:5			

v1	=			

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Colon (:) operator continued

1 2 3 4 5

Another form start:stop in this case increment = 1

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>>	v1=1:5					
v1	=					
	1	2	3	4	5	
Not	ice that					
>>	v3=5:1					
v3	=					

Empty matrix: 1-by-0

Produce somewhat unexpected result, since default increment is positive $\Box \mapsto \neg \Box \to \neg = \Xi$ E> イミ> ミ のへで Lecture 02 18 / 25

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Slicing matrices

It is handy to choose a subset (block) from the matrix We have a matrix Mv with size 3×8 and we want to choose all elements from columns 2,5,6

>> 1	Mv							
Mv :	=							
1	2	3	4	5	6	7	8	
2	4	6	8	10	12	14	16	
3	6	9	12	15	18	21	24	
>> 1	Mv(:,[2,5,6])					
ans	=							
2	5	6						
4	10	12						
6	15	18						

The meaning of the : now is choose all. Notice also that we use vector to specify desired columns

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Plotting		

Fiotung

Suppose you have a vector with values of x coordinates and we want to plot sin(x).

```
>> x=linspace(0,2*pi,10)
x =
                                     2.7925
0
     0.6981
               1.3963
                          2.0944
                                                3.4907
4.1888 4.8869
                5.5851
                           6.2832
>> y=sin(x)
У
0
    0.6428
              0.9848
                         0.8660
                                     0.3420
                                               -0.3420
-0.8660 -0.9848 -0.6428 -0.0000 >> plot(x,y,'o') % alternatively plot(x,sin(x),'o')
>> % every plot MUST have title, x and y labels
>> xlabel('x (radians)')
>> ylabel('sin(x)')
>> title('Plot of sin(x)')
```

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Saving plots

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Now we want to save the figure, use print

>> print('-dpdf', 'sin_of_x')

This will generate file *sin_of_x.pdf* notice automatic fileextension addition.

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Saving plots

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Now we want to save the figure, use print

>> print('-dpdf', 'sin_of_x')

This will generate file *sin_of_x.pdf* notice automatic fileextension addition.

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The '-d' switch stands for output format ('pdf', 'ps', 'eps', 'png". . .)

Saving plots

Now we want to save the figure, use print

>> print('-dpdf', 'sin_of_x')

This will generate file *sin_of_x.pdf* notice automatic fileextension addition.

The '-d' switch stands for output format ('pdf', 'ps', 'eps', 'png". . .) To generate 'png' file

>> print('-dpng', '-r100', 'sin_of_x')

By default figure size is 8×6 inches, the '-r' switch tells the figure resolution in dpi (dots per inch). In this case it is 100 dpi so resulting image will be 800×600 pixels.

			Pet d	100			_
-	۰						-
14							-
12							
							-
42							-
2.4			-				-
4.6							-
-12							
		1	3	-	a : 5	6	

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For 3D plots, please see help files for plot3, meshy, surfs, so concerning Learne 02 21/

Special array arithmetic operators

There are special arithmetic operators which applied to the elements of matrices (disregard linear algebra rules), they start with $\ .$

•	•*		
	>> x=1:3		
	x = 1	2 3	
	>> x*x %	will generate an error	
	>> x.*x %	equivalent to x.^2 (see below)	
	ans = 1	4 9	

Special array arithmetic operators

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There are special arithmetic operators which applied to the elements of matrices (disregard linear algebra rules), they start with .

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۹	•*						
	>> x=1:3						
	x = 1	2 3					
	>> x*x %	will ger	nerate	an er	ror		
	>> x.*x %	equivale	ent to	x.^2	(see	below)	
	ans = 1	4	9				
•	· ^						
	>> x.^2						
	ans = 1	4	9				

Special array arithmetic operators

There are special arithmetic operators which applied to the elements of matrices (disregard linear algebra rules), they start with .

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			$< \Box > < \Box > <$	$B \rightarrow + B \rightarrow - B$	୬୯୦
>> x./x ans = 1	1	1			
• ./					
	4	9			
•.^ >> x.^2					
x = 1 :: >> x * x % i	will gen equivale		error 2 (see belov	ī)	
• .*					

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>>	m=[1,2,	3;4,5,	6;7,8,9]
m =	=		
1	2	3	
4	5	6	

Spe

7	1	8	9								
	Linear	algebra	rules			Elemer	nt wise c	peration			
	>> m*m					>> m.*m					
	ans =	:				ans =					
	30	36	42			1	4	9			
	66	81	96			16	25	36			
	102	126	150			49	64	81			

		-	
igeniy Mikhailov (W&M)	Practical Computing		
cial array arith	metic operator		

Eugeniy Mikhailov (W&M) Practical Computing Special array arithmetic operator ./

Eugeniy Mikhailov (W&M) Practical Computing

>	> m=[1,2,3;	4,5,	6;7,8,9]					
n	n =									
1	. :	2	3							
4	L .	5	6							
7	1	8	9							
	Linear algebra rules					Elemer	nt w	ise operati	on	
	>> m/	m % ur	nity	matrix		>> m.	/m	%matrix	of	ones
	ans =					ans =				
	1	0	0			1	1	1		
	0	1	0			1	1	1		
	0	0	1			1	1	1		

1 1 1 1 1 1 1 1

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