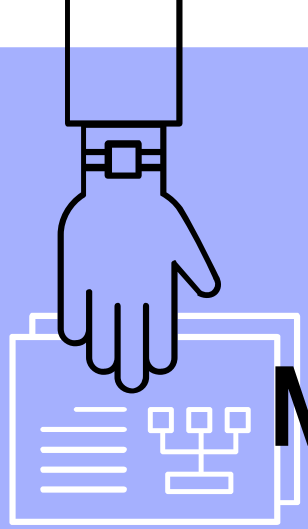

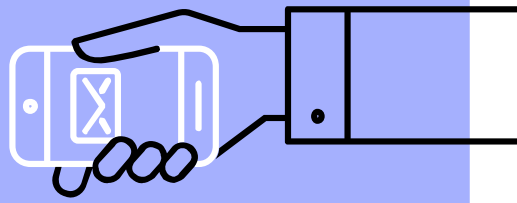

MATLAB Basic Language

DICOM Medical Images

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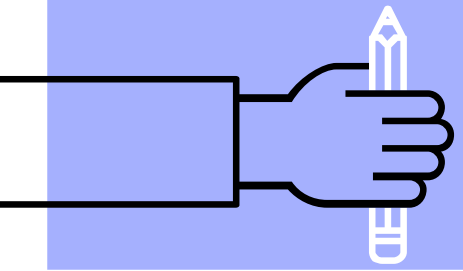
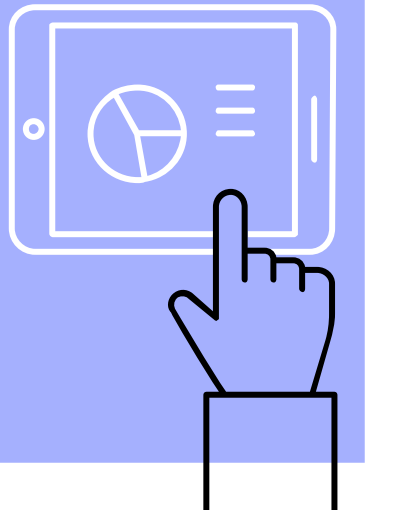
Department of Biomedical Imaging and Radiological Sciences, NYCU
alvin4016@nycu.edu.tw



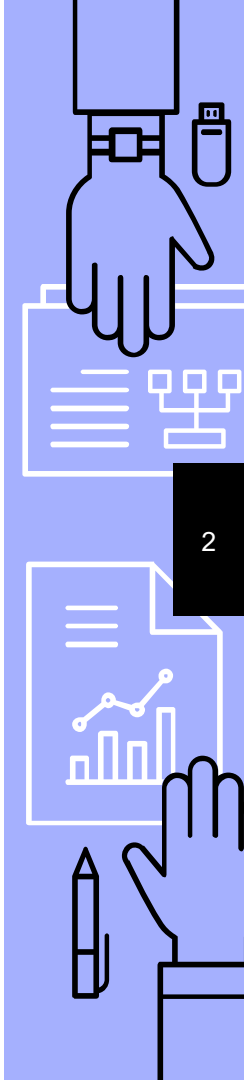


Content

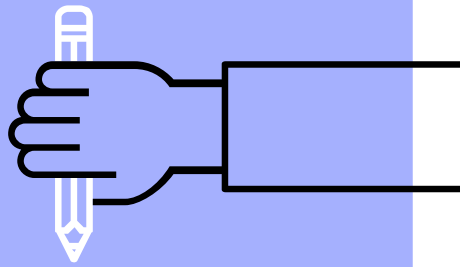
- MATLAB basic language
- DICOM image import

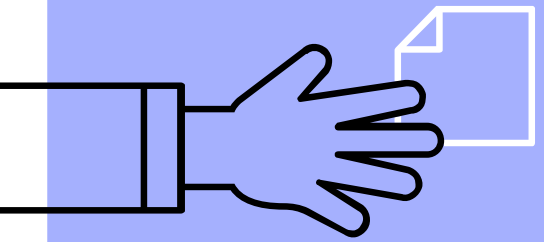
Please download the handout and materials from

http://cflu.lab.nycu.edu.tw/CFLu_course_matlabimage.html

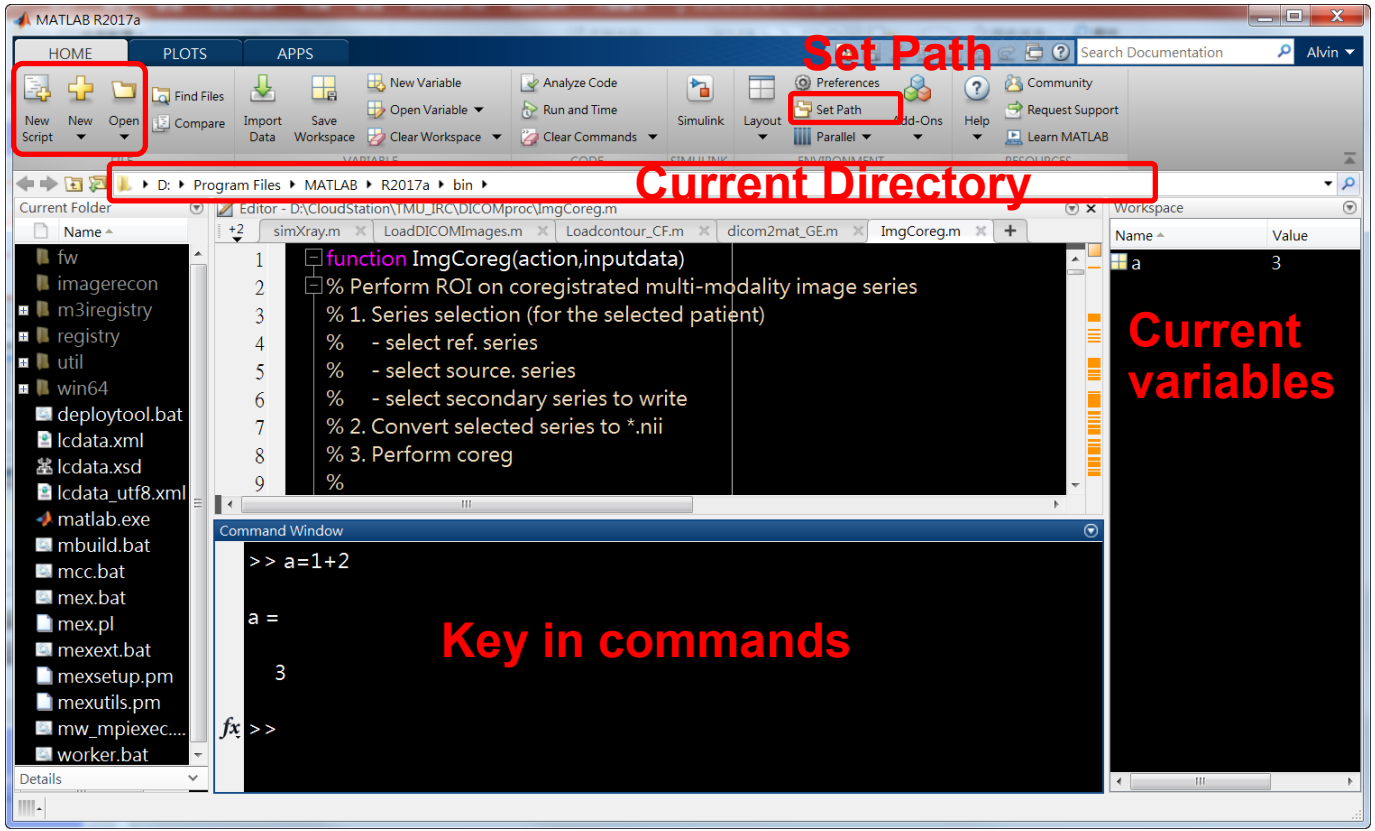


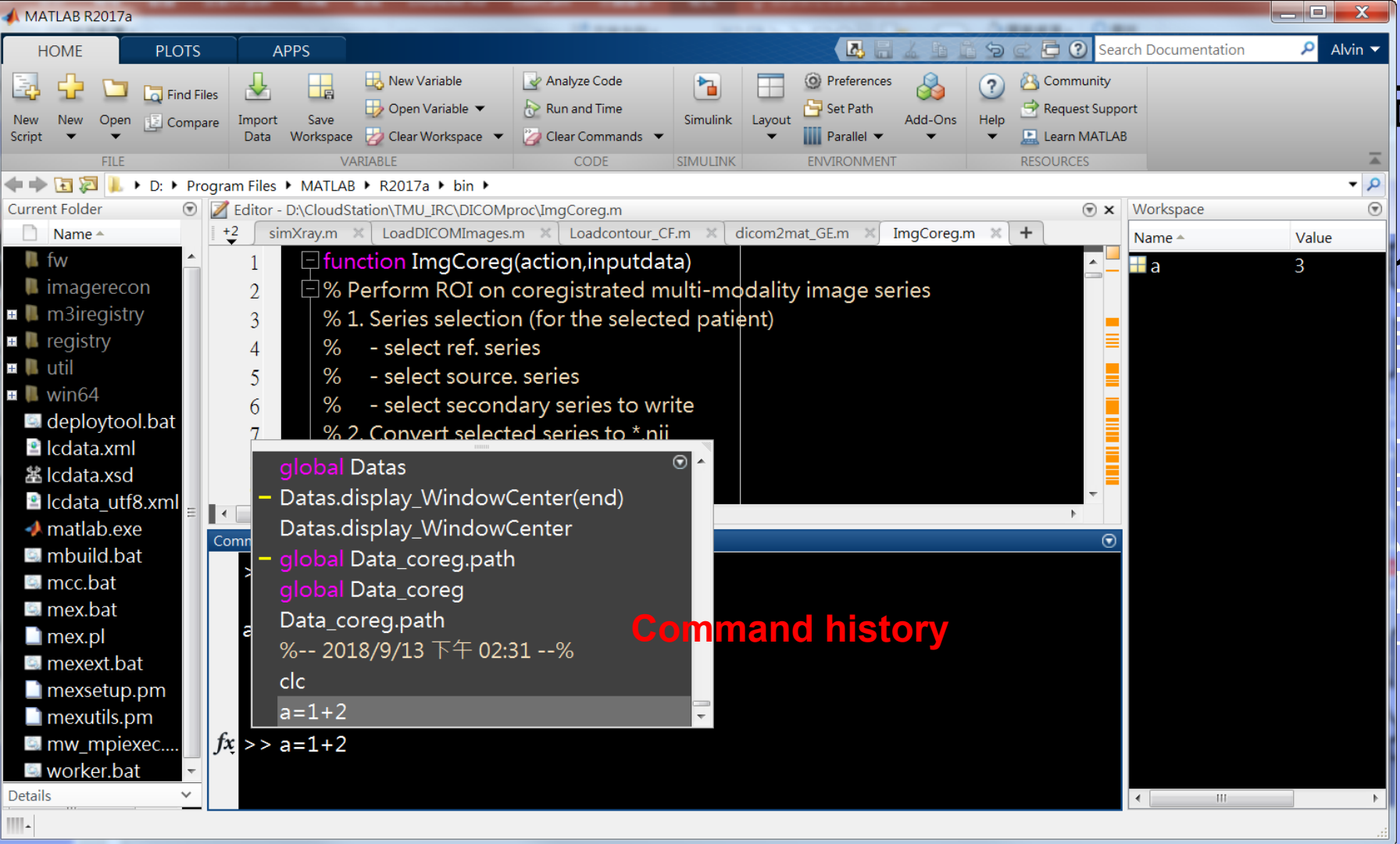
MATLAB
basic language





MATLAB Environment




MATLAB R2017a
HOME
PLOTS
APPS
Search Documentation
Alvin
New Script
New
Open
Find Files
Compare
Import Data
Save Workspace
New Variable
Open Variable
Clear Workspace
Analyze Code
Run and Time
Clear Commands
Simulink
Layout
Preferences
Set Path
Parallel
Add-Ons
Help
Community
Request Support
Learn MATLAB
FILE
VARIABLE
CODE
SIMULINK
ENVIRONMENT
RESOURCES
D: ▸ Program Files ▸ MATLAB ▸ R2017a ▸ bin ▸
Current Folder
Name
fw
imagerecon
m3iregistry
registry
util
win64
deploytool.bat
lcdata.xml
lcdata.xsd
lcdata_utf8.xml
matlab.exe
mbuild.bat
mcc.bat
mex.bat
mex.pl
mexext.bat
mexsetup.pm
mexutils.pm
mw_mpiexec....
worker.bat
Details
Editor - D:\CloudStation\TMU_IRC\DICOMproc\ImgCoreg.m
simXray.m
LoadDICOMImages.m
Loadcontour_CF.m
dicom2mat_GE.m
ImgCoreg.m
1 function ImgCoreg(action,inputdata)
2 % Perform ROI on coregistrated multi-modality image series
3 % 1. Series selection (for the selected patient)
4 % - select ref. series
5 % - select source. series
6 % - select secondary series to write
7 % 2. Convert selected series to *.nii
global Datas
Datas.display_WindowCenter(end)
Datas.display_WindowCenter
global Data_coreg.path
global Data_coreg
Data_coreg.path
%-- 2018/9/13 下午 02:31 --%
clc
a=1+2
Command history
>> a=1+2
Workspace
Name
Value
a
3

Define a Variable

- The 1st character must be a letter.
- The variable name is composed of…
  - Letters (a,b,…,y,z,A,B,…,Y,Z)
  - Numbers (0,1,2,…,9)
  - Underscore (_)
- At most 63 characters (or be automatically truncated)
- Use = to assign right-hand side value to the left-hand side variable

right: coord_x1
wrong: coord x1

Data type of Variable

- Numbers
  - A=18
- Character/String
  - A='a'
  - A='This is a test.'
- Array/Matrix
  - A=[1 2 3 4 5 6 7 8]
  - A=[1 2 3 4; 5 6 7 8]
  - A=[1:4; 5:8]
  - A=[1:2:7; 2:2:8]

Exercise

- Create a variable in the **Commend Window**
- View the variable in the **Workspace**
- Recreate the variable by running **Commend History**

- Do not use preserved variable/function name.
  - pi, inf, nan, sin, cos, max, min, sum, for, end, ….

Useful commands

- clc clear command window
- clear all clear all the variables in workspace

Mathematical operators

Mathematical notation	Matlab-command	Mathematical notation	Matlab-command
a+b	a+b	i	i
a-b	a-b	$4 \cdot 10^3$	4e3 or 4*10^3
ab	a*b	$3-4i$	3-4*i or 3-4*j
3xy	3*x*y	sin x, arctan x, …	sin(x), atan(x), …
$\frac{a}{b}$	a/b or a\b	e^x	exp(x)
a^b	a^b	ln x	log(x)
$\sqrt{x}$	sqrt(x) or x^0.5	log x	log10(x)
π	pi	$\|x\|$	abs(x)
e	exp(1)		

Mathematical functions

Command	Usage	Command	Usage
abs(x)	absolute value	**median(x)**	median
sin(x)	sine	**sinh(x)**	hyperbolic sine
exp(x)	exponential	**asin(x)**	inverse sine
log(x)	natural logarithm	**inv(x)**	matrix inverse
sqrt(x)	square root	**rank(x)**	matrix rank
min(x)	minimum	**round(x)**	round towards nearest integer
max(x)	maximum	**floor(x)**	round towards minus infinity
mean(x)	mean	**ceil(x)**	round towards plus infinity
sum(x)	sum	**sort(x)**	sort
std(x)	standard deviation		

Exercise

- X=[3 1 8 6 5 4 3 5 4 1 6 8 7 9 6]
- Calculate sample mean *(where N=15)*

$$\mu = \frac{\sum_{k=1}^{N} x_k}{N}$$

- Calculate sample variance

$$S^2 = \frac{\sum_{k=1}^{N} (x_k - \mu)^2}{N-1}$$

Numbers vs. Characters

ASCII 碼 十進位	ASCII 碼 十六進位	字元	ASCII 碼 十進位	ASCII 碼 十六進位	字元	ASCII 碼 十進位	ASCII 碼 十六進位	字元	ASCII 碼 十進位	ASCII 碼 十六進位	字元
032	20		056	38	8	080	50	P	104	68	h
033	21	!	057	39	9	081	51	Q	105	69	i
034	22	"	058	3A	:	082	52	R	106	6A	j
035	23	#	059	3B	;	083	53	S	107	6B	k
036	24	$	060	3C	<	084	54	T	108	6C	l
037	25	%	061	3D	=	085	55	U	109	6D	m
038	26	&	062	3E	>	086	56	V	110	6E	n
039	27	'	063	3F	?	087	57	W	111	6F	o
040	28	(	064	40	@	088	58	X	112	70	p
041	29	)	065	41	A	089	59	Y	113	71	q
042	2A	*	066	42	B	090	5A	Z	114	72	r
043	2B	+	067	43	C	091	5B	[	115	73	s
044	2C	,	068	44	D	092	5C	\	116	74	t
045	2D	-	069	45	E	093	5D	]	117	75	u
046	2E	.	070	46	F	094	5E	^	118	76	v
047	2F	/	071	47	G	095	5F	_	119	77	w
048	30	0	072	48	H	096	60	`	120	78	x
049	31	1	073	49	I	097	61	a	121	79	y
050	32	2	074	4A	J	098	62	b	122	7A	z
051	33	3	075	4B	K	099	63	c	123	7B	{
052	34	4	076	4C	L	100	64	d	124	7C	|
053	35	5	077	4D	M	101	65	e	125	7D	}
054	36	6	078	4E	N	102	66	f	126	7E	~
055	37	7	079	4F	O	103	67	g	127	7F	⌂

- Character is recognized as numbers by computers
  - ASCII code chart (0~127), UNICODE (128~65535)

(http://cflu.lab.nycu.edu.tw/CFLu_course_matlabsig.html, **Week 4)**

Numbers vs. Characters

- Try it !
  - abs('s')
  - char(115)

  - abs('我很欣賞你')
  - char([25105 24456 27427 36062 20320])

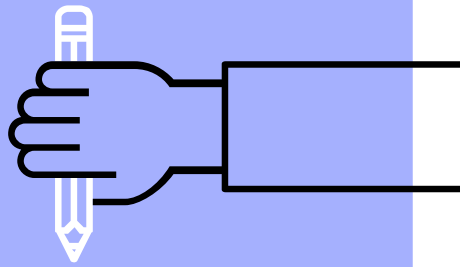
Useful Functions

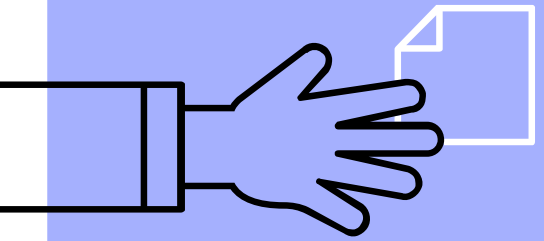
- **str2num**
  - Convert string matrix to numeric array.
- **num2str**
  - Convert numbers to a string.

```
Command Window
>> str2num('44')

ans =

   44

>> str2num('44 21')

ans =

   44   21
```

```
Command Window
>> num2str(44)

ans =

44

>> num2str([44 21])

ans =

44  21
```

DICOM
Image Import





DICOM (1993)

- **D**igital **I**maging and **CO**mmunication in **M**edicine

DICOM℠
Digital Imaging and Communications in Medicine

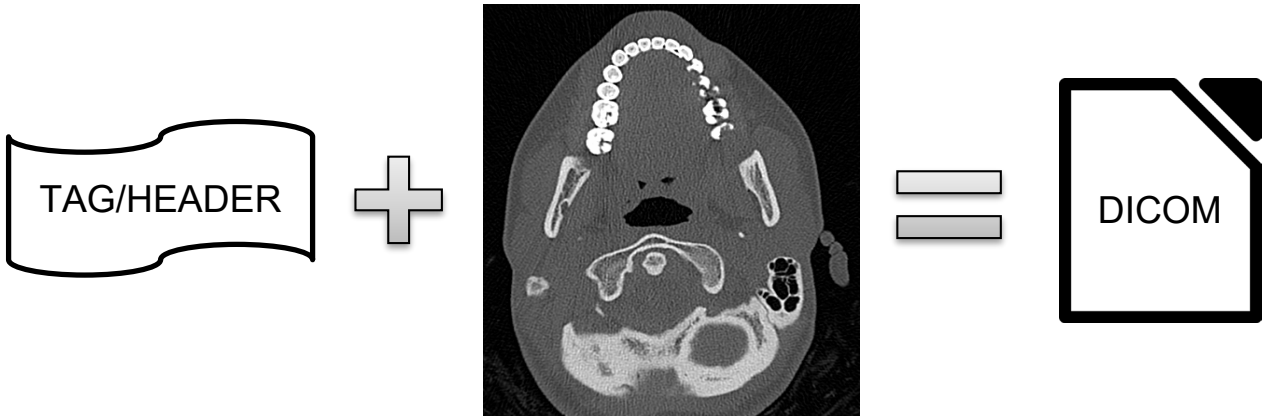
NEMA, Suite 1752
1300 North 17th Street
Rosslyn, VA 22209
Ph: (703) 841-3285
http://dicom.nema.org

- ACR & NEMA formed a committee in 1983
  - American College of Radiology
  - National Electrical Manufacturers Association

"The Common Language of Medical Equipment"

DICOM File Format

- Header and image data stored in the same file (so the important info can't be lost)
- Stores hundreds of pieces of information about the patient, machine, and data acquisition



MATLAB exercise - help

- **dicominfo**

  dicominfo Read metadata from DICOM message.

  INFO = dicominfo(FILENAME) reads the metadata from the compliant DICOM file specified in the string FILENAME.

Important Tags

Each data field has a unique tag.

- **(0008 0020) Study Date**
- (0010 0010) Patient's Name
- **(0010 0020) PatientID**
- (0010 0040) Patient Sex
- (0010 1010) Patient Age
- **(0020 0011) Series Number**
- **(0008 103E) Series Description**
- **(0020 1041) Slice Location**
- **(0020 1002) Images in Acquisition**

Important Tags

Each data field has a unique tag.

- (0008 0090) Referring Physician's Name
- (0008 1010) Station Name

- Image "Shape"
  - **(0028 0010) Rows**
  - **(0028 0011) Columns**
  - (0028 0030) Pixel Spacing
  - **(0018 0050) Slice Thickness**
  - **(0018 0088) Spacing Between Slices**
  - **(0020 1041) Slice Location**

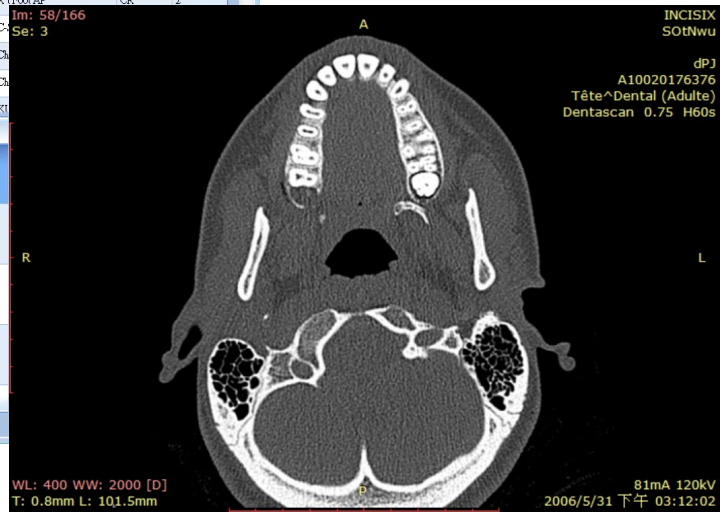
Exercise

- Please identify the value of **SliceLocation** in the DICOM header (**info**).

- info=dicominfo('IM-0001-0081.dcm')

NBA Laboratory of Neuroimage Biomarker Analysis

DICOM Usage



- **Data query**
- **Image Information**
- **Communication**

MATLAB exercise - help

- **dicomread**

  dicomread Read DICOM image.

  X = dicomread(FILENAME) reads the image data from the compliant DICOM file FILENAME. For single-frame grayscale images, X is an M-by-N array. For single-frame true-color images, X is an M-by-N-by-3 array. Multiframe images are always 4-D arrays.

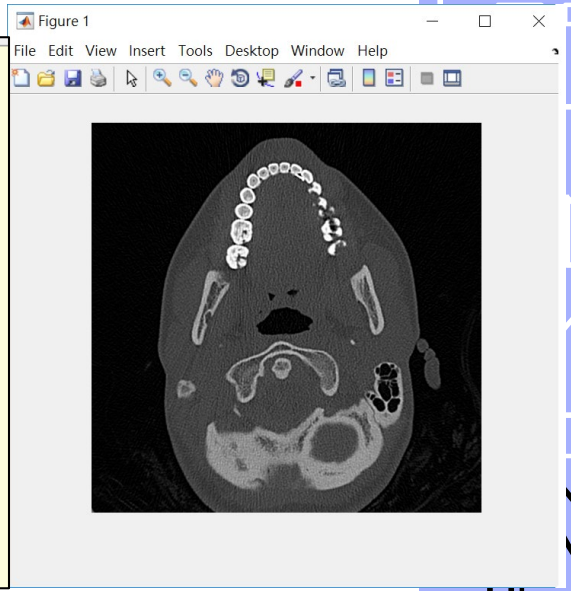
Useful commands

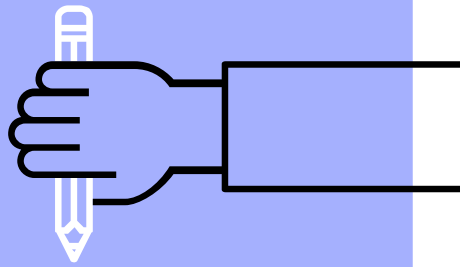
- % To indicate nonexecutable text within the body of a program.
- ; To indicate end of row or suppress output of code line in commend window

MATLAB Homework

Create your very first script file (*.m). Please name it as hw01.m and upload to E3 system.

```
1   %% Read DICOM info. (tags) and image using Matlab
2
3   % get the tag information of a DICOM file
4   info=dicominfo('IM-0001-0081.dcm');
5   info.SliceLocation
6
7   % get the image data of a DICOM file
8   img=dicomread('IM-0001-0081.dcm');
9
10  % display DICOM image
11  imshow(img,[])
```





THE END

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