Practical session I: Data types & basic operations

# Guidelines

The students are allowed to work alone during the practical sessions. When you have completed the exercises, you are allowed to leave the room. Don’t forget to save your work on a USB flash drive, or on your network space (see: how to use filezilla.docx). Write a report of this practical session and sent it to [maarten.afschrift@faber.kuleuven.be](mailto:maarten.afschrift@faber.kuleuven.be). This report will not be evaluated or corrected. You can compare your own answers with the answers that are posted on Toledo.

# Matlab interface

Read the *inroduction* and *MATLAB-interface* section of theory part. Try to execute the simple examples in Matlab. Afterwards, you can solve the exercises below in the command window.

Matlab has a large library of simple and complex functions that are available for use. During this practical session you’ll encounter Matlab function like ***mean,max,min ,round,….*** . If you want to know more about these functions, don’t be afraid to search more information in the Help function.

Exercise I: Matlab-command window

Enter the following instructions in the command window. Explain the output and the changes in the workspace

|  |  |  |
| --- | --- | --- |
| Input | Output | workspace |
| 5 +8 +3 | 16 | Maakt variable ans |
| 2.8 + 3.9 | 6.7 | Maakt variable ans |
| G=0.16+8.196 | ...... | Maakt variable G |
| G=round(G) | Afronden waarde G | Overchrijft variable G |
| G=G+25 | ..... | Overschrijft waarde in variable G |
| a= cos(0.5) |  | Maakt variable a aan. |
| a= cos (0,5) | Error (. In plaats van , om decimalen weer te geven) |  |
| b= sin(pi/2) | ….. | Maakt variable b aan |
| A= -2.\*pi/3 | A=..... *(pi = 3.14…)* | Maakt variabele A aan |
| D=cos(A) | ....... | Maakt variable D aan |
| d=abs(D) | Absolute waarde van D | Maakt variable d aan |
| 0/0 | Niet oplosbaar= NaN | Maakt variable ans |
| tan(pi/2) | Oneindig (heel grote waarde) | Maakt variable ans |
| *Remarks: Operations that are not possible, like 0/0, give NaN (Not any Number). Operations with + or – inifinity as output,like tan(pi/2), have a high number as output that we should interpret as infinity.* | | |

# Data types

Read the Data types section of theory part. Try to execute the simple examples in Matlab. Afterwards, you can solve the exercises below.

Exercise II: Datatypes

1. The variables that are created in exercise 1 have the same data type. Determine the data type of the variable D with the function ***whos.***
2. Load the .mat file “*exercise\_2\_datatypes.mat”* into the workspace with the function by double clicking on the .mat file in the directory window. Determine the datatype and the size of the variables. You can visualize the variable by double clicking on the variable in the workspace.

|  |  |  |
| --- | --- | --- |
| **Variable** | **Data type** | **size** |
| subjects | Cell array | 1 x 4 |
| Mass | Matrix | 1 x 4 |
| Ankle angle | Matrix | 100 x 4 |
| Ankle moment | Matrix | 100 x 4 |
| Gait | Structure | 1 x 4 |
| condition | / | / |

1. Use indices to select data from a variable and assign this to a new variable.

|  |  |  |
| --- | --- | --- |
|  | Datatype | Command |
| Select the name of the 3th subject | String | Subject{3}; |
| Select the mass of the 4th subject | double | Mass(4); |
| Create a matrix that contains the ankle angle at 50% of the gait cycle for the 4 subjects. | matrix | Ankle\_angle(50, : ); |
| Add the second names of the subjects to the second row of the variable subjects. | Cell | Subject(:,2)=  {‘name1’,’name2’,’name’,’name4’}; |
| Create for each subject a new field in the structure Gait that contains the mass of the subject. |  |  |

1. Divide the ankle joint moment by the body mass for each subject (i.e. Normalize the ankle joint moment to body mass).

Ankle\_moment(:,1)=Ankle\_moment(:,1)./mass(1);

Ankle\_moment(:,2)=Ankle\_moment(:,2)./mass(2);

Ankle\_moment(:,3)=Ankle\_moment(:,3)./mass(3);

Ankle\_moment(:,4)=Ankle\_moment(:,4)./mass(4);

# Basic Operations

Read the Basic operations section of theory part. Try to execute the simple examples in Matlab. Afterwards, you can solve the exercises below. You have to create an M-file to solve these questions. To create an M-file, go to **File>New>Script.** After you have saved the M-file, you can execute it with the F5 button.

1. Create the following matrices and execute the required calculations

G =

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 |

H =

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 |

I=

|  |  |
| --- | --- |
| 1 | 5 |
| 3 | -2 |
| 0 | -1 |
| -4 | 3 |

|  |  |
| --- | --- |
| **Command** | **Remarks matrix operation** |
| >>G+H | Elementsgewijs optellen |
| >>G-2\*H | Elementsgewijs aftrekken en elementsgewijze vermenigvuldiging getal met matrix. |
| >>G.\*H | Elementsgewijze matrix vermenigvuldiging (size G moet gelijk zijn aan size H) |
| >>G./H | Elementsgewijze matrix deling (size G moet gelijk zijn aan size H) |
| >>G.ˆ2 | Elementsgewijze exponentiële bewerking. |
| >>G\*H | Matrix vermenigvuldiging: niet mogelijk want het aantal kollommen van G is niet gelijk aan het aantal rijen van H. |
| >>G\*I | Matrix vermenigvuldiging wel mogelijk. |
| >>I\*G | Matrix vermenigvuldiging niet mogelijk. |
| >>G/H | Matrix deling. |

Write a script (m-file) that:

* Calculates them maximal value of the elements of matrix I (use the function **max**)

Max\_values\_i=max(max(I));

* Calculates the average value of the elements of G(use the function **mean)**

Mean\_G=mean(mean(G));

* The sum of the elements in the first row of matrix G (use the function **sum**).

G\_first\_row=sum(G(1, : );

* The product of the elements in the matrix G (use the function **prod**).

Prod\_elements\_G=prod(prod(G));

# More exercises

## EMG signal

We have measured the activity of the vastus lateralis with Electromyography (EMG) during the sit to stand and stand to sit movement. The file *emg\_sts.mat* contains the raw EMG signal (*Vastus\_lateralis\_raw*) and the processed signal (*Vastus\_lateralis\_proc*). The first column of the matrices contains a vector with the time information. The variables *time\_sit\_to\_stand* and *time\_stand\_to\_sit* contain the start and end time of the motion.

1. Select the raw EMG signal during the sit to stand movement and the stand to sit movement (*Vastus\_lateralis\_raw*).
2. Convert all negative amplitudes of the raw signal in positive amplitudes (use the function abs). This process is called the rectification of the EMG signal.
3. Calculate the mean of the rectified EMG signal during the sit to stand and stand to sit motion. Which movement has the highest average muscle activity (*Unit=mV*)?
4. Normalize the processed EMG signal to the max value during the sit to stand and stand to sit motion (without the time in between) (*Vastus\_lateralis\_proc)*.
5. Calculate the time of when the Vastus lateralis is maximally activated during the sit to stand and during the stand to sit movement.
6. Calculate the peak value of the muscle activation during the sit to stand and stand to sit movement. Which movement has the highest activation of the Vastus lateralis. Furthermore, calculate the percentage of the movement when this peak activation occurs.

( answer in the attached M-file (*Practical\_session\_1\_oefn\_5\_1.m*))

## Kinematics and kinetics

We have measured the movement of a subject with Motion Capture and the ground reaction forces during the sit to stand movement. The ***file knee\_moment\_sts.mat*** contains a matrix "*one\_trial\_moment*" with the knee sagittal moment during the sit to stand movement for one trial. This contains 100 datapoints that represent the percentage of a sit to stand movement. The file "*multiple\_trails\_moments*" contains several sit to stand movements of this subject.

1. load the file: -- *knee\_moment\_sts.mat* --
2. visualize the one\_trial moment data with the function "---- *plot* ----" (use the help function for more information)
3. Calculate the peak flexion and peak extension moment and the point in time (as percentage at which these peak values occur. (Remark: positive values= internal extension moment).
4. Normalize the moment to body mass, the mass of the subject is 60kg.
5. Visualize the *multiple\_trials\_moments* with the function plot.
6. Which trial has the highest peak internal knee extension moment?
7. Calculate the standard deviation of the peak knee extension moments.
8. Calculate the mean moment and standard deviation on each percentage of the sit to stand movement.

( answer in the attached M-file (*Practical\_session\_1\_oefn\_5\_2.m*))