



Introduction to Programming in Matlab

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1 Assignment

Type the following commands in the command window, followed by the enter key. Try to predict the result each time and check your prediction.

```
clear all
a=2
b=a+1
a
a=a+3
c=b*sqrt(a-1)
d=a*cos(c*pi)+2
```

```
x=[1 4 9]
y=2*sqrt(x)
y(3)
y=y-1
y(2:3)
z=[2 4]
v=zeros(1,5)
w=z+x
```

```
A=[1 2; 3 4]
A(2,1)
IA=inv(A)
x=[-1 2]
x=[-1 2] '
A*x
B=ones(5,5)
```

```
x=1:1:14
y=1:3:20
size(y)
z=60:-10:10
```

```
M=[1 2 3; 4 5 6; 7 8 9]
size(M)
M(1,:)
M(:,2)=23
```

Exercises

1. Calculate for $x=2$, by introducing a number of auxiliary variables, the value of

$$p = \sin \sqrt{(5x + 1)}$$

2. Calculate (the -1 denotes inverse matrix)

$$\begin{pmatrix} 1 & -3 \\ 2 & 4 \end{pmatrix}^{-1} \begin{pmatrix} 1 \\ -6 \end{pmatrix}$$

3. Create an array r containing the numbers 0,5,10,15...,200. How many numbers does this array contain?
4. Define a 20x10 matrix M containing only zeros, except in the second row, which contains the number 4 everywhere:

$$M = \begin{pmatrix} 0 & \dots & \dots & 0 \\ 4 & \dots & \dots & 4 \\ 0 & \dots & \dots & 0 \\ \vdots & & & \vdots \\ 0 & \dots & \dots & 0 \end{pmatrix}$$

2 If statement

Create a file 'pietje.m' by typing `edit pietje`, enter the following program (use copy-paste) and save the file.

```
% this is my if program
% input:  a
% output: z
if a>2,
    z=5
else
    z=15
end
```

Then enter the following commands in the command window. Figure out each time the expected result before typing.

```
clear all
help pietje
a=4
pietje
a=-1
pietje
b=3
pietje
a=2
pietje
z=4
pietje
```

Exercises

1. Write a program that, depending on the sign of the variable $x \neq 0$, assigns the value +1 or -1 to the variable p . Check your program for $x = -3$ and $x = 3$.
2. Write a program that reads an input variable x and changes the value of that x to zero when x is positive and not larger than 15. Check your program for $x = -3$, $x = 3$ and $x = 30$.

3 For statement

Create a file 'jantje.m' by typing `edit jantje`, enter the following program (use copy-paste) and save the file.

```
% this is my for program
% input: N (integer number)
% output: x (array)
x=zeros(1,N);
for i=1:N,
    x(i)=i*i;
end
```

Enter the following commands in the command window. Figure out the expected results before typing.

```
clear all
help jantje
N=7
jantje
x
x(1:3)
```

Exercises

1. Write a program that stores the multiplication table of 7 in an array `taf(1:10)` by means of a for-loop.
2. (a) Someone saves a sum of 100 Euro on the bank against an interest rate of 5%. The interest is paid at the end of each year. Compute the total sum after 16 years using a for-loop.
(b) Compute the total sum when in the 7th year the interest rate is increased to 6%. To do this, insert an if-statement inside the for-next loop.
3. Create a 7x7 matrix M , with all elements zero, except on the diagonal where $A_{ii} = i$.

4. Consider the forward recurrence relation $a_n = n * a_{n-1} + 0.1$, with initial value $a_1 = 0$. Check that $a_7 = 362$ by means of a for-loop. Remark: this can be done without using arrays.



5. Consider the backward recurrence relation $a_{n-1} = (a_n - 0.1)/n$, with initial value $a_7 = 362$. Check that $a_1 = 0$ using a for-loop. Convince yourself that this formula is the reverse of the one given in exercise 4.

4 While statement

Create a file 'hallo.m' by typing `edit hallo`, enter the following program (use copy-paste) and save the file.

```
% programma hallo
% input: m
% output: xm,i
i=0;
xm=m;
while xm>1e-8
    xm=xm/2
    i=i+1
end
```

Enter the following commands. Figure out the expected results before typing.

```
m=100
hallo
m=512
hallo
m=0
hallo
```

Exercises

1. What is the role of the output variable i in 'hallo.m'? The condition $xm > 1e-8$ is known as the 'guard'. Why? What happens if in 'hallo.m' the line $xm = xm/2$ is replaced by $xm = xm*2$ and the program is started with $m=100$?
2. Someone saves a sum of 100 Euro on the bank against an interest rate of 5%. The interest is paid at the end of each year. Use a while-statement to determine after how many years the total sum will be greater than 200 Euro.
3. Determine the largest integer n for which $2^n < \text{Inf}$ (infinity) by means of a while-statement.

5 Functions

Create a file 'myfunc.m' by typing `edit myfunc`, enter the following program (use copy-paste) and save the file.

```
function [p,q]=myfunc(n,m)
% function myfunc
% input: m,n
% output: product and quotient of m and n
p=m*n;
q=m/n;
```

Enter the following commands. Figure out the expected results before typing.

```

clear all
[x,y]=myfunc(2,16)

n=3
m=6
[x,y]=myfunc(n,m)

myfunc(4,100)
y

x=zeros(1,6)
y=zeros(1,6)
for n=1:6, [x(n),y(n)]=myfunc(n,m), end

```

Exercises

- (a) What goes wrong if a new line `m=5` is added inside the function:

```

p=m*n;
q=m/n;
m=5;

```

NOTHING GOES WRONG ???

Remove the extra line `m=5`, and continue with the original function.

- (b) Change the function 'myfunc.m', such that the variables have 'better' names. Why are these names better?
- (c) Change the name of the function, and store the function in a new .m file accordingly.
2. Create a program containing the function $p(x) = \sin \sqrt{(5x + 1)}$. Use this program to calculate $p(0)$ and check the result.
3. Calculate the values of $p(x)$ at the points $x = 0 : 0.1 : 2$, with $p(x)$ as in exercise 1). Store these values in the array `pres`. How many elements does `pres` contain?

6 Plot

Execute the following commands:

```

clear all
x=[0:0.01:4];
y=sin(x.^2);
plot(x,y)
plot(x,y,'*')
plot(x,y,'g--')

w=cos(x.^2);
hold on
plot(x,w,'m.')
wysum=abs(y+w);
plot(x,wysum,'d')

```

```
title('nice plot')
xlabel('x coord')
ylabel('function value')
```

```
hold off
plot(x,10*w-5,'m.')
```

Exercises

1. Make a plot of the function $w(x) = \sqrt{x}$, for the domain $0 \leq x \leq 16$.
2. Make a plot of the function $p(x)$ (see previous section) for $x = 0 : 0.1 : 2$.

7 Output format

Execute the following commands:

```
clear all
em1=exp(1)
i=23
format long
em1
i
format short
em1
i
format long e
em1
i
fprintf('e= %8.6f \n',em1);
fprintf('e= %8.4e \n',em1);
fprintf('%6.0f %15.6e \n',i,em1);
disp('hello')
str1='uitv: ';
str2=num2str(i);
str3=num2str(em1);
disp([str1 ' i=' str2 ' e=' str3])
```

Exercises

1. Print the number $\sqrt{3}$ with successively 1, 8 and 30 digits behind the decimal point.
2. Define the variables $i=3$, $j=-5$, $x=\sqrt{2}$. Print these 3 variables in a single line using a nice format with x having 6 digits behind the decimal point.

8 Structs (groups of variables)

Execute the following commands in the command window. Try to predict the result each time and check your prediction.

```
clear all
field1 = 'f1';
field2 = 'f2';
field3 = 'f3';
field4 = 'f4';

value1 = {[1 2 3 4 5], [10 20 30], [100 200 300 400]};
value2 = {'a', 'b', 'c'};
value3 = {pi, pi.^2, pi.^3};
value4 = {'first', 'second', ['hello', 'there']};

s = struct(field1,value1, field2,value2, field3,value3, field4,value4);

s(1)
s(2)
s(3)
s(4)
s

s(1).f1
s(1).f3

s(1).f1(5)
s(1).f3(2)

s(2).f1
s(2).f3

s(2).f1(3)
s(2).f1(5)
s(2).f3(2)

s(3).f2
s(3).f4
s(3).f4(6)

sdum = s(2)

for i=1:3
    s(i)
end

s(1).f1(5)=36
s(1)
```

Exercises

1. Suppose this course is done by 5 students. Create a struct 'course' with 3 fields containing the names of the students (Adam, Bob, Chris, Dan, Elmo), their student number (11,12,13,14,15) and birthdate in an array with length 2 (day and month 20/01,21/02,22/03,23/04,24/05).
2. It appears that the student number of Dan was wrong, change it into 84. Moreover, Chris was born in July, not in March, so update it accordingly.