Doing Economics with the Computer

Lecture 2: SOLUTIONS

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Introduction to Matlab: Controlling the Flow

The objective of this exercise is to help you develop your Matlab skills along two dimensions: Writing script files. Controlling the flow (the for, if, while commands).

Compulsory Readings

Read chapters 1 - 5 in Attaway (2019). The book is provided on Ilias.

Further Exercises

Practice by going through the practice questions in chapters 1 - 5 in Attaway (2019). Solutions to the practice questions in chapters 3 - 5 are available on Ilias.

Housekeeping

When you write a script, you should include these commands at the start.

```
clear all % Deletes memory
close all % closes open windows (figures etc.)
clc       % clears command window
```

1 Example 1

Open a new M-File, write the below command and save the file as Lecture_2.m and run it from the Matlab prompt by typing Lecture_2

```
disp('hello world');
```

1.1 Script M-files

Example 2

Write and run the following script M-file. Then type the name of the variables a, b, c in the Matlab prompt and see what happens.

```
a = [1 2];
b = [3 4];
c = a + b;
```

Example 3

Add comments to the above script

```
% Define some variables
a = [1 2]; % this is a vector
b = [3 4]; % this is another vector

% Calculate new variables
c = a + b  % add
```

1.2 Controlling the flow

1.2.1 The for loop

Example 4

```
for i = 1:10; disp(i); end

% equivalently (but more readable):

for i = 1:10
    disp(i);
end
```

Example 5

```
for i = 1:10
    x(i)=2^i;
end;
x
```

Example 6

```
for i = 1:10
    x(i)=i^2;
end
x
```

Example 7

```
A = zeros(5,5);
for i = 1:5
    for j = 1:5
        A(i,j) = i^j;
    end
end
A
```

Example 8

```
for i = 1:2:9
    disp(i);
end
```

Example 9

```
y = zeros(10,1);
for i = [2 4 6 8 10]
    y(i) = 2^i;
end
y;
```

In Class Exercise 1: Geometric Series

Consider the geometric series $x(n) = q^{n-1}$ for n=1,2,3,... .

a)

Calculate the values of the series for n = 1:10, q = 0.5 and store the results in a vector S1.

```
q=0.5;
for n=1:10
    x(n)=q^(n-1);
end
S1=x;
```

b)

Compute the sum $s(n) = 1 + q + q^2 + q^3 + \ldots + q^{n-1}$ for q=0.5 and n=10. This can be done in several ways, b1 to b3:

b1)

Method 1: A recursive representation:
$s(n) = 1 + q + \ldots + q^{n-2} + q^{n-1}$
$s(n-1) = 1 + q + \ldots + q^{n-2}$
$s(n) - s(n-1) = q^{n-1} \rightarrow s(n) = s(n-1) + q^{n-1}$
Try out n=1:10

```
q=0.5;
s(1)=1;
for n=2:10;
    s(n)=s(n-1)+q^(n-1);
end;
s(end)
```

b2)

Method 2:
$q * s(n-1) = q * (1 + q + \ldots + q^{n-2}) = q + q^2 + \ldots + q^{n-1}$
$s(n) = 1 + q + \ldots + q^{n-2} + q^{n-1}$
$\rightarrow s(n) = 1 + q * s(n-1)$

```
q=0.5;
s(1)=1;
for n=2:10
    s(n)=q*s(n-1)+1;
end
s(end)
```

b3)

Method 3: Apply The standard formula: $(1 - q^n)/(1 - q)$

```
% YOUR CODE HERE
```

c)

Store the values of the geometric series $x(n) = q^{(n-1)}$ for n = 1:10 and q = 0.2 in the first row of a matrix S. Store the values for q = 0.5 and q = 0.8 in rows 2 and 3.

```
S=[];

q=0.2;
for n=1:10
    S(1,n)=q^(n-1);
end

q=0.8;
for n=1:10
    S(2,n)=q^(n-1);
end

q=0.8;
for n=1:10
    S(3,n)=q^(n-1);
end

S
```

In Class Exercise 2: Difference Equations

i) First order, linear difference equation

Let $y(t+1) = f * y(t) + w(t+1)$. Assume that f = 0.7, y(1) = 1.5 and w(t) = 0 for all periods t.

a)

Generate the time path of y for $t = 1, 2, \ldots, 20$ using a for loop. Plot the time path of y. What happens if f = 1?

```
y=[];
f=0.7;
y(1)=1.5;
T=20;
w=zeros(21,1);

for t=1:T
    y(t+1)=f*y(t)+w(t+1);
end
plot(y)
```

b)

Consider a temporary change in w: $w(4) = 1$. How is the time path of y affected? Compute and plot the impulse response function.

```
y=[];
f=0.7;
y(1)=1.5;
T=20;
w=zeros(21,1);
w(4)=1;
for t=1:T;
    y(t+1)=f*y(t)+w(t+1);
end;
plot(y)
```

c)

Consider a permanent change in w: $w(t) = 1$ for $t = 2, 3, \ldots$ How is the time path of y affected? Compute and plot the immediate and future effects.

```
y=[];
f=0.7;
y(1)=1.5;
T=20;
w=ones(21,1);
w(1:2)=0;
for t=1:T
    y(t+1)=f*y(t)+w(t+1);
end
plot(y);
```

d)

Let's assume that w(t) is a stochastic variable, a normally distributed random variable: $w(t) : N(0, s^2 = 0.1)$. Generate a sequence $w(t)$ for $t = 2, .., 20$. Compute and plot the time path of y. Compare this to the time path under (a).

```
y=[];
f=0.7;
y(1)=1.5;
T=20;
w=0.1*randn(1,21);
for i=1:T
    y(i+1)=f*y(i)+w(i+1);
end
plot(y)
```

ii) Second order, linear difference equation

a)

Let $y(t+1) = f * y(t) + g * y(t-1) + w(t+1)$. Assume that f=0.7, g=-0.2, y(1)=1.5, y(2)=1, and w(t)=0 for all periods t. Generate the time path of y for $t = 1, 2, ..., 20$ using a for loop. Plot the time path of y.

```
y=[];
f=0.7;
g=-0.2;
y(1)=1.5;
y(2)=1;
T=20;
w=zeros(21,1);
for t=2:T
    y(t+1)=f*y(t)+g*y(t-1)+w(t+1);
end
plot(y)
```

iii) 1st order, non-linear difference equation

a)

Consider the non-linear, difference equation $y(t+1) = w * y(t)^{1/\sqrt{(m)}} + k$. Let m=1.5, y(1)=2, w=0.5 and k=1. Suppose that when t=10, k becomes 2 and remains at this level thereafter. Plot the path of the difference equation over 50 periods.

```
y=[];
k=[];
m=1.5;
y(1)=2;
T=50;
k(1:9)=1;
k(10:50)=2;
w=0.55;
for t=1:T
    y(t+1)=w*y(t)^(1/sqrt(m))+k(t);
end
plot(y)
```

b)

Consider the non-linear, difference equation $y(t+1) = w * y(t)^{1/\sqrt{(m)}} + k$ where w is a random number from a uniform distribution. Let m=1.5, y(1)=2, and k=1. Suppose that when t=10, k becomes 2 and remains at this level thereafter. Plot the path of the difference equation over 50 periods.

```
y=[];
k=[];
m=1.5;
y(1)=2;
T=50;
k(1:9)=1;
k(10:50)=2;
w=rand(1,50);

for t=1:T
    y(t+1)=w(t)*y(t)^(1/sqrt(m))+k(t);
end
plot(y)
```

1.2.2 The if statement

Example 10

```
a = 4;
b = 3;

if a>b
    disp('a is bigger than b');
end
```

Example 11

```
a = 2;
b = 3;

if a>b
    disp('a is bigger than b');
else
    disp('a is smaller or equal to b');
end
```

Example 12

```
a = 2;
b = 3;

if a>b
    disp('a is bigger than b');
elseif a == b
    disp('a is equal to b');
else
    disp('a is smaller than b');
end
```

Example 13

```
a = 2; b = 3; c = 3;

if (a < b) && (b  ~= c)
    disp('a is smaller than b and b is not equal to c');
end
```

Example 14

```
x(1) = 1;
for i = 1:1000
    x(i+1) = x(i)*2;
    if x(i+1) > 100
        break
    end
end
x
```

In Class Exercise 3

The sum of (infinite) geometric series: Calculate the sum of a geometric series $s(n) = 1 + q + q^2 + q^3 + \ldots + q^{n-1}$ for q=0.5 and $n \to \infty$ using a for loop. Stop the loop when the value of s(n) equals approximately s(n-1). Example 14 gives an idea of how to do it.

```
s=[]; tol=1e-05; crit=1; s(1)=1; q=0.5;

for n=1:10000
    s(n+1)=s(n)+q^n;
    crit=abs(s(n+1)-s(n));
    if crit<tol
        break
    end
end
size(s)
```

In Class Exercise 4: The solution to a linear difference equation

The difference equation $y(t+1) = f * y(t) + w(t+1)$ converges towards a certain value when w is a constant and $-1 < f < 1$. Calculate this value when y(1)=1, w=1 using a for loop (terminate the loop when the value of y(t) no longer changes.

```
N=10000; f=0.7; y(1)=1; w=ones(1,N); tol=1e-5; crit=1;
for i=1:N
    y(i+1)=f*y(i)+w(i+1);
    crit=abs(y(i+1)-y(i));
    if crit<tol
        break;
    end
end
y(end)
```

In Class Exercise 5

Consider the non-linear difference equation, $y(t+1) = f * (y(t))^{0.3} - k * (y(t-1))^{-0.2} + w$. Let f=0.5, k=0.4, w=1. Use an if loop in order to get to find the value this equation converges to when $t \to \infty$.

```
N=1000; f=0.5; k=0.4; y(1)=1; y(2)=1; w=1; tol=1e-5; crit=1;
for t=2:N
    y(t+1) = f*(y(t))^(0.3)- k*(y(t-1))^(-0.2)+w;
    crit=abs(y(t+1)-y(t));
    if crit<tol
        break;
    end
end
y(end)
```

1.2.3 The while loop

Example 15

```
i = 0;
while i<=9
    i = i+1;
    disp(i);
end
```

Example 16

```
x = 1;
while x<=100
    x = x*2;
end
x
```

In Class Exercise 6

Redo In Class Exercise 4 using a while loop in order to get the value at which the change in successive values of the difference equation is ”negligible”. Example 16 may help.

```
tol=1e-5; crit=1; x0=1; w=1; N=1; phi=0.7;
while crit>tol
    x=phi*x0+w;
    crit=abs(x-x0);
    x0=x;
    N=N+1;
end
```

In Class Exercise 7

Consider the non-linear difference equation, $y(t+1) = f * \sqrt{y(t)} + w$. Let f=0.5, y_1= 1, w=1. Use a while loop in order to get the value at which the change in successive values of the difference equation is ”negligible”.

```
tol=1e-5; crit=1; x0=1; w=1; f=0.7;
while crit>tol
    x=f*sqrt(x0)+w;
    crit=abs(x-x0);
    x0=x;
end
```

Note

```
tol=1e-5; crit=1; x0=1; q=0.5;
while crit>tol
    x=q*x0+1;
    crit=abs(x-x0);
    x0=x;
end

% x(n)=1+q+...+q^(n-1)
% x(n-1)=1+q+...+q^(n-2)
% q*x(n-1)=q+...+q^(n-1) = x(n)-1
% x(n) = q*x(n-1)+1
```