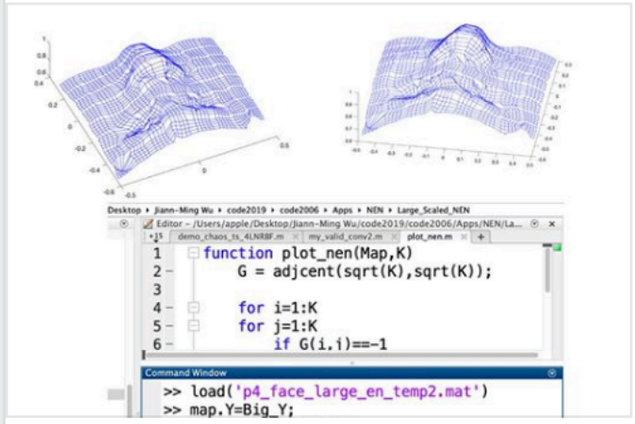
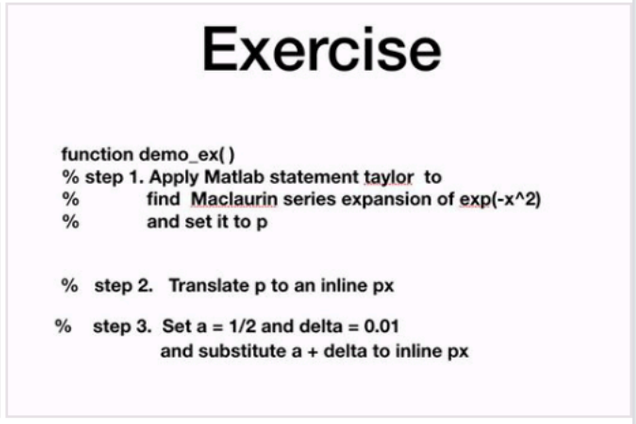
Matlab
Taylor expansion

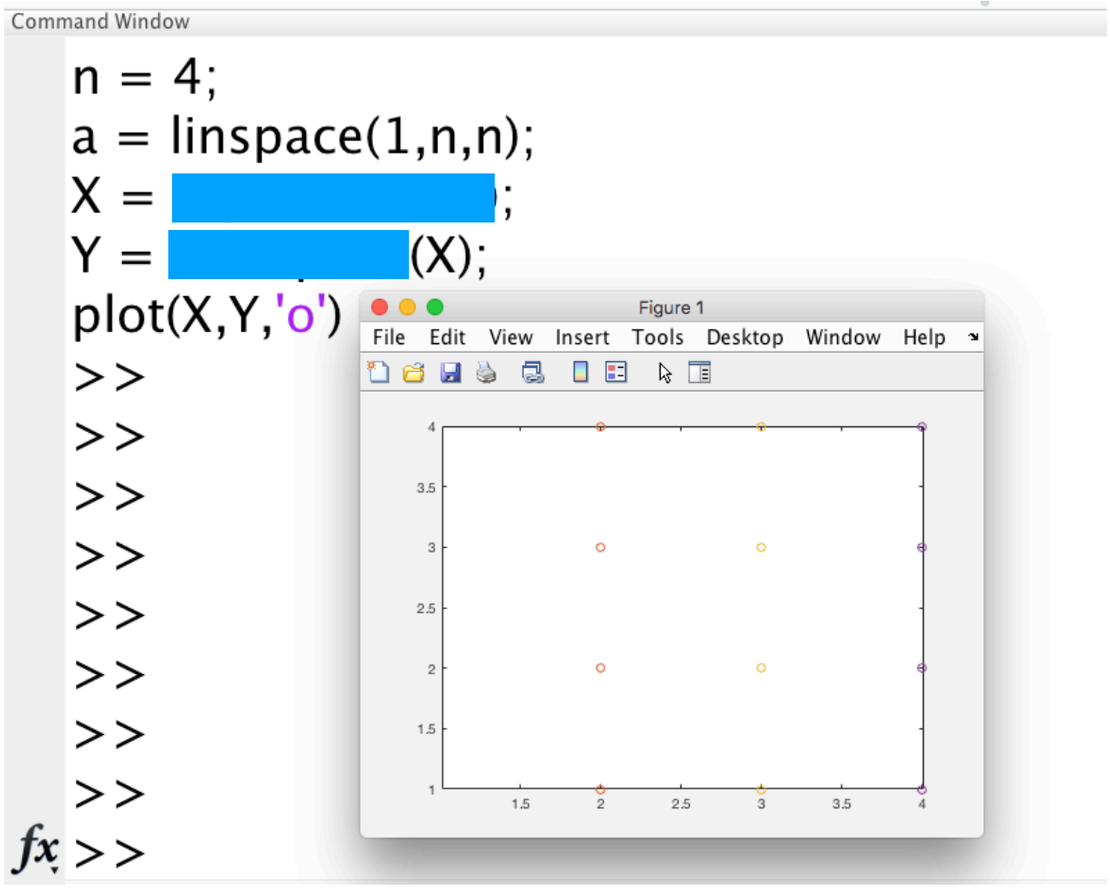
$$f(a+\delta) \sim f(a) + \sum_{k=1}^{K} \frac{1}{k!} f^k(a)\delta^k$$

人工智慧基礎課程
備課點心





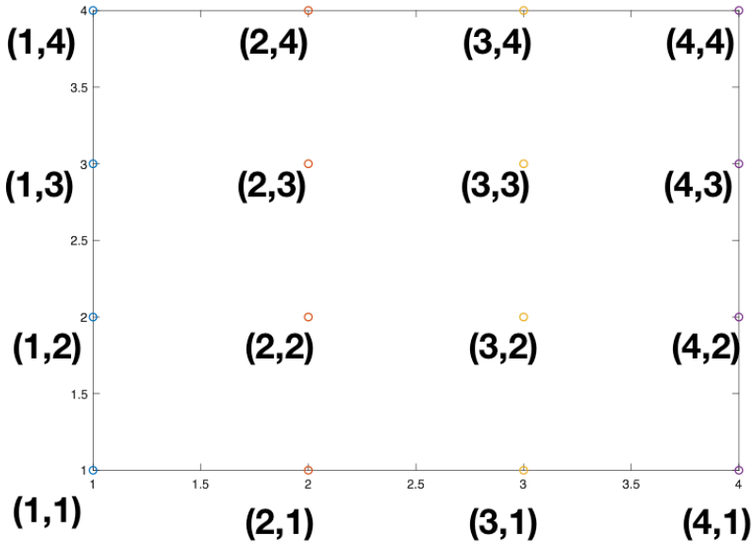
右圖中十六個點呈4x4方陣排列，矩陣X的元素代表相對應方陣點的橫坐標，Y矩陣的元素代表相對應方陣點的縱坐標．請完成下列程式，畫出方陣點



a = [1 2 3 4]

$$Y = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 2 & 2 & 2 & 2 \\ 3 & 3 & 3 & 3 \\ 4 & 4 & 4 & 4 \end{bmatrix}$$

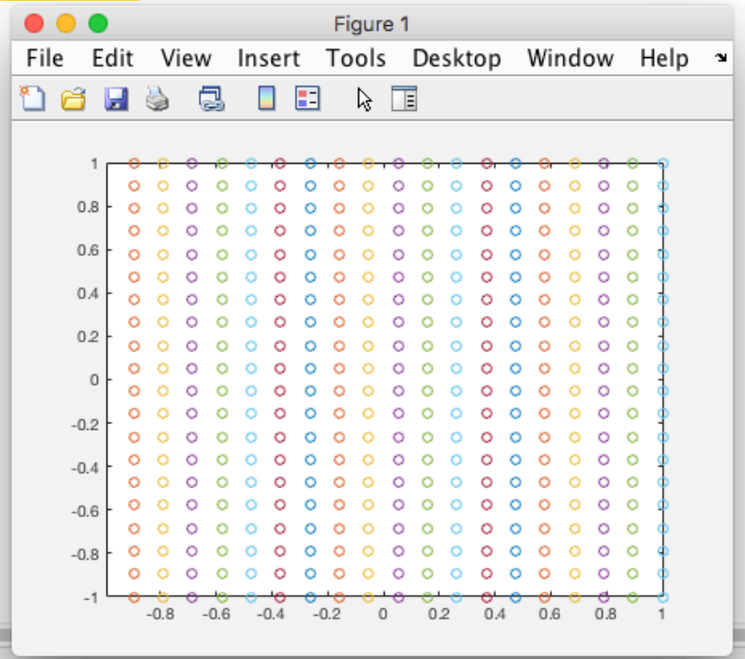
$$X = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 1 & 2 & 3 & 4 \\ 1 & 2 & 3 & 4 \\ 1 & 2 & 3 & 4 \end{bmatrix}$$



在[-1, 1]x[-1, 1]的區域中繪製20x20的點矩陣

```
n = 20;
a = [redacted];
X = [redacted];
Y = [redacted];
plot(X,Y,'o')
>>
>>
>>
>>
>>
>>
>>
```

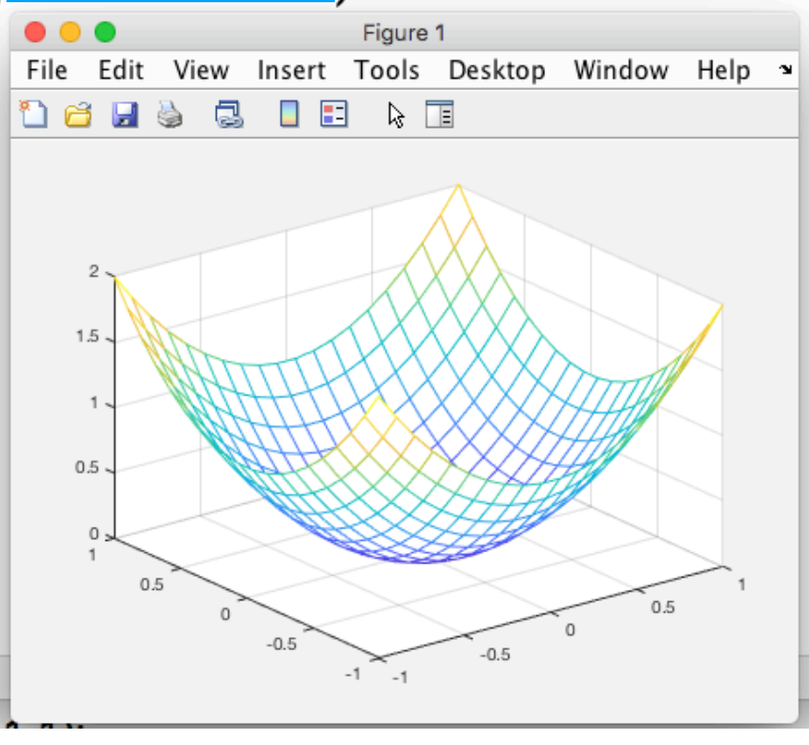
本題答題

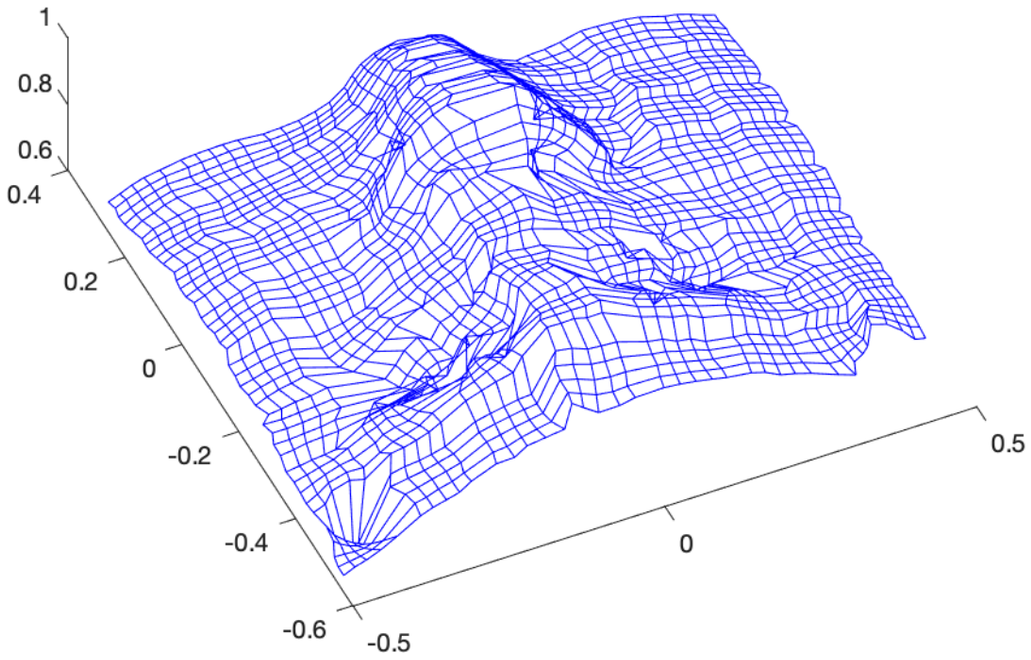


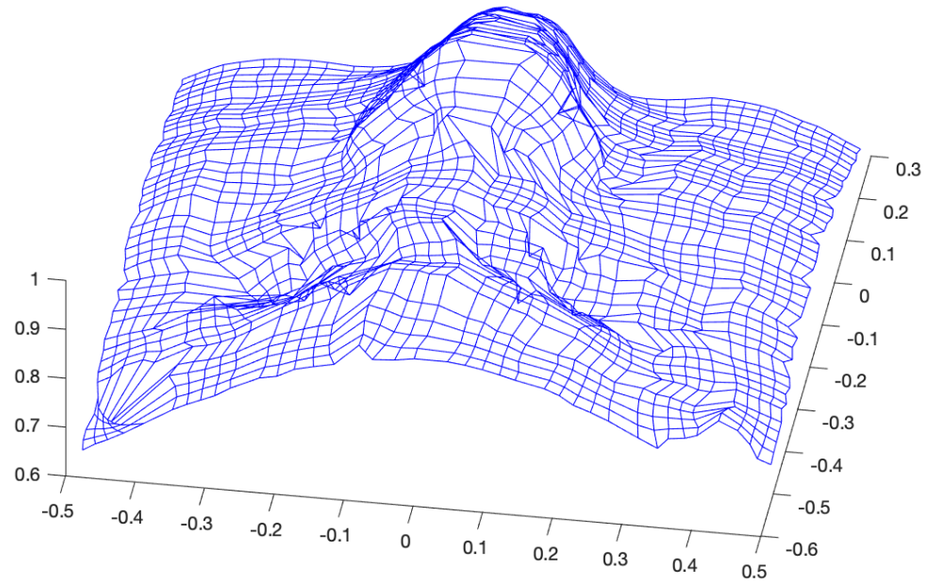
請完成mesh指令，繪製 $f(x,y)=x^2+y^2$ 的立體圖

```
n = 20;
a = [redacted];
X = [redacted];
Y = [redacted];
mesh(a,a,[redacted])
>>
```

本題答題







Desktop ▸ Jiann-Ming Wu ▸ code2019 ▸ code2006 ▸ Apps ▸ NEN ▸ Large_Scaled_NEN

Editor - /Users/apple/Desktop/Jiann-Ming Wu/code2019/code2006/Apps/NEN/La...

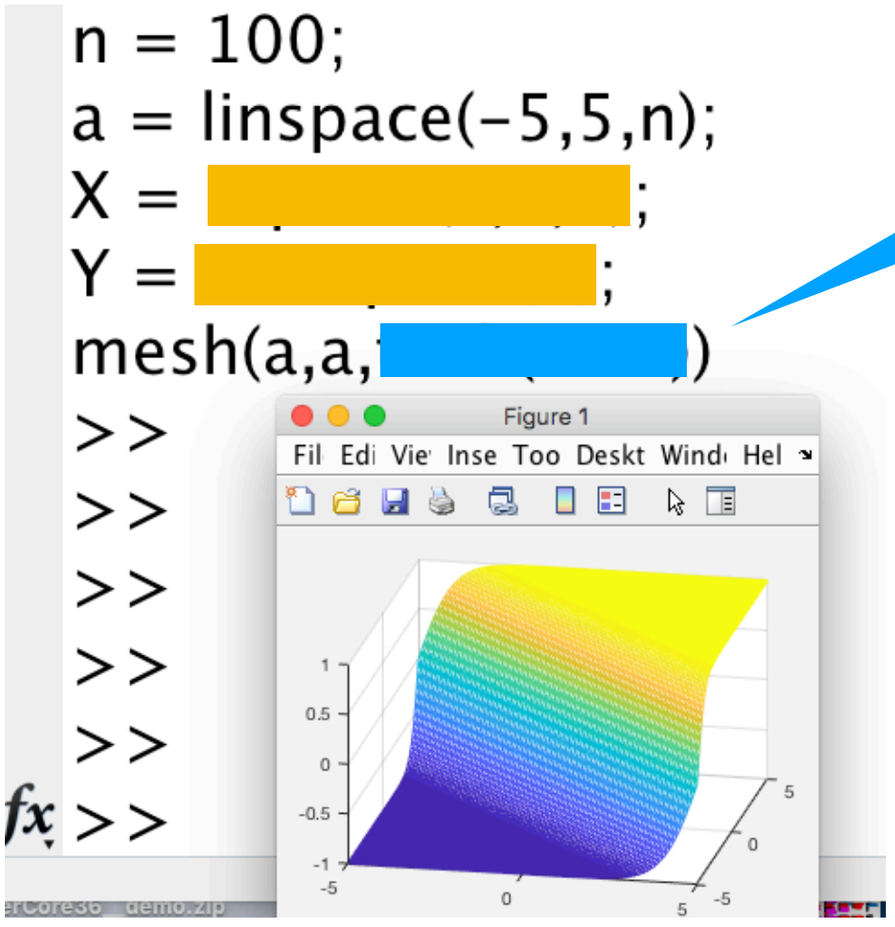
+15 | demo_chaos_ts_4LNRBF.m | my_valid_conv2.m | plot_nen.m | +

```
1  function plot_nen(Map,K)
2      G = adjcent(sqrt(K),sqrt(K));
3
4      for i=1:K
5      for j=1:K
6          if G(i,j)==-1
```

Command Window

```
>> load('p4_face_large_en_temp2.mat')
>> map.Y=Big_Y;
>> plot_nen(map,40*40)
>> plot_nen(map,40*40)
```

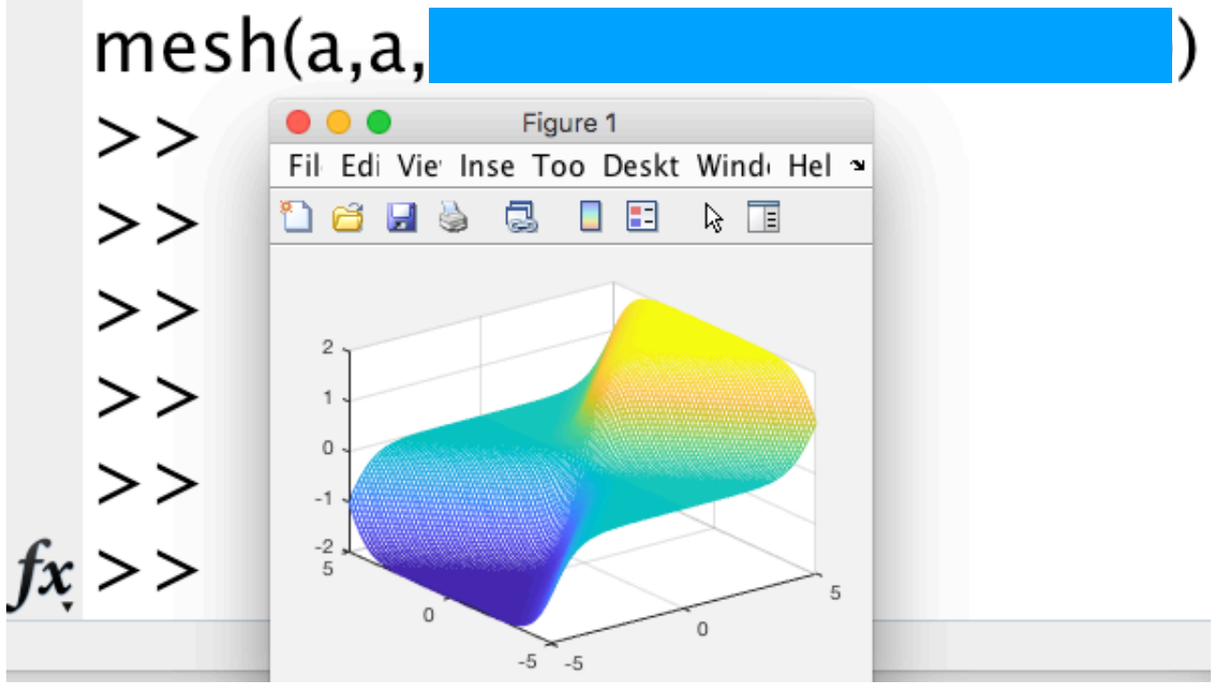
請完成mesh指令，繪製 $f(x,y) = tanh(x+y)$ 的立體圖



請完成mesh指令，繪製 $f(x,y) = tanh(x+y) + tanh(x-y)$ **的立體圖**

```
n = 100;
a = linspace(-5,5,n);
X = [redacted];
Y = [redacted];
mesh(a,a,[redacted])
```

本題答題



Find the Maclaurin series expansions of the exponential, sine, and cosine functions up to the fifth order.

```
syms x
T1 = taylor(exp(x))
T2 = taylor(sin(x))
T3 = taylor(cos(x))
```

$$f(a+\delta) \sim f(a) + \sum_{k=1}^{K} \frac{1}{k!} f^k(a)\delta^k$$

Exercise taylor_ex1

```
function taylor_ex1( )
% step 1. Apply Matlab statement taylor  to
%              find  Maclaurin series expansion of exp(-x^2)
%              and set it to p

%    step 2.   Translate p to an inline px

%     step 3.  Set a = 1/2 and delta = 0.01
                and substitute a + delta to inline px
```

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Code
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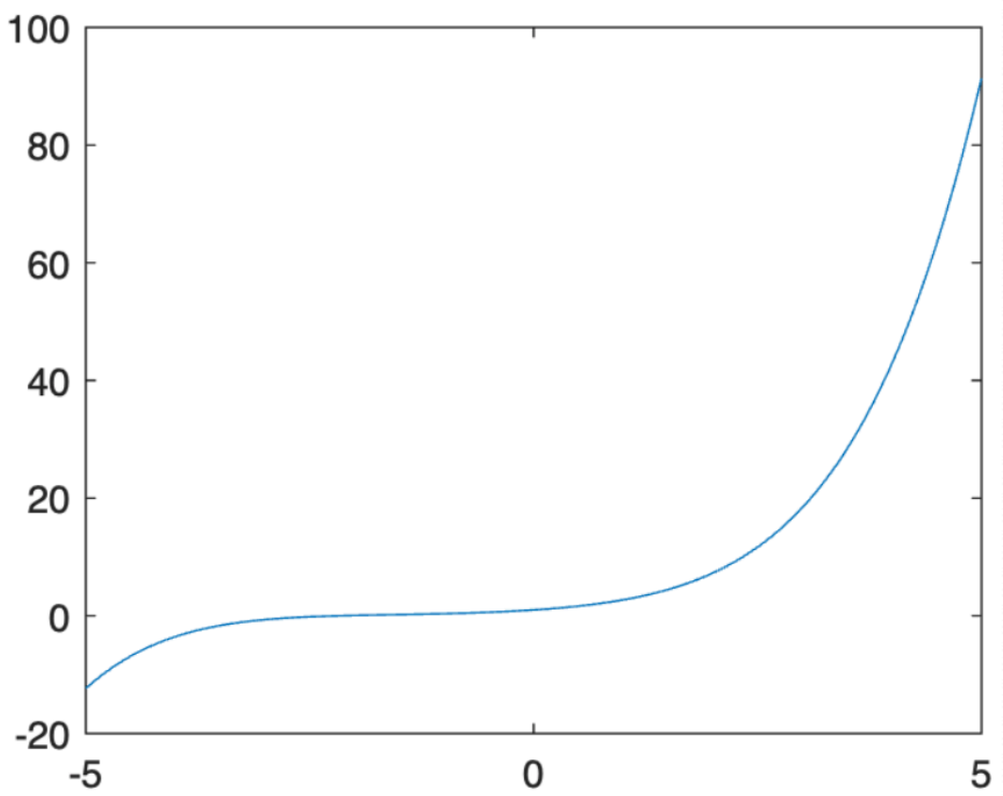
third_derivatives.m | demo_Taylor_ex1_jmwu.m

New Script

```
1  function demo_Taylor_ex1_jmwu()
2
3 -     syms x;
4 -     p = taylor(exp(x));
5 -     px = inline(p);
6 -     a = linspace(-5,5,100);
7 -     plot(a,px(a))
8
9 - end
```

Figure 1



s.m

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COMMAND WINDOW

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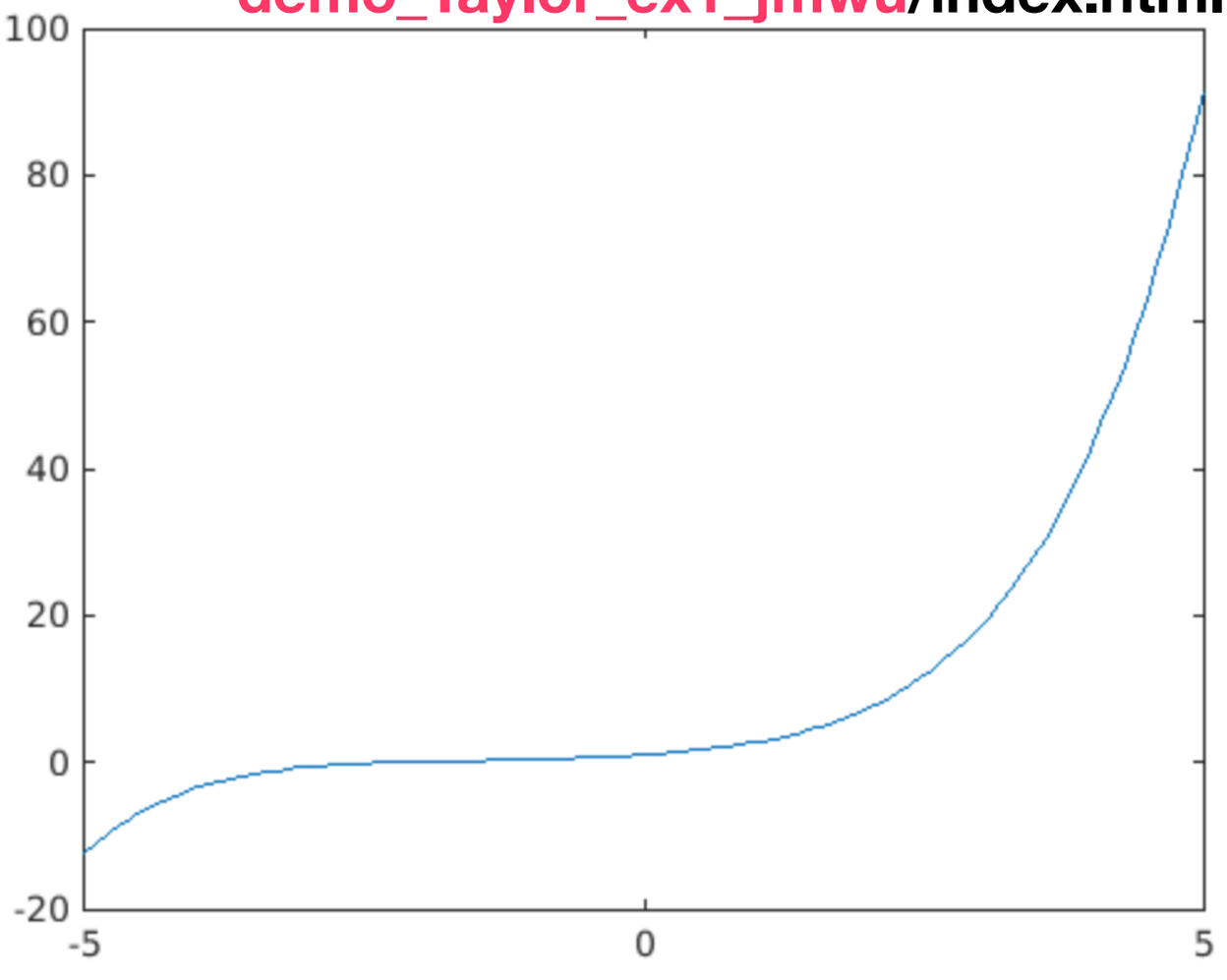
matlab.mathworks.com

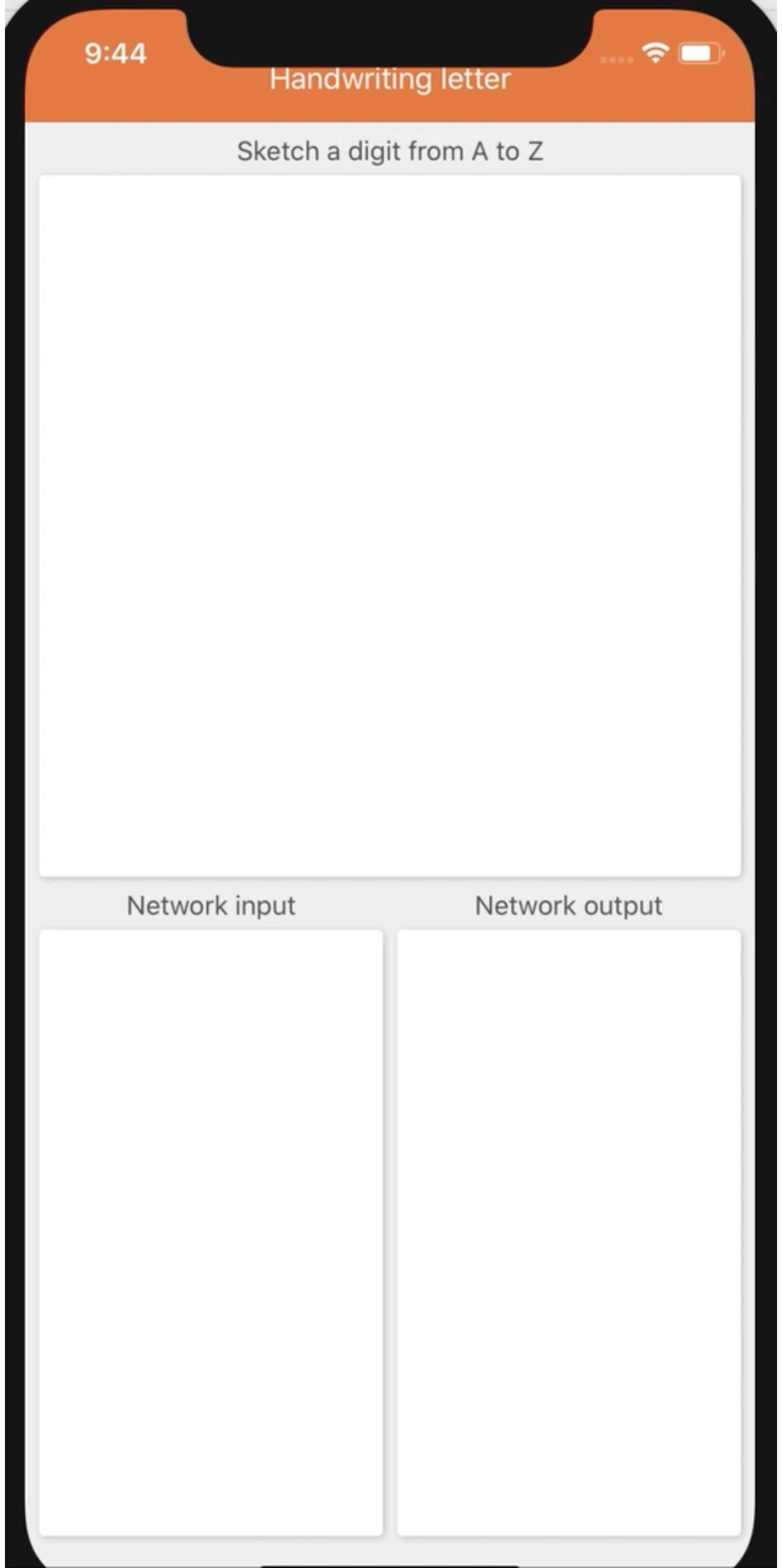
MATLAB Online R2019b

```
function demo_Taylor_ex1_jmwu()

    syms x;
    p = taylor(exp(x));
    px = inline(p);
    a = linspace(-5,5,100);
    plot(a,px(a))

end
```

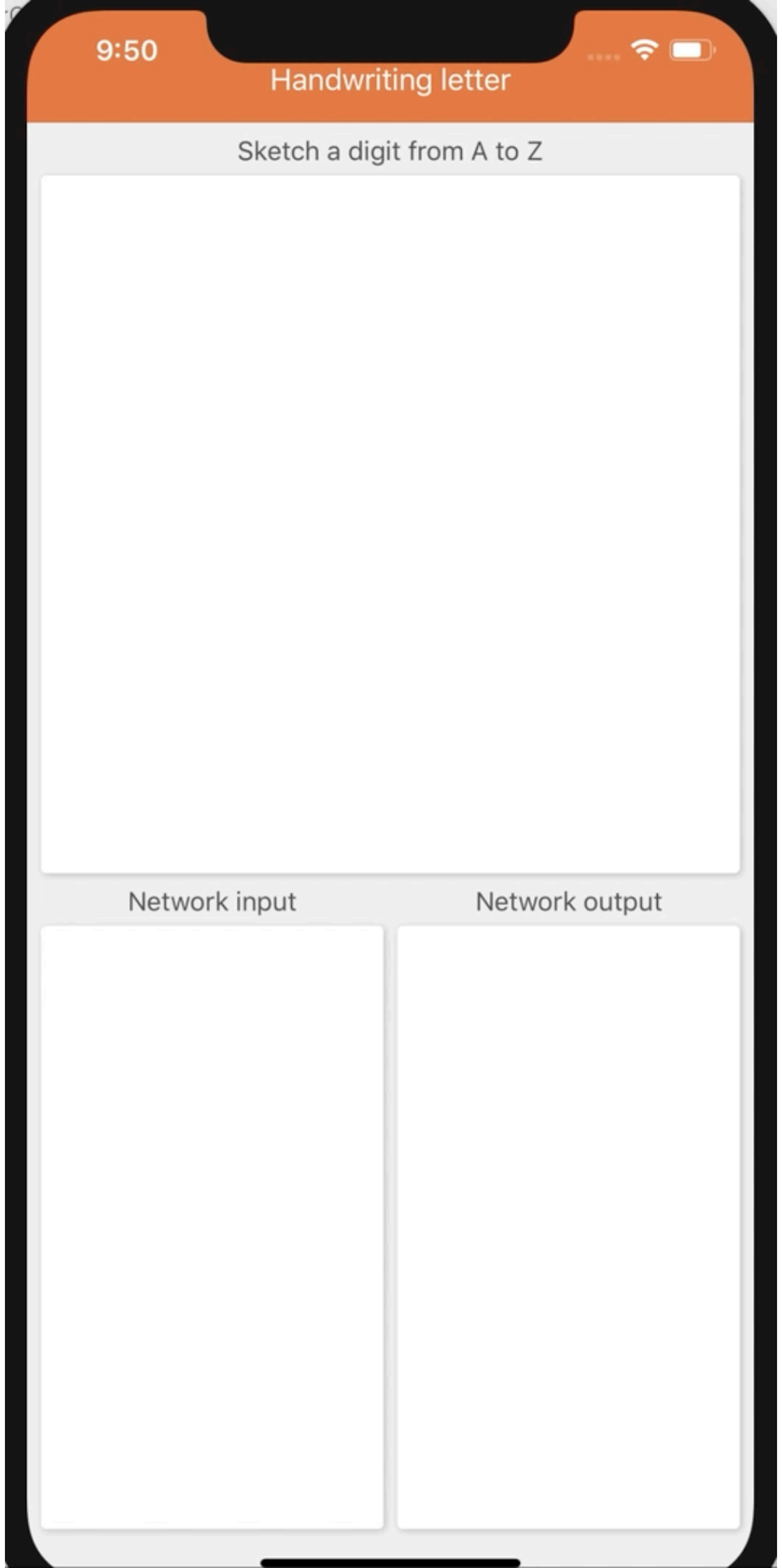
https://matlab.mathworks.com/users/jmwu@mail.ndhu.edu.tw/Published/demo_Taylor_ex1_jmwu/index.html



LetterCore36



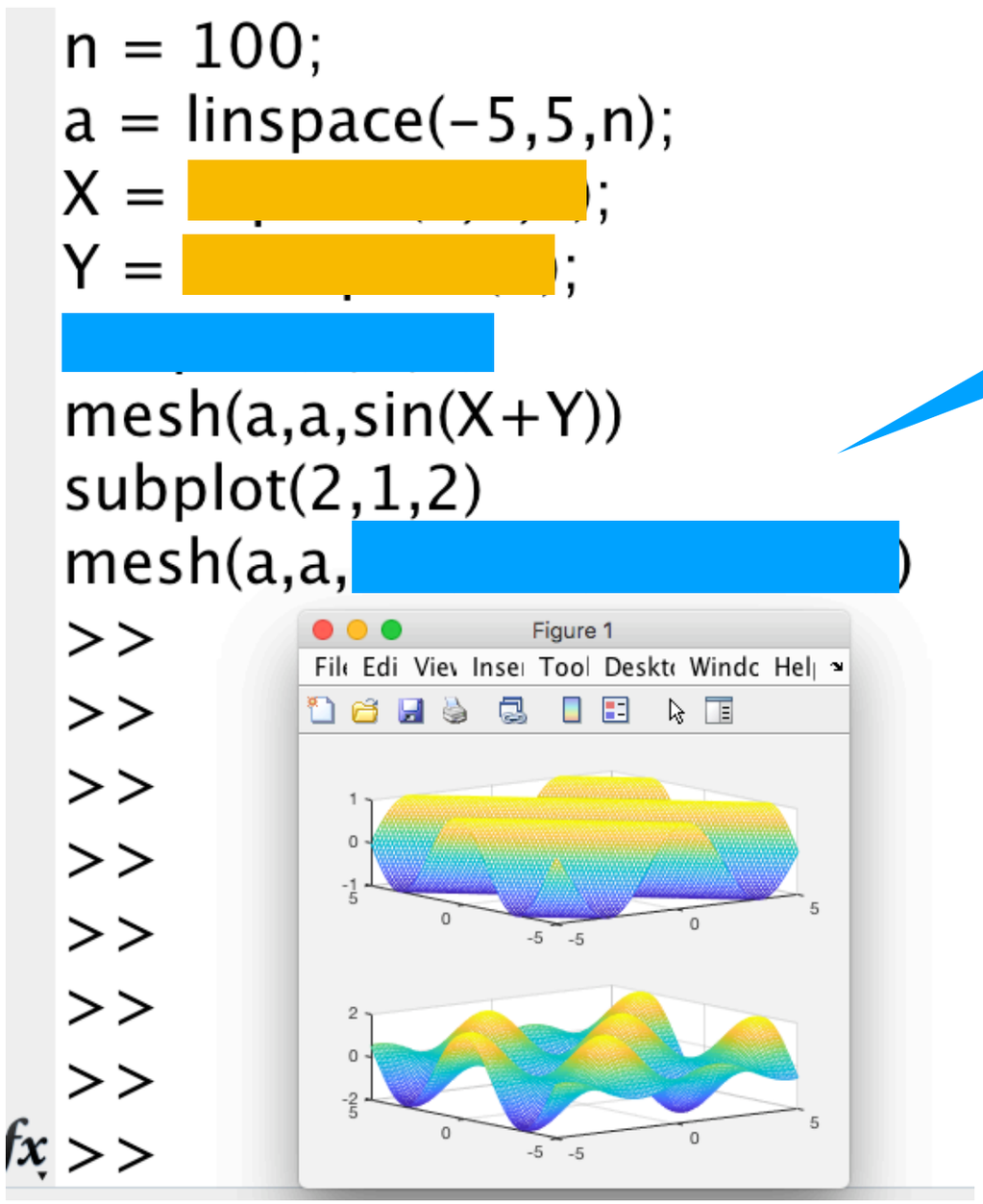
LetterCore38



請完成mesh指令，繪製 $f(x,y) = sin(x+y) + sin(x-y)$ **的立體圖**

```
n = 100;
a = linspace(-5,5,n);
X = [redacted];
Y = [redacted];
[redacted]
mesh(a,a,sin(X+Y))
subplot(2,1,2)
mesh(a,a,[redacted])
```

本題答題



請完成下列程式，印出 $x^3 - 2x + 1$ 的一階導數、二階導數及三階導數

Command Window

```
x = [redacted]('x');
s= diff(x^3-2*x+1)
for i = 2: 3
    s = [redacted](s)
end

s =

3*x^2 - 2


s =

6*x


s =

6
```

請將代表 $x^3 - 2x + 1$
的一階導數、二階導數與三階導數的字串分別儲存於cell， s{1}、s{2}與s{3}

```
x = sym('x');
s{1}= diff(x^3-2*x+1);
display(s{1})
for i = 2: 3
    s{i} =          ;
    display(s{i})
end
```

```
ans =

3*x^2 - 2


ans =

6*x


ans =

6
```

請將代表 $x^3 - 2x + 1$

的一階導數、二階導數與三階導數的inline函數分別儲存於cell， f{1}、f{2}與f{3}

```
>>
x = sym('x');
s{1} = diff(x.^3-2*x+1);
for i = 2: 3
    s{i} =                ;
end
for i = 1 : 3
    f{i} =                );
    display(f{i})
end
```

```
=

    Inline function:
    (x) = x.^2.*3.0-2.0


=

    Inline function:
    (x) = x.*6.0


=

    Inline function:
    (x) = 6.0
```

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Name

- sinch_plot_01.png
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- sinch_plot.html
- demo_hagan_01.png
- demo_hagan.png
- demo_hagan.html
- third_derivatives

my_latinsquare_list.m | my_picture.m | demo_det.m | third_derivatives.m

```
1 - syms x;
2 - s{1} = diff(x.^3-2*x+1);
3 - for i = 2:3
4 -     s{i} = diff(s{i-1});
5 - end
6 - for i = 1:3
7 -     f{i} = inline(s{i});
8 -     display(f{i});
9 - end
```

Press to publish

WORKSPACE

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ans	'/MATLAB ...	1×52	char
f	*1×3 cell*	1×3	cell
i	3	1×1	double
s	*1×3 cell*	1×3	cell
x	*1×1 sym*	1×1	sym

COMMAND WINDOW

New to MATLAB? See resources for Getting Started.

>>

Directory

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https://
matlab.mathworks.com/users/
jmwu@mail.ndhu.edu.tw/
Published/
third_derivatives/
index.html

Your matlab user id

Published directory

```
syms x;
s{1} = diff(x.^3-2*x+1);
for i = 2:3
    s{i} = diff(s{i-1});
end
for i = 1:3
    f{i} = inline(s{i});
    display(f{i});
end
```

```
 =

     Inline function:
     (x) = x.^2.*3.0-2.0


   =

       Inline function:
       (x) = x.*6.0


   =

       Inline function:
       (x) = 6.0
```

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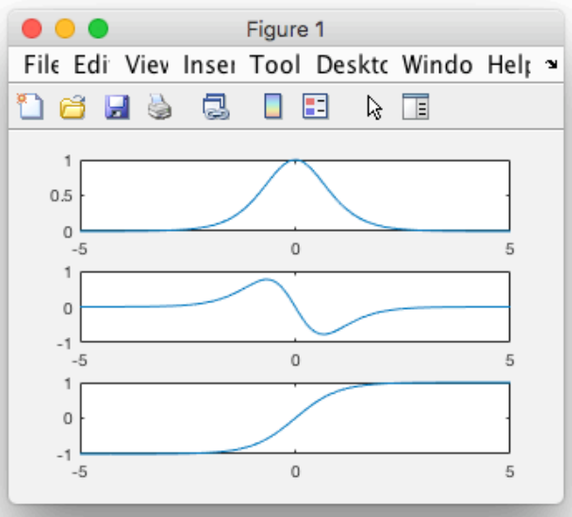
請以plot指令繪製f{i}所代表的inline函數，plot的兩個輸入參數分別為向量a，以及將向量a代入函數f{i}的結果

```
>> x = sym('x');
s{1} = diff(tanh(x));
for i = 2: 3
    s{i} =                    ;
end
a = linspace(-5,5);
for i = 1 : 2
    f{i} =                    ;
    subplot(3, 1, i)
                              
end
subplot(3,1,3)
plot(a, tanh(a))
```



本題求tanh(a+da)的泰勒展開，展開的項數為三，請將第一項的內容儲存在變數app，並在迴圈中將da的k次方項加入變數app中

$$f(a+\delta) \sim f(a) + f'(a)\delta + \frac{1}{2!}f''(a)\delta^2$$

```
K = 2; a = pi/4; da = 10^-2;
x = sym('x');
s{1} = diff(tanh(x));
for i = 2: K
    s{i} = diff(s{i-1});
end
fprintf('tanh(a+da) = %15.14f\n',tanh(a+da));
app =          ;
for k = 1 : K
    f{k} = inline(s{k});
    app = app +                                  ;
end
fprintf('app          = %15.14f\n', app);

tanh(a+da) = 0.66145622234088
app        = 0.66145616633167
```

本題求tanh(a+da)的泰勒展開，展開的項數為五，請將第一項的內容儲存在變數app，並在迴圈中將da的k次方項加入變數app中

```
K = ; a = pi/4; da = 10^-2;
x = sym('x');
s{1} = diff(tanh(x));
for i = 2: K
    s{i} = diff(s{i-1});
end
fprintf('tanh(a+da) = %15.14f\n',tanh(a+da));
app = ;
for k = 1 : K
    f{k} = inline(s{k});
    app = app + ;
end
fprintf('app          = %15.14f\n', app);
tanh(a+da) = 0.66145622234088
app        = 0.66145622234724
```

本題求tanh(a+da)的泰勒展開，展開的項數為七，請將第一項的內容儲存在變數app，並在迴圈中將da的k次方項加入變數app中

```
K = ; a = pi/4; da = 10^-2;
x = sym('x');
s{1} = diff(tanh(x));
for i = 2: K
    s{i} = diff(s{i-1});
end
fprintf('tanh(a+da) = %15.14f\n',tanh(a+da));
app = ;
for k = 1 : K
    f{k} = inline(s{k});
    app = app + ;
end
fprintf('app          = %15.14f\n', app);
tanh(a+da) = 0.66145622234088
app        = 0.66145622234088
```

Exercise taylor_ex2

$$f(x) = exp(-x^2)$$

$$f(a+\delta) \sim f(a) + \sum_{k=1}^{K} \frac{1}{k!} f^k(a)\delta^k$$

$$a = \frac{1}{2}, \quad \delta = 0.01$$

$$f(a+\delta) = ?$$

1. **Revise the Matlab script at page 20 to find Taylor expansions of e^{-x^2} with K = 6**

2. **Set a = 1/2 and delta = 0.01 Substitute a + delta to the Taylor expansions**