**一、**

只有做 Extra Bonus1。

**二、**

**(1)Extra Bonus1 : ImpliedVolitility.py**

*def* binomial\_prob(*n*, *j*, *p*):...

*def* bs(*S0*, *K*, *T*, *r*, *q*, *sigma*, *call\_put*):...

*def* binomial\_European(*S0*, *K*, *T*, *r*, *q*, *sigma*, *layers*, *call\_put*):...

*def* binomial\_American(*S0*, *K*, *T*, *r*, *q*, *sigma*, *layers*, *call\_put*):...

# 定義損失函數

*def* loss\_function\_bs(*marketPrice*, *S0*, *K*, *T*, *r*, *q*, *sigma*, *call\_put*):...

*def* loss\_function\_binomial(*marketPrice*, *S0*, *K*, *T*, *r*, *q*, *sigma*, *call\_put*, *layers*, *type*):...

# 計算隱含波動度

# bisection method

*def* iv\_bisection(*marketPrice*, *S0*, *K*, *T*, *r*, *q*, *call\_put*, *type*, *model*, *layers*, *converCrit*):...

# 計算導數

*def* vega\_bs(*S0*, *K*, *T*, *r*, *q*, *sigma*):...

*def* vega\_binomial(*S0*, *K*, *T*, *r*, *q*, *sigma*, *layers*, *call\_put*, *type*):...

# Newton method

*def* iv\_newton(*marketPrice*, *S0*, *K*, *T*, *r*, *q*, *call\_put*, *type*, *model*, *layers*, *converCrit*):...

# main

S0 = 50

K = 55

r = 0.1

q = 0.03

T = 0.5

直接調整 **#main** 下面的變數，呼叫函式存入變數，再印出即可(所有參數以及函式都已預先輸入好，直接執行即可以看到精美的結果)。

輸出看起來會是這樣 :

==========BISECTION METHOD==========

European Call

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IV of European Call : 26.8393 % (BS)

IV of European Call : 26.7846 % (CRR)

American Put

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IV of American Put : 30.4905 % (CRR)

==========NEWTON METHOD==========

European Call

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IV of European Call : 26.8393 % (BS)

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