

## 112-2 財務演算法 期中作業

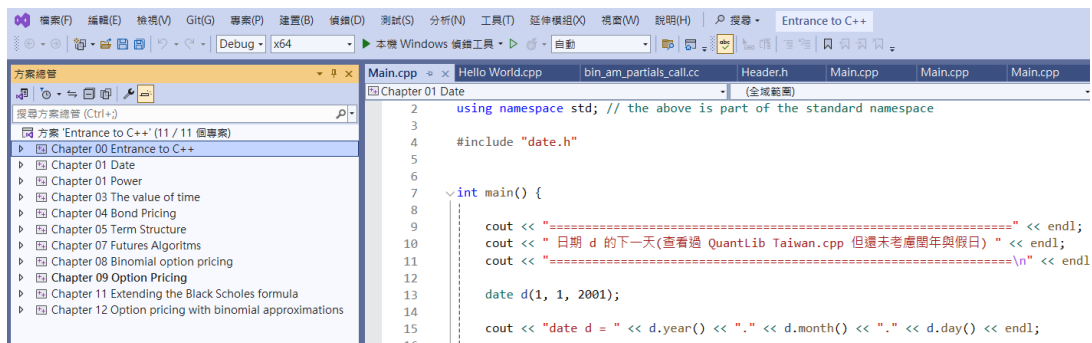
D11723002 張詠瑄

### 一、操作說明

【Visual Studio 2022】<https://visualstudio.microsoft.com/zh-hant/vs/>

在名為 Midterm 的資料夾下開啟 Entrance to C++.sln 檔案即可開啟方案，此方案中包含 11 個專案。這些專案包括老師從開學至今授課內容所提及的 C++ 練習題。

Table 1




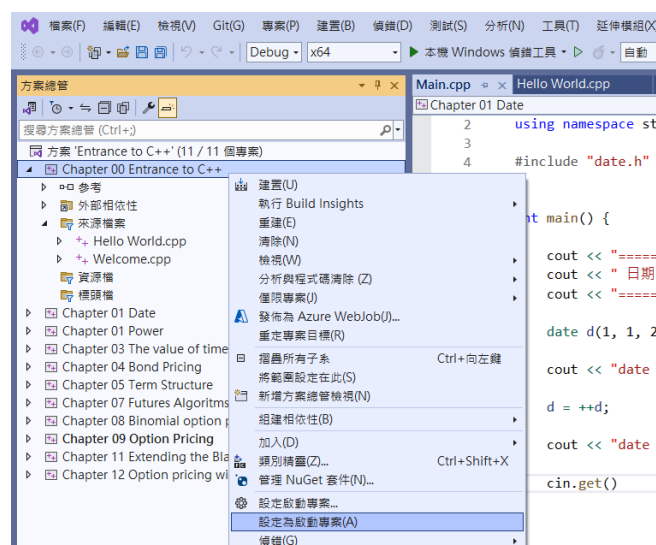
方案總管中黑色粗體字的專案是目前跑程式(按綠色三角形  本機 Windows 偵錯工具)會執行的專案。如 Table 1 中目前運行的程式將為“Chapter 09 Option Pricing”的結果；若想更改為執行“Chapter 00 Entrance to C++”的結果，可以在方案總管中專案的地方點選右鍵 > 設定為啟動專案，再跑程式即可呈現結果。

Table 2

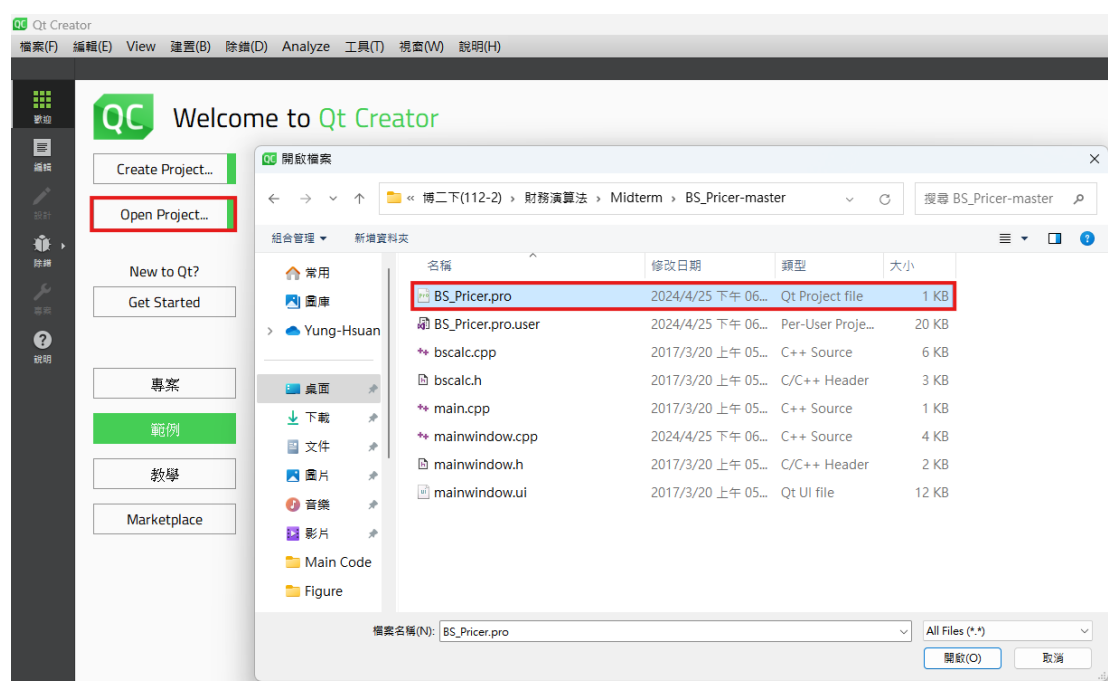


在跑 Chapter 09、11 時可能會遇到 gsl 相關報告錯誤問題，這是源於 N3.cpp 需

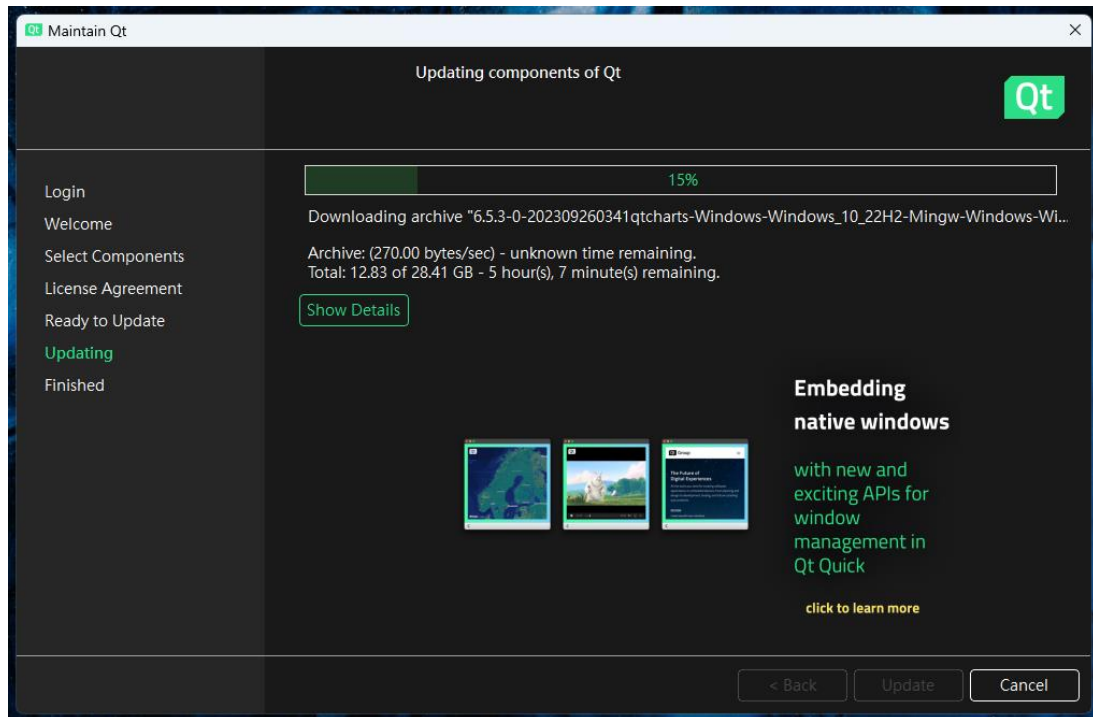
要用到 `gsl_integration.h`，而所在的專案沒有安裝套件的問題。雖然老師上課曾解說希望小的函數可以自己寫、且用自己的代碼執行效率也較好。但因為目前的能力與時間有限，將暫以安裝套件為解決方案處理。安裝套件的方法如下：對目標專案按右鍵 > 管理 NuGet 套件 > 安裝 "gsl-msvc14-x64"。安裝後再重新運行程式即可。

### 【Qt】開源版下載頁面 <https://www.qt.io/download-open-source>

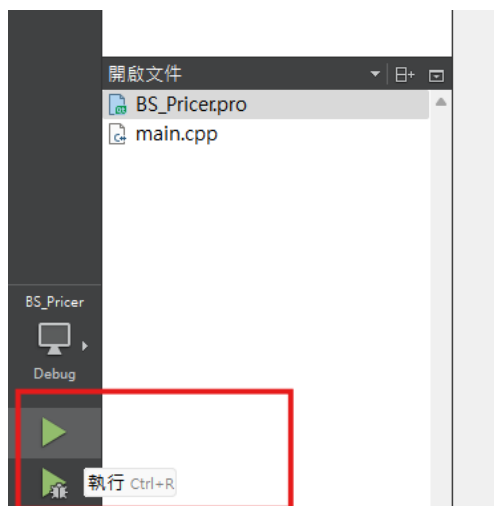
下載完畢後打開 Qt Creator > 點選 Open Project... > Midterm > BS\_Pricer-master > BS\_Pricer.pro > 開啟。Qt 專案檔的副檔名是 .pro，它用於組織整個 Qt 專案，包含原始碼，進行編譯器各種設定等等。



我的電腦下載 Qt Creator 後仍無法運行 `#include <QApplication>`，需要在 Windows 打開 Qt Maintenance Tool，登入帳號並 Updating components of Qt 才能順利運行程式。



順利的話，點選左下角的綠色三角形或是按 Ctrl + R 即可跑程式



## 二、專案文件說明與結果呈現

### 【Visual Studio 2022】

**Chapter 00 Entrance to C++**: 參考中國學者在 YouTube 影片中的入門練習。cin 就是等待鍵盤輸入。

運行程式後，可以輸入自己的名字 > 按 Enter > 顯示 Hello, 名字 :)

```
=====
First time learning C++
=====
Hello C++ World!
Input your name:
|
>
=====
First time learning C++
=====
Hello C++ World!
Input your name:
Sherry
Hello, Sherry:)
```

**Chapter 01 Date**: 日期的前一天、下一天練習。有找到 QuantLib 的寫法，大致有發現他是分國家、分年、分每年有哪些節日慢慢寫好的，但是還在研究中 (<https://github.com/lballabio/QuantLib/tree/master/ql/time/calendars>)。

```
=====
日期 d 的下一天(查看過 QuantLib Taiwan.cpp 但還未考慮閏年等問題)
=====
date d = 2001.1.1
date d+1 = 2001.1.2
|
```

**Chapter 01 Power**: 最一開始老師教我們操作的次方、函數以及迴圈的練習。

```
=====
次方 與 迴圈 練習
=====
2^1 = 2
2^2 = 4
2^3 = 8
2^4 = 16
2^5 = 32
|
```

**Chapter 03 The value of time**: Present value 的練習

```
=====
Present Value 練習
=====
When C=[-100 75 75], t=[0 1 2], r=0.1,
Present value, 10 percent discretely compounded interest = 30.1653
|
```

## Chapter 04 Bond Pricing :

### Bond Pricing with a flat term structure Chapter

When  $C=[10 \ 10 \ 110]$ ,  $t=[1 \ 2 \ 3]$ ,  $r=0.09$ ,

bonds price	= 102.531
bond yield to maturity	= 0.09
bond duration	= 2.73895
bond duration modified	= 2.5128
bond convexity	= 8.93248
new bond price	= 100

## Chapter 05 Term Structure :

### Term structure of interest rates examples

Example 1 : Given the one period spot rate  $r_1=5\%$  and the two period discount factor  $d_2=0.9$ .  
Calculate the two period spot rate and the forward rate from 1 to 2.

Answer 1 :

a 1 period spot rate of 0.05 corresponds to a discount factor of 0.951229  
a 2 period discount factor of 0.9 corresponds to a spot rate of 0.0526803  
the forward rate between 1 and 2 is 0.0553605 using discount factors  
and is 0.0553605 using yields

Example 2 : The term structure is flat with  $r=5\%$ .  
Determine the discount factors for years 1 and 2 and the forward rate between 1 and 2.

Answer 2 :

discount factor  $t_1 = 1:0.951229$   
discount factor  $t_2 = 2:0.904837$   
spot rate  $t = 1:0.05$   
spot rate  $t = 2:0.05$   
forward rate from  $t_1= 1$  to  $t_2= 2:0.05$

Example 3 : Time=[0.1 0.5 1 5 10],  $r=[0.1 \ 0.2 \ 0.3 \ 0.4 \ 0.5]$ .  
Interpolate spot rates(zero rate) at times 0.1, 0.5, 1, 3, 5 and 10.

Answer 3 :

yields at times:

t = 0.1,	r = 0.1
t = 0.5,	r = 0.2
t = 1,	r = 0.3
t = 3,	r = 0.35
t = 5,	r = 0.4
t = 10,	r = 0.5

Example 4 : The term structure is flat with  $r=10\%$  continuously compounded interest.  
Calculate price, duration, and convexity of a 10%, 2 year bond.

Answer 4 :

price = 99.1088  
duration = 1.9087  
convexity = 3.72611

## Chapter 07 Futures Algorithms :

```
=====
Futures/Forwards pricing
=====

Let S=100 and r=10%. What is the future price for a contract with time to maturity of half a year?

futures price = 105.127
|
```

## Chapter 08 Binomial option pricing :

```
=====
Binomial Chapter
=====

Let S=100.0, K=100.0, r=0.025, u=1.05 and d=1/u. Price one and two period European Call options.

one period european call = 3.64342
two period european call = 5.44255
|
```

## Chapter 09 Option Pricing : 以下是老師要求的 Black Scholes 解析解和 Greeks 。

```
=====
Examples in Black Scholes chapter
=====

Example 1 : To calculate the price of option using Black Scholes formula
            with inputs S = 50, K = 50, r = 0.10, sigma = 0.3 and (T - t) = 0.5.

Answer 1 :

Black Scholes call price = 5.45325

-----

Example 2 : To calculate the partial derivatives using inputs S=50, K=50, r=0.10, sigma=0.3 and (T-t)=0.5.

Answer 2 :

Delta = 0.633737
Gamma = 0.0354789
Theta = -6.61473
Vega = 13.3046
Rho = 13.1168

-----

Example 3 : The current option price is C=2.5. Determine the volatility implicit in this price.
            To calculate using inputs S = 50, K = 50, r = 0.10 and (T - t) = 0.5.

Answer 3 :

Black Scholes implied volatility using Newton search = 0.0500427
Black Scholes implied volatility using bisections = 0.0500419
|
```

## Chapter 11 Extending the Black Scholes formula :

```
=====
Black Scholes extensions
=====

Example 1 : Consider a stock option with S=100, K=100, r=0.1, sigma=0.25, time to maturity is one year.
            dividend yield = 5 %. Dividend payments at times 0.25 and 0.75.
            Determine the option price.
Answer 1 :

    european stock call option with continuous dividend = 11.7344
    european stock call option with discrete dividend = 11.8094
-----

Example 2 : Price a futures option in the Black setting.
            Information: F = 50, K = 45, r = 8%, sigma = 0.2, and time to maturity is a half year.
Answer 2 :

    european futures call option = 0.851476
-----

Example 3 : Price European currency call given that S=50, K=52, r=8%, rf=5%, sigma=20% and time to maturity=0.5 years.
Answer 3 :

    european currency call option = 2.22556
|
```

## Chapter 12 Option pricing with binomial approximations :

```
=====
Binomial Approximations examples
=====

Example 1 : An option : S=100, K=100, r=0.1, sigma=0.25 and time to maturity is 1 year.
            Price American calls and puts using binomial approximations with 100 steps.
Answer 1 :

    european call = 14.9505
    american call = 14.9505
    american put = 6.54691
-----

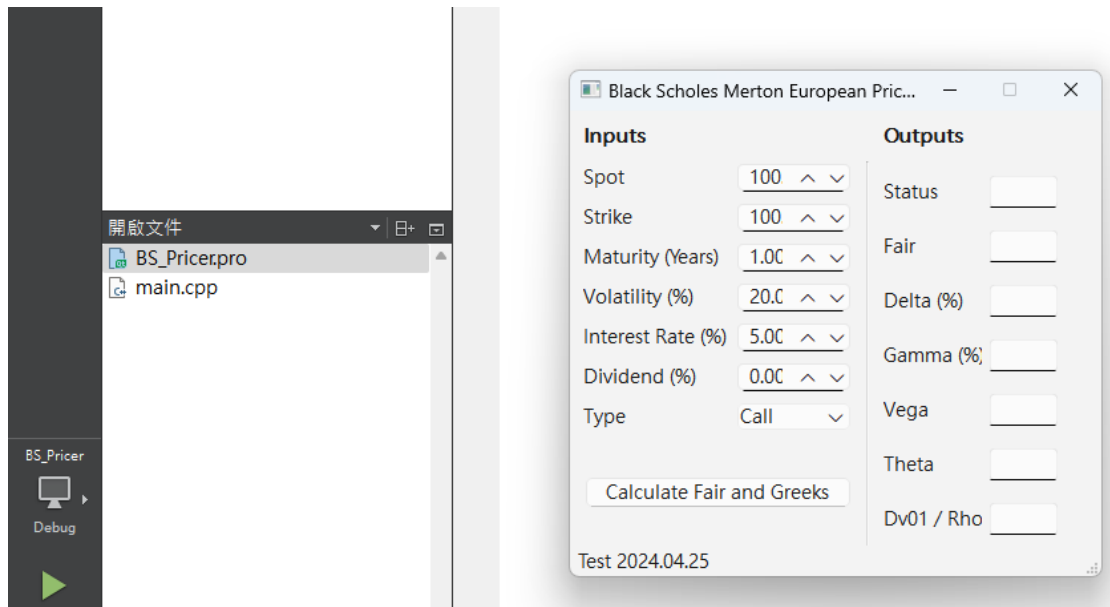
Example 2 : Given that S=100, K=100, r=0.1, sigma=0.25 and time to maturity is 1 year,
            Use 100 steps in the binomial approximation.
            Estimate all the greeks for the option : delta, gamma, theta, vega and rho.
Answer 2 :

    Call price partials

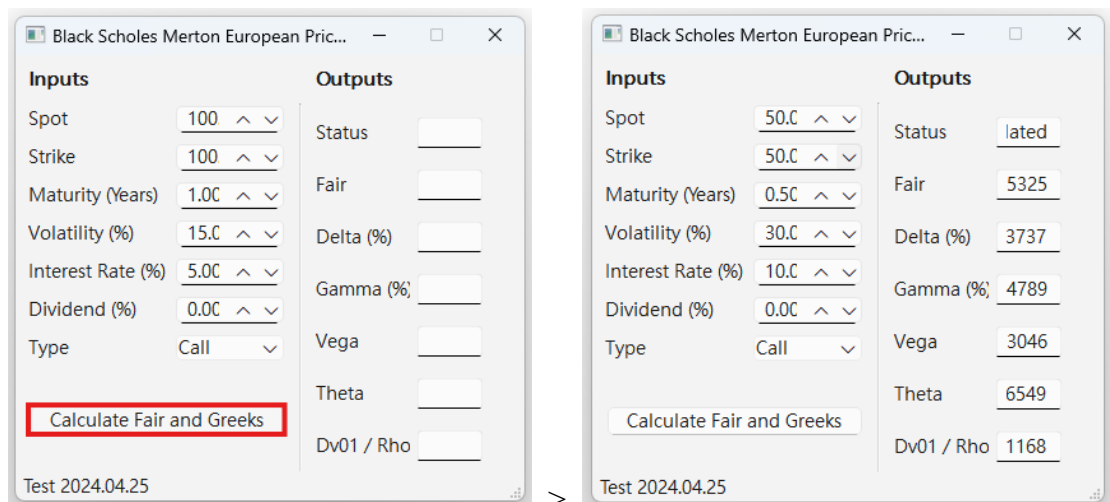
    delta = 0.699792
    gamma = 0.0140407
    theta = -9.89067
    vega = 34.8536
    rho = 56.9652
|
```

## 【Qt】

**BS\_Pricer.pro**：參考網路上作者們的程式拼湊中，還在測試和理解程式中。  
點選綠色三角形後應該可以順利跳出運算 Black Scholes Merton European Price 的介面。



根據需求在 Input 的地方調整數值 > 點選 Calculate Fair and Greeks > 得到 Outputs



程式還有問題，目前僅跑得出來介面但是 Outputs 都不對。

## Reference

【尚硅谷】2023 版 C++ 零基础教程，c++项目实战，清华学神帶你一套通关  
<https://www.youtube.com/playlist?list=PLmOn9nNkQxJFgVZJqpMCAOtPIExvpZjp>

chchwy, iT 邦幫忙：Qt 6 跨平台應用程式開發系列

<https://ithelp.ithome.com.tw/users/20084263/ironman/6778>