

Gurobi 使用經驗分享

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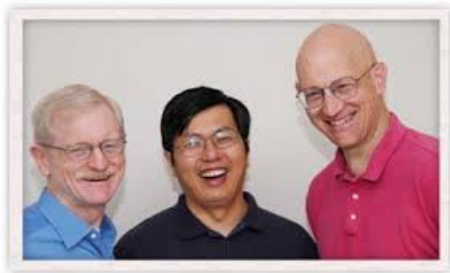
2015/10/12-13

簡介

安裝

設定

範例



Robert Bixby, Zonghao Gu, Edward Rothberg

什麼是 Gurobi

Gurobi 全名為 Gurobi Optimizer，是一套強大的規劃求解工具，其開發團隊為原 CPLEX 的開發團隊，在 CPLEX 轉售給 IBM 後成立。

Gurobi 可以求解的問題類型包括線性規劃 (LP)、二次規劃 (QP)、二次約束規劃 (QCP)、混合整數規劃 (MILP)、混合整數二次規劃 (MIQP)、混合整數二次約束規劃 (MIQCP) 等。

安裝 1/8

The screenshot shows the Gurobi Optimization website. The top navigation bar includes links for PRODUCTS, DOWNLOADS, RESOURCES, ACADEMIA, SUPPORT, and ABOUT, along with Login and Register buttons. The main banner features the text "An easier way to make better decisions." and "The state-of-the-art mathematical programming solver". Below this, there are three columns: "Learn About" (with a magnifying glass icon), "Get Gurobi" (with a hand icon), and "Use Gurobi" (with a wrench and screwdriver icon). The "Learn About" column describes the solvers available. The "Get Gurobi" column mentions versions for commercial, ISV, and academic users. The "Use Gurobi" column states that the software is designed to be easy to start with or switch to. A "Gurobi News and Events" section is also visible, listing recent updates. A testimonial box on the right says "What users are saying..." and "Industry leading performance and incomparable support."

GUROBI
OPTIMIZATION

PRODUCTS DOWNLOADS RESOURCES ACADEMIA SUPPORT ABOUT Login Register

An easier way to make better decisions.

The state-of-the-art mathematical programming solver

Gurobi Optimizer 6.0

- Faster times to feasibility and optimality
- No-surprises pricing
- Intuitive interfaces
- Easy-to-reach technical support

Get Started Today!

See what's new in v6.0!

Learn About

Gurobi builds and supports the best math programming solvers available for all major problem types. It's all we do...

Get Gurobi

We offer versions designed specifically for the needs of commercial, ISV, and academic users...

Use Gurobi

We've worked hard to make it easier to get started with or switch to Gurobi than you may have thought possible...

Gurobi News and Events

- Dr. Robert Bixby Moves to Chief Strategy Officer Role [more...](#)
- See us at this Fall's INFORMS conference [more...](#)
- AIMMS releases new version for Gurobi version 6.0 [more...](#)
- Highlights of Gurobi Optimizer 6.0 [more...](#)

What users are saying...

"Industry leading performance and incomparable support."

進入 Gurobi 官網

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Account Type:

☐ Commercial

☒ Academic

First Name:

*

Last Name:

*

Email Address:

*

University:

*

Academic Position:

Select one... ▼

Phone Number:

Check this box if you also consult with
commercial businesses: ☐

Access Now

Can't see the registration form above? [Click here](#) to open a new window and form you can use.

申請學術帳號

安裝 3/8

Download Center

To use Gurobi, you need to first download the software and then get a license key.



Download the Latest Version of Gurobi

To download the Gurobi Solver, you need to be logged in. First [register](#), if you don't already have an account, and then [login](#), if you are not already logged in.

To get Gurobi, click on the Gurobi Solver link below. If you would like to use Gurobi from within AMPL, click one of the two AMPL links below or learn more on our [AMPL Software](#) page.

 Gurobi Optimizer


 Gurobi Solver for AMPL



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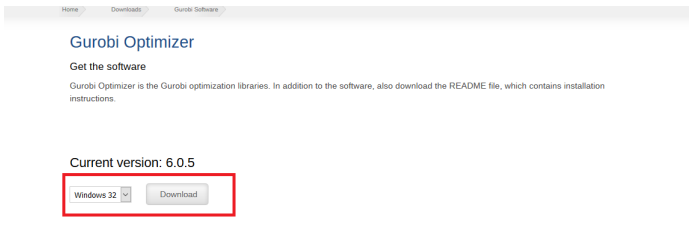
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 Your Gurobi Licenses

Evaluation License Request

進入 Download 點選 GUROBI OPTIMIZER 下載當前版本

安裝 4/8



點選紅框內的選單，選擇您的 IDE 環境所需要的位元版本

安裝 5/8

Download the Latest Version of Gurobi

To download the Gurobi Solver, you need to be logged in. First [register](#), if you don't already have an account, and then [login](#), if you are not already logged in.

To get Gurobi, click on the Gurobi Solver link below. If you would like to use Gurobi from within AMPL, click one of the two AMPL links below or learn more on our [AMPL Software](#) page.

[Gurobi Optimizer](#)[Gurobi Solver for AMPL](#)[AMPL & Gurobi Software](#)

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安裝 6/8

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Conditions for the use of an Academic License: An academic license may only be used by a faculty member, a student, or a member of the research or administrative staffs of a degree-granting academic institution. The code may be used only for research and educational purposes. Access for commercial purposes is forbidden.

I accept these conditions: ☒

We urge academic users to upgrade to the latest version of Gurobi Optimizer. Some features, such as `grbgetkey`, may not work correctly in older releases.

Request License

安裝 7/8

[Home](#)[Downloads](#)[Licenses](#)[Your Gurobi Licenses](#)

License Detail

License ID 104551

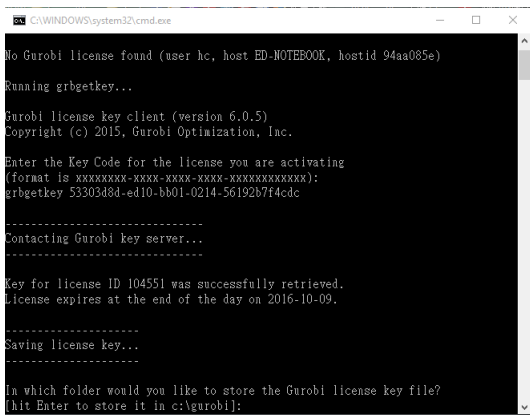
Information and installation instructions

License ID	104551
Date Issued	2015-10-10
Purpose	Trial
License Type	Free Academic
Key Type	ACADEMIC
Version	6
Distributed Limit	0
Expiration Date	2016-10-09
Host Name	
Host ID	

To install this license on a computer where Gurobi Optimizer is installed, copy and paste the following command to the Start/Run menu (Windows only) or a command/terminal prompt (any system):

```
grbgetkey 53303d8d-ed10-bb01-0214-56192b7f4cdc
```

安裝 8/8



```
CA\WINDOWS\system32\cmd.exe

No Gurobi license found (user hc, host ED-NOTEBOOK, hostid 94aa085e)

Running grbgetkey...

Gurobi license key client (version 6.0.5)
Copyright (c) 2015, Gurobi Optimization, Inc.

Enter the Key Code for the license you are activating
(format is xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx):
grbgetkey 53303d8d-ed10-bb01-0214-56192b7f4cdc

-----
Contacting Gurobi key server...
-----

Key for license ID 104551 was successfully retrieved.
License expires at the end of the day on 2016-10-09.

-----
Saving license key...
-----

In which folder would you like to store the Gurobi license key file?
[hit Enter to store it in c:\gurobi]:
```

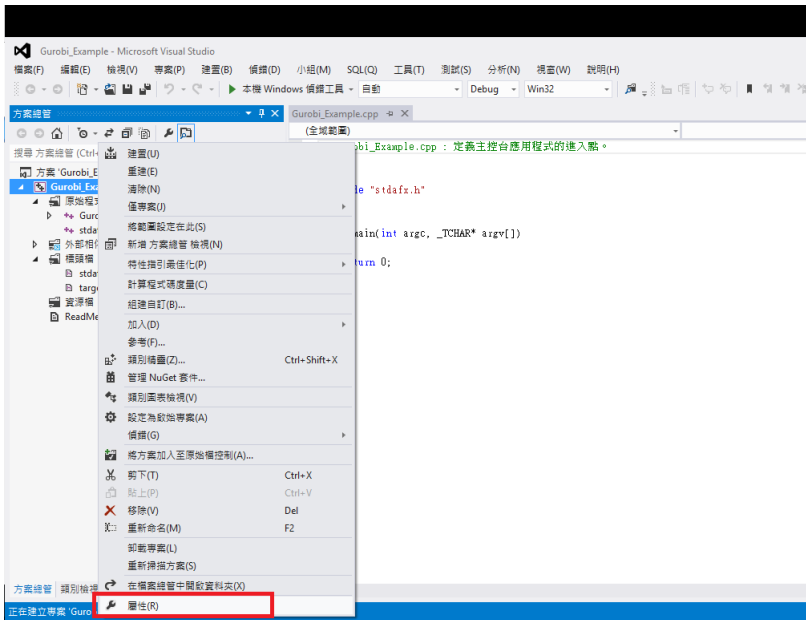
打開桌面的 Gurobi.bat，將您所拿到的 key 複製貼上到裡面，然後一直按 Enter 到這隻程式結束。

Visual Studio 連接設定

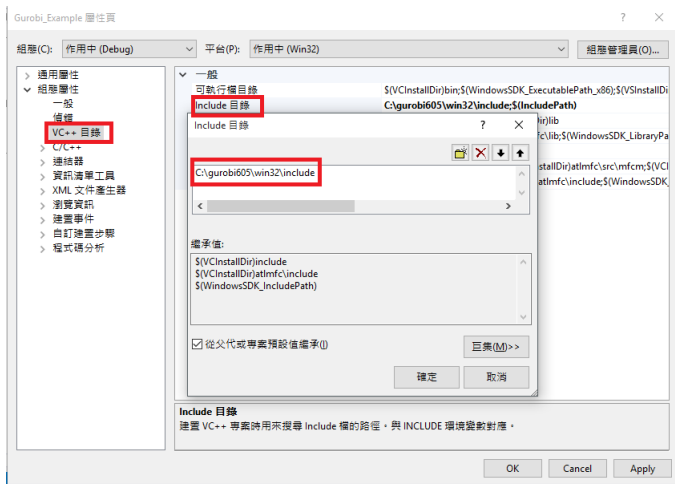
學校的 visual studio 2012 是 32 位元的版本，請同學注意 gurobi 也要下載 32 位元。

同學們可以將 gurobi 當作 library 來使用，但是要將他 include 進去程式裡還需要一些設定。

設定 1/8



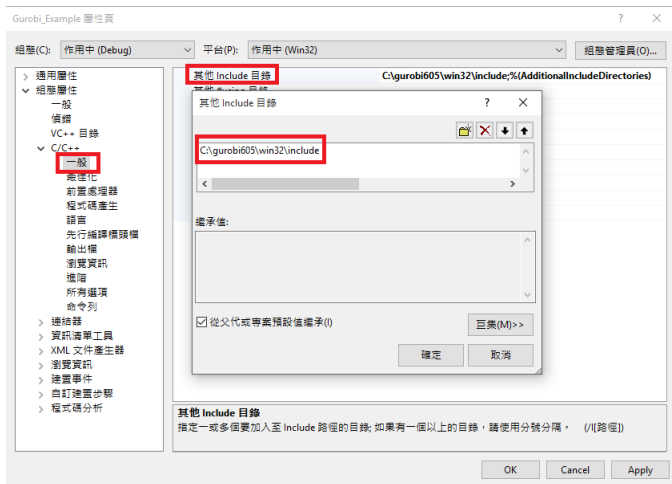
設定 2/8



VC++ 目錄 → Include 目錄

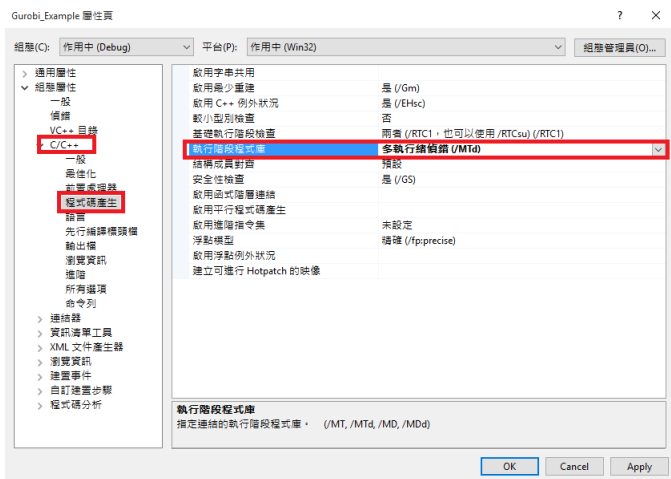
新增您所安裝 Gurobi 的路徑中之 include 資料夾 (畫面上為預設路徑)

設定 3/8



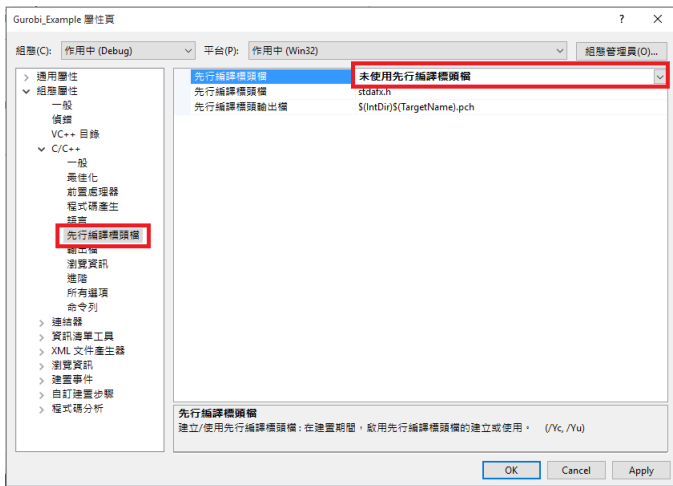
C/C++ → 一般 → 其他 Include 目錄
新增您所安裝 Gurobi 的路徑之 include 資料夾 (畫面上為預設路徑)

設定 4/8



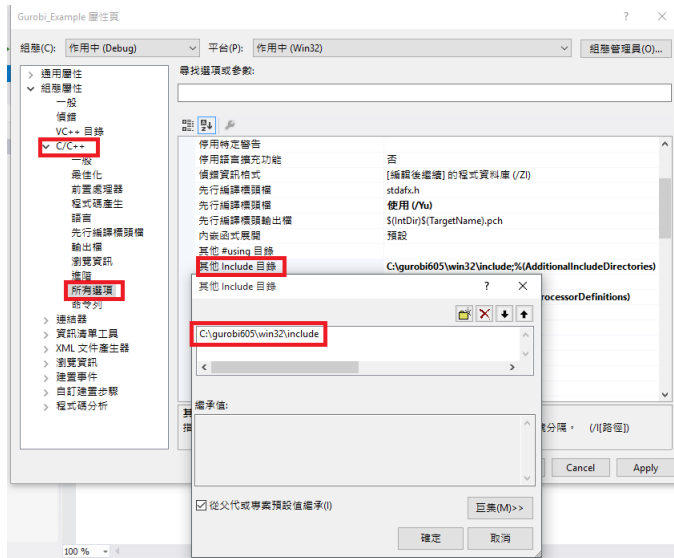
C/C++ → 程式碼產生 → 選取多執行緒偵錯

設定 5/8



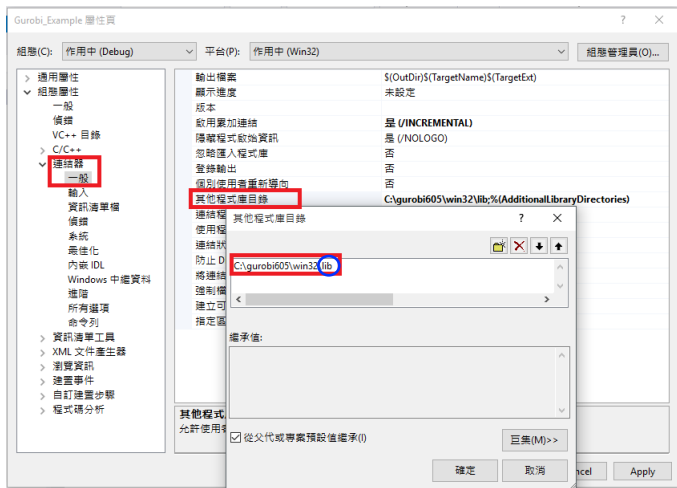
C/C++ → 先行編譯標頭檔 → 選擇未使用先行編譯標頭檔

設定 6/8



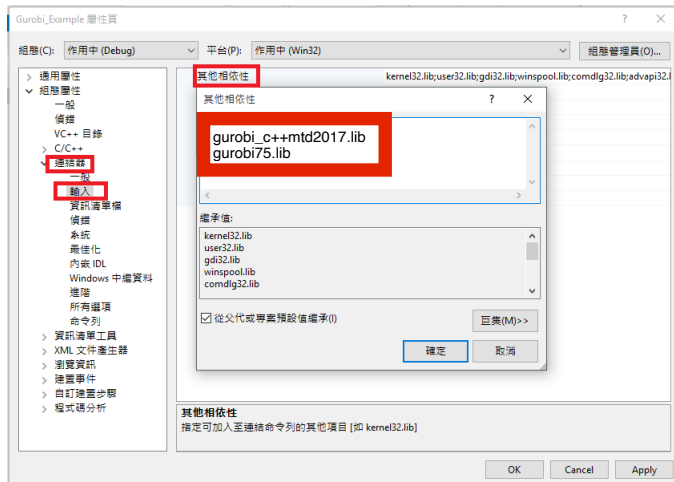
C/C++ → 所有選項 → 其他 Include 目錄

設定 7/8



連結器 → 一般 → 其他程式庫目錄

設定 8/8



連結器 → 輸入 → 其他相依性

PS. 因為是 visual studio2017 版本且 gurobi752 版本

Example 1: Gurobi 範例檔

```
maximize      x +    y + 2 z
subject to    x + 2 y + 3 z <= 4
              x +    y          >= 1
x, y, z binary
```

Example 1: 環境與模型宣告

```
GRBEnv env = GRBEnv();           //創建一個GUROBI環境叫做 env  
GRBModel model = GRBModel(env); //創建一個GUROBI模型叫做model
```

GRBEnv 和 GRBModel 是 Gurobi 自訂的變數類型

Example 1: 宣告變數

```
// Create variables
```

```
GRBVar x = model.addVar(0.0, 1.0, 0.0, GRB_BINARY, "x");  
GRBVar y = model.addVar(0.0, 1.0, 0.0, GRB_BINARY, "y");  
GRBVar z = model.addVar(0.0, 1.0, 0.0, GRB_BINARY, "z");
```

- model 裡面所使用的 decision variable 需要透過 Gurobi 所提供的函式初始化
- 第一個參數與第二個參數分別代表此變數的上下界
- 第四個參數是這個變數的類型包含：
 - **GRB_CONTINUOUS**: 變數為實數
 - **GRB_INTEGER**: 變數為整數
 - **GRB_BINARY**: 變數為 0/1 變數
- 第五個參數為變數的命名

Example 1: 目標式設定

```
// Set objective: maximize  $x + y + 2z$ 
```

```
model.setObjective(x + y + 2 * z, GRB_MAXIMIZE);
```

- 參數之第一項是 Obj
- 第二項為設定最大化或最小化
 - **GRB_MAXIMIZE**
 - **GRB_MINIMIZE**

Example 1: 限制式設定

```
// Add constraint:  $x + 2y + 3z \leq 4$   
model.addConstr(x + 2 * y + 3 * z <= 4, "c0");  
  
// Add constraint:  $x + y \geq 1$   
model.addConstr(x + y >= 1, "c1");
```

- 參數之第一項是限制式之條件 (\geq , \leq , $=$)
- 第二項為限制式名稱

Example 1: 開始解題

```
// Optimize model
```

```
model.optimize();
```

- 前面所有的程式碼都只是在設定 model 長什麼樣子
- 下達這個指令才會真正開始解題

Example 1: 最佳解變數輸出方法

```
cout << x.get(GRB_StringAttr_VarName) << " "  
      << x.get(GRB_DoubleAttr_X) << endl;  
cout << y.get(GRB_StringAttr_VarName) << " "  
      << y.get(GRB_DoubleAttr_X) << endl;  
cout << z.get(GRB_StringAttr_VarName) << " "  
      << z.get(GRB_DoubleAttr_X) << endl;
```

- 因為使用 **GRB_VAR** 所宣告的 decision variable 無法直接取得內容
- 必須使用 GUROBI 的函式才能拿到值
- **GRB_StringAttr_VarName** 是變數的名字
- **GRB_DoubleAttr_X** 則是變數值

Example 1: 最佳解之目標式值輸出方法

```
cout << "Obj: " << model.get(GRB_DoubleAttr_ObjVal) << endl;
```

- 使用 **GRB_DoubleAttr_ObjVal** 得到最佳解

Example 1: 印出 error code 的方法

```
} catch(GRBException e) {  
    cout << "Error code = " << e.getErrorCode() << endl;  
    cout << e.getMessage() << endl;  
} catch(...) {  
    cout << "Exception during optimization" << endl;  
}
```

- 這段 code 是當 model 有問題時，能夠列出出錯的類型
- error type code 的 解釋

遇到 Σ 時

$$\min \sum_{i=0}^n \sum_{j \neq i, j=0}^n c_{ij} x_{ij}$$

- 方法 1: 寫一大串
- 方法 2: 使用 GRBLinExpr

```
GRBLinExpr sum=0;  
for(int i=1;i<10;i++)  
    sum+=X[i];
```

小技巧

- 除了最常用的 ObjVal 以外
- gurobi 所定義的 model 有許多的 attributes 可以用
- 請參閱 [連結](#)

Example 2 : TSP

$$\begin{aligned} \min & \sum_{i=0}^n \sum_{j \neq i, j=0}^n c_{ij} x_{ij} \\ & 0 \leq x_{ij} \leq 1 & i, j = 0, \dots, n \\ & u_i \in \mathbf{Z} & i = 0, \dots, n \\ & \sum_{i=0, i \neq j}^n x_{ij} = 1 & j = 0, \dots, n \\ & \sum_{j=0, j \neq i}^n x_{ij} = 1 & i = 0, \dots, n \\ & u_i - u_j + nx_{ij} \leq n - 1 \quad 1 \leq i \neq j \leq n \end{aligned}$$