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Exercise (Modeling with Desmos)

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1 Introduction on Desmos
Desmos 簡介

Desmos is an online graphing calculator and a powerful tool for mathematical modeling. This supplementary material is designed to help you understand how to use Desmos effectively for mathematical modeling. You will learn to graph equations, use sliders to explore parameter changes, plot data, and fit models to real-world problems.
Desmos 是一個網上繪圖計算機，也是一個强大的數學建模工具。本補充教材旨在幫助學生了解如何有效使用Desmos 進行數學建模。學生將學習繪畫方程圖像、使用滑桿探索參數變化、繪畫數據點，以及將模型擬合至現實世界的問題。

2 Getting Started with Desmos
Desmos 入門指南

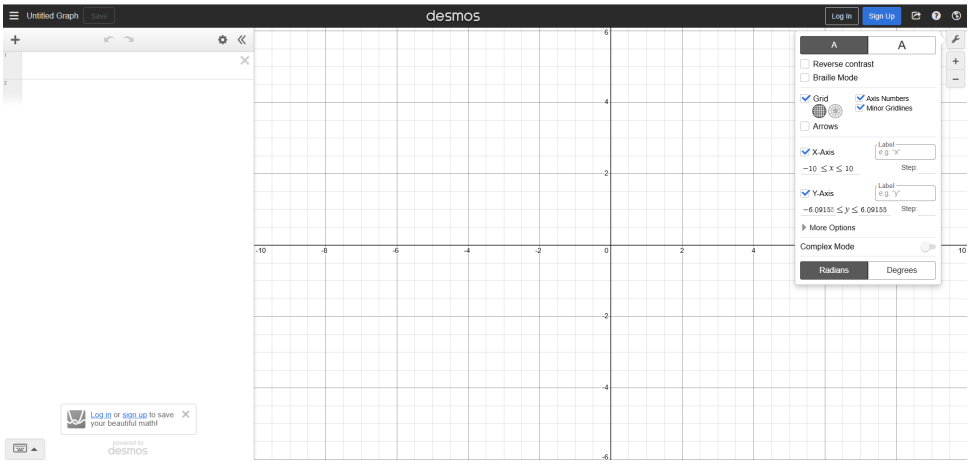
Accessing Desmos
存取Desmos

You can go to https://www.desmos.com/calculator to start using Desmos.
大家可以前往https://www.desmos.com/calculator 開始使用Desmos。

Overview of the interface
介面概述

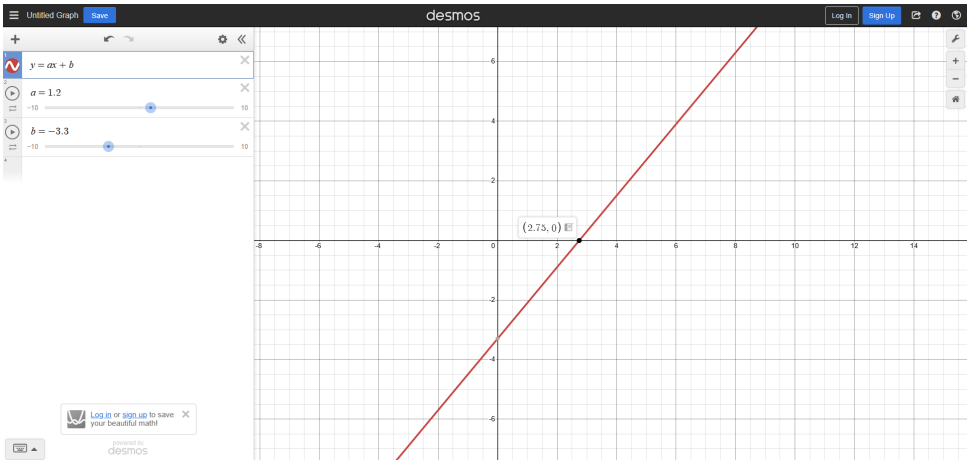
Here you can notice:
界面包含以下部分：

- On the left, we have equation bars for inputting equations and expressions.
  左側為方程欄，我們可以在這裡輸入方程和表達式。
- In the middle, we have the graph window that visualizes the equation.
  中間為圖像窗口，輸入的方程會在這裡顯示出來。
- On the top-right-hand corner, we have the toolbox for different options of the grid.
  右上角為工具箱，我們可以在這裡調整網格的各種設定。



Let's get your hands dirty!
動手練習

Let's try to have our first graph plotting. You can input $y = ax + b$ to the equation bars. Then we can add sliders for variables a and b. By adjusting the values of a and b, different linear equations will be shown in the graph window. You can even pinpoint some of the special points such as the x-intercept and y-intercept too.
現在我們來嘗試繪畫第一個圖像。在方程欄輸入$y = ax + b$，然後為變數a 及b 加入滑桿。通過調整a 及b 的數值，圖像窗口將顯示不同的線性方程。大家也可以嘗試標示一些特殊點，例如x 截距及y 截距。

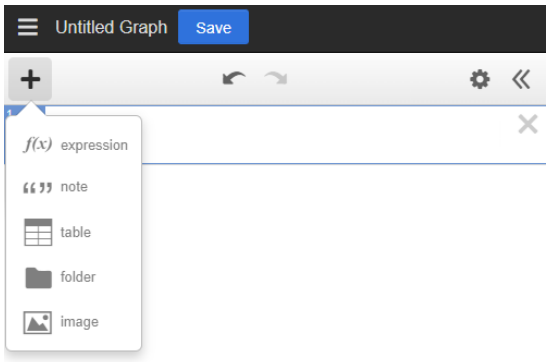


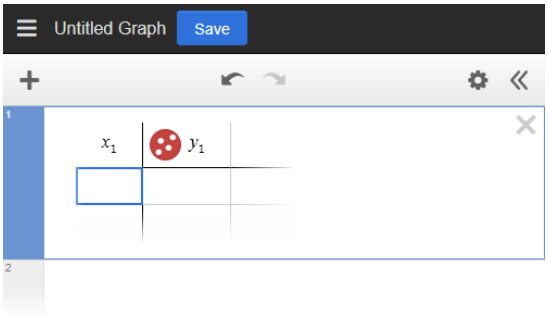
Quick exercise
簡易練習

Also try to plot graphs for quadratic equation $y = ax^2 + bx + c$, exponential equation $y = ae^{bx}$, and trigonometric function $y = asin(bx), y = acos(bx), y = atan(bx)$.
我們也可以嘗試繪畫其他類型的圖像，例如二次方程$y = ax^2+bx+c$、指數方程$y = ae^{bx}$及三角函數$y = a\sin(bx)$、$y = a\cos(bx)$、$y = a\tan(bx)$ 的圖像。

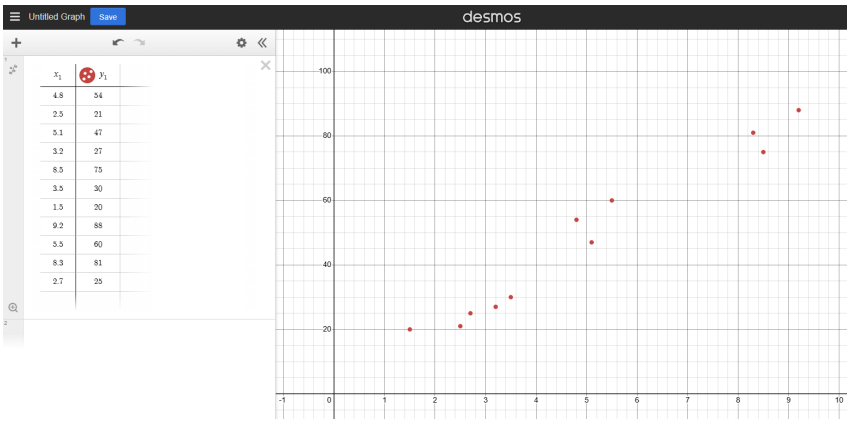
How to apply Desmos to math modeling?
如何將Desmos 應用於數學建模？

Other than directly input functions, we can also use Desmos for different function regressions. But first, we need to input data points. By clicking the plus sign in the top-left-hand corner, we can insert a table for data point input.
除了直接輸入函數外，我們亦可使用Desmos 進行不同的函數迴歸分析。首先需要輸入數據點：點擊左上角的加號，插入一個用於輸入數據點的表格。

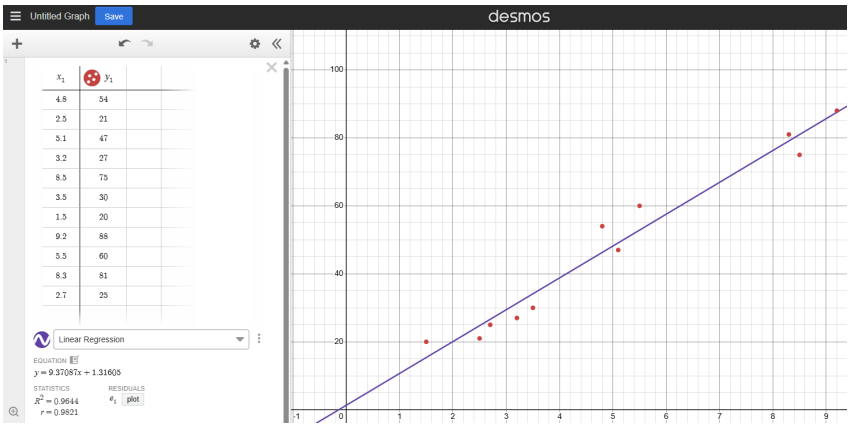




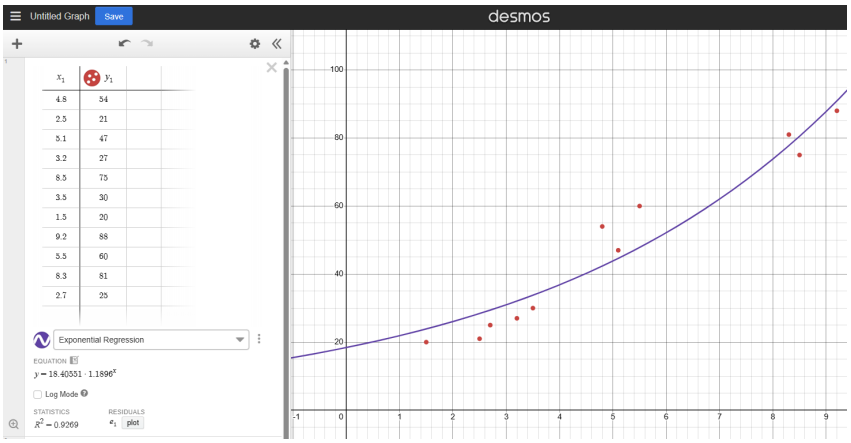
Let's take the data for weekly study hours by students and their scores in an exam as an example. We can input the data as follows:
以學生每週溫習時數與考試成績的數據為例，我們可以這樣輸入數據：



By clicking the icon on the top-left-hand corner, we can add a regression line to the data, and many statistics such as R-square value and residues can be immediately calculated too.
點擊左上角的圖標，可以為數據加入一條迴歸線，系統會即時計算出各種統計數據，例如R 平方值及殘差。



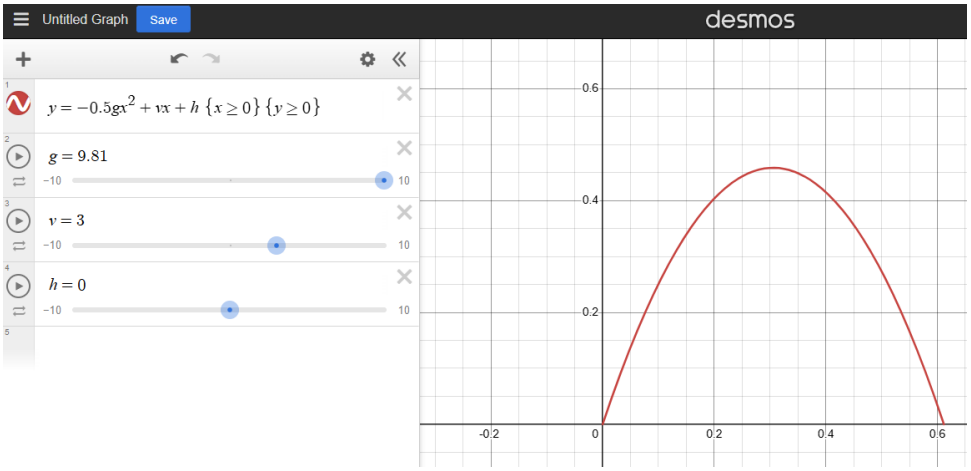
Moreover, we can choose different regression functions to be used as well.
此外，我們亦可以選擇使用不同的迴歸函數。



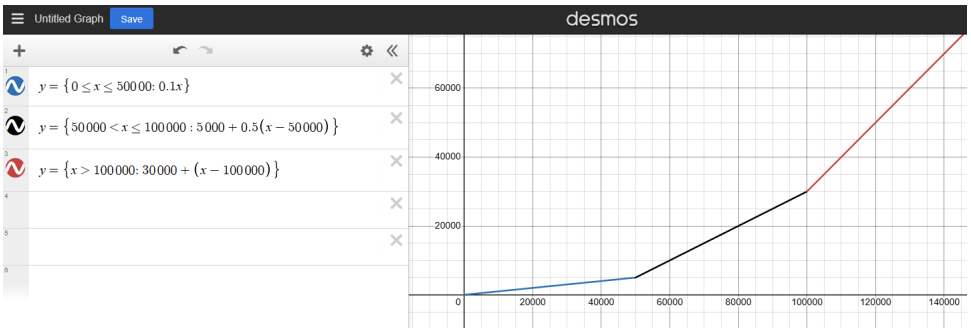
3 More skills and tips on Desmos
更多Desmos 技巧與提示

Here are some tips that you may found useful when using Desmos:
以下是一些使用Desmos 時可能會用到的實用技巧：

1. **Restrictions on functions**
   函數限制
   You can restrict functions in Desmos to model real-world conditions. For example, if you want to model a projectile's motion, you can restrict the time to be no less than zero by specifying the domain.
   我們可以在Desmos 中為函數加上限制以模擬現實情況。例如，若要模擬拋體運動，可以通過設定定義域限制時間不小於零。



2. **Use Piecewise Functions for Complex Scenarios**
   使用分段函數處理複雜情況
   Piecewise functions are ideal for modeling situations with different rules for different intervals. For example, a tax model where different income brackets are taxed at different rates.
   分段函數適合用於建模在不同區間有不同規則的情況。例如，稅務模型中不同收入階層適用不同稅率。



4 Further Readings
延伸閱讀

For more information on regression using Desmos,you can also make reference to the link: https://help.desmos.com/hc/en-us/articles/4406972958733-Regressions
欲了解更多關於使用Desmos 進行迴歸分析的資訊，可參考以下連結：https://help.desmos.com/hc/en-us/articles/4406972958733-Regressions