

THE CHINESE UNIVERSITY OF HONG KONG
Department of Mathematics

Mathematical Modeling Project Team
mathmodel@math.cuhk.edu.hk

Modeling with R Shiny (Find What Fits)

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1 Introduction to the Find What Fits R Shiny tool 找出擬合線R Shiny 工具簡介

R is a powerful statistical programming language that allows us to perform data analysis, which is useful for mathematical modeling. Even better, we have set up a set of online tools using R Shiny so that you can perform various mathematical modelling tasks without any coding background.

R 是一種功能強大的統計程式語言，讓我們能夠進行數據分析，對數學建模十分有用。更理想的是，我們利用R Shiny 建立了一系列線上工具，讓使用者即使不具備程式設計背景，也能夠執行各種數學建模任務。

The Find What Fits R Shiny tool provides an interactive way to explore different definitions of a “best-fit” line. Rather than assuming that there is only one way to define the best fit, the tool allows users to investigate different criteria for determining how well a line fits a set of data points.

找出擬合線R Shiny 工具提供了一個互動式平台，讓使用者探索「最佳擬合」線的不同定義。工具並不假設最佳擬合只有唯一的定義，而是讓使用者探討不同的準則，以決定一條直線與一組數據點的擬合程度。

The tool contains four questions based on different datasets and situations. By considering the possible meanings of a best-fit line in each question, users can develop a better understanding of data fitting and the role of context in mathematical modelling. 工具包含四個問題，分別基於不同的數據集及情境。透過思考每個問題中「最佳擬合」線的不同可能含義，使用者可以更深入理解數據擬合，以及情境在數學建模中的作用。

2 Using the Find What Fits R Shiny tool 使用找出擬合線R Shiny 工具

To use the tool, please visit our main website:
如要使用此工具，可前往我們的主網站：

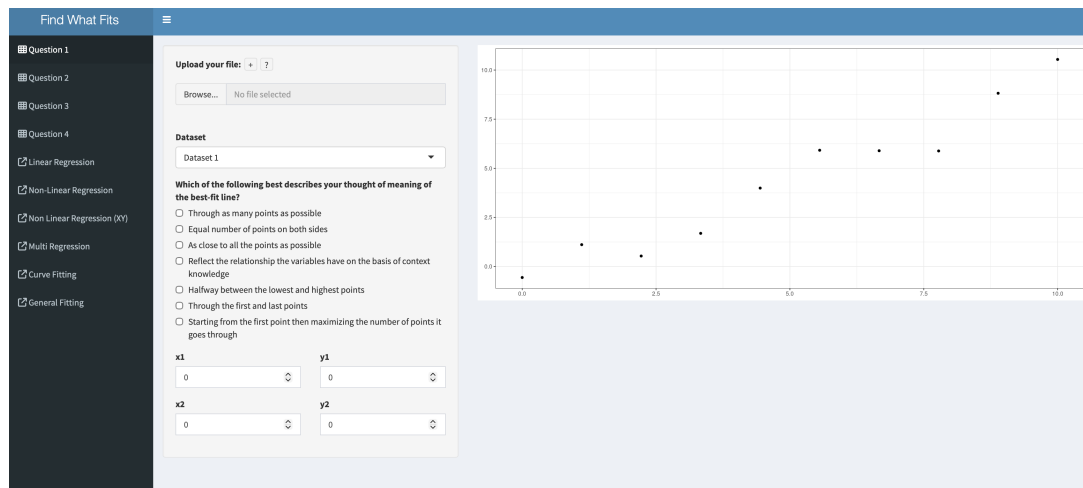
<https://cuhkmathmodel.com/>

for the list of tools, or simply go to
瀏覽工具列表，或直接前往

<https://mathmodelcuhk.shinyapps.io/find-what-fit/>

for the Find What Fits R Shiny tool.
使用找出擬合線R Shiny 工具。

After getting into the website, you can see the following:
進入網站後，你會看到以下畫面：



Don't worry if you think this is complicated! We will guide you step by step, and you can the best fit line using our R Shiny tool.
如果你覺得這個界面有點複雜，不用擔心！我們會逐步引導你，讓你能夠順利使用我們的R Shiny 工具找出最佳擬合線。

2.1 Exploring different definitions of “best-fit”

探索「最佳擬合」的不同定義

When a set of data points is given, we may want to find a line that represents the data as well as possible. However, the meaning of “as well as possible” depends on how the quality of the fit is defined. Different definitions of “best-fit” may therefore lead to different lines. 當給定一組數據點時，我們可能希望找出一條能夠盡可能代表數據的直線。然而，「盡可能代表」的具體含義取決於我們如何定義擬合的優劣。因此，不同的「最佳擬合」定義可能會得到不同的直線。

The Find What Fits tool provides several questions that allow users to investigate this idea interactively. By exploring the questions and comparing the resulting lines, users can develop a better understanding of what it means for a line to be a “best fit”. Find What Fits 工具提供多個問題，讓使用者以互動方式探索這個概念。透過探索不同問題並比較所得的直線，使用者可以更深入理解一條直線成為「最佳擬合」線究竟代表甚麼。

2.2 Using the Find What Fits R Shiny tool

使用Find What Fits R Shiny 工具

The tool contains a series of questions for exploring different interpretations of a best-fit line. Select a question from the menu and follow the instructions displayed on the page. The corresponding graph or interactive elements can then be used to investigate the definition of best fit.

工具包含一系列問題，用於探索「最佳擬合」線的不同理解方式。從選單中選擇問題，並按照頁面上的指示進行操作。使用者可以透過相應的圖表或互動式元素，探索最佳擬合的定義。

By changing the relevant settings and observing the resulting changes, users can compare different possible criteria for determining whether a line provides a good fit to the data. 透過改變相關設定並觀察所得結果的變化，使用者可以比較不同的準則，以了解如何判斷一條直線是否能夠良好地擬合數據。

2.3 Question 1

問題一

For Question 1, users can upload their own data or select a dataset from “Dataset 1” to “Dataset 4”.

在問題一中，使用者可以上傳自己的數據，或從「Dataset 1」至「Dataset 4」中選擇一組數據。

Upload your file:

No file selected

Dataset

Dataset 1

Dataset 1

Dataset 2

Dataset 3

Dataset 4

☐ AS close to all the points as possible

☐ Reflect the relationship the variables have on the basis of context knowledge

☐ Halfway between the lowest and highest points

☐ Through the first and last points

☐ Starting from the first point then maximizing the number of points it goes through

x1

0

y1

0

x2

0

y2

0

The tool then asks:

工具會提出以下問題：

Which of the following best describes your thought of meaning of the best-fit line?

The descriptions include:

描述包括：

- Through as many points as possible
通過盡可能多的數據點
- Equal number of points on both sides
線的兩側有相同數量的數據點
- As close to all the points as possible
盡可能接近所有數據點
- Reflect the relationship the variables have on the basis of context knowledge
根據情境知識反映變量之間的關係
- Halfway between the lowest and highest points
位於最高點與最低點之間的中間位置
- Through the first and last points
通過第一個及最後一個數據點
- Starting from the first point then maximizing the number of points it goes through
從第一個數據點開始，然後使直線通過盡可能多的數據點

Select the description that best represents your current understanding of a best-fit line. After selecting a conceptual definition, the tool will draw the corresponding line on the

scatter plot, allowing users to visually evaluate whether the displayed line matches their chosen definition of “best-fit”.

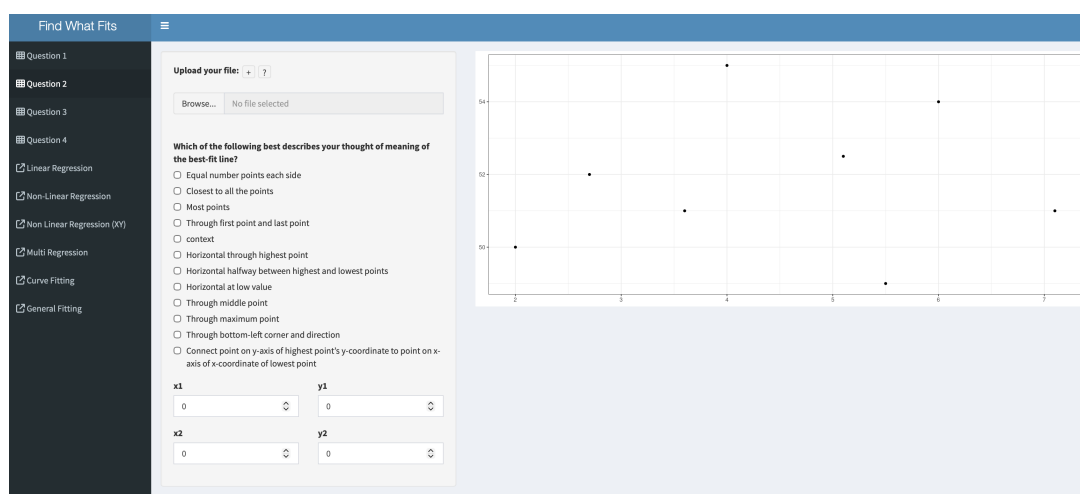
選取概念定義後，工具會在散佈圖上繪製出對應的直線，讓使用者直觀地評估顯示的直線是否符合其所選的「最佳擬合」定義。

2.4 Question 2

問題二

Question 2 provides another dataset and asks users to consider what they think a best-fit line should represent. Users can upload their own data and choose from several possible descriptions.

問題二提供另一組數據，讓使用者思考「最佳擬合」線應該代表甚麼。使用者可以上傳自己的數據，並從多個可能的描述中進行選擇。



The descriptions include:
描述包括：

- Equal number points each side
線的兩側有相同數量的數據點
- Closest to all the points
盡可能接近所有數據點
- Most points
通過最多數據點
- Through first point and last point
通過第一個及最後一個數據點
- Context
根據情境
- Horizontal through highest point
通過最高點的水平線
- Horizontal halfway between highest and lowest points
位於最高點與最低點之間中間位置的水平線

- Horizontal at low value
位於較低數值的水平線
- Through middle point
通過中間的數據點
- Through maximum point
通過最高點
- Through bottom-left corner and direction
從左下角的數據點開始並沿相應方向延伸
- Connect point on y-axis of highest point's y-coordinate to point on x-axis of x-coordinate of lowest point
將 y 軸上與最高點 y 座標相同的點，連接至 x 軸上與最低點 x 座標相同的點

These choices illustrate that a “best-fit” line may be interpreted in many different ways when looking at a graph. Users can compare these descriptions and consider which interpretation they would naturally use.

這些選項展示了在觀察圖表時，「最佳擬合」線可以有許多不同的理解方式。使用者可以比較這些描述，並思考自己直觀上會採用哪一種理解。

2.5 Question 3 問題三

Question 3 provides another dataset and asks users to select the description that best matches their understanding of a best-fit line.

問題三提供另一組數據，讓使用者選擇最符合自己對「最佳擬合」線理解的描述。

The screenshot shows the 'Find What Fits' interface. On the left is a sidebar with a list of questions and regression types. The main area displays a scatter plot with approximately 10 data points. Below the plot is a form with the following elements:

- Upload your file:** A button labeled 'Browse...' and a status 'No file selected'.
- Dataset:** A dropdown menu currently showing 'Dataset 1'.
- Which of the following best describes your thought of meaning of the best-fit line?** A list of 11 radio button options:
 - ☐ Most points
 - ☐ Through origin and last point
 - ☐ Through origin and most points
 - ☐ Through first point and last point
 - ☐ Equal number points each side
 - ☐ Closest to all the points
 - ☐ Horizontal through highest point
 - ☐ Horizontal at average of y-variable
 - ☐ Through middle point, intersect middle of x-axis
 - ☐ Vertical to hit x-axis at value of lowest point, upper end across from highest point
- Coordinates:** Four input fields labeled x1, y1, x2, and y2, each with a '0' value and a small circular icon to its right.

The possible descriptions include:
描述包括：

- Most points
通過最多數據點
- Through origin and last point
通過原點及最後一個數據點

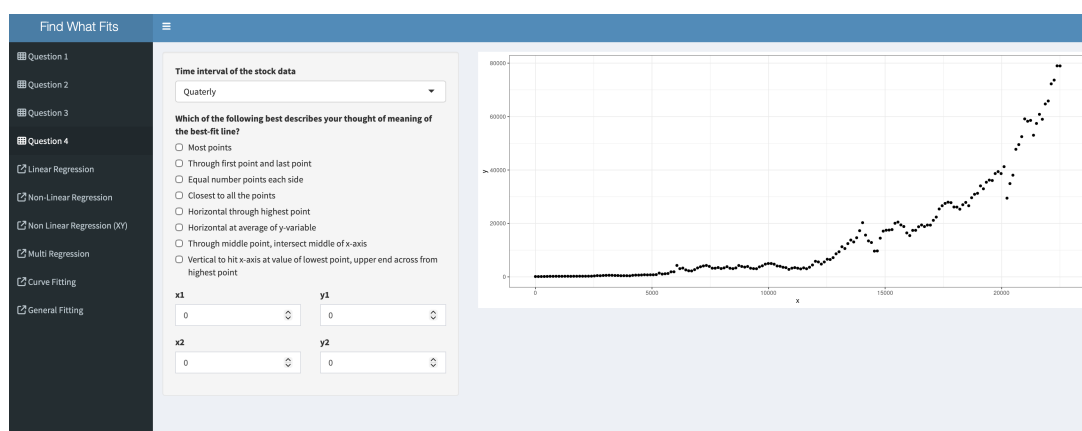
- Through origin and most points
通過原點及最多數據點
- Through first point and last point
通過第一個及最後一個數據點
- Equal number points each side
線的兩側有相同數量的數據點
- Closest to all the points
盡可能接近所有數據點
- Horizontal through highest point
通過最高點的水平線
- Horizontal at average of y -variable
位於 y 變量平均值的水平線
- Through middle point, intersect middle of x -axis
通過中間數據點，並與 x 軸的中間位置相交
- Vertical to hit x -axis at value of lowest point, upper end across from highest point
垂直於 x 軸，並以最低點的 x 值作為位置，上端與最高點相對

The different choices allow users to compare several possible geometric interpretations of a fitted line, including interpretations involving the origin, extreme points, the middle of the data, and the average value of the response variable.

不同的選項讓使用者可以比較多種對擬合線的幾何理解方式，包括涉及原點、極值點、數據中間位置及應變量平均值等不同概念。

2.6 Question 4 問題四

Question 4 uses stock data and allows users to select the time interval of the data.
問題四使用股票數據，並讓使用者選擇數據的時間間隔。



The available choices are:
可選的時間間隔包括：

- Daily (日)
- Weekly (週)
- Monthly (月)
- Quarterly (季度)
- Yearly (年)

After selecting the time interval, users are asked to consider which description best represents their understanding of a best-fit line.

選擇時間間隔後，使用者需要思考哪一種描述最符合自己對「最佳擬合」線的理解。

The descriptions include:

描述包括：

- Most points
通過最多數據點
- Through first point and last point
通過第一個及最後一個數據點
- Equal number points each side
線的兩側有相同數量的數據點
- Closest to all the points
盡可能接近所有數據點
- Horizontal through highest point
通過最高點的水平線
- Horizontal at average of y -variable
位於 y 變量平均值的水平線
- Through middle point, intersect middle of x -axis
通過中間數據點，並與 x 軸的中間位置相交
- Vertical to hit x -axis at value of lowest point, upper end across from highest point
垂直於 x 軸，並以最低點的 x 值作為位置，上端與最高點相對

The use of stock data provides an opportunity to consider how the meaning of a best-fit line may depend on the context and the time scale of the data.

使用股票數據可以讓使用者進一步思考，「最佳擬合」線的含義是否會受到數據情境及時間尺度的影響。

2.7 Comparing different interpretations 比較不同的理解方式

Across the four questions, the tool presents a variety of possible interpretations of a “best-fit” line. These include maximizing the number of points on the line, keeping similar numbers of points on both sides, minimizing the distance from the line to the data points, connecting selected points, and considering the context of the variables.

在四個問題中，工具展示了多種對「最佳擬合」線的可能理解方式，包括使直線通過最多數據點、使直線兩側具有相近數量的數據點、減少直線與數據點之間的距離、連接特定數據點，以及考慮變量所處的情境。

The questions are designed to encourage users to think about what “best fit” means rather than simply applying a predefined formula. Different interpretations can lead to different candidate lines, so the meaning of “best” should be considered carefully in the context of a modelling problem.

這些問題旨在鼓勵使用者思考「最佳擬合」究竟代表甚麼，而不是單純套用預先定義的公式。不同的理解方式可能會導致不同的候選直線，因此在數學建模問題中，需要仔細考慮「最佳」的具體含義。

3 Related fitting tools 相關擬合工具

The tool also provides links to other R Shiny tools for further exploration of data fitting and regression. These include Linear Regression, Non-Linear Regression, Non-Linear Regression (XY), Multi Regression, Curve Fitting, and General Fitting.

工具亦提供連結至其他R Shiny 工具，讓使用者進一步探索數據擬合及迴歸分析，包括線性迴歸、XY數據非線性迴歸、非線性迴歸、多元線性迴歸、曲線擬合及通用擬合。

After exploring the meaning of a best-fit line, users can use these tools to investigate different regression and curve fitting methods in greater detail.

在探索「最佳擬合」線的含義後，使用者可以使用這些工具進一步研究不同的迴歸及曲線擬合方法。

4 Conclusion 總結

A “best-fit” line does not have meaning without a criterion for deciding what “best” means. By exploring different possible definitions and considering different datasets and contexts, we can better understand the ideas behind data fitting and mathematical modelling. We hope that this R Shiny Find What Fits tool may help you think critically about how a fitting model should be chosen. Good luck!

「最佳擬合」線的含義取決於我們如何定義「最佳」。透過探索不同的可能定義，並考慮不同的數據集及情境，我們可以更深入理解數據擬合及數學建模背後的概念。我們衷心希望這個R Shiny 找出擬合線工具能夠幫助你以更具批判性的方式思考應如何選擇擬合模型。祝你一切順利！