統計諮詢

Fall 2025

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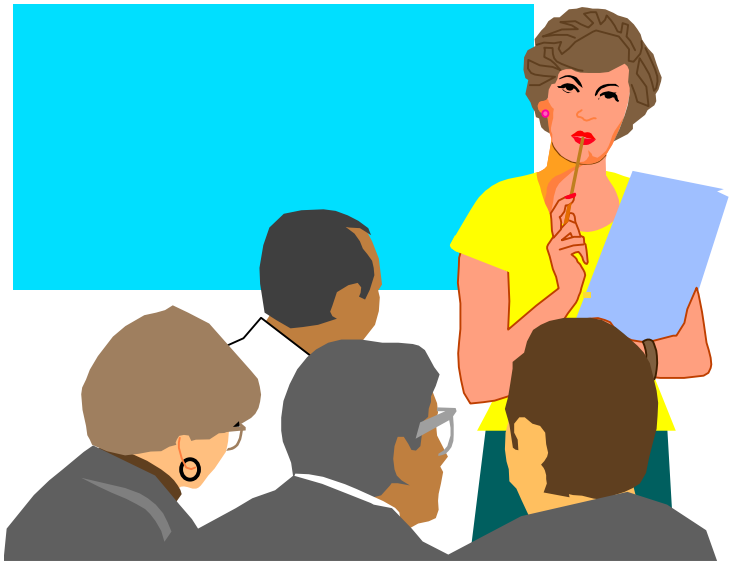
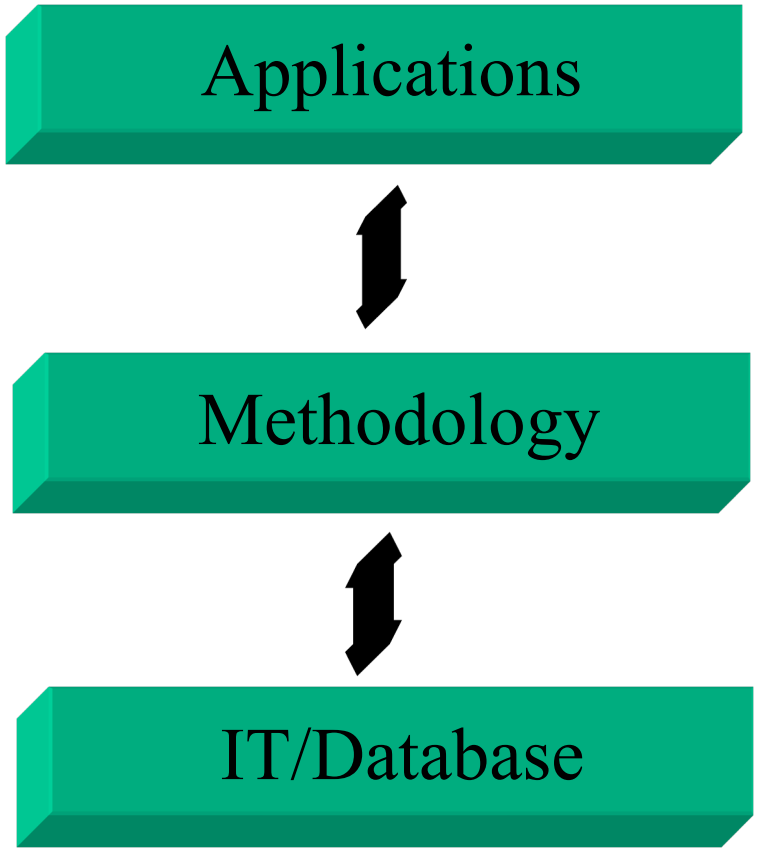
日期：2025年9月18日

第三週：定義問題



統計與實務應用

- 統計分析與方法論（Methodology或Model Construction）有關，需要配合應用領域的專業知識以及相關的資料庫。



統計扮演的角色

- 不少人認為統計是很好用的工具，透過分析及推理可以找出資料潛在的價值。

→統計只能扮演工具的角色嗎？

→統計是數學的分枝嗎？（主要差異？）

- 統計是一門科學，有哪些主特色？

→假設檢定、型一及型二誤差等如何詮釋？

註：近年有些學門提議廢除p-value，認為這些數值只會扭曲事實，你/妳覺得呢？

	有病者	無病者
檢驗結果 陽性 +	真陽性 a	偽陽性 c
檢驗結果 陰性 -	偽陰性 b	真陰性 d

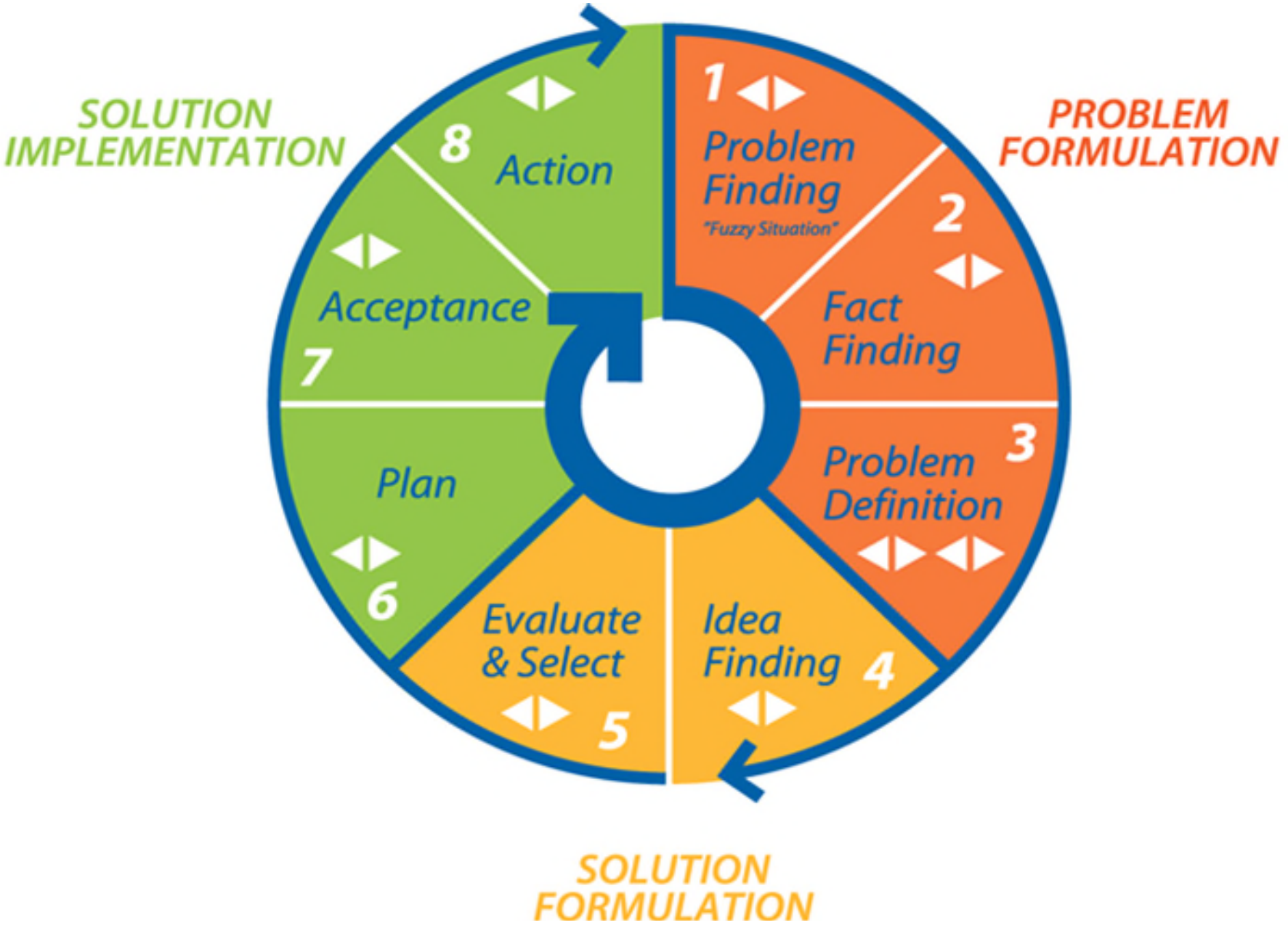
https://epaper.ntuh.gov.tw/health/201606/images/health_5_clip_image002.jpg

敏感性 $= \frac{a}{a+b}$ · 真陽性率：有病者檢驗結果為陽性的比率

特異性 $= \frac{d}{c+d}$ · 真陰性率：無病者檢驗結果為陰性的比率

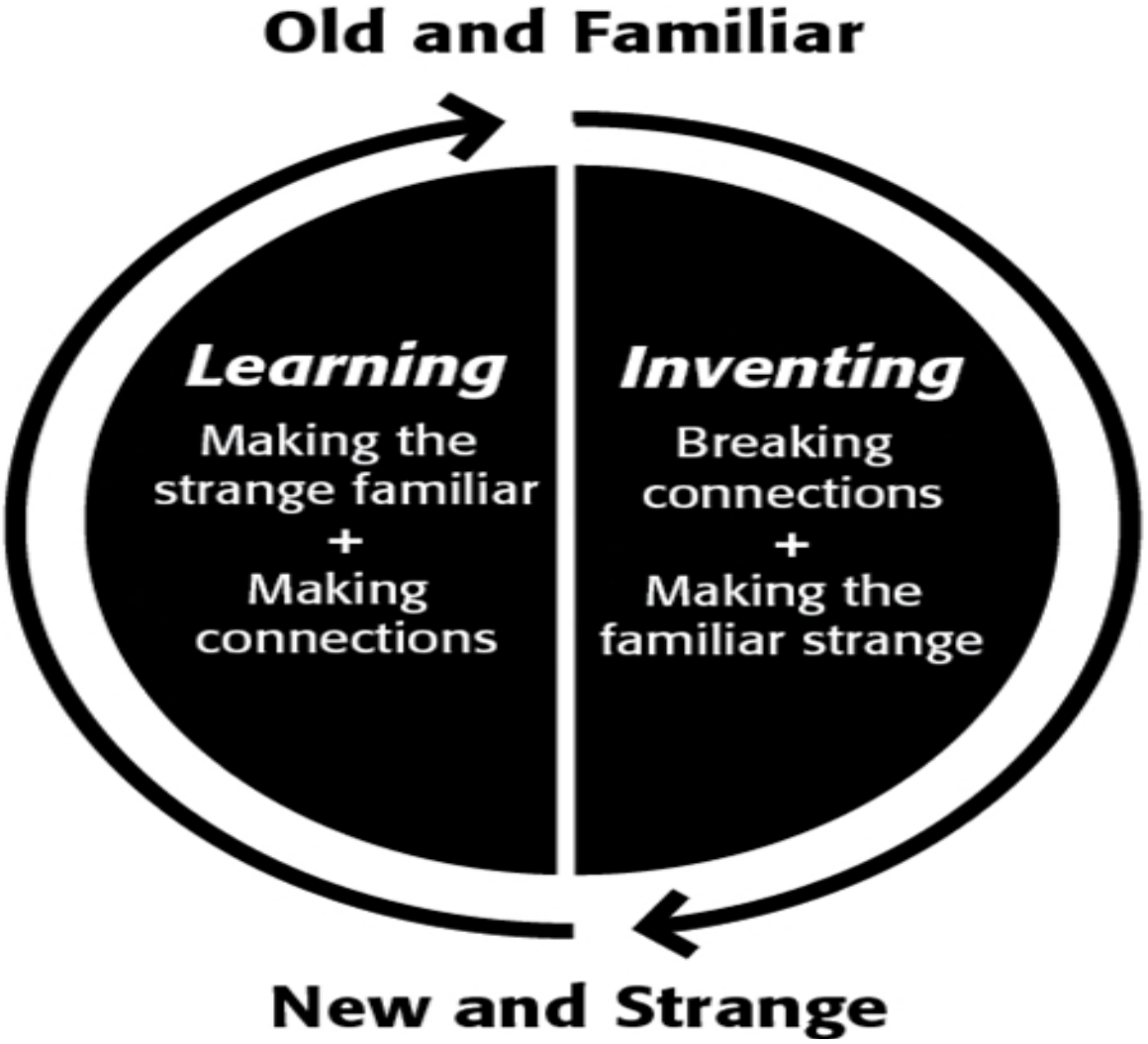
虛無假設H_0為沒病，偽陽性為型一誤差、偽陰性為型二誤差。

- 型一誤差(Type-1 Error)等於P(拒絕H_0|H_0為真)
- 型二誤差(Type-2 Error)等於P(不拒絕H_0|H_0不為真)



http://www.basadur.com/insightsresearch/OurThoughtsonCreativityandInnovation/TheProcessofInnovationLearningandInventing/tabid/168/Default.aspx

Two Halves of Simplexity Thinking: A Continuous Process of Inventing and Learning



http://www.basadur.com/insightsresearch/OurThoughtsonCreativityandInnovation/TheProcessofInnovationLearningandInventing/tabid/168/Default.aspx

如何定義決定一切

- Rittel and Webber (1973) suggests that

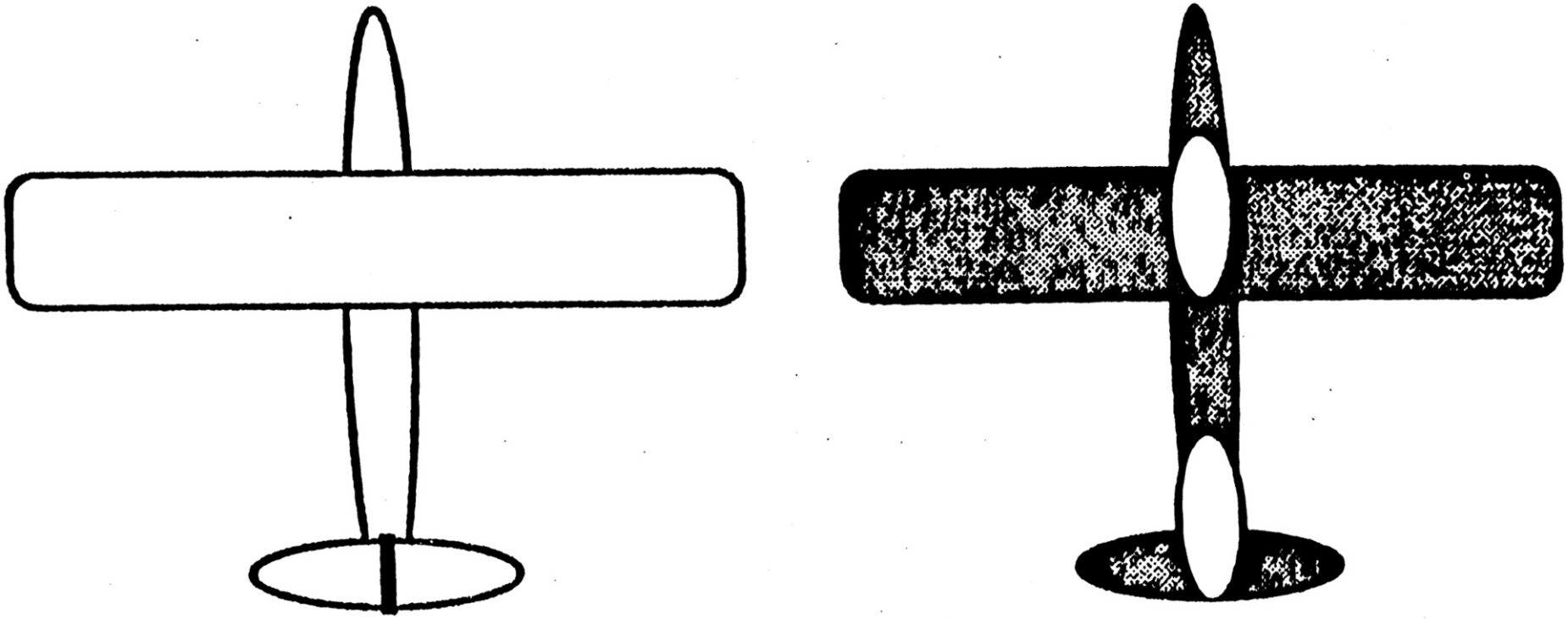
→The process of formulating the problem and of conceiving a solution..... are identical, since every specification of the problem is a specification of the direction in which a treatment is considered.

註：A problem's definition determines the solution space.

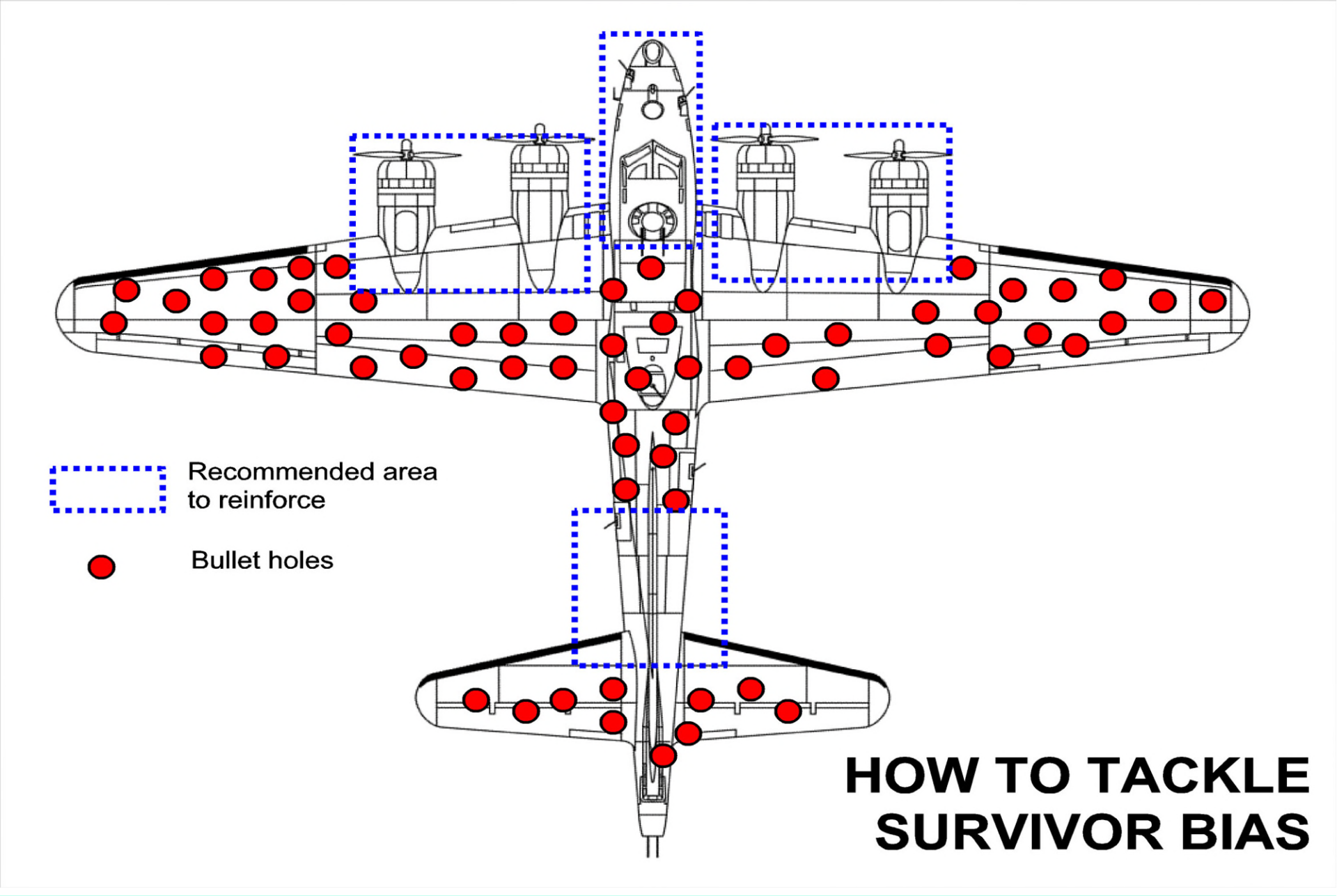
有趣(或殘酷)的範例

- 教授及其學生到阿拉斯加探勘，在一望無際的冰原上被北極熊追殺。眼看即將被追到，學生趕緊換上球鞋，教授說：「換上球鞋也跑不過北極熊。」學生卻說：「我不必跑贏北極熊，只要跑贏你就夠了。」

→ 真正的問題是甚麼？



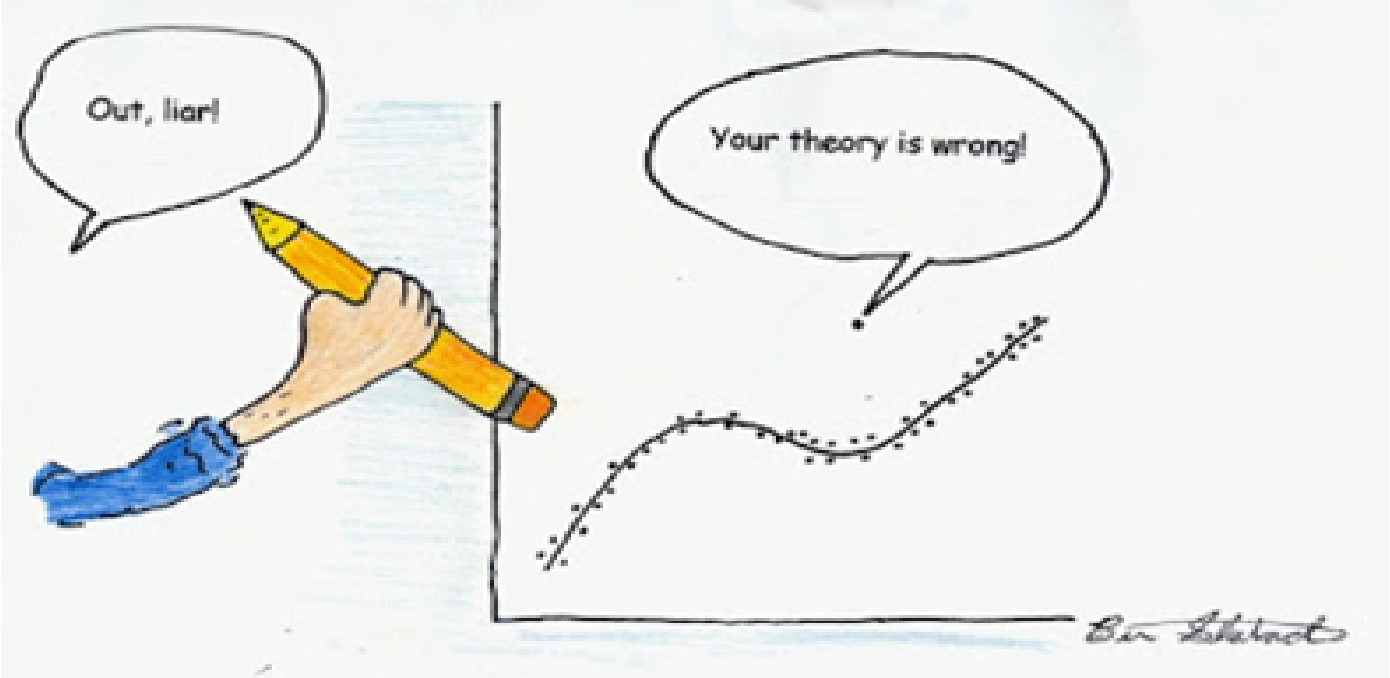
A graphical depiction of ***Wald's bullethole*** *data.*



倖存者偏差（Survivorship Bias）

倖存者偏差(Survivorship Bias)

- 有時無法確定蒐集到局部或全體資料，檢查是否存在倖存者偏差(谷歌流感趨勢預測)；有為了省事與得到漂亮結果，而移除離群值！



解決問題(Problem Solving)的流程

定 義 問 題

↓

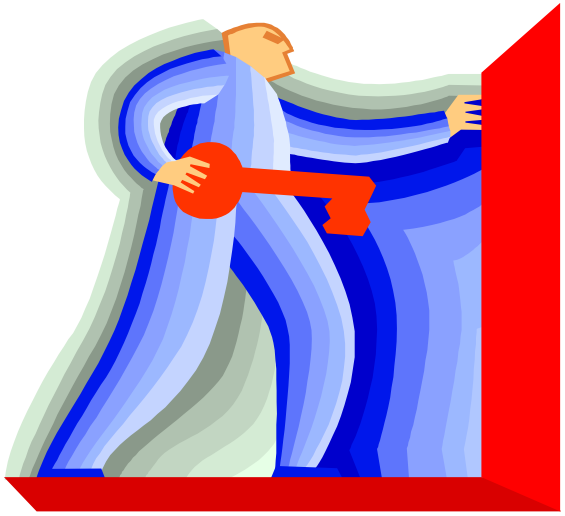
蒐 集 資 料

↓

分 析 資 料

↓

詮 釋 結 果



絕大多數
（統計）教學重心

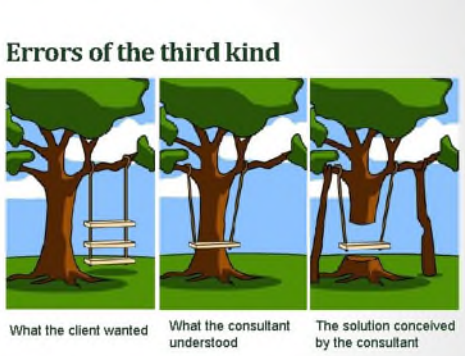
定義問題(Problem Definition)

「正確問題的近似答案，遠比錯誤問題的精確答案有價值。」

"An approximate answer to the right question is worth a great deal more than a precise answer to the wrong problem."

--- the first golden rule of applied mathematics

https://slidetodoc.com/sdasa-oneday-conference-best-practices-in-statistical-consulting/



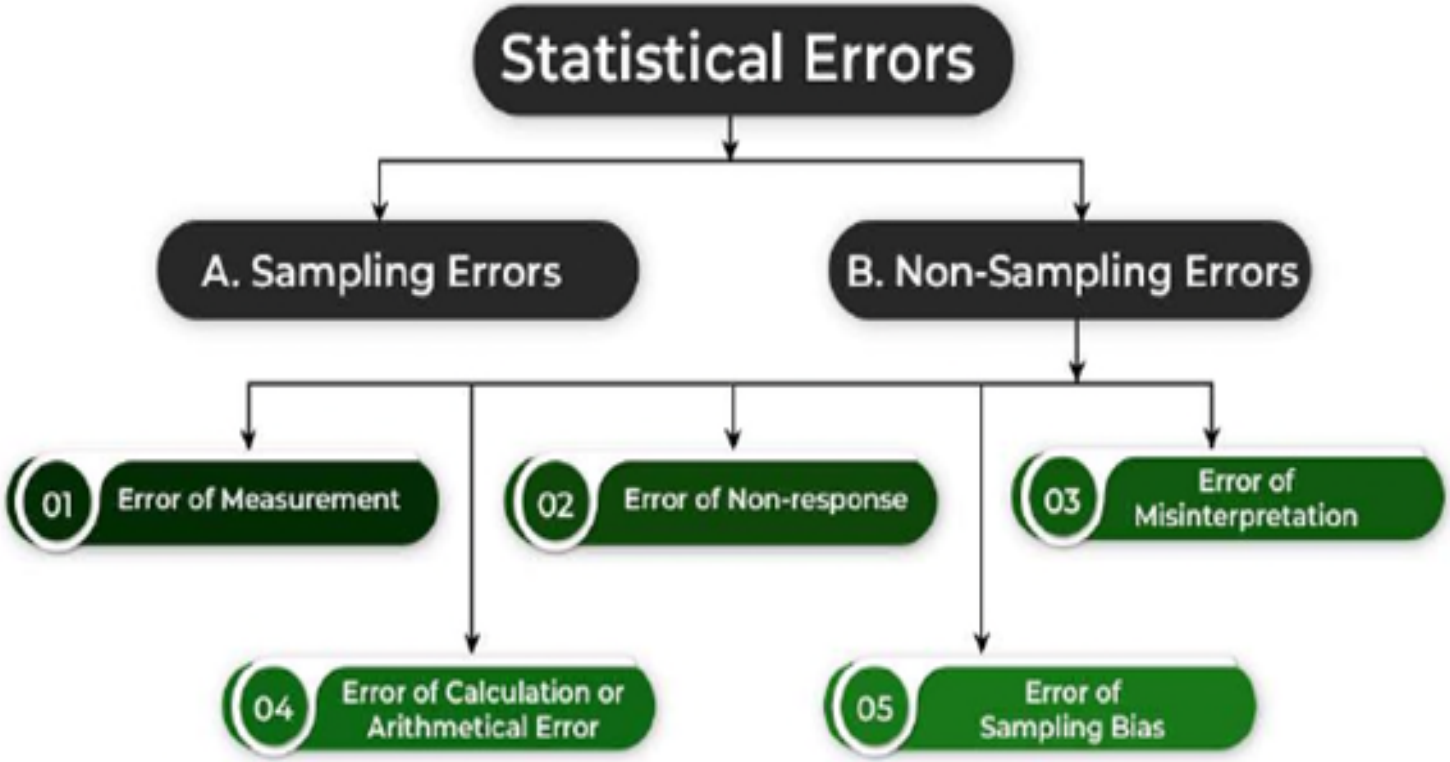
統計的第三型誤差

- Type III error (error of the third kind):
  → Giving the "right" answer to the wrong question (Kimball, 1957)

A simple and almost ludicrous definition of *the error of the third kind* is *the error committed by giving the right answer to the wrong problem*. In defining it this way we are allowing the statistician the benefit of the doubt by rejecting the possibility that he would give the wrong answer to the wrong question. We are also protecting ourselves against the occurrence of a false positive, that is, the situation in which the wrong answer to the wrong problem turns out to be the right answer to the right problem.

What are Statistical Errors?

The errors which are occurred while collecting data are known as **Statistical Errors.** These are dependent on the sample size selected for the study. There are two types of Statistical Errors; viz., **Sampling Errors** and **Non-Sampling Errors.**



https://www.geeksforgeeks.org/data-science/what-are-statistical-errors/

統計大師的建議

- John Tukey: “An approximate answer to the right question is worth a great deal more than a precise answer to the wrong question”

→Q: Check EDA (Exploratory Data Analysis)

- George Box: “All models are wrong; but some are useful.”

→Q: Check Box-Cox transformation

另一個定義問題的範例

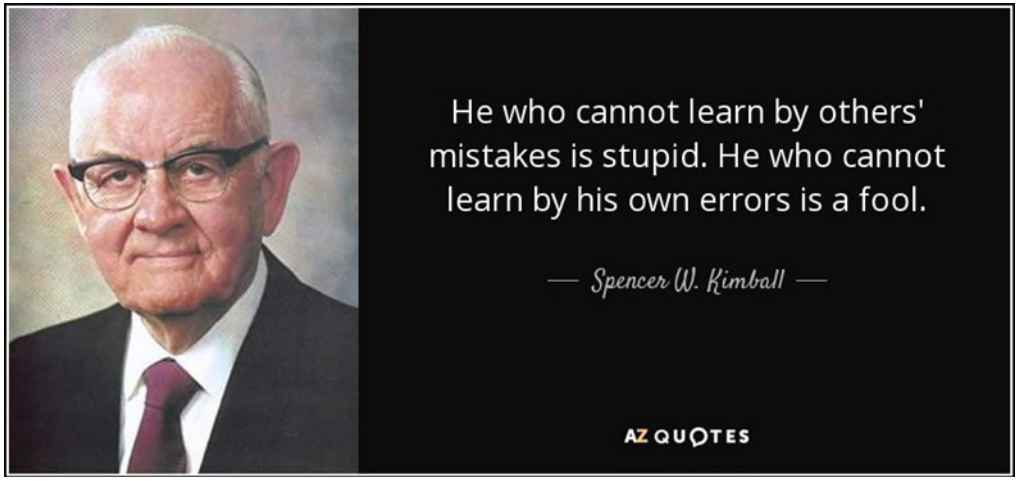
- 某家旅館重新整修內部，將客房數增為原先的1.25倍，但電梯數維持不變，房客因等待時間增長而抱怨連連。

解決方案：

→ 增加電梯數？

→ 加快電梯速度？

→ 電梯門加設鏡子？



https://www.azquotes.com/quote/916594

政治大學商學院電梯改善方案

- 對於商學院電梯使用的缺點，有47%的同學認為「未顯示樓層」是最大缺點，其次是「速度太慢」，有29%的比例。

→樓層顯示版整棟總價至少約50萬台幣(需再加大理石牆壁施工費用)

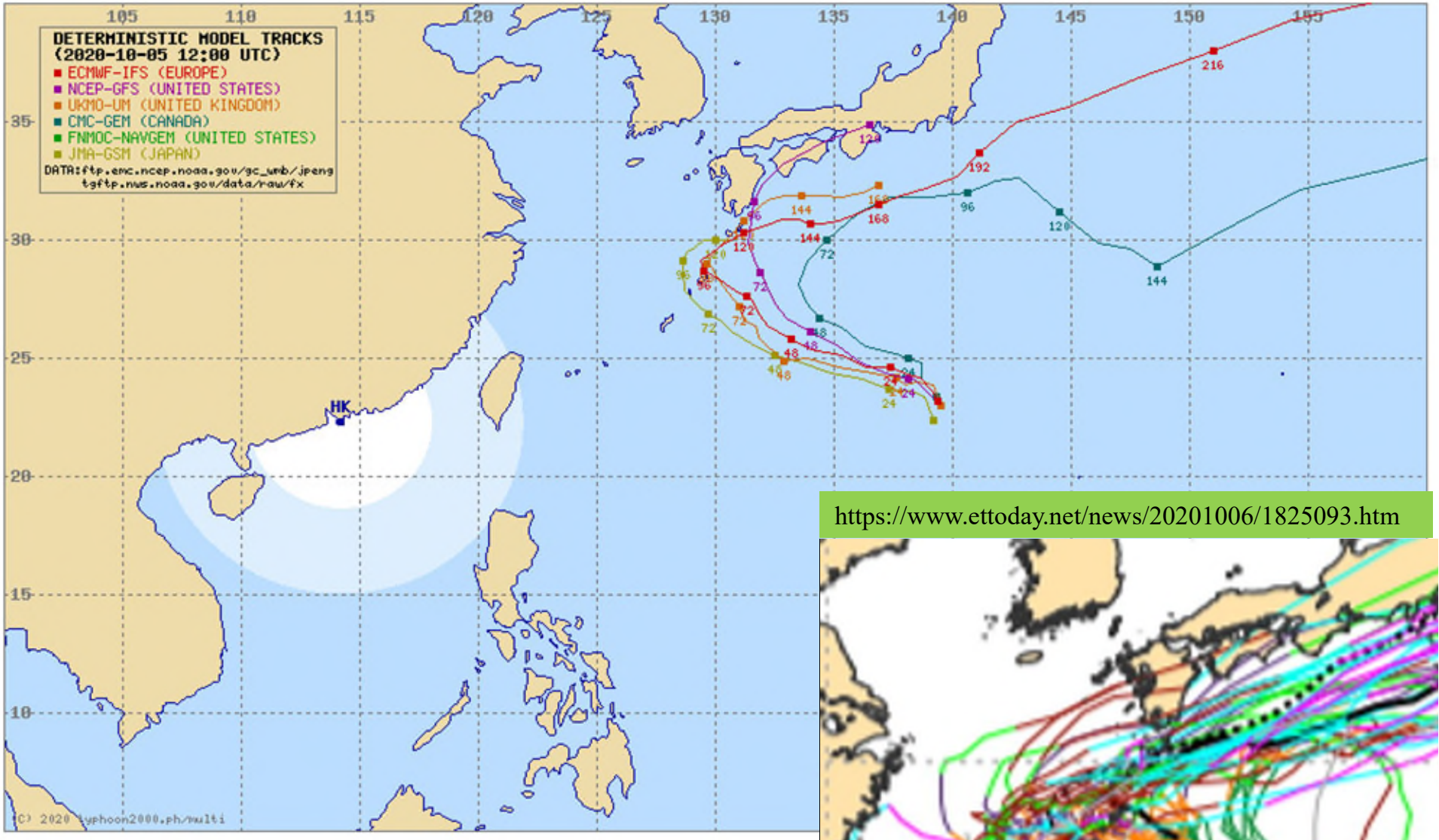
→電梯速度無法調整加快

- 哪些問題可能改善？

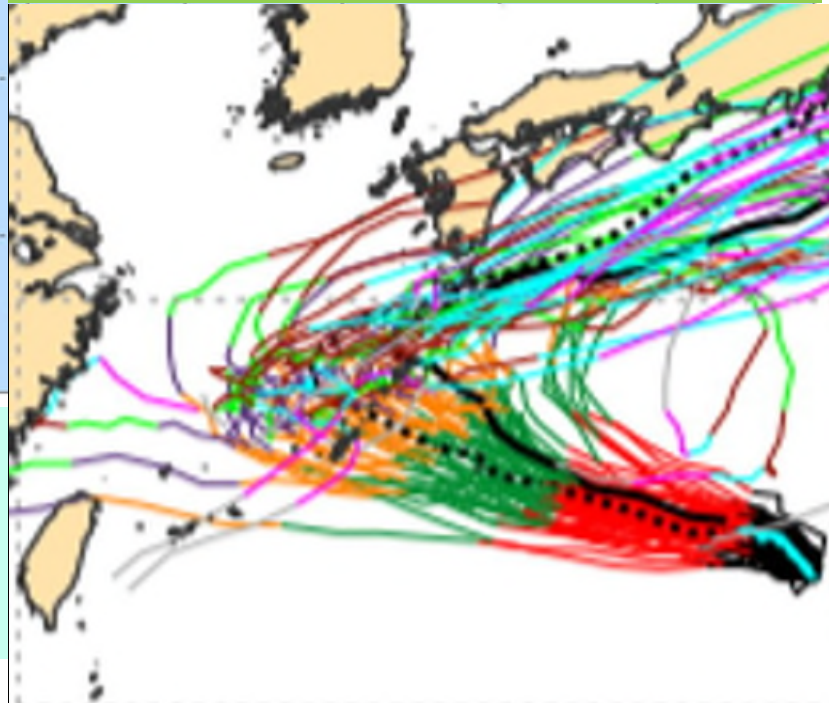
真正的問題在哪裡？

- 有時呈現在表面的因素並非造成問題的實際原因，解決方案需從另一方向或更深層的部分去探索。
- 討論：近來關於氣象預測的話題(尤其是預測的準確性)廣為大家討論，請問你/妳覺得問題為何？

  → 如何解決？

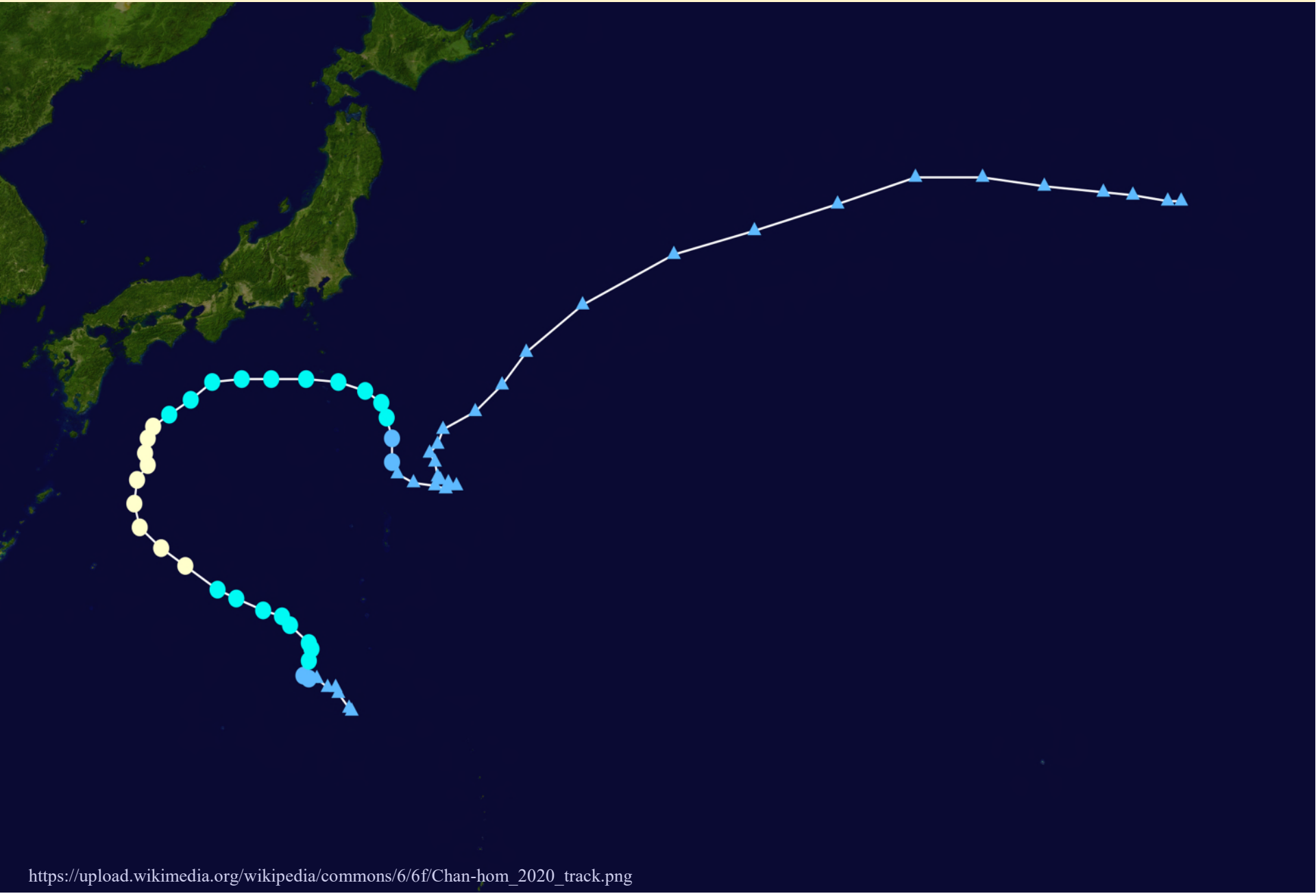


https://www.ettoday.net/news/20201006/1825093.htm



2020年10月 昌鴻颱風
「鞍形場」成關鍵！

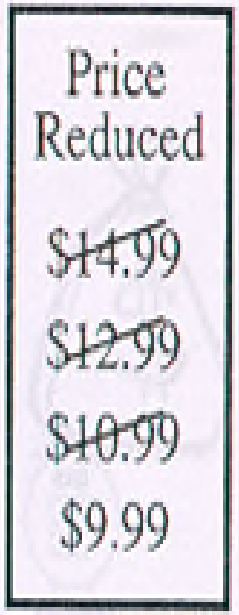
2020年10月 昌鴻颱風路徑



https://upload.wikimedia.org/wikipedia/commons/6/6f/Chan-hom_2020_track.png

Bargain Prices

The Situation: A local merchant on Main Street in Ann Arbor was having difficulty selling a health food mix from the rain forest called Rain Forest Crunch, which was a hot selling item in other stores. Part of the attractiveness of Rain Forest Crunch was that it was indeed from the Brazilian rain forest and part of the proceeds of the sale went to protect the rain forest. The instructions given by the store manager: *"Lower the price of the item to increase sales."* Rain Forest Crunch still did not sell. The manager lowered the price further. Still no sales. After lowering the price two more times to a level that was well below the competitors', the item still did not sell. Finally, the manager walked around the store, and studied the display of Rain Forest Crunch. Then the real problem was uncovered. The problem was not the high cost of the item; the **real problem** was that it was not in a prominent position in the store to be easily seen by the customers. Once the item was made more visible, sales began to soar.[4]



Face the Reality?

- 美國某家石油公司以管線的方式將阿拉斯加的天然氣輸往本土，但因天然氣中含有腐蝕性物質(二氧化硫)，連接管線間的測量表常遭腐蝕，造成天然氣外洩，該公司必須派人不定時檢修量表。

→該公司希望研發耐腐蝕的量表，但橡膠墊片會與二氧化硫作用。

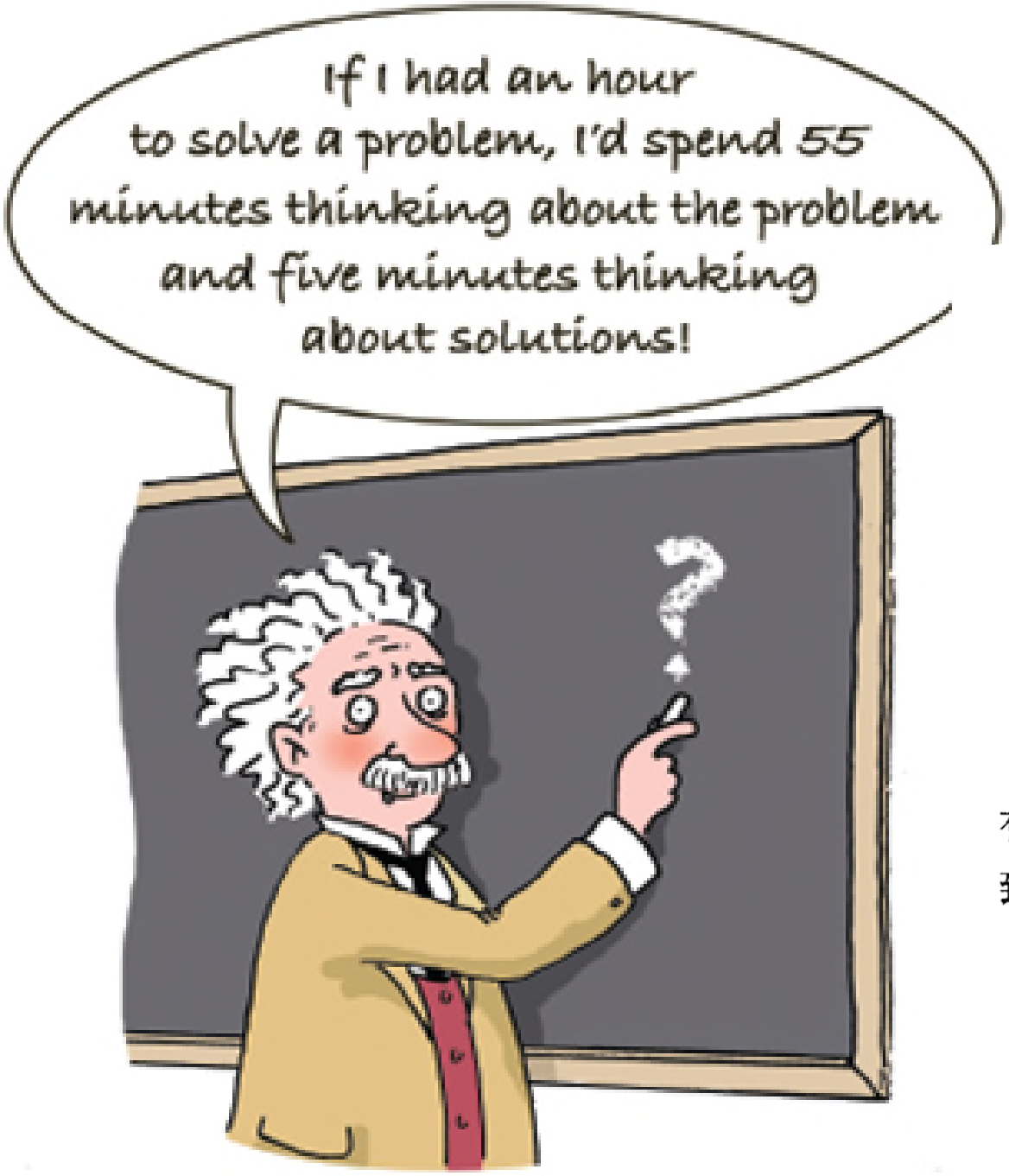
"Uh, yeah, Homework Help Line? I need to have you explain the quadratic equation in roughly the amount of time it takes to get a cup of coffee."

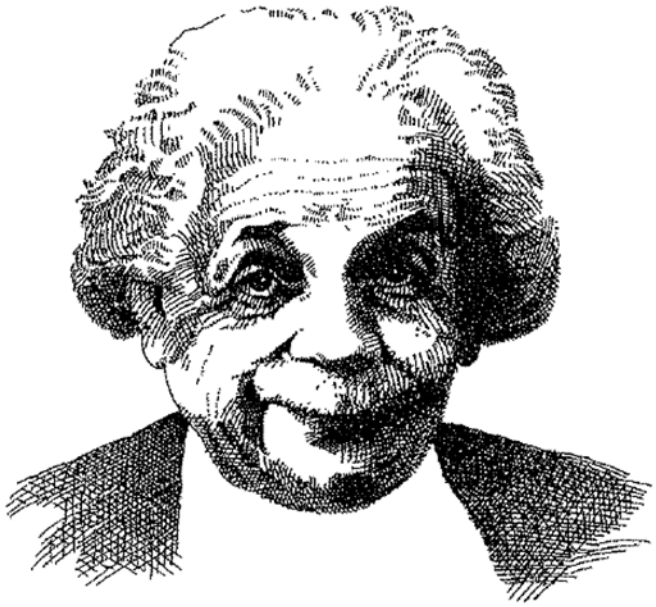
Definition of Problem

- A problem is decided by purposes. For example, manufacturing managers are usually evaluated with line-operation rate, which is shown as a percentage of operated hours to potential total operation hours. Therefore manufacturing managers sometimes operate lines without orders from their sales division. This operation may produce more than demand and make excessive inventories. The excessive inventories may be a problem for general managers. But for the manufacturing managers, the excessive inventories may not be a problem.
- Therefore, in order to identify a problem, problem solvers such as consultants must clarify the differences of purposes.

Three steps to a good decision

- Define the problem
- Set the decision criteria
- Choose the right analytical methods to satisfy the criteria





有個問題我常常搞不清楚：
到底是我瘋了，還是其他人都瘋了？

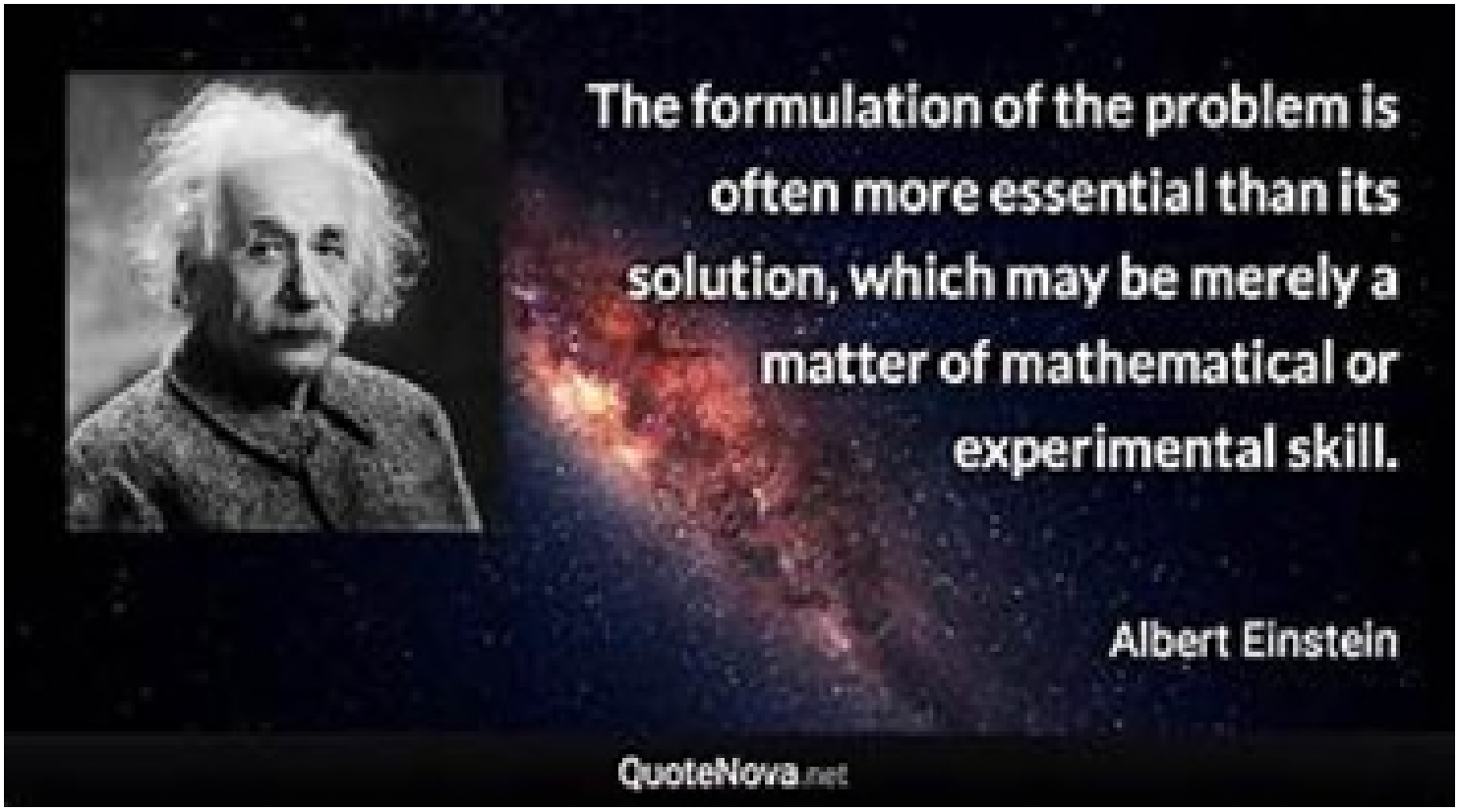
- “The formulation of the problem is often more essential than its solution.”

→如果我有一個小時拯救地球，

我會用59分鐘界定問題，然後用一分鐘解決它。

— Albert Einstein

https://www.quotenova.net/authors/albert-einstein/xmppeq



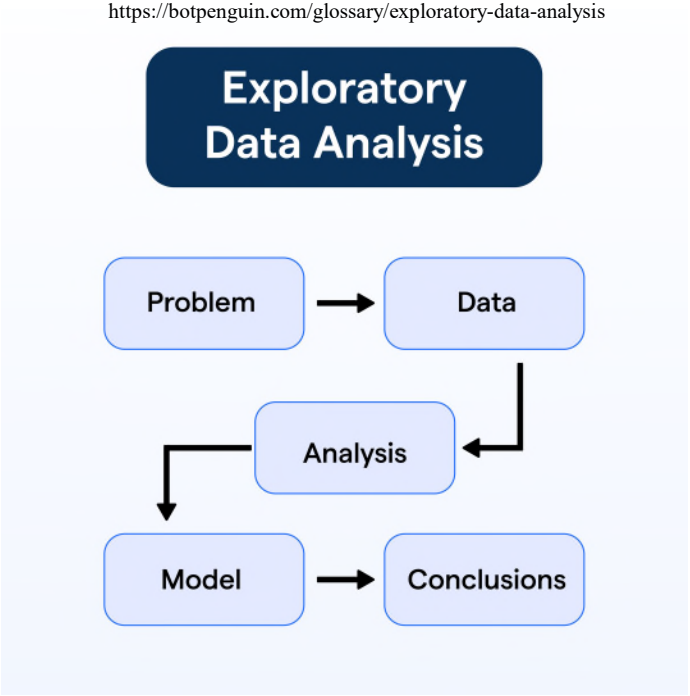
- "Exploratory research is often required to help in the formulation of the research problem.

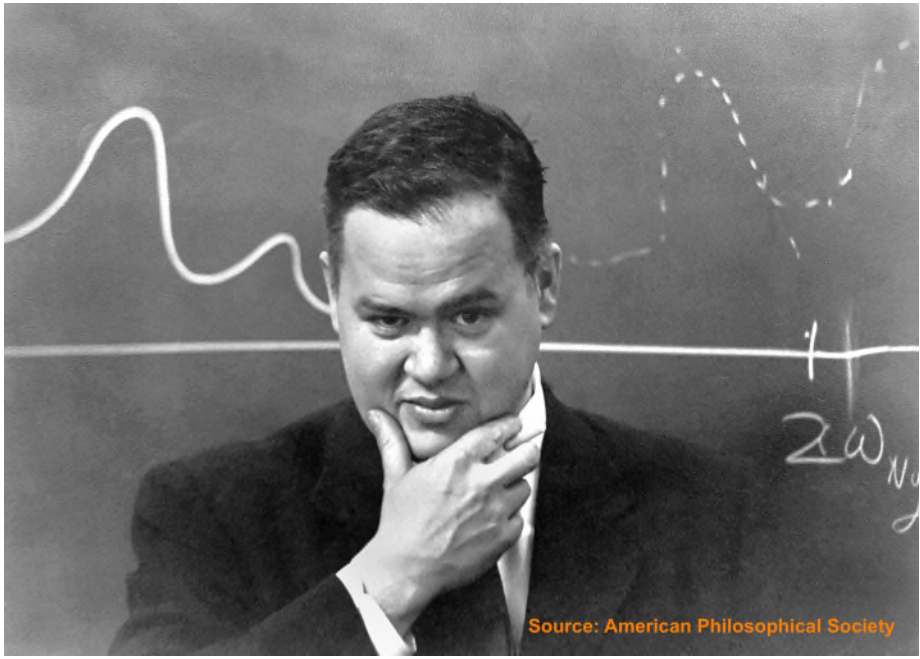
→All research is based on a set of assumptions or factors that are presumed to be true and valid.

(It is called "hypothesis" in science.)

→But be careful not to give too many assumptions.

https://botpenguin.com/glossary/exploratory-data-analysis





創造來自於需求

- 如何定義問題與需求有關，根據實際發生的狀況**量身訂製**。

→統計假設檢定中H_0及H_a如何決定？

- 以木柵牙醫為例，如何決定「最佳」與實際問題有關。

→例如：根據「檢查」、「補牙」、「拔牙」、「植牙」等整理資訊及判斷。

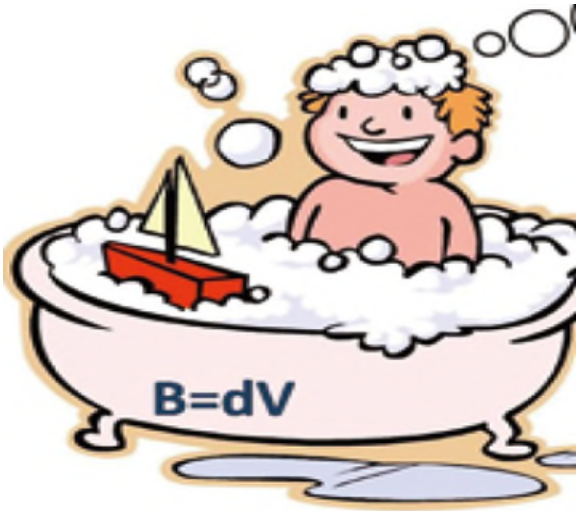
註：人與機器如何在大數據時代合作？

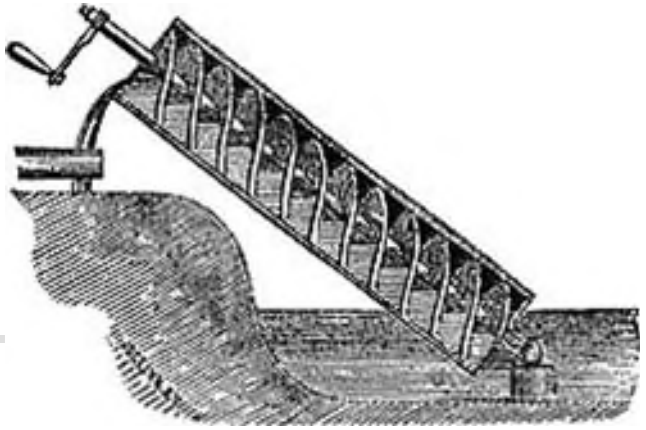
Ten ways to murder creativity

- Always pretend to know more than everybody around you.
- Get employees to fill in time sheets.
- Run daily checks on progress of everyone's work.
- Ensure that highly qualified people do mundane work for long periods.
- Put barriers up between departments.
- Don't speak personally to employees, except when announcing increased targets, shortened deadlines and tightened cost restraints.
- Ask for a 200-page document to justify every new idea.
- Call lots of meetings.
- Place the biggest emphasis on the budget.
- Buy lots of computers.

真正的問題在哪裡？

- 有時呈現在表面的因素並非造成問題的實際原因，解決方案需從另一方向或結合專業知識去探索。
- 古今中外的突破與發展，許多藉助於變換思考方向(Paradigm Shift)，換個角度思考有意想不到的驚喜！
- 討論：阿基米德的浮體原理。

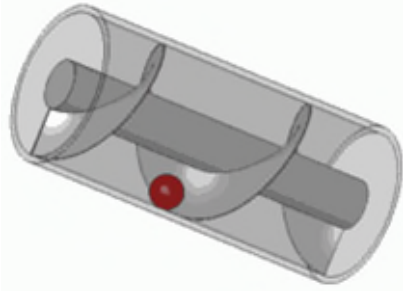




突破性思考的特色

- 長期探索(Long search)
- 沒有明顯的進展(Little apparent progress)
- 突發事件(Precipitating event)
- 靈光一閃(Cognitive snap)
- 轉換(Transformation)

→歷史上幾位著名人物的例子：阿基米德、孟德爾、達爾文、費曼。



統計研究的首要步驟

- 獲取研究問題的相關背景知識
- 確立問題的目標(研究目的)
- 以統計的語言定義問題

→如果與其他人合作，儘量「多發問」！

定義問題前四個步驟(準備工作)

- Collect and analyze information and data
- Talk with people familiar with the problem

→請教專家、尋求專業建議

- If at all possible, view the problem first hand

→不只紙上談兵(費曼的太空梭調查！)

- Confirm all findings

過去的習慣不見得有道理

A little girl was watching her mother prepare a fish for dinner. Her mother cut the head and tail off the fish and then placed it into a baking pan. The little girl asked her mother why she cut the head and tail off the fish. Her mother thought for a while and then said, "I've always done it that way – that's how babicka (Czech for grandma) did it."

Not satisfied with the answer, the little girl went to visit her grandma to find out why she cut the head and tail off the fish before baking it. Grandma thought for a while and replied, "I don't know. My mother always did it that way." So the little girl and the grandma went to visit great grandma to find ask if she knew the answer. Great grandma thought for a while and said,

"**Because my baking pan was too small to fit in the whole fish.**"

定義問題的後續四個步驟

- Determine if the problem should be solved
- Continue to gather information and search the literature
- Form simple hypotheses and quickly test them
- Brainstorm potential causes and solution alternatives

定義問題的幾個技巧

- Finding out where the problem came from
- Explore the problem
- Present/Desire state technique
- Duncker diagram
- Statement-restatement technique

The sweet old couple (dangers of making assumptions, understand before you intervene)

A little old couple walked into a fast food restaurant. The little old man walked up to the counter, ordered the food, paid, and took the tray back to the table where the little old lady sat. On the tray was a hamburger, a small bag of fries and a drink. Carefully the old man cut the hamburger in two, and divided the fries into two neat piles. He sipped the drink and passed it to the little old lady, who took a sip and passed it back. A young man on a nearby table had watched the old couple and felt sorry for them. He offered to buy them another meal, but the old man politely declined, saying that they were used to sharing everything. The old man began to eat his food, but his wife sat still, not eating. The young continued to watch the couple. He still felt he should be offering to help. As the little old man finished eating, the old lady had still not started on her food. "Ma'am, why aren't you eating?" asked the young man sympathetically. The old lady looked up and said politely,

"I'm waiting for the teeth..."

http://1.bp.blogspot.com/-HWsJkhuXhp0/UD774ABVi8I/AAAAAAAAEdY/W3n_wM90W0A/s1600/The+sweet+old+couple.jpg

從眾行為(Bandwagon Effect)

http://i.snag.gy/kdu77.jpg

A group of scientists placed 5 monkeys in a cage and in the middle, a ladder with bananas on the top.

Every time a monkey went up the ladder, the scientists soaked the rest of the monkeys with cold water.

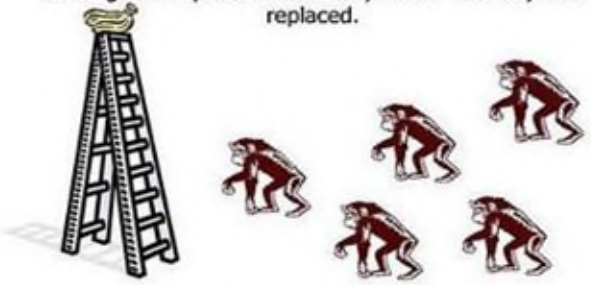
After a while, every time a monkey went up the ladder, the others beat up the one on the ladder.

After some time, no monkey dare to go up the ladder regardless of the temptation.

Scientists then decided to substitute one of the monkeys. The 1st thing this new monkey did was to go up the ladder. Immediately the other monkeys beat him up.

After several beatings, the new member learned not to climb the ladder even though never knew why.

A 2nd monkey was substituted and the same occurred. The 1st monkey participated on the beating for the 2nd monkey. A 3rd monkey was changed and the same was repeated (beating). The 4th was substituted and the beating was repeated and finally the 5th monkey was replaced.



What was left was a group of 5 monkeys that even though never received a cold shower, continued to beat up any monkey who attempted to climb the ladder.

If it was possible to ask the monkeys why they would beat up all those who attempted to go up the ladder.....
I bet you the answer would be....

"I don't know – that's how things are done around here"

Does it sounds familiar?

Don't miss the opportunity to share this with others as they might be asking themselves why we continue to do what we are doing if there is a different way out there.

當初的問題來源

- Where does the problem originate?
- Who did pose the problem statement in the first place?
- Can that person explain the reasoning as to how they arrived at that particular statement?
- Are the reasoning and assumptions valid?
- Has that person considered the situation from a number of different viewpoints before?
- Have you used the first fours steps?

定義問題練習#1

- *The client is the manager of a factory. Her products are bolted together on the assembly line with air wrenches. They are so noisy and thus damage workers' ears and ruin morale and job satisfaction.*

→*Problem: Reducing the noise from the air wrenches!*

- Let's approach the problem by decomposing everything we know about the situation.

Source:Robert Harris VirtualSalt.com

定義問題練習#1(續1)

1. Assembly happens in the factory.

→Can it be done outside?

→Can it be outsourced to another company?

2. The products are assembled with bolts.

→Can they be glued, taped, welded, riveted, or molded?

→Can the manufacturing process be modified to eliminate the need for bolts?

3. Air wrenches are used in assembly.

→Can hand wrenches be used?

→What about electric or hydraulic wrenches?

定義問題練習#1(續2)

4. People use the air wrenches.

→Can robots do the same job?

→Can people be rotated so their exposure to noise is minimized?

5. Air wrenches are noisy.

→Do quiet air wrenches exist?

→Is there a way to minimize the noise from air wrenches?

6. The employees dislike the noise.

→Are there employees that don't mind noise?

- There are often multiple solutions to a problem, and it's a matter of how you define the problem.

定義問題練習之一

- 家庭中常見的意外之一是嬰幼兒誤食藥品而中毒，如何解決這個問題？
- 可能的問題定義是嬰幼兒自己打開藥瓶。

→解決之道為設計較難打開的瓶蓋。

- 然而仍有許多幼兒誤食藥物的案件發生。

→真正的問題是甚麼？

(有許多人用藥後忘了蓋上蓋子。)

- 如果在這個例子中以改變結果為目標，也就是減少嬰幼兒藥物中毒的案例為標準，或許問題會更為直接。

→如何減少嬰幼兒自己拿到藥品的機會？

- 如此可將問題分為兩個方向：

(1)在藥瓶上增加警示說明，提醒成年人不讓嬰幼兒有機會拿到藥品。

(2)即使嬰幼兒拿到藥品，他們不見得有機會食用藥物。

定義問題練習之二

- 政大商學院後門改裝完成的殘障專用道，採用類似貪食蛇的路線設計。

（註：商學院前門與行政大樓採類似設計）

→優點：減低殘障專用道的坡度

→缺點：路線加長為三倍、180度的轉角

- 問題：殘障步道的只要求坡度平緩嗎？

→對輪椅使用者而言（類比推車），轉彎和坡度兩者哪一個較吃力。

- 商院的坡道設置僅考量了『如何降低坡度』，而學思及研究大樓除了達到降低坡度的條件外，更顧及了『如何使輪椅使用者的負擔最小』。

定義問題討論

- 2009年10月教育部提出為避免學童上體育課後，全身濕淋淋地吹風容易感冒，研議設置在各中小學淋浴設備。

→需要額外的淋浴時間、儲物櫃空間！

- 1966年時美國國會抨擊汽車業者生產的車輛不夠安全，希望強化汽車結構。

→「駕駛人」vs.「汽車結構」，何者較容易改善？

定義問題討論(續)

- 生活中還有不少定義問題錯誤的範例：捷運新莊線通車後，捷運、公車站齊聚在輔大附近，造成交通動線打結。（政大公車站）

→新北市府分散公車站牌，並禁止車輛轉彎，但出現「等同向公車差百米」的怪現象。

註：參考各報章雜誌的新聞報導。

- 類似題目練習：金融海嘯是由誰引發？中國毒奶粉含「三聚氰氨」的處理？

定義問題的九個步驟：

- Rephrase the Problem
- Expose and Challenge Assumptions
- Chunk Up (Each problem is a small piece of a greater problem.)
- Chunk Down
- Find Multiple Perspectives
- Use Effective Language Constructs
- Make It Engaging
- Reverse the Problem
- Gather Facts

註：參考網站「How to Define a Problem」

http://www.wikihow.com/Define-a-Problem

- 一有徵兆顯示可能造成異常現象，或出現有違常理的事件時，有效的決策者總是主動進行測試。他們總會一一寫下，在既有定義之下，他們預期哪些事情會發生（例如：預期交通意外的發生率降為零）？並定期測試是否真會出現自己所預期的情況。
- 愛因斯坦：「陳述一個問題、尋找一個問題，往往比解答一個問題更重要，解答所需要的可能只是數學或實驗的技巧而已，提出新的問題、新的可能性或從新的角度思考舊問題，需要的是創意的想像，才是科學真正的內涵。」