Fall 2022 (111-1)

控制系統
Control Systems

Unit 1F
Emergent Example of Feedback and Control

Feng-Li Lian

NTU-EE

Sep 2022 – Dec 2022

- CoViD – 19 （新型冠狀病毒肺炎）

衛生福利部疾病管制署
Taiwan Centers for Disease Control

Centers for Disease Control and Prevention

Open-Loop Control vs Closed-Loop Control

- CoViD – 19（新型冠狀病毒肺炎）
- 口罩自動化生產系統

- 主要變數（信號）：
  - 所需的口罩數量
  - 生產原料種類與數量
  - 每一片口罩生產所需的時間
  - 單位時間產量的良率
  - 整體的產能等等等

- 系統：
  - 備料
  - 分批
  - 組裝
  - 包裝
  - 傳送
  - 旋轉
  - 擠壓

https://youtu.be/DCee9sSA_mY
https://youtu.be/UB0gEHqc1GI

Open-Loop Control vs Closed-Loop Control

- CoViD – 19（新型冠狀病毒肺炎）
- 即時口罩地圖 https://mask.goodideas-studio.com/

udn / 信讀家 / 新社會

讚 314 分 分

看見我科技實力！唐鳳：多國對台灣口罩地圖有興趣

2020/02/18 張文馨

行政院政務委員唐鳳受華府智庫邀請訪問美國，他14日在駐美代表處分享此行訪問經驗；被問到新冠肺炎（COVID-19）在台灣造成口罩搶購，唐鳳說，台灣藉此機會實作開放政府，把原始碼放在網路上成立口罩地圖，引起美國等國家的興趣，他們都可以直接在網路上看到這次實作過程。

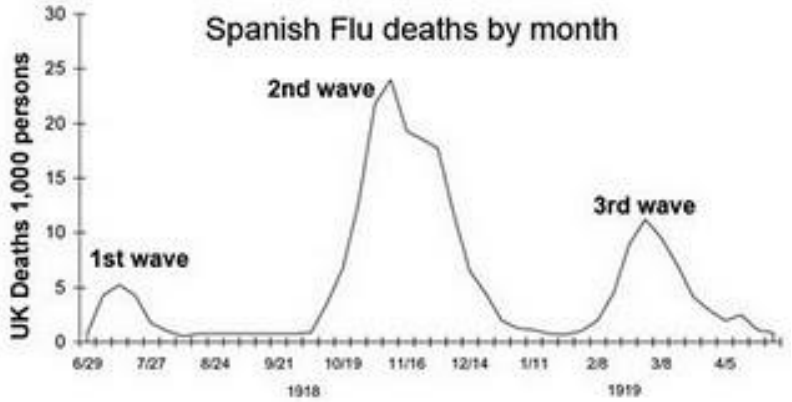
行政院政務委員唐鳳。 圖 / 黃仲裕攝影

唐鳳指出，此行也有和美國國會與行政機關官員互動，和美國國會眾議院物聯網連線的主席、金融服務小組委員會、人工智慧任務小組主席，以及行政機關的數位任務小組成員都到齊，話題聚焦開放政府，唐鳳稱，與行政官員深入交換意見，並商討可以如何合作。

- 主要變數（信號）：
  - 販賣處的位置（距離）
  - 販賣時間（絕對時間點，持續時間）
  - 口罩存量（與時間的關係式）
  - 口罩種類
- 系統：
  - 排隊
  - 分包
  - 交通時間
  - 運送時間

Open-Loop Control vs Closed-Loop Control

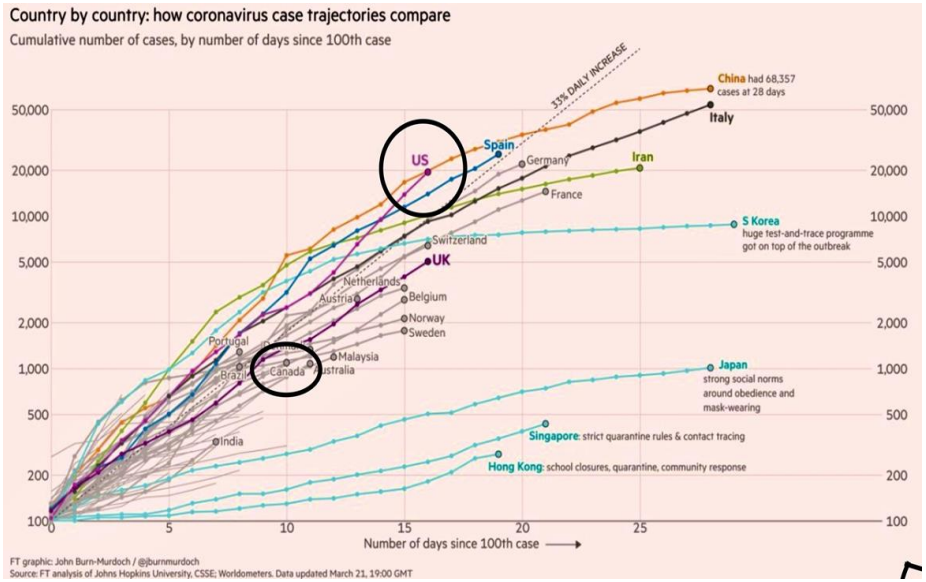
- CoViD – 19（新型冠狀病毒肺炎）
- 1918年西班牙流感大流行

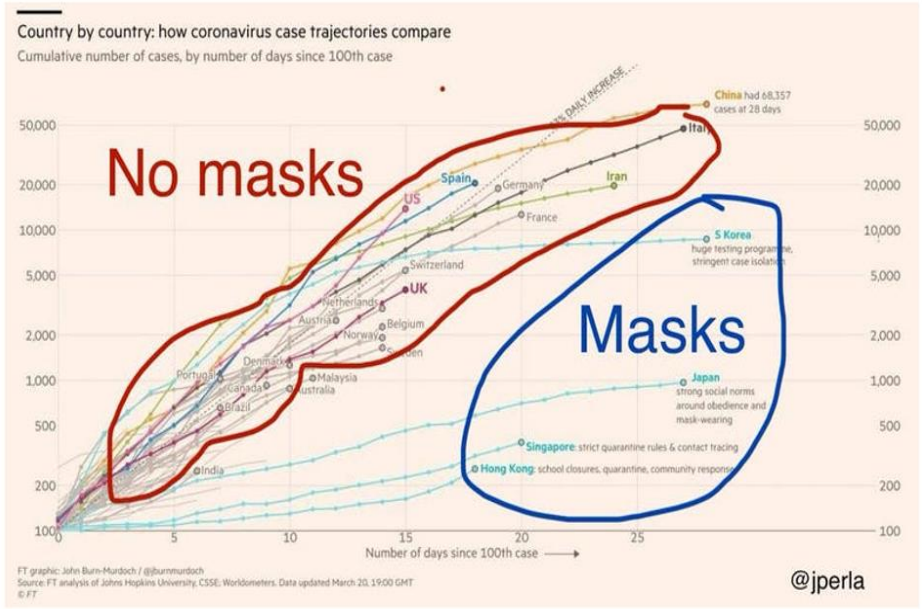


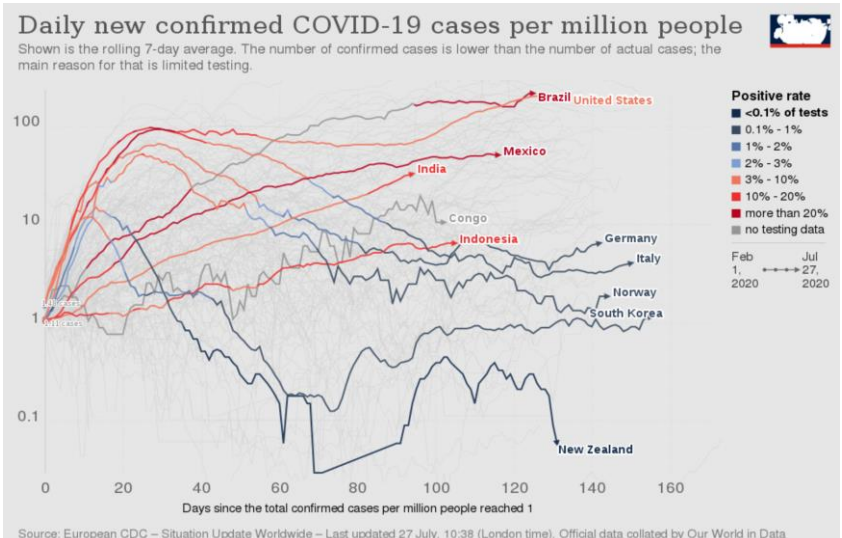
- 主要變數（信號）：
  - 確診人數 vs 不同時間點
  - 死亡人數 vs 不同時間點
  - 產生抗體人數 vs 不同時間點
  - 醫療數量，位置，品質，效能
- 系統：
  - 感染機制
  - 治療機制
  - 隔離機制

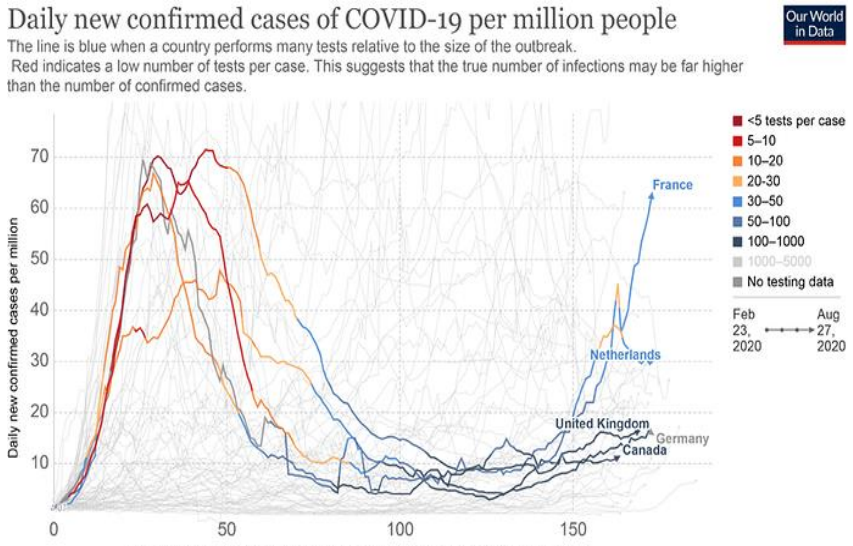
Open-Loop Control vs Closed-Loop Control

- CoViD – 19（新型冠狀病毒肺炎）
- 2019年新型冠狀病毒肺炎大流行





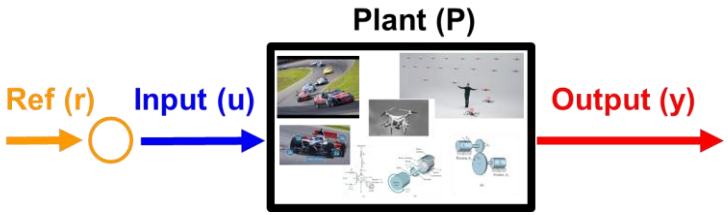




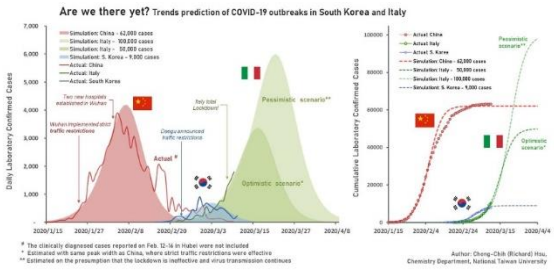
Open-Loop Control vs Closed-Loop Control

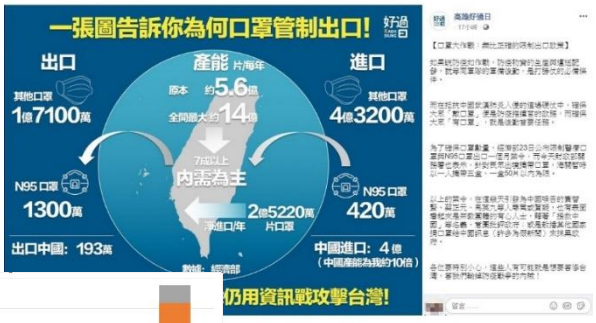
- 預防：
  - 預期口罩需求量
  - 預期購買時間
- 治療：
  - 預期感染人數
  - 預期死亡人數

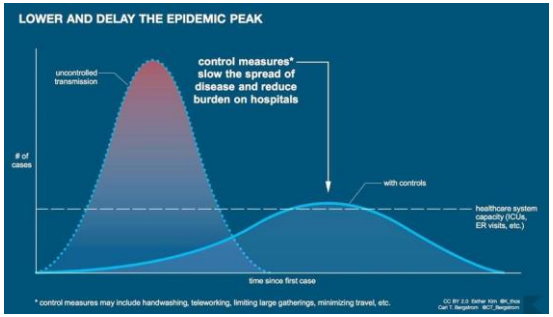
- 生活圈：
  - 人：人民，醫生，工程師等
  - 物：口罩，藥物等
  - 地：隔離區，醫院，住家

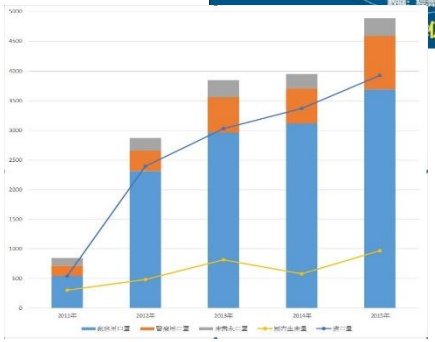


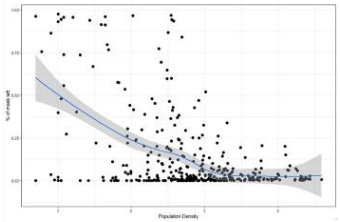
- 預防：
  - 口罩使用量
  - 購買等待時間
- 治療：
  - 感染人數
  - 死亡人數









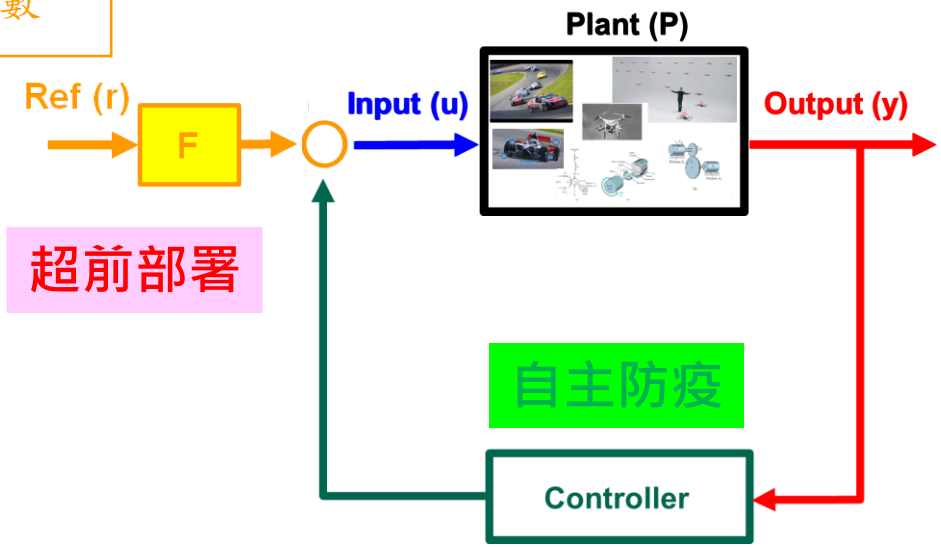


- 人民
- 口罩
- 試劑

Open-Loop Control vs Closed-Loop Control

- 預防：
  - 預期口罩需求量
  - 預期購買時間
- 治療：
  - 預期感染人數
  - 預期死亡人數

- 生活圈：
  - 人：人民，醫生，工程師等
  - 物：口罩，藥物等
  - 地：隔離區，醫院，住家



- 預防：
  - 口罩使用量
  - 購買等待時間
- 治療：
  - 感染人數
  - 死亡人數

- 預防：
  - 生產機器產能與效率
  - 即時口罩地圖
- 治療：
  - 隔離
  - 藥物
  - 疫苗

- 人民
- 口罩
- 試劑

Open-Loop Control vs Closed-Loop Control

- 預防：
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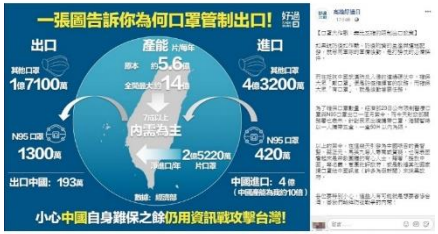

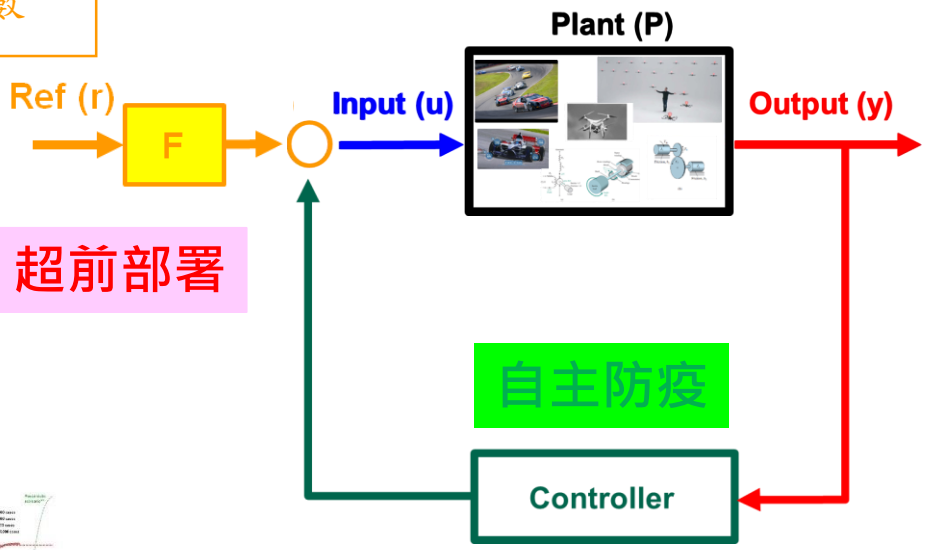

- 預防：
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  - 購買等待時間
- 治療：
  - 感染人數
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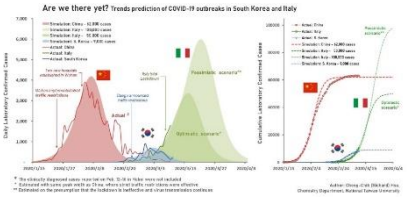
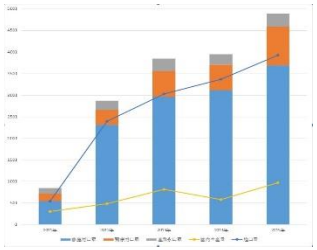
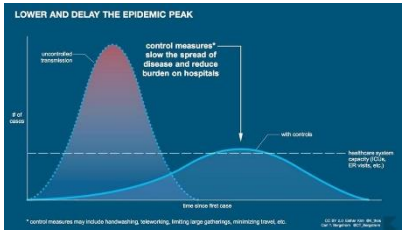
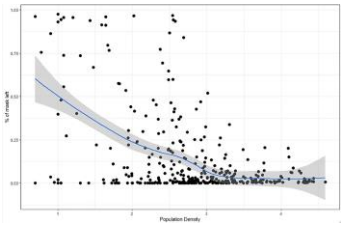




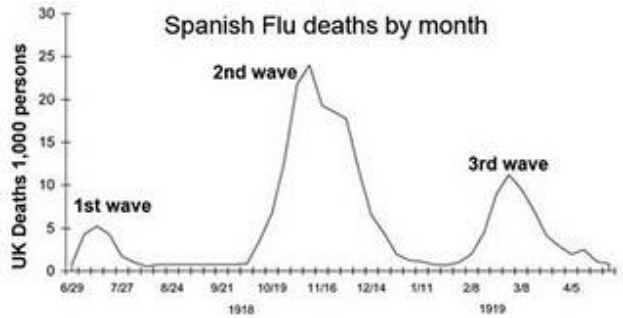


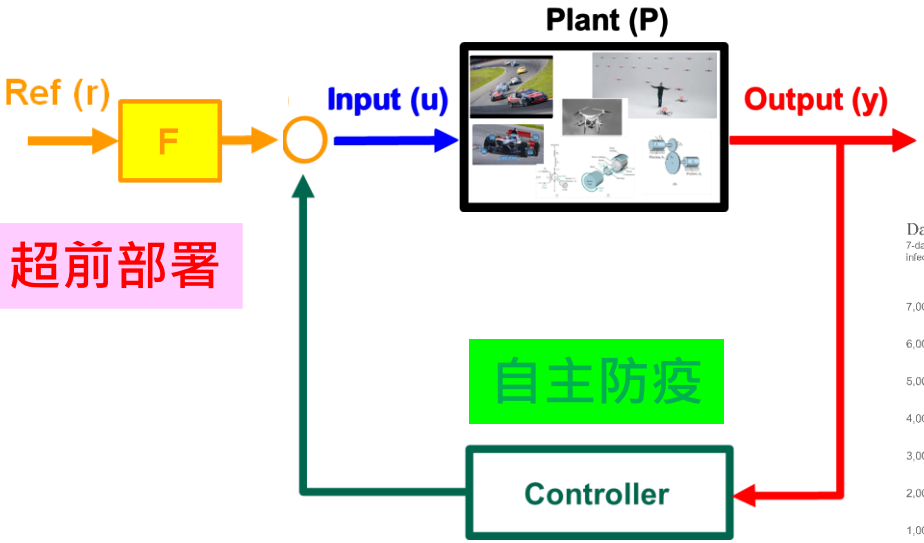
- 預防：
  - 生產機器產能與效率
  - 即時口罩地圖
- 治療：
  - 隔離
  - 藥物
  - 疫苗

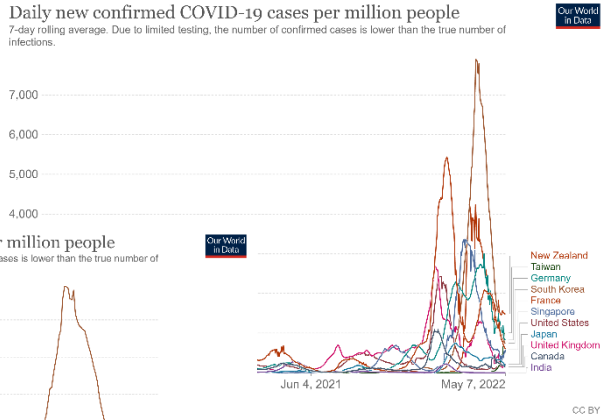


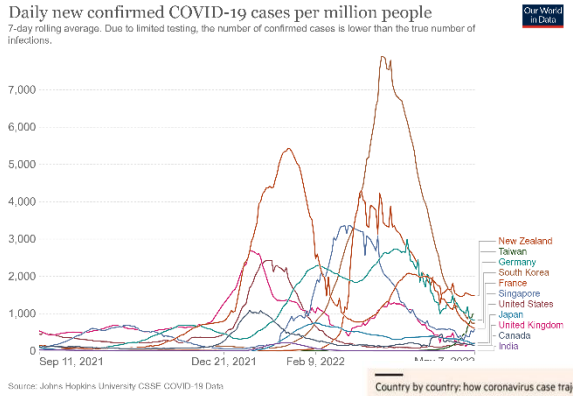
Open-Loop Control vs Closed-Loop Control

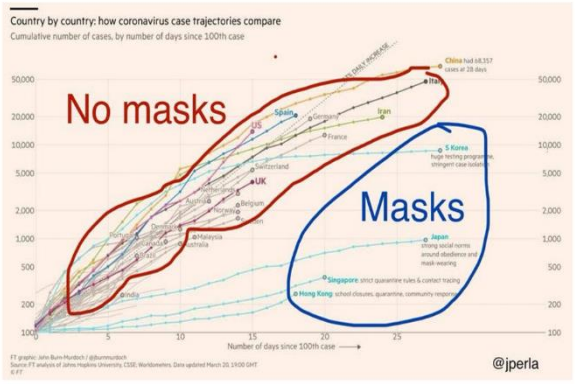
衛生福利部疾病管制署
Taiwan Centers for Disease Control











CDC Centers for Disease Control and Prevention

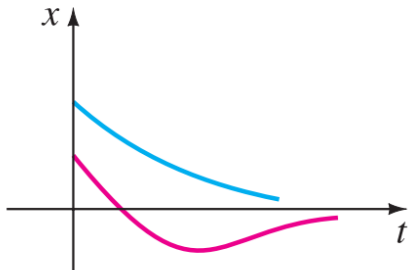
Understand the System by Differential Equations

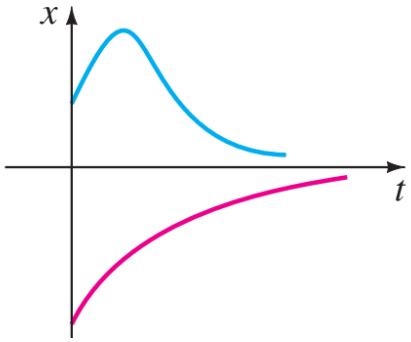
$$\frac{d^2x}{dt^2} + 2\lambda\frac{dx}{dt} + \omega^2 x = 0,$$

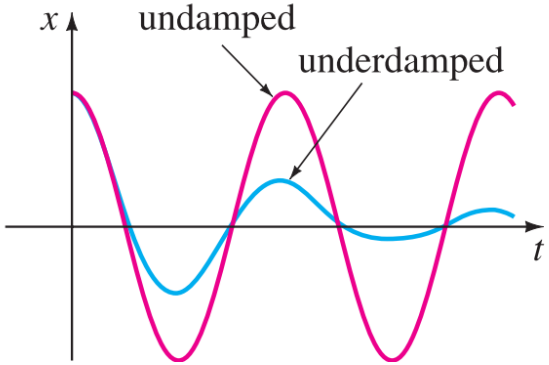
$$\frac{d^2x}{dt^2} + 2\lambda\frac{dx}{dt} + \omega^2 x = F(t),$$

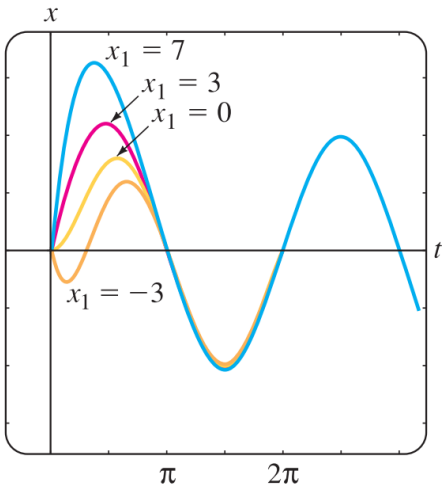
$$xy' - y = x^2 \sin x$$

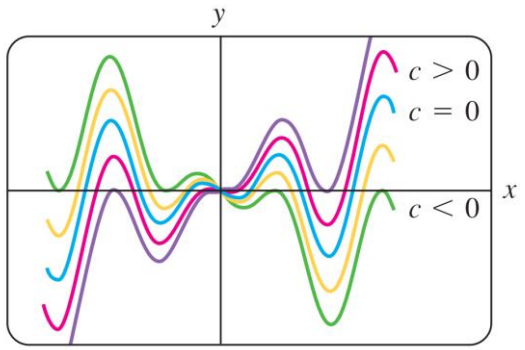
$$y = cx - x\cos x$$

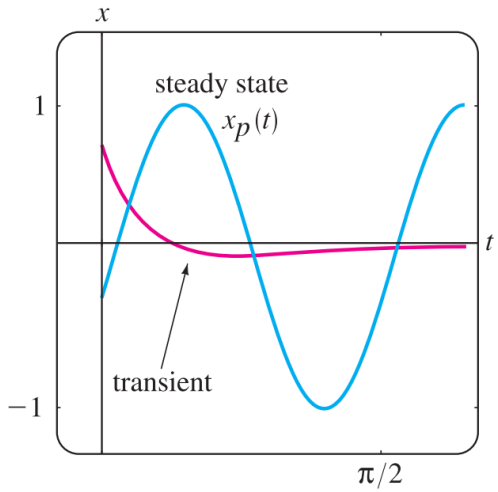












- Bead Sliding Along a Sine Wave

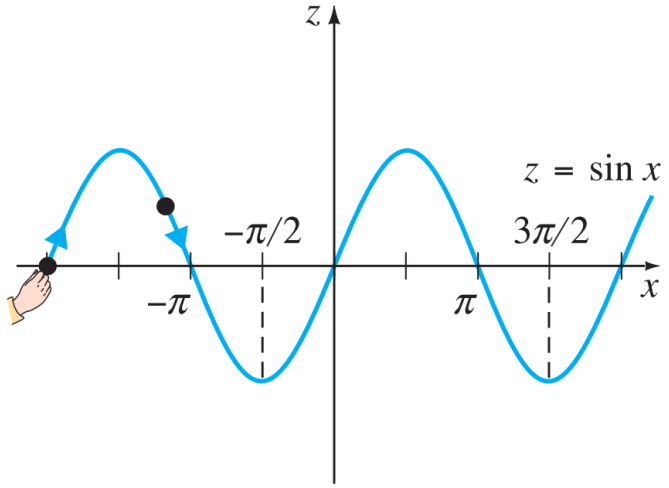


FIGURE 10.4.4 $-\pi/2$ and $3\pi/2$ are stable.

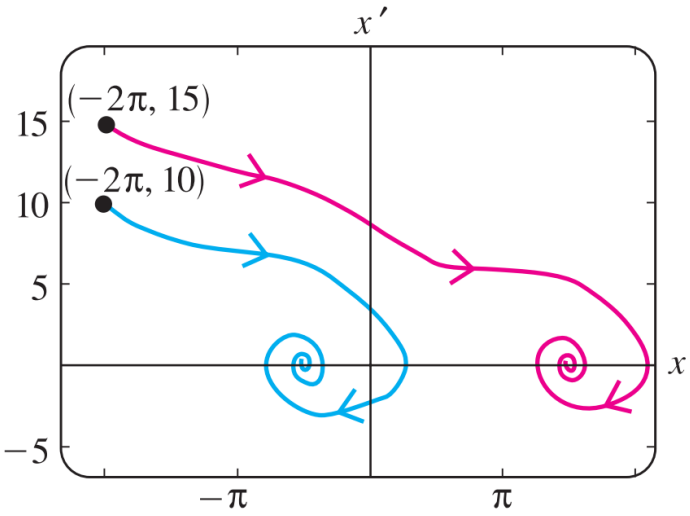


FIGURE 10.4.5 $\beta = 0.01$

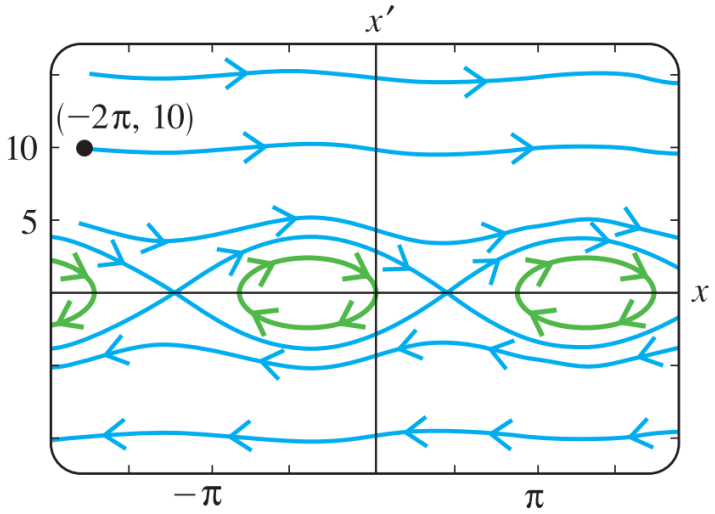
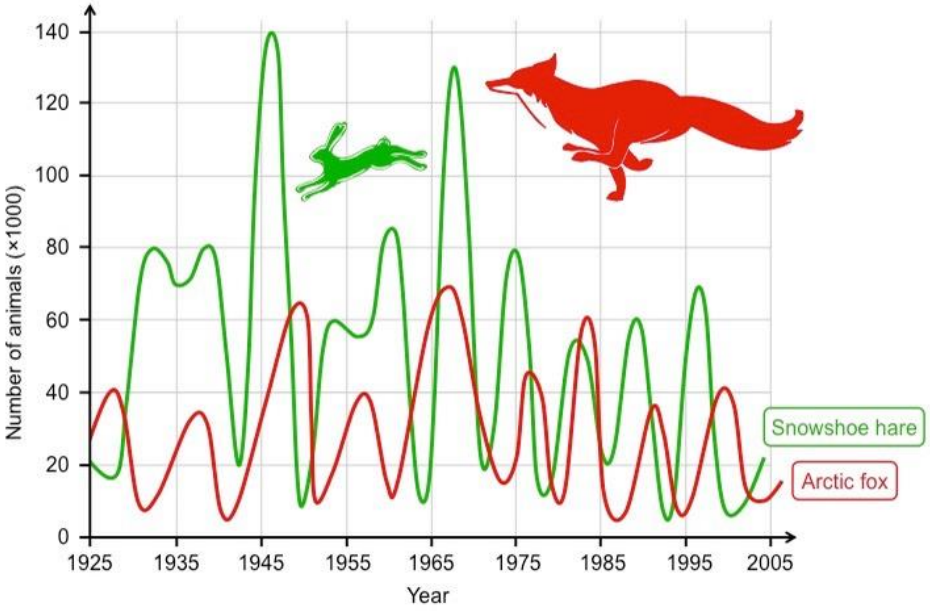


FIGURE 10.4.6 $\beta = 0$

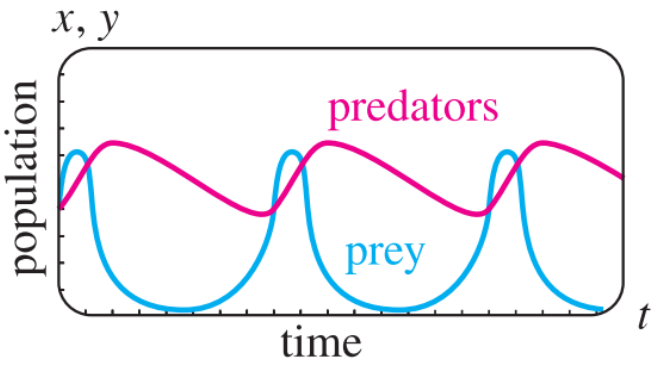
Understand the System by Differential Equations

- Lotka-Volterra Predator-Prey Model （兔子與狐狸）



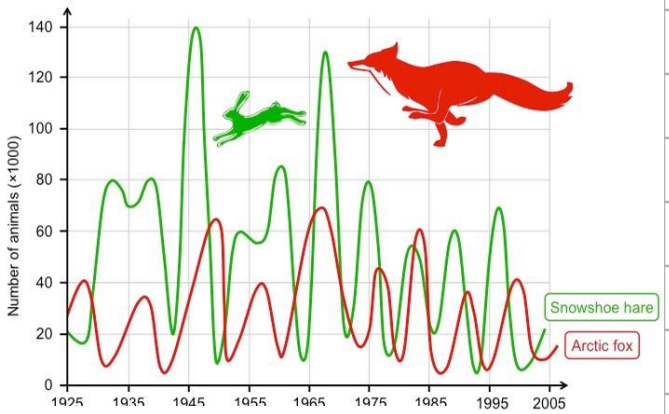
$$\frac{dx}{dt} = -0.16x + 0.08xy$$

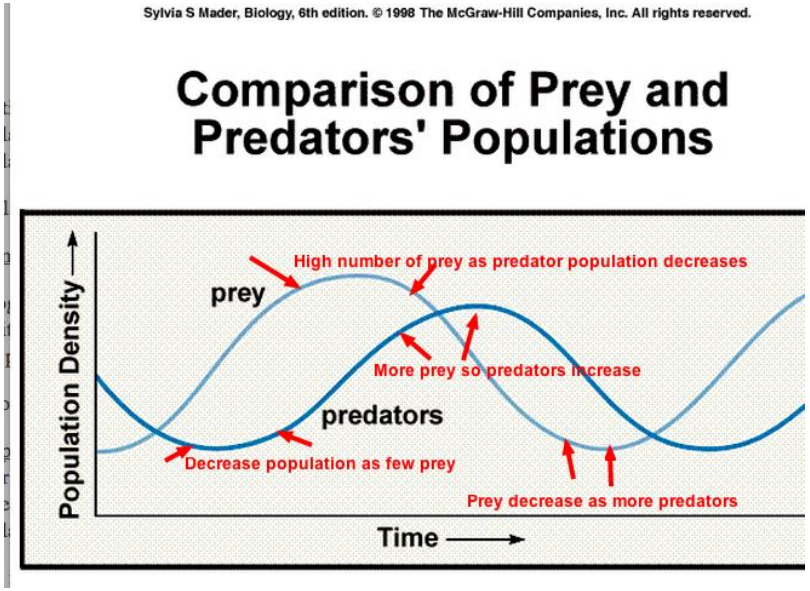
$$\frac{dy}{dt} = 4.5y - 0.9xy$$

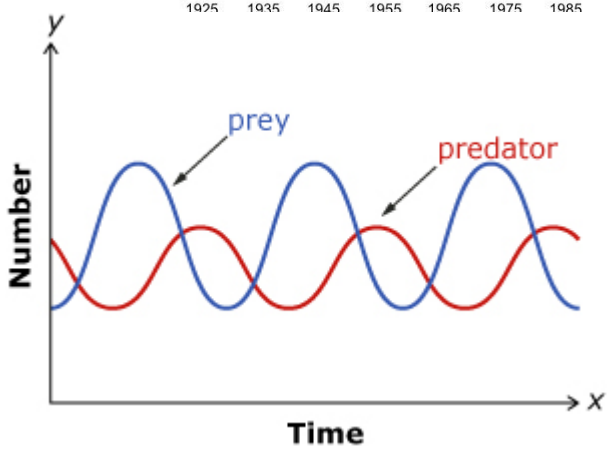


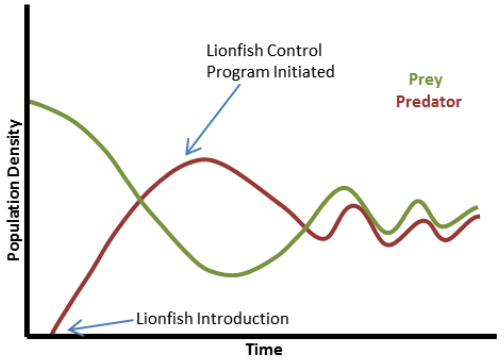
Understand the System by Differential Equations

- Lotka-Volterra Predator-Prey Model （兔子與狐狸）









Understand the System by Differential Equations

- Lotka-Volterra Predator-Prey Model （兔子與狐狸）

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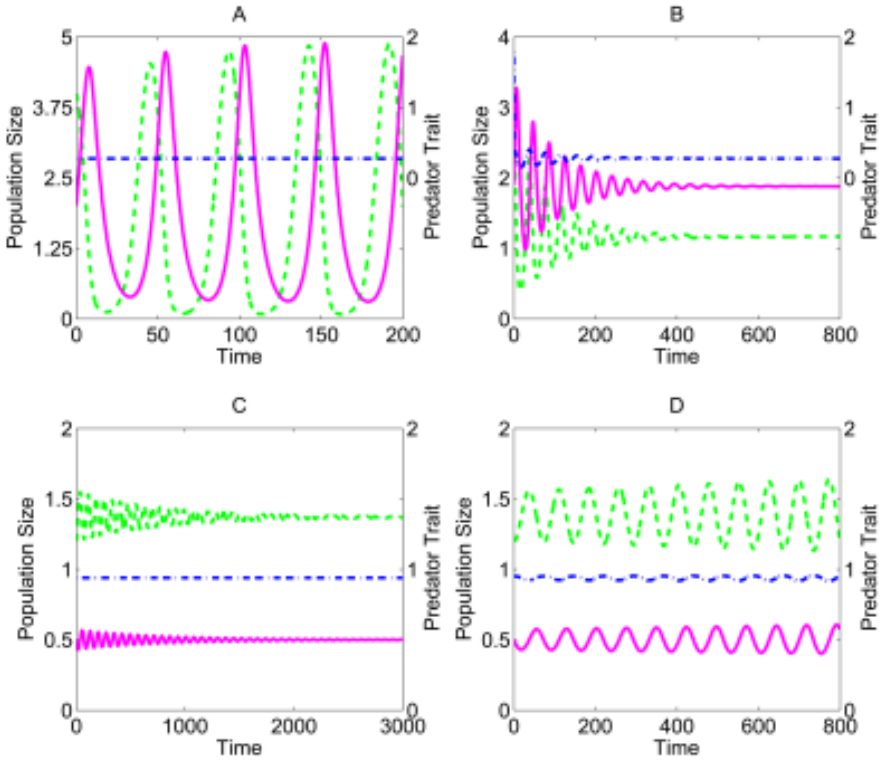
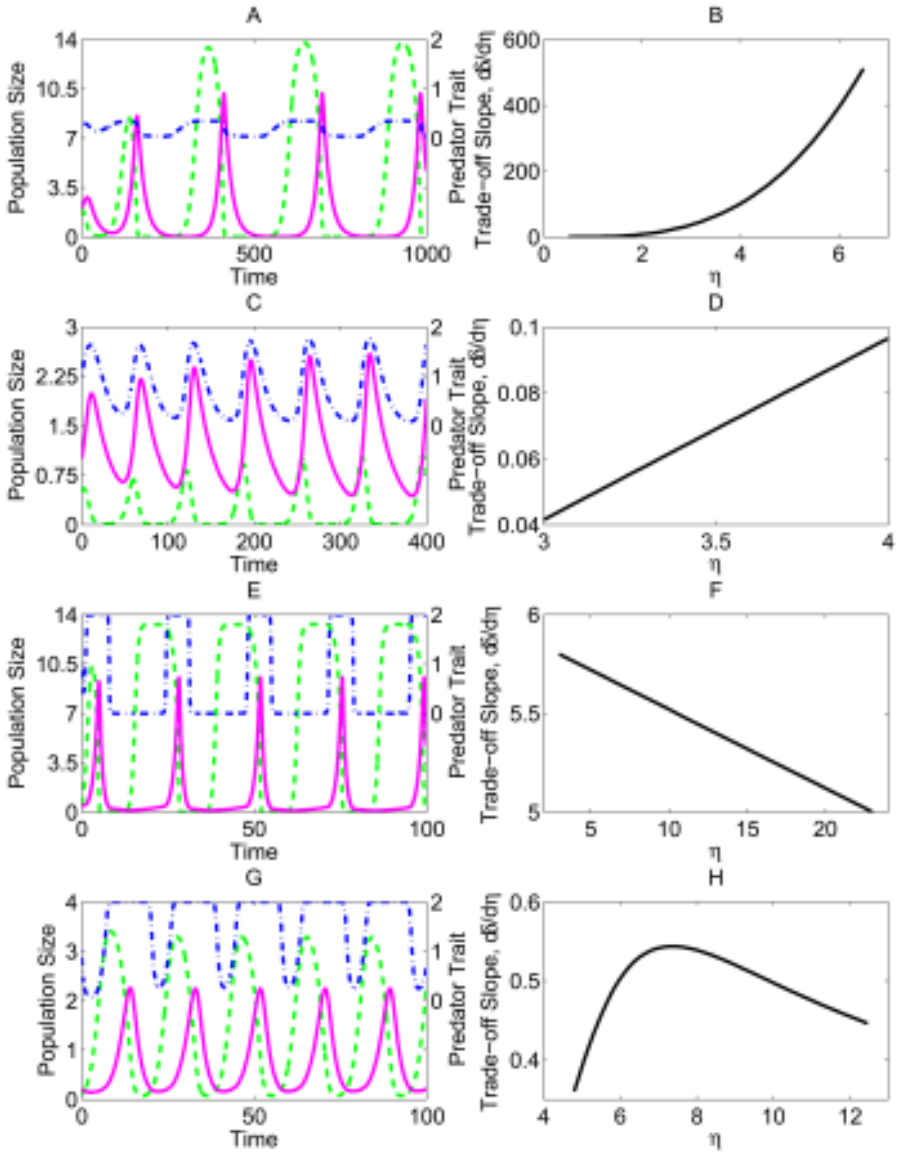
E-ARTICLE

Understanding Rapid Evolution in Predator-Prey Interactions Using the Theory of Fast-Slow Dynamical Systems

Michael H. Cortez[1,*] and Stephen P. Ellner[1,2]





Understand the System by Differential Equations

Lotka-Volterra Predator-Prey Model （兔子與狐狸）

Resilience Modeling by Means of a Set of Recursive Functions.

Maria Teresa Signes Pont, Juan Manuel García Chamizo, Higinio Mora Mora, Jerónimo Mora Pascual
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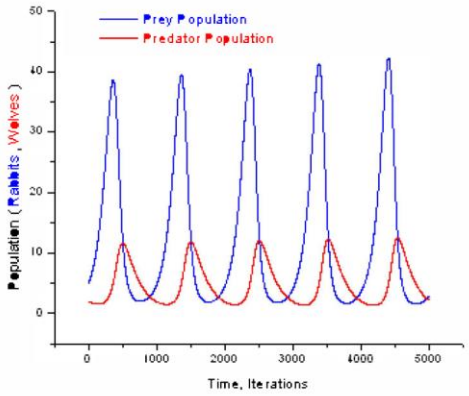
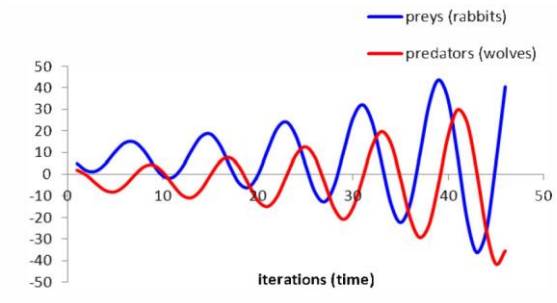
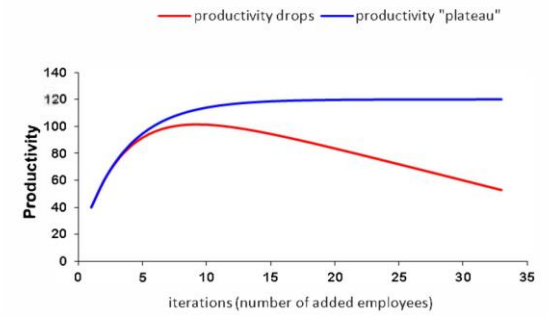
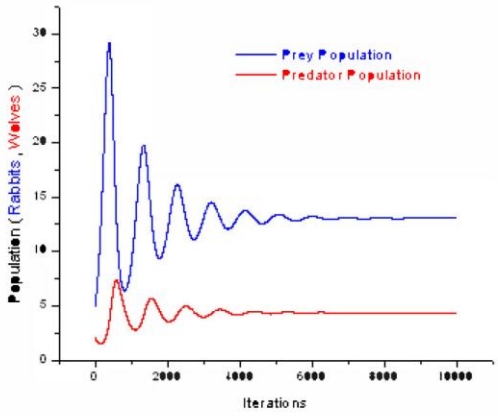
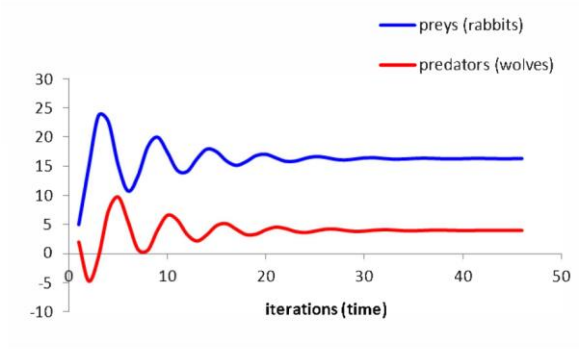
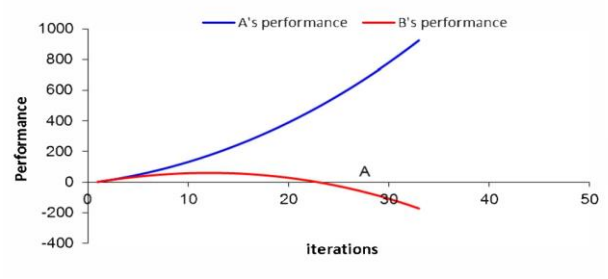


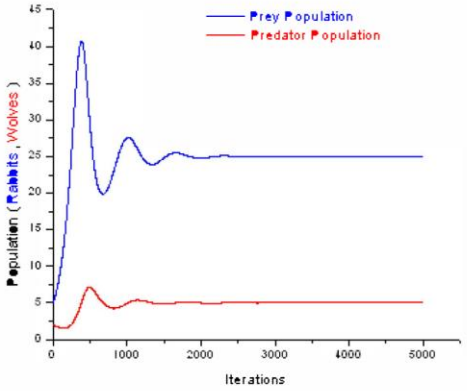


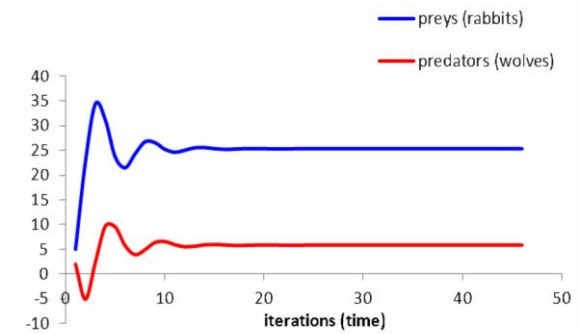




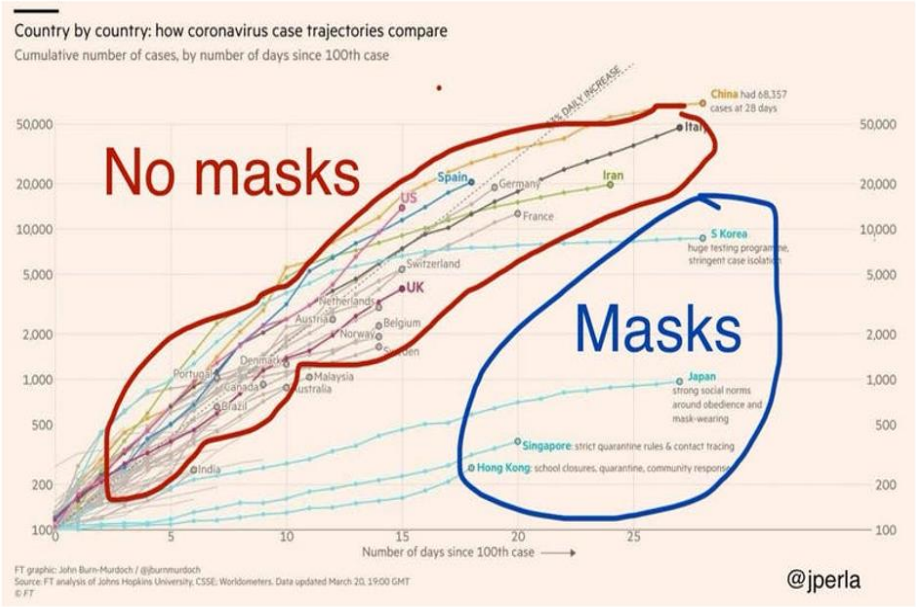


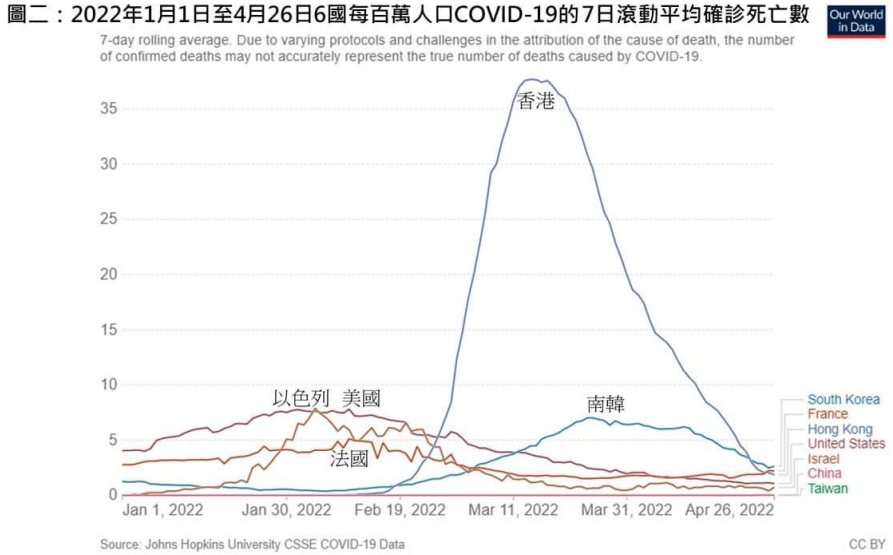




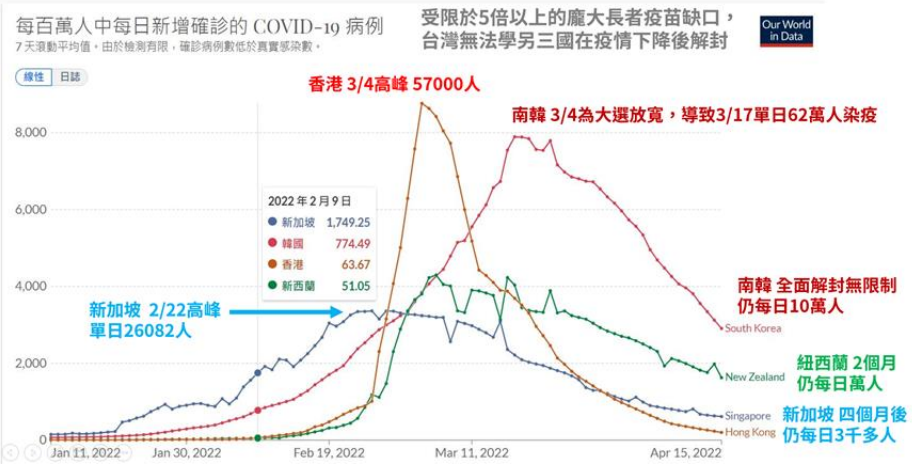


CoViD – 19（新型冠狀病毒肺炎）

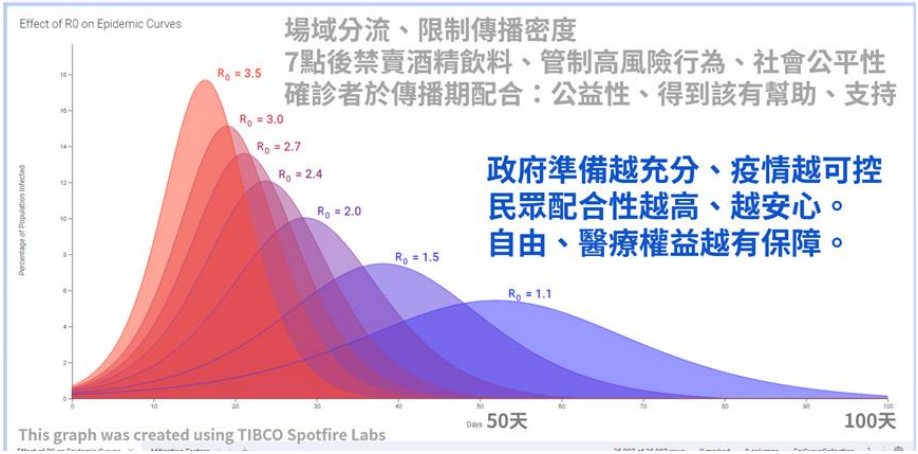




準備不充分，政治影響防疫，將造成難以承受患者潮



隔離確診者目的：避免大量患者，癱瘓社會功能



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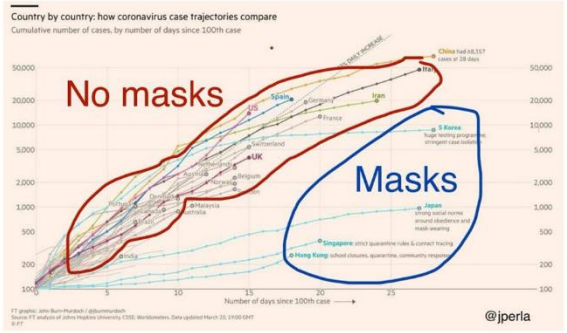

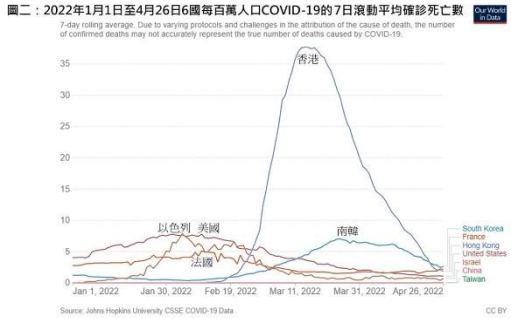

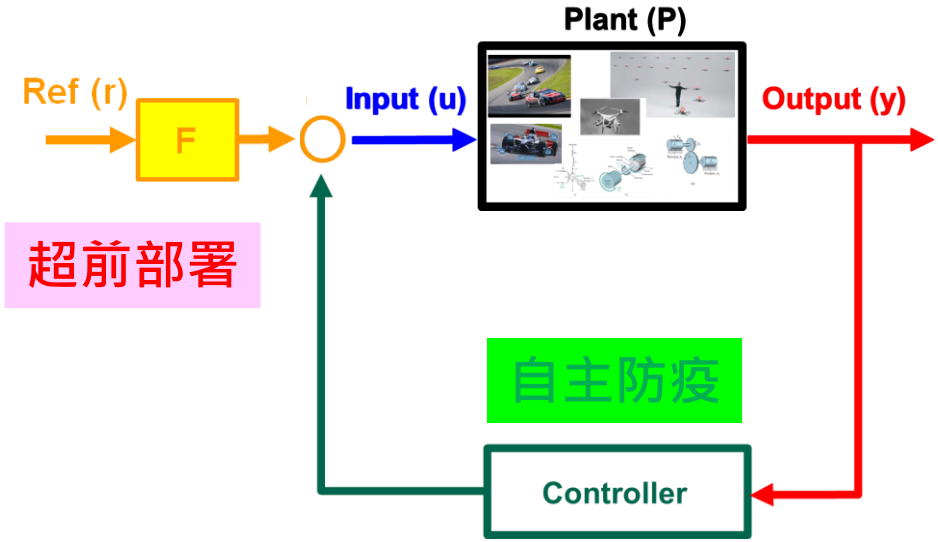

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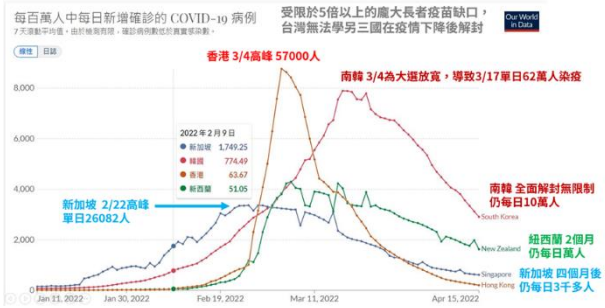

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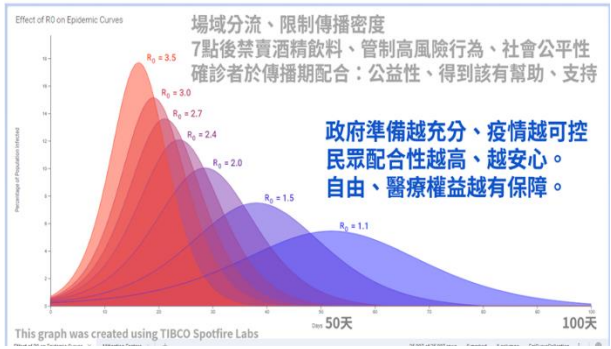
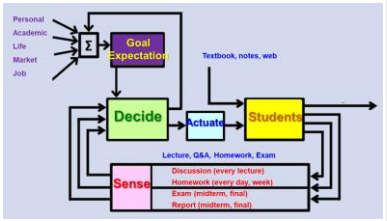


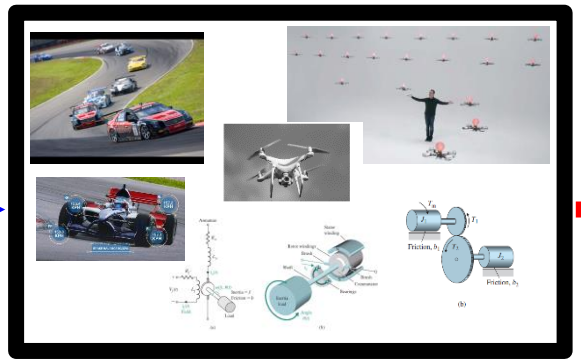
Plant, Input, Output, Action, Goal



Plant (P)

Ref (r)

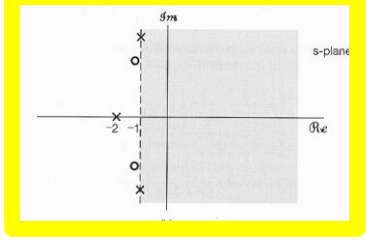
Input (u)

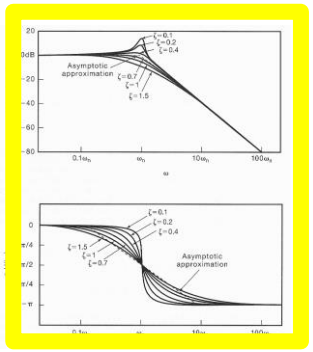


Output (y)

$$\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} - 3\,y(t) = 5\,u(t)$$

$$P(s) = \frac{Y(s)}{U(s)} = \frac{5}{s^2 + 2s - 3}$$





Controller

$$\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3\,y(t) = 3\,r(t)$$

$$G(s) = \frac{Y(s)}{R(s)} = \frac{3}{s^2 + 4s + 3}$$

1. Model
2. Response
3. Analysis
4. Feedback
5. Control

Where is the control? Who is the controller?

C

Plant (P)

B

Ref (r)

Input (u)

Output (y)

D

A

Controller

Where is the control? Who is the controller?

C

B

Plant (P)

Ref (r)

Input (u)

Output (y)

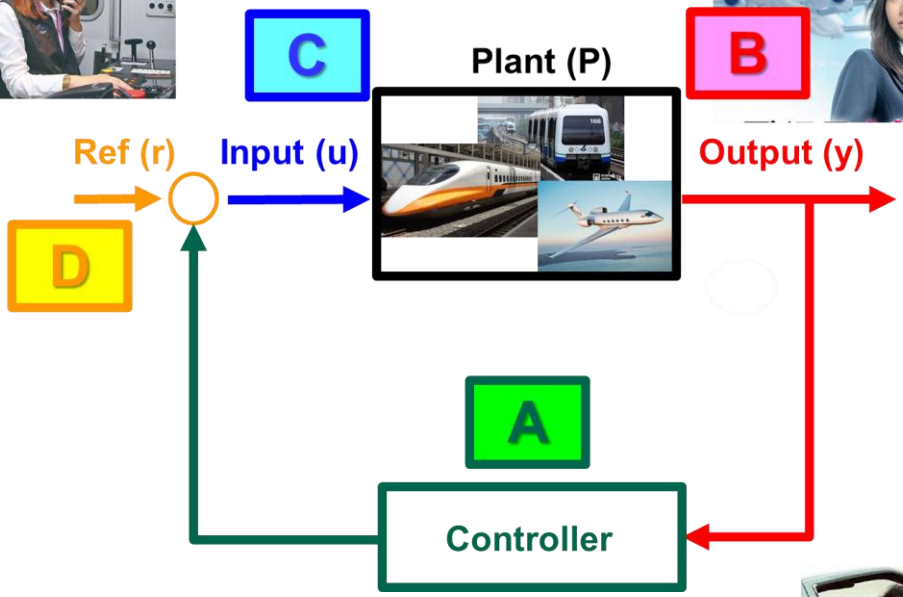
D

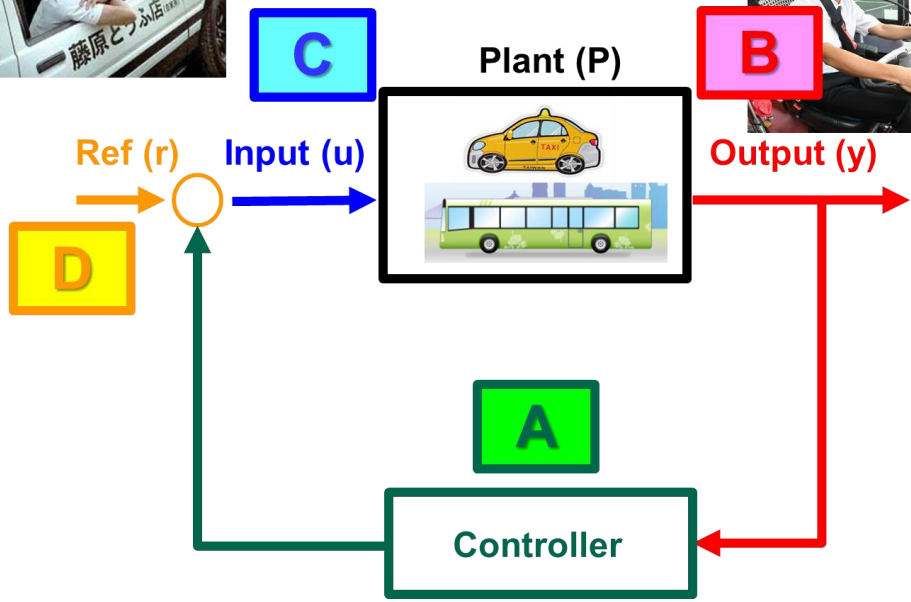
A

Controller

Where is the control? Who is the controller?

- A, B, C, or D





- A, B, C, or D