Spring 2020

控制系統
Control Systems

Unit 11
Introduction - Feedback and Control

Feng-Li Lian & Ming-Li Chiang

NTU-EE

Mar 2020 – Jul 2020

Control vs Non-Control

- AlphaGo（圍棋）
- 人的手下棋

- 機械手下棋

Control vs Non-Control

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

- 口罩自動化生產系統

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

udn / 信議家 / 新社會

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聊到做醫不能，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。

網曝醫療口罩製造秘辛：2禮拜開60生產線要跪哭了

新頭殼 12k 人追蹤 追蹤

新頭殼newtalk 洪翠華 綜合報導

2020年2月15日 下午5:14

414 則留言

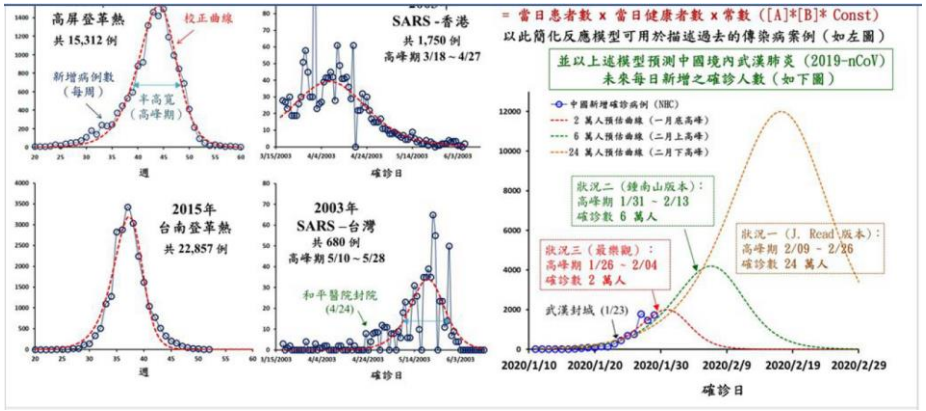
行政院長蘇貞昌（左）14日視察口罩生產工廠，表示最快月底，口罩產能將可望達日產千萬片。 圖：新頭殼資料照/林昀真攝

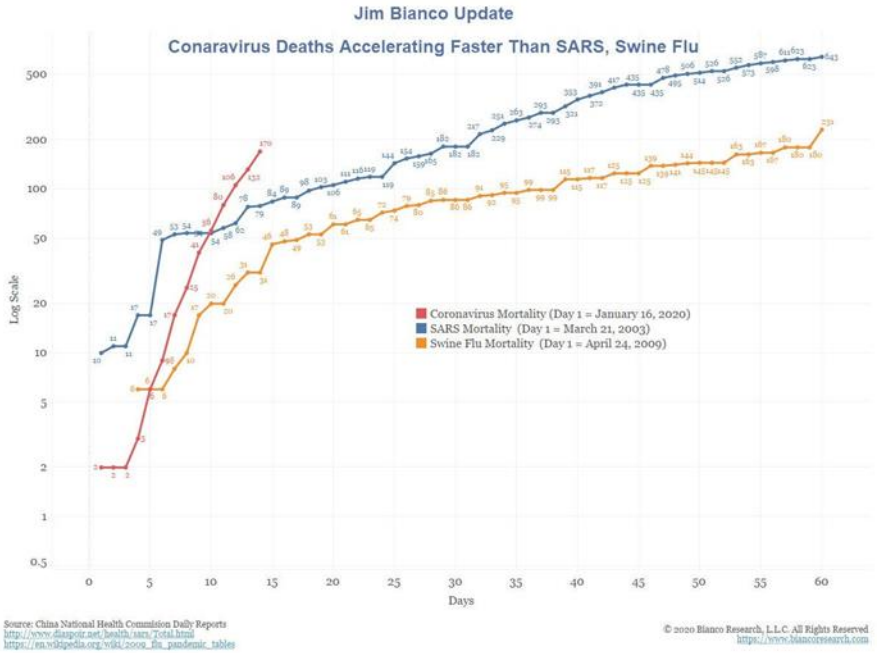
[新頭殼newtalk] 中國武漢肺炎疫情發燒，全球口罩需求量供不應求，行政院長蘇貞昌視察口罩工廠時指出，2月底或3月初，產能可拉高到每日千萬片，台灣將成為全球第2大口罩生產國。對此，有網友加碼爆料，指製造低單價低利潤醫療用口罩的產業，早在20多年前就外移，經濟部此次2個禮拜就開出60條生產線，台灣人真的要跪下來哭了，謝謝再謝謝！

網友「Ann Chang」在臉書曝光「怎麼生產醫療用口罩？」，指出3層厚的醫療用口罩最重要的是不織布那一層，利用不織布防水的特性阻隔飛沫傳播，而製作時必須採用超音波震動，將布料的四邊熱熔密合，才能達到醫療用防止傳染的要求。

Control vs Non-Control

- CoViD – 19（新型冠狀病毒肺炎）



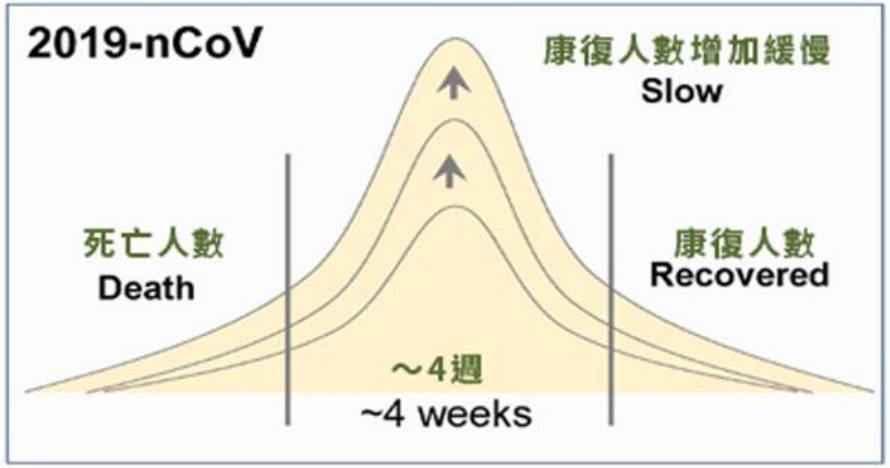


Control vs Non-Control

- CoViD – 19（新型冠狀病毒肺炎）
- 馬偕醫學院 學務長 張南驥教授

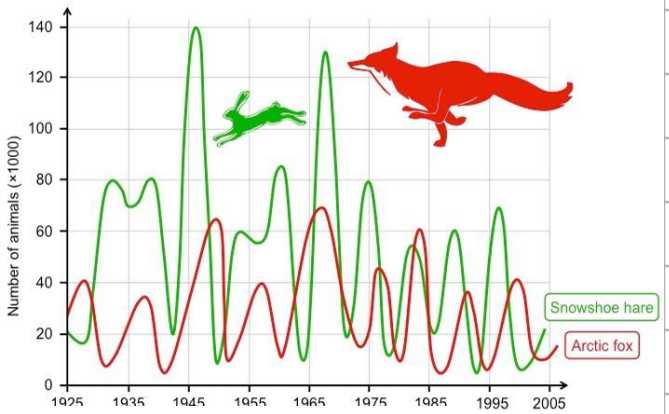
流感

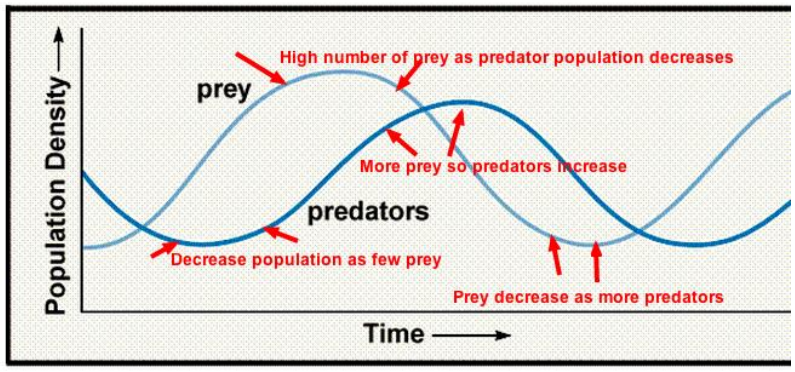
武漢肺炎

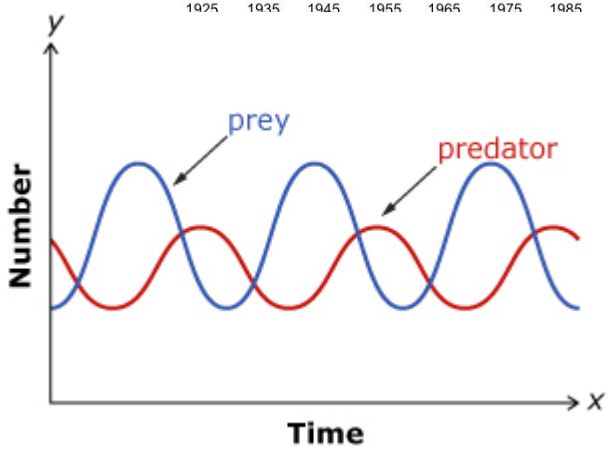


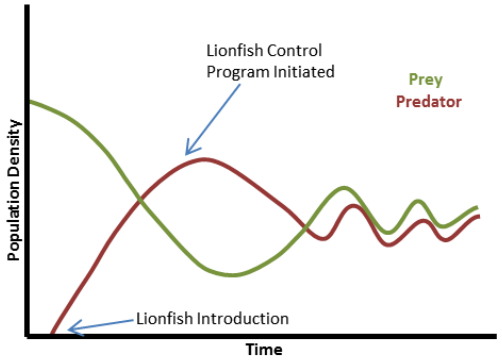
Control vs Non-Control

- Prey-Predatory（兔子與狐狸）









Control vs Non-Control

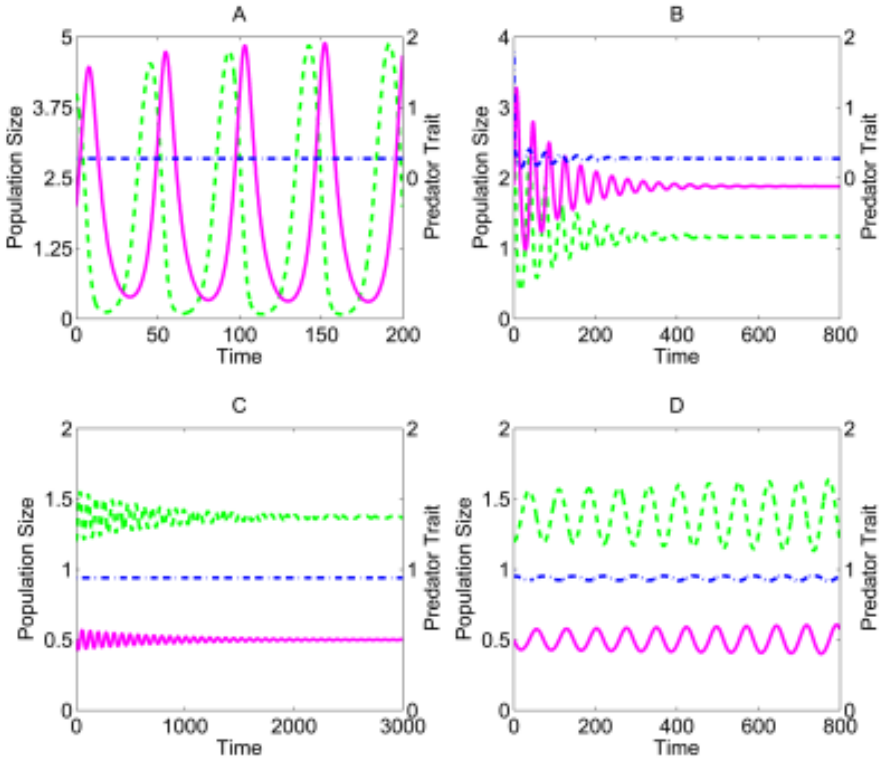
- Prey-Predatory（兔子與狐狸）

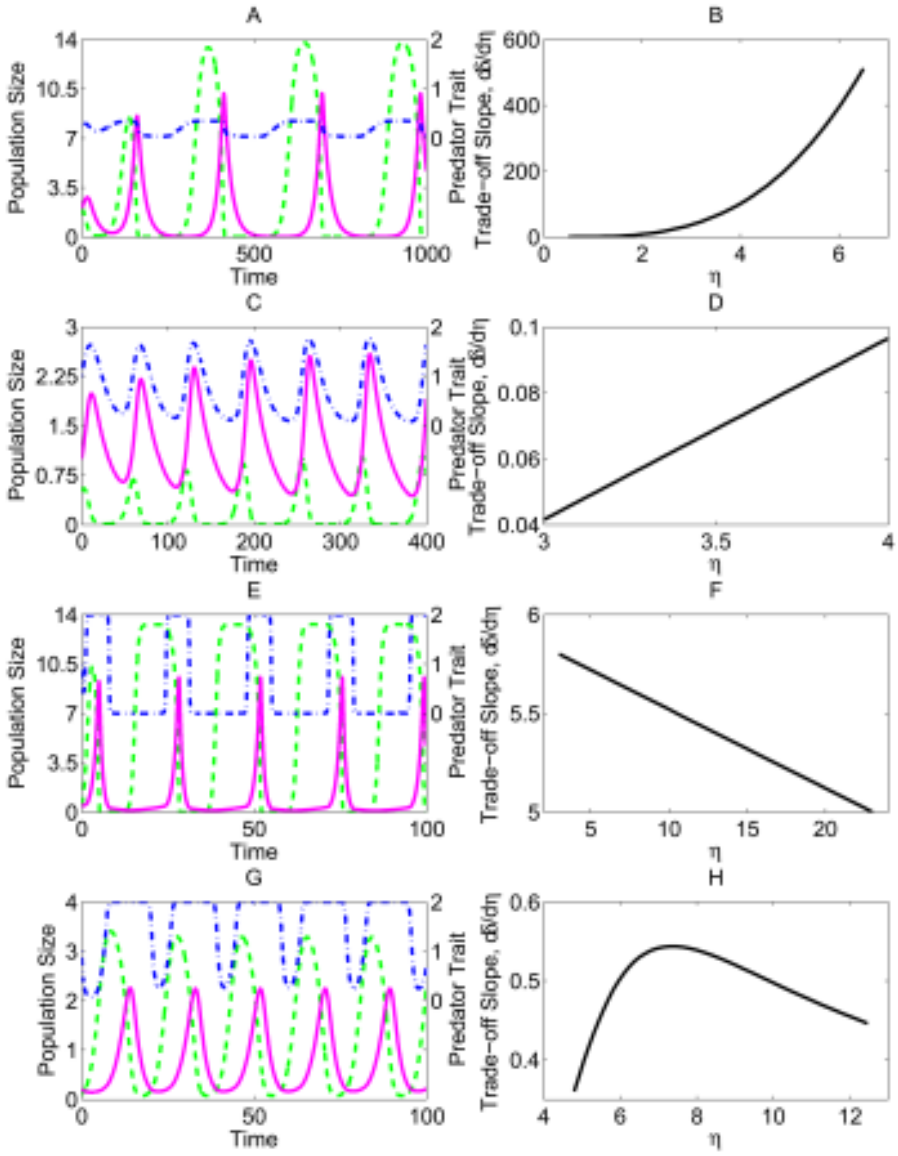
vol. 176, no. 5 the american naturalist november 2010

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]





Control vs Non-Control

- Prey-Predatory（兔子與狐狸）

Resilience Modeling by Means of a Set of Recursive Functions.

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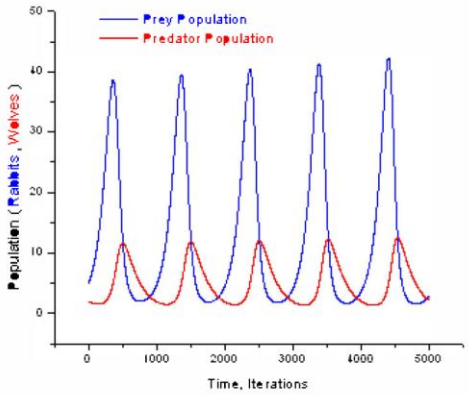
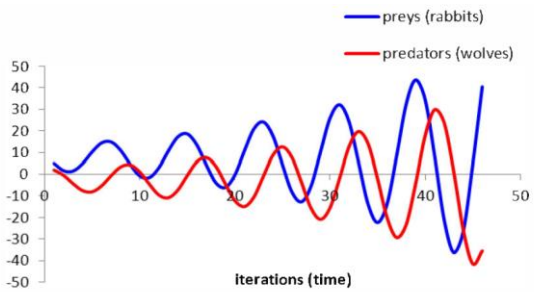
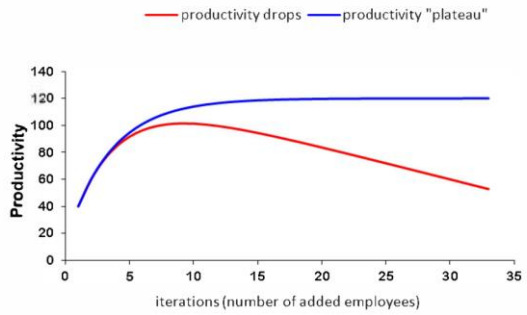
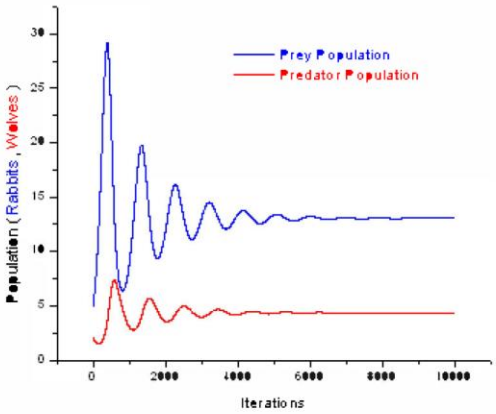
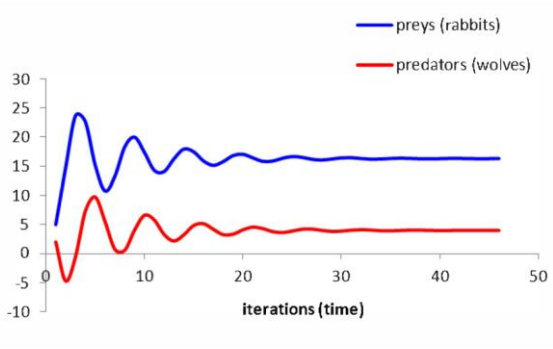
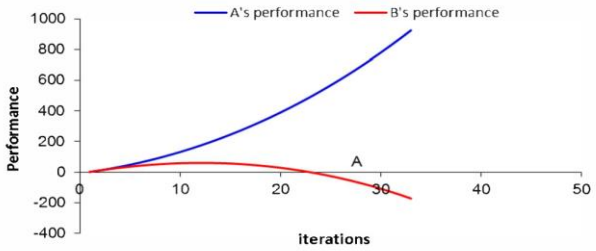


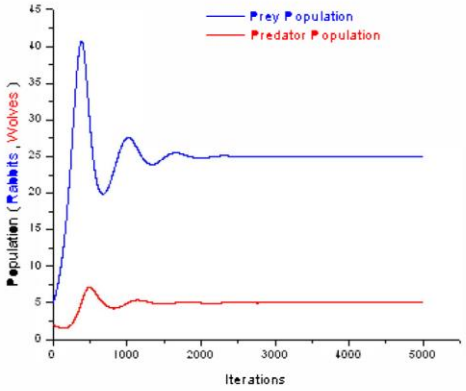


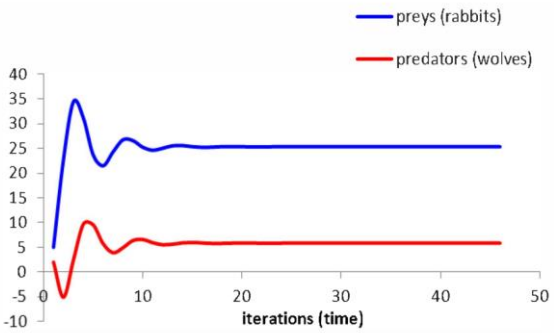




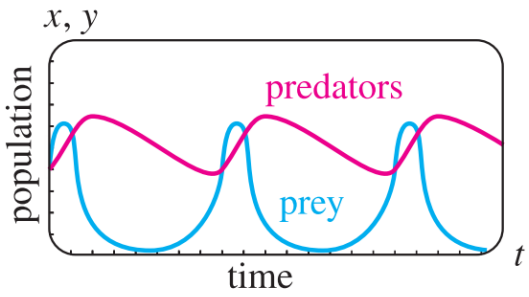






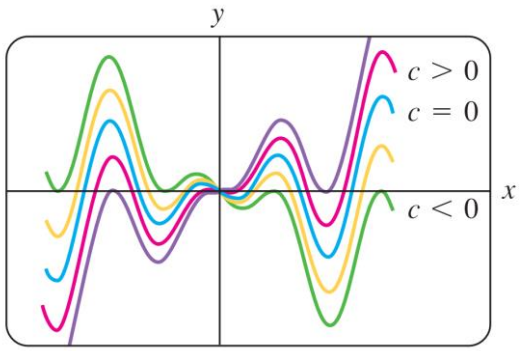


Understand the System by Differential Equations



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

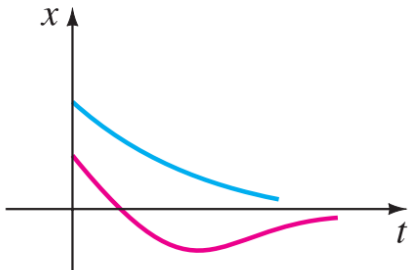
$$\frac{dy}{dt} = 4.5y - 0.9xy$$

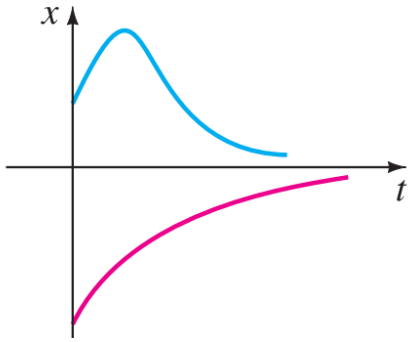


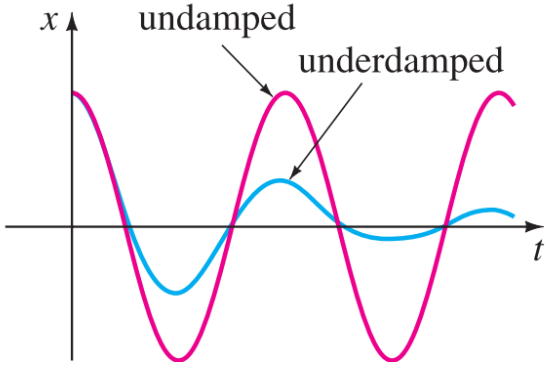
$$xy' - y = x^2 \sin x$$

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

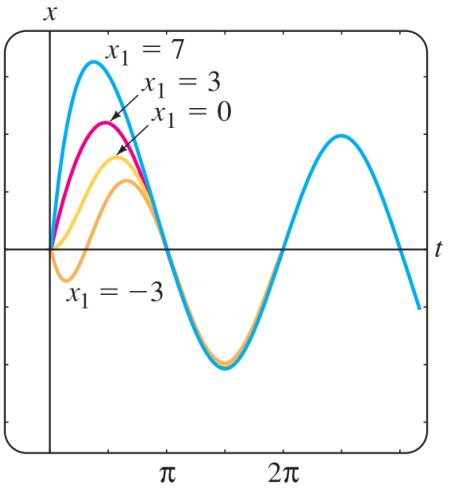
$$\frac{d^2x}{dt^2} + 2\lambda\frac{dx}{dt} + \omega^2 x = 0,$$

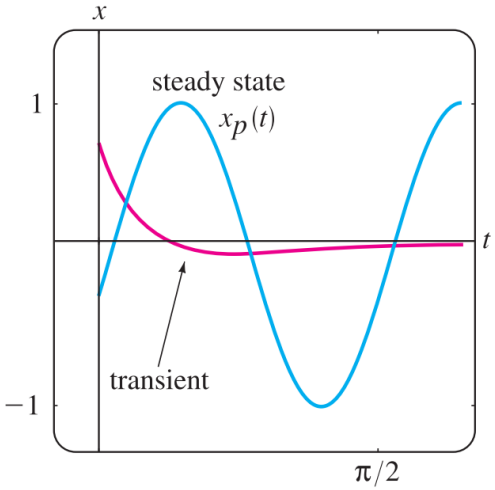






$$\frac{d^2x}{dt^2} + 2\lambda\frac{dx}{dt} + \omega^2 x = F(t),$$





Mobile Robots, Autonomous Driving Vehicles

http://cc.ee.ntu.edu.tw/~fengli/Research

- Google Self-Driving Cars in 2014

Source: https://youtu.be/TsaES--OTzM Time: 1:03 – 8:37

- 2020年的交通與生活 Toyota e-Palette

Source: https://www.youtube.com/watch?v=XmoPQuMlOYE
https://www.servicejdc.com/product/blog/item/60-20181015.html

Unmanned Arial Vehicles (UAV)

- Olympic Winter Games by Intel
- 2,000 Drones in Shanghai to Welcome New Year
- 2020 義大世界跨年夜《400台無人機視覺超震撼》
- 2020 台灣燈會無人機展演

https://youtu.be/eIk6j6dprnA

https://youtu.be/v05uHuJj7Hs

https://youtu.be/XS--SQMUeUY

https://youtu.be/XTUS3cfKUuc

https://news.ltn.com.tw/news/life/breakingnews/3077228

Three Layers of Control Tasks

- Top Layer:
  - For Multiple Agents (Group of Vehicles, Cars, Drones)

https://images.app.goo.gl/Zvqbjf3nsAFoLBFK8

https://images.app.goo.gl/FjoqLo13CQ8o4v83A

https://images.app.goo.gl/A9yhHUUEsoJKWPLj9

https://images.app.goo.gl/ErUGddRBXwdwr2b17

- Action:
  - 方向盤
  - 油門煞車
- Goal:
  - 位置/車道
  - 速度/方向

Three Layers of Control Tasks

Middle Layer:

- For Single Agent (Single Vehicle, Car, Drone)

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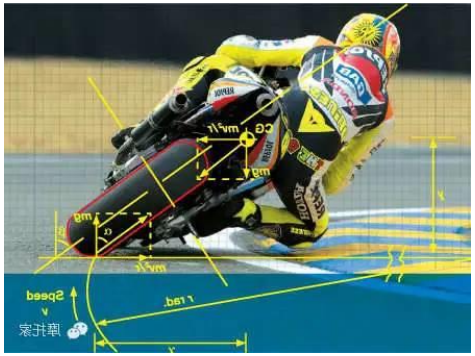


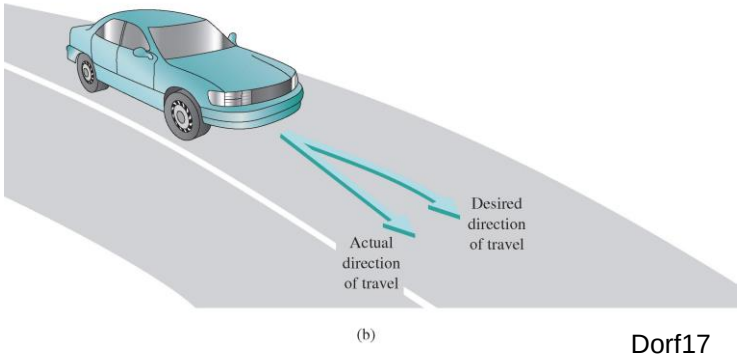
https://images.app.goo.gl/5p7G4g19ZayMYkb28

https://images.app.goo.gl/GzScsbcFTDPsaApJ8

- Action:
  - 統整四個輪子
  - 統整四個螺旋槳
- Goal:
  - 方向
  - 加減速

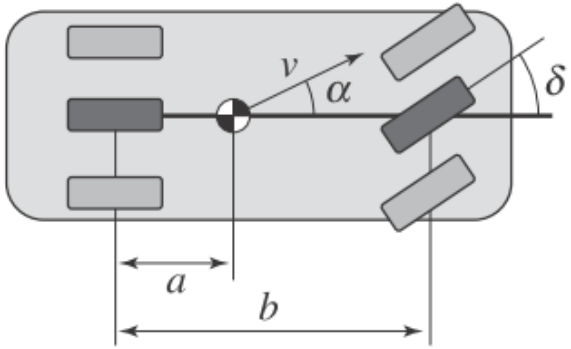
Three Layers of Control Tasks

- Middle Layer:
  - For Single Agent (Single Vehicle, Car, Drone)

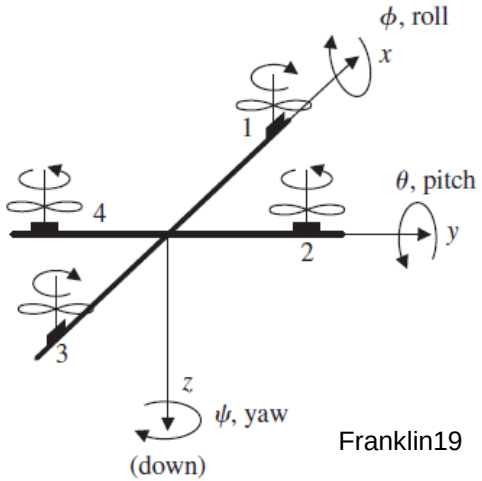


Dorf17

Franklin19



Astrom19

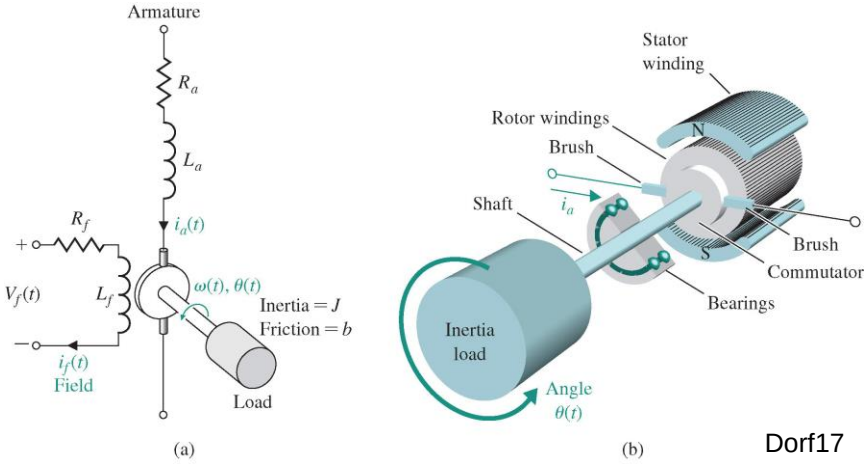


Franklin19

- Action:
  - 統整四個輪子
  - 統整四個螺旋槳
- Goal:
  - 方向
  - 加減速

Three Layers of Control Tasks

- **Bottom Layer:**
  - For Subsystems (Wheel, Motor, Engine, Gear Box, Braking)



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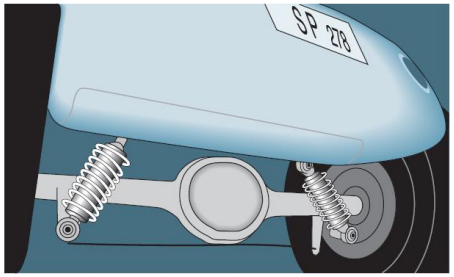
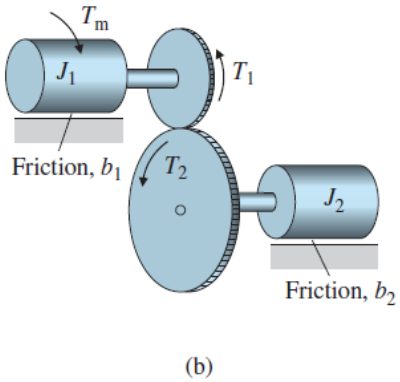


Franklin19



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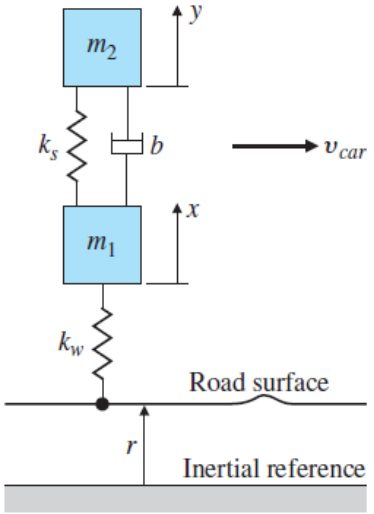


Franklin19

- **Action:**
  - 控制驅動電流/電壓
- **Goal:**
  - 每一個輪子/螺旋槳的轉速/轉角

Three Layers of Control Tasks

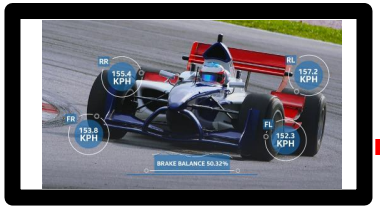
- **Top Layer:**
  - For Multiple Agents (Group of Vehicles, Cars, Drones)

➢ 方向盤
➢ 油門煞車

➢ 位置/車道
➢ 速度/方向

- **Middle Layer:**
  - For Single Agent (Single Vehicle, Car, Drone)

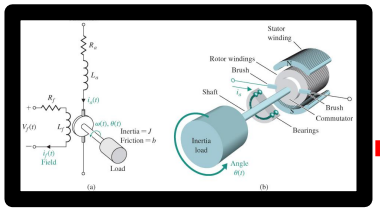
➢ 統整四個輪子
➢ 統整四個螺旋槳



➢ 方向
➢ 加減速

- **Bottom Layer:**
  - For Subsystems (Wheel, Motor, Engine, Gear Box, Braking)

➢ 控制驅動電流/電壓

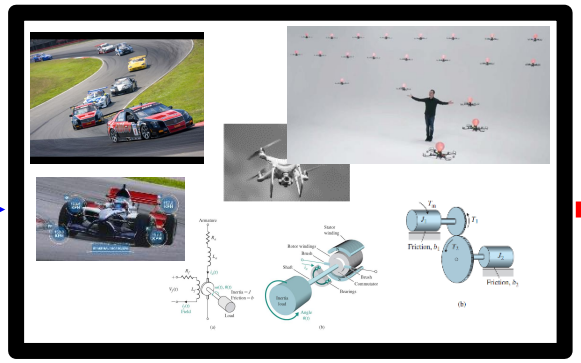


➢ 每一個輪子/螺旋槳的轉速/轉角

Plant, Input, Output, Action, Goal

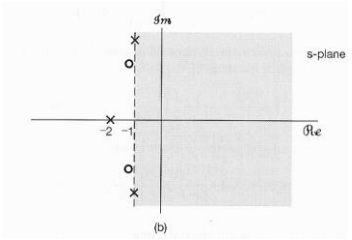
Plant (P)

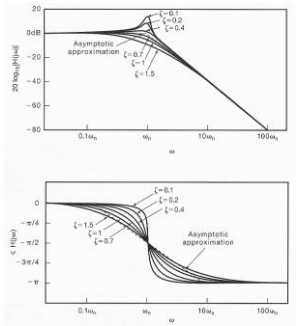
Ref (r) → Input (u) → Plant (P) → Output (y)



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

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





Output (y) → Controller → Input (u)

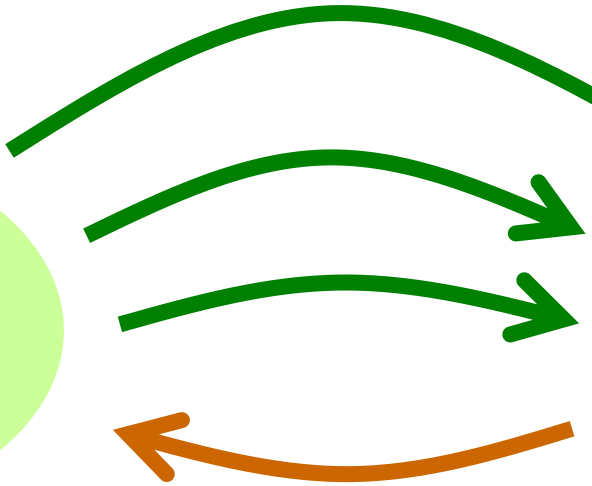
1. Model
2. Response
3. Analysis
4. Feedback
5. Control

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

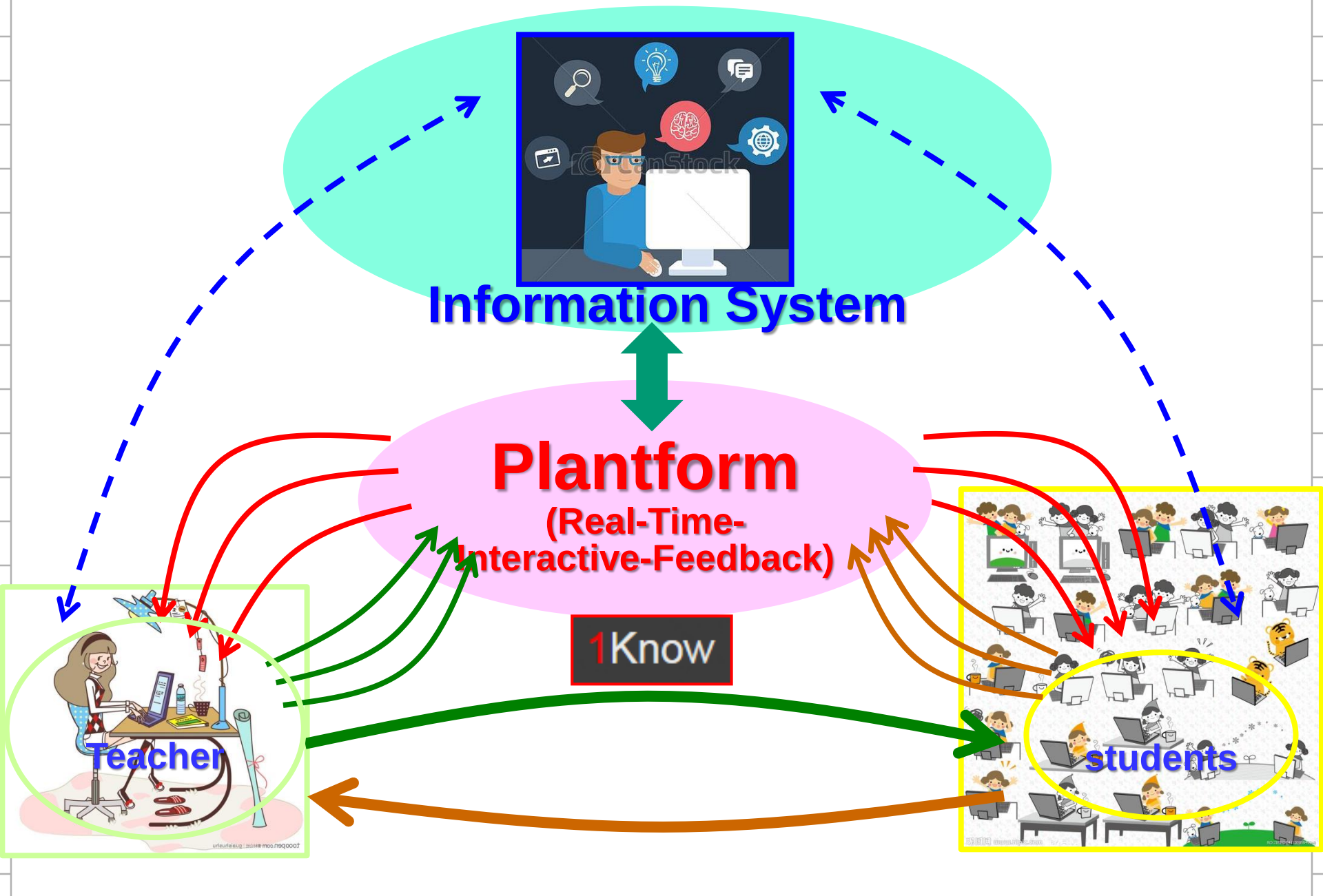
$$G(s) = \frac{Y(s)}{R(s)} = \frac{3}{s^2 + 4s + 3}$$

Feedback and Control in Teaching and Learning

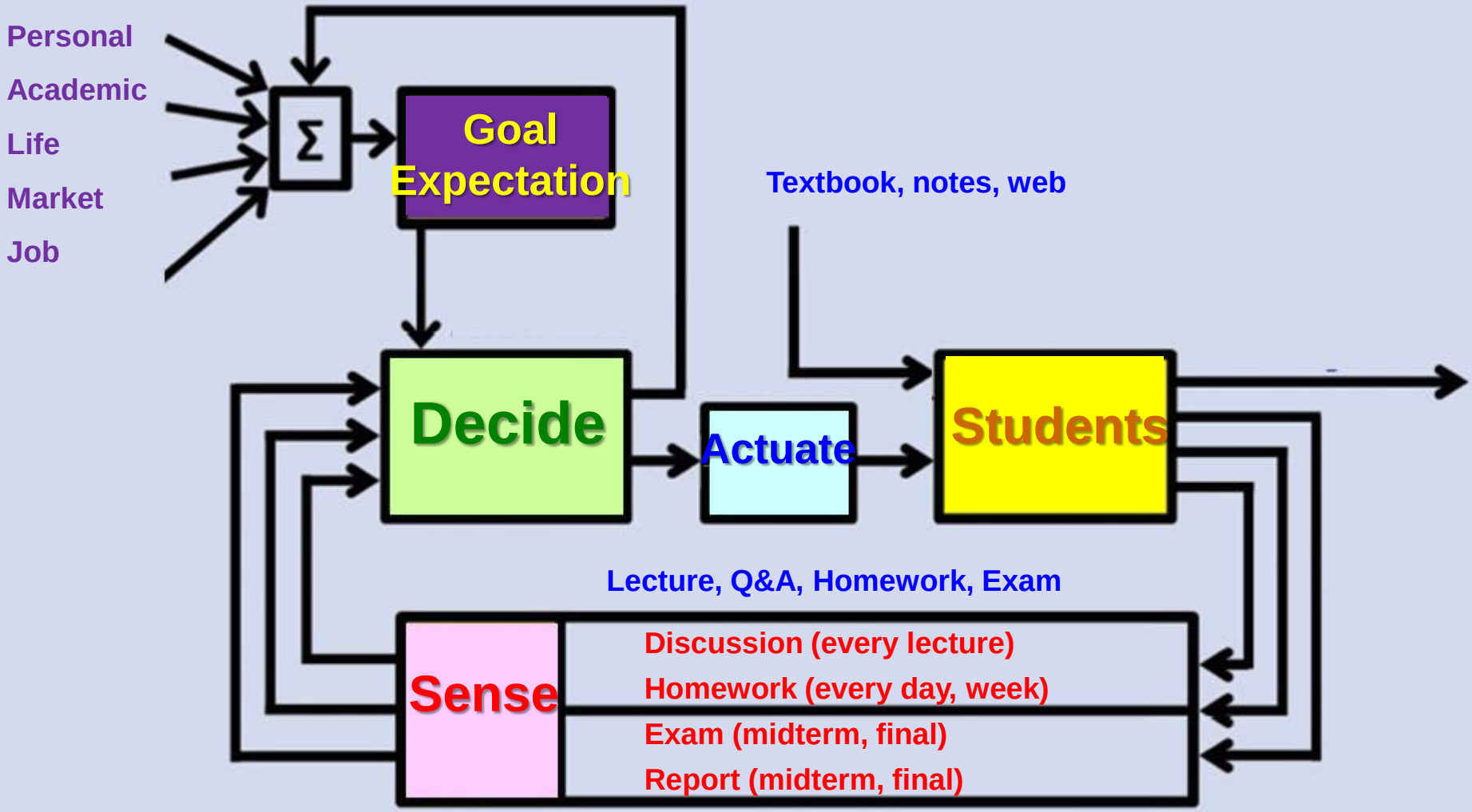
Teacher



Students


Information System
Plantform
(Real-Time-
Interactive-Feedback)
1Know
Teacher
students

Feedback and Control in Teaching and Learning



Source：IEEE CSM 2013

Key Terminologies in Feedback and Control

- Manual Control
- Automatic Control

- Open-Loop Control
- Closed-Loop Control or Feedback Control

- Regulation
- Tracking or Servo System

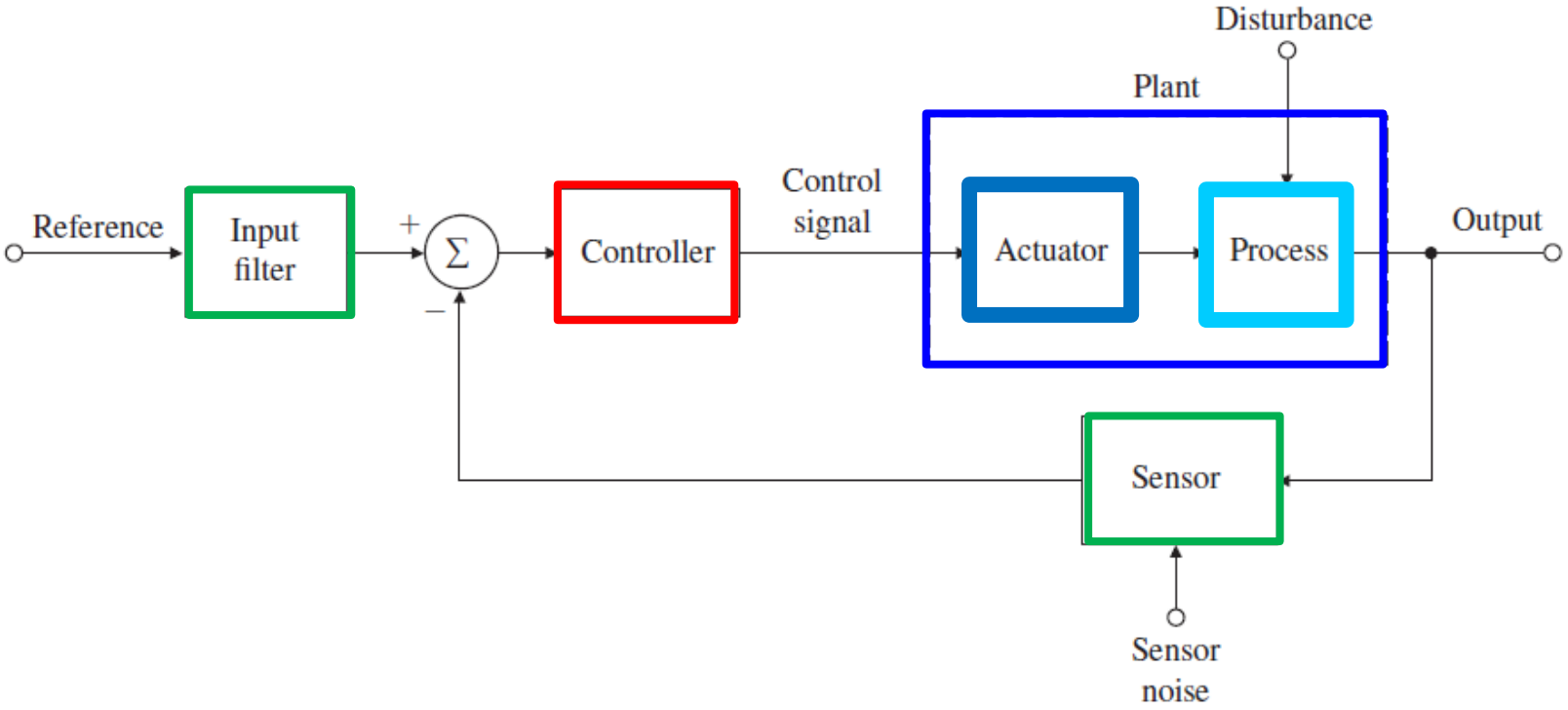
- Feedback
- Feedforward
- Control as a hidden technology

- Systems, Subsystems, Signal/Information Flow
- Process, Plant,
  Actuator, Sensor, Filter, Controller, Compensator

Key Terminologies in Feedback and Control

- Goals:
  - Stability
  - Tracking
  - Disturbance Rejection
  - Robustness
- Classic Control
- Modern Control

Key Terminologies in Feedback and Control



- **Modeling**: the plant
- **Analysis**: the plant
- **Design**: the controller for the plant