Fun courses in DOC (ꂯˇ‿ˇꂯ)
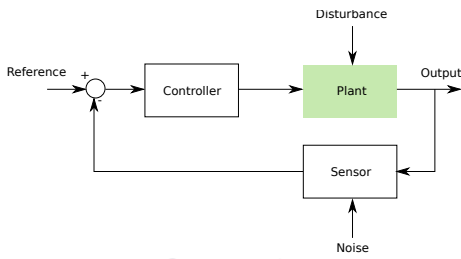
Data Analytics, Optimization, and Control

Prepared by Jitkomut Songsiri (JSS)

System Dynamics and Control

\\(^ o ^)/
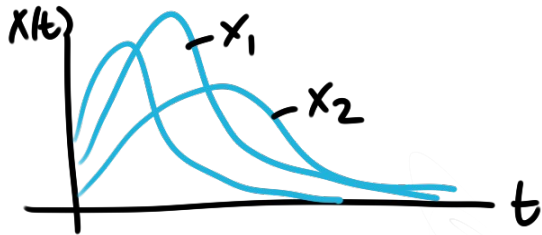
EE432 LINCON 2

$$\dot{x} = Ax + Bu$$
$$y = Cx + Du$$

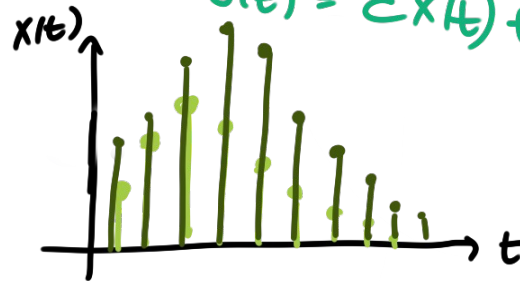$x(t)$

X_1

X_2

t

CT ● DT

EE 433 DIGITAL CONTROL

$$x(t+1) = A\,x(t) + Bu(t)$$
$$y(t) = Cx(t) + D\,u(t)$$

$x(t)$

t

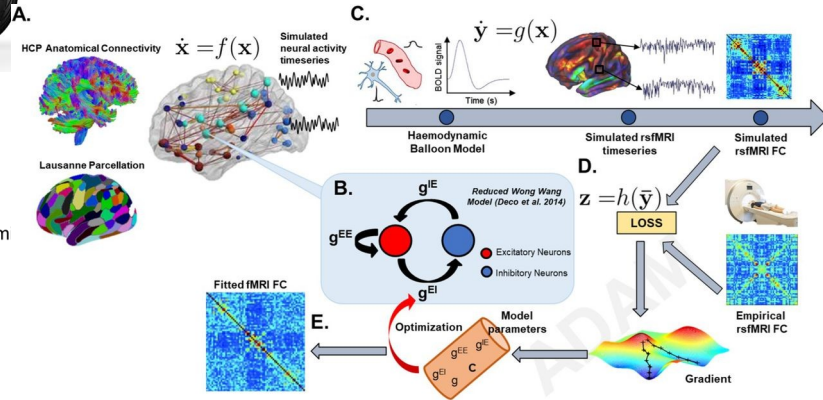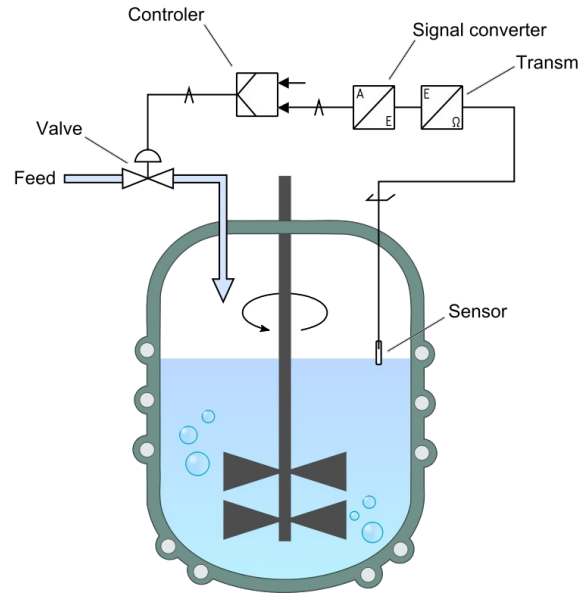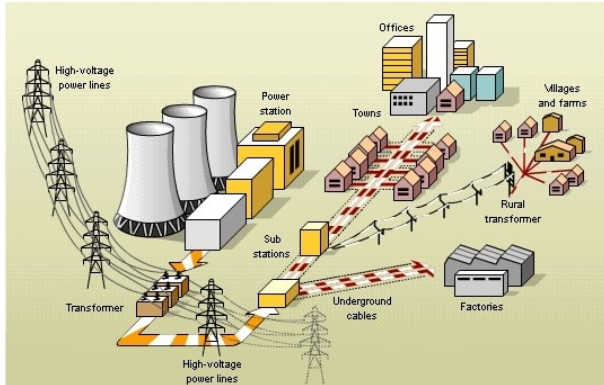**EE 536 NONLINEAR CONTROL**

$$\dot{x} = f(x, u)$$
$$y = g(x, u)$$

x_2

x_1

$$\frac{d}{dt}\begin{bmatrix} \theta \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} \dot{\theta} \\ \dfrac{mg\ell \sin\theta}{J} - \dfrac{r\dot{\theta}}{J} + \dfrac{\ell\cos\theta\, u}{J} \end{bmatrix}$$

Applications

A. HCP Anatomical Connectivity

Lausanne Parcellation

$\dot{\mathbf{x}} = f(\mathbf{x})$ Simulated neural activity timeseries

Haemodynamic Balloon Model

C. $\dot{\mathbf{y}} = g(\mathbf{x})$

Simulated rsfMRI timeseries Simulated rsfMRI FC

B. g^{IE} Reduced Wong Wang Model (Deco et al. 2014)

g^{EE}

g^{EI}

Excitatory Neurons
Inhibitory Neurons

D. $\mathbf{z} = h(\bar{\mathbf{y}})$

LOSS

Empirical rsfMRI FC

E. Optimization Model parameters g^{EE} g^{EI} g C

Gradient

Fitted fMRI FC

Controler

Signal converter

Transm

Valve

Feed

A
E

E
Ω

Sensor

High-voltage power lines

Power station

Offices

Towns

Villages and farms

Sub stations

Rural transformer

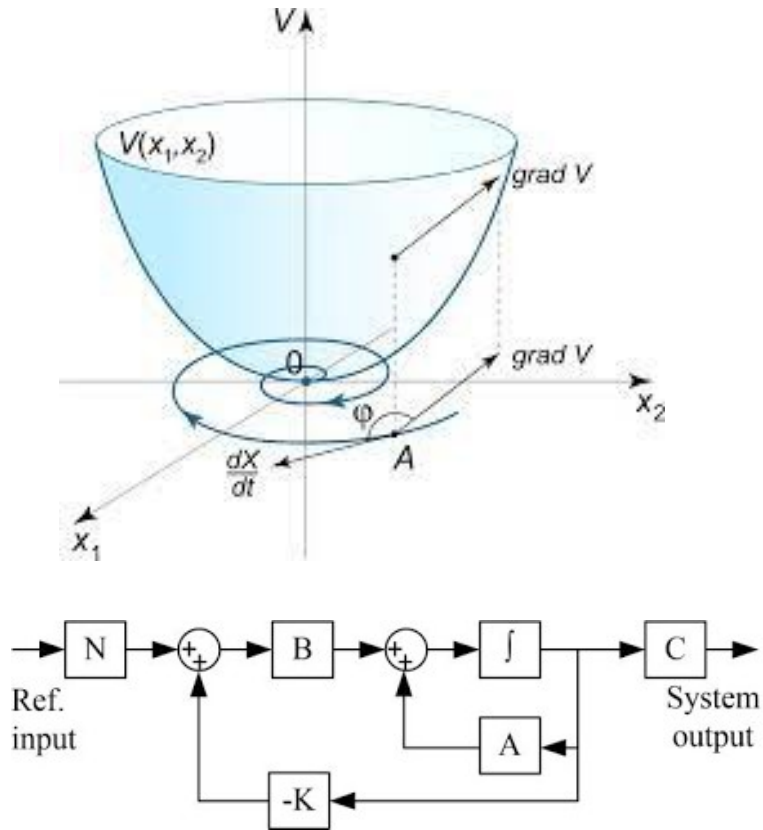Transformer

Underground cables

Factories

High-voltage power lines

Robotic, drone, aircraft, power system, chemical process, neural system, epidemiology, and more
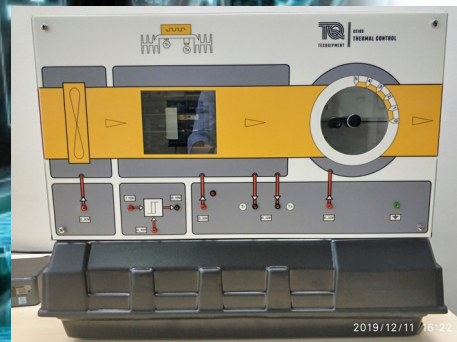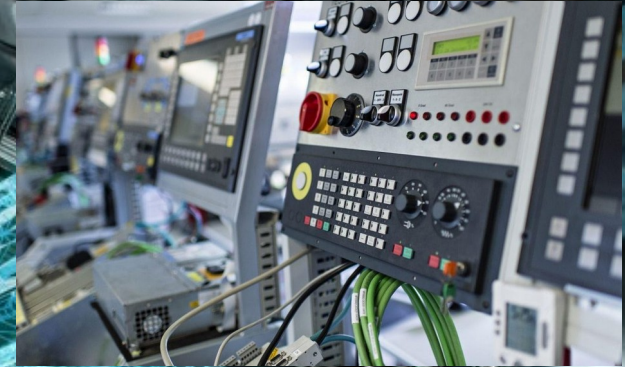
Controller design

- PID
- State feedback and observer design
- Lyapunov theory
- Optimal controller (LQR, LQG)
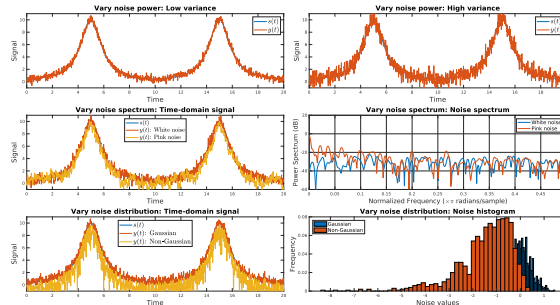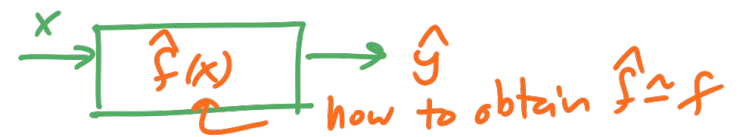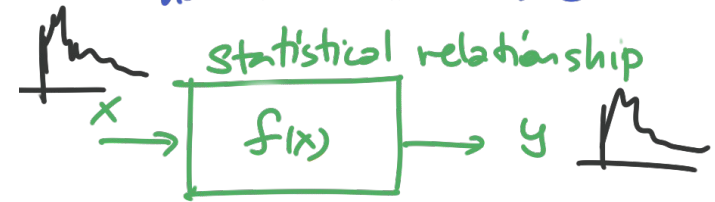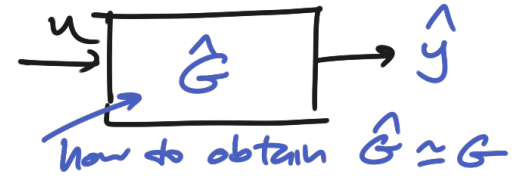- Robust control
- Iterative learning control

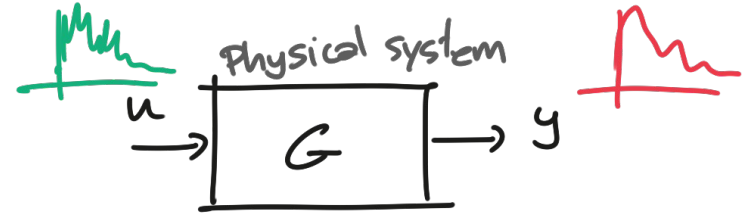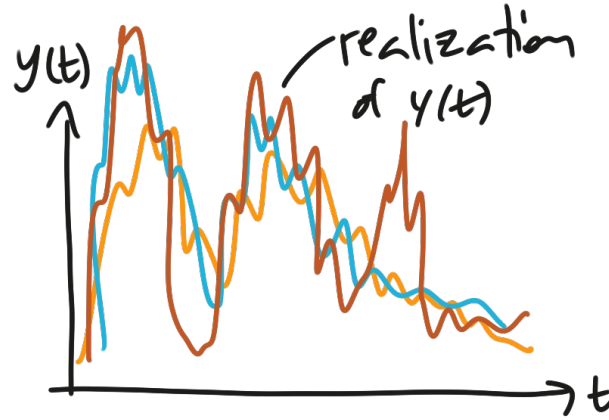# Control applications

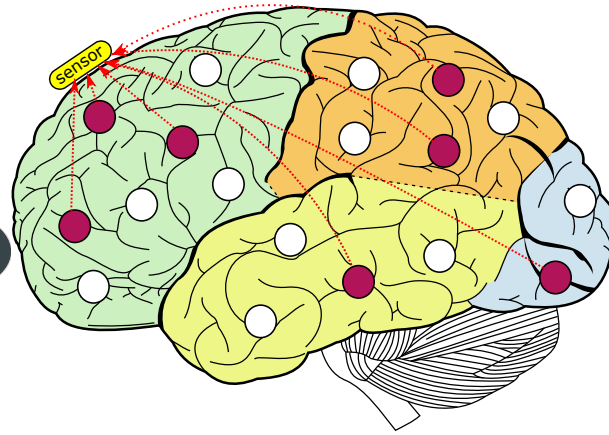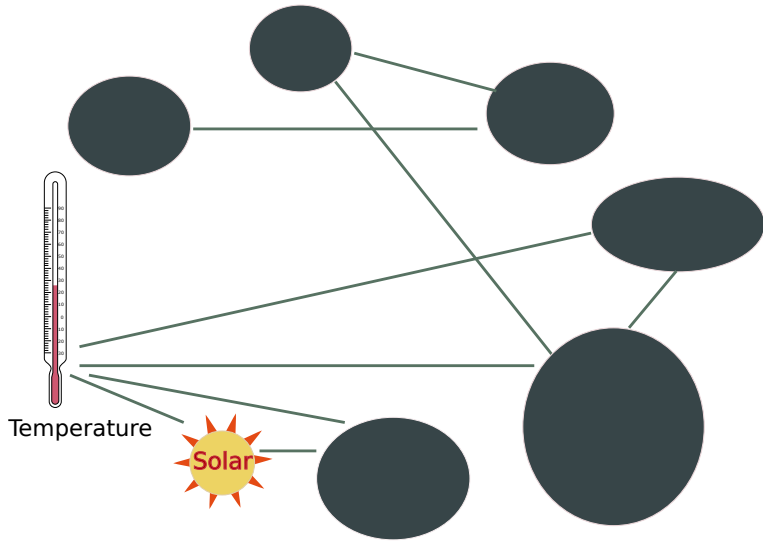- EE435 Industrial Automation

- EE436 Control laboratory

System Modeling : Probabilistic approach

- **EE401/501** Random process

- **EE523** Estimation theory

- **EE521** System Identification

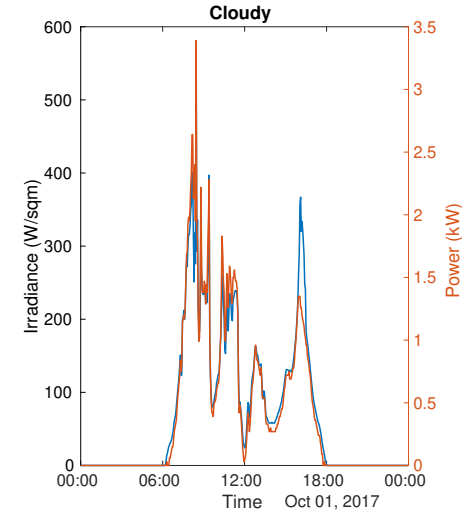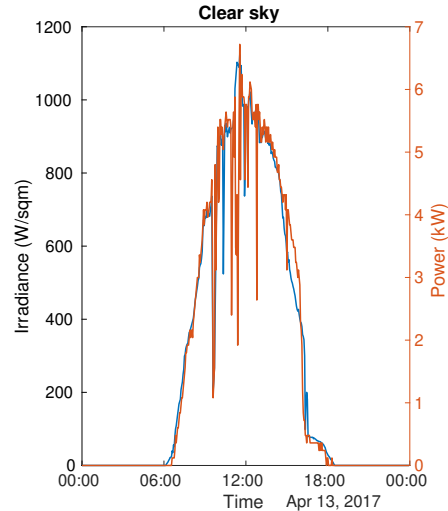- **EE575** Statistical inference and modeling

same foundation for machine learning and data analytics

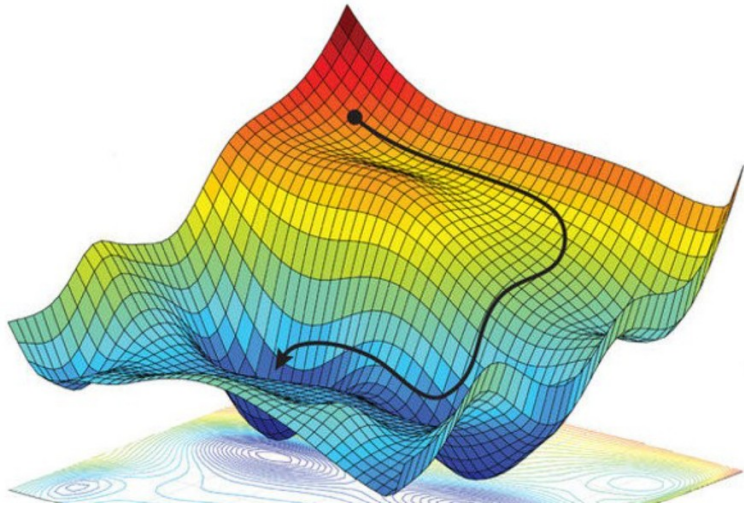# Applications of model estimation

Neuroscience
environmental systems
solar energy

and many more ...

Optimization concept (っ ^3^)♪🎵

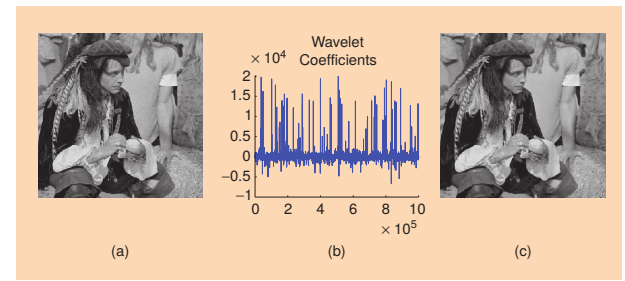

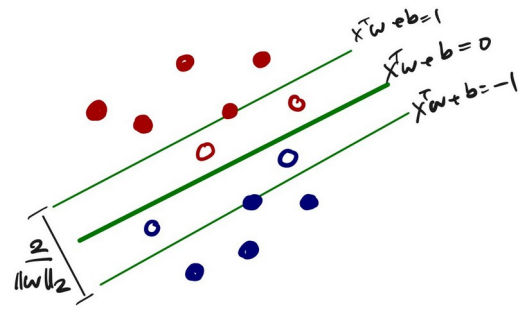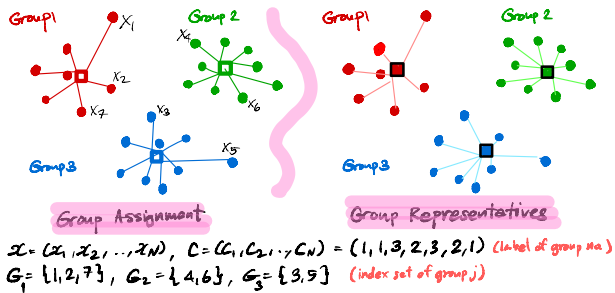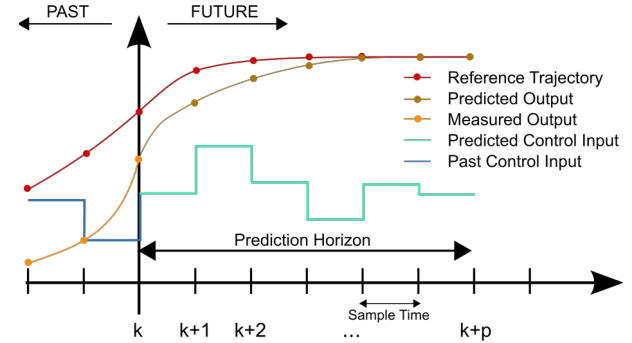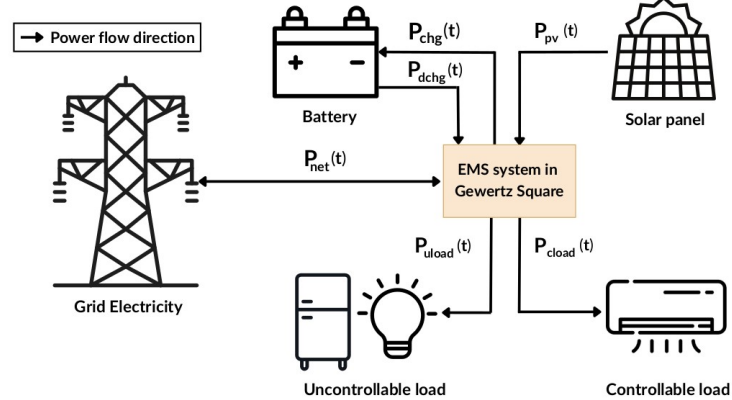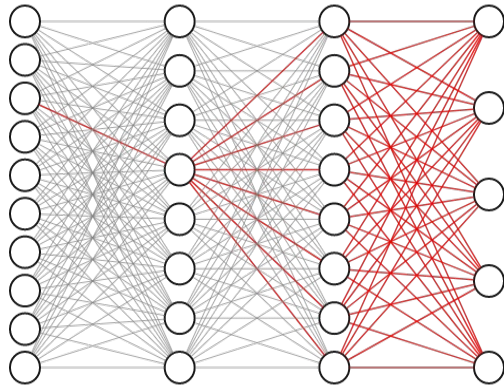How to select a variable to minimize some loss function

Minimize f(x) subject x is in a set

Minimize fuel cost (v) + travel time (v)
Subject to   80 <= v <= 120 km/h

EE508, 509, 510, 511, 512 **Optimization concepts**, techniques, linear program, engineering & ML applications, heuristic techniques
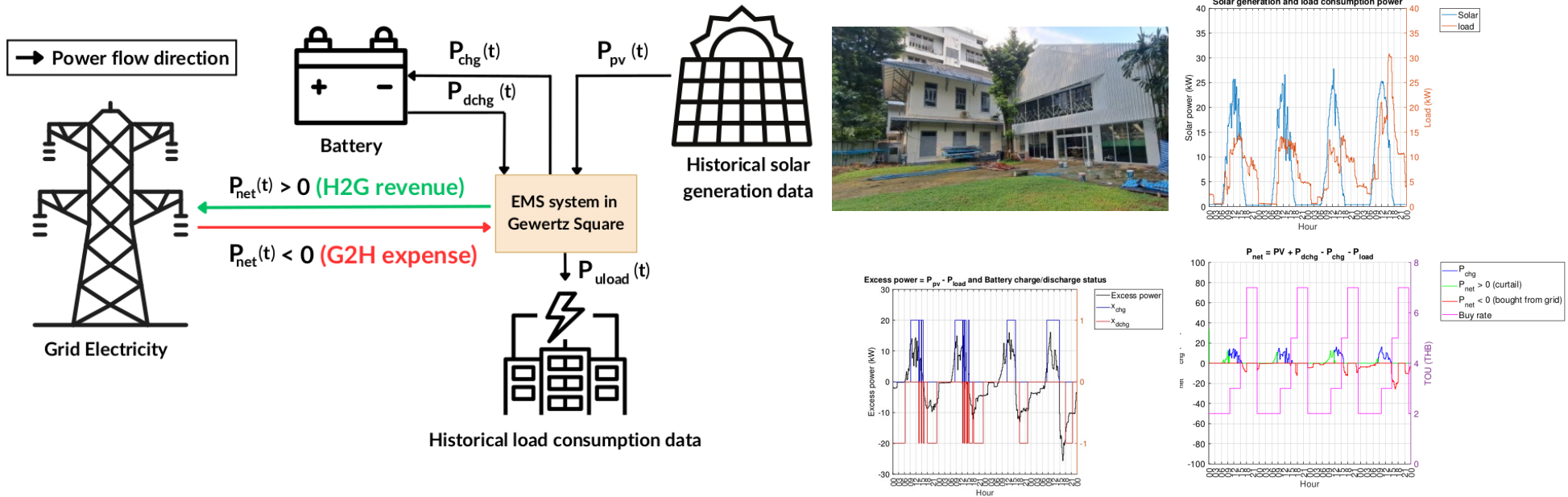
Optimization applications

EE508, 509, 510, 511, 512 **Optimization concepts**, techniques, linear program, **engineering & ML applications**, heuristic techniques

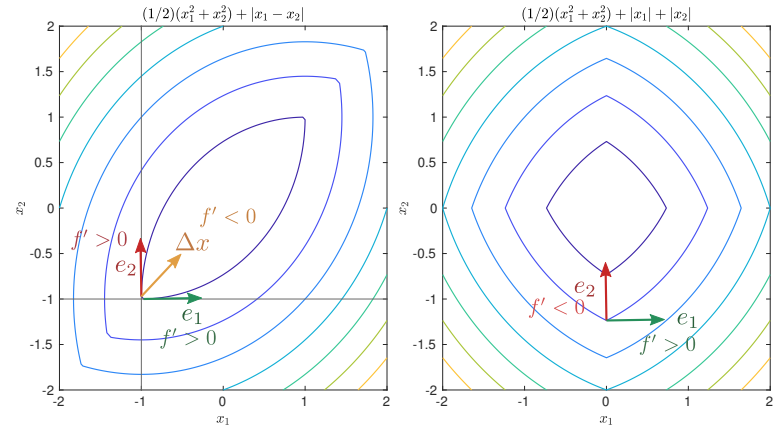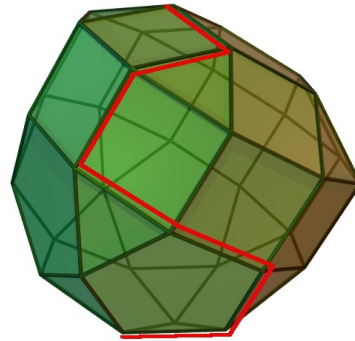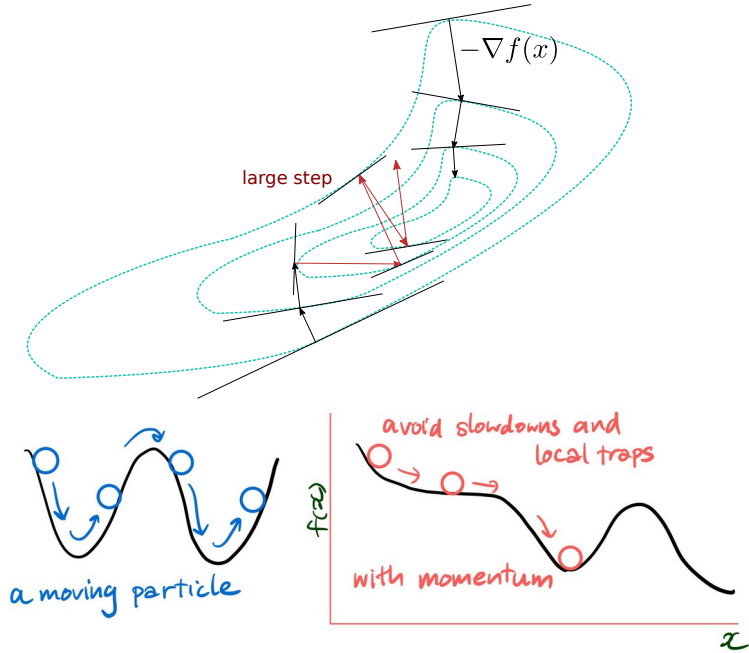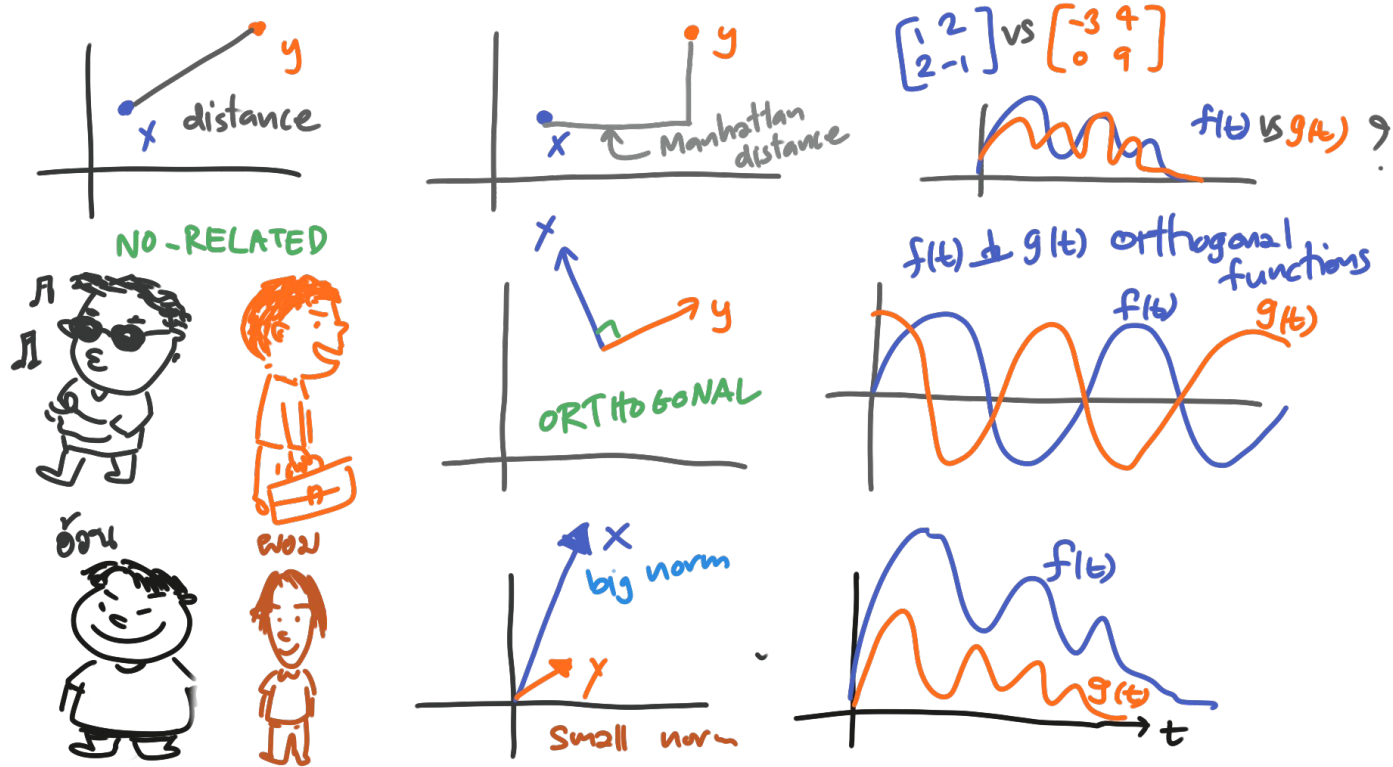# Optimization application: EMS@ Gewertz Square Ꮣ(ò.ȯ.ó)Ꮛ

EE508, 509, **510**, 511, 512 Optimization concepts, techniques, **linear program**, engineering & ML applications, heuristic techniques

Optimization techniques (•̀ᴗ•́)و

EE508, **509, 510, 511, 512** Optimization concepts, **techniques, linear program, engineering & ML applications, heuristic techniques**

Build up your foundation <(→_←")>

- EE500 (linear algebra), EE504 (intro to math analysis)

DOC Course map (*・_・)ノ⌒*:・゚✧

https://ee.eng.chula.ac.th/data-analytics-dta/