Introduction

Industrial AI Lab.

Prof. Seungchul Lee

Course Information For MECH490

- Course title: AI for ME (= Machine Learning)

- Instructor: Prof. Seungchul Lee
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- TAs: TBD
  - Will be announced later
  - Office: 5-427

Introduction

- 2018 - present: POSTECH
  - Industrial AI Lab.
- 2013 - 2017: UNIST
  - iSystems Design Lab.
- 2010, Ph.D. from the University of Michigan, Ann Arbor
  - S. M. Wu Manufacturing Research Center
  - The Center of Intelligent Maintenance Systems (IMS)
- 2008, M.S. from the University of Michigan, Ann Arbor
- 2005, B.S. of Electrical Engineering from Seoul National University
- 2001, B.S. of Mechanical Engineering from Seoul National University

Course Information For MECH490

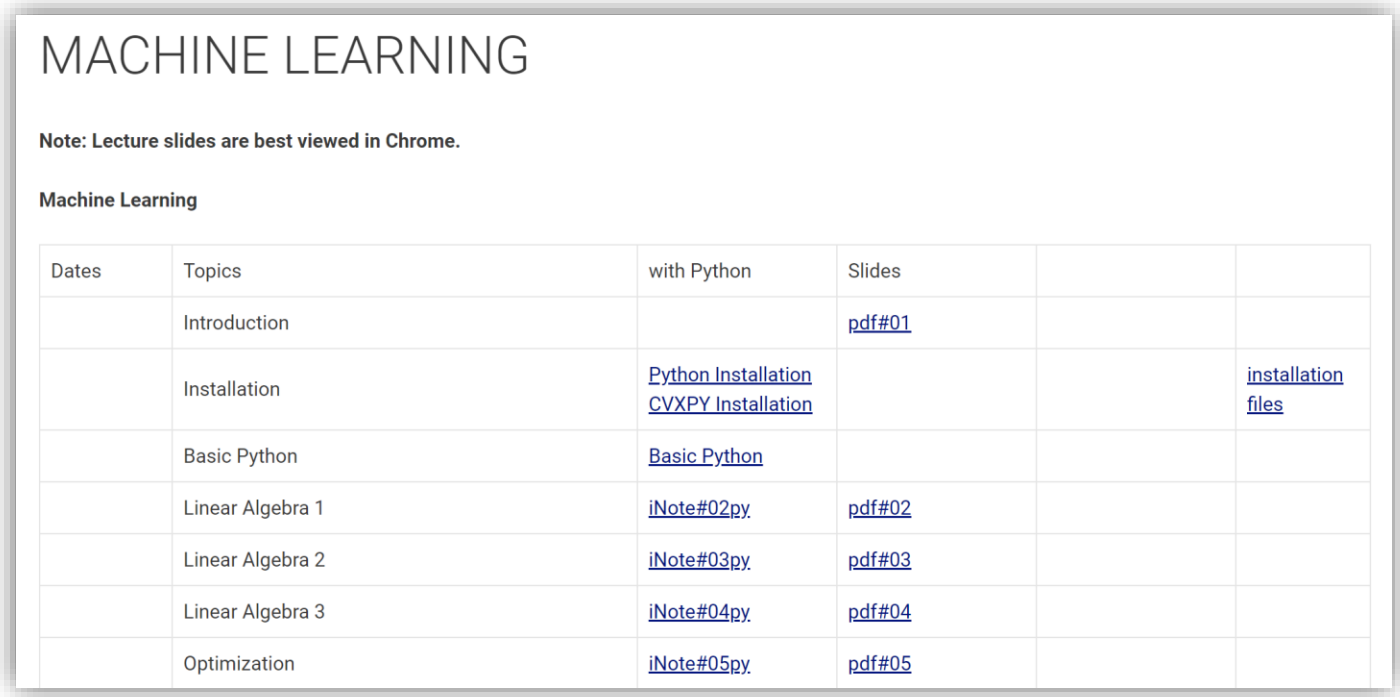
- Basic knowledge for machine learning
  - Linear algebra
  - Optimization
  - Statistical and probabilistic approaches

- Python in class and assignments
  - Used a lot
  - I highly recommend not to take this course for those who are not familiar with coding
  - Lots of coding problems in both homework and exam

- Grading
  - Two in-class exams (30% + 35%)
  - Many assignments (25%)
  - Class participation (10%)

Lecture Materials

- All lecture materials are already available at
  - http://iai.postech.ac.kr/index.php/machine-learning/
  - Homework assignments (with an email notice)
- Minor changes can be made as semester goes



MACHINE LEARNING

Note: Lecture slides are best viewed in Chrome.

Machine Learning

Dates	Topics	with Python	Slides		
	Introduction		pdf#01		
	Installation	Python Installation CVXPY Installation			installation files
	Basic Python	Basic Python			
	Linear Algebra 1	iNote#02py	pdf#02		
	Linear Algebra 2	iNote#03py	pdf#03		
	Linear Algebra 3	iNote#04py	pdf#04		
	Optimization	iNote#05py	pdf#05		

Communication Channel

- Communication will mainly be done through LMS
  - Announcement
  - Group e-mail

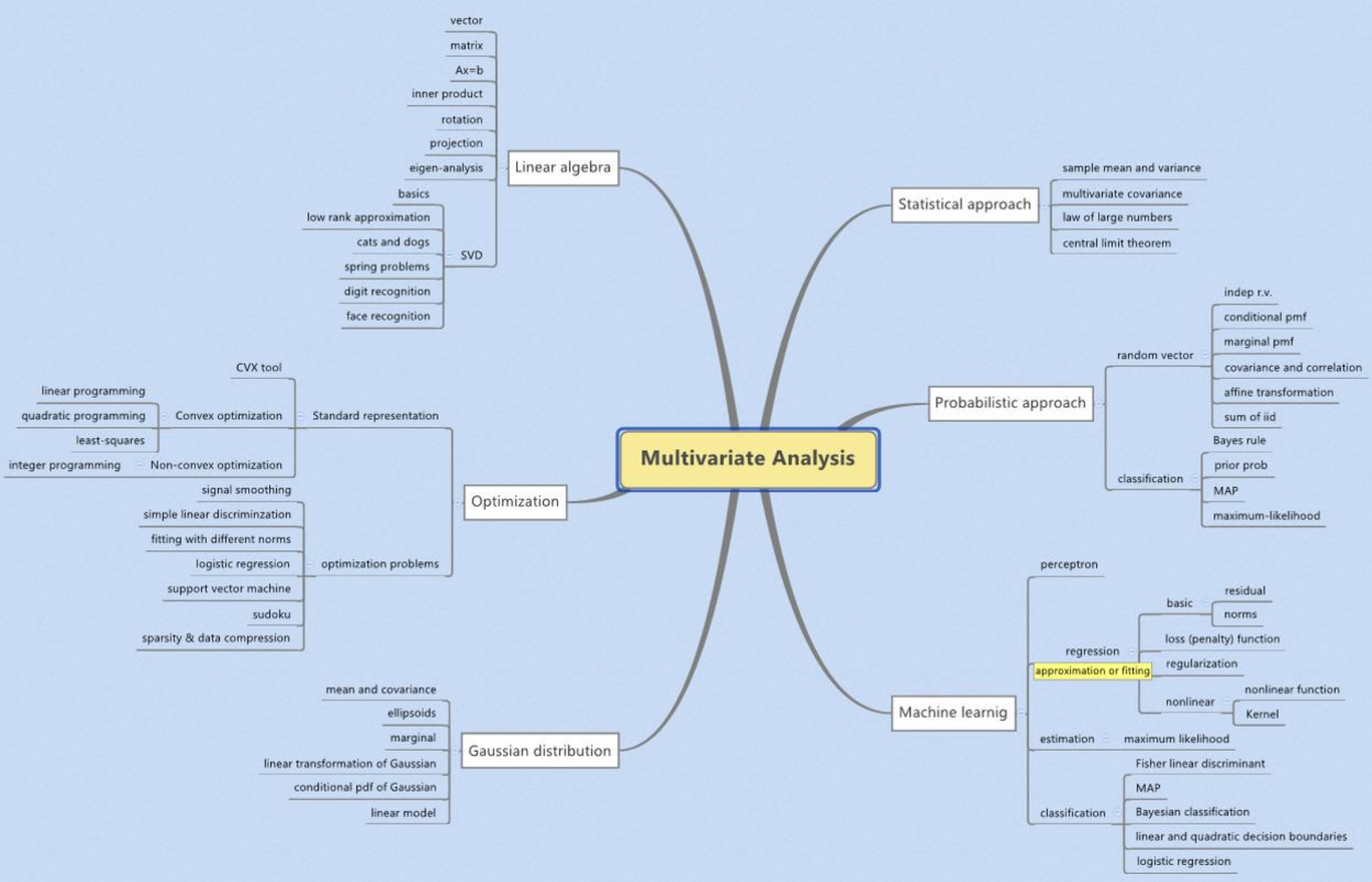
Registration Status

- 40 students are registered
  - 20 Graduates
  - 20 Undergraduates

- I will consider them as two separate groups.
  - Final letter grades will be evaluated based on the total scores in each group

What Will We Cover?

Course Roadmap



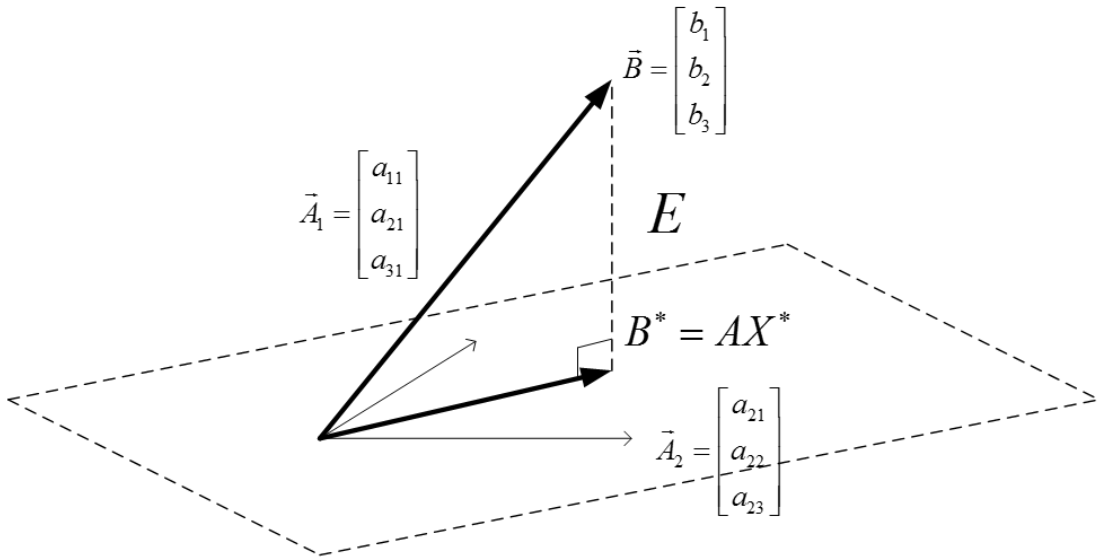
Python

- Python coding example

```
y = np.empty([m,1])

# Run K-means
for n_iter in range(500):
    for i in range(m):
        d0 = np.linalg.norm(X[i,:] - mu[0,:],2)
        d1 = np.linalg.norm(X[i,:] - mu[1,:],2)
        d2 = np.linalg.norm(X[i,:] - mu[2,:],2)

        y[i] = np.argmin([d0, d1, d2])

    err = 0
    for i in range(k):
        mu[i,:] = np.mean(X[np.where(y == i)[0]], axis=0)
        err += np.linalg.norm(pre_mu[i,:] - mu[i,:],2)

    pre_mu = mu.copy()

    if err < 1e-10:
        print("Iteration:", n_iter)
        break
```

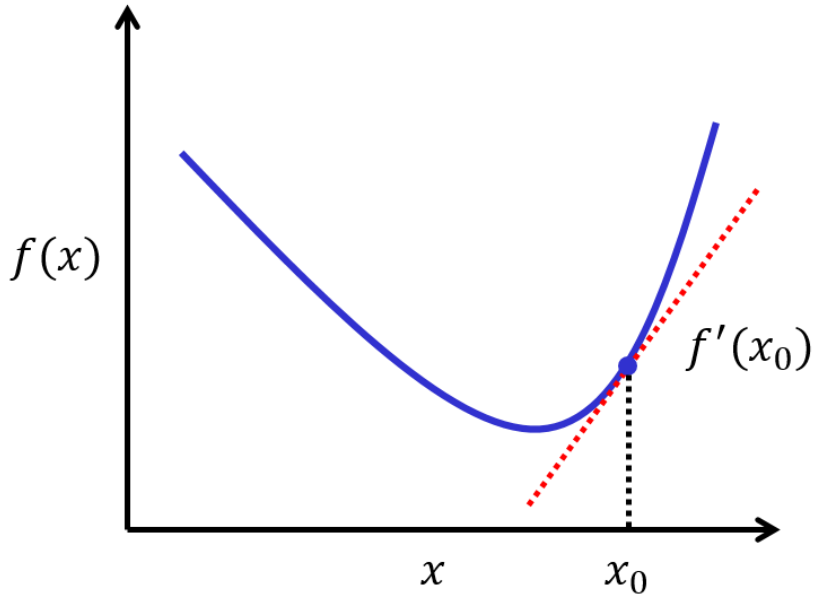
Linear Algebra

- Vector and Matrix
- $Ax = b$
- Projection
- Eigen analysis
- Least squares



Optimization

- Least squares
- Convex optimization (cvx or cvxpy)
- Gradient descent



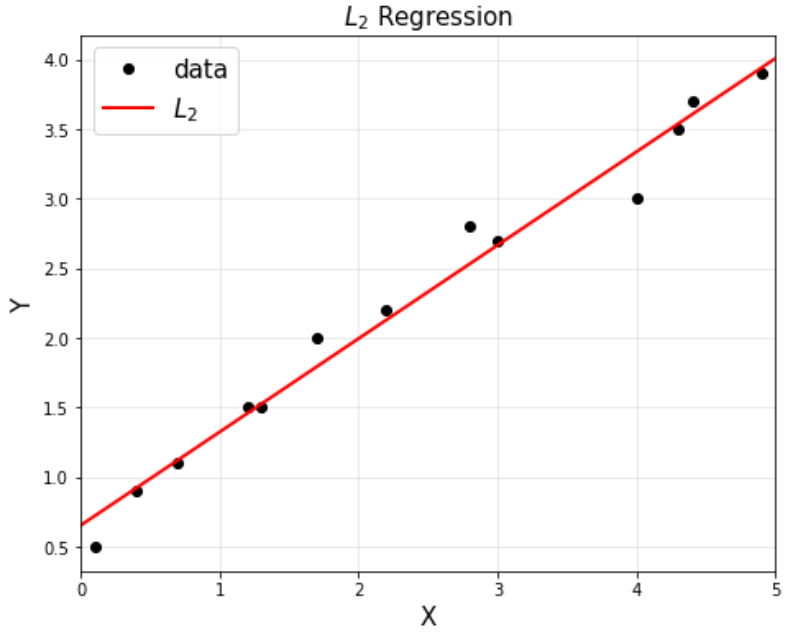
Statistics and Probability

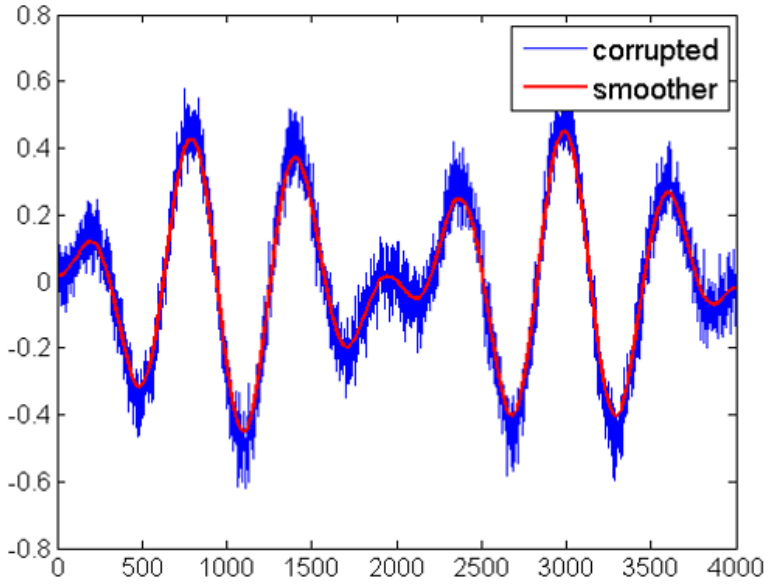
- Statistics
  - Law of large numbers, central limit theorem
  - Correlation
  - Monte Carlo simulation

- Probability
  - Random variable, Gaussian density distribution, conditional probability
  - maximum likelihood (MLE), maximum a posterior (MAP), Bayesian thinking

Regression (Data Fitting or Approximation)

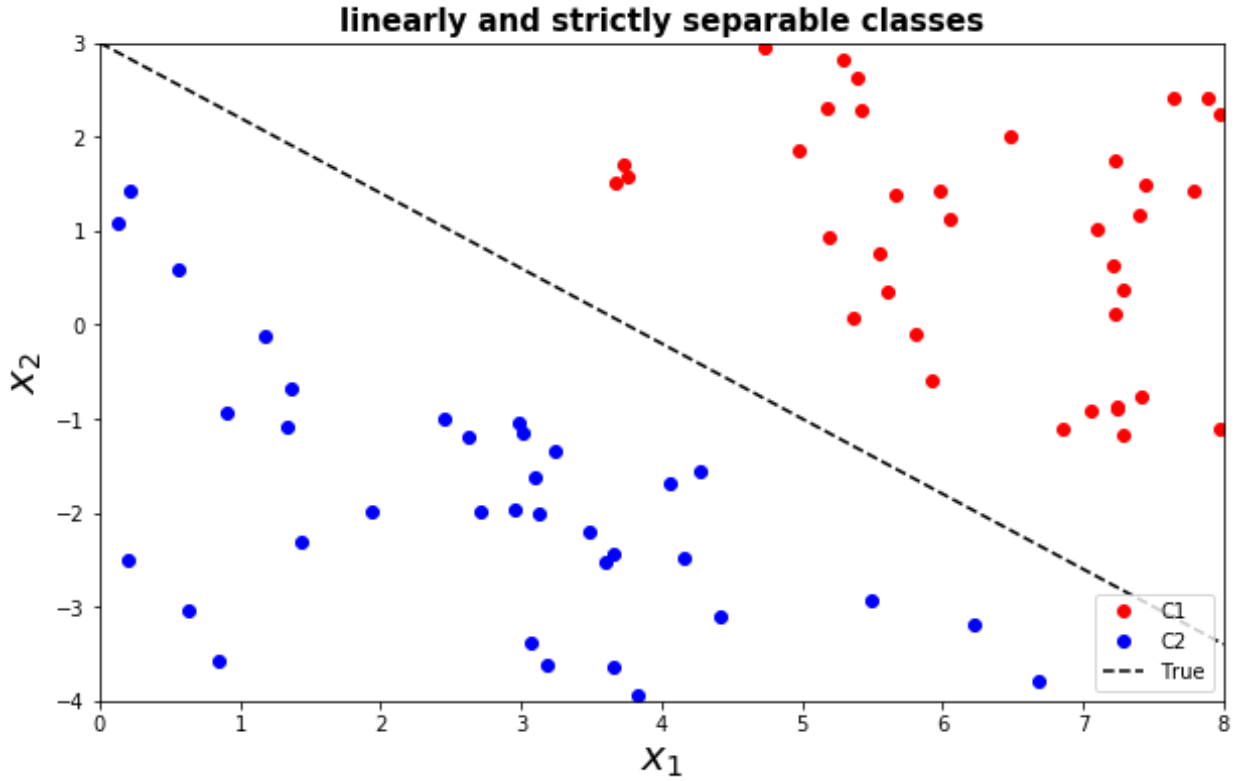
- Statistical process for estimating the relationships among variables





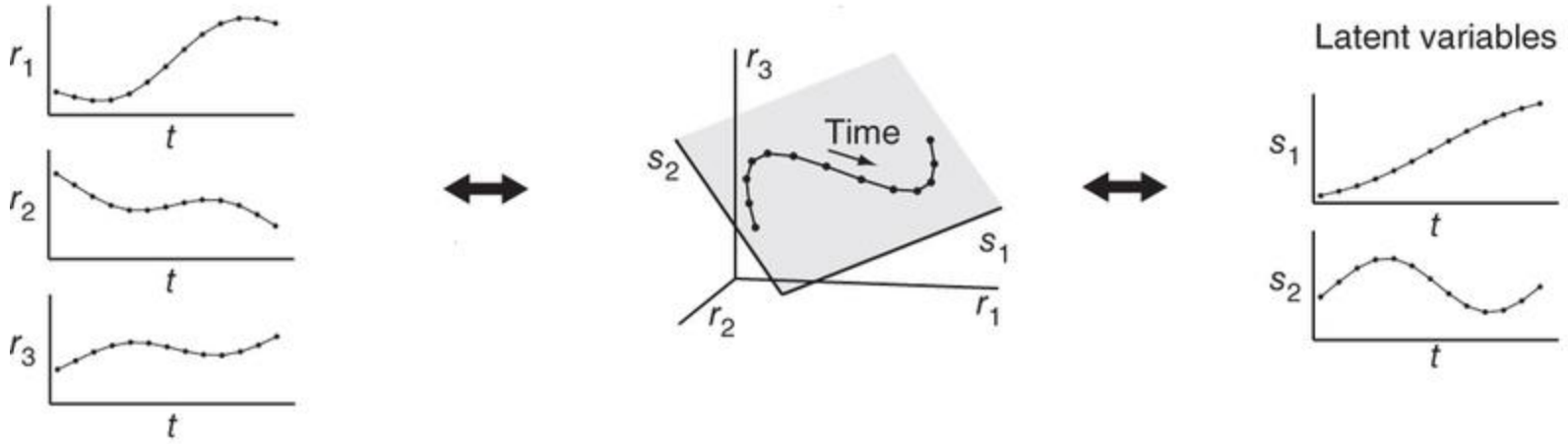
Classification

- The problem of identifying to which of a set of categories (sub-populations) a new observation belongs, on the basis of a training set of data containing observations (or instances) whose category membership is known
- To find classification boundaries

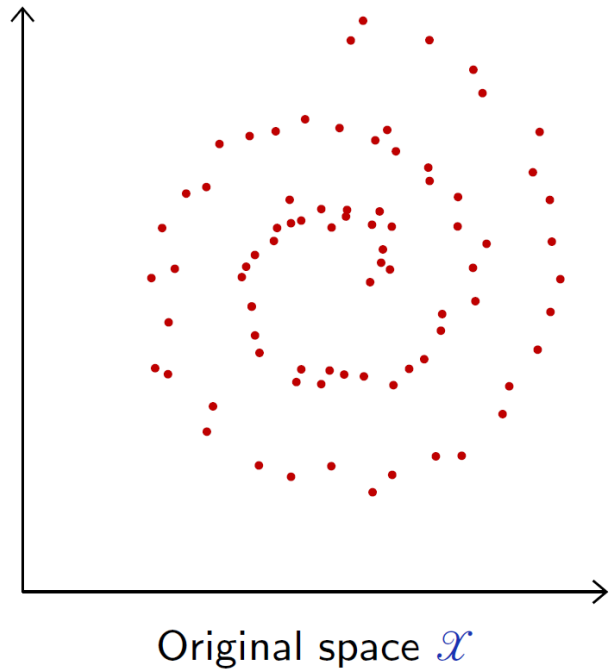


Dimension Reduction

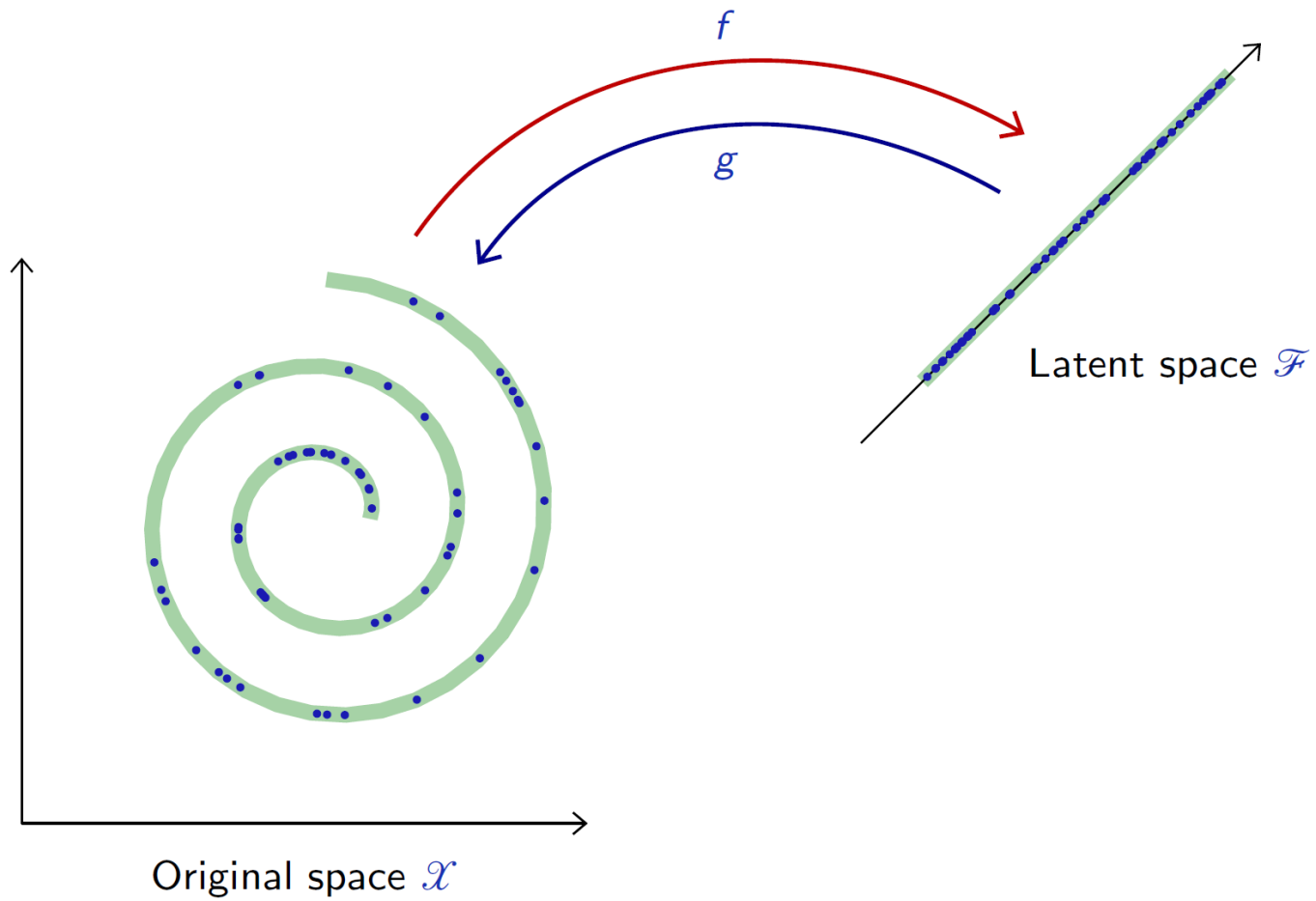
- Multiple Sensors + Principal Components
- the process of reducing the number of random variables under consideration, and can be divided into feature selection and feature extraction.



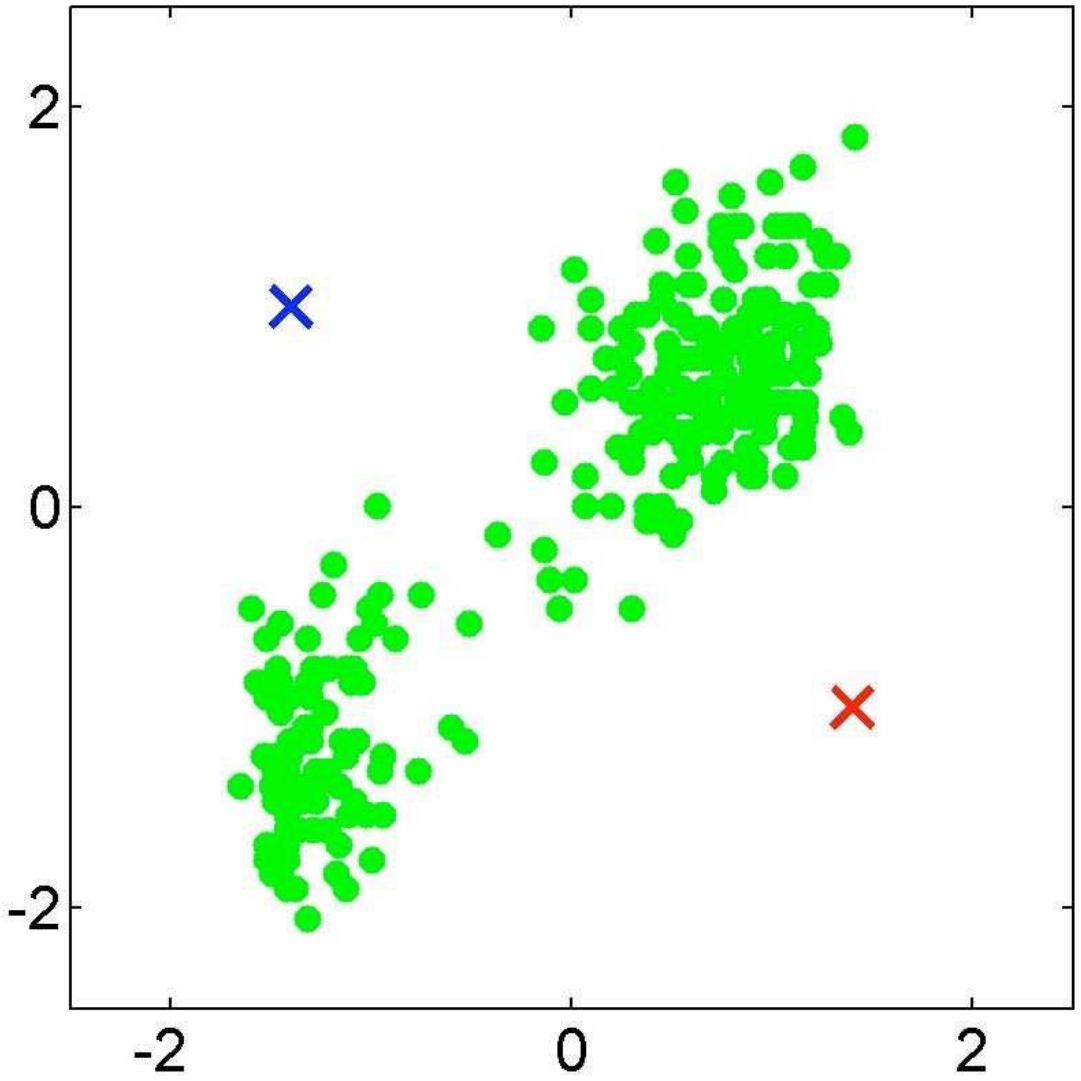
Dimension Reduction



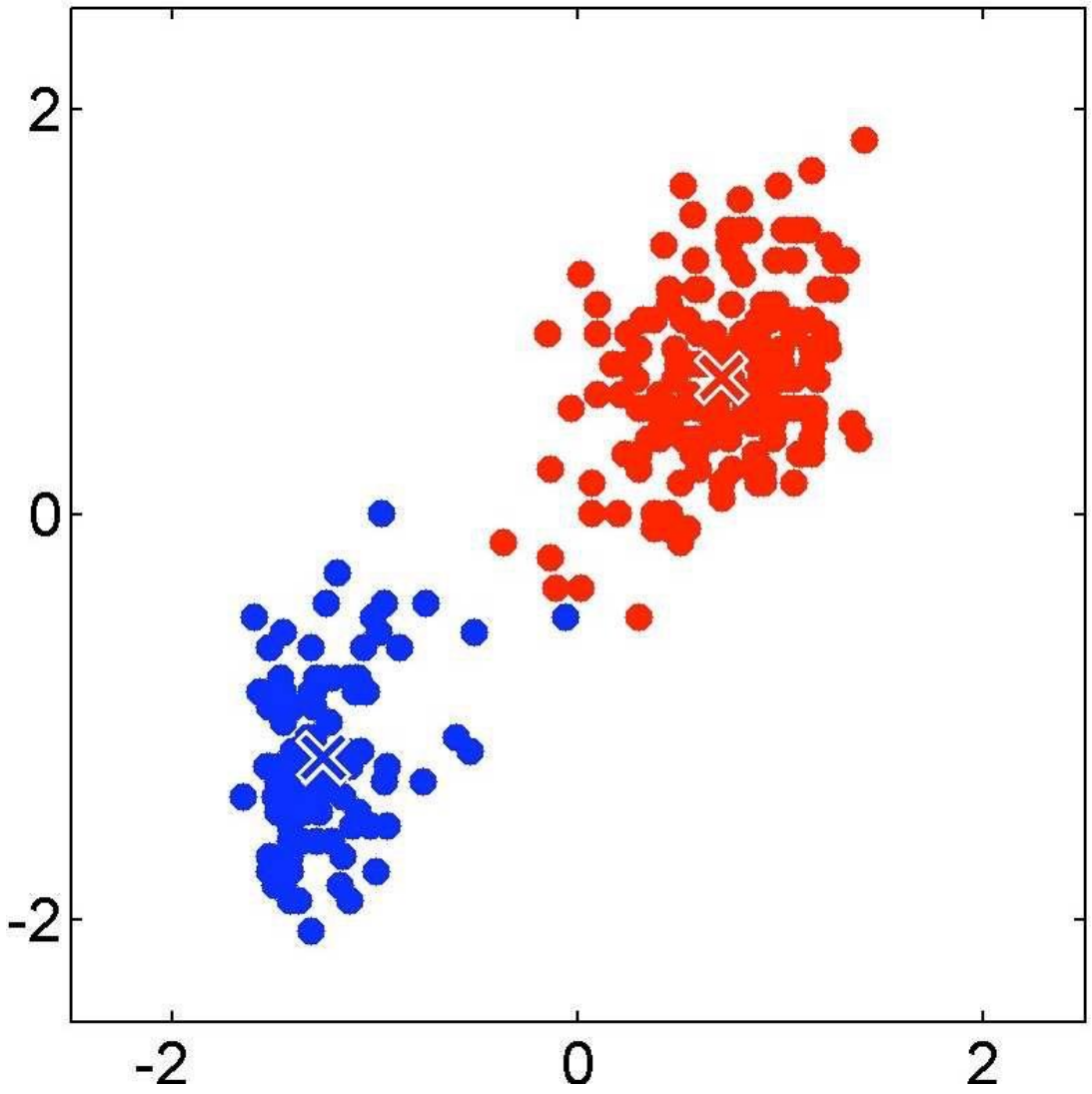
Dimension Reduction



Clustering

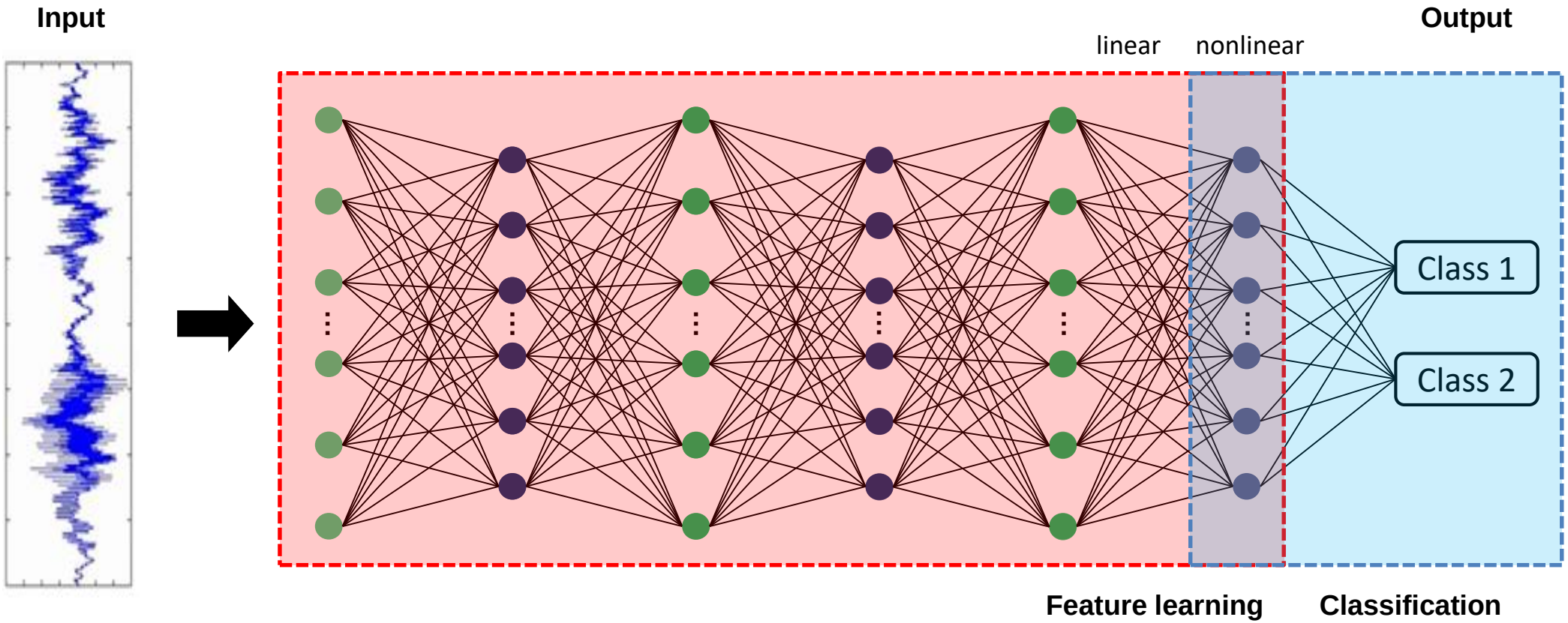


Clustering



Deep Artificial Neural Networks

- Complex/Nonlinear universal function approximator
  - Linearly connected networks
  - Simple nonlinear neurons



Deep Learning

- Deep Learning will not be covered in this course

- I am lecturing a new graduate course for deep learning in this semester as well
  - Advanced AI for ME (MECH 701G)
  - 고급기계인공지능 in Korean

- For those who are eager to learn about deep learning,
  - http://iai.postech.ac.kr/index.php/machine-learning/
  - Short course tutorials
  - Installation and TensorFlow

Flipped Learning Classes for Make-up

- 02/21 (Thursday)
  - http://www.postechx.kr/ko/school/2019springlecture/courseware/62965

- 02/28 (Thursday)
  - http://www.postechx.kr/ko/school/2019springlecture/courseware/62965