



Introduction

Prof. Seungchul Lee
Industrial AI Lab.

Course Information For MECH437

- Course title: AI for ME (= Machine Learning)
 - B011
- Instructor: Prof. Seungchul Lee
 - Office: 5-223
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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 MECH437

- Basic knowledge for machine learning
 - Linear algebra
 - Optimization
- Python in class, assignments, and project
 - 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% + 30%)
 - Many assignments (20%)
 - Project (10%)
 - 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 and POSTECHx
 - Announcement
 - Group e-mail

The screenshot displays the eClass LMS interface. The top navigation bar includes 'Home', 'eClass', 'Open 과정', '특강/세미나', '학습가이드', and an 'ENGLISH' button. The user profile on the left shows '이승철 (00100925)' with a message icon and '(0)'. Below this is a sidebar menu with '강의실 이동' (2019년도 1학기, 강의실선택) and a list of links: '학습목차', '학습일정관리', '강의실알림' (with a red plus icon), and '과목관리' (with a red plus icon). The '강의실알림' section lists '공지사항', '질의응답', '쪽지/메일', and '일정표'. The '과목관리' section lists '과목정보', '강의계획서', and '조교관리'.

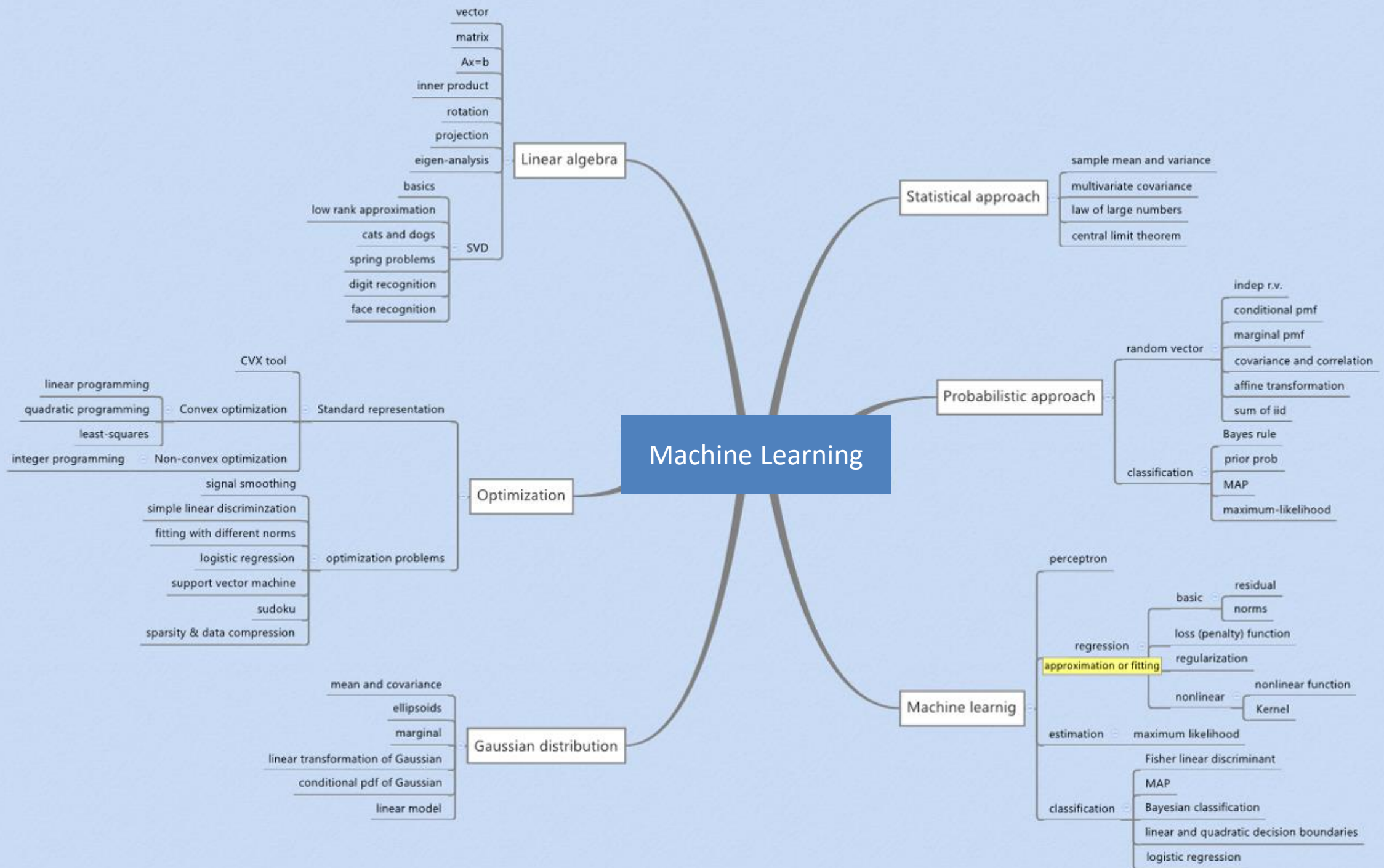
The main content area shows the course '기계인공지능 [MECH490K-01]' with a magnifying glass icon. Below the course name is the representative professor '이승철' with contact information: phone '054-279-2181', email 'seunglee@postech.ac.kr', and a chat icon. A '나가기' button is in the top right corner.

Below the course information is a table titled '학습목차' (Course Outline) with columns for '1주차' (2019-02-18 ~ 2019-02-24), '2주차' (2019-02-25 ~ 2019-03-03), and '3주차' (2019-03-04 ~ 2019-03-10). The table lists '공지사항', '질의응답', and '발표자료' as items to be reviewed.

| | 1주차 2019-02-18 ~ 2019-02-24 | 2주차 2019-02-25 ~ 2019-03-03 | 3주차 2019-03-04 ~ 2019-03-10 |
|------|--------------------------------|--------------------------------|--------------------------------|
| 공지사항 | | | |
| 질의응답 | | | |
| 발표자료 | | | |

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])

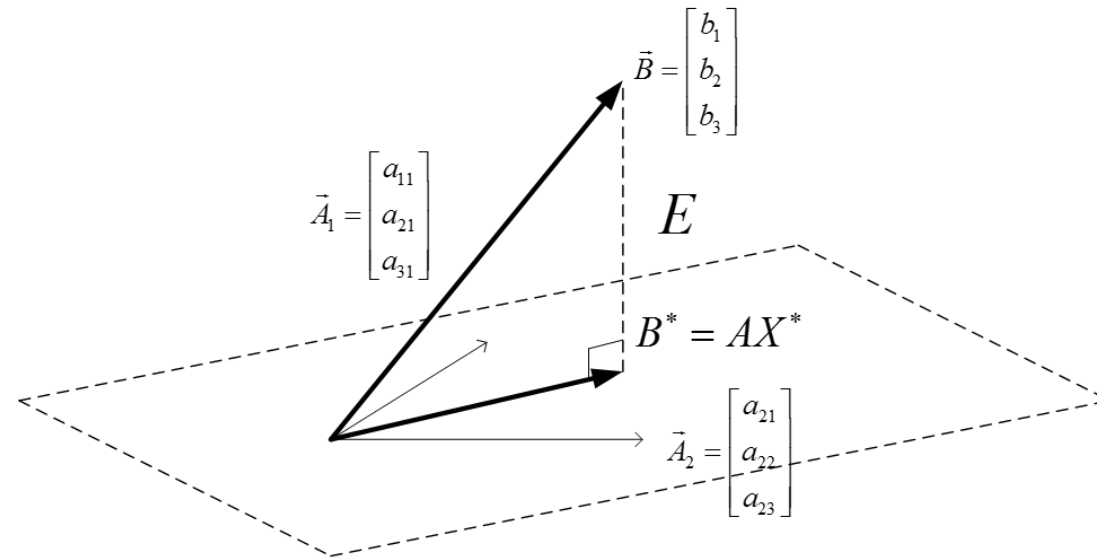
    err = 0
    for i in range(k):
        mu[i,:] = np.mean(X[np.where(y == i)[0]], axis=0)
        err += np.linalg.norm(pre_mu[i,:] - mu[i,:],2)

    pre_mu = mu.copy()

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

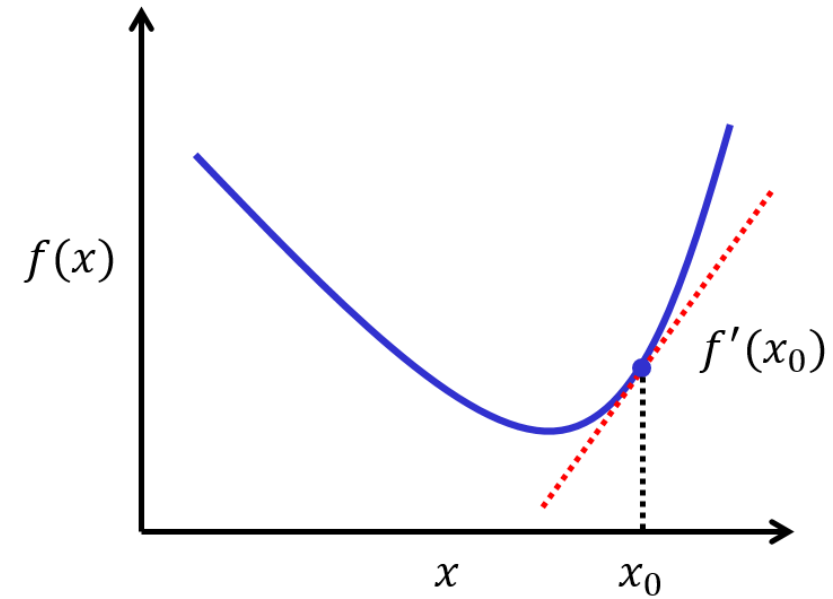
Linear Algebra

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



Optimization

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

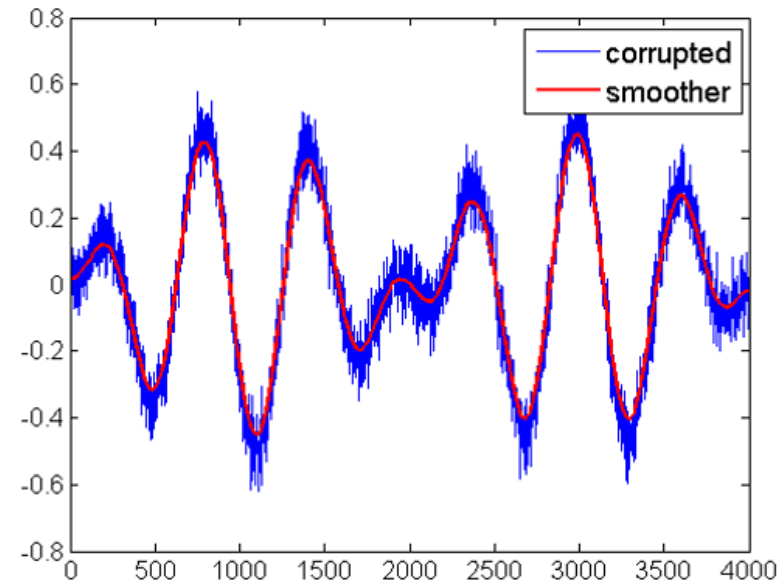
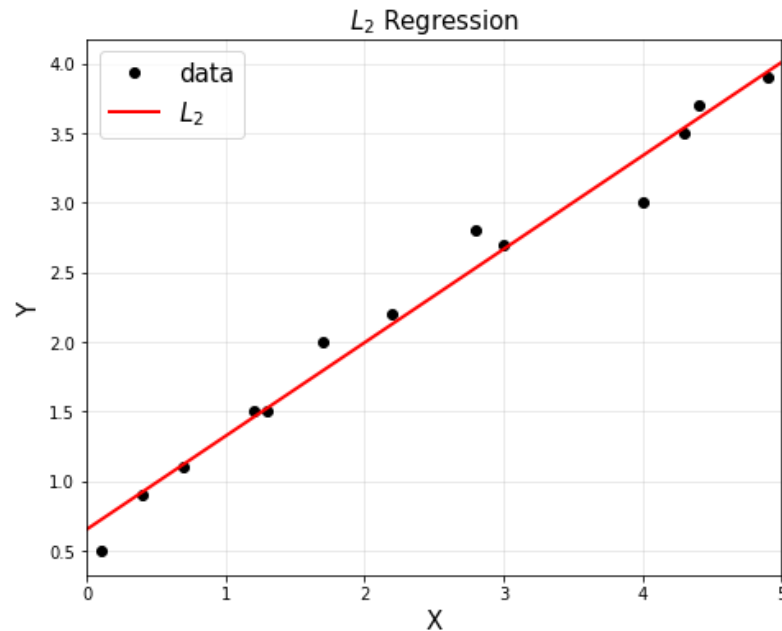


Statistics and Probability

- 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

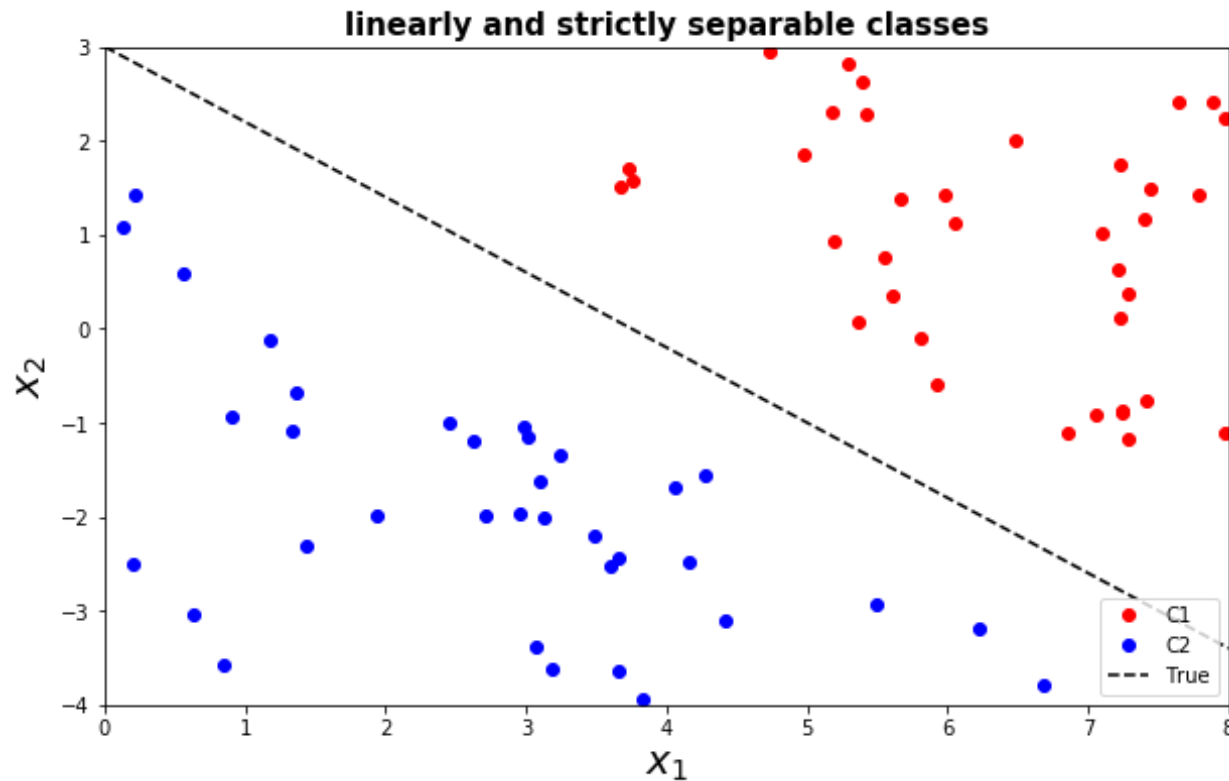
Regression (Data Fitting or Approximation)

- Statistical process for estimating the relationships among variables



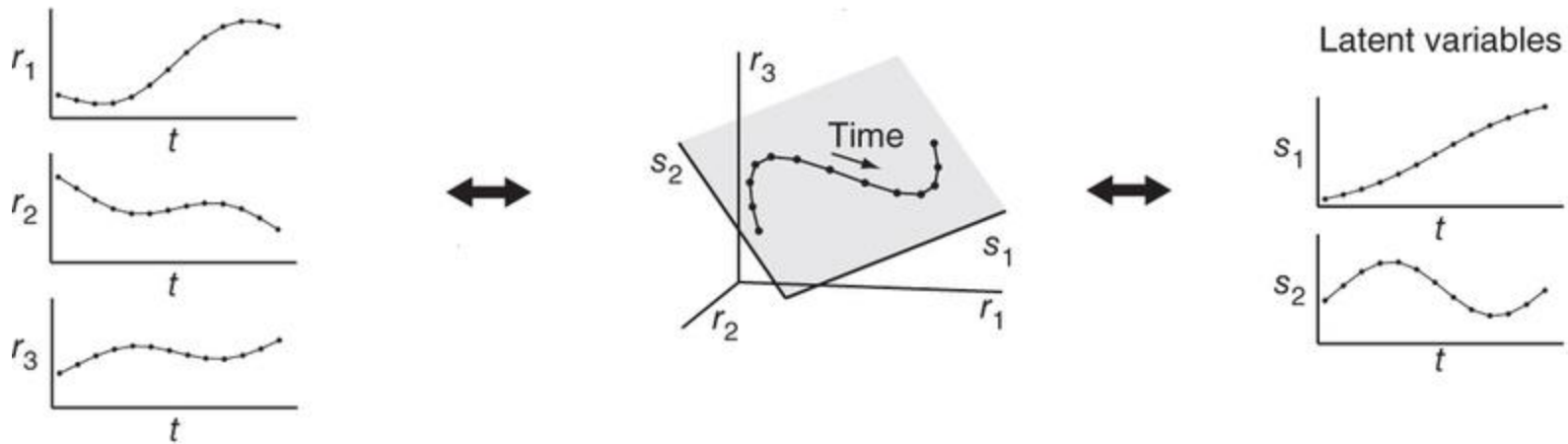
Classification

- 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

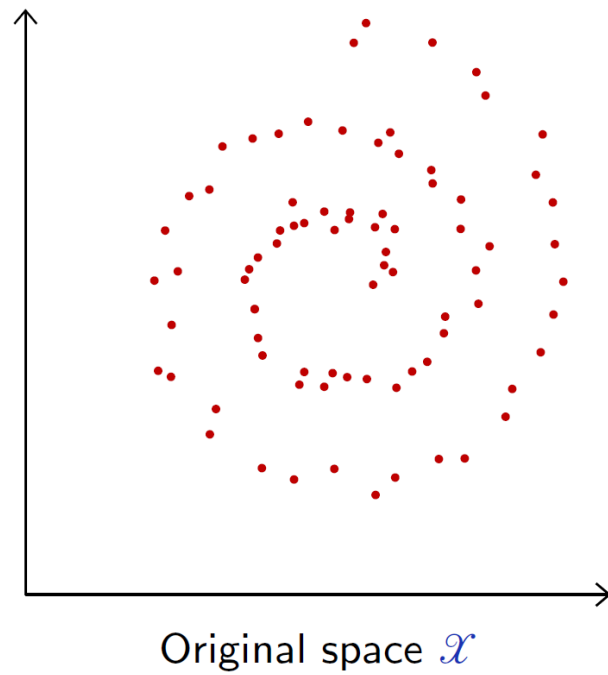


Dimension Reduction

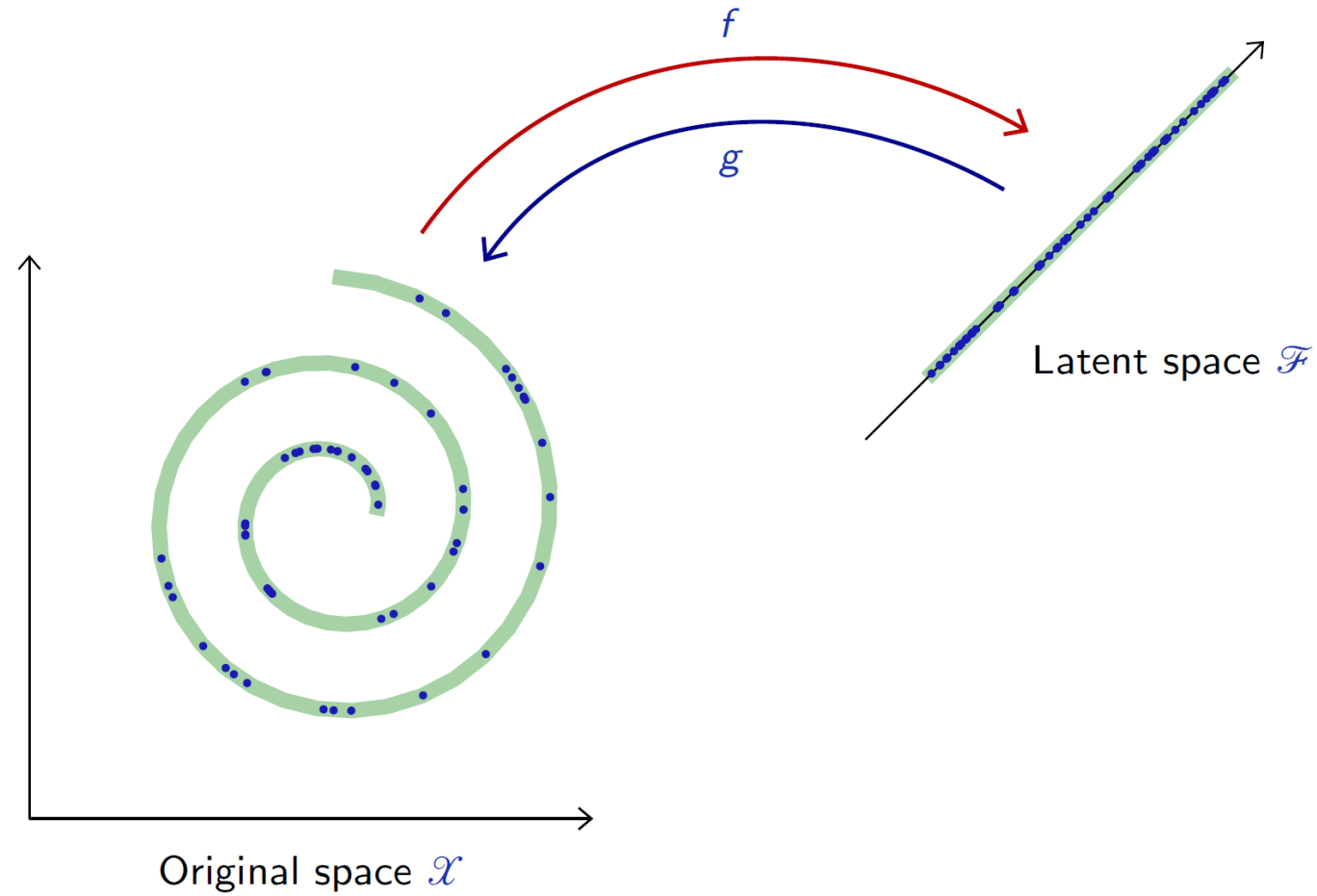
- Multiple Sensors + Principal Components
- the process of reducing the number of random variables under consideration, and can be divided into feature selection and feature extraction.



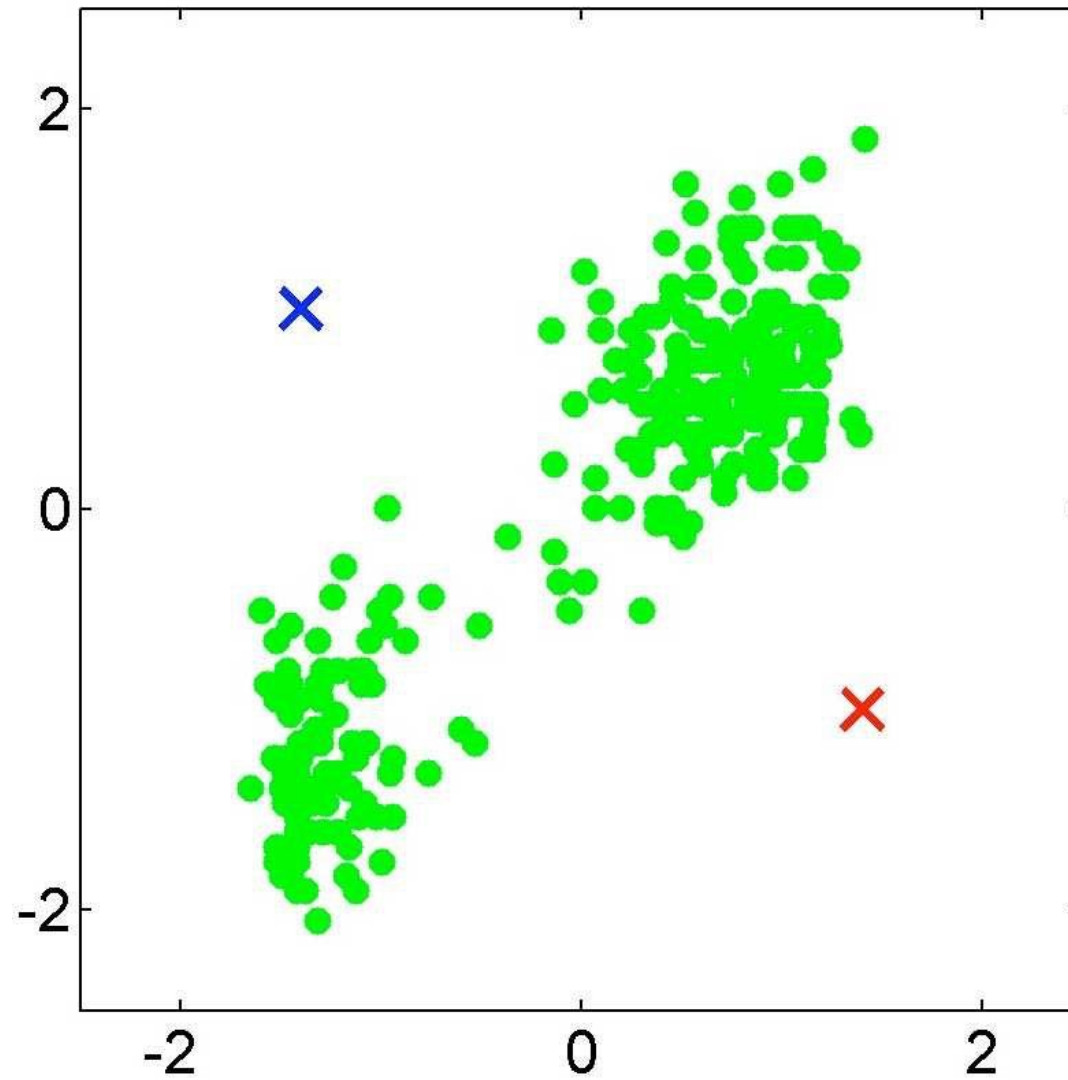
Dimension Reduction



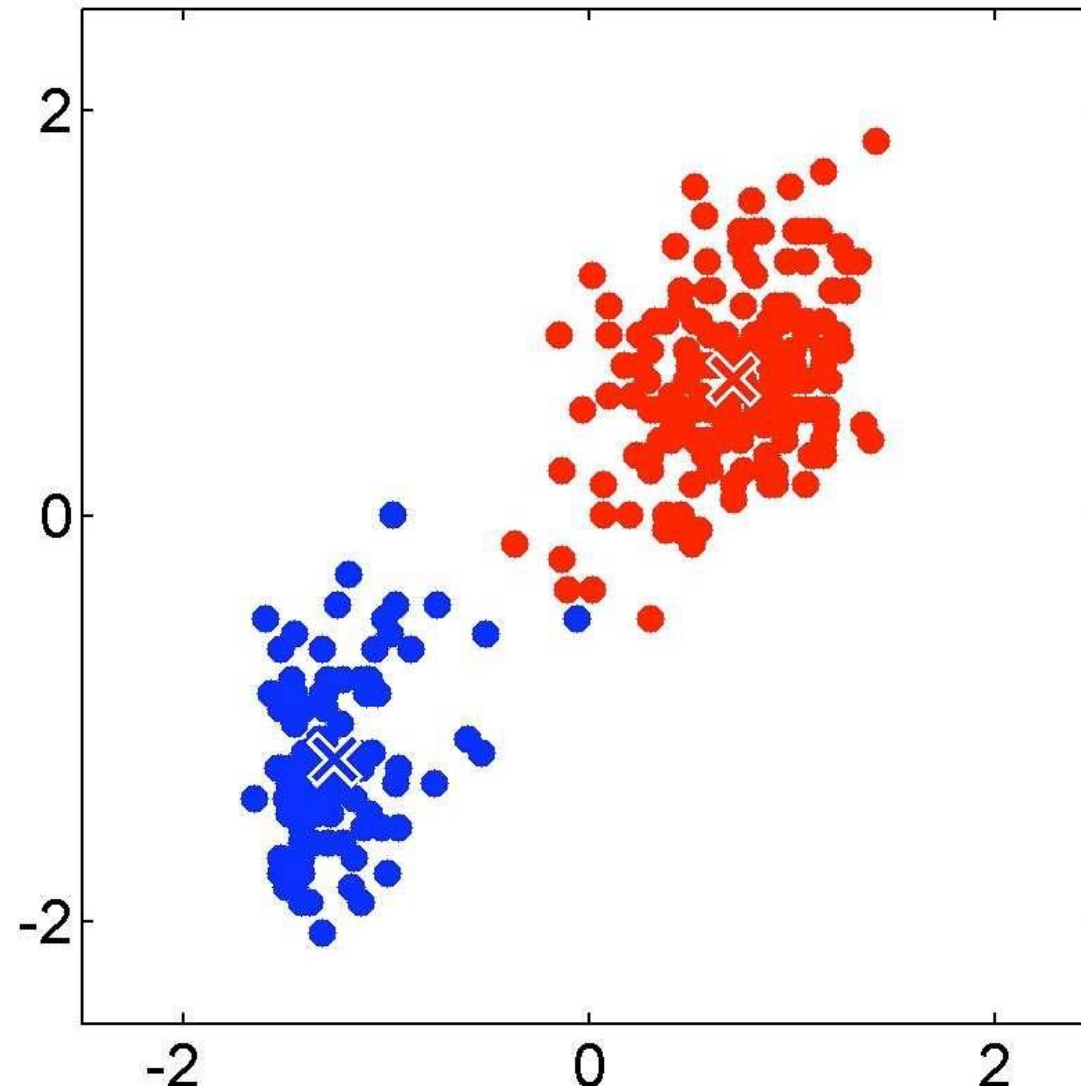
Dimension Reduction



Clustering

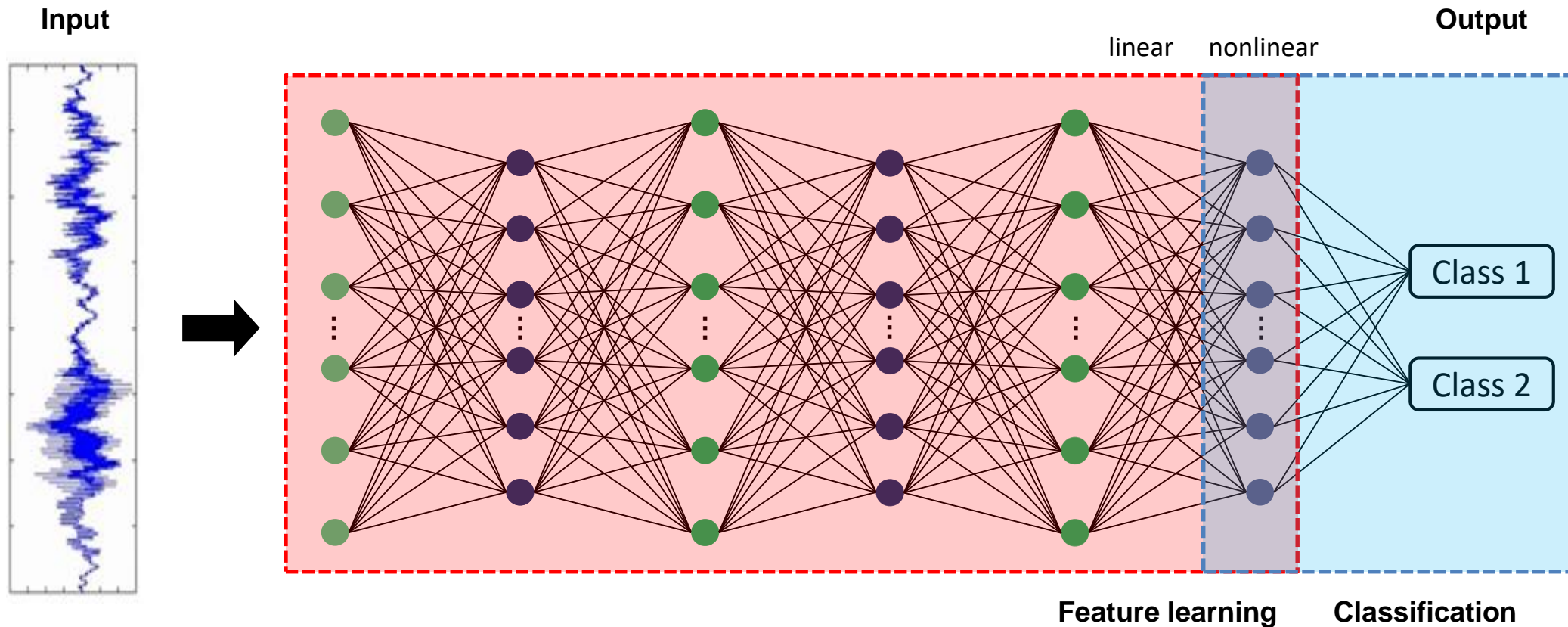


Clustering



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 graduate course for deep learning in this semester as well
 - Advanced AI for ME (MECH527)
 - 고급기계인공지능 in Korean
- For those who are eager to learn about deep learning,
 - <http://iai.postech.ac.kr/index.php/machine-learning/>