# Introduction

- About This Course
  - Introduction to probabilistic analysis
  - Introduction to statistical inference (統計推論)
- Why Probabilistic Analysis?
- Some commonly used mathematical expressions

# Time/Date/Instructor

- Monday 9:00 – 9:50am,
  Wednesday 10:10 –12:00am,
  (Feb. 21 – June 24, 2011); 工程四館ED301
- **Instructor**: Hsueh-Ming Hang, 杭學鳴 (ED609)
  hmhang@mail.nctu.edu.tw
- **Office hours**: (need appointment)
  Monday 10:am -- 12:noon,
  Wednesday 1:30pm -- 3:30pm (ED609)
- **Classnotes**: http://cwww.ee.nctu.edu.tw/
  (password: )
  (modified from Profs. Feng-Tsun Chien (簡鳳村教授) and
  Tzuhsien Sang (桑梓賢教授))

# Teaching Assistants

- **TAs**:

  Jau-Shiuan Lee 李兆軒 pig19870210@hotmail.com

  Jen-Yuan Luo 羅偵源 jrwinds@hotmail.com

  Office hours: (appointment) – to be announced

- **Pi-Li PhD** (霹靂博) **TA**:

  Chen-Yang Lin 林振揚 talent31022@gmail.com

  Recitation hours: once every week -- to be announced

  Appointments

# Grading

- **Homework: 20 %**
- **Quiz 1** and **Quiz 2: 10%** each ➔ 20%
- **Midterm**: **30%** (2 hours, closed book)
- **Final Examine: 30%** (2 hours, closed book)
- The same set of homework problems and exams are given to both Chinese and English classes.
- Scores will be adjusted to meet the 78 average value suggested by the School. ← Additional adjustment may be considered if needed.

# Textbook and Recommended Readings

- **Textbook:**

  D. P. Bertsekas and J. N. Tsitskilis, ***Introduction to Probability***, Athena Scientific, 2nd edition, 2008

- **Recommended Readings**:

  - R.V. Hogg and E.A. Tanis, *Probability and Statistical Inference*, 8th ed., Pearson, 2010.

  - H. Stark and J.W. Woods, *Probability, Random Processes with Applications to Signal Processing*, 3rd ed., Prentice-Hall, 2002.

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# About This Course

**Main Theme**

- Introduction to probabilistic analysis
  - Modeling and analysis of experiments with uncertain outcomes
  - Example: what is the probability of winning the grand prize of lottery?
- Brief introduction to statistics and some statistical signal processing

**Why you need Probability in EE/CS professionals?**

- In junior, senior year:
  - Principle of Communication Systems I,II, (通訊原理 I,II), Modern Physics (近代物理)
- In senior year or graduate school:
  - Communications Theory, Networking, Signal Proc., Control, Quantum Mechanics, etc. → Topics deal with uncertainties

# Related Courses

- ***Probability Theory (Measure Theory, Real Analysis)***
- ***Statistics***
- ***Stochastic Processes*** (隨機程序)
  Incorporate the concept of ***time*** to model real world phenomena and perform probabilistic analyses
- ***Statistical Signal Processing*** (統計訊號處理)
  Applications of probability and statistics to specific ***random signals*** such as speech, audio, images, video, EKGs, etc. in order to predict, smooth, extract, compress, infer, find, classify, estimate, interpolate, modify, . . .

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# Probability and Statistics
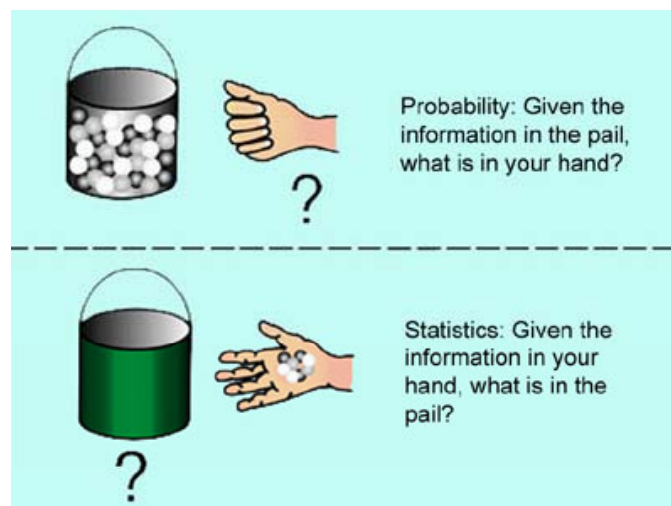


*Example*:

> ➤ (Probability)
>
> Flipping a fair coin, the probability of "head" is ½

> ➤ (Statistics)
>
> Flipping a coin (with unknown bias), how to estimate the probability of appearing a "head"?

# Mathematical Models

- Probability model is often used as a substitute for reality
  - Deterministic vs. probabilistic (stochastic)
  - Reality is sometimes too complex to describe in every little detail
  - In practice, "probabilistic signals" are more important.
- Main concepts and tools:
  - Sample space

    A description of all possible outcomes of an experiment
  - Outcomes, Events, algebra of events (or sets) and Probability law

  - Calculus

    To manipulate probability measures and compute expectations
  - Heuristics (直覺)

    How to construct a model? How to solve a problem? Learn by practicing. Do exercises!

# Why Probabilistic Analysis?

**Major Aim:**
  - Making decisions out of uncertainties
  - Trying to do a better job, such as taking certain actions to lower risks or to increase profits

  *Examples*:
  - How to play black jack poker game in order to make profit in the long run?
  - How to decide whether or not to approve a new medicine?

**Applications**
- Engineering
  - Statistical signal processing
  - Communications
  - Systems and control (e.g., aircraft control)
  - Decision and resource allocation under uncertainty (e.g., communication networks)
  - Reliability (dealing with noise, error control, failures)
- Economics and finance
- Physics, statistical mechanics, thermodynamics
- Medicine, FDA (Food and Drug Administration), drugs and procedures

# English Descriptions of Math Expressions

Commonly used mathematical expressions and their English as well as Chinese descriptions

- Polynomial (多項式): $a_n X^n + a_{n-1} X^{n-1} + \ldots + a_1 X + a_0$
- Set (集合):
  $x \in F$: $x$ is in $F$, or $x$ is an element of $F$;  $F \subset \Omega$: $F$ is a subset of $\Omega$
- $a^b$: "a" to the order of "b" (a 的 b 次方) or "a" to the "b"*th* power,  $a^2$: "a" square,  $a^3$: "a" cube
- A+B: A plus B;  A-B: A minus B;  AxB: A times B, A is multiplied by B;  A/B: A over B, or A is divided by B
- (.): parenthesis;  [.]: square bracket;  {.}: bracket
- $\begin{pmatrix} N \\ x \end{pmatrix}$ : N choose x
- $e$: exponential (自然對數底數)