Introduction

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School of Software Engineering
TongJi University
Course Information

• Schedule
  – 8:00-9:40, Wednesday (even weeks)
  – 15:20-17:00, Friday
  – 17 weeks

• Location
  – C201, Cheng Building, Jiading Campus

• Office Hours
  – 10:30-11:30, Monday
• Dr. Hongyu Li
  – Associate professor, SSE, Tongji
    • Education
      – B.Sc, Tongji University, 1996-2000
      – PhD in Computer Science, Fudan University, 2003-2008
      – PhD in Eastern Finland University, Finland, 2006-2012
  – Contact
    • Office: Room 314, Jishi Building, Jiading Campus
    • Email: hyli@tongji.edu.cn
Materials

• The course slides
• Reference papers
• Texts


Prerequisites

- Probability theory
- Statistics
- Linear algebra
- Geometry
Grading Policy

- **Class participation** 5%
  - Please do NOT be absent for more than 5 times, otherwise you will fail.

- **Assignment x 3** 45%
  - Individual homework

- **Project** 50%
  - Teamwork by 2 or 3 people

- **Bonus** 10%
  - For being active in class

- **Plagiarism is not allowed!**
Today’s Topics

• What is pattern recognition?
Human Perception

• Humans have developed highly sophisticated skills for sensing their environment and taking actions according to what they observe, e.g.
  – Recognizing a face,
  – Understanding spoken words,
  – Reading handwriting,
  – Distinguishing fresh food from its smell,
  – .......

• We could like to give similar capabilities to machines.
What is Pattern Recognition?

• *Pattern recognition* is the study of how machines can
  – Observe the environment,
  – Learn to distinguish patterns of interest from their background,
  – Make sound and reasonable decisions about the categories of the patterns.
What is a Pattern?

• A pattern is defined as
  – “the opposite of a chaos; it is an entity, vaguely defined, that could be given a name”
    • Fingerprint image
    • Handwritten word
    • Human face
    • Speech signal
    • DNA sequence
    • ......
Other Patterns

• Insurance, credit card applications
  – Applicants are characterized by
    • No. of accidents, make of car, year of model
    • Income, No. of dependents, credit worthiness, mortgage amount

• Dating services
  – Age, hobbies, income, etc. establish your “desirability”
    • E.g., 百合网

• Web documents
  – Key words based descriptions
    • E.g., documents containing “rain”, ”hurricane”, are different from those containing ”basketball”, ”NBA”.
    • Google, 百度

• Housing market
  – Location, size, year, school district, etc
Pattern Class

• A collection of “similar” (not necessarily identical) objects
  – Intra-class variability
    • The letter “T” in different typefaces

– Inter-class variability
  • Characters that look similar
## Pattern Recognition Applications

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<th>Application</th>
<th>Input Pattern</th>
<th>Pattern Classes</th>
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<td>Document image</td>
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<tr>
<td>Document classification</td>
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<td>Natural language processing</td>
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<td>Biometric recognition</td>
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<td>Face, iris, fingerprint</td>
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<td>Medical</td>
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<td>Military</td>
<td>Automatic target recognition</td>
<td>Optical or infrared image</td>
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<td>Bioinformatics</td>
<td>Sequence analysis</td>
<td>DNA sequence</td>
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<td>Data mining</td>
<td>Searching for meaningful patterns</td>
<td>Points in multidimensional space</td>
<td>Compact and well-separated clusters</td>
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</table>
Pattern Recognition Applications

• English handwriting recognition
Pattern Recognition Applications

• Chinese handwriting recognition

(a) Handwriting

故天将降大任于是人也，必先苦其心志，劳其筋骨，饿其体肤，空乏其身，行拂乱其所为，所以动心忍性，增益其所不能。

(b) Corresponding Machine Print

故天将降大任于是人也，必先苦其心志，劳其筋骨，饿其体肤，空乏其身，行拂乱其所为，所以动心忍性，增益其所不能。
Pattern Recognition Applications

- Fingerprint recognition
Pattern Recognition Applications

- Biometric recognition
Pattern Recognition Applications

• Autonomous navigation
Pattern Recognition Applications

- Cancer detection and grading using microscopic tissue data
Pattern Recognition Applications

• Land cover classification using satellite data
Pattern Recognition Applications

- Building and building group recognition using satellite data
Pattern Recognition Applications

• License plate recognition
  – US license plates
Pattern Recognition Applications

- Clustering of microarray data
Related Courses

• Information Theory
• Introductory Applied Machine Learning
• Data Mining and Exploration
• Probabilistic Modeling and Reasoning
• Neural Information Processing
• Reinforcement Learning
• ……
Related Areas

- Brain science
- Image analysis and computer vision
- Language modeling
- Speech modeling
- Handwriting recognition
- Risk management
- Medical imaging
- Web analytics
- Recommender engines
- Computer games engines
- Financial modeling
- Geoinformational systems
- Intelligent management
- .......
Why Welcome?

• Exciting area
  – Interesting problems
    • Some unsolved
  – Now ubiquitous
  – In great demand
  – Related to many domains
12 IT Skills Employers Can’t Get Enough Of

• So what is number one?
12 IT Skills Employers Can’t Get Enough Of

- Machine Learning
- But that was 2007. What about more recently......
Top 3 Hottest Majors for a Career in Technology

• The top 3 hottest majors for a career in technology are...

The JobsBlog

The Top Three hottest new majors for a career in technology
Posted Monday, August 23 2010 by The JobsBloggers

Have you ever wondered what fields of study are hot right now in the world of technology? Or maybe you're starting to think about declaring your major and you're looking for some real world guidance?

It is worth thinking beyond a traditional Computer Science degree or even an Electrical Engineering & Computer Science (EECS) program. Microsoft is hiring people with unique backgrounds, some that are new with the inception of the Cloud, web services and the amazing scale at which the industry is operating (Exabyte anyone?).

The following is my list of the Top Three hottest academic areas for a future career in tech:
Top 3 Hottest Majors for a Career in Technology

• Pattern recognition skills are in high demand

Data Mining/Machine Learning/AI/Natural Language Processing
All of these fields help us sift through and organize huge amounts of information or data. When you apply your knowledge in these areas to a challenging problem in the online space, you know that you are working at a scale that is just immense. It’s much easier said than done. If you have a passion for this area and have a technical background there are a multitude of open positions that might hold a long-term career for you. With the move to the cloud and the sheer amount of information on the web, this area of expertise will continue to be in great demand. Microsoft has a great need for both people interested in the research space and the applied space which is very refreshing.

Business Intelligence/Competitive Intelligence
The ability to see trends, make sense of data to a business audience and help to understand your customers requires a special person. Someone with a mix of engineering, BI/CI experience and a business mindset can take this field to the next level. You will help increase any employer’s bottom line and be able to provide organized data that is extremely valuable to any business. You can help drive business decisions and help your internal audience understand what the data is telling or showing you.

Analytics/Statistics – specifically Web Analytics, A/B Testing and statistical analysis
All of these subjects are offshoots of traditional degrees in CS and mathematics. They all apply to the online world we live in and will also be in great demand as we continue to monetize the web. Retailers, web services, and advertisers will need people in these fields as they try to get the most for their advertising money. As we continue to see the dollar amounts spent for online advertising worldwide, these fields will be hot and we will see online advertising change over time as a result of these positions.
What is the Point of Studying this Course?

• What should you be able to do after this course?
  – Understand why and how it is possible to do pattern recognition
  – Understand how the wide set of pattern recognition methods fit into an overall framework
  – Know how to use and justify these methods
  – Be able to create to create your own pattern recognition methods
  – Learn to think in terms of probabilistic models
What Capabilities can be Improved in this Course?

- Theoretical analysis
- Reasoning ability
- Summarizing ability
- Team working
- Communication
- Presentation
- Expression
Course Outline

- Pattern recognition systems
- Classification
- Feature selection
- Clustering
- Matching
- Other topics if possible
Let’s begin to explore the PR world!