SYDE 675
Pattern Recognition

Ali Ayub

Electrical and Computer Engineering

University of Waterloo

Course Info

- Instructor: Ali Ayub (a9ayub@uwaterloo.ca)
- TAs: Yuxian Huang (y675huan@uwaterloo.ca)
- Website: https://sites.google.com/view/aliayub/teaching/syde-675-winter-2024
- Updates and news will be posted on the course website and LEARN.
- Website:
  - Slides, notes, assignments, logistics
- LEARN
  - Submissions and grades
- Office Hours (E7, 5402). Wed 12:00 – 1:00 PM (or by appt)

Course Goals

- To introduce the fundamental principles of pattern recognition such as pattern representation, distance measures, probability measures, model learning, etc.
- To learn how to choose appropriate technique for a given problem and verify the capabilities of the chosen technique.
- To focus on using learned concepts for applications such as optical character recognition, speech recognition, robot vision, medical imaging, remote sensing, satellite image analysis, etc.
- To learn how to do research and write a scientific paper.

Topics Covered

- Introduction, Pattern Recognition Problem Definition, Machine Learning, Bias-Variance Trade-off
- Distance Measures for Pattern Classification
- Bayesian Decision Theory
- Probabilistic Methods for Classification
- Parametric and Nonparametric Density Estimation
- Parametric and Nonparametric Clustering
- Classical supervised learning techniques
- Feature Extraction, Feature Selection, Feature Engineering
- Deep Learning

Textbook

No textbook. Following, however, are some excellent resources:

- An Introduction to Patten Recognition and Machine Learning, by Paul Fieguth
- Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong. Mathematics for Machine Learning. Cambridge University Press, 2020. **freely available online**
- Aston Zhang, Zack C. Lipton, Mu Li and Alex J. Smola. Dive into Deep Learning. 2019. **freely available online**
- Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning (2016). **freely available online**

Workload

- Between 20 25 lectures, each ~1 hour
- Three assignments, roughly every two and a half weeks
- Each one worth 18%, 3 x 18% = 54% total
- Submit on LEARN
  - LaTeX typesetting is recommended

Policies

- Do your own work!
  - High-level discussion: Great!
  - Copying/sharing code/solutions: Bad! (0% in the assignment/project)
  - Acknowledge sources
  - Please refer to Policy 71 on student academic discipline
- No late submissions unless you have a legitimate reason
  - Travelling, being busy with other stuff, or simply forgetting to submit are not considered legitimate reasons
- Regrade requests: within 1 week of grades released

Project

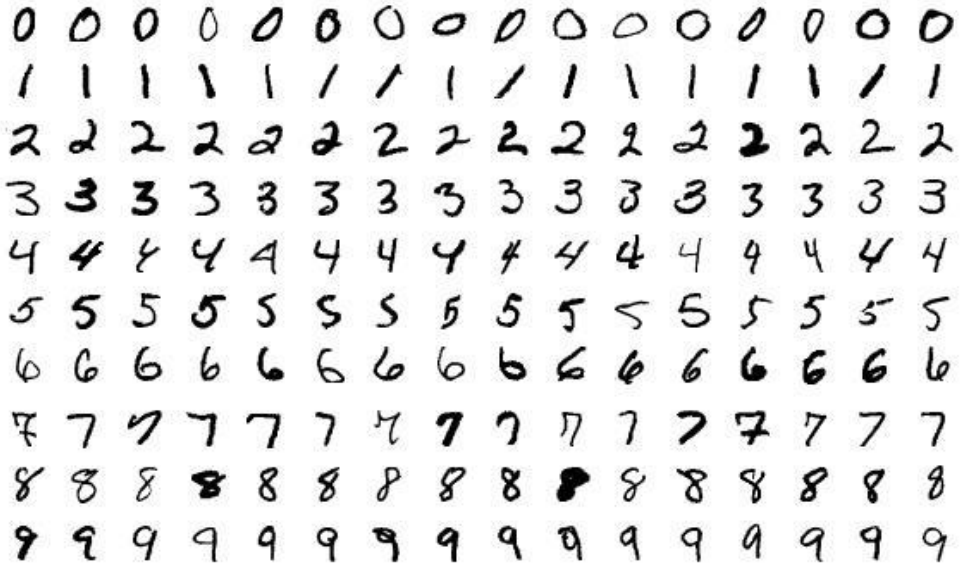
- Remaining 46%
- You need at least 50% in the project to pass the course.
- Research project:
  - Ideal: A novel and interesting project submittable to an ML conference
  - Project proposal: 10% of the project grade
  - Project presentation: (last week of classes) 10% of the project grade
  - Writeup: 80% of the project grade
- The projects will be done in groups of 2 or 3 students, and generally involve implementing a method from a paper, and extending that method in a novel or interesting way. If you desire some inspiration, a list of example papers will be posted.

Project Ideas

- Some general categories of project ideas:
  - Literature survey: include the problem definition and cite at least 10 papers that you plan to survey
  - Empirical evaluation: include the problem definition that you want to study, and cite at least 5-8 papers that you plan to review
  - Algorithm design: include the problem definition and a justification for why the current approaches are not satisfactory for the given problem. Cite at least 5 papers related to the chosen problem

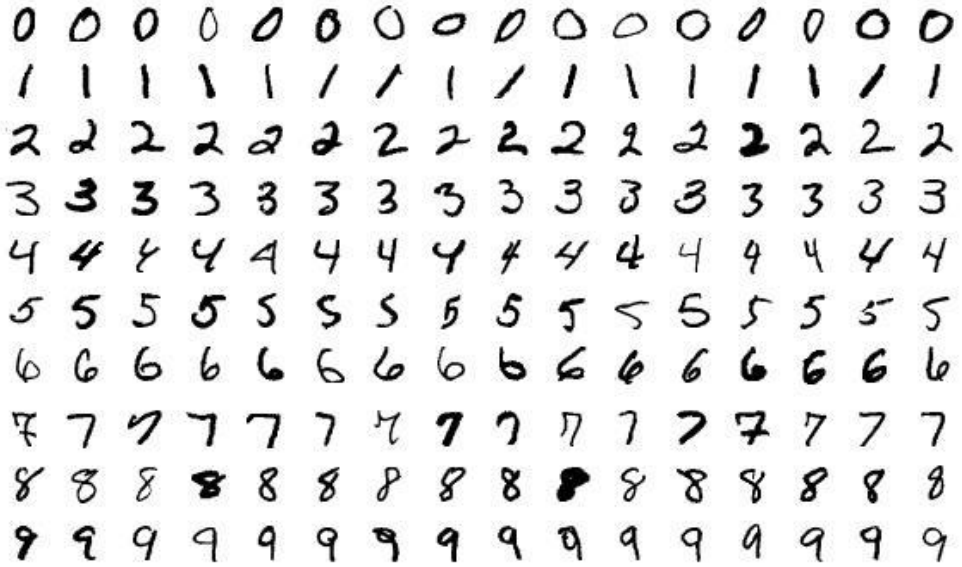
Pattern Recognition

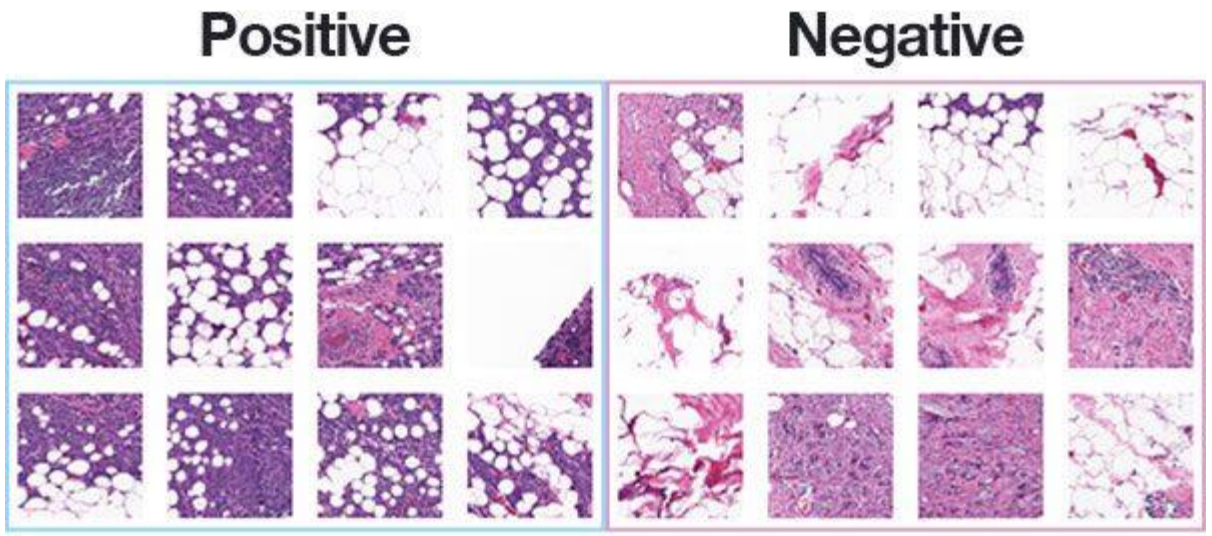
- An automated process of finding/recognizing some pattern/consistency in any given data.
- Applications: image classification, speech recognition, medical image analysis, etc.



Pattern Recognition

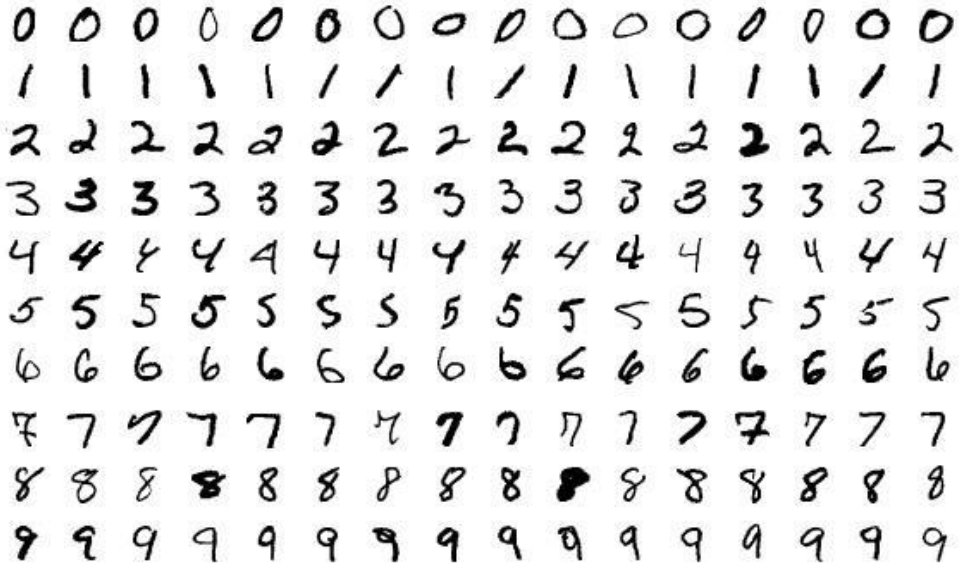
- An automated process of finding/recognizing some pattern/consistency in any given data.
- Applications: image classification, speech recognition, medical image analysis, etc.

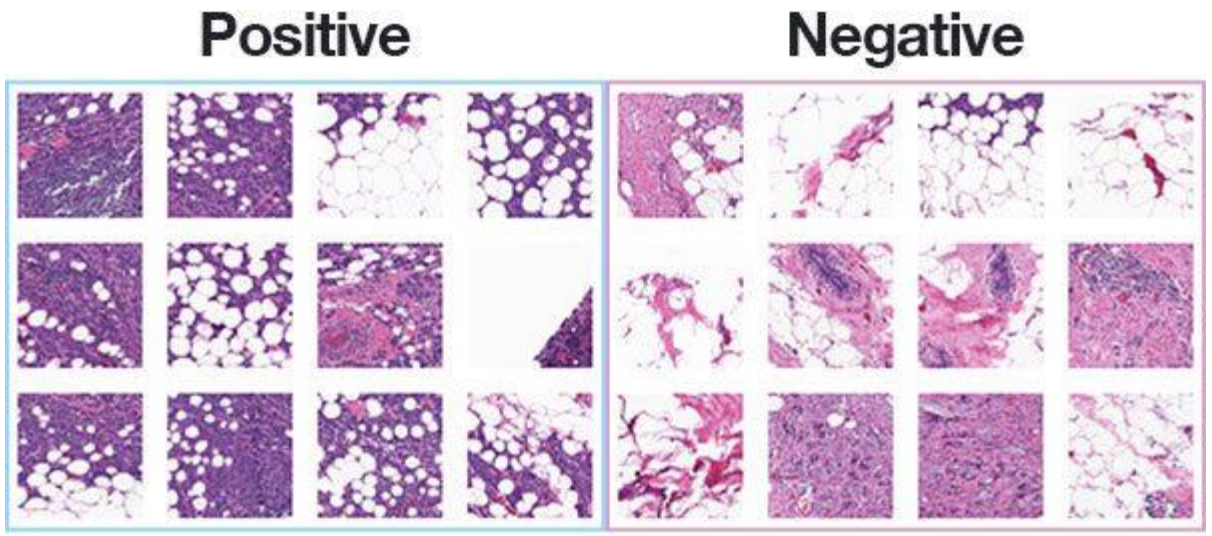




Pattern Recognition

- An automated process of finding/recognizing some pattern/consistency in any given data.
- Applications: image classification, speech recognition, medical image analysis, etc.





Learning

- How do we recognize patterns?
- Develop algorithms that can learn from some examples and then be able to recognize patterns in the real world (Machine Learning).

Learning

- How do we recognize patterns?
- Develop algorithms that can learn from some examples and then be able to recognize patterns in the real world (Machine Learning).
- Simple overview:

Learning

- How do we recognize patterns?
- Develop algorithms that can learn from some examples and then be able to recognize patterns in the real world (Machine Learning).
- Simple overview:
  - Get some examples (data: X) for the task that we are trying to perform, also get the labels/classes (y) for the examples.

Learning

- How do we recognize patterns?
- Develop algorithms that can learn from some examples and then be able to recognize patterns in the real world (Machine Learning).
- Simple overview:
  - Get some examples (data: X) for the task that we are trying to perform, also get the labels/classes (y) for the examples.
  - Train the model (a function: f) with some parameters θ.

Learning

- How do we recognize patterns?
- Develop algorithms that can learn from some examples and then be able to recognize patterns in the real world (Machine Learning).
- Simple overview:
  - Get some examples (data: X) for the task that we are trying to perform, also get the labels/classes (y) for the examples.
  - Train the model (a function: f) with some parameters θ.
  - Goal: the function f is able to perform predictions/inferences on some unseen data that was not in the training examples (test data).

Questions?