COMP 875
Machine Learning Methods in Image Analysis
What the class is about

- “Applied” machine learning and statistical methods
- Applications are primarily, though not exclusively, to computer vision and medical imaging
- Students from other research areas are welcome
- Exact list of topics to be determined by you!
Who should take this class?

- This is meant as an “advanced” graduate course
- Ideally, you should have taken COMP 665, 775, 776, or Data Mining (or similar courses elsewhere)
- You should be comfortable reading and understanding papers in recent conferences such as CVPR, ICCV, MICCAI, NIPS, ICML, etc.
- You should have some experience doing research presentations
- If you have questions or doubts about your background, please talk to me after this class
Why Machine Learning?

• Image analysis early on: simple tasks, few images

Why Machine Learning?

- Image analysis early on: try to program a computer directly using rules and symbolic representations.

Why Machine Learning?

• Today: Lots of data, complex tasks

- Internet images, personal photo albums
- Movies, news, sports
- Surveillance and security
- Medical and scientific images
Why Machine Learning?

• Today: Lots of data, complex tasks
• Instead of trying to encode rules directly, learn them from examples of inputs and desired outputs
Not Just Image Analysis

• Speech recognition
• Document analysis
• Spam filtering
• Computer security
• Statistical debugging
• Bioinformatics
• ....
Topics (tentative)

- Classifiers: linear models, boosting, support vector machines
- Kernel methods
- Bayesian methods, Expectation Maximization
- Random field models
- Sampling techniques such as Markov Chain Monte Carlo
- Unsupervised learning: density estimation, clustering
- Manifold learning and dimensionality reduction
- Distance metric learning
- Semi-supervised learning
- Online and active learning
- Sequential inference (i.e., tracking)
- Large-scale learning
Class requirements

- Class format: lectures and student presentations
- Grading:
  - Presentation: 35%
  - Project: 35%
  - Participation: 30%
Presentation

- You are “professor for a day”: you need to give a one-hour lecture that would be interesting and accessible to all the students in the class

- You are responsible for selecting your own topic and paper(s)
  - Look at the list of reading materials on the class webpage
  - Look through recent conference proceedings
  - Pick a topic of interest based on your own research
Presentation Guidelines

• Evaluation criteria
  • Integration: utilize multiple sources
  • Critical thinking: separate the essential from the non-essential; critique the papers you present; think of alternative applications and future research directions
  • Interactivity: try to involve the rest of the class

• Structuring the presentation
  • Will depend on your focus
  • Broadly speaking, you may want to focus either on a particular learning topic, or a particular application
Sample Presentation Outline

• Introduction
  • Problem definition
  • Problem formulation
  • Significance

• Survey of methods for solving this problem

• Detailed presentation of one or more specific methods

• Discussion
  • Pluses and minuses of different methods
  • Compare and contrast different approaches
  • Ideas for improvement and future research
  • Alternative applications
  • Alternative methods for solving the same problem
  • Connect your topic to other topics discussed earlier in class
Presentation Timeline

- **Reading list**: due next Thursday, September 3rd
- **Preliminary slides**: due Monday the week before your scheduled presentation
- **Practice meeting**: scheduled for the week before your presentation
- **Final slides**: due by the end of the day after your presentation

All of the above are part of your presentation grade (35% of total class grade)

- A note on slides: you must explicitly credit all sources
Project

• Your project topic may be the same as your presentation topic
  • Not required, but may make your life easier

• Two options: implementation or survey paper
Implementation

• Implement one or more methods from literature
• Conduct a comparative evaluation
• Implement your own ideas or extensions of existing methods

• Deliverable: an “informal” final report and (possibly) a short presentation
• Students may collaborate, but each must submit his/her deliverables
• You can use existing code and/or software, provided you document all your sources and it doesn’t make your project trivial
Survey Paper

- Comprehensive tutorial, literature review
- A “formal” academic paper
- Typeset in LaTeX, 10-15 pages (single-spaced, 11pt font)
- Must be individual
Project timeline (tentative)

• **Project proposal:** due end of September (details to follow)

• **Progress report** (for implementation) or **draft paper** (for survey, ~5 pages): due end of October

• **Final report or paper:** due last day of class (December 8th)

• All of the above are part of your project grade (35% of total class grade)
Participation (30% of the grade)

• Class attendance, being on time
• Answer questions in review sessions at the beginning of class
• Be prepared
  • Read all the material before the class and come up with ~3 questions for discussion
  • I may call on anyone at any time
• Participate in discussions
• Send email to me and/or the class mailing group links to material that may be of interest

• *If you never speak up in class, the best grade you can get is P+!*
What’s next?

• First few weeks: lectures on the basics of machine learning

• Reading lists due next Thursday, September 3rd
  • Also send any date constraints/preferences
  • Topics may require some conflict resolution
  • “Bonus points” for the first two students to present

• Class schedule finalized by the end of third week of class

• If you have any questions about whether you should take this class, talk to me now!