STA5934-02/STA4930-03 Medical Image Analysis
Spring 2012

Course Information

Class Meeting Place/Time: Tuesday/Thursday 11:00-12:15pm in OSB 205

Instructor: Dr. Adrian Barbu

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Office Hours: Wednesday 3:00-5:00pm or by appointment

Textbooks: Medical Imaging: Signals and Systems by Jerry Prince & Jonathan Links (publisher: Pearson) for the first part
The textbook is optional since the course will not follow any particular book.

Course Objectives: This course is a practical overview of current methods in Medical Image Analysis, with a focus on learning based methods.

- Image acquisition:
  - Radiography, fluoroscopy
  - Computed Tomography (CT)
  - Magnetic Resonance Imaging (MRI)
  - Ultrasound
- Image Segmentation
  - Mean shift segmentation
  - Level Sets
  - Normalized Cuts, Graph Cuts, Belief Propagation
  - Procrustes Analysis
  - Active Shape Models
  - Active Appearance Models
  - Hybrid models
  - Auto Context
- Learning-based object detection:
  - Machine learning methods: Decision Trees, Random Forest, Boosting, SVM, Regression
  - Efficient Inference: Marginal Space Learning
  - Applications: 2D Face detection, 2D guidewire localization in fluoroscopy, 2D LV detection and segmentation in ultrasound, 3D LV detection in CT, Lymph node detection in CT.
- Image Registration
  - Mutual Information

Some of the most important methods will be accompanied by small projects for a better understanding of their advantages and limitations.

Grading: There will be 8 homework projects worth 10-25 points, and paper presentations worth 15 points each. The students can choose the projects they want to turn in or the papers they want to present to reach 100 points.
The following scheme will be used to convert the points to letter grades

- 90-100 A range, 80-89 B range, 70-79 C range, 60-69 D range, 0-59 F range.

Prerequisites: STA 3032 and knowledge of Matlab, C++ or other programming language or consent of instructor.

Course Materials

- Blackboard class website: go to http://campus.fsu.edu/ and login using you ACNS username and password. Homework, datasets, grades, course notes and other course material will be posted there.
- CMU Machine Learning Class: http://www.cs.cmu.edu/~tom/10701_sp11/lectures.shtml
- Tom Michell's ML book website: http://www.cs.cmu.edu/~tom/mlbook.html
- Nillson's ML book: http://ai.stanford.edu/~nilsson/mlbook.html

Course Policy

- **Classroom policies:** The classroom environment is an important factor for effective learning. In order to not distract other students' attention please follow these classroom policies. The first one of these is the university policy.
    - Remember that no food or drinks are allowed in the classroom.
    - Turn off all audible alarms (cell phones, pagers, calculators, watches etc.)
    - Do not use cell phones in the class.
    - Come to the class on time. Opening and closing the classroom door in the middle of a class cause distraction to the students and the teacher.
    - Do not talk to other students without permission while the professor is teaching. More than one conversation creates noise and makes it difficult for the students to pay attention to the lecture.
- **Attendance:** You are required to attend all classes. The class activities will help you assimilate the lessons more easily, giving you an opportunity for active learning. Do not let this opportunity slip away. Any foreseen absence must be cleared with the instructor. If the absence is due to emergencies, it is the student's responsibility to notify the instructor at the earliest opportunity of the emergency.
- **Paper presentations:** The papers listed at the end of the syllabus can be presented by students in front of the class for **15 points each**. A paper presentation will typically last 30-45 minutes and should be prepared thoroughly by the student in advance. Each paper can be presented only once. The students should notify the instructor which paper they want to present, on a **first-come-first-serve** basis.
- **Homework projects:** There will be 8 homework projects worth **15 points each**, typically due in two weeks from the date they are announced.

	Project	Points	Duration
1	Mean Shift	10	1 week
2	Level Sets	15	2 weeks
3	Procrustes and PCA	15	2 weeks
4	Active Shape Models	25	3 weeks
5	Weka	10	1 week
6	Graph Cuts	15	2 weeks
7	Normalized Cut	10	1 week
8	Final Project	15	All semester

The homework must be neatly written, preferably typed. Computer output should be kept to a minimum. You are encouraged to submit the project code by email. The best code will be posted on Blackboard to be available for all students attending the class.

- **Code:** It is acceptable to use code downloaded from the internet for the homework as long as a reference to the code website or the appropriate paper is added to the bibliography of the homework.
- **Collecting returned homework:** It is the student's responsibility to retrieve his or her homework whenever they are returned and to check grades on the Blackboard class page. If you notice any mistake in recording grades on the Blackboard page, please inform the instructor about it as soon as possible.
- **Homework re-grade:** You have one week to request a re-grade of a homework from the date on which the graded homework is available to the students of the class. Submit a written request detailing the nature of the grading error to the instructor along with the relevant homework.
- **Contacting the instructor outside the class:** You are strongly encouraged to come to the instructor during his office hours. If your schedule conflicts with the office hours, you can make an appointment. You may ask the instructor brief questions by e-mail, but you may be asked to come to office hours if the instructor thinks that the questions are better answered in person.
  When you send e-mails remember the following:
  - Always e-mail from your FSU accounts. The e-mails from non-FSU accounts may not reach me due to filters.
  - Always write your full name at the end of each e-mail message you send.
  - Always write the course number at the beginning of the subject line.
- **Academic honor policy:** The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to ". . . be honest and truthful and . . . [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at http://dof.fsu.edu/honorpolicy.htm.)
- **Americans with Disabilities Act**:
  Students with disabilities needing academic accommodation should:
  1) register with and provide documentation to the Student Disability Resource center; and
  2) bring a letter to the instructor indicating the need for accommodation and what type.
  This should be done during the first week of class.
  This syllabus and other class materials are available in alternative format upon request.

For more information about services available to FSU students with disabilities, contact:

Student Disability Resource Center
874 Traditions Way
108 Student Services Building
Florida State University
Tallahassee, FL 32306-4167
(850) 644-9566 (voice)
(850) 644-8504 (TDD)
sdrc@admin.fsu.edu
http://www.disabilitycenter.fsu.edu/

Papers for student presentations

1. Zhu, S. C., & Yuille, A. Region Competition: Unifying Snakes, Region Growing, and Bayes/MDL for Multiband Image Segmentation. *IEEE Transactions on Pattern Analysis and Machine Intelligence,* 18(9), 884-900. 1996.
2. Held, K., Kops, E. R., Krause, B. J., Wells, W. M., III., Kikinis, R., & Muller-Gartner, H. W. Markov random field segmentation of brain MR images. *Medical Imaging, IEEE Transactions on,* 16(6), 878-886. 1997.
3. Zhang, Y., Brady, M., & Smith, S. Segmentation of Brain MR Images Through a Hidden Markov Random Field Model and the Expectation-Maximization Algorithm. *IEEE Transactions on Medical Imaging,* 20(1), 45-57. 2001.
4. Sharon, E., Brandt, A., & Basri, R. Fast Multiscale Image Segmentation. *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition,* vol. I. Pages 70-77 2000.
5. Sharon, E., Brandt, A., & Basri, R. Segmentation and Boundary Detection Using Multiscale Intensity Measurements. *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition,* vol. I. Pages 469-476. 2001.
6. Joshi, S., Pizer, S. M., Fletcher, P. T., Thall, A., & Tracton, G. Multi-scale 3D Deformable Model Segmentation Based on Medical Description. *Information Processing in Medical Imaging (IPMI 2001)* Pages 64-77. 2001.
7. Lafferty, J., McCallum, A., & Pereira, F. Conditional Random Fields: Probabilistic Models for Segmenting and Labeling Sequence Data. *Proceedings of International Conference on Machine Learning.* 2001.
8. Davies, R. H., Twining, C. J., Cootes, T.F., Waterton, J. C., & Taylor, C.J. A Minimum Description Length Approach to Statistical Shape Modeling. *IEEE Transactions on Medical Imaging,* 21(5), 525-537. 2002.
9. Kumar, S., & Hebert, M. Discriminative Random Fields: A Discriminative Framework for Contextual Interaction in Classification. *International Conference on Computer Vision.* 2003.
10. Pizer, S. M., Fletcher, P. T., Joshi, S., Thall, A., Chen, J. Z., Fridman, Y., Fritsch, D. S., Gashi, A. G., Glotzer, J. M., Jiroutek, M. R., Lu, C., Muller, K. E., Tracton, G., Yushkevich, P., & Chaney, E. L. Deformable M-Reps for 3D Medical Image Segmentation. *International Journal of Computer Vision,* 55, 85-106. 2003.
11. Heimann, T., Wolf, I., Williams, T. G., & Meinzer, H.-P. 3D Active Shape Models Using Gradient Descent Optimization of Description Length. *Proceedings of Information Processing in Medical Imaging.* Pages 566-577, 2005.
12. Akselrod-Ballin, A., Galun, M., Gomori, M. J., Filippi, M., Valsasina, P., Basri, R., & Brandt, A. Integrated Segmentation and Classification Approach Applied to Multiple Sclerosis Analysis. *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition.* 2006.
13. Corso, J. J., Tu, Z., Yuille, A., & Toga, A. W. Segmentation of Sub-Cortical Structures by the Graph-Shifts Algorithm. Pages 183-197 of: Karssemeijer, N., & Lelieveldt, B. (eds), *Proceedings of Information Processing in Medical Imaging,* 2007.
14. Tu, Z., Narr, K. L., Dinov, I., Dollar, P., Thompson, P. M., & Toga, A. W. Brain Anatomical Structure Segmentation by Hybrid Discriminative/Generative Models. *IEEE Transactions on Medical Imaging.* 2007.