

## Guideline for Term Project

CAP 5638, Pattern Recognition, Fall 2015

Department of Computer Science, Florida State University

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**Points: 100**

**Maximum Team Size: 2** (In other words, this can be a two-person team project or an individual project)

**Due: Brief Proposal, at the beginning of class, Friday, November 6, 2015**

**Final Report, 5:00PM, Friday, December 11, 2015**

**Purpose:** To gain research experience using pattern recognition techniques to solve real world problems or gain further understanding of implementation issues of pattern recognition techniques for large scale datasets.

**Background:** There is very rich literature on various pattern recognition techniques and in particular on applying pattern recognition techniques to real world applications. This class has covered the basic principles and algorithms for different pattern recognition techniques with emphasis on statistical pattern recognition and discriminant functions. As in any engineering efforts, solving practical problems requires implementations and other considerations to achieve the best performance under constraints.

**Assignment:** Recognizing the diverse background of this class and the availability of implementations of pattern recognition techniques on the web, there are four general options for this assignment.

- **Implementation of a set of pattern recognition techniques** – In this option, you need to implement pattern recognition techniques that involve substantial programming/coding. There are two options here.
  - **Implementation for educational purpose** – In this case, you need to provide nice graphical user interfaces that allow users to set/change parameters and some working examples, and tools/ways to visualize results; you have to make the programs available on-line with reasonable documents. While you can use components that are available on the web or other sources, you have to write the majority of the components. Possible topics include linear discriminant functions, support vector machines, Adaboost algorithms, Parzen window estimation, k-nearest neighbor estimation, and decision tree classifiers. Note that you may need to implement more than one topic, depending on the features you include and the topics you choose.
  - **Implementation of a particular task** – In this case, you need to implement a set of programs to solve a particular task. While you can duplicate some existing programs on the web or in other sources, your implementation has to provide some distinctive features, such as efficiency. You have to make the programs available on-line with reasonable documents. Possible topics here include optical character recognition, face recognition, face detection, and object detection.
- **Application of existing pattern recognition programs on (large-scale) datasets** – In this case, you can download and use existing pattern recognition programs. But you have to use the programs on at least three nontrivial datasets. Possible choices include support vector machines/boosting algorithms/neural networks for optical character recognition, face recognition, gender classification, iris classification, gene classification, spam filtering, speech

recognition, medical image analysis and so on. Note that these must be different from the ones in the two programming assignments.

- **In-depth literature review**

If you do not have a strong programming background, you can take this option by reviewing advances in a particular aspect of pattern recognition techniques or pattern recognition techniques used in a particular field. In this case, the project must be an individual one and your report must demonstrate that you understand clearly the key issues, different proposed solutions (advantages and disadvantages of these methods), and open questions/future research problems.

- **Pattern recognition research** – There are three choices for this option.

- **Novel research** – In this option, you need to have either a problem that requires some novel ways of using pattern recognition techniques or a new pattern recognition method that provides features that are not available in existing methods. If your research is related to pattern recognition, this may be the best option for you.
- **Novel application** – In this option, you need to create a novel application of your own using pattern recognition techniques. For example, you can create a system to recognize a face based on a picture taken by a mobile phone camera (see a recent report on what can be done <http://www.heinz.cmu.edu/~acquisti/face-recognition-study-FAQ/>); you can also create a system to recognize your hand written digits by collecting a training set of your own handwritten digits, and then use the trained classifier to classify interactive inputs of handwritten digits, and so on.
- **Recreation of a research project** – In this case, you can choose a paper from the literature that is closely related to pattern recognition and then duplicate the research or significant components of it. The following papers may give you some ideas.
  - Face recognition
    - W. Zhao, R. Chellappa, P. J. Phillips, A. Rosenfeld,, ``Face recognition: A literature survey," *ACM Computing Surveys*, vol. 35, no. 4, pp. 399--458, 2003.
  - Face detection
    - H. A. Rowley, S. Baluja, and T. Kanade, "Neural network-based face recognition," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 20, no. 1, pp. 23-38, 1998.
    - E. Hjelmas and B. K. Low, ``Face detection: a survey," *Computer Vision and Image Understanding*, vol. 83, pp. 236--274, 2001.
    - M. H. Yang, D. Kriegman, and N. Ahuja, ``Detecting faces in images: a survey," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 24, no. 1, pp. 34--58, 2002.
    - P. Viola and M. Jones, "Robust Real-time Object Detection," *International Journal of Computer Vision*, vol. 57, no. 2, pp. 137—154, 2004.
  - Medical image analysis
    - J. S. Duncan, and N. Ayache, "Medical image analysis: progress over two decades and the challenges ahead," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 22, no. 1, pp. 85-106, 2000.
    - Breast cancer detection and classification.

- Financial engineering
  - A. P. Refenes, A. N. Burgess, and Y. Bentz, "Neural Networks in Financial Engineering," *IEEE Transactions on Neural Networks*, vol. 8, pp. 1222-1267, 1997.
  - Stock prediction
  - Intelligent investment recommendations.
- Computer security, steganography and stenanalysis
  - J. Fririch, T. Pevny, and J. Kodovsky, "Statistically undetectable JPEG Steganography: Dead ends, challenges, and opportunities," in the Proceedings of ACM Multimedia and Security Workshop, 2007.
  - J. Ma, L. K. Saul, "Learning to Detect Malicious URLs," *ACM Transactions on Intelligent Systems and Technology*, Vol. 2, No. 3, 2011.
  - W. Wong and M. Stamp, "Hunting for metamorphic engines," *Journal of Computer Virology*, vol. 2, pp. 211-229, 2006. (Available from <http://www.truststc.org/pubs/237/hunting.pdf>) .
- Medical image analysis
  - P. J. Nestor, P. Scheltens, and J. R. Hodges, "Advances in the early detection of Alzheimer's disease," *Nature Reviews Neuroscience*, vol. 5, pp. S34-S41, 2004 (Available from <http://www.nature.com/nm/journal/v10/n7s/pdf/nrn1433.pdf>).
- Deep learning architecture
  - G. E. Hinton, S. Osindero, and Y.-W. Teh, "A fast learning algorithm for deep belief nets," *Neural Computation*, 18, pp 381-344, 2006.
  - M. Ranzato, J. Susskind, V. Mnih, and G. Hinton, "On deep generative models with applications to recognition," *IEEE Conference on Computer Vision and Pattern Recognition*, 2011.
  - Y. Bengio, "Learning Deep Architectures for AI," Technical Report, University of Montreal. (Available from <http://www.iro.umontreal.ca/~lisa/pointeurs/TR1312.pdf> ).
  - Y. Bengio and Y. LeCun, "Scaling Learning Algorithms towards AI," in *Large-Scale Kernel Machines*, 2007 (Available from [http://www.iro.umontreal.ca/~lisa/bib/pub\\_subject/language/pointeurs/bengio+lecun-chapter2007.pdf](http://www.iro.umontreal.ca/~lisa/bib/pub_subject/language/pointeurs/bengio+lecun-chapter2007.pdf)).
  - Y. Bengio, I. Goodfellow, and A. Courville, *Deep Learning*, MIT Press, in press (current version available from <http://www.iro.umontreal.ca/~bengioy/dlbook/>).
- Natural language processing
  - Ronan Collobert , Jason Weston , Léon Bottou, Michael Karlen, Koray Kavukcuoglu, and Pavel Kuksa, "Natural Language Processing (Almost) from Scratch," *The Journal of Machine Learning Research*, Volume 12, 2/1/2011, Pages 2493-2537 (Available from <http://jmlr.org/papers/volume12/collobert11a/collobert11a.pdf>).
- Speech recognition
- Voice mail technology

Additionally, you can search on the web, the IEEE web site (<http://ieeexplore.ieee.org/Xplore/dynhome.jsp>) or the ACM digital library site (<http://portal.acm.org/dl.cfm>). (Note that you do have access to the IEEE and ACM sites from any machine on the FSU network.)

The assignment consists of two steps.

- **A brief proposal** -You need to prepare a one- or two-page proposal, stating clearly your choice and specifics of your proposed task and outlining clearly your goals and a plan to achieve your goals. Only one copy is required for each team.
- **Final report** – You need to write a report on what you have achieved by doing this project. While the details depend on your choice, you must include all the important aspects to support that you have achieved the specified goals as outlined in the assignment and in your proposal. Only one copy of report is required for each team.

## Grading

- **Proposal** – 10 points
  - However, the penalty of missing a proposal is 30 points.
- **Final report** – 30 points
  - You need to include
    - A report summarizing what you have achieved.
    - All programs you developed/used for the project.
    - Typical results to demonstrate the correctness and significance of the methods you used, and comparisons with other existing related techniques.
- **Correct understanding/implementation/significance** – 60 points
  - Significance of the problem(s)
  - Significance of the dataset(s)
  - Correctness of your pattern recognition techniques
  - Amount of work
    - In case that you have used other programs' in your project, you will be graded based on your efforts beyond other's programs.
  - Experimental results if applicable
- **Optional in-class presentation** – 5 points (extra credit)
  - Your group can earn up to five extra credit points if you choose to give an in-class presentation that is about ten minutes long; you need to schedule your presentation with the instructor in advance; the presentation slots are available during the last week of classes (in other words, you need to complete your project earlier.).

## Additional Information

Please note that copying of other's work without proper references is a violation of the academic honor code and is an example of plagiarism. To avoid this, you must cite references properly; in case that you have used some of the programs available on the web, you need to reference them clearly in your report. In case that your project is based on other's work, yours will be graded based on your own contributions, i.e., the parts you have done beyond the other's work.