Medical Imaging Informatics
Course # 170.03

January 10 – March 20, 2012
Tuesdays 9-11AM
Room GEN-S202
Course Synopsis

- Overall Objective:
  - Learn modern concepts of medical image processing and analysis

- Specific learning goals:
  - Understand principles of imaging informatics and information theory
  - Learn modern strategies of medical image processing
  - Recognize new trends in image statistics
Course Outline

Basics:
- This segment of the course will provide an overview of medical imaging modalities, image representations, foundations of imaging informatics and concepts of information theory, including definitions of entropy, complexity, and probability.

Image Processing Techniques:
- This segment will introduce general algorithms for rigid and non-rigid image registrations, the concept of atlas building, image segmentation, and new trends in computational anatomy.
Course Outline

- **Statistical Analysis:**
  - This segment will present statistical concepts for image analysis, including linear modeling, univariate and multivariate analysis, independent components analysis, joint independent components analysis, as well as emerging trends in network analysis.

- **Data Mining:**
  - This segment will introduce basic concepts of data mining for uni- and multimodal imaging applications. Different mining algorithms will be discussed, including decision trees, neural nets, Bayesian classifiers, support vector machines, non-parametric and reinforcement learning.
## Timeline

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<tr>
<th>Dates</th>
<th>Lecture Titles</th>
<th>Presenters</th>
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<td><strong>2012</strong></td>
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<tr>
<td></td>
<td><strong>Basics</strong></td>
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<tr>
<td>1/10</td>
<td>1. Introduction to imaging informatics</td>
<td>N. Schuff</td>
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<td>1/17</td>
<td>2. Uses of information theory in imaging</td>
<td>N. Schuff</td>
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<td><strong>Image Processing</strong></td>
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<td>1/24</td>
<td>3. Segmentation</td>
<td>N. Schuff</td>
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<td>1/31</td>
<td>4. Rigid Image Registration</td>
<td>Cardenas/Tosun</td>
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<td>2/07</td>
<td>5. Non-rigid Registration/Atlas building</td>
<td>Cardenas/Tosun</td>
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<td>2/14</td>
<td>6. Computational Anatomy</td>
<td>Tosun</td>
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<td></td>
<td><strong>Statistical Analysis</strong></td>
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<td>2/21</td>
<td>7. Linear Modeling in Medical Imaging</td>
<td>J. Kornak</td>
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<td>2/28</td>
<td>8. Multimodal Imaging Analysis</td>
<td>D. Tosun</td>
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<td>3/06</td>
<td>9. Network Analysis</td>
<td>V. Cardenas</td>
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<td><strong>Data Mining</strong></td>
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<td>3/13</td>
<td>10. Principles of Data Mining</td>
<td>K. Young</td>
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<tr>
<td>3/20</td>
<td>11. Multimodal Image Mining</td>
<td>K. Young</td>
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http://www.cind.research.va.gov/
## Contact Information

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<tr>
<th>Instructors</th>
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Foundation of Imaging (MRI)

Foundations of medical imaging and signal recording --
Spectral transformations --
Information theory and principal component analysis --
Independent component analysis and blind source separation --
Dependent component analysis --
Pattern recognition techniques --
Fuzzy clustering and genetic algorithms --
Exploratory data analysis methods for fMRI --
Low-frequency functional connectivity in fMRI --
Classification of dynamic breast MR image data --
Dynamic cerebral contrast-enhanced perfusion MRI --
Skin lesion classification --
Microscopic slice image processing and automatic labeling --
NMR water artifact removal.
Foundation of Functional Imaging

Statistical Parametric Mapping
The Analysis of Functional Brain Images
Information Theory

Part I: Theories of Perception and Learning
Chapter 1: Bayesian Modelling of Visual Perception, by P. Mamassian, M. Landy and L. Maloney
Chapter 2: Vision, Psychophysics, and Bayes, by P. Schrater and D. Kersten
Chapter 3: Visual Cue Integration for Depth Perception, by R. Jacobs
Chapter 4: Velocity Likelihoods in Biological and Machine Vision, by Y. Weiss and D. Fleet
Chapter 5: Learning Motion Analysis, by W. Freeman, J. Haddon and E. Pasztor
Chapter 6: Information Theoretic Approach to Neural Coding and Parameter Estimation: A Perspective, by J.-P. Nadal
Chapter 7: From Generic to Specific: An Information Theoretic Perspective on the Value of High-Level Information, by A. Yuille and J. Coughlan
Chapter 8: Sparse Correlation Kernel Reconstruction and Superresolution, by C. Papageorgiou, F. Girosi and T. Poggio
R Scripts

Introduction Computational Statistics and Statistical Computing
The R Environment Getting Started with R
Using the R Online Help System Functions Arrays, Data Frames, and Lists
Workspace and Files Using Scripts
Using Packages Graphics Probability and Statistics
Review Random Variables and Probability Some Discrete Distributions Some Continuous Distributions
Multivariate Normal Distribution Limit Theorems
Statistics Bayes' Theorem and Bayesian Statistics
Markov Chains Methods for Generating Random Variables Introduction

And much more…..