Course Director: Dr. Kayvan Najarian (DCM&B, kayvan@umich.edu)
Lectures: Mondays and Wednesdays 9:00-10:30 AM
Labs: Wednesdays 10:30 – 11:30 AM (alternate weeks)
both lectures & labs meet in Rm. 2036 Palmer Commons Bldg.

Lecture (1): Introduction to Continuous and Discrete Signals
Instructor: Dr. Kayvan Najarian
Time: September 2 (Wednesday), 9:00 – 10:30 AM
Topics: Continuous, analog, discrete and digital signals, 1-D, 2-D and multi-dimensional signals, as well as concept of signal transformation are introduced.

Lecture (2): Fourier Transform I
Instructor: Dr. Kayvan Najarian
Time: September 8 (Monday), 9:00 – 10:30 AM
Topics: Introduction to Fourier Transform I

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Lecture (3): Fourier Transform II
Instructor: Dr. Kayvan Najarian
Time: September 10 (Wednesday), 9:00 – 10:30 AM
Topics: Fourier Transform and its applications are introduced.

Lab (1): Introduction to MATLAB
Instructor: Dr. Kayvan Najarian
Time: Sept 10 (Wednesday) 10:30 – 11:30 AM
Topics: Basic operations in MATLAB, using MATLAB for manipulation of matrices and functions, graphical representation of data using MATLAB is presented.

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Lecture (4): From Fourier Transform to Wavelet Transform
Instructor: Dr. Kayvan Najarian
Time: September 15 (Monday), 9:00 – 10:30 AM
Topics: Shortcomings of Fourier Transform resulting to Short-Time Fourier Transform are provided. Also, a brief introduction to Wavelet Transform is given.

Lecture (5): Wavelet Transform
Instructor: Dr. Kayvan Najarian
Time: September 17 (Wednesday), 9:00 – 10:30 AM
Topics: Different types of wavelet transform and applications of wavelet transform are covered.

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Lecture (6): Applications of Fourier and Wavelet Transforms in Biomedical Sciences I  
**Instructor:** Dr. Kayvan Najarian  
**Time:** September 22 (Monday), 9:00 – 10:30 AM  
**Topics:** Biomedical and biological applications of signal transform, including filtering and feature extraction, are explained.

Lecture (7): Applications of Fourier and Wavelet Transforms in Biomedical Sciences II  
**Instructor:** Dr. Kayvan Najarian  
**Time:** September 24 (Wednesday), 9:00 – 10:30 AM  
**Topics:** More biomedical and biological applications of signal transform are covered.

Lab (2): Using Fourier and Wavelet Transforms to Analyze Biomedical Data  
**Instructor:** Dr. Kayvan Najarian  
**Time:** September 24 (Wednesday) 10:30 – 11:30 AM  
**Topics:** Using Fourier and wavelet transforms filtering and frequency analysis in some practical biomedical / biological scenarios are practiced.

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Lecture (8): Introduction to Information Theory  
**Instructor:** Dr. Kayvan Najarian  
**Time:** September 29 (Monday), 9:00 – 10:30 AM  
**Topics:** The need for measuring “information” and the concept of entropy will be explained.

Lecture (9): Concepts in Information Theory I  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 1 (Wednesday), 9:00 – 10:30 AM  
**Topics:** Different types of conditional entropy will be introduced.

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Lecture (10): Concepts in Information Theory II  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 6 (Monday), 9:00 – 10:30 AM  
**Topics:** Mutual information, KL-distance and information distance and other definitions will be introduced.

Lecture (11): Applications of Information Theory in Biomedical Data Analysis I  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 8 (Wednesday), 9:00 – 10:30 AM  
**Topics:** Review of the role of entropy, KL-distance and mutual information as fundamental measures in assessment of dependency among biological / biomedical data.
Lab (3): Applications of Information Theory in Biomedical Data Analysis II  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 8 (Wednesday), 10:00 – 11:30 AM  
**Topics:**  
More biomedical applications of information theory will be covered.

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Lecture (12): Introduction to Natural Language Processing  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 15 (Wednesday), 9:00 – 10:30 AM  
**Topics:**  
Basic definitions and applications of natural language processing in biomedical data analysis are covered.

Lab (4): Using Information Theoretic Measures in Biomedical Data Analysis  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 15 (Wednesday), 10:30 – 11:30 AM  
**Topics:**  
In some biomedical / biological scenarios, the applicability of information-theoretic measures, such as entropy and mutual information gain, will be compared with those of purely statistical metrics such as standard deviation and correlation.

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Lecture (13): Clustering vs. Classification  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 20 (Monday), 9:00 – 10:30 AM  
**Topics:**  
Basic concepts of classification and clustering will be introduced and compared.

Lecture (14): Simple Clustering and Classification Methods  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 22 (Wednesday), 9:00 – 10:30 AM  
**Topics:**  
K-Means and K-Nearest Neighbors are presented.

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Lecture (15): Feature Selection  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 27 (Monday), 9:00 – 10:30 AM  
**Topics:**  
The need for feature selection and the overall approaches for this process will be introduced.

Lecture (16): Cross Validation  
**Instructor:** Dr. Kayvan Najarian  
**Time:** October 29 (Wednesday), 9:00 – 10:30 AM  
**Topics:**  
Cross validation methods, such as 10-fold cross validation and leave-one-out, will be introduced.
Lab (5): Classification and Clustering of Biomedical Data  
Instructor: Dr. Kayvan Najarian  
Time: October 29 (Wednesday) 10:30 – 11:30 AM  
Topics:  
Introduction to Weka. For at least one biomedical signal/image processing application, classification/clustering along with feature selection and cross validation will be conducted.

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Lecture (17): Public Biomedical Databases (1)  
Time: November 3 (Monday), 9:00 – 10:30 AM  
Instructor: Dr. Yuanfang Guan  
Topics:  
Overview of public biomedical databases.

Lecture (18): Public Biomedical Databases (2) -- accessing and analyzing GEO data from a published paper.  
Time: November 5 (Wednesday), 9:00 – 10:30 AM  
Instructor: Dr. Yuanfang Guan  
Topics:  
An example of how to use a GEO dataset to do some research.

Lab (6): TCGA data  
Time: November 5 (Wednesday), 10:30 – 11:30 AM  
Instructor: Dr. Yuanfang Guan  
Topics:  
TBA

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Lecture (19): Introduction to Machine learning (1)  
Time: November 10 (Monday), 9:00 – 10:30 AM  
Instructor: Dr. Yuanfang Guan  
Topics:  
Introduction to mainstream machine learning tools

Lecture (20): Introduction to Machine learning (2) – Support Vector Machines  
Time: November 12 (Wednesday), 9:00 – 10:30 AM  
Instructor: Dr. Yuanfang Guan  
Topics:  
A practical introduction to the theory and application of SVM in the Biomedical field; SVMlight.

Lab (7): Predicting Cancer Outcomes with TCGA data  
Time: November 12 (Wednesday), 10:30 – 11:30 AM  
Instructor: Dr. Yuanfang Guan  
Topics:  
Use Weka and the TCGA data downloaded from the previous lecture to do some clinical outcome prediction.

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Lecture (21): Mathematical foundations of machine learning (1)
Time: November 17 (Monday), 9:00 – 10:30 AM
Instructor: Dr. Jieping Ye
Topics: TBA

Lecture (22): Mathematical foundations of machine learning (2)
Time: November 19 (Wednesday), 9:00 – 10:30 AM
Instructor: Dr. Jieping Ye
Topics: TBA

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Lecture (23): Sparse linear regression and its biomedical application
Time: November 24 (Monday), 9:00 – 10:30 AM
Instructor: Dr. Jieping Ye
Topics: TBA

Lecture (24): Structured sparse regression and its biomedical application
Time: November 26 (Wednesday), 9:00 – 10:30 AM
Instructor: Dr. Jieping Ye
Topics: TBA

Lab (8): Using SLEP to analyze ADNI data
Time: November 26 (Wednesday), 10:30 – 11:30 AM
Instructor: Dr. Jieping Ye
Topics: TBA

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Lecture (25): Missing data estimation (1)
Time: December 1 (Monday), 9:00 – 10:30 AM
Instructor: Dr. Jieping Ye
Topics: TBA

Lecture (26): Missing data estimation (2)
Time: December 3 (Wednesday), 9:00 – 10:30 AM
Instructor: Dr. Jieping Ye
Topics: TBA

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Lecture (27): Sparse coding for image annotation  
**Time:** December 8 (Monday), 9:00 – 10:30 AM  
**Instructor:** Dr. Jieping Ye  
**Topics:**  
TBA

Lecture (28): Deep learning for image annotation  
**Time:** December 10 (Wednesday), 9:00 – 10:30 AM  
**Instructor:** Dr. Jieping Ye  
**Topics:**  
TBA

Lab (9): FlyExpress image analysis  
**Time:** December 10 (Wednesday), 10:30 – 11:30 AM  
**Instructor:** Dr. Jieping Ye  
**Topics:**  
TBA

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