

## EE 638 – Applications of Machine Learning for Medical Data

Units: 4

Term—Day—Time: TTh 4 PM to 5:50 PM

Location: SOS B52

Instructors: Prof. Cauligi Raghavendra, Prof. Ajitesh Srivastava

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### Course Description

Application of machine learning models and algorithms to medical applications, learning from data and classification of disorders. Overview of health data, collection with sensors, body area networks, brain image data and other publicly available medical applications and public health data. Issues and methods for handling real world data with respect to missing and inconsistent data. Application of machine learning techniques to brain image data to classify various mental disorders, including Alzheimer's, Autism, TBI and PTSD, etc. Brain image data to include MRI, fMRI, and SPECT data. Using time-series data for infectious disease forecasting. Students will learn about machine learning applications to real world medical data through examples and reading papers. Students are expected to work on a semester long project on a medical application with real world data, get research results, and write a term paper.

### Learning Objectives

Students will learn about issues with real world data and how to deal with them in analyzing data;  
Students will learn about medical applications and types of data;  
Students will learn about methodologies for applying machine learning to medical applications and for real world data;  
Doing literature search, conduct research, working on a team project, making presentations, and writing a paper.

**Prerequisite(s):** EE 660 or CSCI 567 or INF 552

**Concurrent Enrolment:**

**Recommended Preparation:**

**Co-Requisites:** None

### Course Notes

Materials will be from papers and slides used in class. There will be guest lectures.

### Technological Proficiency and Hardware/Software Required

Students are required to have familiarity with Matlab, Scikit learn, or other ML tools, and coding language of their choice. Access to Matlab is provided on campus. ML tools are publicly available. Students can use their own machines or use machines provided on campus.

## Required Readings and Supplementary Materials

Required readings and supplementary materials are published journal and conference papers. Papers will be drawn on sensors and medical data, practical uses of machine learning, and publications in medical journals. A list of papers is made available at the beginning of each semester.

## Description and Assessment of Assignments

This is a research and project oriented course. Students are required to choose a medical application problem of their interest early in the semester. They will be given a list of possible ideas, links to websites, and from a few guests/collaborators. Students do literature survey, learn and acquire data needed for their project (either public sources or from mentors), design and apply machine learning to that problem, and write a term paper. Students are expected to participate in class discussions, make short presentations during the semester, and a final presentation on their project at the end of semester. Each team will make a presentation of their project towards the end of the semester.

## Grading Breakdown

How will students be graded overall, including the assignments detailed above. Participation should be no more than 15%, unless justified for a higher amount. All must total 100%.

Assignment	Points	% of Grade
Summary writeup 1	10	10
Summary writeup 2	15	15
Home Work	15	15
Short Class presentations	10	10
Project and report	30	30
Final Presentation	20	20
<b>TOTAL</b>	100	100

## Assignment Submission Policy

Assignments are assigned in class and it is written summary of papers read related to the project. Assignments are written reports and presentations.

## Additional Policies

In team projects, each member should contribute to the success of the project. Responsibility of each member to be documented in the report. Expectation is for the project to be a publishable work.

## Course Schedule: A Weekly Breakdown

**Note: Topics from guest lectures depend on the availability of guest lecturers.**

	Topics/Daily Activities	Readings and Homework	Deliverable/ Due Dates
<b>Week 1</b>	Introduction and overview of course, data, and tools to use Useful things to know about Machine Learning	Papers 1,2	Class discussion
<b>Week 2</b>	Machine Learning basics; Machine learning in medicine; Guest Lecture	Papers 2, 3, 7	Class discussion

<b>Week 3</b>	Health data, Sensors, Body area networks; Feature selection, Evaluation Machine Learning algorithms for unstructured data	Paper 4, 5	Class discussion Introduce possible project datasets
<b>Week 4</b>	COVID-19 applications and datasets	Paper 6	Choose topic and identify team Select papers on topic
<b>Week 5</b>	Cancer, tumor detection, spine image classification, Parkinson's disease  Relevant paper discussion	Papers 9, 14	Short write up on literature Home Work on applying Machine Learning to a public dataset
<b>Week 6</b>	Alzheimer's disease and prediction; Short presentations by Student teams	Paper 6	Short write up on project proposal and plan
<b>Week 7</b>	Heart imaging, heart attack prediction  Guest lecture	Papers 8	
<b>Week 8</b>	Connectome and brain networks, Graph machine learning	TBD	
<b>Week 9</b>	Machine learning for mental disorders Short presentations by student teams	Paper 10	Short project presentations
<b>Week 10</b>	Mental disorders continued Autism, TBI, PTSD	Papers 12, 13, 15	Class discussion
<b>Week 11</b>	Treatment Recommendation  Guest lecture	Papers 10	Class discussion
<b>Week 12</b>	Project progress review and discussions Guest lecture	TBD	Class discussion
<b>Week 13</b>	Project progress review and discussions	TBD	Class discussion
<b>Week 14</b>	<b>Project Presentations</b>		<b>Each student team to make a presentation on their project</b>
<b>Week 15</b>	<b>Project Presentations</b>		<b>Final Project Report Due</b>
<b>FINAL</b>			Date: For the date and time of the final for this class, consult the USC <i>Schedule of Classes</i> at <a href="http://www.usc.edu/soc">www.usc.edu/soc</a> .

## List of Papers

1. Tom Mitchell. The Discipline of Machine Learning.  
<http://www.cs.cmu.edu/~tom/pubs/MachineLearning.pdf>
2. Pedro Domingos . A Few Useful Things to Know about Machine Learning  
<https://homes.cs.washington.edu/~pedrod/papers/cacml12.pdf>
3. Kiri L. Wagstaff. Machine Learning that Matters. Proceedings ICML 2012.  
<http://www.icml.cc/2012/papers/298.pdf>
4. George D. Magoulas, Andriana Prentza. Machine Learning in Medical Applications. Proceedings Machine Learning and Its Applications, Advanced Lectures Pages 300-307. [http://www.dcs.bbk.ac.uk/~gmagoulas/ACAI99\\_workshop.pdf](http://www.dcs.bbk.ac.uk/~gmagoulas/ACAI99_workshop.pdf)
5. Wullianallur Raghupathi, Viju Raghupathi. Big data analytics in healthcare: promise. Health Information Science and Systems, 2014, 2:3  
<http://www.hissjournal.com/content/pdf/2047-2501-2-3.pdf>
6. A. Srivastava, V. K. Prasanna. Fast and Accurate Forecasting of COVID-19 Deaths Using the SIKJ $\alpha$  Model, <https://arxiv.org/abs/2007.05180>.
7. Kenneth R Foster, Robert Koprowski and Joseph D Skufca. Machine learning, medical diagnosis, and biomedical engineering research – commentary. BioMedical Engineering OnLine 2014, 13:94. <http://biomedical-engineering-online.biomedcentral.com/articles/10.1186/1475-925X-13-94>
8. Lukasz A. Kurgana, Krzysztof J. Ciosa, Ryszard Tadeusiewicz, Marek Ogielae, Lucy S. Goodenday. Knowledge discovery approach to automated cardiac SPECT diagnosis. Artificial Intelligence in Medicine, Volume 23, Issue 2, October 2001, Pages 149–169. <http://www.sciencedirect.com/science/article/pii/S0933365701000823>
9. J.A. Cruz, D.S. Wishart, Applications of Machine Learning in Cancer Prediction and Prognosis, Cancer Informat, 2 (2006), p. 59-77. [http://www.la-press.com/redirect\\_file.php?fileId=150&filename=CIN-2-Wishart-et-al&fileType=pdf](http://www.la-press.com/redirect_file.php?fileId=150&filename=CIN-2-Wishart-et-al&fileType=pdf)
10. Sesen MB, Kadir T, Alcantara RB, Fox J, Brady M. Survival prediction and treatment recommendation with Bayesian techniques in lung cancer. AMIA Annu Symp Proc. 2012;2012:838-47. Epub 2012 Nov 3.  
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3540451/>
11. Fernando Yepes-Calderon, Fabian Pedregosae, Bertrand Thirione, Yalin Wang, and Natasha Lepore, Automatic pathology classification using a single feature machine learning - support vector machines.  
<http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1852210>

12. Cyrus A. Raji, Kristen Willeumier, Derek Taylor, Robert Tarzwell, Andrew Newberg, Theodore A. Henderson, Daniel G. Amen, “Functional neuroimaging with default mode network regions distinguishes PTSD from TBI in a military veteran population,” *Brain Imaging and Behavior*, 23 April 2015.  
<http://link.springer.com/article/10.1007/s11682-015-9385-5/fulltext.html>
  
13. Daniel G. Amen, Cyrus A. Raji, Kristen Willeumier, Derek Taylor, Robert Tarzwell, Andrew Newberg, Theodore A. Henderson, “Functional Neuroimaging Distinguishes Posttraumatic Stress Disorder from Traumatic Brain Injury in Focused and Large Community Datasets,” *PLoS One*, July 2015.  
<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0129659>
  
14. Ivo D. Dinov , Ben Heavner, Ming Tang et. al. Predictive Big Data Analytics: A Study of Parkinson’s Disease Using Large, Complex, Heterogeneous, Incongruent, Multi-Source and Incomplete Observations. *PLoS One*. August 2016.  
<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0157077>
  
15. D. Bone D, M. S. Goodwin, M. P. Black, C. C. Lee, K. Audhkhasi, S. Narayanan, “Applying Machine Learning to Facilitate Autism Diagnostics: Pitfalls and Promises,” *J Autism and Developmental Disorders* 2015 May;45(5):1121-36. doi: 10.1007/s10803-014-2268-6. <http://link.springer.com/article/10.1007%2Fs10803-014-2268-6>
  
16. Lukasz A. Kurgan, Krzysztof J. Cios, Ryszard Tadeusiewicz, Marek Ogiela, Lucy S. Goodenday, “Knowledge discovery approach to automated cardiac SPECT diagnosis,” *Artificial Intelligence in Medicine* 23 (2001) 149-169.  
<http://www.sciencedirect.com/science/article/pii/S0933365701000823/pdf?md5=6aaa860dc02a2e1e6e2a8f6ad152e25a&pid=1-s2.0-S0933365701000823-main.pdf>
  
17. John D. Medaglia, Mary-Ellen Lynall, and Danielle S. Bassett. *Cognitive Network Neuroscience*. [http://www.mitpressjournals.org/doi/pdf/10.1162/jocn\\_a\\_00810](http://www.mitpressjournals.org/doi/pdf/10.1162/jocn_a_00810)

[https://www.alz.org/aaic/releases\\_2015/Sun-8amET.asp](https://www.alz.org/aaic/releases_2015/Sun-8amET.asp)

<http://time.com/3590494/alzheimers-blood-test/>

## Statement on Academic Conduct and Support Systems

### Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu> or to the *Department of Public Safety* <http://adminopsnet.usc.edu/department/department-public-safety>. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage <http://sarc.usc.edu> describes reporting options and other resources.

### Support Systems

A number of USC’s schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* [http://sait.usc.edu/academicsupport/centerprograms/dsp/home\\_index.html](http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html) provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.