USCViterbi

EE 638 – Applications of Machine Learning for Medical Data

Units: 4
Term—Day—Time: MW 5 PM to 6:50 PM
Location: CPA 258

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Course Description

Application of machine learning models and algorithms to medical applications, public health, and classification of disorders. Issues and methods for handling real world data with respect to missing and noisy data, choosing data-preprocessing and machine learning techniques and domain-specific evaluations. Techniques in image classification, time-series classification and regression, text mining, and graph neural networks. Applications include infectious disease forecasting for influenza and COVID-19, mental disorder classification including Alzheimer's, Autism, TBI and PTSD, and cancer detection.
The course will also cover other applications with similar challenges in computer systems (predicting memory accesses, program behavior), load forecasting in smart grids, and making a robot stand-up comedian.
Students will learn how to deal with challenges of real-world data through examples and reading papers.

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 public health and types of data;
Students will learn about methodologies for applying machine learning, and evaluations in applications arising in the real world;
Doing literature search, conduct research, working on a team project, making presentations, writing a paper, and writing peer-review.

Prerequisite(s): EE 660 or CSCI 567 or DSCI 552 or other graduate-level Machine Learning course
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, Python, 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
TOTAL	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
Week 1	Introduction and overview of course, data, and tools to use Useful things to know about Machine Learning	Papers 1,2	Class discussion
Week 2	Machine Learning basics on structure and unstructured data; Machine learning and Data in medicine;	Papers 2, 3, 4	Class discussion Introduce possible project datasets
Week 3	Infectious disease forecasting, COVID-19, Influenza	Paper 7	Class discussion

Week 4	Ensembles and evaluations	Paper 8, 9	Choose topic and identify team Select papers on topic
Week 5	Image classification for Cancer, tumor detection, spine, Parkinson's disease Guest Lecture	Papers 9, 12, 14	Short write up on literature; Home Work on applying Machine Learning to a public dataset
Week 6	Machine learning for mental disorders: Autism, Alzheimer Alzheimer's disease and prediction; Short presentations by Student teams	Paper 14, 15, 17	Short write up on project proposal and plan
Week 7	Heart imaging, heart attack prediction, Treatment Recommendation Guest lecture	Papers 10, 12, 18	
Week 8	Connectome and brain networks, Graph machine learning	TBD	
Week 9	Lessons from other domains: Audio classification for Robot comedian Short presentations by student teams	Paper 20	Short project presentations
Week 10	Lessons from other domains: sequence prediction in memory systems, neural networks for compiler optimizations Guest lecture	Papers 22, 23	Class discussion
Week 11	Lessons from other domains: time-series problems in smartgrids Guest lecture	Paper 21	Class discussion
Week 12	How to write a paper Project progress review and discussions	Paper 24	Class discussion
Week 13	Project progress review and discussions		Class discussion
Week 14	**Project Presentations**		**Final Project Report Due;** **Each student team to make a presentation on their project**
Week 15	**Project Presentations**		**Each student team to make a presentation on their project**
FINAL			

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/cacm12.pdf

3. Kiri L. Wagstaff. Machine Learning that Matters. Proceedings ICML 2012. http://www.icml.cc/2012/papers/298.pdf

4. 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

5. 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

6. 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

7. A. Srivastava, V. K. Prasanna. Fast and Accurate Forecasting of COVID-19 Deaths Using the SIkJα Model, https://arxiv.org/abs/2007.05180.

8. A. Srivastava, S. Singh, and F. Lee. Shape-based Evaluation of Epidemic Forecasts, IEEE BigData 2022, https://arxiv.org/abs/2209.04035

9. E. Cramer et. al. Evaluation of individual and ensemble probabilistic forecasts of COVID-19 mortality in the United States. Proceedings of the National Academy of Sciences, 2022. https://www.pnas.org/doi/full/10.1073/pnas.2113561119

10. Lukasz A. Kurgana, Krzysztof J. Ciosa, Ryszard Tadeusiewicze, 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

11. 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

12. 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/

13. 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

14. 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

15. 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

16. 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

17. 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

18. 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/pdfft?md5=6aaa860dc02a2e1e6e2a8f6ad152e25a&pid=1-s2.0-S0933365701000823-main.pdf

19. John D. Medaglia, Mary-Ellen Lynall, and Danielle S. Bassett. Cognitive Network Neuroscience. http://www.mitpressjournals.org/doi/pdf/10.1162/jocn_a_00810

20. C. Gray et al., ""This Bot Knows What I'm Talking About!" Human-Inspired Laughter Classification Methods for Adaptive Robotic Comedians," 2022 31st IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), 2022, pp. 1007-1014, doi: 10.1109/RO-MAN53752.2022.9900634.

21. C.M. Cheung et. al., Behind-the-meter solar generation disaggregation using consumer mixture models, IEEE, In 2018 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm), 2018. https://ieeexplore.ieee.org/document/8587539/

22. Zhang et. al. ReSemble: Reinforced Ensemble Framework for Data Prefetching, In ACM/IEEE Supercomputing Conference (SC), 2022. https://www.computer.org/csdl/proceedings-article/sc/2022/544400b168/1I0bTdNcXjG

23. A. Srivastava et. al. Towards High Performance, Portability, and Productivity: Lightweight Augmented Neural Networks for Performance Prediction, IEEE, In 2020 IEEE 27th International Conference on High Performance Computing, Data, and Analytics (HiPC), 2020. https://ieeexplore.ieee.org/document/9406682

24. https://www.cs.ucr.edu/~eamonn/Keogh_SIGKDD09_tutorial.pdf

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 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.