**San José State University**
**Department of Computer Science**
**CS271, Topics in Machine Learning, Section 1, Spring, 2023**

## Course and Contact Information


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| Instructor: | Saptarshi Sengupta, PhD |
| Office Location: | MacQuarrie Hall 416 |
| Telephone: | 408-924-4808 |
| Email: | saptarshi.sengupta@sjsu.edu |
| Office Hours: | Thursday, 10:30 AM – 12:30 PM |
| Class Days/Time: | MW 10:30 AM - 11:45 AM |
| Classroom: | Clark Hall 238 |
| Prerequisites: | Graduate standing. Allowed Declared Major: Computer Science, Bioinformatics, Data Science. |


## Course Format

## Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on Canvas Leaning Management System course login website at http://sjsu.instructure.com. You are responsible for regularly checking with the messaging system through MySJSU at http://my.sjsu.edu (or other communication system as indicated by the instructor) to learn of any updates.

## Course Description

This course explores the mathematics as well as related practical applications in the field of deep learning. Students will explore pattern recognition in the context of computer vision, generative adversarial networks, autoencoders, language processing, robustness, predictive analytics, and time series forecasting. In addition, students will explore the fundamentals and various use cases in data-driven methods using packages such as Scikit-Learn, Tensorflow, Keras, PyTorch, SpaCy, NLTK etc.

## Course Learning Outcomes (CLO)

The focus of this course will be machine learning, with examples from fields such as computer vision, language processing, anomaly detection, health informatics and prognostics. After completing this course students should have a working knowledge of a wide variety of machine learning topics and have a good understanding of how to apply such techniques to real-world problems in the industry.

## Required Texts/Readings

## Textbook

None required

## Other Readings

Deep Learning (Adaptive Computation and Machine Learning series)
Authors: Ian Goodfellow, Yoshua Bengio, Aaron Courville
ISBN-13: 9780262035613
ISBN-10: 0262035618

**Other technology requirements / equipment / material**

Python 3, Scikitlearn libraries, numpy/scipy, Tensorflow and Keras, PyTorch, gym, Jupyter notebooks. Installing Anaconda is highly recommended. I will be using Jupyter Notebook and VS code in my demos in class.

**Course Requirements and Assignments**

SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of forty-five hours for each unit of credit (normally three hours per unit per week), including preparing for class, participating in course activities, completing assignments, and so on. More details about student workload can be found in University Policy S12-3 at http://www.sjsu.edu/senate/docs/S12-3.pdf.

Homework, Exams and Final Projects are expected for this class. Homework is due on Canvas by midnight on the due date. Each assigned problem requires a solution and an explanation (or work) detailing how you arrived at your solution. Cite any outside sources used to solve a problem. When grading an assignment, I may ask for additional information.

NOTE that University policy F69-24 at http://www.sjsu.edu/senate/docs/F69-24.pdf states that "Students should attend all meetings of their classes, not only because they are responsible for material discussed therein, but because active participation is frequently essential to insure maximum benefit for all members of the class. Attendance per se shall not be used as a criterion for grading."

**Final Examination or Evaluation**

The final project presentations may be administered in person/online.

**Grading Information**

- Homework: 25%
- Exam 1: 25%
- Exam 2: 25%
- Final Project: 25%

Note that "All students have the right, within a reasonable time, to know their academic scores, to review their grade-dependent work, and to be provided with explanations for the determination of their course grades." See University Policy F13-1 at http://www.sjsu.edu/senate/docs/F13-1.pdf for more details.

**Determination of Grades**

Semester grade will be computed as a weighted average of the scores obtained in each of the four categories listed above. No make-up tests or quizzes will be given, and no late homework (or other work) will be accepted. Also, in-class work must be completed in the section that you are enrolled in.

Nominal Grading Scale:

| Percentage | Grade |
|---|---|
| 97 – 100 plus | A+ |
| 93 – 96 | A |
| 90 – 92 | A- |
| 87 – 89 | B+ |
| 83 – 86 | B |
| 80 – 82 | B- |
| 77– 79 | C+ |
| 73 – 76 | C |
| 70 – 72 | C- |
| 67 – 69 | D+ |
| 63 – 66 | D |
| 60 - 62 | D- |
| 0-59 | F |

**Classroom Protocol**

- **Cheating** will not be tolerated.
- Student must be respectful of the instructor and other students. For example, No disruptive or annoying talking.
- Turn off cell phones
- Class begins on time
- Valid picture ID required at all times

**University Policies (Required)**

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/". Make sure to review these policies and resources.

**CS 271 / Topics in Machine Learning, Spring 2023, Course Schedule**
*The schedule is subject to change with fair notice communicated via Canvas course page/in-class*

**Course Schedule**

| Week | Date | Topics, Readings, Assignments, Deadlines |
|---|---|---|
| 1 | 01/25 | Introduction |
| 2 | 01/30 | Classification, Regression, Generalization and Model Complexity |
| 2 | 02/01 | K Nearest Neighbors, Linear Models, Naïve Bayes |
| 3 | 02/06 | Decision Trees, Kernelized SVM |
| 3 | 02/08 | Neural Networks Fundamentals |
| 4 | 02/13 | Introduction to Deep Learning |
| 4 | 02/15 | Computer Vision with Convolutional Neural Networks |
| 5 | 02/20 | Advanced Computer Vision: Architectures |
| 5 | 02/22 | Computer Vision Applications, Neural Style Transfer |
| 6 | 02/27 | Generative Adversarial Networks: DCGAN, SRGAN, CycleGAN and InfoGAN |
| 6 | 03/01 | Autoencoders: Vanilla, Sparse, Denoising and Stacked |
| 7 | 03/06 | Recurrent Neural Networks, BPTT, Vanishing and Exploding Gradients |
| 7 | 03/08 | RNN Cell Variants, RNN Variants and RNN topologies |
| 8 | 03/13 | Attention mechanisms in RNN, Transformers and other SOTA models |
| 8 | 03/15 | **Exam 1** |
| 9 | 03/20 | Language Modeling: Types, Bag-of-Words, Stopwords, Rescaling, Model Coefficients, n-Grams, Advanced Tokenization, Stemming and Lemmatization |
| 9 | 03/22 | Different kinds of Embeddings |
| 10 | 03/27 | **Spring recess – no classes** |
| 10 | 03/29 | **Spring recess – no classes** |
| 11 | 04/03 | Large language models: BERT and derivatives |
| 11 | 04/05 | Sequence to sequence learning and speech recognition |
| 12 | 04/10 | Unsupervised Learning: PCA, NMF, Manifold Learning |
| 12 | 04/12 | Unsupervised Learning: K-Means, Agglomerative Clustering, DBSCAN, CART |
| 13 | 04/17 | Robustness of Models |
| 13 | 04/19 | Time Series Analysis: Classical Approaches |
| 14 | 04/24 | Time Series Analysis: Data-driven Approaches |
| 14 | 04/26 | Predictive Maintenance in the Data-driven Age |
| 15 | 05/01 | Cyber Physical Systems and Fault Diagnosis |

| Week | Date | Topics, Readings, Assignments, Deadlines |
|---|---|---|
| 15 | 05/03 | **Exam 2** |
| 16 | 05/08 | **Project Presentations** |
| 16 | 05/10 | **Project Presentations** |
| 17 | 05/15 | Wrap Up |