## San José State University
## Computer Science Department
## CS276 Section 2, Machine Learning on Graphs, Spring 2024

### Course and Contact Information

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|---|---|
| **Instructor:** | Aikaterini Potika |
| **Office Location:** | MacQuarrie Hall 215 |
| **Telephone:** | 408-9245134 |
| **Email:** | katerina.potika@sjsu.edu |
| **Office Hours:** | Mondays-Wednesdays 9:30-10:00 am  and Mondays 12-1 pm or by appointment |
| **Class Days/Time:** | Mondays-Wednesdays 1:30-2:45 pm |
| **Classroom:** | MacQuarrie Hall 223 |
| **Prerequisites:** | CS 146 (with a grade of "C-" or better in each); or instructor consent. |

### Course Format

### Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on Canvas Learning 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 systems as indicated by the instructor) to learn of any updates.

### Course Description

Graphs are a powerful way to model networks. Networks contain a plethora of valuable information about the underlying data of various scientific fields. Students are introduced to various network analysis and machine learning techniques to help them extract, analyze, and visualize networks.

### Course Learning Outcomes (CLO)

Upon successful completion of this course, students will be able to:

- **CLO1** Select techniques for analyzing complex networks.
- **CLO2** Recognize and compute network properties and features, like node centralities, similarities, graphlets, and graph kernels.
- **CLO3** Integrate machine learning techniques, like clustering and classification, for graph problems.
- **CLO4** Create and use deep learning techniques for graph, node, and edge problems.

**Required Texts/Readings**

**Textbooks recommended**

[Graph Representation Learning](#), by William L. Hamilton

[Networks, Crowds, and Markets: Reasoning About a Highly Connected World](#), by David Easley and Jon Kleinberg, Cambridge University Press, ISBN-13 978-0521195331

[Network Science by Albert-László Barabási](#), Cambridge University Press, ISBN-13 978-1107076266

[Introduction to Machine Learning with Applications in Information Security by By Mark Stamp](#), 2nd edition, Chapman & Hall, ISBN-13 978-1032204925

[Deep Learning](#),  Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT press, ISBN-13 978-0262035613

[Knowledge Graphs: Fundamentals, Techniques, and Applications](#), by Mayank Kejriwal, Craig A. Knoblock and Pedro Szekely, MIT press, ISBN-13 978-0262045094

Online resources: paper, tutorials.

**Course Requirements and Assignments**

Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course-related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus.

**Final Examination or Evaluation**

Faculty members are required to have a culminating activity for their courses, which can include a final examination, a final research paper or project, a final creative work or performance, a final portfolio of work, or other appropriate assignments.

**Homework assignments:** individual, regularly assigned will include written problem assignments, and perhaps some online exercises. Solutions will not be posted. The homework is a tool for you to learn the material and prepare for the exams.

**Reading assignments:** Reading assignments will regularly be for the next class (see schedule).

**Quizzes**: Unannounced quizzes may be given during class, each of 10 minutes total. These will generally be problems from the reading assignment and/or the homework.

**Class notes and Activities**: In-class note-taking of a topic, writing a small report, and hands-on examples of the problems and methods we cover using various datasets.

Group Project: A programming project of your choice related to the course's topics in groups of no more than three students. Never use any code you find on the web unless given by me. The penalty for late submission is 5% for every 3 days up to 9 days, after that, no submission will be accepted. The final presentation at the end of the semester is mandatory.

**Participation:** In-class participation and activities, online polls etc.

**Midterm exam:** There will be one written Midterm exam during the semester.

**Final exam:** One written final exam.

The exams will contain multiple-choice questions, short answer questions, and questions that require pseudocode and/or computations.

**Grading Information**

**Determination of Grades**

Final Grade:
25% Project
10% Homework
10% Participation & Discussions
15% Quizzes
5% Class notes
5% Activities
15% Midterm
15% Final

The final exam is comprehensive.

| Grade | Percentage |
|---|---|
| A plus | 96 to 100% |
| A | 93 to 95% |
| A minus | 90 to 92% |
| B plus | 86 to 89 % |
| B | 82 to 85% |
| B minus | 78 to 82% |
| C plus | 74 to 77% |
| C | 70 to 73% |
| C minus | 65 to 69% |
| D plus | 62 to 64% |
| D | 58 to 61% |
| D minus | 55 to 57% |
| F | <54% |

**Classroom Protocol**

Attendance is highly recommended. Please avoid disturbing the class: turn-off cell phones (or put them on vibrate mode), no text messaging in the class or the exams, **no taking pictures and video**, and avoid coming late. Without my consent, you may not publicly share or upload material for this course such as exam questions, lecture notes, or solutions.

**University Policies**

Per University Policy S16-9 *(http://www.sjsu.edu/senate/docs/S16-9.pdf)*, relevant information to all courses, such as academic integrity, accommodations, dropping and adding, consent for recording of class, etc. is available on the Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/".

### CS276: Machine Learning on graphs, Spring 2024

*The schedule is subject to change with fair notice and how the notice will be made available*

| Lesson | Date | Topic | Reading/Projects (part of chapters covered) |
|---|---|---|---|
| 1 | 1/24 | Introduction | |
| 2 | 1/29 | Motivation and problems | |
| 3 | 1/31 | Graph Algorithms for Network Science | |
| 4 | 2/5 | Network Science tools, Node Statistics intro | |
| 5 | 2/7 | Node statistics | |
| 6 | 2/12 | Edge statistics | |
| 7 | 2/14 | Graph statistics | |
| 8 | 2/19 | Traditional ML approaches basics | |
| 9 | 2/21 | Traditional ML approaches on graphs | |
| 10 | 2/26 | Deep Learning basics | |
| 11 | 2/28 | Natural Language Processing and graphs | |
| 12 | 3/4 | Node, edge, and graph representations | |
| 13 | 3/6 | Random walks | Project proposal |

| 14 | 3/11 | Link analysis and web search | |
|----|------|------------------------------|---|
| 15 | 3/13 | Recommender Systems | |
| 16 | 3/18 | Community detection | |
| | 3/20 | **Midterm** | |
| 17 | 3/25 | Homophily and CNNs | |
| 18 | 3/27 | Graph Neural Networks message passing | |
| | 4/1-4/5 | **Break** | |
| 19 | 4/8 | Graph Neural Networks neighborhood aggregation | Project demo |
| 20 | 4/10 | Graph Neural Networks applications | |
| 21 | 4/15 | Hierarchical graph representation | |
| 22 | 4/17 | Influence maximization | |
| 23 | 4/22 | Knowledge graphs | |
| 24 | 4/24 | Knowledge graphs embeddings | Project presentations due |
| 25 | 5/1 | Random graphs | |
| 26 | 5/6 | Graph Generation | Project due |
| 27 | 5/8 | Project presentations | |
| 28 | 5/13 | Project presentations | |
| | | **Final exam** <br> Thursday, May 16,   12:15-2:30 PM | |