XCS224W: Machine Learning with Graphs

Syllabus and Course Information

Welcome

Welcome to XCS224W: Machine Learning with Graphs! This professional course is based on graduate-level material from Stanford's on-campus course CS224W, adapted for a professional certificate format. In this course you will:

- Learn from Stanford graduate lecture videos (Spring 2021) that have been edited for easier navigation, reference, and review.
- Complete guided homework assignments implementing content covered in the course lectures.
- Receive support from Stanford-affiliated Course Facilitators.
- Connect to a cohort of peers from diverse locations and professional backgrounds.

Course Launch

All lecture videos will be available on the first day of the course **(September 13th) at 12:00pm Pacific Time**.

Getting Started

This course will use different tools to distribute content, run assignments, and deliver support. They are:

1) **SCPD Learning Management System** – accessed via the mystanfordconnection site which you used to apply to and enroll in this course.
2) **Google CoLab** – for assignment notebooks and data.
3) **Slack** – for additional course support and class discussions.

Joining Slack

In addition to individual support from Course Facilitators (more details and guidelines in Course Facilitators, Support, and Guidelines section below), the cohort will have a Slack workspace to ask additional questions and discuss course topics. An email invitation to http://xcs224w-scpd.slack.com/ will be sent to your email address on file with SCPD on **September 10th**.

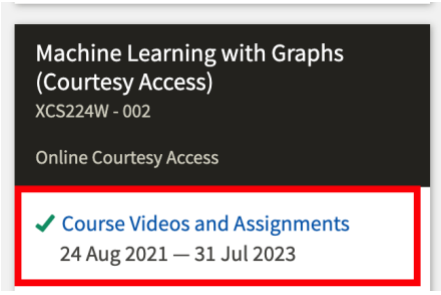
If you have previously joined an SCPD or Stanford Slack Workspace for a different course in the AI Professional Program, we have found that Slack does not send a notification when our staff invites you to an additional workspace. Instead, you are automatically re-activated in the system. On **September 10th** you should proceed directly to http://xcs224w-scpd.slack.com/ → I have a guest account → Log in using your credentials.

Google CoLab

Course notebooks and homework will be posted in public Google CoLab links. In order to complete them, you'll need to make a copy within your own Google account. If you are unfamiliar with CoLab, you can explore some resources here and here to get started.

Accessing Your Course

1. On **September 13th after 12pm Pacific Time**, log in to the mystanfordconnection account you used when applying for the Artificial Intelligence Professional Program.
2. XCS224W: Machine Learning with Graphs will be visible as a live course. Click the link titled "Course Videos and Assignments" to enter our learning management system.



Course Calendar

Below is a ***potential*** pacing guide for moving through the course, however you are free to watch videos at a faster or slower pace depending on your availability. You are welcome to move through the videos at a different pace if you prefer:

WEEK	POTENTIAL VIDEO PACING	ASSIGNMENTS	
1	Module 1: Traditional Method for ML on Graphs	**CoLab 1 Open & CoLab 2 Open**	**September 13**
2	Module 2: Introduction to Graph Neural Networks	**CoLab 3 Open**	**September 24**
		CoLab 1 Due	**September 26**
3	Module 3: Theory of Graph Neural Networks		
4	Module 4: Knowledge Graphs	**CoLab 4 Open**	**October 8**
		CoLab 2 Due	**October 10**
5	Module 5: Network Motifs and Community Structure	**Q&A Webinar with Prof. Leskovec**	**October 14**
6	Module 6: Generative Models for Graphs	**CoLab 5 Open**	**October 22**
		CoLab 3 Due	**October 24**
7	Module 7: Advanced Topics in GNNs		
8	Module 8: Special Topics and Research on GNNs	**CoLab 4 Due**	**November 7**
9			
10			
		CoLab 5 Due	**November 21**

Assignments and Quizzes

Each CoLab will consist of a notebook that contains guided cells as well as homework prompts. You'll upload your notebooks to the SCPD Gradescope autograder, which will report back your current score on the assignment. You are allowed to submit an assignment unlimited times before the stated due date so you can continue to get feedback and de-bug.

CoLab 1

In this Colab you will write a full pipeline for learning node embeddings. To start, you will load a classic graph in network science, the Karate Club Network. Then you will explore multiple graph statistics for that graph. You will then transform the graph structure into a PyTorch tensor, so that you can perform machine learning over the graph. Finally, you will finish the first learning algorithm on graphs: a node embedding model.

CoLab 2

In this Colab you will construct our own graph neural network by using PyTorch Geometric (PyG) and apply the model on two of Open Graph Benchmark (OGB) datasets. First, you will learn how PyTorch Geometric stores the graphs in PyTorch tensor. You will then load and take a quick look on one of the Open Graph Benchmark (OGB) datasets by using the ogb package. Finally, you will build our own graph neural networks by using PyTorch Geometric.

CoLab 3

In this Colab you will implement the GraphSAGE (Hamilton et al. (2017)) and GAT (Veličković et al. (2018)) layers directly. Then you will run your models on the CORA dataset, which is a standard citation network benchmark dataset. You will then use DeepSNAP, a Python library assisting efficient deep learning on graphs, to split the graphs in different settings and apply dataset transformations. Finally, using DeepSNAP transductive link prediction split functionality, you will construct a simple GNN model on the edge property predition (link prediction) task.

CoLab 4

In this Colab, you will shift your focus from homogenous graphs to heterogeneous graphs. Heterogeneous graphs extend the traditional homogenous graphs that you have seen before by specifically incorporating different node and edge types. This additional information allows you to extend the graph neural network

models that you have worked with before. Namely, you can apply heterogenous message passing, where different message types now exist between different node, edge type relationships.

CoLab 5

In this Colab you will experiment on scaling up GNNs using PyTorch Geometric, DeepSNAP and NetworkX. At first, you will use PyTorch Geometric NeighborSampler to scale up the training and testing on OGB arxiv dataset. Then, using the DeepSNAP and NetworkX, you will implement a simplified version of NeighborSampler and run experiments with different smapling ratios on the Cora graph. Finally, you will partition the Cora graph into clusters by using different partition algorithms and then train the models in the way of vanilla Cluster-GCN.

Late Assignments and One-time Penalty Waiver

Late assignments are assessed a penalty of **one point per day late, up to a maximum of five days late at which point the submission link will close**.

We understand that personal or professional events may cause you to miss a deadline on a homework. Each student is able to use a **one-time penalty waiver on any assignment,** on which the regular penalty will not be applied. The extension cannot be split into smaller parts (e.g. you cannot use two days on CoLab 1 and three days on CoLab 3.). In order to use your extension, contact your Course Facilitator and SCPD staff.

Honor Code

Students are asked to review and maintain the standards set forth by the Stanford Honor Code when completing quizzes and assignments in this course. You can review the section labeled *Violations of the Honor Code* for representative examples relevant to this course.

We encourage students to form study groups. Students may discuss and work on homework problems in groups. However, each student must write down the solutions independently, and without referring to written notes from the joint session. **In other words, each student must understand the solution well enough in order to reconstruct it by him/herself.** Further, because we occasionally reuse problem set questions from previous years, we expect students not to copy, refer to, or look at the solutions in preparing their answers. It is an honor code violation to intentionally refer to a previous year's solutions.

Passing the Course and Earning the Certificate

In order to earn the Certificate of Achievement for this course, you must achieve a final cumulative score of 70% or higher. Once you have successfully completed the course and the post-class survey, a digital Record of Completion will be emailed to you and the Certificate of Achievement will be mailed in approximately four weeks.

Course Facilitators, Support, and Guidelines

You have a wide range of support available to you throughout the course. You will be assigned and receive contact information for an individual Course Faciltiator (CF) who will act as your primary point of contact.

Below is a summary of the available resources and course support:

Office Hours

Your CF will be in touch with availability and scheduling logistics for video conference office hours. Office hours may be conducted using the Zoom conference service or via Slack video (more information below on the course Slack workspace). Your CF will provide further information on how they will schedule and run office hour sessions.

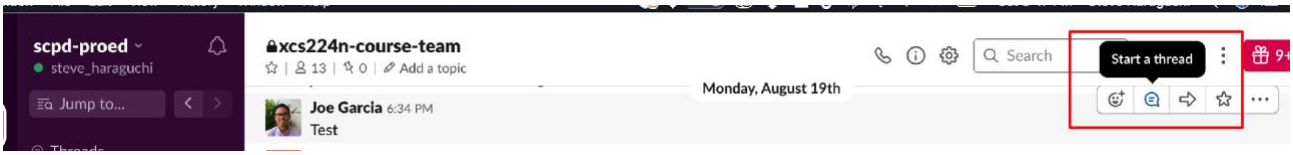
Email

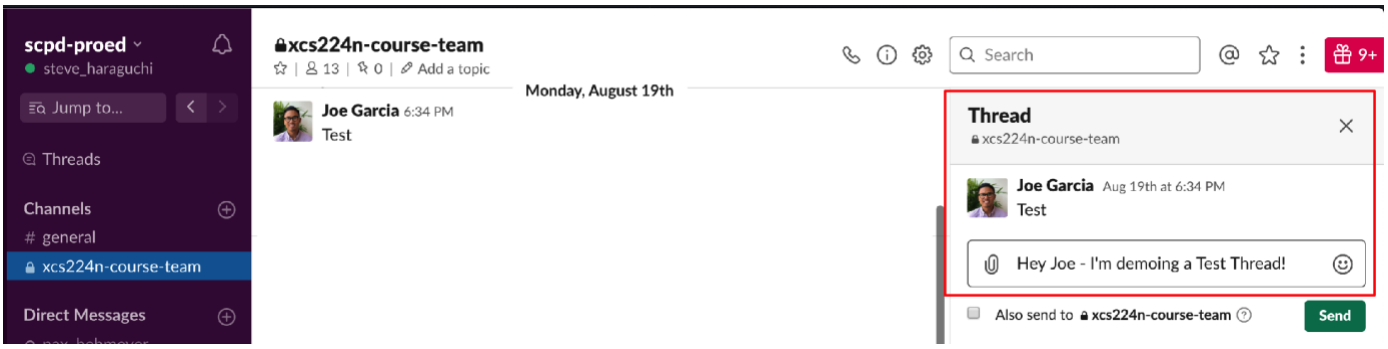
Your CF will also be available to answer questions via email – a Stanford contact address will be provided when you are first connected to your CF.

Slack Workspace – Usage and Guidelines

In addition to the individual and small group support provided by CFs, Slack will be a place where questions may be posed to the entire community (this is the fastest way to get an answer!). **In order to keep the Slack workspace readable, searchable, and useful to all, please follow the following guidelines:**

Reply in Threads to Keep Conversation Organized – When you are replying to a post or joining a conversation, respond by starting or joining a threaded conversation, rather than responding in the full flow of the standard timeline. See below for an example of how to respond in a threaded conversation to Joe's test message:





Use Multi-line Messages – Even if messages are threaded, you will soon see that Slack becomes unmanageable unless people use **single, multi-line messages instead of multiple, single-line messages**. Especially for mobile Slack users, it gets out of control!

Rather than the following:
"Hey all I have a question" [RETURN] <-- Creates new message
"I am a little confused about the quiz" [RETURN] <-- Creates new message
"I'm getting F for Question 40, but it seems like T is better" [RETURN] <-- Creates new message
---
Instead, try this!
"Hey all I have a question" [SHIFT+RETURN] <-- Creates new line in SAME message
"I am a little confused about the quiz" [SHIFT+RETURN] <-- Creates new line in SAME message
"I'm getting F for Question 40, but it seems like T is better" [SHIFT+RETURN] <-- Creates new line in SAME message
{RETURN} <-- Posts message

Note on Code Assignments and Debugging

While the course team is here to help and support your experience, it is ultimately your responsibility to write, test, and de-bug your own code. CFs may view and provide guidance on your work, however they will not send you exact answers on what to insert into your assignments. Additionally, before reaching out to a CF or Slack for help, it's expected that you have taken the reasonable steps of reading and performing an analysis yourself. This policy is meant to ensure that you leave the course having mastered the material and enable CFs to focus attention on questions where their guidance is most impactful.

Drop/Transfer Policy

You may drop this course for a full refund up until September 13th, 2021 – the first day of the course. Once the course has begun, if you request to drop the course by Friday at 5:00pm PST on the third week of the cohort (**October 1st, 2021**) you will be reimbursed 100% of your tuition minus a drop fee of $100. Beyond the third week of the course, tuition refunds are not granted. Up until **October 1st, 2021** you may also request to transfer your enrollment to a future cohort of XCS224W or another course in the AI Professional Program, also for a transfer fee of $100. To drop or transfer the course, send an email to xcs224w-staff@stanford.edu

Questions and Contacts

For course-specific questions or concerns (content, assignments, CF support), please contact your designated Course Facilitator.

For other course related questions, email xcs224w-staff@stanford.edu