

# **DS-GA 3001.001 Special Topics in Data Science: Probabilistic Time Series Analysis**

Instructor: Cristina Savin

TAs: Caroline Haimerl and Yiqiu (Artie) Shen

## **Overview**

This graduate level course presents fundamental tools for characterizing data with statistical dependencies over time, and using this knowledge for predicting future outcomes. These methods have broad applications from econometrics to neuroscience.

The course emphasizes generative models for time series, and inference and learning in such models. We will cover range of approaches including AR(I)MA, Kalman filtering, HMMs, RNNs, Gaussian Processes, and their application to several kinds of data.

*Note: information presented is tentative, syllabus may be subject to change as the course progresses.*

## **Course details**

Lecture (Section 008)

Mo 2.00pm - 3.40pm

60 5th Avenue, Room 110

Lab (Section 009)

Wed 3:30pm-4:20pm

60 5th Avenue, Room 110

Enrollment cap: 64

**Web:** <https://github.com/savinteaching/pTSAfall2019>

## **Office hours**

CS: Mo 4:00-5:00pm. Location: 60 5th ave, 6th floor, room 608.

CH/YS: TBD. Location: 60 5th ave, 6th floor, room 660.

## **Grading**

problem sets (25%) +  
midterm exam (25%) +  
final project (25%) +  
lab(20%)+  
participation(5%)

Participation: piazza, engagement during lectures, labs, and office hours

## Piazza

We will use [Piazza](#) for announcements, and discussions about the course. Interactions on Piazza, particularly good answers to other students' questions, will count toward the participation grade.

## Projects

Work in groups of 2-3 students.\* Topics are flexible, including applying known algorithms to an interesting dataset, reviewing and implementing a state of the art solution, to improving an existing algorithm. Project proposals due in week 4.

\*Check with CS if you are considering working individually or in a larger group.

## Video

Video recordings of the lectures will be available via NYU Classes. Class attendance is still required.

Date	Lecture title	Assignments
Sept. 4	no lab	
Sept. 9	Lecture 1: Logistics. Introduction. Basic statistics for characterizing time series.	
Sept. 11	Recap basic Bayes, graphical models	
Sept. 16	Lecture 2: AR(I)MA	Problem set 1
Sept. 18	Lab 1: ARIMA	
Sept. 23	Lecture 3: LDS; Kalman filtering	Projects initial discussion
Sept. 25	Lab 2: Inference in LDS	
Sept. 30	Lecture 4: Particle filtering	Problem set 2
Oct. 2	Lab 3: LSD parameter learning	
Oct. 7	Lecture 5: Hidden Markov Models	Project proposal due
Oct. 9	Lab 4: Particle filtering	
Oct. 14	FALL RECESS	
Oct.15 (TUE!)	Lecture 6: A unified view of linear models	Problem set 3
Oct.16	Lab 5: HMMs	
Oct.21	Introduction to Gaussian Processes	
Oct.23	No lab. Office hours	

Date	Lecture title	Assignments
Oct.28	Mid-term exam	
Oct.30	No lab	
Nov. 4	GP advanced topics.Intro to RNNs	Problem set 4
Nov. 6	Lab GP	
Nov.11	Deep learning for time series	
Nov.13	RNNS lab	
Nov.18	Spectral methods 1	Problem set 5
Nov. 20	Lab spectral methods	
Nov. 25	Spectral methods 2	
Nov. 27	Thanksgiving	
Dec. 2	Guest lecture: Joan Bello	
Dec. 4	No lab. Work on projects	
Dec. 9	Final projects presentation	Project reports due Dec.15
Dec. 11	No lab	

## Bibliography

There is no required textbook.

Required reading will be provided on the course page in electronic format.

We use *python* for all the lab work.

## Core material

- *Time series analysis and its applications*, by Shumway and Stoffer, 4th edition
- *Pattern recognition and machine learning*, Bishop
- *Gaussian processes*, Rasmussen & Williams

## Useful extras

- [Review notes from Stanford's machine learning class](#)
- Sam Roweis's [probability review](#)
- [Carlos Fernandez's notes on Statistics and Probability for Data Science DS-GA 1002](#)

## Policies

Try to solve problems on your own first. If you get stuck, you can discuss homework questions with colleagues, but *you need to write up the final solution individually*. Any violation will be penalized with a **zero** score for the assignment and referred to the DGS. Credit should be explicitly given for any code you use that you did not write yourselves. Late submission penalties: 20% points off for *each* extra day of delay.