

# Robot Localization and Mapping (16-833), Spring 2018

**Days** Monday and Wednesday

**Time** 1:30pm - 2:50pm

**Room** NSH 1305

**Lecturer** Michael Kaess (kaess@cmu.edu)

**TAs** Paloma Sodhi (psodhi@andrew.cmu.edu), Rick Goldstein (rgoldste@cs.cmu.edu)

**TA Office Hour** Monday 3pm-4pm, Thursday 4pm-5pm, in NSH 4201

**Piazza** piazza.com/cmu/spring2018/16833a

## Course Description

Robot localization and mapping are fundamental capabilities for mobile robots operating in the real world. Even more challenging than these individual problems is their combination: simultaneous localization and mapping (SLAM). Robust and scalable solutions are needed that can handle the uncertainty inherent in sensor measurements, while providing localization and map estimates in real-time. We will explore suitable efficient probabilistic inference algorithms at the intersection of linear algebra and probabilistic graphical models. We will also explore state-of-the-art systems.

## Schedule

Date	Topic	Lecturer	Projects
01-17-18	L01: Introduction	M. Kaess	
01-22-18	L02: Probability Review	M. Kaess	
01-24-18	L03: Bayes Filter	M. Kaess	
01-29-18	L04: Particle Filters	E. Westman	HW1 out
01-31-18	L05: Monte Carlo Localization	E. Westman	
02-05-18	L06: Expectations & Covariances	M. Kaess	
02-07-18	L07: Gaussian	M. Kaess	
02-12-18	L08: Visualizing Gaussians, Central Limit Theorem	M. Kaess	HW1 due
02-14-18	L09: Kalman Filter	M. Kaess	HW2 out
02-19-18	L10: Extended Kalman Filter	M. Kaess	
02-21-18	L11: EKF/UKF/Least-Squares	M. Kaess	
02-26-18	L12: Least-Squares (LS)	M. Kaess	
02-28-18	L13: LS: Structure, Sparsity, Ordering	M. Kaess	
03-05-18	L14: Nonlinear LS	M. Kaess	HW2 due
03-07-18	L15: Levenberg-Marquardt, Dog-Leg	M. Kaess	HW3 out, project proposal
03-12-18	NO CLASS - SPRING BREAK		
03-14-18	NO CLASS - SPRING BREAK		
03-19-18	L16: Rotations and Manifolds	M. Kaess	reading 1
03-21-18	canceled		
03-26-18	PTAM/KinectFusion	P. Sodhi, M. Hsiao	reading 2
03-28-18	L17: Occupancy Grids	E. Westman	HW3 due
04-02-18	ORB-SLAM/Semi-direct	P. Sodhi, M. Hsiao	HW4 out
04-04-18	L18: Sequential Estimation	M. Kaess	
04-09-18	L19: Intro to Graphical Models	M. Kaess	project midterm
04-11-18	L20: Inference in Graphical Models	M. Kaess	
04-16-18	L21: Incremental Nonlinear Least-Squares	M. Kaess	
04-18-18	L22: Incremental Nonlinear Least-Squares (2)	M. Kaess	HW4 due
04-23-18	L23: Data Association	M. Kaess	
04-25-18	L24: Inertial Navigation	M. Kaess	
04-30-18	Course Project Presentations	class	
05-02-18	Course Project Presentations	class	final report due

## **Integrity**

All encouraged to work together BUT you must do your own work (code and write up). If you work with someone, please include their name in your write up and inside any code that has been discussed. If we find highly identical write-ups or code without proper accreditation of collaborators, we will take action according to university policies.

## **Grading**

- 60% Homeworks (15% each)
- 10% Participation
- 30% Course Project

## **Late Day Policy**

- 3 flexible late days to push deadlines back
- Before deadline 100% credit
- Within 48 hours of deadline 50%
- After 48 hours 0% (you must submit something)

## **Learning Outcomes**

- Implement an extended Kalman filter in the context of robot localization and mapping
- Derive and apply rigid body transformations
- Derive the analytical form of motion and measurement models
- Formulate state estimation problems as graphical models such as factor graphs
- Implement linear and nonlinear least-squares solvers for the simultaneous localization and mapping problem

## **Health**

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:

- CaPS: 412-268-2922
- Re:solve Crisis Network: 888-796-8226

If the situation is life threatening, call the police:

- On campus: CMU Police: 412-268-2323
- Off campus: 911

If you have questions about this or your coursework, please let one of us know.