جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Dynamic Programming and Optimal Control - EE 372

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	EE 372
Course Title	Dynamic Programming and Optimal Control
Academic Semester	Summer
Academic Year	2018/2019
Semester Start Date	06/16/2019
Semester End Date	08/08/2019
Class Schedule (Days & Time)	09:00 AM - 12:00 PM | Sun Mon

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Jeff S. Shamma	jeff.shamma@kaust.edu.sa	+966128084409	3220, 3, Ibn Sina (bldg. 3)	TBD

Teaching Assistant(s)

Name	Email
TBD	TBD

Course Information

Comprehensive Course Description	Dynamic programming is a framework for deriving optimal decision strategies in evolving and uncertain environments. It is relevant to a broad range of fields, ranging from control to operations research to artificial intelligence. The approach starts with a model of an evolving process and a description of sources of modeling uncertainty, typically in the form of stochastic perturbations. At the core is the principle of optimality, which states that optimal decision strategies must have a particular temporal consistency property. This property then can be used to construct optimal strategies in a recursive manner. The approach is demonstrated on a variety of settings, including path planning, inventory control, hypothesis testing, and signal reconstruction. The course considers both finite-horizon problems, where there is a specified terminating time, and infinite-horizon problems, where the duration is indefinite. While dynamic programming offers a significant reduction in computational complexity as compared to exhaustive search, it suffers from the so-called curse of dimensionality, which makes the methods of dynamic programming impractical for large scale problems. The course concludes with online learning approaches that seek to alleviate this issue through approximate implementation of dynamic programming algorithms. Throughout the course, computational assignments are given as homework to complement the coverage of analytical foundations.
Course Description from Program Guide	Dynamic programming is a framework for deriving optimal decision strategies in evolving and uncertain environments. Topics include the principle of optimality in deterministic and stochastic settings, value and policy iteration, connections to Pontryagin maximum principle, imperfect state measurement problems, and simulation-based methods such as online reinforcement learning.
Goals and Objectives	To develop a foundational understanding of dynamic programming and its broad relevance to many applications and to gain experience in computational implementation of dynamic programming algorithms.
Required Knowledge	Basic probability, optimization, and differential equations.
Reference Texts	DP Bertsekas, Dynamic Programming and Optimal Control, Vol. I
Method of evaluation	**25.00**% - Course Project(s) **25.00**% - Midterm exam **50.00**% - Homework /Assignments

Nature of the assignments	HW assignments to consist of analytical problems (ungraded) and computational assignments (graded). Computational assignments must be completed using Matlab.
Course Policies	Assignment due dates flexible with permission from instructor.
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Sun 06/16/2019 Mon 06/17/2019	Principle of optimality: Deterministic Variations: Minimax & Shortest Path
2	Sun 06/23/2019 Mon 06/24/2019	Connections to deterministic optimal control Revew: Markov chains
3	Sun 06/30/2019 Mon 07/01/2019	Principle of optimality: Stochastic Bellman equation and value iteration
4	Sun 07/07/2019 Mon 07/08/2019	Variations and applications Exam & review
5	Sun 07/14/2019 Mon 07/15/2019	Imperfect state measurements Infinite horizon: Stochastic shortest path
6	Sun 07/21/2019 Mon 07/22/2019	Infinite horizon: Discounted and average cost Q-learning and reinforcement learning
7	Sun 07/28/2019 Mon 07/29/2019	Approximate dynamic programming
8	Sun 08/04/2019 Mon 08/05/2019	Final projects and review

Note

The instructor reserves the right to make changes to this syllabus as necessary.