University of Alberta

Math 663: Topics in Applied Mathematics I: Optimal Transport + Economics
Section Number A1
Fall, 2020

(Note: This is a streamlined version of the syllabus, for those interested in following the course but not obtaining course credit).

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Liaisons at other PIMS sites: The following faculty members have offered to be available to help students at their universities: Soumik Pal (University of Washington, soumikpal@gmail.com), Young-Heon Kim (University of British Columbia, yhkim@math.ubc.ca).

Office Hours: Tuesday, 3:30-4:20pm, Wednesday, 1-1:50pm, Mountain time, or by appointment. Office hours will be virtual.

Lecture Time: Tuesday and Thursday, 2-3:20pm, Mountain Time. Lectures will be virtual, and will be recorded and available on the class website.

Administrative Information: This is a PIMS online course, based at the University of Alberta but open to students at all PIMS universities, and to industrial participants. Students at other Canadian PIMS Universities may enrol for credit through the Western Canadian Deans' Agreement. Students at the University of Washington may obtain credit by registering for the UW reading course Math 600. Participants are also welcome to follow the course without registering for course credit; these participants are asked to sign up using the link provided at https://kantorovich.org/project/optimal-transport-in-x/ to ensure that the instructor has their contact information.

Course Description: formulation of the optimal transport problem, Kantorovich duality theory, existence and uniqueness theory, c-monotonicity and structure of solutions, discrete optimal transport. Economic applications including: transferable utility models in matching theory, hedonic and discrete choice models in contract theory, inference in incomplete models and multi-variate analogues of quantiles in the analysis of dependence structures in econometrics, the analysis of profit maximization and screening problems, optimal portfolio rebalancing and robust option pricing.

Course Prerequisites: basic integration and measure theory, topology, probability and

linear algebra.

Lecture Schedule:
Note: the order and contents below is tentative and subject to change.

Week	Dates	Topics
1	Sept. 1, 3	Introduction, formulations of the problem
2	Sept. 8, 10	existence of Kantorovich solutions, duality
3	Sept. 15, 17	c-cyclical monotonicity, one dimensional solutions
4	Sept. 22, 24	c-concave functions: definition + basic properties
5	Sept. 29, Oct. 1	c-concave analysis
6	Oct. 6, 8	uniqueness and characterization of solutions
7	Oct. 13, 15	examples, discrete OT and approximation
8	Oct. 20, 22	extensions and other topics (time permitting)
9	Oct. 27, 29	matching theory, hedonic pricing
10	Nov. 3, 5	Econometrics: two guest lectures by Yanqin Fan (University of Washington Economics)
11	Nov. 10, 12	Reading week: no lectures.
12	Nov. 17, 19	optimal portfolio rebalancing: guest lectures by Guillaume Rabault (HSBC Global Asset Management) and Soumik Pal (University of Washington Mathematics)
13	Nov. 24, 26	the principal agent problem
14	Dec. 1, 3	martingale OT: guest lecture by Julio Backhoff (University of Twente Statistics), additional topics (time permitting)

Optional learning resources:
-Filippo Santambrogio. *Optimal transport for applied mathematicians.* Birkhauser, 2015.
-Alfred Galichon. *Optimal transport methods in economics*. Princeton University Press, 2016.
-Cedric Villani. *Topics in optimal transportation.* American Mathematical Society, 2003.
-Cedric Villani. *Optimal transport: old and new.* Springer-Verlag, 2009.
-Gabriel Peyre and Marco Cuturi. *Computational optimal transport.* Available at https://arxiv.org/abs/1803.00567 .
-Pierre Henry-Labordere. *Model-free Hedging: A Martingale Optimal Transport Viewpoint.* Chapman and Hall, 2017.
-Pierre-Andre Chiappori. *Matching with transfers: the economics of love and marriage.* Princeton University Press, 2017.