Time and Room:

- Time: Spring Quarter 2018, WF, 1:00 PM - 2:20 PM
- Room: CMU 228

Instructors: Joseph Salmon,
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Office Hours:

- Friday 10:30-11:30 AM, by appointment only.

Prerequisites
Stat 538, and Stat 535 (or CSE 546) or an equivalent first course in statistical learning. Students are expected to be familiar with probability theory, multivariate analysis, linear algebra, advanced calculus, and convex optimization. Students should be able to complete short programming tasks using high level programming language (e.g. Python, Matlab, R/S-Plus).

Course description
This course will introduce the basis on robust statistics. On top of modeling and theoretical aspects (influence function, breaking point, depth, sensitivity curves, etc.), the course will cover some numerical optimization for implementing the introduced methods. Time permitting, each registered student will report on a topic of interest to her/him.

Grading
This course will be project oriented. Final projects will be proposed based on a selection of a short list of articles or according to students' relevant propositions. This will be **a credit / no credit course**.

Topics include (as time permits):

1. Introduction. Examples Basic concepts.
2. Location scale, equivariance, M-estimates, Pseudo-observations, breaking point, depth
3. L-statistics: Linear combination of order statistics
4. Gâteaux differentiability, Sensitivity curve, Influence Function
5. Numerical computation of M-estimates, reminders on non-smooth convex optimization, Iterative Reweighted Least Square (IRLS)
6. Smoothing non smooth problems
7. Robust regression for multivariate statistics
8. Quantile regression, "crossing"

Textbook:

- Maronna, R.A., Martin, R.D. and Yohai, V.J. (2006). Robust Statistics: Theory and Methods. Wiley, New York.

Additional books

- Huber, P.J., Ronchetti, E. M. (2009). Robust Statistics. Wiley, New York.
- Hampel, F.R., Ronchetti, E.M., Rousseeuw, P.J. and Stahel, W.A. (1986). Robust Statistics: The Approach Based on Influence Functions. Wiley, New York.
- Bauschke, H. H. et P. L. Combettes. Convex analysis and monotone operator theory in Hilbert spaces. New York : Springer, 2011, p. xvi+468.
- Bertsekas, D. P. Nonlinear programming. Athena Scientific, 1999.
- Boyd, S. et L. Vandenberghe. Convex optimization. Cambridge University Press, 2004, p. xiv+716.

Additional articles

- N. Parikh , S. Boyd, E. Chu, B. Peleato and J. Eckstein (2013). "Proximal algorithms", Foundations and Trends in Machine Learning.
- Alfons, A., C. Croux and S. Gelper. "Sparse least trimmed squares regression for analyzing high-dimensional large data sets". In : Ann. Appl. Stat. 7.1 (2013), p. 226–248.
- Avella-Medina, M. and E. M. Ronchetti. "Robust and consistent variable selection in high-dimensional generalized linear models". In : Biometrika 105.1 (2018), p. 31–44.
- Chen, Y., C. Caramanis and S. Mannor. "Robust sparse regression under adversarial corruption". In : ICML. 2013, p. 774–782.
- Parikh, N. et al. "Proximal algorithms". In : Foundations and Trends in Machine Learning 1.3 (2013), p. 1–108.
- Xu, H., C. Caramanis and S. Mannor. "Robust regression and Lasso". In : IEEE Trans. Inf. Theory 56.7 (2010), p. 3561–3574.
- Bertsimas, D., D. B. Brown and C. Caramanis. "Theory and applications of robust optimization". In : SIAM Rev. 53.3 (2011), p. 464–501.
- Chen, M., C. Gao and Z. Ren. "A General Decision Theory for Hubers ϵ-Contamination Model". In : Electron. J. Stat. 10.2 (2016), p. 3752–3774.
- M. Avella-Medina and E. M. Ronchetti. "Robust and consistent variable selection in high-dimensional generalized linear models". In : Biometrika 105.1 (2018), p. 31–44.
- S. Minsker. "Geometric median and robust estimation in Banach spaces". In : Bernoulli 21.4 (2015), p. 2308–2335.

- X. Wei and S. Minsker. Estimation of the covariance structure of heavy-tailed distributions. In : NIPS. 2017, p. 2859–2868.
- Y. Nesterov. "Smooth minimization of non-smooth functions". In : Math. Program. 103.1 (2005), p. 127–152.
- A. Beck et M. Teboulle. "Smoothing and first order methods : A unified framework". In : SIAM J. Optim. 22.2 (2012), p. 557–580.

Course web page:
http://josephsalmon.eu/index.php?page=teaching_17_18&lang=en