

Course Description – Stat 991
Topics in Statistics (Section #301), Spring 2012
Coordinating Instructor – L. Brown
Visiting Lecturers: A. Tsybakov & A. Shiryaev

General Description: This will comprise a series of 8 lectures by A. Tsybakov and a series of 8 lectures by A. Shiryaev. These will be supplemented by additional lectures by those registered in the course and (perhaps) by other faculty or short-term visitors.

Meeting Time & Place: Monday and Wednesday 1:30 – 3:00 in JMHH, F96.
(It is anticipated that all lectures will be held during this scheduled time frame. However it is possible that there may be an occasional lecture scheduled at a different time.)

First meeting: There will be an organizational meeting on Wednesday, Jan 11 (first day of classes). Tsybakov's lectures will begin on Jan 30.

(At the organizational meeting we will discuss the schedule for the three class days until Tsybakov begins (1/18, 1/23, 1/25).)

Registration for the course or attendance as an auditor: We want to encourage graduate students to officially register for the course. However auditors will also be welcome for individual lectures or for the entire series. Those registered for the course will be expected to attend conscientiously and to participate in presentations of additional supplementary material based on published papers by one of the lecturers or others.

(In past years some of the visiting lecturers have prepared exercises to be handed in and graded to highlight important points in the lectures. Students have found these very useful. If Tsybakov or Shiryaev decide to follow such a path, then registered students will be expected to participate in this manner – this a possible alternative to the presentations mentioned above.)

e-mail: Information about meetings of the course, lecture topics, additional handouts, etc, will be distributed by email and probably also webcafe. All those interested in continuing information of this type (including registered students and potential auditors) should let me know at the organizational meeting or by email to lbrown@wharton.upenn.edu.

Visiting Lecturers: Both Alexandre (Sasha) Tsybakov and Albert Shiryaev are senior, internationally recognized and highly respected scholars.

Tsybakov has chosen a title and submitted an abstract for his lectures on 1/30 – 2/22. The title is “Aggregation, adaptive estimation and sparsity”. The abstract is attached below. He will begin with material from the first chapter of his Springer text, “Introduction to Nonparametric Estimation”. But he also recommends that students read that Chapter as background preparation for the series of lectures. One possibility for our meetings on 1/18 – 1/25 is to have someone present highlights of this material. [I have a copy of his monograph if anyone would like to look at and/or duplicate material from it.]

Shiryaev will be lecturing in April. He has researched extensively on theory and applications of Martingales, and this will be the theme of his lectures. He has written several monographs. You could consult these for a better idea of the scope and depth of his contributions. See below for a listing of (some of) these contributions.

Aggregation, adaptive estimation and sparsity

Alexandre Tsybakov CREST(ENSAE)

This course provides an introduction to theory of aggregation of estimators. Given a collection of estimators, the problem of linear, convex or model selection type aggregation consists in constructing a new estimator, called the aggregate, which is nearly as good as the best among them (or nearly as good as their best linear or convex combination), with respect to a given risk criterion. This problem can be also considered with a given dictionary of functions instead of estimators. When the underlying model is sparse, which means that it is well approximated by a linear combination of a small number of functions in the dictionary, the aggregation techniques turn out to be very useful in taking advantage of sparsity. On the other hand, aggregation is a general technique of producing adaptive nonparametric estimators, which is more powerful than the classical methods since it allows to combine estimators of different nature. Aggregates are usually constructed by mixing the initial estimators or functions of the dictionary with data-dependent weights that can be computed in several possible ways. Important examples are aggregates with exponential weights, as well as the BIC and Lasso type aggregates. They have some remarkable properties. In particular, they satisfy sharp oracle inequalities that allow one to treat in a unified way three different problems: Adaptive nonparametric estimation, aggregation and sparse estimation.

Program for the lectures:

- Nonparametric regression. Linear estimators. Optimal rates of convergence. Unbiased estimation of the risk and adaptation.
- Sparsity in the Gaussian sequence model. Hard and soft thresholding and related techniques.
- Dictionaries, approximation and sparsity. Three main types of aggregation. Least squares versus exponentially weighted aggregates.
- Decision theoretic framework of aggregation. Oracle inequalities and optimal rates of aggregation. Connection to nonparametric estimation and adaptation.
- BIC, Lasso and Dantzig selector. Sparsity oracle inequalities for the Lasso.
- PAC-Bayesian bounds. Exponential screening and optimal rates of sparse estimation.

Background reading:

Tsybakov, A. B. (2009). *Introduction to Nonparametric Estimation*. Springer, New York.
[Especially, Chapter 1.]

A. Shiryayev
Books (Selected, partial list)

Optimal Stopping Rules (1978). Springer, NY

Probability, Second Edition (1996). Springer, NY

Essentials of Stochastic Finance (1999). World Scientific, Singapore.

Statistics of Random Processes, Second Edition (2001) with R. S Liptser. Springer, NY.