Abstracts

K.C. Cheung, Statistics and Actuarial Science, HKU

Optimal asset allocation under Regime-Switching Model

In this talk, several optimal asset allocation problems under a regime switching model will be examined. Different regimes represent different investment environment, hence the asset return will depend on the regime. Switching between regimes is modeled by a Markov Chain. Optimal trading strategies are obtained. Some natural properties and economic interpretations of the optimal strategies will be given.

X. Guo, Cornell University, USA

Wonham Filters with random parameters: optimality, error bounds, and estimation in financial time series data

This talk is based on several pieces of joint works. The basic mathematical framework starts from the following: Let $\alpha(t)$ be a finite-state continuous-time Markov chain with generator $Q = (q^{ij})_{m\times m}$ and state space $\mathcal{M} = \{z^1, \dots, z^m\}$. When the state space and the generator are known *a priori*, the best estimator of $\alpha(t)$ (in terms of mean square error) under noisy observation is the celebrated Wonham filter.

The first part of the talk will address the filtering issue when values of the state space or values of the generator are *unknown a priori*. In each case, we propose a (suboptimal) filter and show its convergence to the desired Wonham filter under simple conditions. Moreover, we obtain the (exponential) rate of convergence via studies of error bounds. (With G. Yin of Wayne State Univ.)

The second part of the talk will be devoted to showing the optimality of Wonham filters for a general class of error functions known as the Bregman loss functions, which include the mean square error as well as the KL-divergence functions. (With A. Barnejee Unv. of Texas and H. Wang. of Brown Univ.)

Finally, we report a statistical estimation methodology and model selection strategies within a Bayesian framework. Based on a case study of ATT stock price data, we propose a notion of "regime shift detection" in financial time series data, and suggest a detection method based on our estimation algorithm. (With D. Chan, CSIRO of Australia)

Lishang Jiang, Tongji University, PRC

Recovering the volatility of underlying asset from option prices

An optimal control framework is used to determine the implied volatility. Besides the existence and uniqueness of an implied volatility the necessary optimality condition is proved and some numerical results are obtained.

Y.K. Kwok, Mathematics, HKUST

Optimal strategies associated with optionality features in financial contracts

Early exercise feature, reset feature, reload feature are common embedded option features in financial instruments. For example, the reset right embedded in an option contract is defined to be the privilege given to the option holder to reset certain terms in the contract according to specified rules, where the time to shout is chosen optimally by the holder. Since the critical asset price at which the holder should exercise the feature is not pre-determined, rather it has to be determined as part of the solution procedure. This leads to a free boundary value problem. In this talk, we examine the theoretical framework of analyzing the optimal policies to be adopted by the derivative holders with these embedded features. Also, we discuss the nature and impact of these embedded features in different types of financial instruments, in particular, the reload feature in employee stock options, shout options, reset guarantee in equity linked annuities, etc.

Tiong-Wee Lim, National University of Singapore, Singapore

Singular stochastic control and optimal consumption and investment

In an idealised model without transaction costs, Merton (1969, 1971) showed that an investor seeking to maximize expected utility of consumption would optimally invest a constant proportion (the "Merton" proportion) of wealth in stock and consume at a rate proportional to wealth. Such a continuous strategy is no longer admissible once proportional transaction costs are introduced. The investor must then determine when the stock position is sufficiently "out of line" to make portfolio adjustment worthwhile and the problem of optimal consumption and investment becomes one of singular stochastic control. We provide a numerical scheme for the computation of optimal strategies associated with this singular stochastic control problem.

Wei Lin, Case-Western University, USA and CUHK

Recent advances in global stabilization of nonlinear systems via output feedback

This talk presents some of exciting developments recently in the area of global stabilization by smooth output feedback, for a class of homogeneous and high-order systems whose Jacobian linearization is uncontrollable and unobservable. A new output feedback control scheme is proposed for the explicit design of both homogeneous observers and controllers. While the state feedback control law is constructed by the tool of adding a power integrator, the observer design is new and carried out by developing a machinery, which assigns the observer gains one-by-one, in an iterative manner. Such design philosophy is fundamentally different from that of the traditional "Luenberger" or "high-gain" observer in which the observer gain is determined by observability. If time is allowed, we will also discuss how the new design method, with a suitable twist, can be used to solve the problem of global output feedback stabilization for a class of high-order non-homogeneous systems.

M. Tucsnak, University of Nancy I and INRIA, France

The numerical viscosity method for the approximation of infinite dimensional LQR problems

Let H and U be real Hilbert spaces, let $A_0 : \mathcal{D}(A_0) \to H$ be a self-adjoint, positive operator with A_0^{-1} compact in H and let $B_0 \in \mathcal{L}(U, H)$ be a control operator. Most of the linear equations modelling the undamped vibrations of elastic structures can be written in the form

$$\dot{z}(t) = Az(t) + Bu(t) \ , \ z(0) = z_0 \ , \tag{0.1}$$

where the state space X is defined by $X = \mathcal{D}(A_0^{\frac{1}{2}}) \times H$, whereas the operators A, B and the initial state z_0 are given by

$$\mathcal{D}(A) = \mathcal{D}(A_0) \times \mathcal{D}(A_0^{\frac{1}{2}}) \ , \ A = \begin{bmatrix} 0 & I \\ -A_0 & 0 \end{bmatrix} \ , \ B = \begin{bmatrix} 0 \\ B_0 \end{bmatrix} \ . \tag{0.2}$$

We associate to (0.1) the *cost functional* $J(w_0, w_1; u) = \int_0^\infty (\|u(t)\|_U^2 + \|z(t)\|_X^2)dt$, where $\|\cdot\|_U$ denotes the norm on U. Under standard assumptions there exists a self-adjoint and nonnegative operator $P \in \mathcal{L}(X)$ such that the optimal control u_{opt} is given by the feedback law $u_{\text{opt}}(t) = -B^*PS(t)z_0$, where S is the strongly continuous semigroup generated by $A - BB^*P$. The operator P, called the Riccati operator, satisfies an algebraic Riccati equation. Our goal is to construct two sequences of finite dimensional subspaces $(X_h) \subset X$, $(U_h) \subset U$, and the approximate control systems

$$\dot{z}_h(t) = A_h z_h(t) + B_h u_h(t) \ , \ z_h(0) = z_{0h} \ , \tag{0.3}$$

where $A_h \in \mathcal{L}(X_h)$, $B_h \in \mathcal{L}(U_h, X_h)$ and such that the sequence (P_h) of approximate Riccati operators strongly converges to the Riccati operator P. We consider a sequence of subspaces (U_h) approximating U and V_h approximating $\mathcal{D}(A_0^{\frac{1}{2}})$. Moreovr, we denote by $A_{0h} \in \mathcal{L}(V_h)$ and $B_{0h} \in \mathcal{L}(U_h, V_h)$ the corresponding approximations of A_0 and B_0. Our main result gives sufficient conditions for the strong convergence of the sequence of Riccati operators, provided that we set

$$X_h = V_h \times V_h \ , \ A_h = \begin{bmatrix} 0 & I \\ -A_{0h} & -h^\theta A_{0h} \end{bmatrix} \ , \ B_h = \begin{bmatrix} 0 \\ B_{0h} \end{bmatrix} \ .$$

The main novelty is the presence of the numerical viscosity term $h^\theta A_{0h}$ in the expression of A_h. This terms damps the spurious high frequency numerical oscillations and it still guarantees the convergence of our numerical scheme. We apply our general results to systems modelling the vibrations of a non homogeneous string, of a Bernoulli-Euler beam and of an elastic plate. (with K. Ramdani and T. Takahashi)

J.-C. Vivalda, INRIA, France

On the genericity of the observability for discrete-time systems

In this talk, I will speak about the observability of discrete-time systems, that is to say systems written as

$$\begin{cases} x_{k+1} & = f(x_k, u_k) \\ y_k & = h(x_k) \end{cases}$$

where the state x_k belongs to a compact manifold M, f is a parametrized diffeomorphism, h a smooth mapping from M to $\mathbb{R}^p$. Using the tools from the transversality theory, we will prove that, generically, this kind of system is strongly observable provided that the number of outputs (the dimension of y_k) is greater than the number of inputs (the dimension of u).

Hailiang Yang, Statistics and Actuarial Science, HKU

Optimal investment for an insurer to minimize its probability of ruin

This paper studies the optimal investment strategy of an investor such as an insurance firm. We assume that the insurance company receives premium at a constant rate, the total claim is modeled by a compound Poisson process, and the insurance company can invest its surplus in the money market and in a risky asset such as stock. This model generalizes the model in Hipp and Plum (2000) by including a risk free asset. The investment behaviour is investigated numerically under the assumption of different claim size distributions. The optimal policy and the solution of the associated Hamilton-Jacobi-Bellman (HJB) equation are then computed under each assumed distribution. Our results provide some insight to the managers of the insurance companies as to how to invest. We also investigated the effects of changes in various factors, such as stock volatility, on optimal investment strategies and survival probability. The model is generalized to cases in which borrowing constraints or reinsurance are present. (with Chi Sang Liu)

S.P. Yung, Mathematics, HKU

On the Riesz-Basis-Property of control problems

A system possesses the so-called Riesz-Basis-Property if its (generalized) eigenfunctions form a Riesz basis. In this talk, we shall exhibit some criteria for determining this property. Their significances as well as their applications to nonhomogeneous beam problems under boundary feedbacks or internal dampings will be discussed.

Xunyu Zhou, Systems Engineering & Engineering Management, CUHK

Constrained stochastic LQ control with random coefficients, with application to portfolio selection

This paper is devoted to the study of a stochastic linear – quadratic (LQ) optimal control problem where the control variable is constrained in a cone, and all the coefficients of the problem are random processes. Employing Tanaka's formula, optimal control and optimal cost are explicitly obtained via solutions to two extended stochastic Riccati equations (ESREs). The ESREs, introduced for the first time in this paper, are highly nonlinear backward stochastic differential equations (BSDEs), whose solvability is proved based on a truncation function technique and Kobylanski's results. The general results obtained are then applied to a mean–variance portfolio selection problem for a financial market with random appreciation and volatility rates, and with short-selling prohibited. Feasibility of the problem is characterized, and efficient portfolios and efficient frontier are presented in closed forms.