Université catholique de Louvain – Institut de statistique, biostatistique et sciences actuarielles

Young Researchers' Day

3 February, 2012

9^{00}	**Anne Benoit**	Challenges in assessing efficacy of seasonal influenza vaccine
9^{30}	**Jonathan Jaeger**	Bayesian ODE-penalized B-spline model with Gaussian mixture as error distribution
10^{00}	**Catherine Timmermans**	Perspectives on Bagidis for image processing

Coffee Break

11^{00}	**George Babajan**	Stochastic modeling of gaz and electricity derivatives markets
11^{30}	**Habiba Tassa**	Pension valuation and solvency
12^{00}	**Aleksandar Sujica**	The copula-graphic estimator in censored nonparametric location-scale regression models

The seminar is followed by the annual lunch of the ISBA.

The Young Researchers' Day is held in room c.115 of the Institut de statistique, biostatistique et sciences actuarielles, Voie du Roman Pays 20, Louvain-la-Neuve.

Challenges in assessing efficacy of seasonal influenza vaccine

ANNE BENOIT (anne.benoit@uclouvain.be)

Influenza epidemics occur yearly. Vaccination is recommended by the public health organizations, especially to patients at risk of complications. New vaccine clinical development generally takes place in three phases to seek registration. In the two first steps, safety, reactogenicity and capacity to activate an immune response (immunogenicity) are assessed in relatively small groups of subjects. Clinical efficacy is studied in a large phase III randomized multi-centered trial, where clinical cases are collected during an influenza season.

In the context of the clinical development of influenza vaccine, the Haemagglutinin Inhibition (HI) titres indicating the amount of antibodies against a specific influenza strain are used as markers for efficacy in the earlier phases (I and II) of development. However, the association between HI titres and infection risk has yet to be fully characterized. In order to study correlate of protection (COP), HI titres are collected in a semi random sample of the efficacy trial participants. Models are built in order to characterize the link between the immuno-protection levels and the probability of influenza infection.

The epidemiology of the disease makes the statistical analyses through the whole clinical development difficult. Assumptions on which standard models are built can often be challenged in the influenza context. Unmeasured heterogeneities in susceptibility, protection and exposure to infection can introduce bias in the estimators of vaccine immunogenicity capacity and efficacy. Models and trial designs should hence be adapted in order to take into account the sources of heterogeneity.

In this introducing talk, we present the clinical development steps for influenza vaccine. We put emphasis on the challenges met when designing and analysing trials. We illustrate our point through the example of a COP study.

Bayesian ODE-penalized B-spline model with Gaussian mixture as error distribution

JONATHAN JAEGER (jonathan.jaeger@uclouvain.be)

Ordinary differential equations (ODEs) are frequently used to model physical, chemical and biological processes. Currently, the most commonly used estimation procedures rely on nonlinear least squares [1]. These approaches are computationally intensive and often poorly suited for statistical inference.
Alternative estimation methods of the state functions and the ODE parameters were proposed in Ramsay et al. [5]. It may be viewed as a generalization of the P-spline theory [2] that involves some basis function expansion of each state function and a penalty term expressed using the set of differential equations. Jaeger and Lambert [3] adapts this approach to a full Bayesian ODE-penalized B-spline approach when the ODEs are affine and the data distribution is assumed Gaussian. The two major drawbacks of the frequentist ODE-penalized smoothing approach are overcome in the Bayesian framework: the selection of the ODE-adhesion parameter is now automatic and uncertainty measures about parameters can simply be obtaining using MCMC. In addition, the possible use of prior information about the ODE parameters is a definite advantage.
The assumption of a Gaussian data distribution is most of the time inappropriate but is very convenient as it enables to marginalize the joint posterior distribution with respect to the spline coefficients and therefore to get rid simply of the inconvenient posterior correlation between the spline coefficients and the ODE parameters. To overcome this limitation, we model homogeneous non-normal data distribution using finite mixture of Gaussian distributions by adapting the approach of Komárek and Lesaffre [4].
In this talk, we present a fully Bayesian approach to jointly estimate parameters and state function of affine ODE models when the data distribution is homogeneous non-Gaussian. The strategies used to explore the joint posterior distribution with MCMC are presented. Some simulations comparing the performance of the basic Bayesian ODE-penalized approach to the Bayesian Gaussian mixture model are then given. We conclude the presentation with the analysis of pharmacokinetic data.

References

[1] L Biegler, J Damiano, and G Blau. Nonlinear parameter estimation: A case study comparison. *AIChE Journal*, 32(1):29–45, 1986.

[2] P Eilers and B Marx. Flexible smoothing with B-splines and penalties. *Statistical Science*, 11:89–121, 1996.

[3] J Jaeger and P Lambert. Bayesian generalized profiling estimation in hierarchical linear dynamic systems. Discussion Paper 1101, Institut de Statistique, Biostatistique et Sciences Actuarielles, 2011.

[4] A Komárek and E Lesaffre. Bayesian accelerated failure time model for correlated interval-censored data with a normal mixture as error distribution. *Statistica Sinica*, 17:549–569, 2007.

[5] J O Ramsay, G Hooker, D Campbell, and J Cao. Parameter estimation for differential equations: a generalized smoothing approach. *Journal of the Royal Statistical Society, Series B*, 69:741–796, 2007.

Perspectives on Bagidis for image processing

CATHERINE TIMMERMANS (catherine.timmermans@uclouvain.be)

The BAGIDIS methodology has been designed around the definition of a data-driven wavelet-based semi-distance between curves. It relies on a new paradigm for measuring dissimilarities between functional data, which has proven to be an efficient tool for investigating datasets of curves with possibly misaligned sharp patterns. This communication presents and discusses the extension of the BAGIDIS methodology to image data.

Stochastic modeling of gaz and electricity derivatives markets

GEORGE BABAJAN (george.babajan@uclouvain.be)

Energy markets are known to be very volatile compared to other markets and the need of financial derivatives to hedge risk exposure becomes more important with time as the markets mature and become more liquid. One of the aims of this work is to describe these markets with a special emphasis on their financial derivatives and the stochastic models that capture market prices and other stylized facts of their price dynamics. Contrary to equity, the gas and power price dynamics have several unique features that have to be matched by using *jump processes* as noise factors.

A first design of a *risk-neutral (market based)* model is presented and discussed. Its *implied volatility curve* structure is analyzed. Derivatives are priced according to Monte-Carlo simulations and Fourier-based techniques using the analytical tractability of the model. Finally, a calibration case-study on electricity option data is used to illustrate the applicability of the model.

A second modelling approach focuses on the spot price behaviour of gas and its stylized facts for which a case-study to the UK market is analyzed. Mean reverting *Ornstein-Uhlenbeck* processes are used as a first modelling tool and its implications on the implied volatility curve is discussed.

Finally, all these modelling approaches are shown to have the potential to be used for *electricity contingent claim* pricing. Power derivatives can be priced and hedged using derivatives of gas and possibly other fuels.

Pension valuation and solvency

HABIBA TASSA (habiba.tassa@uclouvain.be)

As the premiums collected from policyholders, are invested in risky or risk-less assets, the idea is to study, in parallel, the evolution of contributions and the level of liabilities.

Regarding asset(contributions), several stochastic models will be presented and compared. On the other hand, the liability depends on the category of the scheme: Defined Contribution Schemes or Defined Benefit Schemes. For each category of schemes, some risk measures will be presented, with comparisons between the models used.

After studying the situation of ruin for each category, we need to estimate the initial level of solvency capital,to protect against the insolvency risk, taking into account the commitment of the liabilities. Therefore, various stochastic models, in continuous time, have been studied to better address the important risks faced by pension funds: market risk and inflation risk.

The copula-graphic estimator in censored nonparametric location-scale regression models

ALEKSANDAR SUJICA (aleksandar.sujica@uclouvain.be)

When estimating from right censored data there is always area in the right tail that can't be estimated consistently. In our approach we are forced to estimate that area.

In survival analysis, we are interested in the distribution function of the lifetime of some event. Due to different practical reasons we only observe a lower bound of the true lifetime. The survival time often depends on some covariate. In this case Van Keilegom and Akritas (1999) proposed a nonparametric location-scale regression model. Under the assumption of independence between the survival time and the censoring time they derived an explicit form for the estimator and its asymptotics.

However, often the assumption of independence is not satisfied. In this case, Braekers and Veraverbeke (2005) considered a fixed design regression model where the dependence is described via an Archimedean copula.

We are extending the model from Van Keilegom and Akritas by using the idea from Braekers and Veraverbeke, that is by assuming that the relation between the survival time and the censoring time is described via a known Archimedean copula which depends on a covariate.

References

[1] R. Braekers and N. Veraverbeke, A copula-graphic estimator for the conditional survival function under dependent censoring, *Canad. J. Statist.*, **33**, 429-447 (2005).

[2] I. Van Keilegom and M.G. Akritas, Transfer of tail information in censored regression models, *Ann. Statist.*, **27**, 1745-1784 (1999).