

Fall 2014 CO/WY ASA Meeting
Anschutz Medical Campus, Ed 2 North Building, Room 2302
Friday, October 17, 2014
Time: 11:50-3:30 pm (lunch provided)

Agenda:

11:50 - 12:15	Welcome and lunch
12:15 - 12:30	Gabriel Young, CSU. <i>KPSS test for functional time series.</i>
12:30 - 12:45	Paul Constantine, CSM. <i>Active subspaces for dimension reduction in complex simulations.</i>
12:45 - 1:00	Andy (Mason) Kass, USGS. <i>Compressive inversion: a framework for the efficient construction of earth models from geophysical data.</i>
1:00 - 1:15	Burke Minsley, USGS. <i>Reject the ridiculous and explore the plausible: A Bayesian McMC approach to model assessment and uncertainty analysis for airborne electromagnetic surveys.</i>
1:15 - 1:30	Break
1:30 - 1:45	Business meeting
1:45 - 2:00	Misha Kummel, D. Young Award Winner. <i>The effect of Fountain Creek on fluvial processes and ecology of the Arkansas River.</i>
2:00 - 2:15	Jonathan Snedeker, D. Young Award Winner. <i>Are Food Additives Health Substractives? The Drosophila in the Coal Mine.</i>
2:15 - 2:30	Ekaterina Smirnova, UW. <i>Wavelet based voxel-wise methods for resting state inter hemispheric connectivity estimation.</i>
2:30 - 2:45	Break
2:45 - 3:00	Khalil Shafie, UNC. <i>RKHS approach to detection for rotation and scale space random fields.</i>
3:00 - 3:15	Stefan Sillau, UCD. <i>Regression analysis for binary outcomes with relative risks as effects.</i>
3:15 - 3:30	Huayu (Karen) Liu, UCD. <i>A Bayesian Cox-Cluster Model to Study the Relationship between Two Pulsing Hormone.</i>

Abstracts:

Gabriel Young, CSU. *KPSS test for functional time series.*

Stationarity is fundamental to many time series analysis methods. The canonical example of a non-stationary process is the random walk. Thus it is natural to test for stationarity against a random walk alternative. For the scalar case, testing stationarity against a random walk is the well-known KPSS test. This procedure was developed for both level and trend stationary cases. Extending the KPSS test, we develop an analogous testing procedure for functional time series. In this talk, our goal is to motivate and summarize testing trend stationarity of functional time series against a random walk alternative. This includes details about the test statistic, asymptotic distribution, empirical size, empirical power and applications to financial data.

Paul Constantine, CSM. *Active Subspaces for Dimension Reduction in Complex Simulations.*

Simulated predictions from complex science and engineering computer models typically depend on many input parameters. When the models are expensive to run, studying the relationships between inputs and outputs becomes infeasible. One must identify exploitable low-dimensional structure to enable such studies. One type of structure encountered in many applications is that the model's predictions change more along a few directions in the high-dimensional space of inputs; the active subspace is the span of these directions. This talk will precisely define the active subspace and propose a random sampling method for estimating it. We then discuss how to exploit the active subspace to enable common parameter studies, e.g., response surface modeling, optimization, and averaging.

Andy (Mason) Kass, USGS. *Compressive inversion: a framework for the efficient construction of earth models from geophysical data.*

Compressive inversion is a technique used to reduce the dimensionality of the data space to improve the efficiency of inversion. We develop a compressive inversion method for inverting large-scale multichannel geophysical datasets. We then develop the framework to apply this technique to airborne electromagnetic (AEM) surveys to allow for the rapid inversion of airborne time-domain data.

Burke Minsley, USGS. *Reject the ridiculous and explore the plausible: A Bayesian McMC approach to model assessment and uncertainty analysis for airborne electromagnetic surveys.*

Geophysical data are typically used to infer a single 'best' model consistent with observations and prior information. However, because of non-uniqueness, limited resolution, and data errors, many models satisfy both the data and reasonable prior assumptions. Instead of seeking to describe the properties of any single model, a trans-dimensional Bayesian Markov chain Monte Carlo (McMC) algorithm is developed for the analysis of airborne electromagnetic (AEM) surveys that assesses the characteristics of models that are consistent with observations and prior assumptions. This is a powerful tool for model assessment and uncertainty analysis, and provides a wealth of information that can be used to make inferences about plausible subsurface properties. For example, we can estimate the likelihood of geological interfaces as a function of depth, quantify the probability that resistivity is above or below a certain threshold within a given depth range, assess model resolution and depth of investigation, or query subsets of models that are consistent with auxiliary datasets.

After introducing the basic role of AEM surveys for subsurface mapping, I will discuss the mechanics of a McMC algorithm developed for the analysis AEM data, along with examples where this algorithm has been used to add new insight into model uncertainty and geological interpretations. Specific aspects of the algorithm that will be discussed include: the trans-dimensional nature of the program, which allows the number of layers (unknowns) to be a free parameter; the capability to assess random and/or systematic data errors as unknown parameters; the use of parallel computing tools to run multiple chains for a single dataset in order to assess convergence, and to analyze many datasets simultaneously; the use of stochastic Newton

sampling to optimize sampling efficiency; and the ability to integrate multiple data types to probabilistically assess geological or hydrological properties directly.

Misha Kummel, D. Young Award Winner. *The Effect of Fountain Creek on Fluvial Processes and Ecology of the Arkansas River.*

Urbanized creeks are often not at equilibrium—they have unstable sediment, a lot of sediment transport, and they support very little aquatic life. This study aimed to analyze how Fountain Creek changes as it goes through Colorado Springs, and how Fountain Creek impacts the Arkansas River.

Each part of the study used 15 field sites for each analysis. At each field site, measurements of rock size, algal abundance, macroinvertebrate abundance, waterbird abundance, dissolved oxygen, and water temperature were recorded. The amounts of bedload and suspended load (sediment) were recorded. ANOVAs and Kruskal-Wallis Tests were used to analyze the data.

It was found that Colorado Springs completely changed the nature of Fountain Creek. The tributaries of Fountain Creek (Monument Creek and Fountain Creek) have more algae, macroinvertebrates, and less bedload. After passing through Colorado Springs, the creek was no longer at equilibrium.

It was also found that at the confluence of Fountain Creek and the Arkansas River, the Arkansas River above the confluence was healthy and at equilibrium: there were a lot of algae, water birds and macroinvertebrates. There were high levels of dissolved oxygen and low water temperature. There was little sediment movement (bedload, suspended load). After the confluence, the river was no longer at equilibrium.

In conclusion, after the Fountain Creek joins the Arkansas River, the characteristics of the Arkansas changes and it becomes a lot like Fountain Creek; it is no longer a healthy river. These findings have implications for river management and restoration.

Jonathan Snedeker, D. Young Award Winner. *Are Food Additives Health Substractives? The Drosophila in the Coal Mine.*

Currently, fewer than 10% of the over 80,000 anthropogenic chemicals on market have been studied for toxicology, largely due to the high expense of mouse toxicology research. The goal of this study was to design a new model for toxicology screening of food additives using the fruit fly, *Drosophila Melanogaster*, as a model organism for toxicology in a trigenerational study. This model was used to assess the toxicology of saccharin, aspartame, FD&C red 40, and FD&C yellow 5, ubiquitous food additives in the American diet. The fruit flies were exposed to the chemicals in the P generation as adults only, with full life exposure in the F1 generation, and with early development exposure only in the F2 generation. The data were analyzed using two-tailed heteroscedastic T-tests and the bonferroni post-test. In the study, the food dyes FD&C yellow 5 and red 40 both appeared to cause physiological developmental issues in male fruit flies. Yellow 5 may also have caused reproductive developmental issues. Red 40 may have also been toxic to adult fruit flies. Saccharin was found to be acutely toxic to the fruit flies both as adults and

larvae, potentially interfering with metabolism. Saccharin also was found to sterilize the media and could be acting as a general antibiotic to the microbiota. Aspartame was found to be toxic to adult fruit flies, but may have promoted microbiota growth in development. Not all toxicology found in the fruit flies will be conserved for humans and this model does not give a mechanistic understanding of the toxicology of the chemicals, but does serve as a cost-effective and thorough screen for toxicology.

Ekaterina Smirnova, UW. *Wavelet based voxel-wise methods for resting state inter hemispheric connectivity estimation.*

New methods for analysis of functional connectivity MRI (fMRI) studies are presented. Alternations in resting state inter-hemispheric connectivity due to a recent task are studied. In particular the effect of simple button presses, which are used in many cognitive fMRI tasks as a response recording method, is presented. Traditionally these studies are based on averaging images over large areas in right and left hemispheres and then finding a single cross-correlation function. It is proposed to conduct such an analysis based on a voxel-to-voxel level, which automatically creates a problem of large noisy data analysis leading to spurious correlations. Main steps in solving the problem are: (i) treat observations, available for a single voxel, as a nonparametric regression; (ii) use a wavelet transform and then work with empirical wavelet coefficients; (iii) develop the theory and methods of adaptive simultaneous confidence intervals and adaptive rate-minimax thresholding estimation for the matrices. The results allow us not only conclude that during fMRI experiments there is a change in cross-correlation between left and right hemispheres (the fact well known in the literature) but that we can also enrich our understanding how neural pathways are activated and then remain activated in time on a single voxel-to-voxel level.

Khalil Shafie, UNC. *RKHS approach to detection for rotation and scale space random fields.*

Two important papers of Worsley, Siegmund and coworkers consider rotation and scale space random fields for detecting signals in fMRI (functional magnetic resonance imaging) brain images. They use the global maxima of images for detection of a signal. In the current work, we utilize a reproducing kernel Hilbert space (RKHS) approach to show for both rotation and scale space random fields the global maximum of the image is the likelihood ratio test statistic.

Stefan Sillau, UCD. *Regression analysis for binary outcomes with relative risks as effects.*

Standard logistic regression describes effects as odd ratios, but relative risks are more interpretable. Regression for a binary outcome can be modified to model the effects of explanatory variables as relative risks by replacing the logit link with a log link, modifying the score equations, and estimating the parameter covariance matrix empirically.

Huayu Liu, UCD. *A Bayesian Cox-Cluster Model to Study the Relationship between Two Pulsing Hormone.*

The negative effect of obesity on women's reproductive and off-spring health is well-documented, but the mechanisms remain poorly understood. The reproductive axis is regulated

by the complex feed-forward and –backward interactions of the hormones in the hypothalamic-pituitary-ovary (HPO) axis. Studying HPO axis hormone dynamics is particularly difficult because many reproductive hormones are secreted intermittently in boluses, called pulses. Our study focuses on quantifying the correlation between a trigger's hormone and response' hormone on pattern of pulse release times along with characteristics of the pulse (e.g. size and duration), and how this relationship is altered in obese women, specifically when the relationship is not a perfect one-to-one. A Bayesian joint model is developed for characterizing features of driver's and response's hormone. A Cox process model is used to mimic biologically-possible relationships between the two hormone dynamics, allowing the flexibility for possibility of multiple-trigger or imperfect trigger.