John W. Tukey 100th Birthday Celebration
at
Princeton University
September 18, 2015

Speakers, Titles, and Abstracts
Tukey’s Two Statistical Cornerstones of Replicability

In Tukey’s last paper, an encyclopedic entry about multiplicity published postmortem, he merely discussed in depth two concepts: Mixed Model Analysis of Variance and the False Discovery Rate. The first is based on one of his earliest statistical papers, the second on some of his latest. No explanation was given in the paper for integrating these two - seemingly unrelated - concepts into a single document. Sadly he was no longer with us to explain.

I have argued that the connecting theme was his concern about replicability, a concern of great current importance all across science. More concretely, in the last three years we have been involved in efforts to transform these concepts into an operational paradigm, for the benefit of researchers in the field of mouse phenotyping. I shall review the concepts, the problems, and the progress made, with an eye towards science at large.
Over the last two decades, many exciting variable selection methods have been developed for finding a small group of covariates that are associated with the response from a large pool. Can the discoveries by such data mining approaches be spurious? Can our fundamental assumptions on exogeneity of covariates needed for such variable selection be validated with the data? To answer these questions, we need to derive the distributions of the maximum spurious correlations given certain number of predictors. When the covariance matrix of covariates possesses the restricted eigenvalue property, we derive such distributions, using Gaussian approximation and empirical process techniques. However, such a distribution depends on the unknown covariance matrix of the covariate. Hence, we propose a multiplier bootstrap method to approximate the unknown distributions and establish the consistency of such a simple bootstrap approach. The results are further extended to the situation where residuals are from regularized fits. Our approach is then applied to construct the upper confidence limit for the maximum spurious correlation and testing exogeneity of covariates. The former provides a baseline for guiding false discoveries due to data mining and the latter tests whether our fundamental assumptions for high-dimensional model selection are statistically valid. Our techniques and results are illustrated by both numerical examples.
Stephan Morgenthaler
École Polytechnique Fedéderale de Lausanne

The Dilemma of Multiplicity

John W. Tukey has made substantial contributions to multiple comparisons, simultaneous confidence statements and the combination of datasets. My talk is a commentary on his views.

Second level significance procedures or higher criticism were John's names for methods dealing with the assessment of significance when many significance tests are performed in parallel. Applications of these ideas to science abound, for example, to the study of the human brain, the search for genetic factors of common diseases or the cataloguing of stars. According to John: "These problems can have more than one resolution, but the more unhappy resolutions (in terms of discovering less) are often those that seem better justified when we consider things carefully." In other words -- to what extent is a weakening of what he called the Ferroni advisable? The simple Bonferroni procedure works with the significance level $\alpha/m$ instead of $\alpha$ when $m$ tests are involved. I will talk about alternatives and explore their properties.
Methodology Inspired by Applications: Some Examples from John W. Tukey’s Work

The notion of applications as inspirations for methodology seems to have been rediscovered in the statistics profession. In fact, applications have advanced research in statistics for centuries; e.g., Fisher and the Design of Experiments for agriculture; Wald and decision analysis during World War II; Hotelling and multivariate analysis for multiple outcomes; statistics graphics by Bell Labs statisticians for displaying "big data".

Because of his wide range of consultancies in industry and government, John Tukey contributed much methodology motivated by real problems. In this talk, I discuss a few examples, from two-dimensional smoothing, errors in variables, clustering, spectral analysis, and multiple comparisons.
Rafael Irizarry
Dana Farber Cancer Institute and Harvard University

On the Importance of Exploratory Data Analysis in Biomedical Research
David Donoho  
Stanford University  

John W. Tukey: Scientist, Oracle, and Prophet
Even as Tukey fought against the "mathematization" of Statistics, he had a superb research background. This ranges from Topology (uniform spaces) logic (every vector space has a basis being an equivalent of the axiom of choice), and Geometry (the "ham sandwich" theorem). He also did important Math-Stat work (polykays, analysis of variance, statistically-equivalent blocks). I will try to bring this material to life for a non-specialist audience hoping to illuminate Tukey's love-hate relationship with Mathematics.
Improving population health at more affordable costs is a national goal. A hundred years ago, Dr. William Osler (Acquanimitas, 1932) said: “Variability is the law of life, and as no two faces are the same, so no two bodies are alike, and no two individuals react alike and behave alike under the abnormal conditions which we know as disease”. Revolutions in biologic and information technologies have unleashed a torrent of new data that is beginning to explain the variation of which Osler spoke. The continuous aggregation of data from individual patients now builds large datasets that, in turn, create a foundation from which better-informed health care decisions can benefit both the individual and the population. John Tukey seems to have successfully used what are now called hierarchical models in his prediction of local and national elections 50 years ago. This lecture will address these models to more precisely define, measure, and communicate each person’s unique health state and the trajectory along which it is changing with the goal of improving interventions and their outcomes. The methods are illustrated with recent examples from public health and biomedical research at Johns Hopkins Medicine.
Jerome Friedman
Stanford University

John W. Tukey at the Stanford Linear Accelerator Center
Luisa Fernholz
Temple University

John W. Tukey’s Life and Legacy