Functional ANOVA for ERP data analysis

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Event-related potentials (ERPs) are recordings of electrical activity along the scalp time-locked to stimulus or response events. Employing designs of experiments to collect ERPs, psychologists can discover the relationship between treatment variables and the time course of mental processes. Analysis of variance (ANOVA) is widely used to analyze data collected using experimental designs. For ERP studies, the unit of analysis is, however, a curve over time. In significance testing with ANOVA for curves, researchers typically analyze them as repeated measures aggregated from a small number of arbitrarily (or strategically?) defined blocks. Such an approach not only trades the loss in time resolution for a (dubious) gain in statistical power but also fails to fully account for the inherent dependent structure in sampled observations constituting the curve. The p-value adjustment to control for false discovery rate further hampers researcher's ability to identify when curves from different experimental conditions truly diverge.

This talk introduces the functional analysis of variance approach developed by David Causeur and myself for the analysis of curves. The method is characterized by a factor decomposition of residual covariance matrix to account for the complex dependence commonly found in high-dimensional data. The method is designed to test for global differences among mean curves followed by a local procedure to locate where significant differences lie. We present analysis of real data examples to illustrate the methodology.