

ASP FITS TO MULTI-WAY LAYOUTS*

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Abstract. The balanced complete multi-way layout with ordinal or nominal factors is a fundamental data-type that arises in medical imaging, agricultural field trials, DNA microassays, and other settings where analysis of variance (ANOVA) is an established tool. ASP algorithms weigh competing biased fits in order to reduce risk through variance-bias tradeoff. The acronym ASP stands for **A**daptive **S**hrinkage on **P**enalty bases. Motivating ASP is a penalized least squares criterion that associates a separate quadratic penalty term with each main effect and each interaction in the general ANOVA decomposition of means. The penalty terms express plausible conjecture about the mean function, respecting the difference between ordinal and nominal factors. Multiparametric asymptotics under a probability model and experiments on data elucidate how ASP dominates least squares, sometimes very substantially. ASP estimators for nominal factors recover Stein's superior shrinkage estimators for one- and two-way layouts. ASP estimators for ordinal factors bring out the merits of smoothed fits to multi-way layouts, a topic broached algorithmically in work by Tukey.

Key words and phrases: Nominal factors, ordinal factors, estimated risk, penalized least squares, annihilator matrix, balanced complete layout, multiparametric asymptotics.

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