# Simultaneous test procedures in terms of $p$-value copulae

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## (joint work with Jakob Gierl)

At least since Gabriel (1969), a broad class of multiple comparison procedures, so-called simultaneous test procedures (STPs), is established in the statistical literature. Elements of an STP are a testing family $(\mathcal{H}, \mathcal{T})$, consisting of a set of null hypotheses and corresponding test statistics, and a common critical constant $c_\alpha$. The threshold $c_\alpha$ with which each of the test statistics has to be compared is calculated under the (joint) intersection hypothesis of $\mathcal{H}$. Under certain structural assumptions on $(\mathcal{H}, \mathcal{T})$, the so-constructed STP provides strong control of the family-wise error rate, FWER for short, at level $\alpha$. More recently, Hothorn et al. (2008) developed a general method to construct STPs in the case of asymptotic (joint) normality of the family $\mathcal{T}$ of test statistics, and provided numerical solutions to compute $c_\alpha$ in such cases.

Here, we propose to look at the problem from a different perspective. We will show that $c_\alpha$ can equivalently be expressed by a quantile of the copula of the family of $p$-values associated with $\mathcal{T}$, assuming that each of these $p$-values is marginally uniformly distributed on the unit interval under the corresponding null hypothesis. This will offer the opportunity to exploit the rich and growing literature on copula-based modeling of multivariate dependency structures for multiple testing problems and in particular for the construction of STPs in non-Gaussian situations.

## References

Gabriel, K. R. (1969). Simultaneous test procedures - some theory of multiple comparisons. *The Annals of Mathematical Statistics* **40**, 224-250.

Hothorn, T., Bretz, F., Westfall, P. (2008). Simultaneous inference in general parametric models. *Biometrical Journal* **50**, 3, 346-363.