Penalized Bayesian Methods for Product Ranking Using Both Positive and Negative References

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Product ranking (e.g., formulations, molecules…) according to pre-specified criteria (efficacy, safety, etc.) can be essential for companies when developing new technologies. In the pharmaceutical or cosmetic industry, ranking can allow to identify the best candidates for further development. Ranking involving both a negative and a positive reference enable the scientist to directly compare tested products against competitors. Best candidates should be products that approach the ideal case while being the farthest away from the worst case. This paper provides a metric to quantify the joint distance with respect to both the negative and positive references. The Bayesian method presented does not simply rely on point estimates to perform the comparisons, but also accounts for their uncertainty via the posterior probabilities. For each product, the posterior probability to outperform the positive reference is computed and is penalized by the posterior probability of performing worse than the negative reference. This computation is then compared to a hypothetical case of no knowledge as represented by a uniform distribution (i.e., products are gauged against their odds to be efficacious purely randomly). The final result provided is a metric which is directly interpretable as the improvement of a product from this state of ignorance. This methodology is presented through a case study comparing several products tested in a meta-analytical framework.