The outcome of high-throughput biological experiments is affected by many operational factors in the experimental and data analytical procedures. Understanding how these factors affect the reproducibility of the outcome is critical for establishing workflows that produce replicable discoveries.

In this work, we propose a regression framework to assess the covariate effects of influencing factors on the reproducibility of findings from high-throughput experiments. In contrast to existing graphical approaches, our method allows one to succinctly characterize the simultaneous and independent effects of covariates on reproducibility and to compare reproducibility while controlling for potential confounding variables. By establishing a connection between our regression model and Archimedean copula models, we develop a procedure to choose functional forms of the regression model and provide an interpretation of the regression model in the context of multivariate dependence models. We illustrate the usefulness of our methods using ChIP-seq and microarray studies, and demonstrate how to use this approach to select cost-effective experimental parameters.