1. The Levene’test for variance heterogeneity is generalized to accommodate the case when there are sample correlation and group membership uncertainty. Then it is incorporated into the joint-testing of location and scale framework which will be especially useful when interaction with an unknown variable exists in the model.

2. The reason that Levene’s test is popular in Statistical genetics problem is because of its simplicity. In big data setting such as GWAS, graphical and other computationally burdensome approaches are not ideal.

3. The main idea of the generalized Levene’s test is to reformulate it as a two-stage regression framework:

First stage: Regression y on groups, and obtain the residuals , take the absolute value of these residuals, as

Second stage: Regression of on groups again and use F-test to test for association.