

**The Maharaja Sayajirao University of Baroda**

**Faculty of science**

**Department of statistics**

***Write-Up on***

***MANOVA***

**BY**

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**EXPERIMENTAL DESIGN AND COMPUTATIONS**

**MANOVA**

What is MANOVA?

* MANOVA is variation of ANOVA…. Which you already know!
* MANOVA assesses the statistical significance of the effect of **one or more** IV’s on a set **of two or more** dependent variables.
* Its simply ANOVA with several DV.

IV-Independent variable, DV-Dependent variable

Why MANOVA?

* MANOVA has the ability to examine more than one DV at once or simultaneous effect of IV’s on multiple DV’s.
* The major benefit of MANOVA over multiple ANOVAs=controlling Type I error rate.

IV-Independent variable, DV-Dependent variable

**How’s it Do that?**

* Over all(omnibus) MANOVA is run to determine if significant. If so, then univariate ANOVA’s are conducted for each DV.
* DV’s must be correlated in MANOVA!
* MANOVA includes the correlation between DV’s…. Therefore, the analysis removes/accounts for any redundancy in DV’s

**EXAMPLE**

* Case study on 2 different text books & student improvement in math and physics.
* Dependent variables here are improvement in math and physics.
* Our hypothesis: both the DV are affected by difference in text books.
* MANOVA is used to test this hypothesis.

**Advantage of MANOVA over ANOVA**

* MANOVA produces significant main effect on the DV, but ANOVA do not.
* Because variables are more significant together than considered separately.
* It considers inter correlation between DV’s.
* It controls the inflation of Type I error\*.
* If a null hypothesis is incorrectly rejected when it is fact true, this is called a type I error

**A word about power**

* The power of a MANOVA actually depends on the nature of the DV correlations
* Power increases as correlations between DV with large consistent effect sizes (that are in the same direction) move from near 1.0 toward -1.0
* Power increases as correlations become more positive or more negative between DV that have very different effect sizes (i.e., one large and one negligible)
* Power increases as correlations between DV with negligible effect sizes shift from positive to negative (assuming that there are DV with large effect sizes still in the design).

**Rules, just like in ANOVA**

* DV’s must be continuous.
* IV’s are categorical.
* Covariates may be included and must be continuous.
* All assumptions of ANOVA hold with a few minor exceptions…

**Assumptions of MANOVA**

* Multivariate normality.
* Homogeneity of covariance matrices.
* Independence of observations.
* Linearity.

**Assumptions of MANOVA**

***Multivariate normality:***

* DV should be normally distributed within groups.
* Linear combinations of DV must be distributed.
* All subjects of variables must have multivariate normal distribution.

***Homogeneity of covariance matrices:***

* The inter correlations (co variances) of the multiple DV across the cells of design.
* BOX test is used for this assumption.

**Assumptions of MANOVA**

***Independence of observations:***

* Subject score on DV are not influenced or related to other subject scores.
* (E g) can be tested with an interclass correlation coefficient if lack of independence of observation is suspected.

***Linearity***

* Linear relationship against
* All pairs of dependent variables,
* All pairs of covariates,
* All dependent variable-covariate pairs in each cell.
* Therefor if relationship deviates from linearity the power of analysis will be compromised.

**Limitations of MANOVA**

***Outliers:***

* As in ANOVA, MANOVA sensitive to outliers.
* It may produce Type 1 error.
* But no indication which type of error it is.
* Several programs available to test for univariate & multivariate analysis.

***Multicollinearity & Singularity:***

* High correlation between dependent variables.
* One DV becomes linear combination of other DV.
* So it becomes statistically redundant & suspect to include both combinations.

**MANCOVA**

* Extension of ANOVA.
* Its simply MANOVA where the artificial DV are initially adjusted differences in one or more covariates.
* This can reduce error/noise, when error associated with covariates are removed.

**References**

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**Thank You**