Regression Analysis

Multiple Linear Regression

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Model Interpretation

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Model Interpretation: Parameters

The Least Squares estimated coefficients have specific interpretations:

$\widehat{\boldsymbol{\beta}}_0$ The estimated expected value of the response variable when all predicting variables equal zero.

$\widehat{\boldsymbol{\beta}}_i$ The estimated expected change in the value of the response variable associated with one unit of change in the value of the i^{th} predicting variable (i.e., associated with a one-unit change in $\boldsymbol{x}_i$, where i is any of $1, \ldots, p$), holding all other predictors in the model fixed (i.e., holding fixed $\boldsymbol{x}_j$ for $j = 1, \ldots, p$ where $j \neq i$).

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Model Interpretation: Simple vs. Multiple Regression

Marginal versus ***conditional*** relationship:

Marginal Simple linear regression captures the association of a predicting variable to the response variable marginally, *i.e., without consideration of other factors*.

Conditional Multiple linear regression captures the association of a predicting variable to the response variable conditionally, *i.e., conditional of all other predicting variables in the model*.

The estimated regression coefficients for conditional and marginal relationships can differ not only in magnitude but also in sign or direction of the relationship.

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Model Interpretation: Causality vs. Association

Causality Statements: Experimental Designs
Association Statements: Observational Studies

Example: We take a sample of college students and determine their college grade point average ($COLGPA$), high school GPA ($HSGPA$), and SAT score (SAT). The estimated model is: $COLGPA = 1.3 + 0.7(HSGPA) - 0.0003\,(SAT)$.

- **Incorrect Interpretation:** Higher values of SAT are associated with lower values of College GPA.
- **Correct Interpretation:** Higher values of SAT are associated with lower values of college GPA, ***holding high school GPA fixed***.

The coefficients of a multiple regression must not be interpreted marginally!

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Different Roles of Predicting Variables

Predicting variables can be distinguished as:

- ***Controlling*** – to control for bias selection in the sample. They are used as 'default' variables in order to capture more meaningful relationships.
- ***Explanatory*** – to explain variability in the response variable. They may be included in the model even if other "similar" variables are in the model.
- ***Predictive*** – to best predict variability in the response regardless of their explanatory power.

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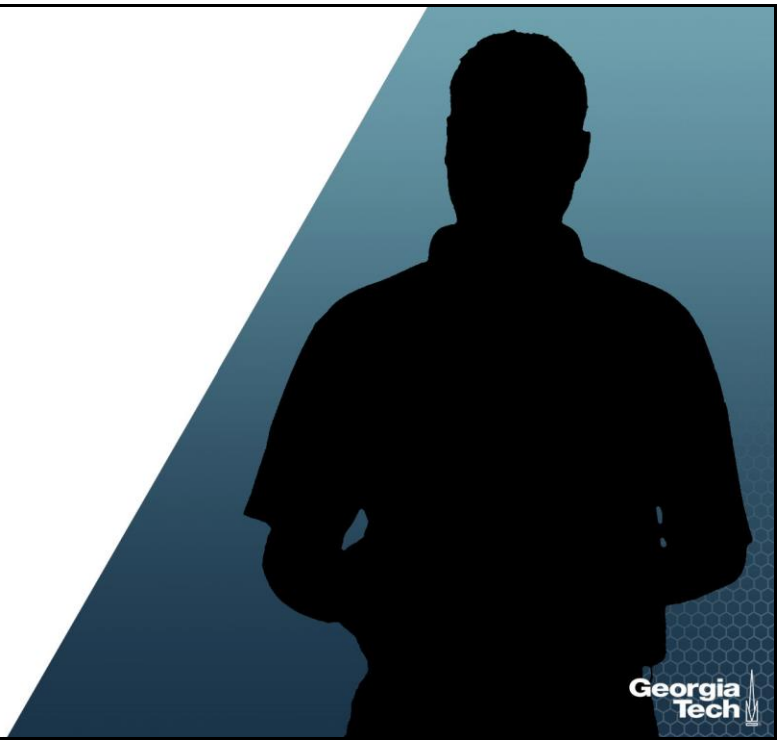

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