Course Syllabus: STA 2312 Regression Modelling 1

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Course Description:

This course provides an in-depth understanding of simple linear regression and multiple linear regression models, covering various designs, assumptions, and techniques for model building, parameter inference, and predictions. Students will also learn about diagnostics, remedial measures, and challenges related to the models, including independent variable selection, multicollinearity, autocorrelation, and non-linear regression. The course emphasizes the use of computers for practical implementation and analysis of these topics.

Course Duration: 12 weeks

Week 1: Introduction to Linear Regression

Overview of linear regression models
Simple linear regression vs. multiple linear regression
Assumptions and limitations of linear regression models
Week 2: Simple Linear Regression Model

Formulating and estimating a simple linear regression model
Assumptions on errors: normality, independence, and constant variance
Inference about model parameters and predictions
Computer implementation using R or Python
Week 3: Hypothesis Testing and Confidence Intervals

Hypothesis testing for model parameters
Confidence intervals for model parameters
Practical interpretation of results
Hands-on exercises with real-world datasets
Week 4: Model Diagnostics and Remedial Measures

Checking model assumptions: linearity, normality, and constant variance
Dealing with violations of assumptions
Diagnostic plots: residual analysis, influence measures, and leverage points
Remedial measures to improve model performance
Week 5: Multiple Linear Regression Model

Extending to multiple predictor variables
Estimation and interpretation of model parameters
Dealing with categorical predictor variables: dummy coding and effect coding
Computer implementation and model comparison
Week 6: Variable Selection and Model Building

Stepwise selection methods: forward, backward, and stepwise regression
Criteria for variable selection: AIC, BIC, and adjusted R-squared
Practical considerations and pitfalls in variable selection
Hands-on exercises on automated variable selection techniques
Week 7: Multicollinearity and Autocorrelation

Understanding multicollinearity causes and consequences
Detecting multicollinearity using correlation matrices and variance inflation factor (VIF)
Remedial measures for dealing with multicollinearity
Introduction to autocorrelation and its implications
Week 8: Heteroscedasticity and Non-Linear Regression

Understanding heteroscedasticity: detection and consequences
Remedial measures for heteroscedasticity
Introduction to non-linear regression models
Estimation and interpretation of non-linear regression models
Week 9: Fixed Effects and Random Effects Models

Introduction to fixed effects models
Incorporating fixed effects in regression models
Introduction to random effects models and mixed-effects models
Applications and interpretation of fixed and random effects models
Week 10: Advanced Topics in Regression Analysis

Interaction effects and their interpretation
Polynomial regression and transformation of variables
Robust regression methods for handling outliers and influential observations
Hands-on exercises on advanced regression techniques
Week 11: Model Validation and Prediction

Assessing model performance: goodness of fit measures, cross-validation, and validation data
Prediction intervals for new observations
Using the regression model for prediction and decision making
Case studies and practical examples
Week 12: Integration of Computers in Regression Analysis

Hands-on sessions using statistical software (R or Python)
Implementing regression models on real-world datasets
Project work and application of regression analysis techniques
Note: This syllabus is a guideline and can be adjusted based on the pace of the course and the specific needs of the students. Additional topics or subtopics related to linear regression and multiple linear regression

References

Weisberg, S. (2005). *Applied linear regression* (Vol. 528). John Wiley & Sons.
Fahrmeir, L., Kneib, T., Lang, S., & Marx, B. D. (2022). Regression models. In *Regression: Models, methods and applications* (pp. 23-84). Berlin, Heidelberg: Springer Berlin Heidelberg.