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American Public University System  
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# DATS301

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## Course Summary

**Course :** DATS301 **Title :** Analytical Methods 2

**Length of Course :** 8 Weeks

**Prerequisites:** DATS201 Analytical Methods 1

**Credit Hours :** 3

**Contact:** frank.appiah@mycampus.apus.edu

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## Description

Whereas the Analytical Methods I primarily deals with continuous data, this course deals with methods and tools used to analyze categorical (discrete) data. For example, researchers analyze categorical data, e.g. using logistic regression, to determine the results of tests such as is a patient's tumor cancerous or not, or whether a consumer will purchase a particular product or not. In addition, this course introduces generalized linear models and logit models.

## Course Scope:

This course is intended for students seriously pursuing a career in data science. It assumes a fairly high level of mathematics in calculus as well as probability and statistics. It provides students with knowledge and skills for analyzing categorical data with tools including a variety of computational methods used to conduct generalized linear regression, contingency tables and matched pairs analyses. Students will complete this course with the basic understanding of how to conduct analyses on data with binary or multinomial outcome.

## Objectives

At the conclusion of this course, students will be able to:

LO1: Discuss the basic strategy and application of the tools and methods used in data science for the analysis of categorical data.

LO2: Report the results of an analysis of categorical data including appropriate contingency tables.

LO3: Describe generalized linear modeling techniques.

## Course Delivery Method

This course delivered via distance learning will enable students to complete academic work in a flexible manner, completely online. Course materials and access to an online learning management system will be made available to each student. Online assignments are due by Sunday evening of the week as noted and include Forum questions (accomplished in groups through a threaded forum), examination, and individual assignments submitted for review by the Faculty Member). Assigned faculty will support the students throughout this eight-week course.

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# Course Materials

## Textbook (Required)

The for the course is available at [Introduction to Categorical Data Analysis](#)

## Software (Required)

1. Install R and RStudio on windows from: <https://cran.r-project.org/bin/windows/base/> and <https://rstudio.com/products/rstudio/download/> (scroll down to All installers and select windows version)
2. Install R and Rstudio on mac from: <https://cran.r-project.org/bin/macosx/> and <https://rstudio.com/products/rstudio/download/> (scroll down to All installers and select mac version)

## Software (Optional)

1. [Python version 3 on mac and windows available at: https://www.python.org/downloads/](https://www.python.org/downloads/)
2. [Other software usage will require approval from the instructor.](#)

## Readings:

Week	Topic	Chapter Coverage	Units
1	Introduction, Categorical Data and Probability Distributions for Categorical Data	Chapter 1	1.1-1.3.4
2	Analyzing Contingency Tables	Chapter 2	2.1-2.4
3	Generalized Linear Models	Chapter 3	3.1-3.3
4	Logistic Regression	Chapter 4	4.1-4.4
5	Building and Applying Logistic Regression Models	Chapter 5	5.1-5.2.6
6	Multicategory Logit Models	Chapter 6	6.1-6.2.6
7	Loglinear Models for Contingency Tables and Counts	Chapter 7	7.1.1-7.1.5
8	Models for Matched Pairs	Chapter 8	8.1-8.3

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# Outline

## Week 1: Introduction, Categorical Data and Probability Distributions for Categorical Data:

At completion of the modules this week students will be able to:

1. Distinguish between nominal and ordinal scales
2. Identify and discuss the characteristics of a binomial distribution.
3. Identify and discuss the characteristics of a multinomial distribution.
4. Discuss the similarities and differences between the binomial and multinomial distributions
5. Hypotheses, Statistical tests and inference

### Module 1: Unit 1.1.2 Nominal and Ordinal Scale Distinction

Extra reading: Bernoulli Distribution:

<https://web.stanford.edu/class/archive/cs/cs109/cs109.1178/lectureHandouts/070-bernoulli-binomial.pdf>

### Module 2: Unit 1.2.1 Binomial distribution

#### Unit 1.2.2 Multinomial Distribution

### Module 3: Unit 1.3.1 Likelihood Function and Maximum Likelihood Function

### Module 4: Unit 1.3.2 Statistical testing

#### Unit 1.3.4 Confidence interval for Binomial Proportions

HW Page 16 questions 1, 2, 8, 9, 15

## Week 2: Analyzing Contingency Tables

At completion of the modules this week students will be able to:

1. Identify and distinguish between Joint, Marginal and Conditional probabilities
2. Perform sensitivity and specificity analyses
3. Compare two proportions (dependent and independent)
4. Perform a chi-square test of association/independence

### Module 5: Unit 2.1.1-2.1.2 Joint, Marginal, and Conditional Probabilities

### Module 6: Unit 2.1.3 Sensitivity and Specificity in Diagnostic Tests

### Module 7: Unit 2.2.1-2.2.3 Comparing Proportions in Two-by-Two Tables

### Module 8: Unit 2.4.1-2.4.3 Chi-Squared Tests of Independence

HW 2.1, 2.14, 2.16 & 2.18

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### **Week 3: Generalized Linear Models (GLM)**

At completion of the modules this week students will be able to:

1. Distinguish between the random and non-random (systematic) components of GLM
2. Deepen their understanding of logistic regression and interpret their outcomes
3. Understand the assumptions in a Poisson regression
4. Understand the concept of overdispersion

**Module 8: Unit 3.1.1-3.1.2** Random and systematic components of GLM

**Module 9: Unit 3.2.1-3.2.3** Linear probability model and introduction to logistic regression

**Module 10: Unit 3.3.1 & 3.3.3** Intro to Poisson regression and overdispersion

HW 3.1, 3.7, 3.8, 3.9, 3.11

### **Week 4: Logistic Regression**

At completion of the modules this week students will be able to:

1. Recognize when to apply simple logistic regression
2. Interpret coefficients and odds ratio
3. Distinguish between grouped and ungrouped binary data
4. Calculate and interpret the confidence interval for effects in logistic regression
5. Apply a multiple logistic regression and interpret outcome

**Model 11: Unit 4.1.1 - 4.1.4** Interpreting the Logistic Regression Model

**Model 12: Unit 4.2.1** Binary Data can be grouped or ungrouped

**Module 13: Unit 4.2.2** Confidence Intervals for effects

**Module 14: Unit 4.2.3** Significance testing

**Module 15: Unit 4.4.1-4.4.2, 4.4.3-4.4.4** Multiple logistic regression

HW 4.2, 4.3, 4.7, 4.37

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## **Week 5: Building and Applying Logistic Regression Models**

At completion of the modules this week students will be able to:

1. Apply model selection tools to select the number of predictor for a logistic regression model
2. Assess the predictive power of a logistic regression model
3. Perform logistic regression model diagnostics

**Model 16: Unit 5.1.1-5.1.4** selecting predictors using stepwise approach

**Model 17: Unit 5.1.5** Select subset of a model using AIC approach

**Module 18: Unit 5.1.6-5.1.8** Assess model performance with ROC and confusion matrix

**Module 19: Unit 5.2.1-5.2.5, 5.2.6** model diagnostics with goodness of fit test

HW 5.1, 5.2, 5.3, 5.4, 5.12

## **Week 6: Multicategory Logit Models - Multinomial Regression**

At completion of the modules this week students will be able to:

1. Apply logistic regression to nominal outcome
2. Apply logistic regression to ordinal outcome
3. Perform model fit checks
4. Interpret all outcomes for both nominal and ordinal outcomes
5. Distinguish between the fits for nominal and ordinal outcomes

**Model 20: Unit 6.1.1-6.1.5** logit models for nominal responses

**Model 21: Unit 6.2.1-6.2.6** Cumulative models for ordinal outcomes

HW 6.6, 6.9 & Lab

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## Week 7: Loglinear Models for Contingency Tables and Counts

At completion of the modules this week students will be able to:

1. Fit and interpret 2-way loglinear models
2. Fit and interpret a 3-way loglinear models
3. Discuss the differences between 2 and 3 way log linear models

**Model 22: Unit 7.1.1-7.1.2** Loglinear models of independence for 2-way table and interpretation

**Model 23: Unit 7.1.3** Saturated Model for 2-way table

**Module 24: Unit 7.1.4** Loglinear models for 3-way tables

**Module 25: Unit 7.1.5** 2-Factor parameters described conditional associations

HW in Rmarkdown.

## Week 8: Models for Matched Pairs

At completion of the modules this week students will be able to:

1. Compare dependent proportions
2. Apply logistic regression to matched pairs
3. Compare margins of square contingency tables
4. Analyze rater agreement

**Module 26: Unit 8.1.1-8.1.2** McNemar Test for comparing marginal proportions and differences in proportions

**Module 27: 8.2.1-8.2.3** Marginal models for marginal proportions and logistic regression for matched pairs

**Module 28: 8.2.4-8.2.5** logistic regression for matched case control and tests-McNemars vs Mantel Haenszel

HW: 8.1, 8.2, 8.4

# Evaluation

A variety of weekly exercises (Knowledge Checks/quizzes and discussions) will be used to reinforce the material covered in this course. This course will include a final exam, weekly homework, quizzes, discussions and labs. The grade distribution of the course is shown below.

- Homework 25%
- Laboratories 15%
- Discussions 15%
- Quizzes 25%
- Comprehensive Final Exam 20%

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# Late Assignments

1. Students are expected to submit classroom assignments by the posted due date and to complete the course according to the published class schedule. The due date for each assignment is listed under each Assignment.
2. Generally speaking, late work may result in a deduction up to 15% of the grade for each day late, not to exceed 5 days.
3. As a working adult I know your time is limited and often out of your control. Faculty may be more flexible if they know ahead of time of any potential late assignments.

## Policies

Please see the [Student Handbook](#) to reference all University policies. Quick links to frequently asked question about policies are listed below.

[Drop/Withdrawal Policy](#)

[Plagiarism Policy](#)

[Extension Process and Policy](#)

[Disability Accommodations](#)

### Writing Expectations

All written submissions should be submitted in a font and page set-up that is readable and neat. It is recommended that students try to adhere to a consistent format, such as that described below.

- Typewritten in double-spaced format with a readable style and font and submitted inside the electronic classroom (unless classroom access is not possible and other arrangements have been approved by the professor).
- 11 or 12-point font in a style such as Arial, Helvetica or Times New Roman.

### Citation and Reference Style

Assignments completed in a narrative essay or composition format must follow a widely accepted citation style, such as APA, Turabian or MLA. Please refer to the APUS Online Library for further examples, or contact the instructor with questions.

### Late Assignments

Students are expected to submit classroom assignments by the posted due date and to complete the course according to the published class schedule. As adults, students, and working professionals, I understand you must manage competing demands on your time. Should you need additional time to complete an assignment, please contact me **before the due date** so we can discuss the situation and determine an acceptable resolution. Routine submission of late assignments is unacceptable and may result in points deducted from your final course grade.

### Netiquette

Online universities promote the advancement of knowledge through positive and constructive debate – both inside and outside the classroom. Forums on the Internet, however, can occasionally degenerate into needless insults and “flaming.” Such activity and the loss of good manners are not acceptable in a university setting –

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basic academic rules of good behavior and proper “Netiquette” must persist. Remember that you are in a place for the rewards and excitement of learning which does not include descent to personal attacks or student attempts to stifle the Forum of others.

- **Technology Limitations:** While you should feel free to explore the full-range of creative composition in your formal papers, keep e-mail layouts simple. The Sakai classroom may not fully support MIME or HTML encoded messages, which means that bold face, italics, underlining, and a variety of color-coding or other visual effects will not translate in your e-mail messages.
- **Humor Note:** Despite the best of intentions, jokes and especially satire can easily get lost or taken seriously. If you feel the need for humor, you may wish to add “emoticons” to help alert your readers: ;-), :) )

### Disclaimer Statement

Course content may vary from the outline to meet the needs of this particular group.

## Online library

The Online Library is available to enrolled students and faculty from inside the electronic campus. This is your starting point for access to online books, subscription periodicals, and Web resources that are designed to support your classes and generally not available through search engines on the open Web. In addition, the Online Library provides access to special learning resources, which the University has contracted to assist with your studies. Questions can be directed to [librarian@apus.edu](mailto:librarian@apus.edu).

- **Charles Town Library and Inter Library Loan:** The University maintains a special library with a limited number of supporting volumes, collection of our professors’ publication, and services to search and borrow research books and articles from other libraries.
- **Electronic Books:** You can use the online library to uncover and download over 50,000 titles, which have been scanned and made available in electronic format.
- **Electronic Journals:** The University provides access to over 12,000 journals, which are available in electronic form and only through limited subscription services.
- **Tutor.com:** AMU and APU Civilian & Coast Guard students are eligible for 10 free hours of tutoring provided by APUS. [Tutor.com](http://tutor.com) connects you with a professional tutor online 24/7 to provide help with assignments, studying, test prep, resume writing, and more. Tutor.com is tutoring the way it was meant to be. You get expert tutoring whenever you need help, and you work one-to-one with your tutor in your online classroom on your specific problem until it is done.

### **Library Guide (<http://apus.campusguides.com/SCIN134>)**

The AMU/APU Library Guides provide access to collections of trusted sites on the Open Web and licensed resources on the Deep Web. This course guide provides links to a number of sources relevant to this course, including journals, books, and web sites. Also, you can directly contact the librarian assigned to this course for assistance in locating information.