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| Computational Assignment #4: OLS Regression Modeling with Continuous  and Categorical Variables  *MSDS 410* |

This fourth computational assignment builds on your prior modeling and computing experiences with assignment #3. You may begin to work on this assignment anytime you wish.

**Data:** The data for this assignment is the Nutrition Study data: NutritionStudy.CSV It is a 16 variable dataset with n=315 records. The data was obtained from medical record information and observational self-report of adults. The dataset consists of categorical, continuous, and composite scores of different types. A data dictionary is not available for this dataset, but the qualities measured can easily be inferred from the variable and categorical names for most of the variables. As such, higher scores for the composite variables translate into having more of that quality. The QUETELET variable is essentially a body mass index. It can be googled for more detailed information. It is the ratio of BodyWeight (in lbs) divided by (Height (in inch))^2. Then the ratio is adjusted with an adjustment factor so that the numbers become meaningful. Specifically, QUETELET above 25 is considered overweight, while a QUETELET above 30 is considered obese. There is no other information available about this data.

**Objective:** Use multiple regression to predict CHOLESTEROL using models with continuous and categorical variables. Please note: This assignment is not prescriptive of what you “should do” as an analysis. It is intended to give you experience conducting and reporting on different kinds of multiple regression models.

**Tasks:** To achieve the objective please complete the following tasks enumerated below. You are to use R to obtain any graphs or statistics requested.

For these analyses, let the response variable be: Y = CHOLESTEROL. The remaining variables will be considered explanatory variables, X’s.

1. Consider the continuous variable, FIBER. Is this variable correlated with Cholesterol? Obtain a scatterplot and appropriate statistics to address this question.

Chart, scatter chart

Description automatically generated

Graphical user interface, text, application

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The R^2 value of this model is 0.02371, indicating that Fiber on its own is not a good predictor for cholesterol and that they do not correlate that much.

The correlation coefficient is 0.1539684, which is very low, indicating minimal correlation.

1. Fit a simple linear regression model that uses FIBER to predict CHOLESTEROL(Y). Report the model, interpret the coefficients, discuss the goodness of fit.

The R^2 value of this model is 0.02371, indicating that Fiber on its own is not a good predictor for cholesterol and that they do not correlate that much.

Y=193.701+3.813\*B1

The 193.701 is the intercept and 3.813 is the slope of the linear model, while B1 is the amount of fiber.

Graphical user interface, text, application

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Chart, scatter chart

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1. For the ALCOHOL categorical variable, create a set of dummy coded (0/1) indicator variables. Fit a multiple linear model that uses the FIBER continuous variable and the ALCOHOL dummy coded variables to predict the response variable Y=CHOLESTEROL. Remember to leave one of the dummy coded variables out of the model so that you have a basis of interpretation for the constant term. Report the model, interpret the coefficients, discuss hypothesis test results, goodness of fit statistics, diagnostic graphs, and leverage, influence and Outlier statistics. This is called an Analysis of Covariance Model (ANCOVA)

Text

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Y=189.266+3.984\*B1+44.429\*B2-2.523\*B3,

With 189.266 being the intercept, 3.984 being the impact of Fiber intake on cholesterol, 44.429 being the impact of High alcohol use (value above 10) and -2.523 being the impact of medium alcohol intake (value between 0 and 10).

Hypothesis test:

Null: B1=B2=B3=0

Alt: One of them does not equal 0

99% confidence interval test stat: ~1.97

Only the t-value for Fiber is greater than the test statistic, indicating it is significant in this case, while both the t values for the alcohol variables do not, indicating they do not have significant. The p-value for fiber is also the only one <0.05 supporting the claim that is does not equal zero (rejecting null hypothesis).

Diagram

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1. Use the ANCOVA model from task 3) to obtain predicted values for CHOLESTEROL(Y). Now, make a scatterplot of the Predicted Values for Y (y-axis) by FIBER (X), but color code the records for the different groups of ALCOHOL. What do you notice about the patterns in the predicted values of Y? Now, make a scatterplot of the actual values of CHOLESTEROL(Y) by FIBER (X), but color code by the different groups of the ALCOHOL variable. If you compare the two scatterplots, does the ANCOVA model appear to fit the observed data very well? Or is a more complex model needed?

Chart, scatter chart

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Chart, scatter chart

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I believe a more complex model is required to extract better meanings and correlations between the data due to linear trends being visible in the predicted model with separation of alcohol consumption.

1. Create new interaction variables by multiplying the dummy coded variables for ALCOHOL by the continuous FIBER(X) variable. Save these product variables to your dataset. Now, to build the model, start with variables in your ANCOVA model from task 4) and add the interaction variables you just created into the multiple regression model. Don’t forget, there is one category that is the basis of interpretation. DO NOT include any interaction term that is associated with that category. This is called an Unequal Slopes Model. Fit this model, and save the predicted values. Plot the predicted values for CHOLESTEROL (Y) by FIBER(X). Discuss what you see in this graph. In addition, report the model, interpret the coefficients, discuss hypothesis test results, goodness of fit statistics, diagnostic graphs, and leverage, influence and Outlier statistics.

Chart, scatter chart

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In the graph, I see that there are linear relationships between alcohol consumption and the prediction of cholesterol in individuals. The lower the alcohol consumption, the less cholesterol the individual seems to have in this case.

Text

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Y= 230.3434 + 0.6363\*B1- 63.3814\*B2 - 62.8481\*B3 + 9.0742\*B4 + 4.7976\*B5

With 230.3434 being the intercept, 0.6363 being the impact of Fiber intake on cholesterol, - 63.3814 being the impact of High alcohol use (value above 10) and - 62.8481being the impact of medium alcohol intake (value between 0 and 10), as well as 9.0742 being the impact of fiber along with high alcohol consumption and 4.7976 being the impact of fiber along with medium alcohol use.

Hypothesis test:

Null: B1=B2=B3=B4=B5=0

Alt: One of them does not equal 0

99% confidence interval test stat: ~1.97

None the t-values are greater than the test statistic, indicating it is not significant in this case, except the intercept’s p-value. All of their p-values are less than 0.05, indicating no statistical significance. However, when combined, the p-value is 0.01651, which means all variables combined indicate statistical significance. You can see this through the f-statistic.

1. You should be aware that the models of Task 4) and Task 5) are nested. Which model is the full and which one is the reduced model? Write out the null and alternative hypotheses for the nested F-test in this situation to determine if the slopes are unequal. Use the ANOVA tables from those two models you fit previously to compute the F-statistic for a nested F-test using Full and Reduced models. Conduct and interpret the nested hypothesis test. Are there unequal slopes? Discuss the findings.

Task 4 has the reduced model while task five has the full model.

Hypothesis test:

Null: B4=B5=0

Alt: One of them does not equal 0

Graphical user interface, text, application

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Our f-statistic is 1.7293, with a p-value of 0.1791, which is greater than 0.05. This means we cannot reject our null hypothesis that B4=B5=0.

1. Now that you’ve been exposed to these modeling techniques, it is time for you to use them in practice. Let’s examine more of the NutritionStudy data. Use the above practiced techniques to determine if SMOKE, VITAMINS, or GENDER interacts with the FIBER variable and influences the amount of CHOLESTEROL. Formulate hypotheses, construct essential variables (as necessary), conduct the analysis and report on the results. Which categorical variables are most predictive of CHOLESTEROL, in conjunction with FIBER.

Text

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The most significant variables in this model seem to be (from least significant to greatest) Smoking, Fiber, and equally being a Male and Fiber\*Male.

This is because when conducting hypothesis testing, they have t-values greater than the threshold and very low p-values, meaning that we can reject the null hypothesis that their variable is equal to zero.

Diagram, schematic

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Graphical user interface, text, application

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On their own, the vitamin use variables multiplied by fiber does not have statistically significant evidence to reject the null hypothesis, with both t and f tests.

Chart

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Chart, scatter chart

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Smoking shows to increase one’s cholesterol as well. But people who do not smoke tend to have higher levels of fiber as well. However, the more fiber they have, the more likely they are to have higher cholesterol.

Text

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Once again, fiber is the only significantly significant variable out of the three. However, combined they have a low p-value indicating that a relation between smoking and cholesterol is present as well.

Chart, scatter chart

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This was the most interesting relationship. As females increase their fiber intake, their cholesterol goes down, which is the opposite of men.

Text

Description automatically generated with medium confidence

All variables appear to be statistically significant as well! They have t-values that are high, and low p-values, stating that the null hypothesis of their variables being equal to zero can be rejected.

1. Please write a reflection on your experiences.

Something surprising to me is that being a Male significantly increases your chances of having higher cholesterol with a higher fiber intake, and the complete reverse is the case for Females. This assignment has allowed me to become more familiar with creating linear models, and how sometimes a simple linear model may not explain relationships well, and may in fact hide some in some cases. This is why more complex methods may be necessary to find correlations and causations, as they may not be so clear at first.

1. Extra Credit: Feel free to explore models that have other continuous variables, as well as interactions of categorical variables. The more you do, the more extra credit you can accumulate.