STA 223 Project 2: Wheat Kernel Type Modeling

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Introduction

Biologically, the wheat kernel, also known as the wheat berry, is the seed from which a wheat plant grows

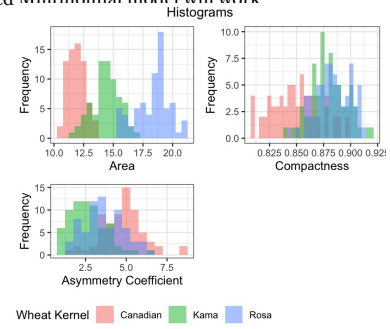
- The main goal of this project is to build a model and find the most significant variables when determining wheat kernel type.

Data Description and Preprocessing

Data: Seed Dataset

This dataset consists of the wheat seed type and the 7 geometric characteristics of the 210 digitized images of soft X-ray technique

- No missing values
- Removed 3 observations
- Response variable: wheat seed type (Kama, Rosa, Canadian)
  - 68 Canadian , 69 Kama , 70 Rosa
- 7 numeric predictors:
  - Length, width, area, perimeter, grove length, compactness,
  - Asymmetry coefficient
- Issue of collinearity between predictors.
  - Kept only area, compactness and asymmetry coefficient.
- Verified Multinomial model will work



- Conditioned on area value of 14.3 and created 2 separate datasets
- Resulted in having two independent logistic regression models.

Methods

Since tumor diagnosis is categorical, we will use logistic regression.

- Linear predictor: $\eta = X\beta$
- Random component: $nY \sim Bin(n, \pi)$
- Link function: $\eta = log\left(\frac{\mu}{1-\mu}\right)$

Before proceeding to model selection, we performed an overall regression test where we test the following:

- $H_o: \beta_p = 0$ versus $H_A: \beta_p \neq 0$ where p denotes the number of coefficients in the model

We proceed to model selection where we choose BIC as our criterion and forwards backwards as our stepwise selection

- BIC(p) = D(p) + p*log(n)

Next, we check for leverage and influential points.

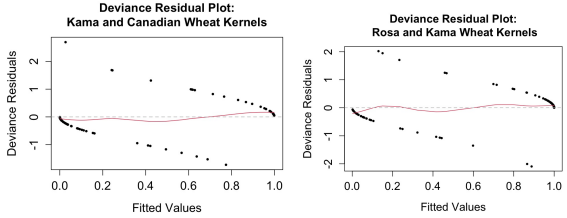
- If $h_{ii} > \frac{2p}{n}$, where n is the sample size, then the observation is a suspected leverage point.
- observations with high Cook's distance are influential points and may need to be deleted.

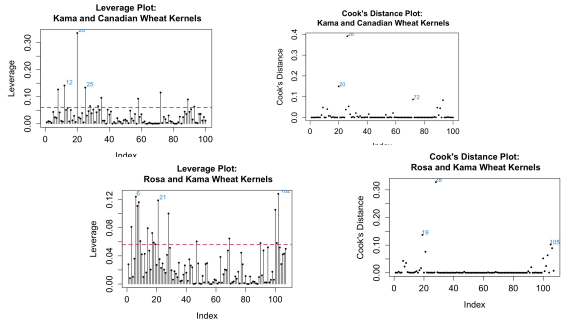
Overall Regression Test & Model Diagnostics

Overall Regression Test:

- Model with only Rosa and Kama wheat seeds
  - $H_o: \beta_{area \leq 14.3} = \beta_{asymmetry\ coefficient} = 0$
  - $H_a: at\ least\ one\ \beta_i \neq 0$
  - we conclude that some predictors have an overall significant effect with type of wheat
- Model with only Kama and Canadian wheat seeds
  - $H_o: \beta_{area > 14.3} = \beta_{asymmetry\ coefficient} = 0$
  - $H_a: at\ least\ one\ \beta_i \neq 0$
  - we conclude that some predictors have an overall significant effect with type of wheat

Model fits the data well and there is no obvious sign of lack of fit





- We found that even after removing these points and performing the same type of analysis as in part A there was no significant difference in our p-values. Thus, there is no need to remove these points

Results

$$ln\left(\frac{P(Y = Kama)}{P(Y = Canadian)}\right)$$

β_i	Estimate	P-value
Intercept	−38.724	1.79×10^{-4}
$Area_{\leq 14.3}$	3.409	9.05×10^{-5}
Asymmetry Coefficient	−1.4124	2.47×10^{-4}

$$ln\left(\frac{P(Y = Rosa)}{P(Y = Kama)}\right)$$

β_i	Estimate	P-value
Intercept	−40.018	7.29×10^{-6}
$Area_{>14.3}$	2.2479	1.94×10^{-5}
Asymmetry Coefficient	1.186	0.00447

- area is the most significant predictor and has a positive effect for both models.
- For small wheat kernels, the more irregular shape it has the more likely it will be Canadian

Acknowledgements

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References

Data:
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Charytanowicz, M. (2018, January 1). *An evaluation of utilizing geometric features for wheat grain classification using X-ray images*. ScienceDirect. https://www.sciencedirect.com/science/article/pii/S0168169917301990?via%3Dihub