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Estimating Miles Per Gallon

When purchasing a car, one might be interested in the car's city-cycle fuel consumption. The dataset in the problem includes the city-cycle fuel consumption in miles per gallon for different cars along with the cars' attributes. The following are the cars' attributes given in the data:

- car_name
- cylinders
- displacement
- horsepower
- weight
- acceleration
- model_year

The **car_name** is not unique to each observation. The **model_year** is the year in which the car was built in the 20th century. For example, if the car was built in 1970, its model_year will be 70. The data includes one more variable, **mpg**, which will be the dependent variable. For this problem, the training and test sets are provided.

Training set: train.csv

Test set: test.csv

Data Source:

Dua, D. and Graff, C. (2019). UCI Machine Learning Repository [http://archive.ics.uci.edu/ml]. Irvine, CA: University of California, School of Information and Computer Science.

Which car name has the least amount of displacement in the training set?
omc gremlin
Odatsun pl510
maxda rx3
o audi fox
O pontiac ventura sj
Chevy c10
In the training set, how many cars have at least eight cylinders?
70 ✓ Answer: 70
70
Note that there are some NA's in the data. Which columns have missing data?

mpg		
cylinders		
displacement		
horsepower		
weight		
acceleration		
model_year		
car_name		
✓		
To deal with the missing values, we will simply remove the observations with the missing values first (there are more sophisticated ways to work with missing values, but for this purpose removing the observations is fine since we do not lose a significant amount of observations). Run the following code:		
train = train[rowSums(is.na(train)) == 0,]		
How many cars are there now in the training set?		
293 ✔ Answer: 293		
293		
Submit You have used 3 of 3 attempts		
Answers are displayed within the problem		

Problem 2.1 - Simple Linear Regression

1.0/3.0 points (graded)

What is the value of mpg that our baseline model predicts?

23.208 **X** Answer: 23.31604

What is the correlation between mpg and weight in the training set?

-0.80 **X** Answer: -0.8025754 -0.80

Choose the most reasonable answer from the following statements:

- Heavier cars are associeted with more miles per gallon, likely because heavier cars are stronger.
- Heavier cars are associeted with less miles per galon, likely because heavier cars are consume more fuel.
- There is no association between a car's mpg and weight.

~

Submit

You have used 2 of 2 attempts

1 Answers are displayed within the problem

Problem 2.2 - Simple Linear Regression (cont'd)

0.0/4.0 points (graded)

Create a linear model that predicts mpg using weight.

What is the coefficient of weight?

-0.00750062

-0.00750062

X Answer: -0.0074467

Load test.csv into a data frame called test and run the following code to remove the single observation with missing horsepower.

test = test[rowSums(is.na(test)) == 0,]

What is the R2 on the test set?

0.7786

X Answer: 0.8069186

0.7786

Submit

You have used 2 of 2 attempts

1 Answers are displayed within the problem

Problem 3 - Adding More Variables

2.0/6.0 points (graded)

As good practice, it is always helpful to first check for multicollinearity before running larger models.

Examine the correlation between the following variables:

cylinders, displacement, horsepower, weight, acceleration, and model_year

Which of the following pairs of variables have correlation with magnitude above 0.8? Select all that apply.

cylinders, displacement		
cylinders, horsepower		
displacement, acceleration		
displacement, model_year		
weight, cylinders		
model_year, weight		
✓		
Create a linear model that predict	ts mpg using the following variables:	
weight, acceleration, and model_y	/ear.	
What is the value of the intercept?		
-0.5700	X Answer: -18.33	
$\begin{bmatrix} -0.5700 \end{bmatrix}$		
What is the R2 on the test set?		
0.79948	X Answer: 0.8844633	
0.79948		
Submit You have used 2 of 2 attempts		
Answers are displayed within the problem		
Problem 4 - Interpreting	Linear Regression	

at a level of 0.001 (p-value below 0.001)? Select all that apply.	
weight	
acceleration	
✓ model_year	
✓	
Using the model from Problem 3, how would you interpret the coefficient of model_year?	
All else being equal, a car older by one year is associated with a 0.7748 increase in mpg.	
All else being equal, a car older by one year is associated with a 0.7748 decrease in mpg.	
✓	
Using the simple model from Problem 2, if the weight of the car is 1000 kg (the units of weight are also in kg), what is the mpg prediction of the simple model?	
7.4467	
o 52.8092	
-52.8092	
○ 37.9158 ✔	
×	
Submit You have used 2 of 2 attempts	

Using the model from Problem 3, which of the following variables are significant

2.0/3.0 points (graded)

1 Answers are displayed within the problem

Problem 5 - CART and Random Forest

2/10 points (graded)

In addition to the linear regression model, we can also train a regression tree. Use the same variable as used in the simple model, weight. Train a regression tree with cp = 0.05.

Looking at the plot of the tree, how many different predicted values are there?



What is the R2 of this model on the test set?



The out-of-sample R2 does not appear to be as good under regression trees, compared to a linear regression model. We could potentially improve it via cross validation.

If running R 3.6.0, run the command:

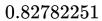
RNGversion("3.5.3")

Set the seed to 10, run a 10-fold cross-validated cart model, with cp ranging from 0.001 to 0.1 in increments of 0.01. What is the optimal cp value on this grid?



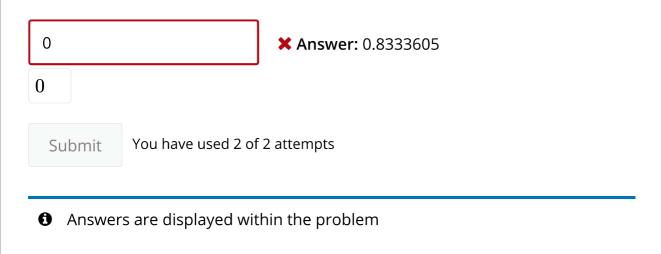
What is the R2 of this new model on the test set?

0.82782251 **✓ Answer:** 0.8229011



Create a random forest model that predicts mpg using the same variable as the CART model, with nodesize = 75 and ntree = 15. Set the random seed to 1.

What is the R2 of this new model on the test set?



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