Data Wrangling

Estimated time needed: **30** minutes

Objectives

After completing this lab you will be able to:

- Handle missing values
- Correct data formatting
- Standardize and normalize data

Table of Contents

What is the purpose of data wrangling?

You use data wrangling to convert data from an initial format to a format that may be better for analysis.

What is the fuel consumption (L/100k) rate for the diesel car?

Import data

You can find the "Automobile Dataset" from the following link: https://archive.ics.uci.edu/ml/machine-learning-databases/autos/imports-85.data. You will be using this data set throughout this course.

Import pandas

In [ ]:
```
#install specific version of libraries used in lab
#! mamba install pandas==1.3.3
#! mamba install numpy=1.21.2
```

In [ ]:
```
import pandas as pd
import matplotlib.pylab as plt
```

Reading the dataset from the URL and adding the related headers

The functions below will download the dataset into your browser:

In [2]:
```
from pyodide.http import pyfetch

async def download(url, filename):
    response = await pyfetch(url)
    if response.status == 200:
        with open(filename, "wb") as f:
            f.write(await response.bytes())
```

First, assign the URL of the data set to "filepath".

In [3]:
```
file_path="https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/IBMDeveloperSkillsNetwork-DA0101EN-SkillsNetwork/labs/Data%2
```

To obtain the dataset, utilize the download() function as defined above:

In [4]:
```
await download(file_path, "usedcars.csv")
file_name="usedcars.csv"
```

Then, create a Python list **headers** containing name of headers.

In [5]:
```
headers = ["symboling","normalized-losses","make","fuel-type","aspiration", "num-of-doors","body-style",
         "drive-wheels","engine-location","wheel-base", "length","width","height","curb-weight","engine-type",
         "num-of-cylinders", "engine-size","fuel-system","bore","stroke","compression-ratio","horsepower",
         "peak-rpm","city-mpg","highway-mpg","price"]
```

Use the Pandas method **read_csv()** to load the data from the web address. Set the parameter "names" equal to the Python list "headers".

In [7]:
```
df = pd.read_csv(file_name, names = headers)
```

> Note: This version of the lab is working on JupyterLite, which requires the dataset to be downloaded to the interface.While working on the downloaded version of this notebook on their local machines(Jupyter Anaconda), the learners can simply **skip the steps above,** and simply use the URL directly in the `pandas.read_csv()` function. You can uncomment and run the statements in the cell below.

In [ ]:
```
#filepath = "https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/IBMDeveloperSkillsNetwork-DA0101EN-SkillsNetwork/labs/Data
#df = pd.read_csv(filepath, header=headers)    # Utilize the same header list defined above
```

Use the method **head()** to display the first five rows of the dataframe.

In [8]:
```
# To see what the data set looks like, we'll use the head() method.
df.head()
```

Out[8]:

	symboling	normalized-losses	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	...	engine-size	fuel-system	bore	stroke	compression-ratio	l
0	3	?	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	130	mpfi	3.47	2.68	9.0	
1	3	?	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	130	mpfi	3.47	2.68	9.0	
2	1	?	alfa-romero	gas	std	two	hatchback	rwd	front	94.5	...	152	mpfi	2.68	3.47	9.0	
3	2	164	audi	gas	std	four	sedan	fwd	front	99.8	...	109	mpfi	3.19	3.40	10.0	
4	2	164	audi	gas	std	four	sedan	4wd	front	99.4	...	136	mpfi	3.19	3.40	8.0	

5 rows × 26 columns

As you can see, several question marks appeared in the data frame; those missing values may hinder further analysis.

So, how do we identify all those missing values and deal with them?
How to work with missing data?

Steps for working with missing data:

1. Identify missing data
2. Deal with missing data
3. Correct data format

Identify and handle missing values

Identify missing values

Convert "?" to NaN

In the car data set, missing data comes with the question mark "?". We replace "?" with NaN (Not a Number), Python's default missing value marker for reasons of computational speed and convenience. Use the function:

```
DataFrame.replace(A, B, inplace = True)
```

to replace A by B.

In [10]:
```
import numpy as np

# replace "?" to NaN
df.replace("?", np.nan, inplace = True)
```

```
df.head(5)
```

Out[10]:

	symboling	normalized-losses	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	...	engine-size	fuel-system	bore	stroke	compression-ratio	I
0	3	NaN	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	130	mpfi	3.47	2.68	9.0	
1	3	NaN	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	130	mpfi	3.47	2.68	9.0	
2	1	NaN	alfa-romero	gas	std	two	hatchback	rwd	front	94.5	...	152	mpfi	2.68	3.47	9.0	
3	2	164	audi	gas	std	four	sedan	fwd	front	99.8	...	109	mpfi	3.19	3.40	10.0	
4	2	164	audi	gas	std	four	sedan	4wd	front	99.4	...	136	mpfi	3.19	3.40	8.0	

5 rows × 26 columns

Evaluating for Missing Data

The missing values are converted by default. Use the following functions to identify these missing values. You can use two methods to detect missing data:

1. **.isnull()**
2. **.notnull()**

The output is a boolean value indicating whether the value that is passed into the argument is in fact missing data.

In [11]:
```
missing_data = df.isnull()
missing_data.head(5)
```

Out[11]:

	symboling	normalized-losses	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	...	engine-size	fuel-system	bore	stroke	compression-ratio	horsep
0	False	True	False	False	False	False	False	False	False	False	...	False	False	False	False	False	
1	False	True	False	False	False	False	False	False	False	False	...	False	False	False	False	False	
2	False	True	False	False	False	False	False	False	False	False	...	False	False	False	False	False	
3	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	
4	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	

5 rows × 26 columns

"True" means the value is a missing value while "False" means the value is not a missing value.

Count missing values in each column

Using a for loop in Python, you can quickly figure out the number of missing values in each column. As mentioned above, "True" represents a missing value and "False" means the value is present in the data set. In the body of the for loop the method ".value_counts()" counts the number of "True" values.

In [13]:
```
for column in missing_data.columns.values.tolist():
    print (missing_data[column].value_counts())
    print("")
```

```
symboling
False    205
Name: count, dtype: int64

normalized-losses
False    164
True      41
Name: count, dtype: int64

make
False    205
Name: count, dtype: int64

fuel-type
False    205
Name: count, dtype: int64

aspiration
False    205
Name: count, dtype: int64

num-of-doors
False    203
True       2
Name: count, dtype: int64

body-style
False    205
Name: count, dtype: int64

drive-wheels
False    205
Name: count, dtype: int64

engine-location
False    205
Name: count, dtype: int64

wheel-base
False    205
Name: count, dtype: int64

length
False    205
Name: count, dtype: int64

width
False    205
Name: count, dtype: int64

height
False    205
Name: count, dtype: int64

curb-weight
False    205
Name: count, dtype: int64

engine-type
False    205
Name: count, dtype: int64

num-of-cylinders
False    205
Name: count, dtype: int64

engine-size
False    205
Name: count, dtype: int64

fuel-system
False    205
Name: count, dtype: int64

bore
False    201
True       4
Name: count, dtype: int64

stroke
False    201
True       4
Name: count, dtype: int64

compression-ratio
False    205
```

```
Name: count, dtype: int64

horsepower
False    203
True       2
Name: count, dtype: int64

peak-rpm
False    203
True       2
Name: count, dtype: int64

city-mpg
False    205
Name: count, dtype: int64

highway-mpg
False    205
Name: count, dtype: int64

price
False    201
True       4
Name: count, dtype: int64
```

Based on the summary above, each column has 205 rows of data and seven of the columns containing missing data:

1. "normalized-losses": 41 missing data
2. "num-of-doors": 2 missing data
3. "bore": 4 missing data
4. "stroke" : 4 missing data
5. "horsepower": 2 missing data
6. "peak-rpm": 2 missing data
7. "price": 4 missing data

Deal with missing data

How should you deal with missing data?

1. Drop data
   a. Drop the whole row
   b. Drop the whole column
2. Replace data
   a. Replace it by mean
   b. Replace it by frequency
   c. Replace it based on other functions

You should only drop whole columns if most entries in the column are empty. In the data set, none of the columns are empty enough to drop entirely. You have some freedom in choosing which method to replace data; however, some methods may seem more reasonable than others. Apply each method to different columns:

Replace by mean:

- "normalized-losses": 41 missing data, replace them with mean
- "stroke": 4 missing data, replace them with mean
- "bore": 4 missing data, replace them with mean
- "horsepower": 2 missing data, replace them with mean
- "peak-rpm": 2 missing data, replace them with mean

Replace by frequency:

- "num-of-doors": 2 missing data, replace them with "four".
  - Reason: 84% sedans are four doors. Since four doors is most frequent, it is most likely to occur

Drop the whole row:

- "price": 4 missing data, simply delete the whole row
  - Reason: You want to predict price. You cannot use any data entry without price data for prediction; therefore any row now without price data is not useful to you.

Calculate the mean value for the "normalized-losses" column

In [14]:
```
avg_norm_loss = df["normalized-losses"].astype("float").mean(axis=0)
print("Average of normalized-losses:", avg_norm_loss)
```

```
Average of normalized-losses: 122.0
```

Replace "NaN" with mean value in "normalized-losses" column

In [ ]:
```
df["normalized-losses"].replace(np.nan, avg_norm_loss, inplace=True)
```

Calculate the mean value for the "bore" column

In [16]:
```
avg_bore=df['bore'].astype('float').mean(axis=0)
print("Average of bore:", avg_bore)
```

```
Average of bore: 3.3297512437810943
```

Replace "NaN" with the mean value in the "bore" column

In [ ]:
```
df["bore"].replace(np.nan, avg_bore, inplace=True)
```

Question #1:

Based on the example above, replace NaN in "stroke" column with the mean value.

In [ ]:
```
# Write your code below and press Shift+Enter to execute
df["stroke"].replace(np.nan,df["stroke"].astype('float').mean(axis=0),inplace=True)
```

▸ Click here for the solution

Calculate the mean value for the "horsepower" column

In [21]:
```
avg_horsepower = df['horsepower'].astype('float').mean(axis=0)
print("Average horsepower:", avg_horsepower)
```

```
Average horsepower: 104.25615763546799
```

Replace "NaN" with the mean value in the "horsepower" column

In [ ]:
```
df['horsepower'].replace(np.nan, avg_horsepower, inplace=True)
```

Calculate the mean value for "peak-rpm" column

In [23]:
```
avg_peakrpm=df['peak-rpm'].astype('float').mean(axis=0)
print("Average peak rpm:", avg_peakrpm)
```

```
Average peak rpm: 5125.369458128079
```

Replace "NaN" with the mean value in the "peak-rpm" column

In [ ]:
```
df['peak-rpm'].replace(np.nan, avg_peakrpm, inplace=True)
```

To see which values are present in a particular column, we can use the ".value_counts()" method:

In [25]:
```
df['num-of-doors'].value_counts()
```

Out[25]:
```
num-of-doors
four    114
two      89
Name: count, dtype: int64
```

You can see that four doors is the most common type. We can also use the ".idxmax()" method to calculate the most common type automatically:

In [26]:
```
df['num-of-doors'].value_counts().idxmax()
```

Out[26]:
```
'four'
```

The replacement procedure is very similar to what you have seen previously:

In [ ]:
```
#replace the missing 'num-of-doors' values by the most frequent
df["num-of-doors"].replace(np.nan, "four", inplace=True)
```

Finally, drop all rows that do not have price data:

In [28]:
```
# simply drop whole row with NaN in "price" column
df.dropna(subset=["price"], axis=0, inplace=True)

# reset index, because we droped two rows
df.reset_index(drop=True, inplace=True)
```

In [29]:
```
df.head()
```

Out[29]:

	symboling	normalized-losses	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	...	engine-size	fuel-system	bore	stroke	compression-ratio	I
0	3	122.0	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	130	mpfi	3.47	2.68	9.0	
1	3	122.0	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	130	mpfi	3.47	2.68	9.0	
2	1	122.0	alfa-romero	gas	std	two	hatchback	rwd	front	94.5	...	152	mpfi	2.68	3.47	9.0	
3	2	164	audi	gas	std	four	sedan	fwd	front	99.8	...	109	mpfi	3.19	3.40	10.0	
4	2	164	audi	gas	std	four	sedan	4wd	front	99.4	...	136	mpfi	3.19	3.40	8.0	

5 rows × 26 columns

Good! Now, you have a data set with no missing values.

Correct data format

We are almost there!

The last step in data cleaning is checking and making sure that all data is in the correct format (int, float, text or other).

In Pandas, you use:

.dtype() to check the data type

.astype() to change the data type

Let's list the data types for each column

In [30]:
```
df.dtypes
```

Out[30]:
```
symboling              int64
normalized-losses     object
make                  object
fuel-type             object
aspiration            object
num-of-doors          object
body-style            object
drive-wheels          object
engine-location       object
wheel-base           float64
length               float64
width                float64
height               float64
curb-weight            int64
engine-type           object
num-of-cylinders      object
engine-size            int64
fuel-system           object
bore                  object
stroke                object
compression-ratio    float64
horsepower            object
peak-rpm              object
city-mpg               int64
highway-mpg            int64
price                 object
dtype: object
```

As you can see above, some columns are not of the correct data type. Numerical variables should have type 'float' or 'int', and variables with strings such as categories should have type 'object'. For example, the numerical values 'bore' and 'stroke' describe the engines, so you should expect them to be of the type 'float' or 'int'; however, they are shown as type 'object'. You have to convert data types into a proper format for each column using the "astype()" method.

Convert data types to proper format

In [31]:
```
df[["bore", "stroke"]] = df[["bore", "stroke"]].astype("float")
df[["normalized-losses"]] = df[["normalized-losses"]].astype("int")
df[["price"]] = df[["price"]].astype("float")
df[["peak-rpm"]] = df[["peak-rpm"]].astype("float")
```

Let us list the columns after the conversion

In [32]:
```
df.dtypes
```

Out[32]:
```
symboling              int64
normalized-losses      int32
make                  object
fuel-type             object
aspiration            object
num-of-doors          object
body-style            object
drive-wheels          object
engine-location       object
wheel-base           float64
length               float64
width                float64
height               float64
curb-weight            int64
engine-type           object
num-of-cylinders      object
engine-size            int64
fuel-system           object
bore                 float64
stroke               float64
compression-ratio    float64
horsepower            object
peak-rpm             float64
city-mpg               int64
highway-mpg            int64
price                float64
dtype: object
```

Wonderful!

Now you finally obtained the cleansed data set with no missing values and with all data in its proper format.

Data Standardization

You usually collect data from different agencies in different formats. (Data standardization is also a term for a particular type of data normalization where you subtract the mean and divide by the standard deviation.)

What is standardization?

Standardization is the process of transforming data into a common format, allowing the researcher to make the meaningful comparison.

Example

Transform mpg to L/100km:

In your data set, the fuel consumption columns "city-mpg" and "highway-mpg" are represented by mpg (miles per gallon) unit. Assume you are developing an application in a country that accepts the fuel consumption with L/100km standard.

You will need to apply **data transformation** to transform mpg into L/100km.

Use this formula for unit conversion:

L/100km = 235 / mpg

You can do many mathematical operations directly using Pandas.

In [33]:
```
df.head()
```

Out[33]:

	symboling	normalized-losses	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	...	engine-size	fuel-system	bore	stroke	compression-ratio
0	3	122	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	130	mpfi	3.47	2.68	9.0
1	3	122	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	130	mpfi	3.47	2.68	9.0
2	1	122	alfa-romero	gas	std	two	hatchback	rwd	front	94.5	...	152	mpfi	2.68	3.47	9.0
3	2	164	audi	gas	std	four	sedan	fwd	front	99.8	...	109	mpfi	3.19	3.40	10.0
4	2	164	audi	gas	std	four	sedan	4wd	front	99.4	...	136	mpfi	3.19	3.40	8.0

5 rows × 26 columns

In [34]:
```
# Convert mpg to L/100km by mathematical operation (235 divided by mpg)
df['city-L/100km'] = 235/df["city-mpg"]
```

```
# check your transformed data
df.head()
```

Out[34]:

	symboling	normalized-losses	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	...	fuel-system	bore	stroke	compression-ratio	horsepow
0	3	122	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	mpfi	3.47	2.68	9.0	11
1	3	122	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	mpfi	3.47	2.68	9.0	11
2	1	122	alfa-romero	gas	std	two	hatchback	rwd	front	94.5	...	mpfi	2.68	3.47	9.0	15
3	2	164	audi	gas	std	four	sedan	fwd	front	99.8	...	mpfi	3.19	3.40	10.0	10
4	2	164	audi	gas	std	four	sedan	4wd	front	99.4	...	mpfi	3.19	3.40	8.0	11

5 rows × 27 columns

Question #2:

According to the example above, transform mpg to L/100km in the column of "highway-mpg" and change the name of column to "highway-L/100km".

In [35]:

```
# Write your code below and press Shift+Enter to execute
df['highway-mpg'] = 235/df['highway-mpg']
df.rename(columns={"highway-mpg":"highway-L/100km"},inplace=True)
```

▸ Click here for the solution

Data Normalization

Why normalization?

Normalization is the process of transforming values of several variables into a similar range. Typical normalizations include

1. scaling the variable so the variable average is 0
2. scaling the variable so the variance is 1
3. scaling the variable so the variable values range from 0 to 1

Example

To demonstrate normalization, say you want to scale the columns "length", "width" and "height".

Target: normalize those variables so their value ranges from 0 to 1

Approach: replace the original value by (original value)/(maximum value)

In [37]:

```
# replace (original value) by (original value)/(maximum value)
df['length'] = df['length']/df['length'].max()
df['width'] = df['width']/df['width'].max()
```

Question #3:

According to the example above, normalize the column "height".

In [38]:

```
# Write your code below and press Shift+Enter to execute
df["height"] = df["height"]/ df["height"].max()
df.head(2)
```

Out[38]:

	symboling	normalized-losses	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	...	fuel-system	bore	stroke	compression-ratio	horsepow
0	3	122	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	mpfi	3.47	2.68	9.0	11
1	3	122	alfa-romero	gas	std	two	convertible	rwd	front	88.6	...	mpfi	3.47	2.68	9.0	11

2 rows × 27 columns

▸ Click here for the solution

Here you've normalized "length", "width" and "height" to fall in the range of [0,1].

Binning

Why binning?

Binning is a process of transforming continuous numerical variables into discrete categorical 'bins' for grouped analysis.

Example:

In your data set, "horsepower" is a real valued variable ranging from 48 to 288 and it has 59 unique values. What if you only care about the price difference between cars with high horsepower, medium horsepower, and little horsepower (3 types)? You can rearrange them into three 'bins' to simplify analysis.

Use the Pandas method 'cut' to segment the 'horsepower' column into 3 bins.

Example of Binning Data In Pandas

Convert data to correct format:

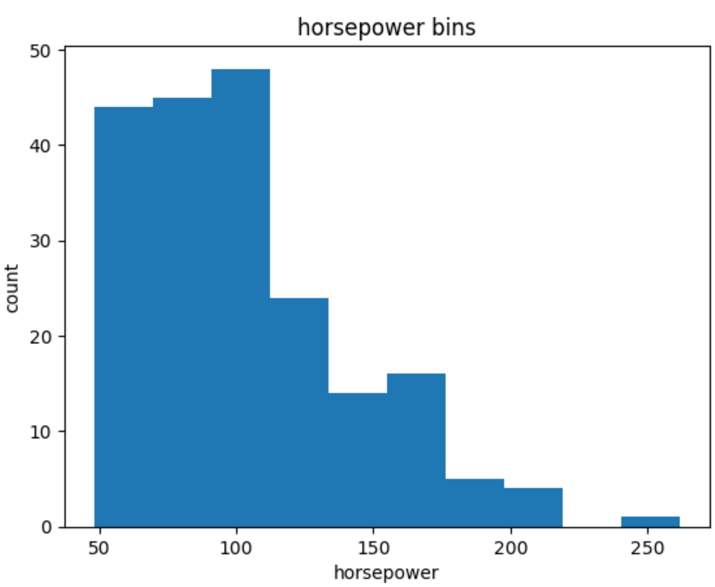
In [39]:
```
df["horsepower"]=df["horsepower"].astype(int, copy=True)
```

Plot the histogram of horsepower to see the distribution of horsepower.

In [40]:
```
%matplotlib inline
import matplotlib as plt
from matplotlib import pyplot
plt.pyplot.hist(df["horsepower"])

# set x/y labels and plot title
plt.pyplot.xlabel("horsepower")
plt.pyplot.ylabel("count")
plt.pyplot.title("horsepower bins")
```

Out[40]:
```
Text(0.5, 1.0, 'horsepower bins')
```



Find 3 bins of equal size bandwidth by using Numpy's `linspace(start_value, end_value, numbers_generated` function.

Since you want to include the minimum value of horsepower, set start_value = min(df["horsepower"]).

Since you want to include the maximum value of horsepower, set end_value = max(df["horsepower"]).

Since you are building 3 bins of equal length, you need 4 dividers, so numbers_generated = 4.

Build a bin array with a minimum value to a maximum value by using the bandwidth calculated above. The values will determine when one bin ends and another begins.

In [41]:
```
bins = np.linspace(min(df["horsepower"]), max(df["horsepower"]), 4)
bins
```

Out[41]:
```
array([ 48.        , 119.33333333, 190.66666667, 262.        ])
```

Set group names:

In [42]:
```
group_names = ['Low', 'Medium', 'High']
```

Apply the function "cut" to determine what each value of `df['horsepower']` belongs to.

In [43]:
```
df['horsepower-binned'] = pd.cut(df['horsepower'], bins, labels=group_names, include_lowest=True )
df[['horsepower','horsepower-binned']].head(20)
```

Out[43]:

	horsepower	horsepower-binned
0	111	Low
1	111	Low
2	154	Medium
3	102	Low
4	115	Low
5	110	Low
6	110	Low
7	110	Low
8	140	Medium
9	101	Low
10	101	Low
11	121	Medium
12	121	Medium
13	121	Medium
14	182	Medium
15	182	Medium
16	182	Medium
17	48	Low
18	70	Low
19	70	Low

See the number of vehicles in each bin:

In [44]:
```
df["horsepower-binned"].value_counts()
```

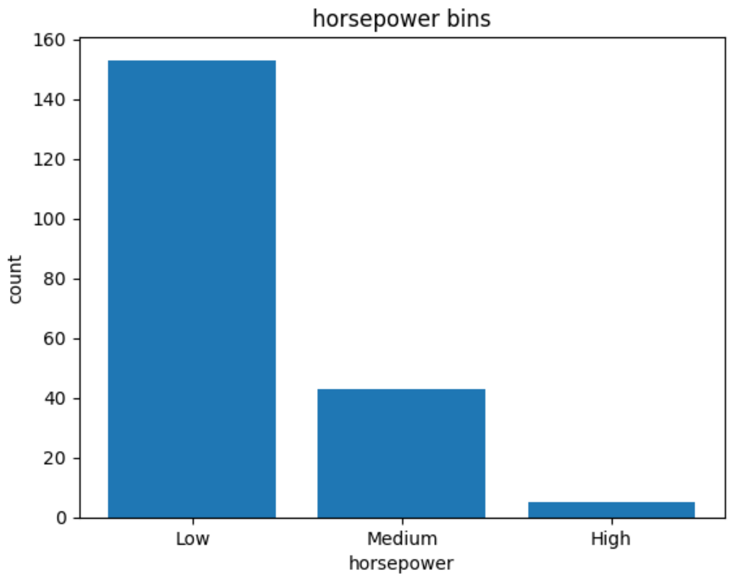
Out[44]:
```
horsepower-binned
Low       153
Medium     43
High        5
Name: count, dtype: int64
```

Plot the distribution of each bin:

In [45]:
```
%matplotlib inline
import matplotlib as plt
from matplotlib import pyplot
pyplot.bar(group_names, df["horsepower-binned"].value_counts())

# set x/y labels and plot title
plt.pyplot.xlabel("horsepower")
plt.pyplot.ylabel("count")
plt.pyplot.title("horsepower bins")
```

Out[45]:
```
Text(0.5, 1.0, 'horsepower bins')
```



Look at the data frame above carefully. You will find that the last column provides the bins for "horsepower" based on 3 categories ("Low", "Medium" and "High").

You successfully narrowed down the intervals from 59 to 3!

Bins Visualization

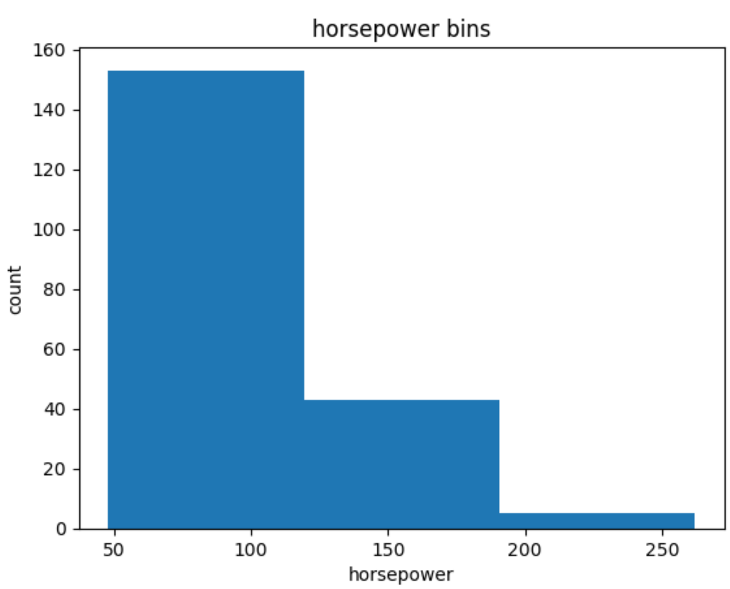
Normally, you use a histogram to visualize the distribution of bins we created above.

In [46]:
```
%matplotlib inline
import matplotlib as plt
from matplotlib import pyplot


# draw historgram of attribute "horsepower" with bins = 3
plt.pyplot.hist(df["horsepower"], bins = 3)

# set x/y labels and plot title
plt.pyplot.xlabel("horsepower")
plt.pyplot.ylabel("count")
plt.pyplot.title("horsepower bins")
```

Out[46]:
```
Text(0.5, 1.0, 'horsepower bins')
```



The plot above shows the binning result for the attribute "horsepower".

Indicator Variable

What is an indicator variable?

An indicator variable (or dummy variable) is a numerical variable used to label categories. They are called 'dummies' because the numbers themselves don't have inherent meaning.

Why use indicator variables?

You use indicator variables so you can use categorical variables for regression analysis in the later modules.

Example

The column "fuel-type" has two unique values: "gas" or "diesel". Regression doesn't understand words, only numbers. To use this attribute in regression analysis, you can convert "fuel-type" to indicator variables.

Use the Panda method 'get_dummies' to assign numerical values to different categories of fuel type.

In [47]:
```
df.columns
```

Out[47]:
```
Index(['symboling', 'normalized-losses', 'make', 'fuel-type', 'aspiration',
       'num-of-doors', 'body-style', 'drive-wheels', 'engine-location',
       'wheel-base', 'length', 'width', 'height', 'curb-weight', 'engine-type',
       'num-of-cylinders', 'engine-size', 'fuel-system', 'bore', 'stroke',
       'compression-ratio', 'horsepower', 'peak-rpm', 'city-mpg',
       'highway-L/100km', 'price', 'city-L/100km', 'horsepower-binned'],
      dtype='object')
```

Get the indicator variables and assign it to data frame "dummy_variable_1":

In [48]:
```
dummy_variable_1 = pd.get_dummies(df["fuel-type"])
dummy_variable_1.head()
```

Out[48]:

	diesel	gas
0	False	True
1	False	True
2	False	True
3	False	True
4	False	True

Change the column names for clarity:

In [49]:
```
dummy_variable_1.rename(columns={'gas':'fuel-type-gas', 'diesel':'fuel-type-diesel'}, inplace=True)
dummy_variable_1.head()
```

Out[49]:

	fuel-type-diesel	fuel-type-gas
0	False	True
1	False	True
2	False	True
3	False	True
4	False	True

In the data frame, column 'fuel-type' now has values for 'gas' and 'diesel' as 0s and 1s.

In [50]:
```
# merge data frame "df" and "dummy_variable_1"
df = pd.concat([df, dummy_variable_1], axis=1)

# drop original column "fuel-type" from "df"
df.drop("fuel-type", axis = 1, inplace=True)
```

In [51]:
```
df.head()
```

Out[51]:

	symboling	normalized-losses	make	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	length	...	compression-ratio	horsepower	peak-rpm	city-mpg	h L
0	3	122	alfa-romero	std	two	convertible	rwd	front	88.6	0.811148	...	9.0	111	5000.0	21	8
1	3	122	alfa-romero	std	two	convertible	rwd	front	88.6	0.811148	...	9.0	111	5000.0	21	8
2	1	122	alfa-romero	std	two	hatchback	rwd	front	94.5	0.822681	...	9.0	154	5000.0	19	9
3	2	164	audi	std	four	sedan	fwd	front	99.8	0.848630	...	10.0	102	5500.0	24	7
4	2	164	audi	std	four	sedan	4wd	front	99.4	0.848630	...	8.0	115	5500.0	18	10

5 rows × 29 columns

The last two columns are now the indicator variable representation of the fuel-type variable. They're all 0s and 1s now.

Question #4:

Similar to before, create an indicator variable for the column "aspiration"

In [55]:

```
# Write your code below and press Shift+Enter to execute
aspiration_dummies = pd.get_dummies(df["aspiration"])
aspiration_dummies.rename(columns={'std':'aspiration-std', 'turbo':'aspiration-turbo'}, inplace=True)
```

Out[55]:

	symboling	normalized-losses	make	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	length	width	...	peak-rpm	city-mpg	highway-L/100km	price	city-L/100km
0	3	122	alfa-romero	two	convertible	rwd	front	88.6	0.811148	0.890278	...	5000.0	21	8.703704	13495.0	11.190476
1	3	122	alfa-romero	two	convertible	rwd	front	88.6	0.811148	0.890278	...	5000.0	21	8.703704	16500.0	11.190476
2	1	122	alfa-romero	two	hatchback	rwd	front	94.5	0.822681	0.909722	...	5000.0	19	9.038462	16500.0	12.368421
3	2	164	audi	four	sedan	fwd	front	99.8	0.848630	0.919444	...	5500.0	24	7.833333	13950.0	9.791667
4	2	164	audi	four	sedan	4wd	front	99.4	0.848630	0.922222	...	5500.0	18	10.681818	17450.0	13.055556

5 rows × 30 columns

▸ Click here for the solution

Question #5:

Merge the new dataframe to the original dataframe, then drop the column 'aspiration'.

In [ ]:

```
# Write your code below and press Shift+Enter to execute
df = pd.concat([df, aspiration_dummies], axis=1)
df.drop("aspiration", axis = 1, inplace=True)
```

In [56]:

```
df.head()
```

Out[56]:

	symboling	normalized-losses	make	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	length	width	...	peak-rpm	city-mpg	highway-L/100km	price	city-L/100km
0	3	122	alfa-romero	two	convertible	rwd	front	88.6	0.811148	0.890278	...	5000.0	21	8.703704	13495.0	11.190476
1	3	122	alfa-romero	two	convertible	rwd	front	88.6	0.811148	0.890278	...	5000.0	21	8.703704	16500.0	11.190476
2	1	122	alfa-romero	two	hatchback	rwd	front	94.5	0.822681	0.909722	...	5000.0	19	9.038462	16500.0	12.368421
3	2	164	audi	four	sedan	fwd	front	99.8	0.848630	0.919444	...	5500.0	24	7.833333	13950.0	9.791667
4	2	164	audi	four	sedan	4wd	front	99.4	0.848630	0.922222	...	5500.0	18	10.681818	17450.0	13.055556

5 rows × 30 columns

▸ Click here for the solution

Save the new csv:

In [57]:
```
df.to_csv('clean_df.csv')
```

Thank you for completing this lab!

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<!-- ## Change Log | Date (YYYY-MM-DD) | Version | Changed By | Change Description | |---|---|---|---| | 2023-09-28 | 2.3| Abhishek Gagneja| Instructional Update | | 2020-10-30 | 2.2 | Lakshmi | Changed URL of csv | | 2020-09-09 | 2.1 | Lakshmi | Updated Indicator Variables section | | 2020-08-27 | 2.0 | Lavanya | Moved lab to course repo in GitLab | --!>