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Correlation:

Hypothesis testing & Graphic Methods

Session 9

Programación Estadística con Python

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MASTER EN DATA ANALYTICS PARA LA EMPRESA

Goals (class session + extra topics)

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- Hypothesis testing over the relatioship of two quantitative variables.
  - Numeric methods:
    - Pearson's r linear correlation coefficient +
    - Significante tests +
    - Kendall's Tau-b / Spearmann Rho (for ordinal variables) (To be developed)
  - Graphic methods:
    - Scatterplots

Correlation

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1. **Describe** the two variables involved in the hypothesis separately. Check and validate the integrity of the data prior to any analysis.
2. **Graphic representation** of bivariate relation: **Scatterplot**
3. **Numeric representation** of bivariate relation: **Pearson's r**
4. **Inference test: p.values.**
5. **When posible, combine:**
   - Scatterplot +
   - Pearson's r +
   - Inference test

Research Question

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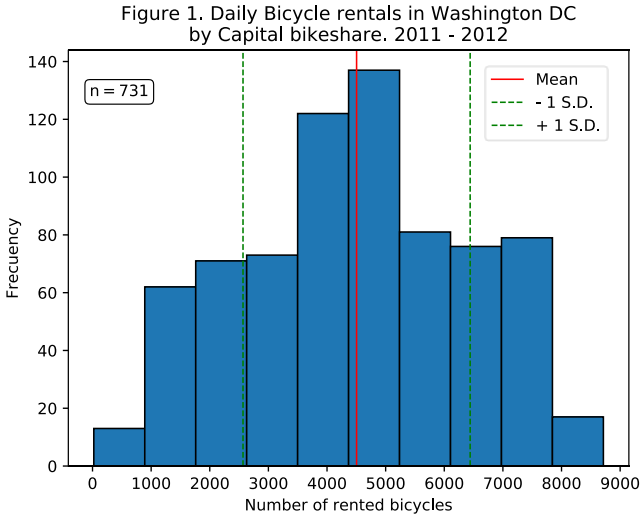
Why some days are rent *more* bikes?

- Temperature ?



- H0.: There is no linear association ($r=0$) between the *number of rentals* and the *temperature*.

- H1.: There is a linear association ($r\neq0$) between the *number of rentals* and the *temperature*.

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Describing quantitative variables

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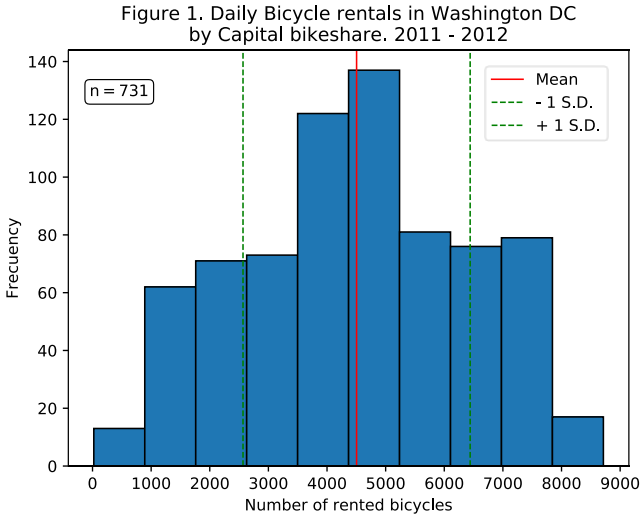
```
x=wbr['cnt']
plt.hist(x, bins=10,
edgecolor='black')
plt.xticks(np.arange(0, 10000,
step=1000))
plt.title('Figure 4. Daily Bicycle
rentals in Washington DC'
          '\n'
          'by Capital bikeshare.
2011 - 2012')
plt.ylabel('Frecuency')
plt.xlabel('Number of rented
bicycles')
```




```
props = dict(boxstyle='round',
facecolor='white', lw=0.5)
textstr = '$\mathrm{n}=%.0f$'%(n)
plt.text (-50,128, textstr ,
bbox=props)
```

Describing quantitative variables

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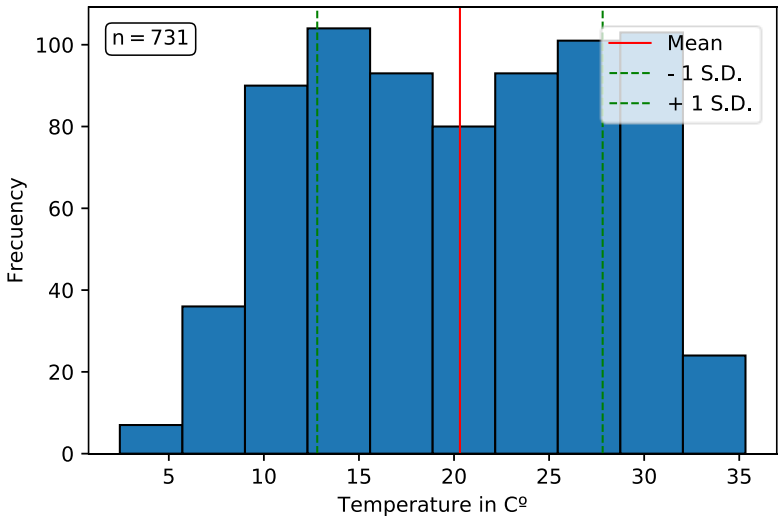
```
##histogram ver4
x=wbr['temp_celsius']
plt.hist(x, bins=10,
edgecolor='black')
#plt.xticks(np.arange(0, 10000,
step=1000))
plt.title('Figure 5. Temperature in
Celsius'
          '\n')
plt.ylabel('Frecuency')
plt.xlabel('Temperature in C°')
props = dict(boxstyle='round',
facecolor='white', lw=0.5)
textstr = '$\mathrm{n}=%.0f$'%(n)
plt.text (2,100, textstr ,
bbox=props)
```

Figure 5. Temperature in Celsius



Correlation

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1. Describe the two variables involved in hypothesis

Temperature

Rentals

Figure 5. Temperature in Celsius

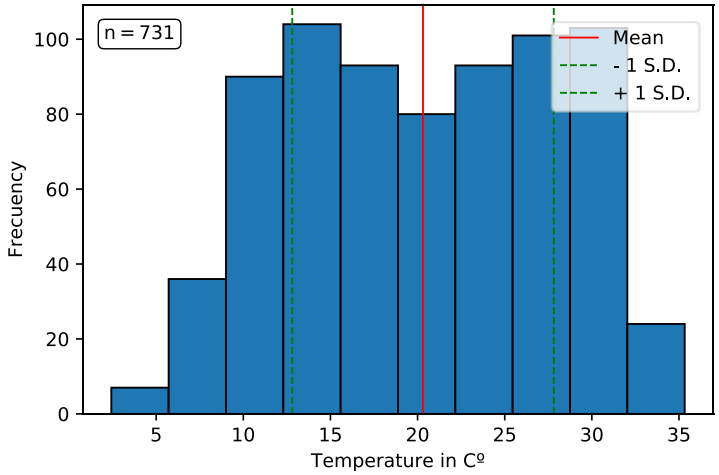
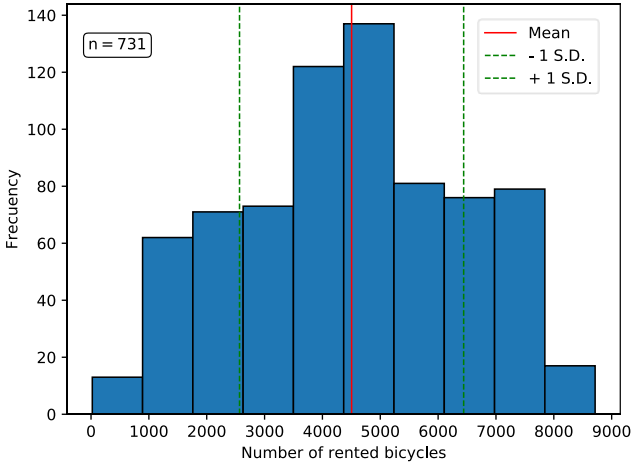


Figure 1. Daily Bicycle rentals in Washington DC by Capital bikeshare. 2011 - 2012



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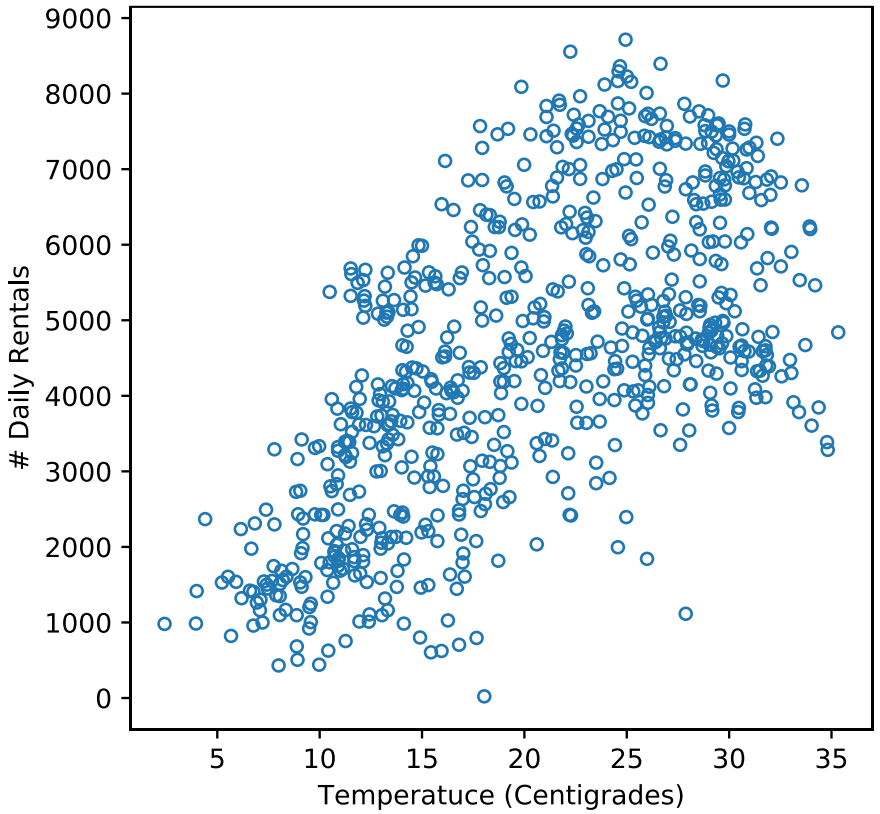
2. Scatterplot

```
x=wbr.temp_Celsius
y=wbr.cnt
plt.scatter (x,y)
```

Figure 9. Daily bicycle rentals, by temperature.



Correlation

3. Pearson's r

```
from scipy.stats.stats import pearsonr
res = pearsonr(x, y)
print (res)

[1] (0.6274940090334919 5, 2.8106223975901415e-81)
```

This is
Perason's r

This is
The P.Value

#correlation

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```
#correlation
from scipy.stats.stats import pearsonr
x=wbr.temp_celsius # Select the variable to plot
y=wbr.cnt # Select the variable to plot
res = pearsonr(x, y)
r  = res[0]
p_val  = res[1]
n = len (wbr.cnt)
```

Scatterplot + Pearson's r + test

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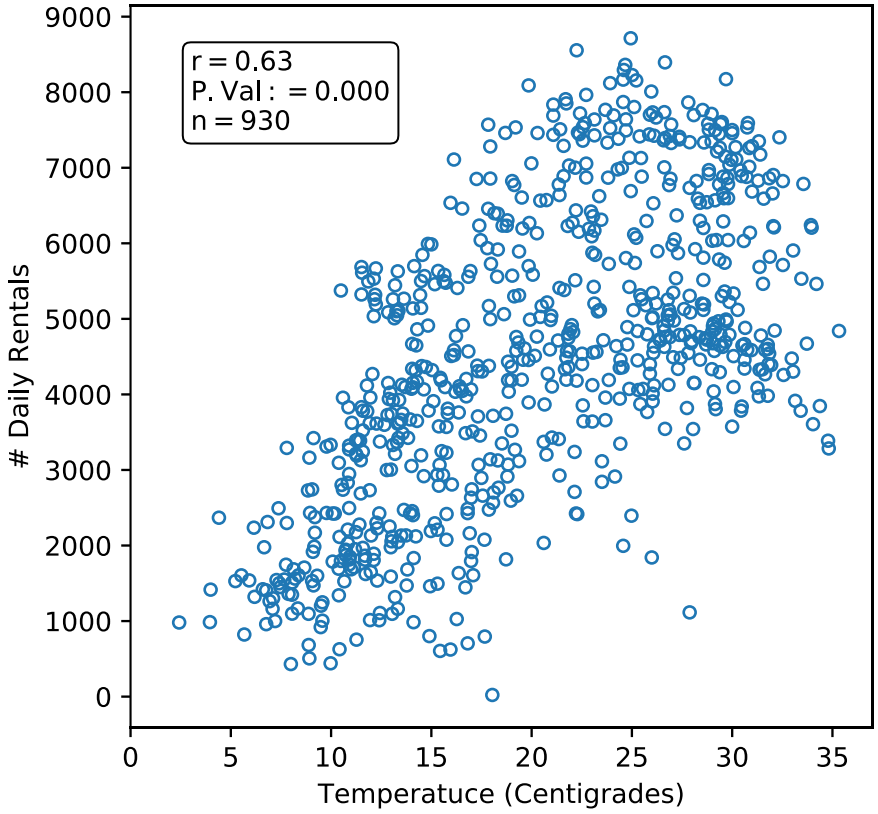
Figure 9. Daily bicycle rentals, by temperature.



Scatterplot + Pearson's r + test

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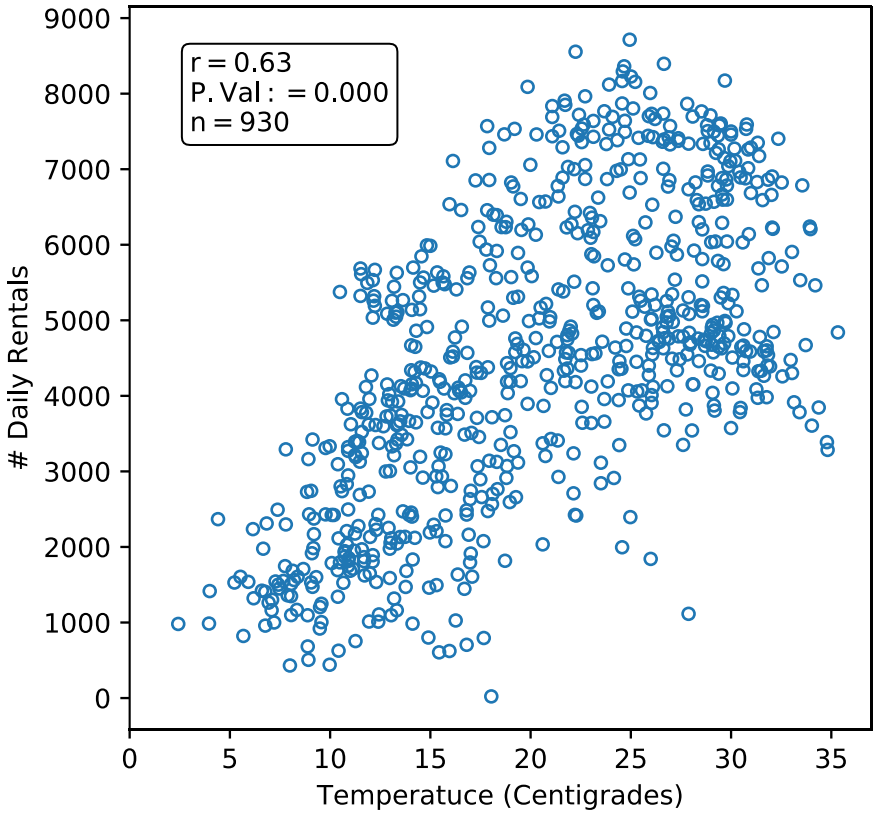
Figure 9. Daily bicycle rentals, by temperature.



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Conclussion

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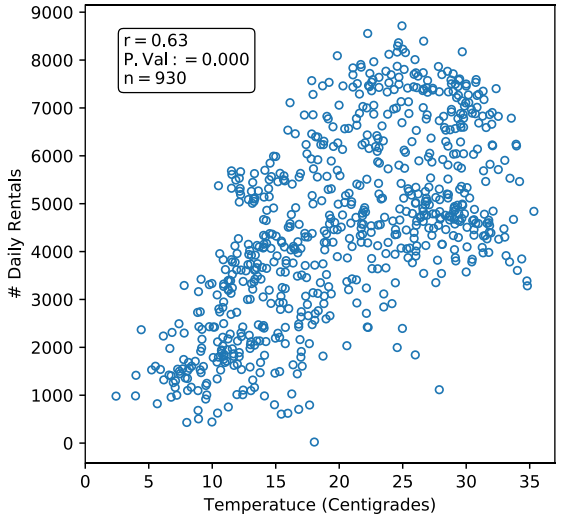
Conclussion:

As P. Value < 0.000

We can reject H0 with a confidence higer tan 99.9

Figure 9. Daily bicycle rentals, by temperature.



✗ H0.: There is no linear association (r=0) between the *number of rentals* and the *temperature*.

✓ H1.: There is a linear association (r≠0) between the *number of rentals* and the *temperature*.

Tricks of the Trade: Split by year…

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```
#Extra topic
plt.scatter ('temp_celsius', 'cnt',  data=wbr, c='yr')
```

Tricks of the Trade: Split by year

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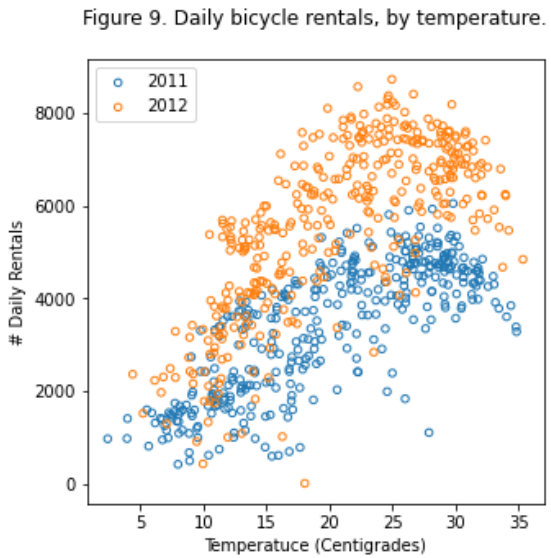
```
plt.figure(figsize=(5, 5))
plt.scatter (wbr.temp_celsius[wbr.yr==0],wbr.cnt[wbr.yr==0], s=20,
             marker="s", facecolors='none', edgecolors='C0', label="2011")
plt.scatter (wbr.temp_celsius[wbr.yr==1],wbr.cnt[wbr.yr==1], s=20,
             facecolors='none', edgecolors='C1', label="2012")
plt.legend(loc="upper right")
props = dict(boxstyle='round', facecolor='white', lw=0.5)
textstr = '$\mathrm{r}=%.2f$\n$\mathrm{P.Val:}=%.3f$\n$\mathrm{n}=%.0f$'%(r,
p_val, n)
plt.text (3,7500, textstr ,   bbox=props)
plt.title('Figure 9. Daily bicycle rentals, by temperature.''\n' )
plt.ylabel('# Daily Rentals')
plt.xlabel('Temperatuce (Centigrades)')
plt.show()
```



Tricks of the Trade: Split by year

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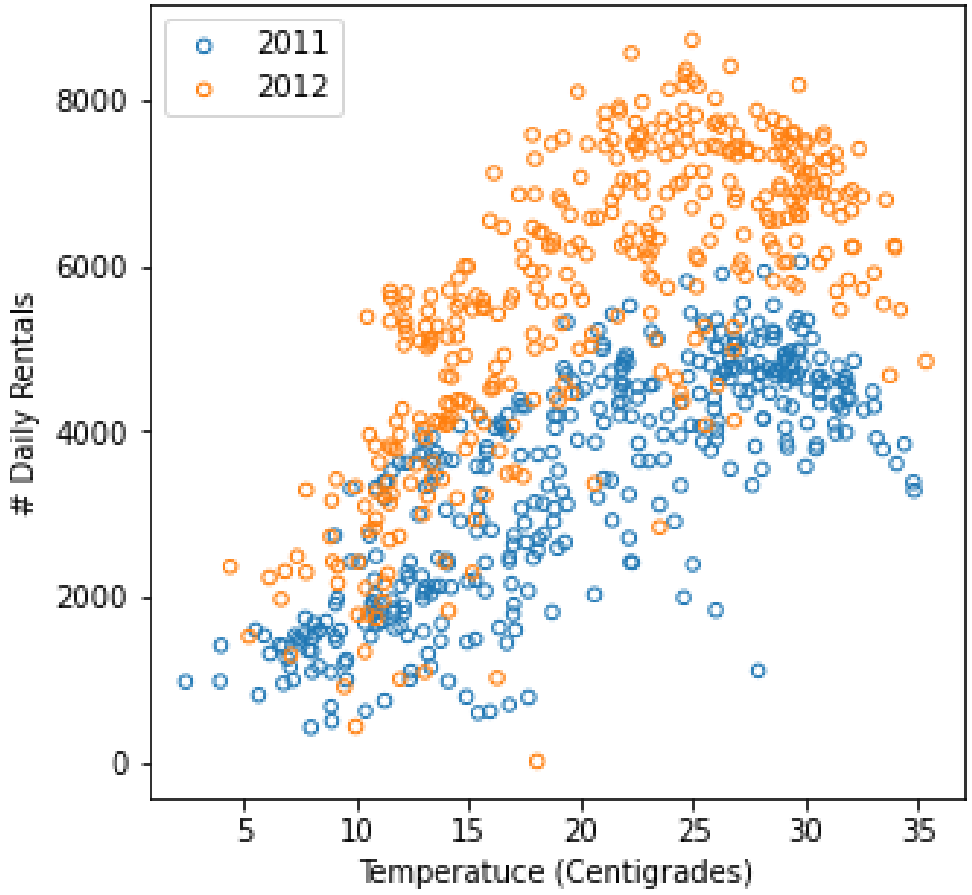
Figure 9. Daily bicycle rentals, by temperature.



Tricks of the Trade:

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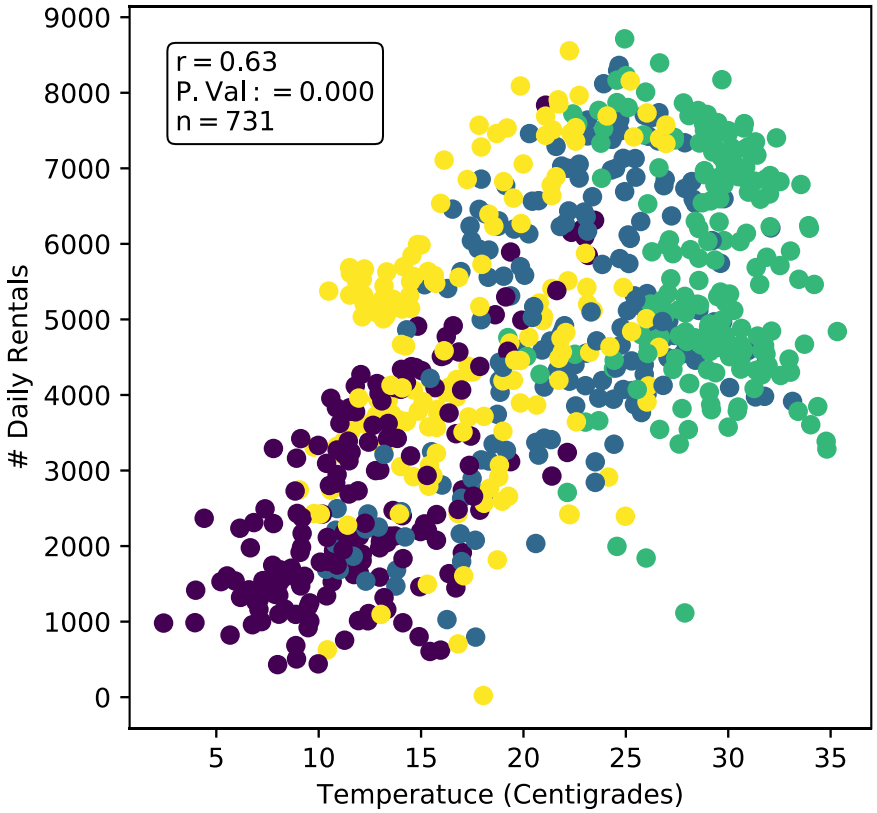
- Split by Season

Figure 9. Daily bicycle rentals, by temperature.



Correlation. Summing UP

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- General Remainder:
  - Allways **describe/explore your data** (numerically + graphically) prior to perform any statistical analysis.

- Main Numeric Procedure:
  - Pearson's Correlation
  - P.Value

- Main Graphic Procedure:
  - Scatterplot

Statistical Programming with Python

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Questions?

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Thank you !

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