STAT383 HW 6
Lewis Collum
Updated: April 4, 2020

---

5 - Paper Tensile Strength

Hypotheses

$$H_0 : \mu_5 = \mu_{10} = \mu_{15} = \mu_{20}$$

$$H_A : \mu_i \neq \mu_j \text{ for some } i \neq j$$

Data

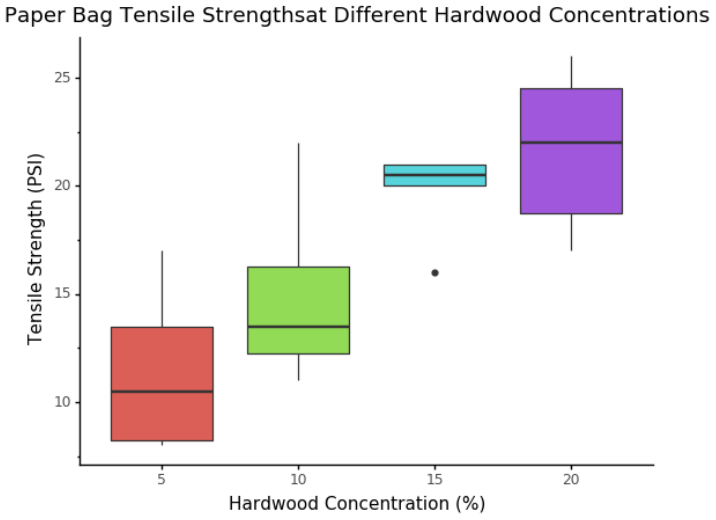
```
import pandas
import plotnine as p9
import matplotlib.pyplot as pyplot

data = pandas.read_excel('q5.xlsx')
data.rename({
    'Hardwood Concentration (%)': 'concentration',
    'Tensile Strength (PSI)': 'psi'}, axis='columns', inplace=True)

data['concentration'] = data['concentration'].astype('category')

g = (p9.ggplot(data)
     + p9.aes(y='psi', x='concentration')
     + p9.geom_boxplot(p9.aes(fill='concentration'))
     + p9.theme_classic()
     + p9.theme(legend_position='none')
     + p9.ggtitle(("Paper Bag Tensile Strengths"
                   "at Different Hardwood Concentrations"))
     + p9.ylab("Tensile Strength (PSI)")
     + p9.xlab("Hardwood Concentration (%)"))

g.draw()
pyplot.savefig('q5_boxplot.png')
```



ANOVA

```
from scipy import stats

f, p = stats.f_oneway(data['psi'], data['concentration'])
print(f'\[\\text{{p-value}} = {round(p, 5)}\]')
```

$$\text{p-value} = 0.0077$$

Tukey HSD

```
from statsmodels.stats.multicomp import pairwise_tukeyhsd
print(pairwise_tukeyhsd(data['psi'], data['concentration']))
```

```
Multiple Comparison of Means - Tukey HSD, FWER=0.05
===================================================
group1 group2 meandiff p-adj   lower   upper  reject
---------------------------------------------------
     5     10      3.5 0.3193 -2.0552  9.0552  False
     5     15      8.5 0.0019  2.9448 14.0552   True
     5     20  10.3333  0.001  4.7781 15.8885   True
    10     15      5.0 0.0873 -0.5552 10.5552  False
    10     20   6.8333 0.0126  1.2781 12.3885   True
    15     20   1.8333 0.7726 -3.7219  7.3885  False
---------------------------------------------------
```

Conclusion

From ANOVA:
Since the p-value is less than 0.05, we reject the null hypothesis. The data suggests that the hardwood concentration has some effect on the tensile strength of the bag.

From Tukey HSD:
The difference in tensile strength between bags with hardwood concentrations of 15% and 20% is not significant. However, the difference of those between 10% and 20% is significant.

Analogously, the difference in tensile strength between bags with hardwood concentrations of 5% and 10% is not significant. However, the difference of those between 5% and 15% is significant.

At the edge-cases, bags with a hardwood concentration between 5% and 20% have significantly different tensile strengths.

---

8 - Paint Weathering