W11. Advertising

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Data: "fruitazia.csv" file

market test for juice with 6 experimental conditions (2 advertising levels Œ 3 price levels), with 5 supermarkets per condition.

```
In [55]: data<-read.csv(file="fruitazia.csv")
         attach(data)
         AdSpend <- as.factor(data$AdSpend)
         Price <- as.factor(data$Price)
         data

The following objects are masked from data (pos = 3):

    AdSpend, AdSpend2, Price, Price4.9, Price5.9, Sales

The following objects are masked from data (pos = 4):

    AdSpend, AdSpend2, Price, Price4.9, Price5.9, Sales

The following objects are masked from data (pos = 5):

    AdSpend, AdSpend2, Price, Price4.9, Price5.9, Sales
```
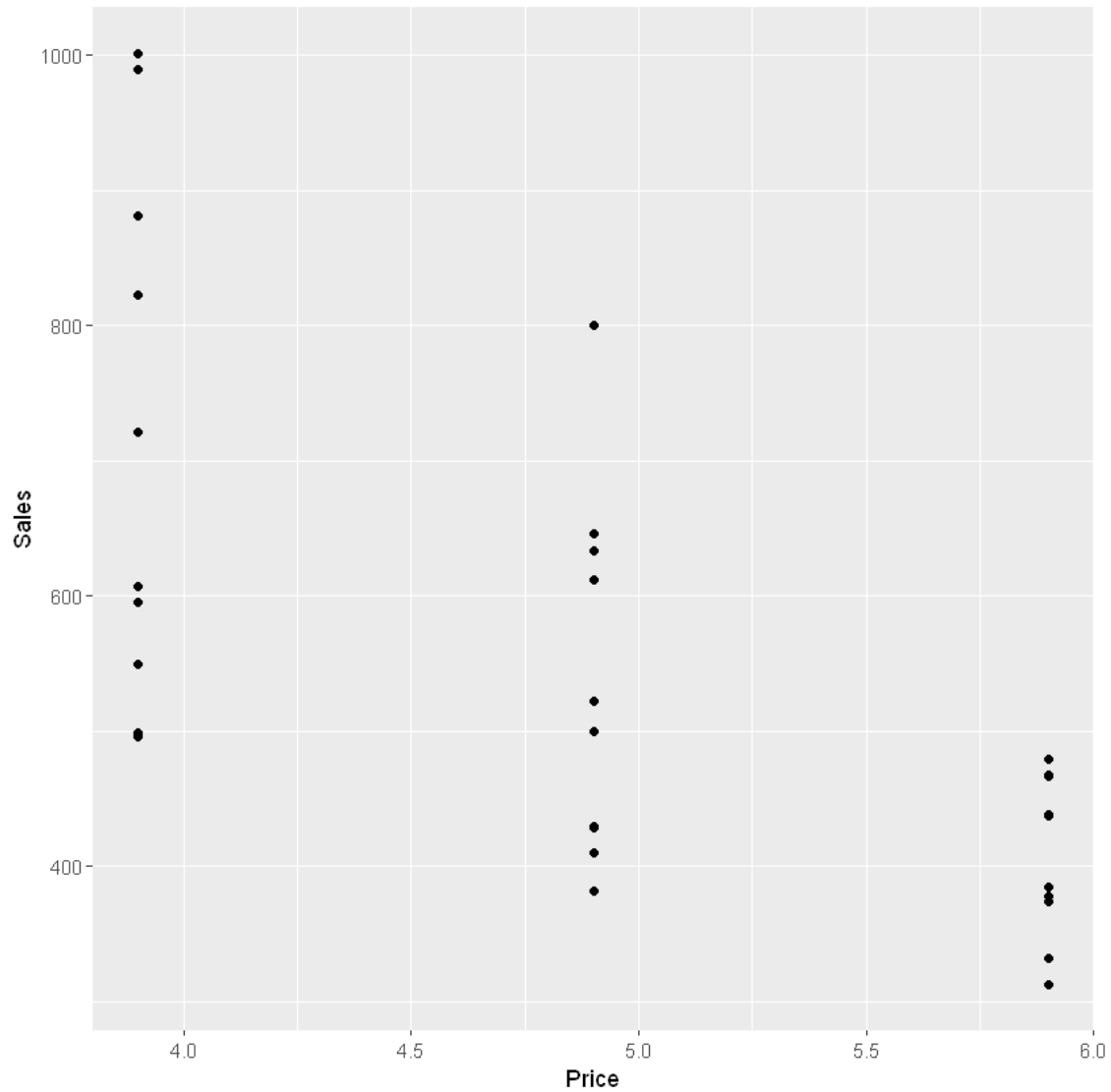
Sales	Price	AdSpend	AdSpend2	Price4.9	Price5.9
499	3.9	1	0	0	0
595	3.9	1	0	0	0
496	3.9	1	0	0	0
607	3.9	1	0	0	0
550	3.9	1	0	0	0
989	3.9	2	1	0	0
721	3.9	2	1	0	0
823	3.9	2	1	0	0
1001	3.9	2	1	0	0
881	3.9	2	1	0	0
382	4.9	1	0	1	0
429	4.9	1	0	1	0
410	4.9	1	0	1	0
500	4.9	1	0	1	0
430	4.9	1	0	1	0
522	4.9	2	1	1	0
800	4.9	2	1	1	0
612	4.9	2	1	1	0
633	4.9	2	1	1	0
646	4.9	2	1	1	0
374	5.9	1	0	0	1
437	5.9	1	0	0	1
385	5.9	1	0	0	1
313	5.9	1	0	0	1
378	5.9	1	0	0	1
332	5.9	2	1	0	1
479	5.9	2	1	0	1
468	5.9	2	1	0	1
467	5.9	2	1	0	1
438	5.9	2	1	0	1

```
In [50]: aggregate(Sales~Price+AdSpend,data=data,FUN=mean)
```

Price	AdSpend	Sales
3.9	1	549.4
4.9	1	430.2
5.9	1	377.4
3.9	2	883.0
4.9	2	642.6
5.9	2	436.8

```
In [70]: library("ggplot2")
         ggplot(data=data,aes(Price,Sales))+geom_point()
```

0.1.1 Regression Model: impact of advertising and price on sales

$$Sales = \beta_0 + \beta_1 * Adv_{2m} + \beta_2 * Price_{4.9} + \beta_3 * Price_{5.9} + e$$

```
In [64]: summary(lm(Sales~ + AdSpend2+Price4.9+Price5.9))
```

```
Call:
lm(formula = Sales ~ +AdSpend2 + Price4.9 + Price5.9)

Residuals:
    Min      1Q  Median      3Q     Max
-176.00  -50.38   -7.40   64.35  183.90
```

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   615.30      34.39  17.893 3.89e-16 ***
AdSpend2      201.80      34.39   5.868 3.46e-06 ***
Price4.9     -179.80      42.12  -4.269 0.000231 ***
Price5.9     -309.10      42.12  -7.339 8.56e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 94.17 on 26 degrees of freedom
Multiple R-squared:  0.7735,Adjusted R-squared:  0.7474
F-statistic: 29.59 on 3 and 26 DF,  p-value: 1.537e-08
```

Significant relationship between two covariates (price and advertising) and sales volumn.
77% of the variability of sales is explained by variability of price and advertising.

0.1.2 Regression Model with interaction terms: impact of increased advertising on sales at different price levels

$$Sales = \beta_0 + \beta_1 * Adv_{2m} + \beta_2 * Price_{4.9} + \beta_3 * Price_{5.9} + \beta_4 * Price_{4.9} * Adv_{2m} + \beta_5 * Price_{5.9} * Adv_{2m} + e$$

```
In [67]: summary(lm(Sales~AdSpend2+Price4.9+Price5.9+Price4.9*AdSpend2+Price5.9*AdSpend2))


Call:
lm(formula = Sales ~ AdSpend2 + Price4.9 + Price5.9 + Price4.9 *
    AdSpend2 + Price5.9 * AdSpend2)

Residuals:
    Min      1Q  Median      3Q     Max
-162.00  -43.80    0.20   39.45  157.40

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)         549.40      33.69  16.309 1.73e-14 ***
AdSpend2            333.60      47.64   7.002 3.06e-07 ***
Price4.9           -119.20      47.64  -2.502 0.019565 *
Price5.9           -172.00      47.64  -3.610 0.001401 **
AdSpend2:Price4.9  -121.20      67.37  -1.799 0.084625 .
AdSpend2:Price5.9  -274.20      67.37  -4.070 0.000442 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 75.33 on 24 degrees of freedom
Multiple R-squared:  0.8662,Adjusted R-squared:  0.8384
```

```
F-statistic: 31.08 on 5 and 24 DF,  p-value: 9.777e-10
```

Effect of increased ad spend at $3.9 : +333.6
Effect of increased ad spend at $4.9 : +333.6 - 121.2
Effect of increased ad spend at $4.9 : +333.6 - 274.2
Advertising works much better at low price for this product.