

## HW 20

The table below gives the energy use of five gas ranges for seven menu days. (The units are equivalent kilowatt-hours;  $0.238\text{kWh}=1\text{ft}^3$  of natural gas.) The energy use calculate is an average over several cooks. Your goal is to describe the variation in the table below in terms of the effects of different ranges and different menu days.

```
mydata <- read.csv("https://raw.githubusercontent.com/ProfSuzy/Stat61/main/gasranges.csv",
                    header=T)
mydata
```

```
##   Day Range1 Range2 Range3 Range4 Range5
## 1   1   8.25   8.26   6.55   8.21   6.69
## 2   2   5.12   4.81   3.87   4.81   3.99
## 3   3   5.32   4.37   3.76   4.67   4.37
## 4   4   8.00   6.50   5.38   6.51   5.60
## 5   5   6.97   6.26   5.03   6.40   5.60
## 6   6   7.65   5.84   5.23   6.24   5.73
## 7   7   7.86   7.31   5.87   6.64   6.03
```

*#Here is some code you may want to use to get the table above into a valid data format.*

```
kWh = as.vector(unlist(mydata[,2:6]))
menu_day=rep(1:7, 5)
range = c(rep("Range1", 7), rep("Range2", 7), rep("Range3", 7),
          rep("Range4", 7), rep("Range5", 7))
```

```
length(kWh); length(menu_day); length(range)
```

```
## [1] 35
```

```
## [1] 35
```

```
## [1] 35
```

```
unit_data_energy <- data.frame(kWh, menu_day, range)
unit_data_energy
```

```
##      kWh menu_day  range
## 1  8.25         1 Range1
## 2  5.12         2 Range1
## 3  5.32         3 Range1
## 4  8.00         4 Range1
## 5  6.97         5 Range1
## 6  7.65         6 Range1
## 7  7.86         7 Range1
## 8  8.26         1 Range2
## 9  4.81         2 Range2
## 10 4.37         3 Range2
## 11 6.50         4 Range2
## 12 6.26         5 Range2
## 13 5.84         6 Range2
```

|            |          |
|------------|----------|
| ## 14 7.31 | 7 Range2 |
| ## 15 6.55 | 1 Range3 |
| ## 16 3.87 | 2 Range3 |
| ## 17 3.76 | 3 Range3 |
| ## 18 5.38 | 4 Range3 |
| ## 19 5.03 | 5 Range3 |
| ## 20 5.23 | 6 Range3 |
| ## 21 5.87 | 7 Range3 |
| ## 22 8.21 | 1 Range4 |
| ## 23 4.81 | 2 Range4 |
| ## 24 4.67 | 3 Range4 |
| ## 25 6.51 | 4 Range4 |
| ## 26 6.40 | 5 Range4 |
| ## 27 6.24 | 6 Range4 |
| ## 28 6.64 | 7 Range4 |
| ## 29 6.69 | 1 Range5 |
| ## 30 3.99 | 2 Range5 |
| ## 31 4.37 | 3 Range5 |
| ## 32 5.60 | 4 Range5 |
| ## 33 5.60 | 5 Range5 |
| ## 34 5.73 | 6 Range5 |
| ## 35 6.03 | 7 Range5 |

## Problem 1

- Find and interpret the grand mean.
- Find and interpret the differential effect of a menu day, for each of the seven days.
- Find and interpret the differential effect of the range, for each of the five ranges.

*#if you use R code for problem 1 put it here*

## Problem 2

Report the estimated additive model for energy use based on this data. (There will be more than one equations that you present.) Complete the following table of the differences of the observed energy use and the predicted energy use from this model. Do these residuals indicate a possible interaction effect between the ranges and the menu days?

| Menu day | Range 1 | Range 2 | Range 3 | Range 4 | Range 5 |
|----------|---------|---------|---------|---------|---------|
| 1        |         |         |         |         |         |
| 2        |         |         |         |         |         |
| 3        |         |         |         |         |         |
| 4        |         |         |         |         |         |
| 5        |         |         |         |         |         |
| 6        |         |         |         |         |         |
| 7        |         |         |         |         |         |

*#if you use R code for problem 2 put it here*

### Problem 3

Complete the following 2-way ANOVA table for this data “by hand” (just show your work). Then calculate the F-test statistic and corresponding p-value for a test of the significance of an interaction effect between the ranges and the menu days.

| Source      | df | SS | MS | F |
|-------------|----|----|----|---|
| Menu day    |    |    |    |   |
| Range       |    |    |    |   |
| Interaction |    |    |    |   |
| Error       |    |    |    |   |
| Total       |    |    |    |   |

*#if you use R code for problem 3 put it here*