

Chapter 13 Worksheet

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Quality Espresso

In Masella et al. (2015), the authors developed a new method of brewing espresso. Traditional methods use the steam from hot water to create enough pressure to move through the coffee grounds. In this new method, the flow of water is created by pressure differentials between the interior and exterior of the chamber which houses the coffee grounds. This new method allows for finer control of both pressure and temperature. The authors wished to understand the effects of pressure and temperature on foam index. The variables are:

Variable	Code
foamIndx	The ratio between the foam and liquid volume (expressed as a percent) measured 30s after extraction
trt_id	A label for each treatment group
tempC	The temperature of the water in Celsius (75, 85, and 90)
prssBar	The pressure in bars (15 and 20)

You can load these data into R using (you might need to change the path):

```
load("../data/espresso2.rdata")
head(espresso)
```

1. Informally explore the effects of pressure and temperature on the foam index by creating an interaction plot. Does pressure look like it increases or decreases the foam index? Does temperature seem like it increases or decreases the foam index? Does the interaction plot make you think that there are strong interactions?
2. Fit the cell means model and evaluate if the assumptions of the ANOVA model seem appropriate.
3. Write out the two-way ANOVA model with interactions.
4. Write out the hypotheses in terms of the parameters to test if there is an interaction.
5. Formally test if there is an interaction.
6. Now fit the additive model. Is there a significant effect of pressure or temperature on the foam index.
7. Extract the coefficients and interpret all of them.
8. Now run three different two sample t -tests for differences in pressure at each temperature (75C, 85C, and 95C). Do we get any significant results?

References

Masella, Piernicola, Lorenzo Guerrini, Silvia Spinelli, Luca Calamai, Paolo Spugnoli, Francesco Illy, and Alessandro Parenti. 2015. "A New Espresso Brewing Method." *Journal of Food Engineering* 146. Elsevier: 204-8.