# Exercise 12: three-way analysis of variance

The dataset `gun` (taken from Chambers and Hastie (1992): "Statistical models in S") consists of data from an experiment on methods for firing naval guns. Two methods were tested by gunners corresponding to three different physiques (slight, average, and heavy). Nine gunners of each physique were divided into three teams, each team tested the two loading methods twice, for a total of 36 runs. The response was the number of rounds fired per minute. The data are given in the table below. For method, 1 and 2 correspond to method number. For physique, 1, 2, and 3 correspond to slight, average, and heavy, respectively. For team, 1, 2, and 3 correspond to team number.

a) Calculate the correlation between the four columns in the data matrix. Comment on the results.

b) Perform a three-way analysis of variance. Explain how the different columns of the ANOVA table are related.

c) Set up the different hypotheses that are relevant in this case, and use the ANOVA table to test the hypotheses.

d) From the conclusions of the tests, what would be your preferred modell?

| Obs | Method | Physique | Team | Rounds | Obs | Method | Physique | Team | Rounds |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 20.2 | 19 | 1 | 1 | 1 | 24.1 |
| 2 | 2 | 1 | 1 | 14.2 | 20 | 2 | 1 | 1 | 16.2 |
| 3 | 1 | 2 | 1 | 22.0 | 21 | 1 | 2 | 1 | 23.5 |
| 4 | 2 | 2 | 1 | 14.1 | 22 | 2 | 2 | 1 | 16.1 |
| 5 | 1 | 3 | 1 | 23.1 | 23 | 1 | 3 | 1 | 22.9 |
| 6 | 2 | 3 | 1 | 14.1 | 24 | 2 | 3 | 1 | 16.1 |
| 7 | 1 | 1 | 2 | 26.2 | 25 | 1 | 1 | 2 | 26.9 |
| 8 | 2 | 1 | 2 | 18.0 | 26 | 2 | 1 | 2 | 19.1 |
| 9 | 1 | 2 | 2 | 22.6 | 27 | 1 | 2 | 2 | 24.6 |
| 10 | 2 | 2 | 2 | 14.0 | 28 | 2 | 2 | 2 | 18.1 |
| 11 | 1 | 3 | 2 | 22.9 | 29 | 1 | 3 | 2 | 23.7 |
| 12 | 2 | 3 | 2 | 12.2 | 30 | 2 | 3 | 2 | 13.8 |
| 13 | 1 | 1 | 3 | 23.8 | 31 | 1 | 1 | 3 | 24.9 |
| 14 | 2 | 1 | 3 | 12.5 | 32 | 2 | 1 | 3 | 15.4 |
| 15 | 1 | 2 | 3 | 22.9 | 33 | 1 | 2 | 3 | 25.0 |
| 16 | 2 | 2 | 3 | 13.7 | 34 | 2 | 2 | 3 | 16.0 |
| 17 | 1 | 3 | 3 | 21.8 | 35 | 1 | 3 | 3 | 23.5 |
| 18 | 2 | 3 | 3 | 12.7 | 36 | 2 | 3 | 3 | 15.1 |