MATH 208 A4

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Q1

The data for this question come from a high performance ceramics experiment done at NIST. The purpose of the experiment was to characterize the effect of five machining factors on the mean strength of the resulting ceramic. The five factors were: Table Speed, Down Feed Rate, Wheel Grit, Direction, and Batch. Each factor had two levels. The Mean Speed was measured for each of the $25 = 32$ possible combinations of factor levels.

Part A

What class of object is ceramic_data?

```
class(ceramic_data)
```

```
## [1] "array"
```

```
attributes(ceramic_data)
```

```
## $dim
## [1] 2 2 2 2 2
##
## $dimnames
## $dimnames$Table_Speed
## [1] "Slow" "Fast"
##
## $dimnames$Down_Feed_Rate
## [1] "Slow" "Fast"
##
## $dimnames$Wheel_Grit
## [1] "140/170" "80/100"
##
## $dimnames$Direction
## [1] "Longitudinal" "Transverse"
##
## $dimnames$Batch
## [1] "Batch 1" "Batch 2"
```

The class of the object ceramic_data is an array

Part B

Using the ceramic_data object, compute the median Mean_Strength by Batch, i.e. write a line of code that produces a vector that computes the mean of all observations in each batch, respectively. What is the difference in mean by Batch?

```r
dim(ceramic_data)
```

```
## [1] 2 2 2 2 2
```

```r
#Line of code that computes the mean of all observations in each batch:
Batch_Mean_Strength <- apply(ceramic_data, "Batch", mean) %>% as.vector(., mode = "numeric")
Batch_Mean_Strength
```

```
## [1] 579.3256 514.4662
```

```r
#Difference in Batch means:
(Difference_In_Batch_Means <- Batch_Mean_Strength[1]-Batch_Mean_Strength[2])
```

```
## [1] 64.85938
```

The difference in batch means is 64.8594

Part C

Compute the overall standard devation of the Mean_Strength values across all 32 observations. Hint: remember that this type of object is stored internally as an generic vector.

```r
sd(ceramic_data)
```

```
## [1] 112.2785
```

The overall standard deviation of the Mean_Strength values across all 32 observations is 112.2785

Part D

Using the ceramic_data object, compute the average Mean_Strength for each of the four groups defined by the cross-classification of Table_Speed and Direction. Hint: the most succinct way to do this would return a 2x2 table with Table_Speed levels in the rows and Direction levels in the columns.

```r
Direction_Table_Speed <- apply(ceramic_data, c(1,4), mean)
Direction_Table_Speed
```

```
##            Direction
## Table_Speed Longitudinal Transverse
##        Slow     647.9987   435.2200
##        Fast     644.2663   460.0987
```

Part E

Compute the difference in means between the Longitudinal and Transverse levels of Direction for each level of Slow and Fast separately. Hint: Use part (d) and the apply function.

```r
attributes(Direction_Table_Speed)
```

```
## $dim
## [1] 2 2
##
## $dimnames
## $dimnames$Table_Speed
## [1] "Slow" "Fast"
##
## $dimnames$Direction
## [1] "Longitudinal" "Transverse"
```

```r
apply(Direction_Table_Speed, c(1), diff)
```

```
##      Slow      Fast
## -212.7787 -184.1675
```

The difference between the longitudinal and Transverse level of Direction for Slow is 212.7787 whereas for Fast it is 184.1675