

## Stat 242 Quiz – Topics Drawn from Chapter 13

What's Your Name? \_\_\_\_\_

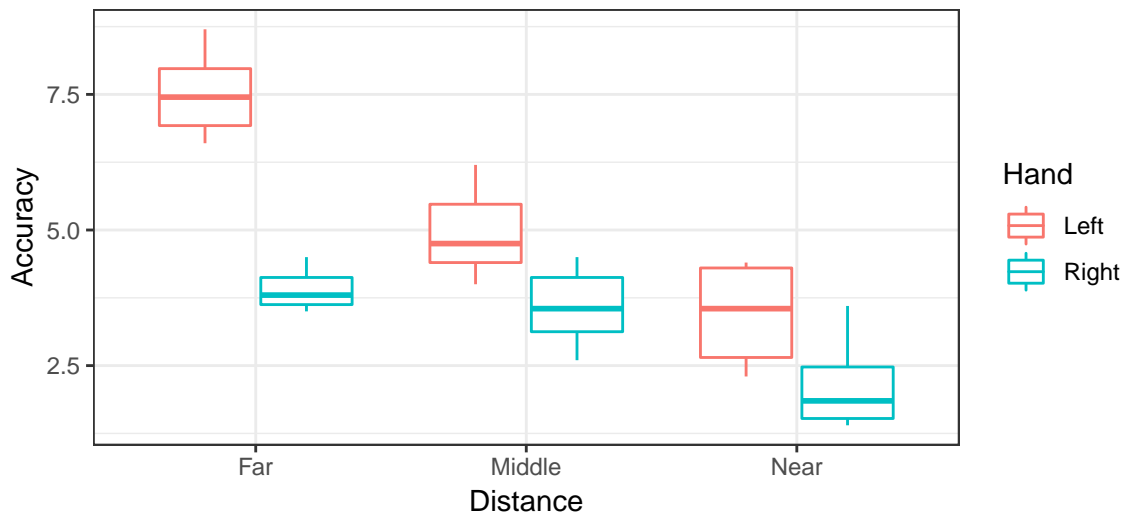
A right-handed person threw darts, varying two conditions:

- **Distance:** either Far, Middle, or Near
- **Hand:** which hand was used to throw the darts, either Left or Right

The accuracy of each throw was measured, in inches away from the target (so a higher value for accuracy indicates a less accurate throw). Six darts were thrown in each condition, in random order.

Here's a plot of the data:

```
ggplot(data = darts, mapping = aes(x = Distance, color = Hand, y = Accuracy)) +  
  geom_boxplot() +  
  theme_bw()
```



1. Explain why this is a 2-way ANOVA problem

2. Does the plot above suggest the use of an additive model or an interactions model? Justify your answer with reference to a specific characteristic of the plot.

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```
lm_fit_additive <- lm(Accuracy ~ Hand + Distance, data = darts)
summary(lm_fit_additive)
```

```
##
## Call:
## lm(formula = Accuracy ~ Hand + Distance, data = darts)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.5417 -0.7458 -0.1500  0.5583  1.9417
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      6.7583     0.3151  21.448 < 2e-16 ***
## HandRight        -2.1000     0.3151  -6.665 1.61e-07 ***
## DistanceMiddle  -1.4417     0.3859  -3.736 0.000731 ***
## DistanceNear    -2.9167     0.3859  -7.558 1.31e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9453 on 32 degrees of freedom
## Multiple R-squared:  0.7604, Adjusted R-squared:  0.7379
## F-statistic: 33.85 on 3 and 32 DF,  p-value: 4.805e-10
```

```
lm_fit_interaction <- lm(Accuracy ~ Hand * Distance, data = darts)
summary(lm_fit_interaction)
```

```
##
## Call:
## lm(formula = Accuracy ~ Hand * Distance, data = darts)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.15000 -0.55833 -0.05833  0.56250  1.46667
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      7.5167     0.3183  23.613 < 2e-16 ***
## HandRight        -3.6167     0.4502  -8.034 5.74e-09 ***
## DistanceMiddle   -2.5667     0.4502  -5.701 3.22e-06 ***
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## HandRight:DistanceMiddle  2.2500     0.6367   3.534 0.00135 **
## HandRight:DistanceNear    2.3000     0.6367   3.613 0.00109 **
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## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
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## Residual standard error: 0.7797 on 30 degrees of freedom
## Multiple R-squared:  0.8471, Adjusted R-squared:  0.8217
## F-statistic: 33.25 on 5 and 30 DF,  p-value: 2.27e-11
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```
anova(lm_fit_additive, lm_fit_interaction)
```

```
## Analysis of Variance Table
##
## Model 1: Accuracy ~ Hand + Distance
## Model 2: Accuracy ~ Hand * Distance
##   Res.Df    RSS Df Sum of Sq    F    Pr(>F)
## 1      32 28.595
## 2      30 18.240  2    10.355 8.5156 0.001178 **
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```

1. What is the `DistanceMiddle` variable referenced in the R summary output above?
2. Based on the model with interactions, what is the estimated mean accuracy for dart throws using the left hand at a far distance? Your answer should involve only numbers, but you do not need to simplify.
3. Based on the model with interactions, what is the estimated mean accuracy for dart throws using the right hand at a far distance? Your answer should involve only numbers, but you do not need to simplify.
4. Based on the model with interactions, what is the estimated mean accuracy for dart throws using the right hand at a medium distance? Your answer should involve only numbers, but you do not need to simplify.

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1. Conduct a test of the claim that no interaction is required between the hand used and the distance thrown. Your hypotheses should be stated in terms of equations involving the parameters from the model with interactions. State your conclusions in terms of strength of evidence against the null hypothesis.

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1. Conduct a test of the claim that the mean accuracy is the same for throws using the left hand at a far distance as it is for throws using the right hand at a far distance. Your hypotheses should be stated in terms of equations involving the parameters from the model with interactions. State your conclusions in terms of strength of evidence against the null hypothesis.