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*Problem 1* (house price data) (38 points)

Construct a 90% confidence interval for adding a 300 sqrft bedroom ($t^*=1.66$)

$t = \frac{\text{param. estimate } (\hat{\beta}_i)}{SE_{\hat{\beta}_i}}$

| Parameter Estimates | | | | | | |
|---|---|---|---|---|---|---|
| Variable | Label | DF | Parameter Estimate (slope $\hat{\beta}_i$) | Standard Error | t Value | Pr > \|t\| |
| Intercept | Intercept | 1 | -19315 | 31047 | -0.62 | 0.5355 |
| sqrft | sqrft | 1 | 128.43621 | 13.82446 | 9.29 | <.0001 |
| bdrms | bdrms | 1 | 15198 | 9483.51703 | 1.60 | 0.1127 |

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$CI: \hat{\beta}_i \pm t^* \cdot SE_{\hat{\beta}_i}$

$-19315 + 128.43621(300) + 15198(1) = 34413.9$

| Covariance of Estimates | | | | |
|---|---|---|---|---|
| Variable | Label | Intercept | sqrft | bdrms |
| ~~Intercept~~ | ~~Intercept~~ | ~~963892569.6~~ | ~~-136222.4363~~ | ~~-180600630.8~~ |
| sqrft | sqrft | -136222.4363 | 191.11564506 | -69678.578 |
| bdrms | bdrms | -180600630.8 | -69678.578 | 89937095.296 |

only significant p-value

Write down the point estimator for calculating the interval (6 pts)

The point estimator for calculating the interval is $y = 128.43621(sqrft) + 15198(bdrms)$ where we plug in 300 for sqrft and 1 for bdrms.

Calculate the point estimate (6 pts)

The point estimate is 53728.9.

Calculate the variance of the point estimator (10 pts)

$var(300\,sqrft + 1\,bdrm) = var(300\,sqrft) + 2\,cov(300\,x, y) + var(y)$

$= 90000\,var(sqrft) + 600\,cov(sqrft, bdrm) + var(bdrm)$

$= 65330355.8$

$SE = 8082.72$

Put together the interval and write a conclusion (6 pts)

$53728.9 \pm 1.66(8082.72) = (40311.6, 67146.2)$

The 90% confidence interval for the price of a house for adding a 300 sqrft bedroom is 40311.6 to 67146.2 dollars.

Do you predict that adding a 300 square feet bedroom will increase the average price of a house in the neighborhood by $40,000? (8 pts for work and 2 pts for writing the correct hypothesis)

$H_0: \mu = 40000 \quad H_a: \mu > 40000$

Yes, adding 300 sqrft bedroom will increase the average price of a house in a neighborhood by $40,000 b/c in the predicted 90% confidence interval above the range of price increase was 40311.6 to 67146.2. The 40,000 is not in this interval so we reject the null hypothesis & conclude that the 300 sqrft room increases the price by $40,000. The CI also goes beyond 40000 in both ways so we can conclude it adds 40000.

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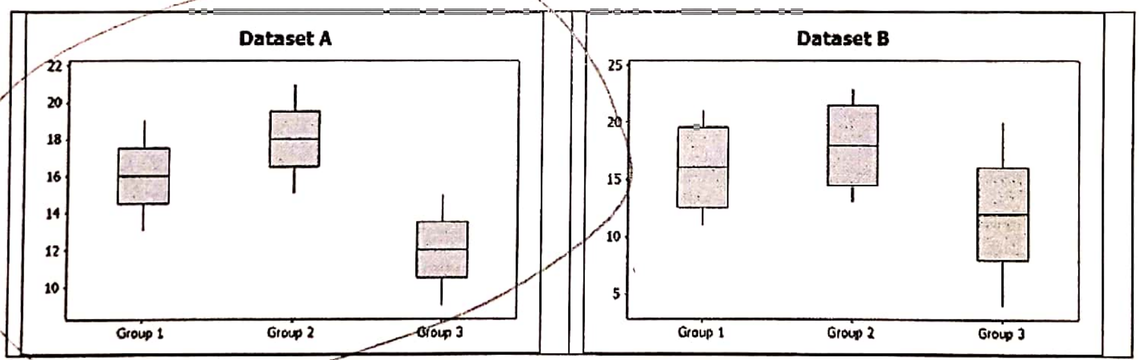
*Problem 2*

Which of these datasets provides stronger evidence of a difference between the means of the groups? Circle the dataset with the stronger evidence. (8 pts)

| Dataset A | | | Dataset B | | |
|---|---|---|---|---|---|
| Group 1 | Group 2 | Group 3 | Group 1 | Group 2 | Group3 |
| 12 | 25 | 8 | 12 | 19 | 12 |
| 8 | 15 | 10 | 11 | 18 | 13 |
| 15 | 12 | 16 | 12 | 18 | 14 |
| 9 | 9 | 17 | 12 | 18 | 13 |
| 17 | 28 | 20 | 12 | 17 | 13 |
| 11 | 19 | 7 | 13 | 18 | 13 |
| $\bar{x}_1 = 12.0$ | $\bar{x}_2 = 18.0$ | $\bar{x}_3 = 13.0$ | $\bar{x}_1 = 12.0$ | $\bar{x}_2 = 18.0$ | $\bar{x}_3 = 13.0$ |

***Explain:*** Dataset B has a stronger evidence of a difference b/w means of the groups b/c the variance w/ in the groups are smaller/narrower. This indicates there is stronger evidence of a difference b/w the means of the groups.

[b] Which of these datasets provides stronger evidence of a difference between the means of the groups? Circle the dataset with the stronger evidence. (8 pts)




***Explain:*** Dataset A has stronger evidence of difference b/w means of groups b/c the boxplots show a narrower range of values w/ in the groups. This indicates there is stronger evidence of a difference b/w the means of the groups.

*Problem 3 (Overlays)*

A study of two surgical methods compare recovery times, in days, for two treatments, the standard and the new method. Three randomly chosen patients got the new treatment; the remaining three patients got the standard. Here are the results:

New procedure 16, 20, 24

Standard 28, 33, 35

[a] Fit (with R) a one-way additive model "days = treatment + error" and write a conclusion (14 points)

If we fit a one-way additive model, we get a p-value of .0182 which is less than the alpha, so we reject the null hypothesis. Thus the type of treatment has a significant impact on the days of recovery.

[b] For the data above decompose the response value as a sum of grand mean + treatment effects + residuals. (14 points)

| | |
|---|---|
| 16 | 28 |
| 20 | 33 |
| 24 | 35 |

=

Grand mean

| | |
|---|---|
| 24.333 | 24.333 |
| 24.333 | 24.333 |
| 24.333 | 24.333 |

\+ treatment effects

| New procedure | Standard |
|---|---|
| -4.333 | 7.667 |
| -4.333 | 7.667 |
| -4.333 | 7.667 |

\+ residuals

| 16-20 | 28-32 |
|---|---|
| -4 | -4 |
| 0 | 1 |
| 4 | 3 |

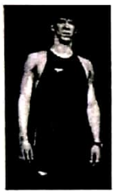
Make sure that the sum of square residuals and the sum of square treatment effects is the same as the Anova table from part [a]

## *Problem 4 (Randomization Matched Pairs Test)*

*"To exploit the data flood, America will need many more [data analysts]... The story is similar in fields as varied as science and sports, advertising and public health-a drift toward data-driven discovery and decision-making."*

Steve Lohr*

The 2008 Olympics were full of controversy about new swimsuits possibly providing unfair advantages to swimmers, leading to new international rules that came into effect January 1, 2010, regarding swimsuit coverage and material. Can a certain swimsuit really make a swimmer faster? A study tested whether wearing wetsuits influences swimming velocity. Twelve competitive swimmers and triathletes swam 1500 m at maximum speed twice each, once wearing a wetsuit and once wearing a regular bathing suit. The order of the trials was randomized. Each time, the maximum velocity in meters/sec of the swimmer was recorded. These data are shown below.



**Maximum velocity swimming with and without a wetsuit**

| Swimmer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wetsuit | 1.57 | 1.47 | 1.42 | 1.35 | 1.22 | 1.75 | 1.64 | 1.57 | 1.56 | 1.53 | 1.49 | 1.51 |
| No Wetsuit | 1.49 | 1.37 | 1.35 | 1.27 | 1.12 | 1.64 | 1.59 | 1.52 | 1.50 | 1.45 | 1.44 | 1.41 |

[a] What is the parameter in this problem? (2 points)

Parameter is the population mean of the differences b/w the two groups

[b] What is the best estimator and the best estimate for the parameter above part [a]? (2 points)

Best estimator for param from pt A is sample mean differences b/w the groups and the best estimate is .0741.

[c] What is the null hypothesis and alternative hypothesis for this problem? (2 points)

$H_0: \mu_s = 0$

$H_a: \mu_s \neq 0$

[d] Explain the algorithm in order to construct a randomization distribution. (6 points)

The algorithm is to treat each subject as a block and each order position as experimental unit. The subjects are then given each treatment. We randomize the order position so the wetsuit & No wetsuit times are compared w/ one another w/ varying subjects.

[e] Write R code with a replicate function or a loop in order to complete the problem and report a randomization p-value and conclusion. (6 points)

The pval is extremely low so we can reject the null hypothesis and conclude that there is a significant difference in the speeds of swimmers wearing wetsuits and not wearing wetsuits.