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PROBLEM SET 6. DUE MONDAY MARCH 15.

1. With the data set “grazing17” we analyzed ANPP (annual net primary productivity) in grazed vs. ungrazed plots using a paired t-test.

A. To do a randomized block ANOVA on this, you will need to reformat the data to be in a standard form with each column representing one variable (e.g. site, grazing treatment, ANPP). You can do this by cutting and pasting in Excel, but if you want to challenge yourself, you could try it in R using the “dplyr” package.

B. Once you’ve reformatted the data, run an ANOVA in R to determine whether there is an effect of bison grazing on ANPP when accounting for site.

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> aov4<-aov(ANPP ~ Site + Grazed, data = dat3) #two way ANOVA
> summary(aov4)
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	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Site	14	254401	18171	17.192	1.94e-06	***
Grazed	1	5767	5767	5.456	0.0349	*
Residuals	14	14798	1057			

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

There is a significant effect of bison grazing on ANPP ($F = 5.426$, $p = 0.035$).

C. What are the R^2 values for grazing treatment and site? Explain what these values mean (i.e. what they tell us about variation in ANPP).

R^2 for Site: $254401 / 274,966 = 0.925$

R^2 for Grazing Treatment: $5767 / 274,966 = 0.021$

This means that the site explains about 92.5 percent of the variation in ANPP values ($R^2 = 0.925$). The Grazing Treatment explains 2.1% of the variation in ANPP values ($R^2 = 0.021$).

D. How do the results for grazing compare to what you got using the paired t-test in the previous problem set? What do you get out of the ANOVA that you don’t get from the paired t-test?

They both have the exact same p-value and both found a significant difference.

A t-test can just show you if two things are statistically different, while the ANOVA can show you three or more populations. ANOVA allows u to calculate R^2 from sum of squares.

2. The data set “CO2_temp_germ.csv” shows the results of another experiment done by Dr. Hamilton exploring the potential effects of climate change on plants. If you’re a plant, increased CO₂ on its own is usually good (more carbon = more growth), but increased temperature is often bad.

This experiment examined germination of seeds of a specific plant species in growth chambers at high or low levels for both CO₂ and temp. The variable “prop_germ” shows the proportion of seeds that germinated in each trial.

A. What are the effects of CO₂ and temp on seed germination. Is there a significant interaction, and if so, what is the nature of this interaction?

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
CO2level	1	0.16256	0.16256	23.109	2.7e-05	***
Temperature	1	0.01056	0.01056	1.501	0.2284	
CO2level:Temperature	1	0.03306	0.03306	4.700	0.0369	*
Residuals	36	0.25325	0.00703			

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1						

There is a significant interaction between CO₂ and Temperature (F = 4.700, p=0.0367). There is a significant positive effect of CO₂ Levels on the proportion of seeds germinated (F=23.1, p = 2.7*10⁻⁵). There is no significant difference of temperature on the proportion of seeds germinated (F= 1.5, p =0.228).

B. Give the R² values for the main effects of CO₂ and temp as well as their interaction. What factor(s) is/are most important for determining the proportion of seeds that germinate.

$$R^2 \text{ CO}_2 = 0.163 / 0.163+0.011+0.033+0.253 = .354$$

$$R^2 \text{ Temp} = 0.011 / 0.163+0.011+0.033+0.253 = .024$$

$$R^2 \text{ interaction: } 0.072$$

This shows that CO₂ is most important in determining the proportion of seeds that germinate.

C. Show an interaction plot that illustrates your answer for part B.

