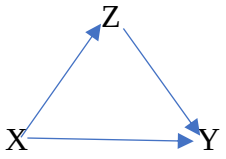
Instructions: Make sure to put your name on your test and to answer all questions. This is not a group project. Thus, I expect you to work independently. You can use textbooks, notes, slides, the internet, or dagitty, but you can't ask another individual to help you with the questions. When you use sources make sure to reference the sources. **Do not copy from the internet; remember this is your work.** When you turn in your exam make sure that your answers include the SAS code and only the printouts that support your answers. **Please do not give me just a printout and expect me to find the answers**. Not all answers will require computer work. Feel free to contact me if you have a question about the exam. I will not tell you the answer, but I will try to explain what I am after. Once you are finished please upload your midterm to canvas. Upload only one file, please. Good luck

For all causal models below assume a linear relationship among the variables and specify the effects with regression or correlations weights. The notation should indicate whether you are holding a variable constant i.e., $\mathbf{b}_{yx.z}$ **or** $r_{yx.z}$**.** Please be consistent with your notation. U variables are not observed.

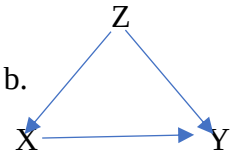
1. Find a model (general model, mental model, SEM, etc.) in the research literature in one of your areas of interest. It can be any model. Make sure to reference the article.
   a. Tell me why you think the author(s) included the model in the article?
   b. What is the usefulness of the model e.g., could it be used to make predictions, to explain associations/correlations among the variables, cause and effect, or to explain differences between groups, etc.?
   c. Did the author(s) refer to causality implicitly or explicitly? Explain.

2. Indicate how would you estimate the total and the direct effect of **X** on **Y** for each of the following causal DAGs. Make sure that each effect is identified, and express each estimate using either regression weights or correlation coefficients.

a.



b.



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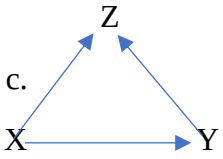
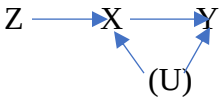
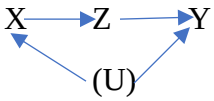


d.

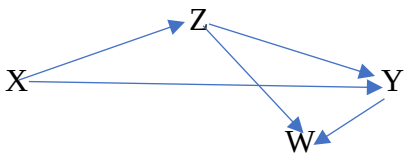
e.



f.



g.



3. What is the difference between a confounder and a collider variable? Draw the DAG's and explain them.

4. Below you will find Kurt Lewin's (1951) often-cited sentiment regarding the pragmatic utility of theory:

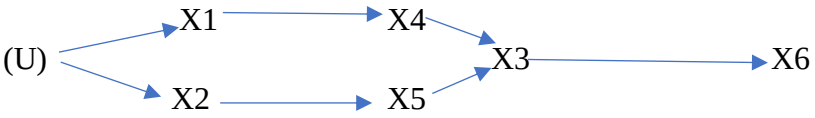
"*The greatest handicap of applied psychology has been the fact that, without proper theoretical help, it had to follow the costly, inefficient, and limited method of trial and error. Many psychologists working today in an applied field are keenly aware of the need for close cooperation between theoretical and applied psychology. This can be accomplished in psychology, as it has been accomplished in physics if the theorist does not look toward applied problems with highbrow aversion or with a fear of social problems, and if the applied psychologist realizes that there is nothing so practical as a good theory*."

(For example, the Florida Death Penalty data that we saw in class showed an effect for race after culpability (or other variables) was held constant. As some have pointed out, it would probably be prudent to obtain economic data for each defendant (can he afford a good defense) before making a final causal claim for race. I believe that this type of argument would have been difficult to make before Pearl's work on causality.

a. Think of a situation in which it would be important to collect F (financial information) for the defendant, and of
b. a situation in which this would not be necessary. Draw the DAG for each situation.

5. Our book indicates that groups in observational studies can differ in terms of baseline or differential treatment effect. Define each and give me the SAS code to adjust for each in an ANCOVA.

6. Consider the following causal design below, find an equivalent model to this design.

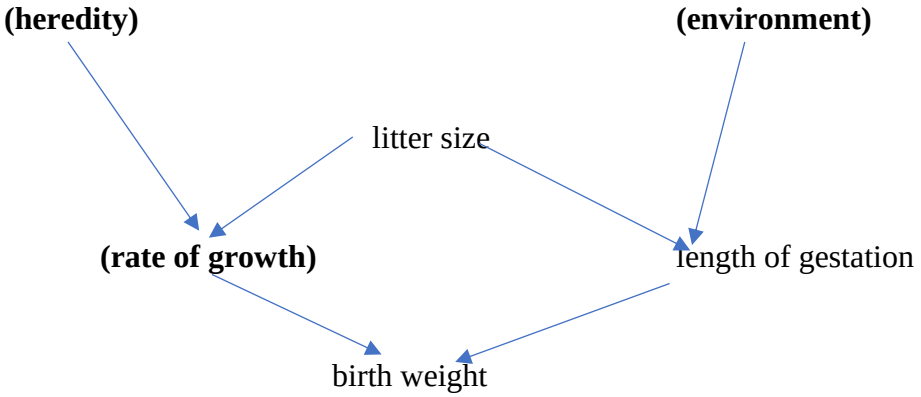


Using the correlation matrix below verify that they are equivalent. Also, double check your conclusions using Dagitty. Report both results.

Input x1, x2, x3, x4, x5; cards;

```
1.0  .  .  .  .
.50 1.0 .  .  .
.60 .40 1.0 .  .
.70 .40 .40 1.0 .
.75 .75 .75 .75 1.0
```

7. Wright (the father of path analysis) observed that guinea pig pups who stayed in utero longer were heavier and had fewer siblings at birth, smaller litters. Wright then considered the following "causal" model:



(Answer a and b assuming that randomization is not possible.)

   a. **Assuming that the variables in parentheses are unmeasured**, show how you would you evaluate the direct effect of length of gestation on birth weight. Please be very clear, so I can tell what you have done.

   b. Assume that we were to replicate the study today and that technology allows you to measure "rate of growth in utero". The rate of growth is no longer an unmeasured variable. Evaluate the effect of **rate of growth** and **length of gestation** on birth weight? What statistic(s) would show the joint effect?

8. Randomization equalizes the groups. It removes all backdoor connections. Nevertheless, it possible to think of a situation in which we must hold a variable constant in spite of randomization; that is, we would run an ANCOVA instead of an ANOVA. Give example of such situation. Explain it using a DAG.

9. Dominance analysis is an important tool when one is interested in variable importance across all possible models. How useful would this analysis be if you were interested in the causal effects? Is this analysis more useful for prediction than causality? Explain.

10. You are studying two types of psychological therapies designed to combat depression. The decision to treat patients with either treatment A or B is made by a clinician and **not by randomization**. The data for the two groups can be found below. Compare the two therapies in terms of remission rates to determine which therapy is more effective. Conduct the naïve analysis, a propensity score analysis, and a covariate analysis. Assume that we have no colliders. Summarize your statistical analyses, results, and conclusion in a brief writeup.

```
data dep; input treat sex age spouse work phg1 remission gender; cards;
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0      0      37     0      0      17     1      0
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0      0      38     1      0      13     0      0
1      0      47     1      0      13     1      0
0      0      50     1      1      19     1      0
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1      1      31     0      0      14     0      1
1      0      31     0      0      17     1      0
0      0      28     1      0      20     0      0
1      0      56     1      0      8      1      0
0      0      32     1      1      11     0      0
0      1      43     1      0      13     1      1
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0      0      34     1      0      21     0      0
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