Bayesian Statistics, Assignment for Friday, Oct. 4

Reading

Study to the end of Chapter 3 of our Bayesian statistics book.

Presentations

To make the reading more lively and to give us all some comic relief, Tahm has volunteered to open Friday's class with a 5-minute presentation on Morton's toe.

For Problem Set 9

Conjoint Tables and Venn Diagrams

In Tuesday's class, we talked about almost all of what you will read about in Chapter 3, except Venn diagrams. Compare Table 3.1 with Figure 3.2 on p. 30. Figure 3.2 is called a Venn diagram.

Also compare Table 3.8 with Figure 3.4 on p. 35. In Table 3.8, you will find four numbers that are on the Venn diagram: 95, 8, 2, and 895. Those four numbers add up to 1000. Those four numbers are the four entries in the 2x2 conjoint table. Make sure you know where the numbers in the table ended up in the Venn diagram.

Problem 1. A Conjoint Table

Recall our made-up numbers for impaired drivers and drivers causing fatal accidents in California: the total number of Californians was 40,000,000; we reckoned that 1,000,000 are impaired at any given time; we said that 4 Californians were the cause of fatal accidents on Sept. 20; finally, we said that of those 4 Californians that caused fatal accidents on Sept. 20, 2 were impaired.

Note that in this "story" some of the values go in the margins of the conjoint table. They don't all go in the main 2x2 block. You have to read and understand the story to figure out what goes where. Enough of the story has been told so that every entry in the table can be filled in. Finish filling in the table:

	Caused a Fatal Accident	Had a Good Day	Sum
Impaired	2		1,000,000
Unimpaired			
Sum	4		40,000,000

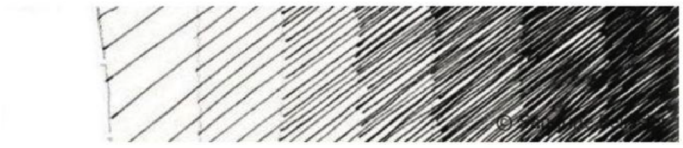
Problem 2. A Venn Diagram

Make a Venn diagram, like the one in Figure 3.4 for the conjoint table in Problem 1. You are putting the four values in the main part of the conjoint table (not the margins), into the diagram.

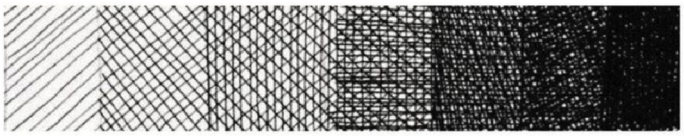
In Figure 3.4, the authors used colors to represent the four regions. The colors were white, pink, light blue, and violet. Unless you have colored pens handy, you can instead use different types of shading. Here are some hatching and cross-hatching ideas (and there are many more ideas if you Google "hatching and cross-hatching"):

In[256]:=

Hatching with lines going in the same direction



Cross hatching with lines going in various directions.



I'm sure you can combine these and other ideas to make a nice Venn diagram:

Bayes Theorem

The simple examples we have been doing are warming you up to the increasingly-complicated ways that Bayes Theorem is actually used. Let's start working at the next level of complication.

Problem 3. Hypotheses and Data

If you want to flip ahead (but I am not suggesting you do), what I am doing in this problem is a little preview of the hypotheses and data in the example on p. 54 of our textbook. When we get to p. 54, H will be Hamilton, ~H will be Madison. The measurements are word frequency counts for 'upon.'

NB: I am having trouble accessing set theory symbols in the program I use to type up problem sets, so I will use && for AND instead of the upside-down U that our textbook uses for AND.

(a) For this part, just fill in all the blanks in the table below.

Out[260]=

	H	~H	Either H or ~H
measurement==0	P(H && M0)	P(~H && M0)	P(M0)
measurement >0 and <=1	P(H && M01)	P(~H && M01)	P(M01)
measurement >1 and <=2			
measurement >2 and <=3	P(H && M23)	P(~H && M23)	P(M23)
measurement >3 and <=4			
measurement >4 and <=5			
measurement >5 and <=6	P(H && M56)	P(~H && M56)	P(M56)
measurement >6 and <=7			
measurement >7 and <=8			
Any measurement		P(~H)	1

(b) Now that you have filled in the blanks, write an equation for P(H | M34) using the entries in the table. HINT: It is a ratio of two of the entries in the table.

(c) Also write an equation for P(M34 | H).

(d) If you did parts (b) and (c) right, both of the equations contain P(H && M34). Do some algebra to use one of the equations to get rid of P(H && M34) in the other. When you are done, you will have an equation that relates P(H | M34) to P(M34 | H).

DISCUSSION: If you flip ahead to p. 60 — just for a moment — you'll see where you will be when we start Term 3 on Tuesday, Oct. 29. We will be making inferences using equations like the equation you