CS 4964: Math for Data **Due: Tuesday 9.13 at noon**

Homework 1: Probability and Bayes' Rule

Instructions: Your answers are due at the beginning of class on the due date. You can either turn in a paper copy, or a pdf version through canvas. I recommend using latex (`http://www.cs.utah.edu/~jeffp/teaching/latex/`) for producing the assignment answers. If the answers are too hard to read you will loose points, entire questions may be given a 0 (e.g. **sloppy pictures with your phone's camera are not ok, but very careful ones are**)

Please make sure your name appears at the top of the page.

You may discuss the concepts with your classmates, but write up the answers entirely on your own. **Be sure to show all the work involved in deriving your answers! If you just give a final answer without explanation, you may not receive credit for that question.**

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1. **[15 points]** For the random variables X and Y, derive the following values
   (a) $\Pr(X = 1)$
   (b) $\Pr(X = 2 \cap Y = 1)$
   (c) $\Pr(X = 3 \mid Y = 2)$

	$X = 1$	$X = 2$	$X = 3$
$Y = 1$	0.1	0.05	0.2
$Y = 2$	0.05	0.25	0.35

2. **[20 points]** Consider rolling two fair die D_1 and D_2; each has a probability space of $\Omega = \{1, 2, 3, 4, 5, 6\}$ which each value equally likely. What is the probability that D_1 has a larger value than D_2? What is the expected value of the sum of the two die?

3. **[10 points]** Let X be a random variable with a uniform distribution over $[0, 2]$; its pdf is described
$$f(X = x) = \begin{cases} 1/2 & \text{if } x \in [0, 2] \\ 0 & \text{if } x \notin [0, 2]. \end{cases}$$
What is the probability that $f(X = 1)$?

4. **[30 points]** Consider a data set D with three data points $\{-1, 7, 4\}$. We want to find a model for M from a restricted sample space $\Omega = \{1, 3, 5\}$. Assume the data has Laplacian noise defined, so from a model m a data point's probability distribution is described $f(x) = \frac{1}{6}\exp(-|m - x|/3)$. Also assume we have an assumption on the models so that $\Pr(M = 1) = 0.4$, $\Pr(M = 3) = 0.3$, and $\Pr(M = 5) = 0.3$. Assuming all data points in D are independent, which model is most likely.

5. **[25 points]** Use python to plot the pdf and cdf of the Laplace distribution ($f(x) = \frac{1}{2}\exp(-|x|)$) for values of x in the range $[-3, 3]$. The function `scipy.stats.laplace` may be useful.