Astronomy 211T **Fall 2017**

Problems for Tutorial Week #3
Signals and Statistics

PART A **Chromey: Ch. 2, problems 7 and 8**

PART B

1. You roll a pair of dice 25 times and get the following: 4, 12, 6, 9, 2, 8, 7, 5, 11, 3, 10, 4, 7, 3, 6, 6, 6, 7, 1, 9, 8, 4, 10, 3, 4. Without using any software or the statistical functions of your calculator, calculate the mean, median, and standard deviation of this sample. Show all work and intermediate values.

2. You observe a star to have an apparent V magnitude of 11.59+/-0.05 on one night, and 11.69+/-0.07 on the next. What is the magnitude difference, and its uncertainty? Is there convincing evidence that the star is variable on a time scale of one day? Explain.

3. Hubble's original data on the velocities of external galaxies included the following:

object (NGC)	598	5357	5194	4214	5236	7331	4151	4649
distance (Mpc)	0.263	0.45	0.5	0.8	0.9	1.1	1.7	2.0
velocity (km/s)	-70	200	270	300	150	500	960	1090

Without using any software or the statistical or least-squares functions of your calculator, determine the slope and y-intercept of the straight line that best fits these data. Show all work and intermediate values. What is R^2 for your fit?

4. In a 10-pc-radius volume around the star TW Hya, there are three stars that lie well above the main sequence and have space velocities of less than 10 km/s relative to the Local Standard of Rest (the speed at which the solar neighborhood is orbiting the Galactic center). In 28 other fields selected in the same way, there are 22 fields with no stars that meet these criteria, 5 fields with one such star, and 1 field with two. Is the TW Hya field unusual? (This is a problem that really had to be solved. When you work the problem, think carefully about whether or not to include the TW Hya field in your calculation of the mean number of stars per field. Should it be included, or omitted? *Taken from E. Jensen*

5. In 1898, an economist and statistician named Ladislaus Bortkiewicz was assigned the task of investigating the number of soldiers in the Prussian army who were accidentally killed by horse kicks. Presumably the motivation was to ascertain the random probability of such events so that any significant deviation from the expected number of fatal kicks could be investigated. The table below contains the raw data by year (across) and battalion (down). Empty cells are zeros.

	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
II				2		2			1	1			2	1	1			2		
III				1	1	1	2		2				1		1	2	1			
IV		1		1	1	1	1					1					1	1		
V					2	1			1			1		1	1	1	1	1	1	
VII	1		1				1		1	1			2			2	1		2	
VIII	1				1			1					1				1	1		1
IX						2	1	1	1		2	1	1		1	2		1		
X			1	1		1		2		2					2	1	3		1	1
XIV	1	1	2	1	1	3		4		1		3	2	1		2	1	1		
XV		1						1		1	1				2	2				

a) These fatal horse kicks are assumed to be random events. What distribution should the annual numbers of these kicks then follow? What is the mean annual number of fatal horse kicks per battalion? Make a table comparing the theoretical probabilities for different numbers of annual fatal kicks per battalion (calculated from your distribution) with the observed probabilities. Show all your work.

b) The XIVth battalion reported 4 fatal kicks in 1882. Would this have warranted an investigation? Suppose it had been 5 fatal kicks? Be quantitative in these assessments.

original article source: Wikipedia; data source: Ladislaus von Bortkiewicz, Das Gesetz der kleinen Zahlen [The law of small numbers] (Leipzig, Germany: B.G. Teubner, 1898).