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MAT 222
Fall 2019
Homework 1

"I'm allergic to sushi. Every time I eat more than 80 pieces, I throw up"
–Andy Dwyer, Parks and Recreation

Problem 1: Watch "Scientific Studies: Last Week Tonight with John Oliver (HBO). What did you learn from the video? Do you think the problems mentioned in the video are scientific problems or communication problems? Explain.

Answers will vary

Problem 2: Watch The Mathematics of History. What did you learn from the video? What implications does the proposals in the video have for Statistics and its role in society? What is question you would like to see investigated using Statistics (or Mathematics generally) in typically non-quantitative fields?

Answers will vary

Problem 3: Each of the type of expressions below appeared in various statistical computations in MAT 221 and appear in MAT 222. Use a calculator to compute each of them.

(a) $\dfrac{1143.2 - 1434.8}{249.7} = \underline{\quad -1.17 \quad}$

(b) $\dfrac{31.5 - 27.6}{7.7/\sqrt{31}} = \underline{\quad 2.82 \quad}$

(c) $\left(\dfrac{1.88 \cdot 8.7}{0.6}\right)^2 = \underline{\quad 743.108 \quad}$

(d) $\dfrac{0.22 \cdot 0.81}{0.65 \cdot 0.91} = \underline{\quad 0.3013 \quad}$

Problem 4: Each of the type of expressions below will appear in various statistical computations in MAT 222. Use a calculator to compute each of them.

(a) $\dfrac{9.2 - 8.3}{\sqrt{\dfrac{2.2^2}{24} + \dfrac{1.8^2}{22}}} = \underline{\quad 1.52 \quad}$

(b) $\dfrac{87.3 - 81.4}{13.3 \cdot \sqrt{\dfrac{1}{15} + \dfrac{1}{18}}} = \underline{\quad 1.27 \quad}$

(c) $\dfrac{(31-1)\cdot 52.3^2 + (28-1)\cdot 53.4^2}{31 + 28 - 2} = \underline{\quad 2790.37 \quad}$

(d) $\sqrt{\dfrac{0.81(1-0.81)}{25} + \dfrac{0.86(1-0.86)}{22}} = \underline{\quad 0.1078 \quad}$

Problem 5: There were 787 documented concussions from 1996–2001 in the National Football League (NFL).[1] Suppose the number of such head injuries followed the distribution $N(780, 121)$. Let X be the random variable representing the number of concussions in the NFL each year. Suppose also that *any* sample from the NFL always uses $N = 45$. Based on this information, complete the following chart:

x	z	Probability
902	1.01	$P(X \le x) = 0.8438$
830	2.77	$P(\overline{X} \le x) = 0.9972$
750	-0.25	$P(X \ge x) = 1 - 0.4013 = 0.5987$
750	-1.66	$P(\overline{X} \ge x) = 1 - 0.0485 = 0.9515$

[1] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3438866/

Problem 6: You work for a technology firm that orders DDR4 memory chips in bulk. The company is opening up a new server data center and needs to order chips. Because no manufacturing process is perfect, some of the chips will be defective. The chip providers claim that no more than 1.5% of chips in any shipment are defective, on average. The company plans to order 1,200 chips from the company, though it only requires 1,170 to run the data center. What is the probability that the company will have too many defective chips to run the data center? Justify your work.

Solution. *The distribution is binomial. Given the n, we use the normal approximation to the binomial distribution. We have $\mu = np = 1200(0.015) = 18$ and $\sigma = \sqrt{1200 \cdot 0.015(1-0.015)} = 4.21$. Then the distribution is approximately $N(18, 4.21)$. The company will have too many defective chips if there are 30 (or more) defective chips. We have*

$$z_{50} = \frac{50-18}{4.21} = 2.85 \rightsquigarrow 0.9978$$

Therefore, $P(X \geq 30) = 1 - 0.9978 = 0.0022 = 0.22\%$. Therefore, it seems likely that the company will have sufficient working chips in the order. Notice that the normal approximation is valid because $np = 18 \geq 10$ and $n(1-p) = 1182 \geq 10$.

Problem 7: Suppose you have a sample with $x_1 = 1.7$, $x_2 = 2.0$, $x_3 = 3.1$, and $x_4 = -2.3$. Find the sample standard deviation, s, and also find $\sum_{i=1}^{4} (x_i - \overline{x})^2$.

Solution. *First, note that $\overline{x} = \dfrac{1.7 + 2.0 + 3.1 + (-2.3)}{4} = \dfrac{4.5}{4} = 1.125$. Then*

x_i	$x_i - \overline{x}$	$(x_i - \overline{x})^2$
1.7	0.575	0.331
2.0	0.875	0.766
3.1	1.975	3.901
−2.3	−3.425	11.731

We know that $\sum_{i=1}^{4} (x_i - \overline{x})^2 = 0.331 + 0.766 + 3.901 + 11.731 = 16.729$. Now we know that $s^2 = \dfrac{1}{n-1} \sum (x_i - \overline{x})^2 = \dfrac{1}{4-1} \cdot 16.729 = 5.576$. Then $s = \sqrt{5.576} = 2.36$.