

(Due Wednesday 08/29/2018 right before class)

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(Your homework shall be stapled if it contains multiple pages.)

FALL/2018/MA526: HOMEWORK 1

Instructor: Guangqu Zheng¹; Grader: Chessa Mccalla²

Total points: 20

Q1 (4 + 3 points) In a study conducted by the Department of Mechanical Engineering at Virginia Tech, the steel rods supplied by two different companies were compared. Ten sample springs were made out of the steel rods supplied by each company, and a measure of flexibility was recorded for each. The data are as follows:

Company A:	9.3	8.8	6.8	8.7	8.5
	6.7	8.0	6.5	9.2	7.0
Company B:	11.0	9.8	9.9	10.2	10.1
	9.7	11.0	11.1	10.2	9.6

- (a) Calculate the sample mean and median for the data for the two companies.
- (b) Plot the data for the two companies on the same line and compute the sample variance for the two companies.

Q2 (1 + 2 + 2 points) Fix an integer $n \geq 2$ and consider the sample x_1, \dots, x_n .

- (a) Recall the definition of sample average and median. Is sample median always bigger than sample average?
- (b) If $f(x) = mx + c$ with $m \neq 0$ and c any given real number, then we call f a linear function. Putting $y_i = f(x_i)$, we get a new sample y_1, \dots, y_n . What is the relation between the sample average of x_1, \dots, x_n and the sample average of y_1, \dots, y_n ?
- (c) Following question (b): What is the relation between the sample variance of x_1, \dots, x_n and the sample variance of y_1, \dots, y_n ?

Q3 (4 points) Let x_1, \dots, x_n be nonnegative real numbers. Let $a \geq 0$ and define

$$\mathbb{P}(x \geq a) = \frac{\text{the number of } x_i \geq a}{n}$$

Show that $a\mathbb{P}(x \geq a) \leq \bar{x}$. Here \bar{x} means the sample average of x_1, \dots, x_n .

Q4 (4 points) Let Ω be our sample space in this question. It models all possible outcomes from our (imaginary) experiment, so it is a nonempty set by default. Let A, B, C be subsets of Ω , written as $A \subset \Omega$, $B \subset \Omega$ and $C \subset \Omega$. Are the following statements true or false? Justify your response carefully.

- (i) If $A \subset B$, then $A^c \subset B^c$. (A^c stands for the complement of the set A .)
- (ii) If $A \subset B$, then $A \cap C \subset B \cap C$.
- (iii) If $A \subset B$, then $A \cup C \subset B \cap C$.
- (iv) If $A \cap C \subset B \cap C$, then $A \subset B$.

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