

## MATH 120: Quiz 2 - 1/31/2019

No reference materials permitted except calculator.

Shown below, in ascending order, are per-capita carbon dioxide emissions in 2017 for 14 countries (in units of metric tons of CO<sub>2</sub> per person):

2.4, 4.1, 5.7, 6.6, 6.8, 7.9, 8.0, 9.2, 9.4, 12.5, 12.6, 16.2, 18.0, 22.3

(a) Sketch a suitably scaled, neat, accurate, boxplot for these data.

[Show all needed steps & calculations - display alone not sufficient.]

(b) An environmental conservation organization, lobbying for cutting CO<sub>2</sub> emissions worldwide, claims that some reductions can be attained via relatively simple changes. They argue that a reasonable short-term CO<sub>2</sub> emission target for each of these 14 countries is:  $y = 0.9x - 1$ , where  $x$  = original per-capita CO<sub>2</sub> emissions,  $y$  = new emissions after reductions. If each country adopts this target, find the median and IQR of per-capita emissions. [Hint: If this takes more than about 1 minute, you may be approaching it incorrectly!]

### Solution

(a) There are 14 data values here, already in ascending order. Therefore:

Median = average of 7th & 8th value =  $(8+9.2)/2 = 8.6$  tons per-capita

Q1 = median of lower 7 values = 4th value = 6.6 tons per-capita

Q3 = median of upper 7 values = 11th value = 12.6 tons per-capita

5-number summary: min = 2.4, Q1 = 6.6, med = 8.6, Q3 = 12.6, max = 22.3. (all values in metric tons of CO<sub>2</sub> per-capita )

IQR =  $12.6 - 6.6 = 6$  tons per-capita

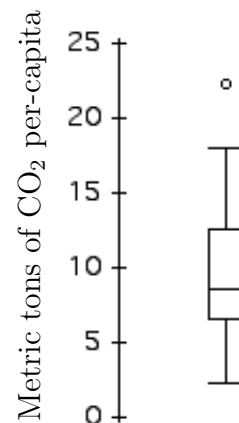
Upper fence:  $Q3 + 1.5 \text{ IQR} = 12.6 + 9 = 21.6$

⇒ outlier at 22.3.

Lower fence:  $Q1 - 1.5 \text{ IQR} = 6.6 - 9 = -2.4$

⇒ no low outliers.

Boxplot sketch shown on the right.



(b) The new emissions target represents a rescaling of the original data, via the formula:

$$y = 0.9x - 1$$

Position based statistics (such as median) are affected by both addition and multiplication. Spread based statistics (such as IQR) are affected by multiplication only.

Therefore, the new median =  $0.9 \times (\text{old median}) - 1 = 0.9 \times 8.6 - 1 = \boxed{6.74}$  tons per-capita

$$\text{new IQR} = 0.9 \times (\text{old IQR}) = 0.9 \times 6 = \boxed{5.4} \text{ tons per-capita}$$

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**Grading:** Total points possible = 6.

4 pt for (a): 1.5pt = find correct median, Q1, and Q3 for original data.

1pt = boxplot fence calculations.

1.5pt = correct boxplot (with outlier, and axis labels for full credit).

2 pt for (b): 1 pt each for median, IQR.

Full credit requires calculation step or reasoning.