MTH1W – Unit 9: Statistics

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Lesson #9.3: Measure of Spread: Box and Whisker Plot

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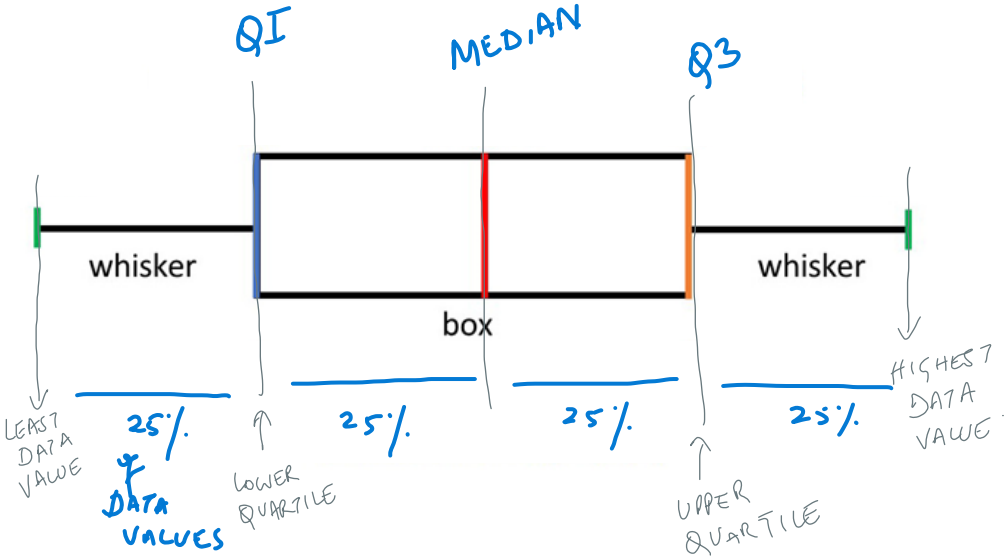
Learning Goal: We are learning to calculate the Interquartile Range and draw a Box and Whisker Plot.

In yesterday's homework, Elon Musk joined the lunch table and you calculated the new average and median of everyone's salary. Hopefully, you noticed that the average went up considerably. In fact, if we calculated the standard deviation, we would get $316,000,000 even though no one else earned over $100,000! The one billion salary greatly skewed the data and, in a way, messes up with our analysis and measure of spread.

Thankfully, there is more than one measure of spread! If you noticed in that question, the median was unchanged. The measure of spread connected to the median is the Interquartile Range and the Box and Whisker Plot. Let's take a look:



* IQR = Q3 − Q1

We need to break the data up into quarters. Here's what we do!

1. Determine the median. This is the middle of a list and splits the list in half.
2. Determine the first/lower quartile by finding the median of the first half of the data (call this Q1).
3. Determine the third/upper quartile by finding the median of the second half of data (call this Q3).
4. Calculate the Interquartile Range (IQR) by Q3 – Q1
5. Draw!

Example 1a: The numbers below are the points earned by the Toronto Maple Leafs in their last seventeen full seasons.

68, 69, 74, 80, 81, 83, 84, 85, 90, 90, 91, 95, 96, 100, 100, 103, 105

Middle # → $\frac{17+1}{2} = \frac{18}{2} = 9$

lower end

$Q1 = \frac{80+81}{2} = 80.5$

MEDIAN

$Q3 = \frac{96+100}{2} = 98$

upper end

* if there were EVEN data points:

68, 69, 74, 80, 81, 83, 84, 85

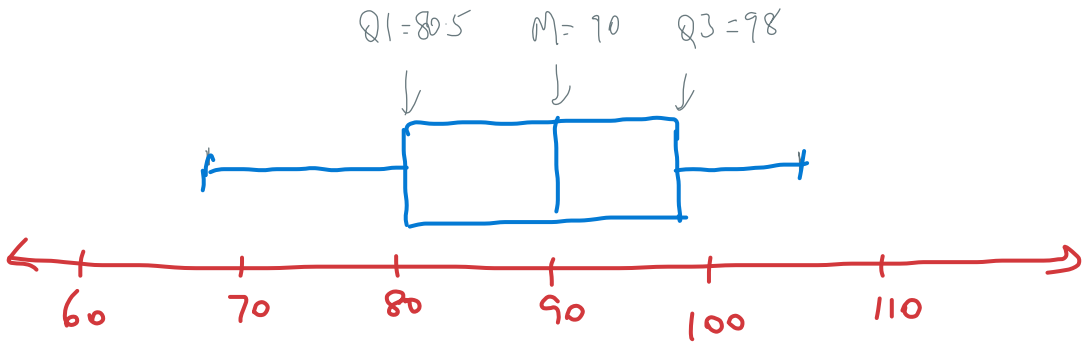
80.5

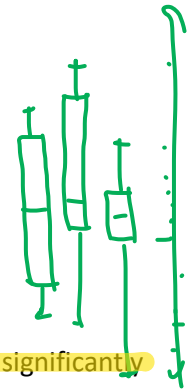
Q1

Q3

* IQR = Q3 − Q1
= 98 − 80.5
= 17.5

Draw:





Going back to the lunch table question, Elon Musk's salary is called an outlier. An outlier is a data value that significantly differs from the rest of the data. If we were to sketch the box and whisker for this, it would look like this:

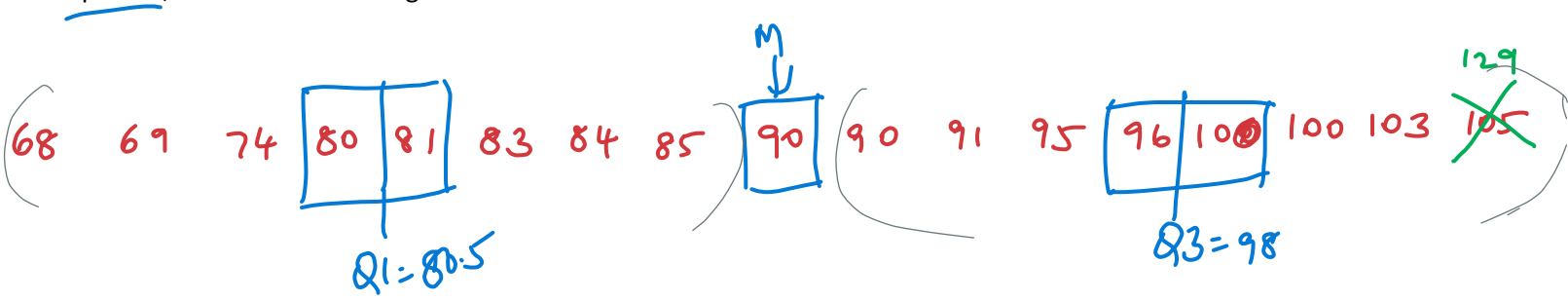
Very messy and uninformative. If there is an outlier, we can draw this differently. There are different ways to determine if a data value is an outlier, but we will stick with using the Interquartile Range to create "thresholds" for where data values become outliers.

Lower Threshold = $Q1 - (1.5 \times IQR)$ * $IQR = Q3 - Q1$

Upper Threshold = $Q3 + (1.5 \times IQR)$

If you have an outlier, then the whiskers go to the lowest and highest non-outlier values.

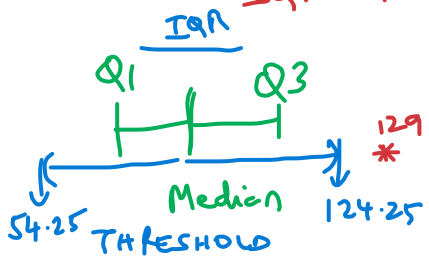
Example 1b: One of the points from 1a were incorrect. 105 was supposed to be 129 The median, lower and upper quartile, and IQR are unchanged. Determine the outlier thresholds.



LOWER THRESHOLD = $Q1 - (1.5 \times IQR)$
$= 80.5 - (1.5 \times 17.5)$
$= 80.5 - 26.25$
$= 54.25$

UPPER THRESHOLD = $Q3 + (1.5 \times IQR)$
$= 98 + (1.5 \times 17.5)$
$= 98 + 26.25$
$= 124.25$

$IQR = Q3 - Q1$
$IQR = 17.5$



∴ 129 is an OUTLIER

Success Criteria:

- I can calculate the median, lower and upper quartiles, interquartile range, and outlier thresholds.
- I can draw a box and whisker plot.