

Presentation:  
CHAPTER 4. DISTRIBUTIONS OF RANDOM VARIABLES

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**Question 4.3 pg.142**

**GRE scores, Part I.**

Sophia who took the Graduate Record Examination (GRE) scored **160** on the Verbal Reasoning section and **157** on the Quantitative Reasoning section. The mean score for Verbal Reasoning section for **all** test takers was **151** with a **standard deviation** of **7**, and the mean score for the Quantitative Reasoning was **153** with a **standard deviation** of **7.67**. Suppose that both distributions are nearly normal.

(a)

Write down the short-hand for these two normal distributions.

*Reference Section 4.1 pg. 133*

**Verbal reasoning section:  $N(\mu = 151, \sigma = 7)$**

**Quantitative Reasoning section:  $N(\mu = 153, \sigma = 7.67)$**

(b)

(i)

What is Sophia's Z-score on the Verbal Reasoning section?

*Reference 4.1.2 pg. 134*

**$Z = \frac{x - \mu}{\sigma}$  Where  $x_{verbal} = 160$**

**$(160 - 151) / 7$**

**## [1] 1.285714**

(ii)

On the Quantitative Reasoning section?

Where  $x_{quantitive}=157$

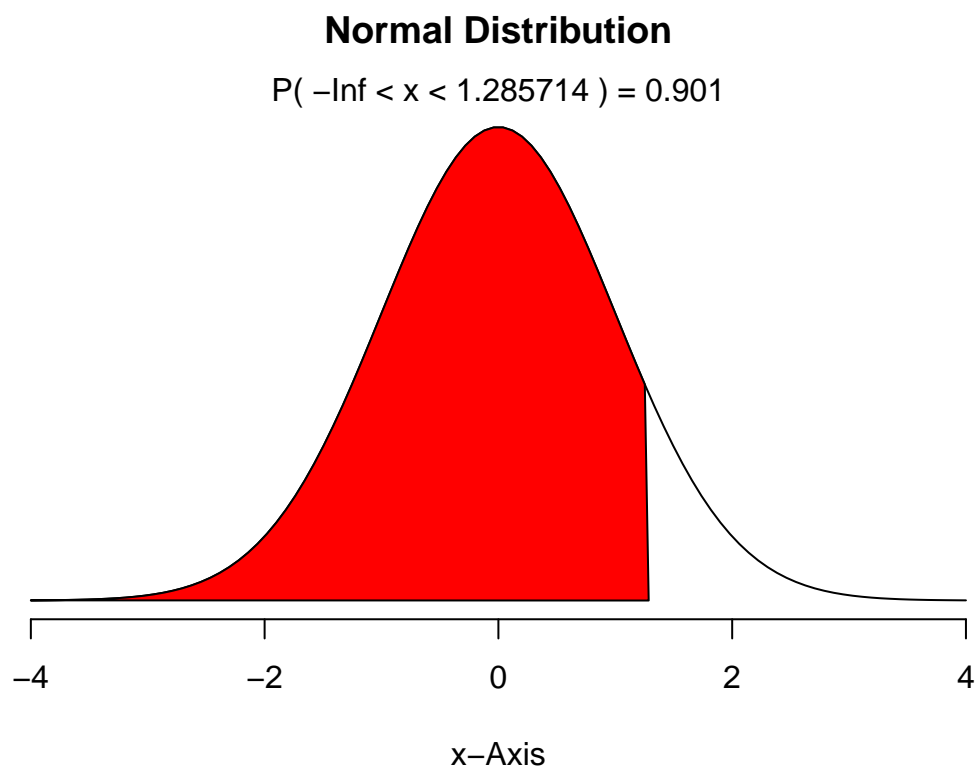
$(157-153)/7.67$

## [1] 0.5215124

(iii)

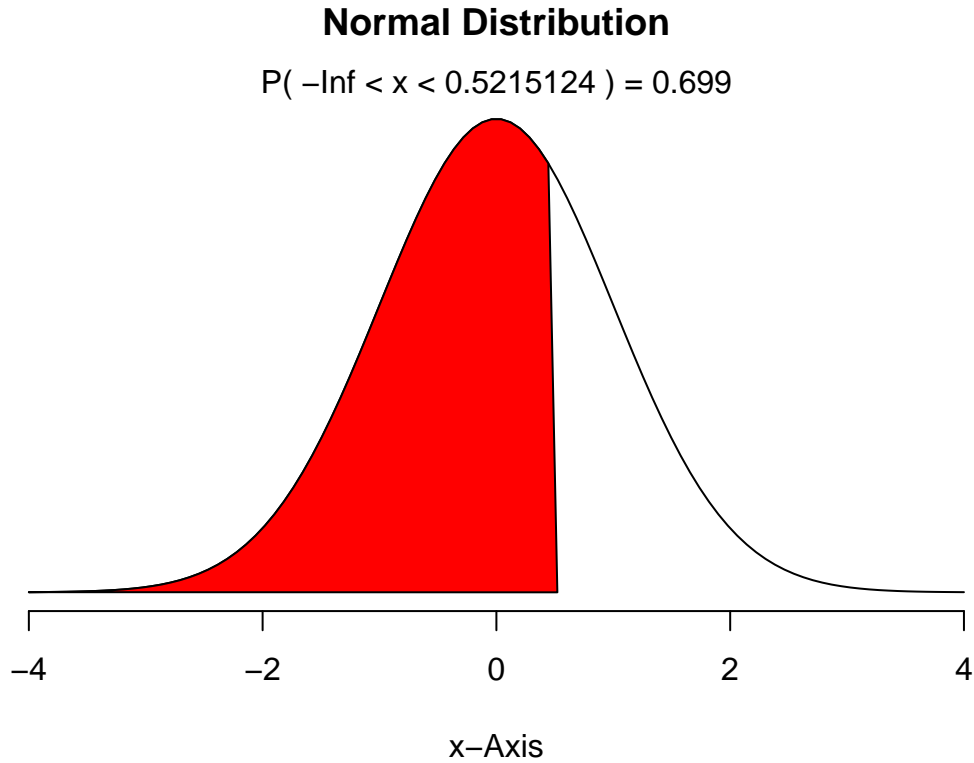
Draw a standard normal distribution curve and mark these two Z-scores.

## [1] 0.9007286



(iv)

## [1] 0.6989951



(c)

What do these Z-scores tell you?

**The Z-scores tell us how far above the mean Sophia scored for each section.**

**For the verbal section Sophia scored 1.285714 standard deviations above the mean.**

**For the quantitative section Sophia scored 0.5215124 standard deviations above the mean.**

(d)

Relative to others, which section did she do better on?

**Sophia's Z-score for the Verbal Reasoning Section is higher indicating she did better on that section relative to others**

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(e)

Find her percentile scores for the two exams. *Using normalPlot() or pnorm() results about*

**Verbal Reasoning Section: 90th percentile**

**Quantitative Reasoning Section: 70th percentile**

(f)

(i)

What percent of the test takers did better than her on the Verbal Reasoning section?

*Using 1-pnorm(Z-score) where one represents 100% of the population minus Sophia's percentile ranking*

*Or subtracting percentages provided e.g.  $100\% - 90\% = 10\%$*

**10% of the test takers did better than Sophia on Verbal Reasoning Section**

```
1-pnorm(1.285714)
```

```
## [1] 0.09927145
```

(ii)

On the Quantitative Reasoning section?

*Using 1-pnorm(Z-score) where one represents 100% of the population minus Sophia's percentile ranking*

*Or subtracting percentages provided e.g.  $100\% - 70\% = 30\%$*

**30% of the test takers did better than Sophia on Verbal Reasoning Section**

```
1-pnorm(0.5215124)
```

```
## [1] 0.3010049
```

(g)

Explain why simply comparing raw scores from the two sections could lead to an incorrect conclusion as to which section a student did better on.

**The weight of Sophia's raw score is on a different scaling system, so comparing her performance against the population makes sense in concluding how well she did.**

(h)

If the distributions of the scores on these exams are not nearly normal, would your answers to parts (b)-(f) change? Explain your reasoning.

**Z-scores will still be calculated with the same formula, but without a nearly normal distribution, we would not be able to use the normal probability table. Therefore we could answer (b)-(c) but not (d)-(f).**