Formative Assessment 8

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Problem 1

An analogue signal received at a detector, measured in microvolts, is normally distributed with mean of 200 and variance of 256.

that is, X ~ N(200, 16).

a. What is the probability that the signal will exceed 224 μV?

P(X > 224)

```
mean <- 200
variance <- 256
standard_dev <- sqrt(variance)
threshold <- 224

prob <- 1 - pnorm(threshold, mean, standard_dev)

print(prob)
```

```
## [1] 0.0668072
```

b. What is the probability that it will be between 186 and 224 μV?

```
l_threshold <- 186
u_threshold <- 224

l_prob <- pnorm(l_threshold, mean, standard_dev)
u_prob <- pnorm(u_threshold, mean, standard_dev)

prob <- u_prob - l_prob
prob1 <- prob/(1-l_prob)
print(prob1)
```

```
## [1] 0.9174418
```

c. What is the micro voltage below which 25% of the signals will be?

```
percentile <- 0.25

threshold <- qnorm(percentile, mean, standard_dev)

print(threshold)
```

```
## [1] 189.2082
```

d. What is the probability that the signal will be less than 240 μV, given that it is larger than 210 μV?

P(X < 240|X > 210)

```
l_threshold <- 210
u_threshold <- 240

l_prob <- pnorm(l_threshold, mean, standard_dev)
u_prob <- pnorm(u_threshold, mean, standard_dev)

prob <- u_prob - l_prob
prob1 <- prob/(1-l_prob)
print(prob1)
```

```
## [1] 0.9766541
```

e. Estimate the interquartile range.

```
percentiles <- c(0.25, 0.75)

quantiles <- quantile(rnorm(100000, mean, standard_dev), probs = percentiles)

IQR <- quantiles[2] - quantiles[1]

print(IQR)
```

```
##      75%
## 21.69276
```

f. What is the probability that the signal will be less than 220 μV, given that it is larger than 210 μV?

P(X < 220|X > 210)

```
l_threshold <- 210
u_threshold <- 220

l_prob <- pnorm(l_threshold, mean, standard_dev)
u_prob <- pnorm(u_threshold, mean, standard_dev)

prob <- u_prob - l_prob
prob1 <- prob/(1-l_prob)
print(prob1)
```

```
## [1] 0.6027988
```

g. If we know that a received signal is greater that 200 μV, what is the probability that is in fact greater than 220 μV?

```
threshold_1 <- 200
threshold_2 <- 220

conditional_prob <- pnorm(threshold_2, mean, standard_dev) - pnorm(threshold_1, mean, standard_dev)

print(conditional_prob)
```

```
## [1] 0.3943502
```

Problem 2

A manufacturer of a particular type of computer system is interested in improving its customer support services. As a first step, its marketing department has been charged with the responsibility of summarizing the extent of customer problems in terms of system failures. Over a period of six months, customers were surveyed and the amount of downtime (in minutes) due to system failures they had experienced during the previous month was collected. The average downtime was found to be 25 minutes and a variance of 144. If it can be assumed that downtime is normally distributed:

a. obtain bounds which will include 95% of the downtime of all the customers;

b. obtain the bound above which 10% of the downtime is included.

```
meandwntm <- 25  # average downtime
vrnce <- 144      # variance

# Confidence interval bounds (95%)
alpha <- 0.05  # significance level
zScore <- qnorm(1 - alpha/2)  # z-score for 95% confidence interval
marginOfError <- zScore * sqrt(vrnce)  # margin of error
lowerBound <- meandwntm - marginOfError
upperBound <- meandwntm + marginOfError

quanBound <- qnorm(0.9, mean = meandwntm, sd = sqrt(vrnce))

cat("95% of the downtime lies between", round(lowerBound, 2), "and", round(upperBound, 2), "minutes.\n")
```

```
## 95% of the downtime lies between 1.48 and 48.52 minutes.
```

```
cat("Above", round(quanBound, 2), "minutes, 10% of the downtime is included.")
```

```
## Above 40.38 minutes, 10% of the downtime is included.
```