Homework One(P8130)

Problem 1

a. The survival status is a binary variable because there are only two options.

b. The stage of cancer is an ordinal variable because there is an order.

c. The type of vaccine is a nominal variable because there isn' t an order.

d. The body temperature is a continuous variable.

e. The number of emergency room visits is a discrete variable.

f. The pain level is an ordinal variable.

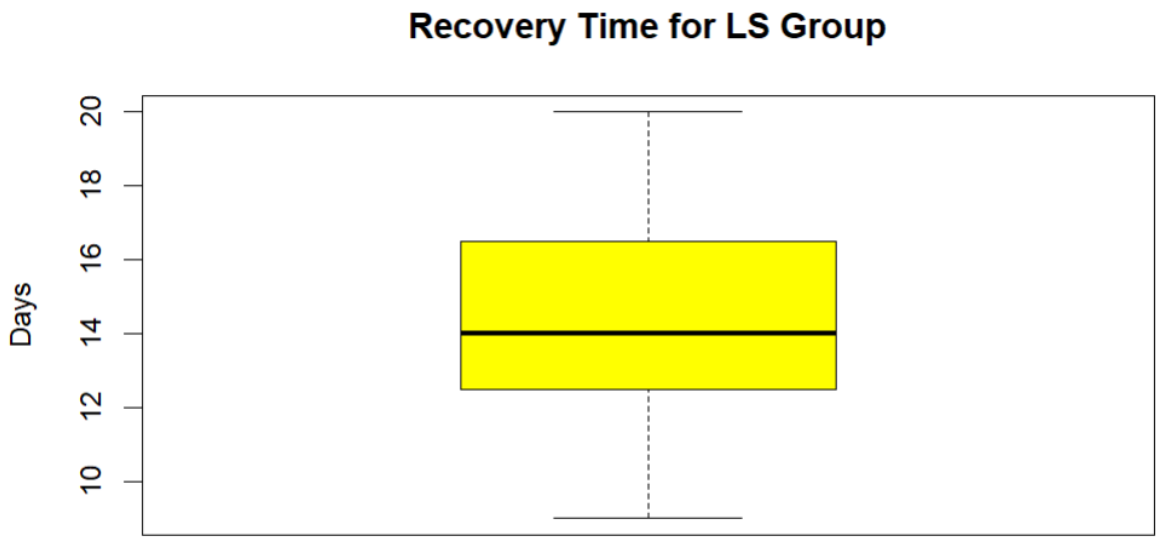
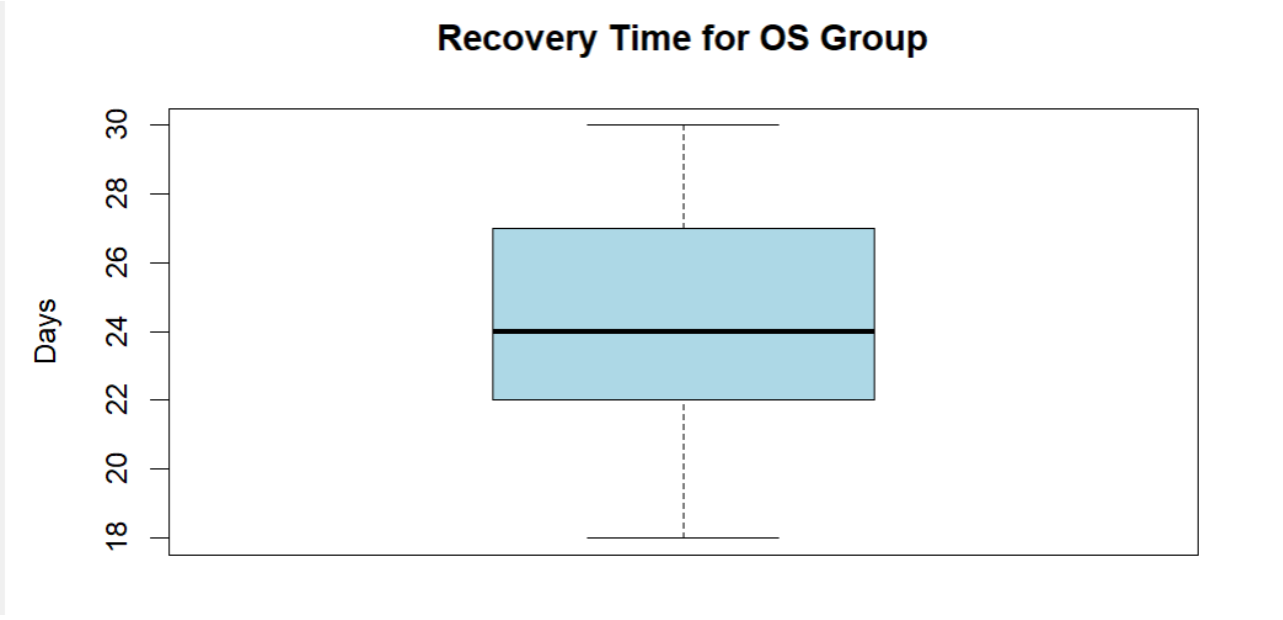
g. The systolic blood pressure is a continuous variable.

h. The diabetes status is an ordinal variable.

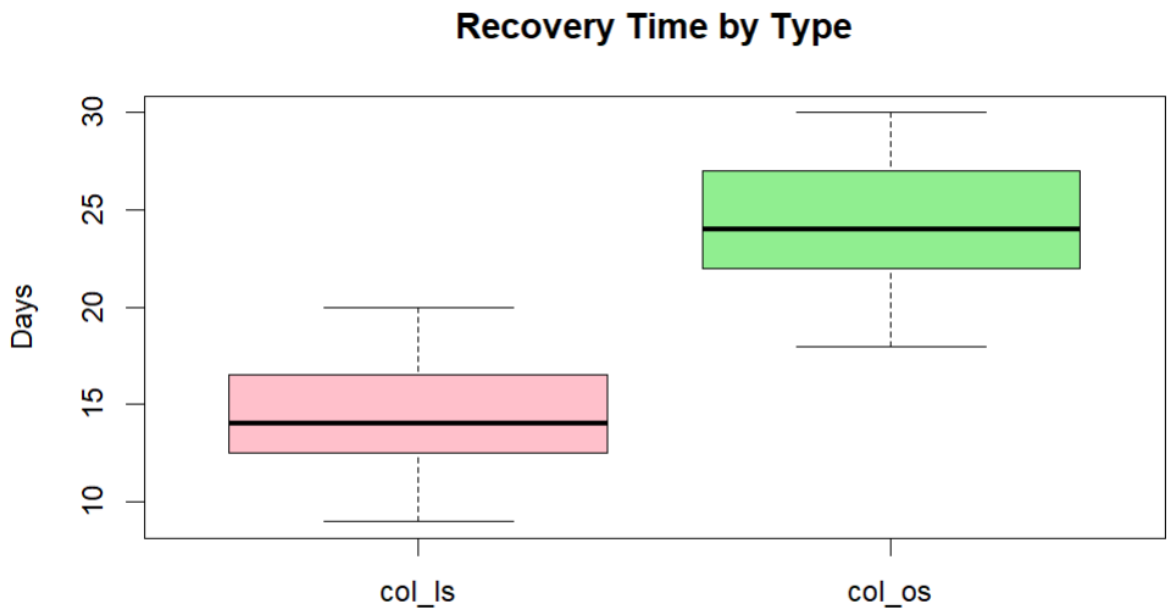
Problem 2

a. After calculation in R, the mean is 14.4, the median is 14, the range is $20 - 9 = 11$ and the standard deviation is 3.224903.

```
## Question a
```{r}
ls_mean = mean(vec_ls)
ls_median = median(vec_ls)
ls_range = range(vec_ls)
ls_sd = sd(vec_ls)

ls_mean
ls_median
ls_range
ls_sd
```

The mean of recovery time for the laparoscopic group is **`r ls_mean`**, median is **`r ls_median`**, the minimum is **`r min(vec_ls)`**, the maximum is **`r max(vec_ls)`** and standard deviation is **`r ls_sd`**.
```

b. The boxplot for LS group



The distribution is more like symmetric, because the upper part of this plot is nearly the same size of the lower one and there are no outliers. As for modality, we cannot find the result from this boxplot, but what we can find out from the data set itself is that most data concentrates between 12 and 16 and there is only one peak.

Here is the R code below.

```
## Question b
```{r drawing a boxplot}
boxplot(vec_ls,
        main = "Recovery Time for LS Group",
        ylab = "Days",
        col = "yellow",
        border = "black"
        )
```
```

c. The mean for OS group is 24.21429, the median is 24, the range is $30 - 18 = 12$ and the standard variance is 3.512145.

```
## Question c
```{r}
os_mean = mean(vec_os)
os_median = median(vec_os)
os_range = range(vec_os)
os_sd = sd(vec_os)

os_mean
os_median
os_range
os_sd
```
```

```
[1] 24.21429
[1] 24
[1] 18 30
[1] 3.512145
```

```
The mean of recovery time for the laparoscopic group is **`r os_mean`**, median is **`r os_median`**, the minimum is **`r min(vec_os)`**, the maximum is **`r max(vec_os)`** and standard deviation is **`r os_sd`**.
```

d. The boxplot for OS group



I think this one is also symmetric which means there are no outliers and the width of each part is similar. As for modality, I suppose this distribution is unimodal and has only one peak.

Here is the R code below.

```
## Question d
```{r}
boxplot(vec_os,
        main = "Recovery Time for OS Group",
        ylab = "Days",
        col = "lightblue",
        border = "black"
        )
```
```

e. The boxplots for both groups



f. We can see clearly from the plots that patients in the LS group tend to recover faster the those in the other group because of the means and medians.

g. We usually describe outliers as those which are bigger than $Q3 + 1.5 * (Q3 - Q1)$ or smaller than $Q1 - 1.5(Q3 - Q1)$. The outliers usually don' t affect medians but do have an obvious impact on means, which can make the average location of a dataset away from the normal one.

```
> summary(vec_ls)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
    9.0    12.5    14.0    14.4    16.5    20.0
> summary(vec_os)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  18.00   22.00   24.00   24.21   26.75   30.00
```

Based on the calculation results above, there are no outliers in both groups.

h. There are some limitations. For example, the sample is small, which means that the outcomes are sensitive to outliers and the estimations are not stable. Besides, there are some other factors that we have not considered like age and medical history which do have huge impacts on the recovery time.

Perhaps we can add more samples and paint histograms.

Problem 3

Proof: We know that $P(A \mid B) = \frac{P(A \cap B)}{P(B)}$, if $P(A \mid B) = P(A)$, then we can get: $P(A) = \frac{P(A \cap B)}{P(B)}$.

Thus, $P(A \cap B) = P(A)P(B)$. Therefore, $P(B \mid A) = \frac{P(A \cap B)}{P(A)} = \frac{P(A)P(B)}{P(A)} = P(B)$.

Problem 4

a. There are 120 people exercising regularly, so $P(A) = 120/200 = 0.6$. There are 70 people consume sugary drinks daily, so $P(B) = 70/200 = 0.35$.

b. First, we need to calculate $P(A \cap B)$.

There are 40 adults both exercise regularly and consume sugary drinks daily, so $P(A \cap B) = 0.2$.

Then, based on the equality $P(A \cup B) = P(A) + P(B) - P(A \cap B)$, we can get $P(A \cup B) = 0.6 + 0.35 - 0.2 = 0.75$

c. $P(B \mid A) = \frac{P(A \cap B)}{P(A)}$ = 0.2/0.6 = $\frac{1}{3}$

d.

We know that $P(A)=0.6$, $P(B)=0.25$, $P(B|A)=\frac{1}{3}$

$$P(A|B^c)=\frac{P(B^c|A)\cdot P(A)}{1-P(B)}=\frac{(1-P(B|A))\cdot P(A)}{1-P(B)}=\frac{(1-\frac{1}{3})\times 0.6}{1-0.25}\approx 0.6154$$

e.

A and B are not independent.

Proof: $P(A\cap B)=0.2$, $P(A)=0.6$, $P(B)=0.35$

It's clear that $0.2\neq 0.6\times 0.35$, then $P(A\cap B)\neq P(A)P(B)$

Therefore, A and B are dependent.

f.

$P(A\cap B^c)=P(A)-P(A\cap B)=0.6-0.2=0.4$

We've learned that two adults're selected independently, then the probability is $0.4\times 0.4=0.16$

Problem 5

a.

Let women having dementia be event A and showing positive finding be event B.

Then we can get $P(A)=0.2$, $P(B|A)=0.7$, $P(B|A^c)=0.15$

$$P(A|B)=\frac{P(B|A)\cdot P(A)}{P(B\cap A)+P(B\cap A^c)}=\frac{P(B|A)\cdot P(A)}{P(B|A)\cdot P(A)+P(B|A^c)\cdot P(A^c)}$$

$$=\frac{0.7\times 0.2}{0.7\times 0.2+0.15\times 0.8}\approx 0.5385$$

b.

$$P(A^c|B^c)=\frac{P(B^c|A^c)\cdot P(A^c)}{1-P(B)}=\frac{(1-0.15)\times(1-0.2)}{1-(0.7\times 0.2+0.15\times 0.8)}\approx 0.9189$$

c. If someone has a negative finding, then it is very likely that she doesn't have dementia(P = 0.9189). However, if the finding is positive, then the possibility of having dementia and not having dementia is nearly fifty-fifty(0.5385-0.4615). Thus, the negative findings are more reliable than the positive ones when it comes to diagnose.

The R markdown file can be found here:

https://github.com/ChrisW12372/2025-09-15_p8130-homework01_r-codes