R for Statistical Computing

R codes for Example 10.3:

With n pairs of untied observations, i.e., $n = r + s$ and $w = max(r, s)$, the sign test can be carried out using the following sentence:

```
2*(1-pbinom(w-1,n,0.5))
```

Codes for sign test:

```
#Sign test
x <- c(9, 5, 9 ,10, 13, 8, 8, 13, 18, 30)
y <- c(10, 6, 9, 8, 11, 4, 1, 3, 3, 10)
2*(1-pbinom(7-1,9,0.5))
```

Output:

```
[1] 0.1796875
```

Codes for large sample sign test:

```
#Large sample sign test
z = 2
n = 9
p = 0.5
prop.test(z, n, p,correct=FALSE) #no continuity correction
```

Output:

```
1-sample proportions test without continuity correction

data:  z out of n, null probability p
X-squared = 2.7778, df = 1, p-value = 0.09558
alternative hypothesis: true p is not equal to 0.5
95 percent confidence interval:
 0.06322511 0.54741103
sample estimates:
```

```
        p
0.2222222

Warning message:
Chi-squared approximation may be incorrect in: prop.test
(z, n, p, correct = FALSE)
```

R codes for Example 10.4:

Example 10.4 is a situation of a paired comparison with ties. In that case, the appropriate R package to use is wilcox.exact. The package wilcox.exact is stored in the library exactRankTests, which is one of the contributed libraries in R. To use wilcox.exact, therefore, the library exactRankTests has to be loaded.

Codes for the Wilcoxon sign rank test, with ties:

```
#Exact test Wilcoxon sign rank test with ties
x <- c(9, 5, 9 ,10, 13, 8, 8, 13, 18, 30)
y <- c(10, 6, 9, 8, 11, 4, 1, 3, 3, 10)
library(exactRankTests) #load the library exactRankTests
wilcox.exact(y,x, paired = TRUE, alternative = "two.sided")
```

Output:

```
Exact Wilcoxon signed rank test

data:  y and x
V = 3, p-value = 0.01563
alternative hypothesis: true mu is not equal to 0
```

Codes for the large sample Wilcoxon sign rank test, with ties:

```
#Large sample sign rank test
x <- c(9, 5, 9 ,10, 13, 8, 8, 13, 18, 30)
y <- c(10, 6, 9, 8, 11, 4, 1, 3, 3, 10)
library(exactRankTests) #load the library exactRankTests
wilcox.exact(y,x,paired=TRUE, alternative = "two.sided",
            exact = FALSE)
```

Output:

```
Asymptotic Wilcoxon signed rank test

data:  y and x
V = 3, p-value = 0.02066
alternative hypothesis: true mu is not equal to 0
```

R codes for Example 10.5:

This set of codes is only appropriate if there are no ties. If there are ties, the package wilcox.exact should be used (see R codes for Example 10.6).

Codes for Wilcoxon rank sum test, without ties:

```
#Exact test
x <- c(14,11,37,17,21)
y <- c(8,13,9)
wilcox.test(y,x,paired=FALSE,alternative="two.sided",
            exact = TRUE)
```

Output:

```
        Wilcoxon rank sum test

data:  y and x
W = 1, p-value = 0.07143
alternative hypothesis: true mu is not equal to 0
```

Codes for large sample Wilcoxon rank sum test with no ties:

```
#Large sample rank sum test with no ties
x <- c(14,11,37,17,21)
y <- c(8,13,9)
wilcox.test(y,x,paired=FALSE,alternative="two.sided",
            exact = FALSE, correct = FALSE)
```

Output:

```
Wilcoxon rank sum test

data:  y and x
W = 1, p-value = 0.05263
alternative hypothesis: true mu is not equal to 0
```

R codes for Example 10.6:

This is another example of a two sample test. But in this example, there are ties. The two sample Wilcoxon-Mann-Whitney test with ties can also be carried out using the package wilcox.exact.

Codes for Wilcoxon rank sum test with ties:

```
#Wilcoxon rank sum test with ties
x <- c(4, 6, 8, 8, 9, 10, 13, 13, 18, 30)
y <- c(1, 3, 3, 5, 8, 9, 9, 10, 10, 11)
library(exactRankTests) #load the library exactRankTests
wilcox.exact(y,x,paired=FALSE, alternative = "two.sided",
            exact = TRUE)
```

Output:

```
Exact Wilcoxon rank sum test

data:  y and x
W = 30, p-value = 0.136
alternative hypothesis: true mu is not equal to 0
```

Codes for large sample Wilcoxon rank sum test with ties:

```
#Large sample Wilcoxon-Mann-Whitney rank sum test with continuity correction
x <- c(4, 6, 8, 8, 9, 10, 13, 13, 18, 30)
y <- c(1, 3, 3, 5, 8, 9, 9, 10, 10, 11)
library(exactRankTests) #load the library exactRankTests
wilcox.exact(y,x,paired=FALSE, alternative = "two.sided",
            exact = FALSE, correct = FALSE)
```

Output:

```
Asymptotic Wilcoxon rank sum test

data:  y and x
W = 30, p-value = 0.1285
alternative hypothesis: true mu is not equal to 0
```

R codes for Example 10.7:

Codes for Spearman correlation:

```
#Spearman correlation
x <- rank(c(9, 5, 9 ,10, 13, 8, 8, 13, 18, 30),ties.method="average")
y <- rank(c(10, 6, 9, 8, 11, 4, 1, 3, 3, 10),ties.method="average")
cor(x,y)
```

Output:

```
[1] 0.2707705
```

The output using R is slightly different from that by formula (10.1) because that formula gives an approximation only. Nevertheless, the two results are close enough for all practical purposes.