HUDM 6026 HW8

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1

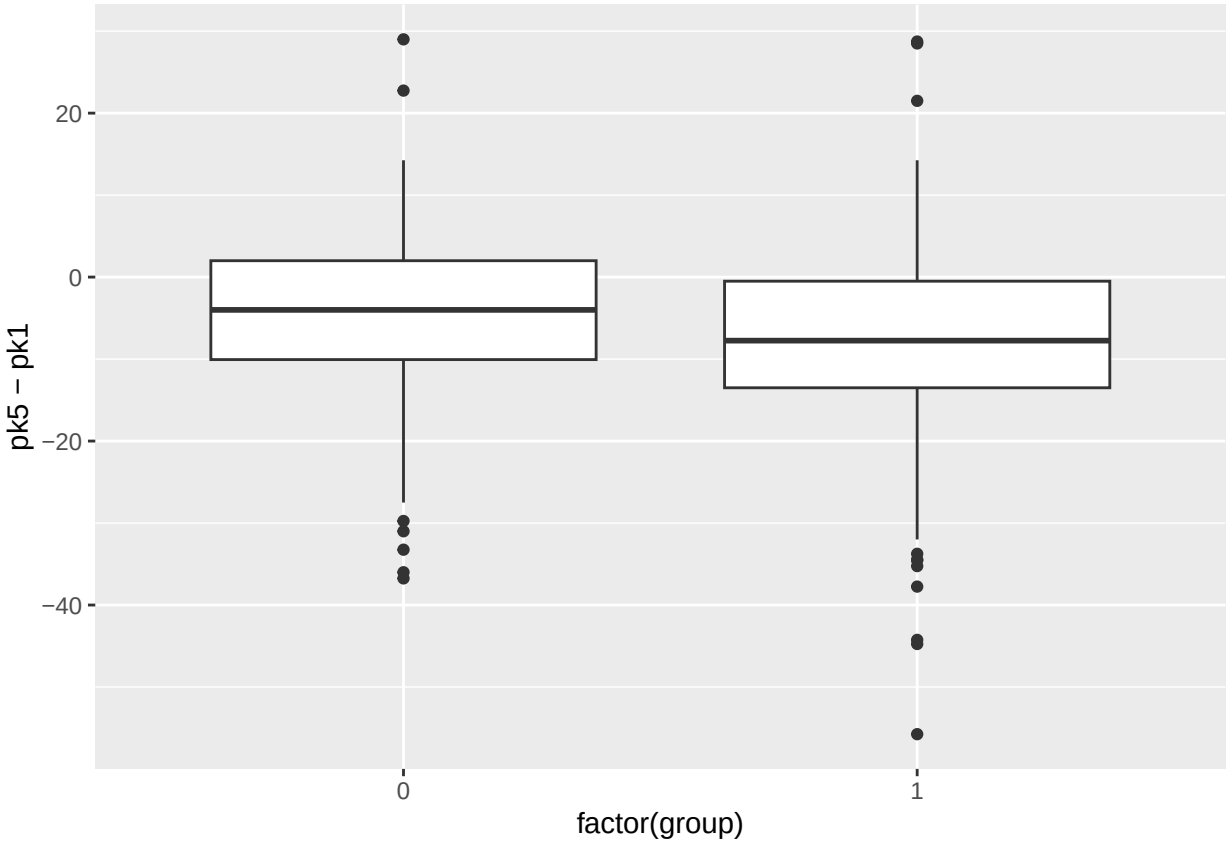
```
data <- read.csv("D:/School/acupuncture.csv")
t.test(pk5-pk1 ~ group, data=data, val.equal = false)
```

```
##
##  Welch Two Sample t-test
##
## data:  pk5 - pk1 by group
## t = 2.9729, df = 297.94, p-value = 0.003191
## alternative hypothesis: true difference in means between group 0 and group 1 is not equal to 0
## 95 percent confidence interval:
##  1.339278 6.584790
## sample estimates:
## mean in group 0 mean in group 1
##       -4.367262       -8.329296
```

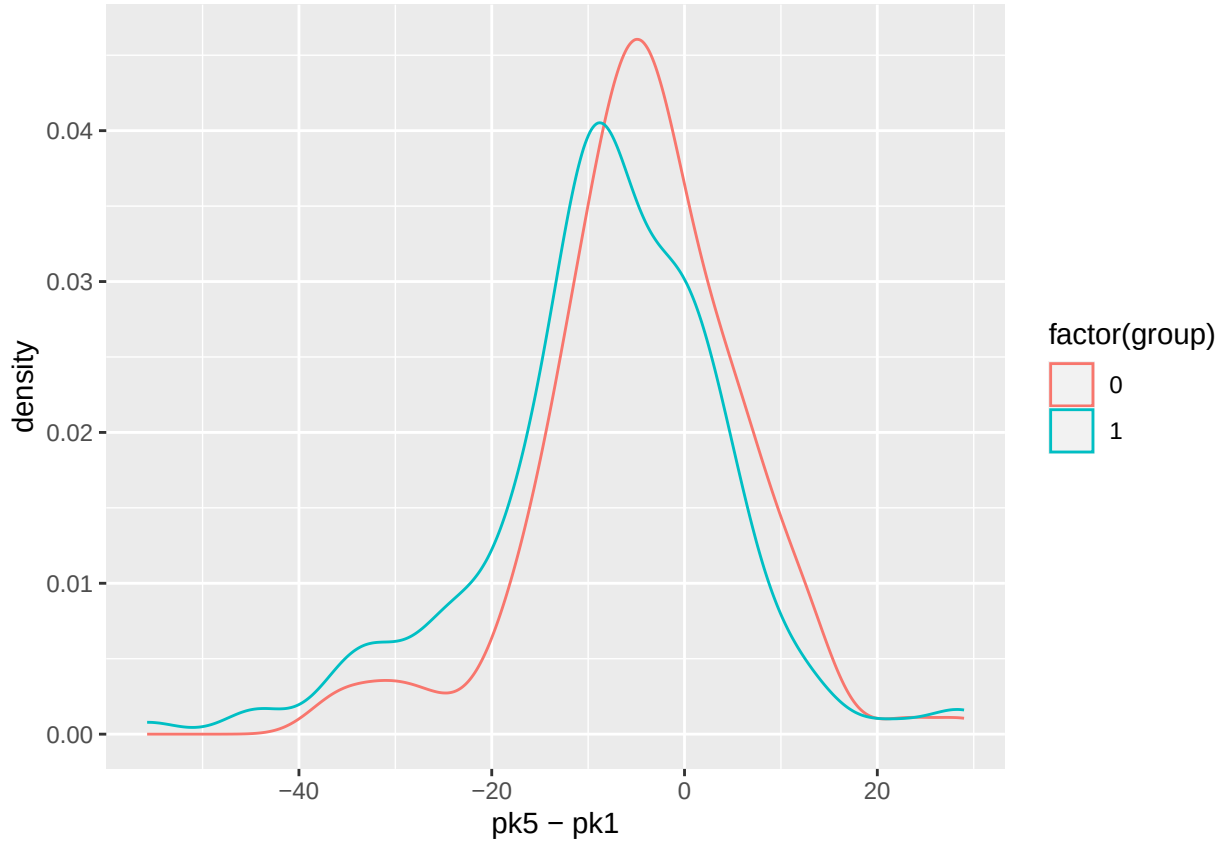
```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --
## v ggplot2 3.4.0     v purrr   1.0.1
## v tibble  3.1.8     v stringr 1.5.0
## v tidyr   1.2.1     v forcats 0.5.2
## v readr   2.1.3
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
data %>% ggplot(aes(x = factor(group), y = pk5-pk1)) +
  geom_boxplot()
```




```
data %>% ggplot(aes(x = pk5-pk1),) +
  geom_density(aes(color = factor(group)))
```



2

We use mean difference between pk1 and pk5 as a non-standard test statistic.

3

```
data$diff_pk <- data$pk1 - data$pk5
pk1_diff <- data[data$group == 1, ]$diff_pk
pk5_diff <- data[data$group == 0, ]$diff_pk

observed_diff <- mean(pk1_diff) - mean(pk5_diff)
n <- 10000
permuted_diffs <- numeric(n)

sample(data$diff_pk)
```

```
##   [1]  17.00000   0.50000  26.25000  25.00000   3.50000  -1.50000  -5.50000
##   [8]  32.00000   5.50000  12.25000   7.50000   8.75000  -8.75000  -4.50000
##  [15]   4.00000   9.75000   8.75000   3.00000   2.50000  -4.00000  10.25000
##  [22]  -3.25000  17.50000   0.00000   7.25000   5.00000   4.00000  11.75000
##  [29] -28.73334  35.25000  17.50000   9.75000   1.00000   2.50000   6.25000
##  [36]   0.50000   7.50000   4.75000   7.50000   6.50000   0.66667   7.00000
##  [43]  -4.00000  12.50000  33.25000   2.50000   7.75000   4.00000   3.00000
```

```
##  [50]   4.75000   7.75000  -4.50000  -2.00000  12.25000   0.75000   2.75000
##  [57]  13.25000   0.75000  -1.75000  29.75000  -4.75000  10.50000  14.75000
##  [64] -10.50000 -12.25000 -10.00000  36.00000  -2.50000   3.00000  -1.75000
##  [71]  27.50000   8.25000   1.75000  16.00000  -2.00000   2.25000  20.00000
##  [78]  13.75000   6.50000  12.00000  27.50000  21.75000  20.75000  -5.00000
##  [85]   5.75000  -1.50000   3.50000   4.00000 -12.50000   5.50000  18.25000
##  [92]  -8.75000   9.00000   1.25000 -22.75000   2.00000   7.25000   5.50000
##  [99]  -7.50000  16.75000   7.50000  15.50000  10.00000  11.75000   4.75000
## [106]   0.50000   7.75000   3.75000  22.75000  10.25000   2.00000  -0.50000
## [113] -14.25000  13.00000  44.25000  -2.00000  -6.75000   1.00000  -3.75000
## [120]  18.00000   4.00000  11.00000  11.25000   4.75000   5.75000  10.75000
## [127]   0.00000   6.50000  16.00000   0.25000  15.25000  -1.00000  10.25000
## [134]   7.25000   4.00000  17.25000  34.50000  14.50000  -2.25000  11.75000
## [141]   2.25000   0.00000   8.25000 -12.25000  -2.25000  -3.75000  -2.75000
## [148] -14.25000  15.75000  -5.25000  12.75000 -21.50000  23.00000  -7.00000
## [155]  15.25000  10.00000  -5.75000  -1.75000  -2.00000  12.25000  -5.00000
## [162]  -5.25000  19.00000  -2.25000   1.50000   9.50000   0.00000  -0.75000
## [169]  -5.25000  -0.75000   8.75000   8.75000  14.50000   7.75000   0.25000
## [176]  12.25000   4.50000  12.00000   7.25000  20.75000  17.25000  12.50000
## [183]  -9.25000   6.50000   3.75000  11.50000   4.00000  12.25000  10.75000
## [190]  -6.50000  -8.25000   7.25000  13.25000  10.25000   3.50000   1.00000
## [197]  31.00000   5.00000  -7.75000 -10.50000  18.00000  13.50000   9.50000
## [204]   3.00000   8.75000  -5.00000  -0.50000   5.75000  55.75000  18.25000
## [211]   7.25000  -8.25000  25.25000  -3.25000  -4.50000  13.00000   8.00000
## [218]   7.75000  -6.50000 -10.75000  29.75000  31.25000  44.75000   7.00000
## [225]   6.25000   7.50000  33.75000   2.50000  24.75000  10.00000  -7.75000
## [232]  -0.75000  -5.00000  25.50000  10.25000   2.00000  -7.75000  16.25000
## [239] -11.75000  34.50000   2.00000  16.00000   1.00000   9.75000  11.75000
## [246]   1.25000   4.00000   0.00000   6.50000   0.75000   6.50000   6.00000
## [253]   7.25000   9.75000  13.75000   9.50000   1.25000  11.50000   8.00000
## [260]  11.25000   8.75000  11.75000  13.50000 -29.00000  10.25000  -6.50000
## [267]   8.00000  11.25000   8.00000   7.25000  37.75000   5.50000  -2.25000
## [274]   5.75000  -3.50000  -0.25000  10.50000 -13.75000  24.50000   3.00000
## [281]   8.00000  -5.00000  36.75000   4.75000 -28.50000  22.50000   4.75000
## [288]   8.75000  18.00000  10.75000   1.00000   9.75000  -2.00000 -13.25000
## [295]  -3.25000  31.00000  14.00000 -12.75000   7.25000   2.50000   3.50000
```

```
set.seed(123)
for (i in 1:n) {
  sample_dat <- sample(data$diff_pk)
  permuted_diffs[i] <- mean(sample_dat[data$group == 1]) - mean(sample_dat[data$group == 0])
}
```

P value

```
p_value <- sum(abs(permuted_diffs) >= abs(observed_diff))/n
p_value
```

```
## [1] 0.0032
```