Linguistic Data: Quantitative Analysis and Visualisation

Lab on a Student's t-test

Aspiration and vowel duration in Icelandic

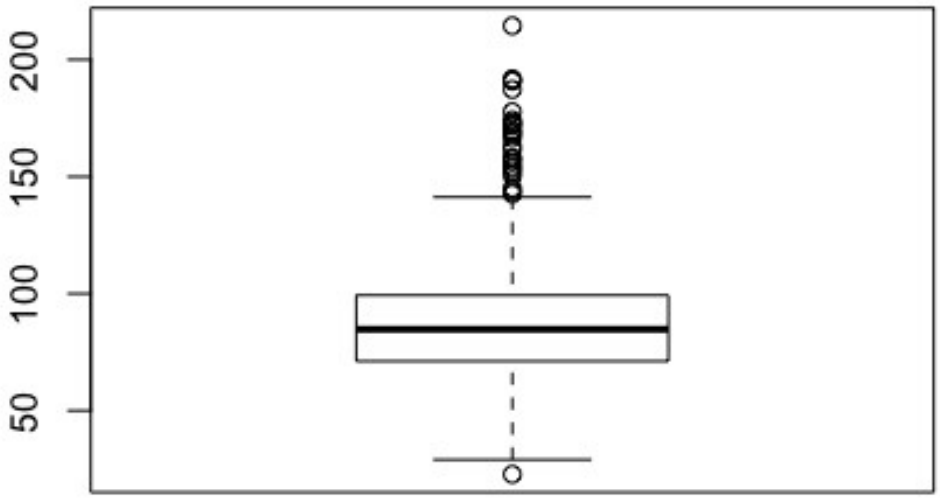
This set is based on (Coretta 2017, link. This dissertation dealt with the relation between vowel duration and aspiration in consonants. Author carried out a data collection with 5 natives speakers of Icelandic. Then he extracted the duration of vowels followed by aspirated versus non-aspirated consonants. Check out whether vowels before aspirated consonants (like in Icelandic takka 'key' [t^{h}a^{h}ka]) are significantly shorter than vowels followed by non-aspirated consonants (like in kagga 'barrel' [k^{h}akka]). Link to the dataset.

```
df <-
read.csv("http://math-info.hse.ru/f/2018-19/ling-data/icelandic.csv")
```

Descriptive statistics

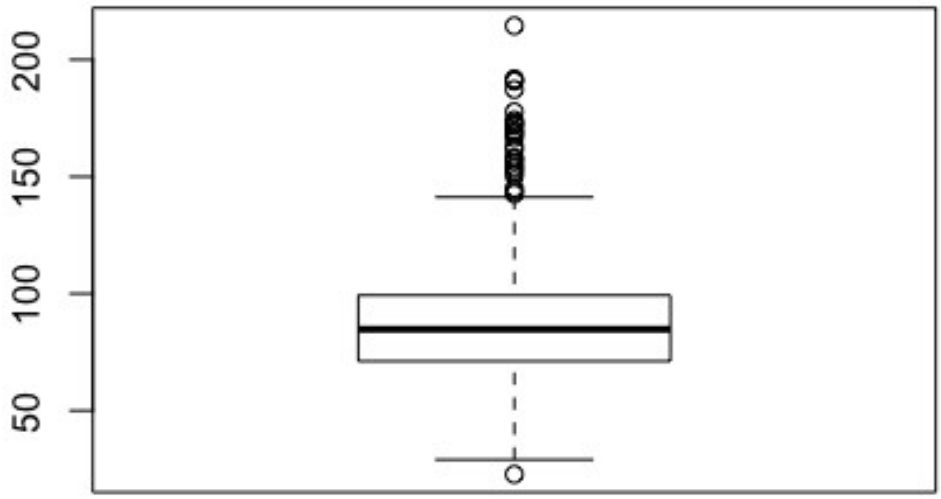
A general boxplot:

```
boxplot(df$vowel.dur)
```



Get the number of outliers:

```
length(boxplot(df$vowel.dur)$out)
```




```
## [1] 27
```

Look at number of observations by groups (aspirated and non-aspirated cases):

```
table(df$aspriration)

## < table of extent 0 >
```

Choose two subsamples, one for words where vowels are followed by aspirated consonants and another for non-aspirated consonants.

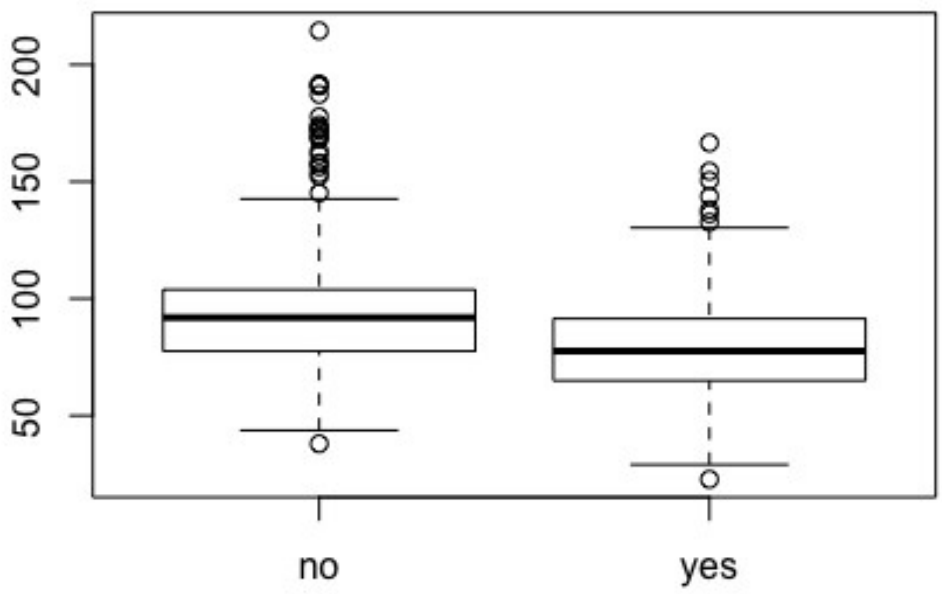
```
asp <- df[df$aspiration == 'yes',]
nasp <- df[df$aspiration == 'no',]
```

Summary for aspirated and non-aspirated cases:

```
summary(asp$vowel.dur)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   22.78   64.96   77.60   78.76   91.46  166.56

summary(nasp$vowel.dur)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   37.98   77.56   91.91   94.69  103.88  214.48
```

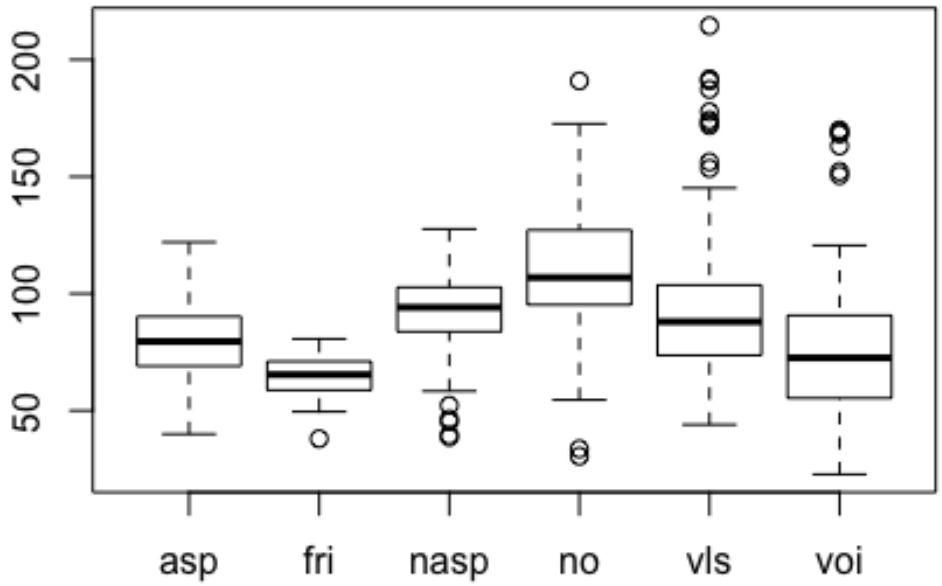
Boxplot by groups:

```
boxplot(df$vowel.dur ~ df$aspiration)
```



More interesting - let us create a boxplot by all groups (see the field `cons1`):

```
boxplot(df$vowel.dur ~ df$cons1)
```



You can compare distribution of `vowel.dur` in asp(irated), fri(cative), nasp(non-aspirated), voi(ced), etc.

We can limit our data to just one type of vowels, say, middle vowels. Therefore, we will work with the same type of a consonant:

```
asp <- df[df$aspiration == 'yes' & df$height == 'mid', ]
nasp <- df[df$aspiration == 'no' & df$height == 'mid', ]
```

Again, here is a summary for a corrected case:

```
summary(asp$vowel.dur)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   38.67   71.41   81.92   82.65   95.19  150.46
```

```
summary(nasp$vowel.dur)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   37.98   80.90   97.97   98.73  110.51  190.93
```

```
nrow(asp)
```

```
## [1] 156
```

```
nrow(nasp)
```

```
## [1] 174
```

T-test

Let us formulate the null hypothesis, the alternative hypothesis, and apply t-test to our dataset.

```
t.test(asp$vowel.dur, nasp$vowel.dur)
```

```
##
##  Welch Two Sample t-test
##
## data:  asp$vowel.dur and nasp$vowel.dur
## t = -6.4869, df = 317.72, p-value = 3.356e-10
## alternative hypothesis: true difference in means is not equal
to 0
## 95 percent confidence interval:
##  -20.94772 -11.19801
## sample estimates:
## mean of x mean of y
##  82.65371  98.72657
```

By default, R calculates t.test with regard to the bi-directional alternative hypothesis, such as $\mu_1 \neq \mu_2$.

Unidirectional t-test

H1: $\mu_{asp} < \mu_{nasp}$

```
t.test(asp$vowel.dur, nasp$vowel.dur, alternative = "less")
```

```
##
##  Welch Two Sample t-test
##
## data:  asp$vowel.dur and nasp$vowel.dur
## t = -6.4869, df = 317.72, p-value = 1.678e-10
## alternative hypothesis: true difference in means is less than
0
## 95 percent confidence interval:
##       -Inf -11.98542
## sample estimates:
## mean of x mean of y
##  82.65371  98.72657
```

Density plots

```
require(tidyverse)
```

```
## Loading required package: tidyverse
```

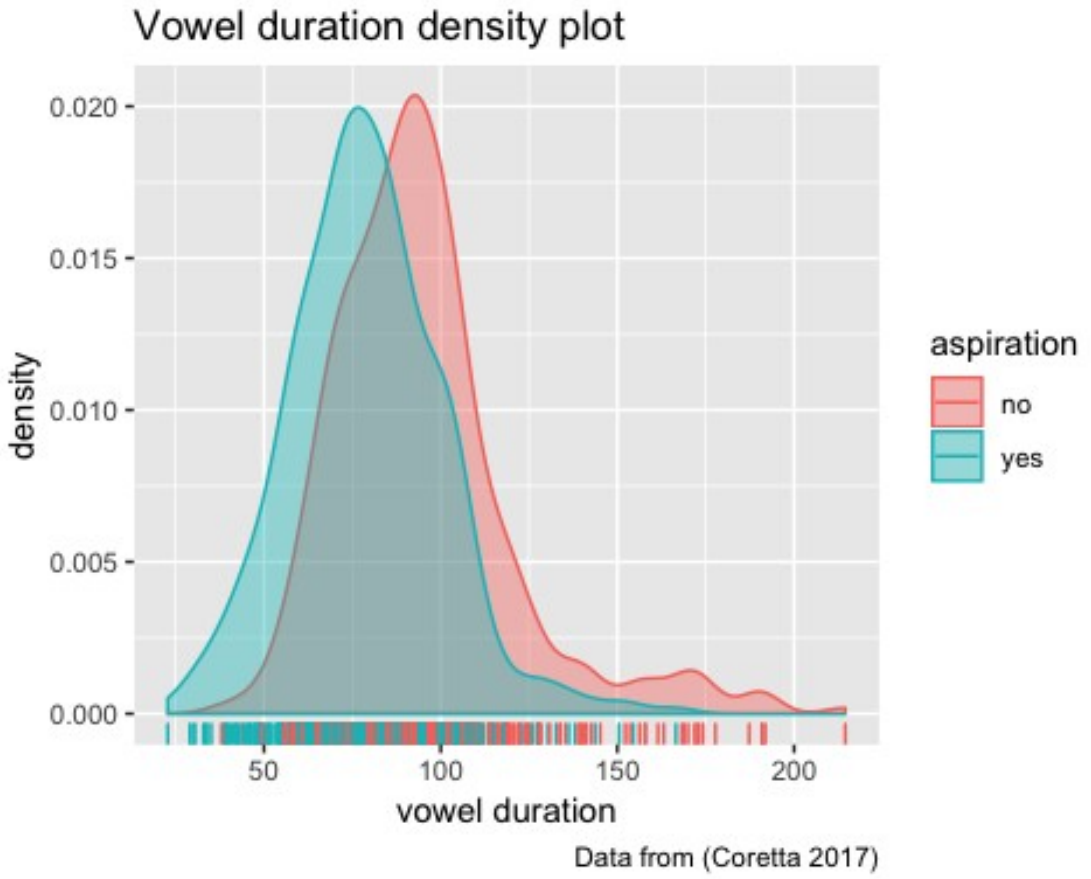
```
## Warning in library(package, lib.loc = lib.loc, character.only
= TRUE,
## logical.return = TRUE, : there is no package called
'tidyverse'

require(dplyr)

## Loading required package: dplyr

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

Let's get a descriptive summary of our data in a dplyr style.

```
df %>%
  group_by(aspiration) %>%
  summarise(mean = mean(vowel.dur),
            st.dev = sd(vowel.dur))

## # A tibble: 2 x 3
##   aspiration  mean st.dev
##   <fct>      <dbl>  <dbl>
## 1 no          94.7   25.9
## 2 yes         78.8   21.2
```

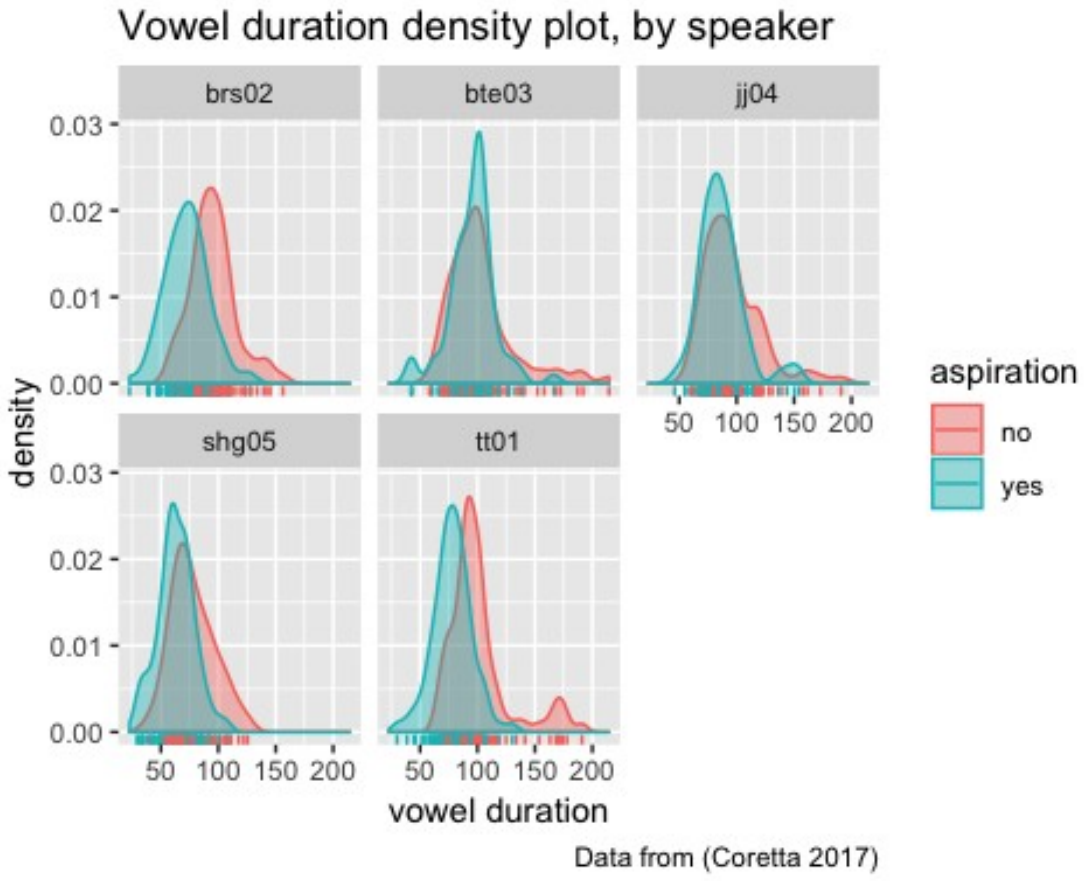
Density plots can be thought of as plots of smoothed histograms.

```
library(ggplot2)
df %>%
  ggplot(aes(vowel.dur, fill = aspiration, color = aspiration))+
  geom_density(alpha = 0.4)+
  geom_rug()+
  labs(title = "Vowel duration density plot",
       caption = "Data from (Coretta 2017)",
       x = "vowel duration")
```



Density plot by speaker:

```
df %>%
  ggplot(aes(vowel.dur, fill = aspiration, color = aspiration))+
  geom_density(alpha = 0.4)+
  geom_rug()+
  facet_wrap(~speaker)+
  labs(title = "Vowel duration density plot, by speaker",
       caption = "Data from (Coretta 2017)",
       x = "vowel duration")
```



and descriptive statistics:

```
df %>%
  group_by(aspiration, speaker) %>%
  summarise(mean = mean(vowel.dur),
            st.dev = sd(vowel.dur))
```

```
## # A tibble: 10 x 4
## # Groups:   aspiration [?]
##    aspiration speaker  mean st.dev
##    <fct>      <fct>   <dbl>  <dbl>
##  1 no         brs02    95.3   19.8
##  2 no         bte03   103.    29.4
##  3 no         jj04     95.7   25.1
##  4 no         shg05    77.7   18.9
##  5 no         tt01    101.    26.8
##  6 yes        brs02    72.9   18.9
##  7 yes        bte03    95.4   20.0
##  8 yes        jj04     86.8   20.1
##  9 yes        shg05    63.3   15.7
## 10 yes        tt01     78.3   16.7
```