Hand Proportions
How average people compare to NBA rookies

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This report addresses the collection and analysis of NBA rookies and measurements collected by students on volenteers. It looks into the relaionship between various measuremeants of volunteers, NBA rookies, and thier proportions. These analysis were evaluated through correlations tables, plots, hierarchical clustering, boxplots, and t test.

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1 Introduction

NBA rookies seem to have abnormally large hand to grasp the ball. Thus giving them leverage on opponents. With that I think it could be important to understand how proportions of NBA rookies relates to their height as well as other students who are in a similar age group. Thus, looking deeper into the correlation/relationships of measurements on our student volunteers and NBA rookies could revel more about that. Are the NBA rookies just larger or proportionally abnormal?
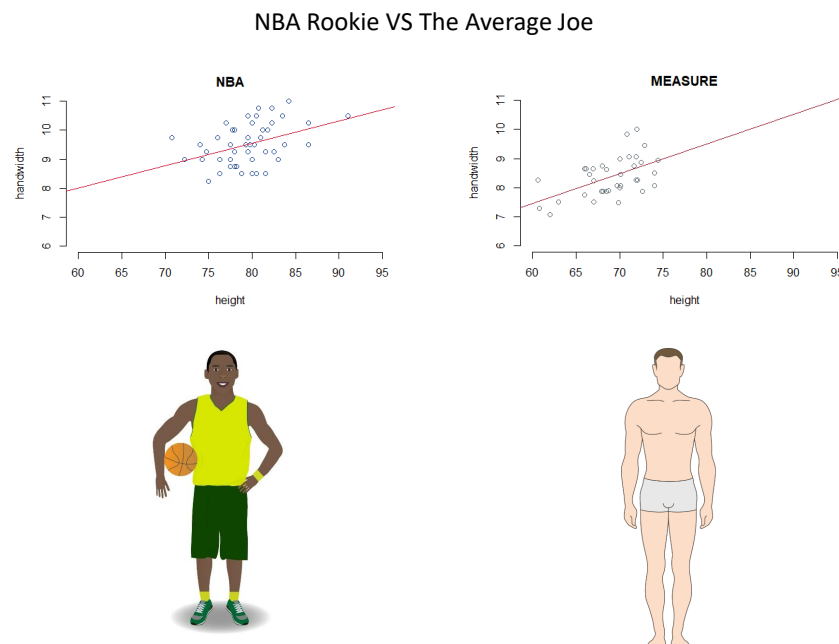
Figure 1: One Image Description: On the left represents a NBA rookies hand width vs height proportions of hand. On the right you can see your average Joe (the student volunteers measured).

2 Research Question: What is my primary question

How do NBA rookies differ from student volunteers?

2.1 What is my secondary question

My secondary question is to see if NBA rookies hand width proportion to height extremely differs when looking and hand width proportions to height for the measurement on students volunteers?

2.2 What is my other secondary question

My other secondary question is to see what measurements have the strongest correlation with our measured volunteers when it comes to hand width, with other body parts?

3 Data Description

The collection of my data was done via a handout I made found 3 and 4 in section~6.1.1. This handout took various measurements and questions regarding things like height, weight, length, dominant hand, etc. I went about collecting this data via email. My data was targeted towards family and closed friends. This data was targeted toward family and friend as there is a pandemic... The data was collected for the purpose of this project. I then merged with the rest of my class data that consist of other students measures that they preformed on volunteers. This combined gave the class a data set of 463 volunteers.

When searching for data I went to Google and found the NBA website, refer to the references where I cited NBA (2020). There I found useful data that related to my measurements I took. The data consisted of NBA rookies hand width, hand length, height, standing reach, wingspan, weight, body fat, and position. The data I used was specifically for 2019 NBA rookies.

3.1 Summary of Sample

The measure volunteer data was narrowed down to only people who are Male as there are no females in the NBA. I also filtered about those who are not between the ages of 18-28. I chose that age range as I think that is the most relevant age for a rookie. I then went on the filter out those who's standing reach was shorter then their height. Lastly, I selected random males from both data sets to do observations on.

3.2 Summary Statistics of Data

Once my data was cleaned, I then selected the relevant data columns to use for my observations. Those being player/volunteer, hand width, hand length, standing reach, wingspan, and height. Those variables were selected for both data sets. The analysis that was done on the selected data sets consisted of correlations, boxplots, hierarchical clustering, and t tests.

Table 1: Descriptive Statistics and Correlation Analysis (NBA)

		M	SD	1	2	3	4
1	**height**	79.2	3.78	1			
2	**wingspan**	82.6	4.49	.90***	1		
3	**standing.reach**	103.7	5.59	.96***	.95***	1	
4	**hand.length**	8.8	.60	.75***	.88***	.84***	1
5	**hand.width**	9.5	.71	.47***	.52***	.51***	.65***

Notes: Pearson pairwise correlations are reported;
a two-side test was performed to report correlation significance.

$^\dagger p < .10$ $^* p < .05$ $^{**} p < .01$ $^{***} p < .001$

Table 2: Descriptive Statistics and Correlation Analysis (MEASURE)

		M	SD	1	2	3	4
1	**height**	69.4	3.72	1			
2	**wingspan**	69.8	4.09	.79***	1		
3	**standing.reach**	86.7	5.32	.88***	.83***	1	
4	**hand.length**	7.6	.43	.55***	.45**	.31†	1
5	**hand.width**	8.4	.67	.53***	.57***	.48**	.56***

Notes: Pearson pairwise correlations are reported;
a two-side test was performed to report correlation significance.

$^\dagger p < .10$ $^* p < .05$ $^{**} p < .01$ $^{***} p < .001$

3.3 Summary of Correlation

When looking at the correlation of NBA rookies measurements, the standing arm reach and height have the highest correlation at 96%. But there are many other high correlated variables such as wingspan and standing reach with a 95% correlation and the wingspan and height with a 90% correlation.

When looking at the measure of students volunteers there seems to be the strongest correlation between standing arm reach and height at 88%. Secondly, standing reach and wingspan have a high correlation at 83%. Looking at what measurements correlate the least it would be students height and hand width with a 53% correlation.

I then preformed a t test for NBA hand width and students hand width to get a p value < .05 so I rejected the null hypothesis that they are similar and conclude that nba rookies have larger hands. I went on to preform t test for NBA and volunteers height, wingspan, and standing reach to find all p values < .05.

4   Key Findings

Proportionally NBA rookies have smaller height in hand proportions, this is because they have larger hands therefore smaller height proportions then students when compared to hand size. You can also see that NBA rookies are bigger larger in general. You can see that by observing the t test, plots, and correlations charts in the appendices.

I also found it interesting that for our measure volunteers the correlation between hand length and height was only 45% but with NBA rookies it was much higher at 88%. This leads me to believe that there was some fabricated or bad data recorded from some of the students.

5   Conclusion

When looking at the volunteers for the measure data I found that the highest correlated variables were standing reach and height. The highest correlated variables for the NBA rookies were also standing reach and height. When comparing NBA hand size proportions you can see the NBA rookies have a lower height proportion than the measure volunteers. Thus meaning NBA rookies have large hands compared to measure volunteers. Lastly, NBA rookies have larger means implying they're overall just bigger people.

I concluded that the NBA has a precise and very accurate way for measuring rookies and the measurements taken by students may very. That is due to some students not understanding how to take the correct measure. But it also appears some students have fabricated their data. It is also suspicious when one of the volunteers was only about 6 feet tall, yet has a 8 foot wing span... Therefore, a re evaluation of this analysis with more accurate measurements may differ the results.

6   APPENDICES

6.1   Data Provenance

I made my handout and sent it out to 10 people to get the specific measurements shown in the handout in figure 3 and 4 in section~6.1.1. Those measurement were taken in centimeters for a more precise measurement and later converted to inches. I then made their data anonymous with a bitly generator. After that I merged my data with classmates data to have a larger data set. I then went on to randomly select 50 males to correlate and compare my NBA rookie data from (NBA 2020) as there are not women who play in the NBA. I started by merging columns, some columns had only one hand measured so I took the left and rights averaging them to create and single column. If there was only one measurement like only left hand length, that would be selected. Out of all the measurements I decided to look into the hand width, hand length, height, wingspan, and standing reach. In that data there were all different ages so I narrowed my ages down to 18-28 as those are the more likely ages to be a rookie in the NBA. I found some people miss entered or miss measured their data, in one case it was the arm reach. When standing some would measure from shoulder to finger tip whereas that measurement should be from the ground to finger tip. With that I filtered out those who measured the standing reach to be shorter than the height.

When looking deeper into the data I found some more anomalies that caused my data to be skewed. My professor found corrupt data where some students had entered some bad data and/or the data was fabricated. With that our professor helped through the cleanup process narrowing down from about 463 to 251 people from there I was able to re apply all of my changes such as age restrictions, investigating of only males, removed unused columns, etc. I finally ended up with 42 student volunteers to compare with my NBA rookies. The clean up process and approach my professor took can be found in references where I cite (Monte Shaffer 2020).

Once I was finished cleaning my NBA data I chose to look into hand width, hand length, height, wingspan, and standing arms reach. For this data I had to convert from feet and inches to just inches. I then decided to look into if NBA rookies and our volunteers are abnormally proportional to other parts of their body such

as hand width relative to their height. I chose to take proportions of hand width as I think larger hands give a leverage in basketball so it would be interesting to see how large these proportions are compared to the average person. I found that on average NBA rookies are one whole hand size larger. That meaning that they are either just bigger people in general or have abnormally large hands. The means of each show you can see that proportionally they are just larger people. Looking at section~6.2.4 you can also see that and that similar groups are grouped together and it is the same for our volunteers as .

Moving forward if I were to re create this project I would make precise measurements were taken. I would do so by having all measurement taken in centimeters and all the same exact way. As I have stated the NBA goes about a very detailed way of measuring rookies. Moving forward another change I would make is to get more NBA data and include the position. If I had position then I could specifically look into what positions related more to each other, as well as potentially make a classifier to predict what position a student is most likely to play.
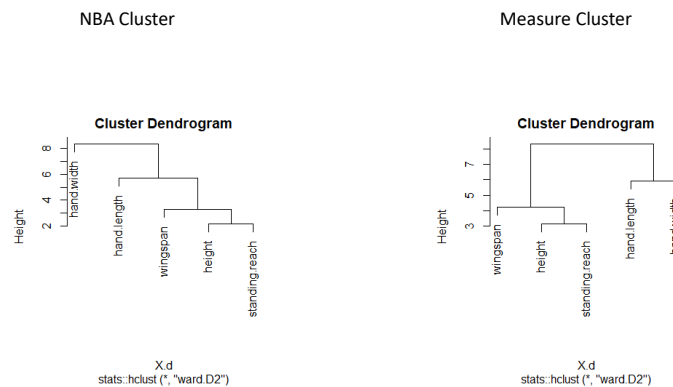
Figure 2: Cluster of like measurements: On the left is a cluster of NBA measurements and on the right is a cluster of student volunteers measurements

6.1.1 Data Collection Handout

Figure 3: Handout Page 1

Measurements

Questions for survey:
Name _____
Gender_____
Ethnicity_____
Age_____
Dominant hand for writing _____
Dominant hand for swinging a bat _____
Eye color_____
How long this survey took _____

Measure the size of your hand (middle finger to wrist) right hand __cm, left hand __cm,
The hand span (pinkie to thumb fully extended) right hand __cm, left hand __cm,
Your wingspan shown on the right (middle finger of each hand fully stretched out) __cm.
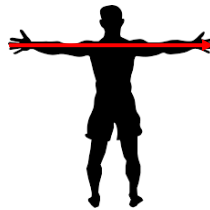
Take four measurements, first being the height (standing) __cm,
Second the height of your head (chin to top of head) __cm,
Third the standing length from the floor to your hip bone right side __cm, left side __cm,
Lastly the standing length (height) from the floor to your armpit, right side __cm, left side __cm.
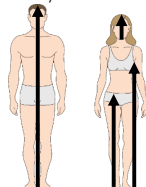
Figure 4: Handout Page 2

Take two measurements for each arm, first being the length from your middle finger to your elbow (measured on the inside) right arm __cm, left arm __cm.
Second the length from your elbow to your armpit right arm __cm, left arm __cm.

Measure the standing reach (flat footed, how far can you reach on a wall with the tip of your finger) __cm,
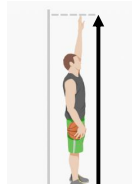
Take two measurements for each foot and leg, your right foot __cm, left foot __cm.
Second the sitting length from the floor to your knee pit (like armpit but for your knee) right leg, __cm, left leg __cm.
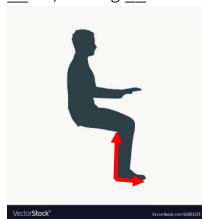
Measure the circumference of your head __cm.

6.2   Preparing the Report

Below is the necessary functions and libraries required to run the code referenced in this document.

```r
library(devtools);        # required for source_url
```

```
## Warning: package 'devtools' was built under R version 4.0.3
```

```r
library(humanVerseWSU)

path.humanVerseWSU = "https://raw.githubusercontent.com/MonteShaffer/humanVerseWSU/"
source_url( paste0(path.humanVerseWSU,"master/misc/functions-project-measure.R") );
```

```
## Warning: package 'survival' was built under R version 4.0.3
```

```
## Warning: package 'Formula' was built under R version 4.0.3
```

```r
path.github = "https://raw.githubusercontent.com/njtrout/WSU_STATS419_FALL2020/"
source_url( paste0(path.github,"master/functions/functions-project-measure.R") );

path.project = "C:/Users/Nic Trout/Documents/C/WSU_STATS419_FALL2020/project-measure_nic/";
path.to.secret = "C:/Users/Nic Trout/Desktop/";
measure = readRDS(paste0(path.to.secret, "final.measure.rds"));
nbadata = read.csv("C:/Users/Nic Trout/Documents/C/WSU_STATS419_FALL2020/project-measure_nic/nbadata.txt

nba.df = prepareDataNBA(nbadata);
```

```
## Warning in prepareDataNBA(nbadata): NAs introduced by coercion
```

```
## Warning in prepareDataNBA(nbadata): NAs introduced by coercion
```

```r
measure.df = prepareMeasureData(measure);
proportions = getProportionHandWidthMeasure(measure.df);
proportionsNBA = getProportionHandWidthNBA(nba.df);
```

6.2.1   Plots

```r
#height vs standing reach
plotcorrS(          x.m = measure.df$height,
                    y.m = measure.df$standing.reach,
                    x.n = nba.df$height,
                    y.n = nba.df$standing.reach,
                    xl = "height(inches)",
                    yl = "standing.reach(inches)")
```

MEASURE   **NBA**
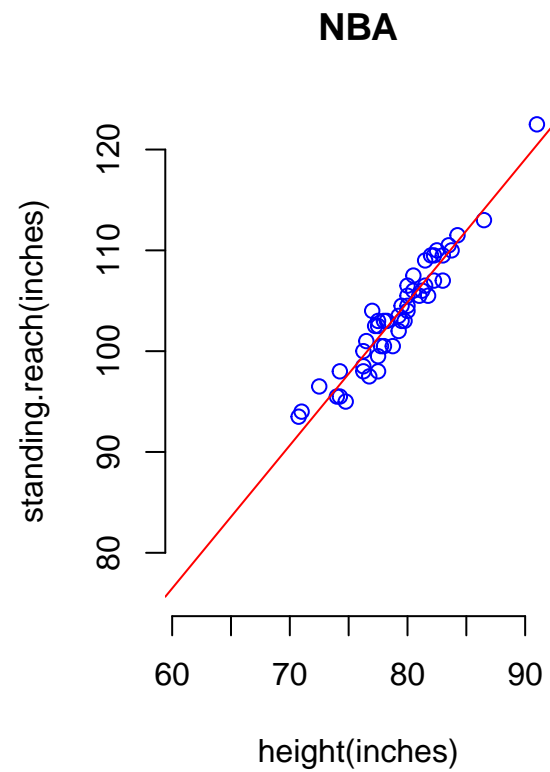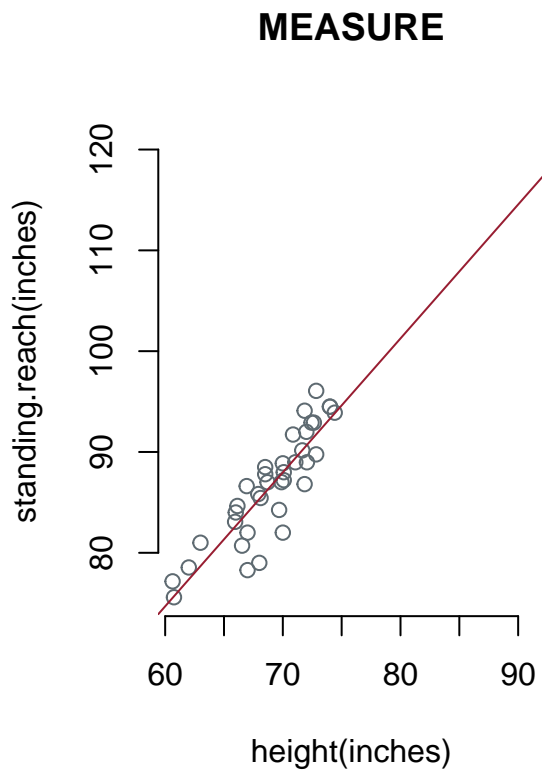

```
##       x.n
## 0.6707615
```

```
#height-vs-hand width
plotcorrS(          x.m = measure.df$height,
                    y.m = measure.df$hand.width,
                    x.n = nba.df$height,
                    y.n = nba.df$hand.width,
                    xl = "height(inches)",
                    yl = "hand.width(inches)")
```
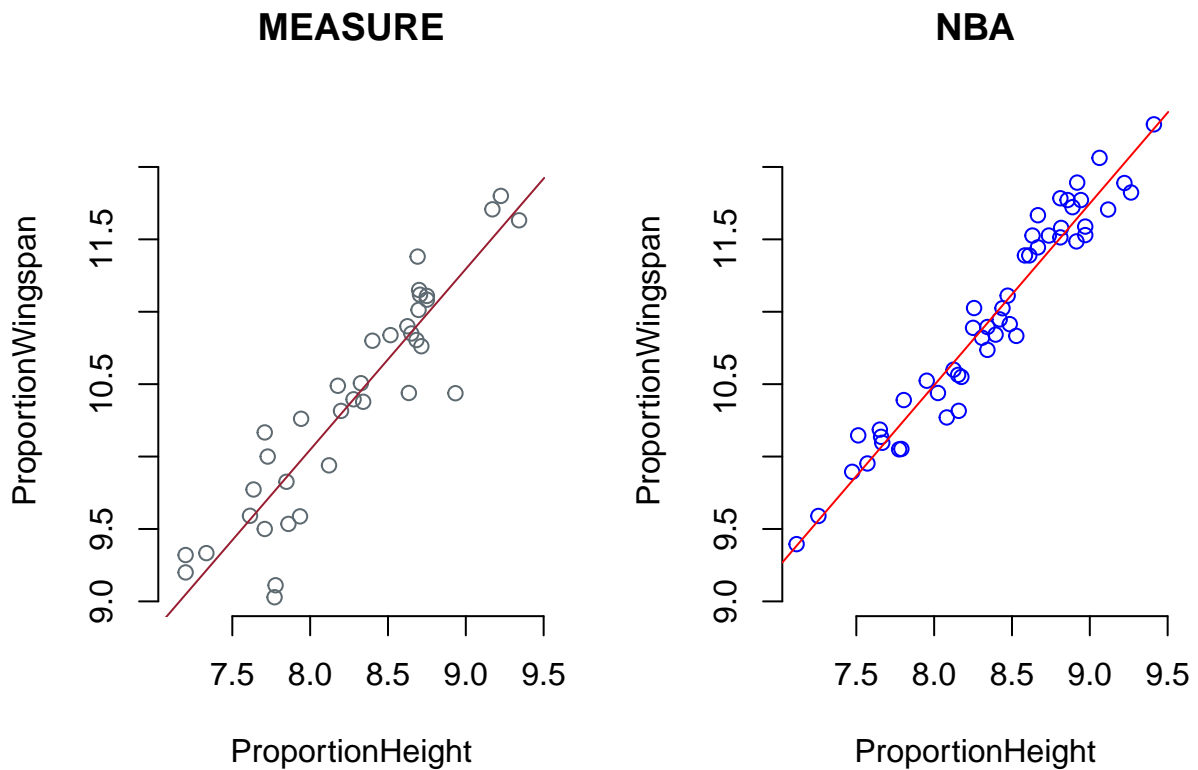
MEASURE

NBA
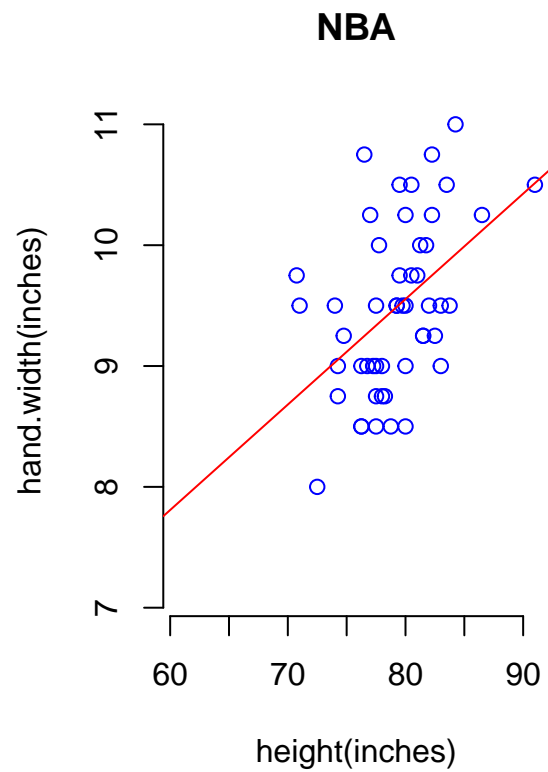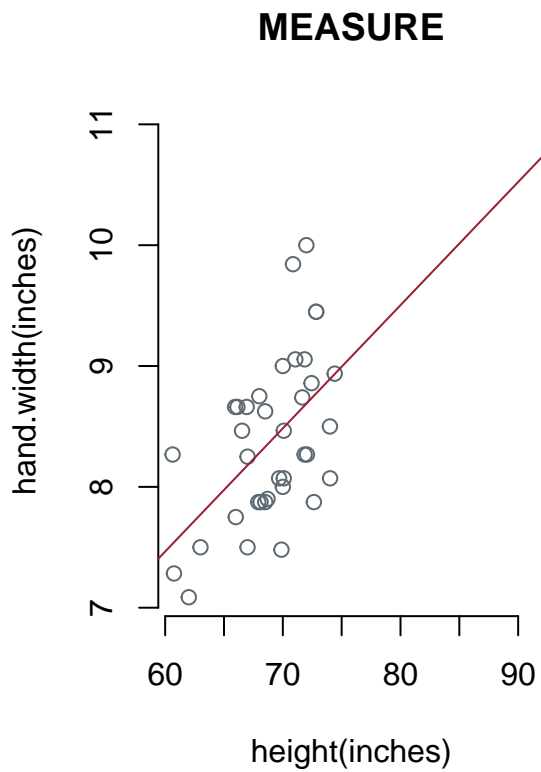

```
##          x.n
## -0.4045789
```

```
#height-vs-wingspan
plotcorrS(        x.m = measure.df$height,
                  y.m = measure.df$wingspan,
                  x.n = nba.df$height,
                  y.n = nba.df$wingspan,
                  xl = "height(inches)",
                  yl = "wingspan(inches)")
```

MEASURE   **NBA**
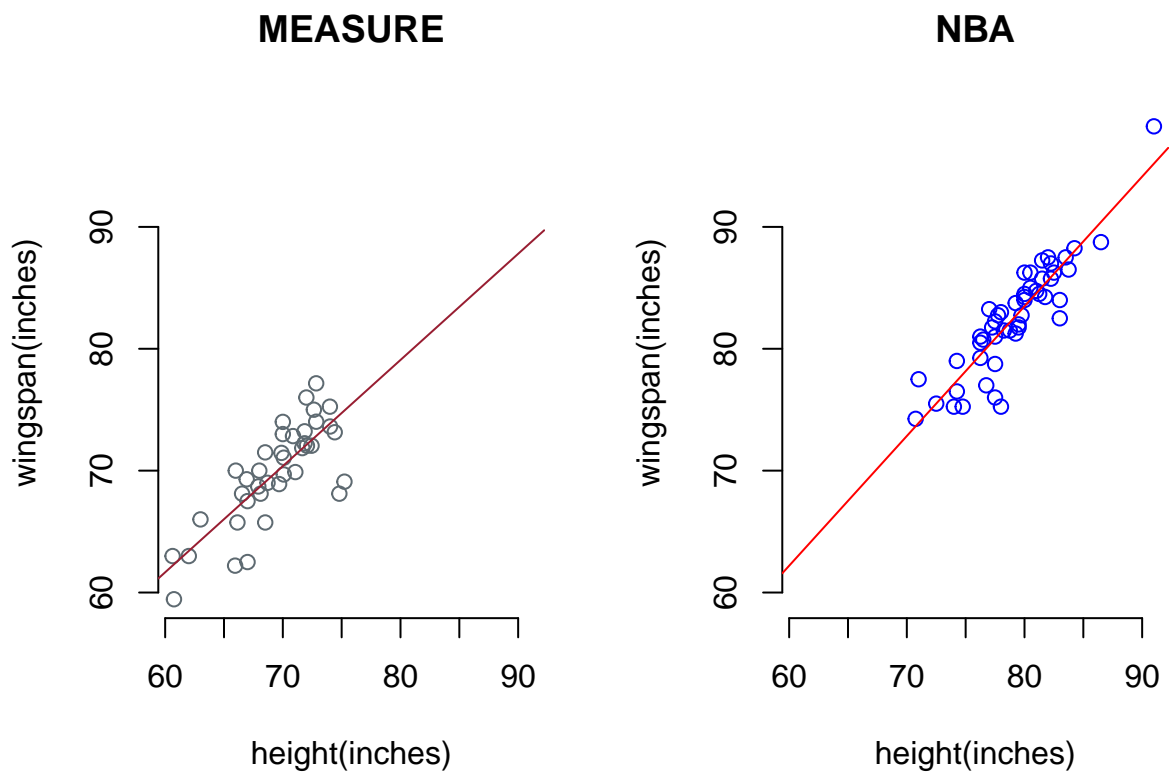

```
##       x.n
## 1.426594
```

```
#nba/measure proportions, height to arm reach
plotcorrS(          x.m = proportions$measure.height.proportion,
                    y.m = proportions$measure.armreach.proportion,
                    x.n = proportionsNBA$nba.df.height.proportion,
                    y.n = proportionsNBA$nba.df.armreach.proportion,
                    xl = "ProportionHeight",
                    yl = "ProportionWingspan")
```

MEASURE

NBA


```
##          x.n
## 0.06226467
```

6.2.2   T-tests

```r
t.test(nba.df$hand.width, measure.df$hand.width, var.equal = FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  nba.df$hand.width and measure.df$hand.width
## t = 7.3471, df = 81.5, p-value = 1.39e-10
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##   0.7932888 1.3824488
## sample estimates:
## mean of x mean of y
##   9.480000  8.392131
```

```r
t.test(nba.df$hand.length, measure.df$hand.length, var.equal = FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  nba.df$hand.length and measure.df$hand.length
```

```
## t = 10.622, df = 87.284, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##   0.9367467 1.3680131
## sample estimates:
## mean of x mean of y
##    8.77000   7.61762
```

```r
t.test(nba.df$height, measure.df$height, var.equal = FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  nba.df$height and measure.df$height
## t = 12.204, df = 82.341, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##    8.179363 11.364879
## sample estimates:
## mean of x mean of y
##   79.15500  69.38288
```

```r
t.test(nba.df$wingspan, measure.df$wingspan, var.equal = FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  nba.df$wingspan and measure.df$wingspan
## t = 14.154, df = 86.481, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##   11.01493 14.61442
## sample estimates:
## mean of x mean of y
##   82.58500  69.77032
```

```r
t.test(proportionsNBA$nba.df.height.proportion, proportions$measure.height.proportion, var.equal = FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  proportionsNBA$nba.df.height.proportion and proportions$measure.height.proportion
## t = 0.93993, df = 77.082, p-value = 0.3502
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##   -0.1273886  0.3551791
## sample estimates:
## mean of x mean of y
##   8.381208  8.267313
```

6.2.3   Boxplots

```
boxplotfunc(proportionsNBA$nba.df.height.proportion, proportions$measure.height.proportion, measure.df$
```

HEIGHT/HAND COMPARI

| NBA HEIGHT | MEASURE HEIGHT | MEASURE HANDWIDTH | NBA HAND WIDTH |
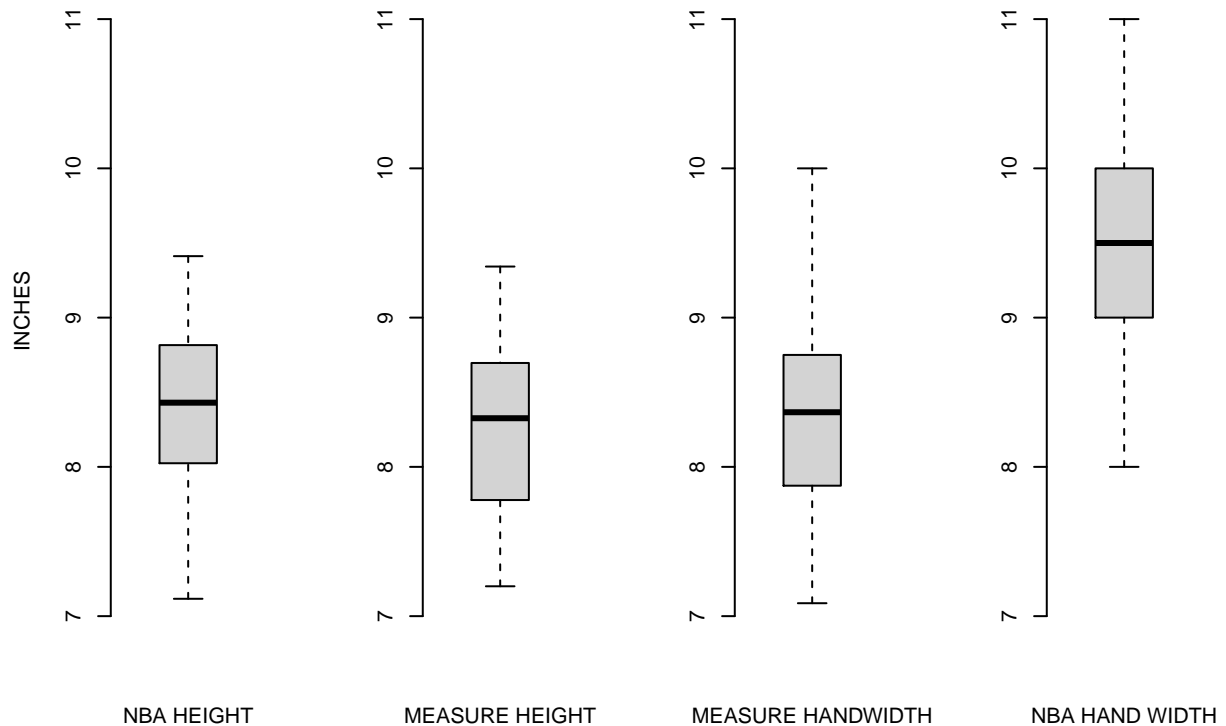
6.2.4   Hclust
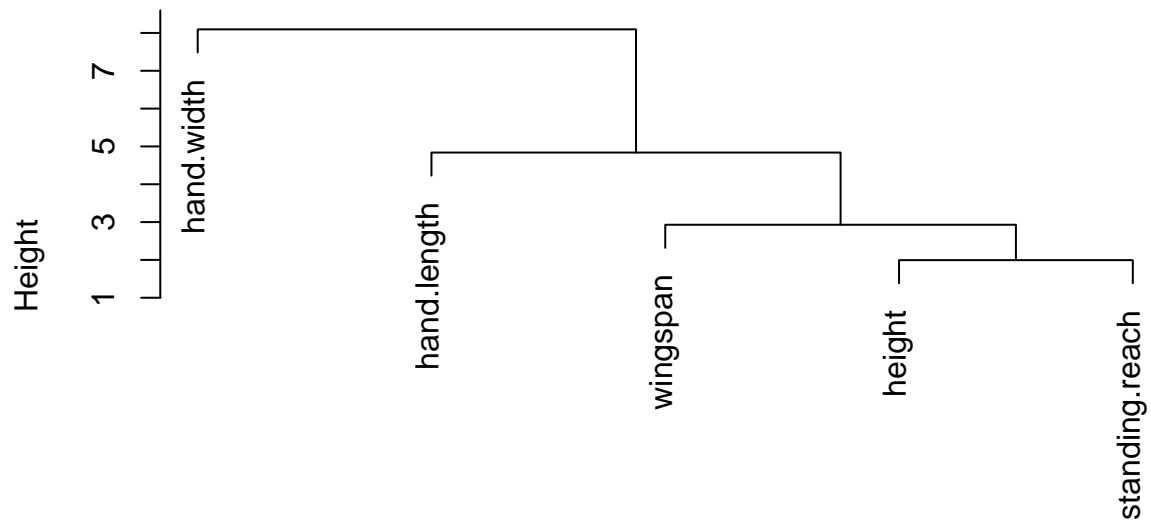
```
source_url( paste0(path.humanVerseWSU,"master/humanVerseWSU/R/functions-EDA.R") );
```

```
## SHA-1 hash of file is dd72e464241952b23d5b08d2213099eccf7a86f6
```

```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
##
## Attaching package: 'psych'
```

```
## The following object is masked from 'package:Hmisc':
##
##     describe
```

```
## The following objects are masked from 'package:ggplot2':
##
##     %+%, alpha
```

```
Xs = scale(nba.df[,c(1,2,3,4,5)])
rownames(Xs) = nba.df$players
do.nothing = perform.hclust(Xs,12)
```

```
## Registered S3 method overwritten by 'dendextend':
##   method        from
##   text.pvclust pvclust
```

Cluster Dendrogram

X.d
stats::hclust (*, "ward.D2")
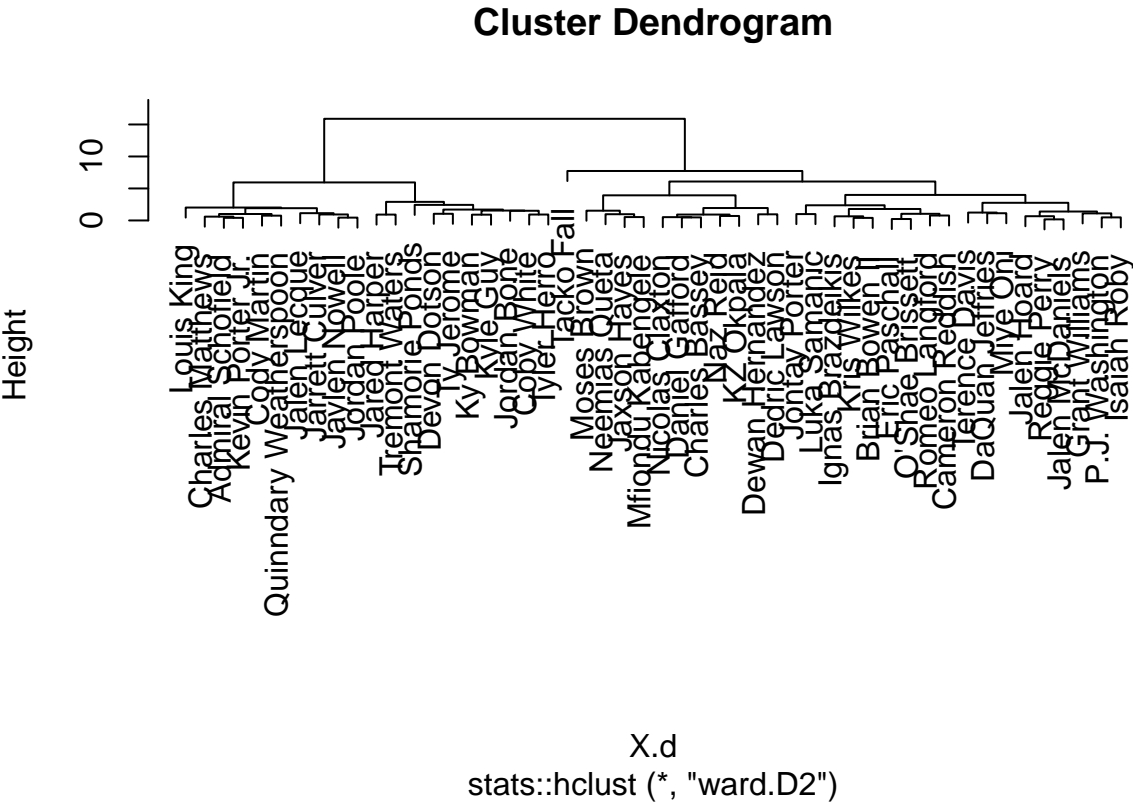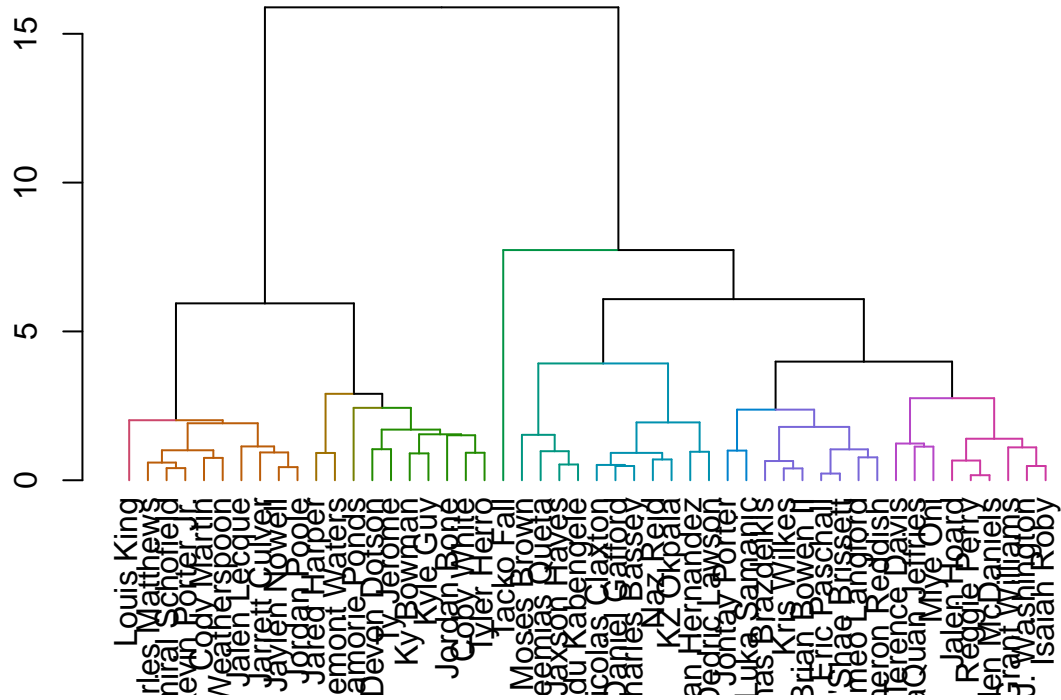
```
## [1] "Pruning 1 of 12"
## [1] "Pruning 2 of 12"
## [1] "Pruning 3 of 12"
## [1] "Pruning 4 of 12"
## [1] "Pruning 5 of 12"
## [1] "Pruning 6 of 12"
## [1] "Pruning 7 of 12"
## [1] "Pruning 8 of 12"
## [1] "Pruning 9 of 12"
## [1] "Pruning 10 of 12"
## [1] "Pruning 11 of 12"
## [1] "Pruning 12 of 12"
```
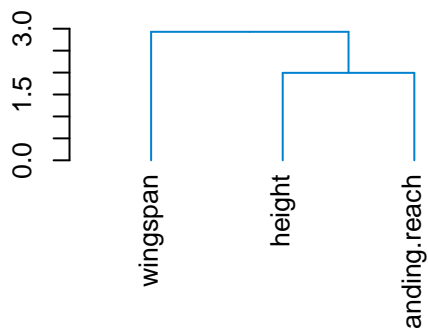
SubTree number 1
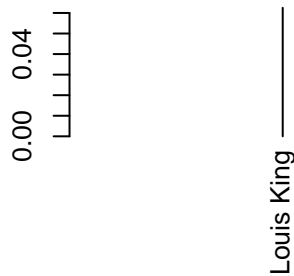
SubTree number 2
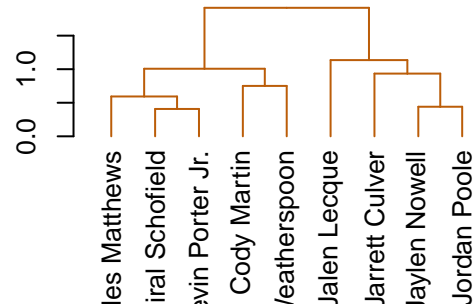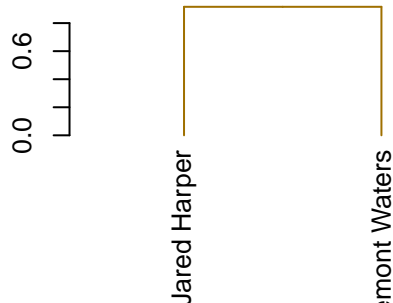
SubTree number 3

SubTree number 4
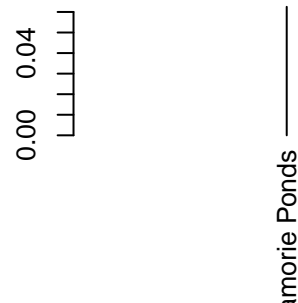
SubTree number 5
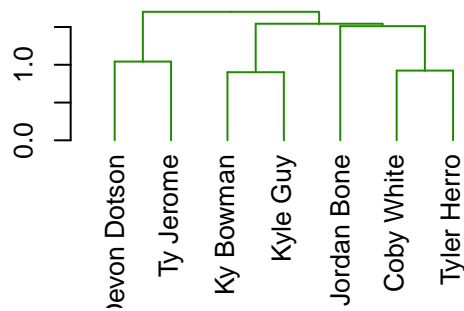
SubTree number 6
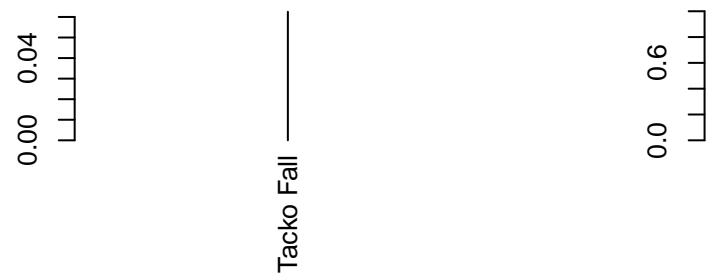
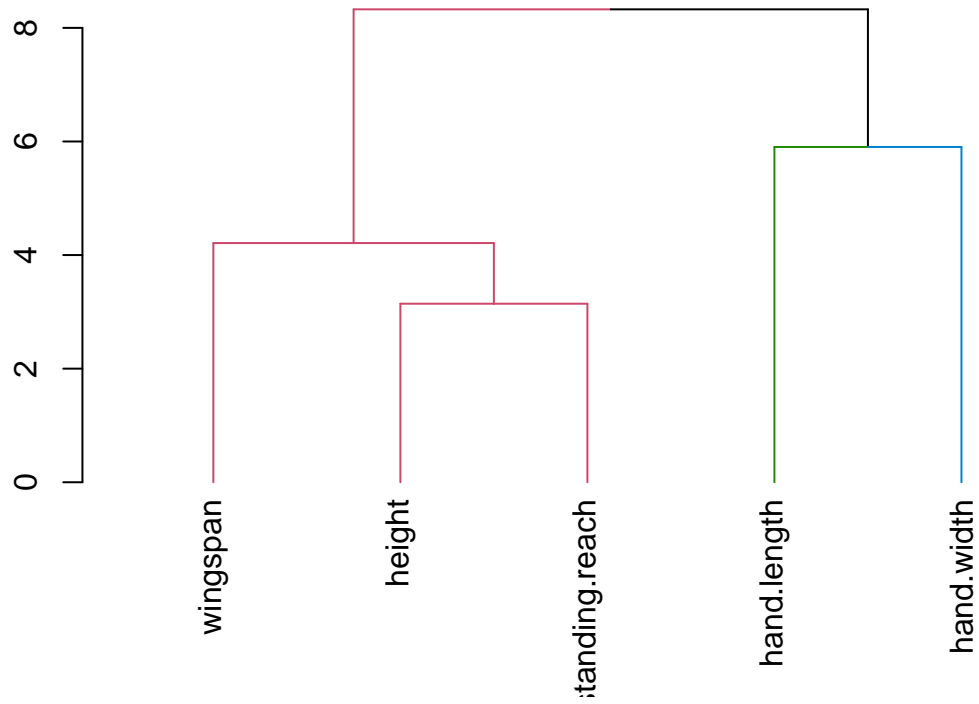## SubTree number 7
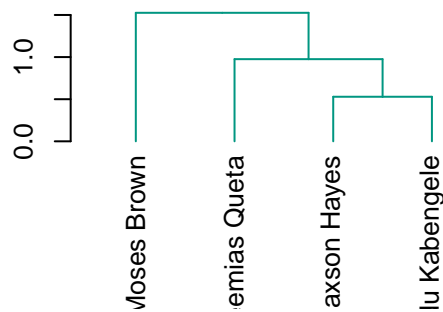
SubTree number 8
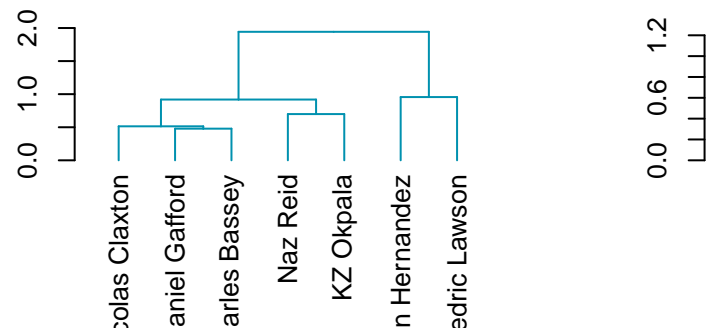
```
source_url( paste0(path.humanVerseWSU,"master/humanVerseWSU/R/functions-EDA.R") );
```

```
## SHA-1 hash of file is dd72e464241952b23d5b08d2213099eccf7a86f6
```

```
Xs = scale(nba.df[,c(1,2,3,4,5)])
Xs = transposeMatrix(Xs)
do.nothing = perform.hclust(Xs,3)
```

## Cluster Dendrogram

X.d
stats::hclust (*, "ward.D2")

```
## [1] "Pruning 1 of 3"
## [1] "Pruning 2 of 3"
## [1] "Pruning 3 of 3"
```
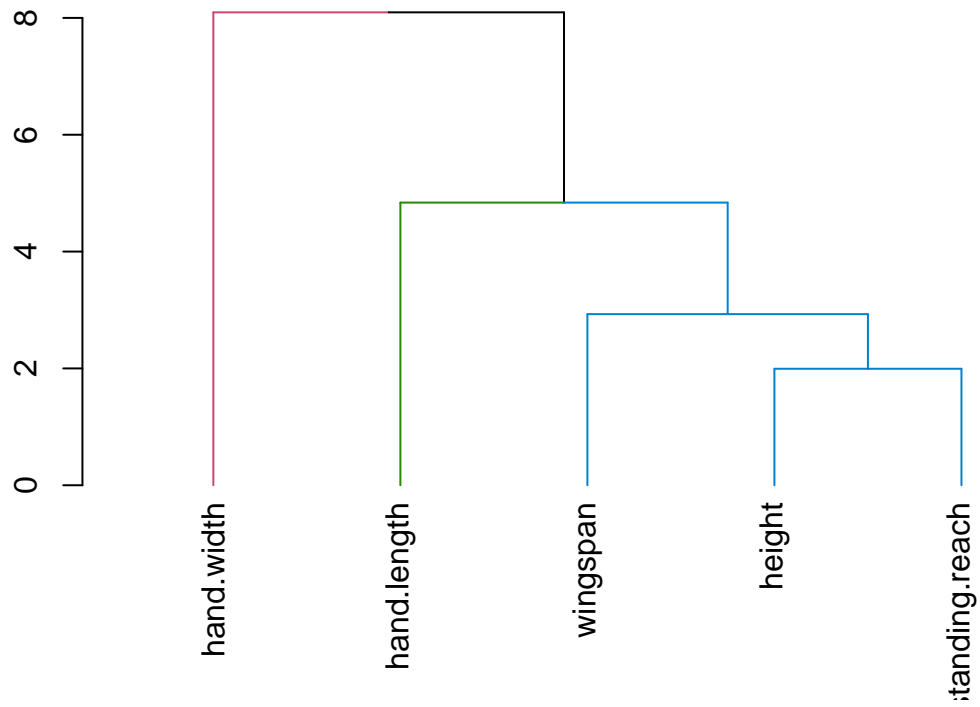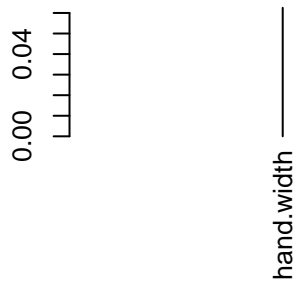
SubTree number 1
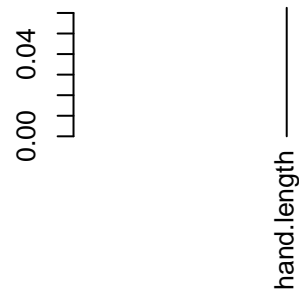
SubTree number 2

SubTree number 3

```
source_url( paste0(path.humanVerseWSU,"master/humanVerseWSU/R/functions-EDA.R") );
```

```
## SHA-1 hash of file is dd72e464241952b23d5b08d2213099eccf7a86f6
```

```
Xs = scale(measure.df[,c(1,2,3,4,5)])
Xs = transposeMatrix(Xs)
do.nothing = perform.hclust(Xs,3)
```
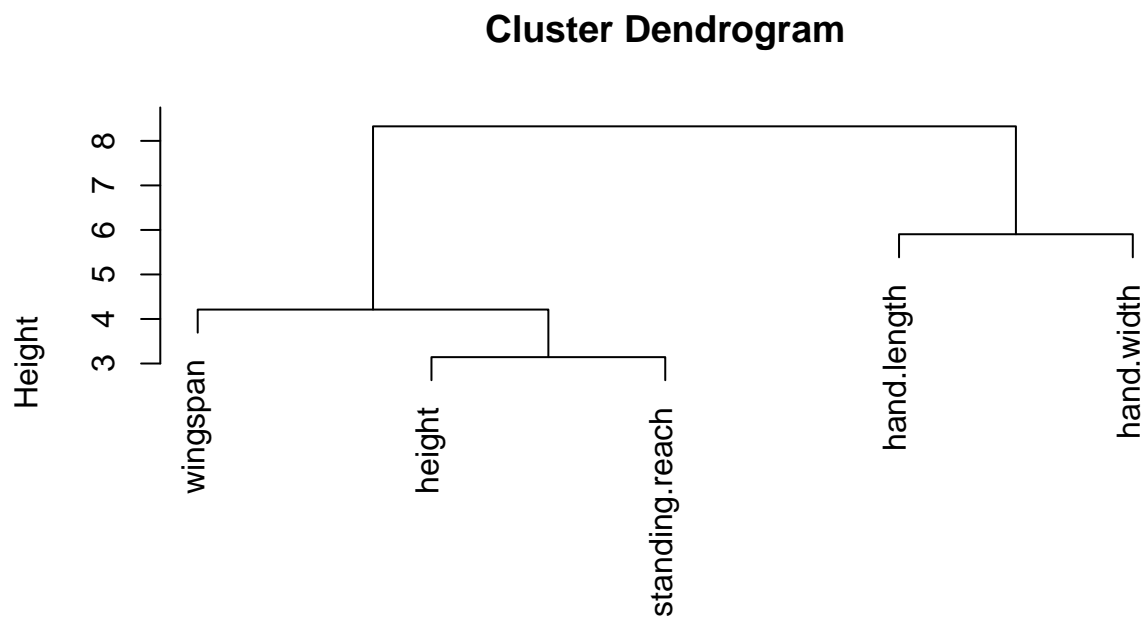
Cluster Dendrogram

X.d
stats::hclust (*, "ward.D2")

```
## [1] "Pruning 1 of 3"
## [1] "Pruning 2 of 3"
## [1] "Pruning 3 of 3"
```
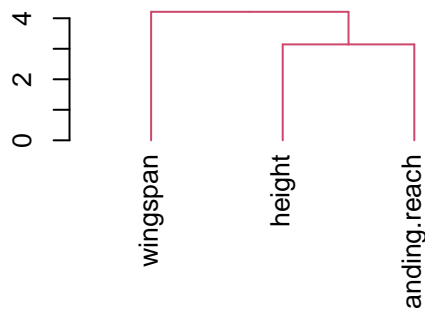
SubTree number 1
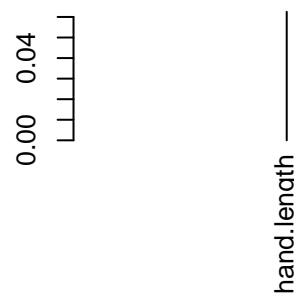
SubTree number 2

SubTree number 3
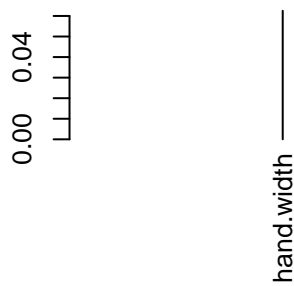
ENDNOTES

REFERENCES

Monte Shaffer. 2020. Homepage, Function Project Measure. (Accessed: November 2020). https://github.com/MonteShaffer/humanVerseWSU/blob/master/misc/functions-project-measure.R.

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