Non-Parametric Demos

Sir Stats McStatserson III

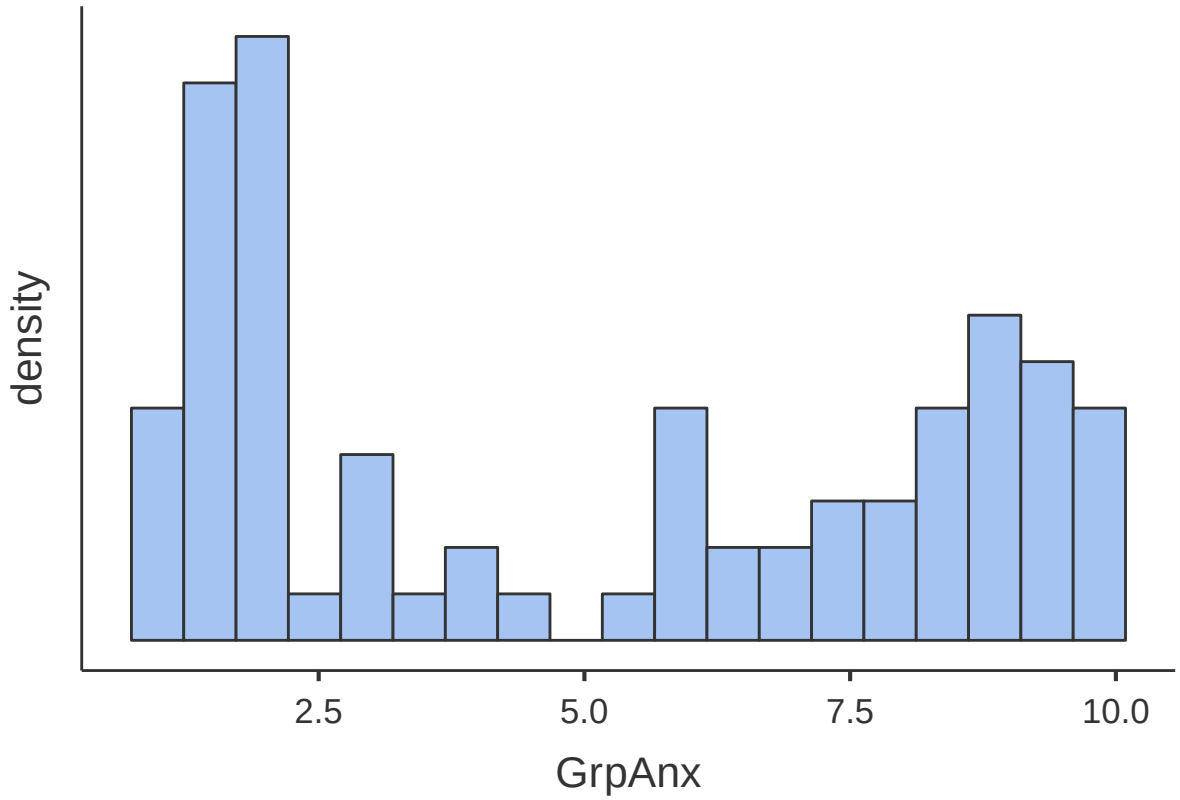
Demo 1 - Independent t-test

A researcher wants to investigate the Imagined Contact Hypothesis using a replication on an online platform (Turner, Crisp, & Lambert, 2007). The study recruits individuals to either read a positive imaginative scenario of a disliked outgroup or a neutral one. Following, outgroup anxiety is measued using a 10-point Likert scale. The researcher is interested in figuring out if the results of the original study hold up - that imaginging positive contact with a negative outgroup reduces outgroup anxiety compared to a control group.

```
# Load data and libraries
dat <- read.csv('https://www.dropbox.com/s/ek205h95ssjxt7w/NonParaDemo1.csv?dl=1')

library(pacman)
p_load(jmv, psych, car, effsize)
```

```
# Descriptives
desc <-descriptives(dat,
                    vars = c('GrpAnx'),
                    sd = TRUE,
                    range = TRUE,
                    min = TRUE,
                    max = TRUE,
                    skew = TRUE,
                    kurt = TRUE,
                    hist = TRUE)
desc
```

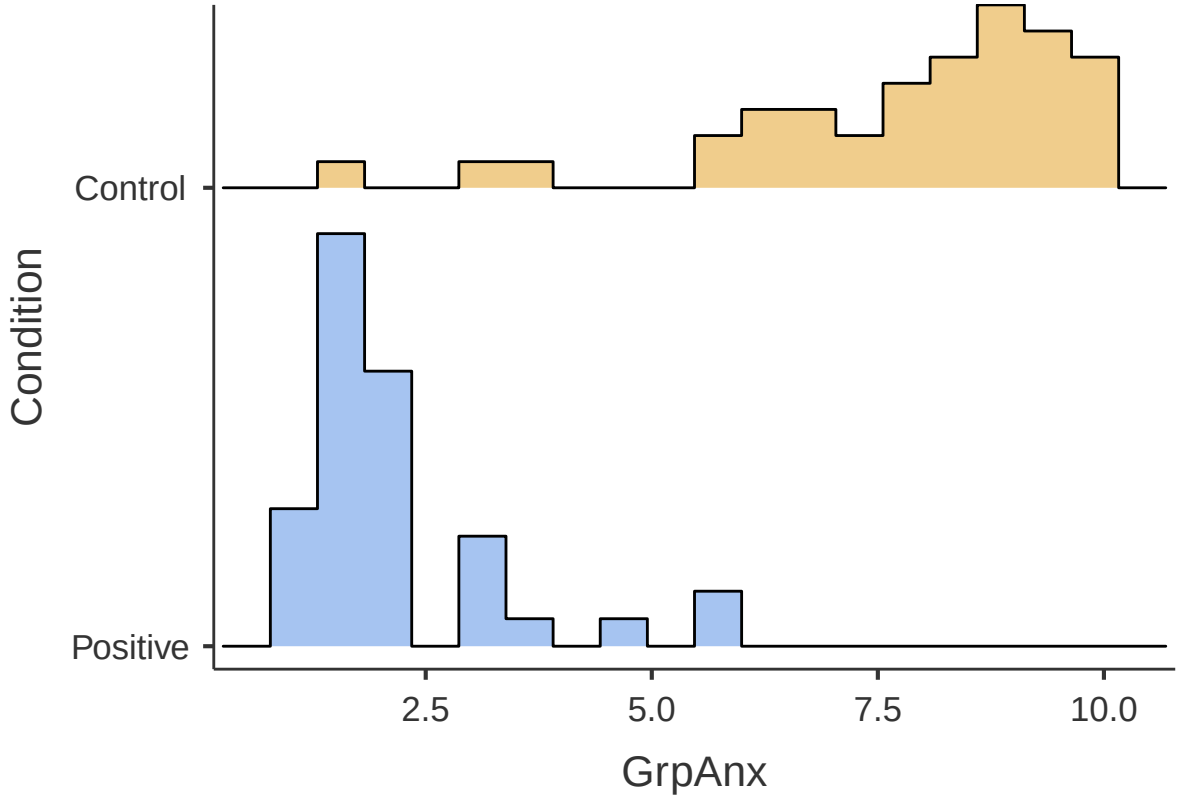
```
##
##  DESCRIPTIVES
##
##  Descriptives
##  ---------------------------------
##                            GrpAnx
##  ---------------------------------
##    N                          78
##    Missing                     0
##    Mean                     5.08
##    Median                   4.97
##    Standard deviation       3.29
##    Range                    8.86
##    Minimum                  1.07
##    Maximum                  9.93
##    Skewness                0.146
##    Std. error skewness     0.272
##    Kurtosis                -1.71
##    Std. error kurtosis     0.538
##  ---------------------------------
```



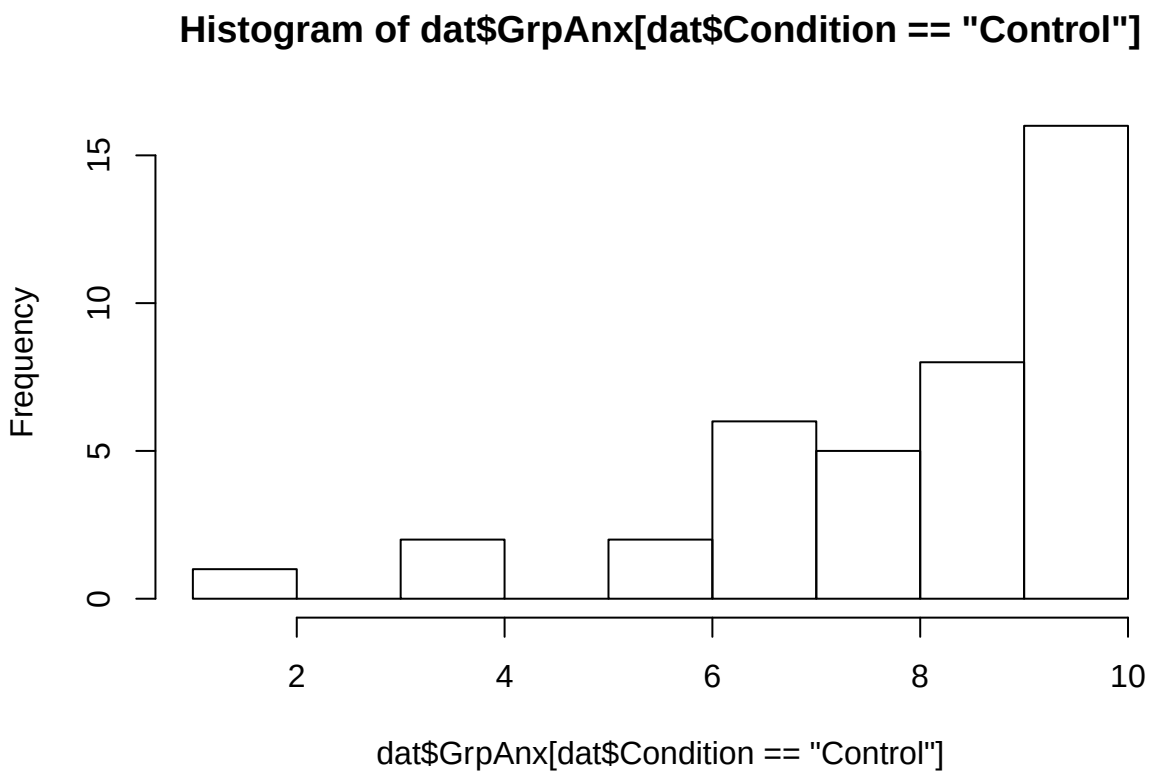

```
# Descriptives by Condition
descriptives(data = dat,
             vars = 'GrpAnx',
             splitBy = 'Condition',
             sd = TRUE,
             min = TRUE,
             max = TRUE,
             skew = TRUE,
             kurt = TRUE,
             hist = TRUE)
```

```
##
##  DESCRIPTIVES
##
##  Descriptives
##  ---------------------------------------------
##                            Condition    GrpAnx
##  ---------------------------------------------
##    N                       Control          40
##                            Positive         38
##    Missing                 Control           0
##                            Positive          0
##    Mean                    Control        7.86
##                            Positive       2.15
##    Median                  Control        8.52
##                            Positive       1.77
##    Standard deviation      Control        1.93
```

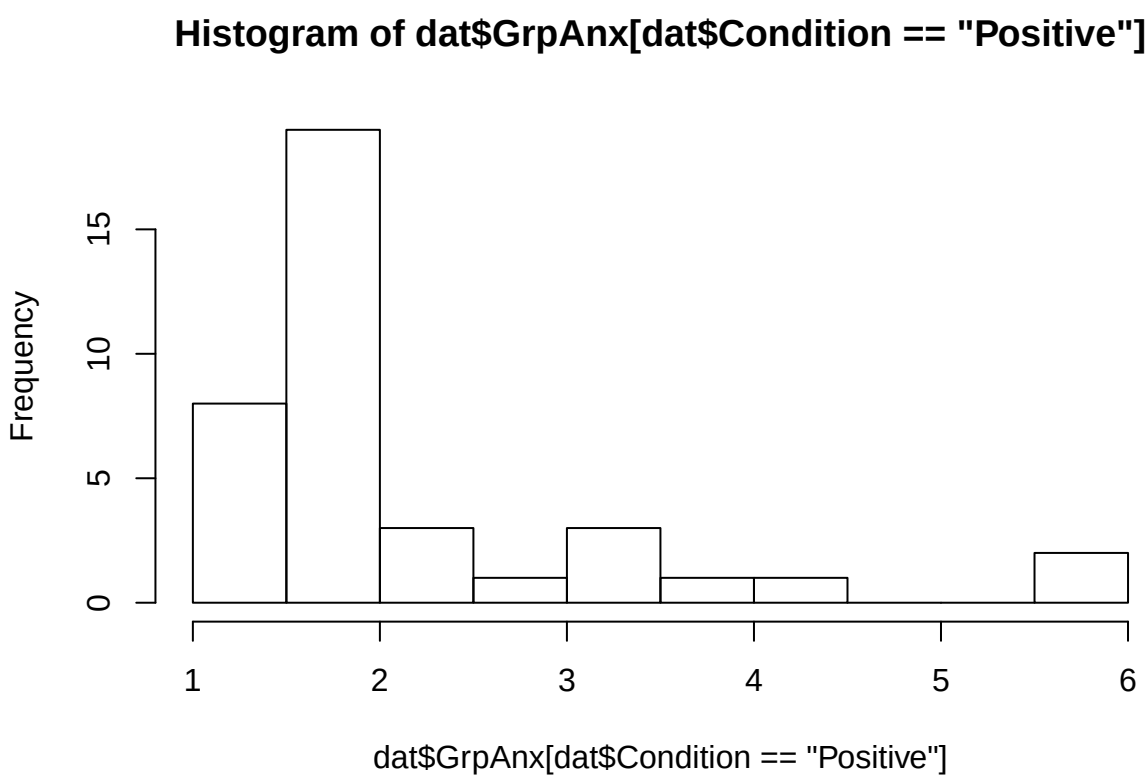
```
##                          Positive       1.18
##    Minimum               Control        1.59
##                          Positive       1.07
##    Maximum               Control        9.93
##                          Positive       5.96
##    Skewness              Control       -1.50
##                          Positive       2.11
##    Std. error skewness   Control       0.374
##                          Positive      0.383
##    Kurtosis              Control        2.27
##                          Positive       4.38
##    Std. error kurtosis   Control       0.733
##                          Positive      0.750
##  ------------------------------------------------
```




```
hist(dat$GrpAnx [dat$Condition== 'Control'])
```




```
hist(dat$GrpAnx [dat$Condition== 'Positive'])
```




```
# Mann-Whitney test (with Levene's)
test <- ttestIS(data = dat,
                vars = 'GrpAnx',      # DV
                group = 'Condition',  # IV
                mann = TRUE,          # Mann-Whitney U
                eqv = TRUE,           # Levene's test
                meanDiff = FALSE,
                effectSize = FALSE)   # Cohen's d
test
```

```
##
##  INDEPENDENT SAMPLES T-TEST
##
##  Independent Samples T-Test
##  ------------------------------------------------------------
##                                statistic    df      p
##  ------------------------------------------------------------
##    GrpAnx    Student's t           15.7    76.0    < .001
##              Mann-Whitney U        40.5            < .001
##  ------------------------------------------------------------
##
##
##  ASSUMPTIONS
##
##  Test of Equality of Variances (Levene's)
##  ----------------------------------------
##              F       df    p
```

```
##  ----------------------------------------
##    GrpAnx    8.06     1    0.006
##  ----------------------------------------
##    Note. A low p-value suggests a
##    violation of the assumption of
##    equal variances
```

```
# Cliff's Delta (non-parametric effect size) - a more robust version of Cohen's d which considers the o

cliff.delta(GrpAnx ~ Condition, data = dat, conf.level = .95, magnitude = TRUE, method = "Cliff's Delta
```

```
##
## Cliff's Delta
##
## delta estimate: 0.9467105 (large)
## 95 percent confidence interval:
##     lower     upper
## 0.8179781 0.9851428
```

```
# Because this package is nice - it gives you the Delta estimate and an interpretation. We can see that
```

Demo 2 - Independent t-test

A local school believes the 2nd grade students are the happiest when they come into school in the morning, regardless of which teacher they have. The principal conducts a quick survey of students as they file into homeroom with Mr. Sad's class and Mrs. Humor's class. Conduct an analysis on the survey data collected with happiness levels being taken on a 1-100 scale.

```
# Load data and libraries
dat2 <- read.csv('https://www.dropbox.com/s/57jdxxkzh2x1koe/NonParaDemo2.csv?dl=1')

library(jmv)
library(psych)
library(car)
library(effsize)
```

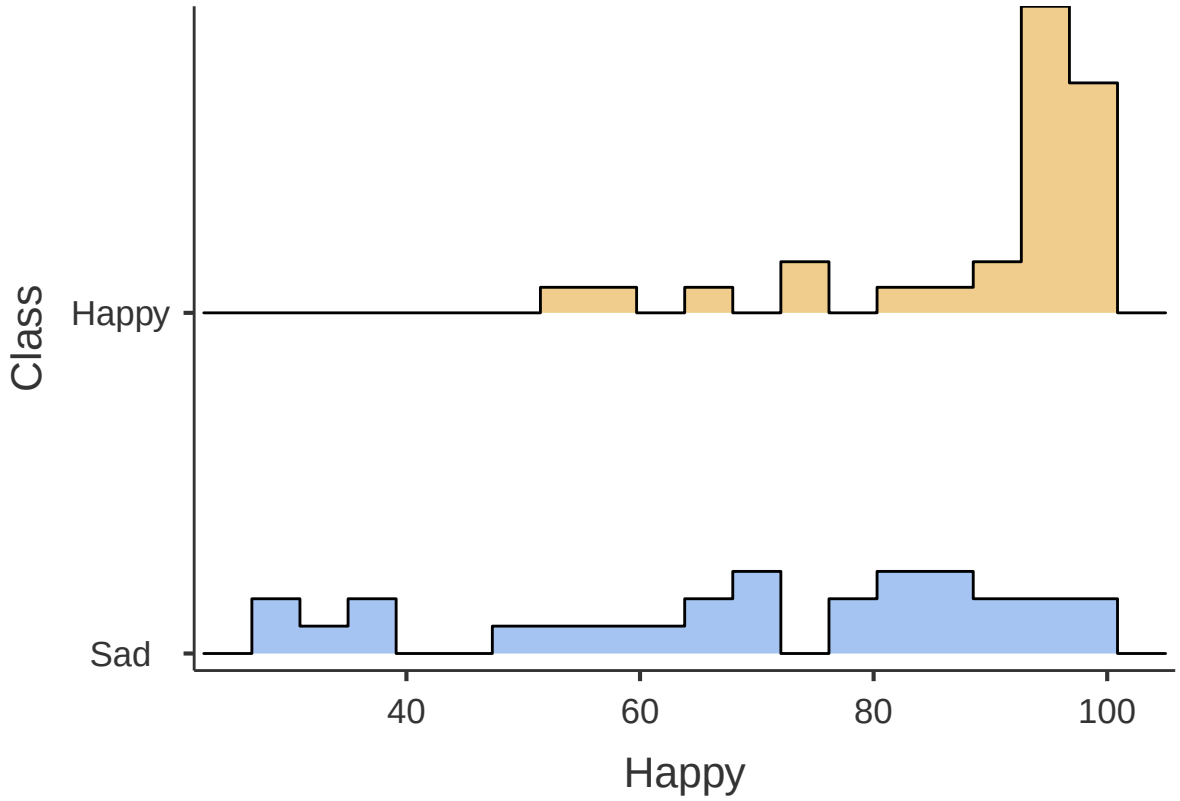
```
# Descriptives
desc2 <- descriptives(dat2,
                      vars = c('Happy'),
                      sd = TRUE,
                      range = TRUE,
                      min = TRUE,
                      max = TRUE,
                      skew = TRUE,
                      kurt = TRUE)
desc2
```

```
##
##  DESCRIPTIVES
##
##  Descriptives
##  --------------------------------
##                             Happy
##  --------------------------------
##    N                           58
##    Missing                      0
##    Mean                      80.1
```

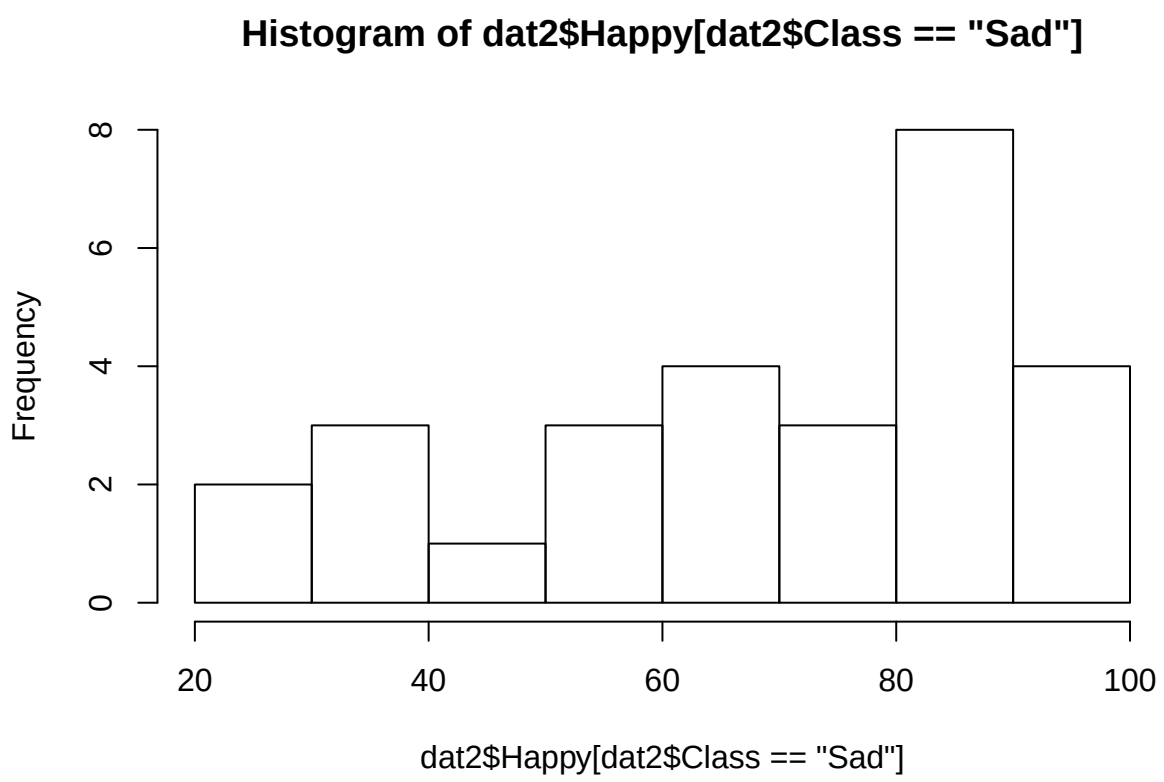
```
##    Median                  87.5
##    Standard deviation      20.1
##    Range                     70
##    Minimum                   29
##    Maximum                   99
##    Skewness                -1.16
##    Std. error skewness     0.314
##    Kurtosis                0.344
##    Std. error kurtosis     0.618
##  --------------------------------
```

```
# Descriptives by Class
descriptives(data = dat2,
             vars = 'Happy',
             splitBy = 'Class',
             sd = TRUE,
             min = TRUE,
             max = TRUE,
             skew = TRUE,
             kurt = TRUE,
             hist = TRUE)
```

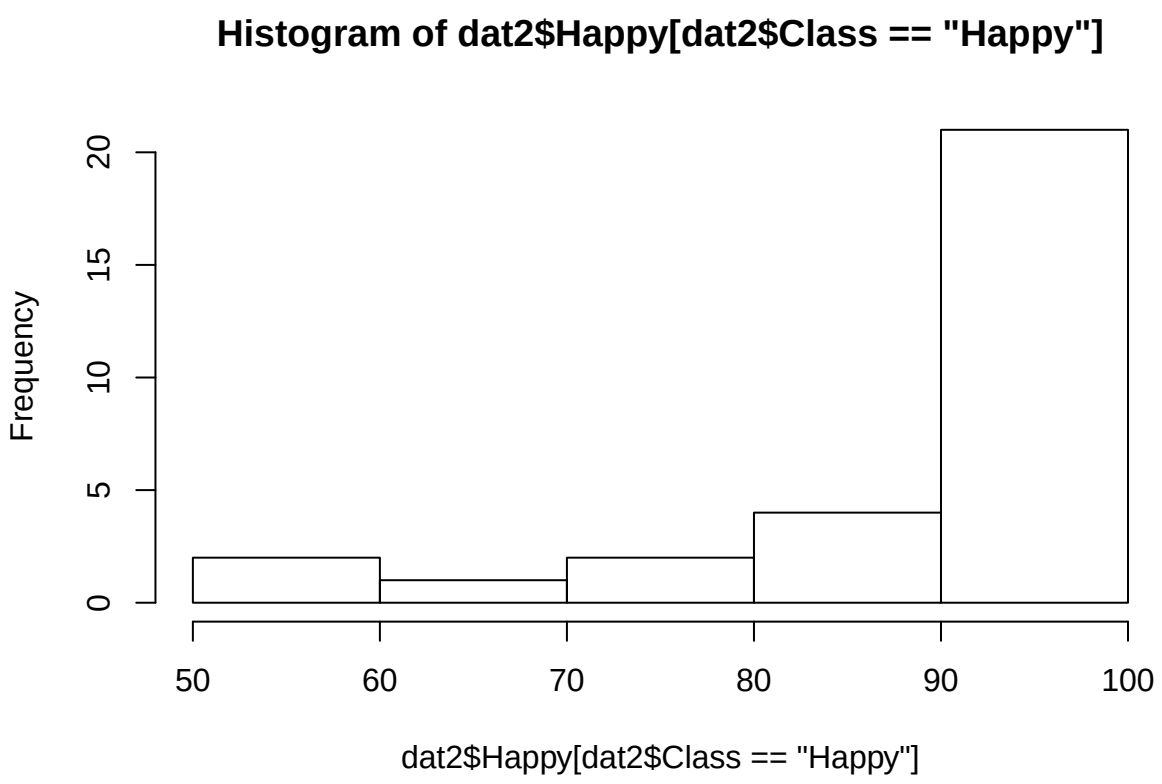
```
##
##  DESCRIPTIVES
##
##  Descriptives
##  -----------------------------------------
##                            Class    Happy
##  -----------------------------------------
##    N                       Happy       30
##                            Sad         28
##    Missing                 Happy        0
##                            Sad          0
##    Mean                    Happy     89.7
##                            Sad       69.8
##    Median                  Happy     96.0
##                            Sad       75.5
##    Standard deviation      Happy     12.7
##                            Sad       21.7
##    Minimum                 Happy       53
##                            Sad         29
##    Maximum                 Happy       99
##                            Sad         98
##    Skewness                Happy    -1.88
##                            Sad     -0.608
##    Std. error skewness     Happy    0.427
##                            Sad      0.441
##    Kurtosis                Happy     2.60
##                            Sad     -0.806
##    Std. error kurtosis     Happy    0.833
##                            Sad      0.858
##  -----------------------------------------
```




```
hist(dat2$Happy [dat2$Class== 'Sad'])
```




```
hist(dat2$Happy [dat2$Class== 'Happy'])
```




```
# Mann-Whitney test (with Levene's)
test2 <- ttestIS(data = dat2,
                 vars = 'Happy',
                 group = 'Class',
                 mann = TRUE,
                 eqv = TRUE,
                 meanDiff = TRUE,
                 effectSize = TRUE)
test2
```

```
##
##  INDEPENDENT SAMPLES T-TEST
##
##  Independent Samples T-Test
##  ---------------------------------------------------------------------------------------------
##                                statistic    df      p         Mean difference    SE difference    Coh
##  ---------------------------------------------------------------------------------------------
##    Happy    Student's t            4.30    56.0    < .001              19.9             4.63
##             Mann-Whitney U          161            < .001              15.0
##  ---------------------------------------------------------------------------------------------
##
##
##  ASSUMPTIONS
##
##  Test of Equality of Variances (Levene's)
##  ----------------------------------------
##             F       df    p
```

```
##  ----------------------------------------
##    Happy    10.8     1    0.002
##  ----------------------------------------
##    Note. A low p-value suggests a
##    violation of the assumption of
##    equal variances
```

```
# Effect size (Cliff's Delta)
cliff.delta(Happy ~ Class, data = dat2, conf.level = .95, magnitude = TRUE, method = "Cliff's Delta")
```

```
##
## Cliff's Delta
##
## delta estimate: 0.6166667 (large)
## 95 percent confidence interval:
##     lower     upper
## 0.3321409 0.7983277
```

```
# Look at the comparison (cautiously) between the Cohen's d and Cliff's Delta. The d = 1.13 which is pr
```

Demo 3 - Paired-Samples t-test

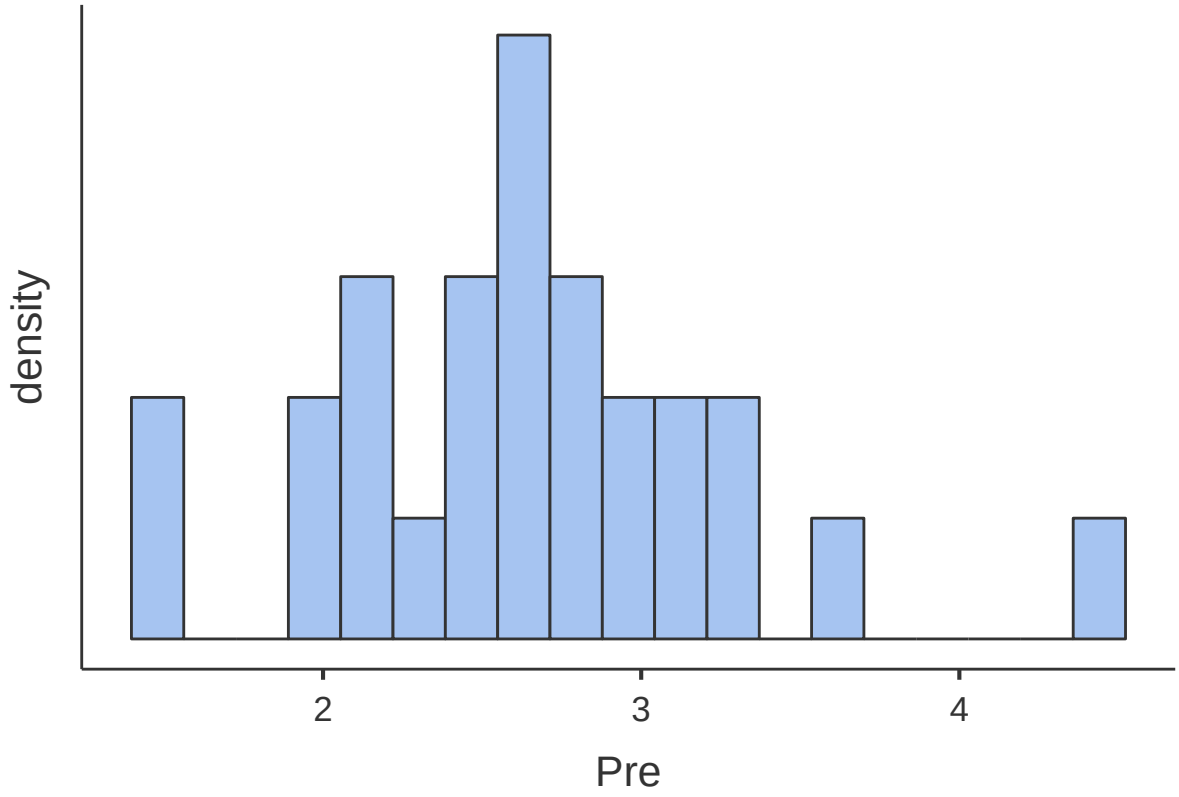
A start-up in Minnesota wants to launch a new app to increase individual's self-awareness. The app sends out two messages per day during reported peak inattention times (10-11 a.m. and 2-3 p.m.) for the typical '9-to-5' worker which spurs them to re-engage and become aware of their environment, reflect on their thoughts, highlight any ruminations, etc. The company measures participants feelings of inattention prior to the use of the app and after two weeks of using it. They are hoping to launch soon. Please assess their app's performance by using the self-awareness ratings which is reported on a 10-point scale.

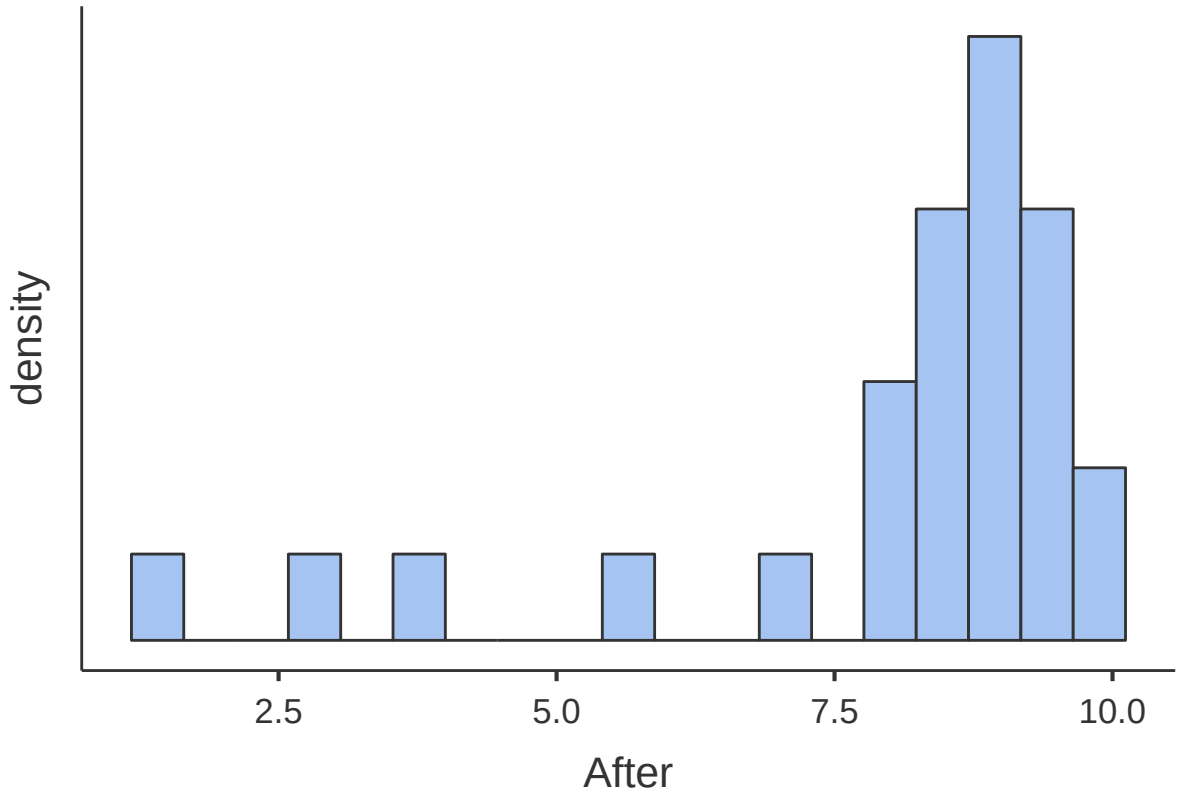
```
# Load data and libraries
dat3 <- read.csv('https://www.dropbox.com/s/lczn6qxs92ol5yl/NonParaDemo3.csv?dl=1')

library(jmv)
library(psych)
library(car)
```

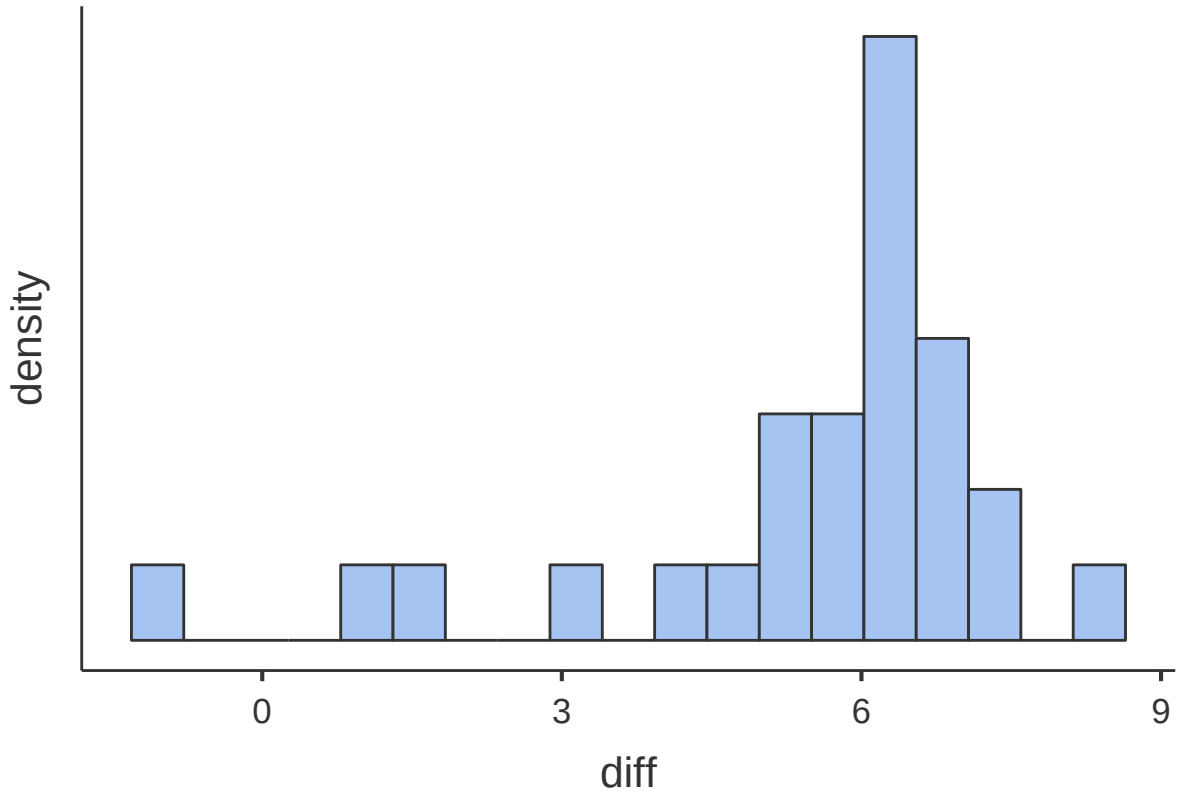
```
# Compute difference scores
dat3$diff <- (dat3$After - dat3$Pre)

# Descriptives
desc3 <- descriptives(dat3,
                      vars = c('Pre', 'After', 'diff'),
                      sd = TRUE,
                      range = TRUE,
                      min = TRUE,
                      max = TRUE,
                      skew = TRUE,
                      kurt = TRUE,
                      hist = TRUE)
desc3
```

```
##
##  DESCRIPTIVES
##
##  Descriptives
##  -------------------------------------------------
##                            Pre      After    diff
```

```
##  ------------------------------------------------
##    N                          27       27       27
##    Missing                     0        0        0
##    Mean                     2.64     8.08     5.44
##    Median                   2.64     8.71     6.16
##    Standard deviation      0.632     2.11     2.10
##    Range                    2.96     8.47     9.43
##    Minimum                  1.43     1.37    -1.23
##    Maximum                  4.39     9.84     8.20
##    Skewness                0.474    -2.13    -1.82
##    Std. error skewness     0.448    0.448    0.448
##    Kurtosis                 1.31     4.01     3.42
##    Std. error kurtosis     0.872    0.872    0.872
##  ------------------------------------------------
```




density
2.5
5.0
7.5
10.0
After




```
# Wilcoxan Signed Rank Test (with Shapiro-Wilk)
test3 <- ttestPS(dat3,
                 pairs = list(
                   list(i1 = 'Pre', i2 = 'After')),
                 wilcoxon = TRUE,
                 norm = TRUE,
                 meanDiff = TRUE)
test3
```

```
##
##  PAIRED SAMPLES T-TEST
##
##  Paired Samples T-Test
##  ---------------------------------------------------------------------------------------------------
##                                    statistic    df      p         Mean difference    SE difference
##  ---------------------------------------------------------------------------------------------------
##    Pre    After    Student's t        -13.5    26.0    < .001             -5.44            0.404
##                    Wilcoxon W          2.00            < .001             -5.90            0.404
##  ---------------------------------------------------------------------------------------------------
##
##
##  Test of Normality (Shapiro-Wilk)
##  ---------------------------------------
##                          W        p
##  ---------------------------------------
##    Pre    -    After    0.807    < .001
##  ---------------------------------------
```

```
##    Note. A low p-value suggests a
##    violation of the assumption of
##    normality
```

Clean this ugly code using defined constants/variables for the homework

```
# Effect size for non-parametric related-samples t-test
# r = z/sqrt(N)

# to find z, we use this formula.
# z = (W - mW + .5)/o ; where mW is the null that there is no difference between T1 and T2 so it will a

# first we need to find o:coxon
# where n = total number of scores (2 x number of cases)
# o = sqrt((n(n+1)(2n+1))/6)
o = sqrt(((54*(54+1)*(2*54)+1))/6)
o
```

```
## [1] 231.2145
```

```
# now to find z:
z = (378-0+.5)/231.2145
z
```

```
## [1] 1.637008
```

```
# r is the Pearson value reported for the non-parametric paired-sample t-test
r = (1.637)/sqrt(54)
r
```

```
## [1] 0.2227675
```

```
# Effect size is the probability of a time 2 score being greater than a time 1 score

# Based on Cohen's criteria of evaluating effect size: .10 = small, .30 = medium, and .50 = large (but
```

```
# To get the "other" sum of ranks, reverse the order of variables
wilcox.test(dat3$After,
            dat3$Pre,
            paired = T,
            exact = FALSE)
```

```
##
##  Wilcoxon signed rank test with continuity correction
##
## data:  dat3$After and dat3$Pre
## V = 376, p-value = 7.441e-06
## alternative hypothesis: true location shift is not equal to 0
```

```
# To get the total sum of ranks:
N <- dim(dat3)[1]
sumranks <- N*(N+1) / 2
```

Demo 4 - ANOVA

A production company that specializes in movie trailers wants to have a friendly competition between their four production teams before the upcoming summer releases. Each team believes they can get viewers to have highest intention to watch an upcoming movie based on their trailer. Each team created a 3-minute trailer for the upcoming Marvel movie and recruited groups of viewers to watch the trailer and take a short survey afterwards indicating their intention to see the movie on a 100-point scale. The company will reward

the best production team by releasing their trailer nationwide but needs your help to determine who they should choose.

```
# Load data and libraries
dat4 <- read.csv('https://www.dropbox.com/s/mwvitjc1cdal0bv/NonParaDemo4.csv?dl=1')

library(pacman)
p_load(jmv, psych, car)
```

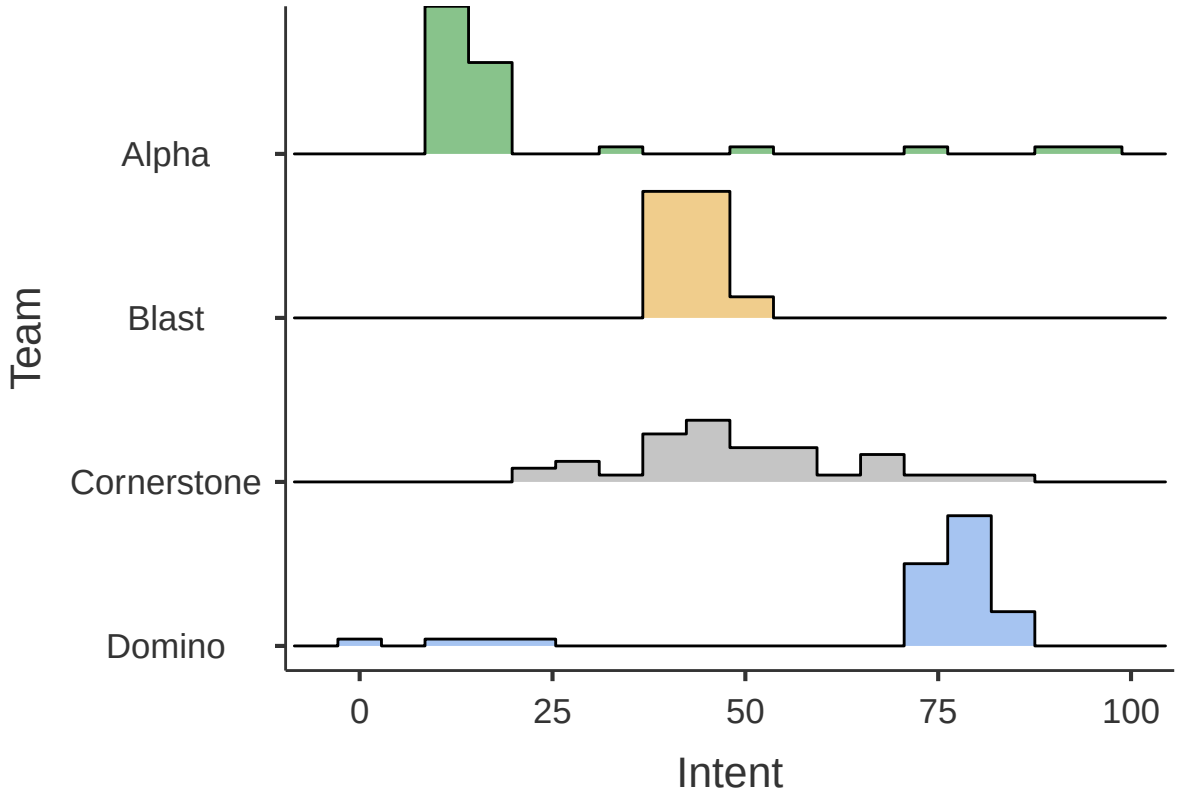
```
# Descriptives
desc4 <- descriptives(dat4,
                      vars = c('Intent'),
                      sd = TRUE,
                      range = TRUE,
                      min = TRUE,
                      max = TRUE,
                      skew = TRUE,
                      kurt = TRUE)
desc4
```

```
##
##  DESCRIPTIVES
##
##  Descriptives
##  ---------------------------------
##                            Intent
##  ---------------------------------
##    N                          158
##    Missing                      0
##    Mean                      46.4
##    Median                    44.0
##    Standard deviation        24.4
##    Range                       96
##    Minimum                      1
##    Maximum                     97
##    Skewness                0.0543
##    Std. error skewness      0.193
##    Kurtosis                 -1.11
##    Std. error kurtosis      0.384
##  ---------------------------------
```

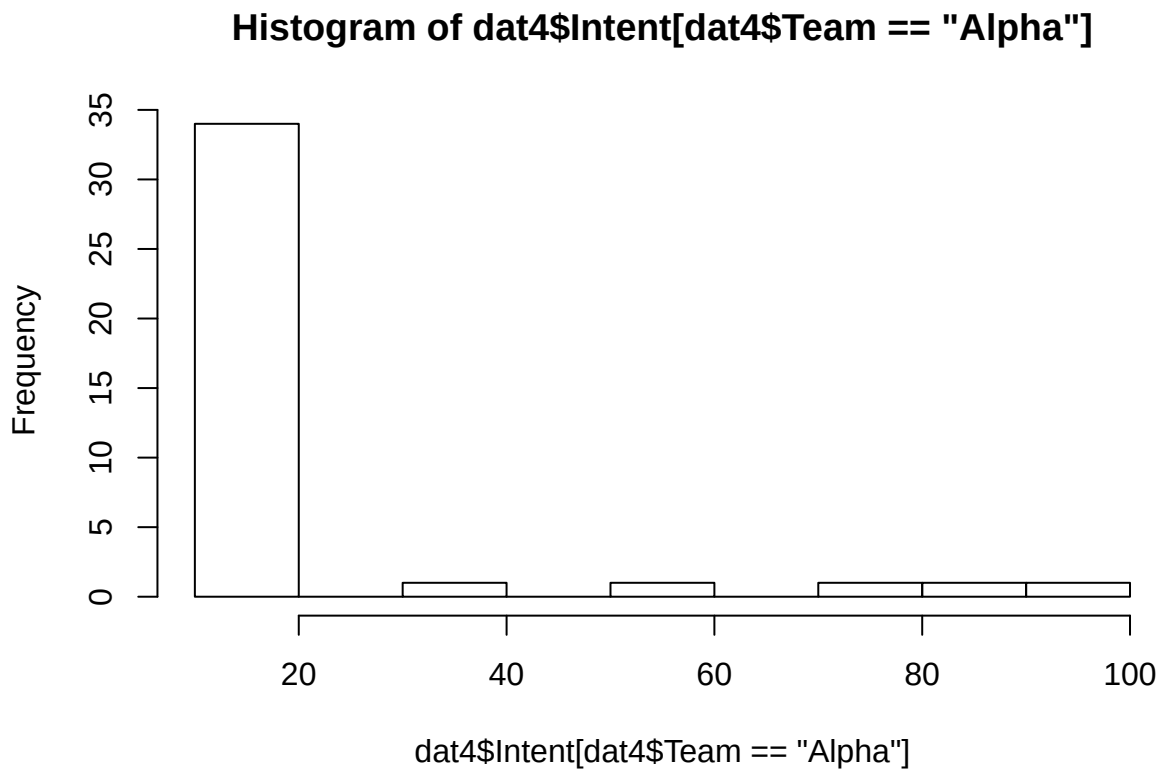
```
# Descriptives by Team
descriptives(data = dat4,
             vars = 'Intent',
             splitBy = 'Team',
             sd = TRUE,
             min = TRUE,
             max = TRUE,
             skew = TRUE,
             kurt = TRUE,
             hist = TRUE)
```

```
##
##  DESCRIPTIVES
##
##  Descriptives
```

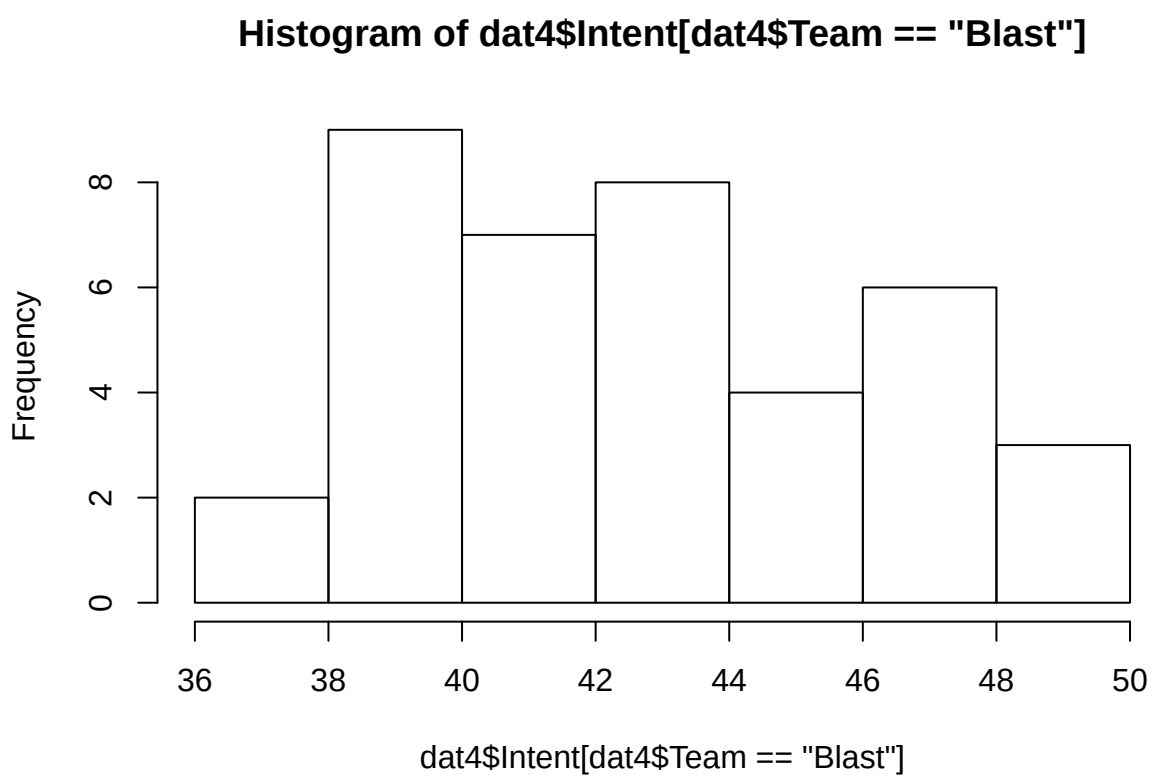
	Team	Intent
N	Alpha	39
	Blast	39
	Cornerstone	40
	Domino	40
Missing	Alpha	0
	Blast	0
	Cornerstone	0
	Domino	0
Mean	Alpha	20.6
	Blast	43.2
	Cornerstone	49.3
	Domino	71.7
Median	Alpha	13
	Blast	43
	Cornerstone	47.5
	Domino	78.0
Standard deviation	Alpha	20.9
	Blast	3.42
	Cornerstone	14.5
	Domino	19.9
Minimum	Alpha	10
	Blast	37
	Cornerstone	22
	Domino	1
Maximum	Alpha	97
	Blast	49
	Cornerstone	82
	Domino	86
Skewness	Alpha	2.85
	Blast	0.183
	Cornerstone	0.364
	Domino	-2.72
Std. error skewness	Alpha	0.378
	Blast	0.378
	Cornerstone	0.374
	Domino	0.374
Kurtosis	Alpha	7.31
	Blast	-0.970
	Cornerstone	-0.0517
	Domino	6.26
Std. error kurtosis	Alpha	0.741
	Blast	0.741
	Cornerstone	0.733
	Domino	0.733



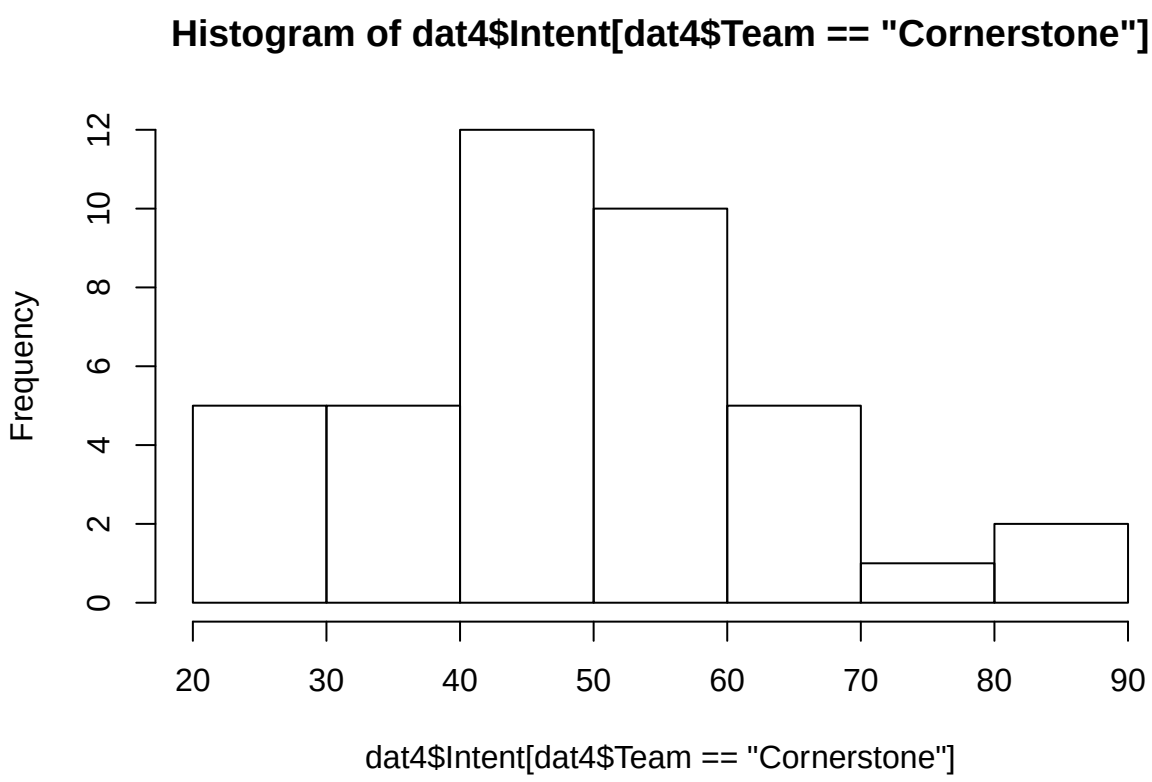

```
hist(dat4$Intent [dat4$Team== 'Alpha'])
```



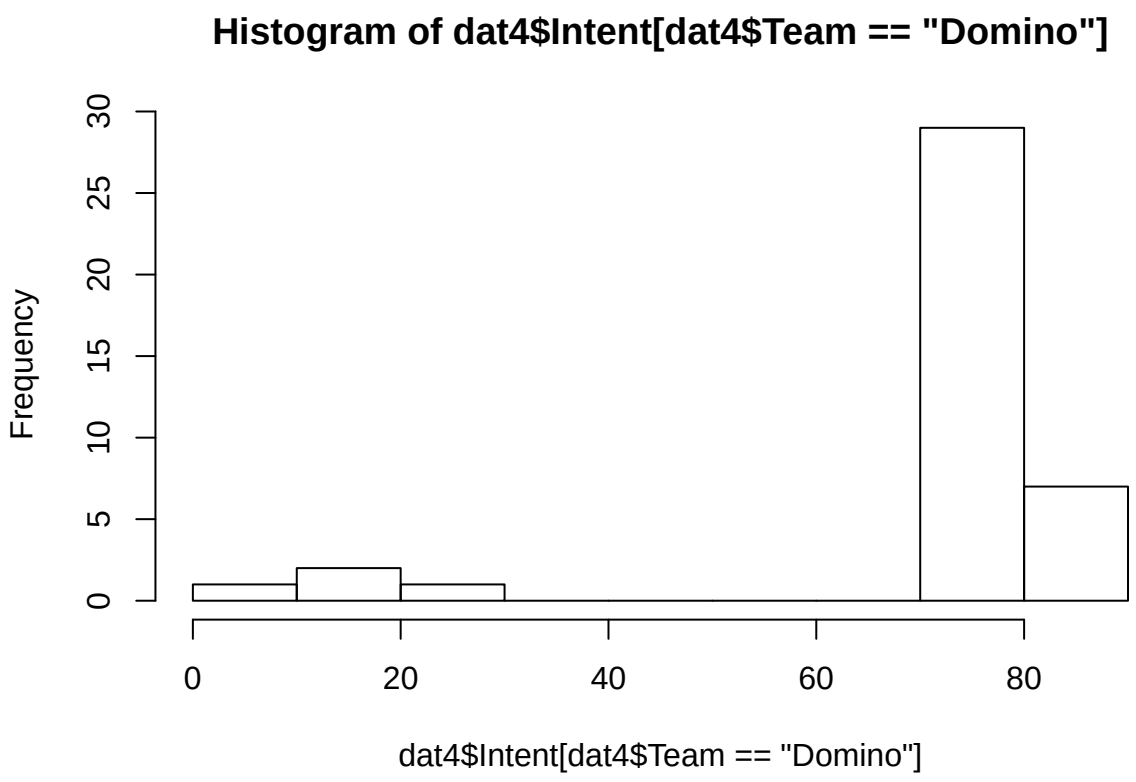

```r
hist(dat4$Intent [dat4$Team== 'Blast'])
```




```r
hist(dat4$Intent [dat4$Team== 'Cornerstone'])
```




```
hist(dat4$Intent [dat4$Team== 'Domino'])
```




```
# ANOVA with each Team on Intent (with Levene's)
INTaov <- jmv::ANOVA(data = dat4, dep = 'Intent', factors = c('Team'), effectSize = 'partEta', postHoc =
INTaov
```

```
##
##  ANOVA
##
##  ANOVA
##  ------------------------------------------------------------------------------
##                  Sum of Squares    df     Mean Square    F       p         <U+03B7>²p
##  ------------------------------------------------------------------------------
##    Team                  52377      3           17459    65.9    < .001    0.562
##    Residuals             40776    154             265
##  ------------------------------------------------------------------------------
##
##
##  ASSUMPTION CHECKS
##
##  Test for Homogeneity of Variances (Levene's)
##  ------------------------------------------
##    F       df1    df2    p
##  ------------------------------------------
##    5.08      3    154    0.002
##  ------------------------------------------
##
##
##  POST HOC TESTS
```

```
##
##  Post Hoc Comparisons - Team
##  ---------------------------------------------------------------------------------------------
##    Team                Team           Mean Difference    SE      df     t          p-tukey
##  ---------------------------------------------------------------------------------------------
##    Alpha           -   Blast                  -22.62    3.68    154     -6.14    < .001
##                    -   Cornerstone            -28.74    3.66    154     -7.85    < .001
##                    -   Domino                 -51.14    3.66    154    -13.96    < .001
##    Blast           -   Cornerstone             -6.12    3.66    154     -1.67      0.342
##                    -   Domino                 -28.52    3.66    154     -7.79    < .001
##    Cornerstone     -   Domino                 -22.40    3.64    154     -6.16    < .001
##  ---------------------------------------------------------------------------------------------
```

```
# Kruskal-Wallis including pairwise comparisons (Dwass-Steel-Crtichlow-Fligner)
KW_INT_aov <- anovaNP(data = dat4,
                      dep = 'Intent',
                      group = c('Team'),
                      pairs = TRUE)
KW_INT_aov
```

```
##
##  ONE-WAY ANOVA (NON-PARAMETRIC)
##
##  Kruskal-Wallis
##  ---------------------------------
##              <U+03C7>²      df    p
##  ---------------------------------
##    Intent    84.3     3    < .001
##  ---------------------------------
##
##
##  DWASS-STEEL-CRITCHLOW-FLIGNER PAIRWISE COMPARISONS
##
##  Pairwise comparisons - Intent
##  -------------------------------------------------
##                                  W       p
##  -------------------------------------------------
##    Alpha           Blast          8.56    < .001
##    Alpha           Cornerstone    8.80    < .001
##    Alpha           Domino         8.73    < .001
##    Blast           Cornerstone    3.31     0.019
##    Blast           Domino         8.66    < .001
##    Cornerstone     Domino         7.76    < .001
##  -------------------------------------------------
```

```
# Epsilon-squared estimate of effect size
# .1 .3 .5 --- .2 .4 .6 are good estimates for small/med/large

# EpiSq = (H)/((n^2-1)/(n+1))

EpiSq = (84.3)/((158^2 -1)/(158+1))
EpiSq
```

```
## [1] 0.5369427
```

```
# Compare this to the eta squared that was printed with the original ANOVA (.56). They are quite simila
```