# Two Sample Mood Test

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# Intro To Two Sample Mood Test

# Scenario

The Two Sample Mood Test can be used to determine whether or not a variable is widely dispersed. So in this case,

$$X \quad X \quad X \quad Y \quad Y \quad Y \quad Y \quad X \quad X \quad X$$

it seems clear that X is far more dispersed than Y as opposed to the following case

$$X \quad Y \quad X \quad Y \quad X \quad Y \quad X \quad Y$$

where the observations seem to be of similar scale.

# Mood Statistic

The mood statistic is

$$M_n = \sum_{i=1}^{N} \left( i - \frac{N-1}{2} \right)^2 Z_i$$

where high values of $M_n$ would lead us to reject the null hypothesis that the scale of $X$ and $Y$ are equal.The code below will do just that.

# R Code for Mood Statistic

```
mood_statistic <- function(X, Y) {
  X <- cbind(X, rep(1, length(X)))
  Y <- cbind(Y, rep(0, length(Y)))
  seq <- rbind(X, Y)
  seq <- seq[order(seq[,1]),]
  N <- length(seq[,2])
  sum <- 0
  for (i in 1:N) {
    sum <- sum + (i-(N+1)/2)^2 * seq[i,2]
  }
  return(sum)
}
```

# Issues with Mood Test

# Low power for high $n$

```
N <- seq(2,100, by = 2)
Mn <- (N/2)*(N^2 - 1)/12
Mn0 <- c()
Mna <- c()
for (i in 1:length(N)) {
  sim_0 <- rnorm(N[i])
  sim_a <- rnorm(N[i],0,3)
  Mn0[i] <- mood_statistic(sim_0,sim_0)
  Mna[i] <- mood_statistic(sim_a, sim_0)
}
plot(N, Mn, main = "Expected Value of Mn versus N", type =
lines(N, Mn0, col = "red")
lines(N, Mna, col = "blue")
```

# Low power for high $n$

```
N <- seq(2,100, by = 2)
Mn <- (N/2)*(N^2 - 1)/12
Mn0 <- c()
Mna <- c()
for (i in 1:length(N)) {
  sim_0 <- rnorm(N[i])
  sim_a <- rnorm(N[i],0,3)
  Mn0[i] <- mood_statistic(sim_0,sim_0)
  Mna[i] <- mood_statistic(sim_a, sim_0)
}
plot(N, Mn, main = "Expected Value of Mn versus N", type =
lines(N, Mn0, col = "red")
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```

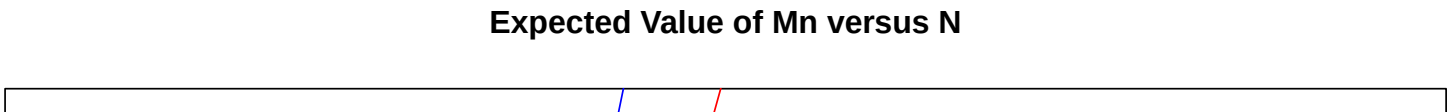

# Difficult to Compute Exact P-Value

- So difficult, not even listed in book as far as I could find
- No function availale to compute it exactly unless someone tells me
- Thank goodness for R

# Sims in R

```
sim_0 <- rnorm(25)
sim_01 <- rnorm(25)
sim_a <- rnorm(25,0,2)
mood.test(sim_0,sim_a)
```

```
##
##  Mood two-sample test of scale
##
## data:  sim_0 and sim_a
## Z = -2.9541, p-value = 0.003135
## alternative hypothesis: two.sided
```

# Sims in R

```
mood.test(sim_0,sim_01)
```

```
##
##  Mood two-sample test of scale
##
## data:  sim_0 and sim_01
## Z = 1.4771, p-value = 0.1397
## alternative hypothesis: two.sided
```

# Sims in R

```
sim_0 <- rnorm(20000)
sim_01 <- rnorm(20000)
sim_a <- rnorm(20000, 0, 2)
mood.test(sim_0, sim_a)
```

```
##
##  Mood two-sample test of scale
##
## data:  sim_0 and sim_a
## Z = -77.422, p-value < 2.2e-16
## alternative hypothesis: two.sided
```

# Sims in R

```
mood.test(sim_0, sim_01)
```

```
##
##  Mood two-sample test of scale
##
## data:  sim_0 and sim_01
## Z = -0.27441, p-value = 0.7838
## alternative hypothesis: two.sided
```