Two-mean resampling

We want to run an approximate two-mean permutation test (sometimes called a randomization test). This test is used to test for a significant difference of means between (possibly) skewed, small samples.

Each sample has a mean. First, determine the actual difference of sample means.

A physical method could be used for the resampling: Write all scores onto playing cards. Shuffle them, then separate into two piles (of sizes of original samples). Get the resampling difference of means. Repeat *many* times and count how often those differences were as large as (or larger than) the actual difference.

Sources:

1. https://en.wikipedia.org/wiki/Resampling_(statistics)#Permutation_tests (see Monte Carlo sampling)
2. https://thomasleeper.com/Rcourse/Tutorials/permutationtests.html
3. OpenIntro Statistics, Third Edition, Chapter 6.6

Actual difference of sample means

You have two samples.

```
sam1 = c(4.6, 6.5, 5.5, 6.1, 6.2)
sam2 = c(3.7, 4.9, 3.9)
```

Determine their sizes and means.

```
n1 = length(sam1)
n2 = length(sam2)
xbar1 = mean(sam1)
xbar2 = mean(sam2)
```

Find the actual difference of sample means.

```
adosm = xbar2-xbar1
aadosm = abs(adosm)
```

Look at the statistics.

$$
\begin{aligned}
n_1 &= 5 \\
n_2 &= 5 \\
\bar{x}_1 &= 5.78 \\
\bar{x}_2 &= 4.1666667 \\
\bar{x}_2 - \bar{x}_1 &= -1.6133333 \\
|\bar{x}_2 - \bar{x}_1| &= 1.6133333
\end{aligned}
$$

Resample

We shuffle the two groups together, resplit, mark the resampling difference of means, repeat.

```
nresample = 10000
combined = c(sam1, sam2)
rdiffs = c()   #How to make empty list
for (rep in 1:nresample){
```

```
  shuffled = sample(combined) #reorder the numbers
  rsam1 = shuffled[1:n1]
  rsam2 = shuffled[(n1+1):(n1+n2)]
  rdiff = mean(rsam2)-mean(rsam1)
  rdiffs = c(rdiffs,rdiff)
}
pval = sum(abs(rdiffs) >= abs(adosm)) / (nresample)
cat(c("p-value = ", pval))
```

```
## p-value =  0.0567
```

$$p\text{-value} = 0.0567$$

We can visualize the results of the simulation with a histogram. We also mark how far the actual difference of sample means was from 0. The p-value represents the fraction of resampling differences that are farther than the actual difference.

```
hist(rdiffs, col = "black", breaks = 100)
abline(v = aadosm, col = "blue", lwd = 2)
abline(v = -aadosm, col = "blue", lwd = 2)
```