

【Exercise 2.3】

Suppose we are studying the effect of diet on height of children, and we have two diets to compare: diet A (a well balanced diet with lots of broccoli) and diet B (a diet rich in potato chips and candy bars). We wish to find the diet that helps children grow (in height) fastest. We have decided to use 20 children in the experiment, and we are contemplating the following methods for matching children with diets:

1. Let them choose.
2. Take the first 10 for A, the second 10 for B.
3. Alternate A, B, A, B.
4. Toss a coin for each child in the study: heads \rightarrow A, tails \rightarrow B.
5. Get 20 children; choose 10 at random for A, the rest for B.

Describe the benefits and risks of using these five methods.

1. Let them choose.

優點: 實驗者較不會排斥試驗所要求的飲食內容, 能夠降低受試者”犯規”的行為。

缺點: 實驗者可能會依據個人喜好來選擇飲食方法, 也不屬於隨機化的方法。受試者自己選擇有可能會造成兩組樣本數不相同, 亦或事因為是透過選擇來進行試驗, 他們猜測實驗的內容, 導致試驗結果會受其他因素影響(ex: 受試者猜測要做兩飲食肥胖的比較, 於是選了 B 組, 然後積極的運動而影響長高, 導致非控制因素變多)

2. Take the first 10 for A, the second 10 for B.

優點: 簡單明瞭, 迅速安排試驗者進行實驗。

缺點: 雖然看起來是隨機的, 但是有可能這些試驗者是按照順序來排列(ex: 身高、體重), 導致可能前 10 個小朋友跟後 10 個小朋友有著不一樣的特徵, 所以這種方法不是隨機化的。

3. Alternate A, B, A, B.

優點: 簡單快速, 很快就安排實驗者進行實驗

缺點: 有可能剛好試驗者排序為男女男女間隔, 按此方法抽出來的組合剛好分成男生女生各一組, 這種方法也不見得會是隨機化的。

4. Toss a coin for each child in the study: heads \rightarrow A, tails \rightarrow B.

優點: 每個試驗者都有可能隨機指派到 A 或 B 試驗(機率皆為 1/2), 為隨機化的方法。

缺點: 兩實驗的樣本數可能會不相同, 硬幣如果是不公平的話也會導致指派的行為傾向某試驗。

5. Get 20 children; choose 10 at random for A, the rest for B

優點: 每個人都有相同機率被抽到 AB 兩組, 為隨機化的方法

【Exercise 2.5】

Chu (1970) studied the effect of the insecticide chlordane on the nervous systems of American cockroaches. The coxal muscles from one mesoand one metathoracic leg on opposite sides were surgically extracted from each of six roaches. The roaches were then treated with 50 micrograms of α -chlordane, and coxal muscles from the two remaining meso- and metathoracic legs were removed about two hours after treatment. The Na^+-K^+ ATPase activity was measured in each muscle, and the percentage changes for the six roaches are given here:

15.3 -31.8 -35.6 -14.5 3.1 -24.5

Test the null hypothesis that the chlordane treatment has not affected the Na^+-K^+ ATPase activity. What experimental technique (not mentioned in the description above) must have been used to justify a randomization test?

我們要測試這項試驗沒有影響 Na^+-K^+ ATP活性，所以這組樣本資料有 $2^6=64$ 種可能的隨機結果，然後使用總和(SUM)來做為統計量，觀察這組樣本在組合中的位置。

這筆資料的總和(SUM)為-88，在64種結果中的位置

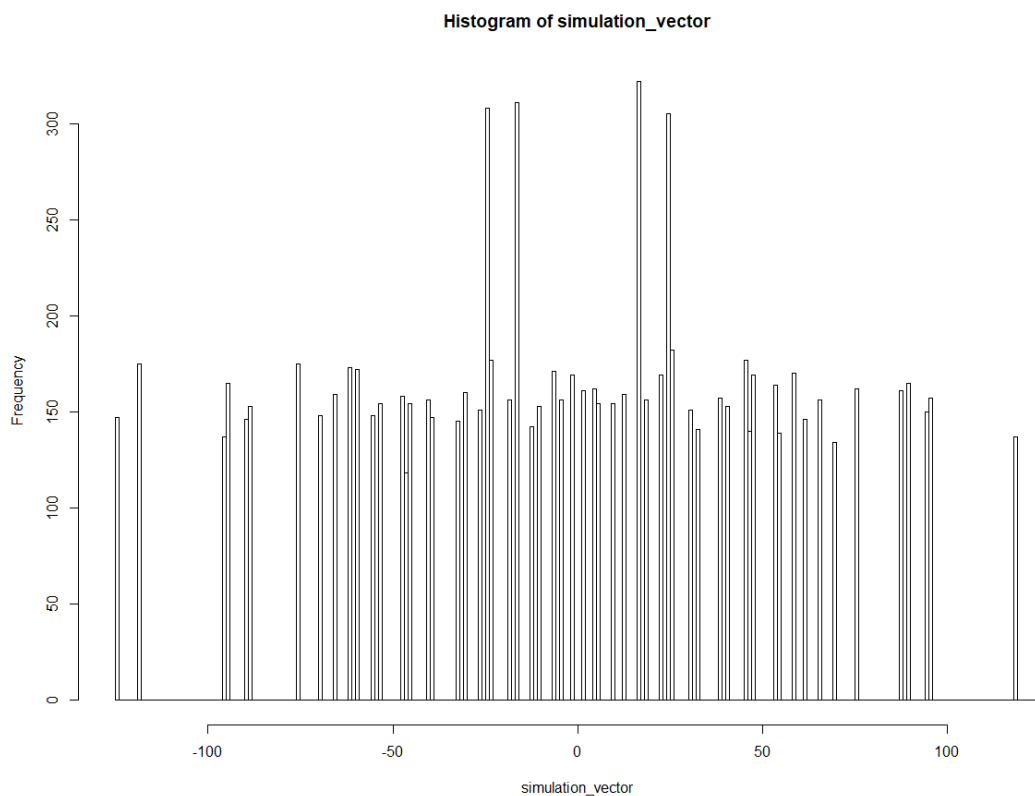
| | | | | | | | |
|--------|--------|-------|-------|-------|-------|-------|-------|
| -124.8 | -118.6 | -95.8 | -94.2 | -89.6 | -88.0 | -75.8 | -69.6 |
| -65.2 | -61.2 | -59.0 | -55.0 | -53.6 | -47.4 | -46.8 | -45.2 |
| -40.6 | -39.0 | -32.2 | -30.6 | -26.0 | -24.6 | -24.4 | -23.0 |
| -18.4 | -16.8 | -16.2 | -12.2 | -10.0 | -6.0 | -4.6 | -1.6 |
| 1.6 | 4.6 | 6.0 | 10.0 | 12.2 | 16.2 | 16.8 | 18.4 |
| 23.0 | 24.4 | 24.6 | 26.0 | 30.6 | 32.2 | 39.0 | 40.6 |
| 45.2 | 46.8 | 47.4 | 53.6 | 55.0 | 59.0 | 61.2 | 65.2 |
| 69.6 | 75.8 | 88.0 | 89.6 | 94.2 | 95.8 | 118.6 | 124.8 |

接下來我們將這64種隨機結果用亂數模擬出一萬筆數值，計算出估計的P值為0.077，假設我們設 α 值為0.05，以這筆樣本來說我們不拒絕虛無假設，即氯丹不會影響蟑螂體內鈉、鉀離子的活性。

experimental technique:

- 1.所有的蟑螂的品種、大小、年齡、生長環境一致
- 2.沒有接受過其他藥劑的注射過
- 3.這六隻蟑螂為隨機抓取

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> #exercise2.5
> #charles's method
> x<-c(15.3,-31.8,-35.6,-14.5,3.1,-24.5)
> y=NULL
> for(i in 1:10000){
+   num=sample(0:6,1,T,prob = c(1,6,15,20,15,6,1)/64);num
+   if(num==0){XX<-x}
+   else{sign=sample(1:6,num,F);sign
+   XX<-c(x[sign]*-1,x[-sign])}
+ }
> y=rbind(y,XX)
> }
> #模擬一萬筆64種組合值的數據，並計算樣本的位置
> simulation_vector<-apply(y,1,sum)
> hist(simulation_vector,breaks=200)
> sum(x)
[1] -88
> sum(sum(x)>simulation_vector)/10000
[1] 0.077
> #x的64種排列組合
> X_combination<-unique(sort(simulation_vector))
> sum(sum(x)>X_combination)/64
[1] 0.078125
```



【Problem 2.1】 Give the histogram of the randomized null distribution of the test statistic as well as the p-value.

McElhoe and Conner (1986) use an instrument called a “Visiplume” to measure ultraviolet light. By comparing absorption in clear air and absorption in polluted air, the concentration of SO₂ in the polluted air can be estimated. The EPA has a standard method for measuring SO₂, and we wish to compare the two methods across a range of air samples. The recorded response is the ratio of the Visiplume reading to the EPA standard reading. There were six observations on coal plant number 2: .950, .978, .762, .733, .823, and 1.011. If we make the null hypothesis be that the Visiplume and standard measurements are equivalent (and the Visiplume and standard labels are just labels and nothing more), then the ratios could (with equal probability) have been observed as their reciprocals. That is, the ratio of .950 could with equal probability have been $1/.950 = 1.053$, since the labels are equivalent and assigned at random. Suppose we take as our summary of the data the sum of the ratios. We observe $.95 + \dots + 1.011 = 5.257$. Test (using randomization methods) the null hypothesis of equivalent measurement procedures against the alternative that Visiplume reads higher than the standard. Report a p-value.

這組樣本資料有 $2^6=64$ 種可能的隨機結果，我們為了計算方便使用總和來進行比較，先列出64種可能的隨機結果值，在將數值進行排序，原本的樣本總和為5.257

| | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|
| 5.235120 | 5.257000 | 5.279615 | 5.301495 | 5.337751 | 5.359632 | 5.382246 | 5.404126 |
| 5.627187 | 5.649067 | 5.671681 | 5.693562 | 5.729818 | 5.751698 | 5.774313 | 5.785456 |
| 5.796193 | 5.807336 | 5.829951 | 5.851831 | 5.866376 | 5.888087 | 5.888256 | 5.909968 |
| 5.910871 | 5.932582 | 5.932751 | 5.954462 | 5.969008 | 5.990888 | 6.013503 | 6.035383 |
| 6.177522 | 6.199403 | 6.222017 | 6.243898 | 6.258443 | 6.280154 | 6.280323 | 6.302034 |
| 6.302938 | 6.324649 | 6.324818 | 6.346529 | 6.361075 | 6.382955 | 6.405569 | 6.416712 |
| 6.427450 | 6.438592 | 6.461207 | 6.483087 | 6.519344 | 6.541224 | 6.563839 | 6.585719 |
| 6.808779 | 6.830659 | 6.853274 | 6.875154 | 6.911411 | 6.933291 | 6.955905 | 6.977786 |

藉由此64種隨機結果，亂數模擬出一萬筆資料，計算出來的估計P值為0.016
假設我們設 α 值為0.05，此樣本為拒絕虛無假設，即兩種測量有明顯的差異。

實驗設計 HW1
統計碩一 106354012
曹立諭

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> #problem2.1
> x<-c(0.950,0.978,0.762,0.733,0.823,1.011)
> y=NULL
> for(i in 1:10000){
+   num=sample(0:6,1,T,prob = c(1,6,15,20,15,6,1)/64);num
+   if(num==0){XX<-x}
+   else{inverse=sample(1:6,num,F);inverse
+     XX<-c(1/x[inverse],x[-inverse])}
+
+   y=rbind(y,XX)
+ }
> #simulation and calculate estimation of P
> simulation_x<-apply(y,1,sum)
> hist(simulation_x,breaks=200)
> sum(x)
[1] 5.257
> sum(sum(x)>simulation_x)/10000
[1] 0.016
```

