```
1. library(multtest), library(Biobase)
2.
data(golub)
golub.frame <- data.frame(golub)
row.names(golub.frame) <- paste("g",1:nrow(golub.frame), sep = "")
3.
ann.dat2= data.frame(golub.cl)
data=list(x=golub.frame,y=data.frame(golub.cl))
4.
wilcox.test.all.genes <- function(x,s1,s2) {
x1 <- x[s1]
x2 <- x[s2]
x1 <- as.numeric(x1)
x2 <- as.numeric(x2)
t.out <- wilcox.test(x1,x2, alternative="two.sided",exact=F, correct=T)
out <- as.numeric(t.out$statistic)
return(out)
}

original.wmw.run <- apply(golub.frame,1,wilcox.test.all.genes,s1=ann.dat2==0,s2=ann.dat2==1)

5.
wlist = replicate(500, apply(golub.frame[ ,sample(ncol(golub.frame))], 1, wilcox.test.all.genes, s1=ann.dat2==0,
s2=ann.dat2==1))
 ps.max= apply(wlist, 1, max)

6. t.test(ps.max)
          One Sample t-test

data:  ps.max
t = 1309, df = 3050, p-value < 2.2e-16
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 237.9143 238.6281
sample estimates:
mean of x
 238.2712

subsetV<-original.wmw.run[original.wmw.run>238.2712,,drop=FALSE]
```

	original.wmw.run
g23	249
g55	251
g66	258
g81	244
g96	274
g126	262
g127	256
g135	244
g158	246
g172	253
g174	262
g182	261
g184	244
g192	241
g202	255
g204	263
g207	246
g220	240
g226	244
g232	250
g239	247
g246	254
g248	244
g253	266
g259	266
g282	242
g283	271
g286	260
g297	257
g304	243
g307	252
g309	245
g313	248
g314	246
g320	241
g323	262
g329	275
g330	245
g335	254
g344	259
g345	274
g357	247
g376	244
g391	245
g394	290
g395	250
g399	247
g407	240
g422	270
g453	242
g462	259
g479	248
g489	250
g490	248
g494	251
g515	264
g522	257
g523	283
g546	274
g560	262
g561	281
g563	255
g590	245
g620	239
g621	269
g634	243
g648	271
g688	258
g695	251
g698	241
g701	240
g703	285
g704	273
g713	266
g715	240
g717	283
g725	252
g738	271
g746	277
g763	248
g764	241
g785	256
g801	263
g807	248
g811	249
g835	272
g838	283
g839	272
g846	242
g849	272
g862	259
g866	269
g922	272
g963	250
g971	242
g984	283
g1006	275
g1011	243
g1014	259
g1019	254
g1025	244
g1030	244
g1037	281
g1042	284
g1045	270
g1060	264
g1070	260
g1081	249
g1086	278
g1094	244
g1101	258

```
g1109        239
g1110        242
g1145        262
g1161        245
g1162        261
g1174        240
g1175        239
g1202        256
g1225        254
g1245        245
g1253        255
g1271        268
g1293        255
g1316        255
g1327        267
g1334        266
g1337        244
g1348        241
g1359        244
g1368        279
g1381        248
g1445        263
g1453        254
g1455        266
g1456        261
g1459        250
g1468        245
g1470        243
g1474        250
g1480        242
g1489        242
g1491        242
g1513        241
g1524        282
g1542        266
g1547        243
g1559        260
g1564        246
g1579        245
g1585        267
g1598        275
g1610        249
g1616        258
g1629        245
g1638        262
g1640        265
g1642        265
g1649        246
g1653        259
g1671        254
g1691        266
g1696        250
g1723        256
g1732        264
g1766        252
g1773        247
```

g1787	245	
g1805	249	
g1807	241	
g1811	284	
g1817	272	
g1834	290	
g1856	263	
g1869	272	
g1882	260	
g1883	281	
g1903	253	
g1909	275	
g1916	273	
g1920	274	
g1926	248	
g1939	268	
g1943	239	
g1944	249	
g1947	254	
g1948	252	
g1955	240	
g1959	272	
g1963	250	
g1978	271	
g1993	246	
g1995	287	
g2002	283	
g2020	265	
g2032	239	
g2052	240	
g2061	241	
g2079	244	
g2087	247	
g2105	252	
g2110	249	
g2122	270	
g2179	267	
g2180	259	
g2208	248	
g2213	252	
g2216	249	
g2235	252	
g2236	242	
g2244	246	
g2262	247	
g2265	259	
g2266	272	
g2276	245	
g2285	244	
g2289	274	
g2297	257	
g2302	254	
g2307	260	
g2313	265	
g2318	239	
g2330	241	
g2330		241
g2343		239
g2347		250
g2356		263
g2365		243
g2374		242
g2386		288
g2402		262
g2410		256
g2418		279
g2430		259
g2438		262
g2459		244
g2466		259
g2489		288
g2506		240
g2538		240
g2576		242
g2593		258
g2616		270
g2627		253
g2642		240
g2645		272
g2673		250
g2686		253
g2693		244
g2702		279
g2736		261
g2753		260
g2786		246
g2801		274
g2803		247
g2829		273
g2851		281
g2860		272
g2879		272
g2903		242
g2939		291
g2950		258
g2955		267
g2985		252
g3046		276

7.
```
fit <- lmFit(golub.frame)
emp<- eBayes(fit)
emp$p.value
```

8.
```
sortpval <- apply(emp$p.value, 2, sort)
subsetP<-sortpval[sortpval<0.05,,drop=FALSE]
subsetPg<-sortpval[sortpval>0.05,,drop=FALSE]

intersect(rownames(subsetP), rownames(subsetV))
```
```
  [1] "g1014" "g1145" "g2466" "g1807" "g2753" "g1202" "g253"  "g560"  "g2438" "g1723" "g2365" "g158"  "g1025" "g1489" "g1869" "g2330" "g849"  "g865"  "g2542" "g1787" "g391"  "g785"  "g479"  "g1834" "g2105" "g1944" "g394"  "g1368" "g2386"
 [30] "g2374" "g2903" "g1943" "g835"  "g746"  "g2265" "g313"  "g1773" "g192"  "g282"  "g494"  "g984"  "g203"  "g590"  "g2402" "g1101" "g320"  "g1042" "g621"  "g620"  "g1993" "g1459" "g2955" "g66"   "g1883" "g838"  "g1474" "g2803" "g2216"
 [59] "g1070" "g1110" "g2538" "g1579" "g1445" "g1955" "g376"  "g2985" "g1856" "g329"  "g439"  "g995"  "g1271" "g2244" "g490"  "g2686" "g1642" "g246"  "g2593" "g2213" "g1564" "g2489" "g422"  "g2556" "g207"  "g1559" "g1006" "g126"  "g1811"
 [88] "g2313" "g1926" "g1903" "g846"  "g2343" "g323"  "g2418" "g607"  "g357"  "g2307" "g23"   "g1653" "g2122" "g1045" "g811"  "g1640" "g1817" "g1060" "g2079" "g1470" "g715"  "g1616" "g648"  "g1916" "g2645" "g922"  "g1316" "g1094" "g1480"
[117] "g563"  "g1455" "g1468" "g1766" "g462"  "g1225" "g703"  "g2673" "g704"  "g172"  "g135"  "g2347" "g1359" "g489"  "g399"  "g174"  "g2180" "g1086" "g522"  "g546"  "g2879" "g1805" "g2627" "g725"  "g839"  "g307"  "g1939" "g1453" "g2430"
[146] "g1542" "g2693" "g2297" "g862"  "g1598" "g182"  "g2302" "g1610" "g453"  "g297"  "g2410" "g1081" "g1245" "g1179" "g1524" "g2801" "g304"  "g971"  "g3046" "g2829" "g2002" "g1109" "g184"  "g2860" "g226"  "g695"  "g738"  "g515"  "g2939"
[175] "g81"   "g96"   "g1691" "g1162" "g2318" "g285"  "g1334" "g1947" "g220"  "g2266" "g202"  "g2851" "g1293" "g1381" "g1995" "g2276" "g1671" "g2110" "g1348" "g2061" "g698"  "g2235" "g1161" "g713"  "g764"  "g1963" "g2052" "g2236" "g1649"
[204] "g2032" "g309"  "g2786" "g2289" "g1337" "g1491" "g763"  "g1959" "g1585" "g1175" "g1011" "g344"  "g286"  "g1978" "g2616" "g2950" "g314"  "g717"  "g345"
```
```
intersect(rownames(subsetPg), rownames(subsetV))
```
```
 [1] "g55"   "g701"  "g2702" "g634"  "g1696" "g2020" "g1513" "g407"  "g801"  "g1948" "g1327" "g335"  "g1456" "g1732" "g232"  "g2506" "g1638" "g1920" "g204"  "g1253" "g259"  "g688"  "g1174" "g1030" "g1909" "g2576" "g561"  "g127"  "g1037"
[30] "g1882" "g2262" "g2459" "g1547" "g2736" "g1019" "g2087" "g248"  "g2208" "g330"  "g963"  "g523"  "g1629"
```

9.
```
t.test.all.genes <- function(x,s1,s2) {
x1 <- x[s1]
x2 <- x[s2]
x1 <- as.numeric(x1)
x2 <- as.numeric(x2)
t.out <- t.test(x1,x2, alternative="two.sided",var.equal=T)
out <- as.numeric(t.out$p.value)
return(out)
}
pv <- apply(golub.frame,1,t.test.all.genes,s1=ann.dat2==0,s2=ann.dat2==1)

pv <- data.frame(pv)

subsetS<-pv[pv<0.01,,drop=FALSE]
intersect(rownames(subsetS), rownames(empV))
subsetemp<-empV[same,,drop=FALSE]
comb<- cbind(subsetS, subsetemp)
colnames(comb) <- c("Student t-test", "Empircal bayes")

plot(comb[,1],comb[,2], xlab="Student t-test", ylab="Empircal bayes", main="Student t-test vs Empircal Bayes
test")
```

Student t-test vs Empircal Bayes test