Graphic Analysis of Lottery Data

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Lottery Data Input

- Pick-it 1976 New Jersey Lottery Game

```
lottery<-read.table("lottery.txt",header=T)
str(lottery)
```

```
## 'data.frame':    254 obs. of  2 variables:
##  $ lottery.number: int  810 156 140 542 507 972 431 981 865 499 ...
##  $ lottery.payoff: num  190 120 286 184 384 ...
```

```
head(lottery)
```

```
##   lottery.number lottery.payoff
## 1            810           190.0
## 2            156           120.5
## 3            140           285.5
## 4            542           184.0
## 5            507           384.5
## 6            972           324.5
```

- 기초통계량을 계산하고 `lottery.number` 의 경우 이론값과 비교. 이론값이라 함은?

```
summary(lottery)
```

```
##  lottery.number  lottery.payoff
##  Min.   :  0.0   Min.   : 83.0
##  1st Qu.:230.0   1st Qu.:194.2
##  Median :440.5   Median :270.2
##  Mean   :472.2   Mean   :290.4
##  3rd Qu.:734.5   3rd Qu.:364.0
##  Max.   :999.0   Max.   :869.5
```

```
apply(lottery, 2, sd)
```

```
## lottery.number lottery.payoff
##       294.4773       128.8884
```

Graphic Analysis on lottery.number

- 당첨번호는 0(사실상 000)에서 999 사이에 254회 추출한 랜덤표본으로 볼 수 있음. `stem()` 을 이용하여 줄기-잎 그림을 그리고, 히스토그램 작성.

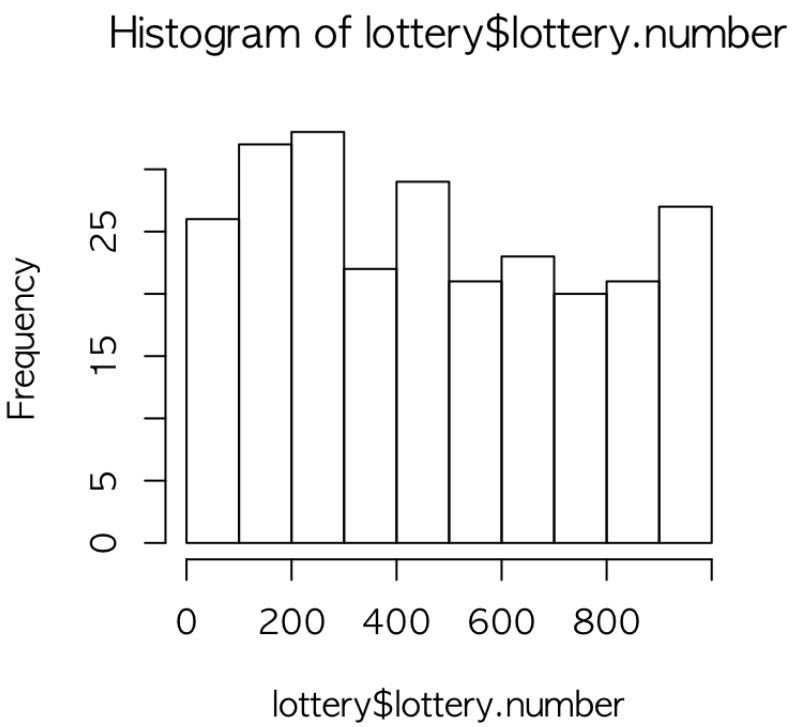
```
stem(lottery$lottery.number,scale=5)
```

```
##
##   The decimal point is 1 digit(s) to the right of the |
##
##    0 | 01788
##    1 | 11568
##    2 | 006
##    3 | 4
##    4 | 27
##    5 |
##    6 | 79
##    7 | 2779
##    8 | 79
##    9 | 29
##   10 | 5679
##   11 | 012247
##   12 | 23
##   13 | 36
##   14 | 0
##   15 | 688
##   16 | 07
##   17 | 048
##   18 | 0257
##   19 | 2789
##   20 | 09
##   21 | 49
##   22 | 36
##   23 | 0015689
##   24 | 355
##   25 | 3345778
##   26 | 78
##   27 | 45
##   28 | 26
##   29 | 349
##   30 | 0059
##   31 | 00449
##   32 |
##   33 | 357
##   34 | 68
##   35 | 6778
##   36 |
##   37 | 4
##   38 | 03
##   39 | 156
##   40 | 236
##   41 | 0136
```

```
##   42 | 4
##   43 | 01444
##   44 | 016
##   45 |
##   46 | 78
##   47 | 246799
##   48 | 05
##   49 | 699
##   50 | 778
##   51 | 5568
##   52 | 478
##   53 | 79
##   54 | 112
##   55 | 359
##   56 |
##   57 |
##   58 | 02
##   59 | 7
##   60 | 24
##   61 | 56
##   62 | 3
##   63 |
##   64 | 068
##   65 | 239
##   66 | 112
##   67 | 7
##   68 | 349
##   69 | 13458
##   70 | 1
##   71 | 14
##   72 |
##   73 | 35
##   74 | 244
##   75 | 01
##   76 | 11477
##   77 | 19
##   78 | 111
##   79 |
##   80 | 889
##   81 | 02
##   82 | 78
##   83 |
##   84 | 129
##   85 | 448
##   86 | 335
##   87 | 9
##   88 | 4
##   89 | 346
##   90 | 6
##   91 | 33899
##   92 | 18
##   93 | 57
##   94 | 157
##   95 | 4
```

```
##   96 | 0344
##   97 | 258
##   98 | 1177
##   99 | 69
```

```
h10<-hist(lottery$lottery.number)
```



- 메인 타이틀과 x축의 좌표이름, y축의 좌표이름의 디폴트값이 어떻게 주어지는지 살피고, 히스토그램 작성에 계산된 값들 확인(특히 `$breaks` , `$counts` , `$density` 유의)

```
list(breaks=h10$breaks, counts=h10$counts, density=h10$density)
```

```
## $breaks
##  [1]    0  100  200  300  400  500  600  700  800  900 1000
##
## $counts
##  [1] 26 32 33 22 29 21 23 20 21 27
##
## $density
##  [1] 0.0010236220 0.0012598425 0.0012992126 0.0008661417 0.0011417323
##  [6] 0.0008267717 0.0009055118 0.0007874016 0.0008267717 0.0010629921
```

- 각 계급의 경계선에 있는 관찰값들을 어떻게 처리하는 지 몇 가지 조건을 바꿔가면서 관찰. `right=F` 로 인하여 `$counts` 가 어떻게 변하였는가? `attach()` 의 역할은 무엇인가?. (작업을 끝내기 전에 반드시 `detach()` 할 것). 실제 취하는 값을 1000에서 999로 바꿨을 때, 그리고 `include.lowest=F` 로 했을 때 각각 어떤 일이 일어나는지 확인하고 이유를 생각해 볼 것. `list()` 로 표현하려는 것은 무엇이며 이름을 붙인 까닭은?

```
attach(lottery)
par(mfrow=c(1,2))
h10.2<-hist(lottery.number, breaks=seq(0,1000,by=100),include.lowest=T)
h10.3<-hist(lottery.number, breaks=seq(0,1000,by=100),right=F)
```


```
list(breaks=h10.2$breaks, counts=h10.2$counts, density=h10.2$density)
```

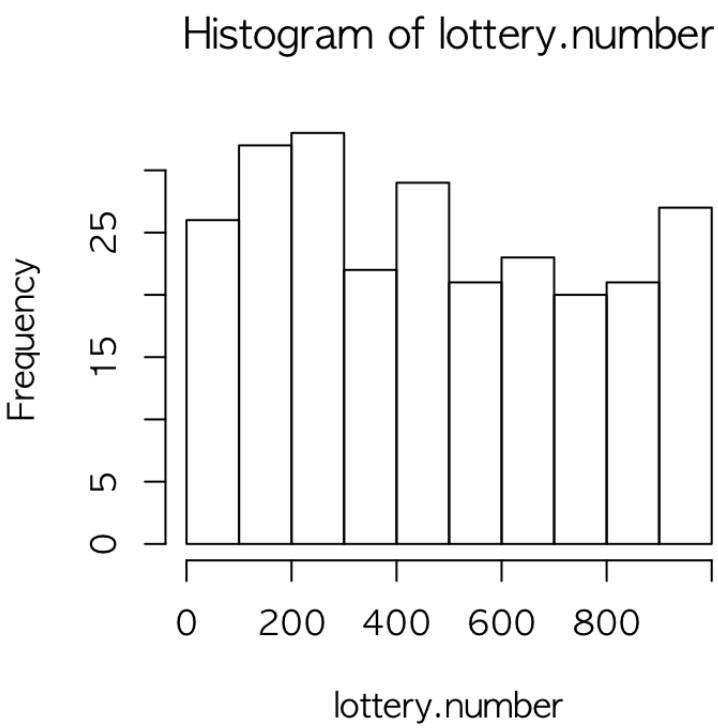
```
## $breaks
##  [1]    0  100  200  300  400  500  600  700  800  900 1000
##
## $counts
##  [1] 26 32 33 22 29 21 23 20 21 27
##
## $density
##  [1] 0.0010236220 0.0012598425 0.0012992126 0.0008661417 0.0011417323
##  [6] 0.0008267717 0.0009055118 0.0007874016 0.0008267717 0.0010629921
```

```
list(breaks=h10.3$breaks, counts=h10.3$counts, density=h10.3$density)
```

```
## $breaks
##  [1]    0  100  200  300  400  500  600  700  800  900 1000
##
## $counts
##  [1] 26 31 32 24 29 21 23 20 21 27
##
## $density
##  [1] 0.0010236220 0.0012204724 0.0012598425 0.0009448819 0.0011417323
##  [6] 0.0008267717 0.0009055118 0.0007874016 0.0008267717 0.0010629921
```

- `breaks` 대신 `nclass=10` 을 사용하였을 때 결과 비교.

```
par(mfrow=c(1,1))
h10.4<-hist(lottery.number, nclass=10)
```

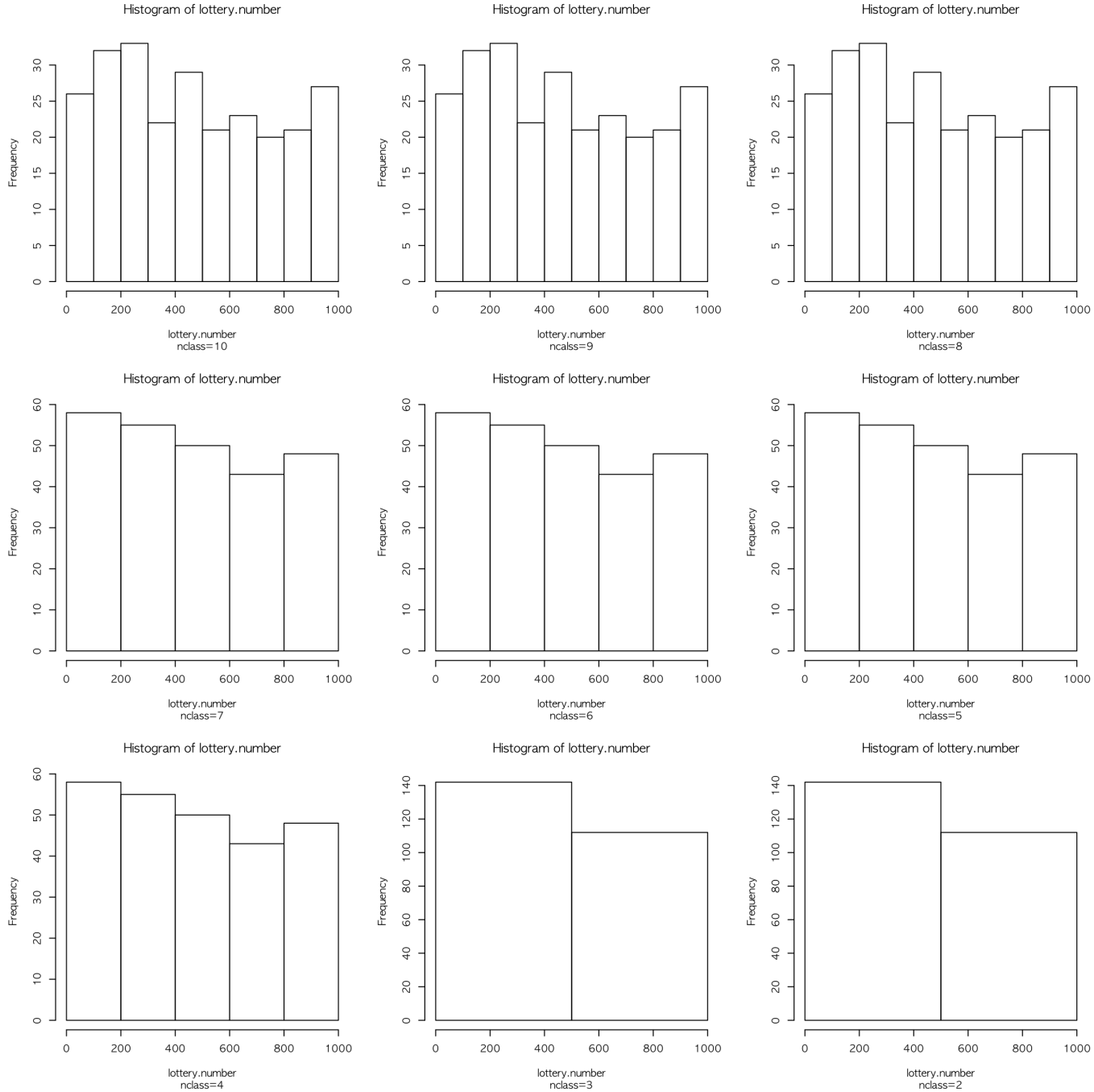



```
list(breaks=h10.4$breaks, counts=h10.4$counts, density=h10.4$density)
```

```
## $breaks
##  [1]    0  100  200  300  400  500  600  700  800  900 1000
##
## $counts
##  [1] 26 32 33 22 29 21 23 20 21 27
##
## $density
##  [1] 0.0010236220 0.0012598425 0.0012992126 0.0008661417 0.0011417323
##  [6] 0.0008267717 0.0009055118 0.0007874016 0.0008267717 0.0010629921
```

- 다양한 `nclass` 값에 대하여 히스토그램 작성. `nclass` 로 요구했을 때 제대로 잘 작동하는가 확인.

```
opar<-par(no.readonly=TRUE)
par(mfrow=c(3,3))
hist(lottery.number, nclass=10, sub="nclass=10")
hist(lottery.number, nclass=9, sub="ncalss=9")
hist(lottery.number, nclass=8, sub="nclass=8")
hist(lottery.number, nclass=7, sub="nclass=7")
hist(lottery.number, nclass=6, sub="nclass=6")
hist(lottery.number, nclass=5, sub="nclass=5")
hist(lottery.number, nclass=4, sub="nclass=4")
hist(lottery.number, nclass=3, sub="nclass=3")
hist(lottery.number, nclass=2, sub="nclass=2")
```



- `nclass=9, 8` 은 모두 `nclass=10` 과 같고, `nclass=7, 6, 4` 는 모두 `nclass=5` 와 같으며, `nclass=3` 인 경우도 요구와 다르게 나온 점에 유의하고 일부 계산값 확인. argument 중에 `sub="nclass=3"` 을 놓아 둔채 `plot=F` 를 하면 어떻게 되는지 시험해 보시오.

```
par(mfrow=c(1,2))
h4<-hist(lottery.number, nclass=4, plot=F)
h3<-hist(lottery.number, nclass=3, plot=F)
list(breaks=h4$breaks, counts=h4$counts, density=h4$density)
```

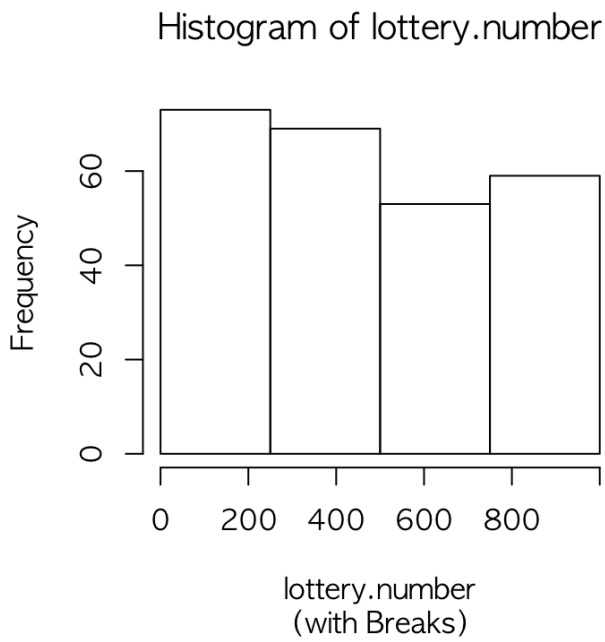
```
## $breaks
## [1]    0  200  400  600  800 1000
##
## $counts
## [1] 58 55 50 43 48
##
## $density
## [1] 0.0011417323 0.0010826772 0.0009842520 0.0008464567 0.0009448819
```

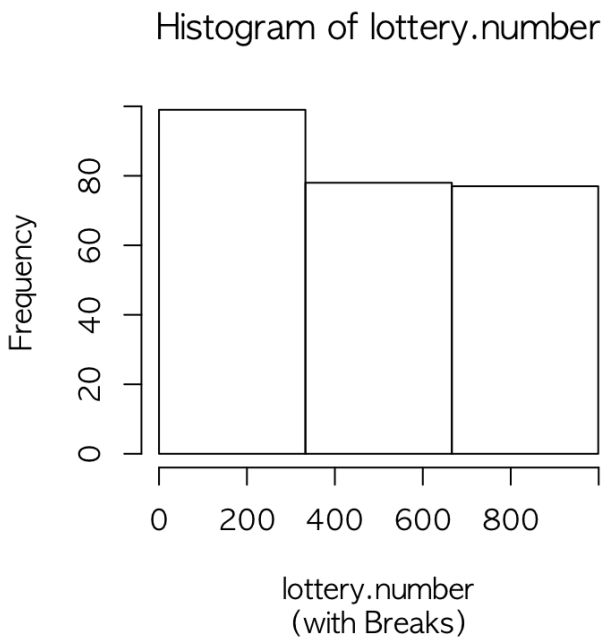
```
list(breaks=h3$breaks, counts=h3$counts, density=h3$density)
```

```
## $breaks
## [1]    0  500 1000
##
## $counts
## [1] 142 112
##
## $density
## [1] 0.0011181102 0.0008818898
```

- `nclass=4` , `nclass=3` 을 그리려면 `breaks` 조정. `breaks` 가 보다 확실한 방법!!

```
par(mfrow=c(1,2))
h4.breaks<-hist(lottery.number, breaks=seq(0,1000, by=250), sub="(with Break
s)")
h3.breaks<-hist(lottery.number, breaks=seq(0,999, by=333), sub="(with Breaks)")
```






```
list(breaks=h4.breaks$breaks, counts=h4.breaks$counts, density=h4.breaks$densit
y)
```

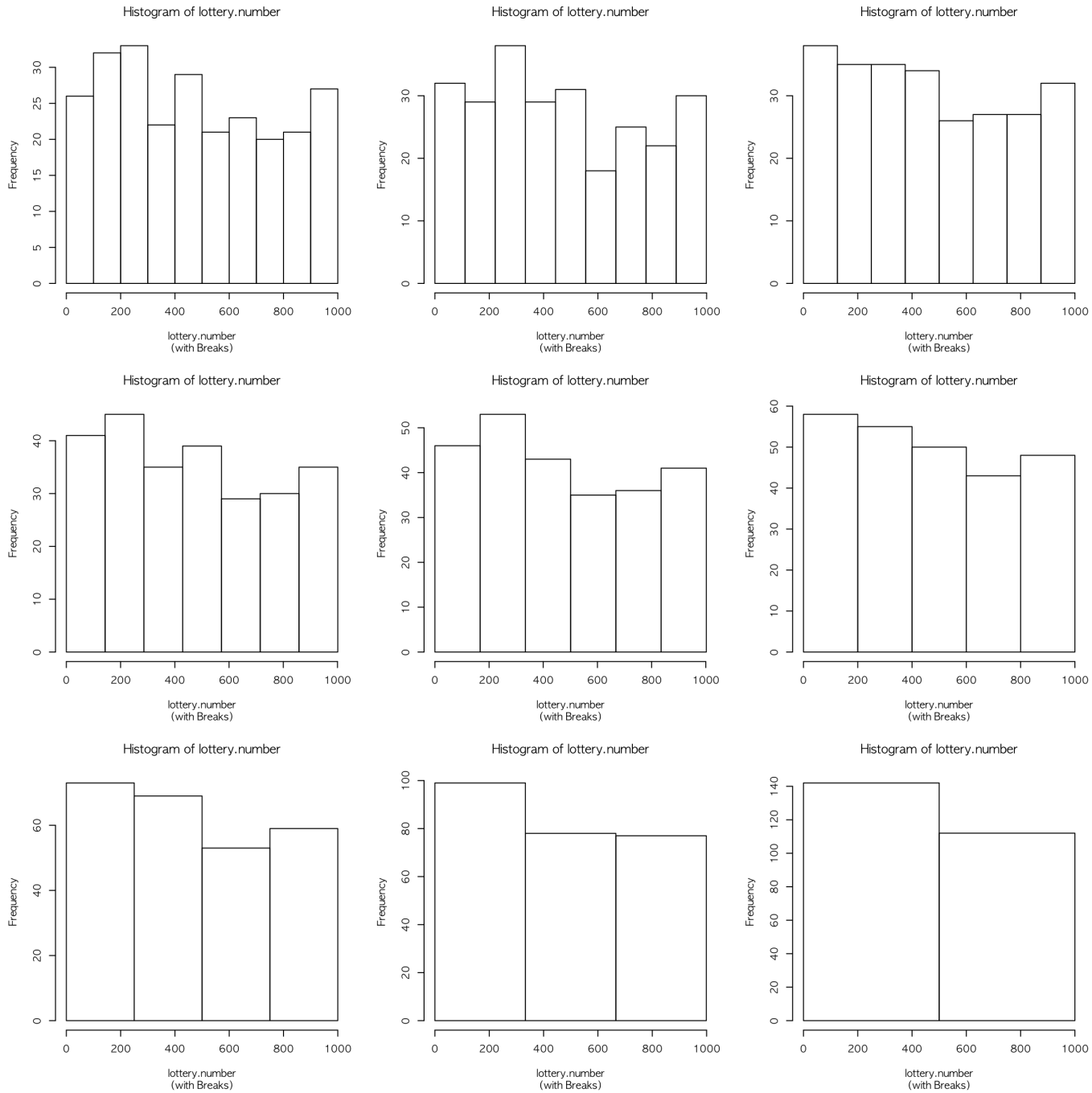
```
## $breaks
## [1]    0  250  500  750 1000
##
## $counts
## [1] 73 69 53 59
##
## $density
## [1] 0.0011496063 0.0010866142 0.0008346457 0.0009291339
```

```
list(breaks=h3.breaks$breaks, counts=h3.breaks$counts, density=h3.breaks$densit
y)
```

```
## $breaks
## [1]   0 333 666 999
##
## $counts
## [1] 99 78 77
##
## $density
## [1] 0.0011704618 0.0009221820 0.0009103592
```

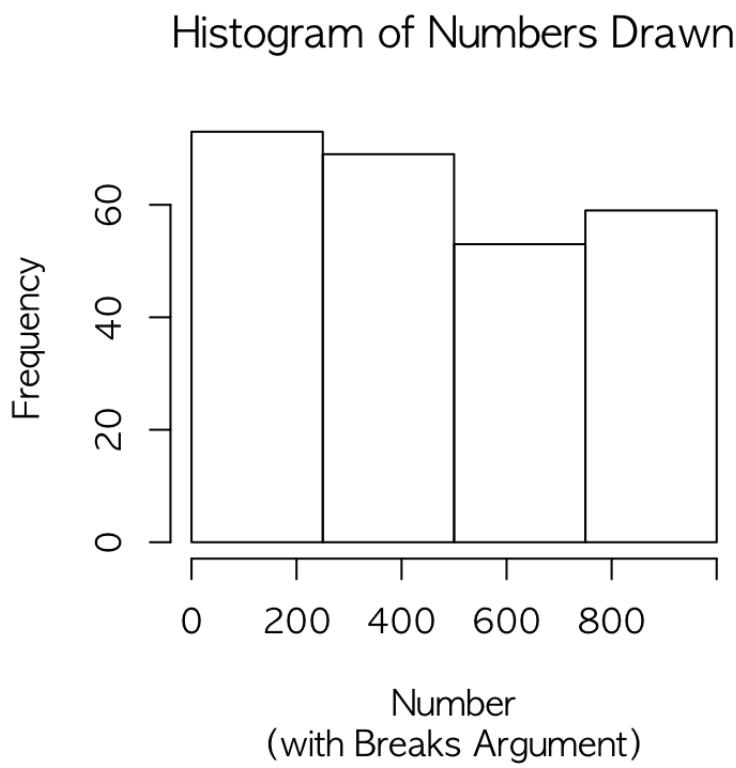
- `breaks` 로 계급의 갯수 조정.

```
opar<-par(no.readonly=TRUE)
par(mfrow=c(3,3))
hist(lottery.number, breaks=seq(0,1000, by=100), sub="(with Breaks)")
hist(lottery.number, breaks=seq(0,999, by=111), sub="(with Breaks)")
hist(lottery.number, breaks=seq(0,1000, by=125), sub="(with Breaks)")
hist(lottery.number, breaks=seq(0,1001, by=143), sub="(with Breaks)")
hist(lottery.number, breaks=seq(0,1002, by=167), sub="(with Breaks)")
hist(lottery.number, breaks=seq(0,1000, by=200), sub="(with Breaks)")
hist(lottery.number, breaks=seq(0,1000, by=250), sub="(with Breaks)")
hist(lottery.number, breaks=seq(0,999, by=333), sub="(with Breaks)")
hist(lottery.number, breaks=seq(0,1000, by=500), sub="(with Breaks)")
```



- 히스토그램의 정보를 보다 알기 쉽게 타이틀과 좌표명을 손보려면 `ann=F` 사용. 다른 히스토그램들에도 적용해 볼 것.

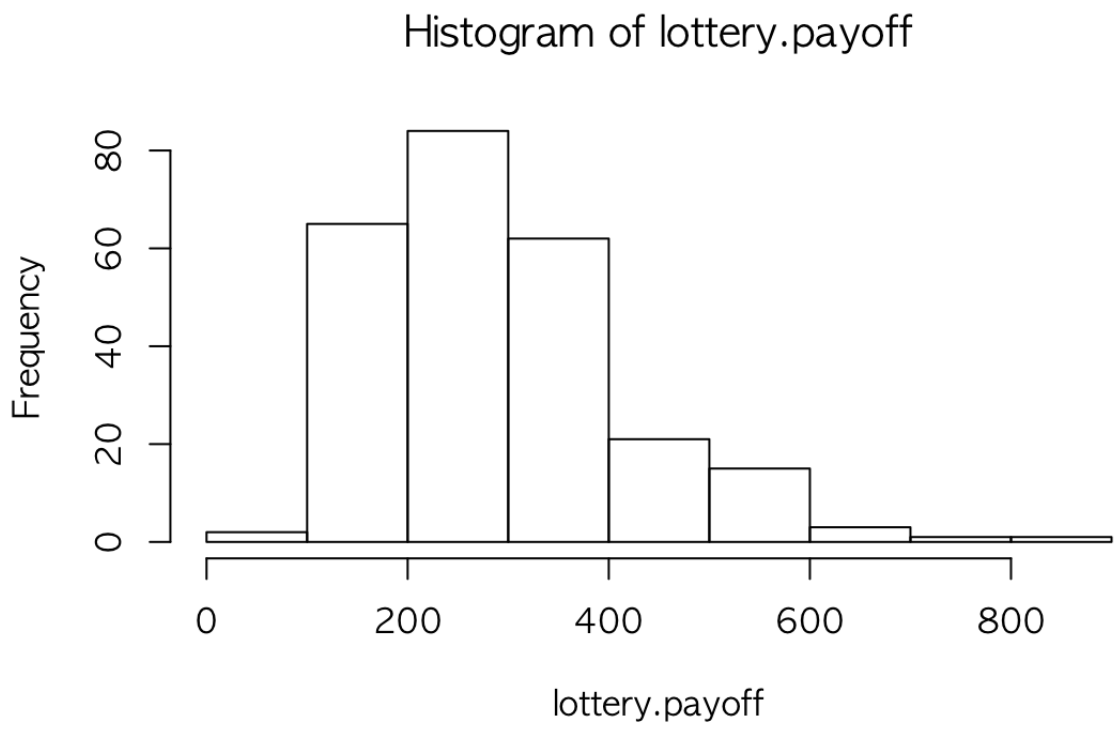
```
par(mfrow=c(1,1))
hist(lottery.number, breaks=seq(0,1000,by=250),ann=F)
title(main="Histogram of Numbers Drawn", sub="(with Breaks Argument)", xlab="Nu
mber", ylab="Frequency")
```



Distribution of lottery.payoff

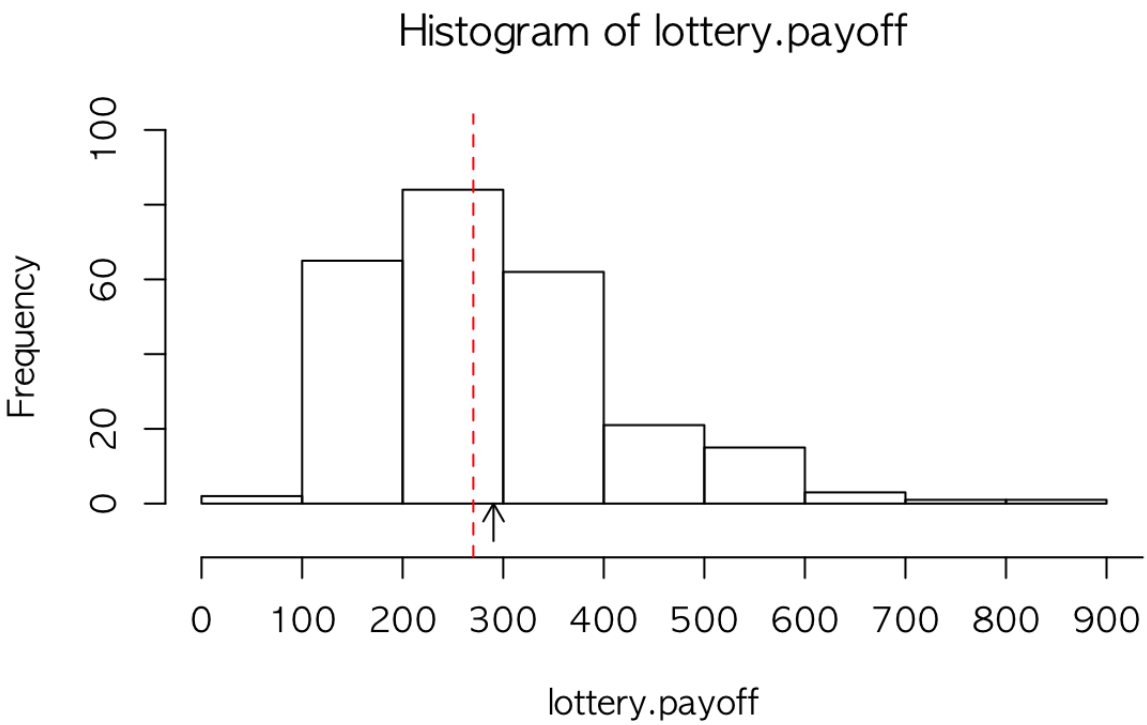
- 이제 당첨번호와 당첨금액과의 관계를 살피기 전에 잠깐 당첨번호의 분포를 살펴보면

```
hist(lottery.payoff)
```



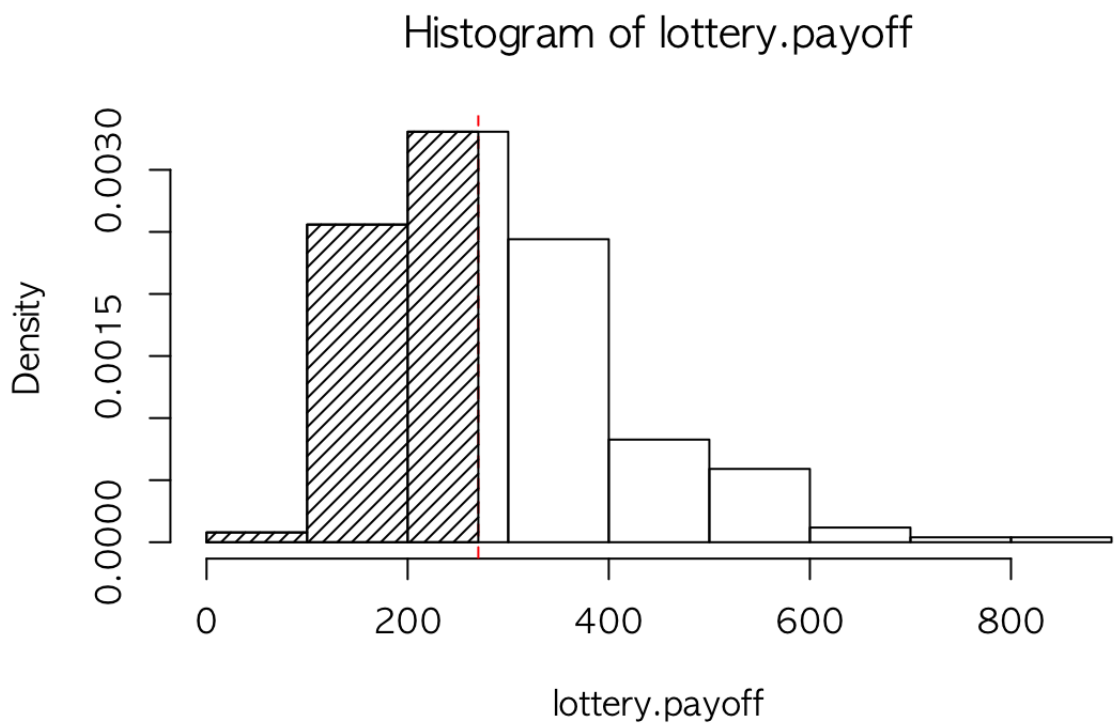
- 평균과 중앙값을 계산하여 화살표와 점선으로 표시하면 다음과 같이 할 수 있는데, 어느 것이 평균이고, 어느 것이 중앙값인가?

```
mean.payoff<-mean(lottery.payoff)
med.payoff<-median(lottery.payoff)
hist(lottery.payoff,axes=F,ylim=c(-10,100))
axis(side=1,at=seq(0,1000,by=100),labels=paste(seq(0,1000,by=100)))
arrows(x0=mean.payoff,y0=-10, x1=mean.payoff, y1=0, length=0.1, code=2)
abline(v=med.payoff,lty=2,col="red")
axis(side=2,at=seq(0,100,by=20),labels=paste(seq(0,100,by=20)))
```



- 확률 히스토그램으로 바꾸고 중앙값의 왼쪽 부분에 빗금을 그었다. 전체 면적의 1/2이 모여 있는 것으로 보이는가?

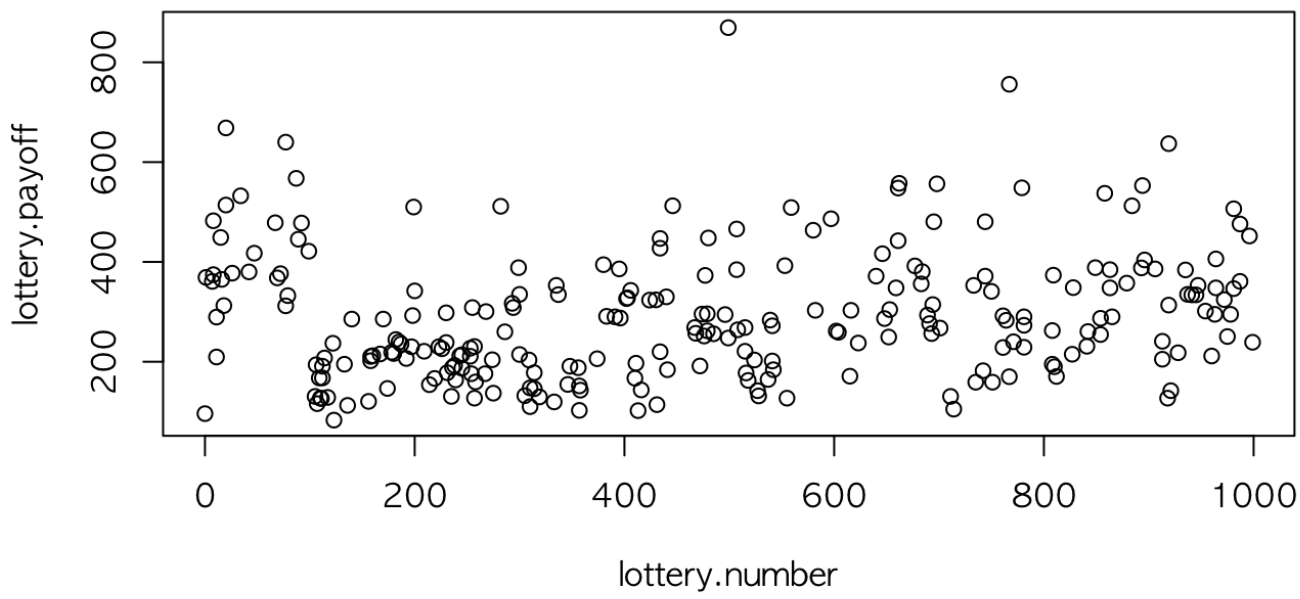
```
h.payoff<-hist(lottery.payoff, plot=F)
hist(lottery.payoff, prob=T)
abline(v=med.payoff,lty=2,col="red")
x.polygon<-c(h.payoff$breaks[1:3], rep(c(med.payoff,rev(h.payoff$breaks[1:3])),
each=2))
y.polygon<-c(rep(0,4), rep(rev(h.payoff$density[1:3]), each=2), 0)
polygon(x=x.polygon, y=y.polygon, density=20)
```



The Relationship between lottery.number and lottery.payoff

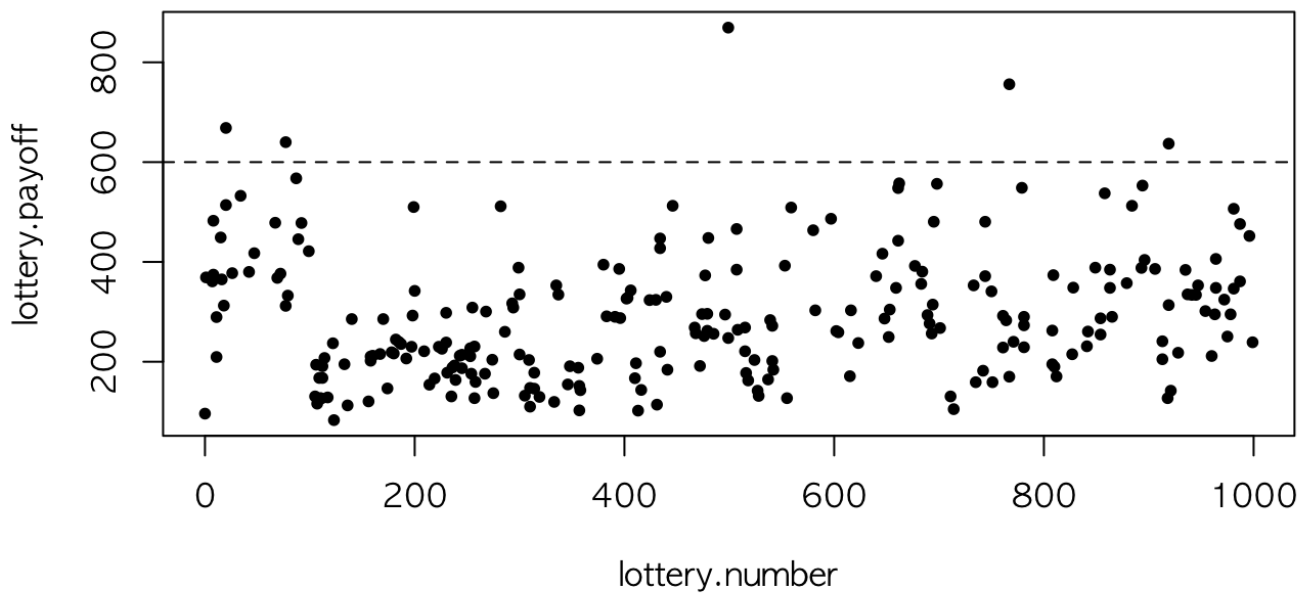
- 이제 두 변수의 산점도를 그려보자.

```
plot(lottery.number, lottery.payoff)
```



- 점의 모양을 바꾸고, 당첨금액이 600불 이상인 당첨번호들을 찾기 위하여 `identify()` 함수를 이용하면 마우스로 직접 찾을 수 있으나 r markdown 에서는 작동하지 않음.

```
plot(lottery.number, lottery.payoff,pch=20)
abline(h=600,lty=2)
identify(lottery.number, lottery.payoff, n=5, labels=paste(lottery.number))
```




```
## integer(0)
```

- `which()` 함수와 subscripting(`[ ]`) 을 이용하여 찾아보면

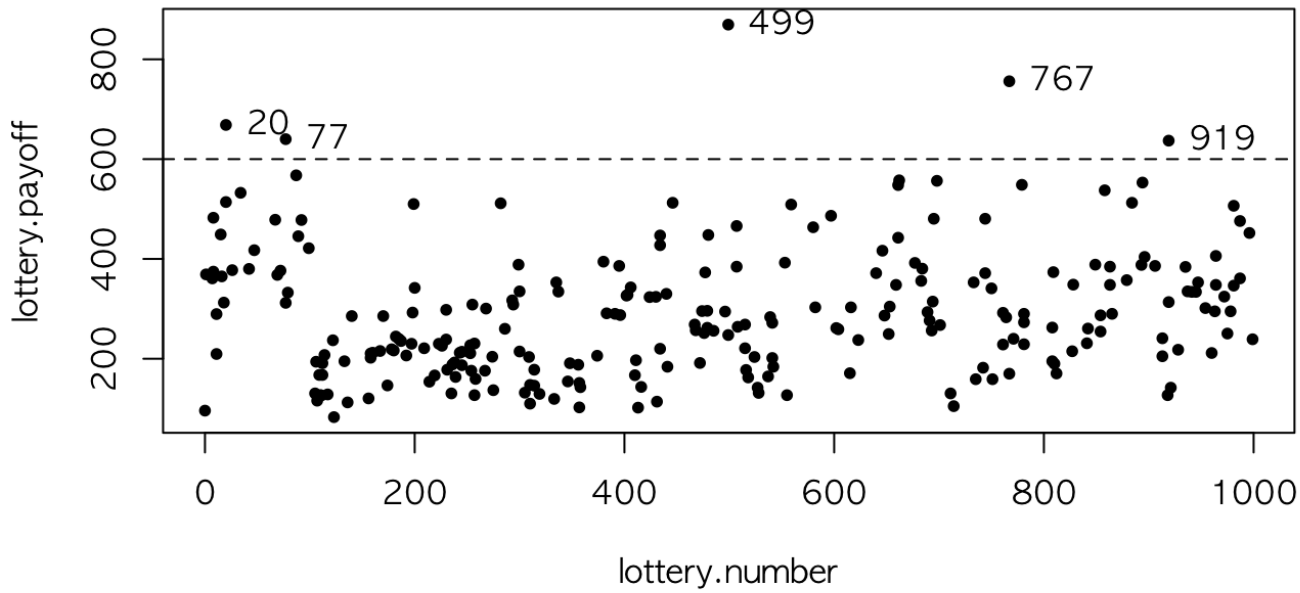
```
high.payoff<-which(lottery.payoff>=600)
high.payoff
```

```
## [1]  10  11  95 107 215
```

```
lottery.number[high.payoff]
```

```
## [1] 499  20  77 767 919
```

```
plot(lottery.number, lottery.payoff,pch=20)
abline(h=600,lty=2)
text(x=lottery.number[high.payoff],y=lottery.payoff[high.payoff],labels=lotter
y.number[high.payoff],pos=4)
```



- 당첨금액 상위 10위까지의 당첨번호를 살펴보면

```
o.payoff<-order(lottery.payoff,decreasing=TRUE)
lottery.payoff[o.payoff][1:10]
```

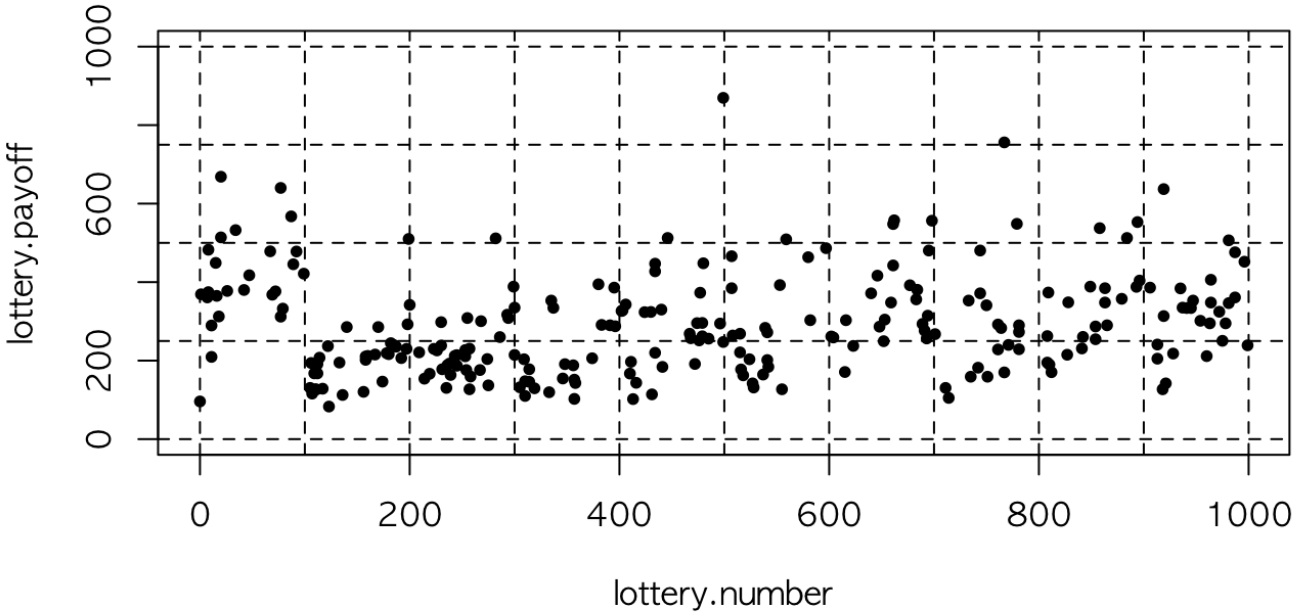
```
##  [1] 869.5 756.0 668.5 640.0 637.0 567.5 557.5 556.5 553.0 548.5
```

```
lottery.number[o.payoff][1:10]
```

```
##  [1] 499 767  20  77 919  87 662 698 894 779
```

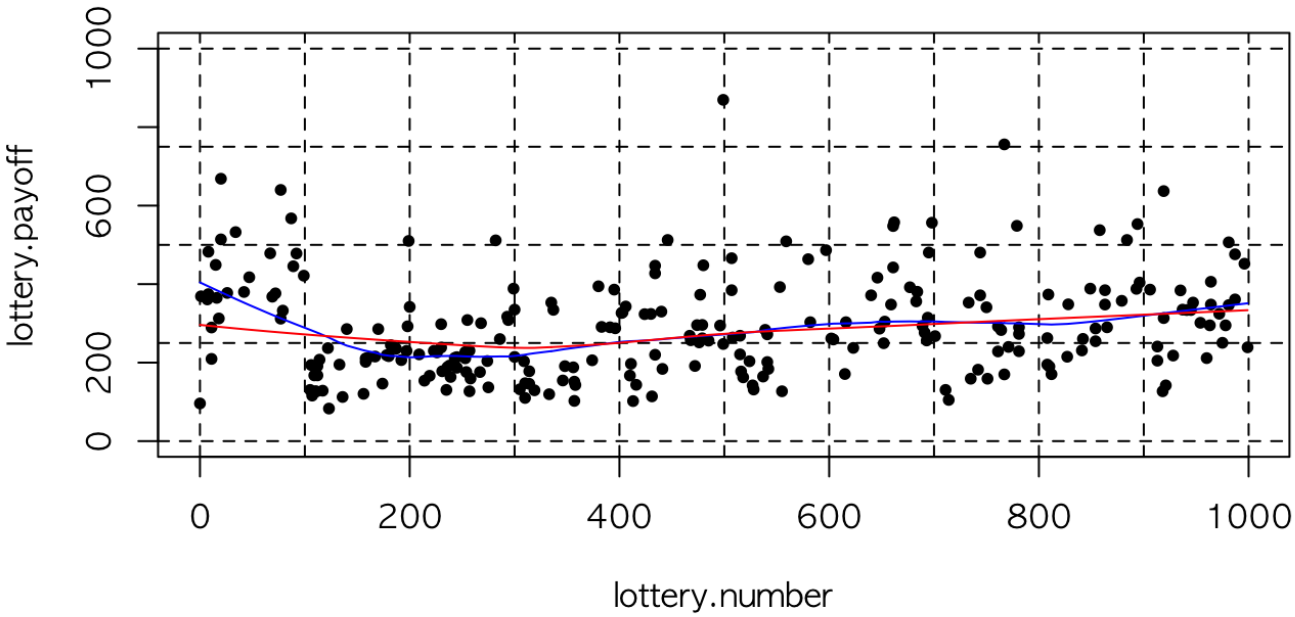
- 당첨번호와 당첨금액의 관계를 살피기 위하여 y축의 범위를 조정하고, 격자를 설치하면

```
plot(lottery.number, lottery.payoff,pch=20, ylim=c(0,1000))
abline(h=seq(0,1000,by=250),lty=2)
abline(v=seq(0,1000,by=100),lty=2)
```



- 흐름을 파악하기 위하여 local smoother, `lowess()` 를 활용.

```
plot(lottery.number, lottery.payoff,pch=20, ylim=c(0,1000))
abline(h=seq(0,1000,by=250),lty=2)
abline(v=seq(0,1000,by=100),lty=2)
lines(lowess(lottery.number,lottery.payoff, f=1/3),col="blue")
lines(lowess(lottery.number,lottery.payoff, f=2/3),col="red")
```



- 이제 당첨금액이 높은 당첨번호들은 숫자가 중복되는 경우가 많고, 당첨번호가 0에서 100 이하인 경우에 당첨금액이 높은지 생각해 보자. `detach(lottery)` 를 하지 않고 `deatch()` 만 해도 되는 이유는 뭘까? `save(file=filename, list=ls())` 와 같은 것이 `save.image(file=filename)` 임. 확인하기를

```
detach()
par(opar)
save(file="lottery.RData",list=ls())
```

```
savehistory("lottery.Rhistory")
```