Session 0: Simulating Random Variables

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01-March-2018

Exercise 0.2. A Coin, a blue dice and a special red dice. Suppose: C is a random variable that gets 1 if you get head after tossing a coin or 0 if you get tail, B is a random variable that gets the value of a blue dice after rolling, and R is a random variable that gets the value of a red dice where the probability of getting an odd number is twice as high as getting an even number.

Now, as we can see C is a random variable that gets 1 if you get head after tossing a coin or 0 if you get tail. Then we can code this situation as,

$$Coin = Head \rightarrow C = 1$$

$$Coin = Tail \rightarrow C = 0$$

Now, since `R` is a random variable that can take the any one of the six values on rolling a dice, the sample space consists of { 1,2,3,4,5,6 }. Now, we know that probability of getting an odd number is twice the probability of getting an even number. In such a case, we assign the probability to the odd numbers i.e. {1,3,5} twice the probability assigned to the even numbers {2,4,6}. So, if the probability assigned to {2,4,6} is `x` then the probability assigned to each of the the {1,3,5} is `2x`. Now, we already know that,

$$x + x + x + 2x + 2x + 2x = 1$$

whihc implies that,

$$9x = 1 \rightarrow x = \frac{1}{9}$$

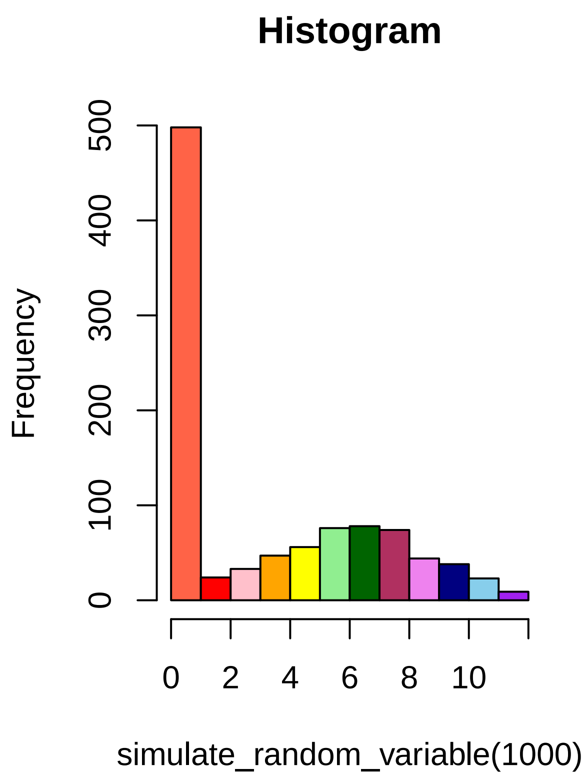
Finally, we use the information drawn from above above random varibales to create a new random variable as,

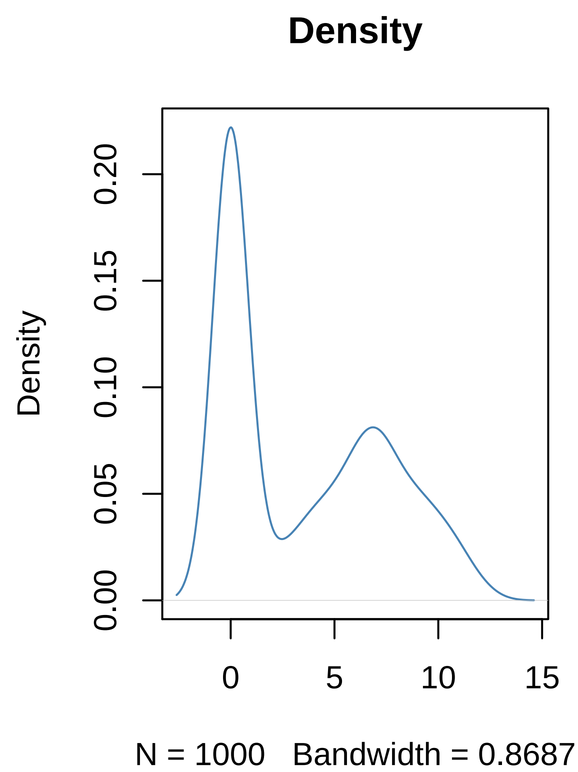
$$Z = C * (R + B)$$

The following function provides this purpose by taking a paramter `n` which corresponds to the number of simulations.

```r
simulate_random_variable <- function(n){
  flip <- sample(c("Heads", "Tails"), n ,replace = TRUE)
  C <- ifelse(flip== "Heads", 1, 0)
  #plot(density(C), main = "")
  B <- sample(1:6, n , replace=TRUE, prob = c(1/9, 1/9, 1/9, 1/9, 1/9, 1/9))
  #plot(density(B), main = "")
  R <- sample(1:6, n , replace=TRUE, prob = c(2/9, 1/9, 2/9, 1/9, 2/9, 1/9))
  #plot(density(R), main = "")
  Z <- C*(B+R)
  return(Z)
}
```

```r
par(mfrow = c(1,2))
hist(simulate_random_variable(1000), col = c("tomato","red", "pink", "orange", "yellow", "lightgreen",
     main = "Histogram")
plot(density(simulate_random_variable(1000)), col="steelblue", main = "Density")
```





Now, let us compute the probability that the random variable Z gets a value greater than 1. The following code achieves this purpose-

```
N <- 1000
Z <- simulate_random_variable(N)
sum(Z > 1)/N
```

```
## [1] 0.489
```