Discussion 8

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3 Write a program to toss a coin 10,000 times. Let Sn be the number of heads in the first n tosses. Have your program print out, after every 1000 tosses, Sn — n/2. On the basis of this simulation, is it correct to say that you can expect heads about half of the time when you toss a coin a large number of times?

Program

I chose to use both `sample` and `rbinom` as functions for generating a random number that simulates a coin flip. The S_n value is calculated using `sample` and the S_x is using `rbinom`

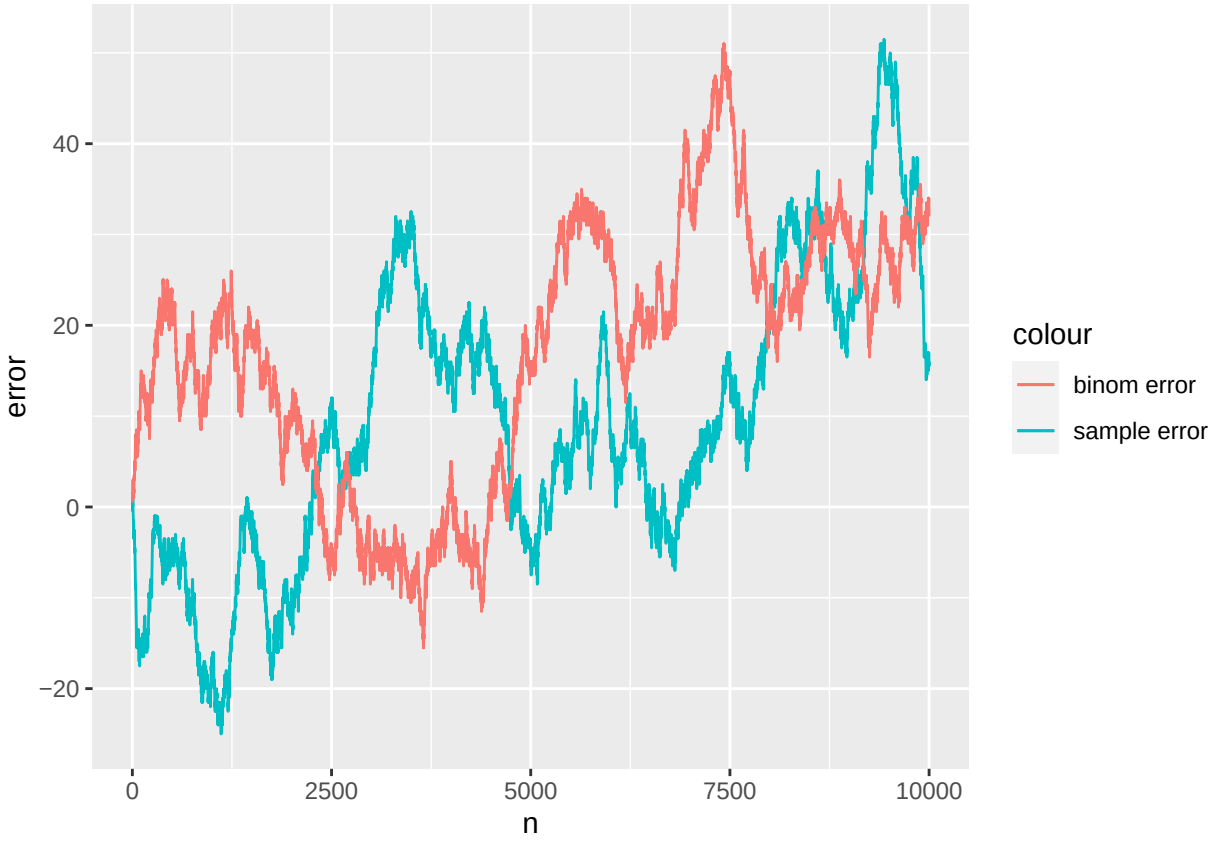
```
library(tidyverse)
```

```
set.seed(1234)
coin <- c('heads','tails')
n <- 1
sn <- 0
sx <- 0
df <- data.frame(matrix(ncol = 5, nrow = 0))
colnames(df) <- c('n', 'error', 'sn','binomError','sx')
repeat {
  result <- sample(coin,1, replace = TRUE, prob = c(.5,.5))
  r <- rbinom(1,1,prob = .5)
  if(result == 'heads'){
    sn <- sn + 1
  }
  if(r == 1){
    sx <- sx + 1
  }
      error <- sn - (n/2)
    binomError <- sx - (n /2)
        df<-df %>% add_row(n, error, sn,binomError,sx)
  if(n %% 1000 == 0){

     print(paste('sn:',error, ' sx:', binomError))
  }
  n <- n + 1

  if(n > 10000){
    break
  }
}
```

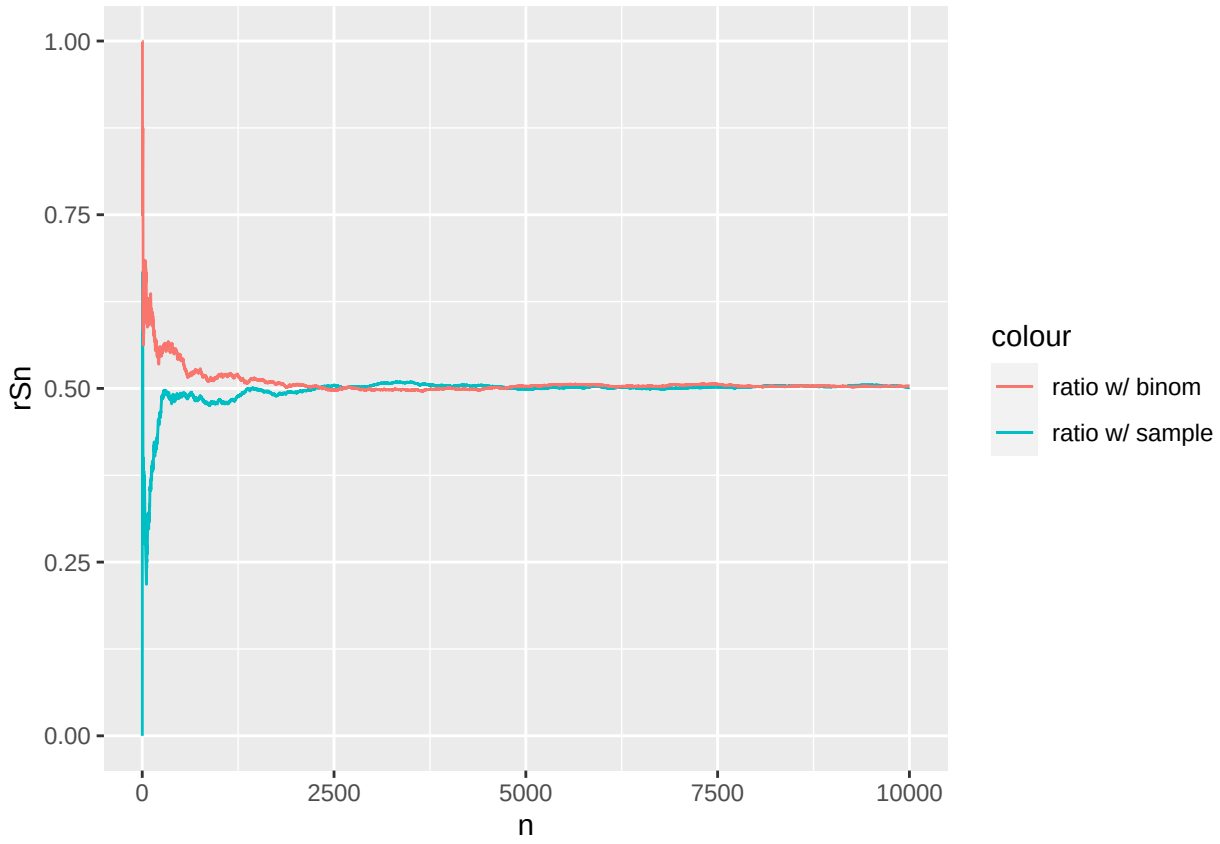
```
## [1] "sn: -17  sx: 20"
## [1] "sn: -10  sx: 9"
## [1] "sn: 13  sx: -7"
## [1] "sn: 15  sx: 4"
## [1] "sn: -6  sx: 16"
## [1] "sn: 7  sx: 26"
## [1] "sn: 3  sx: 33"
## [1] "sn: 21  sx: 21"
## [1] "sn: 23  sx: 28"
```

```
## [1] "sn: 16  sx: 32"
```

```
ggplot(df, aes(n)) +
  geom_line(aes(y = error, colour = "sample error")) +

  geom_line(aes(y = binomError, colour = "binom error"))
```




```
df <- df %>% mutate(rSn = sn / n) %>% mutate(rSx = sx / n)
df %>% ggplot(aes(n)) + geom_line(aes(y=rSn, colour='ratio w/ sample')) + geom_line(aes(y=rSx, colour='
```



Answer

Yes, though what I believe to be the "chance" factor calculated by the $S_n - \frac{n}{2}$ appears to oscillate wildly as demonstrated by my plot, the plot of the ratio of heads to tails shows that there is a rapid convergence towards 0.5 using both methods of generating a random number.