```r
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
## The following objects are masked from 'package:stats':
##
##     filter, lag
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
set.seed(1929)
```

HW3

HW3.1

The distrubution of photons emitted by by X ($X \sim Poisson(100)$) and Y is the number of photons which pass through an object.
If we know the amount of protons emitted by the x-ray beam we can describe the number of photons phasing through the object by using the distrubution $Y|X \sim Binomial(X, 0.4)$

Calculate the probability mass function for (X,Y) [eg $p(k, l) = P((X = k, Y = l))$]

```r
set.seed(1929)
  n_reps = 1

#Creating a data frame containing random draws from the Poisson distrubution
photons_emitted.df <- data.frame(rpois(n_reps, 100))
  names(photons_emitted.df) <-c('Photons')
    #Number of photons emitted
    photons <- sum(photons_emitted.df$Photons)
      #Number of photons from one draw of the Poisson distrubution which passes through the material
      photons_pass_through_material.str <- rbinom(1, photons, 0.4)
      #Probability that a photon is emitted from the x-ray and passes through the object
      photons_pass_through_material.str/photons
```

```
## [1] 0.4059406
```

$p(k, l) = P(X = k, Y = l) = P(X = k) \;*\; P(Y = l|X = k)$

$P(X = k) * P(Y = l|X = k) = \frac{100^k e^{-100}}{k!} * kCl * (0.4)^l (0.6)^{k-l}$

HW3.5

Flip a coin 10 times and let X be the sequence 'HT'. What is $P(X = 0)$?

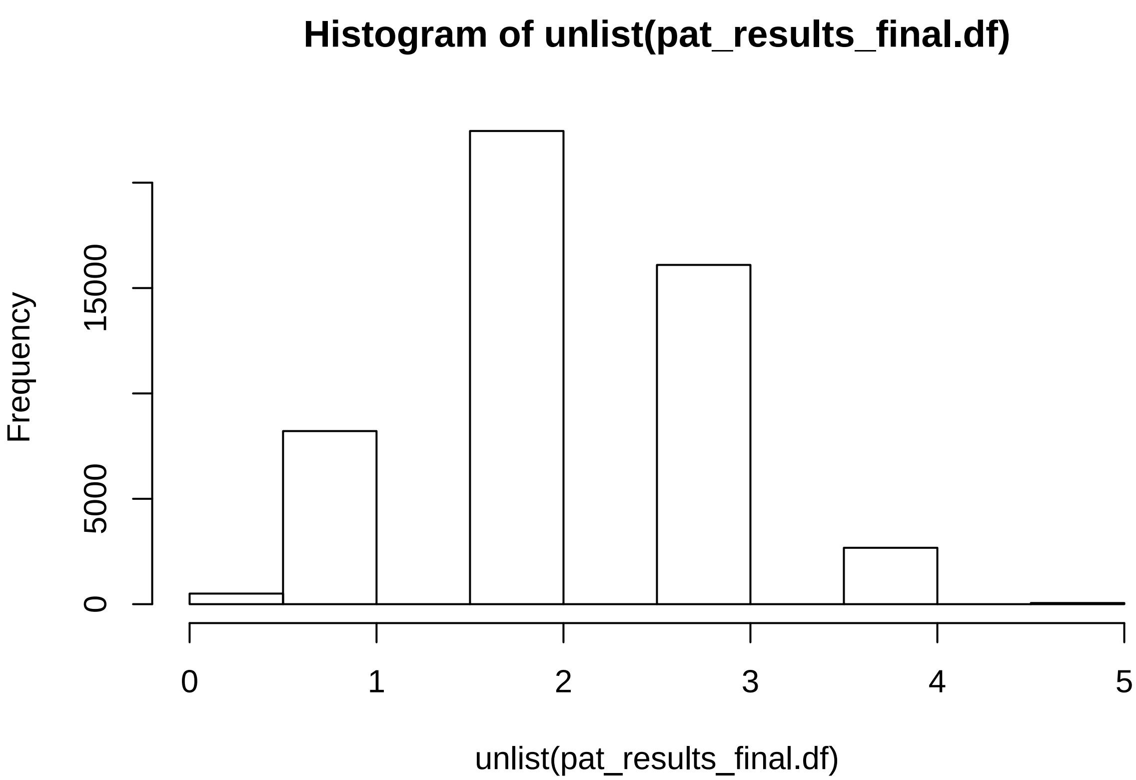
```r
library(stringr)
#Assigning variables
coin_sides <- c('H', 'T')
  pat <- setNames(nm = "HT") #Pattern which we are looking for
    prob <- c(0.5, 0.5) #The coin is fair
      n_reps <- 50000 #Replicaitons of the Experiment
        all_flips.df <- 0 #Zeroing out the data frame
```

```
#A simple program which will toss the coin 'flips' times and record the results, creates a
# string from that data, and returns the number of times the pattern 'HT' is seen in the data
coin_pattern_toss <-function(flips){
all_flips.df <- data.frame(sample(coin_sides, flips, replace = TRUE, prob), stringsAsFactors = TRUE)
  names(all_flips.df) <- c('Coin')

all_flips.str <- paste(unlist(all_flips.df),collapse = '')
  pat_results.df <- data.frame(lapply(pat, str_count, string=all_flips.str))
return(pat_results.df)
}

#A large amount of 10 flip trials
pat_results_final.df <- data.frame(replicate(n_reps, coin_pattern_toss(10)))

#Histogram of the distrubuiton of pattern sucesses
hist(unlist(pat_results_final.df))
```




```
  #Tabulation of the number of successes in the pattern
  pat_results_final.ls <- data.frame(table(unlist(pat_results_final.df)))
    #Probability that P(X = 0)
    (pat_results_final.ls[1,2]/n_reps)
```

```
## [1] 0.01006
```

What is the expectation [$E[X]$]?

The probability that the pattern 'HT' comes up once in the coin tosses is;
$P(Heads\ and\ Tails) = \frac{1}{2} * \frac{1}{2} = \frac{1}{4} = E_i$ Where i is 1-9 and if one was to calculate the expected value by weighing each coin toss by the probability and itterations we would see; $E(X) = E_1 + E_2 + ... +$

$E_9 = \sum_{i=1}^{9} E_i = 9 * E_i = 9 * \frac{1}{4} = 2.25$

```
#Can be found using the weighted.mean function
x <- c(0, 1, 2, 3, 4, 5) #Number of patterns seen in ten flips
  wt <- (pat_results_final.ls$Freq)/n_reps #Weighted rate of patterns seen

#Expected number of patterns
weighted.mean(pat_results_final.df)
```

```
## [1] 2.24786
```

If you were to draw one card at a time from a full deck wihtout replacement what is the probability that you will NOT have the pattern 'RB'?

Use a hypergeometric distrubution in order to determine the chance of drawing only black cards first.

Pseudocode; Perform this drawing action 50000 times using a string of R's and B's, do the same pattern searching as above, and then find the proability by density.