

Assignment 1

1 Blood types genetics

Ex 1.1

$$\Omega = \{I^A, I^A i, I^B I^B, I^B i, I^A I^B, ii\}$$

Ex 1.2

$$P(ii) = 0.25$$

$$P(I^A i, ii) = 0.75$$

Ex 1.3

$$P(C = I^A I^B) = 0.25$$

Ex 1.4

Phenotypes: AB, A, B

Distribution: AB = 0.25; A = 0.375; B = 0.375

Ex 1.5

$$P(I^B i, I^B I^B \mid B = I^A I^B) = 0.375$$

1.1 Some simulation in R

Ex 2.1

```
sample(c("ii", "iB", "iA", "BB", "AA", "AB"), size = 1, replace = TRUE)
```

Ex 2.2

```
offspringG <- function(Parent1, Parent2){
  Allele1 <- sample(unlist(strsplit(Parent1, split = "")), replace = TRUE, size=1)
  Allele2 <- sample(unlist(strsplit(Parent2, split = "")), replace = TRUE, size=1)
  return(paste(Allele1, Allele2, sep = ""))
}

offspringP <- function(Genotype){
  Phenotype <- ""
  if (Genotype == "ii"){
    Phenotype <- "Type 0"
  }
  if (Genotype == "AB" | Genotype == "BA"){
    Phenotype <- "Type AB"
  }
}
```

```

if (Genotype == "iB" | Genotype == "Bi" | Genotype == "BB"){
  Phenotype <- "Type B"
}
if (Genotype == "iA" | Genotype == "Ai" | Genotype == "AA"){
  Phenotype <- "Type A"
}
return(Phenotype)
}

```

Ex 2.3

```

offspringAiA <- c()
for(i in 1:1000){
  offspringAiA[i] <- offspringG("iA", "iA")
}
sum(offspringAiA == "ii")/length(offspringAiA)

```

```
## [1] 0.258
```

```
sum(offspringAiA != "AA")/length(offspringAiA)
```

```
## [1] 0.761
```

Ex 2.4

```

secondGen <- c()

for(i in 1:1000){
  A <- offspringG("iA", "iB")
  B <- offspringG("AB", "AB")
  C <- offspringP(offspringG(A, B))
  secondGen[i] <- C
}

```

```
secondGen
```

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```

2 A case study of DNA sequence

Ex 3.1

$\Omega = \{AA, AT, AC, AG, TA, TT, TC, TG, CA, CT, CC, CG, GA, GT, GC, GG\}$

Ex 3.2

$P(\text{ACG}) = (0.25 \times 0.25 \times 0.25) \times 3 = 0.047$

Ex 3.3

$\Omega = \{\emptyset, A, T, C, AA, AT, AC, AAA, \dots\}$

$P(\text{length } 10 \text{ G}^C) = (0.75)^{10} = 0.05$

Ex 3.4

1: $P(\text{CG}|\text{C}) = 0.5 \times 0.1 = 0.05$

2: $P(\text{CG}|\text{C}) = 0.3 \times 0.4 = 0.12$

2.1 Some simulations in R

Ex 4.1

```
ACGsim <- function(reps){
  count = 0

  for(i in 1:reps){
    sqce_5 <- paste(sample(c("A", "T", "G", "C"), replace = TRUE, size = 5), collapse = "")

    if(grepl("ACG", sqce_5, fixed = TRUE)){
      count <- count + 1
    }
  }
  return(count/reps)
}
ACGsim(10000)
```

```
## [1] 0.0464
```

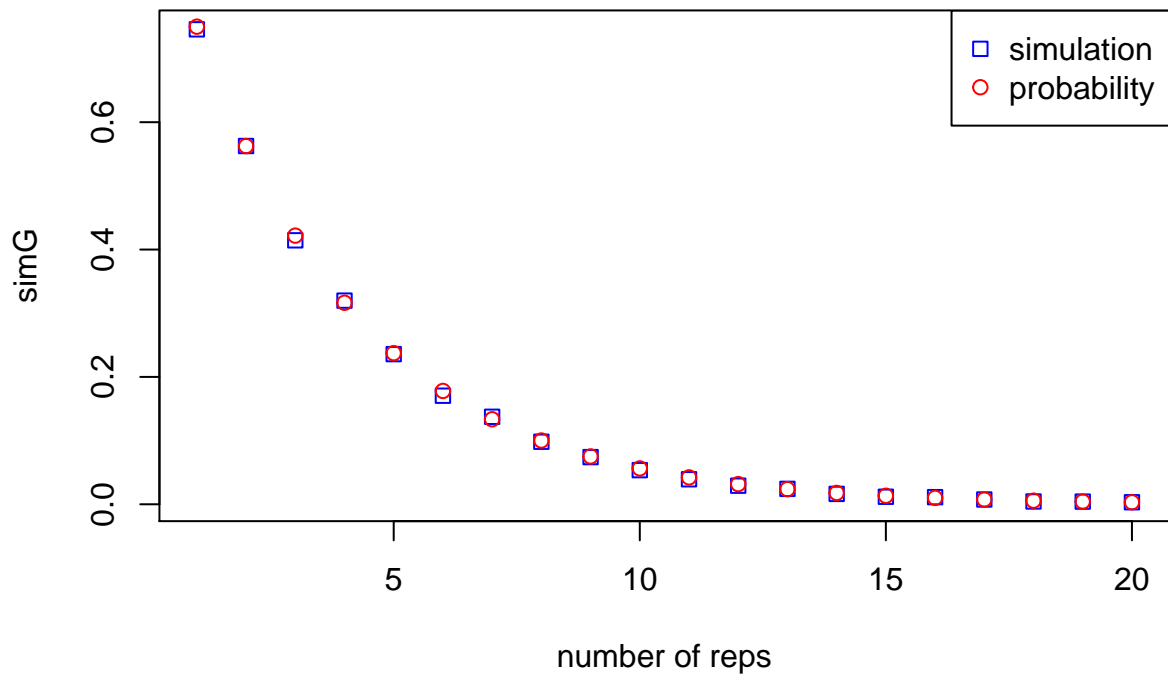
Ex 4.2

```
Gsim <- function(reps, length = 10){  
  sqces_with_G <- 0  
  for(i in 1:reps){  
    seq <- sample(c("A", "C", "T", "G"), replace = TRUE, size = length)  
    if ("G" %in% seq){  
      sqces_with_G <- sqces_with_G + 1  
    }  
  }  
  sqces_with_no_G <- reps - sqces_with_G  
  return(sqces_with_no_G/reps)  
}  
  
Gsim(10000)
```

```
## [1] 0.0573
```

Ex 4.3

```
simG <- c()  
pG <- c()  
for(i in 1:20){  
  simG[i] <- Gsim(10000, length = i)  
  pG[i] <- dbinom(i, size = i, prob = 0.75)  
}  
  
plot(1:20, simG, col = "blue", pch = 0, xlab = "number of reps")  
points(1:20, pG, col = "red", pch = 1)  
legend("topright", legend = c("simulation", "probability"),  
       col = c("blue", "red"), pch = c(0, 1))
```



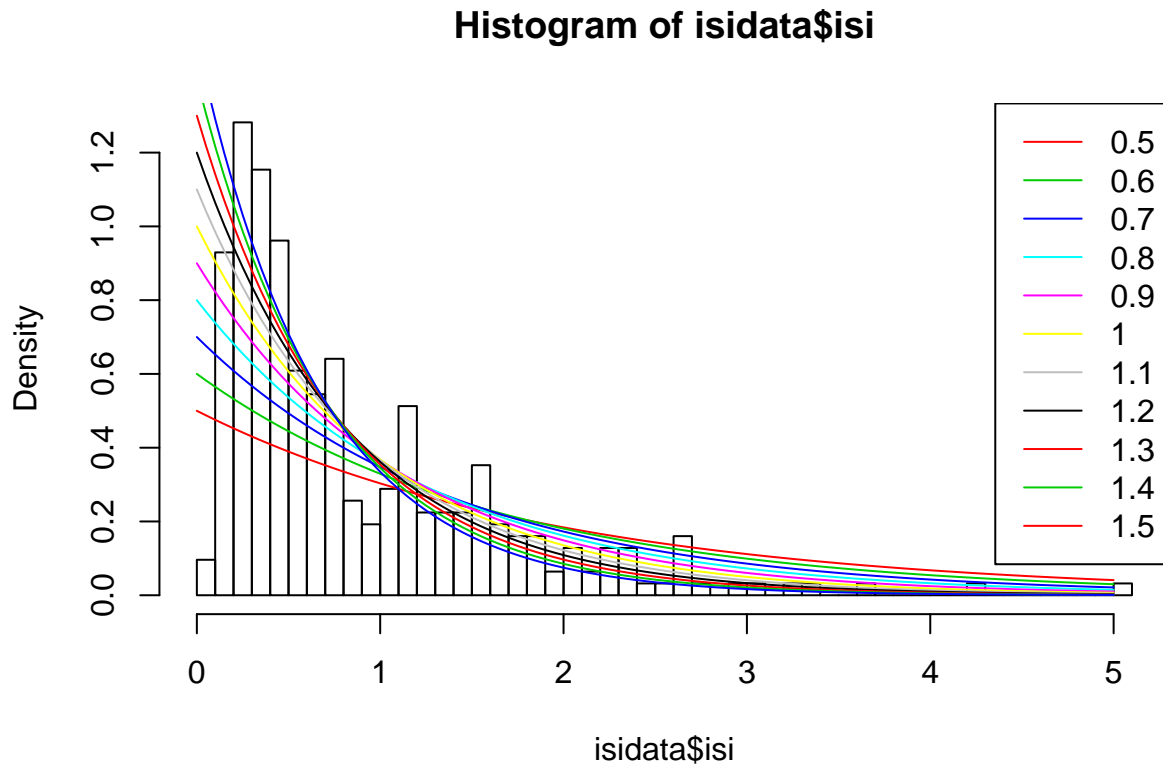
3 A case study of neuronal data

Ex 5.1 and 5.2

```
isidata <- read.table("neuronspikes.txt", col.names = "isi")
hist(isidata$isi, breaks = 50, probability = TRUE)

for(i in seq(0.5, 1.5, 0.1)){
  curve(dexp((x), rate = i), from = 0, to = 5, col= (i*10)-3, add = TRUE)
}

legend("topright", legend=c(seq(0.5,1.5,0.1)),
      col=c(2:length(seq(0.5,1.5,0.1))), lty = 1)
```



A λ value of 1.5 fits the data the best.

Ex 5.3

```
pexp(1, rate = 1.5)
```

```
## [1] 0.7768698
```

```
pexp(1.5, rate = 1.5) - pexp(0.5, rate = 1.5)
```

```
## [1] 0.3669673
```

4 Brain cell database

Ex 6.1

The option na.strings converts empty strings to NA values.

Ex 6.2

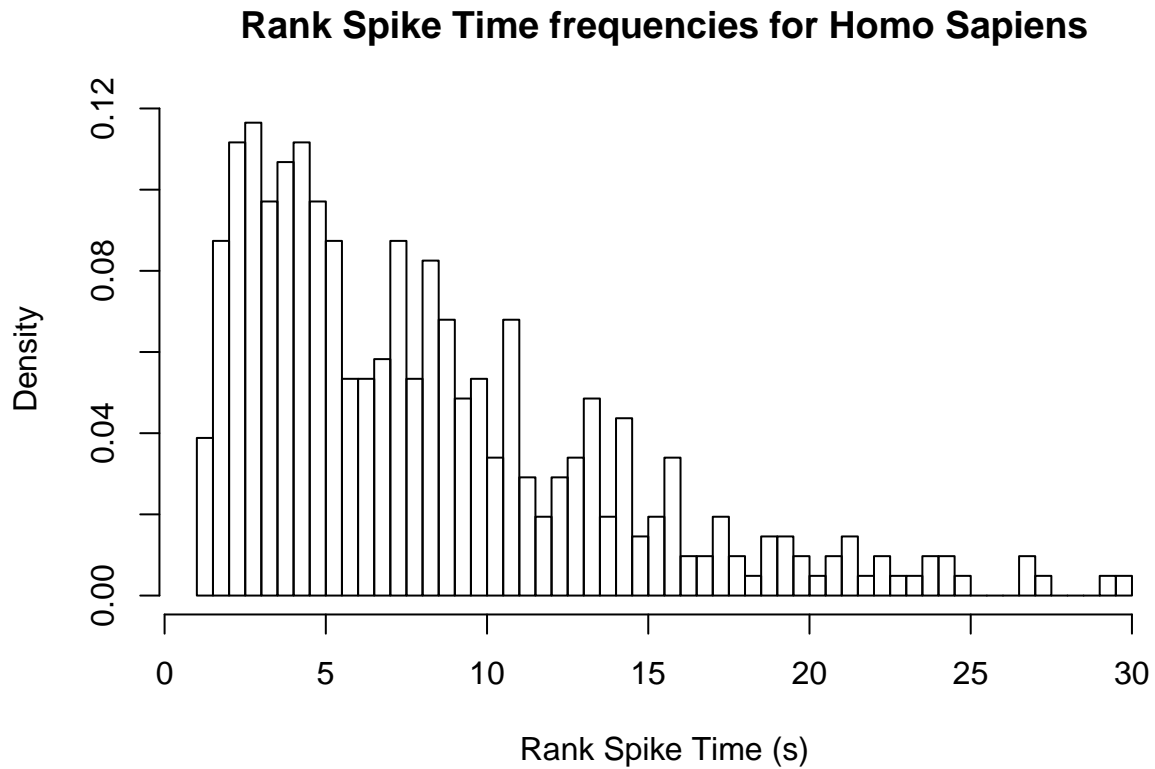
The donor species column indicates which values are humans and which are mice.

```
sum(cells$donor__species == "Homo Sapiens") / length(cells[,1])
```

```
## [1] 0.1770253
```

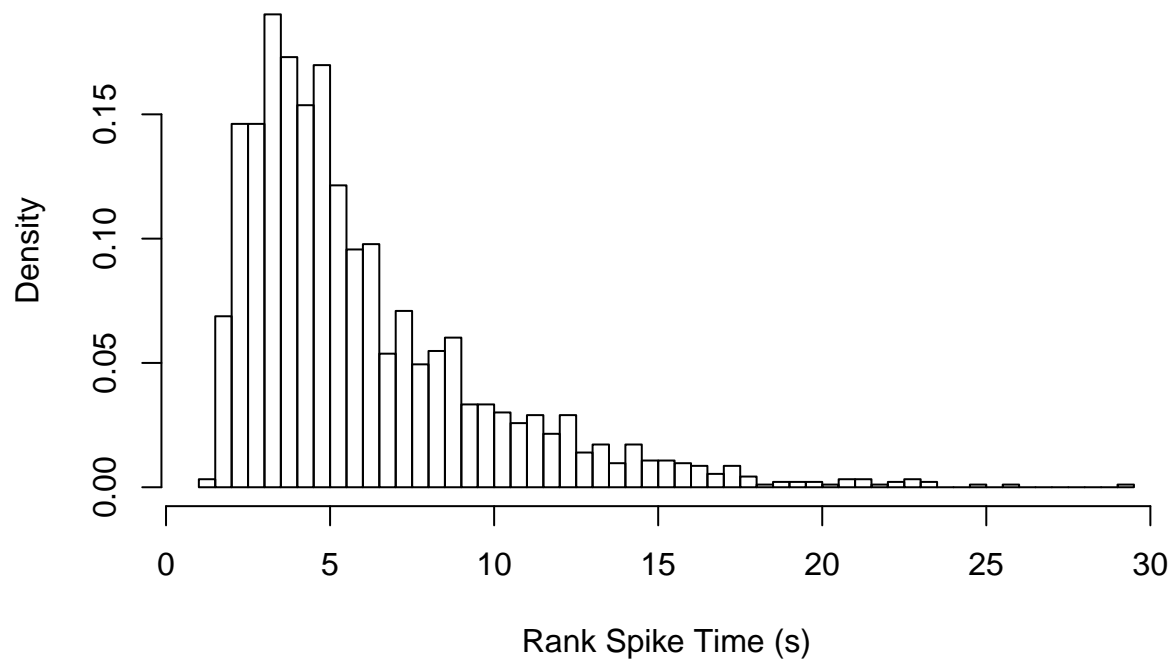

Ex 6.3

```
hist(cells$ef_peak_t_ramp[cells$donor_species == "Homo Sapiens"],  
      proba = TRUE, xlab = "Rank Spike Time (s)",  
      breaks = 50, main = "Rank Spike Time frequencies for Homo Sapiens")
```



```
hist(cells$ef_peak_t_ramp[cells$donor_species == "Mus musculus"],  
      proba = TRUE, xlab = "Rank Spike Time (s)",  
      breaks = 50, main = "Rank Spike Time frequencies for Mus musculus")
```

Rank Spike Time frequencies for *Mus musculus*

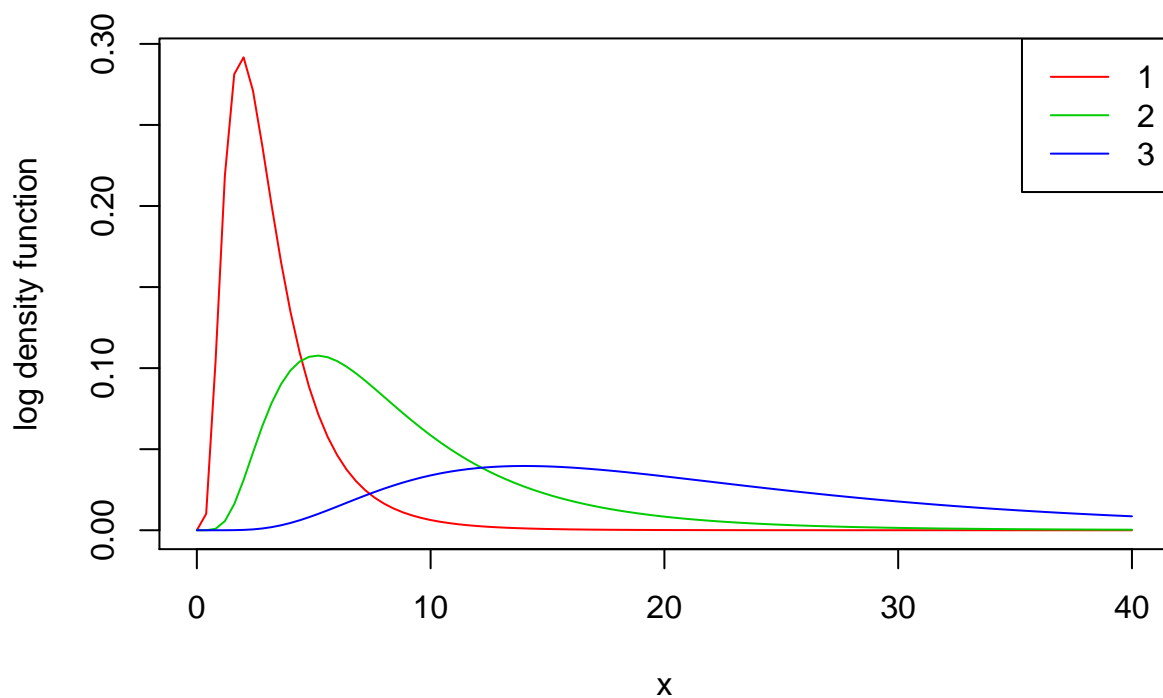


Ex 6.4

```
first_plot = FALSE

for(i in 1:3){
  curve(dlnorm(x, sdlog = 0.6, meanlog = i), from = 0, to = 40,
        add = first_plot, col = i+1, ylab = "log density function")
  first_plot = TRUE
}

legend("topright", legend = 1:3, col = 2:4, lty = 1)
```



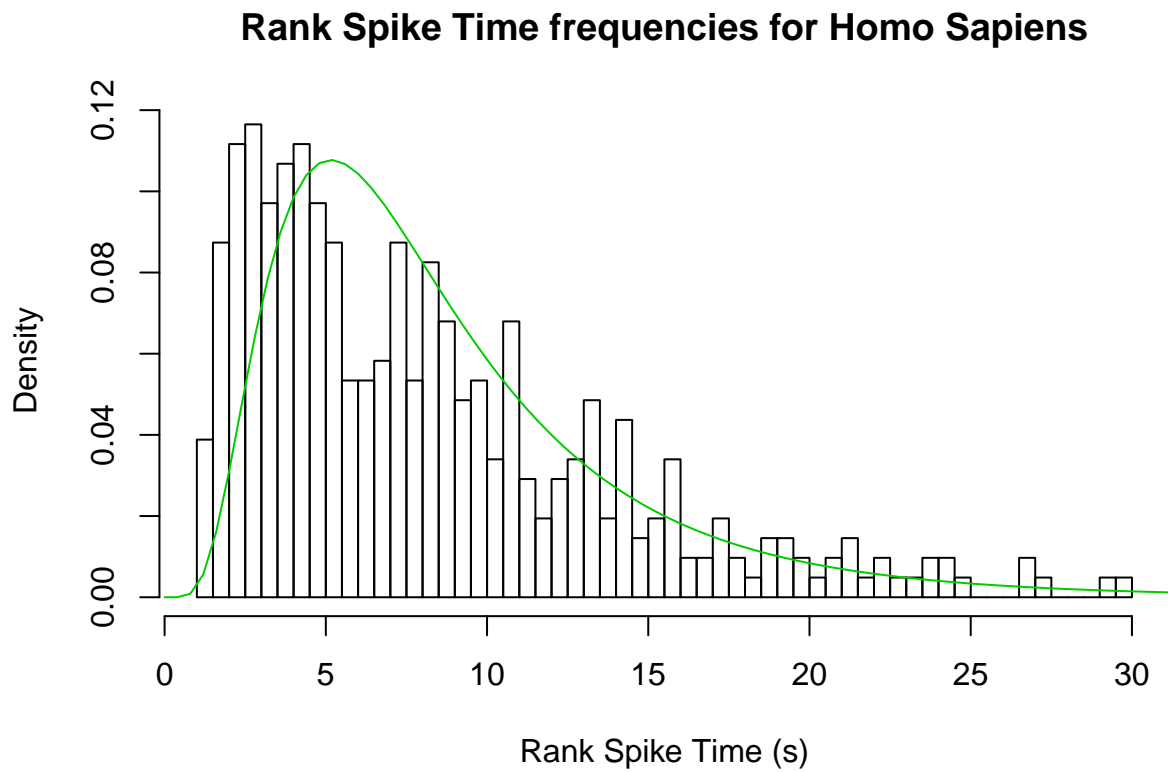
Ex 6.5

meanlog = 2 is best, based on the fit of the corresponding density function in the plot.

Ex 6.6

```
hist(cells$ef_peak_t_ramp[cells$donor_species == "Homo Sapiens"],
     proba = TRUE, xlab = "Rank Spike Time (s)",
     breaks = 50, main = "Rank Spike Time frequencies for Homo Sapiens")

curve(dlnorm(x, sdlog = 0.6, meanlog = 2),
     from = 0, to = 40, add = TRUE,
     col = 3, ylab = "log density function")
```



Yes, the density fits the data.

Ex 6.7

```
sum(cells$donor__species == "Homo Sapiens" & cells$donor__sex == "Male")
```

```
## [1] 234
```

```
sum(cells$donor__species == "Homo Sapiens" & cells$donor__sex == "Female")
```

```
## [1] 179
```