

Tristan De Alwis  
DSC 465: Intermediate Statistics  
Assignment #2  
April 16<sup>th</sup>, 2020

Q1:

$$\pi(\theta | x) = \frac{f(x|\theta) \pi(\theta)}{\int_{\theta=0}^1 f(x|\theta) \pi(\theta) d\theta} = \frac{f(x|\theta) \pi(\theta)}{\sum_{\theta} f(x|\theta) \pi(\theta)}$$

posterior

$$f(x|\theta) = \binom{n}{x} \theta^x (1-\theta)^{n-x}$$

$$\Rightarrow \pi(\theta | x) = \frac{\binom{n}{x} \theta^x (1-\theta)^{n-x} \pi(\theta)}{\sum_{\theta} \binom{n}{x} \theta^x (1-\theta)^{n-x} \pi(\theta)}$$

$$\theta(1/4, 1/2, 3/4) = 1/3$$

$$\pi(\theta | x) = \frac{\theta^x (1-\theta)^{n-x}}{\left(\frac{1}{4}\right)^4 \left(\frac{3}{4}\right)^6 + \left(\frac{1}{2}\right)^4 \left(\frac{1}{2}\right)^6 + \left(\frac{3}{4}\right)^4 \left(\frac{1}{4}\right)^6}$$

$$\pi(\theta | x) = \begin{cases} .397 & \text{for } \theta = 1/4 \\ .558 & \text{for } \theta = 1/2 \\ .044 & \text{for } \theta = 3/4 \end{cases}$$

# Assignment #2: R code

*Tristan De Alwis*

*4/16/2020*

## Loading Neccessary Libraries

```
suppressPackageStartupMessages(library(MASS))
suppressPackageStartupMessages(library(dplyr))
suppressPackageStartupMessages(library("Rlab"))
suppressPackageStartupMessages(library(class))
```

## Q2

Let  $\lambda$  be the traffic flow rate in vehicles per hour and  $M$  be the number of available toll

(c)

```
prior_m <- function(m) {
  if (m == 8) {
    return(4/7)
  } else if (m == 9) {
    return(2/7)
  } else {
    return(1/7)
  }
}

q_m <- function(m, mNew) {
  if (m == 9) {
    return(1)
  } else if (mNew == 9) {
    return(0.5)
  }
}

prior_lam <- function(lambda) {
  return(1/((lambda + 10) - max(c(0, lambda - 10))))
}

get_lam <- function(lambdaOld) {
  return(max(c(0, lambdaOld + runif(1, -10, +10), 1)))
}

q_lam <- function(lambdaOld, lambdaNew) {
  if (lambdaOld == 0) {
    return(abs(lambdaNew - 10)/20)
  } else {
    return(1/20)
  }
}
```

```

}

get_m <- function(mOld) {
  if (mOld == 9) {
    return(sample(c(8, 10), 1))
  } else {
    return(9)
  }
}

xDist <- function(x, lambda, m) {
  poisson <- 1 - exp(-1 * lambda * 15 * (1/3600)/m)
  return(max(dbinom(x, m, poisson, 1e-06)))
}

acceptanceProb <- function(lambdaNew, mNew, lambdaOld, mOld, X) {
  pPrime <- xDist(X, lambdaNew, mNew) * prior_m(mNew) * prior_lam(lambdaNew)
  p <- xDist(X, lambdaOld, mOld) * prior_m(mOld)
  rNum <- pPrime * q_lam(lambdaOld, lambdaNew) * q_m(mOld, mNew)
  rDenom <- p * q_lam(lambdaNew, lambdaOld) * q_m(mNew, mOld)
  r <- rNum/rDenom

  return(min(1, r))
}

MCMC <- function(M, x, ntrace, interval) {
  mOld <- M
  lambdaOld <- x * 240

  Ms <- c(mOld)
  Lambdas <- c(lambdaOld)

  for (i in 1:ntrace) {
    lambdaNew <- get_lam(lambdaOld)
    mNew <- get_m(mOld)

    if (acceptanceProb(lambdaNew, mNew, lambdaOld, mOld, x) >= runif(1,
      min = 0, max = 1)) {
      mOld <- mNew
      lambdaOld <- lambdaNew
    }
    if (i%interval == 0) {
      Ms <- c(Ms, mOld)
      Lambdas <- c(Lambdas, lambdaOld)
    }
  }
  return(list(Ms = Ms, Lambdas = Lambdas))
}

# (iv)
ntrace <- 5e+06
interval = 1000
ans <- MCMC(8, 2, ntrace, interval)
ans

```

```

## $Ms
## [1] 8 8 8 9 8 8 8 8 8 8 9 8 8 8 8 9 8 8 8 8 8 8 9
## [24] 8 8 8 8 8 8 8 8 10 8 8 8 8 8 8 8 8 8 8 9 8 9 8
## [47] 8 10 8 8 8 8 8 8 8 9 9 8 8 8 8 8 9 10 8 8 8 9 8
## [70] 9 8 10 8 10 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8
## [93] 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 10 8
## [116] 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 9 8 8 8 10 9 8 8
## [139] 9 8 8 8 8 9 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [162] 8 8 8 9 8 8 8 8 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [185] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 10 8 8 10 8 8 8 8 8
## [208] 8 8 8 8 9 8 9 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8
## [231] 10 8 8 8 8 8 10 8 8 8 9 8 8 8 8 10 8 9 8 8 8 8 8
## [254] 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8
## [277] 8 9 8 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8
## [300] 8 8 8 8 8 8 8 8 9 8 10 9 8 8 8 8 8 8 8 8 8 8 8
## [323] 8 8 8 8 9 8 8 8 8 8 9 8 8 8 8 8 8 10 9 9 9 8 8
## [346] 8 8 8 10 9 8 8 8 8 8 8 8 8 8 10 9 8 8 8 9 8 10 8
## [369] 8 8 8 8 9 8 8 8 8 10 8 8 8 8 8 8 8 8 8 8 8 8 8
## [392] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8
## [415] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [438] 8 10 8 8 8 8 8 9 8 8 9 10 8 8 8 8 8 8 10 8 9 8 8
## [461] 10 8 8 8 8 8 8 8 8 8 9 8 8 9 8 8 8 8 8 9 8 8 8
## [484] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8
## [507] 8 8 8 8 10 8 9 9 8 8 10 8 8 8 8 8 8 8 8 8 8 8 8
## [530] 8 9 8 8 8 8 8 8 8 8 9 8 9 9 9 9 9 8 8 10 8 8 8
## [553] 8 8 8 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
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## [599] 9 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
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## [645] 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8
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## [760] 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 9 8
## [783] 9 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 10 8 8 8 8 8
## [806] 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8
## [829] 8 8 8 8 8 8 8 8 8 8 9 8 8 10 9 10 8 9 8 8 8 8 8
## [852] 9 8 8 8 8 8 9 8 8 8 8 8 9 10 8 8 8 8 8 8 8 8 8
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## [944] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 10 8
## [967] 9 9 8 8 8 8 8 8 8 8 8 8 8 8 10 8 8 8 8 9 8 8 9
## [990] 8 8 8 9 8 8 9 8 8 8 8 8 8 8 10 8 8 8 8 8 10 8 8
## [1013] 8 8 8 8 8 10 8 8 8 8 8 8 8 8 8 8 8 10 8 8 8 8 8
## [1036] 8 9 8 8 8 9 8 8 8 8 9 8 8 8 8 8 8 8 8 9 8 8 8
## [1059] 8 8 8 9 8 8 8 8 8 8 8 8 8 8 8 9 8 9 8 8 8 9 9
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## [1105] 8 9 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8
## [1128] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 10 8 9 8 8 9 8
## [1151] 8 8 8 8 8 8 10 8 10 8 8 8 8 8 9 8 8 8 8 8 8 8 8
## [1174] 8 8 8 8 8 8 9 8 8 8 8 8 8 10 8 8 8 10 8 8 8 8 8
## [1197] 8 8 8 8 8 8 8 10 8 8 8 9 8 9 9 8 9 9 9 9 8 8 8

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## [1220] 8 9 8 8 10 8 10 9 8 9 8 8 9 8 8 8 10 8 8 8 8 9 8
## [1243] 8 8 8 8 8 8 8 8 8 10 8 8 8 8 8 9 8 8 8 8 9 8 8
## [1266] 8 8 8 8 8 9 8 8 9 8 8 8 8 9 8 8 8 8 8 8 8 8
## [1289] 8 8 8 8 8 8 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9
## [1312] 8 9 8 8 8 8 8 8 8 8 8 8 8 9 9 9 10 8 8 8 8 8
## [1335] 8 8 8 8 8 8 9 8 8 8 8 8 9 8 8 8 8 9 8 10 8 8
## [1358] 8 8 8 8 9 8 8 8 8 9 8 8 8 8 8 8 8 8 8 10 9 8
## [1381] 8 8 8 8 8 8 8 10 8 8 8 8 8 8 8 8 9 8 8 8 8 9
## [1404] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 10 9 9
## [1427] 8 8 8 8 10 10 8 8 8 10 8 8 8 8 8 8 8 8 8 8 8
## [1450] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 10 8 8 8
## [1473] 8 8 8 8 10 8 8 8 8 9 8 8 10 8 8 8 8 8 9 8 8
## [1496] 8 8 8 8 8 8 8 8 8 9 9 8 8 8 8 8 8 8 8 9 8
## [1519] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [1542] 9 8 8 8 8 9 8 8 8 8 8 9 8 8 8 8 8 8 8 9 8
## [1565] 8 8 9 8 8 9 8 10 9 8 8 8 9 8 8 8 8 8 8 8 8
## [1588] 8 8 9 8 8 8 8 8 8 8 9 8 8 8 8 9 8 8 8 8 9
## [1611] 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8
## [1634] 8 8 9 8 8 8 8 8 10 8 8 8 8 8 8 8 9 9 8 8 8
## [1657] 8 9 8 8 8 8 8 10 8 9 8 8 8 8 9 8 9 8 8 8 8
## [1680] 8 8 8 8 8 8 8 8 8 9 8 8 8 8 9 9 8 8 8 9 9
## [1703] 8 8 9 8 8 8 8 8 10 8 8 8 8 8 8 8 8 9 9 8 8
## [1726] 8 8 9 8 8 8 9 8 8 8 8 8 8 8 8 8 8 8 9 8 8
## [1749] 9 8 8 8 8 8 8 8 8 8 8 8 8 8 10 8 8 8 8 8 10
## [1772] 8 8 9 8 8 8 9 8 8 9 8 8 8 9 8 8 8 9 8 8 8
## [1795] 8 9 8 8 8 8 8 8 8 9 9 8 8 8 8 8 8 9 8 8 8
## [1818] 8 8 8 8 9 8 8 8 8 9 10 9 8 8 10 8 8 9 8 8 8
## [1841] 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
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## [1933] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [1956] 8 8 8 9 8 9 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8
## [1979] 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 8 10 8 8
## [2002] 8 8 8 8 8 9 9 8 8 9 8 8 8 8 8 8 8 8 8 9 8
## [2025] 9 8 9 8 8 8 8 8 8 8 9 8 8 8 8 8 9 9 8 9 8
## [2048] 8 8 8 8 9 8 8 9 8 9 8 8 10 8 8 8 9 8 9 8 8
## [2071] 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 8 10 9 8 8 8
## [2094] 8 10 8 8 9 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8
## [2117] 8 8 8 8 8 8 8 8 8 10 8 8 8 8 8 9 8 8 9 8 8
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## [2255] 8 8 8 9 9 8 8 8 8 8 8 8 9 8 8 10 9 8 8 8 8
## [2278] 8 9 8 10 10 8 8 8 9 9 8 8 8 8 8 8 8 8 9 8
## [2301] 8 8 8 8 8 8 8 8 8 8 8 8 10 8 8 8 8 8 8 9 10
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## [2439] 8 9 9 8 8 8 9 8 8 8 10 8 8 8 8 9 8 9 9 8 8

```

```

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## [2485] 10 10 8 8 8 8 8 8 8 8 8 8 8 9 8 9 9 8 8 8 8 8 8
## [2508] 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 10 8 8 8 8 8 8 8
## [2531] 9 8 8 9 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
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## [2577] 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 9 8 8
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## [2623] 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 9 9 8 8 8
## [2646] 8 8 8 8 8 8 9 8 9 8 9 8 8 8 8 8 8 8 8 8 8 8
## [2669] 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 9 10 8 8 9
## [2692] 8 8 8 8 9 8 8 8 8 8 8 8 10 9 8 8 10 8 8 8 8 8
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## [2876] 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 9 8 8 8 9 8
## [2899] 8 8 9 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 9 8
## [2922] 8 8 8 8 8 8 10 8 8 8 8 8 9 8 8 8 8 8 8 9 8 8
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## [3313] 8 8 8 8 8 10 8 8 8 10 8 8 8 8 8 8 8 8 8 8 8
## [3336] 8 8 8 8 8 8 9 8 8 8 8 8 8 8 9 8 8 8 8 9 8 8
## [3359] 8 8 8 8 8 8 9 8 8 8 9 8 8 8 8 8 8 8 8 8 8
## [3382] 8 8 8 8 8 8 9 8 10 10 8 8 8 8 8 8 8 8 8 8 8
## [3405] 8 8 8 8 9 8 8 8 9 8 8 8 8 8 8 10 10 8 9 8 8 8
## [3428] 8 9 8 8 8 8 8 8 9 8 8 8 9 8 8 8 8 8 8 8 9
## [3451] 8 8 8 10 8 8 8 8 8 8 8 10 10 8 10 8 8 8 8 9 8 8
## [3474] 8 8 8 8 8 10 8 8 8 9 8 8 8 8 8 8 9 8 9 8 8 9
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## [3520] 10 10 8 10 9 9 8 8 8 8 9 8 8 8 8 8 8 9 8 8 8
## [3543] 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8
## [3566] 8 8 8 8 8 8 8 8 10 8 8 8 8 8 8 8 8 8 9 8 8
## [3589] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8
## [3612] 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [3635] 8 8 8 8 8 8 8 10 8 8 8 8 8 8 8 8 9 8 8 8 8
## [3658] 8 8 8 8 10 8 9 8 8 8 8 8 8 8 9 8 8 8 8 8 8
## [3681] 8 8 8 8 9 8 8 8 10 8 10 8 9 8 8 8 10 10 8 8 8

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## [3704] 8 8 8 8 8 8 8 8 8 8 8 8 10 8 8 8 8 9 8 8 8 8 9 8
## [3727] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 9 8 8 8 8
## [3750] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [3773] 9 9 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [3796] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 9 8 9 8 8
## [3819] 8 10 8 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8 9
## [3842] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [3865] 8 8 8 8 8 8 8 8 8 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [3888] 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 8 8 8 10 10 8 8 8 8
## [3911] 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 9
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## [3957] 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 9 8 8 8 8 9 9 8
## [3980] 8 8 8 8 8 10 8 8 8 8 9 8 8 8 8 8 8 8 8 9 8 8 8
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## [4026] 8 9 8 8 8 8 8 8 8 8 8 9 8 10 8 8 8 8 8 8 8 8 9 8
## [4049] 8 9 8 9 8 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 9 8 8 8
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## [4302] 8 8 8 8 8 8 8 8 8 8 8 8 10 9 8 8 8 8 8 8 8 10 8
## [4325] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8
## [4348] 9 8 8 8 8 8 8 8 9 8 8 8 8 10 8 8 9 8 8 9 8 9 8
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## [4394] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 10 8
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## [4440] 8 9 8 8 8 9 9 8 8 8 9 9 8 10 8 8 8 8 9 8 8 8
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## [4486] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 10 9 8 8 8
## [4509] 8 8 8 8 8 10 10 8 8 8 8 8 8 8 8 8 8 9 8 8 8 8
## [4532] 8 9 8 8 9 8 8 9 8 8 8 8 9 8 8 8 8 8 8 8 8 10
## [4555] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8
## [4578] 10 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [4601] 9 8 8 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 10
## [4624] 8 10 8 8 10 8 8 8 8 8 8 9 8 8 8 9 8 8 8 8 8 8
## [4647] 8 8 10 8 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 10
## [4670] 8 9 9 8 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
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## [4716] 8 9 8 10 8 8 8 8 8 10 9 8 8 8 8 8 8 8 8 8 8 8
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## [4785] 8 8 8 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [4808] 8 8 8 8 8 8 8 8 8 8 8 8 10 8 8 8 8 9 8 9 8 8
## [4831] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8
## [4854] 8 8 8 8 9 8 8 8 8 10 8 9 8 8 10 8 8 8 8 8 9 8
## [4877] 10 9 8 8 8 8 8 8 8 8 8 8 10 8 8 8 8 8 8 10 8
## [4900] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 10 8 8
## [4923] 8 8 8 8 8 8 8 10 10 10 8 8 8 8 8 8 8 8 8 8 8 8

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## [4946] 8 8 8 8 8 8 8 9 8 8 8 8 8 8 8 8 8 8 9 8 8 8
## [4969] 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
## [4992] 10 8 8 8 8 8 8 8 8 9
##
## $Lambdas
## [1] 480.00000 463.43289 447.86682 479.61707 539.11990 516.57012
## [7] 529.95112 556.20975 490.11247 465.14722 438.23003 436.54074
## [13] 461.80935 494.50402 512.59146 485.74812 560.22906 597.97786
## [19] 609.01754 618.59035 607.72396 611.35850 676.50573 656.92949
## [25] 687.49860 679.47047 683.92668 673.94430 656.43651 668.73689
## [31] 655.55023 622.72380 643.37081 637.35070 639.11876 655.82571
## [37] 674.93530 625.09248 656.42390 706.37754 723.15338 752.25646
## [43] 724.33121 741.97410 758.66532 793.22015 757.97214 777.13022
## [49] 716.60334 756.58842 769.20159 767.98587 762.74180 757.44334
## [55] 742.10161 728.91976 779.22948 806.22719 786.29554 796.03188
## [61] 768.57698 767.47724 723.24861 746.16889 736.25539 765.66443
## [67] 778.03345 771.02730 761.18393 754.80834 768.99042 757.62768
## [73] 740.48132 754.96990 764.11484 826.75164 857.21144 841.64615
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## [85] 789.81765 733.50774 703.01590 709.51980 706.70013 683.54969
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## [157] 1021.76837 1003.17095 923.07253 903.07568 936.97772 919.30564
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## [193] 1162.34396 1160.41350 1143.59430 1162.58600 1141.63871 1114.57907
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## [205] 1078.95226 1081.06776 1068.61698 1052.43290 1064.24751 1091.59637
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## [277] 488.72237 495.63584 516.83389 496.03479 507.79897 469.42022
## [283] 488.54186 500.77390 506.44249 512.41238 515.09436 498.19038
## [289] 488.25662 465.62366 535.94822 512.64248 545.30916 565.86781

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##	[295]	550.79918	499.28439	456.28762	472.28455	437.52373	485.94943
##	[301]	505.94240	534.16171	517.97353	509.08132	506.77622	526.82022
##	[307]	427.56920	371.37602	339.50398	305.02729	282.91214	274.41289
##	[313]	256.02497	247.85728	276.51390	319.86189	303.66943	333.55470
##	[319]	350.89511	342.49166	315.42566	320.74353	321.86743	393.80847
##	[325]	396.72533	376.34846	375.35496	331.50710	313.61276	356.61011
##	[331]	349.57668	302.60900	299.49180	218.83446	224.68671	247.43395
##	[337]	261.01071	252.81340	289.78697	299.67165	329.81941	366.02573
##	[343]	361.41518	351.00419	311.80195	292.47345	322.45768	378.82538
##	[349]	395.84137	378.83264	412.18396	436.38502	470.95076	506.33739
##	[355]	538.63126	512.63717	521.79415	501.35824	474.09379	535.75201
##	[361]	551.43272	538.92699	497.80410	516.57498	513.00159	437.59948
##	[367]	427.01214	456.76902	487.57358	488.91205	485.90932	504.42801
##	[373]	449.58433	395.30754	393.95333	360.61282	385.57004	377.06843
##	[379]	331.50381	311.25263	359.40187	403.78218	362.94008	405.42181
##	[385]	383.34695	340.22685	360.93065	338.63706	355.37637	330.82427
##	[391]	376.01289	375.19906	383.17665	387.30996	386.20391	404.95488
##	[397]	433.75504	378.52176	386.23150	378.77012	413.15157	449.76031
##	[403]	458.95543	486.64226	497.64503	548.70623	563.77894	583.30616
##	[409]	556.27917	471.71291	441.02680	444.53633	463.18464	469.10120
##	[415]	517.12994	522.34835	580.10149	564.06919	547.13876	546.13451
##	[421]	585.28248	598.75104	609.78033	600.54925	636.91760	648.01438
##	[427]	667.98336	660.81905	634.29641	629.54460	593.59998	611.98608
##	[433]	661.43178	672.07127	739.12077	751.40833	797.13243	849.85461
##	[439]	833.45234	826.01085	811.34215	849.91855	874.34210	873.58377
##	[445]	889.63889	897.41605	880.74877	868.55806	896.50298	846.57681
##	[451]	858.03789	881.12667	861.20545	861.76485	868.22028	861.76069
##	[457]	849.25071	831.58798	811.47405	829.44713	857.91217	832.69917
##	[463]	849.31241	839.15513	795.05361	817.73055	778.65004	763.40673
##	[469]	733.83510	711.73327	663.91218	657.96093	657.07369	717.52241
##	[475]	694.95434	689.48440	688.84107	698.89746	706.76161	756.53932
##	[481]	727.21406	733.03655	742.11694	781.07435	767.58524	735.13559
##	[487]	731.48561	796.24041	827.19743	814.67026	846.69340	840.34466
##	[493]	871.35566	899.81934	925.29462	944.80548	929.60471	931.05324
##	[499]	910.80147	923.64239	955.35222	953.88117	904.09563	881.14978
##	[505]	888.98081	870.43997	854.84205	861.80612	905.23682	887.07567
##	[511]	916.13058	856.73402	864.89134	816.50940	771.65921	787.47883
##	[517]	802.61827	791.36669	779.97462	779.13408	746.53119	765.93180
##	[523]	756.42931	783.12229	751.31720	711.21194	693.40533	699.70045
##	[529]	631.04302	644.87995	664.17430	689.52828	674.21214	625.09495
##	[535]	600.36522	533.42720	525.56155	532.62404	515.60070	521.45192
##	[541]	546.78607	477.14321	480.61018	501.28441	521.81801	508.93913
##	[547]	498.01838	545.55275	549.23656	583.91173	503.79607	505.78405
##	[553]	531.84511	530.80070	532.63258	531.27875	519.06756	526.01468
##	[559]	533.33152	520.65413	495.09085	483.62023	529.03400	545.73528
##	[565]	567.71811	607.40290	599.29213	590.27984	594.97798	582.05604
##	[571]	587.51860	611.45954	599.90998	610.83170	537.45570	560.19013
##	[577]	581.82272	587.12705	585.67547	586.80341	611.91646	601.88805
##	[583]	585.00283	565.30787	542.50552	560.52650	535.35182	604.68572
##	[589]	620.19749	638.86990	594.50486	599.25970	540.65345	585.68110
##	[595]	594.20838	560.19812	629.79987	666.78290	700.99456	703.81443
##	[601]	693.96609	661.16010	670.20310	624.95878	624.63244	594.19180
##	[607]	654.69880	611.34595	628.59257	636.69381	604.67911	597.29885
##	[613]	632.55119	669.58943	659.39583	622.85185	614.85504	610.10190

##	[619]	628.78376	605.89318	599.89052	620.59361	588.76020	588.82385
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##	[667]	660.46765	645.50606	654.40708	697.42189	688.65632	700.88871
##	[673]	711.94738	737.56741	737.98132	755.52619	816.32339	781.11004
##	[679]	801.25033	830.61585	837.23342	771.17300	749.49782	697.88755
##	[685]	691.20167	744.02247	745.60466	722.43004	710.54393	711.28411
##	[691]	735.93952	719.70572	723.92052	769.21034	831.60172	812.20734
##	[697]	767.85826	783.48618	744.45657	740.01421	689.88515	698.41592
##	[703]	743.16871	750.40451	764.49028	698.42460	722.63573	716.88212
##	[709]	648.21622	621.60967	580.10732	559.97607	532.97536	539.07567
##	[715]	524.74417	502.84303	499.73018	481.22979	496.79135	499.44825
##	[721]	466.00308	453.65374	449.20931	410.80566	377.68606	359.42129
##	[727]	368.96250	377.64436	369.84758	359.73638	390.22306	402.98585
##	[733]	383.20427	405.44607	354.07290	375.43143	360.79516	375.51624
##	[739]	402.51199	425.30707	434.06415	459.02811	459.17892	468.23636
##	[745]	505.55912	490.29549	516.23796	529.18601	581.80562	589.32801
##	[751]	588.36776	577.18144	586.21628	600.05954	600.98456	622.78207
##	[757]	585.11932	575.10085	597.37087	593.32971	638.26331	680.37469
##	[763]	677.45340	641.31917	659.32538	641.73583	619.90337	633.53234
##	[769]	615.53437	645.36346	618.18122	585.55959	569.52663	579.95333
##	[775]	555.41366	509.67063	501.02204	506.43635	493.82398	486.88351
##	[781]	481.09949	480.44062	548.58423	579.57645	621.01797	620.12242
##	[787]	603.32356	584.12223	598.45216	617.26677	625.86606	580.04658
##	[793]	611.74009	613.21922	573.81069	570.16980	537.16775	526.04560
##	[799]	556.56475	551.19739	570.18530	597.50080	602.99380	592.88105
##	[805]	621.60191	578.92461	559.31708	588.91416	604.11205	585.27189
##	[811]	588.18726	562.74093	516.40007	525.97287	497.50691	492.86469
##	[817]	484.99213	448.26170	444.46832	394.49498	356.10131	366.88871
##	[823]	336.46381	381.44294	420.85659	420.65917	426.18312	425.23142
##	[829]	424.09349	404.87258	390.35698	394.75846	404.84204	439.47021
##	[835]	437.23736	458.79133	458.74558	423.01141	418.06597	411.21107
##	[841]	390.45172	400.41265	368.99739	288.64343	310.41438	375.87803
##	[847]	372.87449	386.14572	402.80451	381.07017	376.97137	376.80831
##	[853]	387.38676	359.54869	329.03085	277.23841	219.68046	226.71746
##	[859]	210.12417	247.97913	227.53149	194.71211	196.99476	196.09855
##	[865]	226.72783	222.14954	204.48023	201.99971	234.92573	223.54662
##	[871]	234.69277	229.53444	258.55677	275.32058	270.13129	280.21740
##	[877]	313.93120	389.86411	396.10678	424.36988	440.01340	470.62553
##	[883]	467.54793	453.62298	470.60914	462.93327	440.17053	438.63104
##	[889]	435.59380	436.78843	409.72581	340.61167	340.84680	370.00633
##	[895]	397.56311	394.18625	400.17229	410.98744	413.41633	468.51647
##	[901]	464.17846	500.69519	512.72645	498.02420	496.07327	505.45935
##	[907]	521.38334	547.64256	572.79910	626.93762	658.50563	673.81917
##	[913]	690.70904	688.31670	687.98446	665.26334	658.02049	670.45520
##	[919]	658.44231	674.36297	632.53066	627.27311	606.28972	577.44800
##	[925]	626.52370	585.82639	568.36932	600.36776	539.84600	541.53223
##	[931]	528.38635	544.33116	492.43835	492.90792	462.17298	482.70907
##	[937]	522.39359	542.84584	486.38177	437.61344	446.28719	427.25037

##	[943]	407.98012	422.49835	460.30039	434.05885	442.71908	395.53460
##	[949]	384.12751	374.16571	335.19220	377.99960	406.79074	445.31585
##	[955]	417.74556	438.75381	402.15980	396.75370	382.87724	404.62636
##	[961]	355.23838	346.83624	374.77336	345.72265	383.88651	358.03156
##	[967]	332.44812	299.35234	306.75322	355.14998	336.91033	318.36507
##	[973]	301.69998	243.27185	212.38055	218.38509	242.60866	277.61715
##	[979]	240.95479	246.96276	242.54729	239.00959	197.16803	164.70340
##	[985]	171.59833	144.87551	166.22753	150.01229	160.56738	157.22081
##	[991]	154.73619	189.13094	192.21834	202.50446	200.87283	219.22999
##	[997]	266.73442	224.11165	227.33270	273.46321	253.30441	309.05359
##	[1003]	327.60462	290.17363	282.23609	283.02354	314.29443	344.18652
##	[1009]	359.90904	372.74709	414.73928	358.17340	361.94967	379.05825
##	[1015]	352.79544	377.26985	309.17425	292.83918	306.31877	306.85307
##	[1021]	303.30613	313.95448	342.86878	316.15052	306.10326	298.48781
##	[1027]	297.26825	346.14396	304.03288	292.01705	316.28818	322.14944
##	[1033]	362.14408	373.65249	412.23001	410.07816	370.81080	416.75918
##	[1039]	476.60786	464.78503	402.85670	419.89661	435.36242	449.51105
##	[1045]	462.80298	477.96893	488.14462	521.42424	547.87947	588.45850
##	[1051]	575.57576	607.39557	602.12963	607.29007	605.44882	615.75492
##	[1057]	676.63805	732.93751	759.52270	810.84680	874.21988	882.71759
##	[1063]	855.99786	892.21927	879.70269	835.54063	847.07031	833.96222
##	[1069]	836.50956	877.09681	860.54924	808.98785	842.16420	841.71526
##	[1075]	787.90240	773.48358	753.29179	779.86978	787.39223	836.93668
##	[1081]	870.80656	860.34469	854.53655	883.81390	904.66932	953.15066
##	[1087]	981.95618	960.24406	928.06343	947.87752	948.08722	897.41085
##	[1093]	872.37245	824.81816	820.22464	793.33368	771.08888	722.37113
##	[1099]	712.38168	676.27973	704.52676	685.29283	671.78532	686.95713
##	[1105]	684.03403	750.09655	755.56827	757.46375	691.11419	690.02468
##	[1111]	687.31797	651.10572	683.53477	701.89931	678.10715	665.37016
##	[1117]	692.20960	712.58715	738.12764	710.30591	704.67586	763.23942
##	[1123]	803.27703	788.60553	742.47328	783.80181	768.93718	706.41212
##	[1129]	703.03028	705.42113	728.24363	718.40415	710.88019	735.10730
##	[1135]	740.00163	765.67620	772.38636	760.95158	753.44361	767.77455
##	[1141]	773.64621	765.03385	750.16956	793.05227	868.08124	874.60993
##	[1147]	870.28977	884.11850	887.66851	913.31266	889.41907	888.89098
##	[1153]	866.39699	907.44600	923.47007	866.76323	896.75532	870.07178
##	[1159]	792.99053	768.86240	806.14605	775.66081	741.85883	760.23828
##	[1165]	739.55203	779.58878	733.57636	741.79169	804.69011	801.86724
##	[1171]	811.74584	816.38671	805.10478	868.21164	852.25014	848.05607
##	[1177]	836.27539	823.70616	831.61782	839.55634	870.77936	881.79908
##	[1183]	893.23845	823.01589	845.57069	902.29884	936.44609	932.77015
##	[1189]	904.94207	899.26071	879.18461	878.43401	880.92432	914.18264
##	[1195]	893.91428	944.70423	937.94491	938.54679	956.58423	936.91535
##	[1201]	930.18033	921.30272	896.32092	902.80118	933.26828	986.77544
##	[1207]	960.92210	951.01213	971.03109	981.30588	960.24318	1028.63469
##	[1213]	1014.85774	1046.81827	1018.65410	996.52329	1002.91389	1023.16934
##	[1219]	1026.13721	1023.19077	1003.99814	993.77485	993.79040	1016.92892
##	[1225]	1017.02380	1031.52214	1028.67777	1119.98662	1058.00004	1056.51158
##	[1231]	1094.53250	1071.23857	1112.88282	1072.83266	1109.84868	1106.55216
##	[1237]	1126.84649	1144.24070	1125.44174	1112.04265	1086.82019	1109.19033
##	[1243]	1091.58915	1060.05350	1029.51248	962.06076	934.49323	944.53592
##	[1249]	890.98636	868.48218	833.56466	844.31578	791.01524	765.44276
##	[1255]	735.99458	724.57188	708.53237	700.03310	743.10465	720.31825
##	[1261]	691.08998	729.96456	747.58103	708.59728	711.48527	721.02623

##	[1267]	676.19905	633.14702	663.16131	704.56567	697.56291	695.79314
##	[1273]	699.38271	675.16396	598.41585	616.02290	684.77859	728.11396
##	[1279]	735.90491	703.65815	698.64893	681.05850	704.43979	721.93840
##	[1285]	701.35913	708.77320	728.00057	756.40802	714.88019	714.40866
##	[1291]	730.09832	685.99396	693.10172	746.78351	682.80752	665.98274
##	[1297]	595.18430	568.76424	600.71989	607.01860	585.67928	545.93869
##	[1303]	563.23357	496.81495	496.61002	467.91969	474.87486	455.72001
##	[1309]	474.61030	495.07676	527.04325	506.38793	495.78037	489.32345
##	[1315]	419.18930	440.88713	460.22173	458.83000	447.06387	447.01926
##	[1321]	436.09127	403.57940	393.06098	424.75577	433.68745	393.54165
##	[1327]	355.46130	414.47043	439.66534	477.96122	466.40068	463.94717
##	[1333]	437.22948	443.51165	430.36456	457.30151	444.78618	461.12834
##	[1339]	413.62428	459.56646	453.06843	407.45615	381.79649	421.05737
##	[1345]	376.93825	374.95820	421.80409	464.79125	446.70692	473.02223
##	[1351]	483.11969	523.67791	535.96805	548.95840	565.65239	555.50029
##	[1357]	572.57722	532.07644	516.03951	538.24519	511.52754	512.17319
##	[1363]	511.26765	480.58289	490.41209	517.84911	496.08423	515.60494
##	[1369]	444.66540	431.83738	443.24488	447.06664	404.95083	404.04951
##	[1375]	387.43031	357.64485	393.35571	428.97314	427.24566	410.09197
##	[1381]	406.01149	419.49808	452.37849	427.11955	401.22103	414.55899
##	[1387]	441.71129	424.14146	424.66602	363.59617	371.63846	333.78332
##	[1393]	358.06484	328.81186	346.51092	327.16383	361.10242	335.03096
##	[1399]	328.22635	322.06658	293.12778	293.76334	301.03268	279.01658
##	[1405]	238.43490	246.99007	281.11771	286.33600	281.24584	272.43169
##	[1411]	269.41883	274.03304	291.79228	245.24568	246.16744	242.52234
##	[1417]	240.94659	223.68334	276.66317	290.20636	272.42548	323.04991
##	[1423]	311.35804	275.25787	300.03623	310.99368	290.91827	329.25079
##	[1429]	319.64859	321.99831	383.53243	373.17687	344.37664	356.20361
##	[1435]	400.65487	419.59733	404.40690	394.60548	393.56732	396.22683
##	[1441]	429.02142	399.06622	393.19650	393.84003	402.06847	397.85616
##	[1447]	419.99151	481.43358	493.52630	529.58712	525.92514	485.03950
##	[1453]	495.73775	460.44032	495.50037	483.90498	504.33121	503.15048
##	[1459]	531.98697	527.09239	525.88256	543.09615	545.12156	593.03595
##	[1465]	578.17238	588.19215	590.30197	591.67029	605.70378	653.02418
##	[1471]	699.43329	699.88791	717.21973	743.78651	751.38903	725.32834
##	[1477]	725.57192	762.98797	786.97911	798.56240	816.94343	822.10499
##	[1483]	846.14098	826.03189	849.35202	858.89250	901.74329	880.99727
##	[1489]	868.54434	813.92971	789.46674	773.44495	748.00669	829.87970
##	[1495]	827.42086	784.34622	747.83219	772.69972	751.92712	755.46631
##	[1501]	790.09278	814.66505	832.13462	797.37319	804.77011	791.74325
##	[1507]	819.48347	838.53650	844.08874	848.14653	856.45916	831.96593
##	[1513]	851.70694	852.60236	870.45146	853.53349	836.06658	806.76632
##	[1519]	763.25208	742.57819	705.81412	714.88944	708.30064	697.29613
##	[1525]	662.29365	670.84331	661.35221	698.91412	681.60193	666.73138
##	[1531]	696.71803	657.16306	659.62957	714.70281	723.85543	762.27728
##	[1537]	777.47098	746.32222	765.02471	752.83586	788.13133	772.75308
##	[1543]	742.33349	690.78350	646.07856	647.80595	627.49788	593.59246
##	[1549]	616.31357	624.46849	611.29626	581.71858	643.03712	666.52868
##	[1555]	628.56827	643.42300	662.86970	619.77942	605.71226	607.55680
##	[1561]	610.95627	599.54396	589.26637	601.88467	578.98406	594.04042
##	[1567]	589.66134	646.61236	648.69150	703.61407	695.55992	700.23095
##	[1573]	735.96230	736.67109	688.93097	727.23045	741.46132	707.73037
##	[1579]	722.45142	683.84644	643.05498	652.50442	578.93329	557.99325
##	[1585]	522.68910	512.07599	514.09887	539.23389	494.73441	475.05734

## [1591]	529.39214	494.92629	504.09964	467.30578	482.03887	493.13803
## [1597]	505.82977	530.05994	487.52677	556.06259	528.26278	568.64394
## [1603]	560.07334	595.43574	608.93937	607.99756	649.41950	673.37156
## [1609]	682.99093	676.03900	677.57273	650.51048	638.09916	588.16150
## [1615]	610.35074	611.06055	617.11032	633.65456	637.81833	634.90926
## [1621]	659.81428	638.22659	662.21058	679.34877	704.73799	700.90583
## [1627]	667.79471	703.31978	718.32102	757.17970	724.02910	684.52853
## [1633]	638.22514	577.71386	599.32216	595.07318	565.49681	578.20481
## [1639]	569.31382	564.94901	546.56174	485.65232	471.49589	440.12759
## [1645]	455.58126	436.56417	435.74022	426.94827	459.99253	452.58828
## [1651]	432.64665	380.09979	356.47536	299.49498	270.88508	254.18180
## [1657]	237.42597	234.19218	183.66570	194.36331	196.58188	191.93093
## [1663]	196.97091	187.31519	165.78883	197.83915	219.72217	191.08444
## [1669]	140.51164	160.14687	200.20603	213.92227	196.28493	181.78446
## [1675]	246.42189	240.35764	222.10890	234.16289	245.65939	244.83897
## [1681]	324.17237	292.86718	260.89324	279.35570	257.15767	263.45851
## [1687]	271.52647	268.83355	266.15932	263.89894	222.25544	253.33668
## [1693]	190.81565	179.80337	208.76790	213.30708	216.07606	175.45010
## [1699]	180.37594	148.56405	176.22641	157.41233	200.04383	208.81278
## [1705]	219.86393	225.86272	241.55635	224.09306	268.02706	279.57752
## [1711]	281.43234	271.42379	219.76569	170.11353	165.95765	164.38981
## [1717]	195.35975	221.70900	191.18114	191.03741	189.37879	187.26594
## [1723]	216.43967	179.61897	159.06585	208.69938	212.60718	213.31096
## [1729]	235.55157	220.98710	227.16285	231.75743	230.63096	140.16584
## [1735]	112.92428	156.65651	170.95180	144.28101	126.56077	88.00117
## [1741]	119.04908	131.58585	123.04053	163.48203	75.30255	117.98069
## [1747]	172.21889	186.27922	177.05083	218.86500	139.52402	91.73608
## [1753]	146.56116	142.89274	203.55102	214.71473	196.52664	176.92978
## [1759]	166.65655	154.39157	108.43462	120.18496	126.49040	130.02020
## [1765]	187.75294	199.34605	248.01190	239.20591	250.17083	221.16606
## [1771]	255.21322	235.30888	284.66076	189.61763	165.74415	213.72261
## [1777]	225.64450	212.63423	139.48420	170.36065	161.85157	187.08996
## [1783]	234.07635	248.19187	292.16840	332.89403	342.91187	374.73890
## [1789]	332.30139	354.58436	316.24891	319.95854	346.03138	344.58781
## [1795]	403.04702	366.39813	357.64506	357.52255	307.39895	265.18121
## [1801]	256.56968	273.00417	293.27173	328.88653	356.71704	357.90256
## [1807]	398.42451	421.54054	484.42291	517.13468	519.55496	517.20400
## [1813]	542.57034	541.05291	519.24232	533.17523	541.25465	565.61493
## [1819]	563.12087	543.20336	528.44228	492.47067	489.98592	461.45848
## [1825]	445.56082	427.63636	348.27061	341.94491	338.05163	321.72393
## [1831]	344.44682	383.00440	374.40015	393.22955	401.91571	390.70974
## [1837]	336.60855	367.02181	356.32920	415.76743	446.38422	468.26532
## [1843]	467.23180	439.09376	467.96587	467.70180	473.21026	423.69198
## [1849]	411.87772	421.19952	458.85674	463.12070	464.82707	478.90734
## [1855]	469.89263	427.16780	414.64941	441.13367	456.07291	448.83642
## [1861]	435.56668	434.46765	459.84351	531.22941	496.02356	526.51422
## [1867]	546.65098	565.91588	601.75272	574.73395	548.87219	530.97486
## [1873]	525.90919	542.11072	501.36218	510.47243	519.41159	500.85126
## [1879]	538.69960	540.04594	543.37909	523.25041	554.21792	603.46042
## [1885]	603.50743	599.34230	592.92769	599.50541	625.45108	617.28886
## [1891]	588.63784	584.02463	533.82498	544.76471	552.51504	580.20244
## [1897]	634.34851	652.35176	615.37045	619.47920	640.96698	605.30781
## [1903]	622.62064	646.14168	639.96455	643.48040	663.55028	606.30407
## [1909]	609.39468	610.38930	622.77500	585.73298	625.64842	623.83343

## [1915]	607.64465	602.79244	594.80015	636.20765	628.09338	616.63863
## [1921]	610.63542	581.12239	584.46362	556.97931	529.72639	534.02823
## [1927]	519.81681	511.17608	489.12806	497.00780	503.26194	520.74865
## [1933]	515.21687	494.08815	446.32791	500.58425	443.46060	470.65472
## [1939]	489.09075	475.91078	467.43581	510.07402	455.49749	443.84591
## [1945]	481.81453	488.29335	522.40417	566.58230	535.16905	571.89495
## [1951]	593.71682	650.68423	671.63477	675.59504	678.05037	664.71815
## [1957]	626.79440	662.83958	684.42212	731.57259	708.34796	770.62627
## [1963]	748.03969	749.05591	730.60341	706.52735	695.03435	690.13717
## [1969]	698.21773	696.56547	668.51001	719.10162	726.85317	721.43280
## [1975]	746.27443	694.72641	658.56197	678.69395	718.58459	775.47410
## [1981]	786.74849	744.84183	751.48822	758.01880	732.96515	701.51387
## [1987]	705.16913	728.22640	675.18472	708.61745	650.26763	655.57316
## [1993]	650.33757	670.93225	671.06618	757.22440	825.45084	805.93248
## [1999]	807.75747	779.81154	775.28193	702.82230	731.86722	751.69010
## [2005]	765.80780	718.39356	718.84064	816.35735	819.37185	802.67386
## [2011]	800.97482	817.63854	793.24439	815.26115	852.15260	794.52087
## [2017]	829.59699	841.68428	845.41710	822.77363	802.90320	850.76373
## [2023]	885.74546	873.12330	861.14667	797.53887	809.38645	810.36742
## [2029]	766.52176	799.87413	760.98132	777.11147	773.27785	779.08473
## [2035]	768.28940	790.36557	783.56670	841.18803	767.37910	737.89378
## [2041]	751.80760	779.79667	802.03064	774.73429	759.00966	760.03274
## [2047]	735.29214	700.61251	652.29152	708.29656	665.92285	623.34565
## [2053]	644.86713	668.42837	707.22528	698.65706	693.21209	659.83483
## [2059]	623.34329	657.75320	618.77650	665.61869	680.82683	697.85408
## [2065]	772.41807	794.35450	782.28663	733.75694	693.95412	636.95939
## [2071]	662.86771	625.49190	639.53729	601.63945	610.81738	588.39668
## [2077]	598.82024	657.73313	682.16055	709.20221	681.92852	663.03994
## [2083]	669.92055	685.89721	671.60817	679.29202	698.52103	694.11557
## [2089]	720.59252	760.43078	774.51643	788.68723	798.23216	725.11796
## [2095]	736.95441	704.75345	693.77403	670.53080	710.30774	628.25101
## [2101]	611.74207	648.11859	600.65104	595.80139	601.63185	609.07830
## [2107]	651.86335	631.09635	569.95052	556.99723	618.24067	623.37363
## [2113]	595.64574	579.61593	571.22824	474.41428	426.17613	404.40770
## [2119]	420.09306	399.56481	395.52823	426.18985	469.75528	415.67900
## [2125]	420.60030	397.09184	350.66541	393.80970	412.89428	375.18430
## [2131]	355.27712	330.37265	304.39842	306.00166	328.33175	302.83819
## [2137]	349.32064	373.90912	304.00670	341.17676	370.93070	418.84786
## [2143]	427.64638	426.57906	473.58815	445.07503	398.93543	406.64823
## [2149]	469.90225	493.24634	491.73335	443.14205	416.46867	396.53854
## [2155]	339.88924	296.29545	368.65224	330.09535	339.34704	346.64197
## [2161]	367.01053	401.17382	412.80201	398.90180	367.21152	428.48371
## [2167]	437.08496	409.71456	394.90817	350.05755	330.25654	341.48333
## [2173]	397.95839	421.16206	462.44457	433.29173	411.34508	413.21237
## [2179]	437.28731	472.76740	495.06706	508.90559	523.21605	513.58715
## [2185]	491.25620	505.68575	496.78658	505.87716	484.89604	474.03775
## [2191]	455.41364	519.82332	517.26788	486.42053	514.18758	473.08028
## [2197]	471.73512	501.72583	481.71547	485.91283	464.62997	503.22780
## [2203]	472.65896	481.32049	478.58388	463.62702	519.11690	485.04918
## [2209]	476.11364	446.26075	412.65781	446.19577	469.43426	502.48351
## [2215]	490.61647	491.79372	476.30224	476.45564	508.59683	473.66843
## [2221]	493.96262	464.95263	451.35146	447.29978	476.92493	448.57587
## [2227]	421.55479	408.95617	396.26125	387.16556	361.77411	326.07450
## [2233]	350.70737	342.83965	372.98779	338.23616	358.09311	427.92750

## [2239]	422.87177	399.73754	391.79140	394.25685	394.51580	405.07372
## [2245]	400.87291	386.04824	350.07993	356.95614	311.79749	325.09111
## [2251]	299.41817	321.93764	313.28214	313.94982	339.91247	314.24560
## [2257]	311.55973	291.11399	278.86079	317.16420	294.52277	285.76762
## [2263]	334.92721	366.30125	390.70486	422.95715	427.38039	432.34426
## [2269]	479.82593	451.96149	412.49190	398.97200	372.35920	397.00190
## [2275]	451.63783	439.52432	430.85282	450.59497	467.67260	425.70501
## [2281]	399.00776	415.85054	410.21486	385.84785	426.28318	456.59359
## [2287]	453.11421	476.65021	508.40561	533.46652	545.44660	497.57475
## [2293]	490.26460	480.86257	480.06119	481.58988	479.42521	465.75478
## [2299]	453.40964	478.92508	414.06852	411.74546	421.64102	399.56196
## [2305]	413.02361	468.05429	446.66520	461.23231	439.72563	455.97377
## [2311]	419.54980	432.18007	382.20761	420.34251	389.26056	388.06648
## [2317]	363.60800	321.88014	328.09749	360.00317	308.73190	300.49057
## [2323]	319.14208	358.55599	391.85145	400.36081	450.61919	428.40315
## [2329]	430.51483	406.47137	432.75184	448.85830	447.90427	424.82185
## [2335]	358.52863	370.21533	345.66226	314.84863	283.99562	337.62548
## [2341]	329.79538	291.21417	297.56793	268.69411	271.06323	312.62712
## [2347]	346.65987	335.30452	359.80155	312.26452	293.71984	309.00857
## [2353]	320.60506	356.83554	413.53977	453.46776	415.24857	417.85955
## [2359]	469.48716	483.85726	471.81296	451.46988	447.37479	486.69947
## [2365]	487.38657	452.48159	494.85835	492.06821	496.93171	508.15702
## [2371]	474.51558	448.71192	449.52383	443.26823	465.19804	438.14626
## [2377]	389.74292	410.21539	388.35527	372.39102	417.47288	375.45489
## [2383]	351.90704	322.61088	337.79700	350.68376	330.29617	352.61133
## [2389]	332.64342	288.67824	270.93053	286.14114	321.31690	308.61534
## [2395]	283.56307	269.87966	272.24206	273.98513	271.09392	262.24281
## [2401]	265.93587	249.88706	250.58627	267.72618	286.60268	289.77027
## [2407]	287.74969	315.76245	305.20496	282.54551	254.79530	244.63086
## [2413]	242.75418	226.26446	169.01694	167.91690	136.92470	163.43126
## [2419]	174.13435	180.29607	192.63773	155.34096	171.45374	143.89591
## [2425]	160.22844	191.88955	190.60657	178.92735	162.27737	142.19424
## [2431]	206.33003	178.37314	174.25487	147.64733	175.46019	209.19774
## [2437]	219.88480	233.98250	224.16897	197.35648	140.12476	145.51190
## [2443]	182.20165	214.86472	253.88118	270.09480	242.80343	237.13498
## [2449]	268.75479	267.54004	277.68119	260.76959	252.80004	284.60884
## [2455]	324.25644	318.47618	298.19637	276.45422	317.87230	325.03254
## [2461]	308.15098	314.02030	309.74402	314.92292	339.53664	282.23917
## [2467]	271.91818	241.74488	253.38946	226.19240	219.12178	228.37802
## [2473]	221.61536	274.22773	276.95028	281.53351	314.53727	335.67173
## [2479]	337.64404	330.39635	289.75830	326.20353	324.26658	323.15087
## [2485]	328.89370	330.43630	335.36243	334.60605	382.28287	386.34103
## [2491]	398.99611	393.08998	376.67398	369.60579	390.55084	347.86162
## [2497]	315.56326	324.30495	332.31890	286.70860	301.75587	333.76345
## [2503]	317.45897	349.81603	364.82144	376.80191	336.09493	313.94940
## [2509]	361.22985	355.68945	370.11382	436.79254	413.55886	465.00137
## [2515]	448.46621	444.23400	406.83348	411.67940	451.73883	431.85043
## [2521]	434.04686	465.94712	431.71547	336.63315	368.96877	407.30773
## [2527]	425.04835	399.68495	449.88987	484.11488	519.70591	484.50407
## [2533]	495.90517	468.42854	471.89331	481.52546	442.86093	456.70341
## [2539]	455.80338	429.37908	390.67170	364.23694	376.03115	395.49791
## [2545]	385.95556	440.81483	443.01306	466.46473	451.31590	452.91878
## [2551]	439.70030	453.65459	500.16877	543.19751	542.26755	547.47705
## [2557]	564.27125	592.82061	582.41165	605.57495	620.03502	585.32092

## [2563]	586.66011	622.92858	578.01508	570.22331	555.12472	585.81632
## [2569]	569.57235	591.77844	628.17644	629.68936	629.34377	638.15864
## [2575]	624.41987	579.77656	615.19489	631.68755	581.58756	570.63168
## [2581]	567.13827	580.84470	590.10543	576.25412	578.67872	608.23923
## [2587]	593.97430	580.99023	539.80623	558.92128	570.82345	567.72854
## [2593]	576.80971	517.44379	457.63753	421.72802	391.33126	414.47692
## [2599]	461.03338	488.69381	459.49994	487.90998	476.48206	449.19854
## [2605]	485.81045	530.08019	552.00584	551.13409	634.08229	595.08705
## [2611]	579.49074	577.63282	574.75573	616.67112	614.22772	628.99752
## [2617]	683.95836	649.35402	607.14344	606.05531	648.07484	638.62090
## [2623]	630.95709	622.39267	600.22673	530.30442	503.75075	488.19747
## [2629]	489.07706	522.05117	484.93443	400.97695	417.89983	471.92644
## [2635]	444.07152	415.70926	422.29900	454.80044	401.49922	435.71453
## [2641]	466.66998	494.76795	470.79233	485.63297	496.45005	504.98577
## [2647]	486.27592	505.13999	530.46111	524.95537	521.06318	512.49137
## [2653]	514.35114	567.30245	586.51852	556.86660	548.10685	573.58167
## [2659]	552.90126	526.38836	508.66834	501.54984	529.12922	506.78496
## [2665]	457.33485	464.45078	543.22198	566.14606	550.64806	581.57930
## [2671]	541.47264	485.27656	502.64296	470.79501	489.45687	491.12632
## [2677]	555.61544	574.68303	599.58913	613.08601	631.10602	592.20268
## [2683]	627.34077	647.36998	664.31872	684.31551	681.08813	658.12500
## [2689]	673.33743	633.88650	586.45225	576.04340	594.00004	594.38641
## [2695]	582.40090	536.47942	566.87110	572.97523	537.80289	530.40118
## [2701]	527.72331	493.44556	536.54641	549.25799	565.11743	597.31868
## [2707]	567.73927	584.64545	624.15647	587.38662	605.95093	618.38042
## [2713]	584.34809	544.40017	549.92120	536.48700	507.96669	496.90877
## [2719]	452.28380	403.93301	417.55471	437.14492	407.21515	440.95887
## [2725]	503.21728	533.53705	518.74867	516.06366	449.70189	442.07911
## [2731]	505.31992	481.18517	492.53188	472.15394	466.78089	476.33392
## [2737]	458.53807	499.88059	473.37854	493.99540	514.49245	547.54443
## [2743]	546.31952	571.62106	560.84434	515.71889	520.57559	483.97999
## [2749]	465.57598	478.16571	487.94047	513.68045	532.92660	541.24872
## [2755]	519.94232	533.48157	524.98205	505.81904	551.32906	562.46951
## [2761]	610.87585	649.89374	598.14983	545.55486	589.39633	569.58212
## [2767]	569.06001	537.66702	490.02546	494.34982	496.97274	495.21441
## [2773]	528.95207	485.72472	460.88320	454.73884	451.09094	489.16172
## [2779]	493.34323	480.45679	445.60151	517.83222	613.74225	570.75315
## [2785]	534.38173	490.44324	598.42544	567.05456	559.73378	619.19013
## [2791]	623.82793	692.97609	688.86808	690.18850	678.30646	683.42828
## [2797]	741.53261	715.44296	718.73358	711.53869	759.11096	773.87496
## [2803]	772.91244	732.65448	730.51691	711.99358	687.21904	671.25904
## [2809]	685.70307	758.01880	720.41489	703.72223	746.02444	775.00185
## [2815]	734.76911	741.67994	722.77222	718.41420	713.74090	686.11563
## [2821]	677.13706	649.43806	704.78067	734.02244	700.92304	692.90343
## [2827]	721.57642	697.00230	688.80560	701.08518	701.22148	742.01824
## [2833]	704.52551	709.57255	723.19392	697.69321	743.28628	792.47446
## [2839]	749.65034	770.57447	768.41426	789.30769	793.62458	804.21694
## [2845]	789.60368	801.35728	777.06076	751.66551	734.68041	749.58010
## [2851]	756.67096	768.92990	760.12729	737.33588	748.62689	758.40854
## [2857]	780.17974	786.69030	801.09705	761.15697	842.10809	814.17980
## [2863]	753.49188	766.09329	747.38135	714.78642	698.17761	701.65689
## [2869]	689.19453	718.30414	717.36863	694.06070	686.26758	678.41004
## [2875]	628.38739	621.86300	613.01406	634.39638	630.18854	629.67561
## [2881]	595.17421	607.75480	647.57055	697.04281	694.49470	685.27625



##	[2887]	677.12279	670.97027	650.96892	673.85064	720.46233	727.99319
##	[2893]	781.40359	784.35259	795.11562	799.74643	776.60982	744.27077
##	[2899]	787.93350	754.82767	745.52806	758.07306	721.35481	721.36727
##	[2905]	690.12722	687.59782	701.00519	696.82117	676.67123	682.68343
##	[2911]	693.50369	722.24517	700.16521	726.62468	734.50790	740.36299
##	[2917]	775.35467	806.33657	813.61081	829.38058	842.42484	876.59986
##	[2923]	862.90081	901.54495	919.47121	901.68037	908.70403	865.80550
##	[2929]	856.30878	814.36656	805.44589	763.62215	737.86283	737.43229
##	[2935]	703.68608	654.60775	609.72497	615.48118	540.58090	572.77199
##	[2941]	530.52098	545.11654	536.58781	549.10175	615.50794	619.95322
##	[2947]	599.99593	588.18536	583.58982	594.28493	555.25978	492.55830
##	[2953]	474.94095	527.34057	477.23593	469.90980	492.53322	507.64006
##	[2959]	512.08062	551.72657	538.25380	536.37100	514.82533	457.33699
##	[2965]	450.59375	435.38664	433.24866	435.15007	430.54524	434.17395
##	[2971]	466.74777	457.03916	441.70414	456.88010	479.28404	498.86903
##	[2977]	514.76968	480.78438	502.74595	451.52943	414.04400	426.46630
##	[2983]	480.55788	504.92024	527.92115	576.69329	537.75897	587.57296
##	[2989]	561.65426	546.18527	586.41493	569.86377	549.55943	583.42553
##	[2995]	588.13596	616.71695	662.84974	696.26729	751.33609	716.79940
##	[3001]	674.96941	679.28217	687.70719	679.92114	719.53137	726.13292
##	[3007]	718.91787	721.13264	685.49104	708.43711	691.56041	662.53105
##	[3013]	676.19067	719.50711	738.83752	758.78350	733.79855	790.66591
##	[3019]	769.16291	800.13572	785.63919	773.10255	755.33440	779.59375
##	[3025]	745.53761	748.14769	688.19715	708.84311	648.25384	660.48455
##	[3031]	668.87414	683.70012	697.53582	672.42313	656.13981	635.09959
##	[3037]	645.62169	643.84064	635.65678	642.72482	633.10183	658.80928
##	[3043]	699.72884	706.31929	728.49226	744.67668	721.22579	730.98379
##	[3049]	712.34447	716.54639	738.03947	798.44640	790.83303	782.05395
##	[3055]	716.04238	698.36801	700.20328	621.55390	643.67405	638.58389
##	[3061]	620.73768	639.29797	678.58326	735.91061	724.20637	716.83535
##	[3067]	723.93761	689.41368	705.27934	689.05720	648.96389	605.92044
##	[3073]	561.19205	569.74614	593.43278	586.51631	578.56595	607.34672
##	[3079]	617.97051	612.22418	598.88330	639.61079	607.23143	648.84389
##	[3085]	629.51827	612.89454	619.72267	628.55622	606.04059	636.72629
##	[3091]	685.80024	685.36668	678.66875	714.35147	759.46055	751.68189
##	[3097]	750.32351	690.58690	693.11199	687.47291	706.42696	700.95816
##	[3103]	731.77936	696.67054	667.38810	664.98049	656.99409	670.74818
##	[3109]	651.00982	655.50283	641.76127	618.44929	569.28069	547.54749
##	[3115]	529.83930	569.60848	566.86576	540.60642	552.95494	527.49246
##	[3121]	536.03798	524.23038	518.51795	524.53439	516.54471	559.84412
##	[3127]	530.92304	486.31903	469.21545	518.58613	490.66213	493.07921
##	[3133]	510.29528	486.92014	512.61550	613.05629	621.75848	673.45512
##	[3139]	686.25959	679.23464	642.68551	637.64772	652.60886	648.75984
##	[3145]	653.30739	656.46091	709.89736	669.04410	666.49230	626.36567
##	[3151]	572.58889	590.65044	598.32366	689.02091	652.81106	669.83349
##	[3157]	721.63085	734.95951	729.47832	698.27878	733.88569	731.53369
##	[3163]	729.34849	743.91363	757.35461	758.55726	753.35445	733.76846
##	[3169]	749.60695	755.96876	704.18603	681.92503	693.38687	658.04625
##	[3175]	676.38321	672.60550	669.75064	665.37815	645.89691	614.44403
##	[3181]	648.64523	682.33091	686.31465	726.54121	695.10550	725.94981
##	[3187]	722.60894	741.77923	750.08121	748.24713	755.99096	741.17867
##	[3193]	744.82368	755.58169	786.16939	840.33670	836.24650	842.37248
##	[3199]	837.81407	819.23912	819.59092	867.84034	900.57226	880.02634
##	[3205]	870.38516	879.93839	878.65931	865.77082	869.56824	883.46556

##	[3211]	932.61387	936.10359	941.58909	940.89703	966.20085	983.01882
##	[3217]	1017.60036	996.96628	1023.94640	1026.21441	954.95118	954.49179
##	[3223]	929.75596	919.37122	941.08014	948.10723	960.13390	981.44601
##	[3229]	950.09512	900.50992	892.45784	899.16379	897.23545	843.80447
##	[3235]	849.18308	830.48127	856.49298	812.22712	808.92244	882.05215
##	[3241]	894.65445	843.17398	820.71915	854.73460	854.58994	841.82245
##	[3247]	814.59614	837.90459	877.90568	842.88570	825.65836	815.49556
##	[3253]	857.09547	850.87344	822.06176	858.41797	822.47701	875.58961
##	[3259]	870.65120	845.62709	847.98779	895.67138	897.27227	874.45011
##	[3265]	934.03599	905.15115	910.39748	874.76136	912.60851	955.26003
##	[3271]	950.55136	962.21456	999.37378	978.06165	985.74348	1015.14273
##	[3277]	1073.53553	1096.44938	1138.49477	1110.71891	1106.03598	1118.77787
##	[3283]	1144.07903	1161.86082	1178.33558	1196.50967	1179.37204	1186.16002
##	[3289]	1197.27087	1165.09273	1148.59193	1110.30945	1123.17348	1156.07404
##	[3295]	1156.73718	1150.74631	1116.27032	1065.04832	1025.46795	1017.79863
##	[3301]	1009.42521	1074.28209	1067.67490	1085.87166	1045.02591	1051.75250
##	[3307]	1066.69778	1106.66545	1127.92287	1183.08885	1171.41827	1216.83843
##	[3313]	1253.33367	1269.29082	1254.46276	1261.80878	1298.01021	1299.27146
##	[3319]	1275.08686	1285.44069	1278.28157	1275.61715	1295.42682	1341.05300
##	[3325]	1349.27229	1371.87823	1382.55743	1389.90501	1432.66835	1431.43641
##	[3331]	1447.37231	1533.83803	1531.90022	1486.65482	1485.78315	1460.55358
##	[3337]	1457.81440	1502.37740	1475.47844	1453.24298	1452.51593	1457.49354
##	[3343]	1486.56498	1551.25627	1546.93154	1551.17433	1532.99317	1562.13411
##	[3349]	1575.67385	1550.03974	1569.95154	1561.40544	1568.91185	1578.86562
##	[3355]	1587.35813	1595.24530	1568.64639	1611.21581	1600.45035	1626.52074
##	[3361]	1664.21865	1637.90987	1655.91208	1563.62786	1551.70251	1508.10720
##	[3367]	1476.03628	1503.38038	1508.56307	1509.34462	1533.10876	1548.58603
##	[3373]	1499.73367	1472.18084	1454.34910	1445.28847	1439.59826	1425.90515
##	[3379]	1443.77770	1479.15229	1419.11957	1392.23030	1378.46178	1332.27039
##	[3385]	1322.85331	1319.50691	1323.08245	1321.34996	1291.03861	1279.43831
##	[3391]	1324.21784	1305.19579	1324.28324	1363.83373	1359.27998	1356.71655
##	[3397]	1353.64917	1354.92069	1373.91018	1349.84897	1366.03814	1408.59539
##	[3403]	1389.48787	1352.46773	1368.52112	1399.54793	1338.62469	1346.98264
##	[3409]	1363.27128	1364.15223	1356.40515	1391.86264	1383.02582	1369.31323
##	[3415]	1366.68093	1442.61792	1445.88655	1410.03221	1405.64251	1422.02304
##	[3421]	1398.04172	1396.64766	1346.42244	1345.66563	1288.52691	1319.25582
##	[3427]	1299.70508	1345.76631	1369.17161	1383.90372	1370.89589	1383.30133
##	[3433]	1356.44709	1371.22203	1381.19987	1380.03504	1313.26994	1351.81229
##	[3439]	1335.78172	1349.98024	1365.48027	1356.93285	1403.87791	1350.97425
##	[3445]	1326.30665	1300.70648	1354.78145	1344.11826	1320.65854	1271.47113
##	[3451]	1292.65418	1348.12206	1348.10924	1362.31931	1360.70940	1369.83587
##	[3457]	1367.51242	1377.13487	1358.39093	1320.83007	1305.35268	1298.03899
##	[3463]	1278.64686	1278.49962	1328.32845	1339.91307	1331.30923	1310.68700
##	[3469]	1354.84709	1331.58933	1344.65408	1331.10928	1353.37994	1307.15369
##	[3475]	1326.54324	1347.00673	1326.59604	1323.47223	1336.21783	1306.47211
##	[3481]	1330.70255	1329.38228	1339.38199	1285.34831	1319.50753	1340.56367
##	[3487]	1434.92952	1519.42553	1525.55993	1581.09132	1573.95312	1558.98780
##	[3493]	1566.75325	1528.09993	1531.48946	1557.35674	1544.27966	1560.04994
##	[3499]	1563.67255	1605.28382	1534.01331	1567.08911	1577.65401	1593.61663
##	[3505]	1547.14722	1542.58828	1528.41399	1532.02765	1553.91192	1533.37215
##	[3511]	1512.57133	1507.78810	1509.38977	1529.87239	1536.93740	1525.45308
##	[3517]	1562.74370	1569.43792	1536.70880	1546.38640	1585.41845	1626.84088
##	[3523]	1623.70249	1684.27451	1642.56008	1629.62605	1615.25989	1576.72184
##	[3529]	1572.31469	1562.64274	1562.10251	1601.71402	1597.97755	1627.02718

##	[3535]	1665.10290	1654.49209	1614.32688	1637.37680	1646.91543	1631.56140
##	[3541]	1604.16241	1615.32845	1630.70021	1572.45464	1582.50279	1601.38589
##	[3547]	1601.60352	1578.33425	1548.63728	1603.50173	1641.40771	1656.54609
##	[3553]	1633.94583	1656.06247	1672.08799	1617.86880	1655.91848	1662.86416
##	[3559]	1687.05749	1647.67589	1693.81203	1690.65022	1667.59463	1666.42525
##	[3565]	1711.66091	1730.03713	1705.66891	1735.64648	1708.38365	1664.41911
##	[3571]	1691.42712	1609.06753	1544.82285	1548.30689	1521.01375	1547.23185
##	[3577]	1490.93817	1485.14993	1507.21270	1490.30532	1540.83470	1569.21367
##	[3583]	1574.76377	1581.74986	1567.23333	1577.39547	1579.86446	1589.08735
##	[3589]	1576.21634	1577.96757	1610.24599	1648.76867	1683.64692	1684.06415
##	[3595]	1678.26518	1709.90423	1634.96882	1625.32829	1659.45319	1606.99519
##	[3601]	1644.89724	1582.85806	1562.43712	1617.44765	1627.08934	1652.10117
##	[3607]	1661.77751	1601.93030	1570.82268	1575.33885	1573.04899	1558.94707
##	[3613]	1560.16739	1538.51848	1540.31964	1518.28177	1541.70196	1534.62907
##	[3619]	1533.25383	1558.35157	1525.64855	1526.71894	1530.12840	1528.80136
##	[3625]	1519.03637	1517.63830	1500.24476	1562.88986	1555.23311	1533.55941
##	[3631]	1496.84924	1542.53858	1558.36810	1596.90660	1585.46453	1613.43916
##	[3637]	1622.16270	1584.40436	1617.72433	1594.87208	1578.92580	1594.01935
##	[3643]	1518.99973	1548.23731	1525.22967	1526.01614	1506.87945	1522.62925
##	[3649]	1501.29176	1490.65594	1465.73311	1521.20753	1505.94747	1487.17380
##	[3655]	1463.92607	1478.49736	1487.33043	1473.63361	1424.41774	1435.36846
##	[3661]	1436.82921	1469.39656	1438.73469	1448.31404	1434.59190	1438.16326
##	[3667]	1475.74702	1447.81165	1461.69564	1419.21879	1374.85759	1375.93890
##	[3673]	1395.11930	1375.18863	1373.86710	1366.53150	1342.19917	1361.20916
##	[3679]	1366.98954	1332.12111	1340.69189	1375.80361	1354.67775	1325.33068
##	[3685]	1328.04522	1288.55363	1303.71372	1272.00314	1238.64018	1244.55443
##	[3691]	1245.09614	1235.11320	1196.85728	1167.22493	1177.81487	1174.73822
##	[3697]	1137.46213	1123.65258	1094.49329	1118.39990	1133.96031	1162.88583
##	[3703]	1179.77708	1205.75203	1165.45483	1155.91957	1084.31401	1059.13372
##	[3709]	1026.57384	1019.34159	984.54766	960.10454	966.77103	978.93319
##	[3715]	974.56161	929.47835	902.08156	856.92542	832.44979	826.08375
##	[3721]	840.47347	831.75175	843.28114	797.72439	822.22986	837.55415
##	[3727]	820.27135	850.48676	841.17020	822.36157	801.23967	802.26471
##	[3733]	833.42860	819.69210	826.50639	814.44303	842.26359	869.50722
##	[3739]	886.55538	907.81764	901.76992	951.76606	962.35952	966.01007
##	[3745]	945.31584	939.09019	930.24550	960.73368	953.68312	959.08007
##	[3751]	953.44801	913.34912	921.70862	928.89794	950.85200	952.92145
##	[3757]	931.98032	915.76437	880.66276	877.19836	857.83984	870.61584
##	[3763]	848.28647	829.38562	878.85176	886.58039	881.63683	917.10311
##	[3769]	961.76306	929.49717	896.47846	876.10205	859.52431	859.87682
##	[3775]	879.14279	814.27974	819.30322	814.23564	869.08201	877.80535
##	[3781]	883.25931	810.37378	789.84499	752.96274	717.61937	740.55416
##	[3787]	716.57019	687.57192	710.37568	733.94446	796.49537	813.85601
##	[3793]	814.59023	782.92600	807.63538	850.73327	861.82810	801.51988
##	[3799]	814.30505	827.84652	813.50506	797.78952	836.26327	869.11785
##	[3805]	856.67793	862.93450	856.41080	914.20705	943.69199	943.35727
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##	[3829]	882.06408	837.48856	868.89634	878.06187	918.91288	892.00644
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##	[3841]	692.39953	676.30292	647.26303	591.02265	550.80014	571.56581
##	[3847]	575.55360	612.09452	632.63400	622.29158	624.99517	628.18457
##	[3853]	609.53023	608.16568	587.62104	649.05631	674.09066	674.49527

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```

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interval = 1000
ans <- MCMC(8, 4, ntrace, interval)
ans
```

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## [67] 432.3766 396.7855 424.5300 451.6323 441.1280 495.7982
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##	[91]	548.7186	565.5953	532.7073	518.5571	482.7904	466.2623
##	[97]	477.6819	489.9205	489.5779	459.8116	436.2046	410.4587
##	[103]	410.1025	346.6940	336.5285	399.5623	405.1509	349.2954
##	[109]	359.8616	366.7217	364.2001	400.6898	414.4838	456.4569
##	[115]	481.5474	507.6173	533.0708	531.4700	543.9720	531.0726
##	[121]	527.3919	561.4819	510.2248	560.2503	567.0079	607.5488
##	[127]	699.5479	740.8415	765.8191	742.8856	750.9777	766.9977
##	[133]	783.3364	798.0518	820.4977	817.5571	807.7717	821.3692
##	[139]	792.8156	873.7454	899.5801	836.1034	899.0795	855.1239
##	[145]	902.8327	910.5678	920.2291	931.9359	873.6724	868.9131
##	[151]	813.9104	780.8643	751.7913	729.6738	762.7783	768.7492
##	[157]	747.0722	774.6733	741.3664	774.5296	787.6065	732.8594
##	[163]	739.8754	706.4312	746.4686	779.6144	753.4771	775.9708
##	[169]	723.1205	750.8460	723.5475	754.8930	783.0489	802.0310
##	[175]	782.3649	825.3499	795.5768	770.7806	772.0588	732.0099
##	[181]	717.6626	754.5982	764.5033	778.5559	780.3715	810.0885
##	[187]	786.5872	754.3382	734.8258	749.1607	741.6514	700.3823
##	[193]	693.9178	655.3534	658.5843	641.1898	638.0576	647.3868
##	[199]	702.2128	655.6066	646.9790	668.1158	664.1596	660.0079
##	[205]	673.1464	697.1862	703.3335	744.7006	756.9651	746.4955
##	[211]	713.2274	650.8200	679.8624	726.1823	697.8346	634.9612
##	[217]	618.6895	592.2221	590.2737	582.8249	583.6978	638.7979
##	[223]	664.4636	663.2388	660.2450	614.1866	616.4117	645.0285
##	[229]	661.2351	632.7814	673.1406	661.5494	684.0664	671.8290
##	[235]	654.5213	633.9285	631.8532	624.9830	623.3471	633.7899
##	[241]	610.6278	580.2578	632.8951	646.6928	717.9187	754.3157
##	[247]	774.8495	808.6698	809.9137	827.7690	822.6382	854.9970
##	[253]	883.8924	859.7445	891.4303	890.8431	887.8631	850.9805
##	[259]	816.7112	792.7972	811.6727	838.5443	809.6494	849.6873
##	[265]	821.0669	838.8353	835.2129	812.3896	850.9264	836.8084
##	[271]	844.4261	848.4092	848.6036	802.1942	835.3229	854.2895
##	[277]	853.3966	828.4128	860.5345	872.7970	864.1013	868.5775
##	[283]	849.1844	872.9538	863.0918	828.1860	846.9275	855.2996
##	[289]	889.4688	861.6663	870.9168	929.5619	901.0784	932.0142
##	[295]	918.5980	880.9234	835.1135	813.7437	808.0448	748.5261
##	[301]	684.7680	686.7683	674.5435	682.8453	695.7559	699.4185
##	[307]	719.7107	712.1794	685.0675	670.1941	655.7700	646.6110
##	[313]	599.2286	603.8404	617.9751	584.6802	579.9351	545.9289
##	[319]	569.9417	610.6293	684.3399	691.4579	680.8177	686.9428
##	[325]	716.9523	746.1396	767.6731	727.9800	749.2577	718.7352
##	[331]	710.3896	746.4618	768.9097	743.9469	760.1251	827.0646
##	[337]	888.2193	885.5925	920.5113	924.7565	944.4889	983.6751
##	[343]	988.5297	1011.0692	996.6612	952.5417	964.1190	1013.0804
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## [1633] 874.9507 875.8700 876.0717 882.1197 924.5166 913.0721
## [1639] 905.4613 913.7536 930.6705 956.7453 1012.1394 1007.9781
## [1645] 1053.9984 1059.1529 1033.5066 1032.8631 1027.0882 992.3222
## [1651] 998.7878 957.9371 959.7256 1024.8205 1056.8950 1115.2153
## [1657] 1147.4235 1148.0272 1185.4192 1167.0513 1170.7213 1147.8018
## [1663] 1133.6558 1122.7959 1170.4799 1230.9251 1232.1840 1266.4659
## [1669] 1289.5564 1299.0683 1313.7060 1312.6748 1317.8220 1309.9882
## [1675] 1288.0289 1313.4148 1317.6817 1305.8985 1330.5214 1296.0559
## [1681] 1289.3774 1265.9006 1250.9774 1257.3426 1236.3757 1229.0029
## [1687] 1257.3115 1275.1380 1272.0528 1278.7869 1281.3422 1250.3445
## [1693] 1238.9211 1151.3256 1125.1612 1124.6048 1105.0970 1079.6364
## [1699] 1050.9602 1095.3245 1078.3526 1088.3219 1087.2517 1094.3618
## [1705] 1108.5182 1130.4499 1167.7098 1153.1127 1143.9583 1137.8513

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##	[1711]	1139.3241	1179.1149	1181.8071	1203.9657	1206.6131	1151.9541
##	[1717]	1180.0115	1191.1154	1163.4856	1113.2237	1127.5829	1158.5746
##	[1723]	1161.9812	1185.4015	1147.3250	1169.9519	1171.4084	1156.6813
##	[1729]	1154.4939	1183.6146	1215.3178	1185.0259	1179.5464	1195.2910
##	[1735]	1118.1234	1076.5944	1086.1099	1107.7699	1122.7253	1140.7105
##	[1741]	1165.6361	1134.6016	1112.4329	1116.3765	1129.0420	1136.7168
##	[1747]	1140.7651	1140.8429	1143.0145	1157.1491	1134.3078	1113.2073
##	[1753]	1091.1241	1116.3056	1009.6722	976.0493	1009.8378	967.7881
##	[1759]	945.7077	981.9652	1004.9504	1032.4615	1029.6203	1035.8884
##	[1765]	1034.5697	1069.1016	1099.2124	1073.3727	1059.0355	1056.4129
##	[1771]	1068.2930	1054.5126	1077.7593	1015.3242	966.3372	950.5092
##	[1777]	1015.3192	1019.8122	1039.8534	1036.9108	1035.4238	995.4777
##	[1783]	963.8459	954.0176	969.9193	952.5864	967.2891	924.8909
##	[1789]	967.1466	960.7323	977.4954	953.7601	927.2385	912.8713
##	[1795]	928.2818	924.6343	920.0003	923.0319	985.8735	984.5003
##	[1801]	954.4048	990.8345	1013.2912	1004.4657	1012.2459	970.1382
##	[1807]	937.1123	967.5037	943.8622	981.7835	978.6169	1019.4912
##	[1813]	995.9631	1005.7564	996.7230	980.4038	958.3278	947.2489
##	[1819]	980.2173	978.4262	1009.5715	1017.7429	1020.0271	1032.3704
##	[1825]	1088.2704	1067.9635	1064.1061	1076.5984	1058.7752	1034.0462
##	[1831]	1077.3504	1066.7730	1058.5669	1059.4722	1044.4030	1029.2315
##	[1837]	1031.9186	997.0682	1008.5585	1027.7459	1020.9453	1018.7313
##	[1843]	1057.5115	1071.8562	1106.0796	1080.9220	994.8705	989.3086
##	[1849]	964.8660	977.6422	966.7931	980.1530	988.1202	977.4145
##	[1855]	966.5388	959.5129	959.5847	982.8703	976.4197	964.5885
##	[1861]	967.3457	991.2560	979.8702	935.1257	907.7584	862.6100
##	[1867]	865.5506	818.9157	841.5106	867.9295	864.0471	853.9309
##	[1873]	840.7125	896.0348	918.2651	842.6689	862.9215	866.9721
##	[1879]	896.0965	875.2435	877.9984	871.3902	871.7925	891.3589
##	[1885]	904.4726	929.1010	983.2948	963.5153	968.8704	952.4270
##	[1891]	893.5507	939.3307	922.3792	839.9958	849.8662	886.7772
##	[1897]	907.7347	883.5436	939.8804	997.5076	1006.7087	1037.2144
##	[1903]	971.7726	1029.1049	1038.6149	1002.5078	1003.6411	998.5852
##	[1909]	1023.6513	1012.0865	1000.8209	947.1474	997.6973	1008.7209
##	[1915]	1020.8242	1019.2226	1091.2597	1076.9514	1041.4743	1046.7955
##	[1921]	1075.0843	1013.9328	983.4508	1007.6734	1033.4719	1090.4131
##	[1927]	1093.5100	1116.0803	1055.4885	1049.2831	1033.5312	1085.0304
##	[1933]	1129.3694	1100.7350	1117.3190	1104.3973	1063.4412	1045.5689
##	[1939]	1036.2422	991.6337	941.4174	973.7580	957.6901	963.0174
##	[1945]	997.4937	992.5126	1018.2568	1050.4682	1025.3371	1028.2043
##	[1951]	1041.9705	1038.6993	1019.8635	991.7475	1042.4184	1054.2541
##	[1957]	1053.2113	1049.5630	1067.8088	997.9458	1008.7335	1022.5938
##	[1963]	963.8268	994.6759	1032.4601	1028.5662	1001.0343	950.6005
##	[1969]	944.7991	959.8003	992.1386	1000.9594	973.4873	983.7830
##	[1975]	972.6962	923.5881	924.1904	921.0494	894.0213	888.8173
##	[1981]	877.5821	937.8748	957.8106	936.5999	904.1729	909.3703
##	[1987]	903.1977	926.1035	911.3271	944.0102	938.7793	924.8978
##	[1993]	945.0354	955.7824	932.4254	937.5567	946.3022	930.1989
##	[1999]	941.2356	918.4610	911.2490	860.3908	832.0311	821.0168
##	[2005]	841.3177	842.7073	880.6336	904.9994	887.3140	925.1310
##	[2011]	899.8926	882.7805	872.9191	847.4500	847.9964	891.0279
##	[2017]	928.9682	917.4430	892.6936	881.3799	873.7431	875.1378
##	[2023]	831.5776	822.2682	840.9837	822.1206	857.9513	840.3671
##	[2029]	806.5880	841.9628	851.0547	849.8763	849.5347	865.4041

##	[2035]	828.3815	868.1968	866.0039	849.3993	826.7189	846.8959
##	[2041]	849.1024	907.0078	897.2937	906.6894	970.8411	962.5411
##	[2047]	933.1211	924.7396	879.5185	916.8222	935.1761	886.6590
##	[2053]	857.3029	855.1916	877.2932	861.0834	840.7147	869.3787
##	[2059]	909.7639	890.8183	856.4805	850.2759	830.8840	815.7815
##	[2065]	810.3080	794.5795	815.5589	793.1184	800.0711	829.9008
##	[2071]	809.2494	809.2532	780.0565	797.3357	760.5230	755.0696
##	[2077]	843.7653	848.2937	871.3928	878.0793	826.2282	777.3499
##	[2083]	789.6419	756.4975	726.5473	793.6153	792.7551	818.3035
##	[2089]	767.3761	781.4009	766.3824	786.5765	809.1078	830.2205
##	[2095]	786.5942	770.1575	719.4965	737.2435	788.4797	843.7834
##	[2101]	862.9523	812.5257	805.2601	823.8978	822.7226	876.7840
##	[2107]	908.4653	923.1463	889.6035	843.3574	802.0987	819.1545
##	[2113]	809.8759	807.2251	806.0304	864.1793	856.1328	896.5277
##	[2119]	918.2058	943.0473	918.7842	949.4529	929.6829	977.2688
##	[2125]	978.1089	1023.1245	1020.0860	1042.6356	1041.3007	1045.8652
##	[2131]	1020.9208	997.0306	965.8228	947.2579	938.9690	923.2802
##	[2137]	906.2626	901.0053	848.7038	848.7926	858.5538	886.8847
##	[2143]	887.4362	919.8990	945.2925	913.8713	898.4944	905.0420
##	[2149]	900.6477	887.7759	919.8974	914.0857	903.7892	876.3575
##	[2155]	869.3707	888.4103	914.6389	915.4838	892.6974	886.7891
##	[2161]	916.9464	915.5714	913.8052	926.4281	944.7585	926.6220
##	[2167]	916.1283	906.4229	922.4864	926.0209	931.7844	920.7730
##	[2173]	923.5073	973.1870	914.7620	919.2554	920.6682	940.0936
##	[2179]	909.5180	880.5782	877.7214	883.3708	878.2133	879.5892
##	[2185]	851.1233	849.4102	898.5761	886.3330	909.9668	865.5819
##	[2191]	832.6086	837.6914	825.0900	860.9083	866.6667	870.2564
##	[2197]	887.5095	887.2343	930.3090	880.2613	847.0324	848.7235
##	[2203]	842.4494	825.3930	907.8602	886.0876	844.3381	825.7930
##	[2209]	807.6830	785.2361	819.3017	824.7566	831.9863	837.9598
##	[2215]	876.3177	863.6358	876.3070	827.7577	838.7812	814.3160
##	[2221]	830.7509	883.0648	917.8020	926.4382	920.8555	971.6190
##	[2227]	967.3189	1023.6268	1035.0987	1059.8448	1076.7995	1080.1359
##	[2233]	1081.4193	1072.6355	1065.7875	1028.1960	1048.2162	1073.4249
##	[2239]	1053.1429	988.5608	981.6331	1030.9506	1109.8838	1100.2138
##	[2245]	1070.0696	1105.5829	1139.2901	1065.3364	1093.2444	1087.8440
##	[2251]	1113.5040	1115.7693	1114.8222	1068.9935	1083.2697	1104.1922
##	[2257]	1114.1862	1103.2011	1091.4895	1101.4936	1126.7858	1109.6983
##	[2263]	1086.5505	1077.9789	1094.7971	1092.4410	1042.1208	1058.3378
##	[2269]	1032.1523	1009.3735	1067.1561	1063.8737	1076.5680	1025.7974
##	[2275]	1003.2083	1014.8409	1017.3443	1000.2774	1008.0283	1029.4007
##	[2281]	1041.5390	1083.7411	1118.9691	1091.5537	1062.7711	1011.2956
##	[2287]	1029.8092	1024.6597	1073.8308	1043.1018	1068.5955	1101.4311
##	[2293]	1074.6030	1044.4270	1012.0692	986.6511	973.1554	938.1179
##	[2299]	976.8081	989.9968	988.3249	992.7183	1014.4556	1037.5750
##	[2305]	1023.3410	1049.3212	1063.2589	1077.6513	1053.9174	1046.0949
##	[2311]	1019.3197	1016.0576	1021.4428	998.7435	1041.3778	1036.3199
##	[2317]	1021.9217	1020.0502	993.5152	961.2705	922.4881	898.1588
##	[2323]	887.3754	894.8708	898.4542	931.9134	957.6927	1027.1646
##	[2329]	1097.7053	1153.2212	1160.3797	1194.6980	1214.9080	1207.8639
##	[2335]	1229.1382	1195.1893	1155.8005	1152.8104	1168.1258	1248.7809
##	[2341]	1262.6454	1221.2637	1181.5925	1195.8302	1141.4635	1131.9876
##	[2347]	1121.8430	1113.9209	1110.8900	1082.7472	1095.6039	1120.1789
##	[2353]	1118.5950	1117.4906	1120.1086	1137.7761	1144.8651	1108.2244

##	[2359]	1139.1768	1129.7561	1126.5757	1145.0290	1103.0241	1141.6087
##	[2365]	1117.4954	1108.6688	1073.9767	1062.2612	1062.5228	1021.4917
##	[2371]	1028.9734	1028.1738	1001.5216	946.4672	941.1169	980.0120
##	[2377]	1001.8135	1028.4838	1006.7829	986.8645	965.7196	979.3543
##	[2383]	953.9434	988.1403	973.7089	1019.0366	989.5672	986.2023
##	[2389]	968.8438	859.5555	839.7922	823.9925	845.7342	881.7876
##	[2395]	910.0594	882.4846	885.8631	929.1501	940.0029	962.0514
##	[2401]	951.8978	926.6925	927.5683	890.7567	870.4181	874.5921
##	[2407]	893.4831	945.3523	950.8641	938.3634	947.9564	951.8090
##	[2413]	947.6523	960.8931	910.3327	870.3324	835.5130	831.9529
##	[2419]	799.6319	847.1156	825.2212	787.2631	804.9928	843.6333
##	[2425]	826.7115	837.1048	841.7463	829.1458	832.4069	869.6828
##	[2431]	894.7109	897.5637	922.6757	916.6756	934.6917	968.4329
##	[2437]	980.0529	986.6506	960.9415	979.1571	969.9540	963.9587
##	[2443]	934.9795	927.8552	947.9535	921.1610	914.1073	910.6207
##	[2449]	868.8013	782.4440	770.9311	751.3064	769.6408	778.7086
##	[2455]	793.9783	808.5376	800.0721	770.9694	758.5447	764.7659
##	[2461]	767.3653	746.8767	734.4201	759.9684	772.5922	753.7751
##	[2467]	757.7201	775.9460	793.3746	786.5591	792.8415	794.8125
##	[2473]	751.3259	785.0909	797.2401	704.2869	688.5076	671.1679
##	[2479]	648.0073	674.7707	629.4664	614.6616	597.8619	597.6948
##	[2485]	606.3853	621.2398	577.6295	561.7833	558.4532	548.3938
##	[2491]	526.9613	528.8046	534.6526	508.1758	527.6378	532.4273
##	[2497]	578.2949	602.1284	596.6215	591.9097	606.3286	599.0334
##	[2503]	634.2683	721.3431	684.7869	679.8933	674.9083	691.0497
##	[2509]	699.1318	687.8735	615.8307	661.5874	714.5906	687.2587
##	[2515]	687.9913	663.6324	686.4039	686.2508	711.8756	696.7282
##	[2521]	702.4806	699.0179	685.2077	694.2551	673.2602	703.3101
##	[2527]	714.7395	710.7734	717.1398	686.5591	682.8367	637.2808
##	[2533]	612.3795	583.9978	582.8792	554.0594	511.7917	548.5177
##	[2539]	520.8080	543.8364	518.7214	550.7164	504.1640	526.1087
##	[2545]	575.0255	595.7407	582.9068	559.6260	568.7624	581.6265
##	[2551]	568.4502	564.3164	562.4376	543.4376	562.8927	535.6053
##	[2557]	526.3793	567.9149	517.1937	547.5240	552.1895	525.6939
##	[2563]	501.5288	538.6070	495.9982	461.6487	435.6548	472.7790
##	[2569]	468.3098	477.4907	495.4581	498.3299	536.6188	505.8137
##	[2575]	541.3436	524.7234	550.8741	575.4507	562.7896	564.0126
##	[2581]	574.1192	608.7904	648.9209	617.9484	651.4275	653.8963
##	[2587]	637.2181	660.0992	678.4016	728.6130	741.9826	759.9480
##	[2593]	725.5180	646.3992	655.9617	669.1013	709.7957	714.3403
##	[2599]	710.7523	732.8878	718.1246	713.4053	708.8630	760.2516
##	[2605]	762.2548	838.7266	856.9395	892.9180	894.0260	863.8378
##	[2611]	868.2224	894.3214	878.8788	859.5283	869.8360	857.9009
##	[2617]	878.1502	822.1515	843.5047	893.8814	906.4455	936.8942
##	[2623]	967.6008	956.3648	954.7901	977.5171	981.8725	987.7169
##	[2629]	973.4346	990.6644	982.2442	979.5785	1003.5115	972.5679
##	[2635]	958.6587	959.9440	922.3578	892.0645	839.9445	849.8603
##	[2641]	860.9168	856.8282	828.8202	760.2989	781.1761	790.1140
##	[2647]	768.6662	856.4705	844.1269	824.2655	848.7147	865.5767
##	[2653]	883.2727	888.2055	905.8567	901.0139	876.6125	883.1681
##	[2659]	900.1161	927.7704	913.5094	890.8942	875.3824	935.4004
##	[2665]	940.2778	960.5448	973.1945	1020.6778	1028.5916	1032.5719
##	[2671]	1068.4189	1091.6009	1072.2271	1076.6724	1083.6311	1094.7750
##	[2677]	1140.0165	1092.7423	1104.2226	1143.9730	1143.2396	1140.8518

##	[2683]	1135.0435	1144.0505	1143.4849	1119.9455	1166.3549	1234.5104
##	[2689]	1227.8437	1180.5233	1173.7358	1201.7650	1154.1347	1164.0372
##	[2695]	1204.0131	1214.1995	1205.4049	1207.8911	1219.9308	1230.0220
##	[2701]	1257.8995	1292.0788	1263.3694	1236.1974	1234.9418	1270.4961
##	[2707]	1242.3228	1259.8662	1261.1311	1241.6675	1211.3754	1232.6396
##	[2713]	1257.7710	1303.0181	1297.2615	1263.2038	1258.6990	1269.2177
##	[2719]	1311.6397	1301.3519	1257.7111	1287.8696	1257.6031	1230.4631
##	[2725]	1273.5328	1271.9642	1297.6534	1283.9671	1290.2917	1302.9794
##	[2731]	1294.7157	1286.1394	1351.5323	1372.5815	1369.4609	1383.6854
##	[2737]	1419.5218	1483.7203	1478.5035	1466.3761	1499.8891	1525.3625
##	[2743]	1547.1090	1526.1620	1526.3760	1506.8136	1532.2940	1555.5290
##	[2749]	1569.4039	1534.6211	1579.2210	1612.0621	1612.5534	1599.5969
##	[2755]	1542.4720	1530.3212	1492.1033	1498.6054	1506.2389	1499.9708
##	[2761]	1481.5660	1472.9915	1525.1717	1519.3710	1502.9291	1496.0485
##	[2767]	1485.3198	1536.5331	1519.7235	1516.8568	1455.4549	1440.4372
##	[2773]	1442.3440	1441.7931	1422.1814	1503.5791	1544.1188	1551.2355
##	[2779]	1537.0950	1533.9616	1547.0786	1506.3053	1491.3165	1536.6826
##	[2785]	1537.6972	1590.8677	1580.1519	1562.0779	1527.2882	1487.3026
##	[2791]	1510.4191	1580.0110	1645.3860	1700.6461	1695.2457	1692.4364
##	[2797]	1710.5642	1733.1407	1692.4958	1673.5092	1630.2463	1641.7853
##	[2803]	1639.5801	1643.9393	1641.3546	1633.5237	1677.8870	1660.1237
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 ## [4117] 1783.5059 1797.9173 1762.5260 1808.4481 1768.4256 1807.6625  
 ## [4123] 1811.1528 1813.0440 1833.3886 1809.2438 1814.2101 1810.5661  
 ## [4129] 1793.9271 1788.3354 1783.1349 1799.0825 1799.2942 1804.3241  
 ## [4135] 1815.9243 1834.5873 1831.0831 1865.9265 1865.7903 1876.5317  
 ## [4141] 1862.8562 1878.7400 1839.5898 1806.5865 1853.3276 1855.6602  
 ## [4147] 1864.9274 1777.0391 1742.7953 1746.2859 1750.4506 1756.3433  
 ## [4153] 1773.4485 1742.1092 1770.4359 1799.3983 1824.0577 1793.3336  
 ## [4159] 1763.0713 1762.2372 1804.9676 1834.9695 1820.5766 1799.8714  
 ## [4165] 1774.4277 1809.7788 1826.0564 1844.4321 1810.6239 1805.5610  
 ## [4171] 1861.7036 1864.4196 1899.4449 1954.0696 1918.6866 1916.9966  
 ## [4177] 1894.0783 1898.3305 1885.8051 1916.7448 1916.7396 1902.0907  
 ## [4183] 1939.4748 1947.8836 1995.0330 1975.8592 2006.7972 2017.2315  
 ## [4189] 2005.2355 1977.5284 1960.7228 1972.9617 1885.6110 1887.8572  
 ## [4195] 1873.2429 1873.7202 1897.7724 1834.7270 1813.8223 1810.7349  
 ## [4201] 1840.0543 1826.2286 1847.4092 1807.1231 1845.8799 1888.6587  
 ## [4207] 1841.5095 1863.8336 1864.7550 1840.2269 1871.4160 1910.7861  
 ## [4213] 1927.6143 1974.2632 1985.9863 1985.5594 2013.8481 2019.5077  
 ## [4219] 2077.7701 2075.9037 2060.8630 2077.9828 2100.4382 2120.1618  
 ## [4225] 2113.1737 2129.4753 2153.7048 2164.4936 2129.9103 2124.6680  
 ## [4231] 2110.4318 2156.7244 2154.7330 2154.7885 2144.9134 2137.4342  
 ## [4237] 2164.8925 2169.1412 2134.6113 2164.3045 2151.3382 2155.2088  
 ## [4243] 2116.2308 2162.0587 2178.1939 2188.2023 2183.9648 2204.6611  
 ## [4249] 2204.7058 2210.4722 2202.2503 2212.0252 2180.8014 2156.0410  
 ## [4255] 2149.7533 2137.8114 2107.1323 2064.5711 2067.0609 2073.4449  
 ## [4261] 2048.2247 2036.9504 2067.9316 2080.2616 2084.0208 2100.1254  
 ## [4267] 2103.2097 2102.4174 2116.7409 2129.4045 2136.5051 2155.9014  
 ## [4273] 2167.0442 2201.7607 2168.8096 2132.5623 2105.5089 2069.1886  
 ## [4279] 2082.8642 2075.2558 2064.5005 2071.5048 2040.5532 2029.7009  
 ## [4285] 1991.9534 1967.4297 1975.2064 2004.7343 1972.2239 1956.3804  
 ## [4291] 1923.8802 1927.0797 1973.8044 1934.6190 1931.6021 2007.3862  
 ## [4297] 1972.8913 1954.2919 1933.3530 1935.3623 1889.9522 1929.5551



## [4303] 1946.1328 1903.8298 1976.7835 1975.6954 1987.4196 2024.9843  
 ## [4309] 2038.6623 2078.6907 2067.0165 2060.4434 2124.5059 2121.8786  
 ## [4315] 2099.6351 2096.2072 2071.4721 2116.5756 2115.2229 2065.3080  
 ## [4321] 2055.4814 2079.5514 2106.6136 2138.9773 2179.3293 2157.2935  
 ## [4327] 2174.9254 2151.7674 2156.9757 2184.3057 2209.7842 2197.2705  
 ## [4333] 2181.0968 2123.4742 2171.0908 2218.3019 2261.6037 2254.1228  
 ## [4339] 2289.0517 2262.7633 2275.3887 2266.4707 2259.1587 2263.2671  
 ## [4345] 2230.3510 2269.7164 2404.1954 2397.6136 2404.5370 2445.8053  
 ## [4351] 2410.2263 2402.4004 2436.1310 2389.8846 2417.0560 2395.6266  
 ## [4357] 2409.8557 2355.3633 2357.8012 2361.3211 2364.7632 2340.6795  
 ## [4363] 2352.7776 2374.0224 2382.4182 2369.6194 2376.4965 2396.6067  
 ## [4369] 2362.9075 2322.7661 2320.6787 2326.9888 2351.7281 2295.7721  
 ## [4375] 2340.7817 2295.9685 2243.5060 2261.8183 2274.1702 2311.9668  
 ## [4381] 2276.5058 2271.4618 2280.6559 2287.2416 2273.8521 2239.7128  
 ## [4387] 2236.8129 2241.9484 2223.7051 2243.5722 2242.5727 2181.4835  
 ## [4393] 2195.9276 2196.4044 2179.7703 2171.0081 2154.1813 2125.9871  
 ## [4399] 2123.1350 2151.9437 2158.6719 2113.5219 2137.2416 2161.2173  
 ## [4405] 2146.9953 2133.8573 2157.1741 2199.4479 2198.2639 2188.1047  
 ## [4411] 2170.2771 2190.3016 2161.1691 2145.9561 2155.7220 2139.3504  
 ## [4417] 2149.4202 2147.0709 2180.4913 2179.5265 2202.1728 2166.4703  
 ## [4423] 2189.4042 2190.2380 2203.3627 2215.3157 2218.3735 2220.2979  
 ## [4429] 2198.0187 2210.1784 2219.3268 2185.2380 2178.0597 2186.9397  
 ## [4435] 2143.2368 2143.5986 2110.4639 2112.0310 2082.6903 2089.0485  
 ## [4441] 2093.5253 2076.4155 2049.8512 2043.0821 2036.8658 2058.9818  
 ## [4447] 2051.7065 2060.7690 2006.0052 1995.4055 1993.3963 1984.1042  
 ## [4453] 1976.9509 1972.9800 1969.1682 1981.6348 1963.4693 1947.1623  
 ## [4459] 1979.1508 1928.0572 1947.5708 1978.4634 1964.4202 1953.2717  
 ## [4465] 1925.8659 1946.8490 1903.2489 1921.5527 1917.6692 1922.0283  
 ## [4471] 1922.7859 1978.1296 1928.1529 1914.4381 1914.3549 1883.7475  
 ## [4477] 1851.7525 1868.4976 1857.3400 1838.3554 1841.6505 1892.8980  
 ## [4483] 1922.4551 1953.6224 1929.4320 1960.2119 1949.3893 1954.3141  
 ## [4489] 1943.0630 1981.4307 1966.4974 1991.1470 1994.7041 1996.1385  
 ## [4495] 1942.8548 1932.3066 1933.3195 1933.2968 1960.2085 1962.4971  
 ## [4501] 1932.5100 1876.3291 1878.9184 1859.7873 1836.3006 1856.8942  
 ## [4507] 1843.1539 1791.6010 1813.7711 1847.0616 1867.3014 1928.7411  
 ## [4513] 1894.1179 1948.7047 1990.8252 1999.7296 2017.0517 2054.8368  
 ## [4519] 2019.8375 2006.1621 2022.4180 2015.1766 1988.0485 2019.2580  
 ## [4525] 2003.0179 1980.4345 1994.9807 2055.4033 2096.3280 2115.8052  
 ## [4531] 2101.8051 2140.4467 2133.7987 2116.9221 2103.5806 2160.3167  
 ## [4537] 2140.5820 2143.5596 2098.8141 2068.1800 2067.7107 2074.8636  
 ## [4543] 2057.7632 2110.1940 2098.5517 2066.8392 2108.8956 2095.8118  
 ## [4549] 2131.1139 2137.7420 2092.9824 2114.7517 2085.4060 2081.8822  
 ## [4555] 2023.1198 2009.4465 1977.3146 2032.3762 2049.7691 2114.4200  
 ## [4561] 2089.5245 2023.8800 2039.3664 2030.2958 2038.3878 1988.4935  
 ## [4567] 2015.7858 1979.6442 1980.2353 1978.6188 1979.0644 2009.5495  
 ## [4573] 2015.5759 1990.1440 2015.5844 1977.6047 1956.0979 1947.1104  
 ## [4579] 1963.2763 1954.9819 1968.4376 1987.7622 1989.7092 1976.8752  
 ## [4585] 1986.0908 1953.2130 2001.7317 1989.5663 2006.7070 2002.4229  
 ## [4591] 2002.0574 1992.7760 2003.1252 1983.1061 1981.9931 2005.1345  
 ## [4597] 2016.7422 2029.8271 2020.8333 2048.0659 2056.6986 2095.7138  
 ## [4603] 2136.0501 2084.7337 2092.1863 2108.1575 2097.0546 2098.9724  
 ## [4609] 2107.8963 2185.2727 2184.1545 2191.8815 2156.5884 2145.8801  
 ## [4615] 2149.3012 2113.8370 2109.4938 2130.2872 2109.9816 2115.6422  
 ## [4621] 2136.0750 2121.2246 2128.0239 2151.3282 2131.8309 2133.6140

##	[4627]	2208.3501	2222.3982	2249.4155	2195.4091	2176.0264	2187.3782
##	[4633]	2176.6306	2209.3201	2228.7349	2256.5085	2298.0119	2310.4528
##	[4639]	2373.1607	2400.3565	2378.8625	2377.9882	2384.3519	2381.9683
##	[4645]	2365.1395	2317.9462	2369.2558	2411.8616	2416.4687	2433.3377
##	[4651]	2401.5007	2384.8567	2298.6380	2316.4031	2305.4910	2303.5528
##	[4657]	2272.9721	2288.4685	2293.7369	2293.8441	2267.0351	2281.6405
##	[4663]	2286.8747	2284.8670	2297.7258	2230.0565	2262.8217	2258.1612
##	[4669]	2239.0788	2229.4167	2230.3237	2287.1324	2308.6347	2346.2888
##	[4675]	2381.6125	2291.7032	2272.1196	2289.9494	2290.0726	2257.6119
##	[4681]	2272.7546	2266.9043	2270.4268	2227.3701	2205.5937	2205.8803
##	[4687]	2161.6968	2139.7233	2146.5803	2144.3716	2129.1852	2140.8336
##	[4693]	2107.1239	2120.2342	2107.5397	2123.9364	2170.7324	2125.4084
##	[4699]	2105.6822	2092.5709	2106.3941	2118.8740	2095.4782	2090.9952
##	[4705]	2091.8520	2056.4748	2065.0668	2047.4577	2055.6554	2023.9716
##	[4711]	2004.8682	2022.1399	2028.1459	2055.7354	2100.4742	2096.8939
##	[4717]	2096.7206	2082.8367	2084.3085	2106.4029	2109.7392	2070.9309
##	[4723]	2113.6092	2145.1408	2151.6574	2154.2272	2167.8836	2151.5277
##	[4729]	2172.4038	2163.8114	2161.6411	2124.6541	2148.3912	2170.1136
##	[4735]	2161.4018	2202.2005	2211.6521	2218.1303	2201.8626	2178.6959
##	[4741]	2151.1912	2163.3056	2174.7748	2170.4318	2190.6419	2243.7495
##	[4747]	2264.3404	2280.3092	2251.4129	2213.8740	2204.9388	2208.3937
##	[4753]	2238.5189	2204.3157	2204.0334	2189.7622	2150.5040	2138.2476
##	[4759]	2114.8835	2064.1201	2068.4736	2059.8124	2098.4881	2122.1464
##	[4765]	2125.2491	2125.4510	2108.3972	2135.3730	2131.7663	2120.8967
##	[4771]	2129.6210	2140.4000	2082.7480	2073.1079	2073.9503	2108.9876
##	[4777]	2048.9770	2039.6120	2016.6189	2002.6069	1960.8254	1952.3778
##	[4783]	1955.3196	1933.1466	1920.3632	1925.3851	1899.6267	1916.0434
##	[4789]	1923.1199	1893.3414	1910.5883	1891.8368	1901.8710	1883.1618
##	[4795]	1843.1871	1855.6198	1863.7023	1871.9201	1880.4169	1862.6651
##	[4801]	1850.3293	1846.7774	1817.2920	1834.0387	1794.8564	1804.4976
##	[4807]	1794.8287	1768.5965	1783.7824	1749.9438	1790.5771	1783.4504
##	[4813]	1754.3309	1742.3497	1712.0893	1709.3861	1737.5201	1808.6756
##	[4819]	1839.9725	1850.9727	1893.7704	1868.1782	1905.9728	1898.7204
##	[4825]	1895.5875	1878.2267	1877.1731	1872.0923	1869.4402	1883.7740
##	[4831]	1916.4180	1940.5498	1951.8511	1946.5262	1982.1093	1960.0967
##	[4837]	1993.0416	2003.1652	2000.3298	2011.0713	1987.0746	2006.4809
##	[4843]	1946.6642	1944.6509	1908.4747	1940.5616	1965.4093	1983.0333
##	[4849]	1976.4738	1999.5847	2101.3772	2066.8125	2064.2364	2036.3268
##	[4855]	2061.5219	2075.1715	2111.2087	2074.3015	2091.2732	2088.9599
##	[4861]	2104.2647	2096.0241	2079.7256	2082.9137	2067.2507	2060.2593
##	[4867]	2023.0223	2042.4426	2052.1671	2051.3757	2054.1703	2039.1081
##	[4873]	2045.9395	2077.9915	2053.3620	2075.1809	2068.2128	2114.8882
##	[4879]	2107.7491	2064.1130	2045.5769	2052.1512	2009.6832	2015.7473
##	[4885]	2013.4932	2025.3989	2018.3281	2013.0127	1965.4098	1943.7873
##	[4891]	1953.0642	1956.6941	1965.6155	1933.4291	1919.6596	1904.9335
##	[4897]	1926.1843	1918.6675	1907.0444	1919.6225	1918.4902	1952.7030
##	[4903]	1918.4671	1910.5842	1939.8016	1975.3275	2009.4466	2006.2439
##	[4909]	1992.9627	2002.9568	2018.5213	2035.7869	2026.4190	2023.6038
##	[4915]	1960.0468	1989.0688	1961.2660	1975.3963	1970.1755	1972.8952
##	[4921]	1991.7078	1984.8341	1951.9715	1915.6811	1947.2951	1938.7880
##	[4927]	1903.4689	1921.6922	1918.6387	1938.2790	1984.1486	1971.6447
##	[4933]	1913.5315	1931.1723	1923.7522	1936.4343	1985.1073	1949.2189
##	[4939]	1976.9443	1946.7137	1950.8874	1940.7767	1916.3430	1862.6358
##	[4945]	1860.2763	1914.4061	1865.3967	1810.1968	1772.6201	1770.1905

```
## [4951] 1757.2881 1764.3495 1759.4180 1771.1301 1781.5335 1757.6530
## [4957] 1729.3142 1733.9742 1699.4032 1726.7054 1704.8339 1722.7643
## [4963] 1750.5913 1748.5647 1724.1160 1716.7109 1715.3030 1754.7601
## [4969] 1721.8586 1719.6038 1692.4152 1712.0219 1711.3161 1746.8649
## [4975] 1751.6500 1748.3786 1758.8865 1735.0161 1749.6555 1762.1900
## [4981] 1753.9637 1716.9059 1701.9491 1665.0100 1661.9924 1664.3828
## [4987] 1683.1849 1686.1074 1702.2379 1731.3695 1671.5135 1688.2011
## [4993] 1671.4619 1694.1161 1670.8577 1651.6153 1606.2972 1541.2562
## [4999] 1528.1000 1561.0084 1608.2450
```

### Q3

```
carsb = Cars93[, c(4, 5, 6, 7, 8, 12, 13, 14, 15, 17, 19:22, 25, 26)]
names(carsb)
```

```
## [1] "Min.Price"      "Price"          "Max.Price"
## [4] "MPG.city"       "MPG.highway"    "EngineSize"
## [7] "Horsepower"     "RPM"            "Rev.per.mile"
## [10] "Fuel.tank.capacity" "Length"         "Wheelbase"
## [13] "Width"          "Turn.circle"    "Weight"
## [16] "Origin"
```

```
carsb[, -16] = log(carsb[, -16])
```

(a)

```
lrfp = function(m) {
  (m[1, 1]/(m[1, 1] + m[2, 1]))/(m[1, 2]/(m[2, 2] + m[1, 2]))
}
lrfn = function(m) {
  (m[2, 1]/(m[1, 1] + m[2, 1]))/(m[2, 2]/(m[2, 2] + m[1, 2]))
}
f0 = function(m) {
  c(1 - sum(diag(m))/sum(m), lrfp(m), lrfn(m))
}
```

(b)

```
fit.lda = lda(Origin ~ ., data = carsb)

confusion.matrix.lda = table(predict(fit.lda)$class, carsb$Origin)

m = confusion.matrix.lda

vector = f0(m)
cat("CE: ", vector[1], "\n")

## CE: 0.1075269

cat("LR+: ", vector[2], "\n")

## LR+: 8.0625
```

```
cat("LR-: ", vector[3], "\n")
```

```
## LR-: 0.1171875
```

(c)

```
fit.qda = qda(Origin ~ ., data = carsb)
```

```
confusion.matrix.qda = table(predict(fit.qda)$class, carsb$Origin)
```

```
m = confusion.matrix.qda
```

```
vector = f0(m)
```

```
cat("CE: ", vector[1], "\n")
```

```
## CE: 0.03225806
```

```
cat("LR+: ", vector[2], "\n")
```

```
## LR+: 43.125
```

```
cat("LR-: ", vector[3], "\n")
```

```
## LR-: 0.04261364
```

Yes, the QDA appears to produce less error

(d)

```
fit.lda = lda(Origin ~ ., data = carsb, CV = TRUE)
```

```
confusion.matrix.lda = table(fit.lda$class, carsb$Origin)
```

```
m = confusion.matrix.lda
```

```
vector = f0(m)
```

```
cat("CE: ", vector[1], "\n")
```

```
## CE: 0.1397849
```

```
cat("LR+: ", vector[2], "\n")
```

```
## LR+: 6.40625
```

```
cat("LR-: ", vector[3], "\n\n")
```

```
## LR-: 0.1682692
```

```
fit.qda = qda(Origin ~ ., data = carsb, CV = TRUE)
```

```
confusion.matrix.qda = table(fit.qda$class, carsb$Origin)
```

```
m = confusion.matrix.qda
```

```
vector = f0(m)
```

```
cat("CE: ", vector[1], "\n")
```

```
## CE: 0.2473118
```

```
cat("LR+: ", vector[2], "\n")
```

```
## LR+: 3.068182
```

```
cat("LR-: ", vector[3], "\n")
```

```
## LR-: 0.3308824
```

lda() does better than qda() with CV because it is better at generalizing

## Q4

```
pima1 = rbind(Pima.tr)[, c(2, 3, 4, 5, 6, 8)]  
names(pima1)
```

```
## [1] "glu" "bp" "skin" "bmi" "ped" "type"
```

(a)

```
yes = length(which(pima1$type == "Yes"))  
yes <- yes/200  
cat("yes: ", yes, "\n")
```

```
## yes: 0.34
```

```
no = length(which(pima1$type == "No"))  
no <- no/200  
cat("no: ", no, "\n")
```

```
## no: 0.66
```

The classifier would be incorrect 34% of the time.

(b)

```
knn.function = function(k.list, xtrain, gr) {  
  
  pr.tab = matrix(NA, length(k.list), 3)  
  for (i in 1:length(k.list)) {  
  
    knn.fit = knn.cv(xtrain, gr, k = k.list[i], use.all = TRUE)  
    cm = table(knn.fit, gr)  
    # print(cm)  
    pr.tab[i, ] = f0(cm)  
  }  
  cm  
  return(pr.tab)  
}
```

(c)

```
k.list = seq(1, 125, 2)  
cv.tab = knn.function(k.list, pima1[, 1:5], pima1[, 6])  
cv.tab
```

##		[,1]	[,2]	[,3]
##	[1,]	0.300	1.639118	0.3974026
##	[2,]	0.295	1.768687	0.3931419
##	[3,]	0.275	1.754735	0.3291246
##	[4,]	0.270	1.663203	0.2966024
##	[5,]	0.260	1.803030	0.2861953
##	[6,]	0.265	1.677922	0.2809917
##	[7,]	0.255	1.742424	0.2575758
##	[8,]	0.265	1.748393	0.2943723
##	[9,]	0.275	1.681818	0.3181818
##	[10,]	0.265	1.645623	0.2736742
##	[11,]	0.250	1.795225	0.2502165
##	[12,]	0.245	1.772727	0.2272727
##	[13,]	0.250	1.757576	0.2424242
##	[14,]	0.250	1.757576	0.2424242
##	[15,]	0.255	1.707359	0.2497704
##	[16,]	0.240	1.787879	0.2121212
##	[17,]	0.250	1.722078	0.2341598
##	[18,]	0.260	1.692641	0.2653811
##	[19,]	0.255	1.742424	0.2575758
##	[20,]	0.255	1.742424	0.2575758
##	[21,]	0.275	1.617003	0.3058712
##	[22,]	0.260	1.692641	0.2653811
##	[23,]	0.265	1.615070	0.2658847
##	[24,]	0.260	1.599681	0.2404040
##	[25,]	0.270	1.545455	0.2664577
##	[26,]	0.265	1.615070	0.2658847
##	[27,]	0.265	1.615070	0.2658847
##	[28,]	0.250	1.688552	0.2253788
##	[29,]	0.250	1.656839	0.2160313
##	[30,]	0.255	1.613238	0.2232323
##	[31,]	0.270	1.519697	0.2575758
##	[32,]	0.270	1.519697	0.2575758
##	[33,]	0.270	1.519697	0.2575758
##	[34,]	0.275	1.506818	0.2759740
##	[35,]	0.265	1.532576	0.2391775
##	[36,]	0.265	1.532576	0.2391775
##	[37,]	0.265	1.532576	0.2391775
##	[38,]	0.260	1.571873	0.2309300
##	[39,]	0.260	1.571873	0.2309300
##	[40,]	0.260	1.571873	0.2309300
##	[41,]	0.265	1.532576	0.2391775
##	[42,]	0.265	1.532576	0.2391775
##	[43,]	0.265	1.532576	0.2391775
##	[44,]	0.265	1.532576	0.2391775
##	[45,]	0.275	1.459596	0.2575758
##	[46,]	0.270	1.495196	0.2480359
##	[47,]	0.275	1.459596	0.2575758
##	[48,]	0.270	1.471861	0.2377622
##	[49,]	0.275	1.416667	0.2361111
##	[50,]	0.270	1.449612	0.2266667
##	[51,]	0.285	1.355072	0.2575758
##	[52,]	0.280	1.366271	0.2341598
##	[53,]	0.280	1.348162	0.2207792

```
## [54,] 0.280 1.348162 0.2207792
## [55,] 0.315 1.198718 0.3541667
## [56,] 0.320 1.119122 0.3090909
## [57,] 0.335 1.055230 0.4292929
## [58,] 0.340 1.007237 0.5151515
## [59,] 0.340 1.000000      NaN
## [60,] 0.340 1.000000      NaN
## [61,] 0.340 1.000000      NaN
## [62,] 0.340 1.000000      NaN
## [63,] 0.340 1.000000      NaN
```

```
cat("Min C.E.: ", min(cv.tab[, 1]), "\n")
```

```
## Min C.E.: 0.24
```

```
cat("Min LR+: ", min(cv.tab[, 2]), "\n")
```

```
## Min LR+: 1
```

```
cat("Max LR+: ", max(cv.tab[, 2]), "\n")
```

```
## Max LR+: 1.80303
```

```
cat("Min LR-: ", min(cv.tab[, 3], na.rm = TRUE), "\n")
```

```
## Min LR-: 0.2121212
```

```
cat("Max LR-: ", max(cv.tab[, 3], na.rm = TRUE), "\n")
```

```
## Max LR-: 0.5151515
```

```
# plot(seq(1, 125, 2), cv.tab[,1], pch=16, ylab='Classification Error',
# xlab='K', main='Normalized Features') lines(seq(1, 125, 2), cv.tab[,1],
# lty=1) abline(h = 0.34, lty = 2, lwd = 3, col = 'dark blue')
```

Using only odd numbers for K avoids the need to break ties within the classification algorithm. The min value of CE is .240 for K = 32. The minimum LR+

(d)

```
norm_feat <- apply(pima1[-6], 2, function(x) {
  return((x - mean(x))/sd(x))
})
```

```
k.list = seq(1, 125, 2)
cv.tab = knn.function(k.list, norm_feat, pima1[, 6])
cat("Min C.E.: ", min(cv.tab[, 1]), "\n")
```

```
## Min C.E.: 0.22
```

```
cat("Min LR+: ", min(cv.tab[, 2]), "\n")
```

```
## Min LR+: 1
```

```
cat("Max LR+: ", max(cv.tab[, 2]), "\n")
```

```
## Max LR+: 1.906061
```

```
cat("Min LR-: ", min(cv.tab[, 3], na.rm = TRUE), "\n")
```

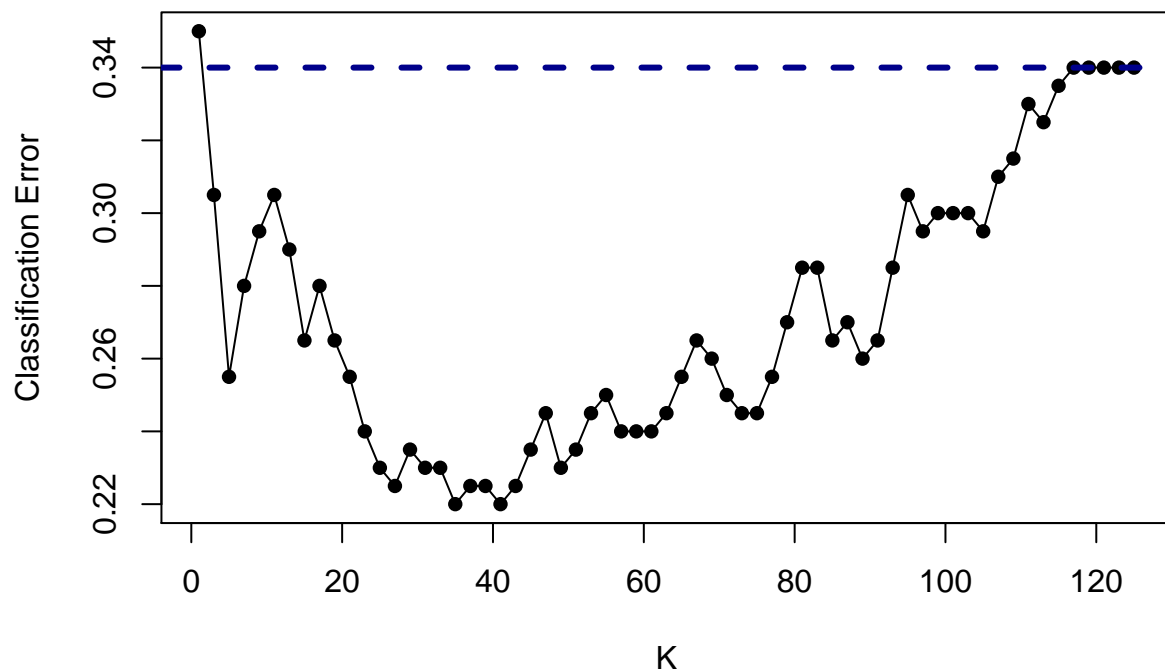
```
## Min LR-: 0.09366391
```

```
cat("Max LR-: ", max(cv.tab[, 3], na.rm = TRUE), "\n")
```

```
## Max LR-: 0.5454545
```

```
knn_mat <- knn.function(k.list, norm_feat, pima1[, 6])
plot(seq(1, 125, 2), knn_mat[, 1], pch = 16, ylab = "Classification Error",
     xlab = "K", main = "Normalized Features")
lines(seq(1, 125, 2), knn_mat[, 1], lty = 1)
abline(h = 0.34, lty = 2, lwd = 3, col = "dark blue")
```

## Normalized Features



```
###
```

Normalize reduces the scale of the variables resulting in reduced error.

## Q5

(a)

```
lambda_bim <- function(lam, X, m = 10, t = 15/3600) {
  return(log(choose(m, X) * (1 - exp((-lam * t)/m))^(X) * (exp((-lam * t)/m)^(m -
    X))))
}

probs <- c()
ind <- seq(500, 700, 1)
for (i in ind) {
  probs <- c(probs, lambda_bim(i, X = 6))
}

plot(ind, probs)
```



Q5:

mCx

$$\log(\log(\frac{M}{x}) - x)$$

$$0 = x \cdot \frac{T}{M} \cdot \frac{1}{e^z - 1} + (M - x) \left( \frac{-T}{M} \right) \left( \frac{M}{x^2} \right) = \frac{1}{e^z - 1}$$

$$T \left( 1 - \frac{x}{M} \right) \left( \frac{M}{Tx} \right) = \frac{1}{e^z - 1}$$

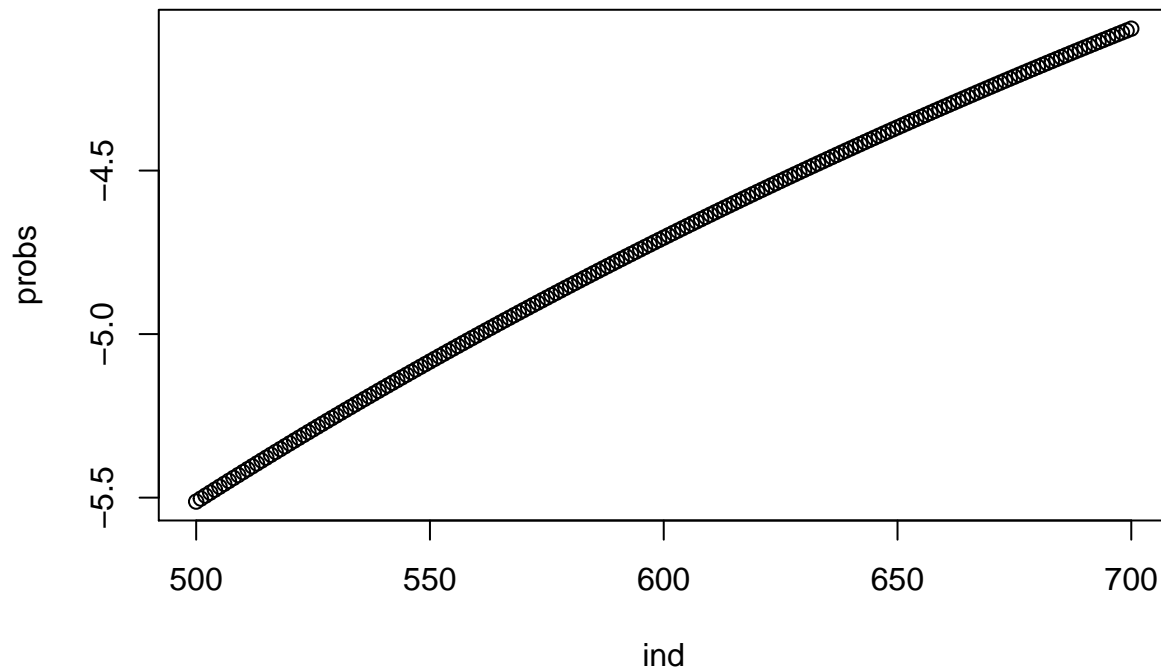
$$\frac{M - x}{x} \rightarrow \frac{M}{x} - 1$$

$$\frac{M}{T} \log\left(\frac{M}{M-x}\right)$$

$$\lambda = 0.5226$$

$$5.526$$

$$\begin{aligned} \frac{M}{M-x} &= \left( \frac{M}{x} - 1 \right)^{-1} + 1 \\ &= \frac{x}{M-x} + \frac{M-x}{M-x} \\ &= \frac{M}{M-x} \end{aligned}$$



(b)

```
lam_mle <- function(x, M = 10, t = (15/3600)) {
  (M/t) * log(M/(M - x))
}

for (i in 0:9) {
  sprintf("MLE for x=%s: %s", i, round(lam_mle(i), 3)) %>% print(.)
}
```

```
## [1] "MLE for x=0: 0"
## [1] "MLE for x=1: 252.865"
## [1] "MLE for x=2: 535.545"
## [1] "MLE for x=3: 856.02"
## [1] "MLE for x=4: 1225.981"
## [1] "MLE for x=5: 1663.553"
## [1] "MLE for x=6: 2199.098"
## [1] "MLE for x=7: 2889.535"
## [1] "MLE for x=8: 3862.651"
## [1] "MLE for x=9: 5526.204"
```

(c)

```
for (i in 0:10) {
  sprintf("MLE for x=%s: %s", i, round(lam_mle(i), 3)) %>% print(.)
}
```

```
## [1] "MLE for x=0: 0"
## [1] "MLE for x=1: 252.865"
## [1] "MLE for x=2: 535.545"
## [1] "MLE for x=3: 856.02"
## [1] "MLE for x=4: 1225.981"
```

```
## [1] "MLE for x=5: 1663.553"  
## [1] "MLE for x=6: 2199.098"  
## [1] "MLE for x=7: 2889.535"  
## [1] "MLE for x=8: 3862.651"  
## [1] "MLE for x=9: 5526.204"  
## [1] "MLE for x=10: Inf"
```

Can't divide by 0 so can't give all estimates