yule model

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library(ape)

## Warning: package 'ape' was built under R version 3.4.4

library(BioGeoBEARS)

## Warning: package 'BioGeoBEARS' was built under R version 3.4.4

## Loading required package: rexpokit

## Warning: package 'rexpokit' was built under R version 3.4.4

## Loading required package: cladoRcpp

## Warning: package 'cladoRcpp' was built under R version 3.4.4

## Loading required package: phylobase

## Warning: package 'phylobase' was built under R version 3.4.4

##   
## Attaching package: 'phylobase'

## The following object is masked from 'package:ape':  
##   
## edges

finch <- read.nexus("http://www.r-phylo.org/w/images/0/02/Geospiza.nex")  
lambda <- seq(0.1,10,by = 0.1)  
phy <- finch  
N = length(phy$tip.label)  
x <- c(NA, branching.times(phy))  
  
  
log\_likelihood <-function (lambda, phy)   
{  
   
 # If the input tree is not a binary tree, stop  
 if (!length(phy$tip.label) - phy$Nnode + is.rooted.phylo(phy) == 2)   
 stop("tree must be dichotomous to fit the Yule model.")  
   
   
 #Total length of the tree  
 X <- sum(phy$edge.length)  
   
   
 #Number of internal nodes in the tree  
 nb.node <- phy$Nnode  
   
   
 #If there is a 'root.edge' element in the phylogenetic tree, and use.root.edge = TRUE, then it is assumed that it has a biological meaning and is counted as a branch length, and the root is counted as a speciation event; otherwise the number of speciation events is the number of nodes - 1  
 if (!is.null(phy$root.edge) && use.root.edge)   
 X <- X + phy$root.edge  
 else nb.node <- nb.node - 1  
   
 #log\_likelihood  
   
 loglik <- -lambda \* X + lfactorial(phy$Nnode) + nb.node \* log(lambda)  
   
 print(paste("lambda=",lambda," loglik=",loglik))  
 return(loglik)  
}  
  
loglik = log\_likelihood(lambda,phy)

## [1] "lambda= 0.1 loglik= -5.53749926280513"  
## [2] "lambda= 0.2 loglik= 2.32162490391422"   
## [3] "lambda= 0.3 loglik= 6.72856420121219"   
## [4] "lambda= 0.4 loglik= 9.72210707063356"   
## [5] "lambda= 0.5 loglik= 11.9411876864041"   
## [6] "lambda= 0.6 loglik= 13.6704043679315"   
## [7] "lambda= 0.7 loglik= 15.0615705258586"   
## [8] "lambda= 0.8 loglik= 16.2053052373529"   
## [9] "lambda= 0.9 loglik= 17.1600596652295"   
## [10] "lambda= 1 loglik= 17.9657438531234"   
## [11] "lambda= 1.1 loglik= 18.6508240107753"   
## [12] "lambda= 1.2 loglik= 19.2363185346509"   
## [13] "lambda= 1.3 loglik= 19.7381890267333"   
## [14] "lambda= 1.4 loglik= 20.168842692578"   
## [15] "lambda= 1.5 loglik= 20.5381151504214"   
## [16] "lambda= 1.6 loglik= 20.8539354040722"   
## [17] "lambda= 1.7 loglik= 21.1227888658695"   
## [18] "lambda= 1.8 loglik= 21.3500478319488"   
## [19] "lambda= 1.9 loglik= 21.5402124871922"   
## [20] "lambda= 2 loglik= 21.6970900198428"   
## [21] "lambda= 2.1 loglik= 21.8239299898759"   
## [22] "lambda= 2.2 loglik= 21.9235281774947"   
## [23] "lambda= 2.3 loglik= 21.9983073283447"   
## [24] "lambda= 2.4 loglik= 22.0503807013702"   
## [25] "lambda= 2.5 loglik= 22.0816026356133"   
## [26] "lambda= 2.6 loglik= 22.0936091934527"   
## [27] "lambda= 2.7 loglik= 22.0878511292468"   
## [28] "lambda= 2.8 loglik= 22.0656208592973"   
## [29] "lambda= 2.9 loglik= 22.0280746970326"   
## [30] "lambda= 3 loglik= 21.9762513171407"   
## [31] "lambda= 3.1 loglik= 21.9110871910166"   
## [32] "lambda= 3.2 loglik= 21.8334295707916"   
## [33] "lambda= 3.3 loglik= 21.7440474747926"   
## [34] "lambda= 3.4 loglik= 21.6436410325888"   
## [35] "lambda= 3.5 loglik= 21.5328494750678"   
## [36] "lambda= 3.6 loglik= 21.4122579986682"   
## [37] "lambda= 3.7 loglik= 21.2824036889256"   
## [38] "lambda= 3.8 loglik= 21.1437806539115"   
## [39] "lambda= 3.9 loglik= 20.9968444907506"   
## [40] "lambda= 4 loglik= 20.8420161865621"   
## [41] "lambda= 4.1 loglik= 20.6796855376466"   
## [42] "lambda= 4.2 loglik= 20.5102141565953"   
## [43] "lambda= 4.3 loglik= 20.3339381255176"   
## [44] "lambda= 4.4 loglik= 20.151170344214"   
## [45] "lambda= 4.5 loglik= 19.9622026144387"   
## [46] "lambda= 4.6 loglik= 19.767307495064"   
## [47] "lambda= 4.7 loglik= 19.5667399577156"   
## [48] "lambda= 4.8 loglik= 19.3607388680896"   
## [49] "lambda= 4.9 loglik= 19.1495283145224"   
## [50] "lambda= 5 loglik= 18.9333188023326"   
## [51] "lambda= 5.1 loglik= 18.7123083298868"   
## [52] "lambda= 5.2 loglik= 18.486683360172"   
## [53] "lambda= 5.3 loglik= 18.2566196998203"   
## [54] "lambda= 5.4 loglik= 18.0222832959662"   
## [55] "lambda= 5.5 loglik= 17.7838309599845"   
## [56] "lambda= 5.6 loglik= 17.5414110260167"   
## [57] "lambda= 5.7 loglik= 17.2951639512095"   
## [58] "lambda= 5.8 loglik= 17.0452228637519"   
## [59] "lambda= 5.9 loglik= 16.7917140640635"   
## [60] "lambda= 6 loglik= 16.5347574838601"   
## [61] "lambda= 6.1 loglik= 16.2744671072746"   
## [62] "lambda= 6.2 loglik= 16.010951357736"   
## [63] "lambda= 6.3 loglik= 15.7443134538933"   
## [64] "lambda= 6.4 loglik= 15.4746517375109"   
## [65] "lambda= 6.5 loglik= 15.2020599759425"   
## [66] "lambda= 6.6 loglik= 14.926627641512"   
## [67] "lambda= 6.7 loglik= 14.6484401698865"   
## [68] "lambda= 6.8 loglik= 14.3675791993082"   
## [69] "lambda= 6.9 loglik= 14.084122792362"   
## [70] "lambda= 7 loglik= 13.7981456417872"   
## [71] "lambda= 7.1 loglik= 13.5097192616907"   
## [72] "lambda= 7.2 loglik= 13.2189121653875"   
## [73] "lambda= 7.3 loglik= 12.9257900309756"   
## [74] "lambda= 7.4 loglik= 12.6304158556449"   
## [75] "lambda= 7.5 loglik= 12.3328500996306"   
## [76] "lambda= 7.6 loglik= 12.0331508206308"   
## [77] "lambda= 7.7 loglik= 11.7313737994391"   
## [78] "lambda= 7.8 loglik= 11.42757265747"   
## [79] "lambda= 7.9 loglik= 11.1217989667991"   
## [80] "lambda= 8 loglik= 10.8141023532814"   
## [81] "lambda= 8.1 loglik= 10.5045305932641"   
## [82] "lambda= 8.2 loglik= 10.1931297043659"   
## [83] "lambda= 8.3 loglik= 9.87994403075404"   
## [84] "lambda= 8.4 loglik= 9.56501632331463"   
## [85] "lambda= 8.5 loglik= 9.24838781507867"   
## [86] "lambda= 8.6 loglik= 8.93009829223696"   
## [87] "lambda= 8.7 loglik= 8.61018616104987"   
## [88] "lambda= 8.8 loglik= 8.28868851093335"   
## [89] "lambda= 8.9 loglik= 7.96564117398055"   
## [90] "lambda= 9 loglik= 7.64107878115805"   
## [91] "lambda= 9.1 loglik= 7.31503481539707"   
## [92] "lambda= 9.2 loglik= 6.98754166178335"   
## [93] "lambda= 9.3 loglik= 6.65863065503394"   
## [94] "lambda= 9.4 loglik= 6.32833212443492"   
## [95] "lambda= 9.5 loglik= 5.99667543640136"   
## [96] "lambda= 9.6 loglik= 5.66368903480891"   
## [97] "lambda= 9.7 loglik= 5.32940047923546"   
## [98] "lambda= 9.8 loglik= 4.99383648124173"   
## [99] "lambda= 9.9 loglik= 4.65702293880995"   
## [100] "lambda= 10 loglik= 4.31898496905197"

plot(lambda, loglik, col="red", xlab = "", xlim = c(0, 12),ylim = c(0, 25))  
legend(8, 10, legend=c("lambda", "mu"),  
 col=c("red", "blue"), lty=3:3, cex=0.8)

