BUSTED_ANALYSIS_3X3

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load libraries

read in data

```
#add rate category count and order and gene for each file (can be found in file name FILE)

mtDNA_SRV_3x3_1_27_2020 <- read_csv("~/bin/mtDNA_redo/data/mtDNA_SRV_3x3_1_27_2020")
```

```
## Parsed with column specification:
## cols(
##   .default = col_double(),
##   FILE = col_character()
## )
```

```
## See spec(...) for full column specifications.
```

```
mtDNA_SRV_3x3_1_27_2020 <- mtDNA_SRV_3x3_1_27_2020 %>%
  mutate(.,
         NS.rates = 3,
         S.rates = 3,
         order = str_extract_all(mtDNA_SRV_3x3_1_27_2020$FILE, "\\w+(?=-)", simplify = T)[,1],
         gene = str_extract_all(mtDNA_SRV_3x3_1_27_2020$FILE, "\\w+(?=-)", simplify = T)[,2])

mtDNA_BUSTED_3x3_1_27_2020 <- read_csv("~/bin/mtDNA_redo/data/mtDNA_BUSTED_3x3_1_27_2020")
```

```
## Parsed with column specification:
## cols(
##   FILE = col_character(),
##   Sites = col_double(),
##   Sequences = col_double(),
##   BUSTED.LR = col_double(),
##   BUSTED.UNLogL = col_double(),
##   CV.NSRV = col_double(),
##   BUSTED.P = col_double(),
##   BUSTED.AICc = col_double(),
##   BUSTED.treelength = col_double(),
##   busted.omega.1.rate = col_double(),
##   busted.omega.2.rate = col_double(),
##   busted.omega.3.rate = col_double(),
##   busted.omega.1.prop = col_double(),
##   busted.omega.2.prop = col_double(),
##   busted.omega.3.prop = col_double()
## )
```

```
mtDNA_BUSTED_3x3_1_27_2020<- mtDNA_BUSTED_3x3_1_27_2020 %>%  mutate(., NS.rates = 3,
          S.rates = 3,
          order = str_extract_all(mtDNA_BUSTED_3x3_1_27_2020$FILE, "\\w+(?=-)", simplify = T)[,1],
            gene = str_extract_all(mtDNA_BUSTED_3x3_1_27_2020$FILE, "\\w+(?=-)", simplify = T)[,2])
```

```
#these are the orders used in the original analysis
orders_used <- read_delim("~/bin/mtDNA_redo/data/actual_orders_used.txt", delim = "\n", col_names = FALS
```

```
## Parsed with column specification:
## cols(
##   X1 = col_character()
## )
```

```
mtDNA_3x3 <- full_join(mtDNA_BUSTED_3x3_1_27_2020, mtDNA_SRV_3x3_1_27_2020, by = c("FILE", "Sites", "Se


#test_row <- bind_rows(mtDNA_BUSTED_3x3_1_27_2020, mtDNA_SRV_3x3_1_27_2020)
```

```
mtDNA_3x3$gene= toupper(mtDNA_3x3$gene)
mtDNA_3x3$order = toupper(mtDNA_3x3$order)

#fix some mispellings of order names
mtDNA_3x3$order[which(mtDNA_3x3$order == "CHIMAERIFORMS")]<-"CHIMAERIFORMES"
mtDNA_3x3$order[which(mtDNA_3x3$order == "CARNIVORES")] <-"CARNIVORA"
mtDNA_3x3$order[which(mtDNA_3x3$order == "GASTEROSTEIFORMES")] <-"GASTEROSTEALES"
```

how many genes per orders originally

```
count(mtDNA_3x3, groups = order) -> temp
temp
```

```
## # A tibble: 61 x 2
##    groups               n
##    <chr>            <int>
##  1 ACIPENSERIFORMES    10
##  2 ANGUILLIFORMES      12
##  3 ANSERIFORMES        12
##  4 ANURA               11
##  5 ARANEAE             13
##  6 ASCARIDIDA          11
##  7 BELONIFORMES        10
##  8 BERYCIFORMES        13
##  9 CARNIVORA           10
## 10 CETACEA             11
## # ... with 51 more rows
```

```
temp %>% filter(n >=12)
```

```
## # A tibble: 34 x 2
##    groups                 n
##    <chr>              <int>
##  1 ANGUILLIFORMES        12
##  2 ANSERIFORMES          12
##  3 ARANEAE               13
##  4 BERYCIFORMES          13
##  5 CHIROPTERA            13
##  6 COLEOPTERA            13
##  7 COLLEMBOLA            12
##  8 CYPRINODONTIFORMES    13
##  9 DASYUROMORPHIA        13
## 10 DECAPODA              13
```

```
## # ... with 24 more rows
```

```
#filter based on orders previously used:
mtDNA_3x3 <- mtDNA_3x3 %>% filter(order %in% orders_used$X1)
```

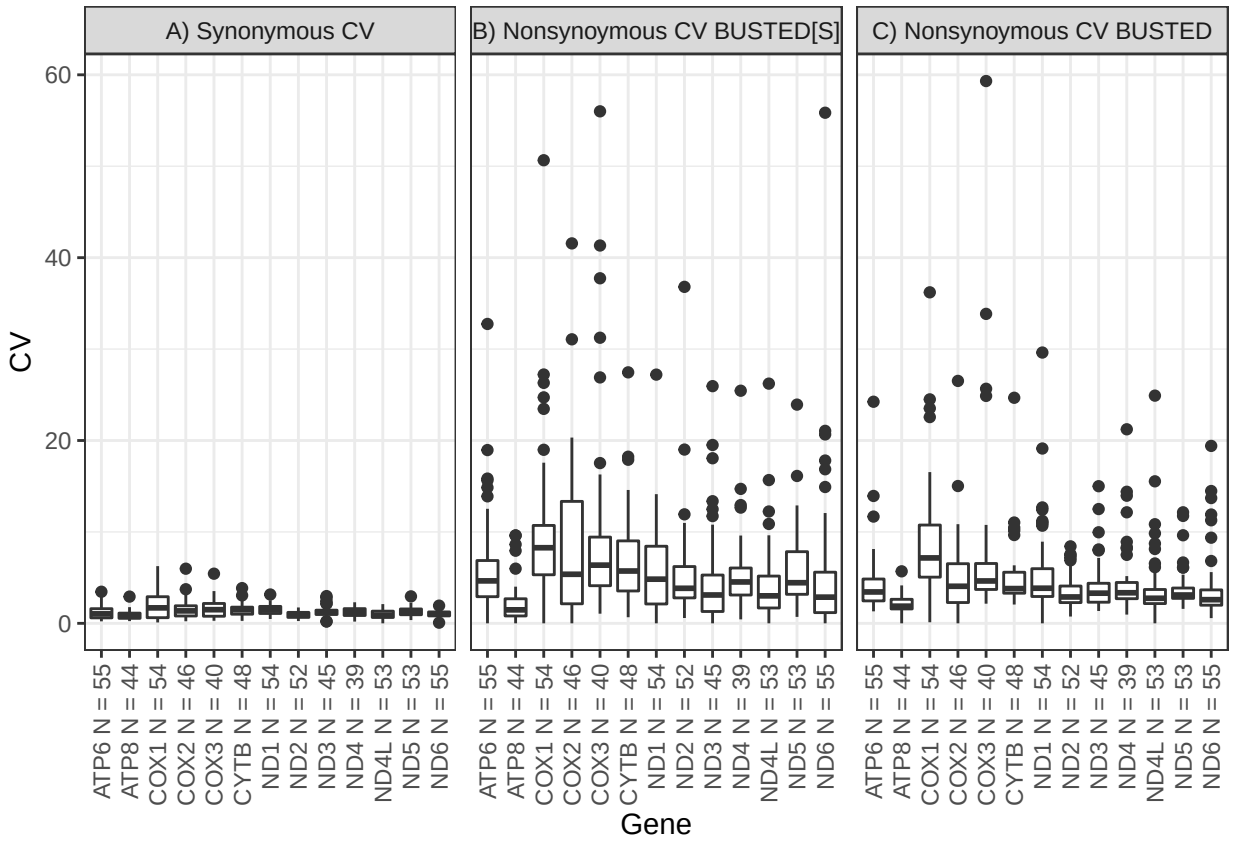
```
syn_labels <- list("Synonymous.CV"="A) Synonymous CV",
                   "NS.CV" = "B) Nonsynoymous CV BUSTED[S]",
                   "CV.NSRV.busted" = "C) Nonsynoymous CV BUSTED")

syn_labeller <- function(variable,value){
  return(syn_labels[value])
}
```

boxplots of the CVs grouped by genes

```
num_orders_per_gene = mtDNA_3x3  %>% count(gene)
gene_boxplots <- mtDNA_3x3 %>% select(CV.SRV, CV.NSRV.srv, CV.NSRV.busted,gene)
gene_boxplots <-gene_boxplots %>% melt(id.vars = "gene")




gene_boxplots %>%ggplot(aes(gene, value))+
  geom_boxplot()+ facet_grid(~variable,labeller = syn_labeller)+
  #coord_cartesian(ylim = c(0,3.5))+
  ylab("CV")+xlab("Gene")+ theme_bw()+
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))+
  scale_x_discrete(labels = paste(num_orders_per_gene$gene, num_orders_per_gene$n, sep = " N = "))
```

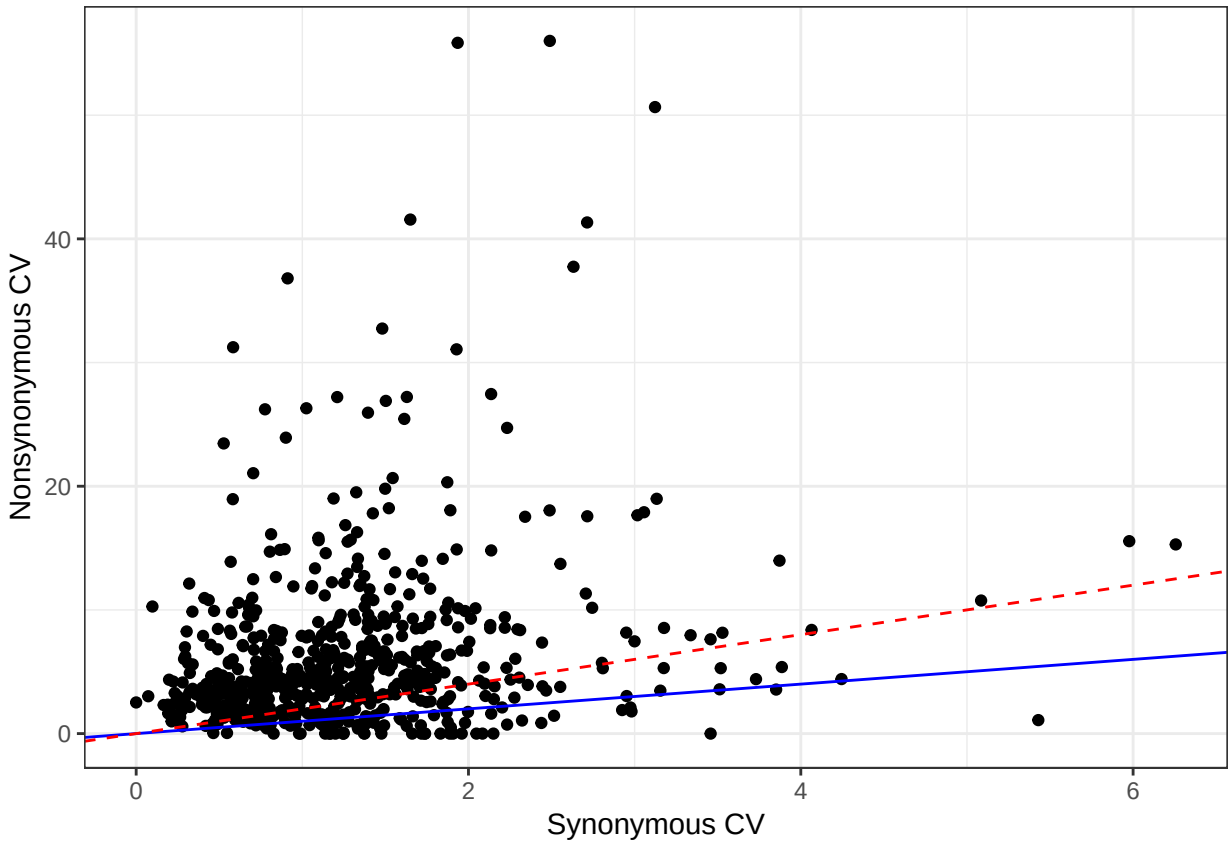
```
## Warning: The labeller API has been updated. Labellers taking `variable`and
## `value` arguments are now deprecated. See labellers documentation.
```

```
## Warning: Removed 2 rows containing non-finite values (stat_boxplot).
```




```
mtDNA_3x3 %>% ggplot()+geom_point(aes(CV.SRV, CV.NSRV.srv))+ xlab("Synonymous CV")+
  ylab("Nonsynonymous CV")+ theme_bw()+
  geom_abline(slope = 1, intercept = 0, color = 'blue') +
  geom_abline(slope = 2, intercept = 0,color='red', linetype = "dashed" )
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```




```
#+
 # coord_cartesian(ylim = c(0,3.5), xlim = c(0,1.65))
```

```
source("/Volumes/GoogleDrive/My Drive/BUSTED-SRV/R/useful_functions.R")
gen.sig.table(mtDNA_3x3)
```

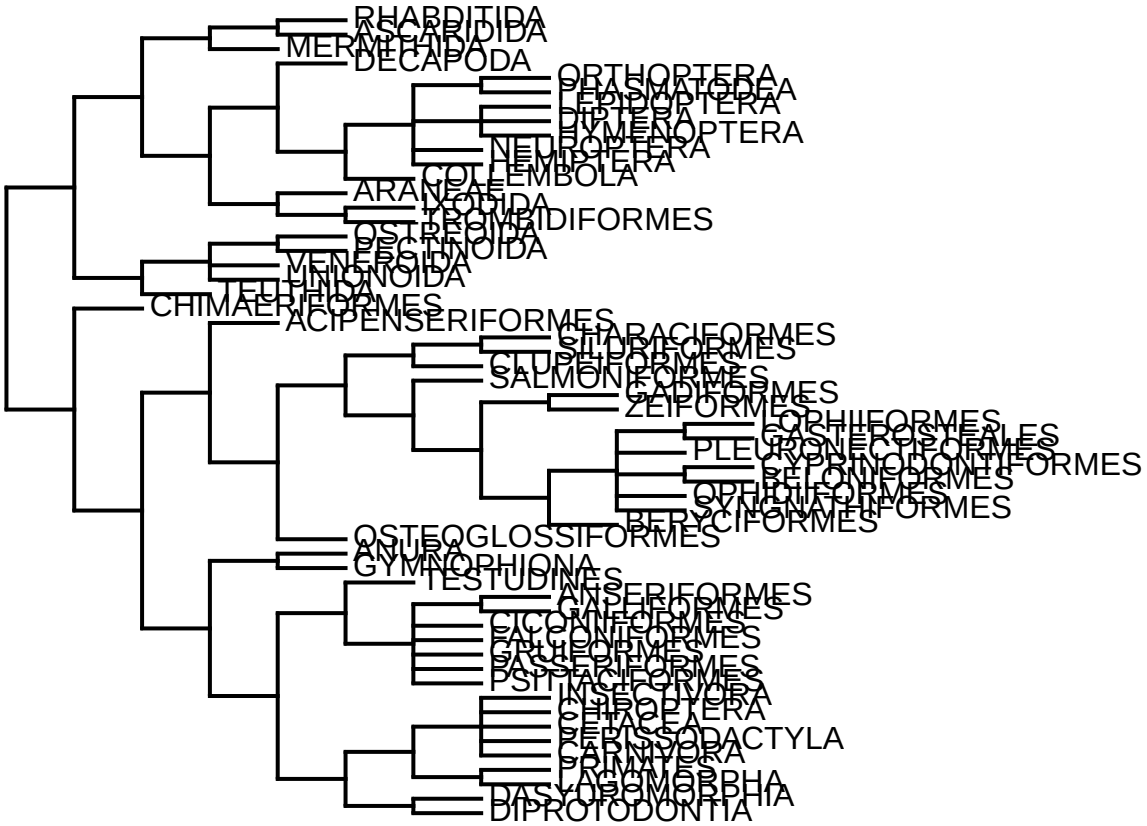
```
## Loading required package: xtable
```

```
##                BUSTED-SRV
## BUSTED          No Selection  Selection
##   No Selection   0.79623824 0.03448276
##   Selection      0.12852665 0.04075235
```

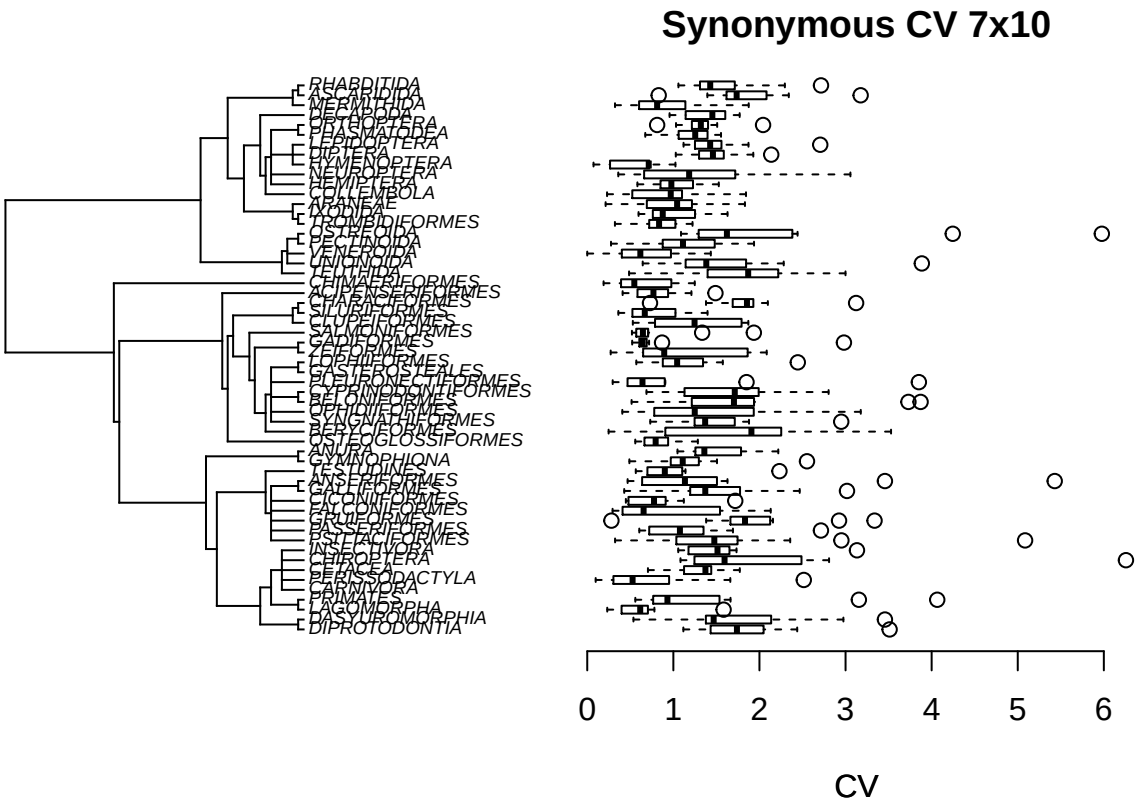
boxplots via order tree

```
#read u=in the tree with ape
class.order.tree <- read.tree(file = "~/bin/mtDNA_redo/data/phyliptree_order_class.phy")
tip_labels = toupper(class.order.tree$tip.label)
class.order.tree$tip.label <- tip_labels
mtDNA_3x3$order <-factor(mtDNA_3x3$order, levels = tip_labels)
Syn.CV.mtDNA_3x3= mtDNA_3x3 %>% select(CV.SRV)
names.Syn.CV.mtDNA_3x3 = mtDNA_3x3 %>% select(order)

Syn.CV.mtDNA_3x3 = as.vector(as.matrix(Syn.CV.mtDNA_3x3))
names.Syn.CV.mtDNA_3x3 = as.vector(as.matrix(names.Syn.CV.mtDNA_3x3))
# for(i in 1:length(new_labels)){
# names.Syn.CV.mtDNA_3x3   =str_replace_all(names.Syn.CV.mtDNA_3x3, pattern=num_genes_per_order$Order[i
# }
names(Syn.CV.mtDNA_3x3) = names.Syn.CV.mtDNA_3x3
```

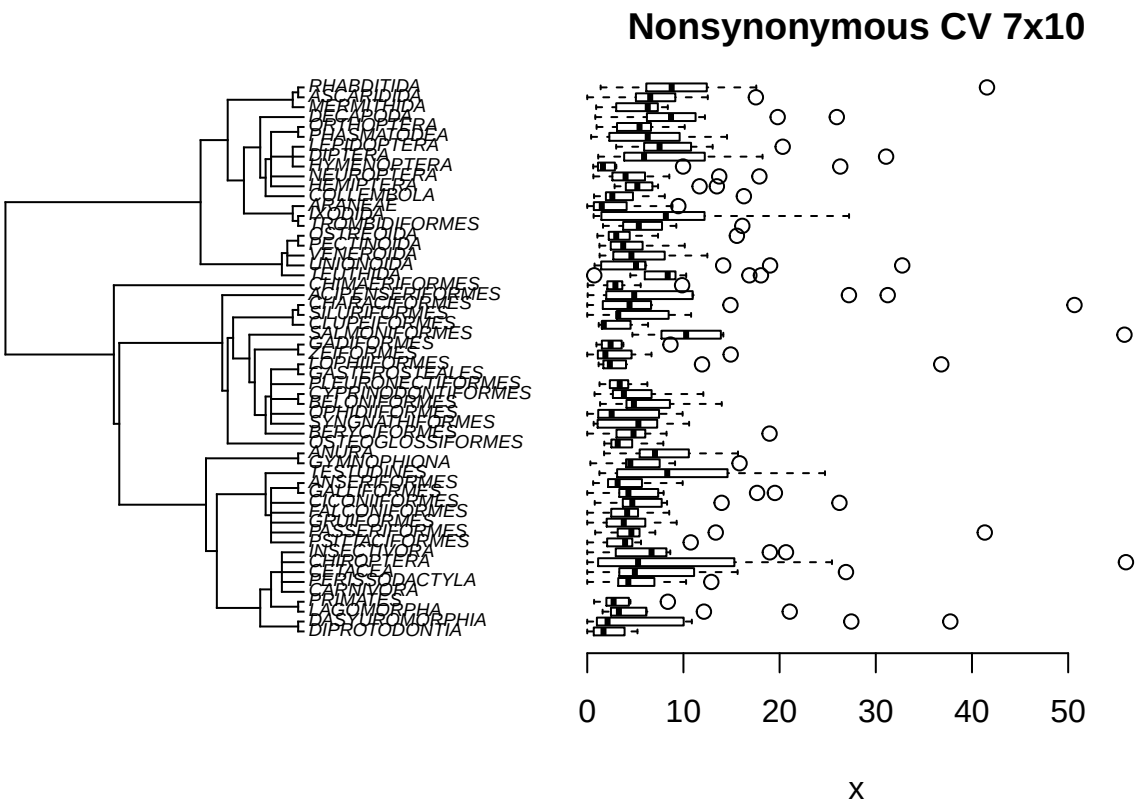
```
NonSyn.CV.mtDNA_3x3 = mtDNA_3x3 %>% select(CV.NSRV.srv)
names.nonSyn.CV.mtDNA_3x3 = mtDNA_3x3 %>% select(order)

NonSyn.CV.mtDNA_3x3 = as.vector(as.matrix(NonSyn.CV.mtDNA_3x3))
names.nonSyn.CV.mtDNA_3x3 = as.vector(as.matrix(names.nonSyn.CV.mtDNA_3x3))
names(NonSyn.CV.mtDNA_3x3) = names.Syn.CV.mtDNA_3x3

#pdf("tree.pdf", height = 11, width = 8.5)
plotTree(class.order.tree)
#dev.off()

#win.metafile("Images/tree.wmf", height = 11, width = 8.5)
plotTree(class.order.tree)
```




```
#dev.off()

class.order.tree$edge.length =NULL
#generate SYNCV tree and box plot
#png(filename = "Images/tree_syn_order.png", width = 500, height = 800)
plotTree.boxplot(class.order.tree, Syn.CV.mtDNA_3x3,
                 args.plotTree = list(fsize = c(0.6)),
                 args.boxplot=list(main = "Synonymous CV 7x10", xlab = "CV"))
```




```
#dev.off()
#generate nonsynCV tree and box plot
#png(filename = "Images/tree_nonsyn_order.png",width = 500, height = 800)
plotTree.boxplot(class.order.tree, NonSyn.CV.mtDNA_3x3,
                 args.plotTree = list(fsize = 0.6),
                 args.boxplot=list(main = "Nonsynonymous CV 7x10"))
```




```
#dev.off()
```

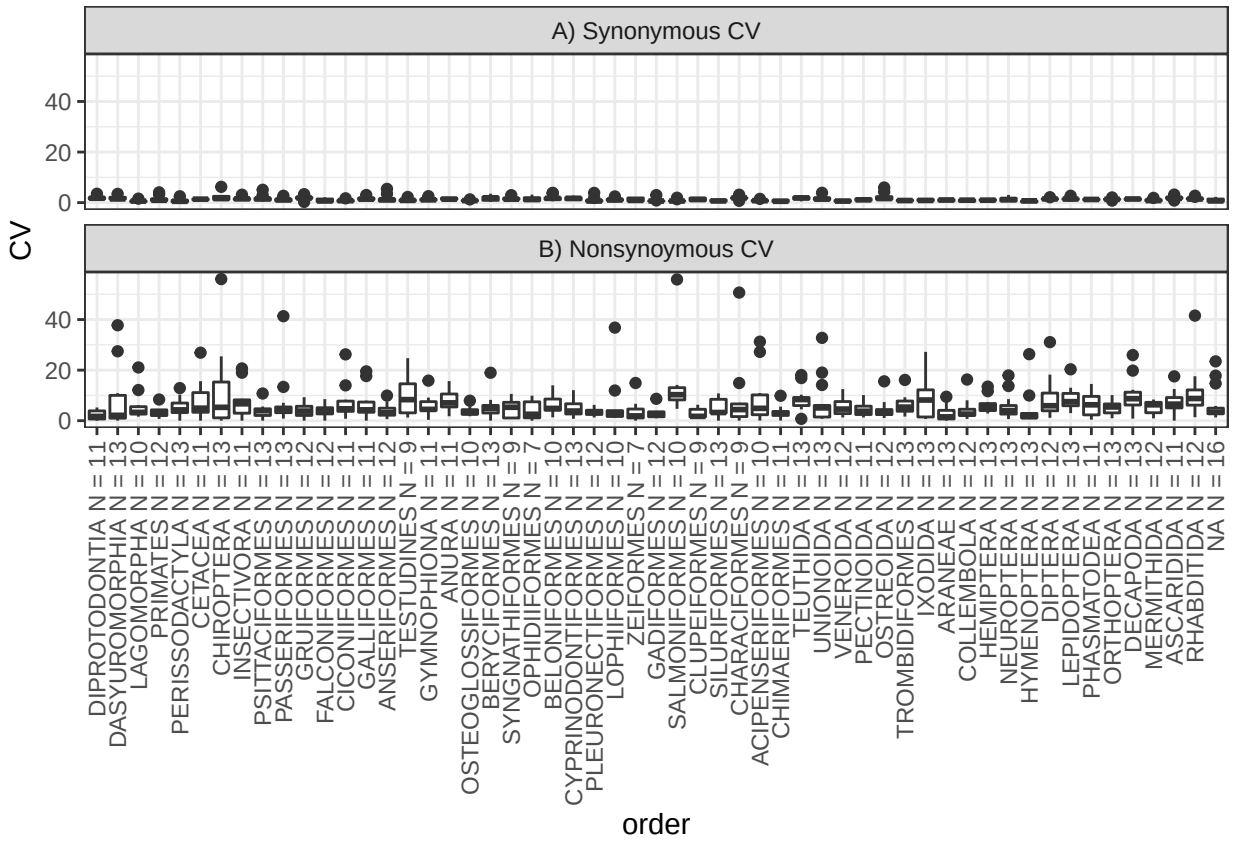
```
###order boxplots w/o tree
num_gene_per_order <- mtDNA_3x3 %>% count(order)
```

```
## Warning: Factor `order` contains implicit NA, consider using
## `forcats::fct_explicit_na`
```

```
order_boxplots <-mtDNA_3x3 %>% select(CV.SRV, CV.NSRV.srv, order)
order_boxplots <- order_boxplots %>% melt(id.vars = "order")

syn_labels <- list("Synonymous.CV"="A) Synonymous CV",
                   "NS.CV" = "B) Nonsynoymous CV")

syn_labeller <- function(variable,value){
  return(syn_labels[value])
}

#png(filename = "Images/no_tree_order_boxplots.png", height = 6, width = 8,res = 700, units="in")
order_boxplots %>%ggplot(aes(order, value))+
  geom_boxplot()+ facet_wrap(~variable,labeller = syn_labeller, nrow = 2)+
  #coord_cartesian(ylim = c(0,3.5))+
  theme_bw()+ ylab("CV")+
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))+
  scale_x_discrete(labels = paste(num_gene_per_order$order, num_gene_per_order$n, sep = " N = "))
```

```
## Warning: The labeller API has been updated. Labellers taking `variable`and
## `value` arguments are now deprecated. See labellers documentation.
```

```
## Warning: Removed 1 rows containing non-finite values (stat_boxplot).
```

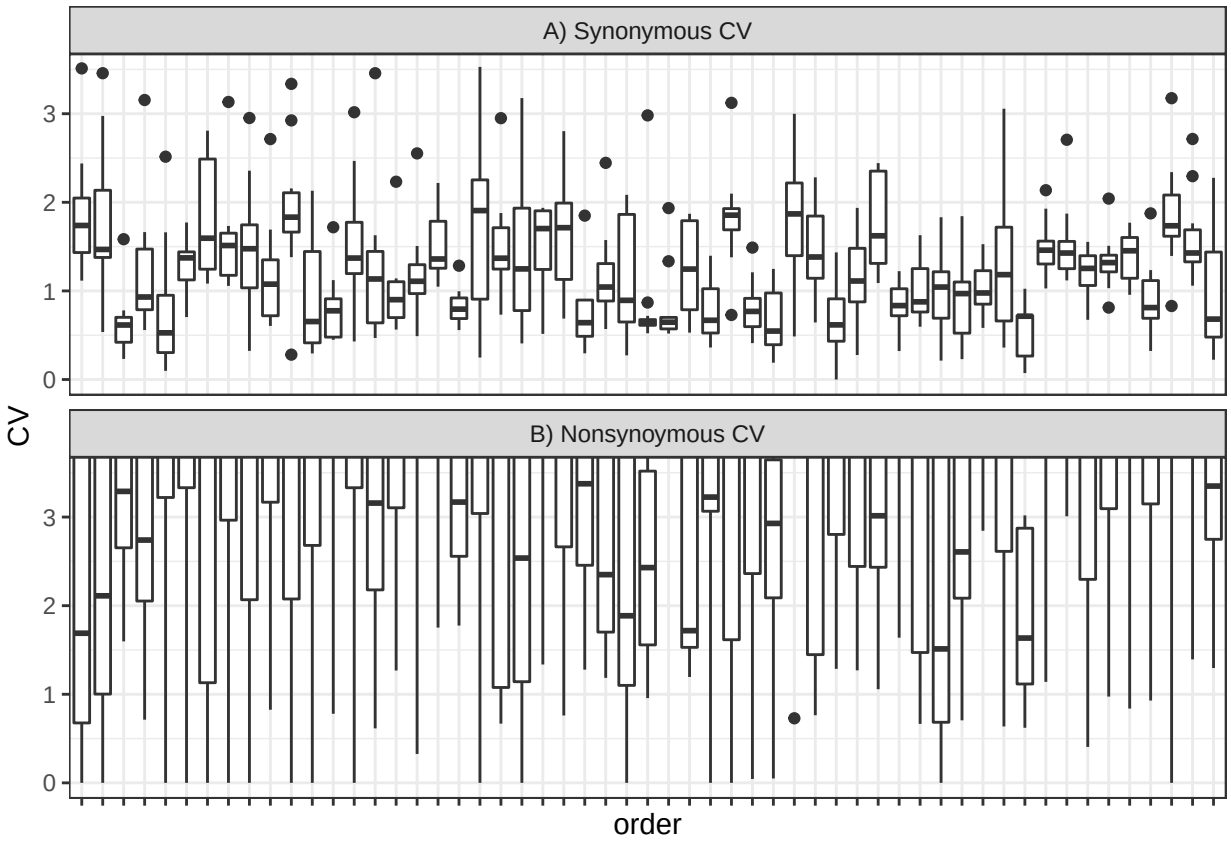



```
#dev.off()

#win.metafile(filename = "Images/no_tree_order_boxplots.wmf", height = 6, width = 10)
order_boxplots %>%ggplot(aes(order, value))+
  geom_boxplot()+ facet_wrap(~variable,labeller = syn_labeller, nrow = 2)+coord_cartesian(ylim = c(0,3.5
  theme_bw()+ ylab("CV")+
theme(axis.text.x = element_text(angle = 65, vjust = 1, hjust=1))+
  scale_x_discrete(labels =num_gene_per_order$Order)
```

```
## Warning: The labeller API has been updated. Labellers taking `variable`and
## `value` arguments are now deprecated. See labellers documentation.
```

```
## Warning: Unknown or uninitialised column: 'Order'.
```

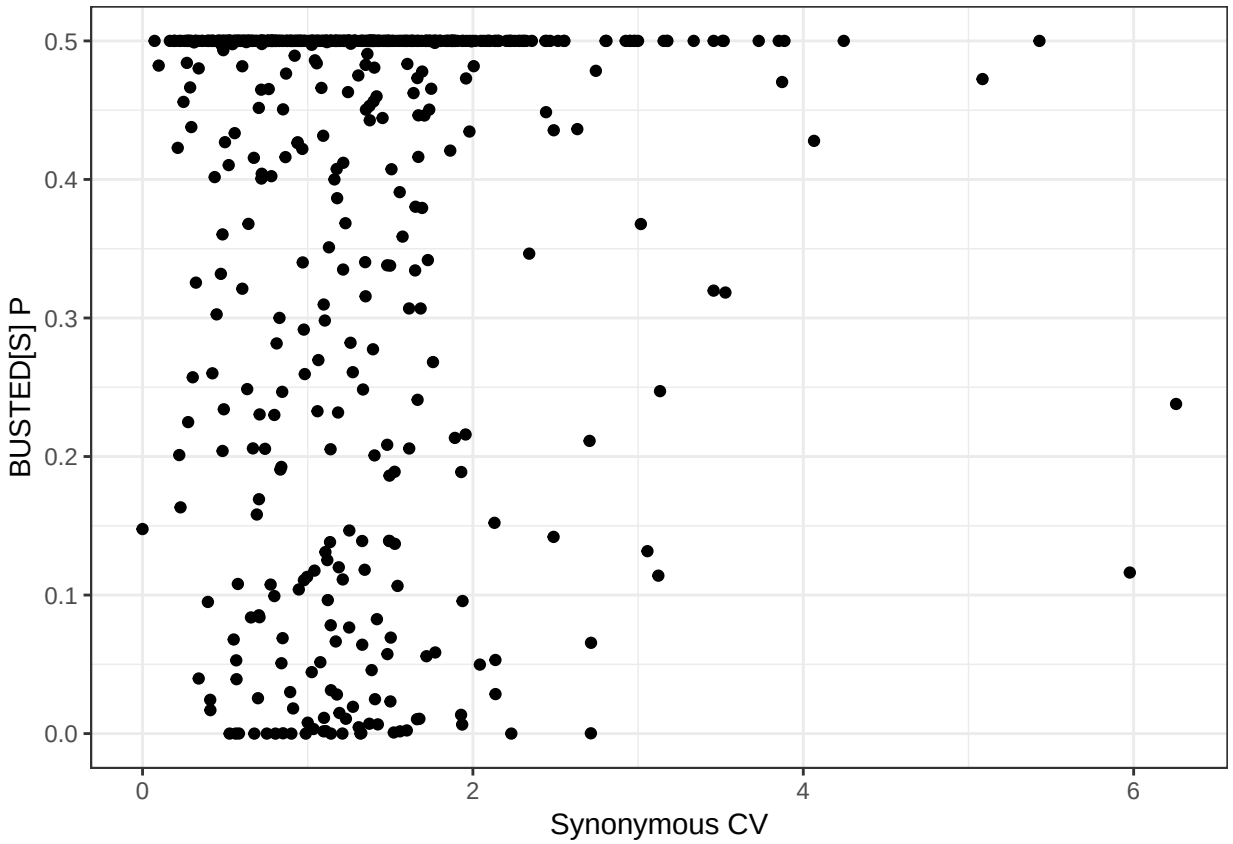
```
## Warning: Removed 1 rows containing non-finite values (stat_boxplot).
```



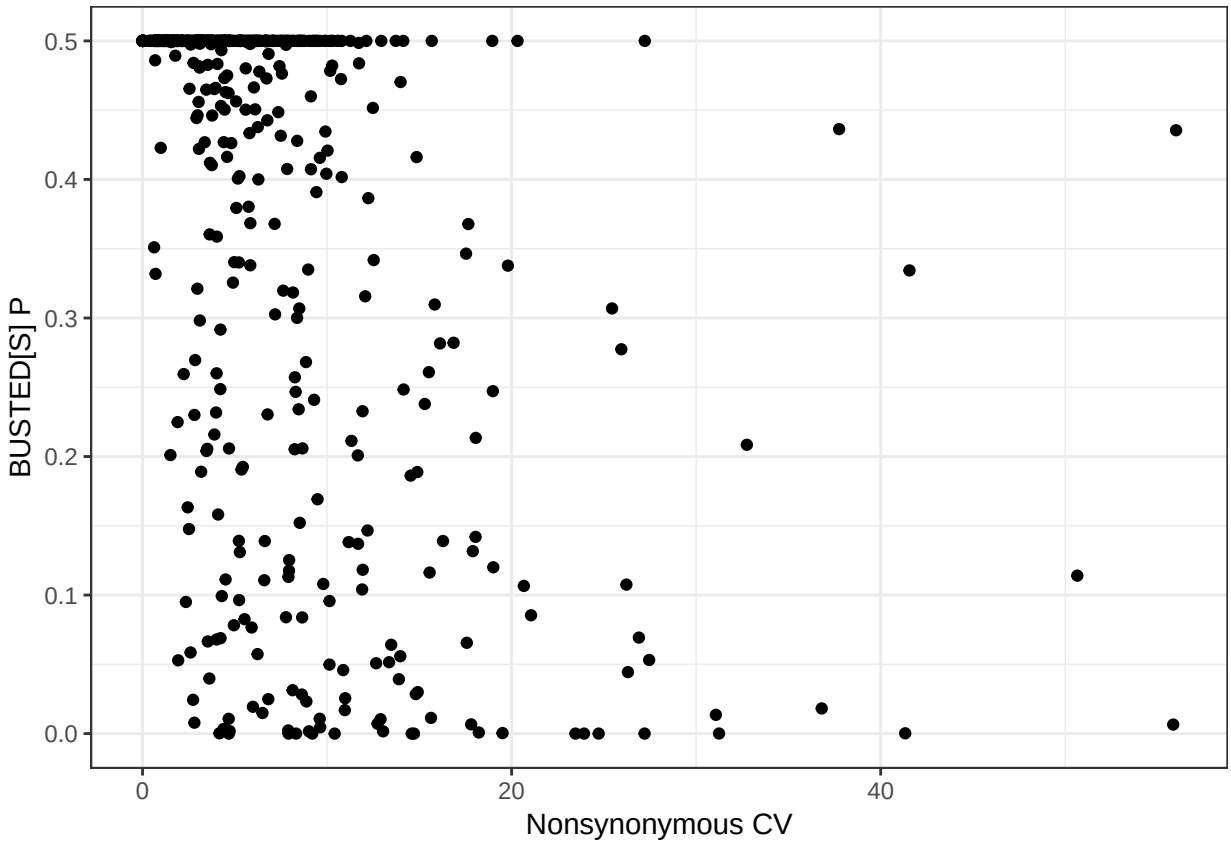

```
#dev.off()
```

```
mtDNA_3x3 %>% ggplot()+geom_point(aes(CV.SRV, BUSTED.SRV.P))+ xlab("Synonymous CV")+
  ylab("BUSTED[S] P")+ theme_bw()
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```

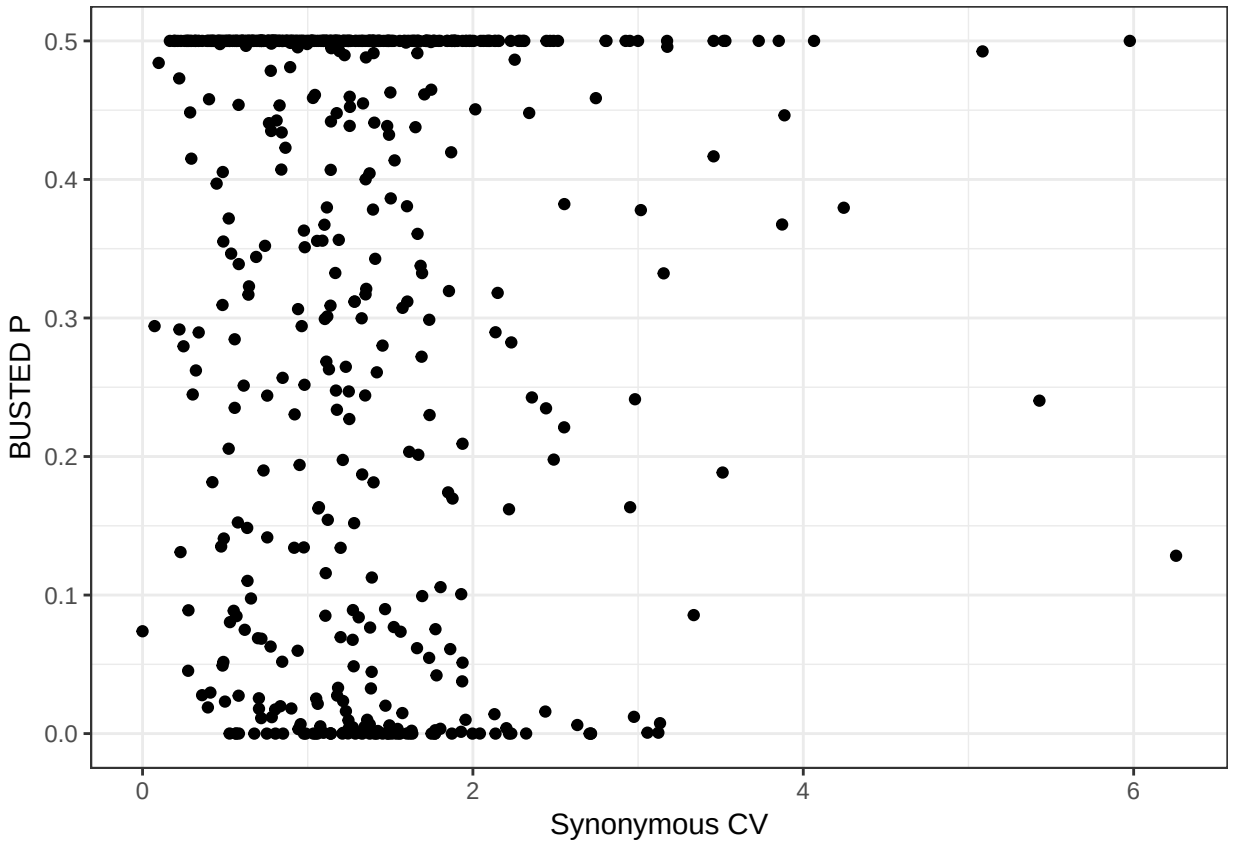



```
mtDNA_3x3 %>% ggplot()+geom_point(aes(CV.NSRV.srv, BUSTED.SRV.P))+ xlab("Nonsynonymous CV")+
  ylab("BUSTED[S] P")+ theme_bw()
```




```
mtDNA_3x3 %>% ggplot()+geom_point(aes(CV.SRV, BUSTED.P))+ xlab("Synonymous CV")+
  ylab("BUSTED P")+ theme_bw()
```

```
## Warning: Removed 2 rows containing missing values (geom_point).
```



Likelihood ratio calculation for Unconstrained log likelihood between BUSTED (H0) and BUSTED[S] (HA)

```
stats = data.frame(File = "",order ="", gene = "", LRT.D = as.numeric(NA), p = as.numeric(NA), stringsAs

#stats =data.frame(File = files, LRT.D = as.numeric(NA), p = as.numeric(NA), stringsAsFactors = F )

#need to make sure things match up
k=1
n=1
for(n in seq(1,nrow(mtDNA_3x3)-1,by=1)){

  D = -2*(mtDNA_3x3$BUSTED.UNLogL[n]-mtDNA_3x3$BUSTED.SRV.UNLogL[n])
  if(as.numeric(D) >= 0 ){
  p =1-pchibarsq(as.numeric(D), df = 1, mix =0.5)
  }
  stats[k,] = c(mtDNA_3x3$FILE[n],mtDNA_3x3$order[n],mtDNA_3x3$gene[n], D, p)
 D = NA
 p = NA
  k=k+1
}
stats$LRT.D = as.numeric(stats$LRT.D)
stats$p = as.numeric(stats$p)
#stats = stats %>% mutate(sort = paste(File, sep = "_"))
```

```
print(stats)
```

```
##
## 1             /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-atp6-align-dr
## 2             /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-atp8-align-dr
## 3             /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-cox1-align-dr
## 4             /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-cox2-align-dr
## 5             /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-cox3-align-dr
## 6              /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-nd1-align-dr
## 7              /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-nd2-align-dr
## 8              /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-nd3-align-dr
## 9              /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-nd5-align-dr
## 10             /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Acipenseriformes/acipenseriformes-nd6-align-dr
## 11                  /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-ATP6-Aligned-DN
## 12                  /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-ATP8-Aligned-DN
## 13                  /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-COX1-Aligned-DN
## 14                  /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-COX2-Aligned-DN
## 15                  /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-COX3-Aligned-DN
## 16                  /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-CYTB-Aligned-DN
## 17                   /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-ND1-Aligned-DN
## 18                   /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-ND2-Aligned-DN
## 19                   /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-ND3-Aligned-DN
## 20                  /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-ND4L-Aligned-DN
## 21                   /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-ND5-Aligned-DN
## 22                   /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anseriformes/Anseriformes-ND6-Aligned-DN
## 23                               /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-ATP6-Aligned-DN
## 24                               /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-COX1-Aligned-DN
## 25                               /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-COX2-Aligned-DN
## 26                               /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-COX3-Aligned-DN
## 27                               /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-CYTB-Aligned-DN
## 28                                /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-ND1-Aligned-DN
## 29                                /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-ND2-Aligned-DN
## 30                                /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-ND3-Aligned-DN
## 31                                /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-ND4-Aligned-DN
## 32                               /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-ND4L-Aligned-DN
## 33                                /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Anura/Anura-ND6-Aligned-DN
## 34                          /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-atp6-align-dr
## 35                          /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-atp8-align-dr
## 36                          /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-cox1-align-dr
## 37                          /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-cox2-align-dr
## 38                          /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-cox3-align-dr
## 39                          /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-cytb-align-dr
## 40                           /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-nd1-align-dr
## 41                           /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-nd2-align-dr
## 42                           /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-nd3-align-dr
## 43                           /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-nd4-align-dr
## 44                           /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-nd5-align-dr
## 45                           /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Araneae/araneae-nd6-align-dr
## 46                  /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-ATP6-Aligned-DN
## 47                  /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-COX1-Aligned-DN
## 48                  /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-COX2-Aligned-DN
## 49                  /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-COX3-Aligned-DN
## 50                  /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-CYTB-Aligned-DN
## 51                   /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-ND1-Aligned-DN
```

```
## 52                    /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-ND2-Aligned-DI
## 53                    /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-ND3-Aligned-DI
## 54                    /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-ND4-Aligned-DI
## 55                   /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Ascaridida/Ascaridida-ND4L-Aligned-DI
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## 248                   /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Galliformes/Galliformes-ND2-Aligned-DI
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## 441                  /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Pectinoida/Pectinoida-COX3-Aligned-DI
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## 447                  /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Pectinoida/Pectinoida-ND4L-Aligned-DI
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## 464                /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Phasmatodea/Phasmatodea-ATP8-Aligned-DI
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## 466                /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Phasmatodea/Phasmatodea-CYTB-Aligned-DI
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## 468                 /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Phasmatodea/Phasmatodea-ND2-Aligned-DI
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## 472                 /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Phasmatodea/Phasmatodea-ND5-Aligned-DI
## 473                 /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Phasmatodea/Phasmatodea-ND6-Aligned-DI
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## 480        /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Pleuronectiformes/Pleuronectiformes-ND2-Aligned-DI
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## 483       /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Pleuronectiformes/Pleuronectiformes-ND4L-Aligned-DI
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## 488                          /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Primates/primates-cox1-align-dn
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## 620                     /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-COX1-Aligned-DI
## 621                     /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-COX2-Aligned-DI
## 622                     /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-COX3-Aligned-DI
## 623                     /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-CYTB-Aligned-DI
## 624                      /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-ND1-Aligned-DI
## 625                      /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-ND2-Aligned-DI
## 626                      /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-ND3-Aligned-DI
## 627                      /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-ND4-Aligned-DI
## 628                     /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-ND4L-Aligned-DI
## 629                      /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-ND5-Aligned-DI
## 630                      /home/swisotsky/mtDNA_BUSTED/mtDNA/INVERT/Veneroida/Veneroida-ND6-Aligned-DI
## 631                         /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Zeiformes/zeiformes-atp6-align-dr
## 632                         /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Zeiformes/zeiformes-atp8-align-dr
## 633                         /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Zeiformes/zeiformes-cox1-align-dr
## 634                          /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Zeiformes/zeiformes-nd1-align-dr
## 635                         /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Zeiformes/zeiformes-nd4l-align-dr
## 636                          /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Zeiformes/zeiformes-nd5-align-dr
## 637                          /home/swisotsky/mtDNA_BUSTED/mtDNA/VERT/Zeiformes/zeiformes-nd6-align-dr
##     order gene        LRT.D            p
## 1      35 ATP6   31.5569061 9.684017e-09
## 2      35 ATP8    1.3657686 1.212701e-01
## 3      35 COX1   44.4414495 1.310396e-11
## 4      35 COX2   30.5278520 1.645538e-08
## 5      35 COX3   23.0740968 7.793830e-07
## 6      35  ND1   24.0512526 4.690261e-07
## 7      35  ND2   54.6372511 7.249756e-14
```

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## 8      35  ND3   13.4109578 1.250793e-04
## 9      35  ND5   15.6929772 3.725014e-05
## 10     35  ND6   24.0744060 4.634202e-07
## 11     16 ATP6   55.5914594 4.463097e-14
## 12     16 ATP8   31.5402749 9.767313e-09
## 13     16 COX1   35.8029154 1.091605e-09
## 14     16 COX2   22.8148050 8.919311e-07
## 15     16 COX3   56.2295017 3.219647e-14
## 16     16 CYTB   59.0910313 7.549517e-15
## 17     16  ND1   35.9356007 1.019740e-09
## 18     16  ND2   22.9699610 8.227632e-07
## 19     16  ND3   20.4357148 3.083407e-06
## 20     16 ND4L   20.2852333 3.335675e-06
## 21     16  ND5   92.2716188 0.000000e+00
## 22     16  ND6   31.0870153 1.233581e-08
## 23     19 ATP6  624.2609838 0.000000e+00
## 24     19 COX1  711.8799139 0.000000e+00
## 25     19 COX2  500.9425005 0.000000e+00
## 26     19 COX3  552.2636041 0.000000e+00
## 27     19 CYTB  983.7722861 0.000000e+00
## 28     19  ND1  884.3962268 0.000000e+00
## 29     19  ND2 1129.5928119 0.000000e+00
## 30     19  ND3  455.9507575 0.000000e+00
## 31     19  ND4 1111.0500140 0.000000e+00
## 32     19 ND4L  246.5394098 0.000000e+00
## 33     19  ND6  644.7037918 0.000000e+00
## 34     44 ATP6    2.7304039 4.922719e-02
## 35     44 ATP8   31.8530123 8.314579e-09
## 36     44 COX1   22.9646887 8.250228e-07
## 37     44 COX2  149.8096253 0.000000e+00
## 38     44 COX3  201.3165446 0.000000e+00
## 39     44 CYTB   31.0317422 1.269215e-08
## 40     44  ND1   10.3595761 6.440239e-04
## 41     44  ND2   50.6649987 5.477840e-13
## 42     44  ND3    1.6006387 1.029064e-01
## 43     44  ND4    1.8819301 8.505747e-02
## 44     44  ND5  121.2118880 0.000000e+00
## 45     44  ND6   -0.1470083           NA
## 46     55 ATP6   53.1328279 1.558753e-13
## 47     55 COX1   32.1265120 7.222628e-09
## 48     55 COX2   35.1594446 1.518923e-09
## 49     55 COX3   70.5441029 0.000000e+00
## 50     55 CYTB  105.3185550 0.000000e+00
## 51     55  ND1   85.7007028 0.000000e+00
## 52     55  ND2   64.1746194 5.551115e-16
## 53     55  ND3   77.1031157 0.000000e+00
## 54     55  ND4   72.4408020 0.000000e+00
## 55     55 ND4L   25.4537485 2.265582e-07
## 56     55  ND6   34.5338541 2.094509e-09
## 57     24 ATP6  121.1112419 0.000000e+00
## 58     24 ATP8   29.1666844 3.320569e-08
## 59     24 COX1  205.6404270 0.000000e+00
## 60     24 COX2   48.6099279 1.561418e-12
## 61     24  ND1  210.0436801 0.000000e+00
```

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## 62     24  ND2  270.1769343 0.000000e+00
## 63     24  ND4  422.9894418 0.000000e+00
## 64     24 ND4L   42.8922035 2.892042e-11
## 65     24  ND5  672.5915329 0.000000e+00
## 66     24  ND6  148.9452237 0.000000e+00
## 67     21 ATP6   71.3026033 0.000000e+00
## 68     21 ATP8   22.1011338 1.293285e-06
## 69     21 COX1   82.7158611 0.000000e+00
## 70     21 COX2   33.5267769 3.514481e-09
## 71     21 COX3   76.3247887 0.000000e+00
## 72     21 CYTB  121.1248879 0.000000e+00
## 73     21  ND1   92.9982140 0.000000e+00
## 74     21  ND2  105.2594642 0.000000e+00
## 75     21  ND3   79.2044671 0.000000e+00
## 76     21  ND4  158.0875544 0.000000e+00
## 77     21 ND4L   42.7184092 3.160727e-11
## 78     21  ND5  249.1093164 0.000000e+00
## 79     21  ND6   29.2314476 3.211413e-08
## 80      7 ATP6  160.9317178 0.000000e+00
## 81      7 ATP8   96.3367159 0.000000e+00
## 82      7 COX1  127.4459875 0.000000e+00
## 83      7 COX2   65.2359982 3.330669e-16
## 84      7 COX3  136.5537902 0.000000e+00
## 85      7 CYTB  188.2783807 0.000000e+00
## 86      7  ND1  174.9508121 0.000000e+00
## 87      7  ND2  137.2219458 0.000000e+00
## 88      7 ND4L   46.0931180 5.638157e-12
## 89      7  ND5  331.8163790 0.000000e+00
## 90      7  ND6  100.9373440 0.000000e+00
## 91     34 ATP6  232.5772885 0.000000e+00
## 92     34 ATP8   98.6090336 0.000000e+00
## 93     34 COX1  327.9194547 0.000000e+00
## 94     34 COX2  173.6312123 0.000000e+00
## 95     34 CYTB  361.2738024 0.000000e+00
## 96     34  ND1  284.4591811 0.000000e+00
## 97     34 ND4L   99.0133706 0.000000e+00
## 98     34  ND5  760.6542889 0.000000e+00
## 99     34  ND6  194.2509938 0.000000e+00
## 100    36 ATP6   11.6237916 3.255676e-04
## 101    36 ATP8   13.4537866 1.222561e-04
## 102    36 COX1   39.8475997 1.372857e-10
## 103    36 COX2   22.4441540 1.081715e-06
## 104    36 COX3   16.5952288 2.313364e-05
## 105    36 CYTB   19.7661793 4.375884e-06
## 106    36  ND1    1.2953416 1.275329e-01
## 107    36  ND2   14.2691949 7.921836e-05
## 108    36 ND4L    8.6779943 1.610376e-03
## 109    36  ND5   18.2402083 9.736219e-06
## 110    36  ND6   10.8384617 4.970664e-04
## 111     8 ATP6  105.9311131 0.000000e+00
## 112     8 ATP8  107.7813057 0.000000e+00
## 113     8 COX1   43.6748552 1.938605e-11
## 114     8 COX2   48.4974694 1.653566e-12
## 115     8 COX3  107.0219345 0.000000e+00
```

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## 116     8 CYTB  146.1799488 0.000000e+00
## 117     8  ND1  150.0553904 0.000000e+00
## 118     8  ND2   76.5587476 0.000000e+00
## 119     8  ND3   50.4552439 6.095124e-13
## 120     8  ND4  214.0864807 0.000000e+00
## 121     8 ND4L   35.5908244 1.217157e-09
## 122     8  ND5  302.8170047 0.000000e+00
## 123     8  ND6   88.4586390 0.000000e+00
## 124    14 ATP6   18.1957241 9.966292e-06
## 125    14 ATP8   19.7563861 4.398363e-06
## 126    14 COX1   12.5603111 1.970131e-04
## 127    14 COX2   52.1065817 2.629008e-13
## 128    14 CYTB   49.7961123 8.528733e-13
## 129    14  ND1   29.1575914 3.336190e-08
## 130    14  ND2   53.0066923 1.662004e-13
## 131    14  ND3   22.9928740 8.130150e-07
## 132    14 ND4L   20.4568595 3.049529e-06
## 133    14  ND5   35.6007115 1.210995e-09
## 134    14  ND6    5.3337019 1.045846e-02
## 135    32 ATP6  232.5622781 0.000000e+00
## 136    32 ATP8   88.5421320 0.000000e+00
## 137    32 COX1  258.7942781 0.000000e+00
## 138    32  ND1  334.9334047 0.000000e+00
## 139    32  ND2  408.2600547 0.000000e+00
## 140    32  ND4  556.4039599 0.000000e+00
## 141    32 ND4L   94.5209025 0.000000e+00
## 142    32  ND5  880.1768651 0.000000e+00
## 143    32  ND6  259.1959770 0.000000e+00
## 144    45 ATP6  143.1989046 0.000000e+00
## 145    45 ATP8   34.6899246 1.933137e-09
## 146    45 COX1  105.2349234 0.000000e+00
## 147    45 COX2  538.1606577 0.000000e+00
## 148    45 COX3  303.3068734 0.000000e+00
## 149    45 CYTB   12.5426268 1.988864e-04
## 150    45  ND1  139.5563950 0.000000e+00
## 151    45  ND2  164.4788439 0.000000e+00
## 152    45  ND3   54.0805717 9.614531e-14
## 153    45 ND4L   19.9033447 4.072884e-06
## 154    45  ND5    5.6367532 8.793874e-03
## 155    45  ND6    0.7674847 1.904981e-01
## 156    25 ATP6   65.8916708 2.220446e-16
## 157    25 ATP8   45.0006477 9.848455e-12
## 158    25 COX1   91.8355916 0.000000e+00
## 159    25 COX2   92.1568997 0.000000e+00
## 160    25 COX3  154.0071520 0.000000e+00
## 161    25 CYTB  120.2294379 0.000000e+00
## 162    25  ND1  212.7035737 0.000000e+00
## 163    25  ND2  118.9533201 0.000000e+00
## 164    25  ND3   91.3089272 0.000000e+00
## 165    25  ND4  316.6138568 0.000000e+00
## 166    25 ND4L   42.1337520 4.261969e-11
## 167    25  ND5  309.7644254 0.000000e+00
## 168    25  ND6  167.7341924 0.000000e+00
## 169     2 ATP6   64.8457062 4.440892e-16
```

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## 170     2 ATP8   16.8201696 2.054710e-05
## 171     2 COX1   51.1857670 4.201084e-13
## 172     2 COX2   51.5221473 3.539391e-13
## 173     2 COX3   75.4003735 0.000000e+00
## 174     2 CYTB  115.1588668 0.000000e+00
## 175     2  ND1   68.6237331 0.000000e+00
## 176     2  ND2  107.7291538 0.000000e+00
## 177     2  ND3   14.1454520 8.460283e-05
## 178     2  ND4  149.2752434 0.000000e+00
## 179     2 ND4L   46.6435784 4.257261e-12
## 180     2  ND5   37.3648173 4.898684e-10
## 181     2  ND6   34.1128787 2.600296e-09
## 182    53 ATP6  537.2843745 0.000000e+00
## 183    53 ATP8  236.4166681 0.000000e+00
## 184    53 COX1  599.5711707 0.000000e+00
## 185    53 COX2  446.3655766 0.000000e+00
## 186    53 COX3  549.8077594 0.000000e+00
## 187    53 CYTB  705.2057137 0.000000e+00
## 188    53  ND1  783.3659537 0.000000e+00
## 189    53  ND2 1019.4978100 0.000000e+00
## 190    53  ND3  413.4026615 0.000000e+00
## 191    53  ND4 1455.6716977 0.000000e+00
## 192    53 ND4L  243.8076981 0.000000e+00
## 193    53  ND5 2128.8540279 0.000000e+00
## 194    53  ND6  611.2958423 0.000000e+00
## 195     1 ATP6  131.1139047 0.000000e+00
## 196     1 ATP8  118.5739972 0.000000e+00
## 197     1 COX1  131.0255406 0.000000e+00
## 198     1 COX2   79.8689713 0.000000e+00
## 199     1 CYTB  259.8945179 0.000000e+00
## 200     1  ND1  214.5577581 0.000000e+00
## 201     1  ND2  321.8631472 0.000000e+00
## 202     1  ND3   94.1563529 0.000000e+00
## 203     1 ND4L   64.6755389 4.440892e-16
## 204     1  ND5  548.3703172 0.000000e+00
## 205     1  ND6  153.2714589 0.000000e+00
## 206    49 ATP6  347.5461538 0.000000e+00
## 207    49 ATP8  162.2738150 0.000000e+00
## 208    49 COX1  515.3502888 0.000000e+00
## 209    49 COX2  246.1084243 0.000000e+00
## 210    49 COX3  386.5491940 0.000000e+00
## 211    49 CYTB  646.1217993 0.000000e+00
## 212    49  ND1  519.7021797 0.000000e+00
## 213    49  ND2  733.8486806 0.000000e+00
## 214    49  ND3  292.5631238 0.000000e+00
## 215    49 ND4L  111.8206334 0.000000e+00
## 216    49  ND5  698.9077731 0.000000e+00
## 217    49  ND6  467.1834564 0.000000e+00
## 218    13 ATP6   32.0906975 7.357009e-09
## 219    13 ATP8   22.1197266 1.280819e-06
## 220    13 COX1   37.5076318 4.552800e-10
## 221    13 COX2   25.8985958 1.799154e-07
## 222    13 CYTB   43.3452882 2.294198e-11
## 223    13  ND1   31.1969643 1.165652e-08
```

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## 224    13  ND2   45.0891371 9.413359e-12
## 225    13  ND3    4.3072790 1.897481e-02
## 226    13  ND4   60.9700061 2.886580e-15
## 227    13 ND4L   45.8730977 6.308287e-12
## 228    13  ND5   59.0504287 7.660539e-15
## 229    13  ND6   12.3377371 2.219464e-04
## 230    30 ATP6  108.9713855 0.000000e+00
## 231    30 COX1  180.7704860 0.000000e+00
## 232    30 COX2   84.4361953 0.000000e+00
## 233    30 COX3   83.6683302 0.000000e+00
## 234    30 CYTB  101.5429096 0.000000e+00
## 235    30  ND1   67.8975586 1.110223e-16
## 236    30  ND2  162.8449584 0.000000e+00
## 237    30  ND3   46.2533792 5.195400e-12
## 238    30  ND4  206.8666075 0.000000e+00
## 239    30 ND4L   34.0436945 2.694413e-09
## 240    30  ND5  235.5124356 0.000000e+00
## 241    30  ND6  103.2920051 0.000000e+00
## 242    15 ATP6  129.2912165 0.000000e+00
## 243    15 ATP8   90.2674897 0.000000e+00
## 244    15 COX1   96.0199624 0.000000e+00
## 245    15 COX2  103.4603243 0.000000e+00
## 246    15 CYTB  207.3733338 0.000000e+00
## 247    15  ND1  298.3403629 0.000000e+00
## 248    15  ND2  222.2233245 0.000000e+00
## 249    15  ND3  138.5483959 0.000000e+00
## 250    15 ND4L   76.4392846 0.000000e+00
## 251    15  ND5  346.7233158 0.000000e+00
## 252    15  ND6  109.7646456 0.000000e+00
## 253    12 ATP6   45.9887883 5.946577e-12
## 254    12 ATP8   31.0302294 1.270204e-08
## 255    12 COX1   25.8548722 1.840372e-07
## 256    12 COX2   36.9785059 5.971934e-10
## 257    12 CYTB   70.9929209 0.000000e+00
## 258    12  ND1   53.7178455 1.156852e-13
## 259    12  ND2   36.7918270 6.572006e-10
## 260    12  ND3   16.6813751 2.210647e-05
## 261    12  ND4  117.7102646 0.000000e+00
## 262    12 ND4L   23.5517232 6.080024e-07
## 263    12  ND5   68.3373147 0.000000e+00
## 264    12  ND6   78.0672785 0.000000e+00
## 265    18 ATP6  186.1193389 0.000000e+00
## 266    18 ATP8   63.4836155 8.881784e-16
## 267    18 COX1  135.8899831 0.000000e+00
## 268    18 COX2  160.9005071 0.000000e+00
## 269    18  ND1  275.0336139 0.000000e+00
## 270    18  ND2  238.8635156 0.000000e+00
## 271    18  ND3  135.9354103 0.000000e+00
## 272    18  ND4  341.7073348 0.000000e+00
## 273    18 ND4L   75.1654269 0.000000e+00
## 274    18  ND5  363.0963609 0.000000e+00
## 275    18  ND6   96.9933968 0.000000e+00
## 276    46 ATP6  696.9731433 0.000000e+00
## 277    46 ATP8  119.0078783 0.000000e+00
```

```
## 278    46 COX1 1488.2566946 0.000000e+00
## 279    46 COX2  693.2013078 0.000000e+00
## 280    46 COX3  593.8865122 0.000000e+00
## 281    46 CYTB 1153.0102791 0.000000e+00
## 282    46  ND1  754.1778547 0.000000e+00
## 283    46  ND2  715.8825328 0.000000e+00
## 284    46  ND3  382.5554862 0.000000e+00
## 285    46  ND4 1423.8737998 0.000000e+00
## 286    46 ND4L  167.5366233 0.000000e+00
## 287    46  ND5 1893.9004555 0.000000e+00
## 288    46  ND6  338.2619851 0.000000e+00
## 289    48 ATP6   80.2711025 0.000000e+00
## 290    48 ATP8   58.6389672 9.547918e-15
## 291    48 COX1  331.9962410 0.000000e+00
## 292    48 COX2  151.0432988 0.000000e+00
## 293    48 COX3  162.1111981 0.000000e+00
## 294    48 CYTB  199.9547812 0.000000e+00
## 295    48  ND1   53.4395864 1.333378e-13
## 296    48  ND2   24.3515656 4.013074e-07
## 297    48  ND3  117.7731380 0.000000e+00
## 298    48  ND4  -22.5451694           NA
## 299    48 ND4L   -2.4569501           NA
## 300    48  ND5  211.9721483 0.000000e+00
## 301    48  ND6   29.0419295 3.541428e-08
## 302     9 ATP6  193.4537470 0.000000e+00
## 303     9 ATP8  161.5184092 0.000000e+00
## 304     9 COX1  167.5242236 0.000000e+00
## 305     9 COX2   99.6480680 0.000000e+00
## 306     9 CYTB  305.3909253 0.000000e+00
## 307     9  ND1  212.3496536 0.000000e+00
## 308     9  ND2  218.6229287 0.000000e+00
## 309     9  ND3  113.9462627 0.000000e+00
## 310     9 ND4L   80.3606171 0.000000e+00
## 311     9  ND5  682.5237229 0.000000e+00
## 312     9  ND6  105.9475174 0.000000e+00
## 313    43 ATP6  288.8209940 0.000000e+00
## 314    43 ATP8   59.3624541 6.550316e-15
## 315    43 COX1  389.6209930 0.000000e+00
## 316    43 COX2  182.5956193 0.000000e+00
## 317    43 COX3  210.5555886 0.000000e+00
## 318    43 CYTB  410.6388138 0.000000e+00
## 319    43  ND1  298.1510466 0.000000e+00
## 320    43  ND2  130.7305574 0.000000e+00
## 321    43  ND3  126.6007310 0.000000e+00
## 322    43  ND4  286.4812212 0.000000e+00
## 323    43 ND4L  110.2858701 0.000000e+00
## 324    43  ND5  653.4857676 0.000000e+00
## 325    43  ND6   80.5323623 0.000000e+00
## 326     3 ATP6   23.0169891 8.028805e-07
## 327     3 ATP8   37.2294214 5.250868e-10
## 328     3 COX1    9.3139043 1.137107e-03
## 329     3 COX2    7.3644499 3.326297e-03
## 330     3 CYTB   33.4135312 3.725190e-09
## 331     3  ND1   24.2796328 4.165769e-07
```

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## 332     3  ND2    7.5329533 3.029026e-03
## 333     3 ND4L    8.8979728 1.427437e-03
## 334     3  ND5   16.5431987 2.377712e-05
## 335     3  ND6   13.5808827 1.142504e-04
## 336    50 ATP6  536.2349412 0.000000e+00
## 337    50 ATP8  261.1885985 0.000000e+00
## 338    50 COX1  615.8058357 0.000000e+00
## 339    50 COX2  322.1303607 0.000000e+00
## 340    50 COX3  623.0999978 0.000000e+00
## 341    50 CYTB  868.8589438 0.000000e+00
## 342    50  ND1  797.3852778 0.000000e+00
## 343    50  ND2  766.4562588 0.000000e+00
## 344    50  ND3  346.1070456 0.000000e+00
## 345    50  ND4 1077.7856733 0.000000e+00
## 346    50 ND4L  185.9803235 0.000000e+00
## 347    50  ND5 1389.8605286 0.000000e+00
## 348    50  ND6  586.2238028 0.000000e+00
## 349    28 ATP6  233.9272583 0.000000e+00
## 350    28 COX1  353.8128526 0.000000e+00
## 351    28 COX2  129.4690432 0.000000e+00
## 352    28 COX3  205.8251185 0.000000e+00
## 353    28 CYTB  364.0161514 0.000000e+00
## 354    28  ND1  324.8146779 0.000000e+00
## 355    28  ND2  437.7735757 0.000000e+00
## 356    28 ND4L   71.8676160 0.000000e+00
## 357    28  ND5  756.2589324 0.000000e+00
## 358    28  ND6  255.8247921 0.000000e+00
## 359    54 ATP6   97.9015865 0.000000e+00
## 360    54 COX1  402.2395166 0.000000e+00
## 361    54 COX2  151.3509576 0.000000e+00
## 362    54 COX3  174.7120309 0.000000e+00
## 363    54 CYTB  345.3598014 0.000000e+00
## 364    54  ND1  187.4209176 0.000000e+00
## 365    54  ND2   86.4909660 0.000000e+00
## 366    54  ND3   24.8719077 3.063439e-07
## 367    54  ND4  225.9847933 0.000000e+00
## 368    54 ND4L   14.0789590 8.764690e-05
## 369    54  ND5  336.4386578 0.000000e+00
## 370    54  ND6    3.6589585 2.788424e-02
## 371    47 ATP6  101.3695494 0.000000e+00
## 372    47 ATP8   53.2632368 1.458833e-13
## 373    47 COX1   31.5491628 9.722710e-09
## 374    47 COX2   55.6135920 4.418688e-14
## 375    47 COX3   86.9068259 0.000000e+00
## 376    47 CYTB   88.8128111 0.000000e+00
## 377    47  ND1   93.8183775 0.000000e+00
## 378    47  ND2   49.0316542 1.259326e-12
## 379    47  ND3   84.3189952 0.000000e+00
## 380    47  ND4   96.5178167 0.000000e+00
## 381    47 ND4L   12.9490908 1.600384e-04
## 382    47  ND5   72.0560676 0.000000e+00
## 383    47  ND6   68.2465694 0.000000e+00
## 384    23 ATP6   41.5957863 5.611744e-11
## 385    23 ATP8   13.4919879 1.197921e-04
```

```
## 386    23 COX1   52.5878589 2.057243e-13
## 387    23  ND1  105.0654217 0.000000e+00
## 388    23 ND4L   20.0838484 3.706000e-06
## 389    23  ND5  194.8313773 0.000000e+00
## 390    23  ND6   57.3375044 1.842970e-14
## 391    52 ATP6  421.2204074 0.000000e+00
## 392    52 ATP8  151.7961740 0.000000e+00
## 393    52 COX1  585.3824957 0.000000e+00
## 394    52 COX2  347.9481725 0.000000e+00
## 395    52 COX3  444.0135152 0.000000e+00
## 396    52 CYTB  753.9228078 0.000000e+00
## 397    52  ND1  650.0507119 0.000000e+00
## 398    52  ND2  614.4764506 0.000000e+00
## 399    52  ND3  350.1177957 0.000000e+00
## 400    52  ND4  802.5141158 0.000000e+00
## 401    52 ND4L  188.2306938 0.000000e+00
## 402    52  ND5 1247.1238551 0.000000e+00
## 403    52  ND6  506.3639563 0.000000e+00
## 404    20 ATP6  167.8667752 0.000000e+00
## 405    20 ATP8  119.2867369 0.000000e+00
## 406    20 COX1  176.8191983 0.000000e+00
## 407    20 COX3  187.8024959 0.000000e+00
## 408    20  ND1  174.4542689 0.000000e+00
## 409    20  ND2  330.6476049 0.000000e+00
## 410    20  ND3  119.6820375 0.000000e+00
## 411    20 ND4L  110.1162923 0.000000e+00
## 412    20  ND5  626.4233703 0.000000e+00
## 413    20  ND6  175.7906441 0.000000e+00
## 414    41 ATP6   33.9991527 2.756804e-09
## 415    41 COX1   88.5368754 0.000000e+00
## 416    41 COX2   18.7704567 7.371668e-06
## 417    41 COX3   95.9668933 0.000000e+00
## 418    41 CYTB  256.3795281 0.000000e+00
## 419    41  ND1   38.5448020 2.675555e-10
## 420    41  ND2   81.4165560 0.000000e+00
## 421    41  ND3   55.2002287 5.440093e-14
## 422    41  ND4  106.3877350 0.000000e+00
## 423    41 ND4L    4.3433754 1.857660e-02
## 424    41  ND5  225.9301272 0.000000e+00
## 425    41  ND6  105.3236753 0.000000e+00
## 426    11 ATP6  156.0805325 0.000000e+00
## 427    11 ATP8  151.1729863 0.000000e+00
## 428    11 COX1  219.3785913 0.000000e+00
## 429    11 COX2  101.4580632 0.000000e+00
## 430    11 COX3  183.6536879 0.000000e+00
## 431    11 CYTB  290.3439342 0.000000e+00
## 432    11  ND1  196.8522525 0.000000e+00
## 433    11  ND2  225.0182009 0.000000e+00
## 434    11  ND3   88.9170389 0.000000e+00
## 435    11  ND4  379.5139934 0.000000e+00
## 436    11 ND4L   85.1371856 0.000000e+00
## 437    11  ND5  459.1659828 0.000000e+00
## 438    11  ND6  308.1158150 0.000000e+00
## 439    40 ATP6   47.2237413 3.166356e-12
```

```
## 440    40 COX1  141.7887925 0.000000e+00
## 441    40 COX3  106.7924252 0.000000e+00
## 442    40 CYTB  118.2176704 0.000000e+00
## 443    40  ND1   43.6270681 1.986522e-11
## 444    40  ND2   57.1620346 1.998401e-14
## 445    40  ND3   29.0347167 3.554638e-08
## 446    40  ND4   91.2321014 0.000000e+00
## 447    40 ND4L    7.3117160 3.425324e-03
## 448    40  ND5  201.9455068 0.000000e+00
## 449    40  ND6    3.1504533 3.795294e-02
## 450     6 ATP6   20.2592556 3.381275e-06
## 451     6 ATP8   42.3710447 3.774980e-11
## 452     6 COX1    3.0712832 3.984327e-02
## 453     6 COX2   10.4454908 6.147462e-04
## 454     6 COX3   41.1620168 7.005951e-11
## 455     6 CYTB   28.0553805 5.894644e-08
## 456     6  ND1   36.9838470 5.955597e-10
## 457     6  ND2   12.0207896 2.630521e-04
## 458     6  ND3    2.1569980 7.096086e-02
## 459     6  ND4   16.3207619 2.673742e-05
## 460     6 ND4L   16.1290278 2.958507e-05
## 461     6  ND5   56.4055560 2.953193e-14
## 462     6  ND6   36.7191531 6.821621e-10
## 463    51 ATP6  228.8927114 0.000000e+00
## 464    51 ATP8   72.4093030 0.000000e+00
## 465    51 COX3  276.1416702 0.000000e+00
## 466    51 CYTB  312.6732802 0.000000e+00
## 467    51  ND1  285.8987884 0.000000e+00
## 468    51  ND2  274.5376808 0.000000e+00
## 469    51  ND3  166.0682020 0.000000e+00
## 470    51  ND4  367.9605028 0.000000e+00
## 471    51 ND4L   97.4690978 0.000000e+00
## 472    51  ND5  542.0962098 0.000000e+00
## 473    51  ND6  219.7953969 0.000000e+00
## 474    26 ATP6   48.8118154 1.408651e-12
## 475    26 ATP8   12.0421612 2.600532e-04
## 476    26 COX1   48.2161359 1.908695e-12
## 477    26 COX3   39.1730076 1.939328e-10
## 478    26 CYTB   71.4897287 0.000000e+00
## 479    26  ND1   20.3745060 3.183621e-06
## 480    26  ND2   13.4532655 1.222901e-04
## 481    26  ND3    1.3445004 1.231209e-01
## 482    26  ND4   37.1834002 5.376259e-10
## 483    26 ND4L   23.3660627 6.696025e-07
## 484    26  ND5  134.4434138 0.000000e+00
## 485    26  ND6   29.6205326 2.627269e-08
## 486     4 ATP6   74.4784561 0.000000e+00
## 487     4 ATP8   73.7714713 0.000000e+00
## 488     4 COX1   53.9031884 1.052491e-13
## 489     4 COX2   24.1478584 4.460766e-07
## 490     4 CYTB  141.0704066 0.000000e+00
## 491     4  ND1   47.3457898 2.975287e-12
## 492     4  ND2   71.7800350 0.000000e+00
## 493     4  ND3   26.9267447 1.056572e-07
```

```
## 494     4  ND4  123.8302437 0.000000e+00
## 495     4 ND4L   41.8449903 4.940182e-11
## 496     4  ND5  157.2603223 0.000000e+00
## 497     4  ND6   48.7324463 1.466827e-12
## 498    10 ATP6   36.8316706 6.439058e-10
## 499    10 ATP8   17.2270867 1.658368e-05
## 500    10 COX1   31.4360289 1.030602e-08
## 501    10 COX2   18.1215036 1.036239e-05
## 502    10 COX3   27.8905911 6.418625e-08
## 503    10 CYTB   35.3687609 1.364139e-09
## 504    10  ND1   34.7730723 1.852311e-09
## 505    10  ND2   21.4145002 1.849813e-06
## 506    10  ND3    8.7803528 1.522461e-03
## 507    10  ND4   47.2774760 3.080869e-12
## 508    10 ND4L   15.7618651 3.591799e-05
## 509    10  ND5   47.2937485 3.055334e-12
## 510    10  ND6   63.8162704 6.661338e-16
## 511    56 ATP6  485.6486120 0.000000e+00
## 512    56 COX1  406.2949835 0.000000e+00
## 513    56 COX2  404.1436287 0.000000e+00
## 514    56 COX3  386.1742932 0.000000e+00
## 515    56 CYTB 1062.1622346 0.000000e+00
## 516    56  ND1  694.7879845 0.000000e+00
## 517    56  ND2  774.3335164 0.000000e+00
## 518    56  ND3  422.7214237 0.000000e+00
## 519    56  ND4 1189.1211656 0.000000e+00
## 520    56 ND4L  156.2165344 0.000000e+00
## 521    56  ND5 1726.0378028 0.000000e+00
## 522    56  ND6  510.6129336 0.000000e+00
## 523    31 ATP6   43.4175117 2.211065e-11
## 524    31 COX1   95.4914209 0.000000e+00
## 525    31 COX2   97.0410010 0.000000e+00
## 526    31 COX3   68.1845425 0.000000e+00
## 527    31 CYTB   44.2760928 1.425882e-11
## 528    31  ND1   47.5294717 2.709166e-12
## 529    31  ND2   65.5143532 2.220446e-16
## 530    31  ND4   81.1614862 0.000000e+00
## 531    31  ND5  150.4018473 0.000000e+00
## 532    31  ND6   51.5978689 3.406164e-13
## 533  <NA> ATP6   30.8769794 1.374568e-08
## 534  <NA> ATP8   13.2011226 1.398907e-04
## 535  <NA> COX1   26.8571489 1.095313e-07
## 536  <NA>  ND1   46.1903342 5.365264e-12
## 537  <NA>  ND2   62.8992640 1.110223e-15
## 538  <NA>  ND3    6.7146279 4.781262e-03
## 539  <NA>  ND4   88.4996077 0.000000e+00
## 540  <NA> ND4L   28.0662301 5.861689e-08
## 541  <NA>  ND5   63.4195866 8.881784e-16
## 542  <NA>  ND6   55.5330678 4.596323e-14
## 543    33 ATP6   75.9785049 0.000000e+00
## 544    33 ATP8   77.8274232 0.000000e+00
## 545    33 COX1   49.6011771 9.420242e-13
## 546    33 COX2   49.0175650 1.268430e-12
## 547    33 COX3   55.9419234 3.730349e-14
```

```
## 548    33 CYTB   52.6569252 1.986189e-13
## 549    33  ND1   36.5514815 7.434346e-10
## 550    33  ND2   63.4982296 7.771561e-16
## 551    33  ND3   40.1565961 1.171994e-10
## 552    33  ND4   96.9050843 0.000000e+00
## 553    33 ND4L   22.7736311 9.112462e-07
## 554    33  ND5  126.2542708 0.000000e+00
## 555    33  ND6   33.8353871 2.998895e-09
## 556  <NA> ATP6   11.1145241 4.282715e-04
## 557  <NA> COX2   48.9383903 1.320721e-12
## 558  <NA> COX3   12.8515977 1.685956e-04
## 559  <NA> CYTB   60.3732391 3.996803e-15
## 560  <NA>  ND3   42.1588354 4.207645e-11
## 561  <NA>  ND4   43.3446436 2.294953e-11
## 562    22 ATP6  136.7063770 0.000000e+00
## 563    22 ATP8   37.2102507 5.302742e-10
## 564    22 COX1  188.3786710 0.000000e+00
## 565    22 CYTB  306.7872876 0.000000e+00
## 566    22  ND1  312.1210035 0.000000e+00
## 567    22  ND2  318.0551734 0.000000e+00
## 568    22 ND4L   23.5534963 6.074423e-07
## 569    22  ND5  659.0895009 0.000000e+00
## 570    22  ND6  171.8868974 0.000000e+00
## 571    17 COX1  113.9488198 0.000000e+00
## 572    17 COX3   71.4618557 0.000000e+00
## 573    17 CYTB  262.6417287 0.000000e+00
## 574    17  ND2  162.5207600 0.000000e+00
## 575    17  ND3   53.0345056 1.638689e-13
## 576    17  ND4  219.5637533 0.000000e+00
## 577    17 ND4L   33.5616305 3.452065e-09
## 578    17  ND5  523.9714401 0.000000e+00
## 579    17  ND6  120.3924702 0.000000e+00
## 580    37 ATP6   97.9467223 0.000000e+00
## 581    37 ATP8   55.0646537 5.839773e-14
## 582    37 COX1   47.9312827 2.207123e-12
## 583    37 COX2   73.3684353 0.000000e+00
## 584    37 COX3  102.6521597 0.000000e+00
## 585    37 CYTB   67.7167498 1.110223e-16
## 586    37  ND1  101.9440246 0.000000e+00
## 587    37  ND2  239.8840379 0.000000e+00
## 588    37  ND3   79.6743294 0.000000e+00
## 589    37  ND4  329.9006398 0.000000e+00
## 590    37 ND4L   39.1483017 1.964024e-10
## 591    37  ND5  341.4798324 0.000000e+00
## 592    37  ND6   80.4312838 0.000000e+00
## 593    42 ATP6  187.8513802 0.000000e+00
## 594    42 ATP8   42.7946312 3.039946e-11
## 595    42 COX1  362.9176435 0.000000e+00
## 596    42 COX2  174.3946794 0.000000e+00
## 597    42 COX3  150.4303100 0.000000e+00
## 598    42 CYTB  330.3483162 0.000000e+00
## 599    42  ND1  171.1760984 0.000000e+00
## 600    42  ND2  168.7206033 0.000000e+00
## 601    42  ND3   41.1963970 6.883805e-11
```

```
## 602    42  ND4  238.9417164 0.000000e+00
## 603    42 ND4L    9.8543164 8.471688e-04
## 604    42  ND5  392.8892959 0.000000e+00
## 605    42  ND6   40.3384199 1.067838e-10
## 606    38 ATP6  210.4292129 0.000000e+00
## 607    38 ATP8  109.6389212 0.000000e+00
## 608    38 COX1  132.7235233 0.000000e+00
## 609    38 COX2  164.6091999 0.000000e+00
## 610    38 COX3  151.7422630 0.000000e+00
## 611    38 CYTB  371.6782961 0.000000e+00
## 612    38  ND1  159.2310558 0.000000e+00
## 613    38  ND2  190.0481803 0.000000e+00
## 614    38  ND3  121.6376772 0.000000e+00
## 615    38  ND4  379.1032637 0.000000e+00
## 616    38 ND4L   53.3801379 1.374456e-13
## 617    38  ND5  525.0197925 0.000000e+00
## 618    38  ND6   63.2763851 8.881784e-16
## 619    39 ATP6   21.3906166 1.873000e-06
## 620    39 COX1  193.3665337 0.000000e+00
## 621    39 COX2   27.3263066 8.592868e-08
## 622    39 COX3   45.8525810 6.374679e-12
## 623    39 CYTB  152.0257939 0.000000e+00
## 624    39  ND1  131.8635905 0.000000e+00
## 625    39  ND2   55.5672141 4.518608e-14
## 626    39  ND3   57.2182638 1.953993e-14
## 627    39  ND4  198.3524799 0.000000e+00
## 628    39 ND4L    0.8348769 1.804331e-01
## 629    39  ND5  180.6086554 0.000000e+00
## 630    39  ND6    5.9427247 7.389078e-03
## 631    29 ATP6    9.2166532 1.199118e-03
## 632    29 ATP8   14.3299294 7.670321e-05
## 633    29 COX1   43.1861105 2.488632e-11
## 634    29  ND1   45.2650730 8.604562e-12
## 635    29 ND4L   20.1260231 3.625172e-06
## 636    29  ND5   28.5758153 4.505027e-08
## 637    29  ND6   43.1369872 2.551914e-11
```

```
#set up crit values
N <- nrow(stats)/3
crit.p.05 <- 0.05/N
crit.p.01 <- 0.01/N


#number of sig datasets
stats %>% filter(p <= crit.p.01)  %>%nrow
```

```
## [1] 585
```

```
stats %>% filter(p <= crit.p.05)  %>%nrow
```

```
## [1] 600
```

```
#make sig table
sig_table <- stats %>% select(order,gene, p)

#sig_table <- mutate(sig_table,fill = "NA")
```

```
sig_table <- mutate(sig_table,fill = "-",ordering = "-",text_size="a")

sig_table$fill[which(sig_table$p>crit.p.05)] <- "-"
sig_table$fill[which(sig_table$p<=crit.p.05)] <-  "*"  #"Sig at alpha = 0.05"
sig_table$fill[which(sig_table$p<=crit.p.01)] <- "**" #"Sig at alpha = 0.01"

sig_table$ordering[which(sig_table$p>crit.p.05)] <- "-"
sig_table$ordering[which(sig_table$p<=crit.p.05)] <- "*"
sig_table$ordering[which(sig_table$p<=crit.p.01)] <- "**"

sig_table$text_size[which(!is.na(sig_table$ordering))] <-"b"

tip_labels = toupper(class.order.tree$tip.label)
sig_table$order = factor(sig_table$order, levels = tip_labels)

sig_table %>% ggplot(aes(x=order,y=gene, fill = ordering))+
  geom_tile(size =0.5,na.rm=TRUE,color="black")+
  scale_fill_manual(values = c("#FFFFFF","#CCCCCC","#999999"))+
  geom_text(aes(label =fill,size=text_size))+ scale_size_manual(values = c(1.75,3),guide =FALSE)+
  theme(panel.grid.major.y = element_blank(),
        panel.grid.major.x = element_blank(),
        axis.text.x = element_text(angle = 90, vjust = 1, hjust=1))+
  coord_fixed(ratio=1)
```