ShortJobs.R

arcs

Wed Dec 20 15:17:35 2017

```
#Aim: To compute the normalised efficiency and study the low efficiency jobs

library(data.table)
library(ggplot2)


setwd("/home/arcs/Oct14/DataCSV")
getwd()
```

```
## [1] "/home/arcs/Oct14/DataCSV"
```

```
jobs <- fread(input = "Nov2017Efficiency_VO_withBigBird.csv", sep = ",", fill = TRUE)
```

```
##
Read 36.6% of 9949749 rows
Read 69.6% of 9949749 rows
Read 98.7% of 9949749 rows
Read 9949749 rows and 8 (of 8) columns from 0.319 GB file in 00:00:05
```

```
############### Function to print values ##########################
printf <- function(...) cat(sprintf(...))


#########################################################################
############# Conversion to numeric values ########################
#########################################################################
jobs[,"RemoteWallClockTime"] <- as.numeric(unlist(jobs[,"RemoteWallClockTime"])) #RemoteWallClockTime
```

```
## Warning: NAs introduced by coercion
```

```
jobs[, "MATCH_HEPSPEC"] <- as.numeric(unlist(jobs[, "MATCH_HEPSPEC"]))
```

```
## Warning: NAs introduced by coercion
```

```
jobs[, "MATCH_TotalCpus"] <- as.numeric(unlist(jobs[, "MATCH_TotalCpus"]))
```

```
## Warning: NAs introduced by coercion
```

```
#########################################################################
############# Removing jobs with NA in      ######################
#############     Particular Col           ######################
#########################################################################
jobs <- jobs[!is.na((jobs$RemoteWallClockTime))]
jobs <- jobs[!is.na(jobs$MATCH_HEPSPEC)]
jobs <- jobs[!is.na(jobs$MATCH_TotalCpus)]

#########################################################################
############# setting default values for     ######################
#############   MATCH_HEPSPEC and MATCH_TotalCpus  ##################
#########################################################################
```

```
index <- jobs$MATCH_HEPSPEC == 0
jobs$MATCH_HEPSPEC[index] <- 80
jobs$MATCH_TotalCpus <- 8

########################################################################
############### Computation of efficiency ##############################
########################################################################
jobs$CPUTime <- jobs$RemoteSysCpu + jobs$RemoteUserCpu
jobs <- jobs[!is.na(jobs$CPUTime)]
jobs$WallTime <- jobs$RemoteWallClockTime
jobs <- subset(jobs, jobs$WallTime != 0) #Removing jobs with WallTime = 0
jobs <- subset(jobs, jobs$MATCH_TotalCpus != 0)
jobs$HEPSPEC_TotalCpus <- jobs$MATCH_HEPSPEC/ jobs$MATCH_TotalCpus
jobs$NWallTime <- jobs$WallTime * jobs$RequestCpus * jobs$HEPSPEC_TotalCpus
jobs$NCPUTime <- jobs$CPUTime * jobs$HEPSPEC_TotalCpus
jobs <- subset(jobs, NWallTime != 0)
printf("\nTotal no of jobs after removing jobs with normalized walltime = 0: %d\n", nrow(jobs))
```

```
##
## Total no of jobs after removing jobs with normalized walltime = 0: 7956220
```

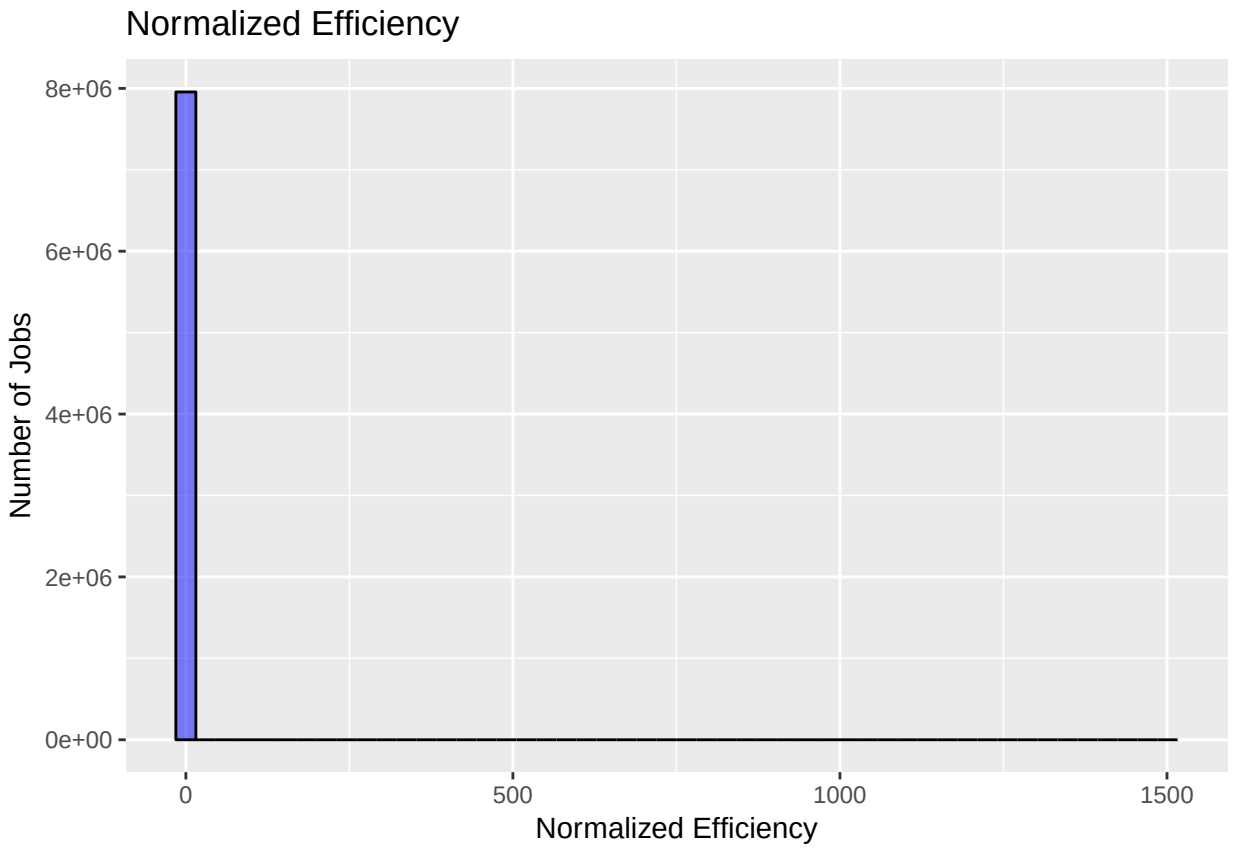
```
jobs$NEfficiency <- jobs$NCPUTime/jobs$NWallTime
Total_NEfficiency <- sum(jobs$NCPUTime)/sum(jobs$NWallTime)

printf("\n\n Normalised Efficiency(For all jobs):")
```

```
##
##
##  Normalised Efficiency(For all jobs):
```

```
print(Total_NEfficiency)
```

```
## [1] 0.7549874
```

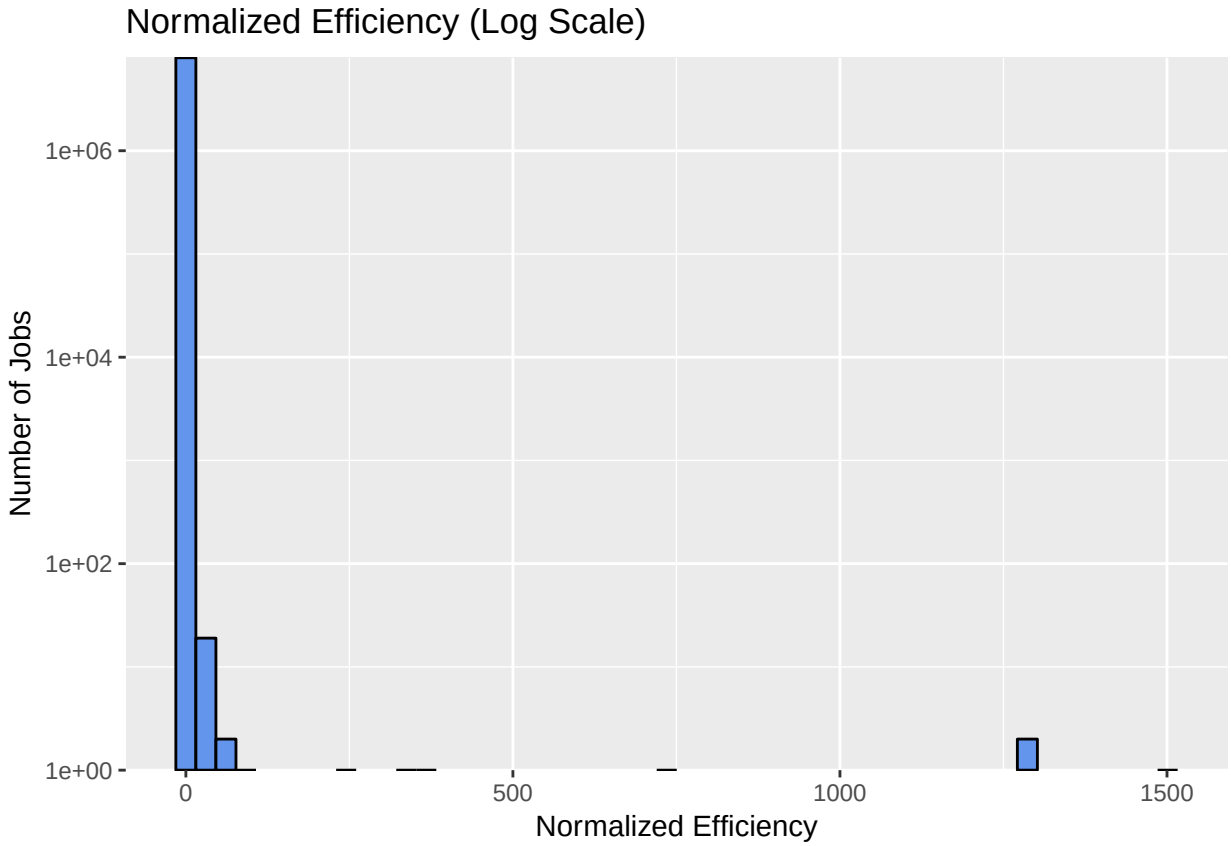
```
########################################################################
############### Visiualisation of Efficiency of jobs ###################
########################################################################

graph1 <- ggplot(jobs, aes(x = NEfficiency)) +
  geom_histogram( color = "Black", fill = "Blue", bins = 50, alpha = 0.5 )
graph1 + labs(title= "Normalized Efficiency", x= "Normalized Efficiency", y = "Number of Jobs")
```




```
graph2 <- ggplot(jobs, aes(x = NEfficiency)) +
  geom_histogram(color = "Black", fill = "cornflowerblue", bins = 50 ) +
  scale_y_continuous(trans="log10", expand=c(0,0))
graph2 + labs(title= "Normalized Efficiency (Log Scale)", x= "Normalized Efficiency", y = "Number of Jo
```

```
## Warning: Transformation introduced infinite values in continuous y-axis
```

```
## Warning: Removed 40 rows containing missing values (geom_bar).
```




```
################################################################################
############### Jobs with very high efficiency- Error ##################
################################################################################

error_jobs <- subset(jobs, NEfficiency > 1.2)
error_fraction <- nrow(error_jobs)/nrow(jobs)

printf("\n\n Fraction of very high efficiency jobs:")
```

```
##
##
##  Fraction of very high efficiency jobs:
```

```
print(error_fraction)
```

```
## [1] 0.0001919253
```

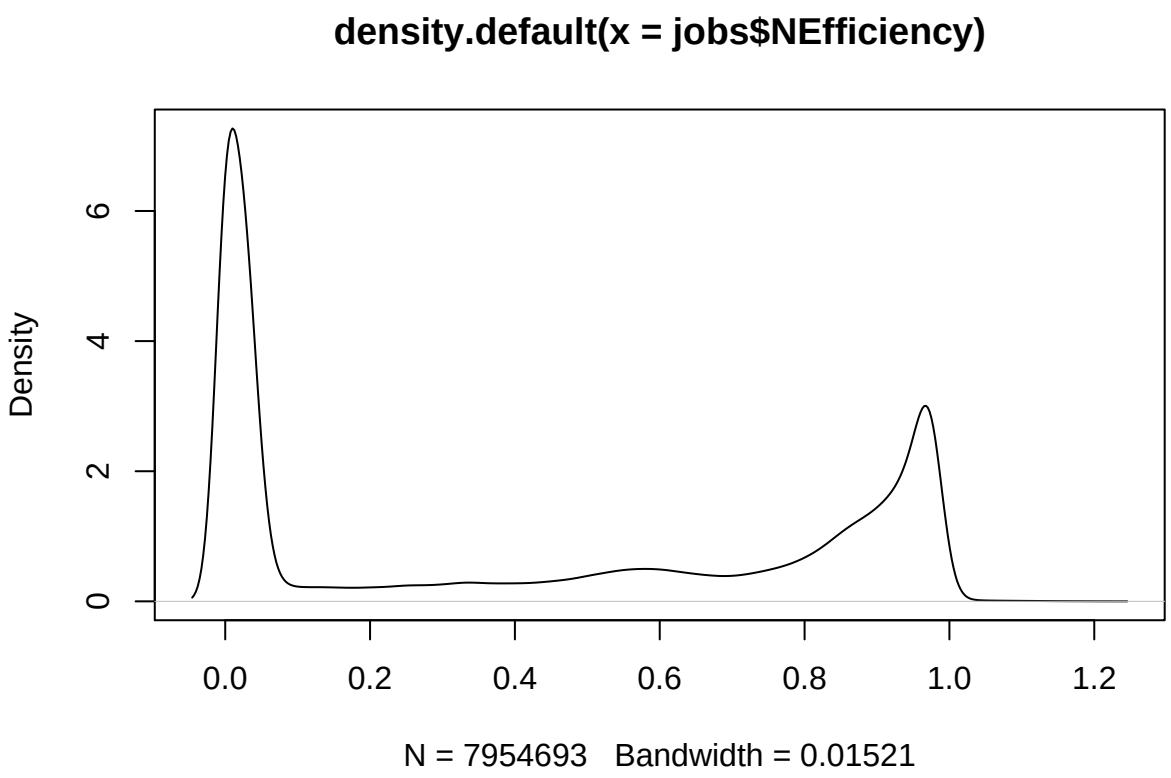
```
#################### Correction by eliminating jobs with high efficiency ################

jobs <- subset(jobs, NEfficiency <= 1.2)
corrected_eff <- sum(jobs$NCPUTime)/sum(jobs$NWallTime)

printf("\n\n Normalised Efficiency after correction:")
```

```
##
##
##  Normalised Efficiency after correction:
```

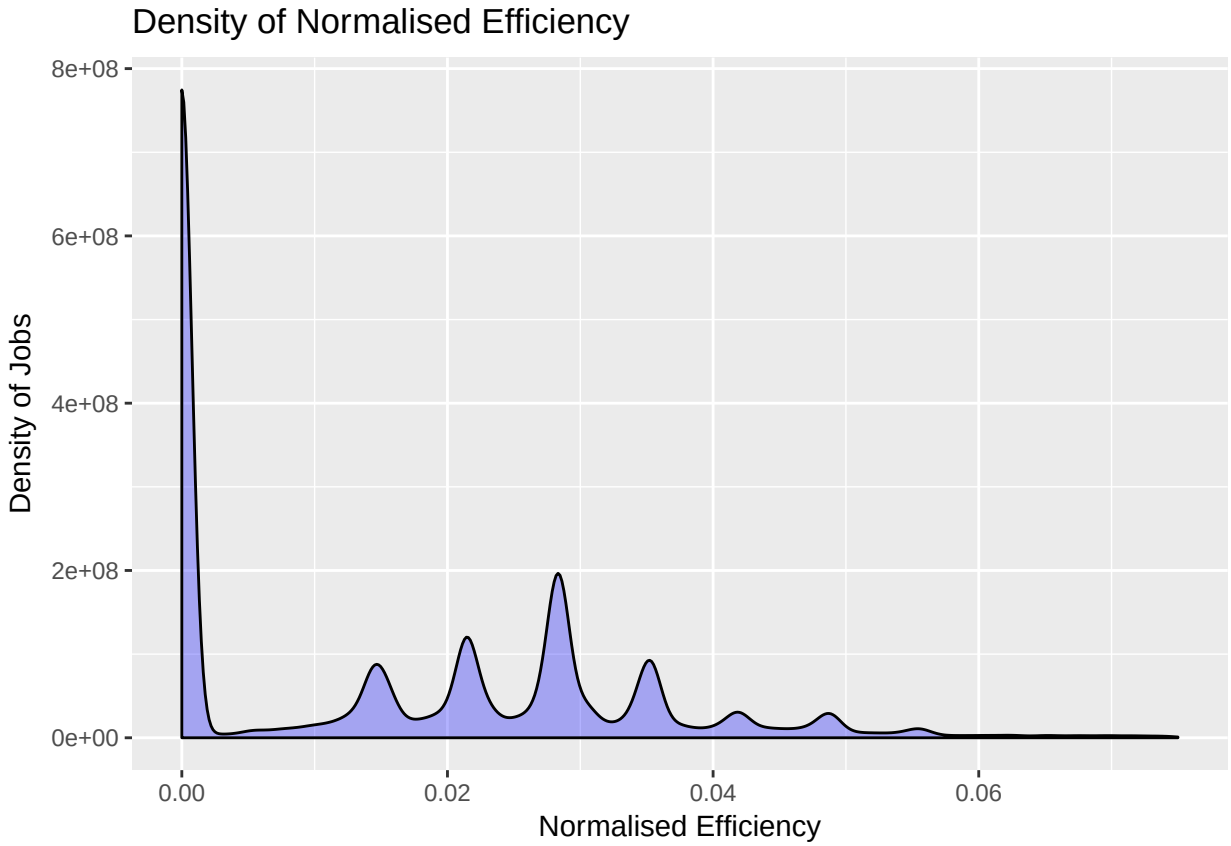
```r
print(corrected_eff)
```

```
## [1] 0.7548596
```

```r
plot(density(jobs$NEfficiency))
```




```r
################################################################################################
######################### Study of low efficiency jobs ##########################################
################################################################################################

low_effi_jobs <- subset(jobs, jobs$NEfficiency < 0.075)

ggplot(low_effi_jobs, aes(x=NEfficiency)) +
  stat_density(aes(y=..count..), color="black", fill="blue", alpha=0.3) +
  labs(title = "Density of Normalised Efficiency ", x = "Normalised Efficiency", y = "Density of Jobs")
```




```
theme_classic()
```

```
## List of 57
##  $ line                :List of 6
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ lineend      : chr "butt"
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ rect                :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ text                :List of 11
##   ..$ family       : chr ""
##   ..$ face         : chr "plain"
##   ..$ colour       : chr "black"
##   ..$ size         : num 11
##   ..$ hjust        : num 0.5
##   ..$ vjust        : num 0.5
##   ..$ angle        : num 0
##   ..$ lineheight   : num 0.9
```

```
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.x         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 5.5 0 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.x.top     :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 5.5 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.y         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : num 90
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 5.5 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.y.right   :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
```

```
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 0 5.5
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text           :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : chr "grey30"
##   ..$ size         :Class 'rel'  num 0.8
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 2.2 0 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x.top     :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 2.2 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
```

```
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.y          :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 1
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 2.2 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.y.right    :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 0
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 0 2.2
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.ticks           :List of 6
##   ..$ colour       : chr "grey20"
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ lineend      : NULL
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ axis.ticks.length    :Class 'unit'  atomic [1:1] 2.75
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##  $ axis.line            :List of 6
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : NULL
##   ..$ lineend      : NULL
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ axis.line.x          : NULL
##  $ axis.line.y          : NULL
##  $ legend.background    :List of 5
##   ..$ fill         : NULL
```

```
##   ..$ colour       : logi NA
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ legend.margin        :Classes 'margin', 'unit'  atomic [1:4] 0.2 0.2 0.2 0.2
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  $ legend.spacing       :Class 'unit'  atomic [1:1] 0.4
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  $ legend.spacing.x     : NULL
##  $ legend.spacing.y     : NULL
##  $ legend.key           : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ legend.key.size      :Class 'unit'  atomic [1:1] 1.2
##   .. ..- attr(*, "valid.unit")= int 3
##   .. ..- attr(*, "unit")= chr "lines"
##  $ legend.key.height    : NULL
##  $ legend.key.width     : NULL
##  $ legend.text          :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         :Class 'rel'  num 0.8
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ legend.text.align    : NULL
##  $ legend.title         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 0
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ legend.title.align   : NULL
##  $ legend.position      : chr "right"
##  $ legend.direction     : NULL
##  $ legend.justification : chr "center"
##  $ legend.box           : NULL
##  $ legend.box.margin    :Classes 'margin', 'unit'  atomic [1:4] 0 0 0 0
##   .. ..- attr(*, "valid.unit")= int 1
```

```
##   .. ..- attr(*, "unit")= chr "cm"
##  $ legend.box.background: list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ legend.box.spacing   :Class 'unit'  atomic [1:1] 0.4
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  $ panel.background     :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : logi NA
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ panel.border         : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.spacing        :Class 'unit'  atomic [1:1] 5.5
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##  $ panel.spacing.x      : NULL
##  $ panel.spacing.y      : NULL
##  $ panel.grid.major     : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.grid.minor     : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.ontop          : logi FALSE
##  $ plot.background      :List of 5
##   ..$ fill         : NULL
##   ..$ colour       : chr "white"
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ plot.title           :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         :Class 'rel'  num 1.2
##   ..$ hjust        : num 0
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 6.6 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.subtitle        :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         :Class 'rel'  num 0.9
##   ..$ hjust        : num 0
##   ..$ vjust        : num 1
```

```
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 4.95 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.caption         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         :Class 'rel'  num 0.9
##   ..$ hjust        : num 1
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 4.95 0 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.margin          :Classes 'margin', 'unit'  atomic [1:4] 5.5 5.5 5.5 5.5
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##  $ strip.background     :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : chr "black"
##   ..$ size         : num 1
##   ..$ linetype     : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ strip.placement      : chr "inside"
##  $ strip.text           :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : chr "grey10"
##   ..$ size         :Class 'rel'  num 0.8
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.text.x         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
```

```
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 5.5 0 5.5 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.text.y         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 5.5 0 5.5
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.switch.pad.grid:Class 'unit'  atomic [1:1] 0.1
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  $ strip.switch.pad.wrap:Class 'unit'  atomic [1:1] 0.1
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  - attr(*, "class")= chr [1:2] "theme" "gg"
##  - attr(*, "complete")= logi TRUE
##  - attr(*, "validate")= logi TRUE
```

```
low_effi_jobs$TotalWallTime <- low_effi_jobs$WallTime * low_effi_jobs$RequestCpus

#########################################################################################################
####### Classification of low efficient jobs into 2 Classes on the basis of CPU Time ############
#########################################################################################################

# Set of jobs that never get CPU Time
low_effi_jobs_ZeroCPU <- subset(low_effi_jobs, CPUTime == 0)
# Set of jobs with low CPU Time and high Wall time
low_effi_jobs_grt_CPUTime <- subset(low_effi_jobs, CPUTime > 0)

#################################################################################
#################### Contribution based on VO ###################################
####################   Zero efficiency jobs   ###################################
#################################################################################

VO = unique(jobs$x509UserProxyVOName)
#
for (vo in VO){
  printf("\n\n\n************ Zero CPU Time - VO Name: %s ***************\n", vo)
  sub_Data <- subset(low_effi_jobs_ZeroCPU, x509UserProxyVOName == vo)
```

```
  printf("\nNumber of observation: %d", nrow(sub_Data))
  printf("\nPercentage of data: %f", (nrow(sub_Data)/nrow(jobs))*100)
}
```

```
##
##
##
## ************ Zero CPU Time - VO Name: None ***************
##
## Number of observation: 592987
## Percentage of data: 7.454555
##
##
## ************ Zero CPU Time - VO Name: cms ***************
##
## Number of observation: 25955
## Percentage of data: 0.326285
##
##
## ************ Zero CPU Time - VO Name: atlas ***************
##
## Number of observation: 31257
## Percentage of data: 0.392938
##
##
## ************ Zero CPU Time - VO Name: lhcb ***************
##
## Number of observation: 6723
## Percentage of data: 0.084516
##
##
## ************ Zero CPU Time - VO Name: vo.compass.cern.ch ***************
##
## Number of observation: 821
## Percentage of data: 0.010321
##
##
## ************ Zero CPU Time - VO Name: ilc ***************
##
## Number of observation: 329
## Percentage of data: 0.004136
##
##
## ************ Zero CPU Time - VO Name: alice ***************
##
## Number of observation: 770963
## Percentage of data: 9.691927
##
##
## ************ Zero CPU Time - VO Name: dune ***************
##
## Number of observation: 7
## Percentage of data: 0.000088
##
```

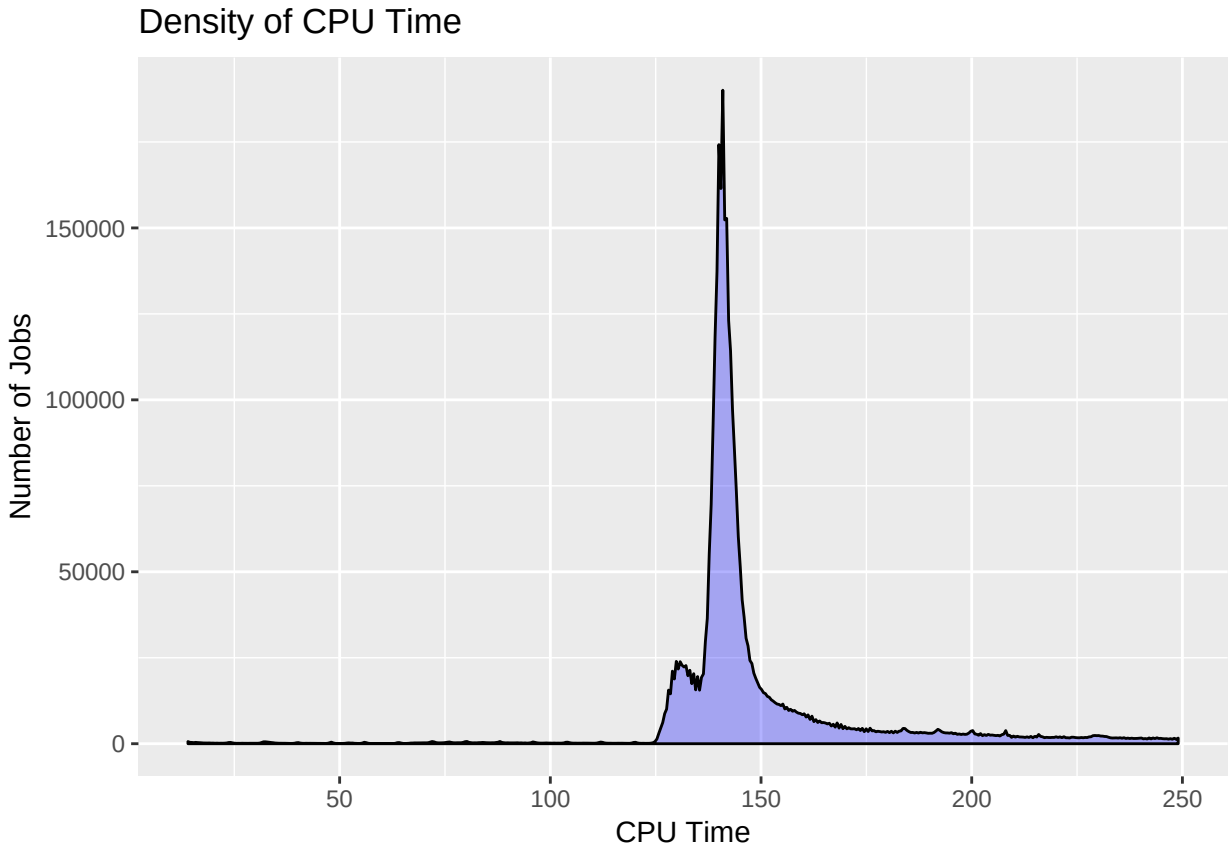
```
##
## ************ Zero CPU Time - VO Name: na62.vo.gridpp.ac.uk ***************
##
## Number of observation: 1
## Percentage of data: 0.000013
```

```
################################################################################
#################### Contribution based on VO ##################################
####################   low efficiency jobs   ###################################
################################################################################

for (vo in VO){
  printf("\n\n\n************ VO Name: %s ***************\n", vo)
  sub_Data <- subset(low_effi_jobs_grt_CPUTime, x509UserProxyVOName == vo)
  printf("\nNumber of observation: %d", nrow(sub_Data))
  printf("\nPercentage of data: %f", (nrow(sub_Data)/nrow(jobs))*100)
  NEfficiency_sub <- sum(sub_Data$NCPUTime)/sum(sub_Data$NWallTime)
  printf("\nNormalized Efficiency: ")
  print(NEfficiency_sub)
}
```

```
##
##
##
## ************ VO Name: None ***************
##
## Number of observation: 1
## Percentage of data: 0.000013
## Normalized Efficiency: [1] 0.01844262
##
##
##
## ************ VO Name: cms ***************
##
## Number of observation: 9792
## Percentage of data: 0.123097
## Normalized Efficiency: [1] 0.009449005
##
##
##
## ************ VO Name: atlas ***************
##
## Number of observation: 78950
## Percentage of data: 0.992496
## Normalized Efficiency: [1] 0.004892503
##
##
##
## ************ VO Name: lhcb ***************
##
## Number of observation: 7654
## Percentage of data: 0.096220
## Normalized Efficiency: [1] 0.004587345
##
##
```

```
##
## ************ VO Name: vo.compass.cern.ch ***************
##
## Number of observation: 1437832
## Percentage of data: 18.075267
## Normalized Efficiency: [1] 0.02469256
##
##
##
## ************ VO Name: ilc ***************
##
## Number of observation: 6252
## Percentage of data: 0.078595
## Normalized Efficiency: [1] 0.05031496
##
##
##
## ************ VO Name: alice ***************
##
## Number of observation: 419727
## Percentage of data: 5.276470
## Normalized Efficiency: [1] 0.02849584
##
##
##
## ************ VO Name: dune ***************
##
## Number of observation: 39
## Percentage of data: 0.000490
## Normalized Efficiency: [1] 0.005240563
##
##
##
## ************ VO Name: na62.vo.gridpp.ac.uk ***************
##
## Number of observation: 0
## Percentage of data: 0.000000
## Normalized Efficiency: [1] NaN
```

```
################################################################################
############## Peak in Total Wall Time - low efficient jobs ####################
################################################################################

j5 <- subset(low_effi_jobs_grt_CPUTime, TotalWallTime < 250)

ggplot(j5, aes(x=TotalWallTime)) +
  stat_density(aes(y=..count..), color="black", fill="blue", alpha=0.3) +
  labs(title = "Density of CPU Time ", x = "CPU Time", y = "Number of Jobs")
```




```
theme_classic()
```

```
## List of 57
##  $ line                :List of 6
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ lineend      : chr "butt"
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ rect                :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ text                :List of 11
##   ..$ family       : chr ""
##   ..$ face         : chr "plain"
##   ..$ colour       : chr "black"
##   ..$ size         : num 11
##   ..$ hjust        : num 0.5
##   ..$ vjust        : num 0.5
##   ..$ angle        : num 0
##   ..$ lineheight   : num 0.9
```

```
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.x         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 5.5 0 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.x.top     :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 5.5 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.y         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : num 90
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 5.5 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.y.right   :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
```

```
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 0 5.5
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text           :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : chr "grey30"
##   ..$ size         :Class 'rel'  num 0.8
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 2.2 0 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x.top     :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 2.2 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
```

```
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.y          :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 1
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 2.2 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.y.right    :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 0
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 0 2.2
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.ticks           :List of 6
##   ..$ colour       : chr "grey20"
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ lineend      : NULL
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ axis.ticks.length    :Class 'unit'  atomic [1:1] 2.75
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##  $ axis.line            :List of 6
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : NULL
##   ..$ lineend      : NULL
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ axis.line.x          : NULL
##  $ axis.line.y          : NULL
##  $ legend.background    :List of 5
##   ..$ fill         : NULL
```

```
##   ..$ colour       : logi NA
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ legend.margin        :Classes 'margin', 'unit'  atomic [1:4] 0.2 0.2 0.2 0.2
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  $ legend.spacing       :Class 'unit'  atomic [1:1] 0.4
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  $ legend.spacing.x     : NULL
##  $ legend.spacing.y     : NULL
##  $ legend.key           : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ legend.key.size      :Class 'unit'  atomic [1:1] 1.2
##   .. ..- attr(*, "valid.unit")= int 3
##   .. ..- attr(*, "unit")= chr "lines"
##  $ legend.key.height    : NULL
##  $ legend.key.width     : NULL
##  $ legend.text          :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         :Class 'rel'  num 0.8
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ legend.text.align    : NULL
##  $ legend.title         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 0
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ legend.title.align   : NULL
##  $ legend.position      : chr "right"
##  $ legend.direction     : NULL
##  $ legend.justification : chr "center"
##  $ legend.box           : NULL
##  $ legend.box.margin    :Classes 'margin', 'unit'  atomic [1:4] 0 0 0 0
##   .. ..- attr(*, "valid.unit")= int 1
```

```
##   .. ..- attr(*, "unit")= chr "cm"
##  $ legend.box.background: list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ legend.box.spacing   :Class 'unit'  atomic [1:1] 0.4
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  $ panel.background     :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : logi NA
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ panel.border         : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.spacing        :Class 'unit'  atomic [1:1] 5.5
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##  $ panel.spacing.x      : NULL
##  $ panel.spacing.y      : NULL
##  $ panel.grid.major     : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.grid.minor     : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.ontop          : logi FALSE
##  $ plot.background      :List of 5
##   ..$ fill         : NULL
##   ..$ colour       : chr "white"
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ plot.title           :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         :Class 'rel'  num 1.2
##   ..$ hjust        : num 0
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 6.6 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.subtitle        :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         :Class 'rel'  num 0.9
##   ..$ hjust        : num 0
##   ..$ vjust        : num 1
```

```
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 0 4.95 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.caption         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         :Class 'rel'  num 0.9
##   ..$ hjust        : num 1
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 4.95 0 0 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.margin          :Classes 'margin', 'unit'  atomic [1:4] 5.5 5.5 5.5 5.5
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##  $ strip.background     :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : chr "black"
##   ..$ size         : num 1
##   ..$ linetype     : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ strip.placement      : chr "inside"
##  $ strip.text           :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : chr "grey10"
##   ..$ size         :Class 'rel'  num 0.8
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.text.x         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
```

```
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 5.5 0 5.5 0
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.text.y         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       :Classes 'margin', 'unit'  atomic [1:4] 0 5.5 0 5.5
##   .. .. ..- attr(*, "valid.unit")= int 8
##   .. .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.switch.pad.grid:Class 'unit'  atomic [1:1] 0.1
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  $ strip.switch.pad.wrap:Class 'unit'  atomic [1:1] 0.1
##   .. ..- attr(*, "valid.unit")= int 1
##   .. ..- attr(*, "unit")= chr "cm"
##  - attr(*, "class")= chr [1:2] "theme" "gg"
##  - attr(*, "complete")= logi TRUE
##  - attr(*, "validate")= logi TRUE
```

```
for (vo in VO){
  printf("\n\n\n************ VO Name: %s ***************\n", vo)
  sub_Data <- subset(j5, x509UserProxyVOName == vo)
  printf("\nNumber of observation: %d", nrow(sub_Data))
  printf("\nPercentage of data: %f", (nrow(sub_Data)/nrow(jobs))*100)
}
```

```
##
##
##
## ************ VO Name: None ***************
##
## Number of observation: 0
## Percentage of data: 0.000000
##
##
## ************ VO Name: cms ***************
##
## Number of observation: 6850
## Percentage of data: 0.086113
##
##
```

```
## ************ VO Name: atlas ***************
##
## Number of observation: 9424
## Percentage of data: 0.118471
##
##
## ************ VO Name: lhcb ***************
##
## Number of observation: 3694
## Percentage of data: 0.046438
##
##
## ************ VO Name: vo.compass.cern.ch ***************
##
## Number of observation: 1253377
## Percentage of data: 15.756447
##
##
## ************ VO Name: ilc ***************
##
## Number of observation: 11
## Percentage of data: 0.000138
##
##
## ************ VO Name: alice ***************
##
## Number of observation: 346139
## Percentage of data: 4.351381
##
##
## ************ VO Name: dune ***************
##
## Number of observation: 0
## Percentage of data: 0.000000
##
##
## ************ VO Name: na62.vo.gridpp.ac.uk ***************
##
## Number of observation: 0
## Percentage of data: 0.000000
```