Final Exam

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2023-11-25

```r
# Load dataset
pudl_data <- read.csv("C:\\Users\\Chris\\Desktop\\Jocelyn\\Machine Learning\\Final_Exam\\fuel_receipts_
pudl_data<-as.data.frame(pudl_data)

## load pacakages
library(caret)
```

```
## Loading required package: ggplot2
```

```
## Loading required package: lattice
```

```r
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ----------------------- tidyverse 2.0.0 --
## v dplyr     1.1.2     v readr     2.1.4
## v forcats   1.0.0     v stringr   1.5.0
## v lubridate 1.9.2     v tibble    3.2.1
## v purrr     1.0.1     v tidyr     1.3.0
## -- Conflicts ----------------------------------------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## x purrr::lift()   masks caret::lift()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```r
library(ggplot2)
library(ISLR)
library(factoextra)
```

```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```r
library(dbscan)
```

```
## Warning: package 'dbscan' was built under R version 4.3.2
```

```
##
## Attaching package: 'dbscan'
##
## The following object is masked from 'package:stats':
##
##     as.dendrogram
```

```r
library(fpc)
```

```
## Warning: package 'fpc' was built under R version 4.3.2
```

```
##
## Attaching package: 'fpc'
##
## The following object is masked from 'package:dbscan':
##
##     dbscan
```

```r
library(cluster)
```

```
## Warning: package 'cluster' was built under R version 4.3.2
```

```r
library(dplyr)
```

```r
##Create assignment dataset of 4% of original data. To ensure a sample of approximately 2% of data used

set.seed(1113)
sampled_data <- pudl_data[sample(nrow(pudl_data), size = 0.03 * nrow(pudl_data)), ]
```

```r
summary(sampled_data)
```

```
##      rowid          plant_id_eia   plant_id_eia_label report_date
##  Min.   :     2   Min.   :    3   Length:19565       Length:19565
##  1st Qu.:162659   1st Qu.: 2716   Class :character   Class :character
##  Median :324513   Median : 6177   Mode  :character   Mode  :character
##  Mean   :324594   Mean   :18529
##  3rd Qu.:487102   3rd Qu.:50776
##  Max.   :652132   Max.   :65978
##
##  contract_type_code contract_type_code_label contract_expiration_date
##  Length:19565       Length:19565             Length:19565
##  Class :character   Class :character         Class :character
##  Mode  :character   Mode  :character         Mode  :character
##
##
##
##
##  energy_source_code energy_source_code_label fuel_type_code_pudl
##  Length:19565       Length:19565             Length:19565
##  Class :character   Class :character         Class :character
##  Mode  :character   Mode  :character         Mode  :character
##
##
##
##
##  fuel_group_code      mine_id_pudl    mine_id_pudl_label supplier_name
##  Length:19565       Min.   :   0.0   Min.   :   0.0      Length:19565
```

```
Class :character   1st Qu.: 50.5   1st Qu.: 50.5   Class :character
Mode :character   Median :1459.0   Median :1459.0   Mode :character
Mean   :1737.1   Mean   :1737.1
3rd Qu.:3157.0   3rd Qu.:3157.0
Max.   :4988.0   Max.   :4988.0
NA's   :12663   NA's   :12663
fuel_received_units fuel_mmbtu_per_unit sulfur_content_pct ash_content_pct
Min.   :   1   Min.   : 0.031   Min.   : 0.0000   Min.   : 0.000
1st Qu.:   3803   1st Qu.: 1.026   1st Qu.: 0.0000   1st Qu.: 0.000
Median :   22459   Median : 1.060   Median : 0.0000   Median : 0.000
Mean   : 255411   Mean   : 8.766   Mean   : 0.5126   Mean   : 3.581
3rd Qu.: 109778   3rd Qu.:17.800   3rd Qu.: 0.4700   3rd Qu.: 5.700
Max.   :12982640   Max.   :30.000   Max.   :11.0100   Max.   :64.800
##
mercury_content_ppm fuel_cost_per_mmbtu primary_transportation_mode_code
Min.   :0.000   Min.   :   0.20   Length:19565
1st Qu.:0.000   1st Qu.:   2.31   Class :character
Median :0.000   Median :   3.35   Mode :character
Mean   :0.008   Mean   :   10.59
3rd Qu.:0.000   3rd Qu.:   5.06
Max.   :1.420   Max.   :53092.41
NA's   :8724   NA's   :6368
primary_transportation_mode_code_label secondary_transportation_mode_code
Length:19565   Length:19565
Class :character   Class :character
Mode :character   Mode :character
##
##
##
##
secondary_transportation_mode_code_label natural_gas_transport_code
Length:19565   Length:19565
Class :character   Class :character
Mode :character   Mode :character
##
##
##
##
natural_gas_delivery_contract_type_code moisture_content_pct
Length:19565   Min.   : 0.000
Class :character   1st Qu.: 6.715
Mode :character   Median :11.910
Mean   :15.520
3rd Qu.:26.790
Max.   :42.830
NA's   :16434
chlorine_content_ppm data_maturity   data_maturity_label
Min.   :   0.00   Length:19565   Length:19565
1st Qu.:   0.00   Class :character Class :character
Median :   0.00   Mode :character Mode :character
Mean   : 66.99
3rd Qu.:   0.00
Max.   :3226.00
NA's   :16434
```

3

```
sampled_data$report_date <- as.Date(sampled_data$report_date, format = "%m/%d/%y")

sampled_data$report_month <- format(sampled_data$report_date, "%m")

boxplot(fuel_cost_per_mmbtu ~ fuel_type_code_pudl, data = sampled_data, col = c("skyblue", "lightgreen"
        main = "Fuel Cost by Fuel Group",
        xlab = "Fuel Group", ylab = "Fuel Cost",
        notch = TRUE,
        ylim = c(0,60)
)
```
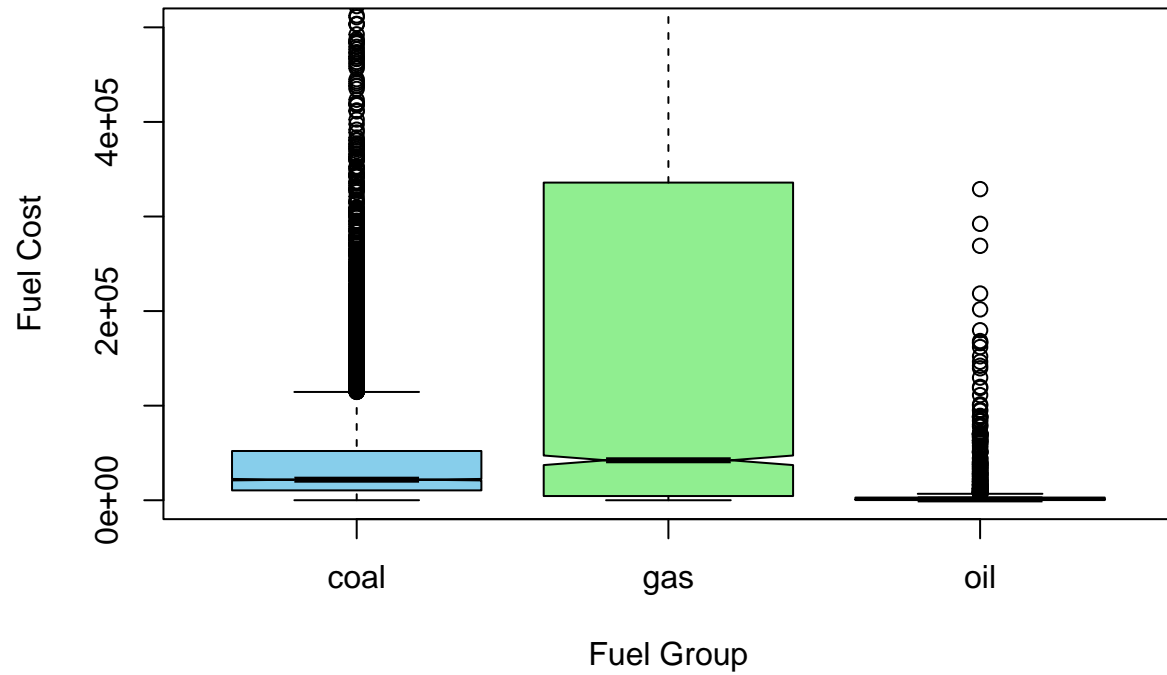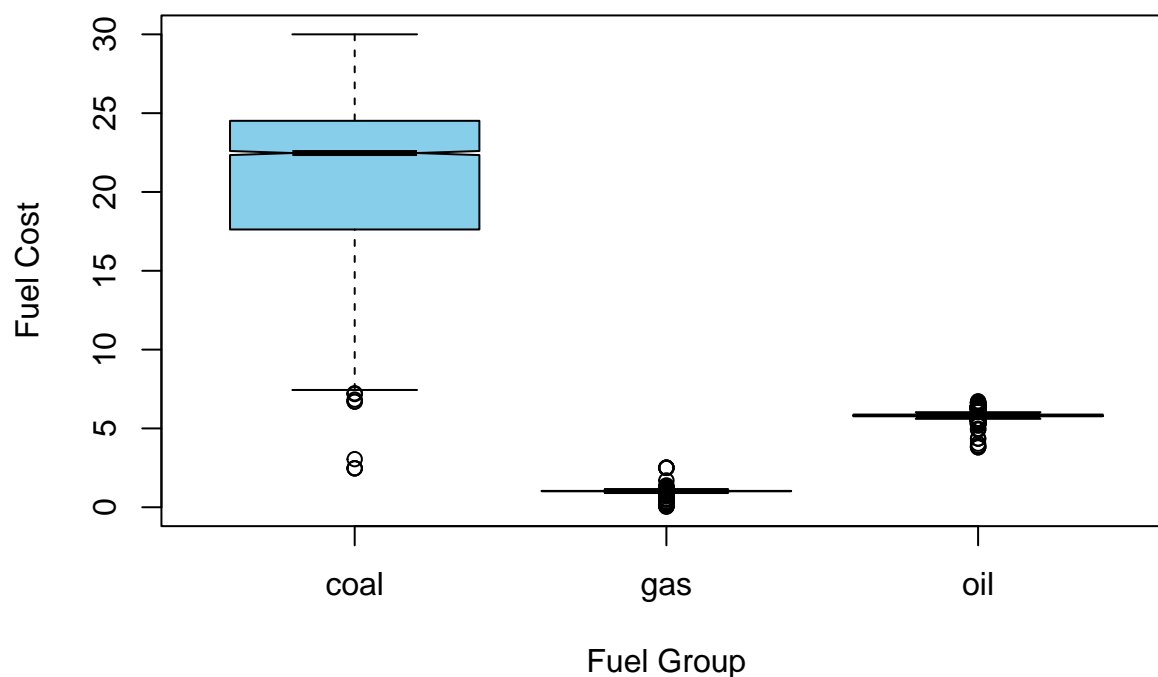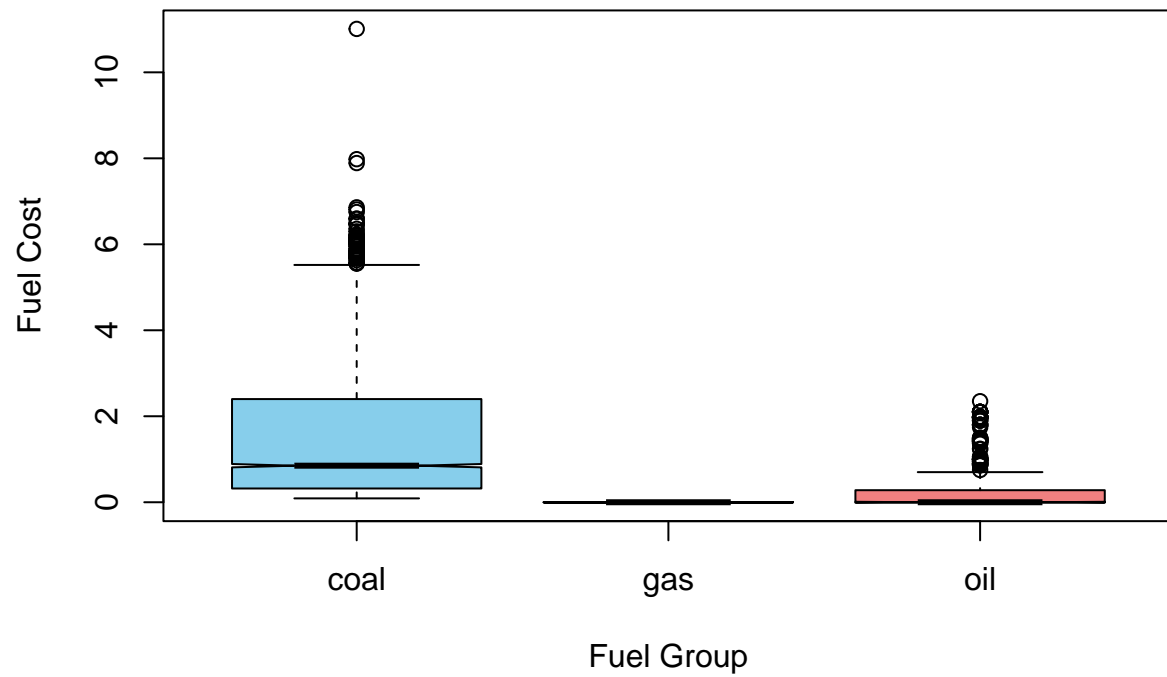
## Fuel Cost by Fuel Group
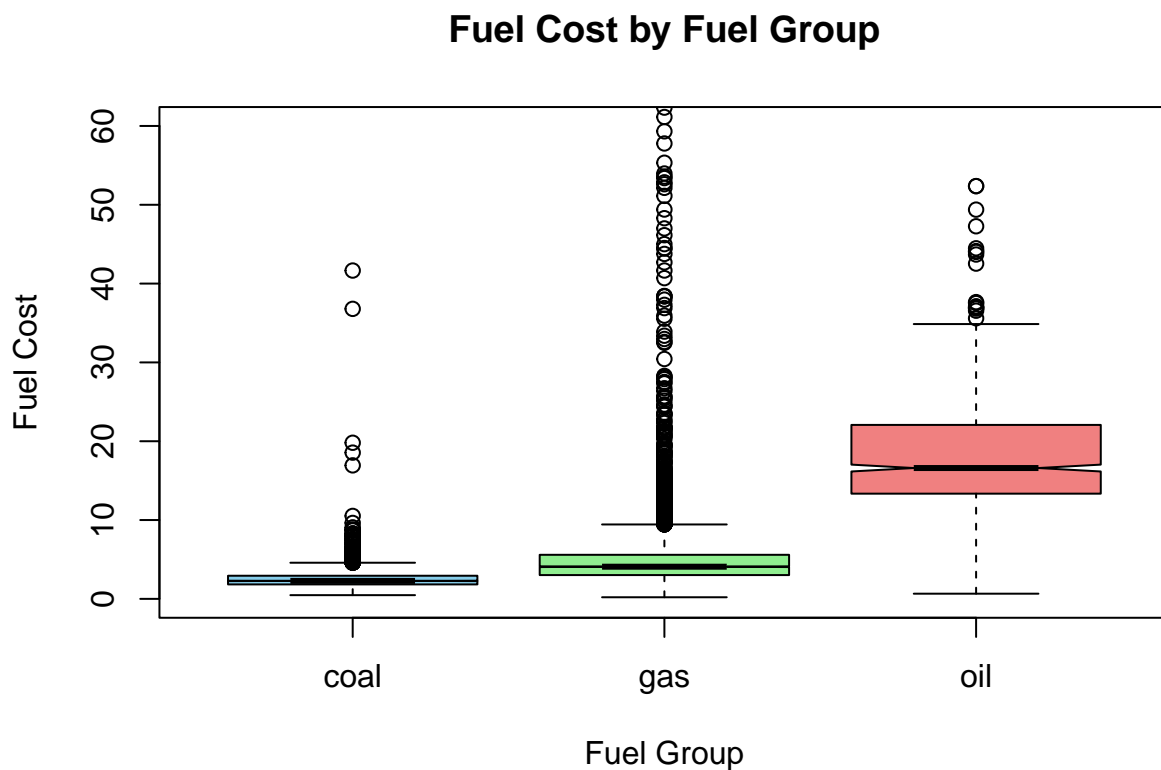


```
boxplot(fuel_received_units ~ fuel_type_code_pudl, data = sampled_data, col = c("skyblue", "lightgreen"
        main = "Fuel Received Units by Fuel Group",
        xlab = "Fuel Group", ylab = "Fuel Cost",
        notch = TRUE,
        ylim = c(0,500000)
        )
```

Fuel Received Units by Fuel Group


```
boxplot(fuel_mmbtu_per_unit ~ fuel_type_code_pudl, data = sampled_data, col = c("skyblue", "lightgreen"
        main = "Fuel mmbtu per unit by Fuel Group",
        xlab = "Fuel Group", ylab = "Fuel Cost",
        notch = TRUE,
        ylim = c(0,30)
        )
```

Fuel mmbtu per unit by Fuel Group


```
boxplot(sulfur_content_pct ~ fuel_type_code_pudl, data = sampled_data, col = c("skyblue", "lightgreen",
        main = "Sulfur content by Fuel Group",
        xlab = "Fuel Group", ylab = "Fuel Cost",
        notch = TRUE,
        ylim = c(0,11)
        )
```

```
## Warning in (function (z, notch = FALSE, width = NULL, varwidth = FALSE, : some
## notches went outside hinges ('box'): maybe set notch=FALSE
```

Sulfur content by Fuel Group


```r
boxplot(ash_content_pct ~ fuel_type_code_pudl, data = sampled_data, col = c("skyblue", "lightgreen", "l
        main = "Ash Content by Fuel Group",
        xlab = "Fuel Group", ylab = "Fuel Cost",
        notch = TRUE,
        ylim = c(0,20)
        )
```

Ash Content by Fuel Group
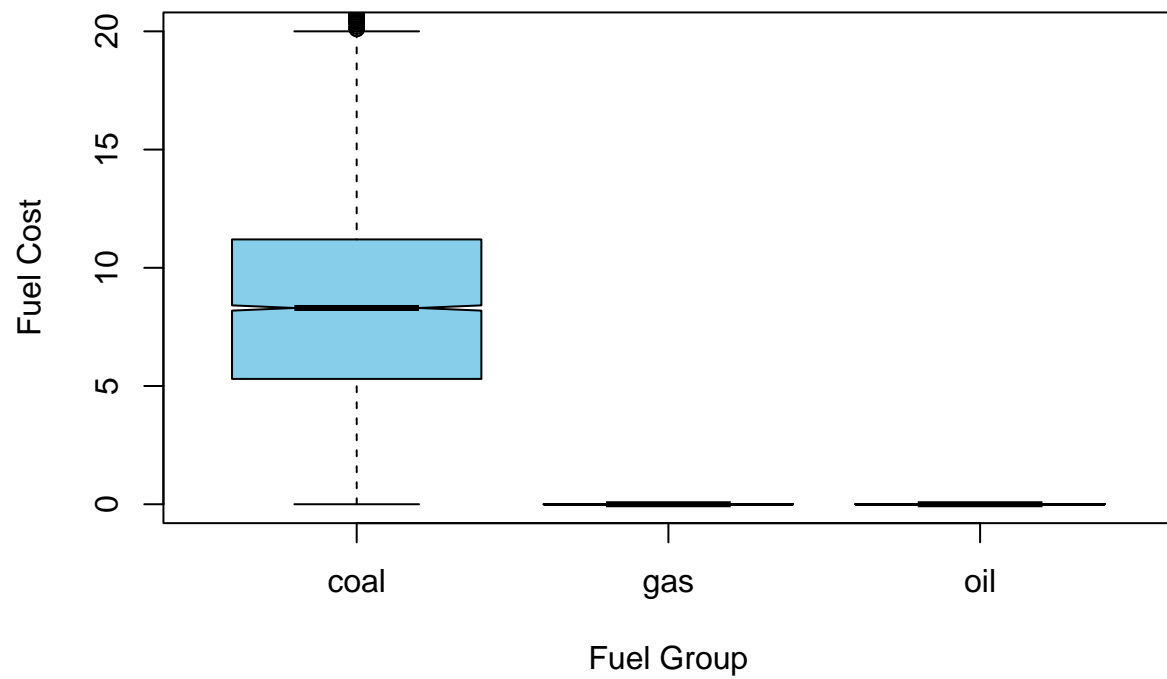

```
boxplot(fuel_cost_per_mmbtu ~ report_month, data = sampled_data,
        main = "Fuel Cost by Report Month",
        xlab = "Report Month", ylab = "Fuel Cost",
        notch = TRUE,
        ylim = c(0, 55))
```

Fuel Cost by Report Month
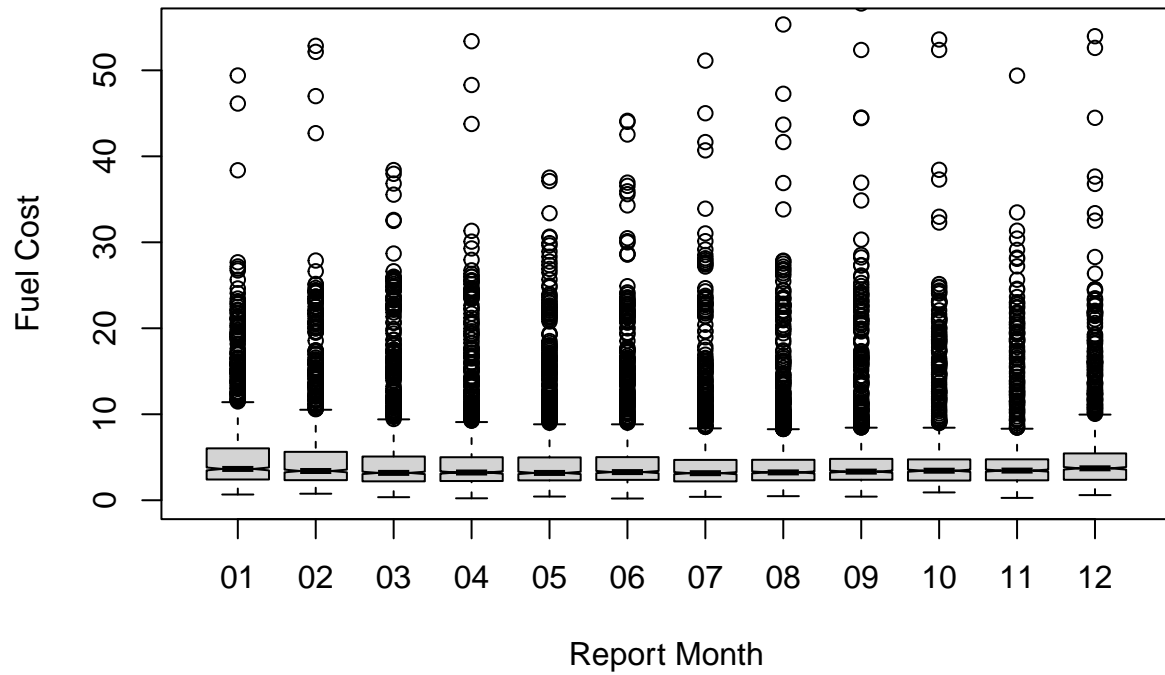

```r
boxplot(fuel_cost_per_mmbtu ~ report_month, data = sampled_data,
        main = "Fuel Cost by Report Month",
        xlab = "Report Month", ylab = "Fuel Cost",
        notch = TRUE,
        ylim = c(0, 8))
```

Fuel Cost by Report Month
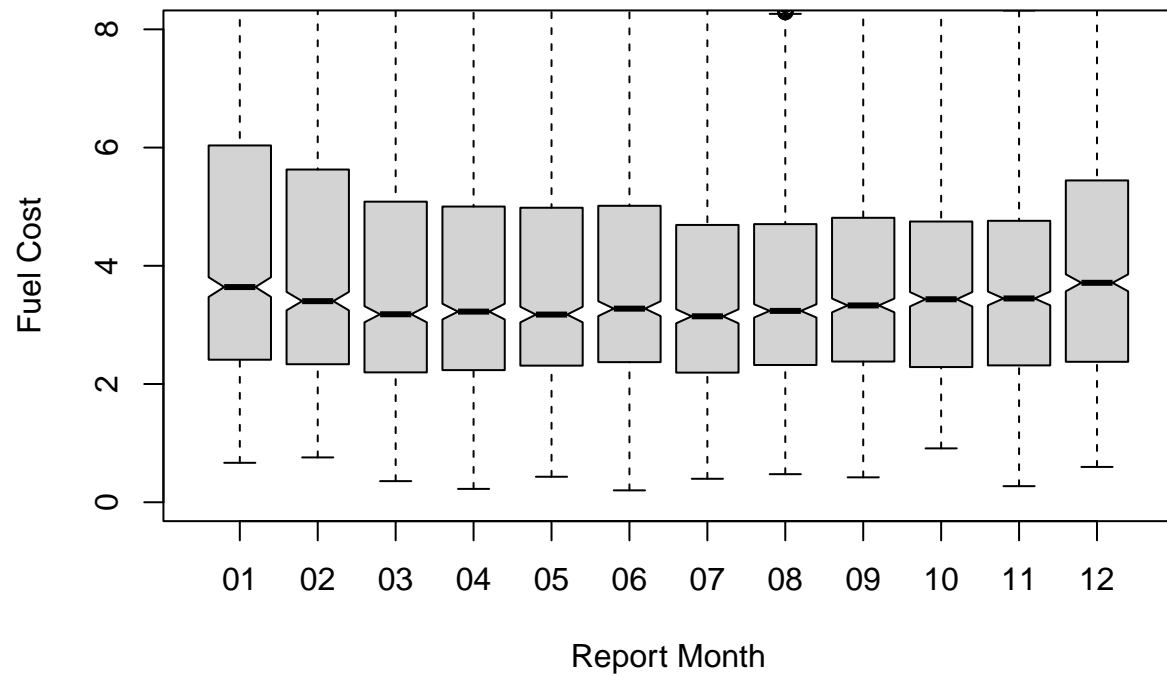

```
boxplot(fuel_received_units ~ report_month, data = sampled_data,
        main = "Fuel Units Received by Report Month",
        xlab = "Report Month", ylab = "Fuel Cost",
        notch = TRUE,
        ylim = c(0, 600000))
```
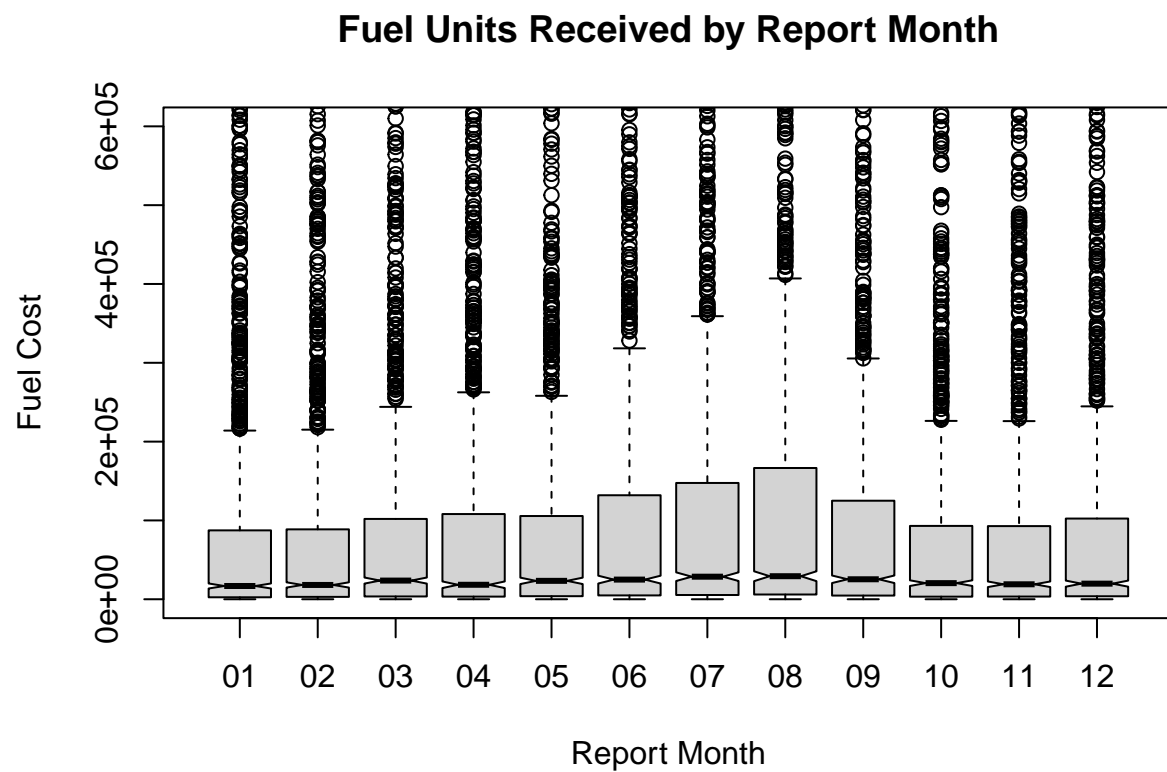
Fuel Units Received by Report Month


```r
ggplot(sampled_data, aes(x = report_month, y = fuel_received_units, fill = fuel_type_code_pudl)) +
  geom_boxplot(notch = TRUE) +
  labs(title = "Fuel Received Units by Report Month and Fuel Type",
       x = "Report Month", y = "Fuel Received Units") +
  ylim(c(0, 100000)) +
  scale_fill_manual(values = c("skyblue", "lightgreen", "lightcoral"))
```

Warning: Removed 5111 rows containing non-finite values ('stat_boxplot()').
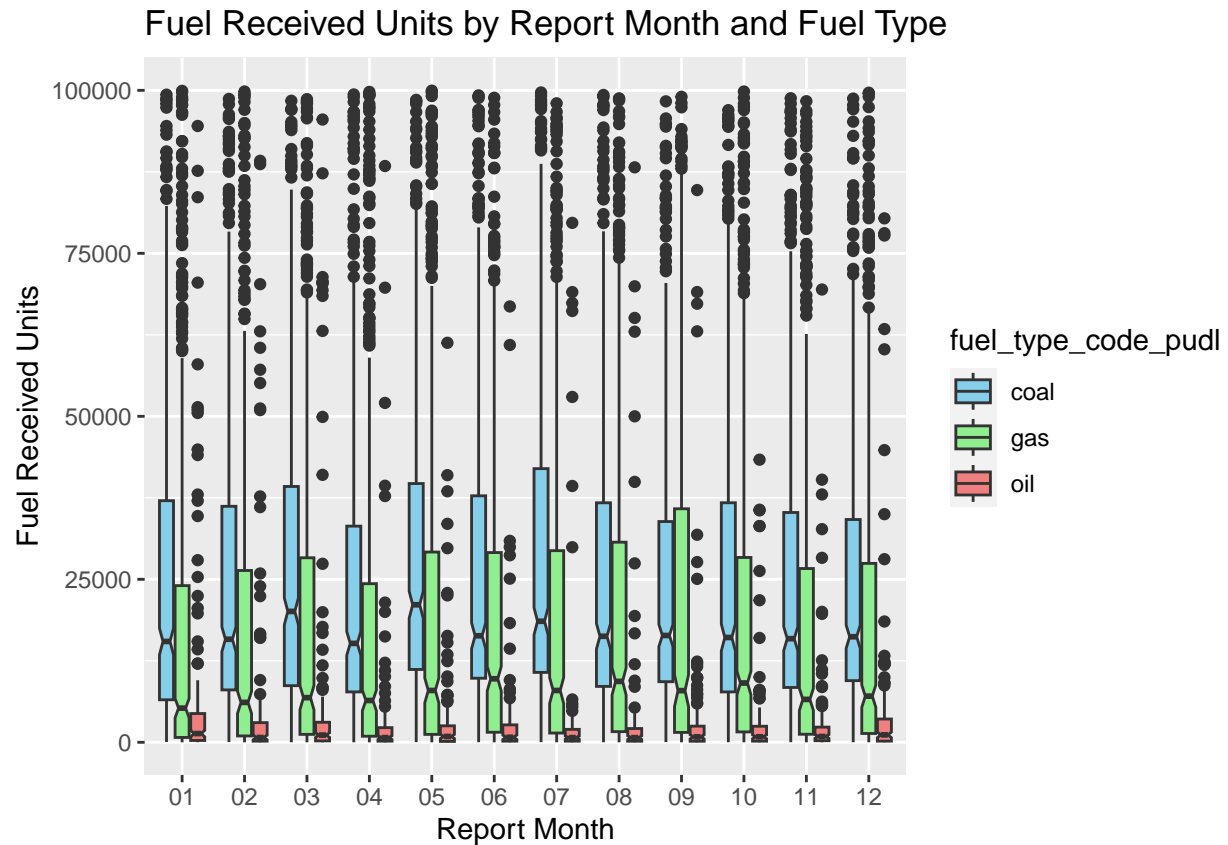
Fuel Received Units by Report Month and Fuel Type

```r
ggplot(sampled_data, aes(x = report_month, y = fuel_received_units, fill = fuel_type_code_pudl)) +
  geom_boxplot(notch = TRUE) +
  labs(title = "Fuel Received Units by Report Month and Fuel Type",
       x = "Report Month", y = "Fuel Received Units") +
  ylim(c(0, 20000)) +
  scale_fill_manual(values = c("skyblue", "lightgreen", "lightcoral"))
```

```
## Warning: Removed 10113 rows containing non-finite values (`stat_boxplot()`).
```

Fuel Received Units by Report Month and Fuel Type
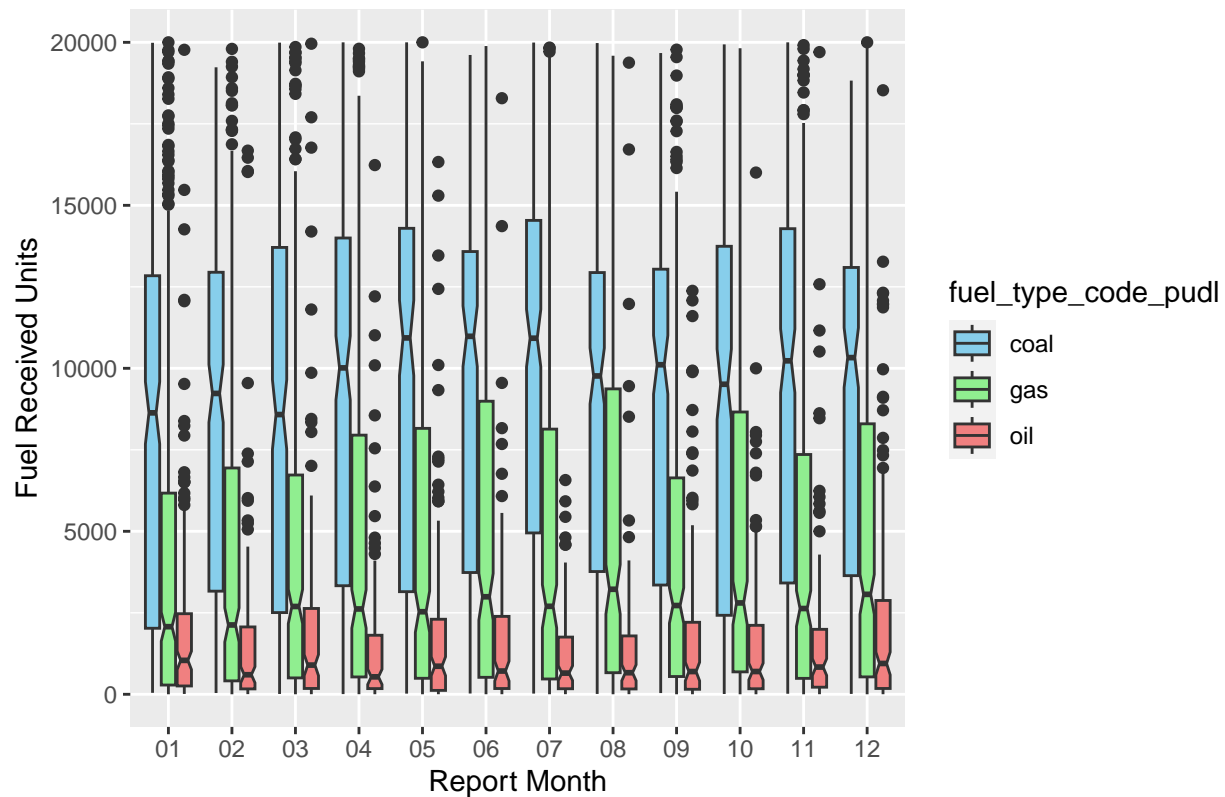
```
order_counts <- sampled_data %>%
  dplyr::group_by(report_month, fuel_type_code_pudl) %>%
  dplyr::summarise(order_count = n())
```

```
## 'summarise()' has grouped output by 'report_month'. You can override using the
## '.groups' argument.
```

```
print(order_counts)
```

```
## # A tibble: 36 x 3
## # Groups:   report_month [12]
##    report_month fuel_type_code_pudl order_count
##    <chr>        <chr>                     <int>
##  1 01           coal                        631
##  2 01           gas                         954
##  3 01           oil                         172
##  4 02           coal                        619
##  5 02           gas                         866
##  6 02           oil                         164
##  7 03           coal                        626
##  8 03           gas                         856
##  9 03           oil                         159
## 10 04           coal                        559
## # i 26 more rows
```

```
ggplot(order_counts, aes(x = report_month, y = order_count, fill = fuel_type_code_pudl)) +
  geom_bar(stat = "identity", position = "dodge") +
  labs(title = "Orders by Fuel Type and Month",
       x = "Month",
       y = "Order Count") +
  scale_fill_manual(values = c("coal" = "blue", "gas" = "orange", "oil" = "gray")) +
  theme_minimal()
```

Orders by Fuel Type and Month
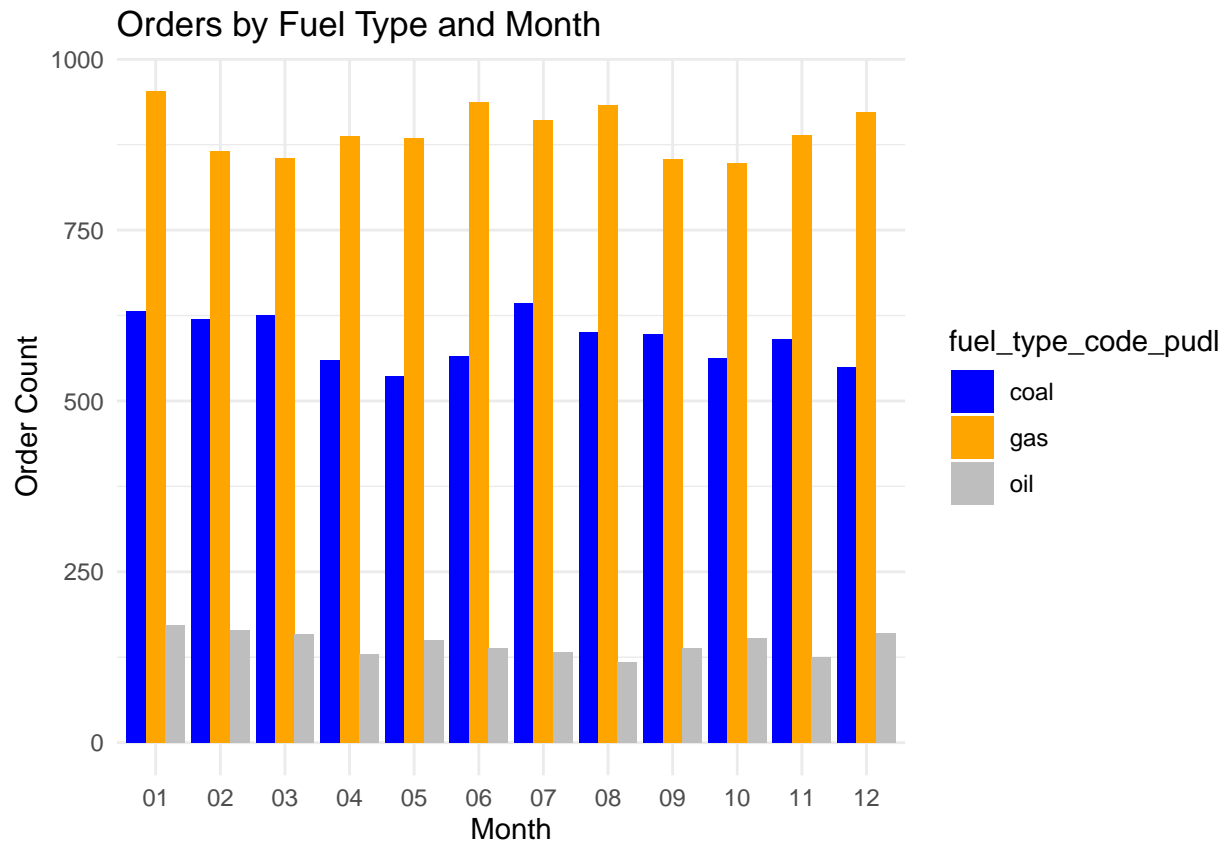

```
## Count missing data by variable
missing_counts <- colSums(is.na(sampled_data))
print(missing_counts)
```

```
##                              rowid
##                                  0
##                       plant_id_eia
##                                  0
##                 plant_id_eia_label
##                                  0
##                        report_date
##                                  0
##                 contract_type_code
##                                  0
##           contract_type_code_label
##                                  0
##           contract_expiration_date
```

```
##                                                       0
## energy_source_code
##                                                       0
## energy_source_code_label
##                                                       0
## fuel_type_code_pudl
##                                                       0
## fuel_group_code
##                                                       0
## mine_id_pudl
##                                                   12663
## mine_id_pudl_label
##                                                   12663
## supplier_name
##                                                       0
## fuel_received_units
##                                                       0
## fuel_mmbtu_per_unit
##                                                       0
## sulfur_content_pct
##                                                       0
## ash_content_pct
##                                                       0
## mercury_content_ppm
##                                                    8724
## fuel_cost_per_mmbtu
##                                                    6368
## primary_transportation_mode_code
##                                                       0
## primary_transportation_mode_code_label
##                                                       0
## secondary_transportation_mode_code
##                                                       0
## secondary_transportation_mode_code_label
##                                                       0
## natural_gas_transport_code
##                                                       0
## natural_gas_delivery_contract_type_code
##                                                       0
## moisture_content_pct
##                                                   16434
## chlorine_content_ppm
##                                                   16434
## data_maturity
##                                                       0
## data_maturity_label
##                                                       0
## report_month
##                                                       0
```

```r
## Show count of each fuel type
count_fuel_type <- table(sampled_data$fuel_type_code_pudl)
print(count_fuel_type)
```

```
## 
##   coal   gas    oil
##  7083 10742  1740
```

```
library(tidyverse)
missing_by_fuel_type <- sampled_data %>%
  group_by(fuel_type_code_pudl) %>%
  summarise(
    missing_mine_id_pudl = sum(is.na(mine_id_pudl)),
    missing_mine_id_pudl_label = sum(is.na(mine_id_pudl_label)),
    missing_mercury_content_ppm = sum(is.na(mercury_content_ppm)),
    missing_moisture_content_pct = sum(is.na(moisture_content_pct)),
    missing_chlorine_content_ppm = sum(is.na(chlorine_content_ppm))
  )
print(missing_by_fuel_type)
```

```
## # A tibble: 3 x 6
##   fuel_type_code_pudl missing_mine_id_pudl missing_mine_id_pudl_label
##   <chr>                              <int>                      <int>
## 1 coal                                 193                        193
## 2 gas                                10732                      10732
## 3 oil                                 1738                       1738
## # i 3 more variables: missing_mercury_content_ppm <int>,
## #   missing_moisture_content_pct <int>, missing_chlorine_content_ppm <int>
```

```
missing_fuel.cost_by_fuel.type <- sampled_data %>%
  group_by(fuel_type_code_pudl) %>%
  summarise(missing_fuel_cost = sum(is.na(fuel_cost_per_mmbtu)))
print(missing_fuel.cost_by_fuel.type)
```

```
## # A tibble: 3 x 2
##   fuel_type_code_pudl missing_fuel_cost
##   <chr>                           <int>
## 1 coal                             2046
## 2 gas                              3591
## 3 oil                               731
```

```
same_contract_type_data <- all(sampled_data$contract_type_code == sampled_data$contract_type_code_label
print(same_contract_type_data)
```

```
## [1] TRUE
```

```
same_energy_source_code_data <- all(sampled_data$energy_source_code == sampled_data$energy_source_code_
print(same_energy_source_code_data)
```

```
## [1] TRUE
```

##since these columns have the same data, column "energy_source_code_label" will be dropped

```
same_primary_transportation_mode_data <- all(sampled_data$primary_transportation_mode_code == sampled_da
print(same_primary_transportation_mode_data)
```

```
## [1] TRUE
```

##since these columns have the same data, column "primary_transportation_mode_code_label" will be droppe

```
same_secondary_transportation_mode_data <- all(sampled_data$secondary_transportation_mode_code == sample
print(same_secondary_transportation_mode_data)
```

```
## [1] TRUE
```

##since these columns have the same data, column "secondary_transportation_mode_code_label" will be drop

```
same_data_maturity_data <- all(sampled_data$data_maturity == sampled_data$data_maturity_label)
print(same_data_maturity_data)
```

```
## [1] TRUE
```

##since these columns have the same data, column "same_data_maturity_data" will be dropped

##remove columns as described above. Also remove rowID column, as the rowIDs are stored in row names. A
```
sampled_data_2 <- sampled_data[, c(
  "plant_id_eia", "plant_id_eia_label",
  "contract_type_code", "contract_expiration_date", "energy_source_code",
  "fuel_type_code_pudl", "fuel_group_code", "supplier_name",
  "fuel_received_units", "fuel_mmbtu_per_unit", "sulfur_content_pct",
  "ash_content_pct", "fuel_cost_per_mmbtu", "primary_transportation_mode_code",
  "secondary_transportation_mode_code", "data_maturity", "report_month" )]
```

secondary_transportation_mode_code also has significant missing data and will by dropped

```
sampled_data_3 <- sampled_data_2[, c(
  "plant_id_eia", "plant_id_eia_label",
  "contract_type_code", "contract_expiration_date", "energy_source_code",
  "fuel_type_code_pudl", "fuel_group_code", "supplier_name",
  "fuel_received_units", "fuel_mmbtu_per_unit", "sulfur_content_pct",
  "ash_content_pct", "fuel_cost_per_mmbtu", "primary_transportation_mode_code",
   "data_maturity", "report_month"
)]
```

The focus of this analysis will be on fuel types, therefore supplier data will also be dropped. Addit

```
sampled_data_4 <- sampled_data_3[, c(
  "contract_type_code", "energy_source_code",
  "fuel_type_code_pudl", "fuel_group_code",
  "fuel_received_units", "fuel_mmbtu_per_unit", "sulfur_content_pct",
  "ash_content_pct", "fuel_cost_per_mmbtu", "primary_transportation_mode_code" , "report_month"
)]
```

```r
##Categorical data will one-hot coded for ease of analysis
sampled_data_4$contract_type_C<-ifelse(sampled_data_4$contract_type_code=="C","1",0)
sampled_data_4$contract_type_NC<-ifelse(sampled_data_4$contract_type_code=="NC","1",0)
sampled_data_4$contract_type_S<-ifelse(sampled_data_4$contract_type_code=="S","1",0)
sampled_data_4$contract_type_T<-ifelse(sampled_data_4$contract_type_code=="T","1",0)


sampled_data_4$energy_source_code_BIT<-ifelse(sampled_data_4$energy_source_code=="BIT","1",0)
sampled_data_4$energy_source_code_NG<-ifelse(sampled_data_4$energy_source_code=="NG","1",0)
sampled_data_4$energy_source_code_DFO<-ifelse(sampled_data_4$energy_source_code=="DFO","1",0)
sampled_data_4$energy_source_code_SUB<-ifelse(sampled_data_4$energy_source_code=="SUB","1",0)
sampled_data_4$energy_source_code_LIG<-ifelse(sampled_data_4$energy_source_code=="LIG","1",0)
sampled_data_4$energy_source_code_RFO<-ifelse(sampled_data_4$energy_source_code=="RFO","1",0)
sampled_data_4$energy_source_code_WO<-ifelse(sampled_data_4$energy_source_code=="WO","1",0)
sampled_data_4$energy_source_code_KER<-ifelse(sampled_data_4$energy_source_code=="KER","1",0)
sampled_data_4$energy_source_code_PC<-ifelse(sampled_data_4$energy_source_code=="PC","1",0)
sampled_data_4$energy_source_code_WC<-ifelse(sampled_data_4$energy_source_code=="WC","1",0)
sampled_data_4$energy_source_code_PG<-ifelse(sampled_data_4$energy_source_code=="PG","1",0)
sampled_data_4$energy_source_code_OG<-ifelse(sampled_data_4$energy_source_code=="OG","1",0)
sampled_data_4$energy_source_code_JF<-ifelse(sampled_data_4$energy_source_code=="JF","1",0)
sampled_data_4$energy_source_code_SC<-ifelse(sampled_data_4$energy_source_code=="SC","1",0)
sampled_data_4$energy_source_code_BFG<-ifelse(sampled_data_4$energy_source_code=="BFG","1",0)
sampled_data_4$energy_source_code_SGP<-ifelse(sampled_data_4$energy_source_code=="SGP","1",0)
sampled_data_4$energy_source_code_RC<-ifelse(sampled_data_4$energy_source_code=="RC","1",0)


sampled_data_4$fuel_type_coal<-ifelse(sampled_data_4$fuel_type_code_pudl=="coal","1",0)
sampled_data_4$fuel_type_gas<-ifelse(sampled_data_4$fuel_type_code_pudl=="gas","1",0)
sampled_data_4$fuel_type_oil<-ifelse(sampled_data_4$fuel_type_code_pudl=="oil","1",0)


sampled_data_4$fuel_group_coal<-ifelse(sampled_data_4$fuel_group_code=="coal","1",0)
sampled_data_4$fuel_group_natural_gas<-ifelse(sampled_data_4$fuel_group_code=="natural_gas","1",0)
sampled_data_4$fuel_group_petroleum<-ifelse(sampled_data_4$fuel_group_code=="petroleum","1",0)
sampled_data_4$fuel_group_petroleum_coke<-ifelse(sampled_data_4$fuel_group_code=="petroleum_coke","1",0)
sampled_data_4$fuel_group_other_gas<-ifelse(sampled_data_4$fuel_group_code=="other_gas","1",0)


sampled_data_4$primary_transportation_RV<-ifelse(sampled_data_4$primary_transportation_mode_code=="RV",
sampled_data_4$primary_transportation_PL<-ifelse(sampled_data_4$primary_transportation_mode_code=="PL",
sampled_data_4$primary_transportation_TR<-ifelse(sampled_data_4$primary_transportation_mode_code=="TR",
sampled_data_4$primary_transportation_RR<-ifelse(sampled_data_4$primary_transportation_mode_code=="RR",
sampled_data_4$primary_transportation_TC<-ifelse(sampled_data_4$primary_transportation_mode_code=="TC",
sampled_data_4$primary_transportation_WT<-ifelse(sampled_data_4$primary_transportation_mode_code=="WT",
sampled_data_4$primary_transportation_TP<-ifelse(sampled_data_4$primary_transportation_mode_code=="TP",
sampled_data_4$primary_transportation_GL<-ifelse(sampled_data_4$primary_transportation_mode_code=="GL",

sampled_data_4$report_month_Jan<-ifelse(sampled_data_4$report_month=="01",1,0)
sampled_data_4$report_month_Feb<-ifelse(sampled_data_4$report_month=="02",1,0)
sampled_data_4$report_month_Mar<-ifelse(sampled_data_4$report_month=="03",1,0)
sampled_data_4$report_month_Apr<-ifelse(sampled_data_4$report_month=="04",1,0)
sampled_data_4$report_month_May<-ifelse(sampled_data_4$report_month=="05",1,0)
sampled_data_4$report_month_Jun<-ifelse(sampled_data_4$report_month=="06",1,0)
```

```r
sampled_data_4$report_month_Jul<-ifelse(sampled_data_4$report_month=="07",1,0)
sampled_data_4$report_month_Aug<-ifelse(sampled_data_4$report_month=="08",1,0)
sampled_data_4$report_month_Sep<-ifelse(sampled_data_4$report_month=="09",1,0)
sampled_data_4$report_month_Oct<-ifelse(sampled_data_4$report_month=="10",1,0)
sampled_data_4$report_month_Nov<-ifelse(sampled_data_4$report_month=="11",1,0)
sampled_data_4$report_month_Dec<-ifelse(sampled_data_4$report_month=="12",1,0)

sampled_data_4$Season <- ifelse(sampled_data_4$report_month_Dec + sampled_data_4$report_month_Jan + samp
  ifelse(sampled_data_4$report_month_Mar + sampled_data_4$report_month_Apr + sampled_data_4$report_month
    ifelse(sampled_data_4$report_month_Jun + sampled_data_4$report_month_Jul + sampled_data_4$report_mon


##remove original categorical columns following one hot coding
sampled_data_5 <- sampled_data_4[, -c(1:4, 10:11, 49:60)]

sampled_data_5$winter<-ifelse(sampled_data_4$Season=="Winter",1,0)
sampled_data_5$fall<-ifelse(sampled_data_4$Season=="Fall",1,0)
sampled_data_5$spring<-ifelse(sampled_data_4$Season=="Spring",1,0)
sampled_data_5$summer<-ifelse(sampled_data_4$Season=="Summer",1,0)

sampled_data_5_Seasons<-sampled_data_5

##remove Season column

sampled_data_5 <- sampled_data_5[, -c(43)]

sampled_data_5 <- as.data.frame(sapply(sampled_data_5, as.numeric))

## Remove missing values
sampled_data_5<-na.omit(sampled_data_5)

summary(sampled_data_5)
```

```
##  fuel_received_units fuel_mmbtu_per_unit sulfur_content_pct ash_content_pct
##  Min.   :       1    Min.   : 0.243      Min.   :0.0000     Min.   : 0.000
##  1st Qu.:    3289    1st Qu.: 1.024      1st Qu.:0.0000     1st Qu.: 0.000
##  Median :   19181    Median : 1.064      Median :0.0000     Median : 0.000
##  Mean   :  174667    Mean   : 9.122      Mean   :0.4991     Mean   : 3.228
##  3rd Qu.:   77290    3rd Qu.:17.950      3rd Qu.:0.4200     3rd Qu.: 5.800
##  Max.   :12982640    Max.   :30.000      Max.   :7.8900     Max.   :49.800
##  fuel_cost_per_mmbtu contract_type_C  contract_type_NC   contract_type_S
##  Min.   :    0.20    Min.   :0.0000   Min.   :0.000000   Min.   :0.0000
##  1st Qu.:    2.31    1st Qu.:0.0000   1st Qu.:0.000000   1st Qu.:0.0000
##  Median :    3.35    Median :0.0000   Median :0.000000   Median :1.0000
##  Mean   :   10.59    Mean   :0.4619   Mean   :0.004547   Mean   :0.5335
##  3rd Qu.:    5.06    3rd Qu.:1.0000   3rd Qu.:0.000000   3rd Qu.:1.0000
##  Max.   :53092.41    Max.   :1.0000   Max.   :1.000000   Max.   :1.0000
##  contract_type_T energy_source_code_BIT energy_source_code_NG
##  Min.   :0       Min.   :0.0000         Min.   :0.0000
##  1st Qu.:0       1st Qu.:0.0000         1st Qu.:0.0000
##  Median :0       Median :0.0000         Median :1.0000
##  Mean   :0       Mean   :0.2251         Mean   :0.5411
##  3rd Qu.:0       3rd Qu.:0.0000         3rd Qu.:1.0000
```

```
## Max.   :0        Max.   :1.0000        Max.   :1.0000
## energy_source_code_DFO energy_source_code_SUB energy_source_code_LIG
## Min.   :0.00000        Min.   :0.0000        Min.   :0.000000
## 1st Qu.:0.00000        1st Qu.:0.0000        1st Qu.:0.000000
## Median :0.00000        Median :0.0000        Median :0.000000
## Mean   :0.07024        Mean   :0.1454        Mean   :0.005607
## 3rd Qu.:0.00000        3rd Qu.:0.0000        3rd Qu.:0.000000
## Max.   :1.00000        Max.   :1.0000        Max.   :1.000000
## energy_source_code_RFO energy_source_code_WO energy_source_code_KER
## Min.   :0.000000        Min.   :0.0000000        Min.   :0.00e+00
## 1st Qu.:0.000000        1st Qu.:0.0000000        1st Qu.:0.00e+00
## Median :0.000000        Median :0.0000000        Median :0.00e+00
## Mean   :0.005456        Mean   :0.0005304        Mean   :7.58e-05
## 3rd Qu.:0.000000        3rd Qu.:0.0000000        3rd Qu.:0.00e+00
## Max.   :1.000000        Max.   :1.0000000        Max.   :1.00e+00
## energy_source_code_PC energy_source_code_WC energy_source_code_PG
## Min.   :0.000000        Min.   :0.000000        Min.   :0.0000000
## 1st Qu.:0.000000        1st Qu.:0.000000        1st Qu.:0.0000000
## Median :0.000000        Median :0.000000        Median :0.0000000
## Mean   :0.004471        Mean   :0.001061        Mean   :0.0004546
## 3rd Qu.:0.000000        3rd Qu.:0.000000        3rd Qu.:0.0000000
## Max.   :1.000000        Max.   :1.000000        Max.   :1.0000000
## energy_source_code_OG energy_source_code_JF energy_source_code_SC
## Min.   :0.0000000        Min.   :0.0000000        Min.   :0.00e+00
## 1st Qu.:0.0000000        1st Qu.:0.0000000        1st Qu.:0.00e+00
## Median :0.0000000        Median :0.0000000        Median :0.00e+00
## Mean   :0.0002273        Mean   :0.0001515        Mean   :7.58e-05
## 3rd Qu.:0.0000000        3rd Qu.:0.0000000        3rd Qu.:0.00e+00
## Max.   :1.0000000        Max.   :1.0000000        Max.   :1.00e+00
## energy_source_code_BFG energy_source_code_SGP energy_source_code_RC
## Min.   :0        Min.   :0.00e+00        Min.   :0
## 1st Qu.:0        1st Qu.:0.00e+00        1st Qu.:0
## Median :0        Median :0.00e+00        Median :0
## Mean   :0        Mean   :7.58e-05        Mean   :0
## 3rd Qu.:0        3rd Qu.:0.00e+00        3rd Qu.:0
## Max.   :0        Max.   :1.00e+00        Max.   :0
## fuel_type_coal    fuel_type_gas    fuel_type_oil    fuel_group_coal
## Min.   :0.0000    Min.   :0.0000    Min.   :0.00000    Min.   :0.0000
## 1st Qu.:0.0000    1st Qu.:0.0000    1st Qu.:0.00000    1st Qu.:0.0000
## Median :0.0000    Median :1.0000    Median :0.00000    Median :0.0000
## Mean   :0.3817    Mean   :0.5419    Mean   :0.07646    Mean   :0.3772
## 3rd Qu.:1.0000    3rd Qu.:1.0000    3rd Qu.:0.00000    3rd Qu.:1.0000
## Max.   :1.0000    Max.   :1.0000    Max.   :1.00000    Max.   :1.0000
## fuel_group_natural_gas fuel_group_petroleum fuel_group_petroleum_coke
## Min.   :0.0000        Min.   :0.00000        Min.   :0.000000
## 1st Qu.:0.0000        1st Qu.:0.00000        1st Qu.:0.000000
## Median :1.0000        Median :0.00000        Median :0.000000
## Mean   :0.5411        Mean   :0.07646        Mean   :0.004471
## 3rd Qu.:1.0000        3rd Qu.:0.00000        3rd Qu.:0.000000
## Max.   :1.0000        Max.   :1.00000        Max.   :1.000000
## fuel_group_other_gas primary_transportation_RV primary_transportation_PL
## Min.   :0.0000000    Min.   :0.00000        Min.   :0.0000
## 1st Qu.:0.0000000    1st Qu.:0.00000        1st Qu.:0.0000
## Median :0.0000000    Median :0.00000        Median :0.0000
```

```
## Mean    :0.0007577    Mean    :0.07873         Mean    :0.4813
## 3rd Qu.:0.0000000    3rd Qu.:0.00000         3rd Qu.:1.0000
## Max.    :1.0000000    Max.    :1.00000         Max.    :1.0000
## primary_transportation_TR primary_transportation_RR primary_transportation_TC
## Min.    :0.0000          Min.    :0.0000         Min.    :0.000000
## 1st Qu.:0.0000          1st Qu.:0.0000         1st Qu.:0.000000
## Median :0.0000          Median :0.0000         Median :0.000000
## Mean    :0.1083          Mean    :0.2472         Mean    :0.004925
## 3rd Qu.:0.0000          3rd Qu.:0.0000         3rd Qu.:0.000000
## Max.    :1.0000          Max.    :1.0000         Max.    :1.000000
## primary_transportation_WT primary_transportation_TP primary_transportation_GL
## Min.    :0.000000          Min.    :0.0000000         Min.    :0.0000000
## 1st Qu.:0.000000          1st Qu.:0.0000000         1st Qu.:0.0000000
## Median :0.000000          Median :0.0000000         Median :0.0000000
## Mean    :0.003789          Mean    :0.0004546         Mean    :0.0002273
## 3rd Qu.:0.000000          3rd Qu.:0.0000000         3rd Qu.:0.0000000
## Max.    :1.000000          Max.    :1.0000000         Max.    :1.0000000
##      winter                fall                spring                summer
## Min.    :0.0000    Min.    :0.0000    Min.    :0.0000    Min.    :0.0000
## 1st Qu.:0.0000    1st Qu.:0.0000    1st Qu.:0.0000    1st Qu.:0.0000
## Median :0.0000    Median :0.0000    Median :0.0000    Median :0.0000
## Mean    :0.2601    Mean    :0.2426    Mean    :0.2447    Mean    :0.2526
## 3rd Qu.:1.0000    3rd Qu.:0.0000    3rd Qu.:0.0000    3rd Qu.:1.0000
## Max.    :1.0000    Max.    :1.0000    Max.    :1.0000    Max.    :1.0000
```

```r
## there are no "contract type Tolling", energy source "BFG" or energy source "RC" in the subsetted dat
sampled_data_5 <- sampled_data_5[, -c(9,24,26)]

## Data exploration
boxplot(sampled_data_5[, 1], main="fuel_recieved_units", col="red", ylim=c(0, 10000000))
```

fuel_recieved_units
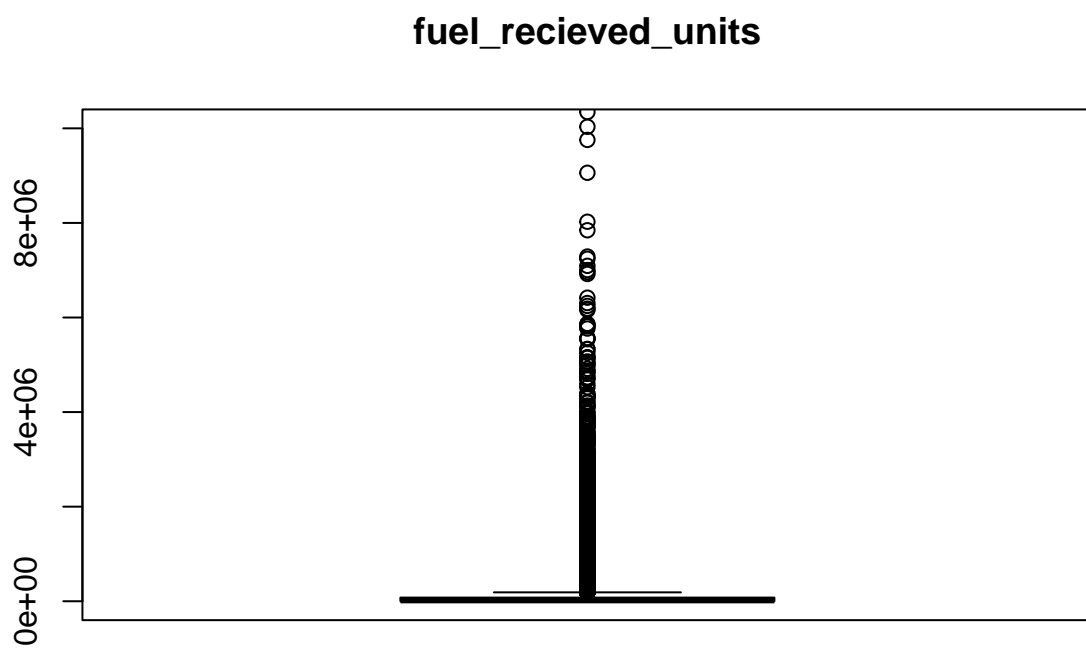

```
boxplot(sampled_data_5[, 2], main="fuel_mmbtu_per_unit", col="blue", ylim=c(0, 50))
```

fuel_mmbtu_per_unit
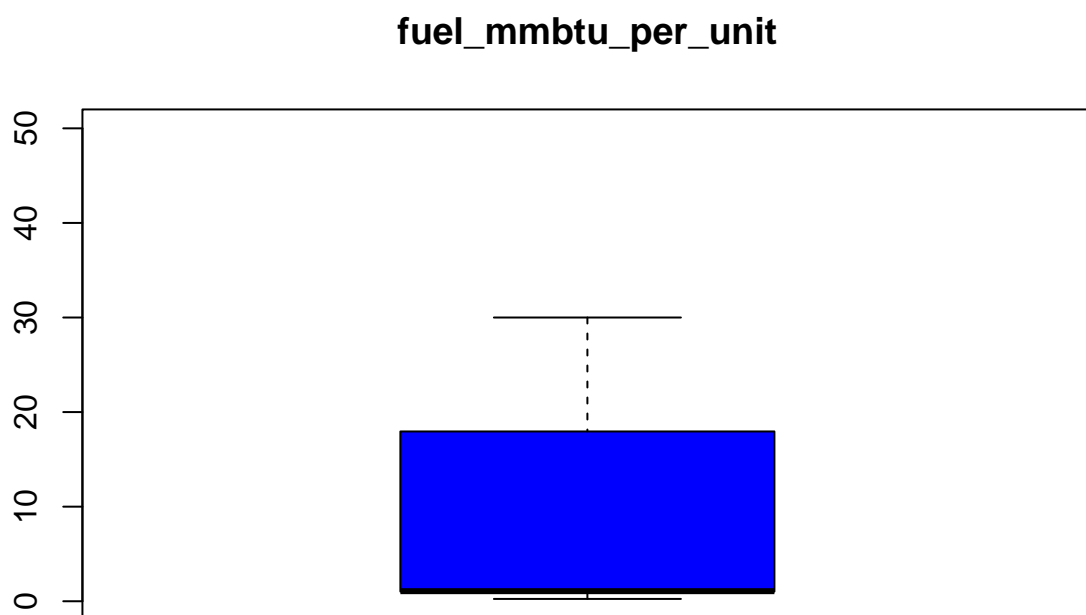

```r
boxplot(sampled_data_5[, 3], main="sulfur_content_pct", col="yellow", ylim=c(0, 10))
```

sulfur_content_pct
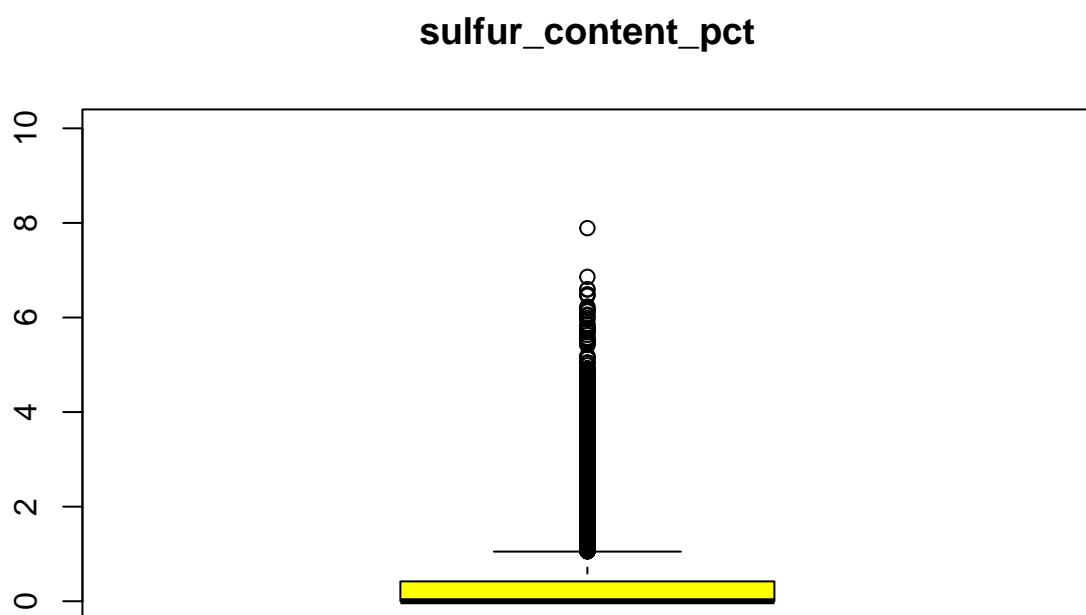

```
boxplot(sampled_data_5[, 4], main="ash_content_pct", col="pink", ylim=c(0, 75))
```

ash_content_pct
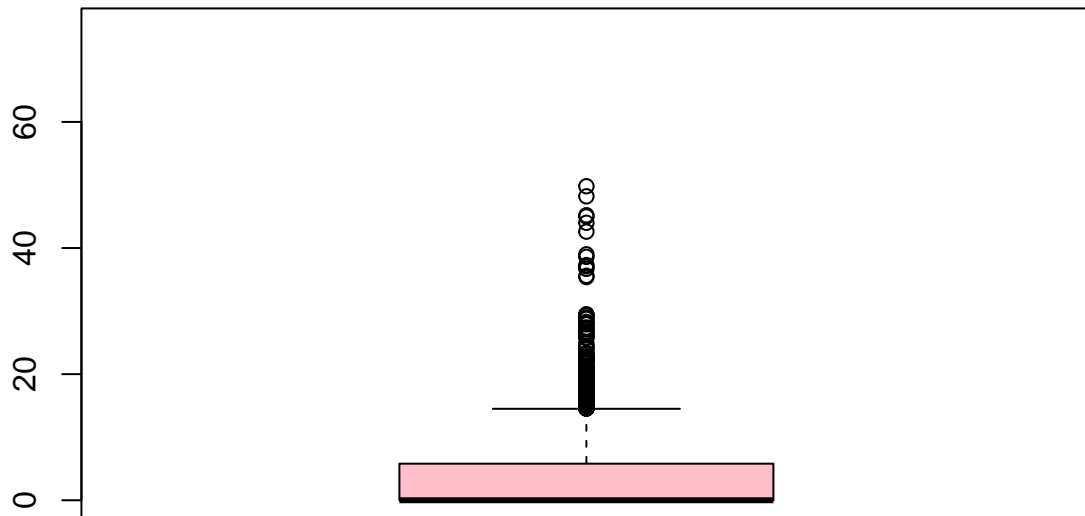

```r
boxplot(sampled_data_5[, 5], main="fuel_cost_per_mmbtu", col="purple", ylim=c(0, 55000))
```
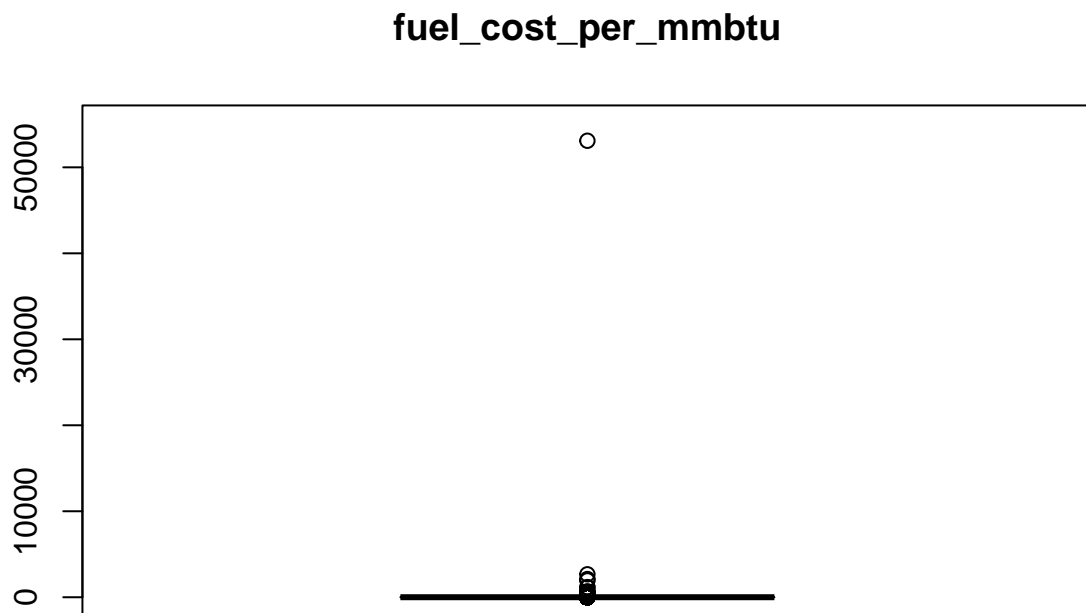
fuel_cost_per_mmbtu


```
##fuel_cost_per_mmbtu has a significant outlier that is likely an error, data will be dropped.

sampled_data_6 <- sampled_data_5[!(rownames(sampled_data_5) == 6390), ]

##check outlier has been removed
boxplot(sampled_data_6[, 5], main="fuel_cost_per_mmbtu", col="purple", ylim=c(0, 55000))
```
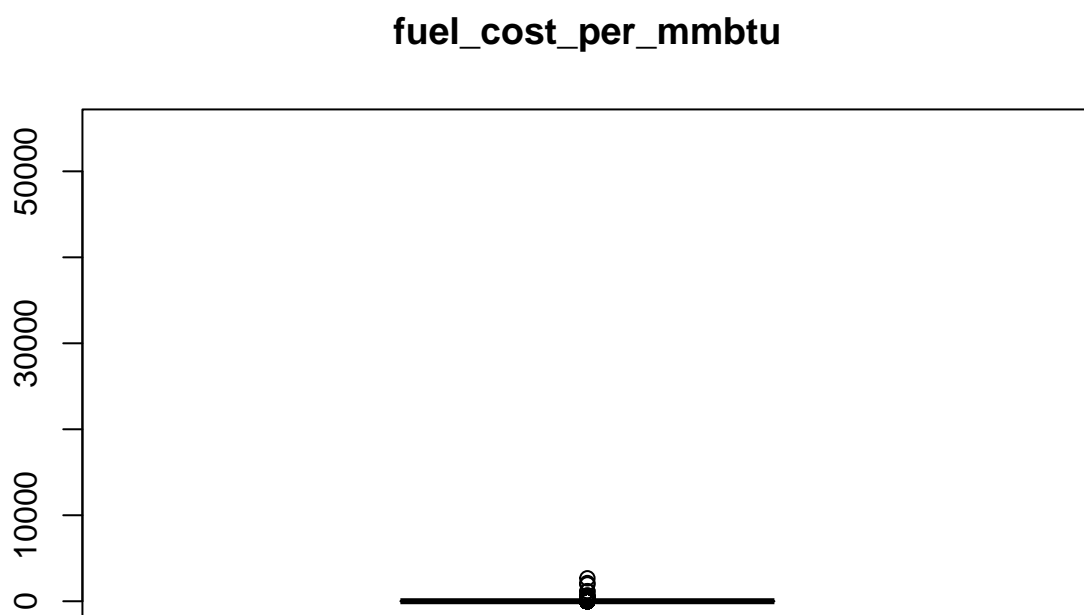
fuel_cost_per_mmbtu


```
##rerun boxplot using new axis values
boxplot(sampled_data_6[, 5], main="fuel_cost_per_mmbtu", col="purple", ylim=c(0, 2500))
```

fuel_cost_per_mmbtu
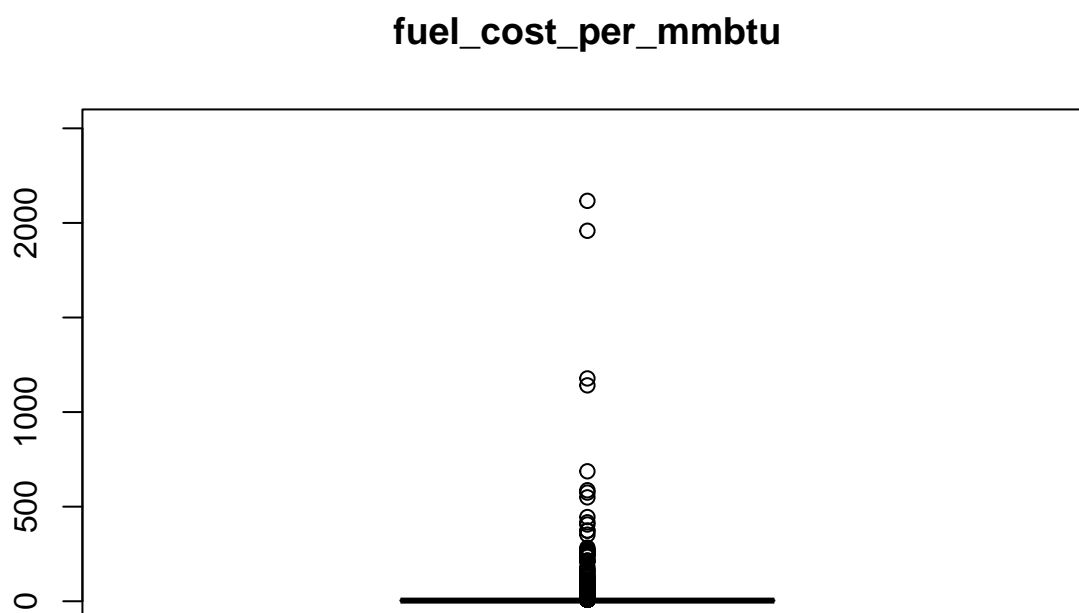

```r
##normalize numerical data, append one hot coded categorical data
pudl_scaled <- scale(sampled_data_6[, 1:5])
combined_pudl_scaled <- cbind(pudl_scaled, sampled_data_6[6:43])


## kmeans cluster the data
## determine optimal number of clusters
fviz_nbclust(combined_pudl_scaled, kmeans, method = "silhouette")
```

Optimal number of clusters
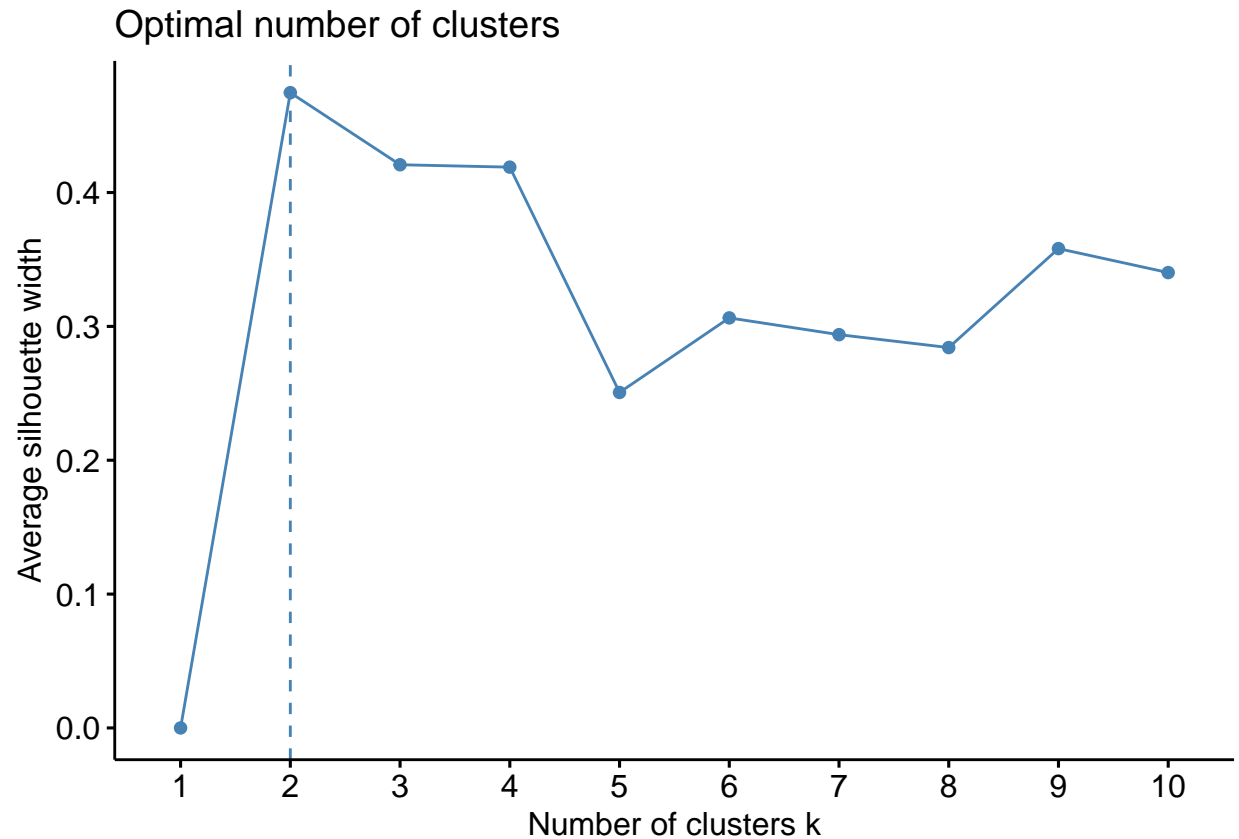
```
set.seed(321)
k2 <- kmeans(combined_pudl_scaled, centers = 2, nstart = 25)
k2$centers
```

```
##   fuel_received_units fuel_mmbtu_per_unit sulfur_content_pct ash_content_pct
## 1          -0.2092098           1.2310106          0.8002405       1.0849696
## 2           0.1291567          -0.7599706         -0.4940326      -0.6698115
##   fuel_cost_per_mmbtu contract_type_C contract_type_NC contract_type_S
## 1         -0.09977739       0.7943220      0.007345642       0.1983323
## 2          0.06159808       0.2567717      0.002818973       0.7404094
##   energy_source_code_BIT energy_source_code_NG energy_source_code_DFO
## 1              0.5896367             0.0000000              0.0000000
## 2              0.0000000             0.8751072              0.1136169
##   energy_source_code_SUB energy_source_code_LIG energy_source_code_RFO
## 1              0.3809807             0.01469128            0.000000000
## 2              0.0000000             0.00000000            0.008824611
##   energy_source_code_WO energy_source_code_KER energy_source_code_PC
## 1           0.0000000000            0.000000000            0.01171332
## 2           0.0008579483            0.000122564            0.00000000
##   energy_source_code_WC energy_source_code_PG energy_source_code_OG
## 1            0.002779432          0.0000000000          0.0000000000
## 2            0.000000000          0.0007353842          0.0003676921
##   energy_source_code_JF energy_source_code_SC energy_source_code_SGP
```

```
## 1       0.0000000000          0.0001985309           0.000000000
## 2       0.0002451281          0.0000000000           0.000122564
##    fuel_type_coal fuel_type_gas fuel_type_oil fuel_group_coal
## 1              1     0.0000000     0.0000000       0.9882867
## 2              0     0.8763329     0.1236671       0.0000000
##    fuel_group_natural_gas fuel_group_petroleum fuel_group_petroleum_coke
## 1               0.0000000            0.0000000                0.01171332
## 2               0.8751072            0.1236671                0.00000000
##    fuel_group_other_gas primary_transportation_RV primary_transportation_PL
## 1            0.00000000                0.202302958                 0.0000000
## 2            0.00122564                0.002451281                 0.7784042
##    primary_transportation_TR primary_transportation_RR primary_transportation_TC
## 1                 0.1076037                0.6470121104                0.01290451
## 2                 0.1087143                0.0003676921                0.00000000
##    primary_transportation_WT primary_transportation_TP primary_transportation_GL
## 1                0.004764741               0.001191185               0.0005955926
## 2                0.003186665               0.000000000               0.0000000000
##      winter      fall    spring    summer
## 1 0.2584872 0.2475680 0.2426047 0.2513401
## 2 0.2610614 0.2394901 0.2459860 0.2534624
```

```
k2$size
```

```
## [1] 5037 8159
```

```
fviz_cluster(k2, data = combined_pudl_scaled)
```
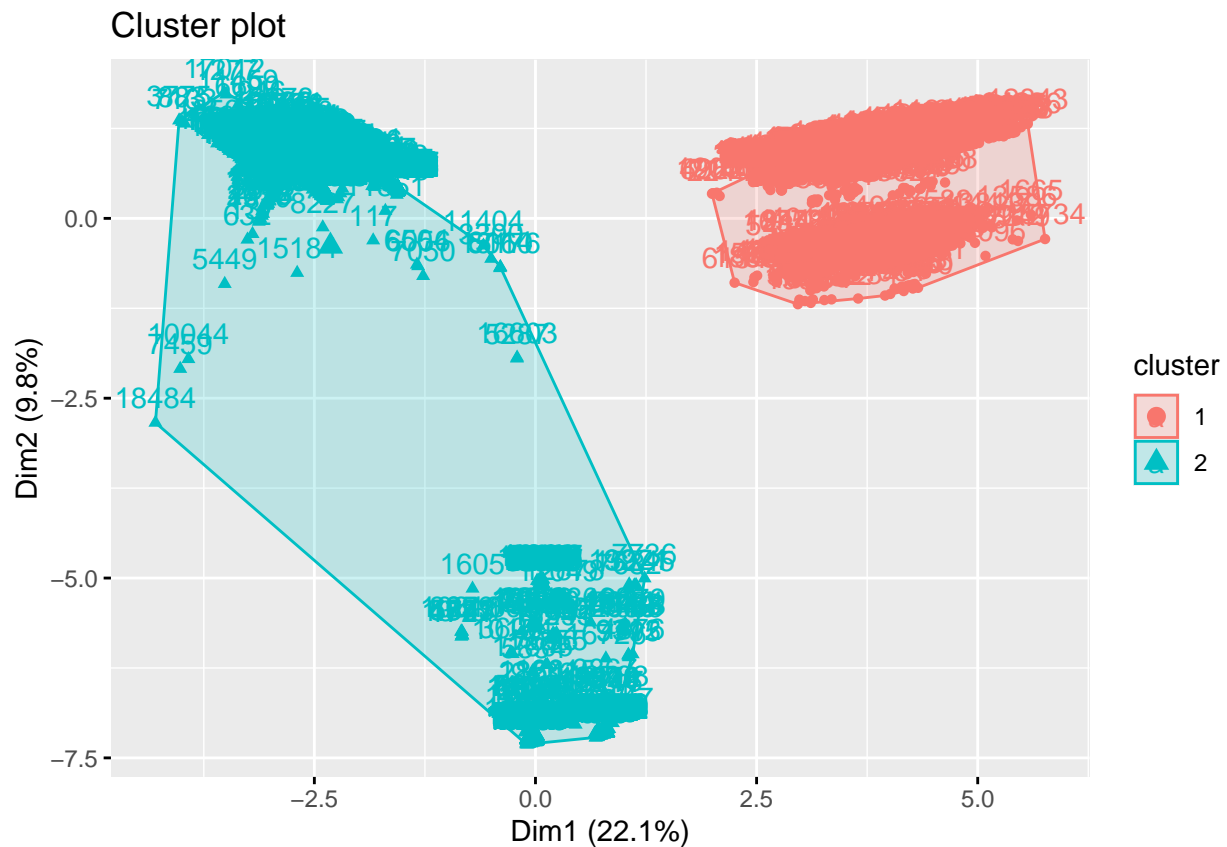
```
k2$cluster
```

```
##    1    2    5    9   10   12   13   14   15   16   17   18   20
##    2    1    1    2    2    2    2    2    2    2    1    2    2
##   22   23   24   25   26   27   28   29   30   32   33   35   36
##    1    1    2    2    2    1    2    1    2    1    2    1    1
##   37   39   40   43   45   46   47   48   50   51   52   54   56
##    1    1    2    2    2    1    1    2    2    2    1    1    2
##   57   61   62   63   64   65   66   68   71   73   76   77   79
##    2    2    2    2    1    2    2    2    2    2    2    2    2
##   80   81   82   83   87   88   89   90   91   92   94   95   96
##    2    1    2    2    2    1    1    2    2    2    2    2    2
##   97   98   99  100  101  103  104  105  106  107  109  113  114
##    2    2    2    2    1    2    2    2    2    2    2    2    1
##  115  117  122  123  125  128  130  133  134  137  138  139  140
##    2    2    2    2    2    2    1    2    2    2    2    2    2
##  142  143  144  145  147  148  151  152  153  154  156  158  159
##    2    2    2    2    1    2    1    2    2    1    2    2    2
##  160  161  163  165  166  167  168  170  171  173  176  177  179
##    2    2    2    2    2    1    1    2    1    2    2    2    2
##  180  181  183  184  185  186  187  188  190  191  192  193  194
##    2    2    2    2    2    2    1    1    2    1    2    2    1
##  195  196  197  200  201  203  204  205  206  207  208  212  213
##    1    2    2    2    2    2    2    1    2    2    2    2    2
##  214  216  218  220  221  222  223  224  226  227  228  230  231
##    2    1    2    1    2    2    2    2    1    2    2    1    1
##  233  235  236  237  238  241  243  244  245  246  248  249  251
##    2    2    1    2    1    1    1    2    2    2    2    2    2
##  254  256  258  259  260  262  263  264  265  266  267  268  269
##    2    1    1    1    2    2    1    2    2    1    2    2    2
##  270  271  272  275  277  279  280  282  284  285  287  288  289
##    2    2    2    2    2    1    1    2    2    2    1    1    2
##  290  292  293  294  295  296  297  298  300  301  302  304  305
##    2    2    1    2    1    2    1    1    1    2    1    2    2
##  307  308  310  312  314  315  316  318  319  320  321  322  324
##    2    2    2    2    2    1    2    2    1    1    2    1    2
##  326  329  331  334  335  339  342  345  348  349  351  353  354
##    2    1    2    2    2    1    2    2    1    1    1    2    2
##  356  357  358  359  360  361  363  364  366  369  371  372  373
##    2    2    2    2    1    1    2    2    2    2    2    2    2
##  375  377  378  379  380  381  382  383  384  385  386  387  389
##    2    1    2    1    2    2    1    1    1    2    2    2    2
##  390  392  393  394  395  396  397  398  399  401  402  403  404
##    2    2    2    1    1    2    1    2    2    1    1    2    1
##  406  407  408  410  412  414  415  416  417  418  419  420  422
##    2    2    2    2    2    1    2    2    2    2    2    1    1
##  425  428  429  431  432  434  435  437  438  439  441  442  443
##    2    2    2    1    1    1    1    2    1    2    2    2    2
##  444  445  448  450  451  452  453  456  457  458  460  461  462
##    2    2    2    2    1    1    2    2    1    1    2    2    2
##  463  464  465  467  468  469  470  471  472  473  475  476  478
##    2    1    1    1    1    2    2    2    1    2    2    2    2
##  479  484  485  486  488  489  490  491  492  493  495  496  498
```

```
##    2    1    1    1    1    2    2    1    2    2    2    1    2
##  499  501  502  503  504  506  508  509  510  511  513  515  516
##    1    2    2    1    2    1    2    1    1    2    2    1    2
##  517  518  519  522  524  525  528  530  531  532  534  535  536
##    1    2    1    2    2    1    2    1    2    2    2    2    2
##  537  539  540  542  543  545  546  547  548  549  550  552  553
##    2    1    2    1    1    2    1    1    1    2    1    1    1
##  554  555  556  558  559  561  562  563  567  568  569  570  571
##    2    2    2    1    2    2    2    1    1    2    2    2    1
##  572  573  574  575  576  577  579  582  584  586  587  588  589
##    2    2    2    2    2    2    1    2    2    2    1    1    2
##  592  593  594  595  596  597  598  600  601  602  603  604  605
##    2    2    1    1    2    1    2    1    1    2    2    1    2
##  608  609  613  614  618  619  620  622  623  624  625  627  628
##    2    2    1    1    2    1    1    2    1    2    1    1    2
##  629  632  633  634  635  637  638  646  647  648  650  651  653
##    2    2    2    2    1    1    2    2    2    2    1    2    2
##  654  655  656  657  659  660  661  664  666  667  669  671  674
##    1    2    1    2    2    1    2    2    2    1    2    2    2
##  675  676  677  678  679  682  683  684  686  687  688  690  691
##    2    1    1    2    1    2    1    2    2    1    2    2    1
##  692  693  695  696  700  701  702  703  704  707  708  709  711
##    2    2    2    2    1    1    2    2    2    2    1    1    2
##  712  714  719  720  722  724  726  727  728  729  730  731  732
##    2    1    2    2    1    2    2    2    2    2    2    2    2
##  734  737  739  740  742  743  744  745  747  748  749  750  752
##    2    2    2    1    1    2    2    1    2    2    1    2    2
##  754  757  759  760  761  763  765  766  767  768  769  770  772
##    1    2    2    1    2    2    2    1    2    2    2    1    2
##  773  774  775  776  777  778  779  780  781  787  788  789  791
##    2    2    1    1    2    2    1    2    2    1    1    2    2
##  792  795  796  797  798  799  800  801  803  804  808  809  810
##    1    2    1    2    2    1    2    1    2    1    1    2    1
##  811  814  816  818  819  821  824  825  826  827  828  830  831
##    2    1    2    2    2    1    1    1    2    2    2    2    2
##  833  834  836  837  838  840  841  842  844  846  848  849  852
##    2    1    2    2    2    2    2    1    1    1    2    2    1
##  853  855  856  857  858  859  860  861  862  865  866  870  871
##    1    1    2    1    1    2    1    2    1    2    2    1    2
##  874  876  877  880  882  883  886  887  889  890  893  894  895
##    1    2    2    2    1    2    2    2    2    2    2    2    2
##  896  898  900  904  908  910  912  913  914  915  916  918  920
##    1    2    2    1    1    1    2    2    2    2    2    1    1
##  921  922  923  924  926  927  928  929  931  932  933  934  936
##    2    2    1    1    1    2    2    2    2    2    2    2    2
##  937  938  939  940  942  944  945  946  947  948  950  953  954
##    1    1    2    1    1    1    2    2    1    1    1    1    1
##  955  958  960  961  962  964  965  967  968  969  970  972  975
##    2    1    2    2    1    2    2    2    1    1    2    2    2
##  977  980  981  985  986  988  990  994  997  998 1003 1004 1005
##    2    1    1    2    2    2    2    1    2    2    2    2    1
## 1008 1011 1012 1019 1020 1022 1023 1024 1026 1027 1028 1029 1031
##    1    1    1    1    2    2    2    2    1    2    2    1    2
## 1032 1034 1036 1038 1039 1041 1043 1045 1046 1048 1050 1051 1053
```

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##    2    2    2    1    1    2    2    1    2    2    2    2    2
## 1057 1059 1060 1061 1062 1064 1065 1067 1068 1070 1071 1073 1074
##    2    2    2    2    2    1    2    2    1    1    2    2    1
## 1075 1078 1079 1080 1082 1083 1084 1085 1086 1087 1088 1089 1090
##    2    2    2    2    1    2    1    2    2    2    2    2    1
## 1093 1094 1095 1099 1100 1101 1102 1103 1104 1106 1107 1108 1109
##    2    2    2    2    2    1    2    1    1    1    2    2    2
## 1110 1111 1113 1115 1116 1118 1119 1121 1122 1124 1125 1128 1129
##    2    1    2    1    2    1    1    1    2    2    2    2    1
## 1136 1138 1141 1143 1144 1145 1146 1147 1148 1149 1154 1155 1156
##    1    1    1    2    2    2    2    2    1    1    1    2    1
## 1157 1158 1159 1161 1163 1164 1165 1166 1167 1168 1172 1173 1174
##    2    2    1    2    2    1    2    2    1    2    1    1    2
## 1175 1176 1177 1179 1181 1182 1185 1187 1188 1189 1191 1192 1193
##    2    2    2    2    1    1    1    1    2    1    2    2    1
## 1195 1196 1197 1199 1201 1202 1203 1204 1208 1209 1211 1213 1214
##    1    1    1    2    1    2    2    2    1    2    1    2    1
## 1215 1218 1219 1220 1223 1224 1225 1226 1227 1228 1229 1230 1232
##    2    2    1    2    1    2    2    2    1    2    2    1    1
## 1233 1234 1237 1238 1239 1240 1243 1244 1245 1247 1248 1249 1251
##    2    1    2    2    1    2    2    1    2    2    2    1    1
## 1252 1254 1255 1256 1257 1258 1259 1261 1263 1264 1265 1266 1267
##    2    2    2    1    1    1    2    2    1    1    2    2    1
## 1268 1269 1271 1273 1274 1275 1276 1277 1278 1279 1281 1282 1283
##    2    2    1    1    1    2    1    2    2    1    2    2    2
## 1284 1286 1287 1288 1289 1290 1293 1294 1298 1299 1300 1301 1302
##    1    2    1    1    1    2    1    1    1    2    2    2    1
## 1306 1308 1309 1310 1312 1313 1314 1315 1316 1319 1320 1322 1323
##    1    2    1    2    2    1    2    1    1    1    2    2    2
## 1325 1327 1328 1329 1330 1331 1332 1333 1335 1337 1338 1339 1340
##    2    1    1    2    2    1    1    1    1    1    1    2    1
## 1341 1343 1344 1345 1346 1347 1348 1349 1350 1351 1352 1353 1355
##    1    2    2    1    1    1    1    1    2    2    2    2    2
## 1356 1357 1358 1361 1362 1364 1365 1366 1367 1369 1370 1372 1373
##    1    1    2    2    2    1    2    2    1    1    2    1    2
## 1374 1375 1376 1378 1379 1380 1384 1386 1388 1389 1391 1392 1393
##    1    1    2    2    2    2    2    1    1    1    1    1    2
## 1394 1395 1396 1397 1401 1402 1403 1405 1407 1409 1411 1412 1414
##    2    1    2    2    1    2    1    2    2    1    2    2    1
## 1416 1419 1420 1422 1425 1427 1428 1429 1430 1431 1432 1433 1434
##    2    1    2    2    2    2    2    1    2    2    2    2    1
## 1436 1439 1440 1441 1442 1445 1446 1447 1448 1449 1450 1451 1453
##    1    1    1    1    1    2    2    2    2    1    1    2    2
## 1454 1455 1456 1457 1458 1460 1461 1462 1464 1465 1466 1467 1469
##    2    1    2    1    2    2    2    2    1    2    2    1    2
## 1471 1473 1475 1476 1477 1479 1480 1481 1483 1484 1486 1487 1490
##    1    2    1    1    2    2    2    2    1    2    1    1    2
## 1491 1492 1493 1495 1498 1502 1503 1504 1505 1506 1507 1508 1509
##    2    2    1    2    1    2    1    2    2    2    1    2    2
## 1511 1514 1516 1517 1518 1519 1520 1521 1522 1523 1524 1526 1528
##    1    1    2    2    2    1    1    2    2    2    2    1    2
## 1529 1531 1532 1533 1535 1536 1538 1540 1541 1542 1543 1544 1545
##    1    2    1    1    1    2    1    2    1    2    2    1    1
## 1547 1549 1550 1552 1553 1554 1555 1556 1557 1559 1560 1561 1562
```

```
##    1    2    1    1    2    1    2    1    1    2    1    1    2
## 1563 1564 1565 1566 1568 1570 1573 1574 1575 1576 1581 1582 1583
##    2    1    2    2    2    1    2    1    1    1    2    2    2
## 1585 1587 1588 1590 1592 1593 1594 1596 1597 1598 1599 1600 1601
##    2    2    2    2    2    1    2    2    1    2    2    2    2
## 1603 1605 1606 1607 1609 1611 1612 1615 1616 1621 1622 1624 1625
##    2    2    2    2    1    2    1    2    2    1    1    1    1
## 1626 1627 1628 1629 1630 1631 1632 1634 1635 1636 1637 1638 1639
##    1    1    2    1    1    1    2    1    1    1    2    1    2
## 1642 1643 1644 1645 1646 1649 1650 1651 1652 1653 1655 1658 1659
##    2    2    2    2    1    2    2    2    1    2    1    2    1
## 1662 1663 1664 1665 1666 1667 1668 1671 1674 1677 1678 1679 1680
##    1    1    1    1    2    2    1    2    2    1    2    2    1
## 1682 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695 1696
##    2    2    2    2    1    1    1    2    2    1    2    2    2
## 1699 1700 1702 1705 1707 1708 1709 1710 1711 1712 1713 1714 1715
##    2    2    2    2    2    2    1    2    2    2    2    1    1
## 1716 1718 1719 1720 1721 1722 1723 1724 1725 1728 1729 1730 1731
##    2    2    2    2    2    1    1    1    2    1    2    2    1
## 1732 1733 1734 1738 1740 1743 1744 1746 1747 1748 1749 1750 1752
##    1    2    2    2    1    2    2    1    1    2    2    2    1
## 1755 1760 1763 1764 1765 1766 1767 1768 1771 1772 1773 1775 1776
##    1    1    2    2    1    1    1    2    2    1    1    2    1
## 1777 1780 1782 1783 1784 1785 1787 1788 1789 1790 1791 1792 1795
##    2    1    2    2    2    2    2    2    2    2    1    2    1
## 1798 1800 1802 1803 1806 1811 1813 1814 1816 1818 1819 1820 1824
##    2    2    2    1    2    2    2    1    2    2    2    2    2
## 1825 1826 1828 1830 1831 1832 1834 1837 1838 1840 1841 1842 1843
##    2    2    2    2    2    1    1    2    2    1    2    1    2
## 1846 1847 1848 1849 1850 1852 1853 1855 1856 1859 1860 1861 1862
##    2    2    1    2    1    1    2    2    1    2    2    2    2
## 1863 1868 1869 1871 1873 1875 1876 1878 1879 1880 1881 1883 1885
##    2    1    2    2    2    2    1    2    2    1    2    1    2
## 1888 1893 1897 1898 1899 1902 1903 1906 1907 1908 1909 1911 1913
##    2    2    2    1    2    2    1    2    2    2    2    2    2
## 1915 1916 1917 1918 1919 1920 1921 1923 1924 1926 1927 1928 1929
##    2    2    1    2    2    2    2    1    2    1    2    1    2
## 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1943 1946
##    1    2    2    2    2    2    1    2    2    2    2    2    2
## 1949 1950 1951 1953 1956 1958 1959 1960 1961 1962 1963 1964 1965
##    1    1    1    2    2    1    1    1    2    1    2    1    1
## 1969 1971 1972 1973 1975 1976 1977 1978 1979 1980 1984 1986 1987
##    2    2    2    1    1    2    1    1    1    2    1    2    2
## 1988 1989 1990 1993 1994 1995 1997 1999 2000 2003 2004 2007 2008
##    2    1    2    2    2    1    1    2    2    1    2    2    2
## 2009 2010 2011 2012 2013 2015 2020 2021 2022 2023 2029 2030 2031
##    2    2    2    2    2    2    1    2    1    2    2    1    2
## 2032 2033 2036 2037 2039 2040 2041 2043 2045 2046 2048 2049 2050
##    2    2    2    2    2    2    1    1    1    2    2    2    2
## 2051 2052 2054 2055 2056 2057 2058 2059 2060 2062 2063 2067 2068
##    2    2    1    2    2    2    2    2    2    2    2    2    1
## 2072 2075 2076 2077 2078 2079 2080 2081 2083 2084 2085 2086 2087
##    1    1    2    1    2    2    2    2    1    2    1    1    2
## 2088 2098 2099 2100 2101 2102 2105 2106 2107 2109 2110 2111 2113
```

```
##    2    1    1    2    2    1    1    2    2    2    1    1    1
## 2114 2115 2116 2118 2119 2120 2122 2123 2124 2125 2126 2127 2129
##    2    2    1    2    2    2    2    2    2    2    2    2    2
## 2130 2131 2133 2137 2140 2142 2143 2144 2145 2146 2147 2148 2149
##    2    1    2    2    1    2    1    2    2    1    1    2    2
## 2150 2151 2152 2154 2156 2157 2158 2160 2161 2163 2164 2166 2167
##    1    2    2    1    1    1    2    1    1    2    2    2    1
## 2168 2169 2170 2172 2173 2175 2178 2180 2181 2183 2184 2186 2187
##    2    2    2    2    2    2    2    2    2    2    1    1    1
## 2188 2189 2191 2195 2196 2197 2198 2199 2200 2204 2205 2206 2207
##    2    1    2    2    2    2    2    1    2    2    1    1    2
## 2209 2210 2211 2212 2213 2214 2217 2219 2220 2221 2222 2223 2224
##    2    2    2    2    2    1    1    2    2    2    1    1    1
## 2225 2226 2229 2230 2231 2233 2234 2237 2238 2239 2240 2241 2242
##    1    2    2    2    2    2    2    2    1    2    2    2    2
## 2243 2244 2245 2246 2247 2248 2249 2250 2251 2255 2256 2257 2258
##    2    1    2    2    2    1    1    2    2    2    2    2    2
## 2259 2263 2264 2265 2266 2267 2268 2270 2271 2275 2276 2278 2279
##    2    2    1    1    2    1    2    2    2    2    1    1    2
## 2280 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2293 2296
##    2    1    2    2    2    2    2    1    1    1    2    2    2
## 2297 2298 2300 2301 2302 2305 2306 2307 2308 2309 2311 2312 2313
##    2    1    2    1    2    1    2    2    2    2    2    1    1
## 2314 2315 2317 2319 2320 2321 2322 2323 2324 2325 2328 2329 2330
##    1    2    1    2    2    2    2    2    2    2    2    2    2
## 2331 2332 2333 2334 2335 2336 2337 2340 2341 2342 2343 2345 2346
##    1    2    2    1    2    1    2    2    1    2    1    1    2
## 2347 2348 2349 2350 2351 2353 2354 2355 2356 2357 2359 2361 2362
##    1    1    2    2    2    1    1    1    2    2    2    1    2
## 2364 2365 2366 2367 2368 2369 2371 2372 2376 2378 2379 2382 2383
##    2    1    1    1    2    2    2    2    2    2    2    2    1
## 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397
##    1    2    2    2    1    2    2    1    2    2    2    2    2
## 2399 2401 2402 2405 2406 2407 2408 2409 2412 2413 2414 2417 2418
##    1    2    2    2    1    1    2    1    1    1    2    1    1
## 2419 2421 2422 2423 2424 2426 2427 2428 2430 2434 2435 2436 2437
##    2    2    2    2    1    1    2    2    2    1    1    1    1
## 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2451
##    1    1    2    2    2    2    2    2    2    1    1    2    2
## 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2464 2465
##    1    2    2    1    2    2    1    1    2    2    2    2    1
## 2466 2468 2470 2471 2472 2476 2477 2478 2481 2482 2483 2485 2486
##    2    1    1    1    2    2    2    1    2    1    2    1    1
## 2487 2490 2492 2493 2495 2496 2497 2498 2500 2501 2502 2503 2504
##    2    1    2    2    2    1    2    1    2    2    1    2    2
## 2505 2507 2508 2509 2511 2513 2514 2520 2524 2528 2529 2532 2534
##    1    2    2    1    1    1    2    1    1    2    1    2    2
## 2536 2537 2538 2540 2542 2545 2546 2547 2548 2549 2552 2553 2554
##    2    2    1    2    1    2    2    2    1    2    1    1    2
## 2557 2558 2559 2560 2562 2563 2567 2568 2569 2570 2571 2574 2576
##    2    1    2    1    2    1    2    1    2    1    2    1    2
## 2577 2578 2579 2580 2581 2583 2584 2585 2588 2591 2593 2594 2597
##    1    1    1    2    2    2    2    2    2    2    1    2    2
## 2599 2601 2602 2606 2607 2609 2610 2612 2613 2615 2616 2617 2618
```

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##    1    1    1    2    1    2    1    1    2    2    1    2    1
## 2619 2622 2624 2625 2628 2629 2631 2632 2635 2636 2637 2638 2640
##    2    2    1    2    2    2    1    2    2    2    2    2    2
## 2641 2642 2643 2645 2646 2647 2649 2652 2653 2654 2655 2656 2657
##    2    1    2    2    1    2    1    2    2    2    2    1    1
## 2658 2660 2662 2663 2664 2667 2668 2669 2671 2672 2673 2674 2675
##    1    1    1    1    2    2    2    1    1    2    2    1    2
## 2676 2677 2678 2679 2680 2681 2682 2683 2684 2685 2686 2687 2688
##    2    1    1    2    2    2    2    2    2    2    1    2    2
## 2690 2693 2694 2695 2698 2700 2701 2702 2703 2704 2706 2708 2709
##    1    1    2    1    1    2    1    2    2    2    2    1    2
## 2710 2711 2712 2715 2716 2717 2718 2719 2720 2721 2722 2724 2726
##    1    2    1    2    2    1    2    1    2    1    2    1    2
## 2727 2728 2729 2731 2732 2733 2735 2736 2737 2739 2740 2741 2742
##    1    2    2    1    2    2    2    2    2    1    2    2    2
## 2744 2745 2747 2748 2749 2750 2751 2752 2753 2754 2755 2757 2759
##    1    1    2    1    2    1    2    2    1    1    1    2    2
## 2761 2766 2767 2769 2770 2771 2772 2773 2774 2775 2777 2778 2779
##    1    1    1    2    2    1    2    2    2    2    1    2    1
## 2780 2781 2783 2786 2787 2788 2789 2790 2791 2792 2793 2794 2795
##    2    2    1    1    2    2    2    2    2    2    2    1    2
## 2796 2799 2801 2802 2803 2804 2805 2806 2807 2809 2810 2811 2814
##    1    2    2    2    2    2    1    2    2    2    2    2    1
## 2815 2817 2818 2819 2821 2822 2823 2824 2826 2828 2830 2831 2832
##    2    2    1    1    1    2    2    2    1    2    2    2    1
## 2833 2834 2837 2838 2839 2841 2842 2844 2845 2846 2847 2848 2849
##    2    2    1    1    2    1    2    2    1    2    1    2    2
## 2851 2852 2853 2854 2855 2856 2858 2860 2861 2864 2865 2867 2868
##    1    2    2    1    2    1    2    2    2    2    2    1    2
## 2869 2870 2872 2873 2874 2875 2876 2877 2879 2880 2881 2883 2886
##    2    1    2    1    1    1    2    2    2    2    2    2    2
## 2888 2889 2890 2894 2895 2897 2898 2906 2907 2908 2912 2915 2917
##    2    2    1    2    2    2    2    2    2    2    2    1    2
## 2918 2919 2921 2922 2923 2924 2925 2926 2927 2929 2930 2932 2933
##    2    1    1    2    2    1    1    2    2    2    2    2    1
## 2934 2935 2936 2937 2938 2939 2940 2943 2945 2946 2947 2948 2949
##    2    1    1    2    1    2    2    2    1    2    1    2    2
## 2950 2952 2953 2954 2957 2958 2959 2960 2961 2962 2963 2965 2966
##    2    1    1    1    1    1    1    2    1    2    1    2    1
## 2967 2969 2970 2972 2973 2975 2976 2978 2979 2981 2983 2984 2985
##    2    1    2    2    2    2    1    1    1    1    2    2    1
## 2986 2987 2989 2990 2993 2994 2995 2996 2998 2999 3001 3004 3005
##    1    2    1    2    1    2    1    2    2    1    1    1    2
## 3008 3009 3010 3012 3014 3015 3019 3020 3022 3023 3024 3025 3026
##    1    2    2    2    2    2    1    1    2    1    2    2    2
## 3028 3030 3032 3033 3035 3036 3037 3039 3040 3041 3043 3044 3045
##    2    2    1    2    1    1    1    2    2    1    2    2    1
## 3047 3050 3051 3052 3053 3054 3055 3059 3060 3061 3062 3063 3064
##    2    2    2    2    1    2    2    1    2    1    2    1    1
## 3065 3067 3068 3070 3071 3072 3074 3075 3077 3079 3080 3081 3082
##    1    2    1    2    2    2    2    2    2    2    2    2    2
## 3083 3085 3086 3087 3088 3091 3092 3095 3096 3097 3099 3100 3101
##    2    1    2    2    2    2    1    2    1    2    1    2    2
## 3102 3103 3104 3105 3107 3108 3109 3111 3112 3113 3114 3117 3118
```

```
##    2    1    1    2    1    2    2    2    2    2    2    2    1
## 3119 3121 3123 3125 3127 3128 3131 3133 3137 3138 3140 3141 3142
##    1    1    2    2    1    1    1    1    2    2    1    1    1
## 3143 3144 3145 3146 3149 3150 3151 3152 3153 3154 3155 3158 3160
##    2    2    1    1    2    2    1    2    2    2    2    2    1
## 3161 3162 3163 3164 3165 3167 3168 3169 3175 3177 3178 3180 3181
##    2    1    2    2    2    2    2    1    1    2    1    1    2
## 3182 3183 3187 3188 3189 3190 3191 3192 3193 3194 3195 3198 3199
##    1    2    1    1    1    2    1    1    1    2    2    2    2
## 3201 3203 3204 3205 3206 3207 3208 3211 3212 3213 3214 3217 3218
##    1    2    2    1    1    1    2    2    1    1    1    2    2
## 3219 3221 3222 3224 3225 3229 3230 3231 3233 3234 3235 3236 3237
##    1    2    1    2    1    2    2    1    1    2    1    1    1
## 3238 3239 3240 3243 3244 3245 3247 3250 3251 3252 3254 3257 3258
##    2    2    1    2    1    2    2    2    1    1    1    2    2
## 3261 3262 3264 3265 3268 3269 3270 3271 3272 3273 3274 3275 3276
##    1    2    2    2    2    1    2    2    1    2    1    1    2
## 3277 3280 3281 3285 3286 3290 3292 3293 3294 3298 3299 3300 3302
##    2    2    2    1    1    2    1    2    1    2    2    1    1
## 3304 3305 3307 3308 3309 3310 3312 3313 3315 3317 3318 3319 3321
##    1    1    1    2    2    2    1    2    2    1    2    1    2
## 3322 3323 3324 3325 3326 3329 3330 3332 3333 3335 3336 3337 3338
##    1    2    2    2    2    2    2    2    1    2    1    1    1
## 3339 3340 3342 3343 3344 3345 3346 3350 3351 3352 3354 3355 3356
##    2    2    2    2    1    1    2    1    2    2    1    2    1
## 3357 3358 3360 3361 3364 3367 3368 3369 3370 3371 3372 3373 3374
##    2    2    2    2    1    1    2    1    2    1    1    2    2
## 3376 3377 3378 3379 3380 3381 3382 3383 3384 3388 3389 3390 3391
##    1    2    2    2    1    2    2    2    2    2    2    2    1
## 3392 3393 3397 3400 3401 3402 3403 3404 3405 3408 3409 3410 3413
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## 3414 3415 3416 3417 3418 3419 3420 3422 3423 3426 3427 3428 3429
##    2    2    1    1    2    2    1    2    2    2    1    2    2
## 3430 3431 3432 3433 3434 3435 3436 3437 3438 3439 3440 3441 3442
##    2    1    1    2    1    1    2    2    1    2    2    2    1
## 3443 3445 3446 3447 3448 3449 3450 3453 3454 3455 3456 3457 3458
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## 3459 3460 3463 3464 3466 3467 3468 3469 3470 3472 3473 3474 3475
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## 3476 3477 3478 3479 3480 3481 3483 3485 3486 3488 3489 3492 3493
##    1    2    2    2    2    1    1    1    1    2    1    1    1
## 3495 3496 3497 3498 3503 3504 3505 3506 3507 3508 3509 3510 3514
##    1    2    2    1    2    2    2    2    2    2    2    2    2
## 3516 3517 3518 3519 3521 3524 3525 3526 3527 3528 3530 3531 3532
##    1    2    2    2    2    1    2    2    1    2    1    2    1
## 3536 3538 3539 3540 3541 3544 3545 3546 3549 3550 3551 3553 3554
##    1    2    2    2    1    2    2    2    1    2    2    1    2
## 3556 3558 3559 3560 3561 3563 3564 3565 3569 3570 3573 3574 3576
##    2    2    1    2    2    2    2    2    2    1    2    1    2
## 3578 3580 3581 3582 3583 3584 3586 3587 3588 3590 3591 3595 3596
##    2    2    1    2    1    1    2    2    1    2    2    2    2
## 3599 3600 3601 3605 3606 3607 3608 3609 3610 3613 3615 3616 3619
##    1    2    1    1    2    1    1    2    1    1    1    2    2
## 3620 3621 3622 3625 3626 3627 3630 3633 3634 3635 3637 3638 3640
```

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##    1    2    1    2    2    1    2    2    2    1    2    1    2
## 3641 3642 3643 3644 3645 3646 3647 3649 3650 3653 3654 3655 3656
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## 3659 3660 3661 3666 3667 3668 3669 3670 3671 3675 3676 3680 3682
##    2    1    2    2    2    2    1    2    1    2    2    1    2
## 3683 3685 3688 3691 3693 3695 3696 3699 3700 3701 3702 3703 3704
##    2    2    2    1    1    2    2    2    2    1    1    1    2
## 3705 3706 3707 3708 3709 3710 3711 3714 3717 3719 3721 3722 3723
##    1    1    2    2    2    1    2    2    2    1    2    2    1
## 3724 3725 3726 3727 3730 3732 3733 3734 3735 3736 3737 3738 3739
##    1    1    2    1    2    1    2    2    2    1    2    2    2
## 3741 3742 3744 3745 3747 3748 3752 3753 3754 3755 3761 3762 3764
##    2    2    1    1    2    2    2    2    2    2    2    2    2
## 3765 3766 3768 3769 3770 3772 3773 3775 3778 3779 3780 3781 3788
##    1    2    2    2    2    1    2    2    2    2    1    2    2
## 3791 3792 3793 3797 3798 3799 3800 3801 3803 3805 3810 3813 3815
##    1    1    2    1    1    2    2    1    2    1    2    2    2
## 3817 3819 3821 3822 3823 3824 3825 3828 3830 3831 3832 3833 3835
##    2    2    2    2    2    1    2    2    1    2    1    2    2
## 3838 3840 3841 3842 3843 3844 3845 3847 3849 3850 3851 3854 3855
##    2    2    1    2    2    2    2    2    1    1    2    2    2
## 3856 3857 3859 3861 3862 3864 3866 3867 3868 3869 3870 3871 3872
##    1    2    2    2    2    1    1    2    1    2    1    1    1
## 3873 3875 3877 3879 3881 3882 3883 3884 3886 3890 3891 3893 3897
##    1    2    1    2    2    2    1    2    1    2    1    1    1
## 3899 3900 3902 3903 3904 3905 3906 3908 3909 3911 3912 3913 3914
##    1    2    2    2    2    2    2    1    2    1    1    2    2
## 3915 3918 3921 3923 3924 3925 3927 3928 3930 3931 3932 3935 3936
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## 3938 3939 3940 3941 3942 3943 3945 3946 3947 3948 3949 3951 3952
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## 3953 3954 3955 3956 3958 3959 3960 3961 3962 3963 3964 3965 3967
##    2    2    2    1    2    2    1    2    1    1    2    2    2
## 3968 3969 3971 3972 3973 3976 3977 3978 3979 3983 3985 3986 3989
##    2    1    1    2    2    1    2    1    1    2    1    2    2
## 3992 3996 3997 3998 3999 4000 4001 4003 4004 4005 4006 4007 4009
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## 4010 4011 4012 4013 4015 4018 4019 4020 4022 4023 4024 4028 4029
##    1    1    1    1    1    2    2    2    2    2    1    1    2
## 4031 4033 4034 4035 4037 4038 4039 4042 4043 4044 4046 4049 4050
##    1    2    2    2    2    2    2    2    2    1    1    2    2
## 4051 4052 4053 4058 4060 4061 4062 4065 4066 4067 4068 4069 4071
##    2    2    2    2    2    1    2    2    1    2    2    2    1
## 4072 4074 4075 4078 4079 4081 4082 4083 4084 4085 4086 4087 4089
##    2    2    2    1    2    2    1    2    2    2    1    1    2
## 4090 4094 4095 4096 4097 4100 4101 4102 4104 4105 4106 4107 4108
##    2    2    2    1    1    2    2    2    2    2    2    2    2
## 4109 4110 4113 4114 4115 4117 4118 4119 4122 4123 4124 4128 4129
##    2    2    2    1    2    2    2    2    2    2    1    2    1
## 4130 4133 4134 4135 4138 4140 4142 4143 4147 4148 4149 4151 4152
##    2    1    2    1    1    2    2    2    2    1    2    2    1
## 4153 4154 4155 4156 4157 4158 4159 4160 4161 4162 4163 4164 4165
##    1    2    2    2    1    2    2    1    1    1    1    2    2
## 4166 4167 4168 4169 4170 4171 4172 4173 4175 4176 4178 4180 4181
```

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##    2    1    1    1    1    1    1    1    2    1    2    1    2
## 4182 4183 4185 4189 4190 4191 4193 4194 4195 4196 4197 4200 4201
##    2    2    2    1    2    2    1    1    2    2    1    2    1
## 4203 4206 4207 4208 4210 4211 4212 4213 4214 4216 4217 4218 4219
##    2    1    2    1    2    2    1    1    1    2    2    2    2
## 4220 4221 4222 4223 4224 4225 4226 4227 4229 4230 4231 4232 4233
##    1    2    1    2    1    2    2    2    1    2    2    2    2
## 4235 4236 4238 4240 4242 4243 4244 4247 4249 4251 4252 4253 4254
##    1    1    2    2    2    2    1    1    2    2    1    1    2
## 4255 4258 4259 4260 4262 4263 4264 4265 4266 4267 4268 4269 4270
##    2    1    2    1    1    2    2    2    2    2    2    2    2
## 4271 4272 4273 4274 4278 4280 4281 4282 4283 4284 4285 4286 4287
##    2    2    2    1    2    2    2    2    1    1    1    2    1
## 4288 4289 4291 4293 4296 4297 4299 4300 4301 4302 4303 4304 4305
##    2    2    2    1    1    2    1    2    2    2    2    2    2
## 4306 4307 4310 4311 4312 4313 4314 4315 4316 4318 4319 4320 4323
##    1    2    2    2    2    1    2    1    2    2    2    2    2
## 4324 4325 4326 4327 4328 4329 4330 4331 4333 4335 4337 4338 4340
##    2    2    2    2    2    2    1    2    1    2    2    1    2
## 4342 4344 4345 4347 4348 4349 4350 4352 4354 4355 4356 4357 4358
##    2    2    2    2    2    2    1    2    2    2    2    1    2
## 4359 4360 4361 4362 4363 4364 4365 4368 4369 4370 4371 4372 4376
##    2    2    2    2    1    2    1    1    2    1    2    1    1
## 4377 4378 4379 4380 4381 4382 4383 4385 4388 4390 4391 4393 4394
##    1    1    1    1    1    2    2    2    2    2    2    1    2
## 4395 4396 4399 4402 4403 4404 4405 4407 4408 4409 4410 4411 4413
##    1    1    2    2    1    2    1    2    2    2    2    2    2
## 4414 4416 4417 4418 4419 4421 4422 4423 4424 4425 4426 4427 4428
##    1    1    2    2    2    2    1    2    2    2    1    1    1
## 4429 4430 4431 4433 4434 4435 4437 4438 4440 4441 4443 4444 4445
##    2    1    1    2    2    2    1    2    2    1    1    2    2
## 4446 4447 4448 4449 4450 4451 4452 4453 4454 4455 4458 4461 4462
##    2    2    2    1    1    1    2    2    1    1    2    2    2
## 4465 4466 4467 4468 4469 4471 4472 4474 4476 4479 4480 4483 4484
##    2    2    1    2    2    2    2    1    2    1    1    2    2
## 4485 4487 4489 4490 4491 4493 4495 4496 4498 4499 4500 4501 4502
##    2    1    2    1    2    2    1    2    2    1    1    1    2
## 4504 4505 4506 4508 4511 4512 4514 4515 4516 4519 4521 4522 4523
##    1    2    2    1    2    2    1    2    2    2    2    1    1
## 4525 4526 4527 4528 4529 4532 4533 4535 4536 4537 4538 4539 4541
##    2    1    1    2    1    2    2    2    2    2    1    2    2
## 4542 4543 4545 4546 4547 4548 4549 4550 4551 4552 4553 4556 4558
##    1    1    2    1    2    2    1    1    2    1    2    1    2
## 4560 4561 4562 4563 4564 4565 4566 4568 4569 4570 4571 4573 4577
##    1    1    2    2    1    1    2    1    1    2    2    2    2
## 4579 4581 4583 4584 4587 4588 4589 4590 4591 4592 4593 4594 4596
##    1    2    2    1    2    2    2    2    2    2    2    2    1
## 4597 4600 4601 4602 4603 4604 4605 4609 4610 4611 4612 4613 4614
##    1    2    2    2    2    1    1    2    2    2    2    2    1
## 4615 4616 4617 4619 4621 4622 4623 4624 4625 4626 4627 4628 4630
##    2    2    1    2    1    2    2    2    1    1    1    1    1
## 4631 4632 4633 4635 4636 4637 4638 4639 4640 4641 4642 4643 4644
##    2    2    2    1    2    2    1    2    2    1    1    1    2
## 4645 4646 4648 4651 4652 4653 4654 4655 4656 4657 4658 4659 4660
```

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##    2    1    2    2    1    2    2    2    2    2    2    2    2
## 4679 4681 4683 4684 4686 4687 4689 4690 4691 4695 4696 4697 4698
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## 4700 4703 4704 4708 4709 4710 4711 4713 4714 4715 4717 4718 4719
##    2    2    2    1    1    1    2    1    2    2    2    1    2
## 4720 4724 4726 4727 4730 4732 4733 4736 4737 4740 4741 4742 4745
##    1    2    1    2    2    2    2    1    2    2    1    1    2
## 4747 4748 4750 4752 4753 4754 4755 4756 4758 4759 4760 4761 4762
##    2    2    2    1    2    2    1    2    1    2    2    1    2
## 4763 4764 4766 4767 4768 4770 4771 4772 4774 4776 4777 4778 4779
##    2    1    2    2    2    1    2    1    1    1    1    2    2
## 4781 4782 4784 4785 4786 4787 4788 4789 4792 4793 4795 4798 4799
##    1    2    1    1    2    2    1    2    1    2    2    2    2
## 4800 4801 4802 4804 4805 4806 4807 4808 4809 4812 4813 4814 4815
##    2    2    1    1    2    2    2    1    1    2    2    2    2
## 4818 4819 4820 4822 4823 4824 4825 4826 4828 4829 4830 4831 4832
##    2    1    2    1    1    1    1    2    2    2    1    1    2
## 4833 4834 4835 4836 4837 4838 4839 4841 4843 4844 4845 4846 4847
##    2    1    2    2    2    2    2    1    1    1    2    2    1
## 4848 4849 4851 4852 4854 4855 4856 4861 4863 4865 4866 4867 4870
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## 4873 4874 4875 4876 4877 4878 4881 4882 4883 4885 4886 4892 4894
##    1    2    1    2    1    2    2    1    1    2    2    2    2
## 4895 4896 4897 4899 4902 4904 4906 4907 4908 4909 4911 4912 4915
##    1    1    2    1    1    2    2    1    2    2    2    2    1
## 4916 4917 4918 4920 4921 4923 4925 4926 4929 4930 4931 4937 4938
##    2    2    2    1    1    2    2    1    2    1    1    1    1
## 4939 4941 4942 4943 4944 4945 4946 4947 4948 4949 4950 4953 4954
##    2    1    1    1    2    2    1    1    2    2    2    1    1
## 4955 4956 4957 4958 4959 4960 4962 4963 4964 4966 4967 4968 4969
##    2    1    1    1    2    2    1    1    1    1    2    2    2
## 4970 4973 4975 4976 4978 4980 4981 4983 4986 4987 4989 4991 4992
##    2    1    2    1    2    2    2    2    2    2    1    2    2
## 4993 4994 4995 4997 4998 4999 5000 5002 5004 5006 5007 5008 5010
##    1    2    2    2    1    1    2    1    2    2    2    2    2
## 5011 5012 5013 5014 5015 5016 5017 5018 5019 5020 5021 5024 5025
##    2    1    2    2    1    1    2    2    2    1    2    2    2
## 5027 5028 5029 5031 5032 5033 5035 5036 5037 5039 5040 5041 5042
##    2    1    2    1    2    2    1    2    2    1    2    2    2
## 5043 5044 5045 5048 5049 5051 5052 5053 5054 5055 5056 5057 5060
##    2    2    1    2    1    2    2    1    2    2    1    2    2
## 5061 5062 5063 5064 5070 5071 5072 5074 5078 5080 5081 5083 5084
##    1    2    1    2    1    1    1    1    2    2    2    2    2
## 5085 5087 5088 5089 5091 5093 5094 5095 5097 5098 5099 5100 5101
##    2    2    2    2    2    1    2    1    1    2    1    2    1
## 5102 5103 5104 5105 5106 5109 5110 5111 5112 5113 5115 5116 5117
##    2    1    2    2    1    1    1    2    1    2    1    2    2
## 5118 5119 5120 5121 5123 5125 5126 5129 5130 5132 5133 5134 5136
##    2    1    2    2    1    1    2    1    1    2    1    1    2
## 5137 5138 5139 5140 5142 5143 5144 5145 5146 5149 5150 5152 5153
##    1    1    2    2    2    2    2    1    2    1    1    2    1
## 5154 5156 5157 5158 5159 5160 5162 5163 5164 5165 5167 5170 5171
```

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##    2    1    2    1    2    2    1    2    2    2    1    2    1
## 5173 5174 5175 5176 5177 5178 5181 5183 5184 5186 5188 5190 5193
##    2    2    2    1    1    1    1    2    1    2    2    2    2
## 5194 5196 5197 5201 5203 5204 5205 5206 5207 5208 5211 5212 5213
##    1    1    2    2    1    2    1    2    2    2    1    1    2
## 5214 5216 5217 5218 5219 5220 5221 5222 5223 5225 5226 5227 5231
##    1    2    2    2    2    2    2    1    2    2    1    1    1
## 5233 5234 5235 5239 5240 5241 5243 5245 5246 5248 5249 5250 5252
##    2    1    2    1    2    1    2    2    2    2    2    2    2
## 5256 5257 5258 5260 5261 5263 5266 5267 5269 5270 5271 5272 5273
##    1    2    1    2    1    2    1    2    2    2    2    2    1
## 5274 5277 5280 5281 5285 5287 5289 5294 5295 5296 5297 5299 5302
##    2    2    1    2    2    2    2    2    2    2    2    2    2
## 5303 5304 5306 5307 5308 5312 5315 5316 5318 5319 5321 5322 5324
##    2    1    2    2    2    1    2    1    2    1    2    1    2
## 5325 5326 5328 5330 5331 5332 5333 5334 5335 5338 5339 5342 5344
##    2    2    1    1    1    2    2    1    2    2    1    2    2
## 5345 5350 5351 5353 5354 5356 5358 5359 5360 5362 5364 5365 5367
##    2    2    1    1    1    2    2    1    2    1    1    1    1
## 5369 5371 5372 5373 5376 5377 5378 5380 5381 5382 5383 5385 5386
##    1    1    2    2    1    2    1    2    2    1    2    2    2
## 5387 5388 5390 5391 5392 5393 5394 5395 5397 5404 5405 5407 5408
##    2    1    2    1    1    1    2    2    2    2    2    2    2
## 5409 5411 5413 5415 5417 5418 5419 5420 5424 5425 5428 5430 5431
##    2    1    1    1    1    2    2    2    1    1    2    1    1
## 5432 5437 5438 5440 5441 5446 5449 5450 5453 5454 5455 5456 5458
##    1    2    2    2    1    1    2    1    2    2    2    1    2
## 5459 5460 5463 5464 5466 5468 5471 5473 5474 5476 5477 5478 5479
##    1    1    2    1    2    1    2    2    2    2    2    2    2
## 5480 5481 5482 5483 5484 5486 5487 5488 5489 5490 5491 5492 5493
##    2    2    1    2    2    1    2    2    2    1    1    2    2
## 5494 5495 5497 5498 5501 5503 5504 5505 5506 5508 5509 5510 5512
##    2    2    2    2    1    2    2    1    1    1    2    2    2
## 5513 5514 5515 5516 5517 5518 5520 5521 5522 5523 5524 5527 5528
##    2    2    1    1    2    2    2    1    2    1    1    2    1
## 5529 5530 5531 5533 5534 5535 5536 5537 5539 5541 5542 5543 5544
##    2    2    1    2    2    2    2    2    1    2    2    1    1
## 5545 5546 5548 5551 5553 5554 5555 5556 5557 5560 5563 5564 5565
##    2    1    2    1    2    2    1    2    2    2    1    2    2
## 5566 5567 5568 5569 5570 5571 5572 5573 5574 5576 5577 5578 5579
##    2    2    2    2    2    2    2    2    1    2    1    2    2
## 5580 5581 5582 5583 5584 5585 5589 5590 5591 5592 5593 5594 5596
##    1    2    2    1    2    1    2    1    1    2    2    2    1
## 5597 5598 5601 5603 5604 5605 5606 5607 5609 5610 5611 5613 5614
##    2    1    2    1    2    2    2    1    2    2    2    2    1
## 5616 5618 5619 5620 5622 5624 5625 5627 5628 5629 5631 5632 5634
##    2    2    2    1    1    1    2    1    2    1    1    1    1
## 5635 5636 5637 5639 5641 5643 5645 5648 5650 5655 5656 5658 5659
##    1    2    2    2    1    2    1    2    2    2    2    2    1
## 5661 5663 5664 5665 5667 5668 5670 5671 5672 5673 5675 5676 5677
##    1    2    2    1    2    2    2    2    2    2    2    1    1
## 5678 5679 5681 5683 5684 5685 5686 5687 5689 5690 5691 5692 5693
##    1    2    1    2    2    2    1    1    1    1    2    2    1
## 5695 5696 5697 5698 5699 5700 5703 5705 5706 5708 5709 5712 5713
```

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##    2    2    2    1    2    2    1    2    2    2    2    2    2
## 5715 5716 5717 5720 5721 5722 5726 5727 5729 5730 5732 5733 5734
##    1    1    2    2    2    2    2    2    1    1    2    2    2
## 5736 5738 5739 5742 5743 5744 5746 5750 5751 5753 5754 5755 5756
##    2    2    1    2    1    1    2    2    2    2    2    1    1
## 5757 5759 5763 5764 5766 5767 5768 5772 5774 5776 5778 5779 5780
##    2    2    2    2    2    2    2    2    1    1    1    2    2
## 5781 5782 5783 5784 5787 5788 5790 5791 5792 5794 5795 5796 5799
##    1    1    2    1    1    1    1    2    1    2    1    1    2
## 5800 5801 5803 5805 5808 5809 5811 5812 5813 5814 5816 5817 5818
##    2    2    2    1    2    2    2    2    2    2    2    1    1
## 5819 5820 5823 5824 5825 5826 5827 5828 5833 5834 5835 5836 5838
##    1    2    1    2    1    1    1    1    1    2    2    2    2
## 5839 5843 5846 5848 5849 5850 5851 5852 5853 5854 5856 5857 5858
##    2    2    1    1    1    2    1    1    2    1    1    1    2
## 5860 5864 5865 5866 5869 5871 5872 5873 5874 5878 5880 5881 5882
##    2    2    2    2    2    1    2    2    1    1    2    1    1
## 5883 5884 5885 5886 5887 5888 5889 5890 5893 5895 5896 5897 5898
##    2    1    1    1    1    1    1    1    2    2    2    1    2
## 5899 5903 5905 5906 5907 5908 5910 5912 5914 5915 5918 5919 5920
##    2    1    2    1    1    1    1    2    1    1    2    2    1
## 5921 5922 5923 5925 5926 5927 5928 5929 5931 5932 5933 5934 5935
##    2    2    1    2    2    1    2    2    1    2    2    1    2
## 5936 5937 5938 5940 5942 5944 5945 5946 5947 5948 5949 5951 5955
##    2    2    2    2    2    2    2    2    2    2    1    2    1
## 5957 5958 5960 5961 5963 5965 5966 5967 5968 5969 5970 5971 5973
##    2    2    1    2    1    2    1    1    2    1    1    1    2
## 5974 5975 5976 5977 5978 5979 5982 5983 5984 5985 5988 5990 5991
##    2    2    1    1    1    2    2    2    2    1    2    1    2
## 5993 5994 5995 5996 5997 5999 6001 6002 6004 6006 6007 6008 6009
##    2    2    2    2    2    2    2    1    1    2    2    1    1
## 6010 6011 6012 6015 6016 6017 6018 6019 6020 6021 6022 6023 6024
##    1    1    1    2    2    2    2    2    2    1    2    1    1
## 6025 6026 6028 6029 6030 6031 6032 6034 6035 6036 6037 6038 6040
##    2    2    2    2    2    2    2    1    1    2    1    2    1
## 6041 6043 6045 6047 6048 6050 6051 6052 6054 6056 6058 6059 6060
##    1    2    1    1    1    2    1    2    2    2    2    2    2
## 6061 6063 6066 6070 6071 6072 6073 6074 6076 6077 6079 6080 6081
##    2    2    1    2    2    2    1    1    2    1    1    2    2
## 6082 6083 6084 6086 6087 6088 6090 6091 6092 6093 6095 6096 6097
##    2    2    1    1    2    2    2    2    1    1    2    1    1
## 6100 6101 6102 6107 6109 6110 6111 6112 6114 6115 6119 6120 6121
##    2    2    2    1    2    2    2    2    2    2    2    2    2
## 6125 6127 6128 6130 6131 6132 6133 6134 6135 6136 6137 6138 6139
##    2    2    1    1    2    2    2    2    1    2    2    1    1
## 6141 6142 6143 6144 6145 6146 6147 6148 6149 6151 6154 6156 6157
##    2    1    1    2    1    2    1    2    1    1    1    1    2
## 6158 6159 6160 6161 6162 6164 6165 6166 6167 6168 6169 6170 6172
##    1    2    2    2    2    2    1    2    2    2    1    2    1
## 6173 6175 6176 6177 6178 6179 6180 6182 6183 6185 6186 6187 6189
##    2    1    2    1    2    2    1    1    2    2    2    2    2
## 6190 6191 6192 6193 6194 6197 6200 6202 6203 6204 6205 6206 6207
##    2    2    1    1    2    2    1    1    1    2    1    2    2
## 6208 6210 6211 6213 6214 6215 6218 6220 6223 6224 6226 6227 6228
```

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```
##    2    1    2    1    1    2    1    2    1    2    1    1    1
## 6230 6232 6233 6235 6236 6238 6239 6240 6245 6247 6248 6249 6252
##    1    1    2    1    1    2    2    2    1    2    2    2    2
## 6253 6254 6255 6257 6258 6259 6260 6262 6264 6266 6267 6268 6269
##    2    2    2    2    2    2    2    2    1    2    2    1    1
## 6270 6271 6272 6274 6275 6276 6277 6278 6279 6280 6281 6282 6283
##    2    1    1    2    1    1    2    2    1    2    2    2    2
## 6284 6286 6287 6289 6290 6292 6294 6295 6297 6298 6300 6302 6303
##    1    1    1    2    2    2    2    1    2    2    2    2    2
## 6306 6307 6308 6310 6313 6317 6319 6320 6323 6324 6325 6327 6329
##    2    1    2    1    2    1    1    1    2    2    2    2    2
## 6334 6335 6336 6339 6340 6341 6342 6343 6344 6345 6347 6348 6349
##    2    1    1    2    1    2    2    2    2    2    2    2    2
## 6350 6351 6353 6354 6356 6359 6360 6361 6367 6369 6370 6371 6372
##    2    2    2    2    1    2    2    1    1    1    2    1    2
## 6374 6375 6376 6377 6378 6379 6381 6382 6383 6384 6385 6387 6389
##    2    2    2    1    1    2    1    1    2    2    1    2    2
## 6392 6393 6394 6396 6399 6400 6401 6405 6406 6408 6409 6410 6411
##    2    2    2    2    2    2    2    2    1    1    2    1    1
## 6412 6414 6417 6418 6419 6423 6424 6425 6427 6429 6430 6431 6435
##    2    2    1    2    2    2    1    1    1    2    2    2    2
## 6437 6438 6442 6443 6444 6446 6450 6451 6456 6459 6460 6463 6464
##    2    1    2    2    2    2    1    2    2    1    2    2    1
## 6465 6466 6467 6468 6471 6474 6475 6478 6479 6481 6482 6484 6485
##    2    2    2    1    2    1    2    1    2    2    2    1    1
## 6488 6489 6492 6493 6494 6495 6497 6498 6499 6501 6502 6503 6504
##    1    2    2    2    2    2    2    1    2    2    2    1    2
## 6505 6507 6508 6510 6511 6512 6513 6514 6515 6517 6520 6522 6523
##    2    2    1    2    2    2    1    1    2    1    1    2    1
## 6524 6526 6527 6528 6530 6531 6533 6534 6535 6536 6537 6538 6541
##    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6543 6545 6546 6547 6549 6550 6551 6552 6553 6554 6555 6556 6557
##    2    1    1    2    2    1    1    2    1    1    2    1    2
## 6559 6560 6562 6563 6564 6565 6566 6567 6568 6571 6572 6574 6575
##    2    2    2    1    2    1    2    1    2    2    1    2    1
## 6576 6579 6580 6581 6582 6584 6585 6586 6587 6588 6589 6590 6591
##    2    2    1    2    1    1    2    2    1    1    1    2    1
## 6592 6593 6594 6595 6596 6597 6598 6600 6601 6607 6608 6609 6610
##    1    1    2    2    1    2    2    2    2    2    1    2    1
## 6611 6612 6613 6614 6615 6616 6617 6618 6619 6620 6624 6626 6627
##    1    2    2    2    1    1    1    2    2    2    2    2    2
## 6628 6632 6633 6635 6636 6638 6639 6640 6641 6644 6646 6648 6650
##    1    2    2    2    2    1    1    2    1    2    2    2    1
## 6652 6653 6656 6657 6658 6659 6660 6661 6664 6665 6668 6669 6670
##    1    2    1    2    1    1    1    2    1    2    2    1    2
## 6671 6672 6673 6674 6678 6679 6680 6681 6682 6683 6684 6685 6687
##    1    1    2    2    2    2    1    1    2    1    2    2    1
## 6688 6689 6690 6692 6693 6695 6696 6698 6699 6700 6701 6702 6703
##    2    2    2    1    1    1    1    1    1    2    2    2    2
## 6704 6706 6709 6711 6713 6715 6716 6718 6720 6721 6722 6723 6724
##    2    2    2    2    2    2    2    2    2    2    2    2    2
## 6726 6727 6728 6729 6731 6733 6735 6737 6740 6741 6742 6744 6745
##    2    1    1    1    1    2    2    2    2    2    2    1    1
## 6746 6747 6748 6750 6751 6752 6754 6755 6756 6757 6758 6759 6760
```

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##    2    1    2    2    1    2    1    2    2    2    2    2    1
## 6761 6762 6765 6766 6767 6769 6770 6771 6772 6774 6775 6776 6778
##    2    1    2    1    2    2    1    2    1    2    1    2    2
## 6779 6781 6782 6783 6785 6786 6787 6788 6789 6791 6793 6794 6795
##    2    2    2    2    1    1    1    2    1    2    2    2    1
## 6797 6798 6799 6801 6802 6804 6805 6806 6807 6808 6810 6811 6812
##    2    2    2    1    1    2    2    1    2    1    2    1    1
## 6815 6817 6820 6821 6822 6823 6826 6829 6830 6832 6833 6834 6835
##    1    2    1    2    1    1    1    1    1    2    1    1    2
## 6841 6843 6844 6845 6846 6848 6850 6852 6853 6854 6855 6857 6859
##    2    2    1    2    1    1    2    2    2    1    1    1    2
## 6861 6864 6865 6866 6867 6868 6869 6870 6871 6872 6876 6877 6879
##    1    1    2    2    1    2    2    2    2    1    1    1    1
## 6880 6881 6882 6884 6885 6886 6887 6888 6889 6890 6891 6893 6894
##    2    2    2    2    1    2    2    2    2    1    2    2    1
## 6895 6897 6898 6899 6900 6901 6902 6904 6905 6906 6907 6908 6909
##    1    2    2    2    2    1    1    1    1    1    2    2    2
## 6911 6912 6913 6916 6918 6919 6921 6922 6923 6924 6927 6928 6929
##    2    2    2    1    1    1    2    2    1    1    2    2    2
## 6931 6933 6934 6935 6936 6937 6938 6939 6940 6943 6944 6946 6947
##    2    2    2    2    1    2    1    2    2    2    1    2    2
## 6948 6949 6950 6952 6953 6955 6957 6959 6961 6962 6963 6965 6966
##    1    1    1    1    2    2    2    2    2    2    2    1    2
## 6968 6971 6973 6975 6978 6979 6981 6982 6983 6985 6987 6988 6990
##    1    1    2    1    2    2    1    2    2    1    2    2    2
## 6993 6997 6998 6999 7000 7001 7002 7004 7005 7006 7007 7008 7009
##    1    1    2    1    2    2    2    1    2    2    2    2    2
## 7012 7013 7014 7015 7016 7017 7018 7020 7021 7023 7025 7026 7027
##    1    2    2    2    1    1    2    1    2    2    2    2    1
## 7028 7029 7030 7031 7035 7038 7039 7042 7044 7047 7048 7049 7050
##    2    1    2    2    2    2    2    2    1    1    1    2    2
## 7051 7053 7054 7055 7057 7059 7061 7062 7066 7068 7069 7071 7072
##    2    2    2    2    2    1    1    1    2    1    2    2    1
## 7073 7076 7077 7079 7082 7083 7086 7087 7088 7090 7091 7093 7094
##    1    1    1    2    1    1    2    1    2    1    2    1    2
## 7098 7099 7100 7103 7104 7107 7110 7111 7112 7113 7114 7115 7116
##    2    2    2    2    2    1    1    2    2    1    2    1    1
## 7118 7121 7125 7128 7131 7133 7134 7137 7139 7140 7142 7143 7144
##    1    2    2    2    1    2    1    2    2    2    2    2    2
## 7145 7146 7147 7148 7153 7154 7155 7157 7158 7159 7162 7163 7166
##    1    1    2    1    2    1    1    2    2    1    2    2    1
## 7167 7171 7172 7174 7175 7176 7177 7178 7179 7180 7181 7182 7184
##    1    1    2    2    2    1    2    2    2    2    2    2    2
## 7186 7188 7189 7191 7192 7193 7194 7195 7198 7202 7205 7206 7207
##    1    1    1    1    2    1    1    1    2    2    2    2    1
## 7208 7209 7210 7211 7212 7213 7214 7217 7218 7219 7220 7221 7222
##    1    2    2    2    2    1    1    1    1    2    2    2    2
## 7223 7224 7225 7227 7228 7229 7232 7234 7236 7237 7240 7241 7243
##    2    1    2    2    2    1    2    2    1    2    1    2    2
## 7245 7246 7247 7248 7249 7250 7251 7252 7253 7254 7255 7256 7258
##    2    2    1    1    2    1    2    2    2    2    2    1    1
## 7260 7262 7263 7264 7266 7267 7268 7271 7275 7276 7277 7278 7283
##    1    2    2    2    2    2    2    2    2    2    2    2    1
## 7284 7286 7289 7290 7291 7293 7295 7297 7299 7300 7304 7307 7309
```

```
##    2    2    1    2    1    2    2    2    2    2    1    1    1
## 7311 7312 7313 7314 7315 7316 7317 7318 7319 7320 7323 7324 7325
##    1    2    2    1    2    1    2    2    2    2    2    2    1
## 7326 7327 7328 7329 7330 7332 7333 7334 7335 7336 7337 7338 7339
##    2    2    1    2    1    2    2    1    2    2    1    2    1
## 7342 7343 7344 7345 7347 7349 7350 7351 7352 7353 7354 7355 7356
##    1    2    2    2    2    2    2    2    1    2    2    2    1
## 7357 7359 7360 7361 7364 7368 7369 7373 7375 7376 7377 7378 7379
##    2    2    2    1    2    1    1    1    2    2    2    2    2
## 7382 7386 7387 7390 7391 7392 7393 7396 7397 7398 7401 7403 7404
##    1    2    1    2    2    2    1    2    2    2    2    1    1
## 7405 7406 7408 7409 7410 7412 7413 7414 7415 7416 7418 7422 7424
##    2    2    1    2    2    1    2    1    2    2    1    2    1
## 7426 7428 7429 7431 7432 7433 7434 7435 7436 7438 7440 7441 7442
##    1    1    2    1    2    2    2    2    2    2    2    2    2
## 7443 7446 7447 7448 7449 7450 7451 7452 7454 7455 7456 7458 7459
##    2    2    2    2    2    1    1    2    2    1    2    1    2
## 7461 7462 7464 7466 7467 7468 7470 7471 7472 7473 7474 7475 7476
##    2    1    1    2    2    1    1    1    1    2    1    1    2
## 7478 7480 7481 7482 7483 7484 7485 7486 7487 7488 7489 7490 7492
##    2    2    1    1    2    2    1    2    1    2    2    2    2
## 7493 7496 7498 7499 7501 7504 7505 7508 7512 7513 7514 7515 7517
##    1    2    2    2    1    1    2    2    2    2    2    2    1
## 7518 7519 7524 7526 7527 7528 7529 7532 7534 7535 7537 7539 7540
##    2    1    2    2    2    2    1    2    2    2    1    1    2
## 7541 7542 7543 7544 7545 7546 7548 7549 7550 7551 7552 7553 7554
##    2    1    2    2    2    1    2    1    2    2    1    1    2
## 7555 7556 7557 7558 7559 7560 7561 7562 7563 7564 7565 7566 7567
##    2    2    2    2    1    2    2    1    1    2    1    1    1
## 7568 7569 7570 7572 7573 7574 7576 7577 7578 7579 7580 7583 7584
##    2    2    2    2    2    2    1    1    2    1    2    1    2
## 7591 7592 7593 7594 7595 7597 7598 7599 7600 7601 7602 7603 7605
##    2    1    2    2    2    1    2    2    1    2    2    1    1
## 7607 7611 7613 7615 7616 7618 7619 7620 7621 7623 7624 7625 7626
##    2    1    2    1    2    2    2    1    2    2    1    2    2
## 7627 7630 7631 7632 7633 7634 7635 7636 7637 7638 7639 7640 7641
##    2    1    1    2    1    1    2    2    2    2    2    2    1
## 7642 7643 7645 7646 7647 7649 7650 7652 7653 7654 7655 7657 7658
##    1    2    1    1    2    2    1    1    1    2    2    2    1
## 7659 7660 7662 7663 7665 7666 7670 7673 7674 7675 7677 7679 7681
##    1    2    1    2    2    1    2    2    2    1    2    2    2
## 7682 7685 7686 7687 7690 7692 7693 7697 7698 7700 7701 7702 7703
##    2    2    2    1    2    1    1    1    2    2    2    2    1
## 7704 7705 7706 7707 7710 7712 7714 7717 7718 7720 7724 7725 7727
##    2    1    1    1    2    2    2    2    2    2    2    2    2
## 7728 7729 7730 7732 7736 7737 7739 7740 7741 7742 7743 7744 7745
##    2    2    2    2    2    1    2    1    1    2    2    2    1
## 7746 7747 7748 7750 7751 7753 7754 7755 7757 7760 7761 7762 7763
##    2    2    1    2    1    2    1    1    2    2    1    2    2
## 7767 7768 7769 7771 7772 7773 7774 7775 7776 7779 7781 7782 7784
##    2    2    1    2    2    1    1    1    1    2    1    1    2
## 7786 7787 7788 7789 7790 7791 7793 7794 7797 7798 7799 7801 7803
##    2    1    1    2    2    2    1    1    2    2    1    1    2
## 7806 7807 7808 7809 7810 7812 7814 7815 7816 7818 7819 7820 7821
```

```
##    2    2    1    2    1    1    1    2    2    2    1    2    2
## 7822 7823 7827 7828 7829 7830 7831 7832 7833 7834 7836 7837 7838
##    1    1    2    1    1    2    2    2    2    2    1    2    2
## 7839 7841 7842 7843 7844 7845 7846 7851 7852 7853 7854 7857 7860
##    2    2    2    1    2    2    1    2    1    2    2    1    2
## 7861 7862 7864 7865 7871 7872 7873 7875 7876 7877 7878 7879 7880
##    2    2    2    2    2    1    2    2    2    1    1    2    2
## 7883 7884 7885 7887 7888 7889 7891 7894 7895 7896 7897 7898 7900
##    2    1    1    2    2    2    1    1    2    1    1    1    2
## 7901 7902 7903 7904 7905 7906 7907 7908 7909 7911 7913 7914 7916
##    1    1    1    2    1    2    1    1    2    1    2    2    2
## 7918 7919 7920 7921 7922 7924 7928 7929 7930 7933 7934 7935 7936
##    1    2    1    1    1    1    1    1    2    1    2    2    2
## 7937 7940 7944 7945 7950 7953 7954 7955 7956 7957 7959 7961 7962
##    2    2    2    2    1    2    2    1    1    1    2    1    1
## 7963 7967 7968 7969 7970 7973 7974 7977 7978 7979 7980 7981 7982
##    2    2    1    1    2    2    2    2    2    2    2    2    1
## 7984 7985 7986 7987 7988 7989 7990 7991 7992 7993 7994 7998 8000
##    1    2    2    1    1    2    2    2    2    1    2    1    2
## 8001 8003 8004 8005 8008 8009 8010 8011 8012 8014 8015 8016 8017
##    2    2    1    1    1    2    2    2    2    1    1    1    2
## 8019 8021 8022 8023 8024 8025 8026 8027 8028 8029 8030 8031 8032
##    1    2    2    2    2    1    2    2    1    1    2    2    2
## 8035 8037 8038 8039 8041 8043 8045 8046 8048 8049 8050 8052 8053
##    2    1    2    1    1    2    2    2    2    1    1    2    2
## 8054 8055 8056 8059 8060 8061 8063 8064 8066 8067 8068 8069 8071
##    1    1    2    2    2    1    2    2    2    2    1    2    2
## 8074 8075 8076 8077 8078 8079 8082 8083 8084 8086 8087 8088 8089
##    1    1    2    2    2    2    2    2    1    2    2    2    1
## 8092 8094 8095 8096 8097 8099 8101 8103 8104 8105 8106 8107 8109
##    1    1    1    2    2    1    1    2    1    2    2    2    1
## 8112 8113 8114 8115 8116 8119 8121 8122 8124 8127 8128 8130 8131
##    2    1    1    2    2    2    1    2    1    1    2    2    2
## 8134 8135 8137 8138 8140 8141 8142 8145 8147 8149 8150 8152 8154
##    2    2    1    2    1    1    1    1    1    2    2    2    2
## 8155 8156 8157 8158 8159 8161 8162 8163 8166 8169 8171 8172 8173
##    2    2    1    2    2    2    2    2    2    1    1    1    2
## 8175 8176 8177 8178 8179 8180 8182 8184 8186 8188 8189 8190 8191
##    2    2    1    2    2    1    1    1    2    2    1    1    1
## 8193 8194 8195 8197 8201 8204 8205 8207 8208 8209 8210 8212 8213
##    2    2    2    1    1    1    1    1    2    2    1    1    2
## 8214 8215 8217 8218 8219 8220 8223 8224 8226 8227 8228 8229 8231
##    1    1    1    2    1    2    2    2    2    2    2    2    1
## 8232 8233 8235 8237 8238 8239 8241 8242 8244 8248 8249 8250 8251
##    2    2    2    2    2    2    2    2    2    2    2    2    1
## 8252 8255 8256 8257 8258 8259 8261 8262 8263 8264 8266 8267 8268
##    1    2    1    1    2    2    2    1    2    2    1    1    1
## 8269 8271 8272 8273 8274 8275 8276 8277 8279 8280 8281 8283 8286
##    1    2    2    2    2    2    2    2    2    2    2    1    2
## 8287 8289 8290 8291 8292 8293 8294 8295 8296 8298 8299 8302 8303
##    2    2    2    2    1    1    1    2    1    1    2    1    1
## 8304 8306 8307 8308 8309 8311 8312 8315 8316 8318 8319 8320 8321
##    2    1    2    1    2    1    2    2    2    2    2    1    2
## 8322 8323 8324 8326 8327 8334 8335 8337 8338 8339 8340 8341 8343
```

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```
##    2    1    2    2    2    2    2    1    2    2    2    2    2
## 8346 8347 8348 8349 8350 8351 8352 8353 8354 8356 8357 8359 8363
##    2    1    1    2    2    1    2    2    2    1    2    1    2
## 8364 8367 8375 8376 8379 8381 8383 8384 8385 8386 8388 8389 8390
##    2    1    1    2    1    1    1    2    2    2    2    1    2
## 8391 8393 8394 8395 8396 8397 8399 8400 8403 8404 8405 8406 8408
##    2    1    2    1    1    2    1    2    1    1    2    2    2
## 8409 8410 8412 8413 8414 8417 8418 8419 8420 8424 8426 8427 8428
##    1    1    2    1    2    2    2    2    2    2    2    2    1
## 8429 8430 8431 8432 8433 8434 8435 8438 8441 8442 8443 8444 8445
##    1    2    1    2    2    2    2    2    1    1    2    2    2
## 8448 8449 8450 8451 8454 8455 8456 8458 8459 8461 8464 8466 8467
##    2    2    2    2    2    1    2    1    2    1    2    2    2
## 8468 8471 8473 8474 8475 8476 8477 8478 8479 8481 8482 8483 8484
##    2    1    2    2    1    1    2    1    2    2    2    1    1
## 8486 8487 8488 8489 8490 8491 8492 8493 8494 8495 8496 8498 8499
##    1    2    2    2    2    2    2    2    1    1    2    1    2
## 8501 8503 8505 8506 8508 8509 8510 8511 8515 8516 8517 8519 8520
##    2    2    1    1    2    2    1    1    1    2    2    1    2
## 8522 8525 8526 8527 8528 8531 8532 8533 8535 8536 8537 8538 8539
##    2    2    1    1    1    1    2    1    1    2    2    1    2
## 8540 8541 8542 8544 8545 8548 8551 8552 8553 8554 8556 8557 8559
##    1    1    2    1    2    1    2    2    2    2    1    2    2
## 8560 8561 8562 8563 8564 8565 8567 8568 8569 8570 8571 8577 8578
##    1    1    2    2    1    2    2    2    2    1    2    2    1
## 8579 8580 8581 8583 8584 8585 8587 8590 8591 8594 8595 8598 8599
##    1    1    1    2    2    2    2    1    2    2    2    2    1
## 8601 8602 8603 8607 8608 8609 8610 8611 8613 8614 8615 8616 8618
##    1    2    2    2    2    2    2    1    2    1    1    2    1
## 8619 8620 8621 8622 8623 8624 8626 8627 8628 8629 8630 8631 8633
##    2    2    2    2    1    2    2    1    1    1    1    2    2
## 8634 8636 8637 8638 8639 8640 8641 8643 8644 8645 8647 8650 8652
##    2    2    2    2    1    1    2    1    1    2    2    2    2
## 8653 8654 8655 8657 8658 8659 8660 8661 8663 8664 8666 8667 8669
##    2    1    2    1    2    2    2    1    2    2    2    2    2
## 8671 8672 8673 8674 8675 8676 8677 8678 8679 8680 8682 8683 8689
##    1    1    2    2    2    2    2    1    2    1    2    2    1
## 8690 8693 8697 8698 8699 8700 8702 8703 8706 8708 8711 8712 8714
##    2    2    1    2    1    1    2    2    2    1    2    1    2
## 8716 8718 8719 8720 8721 8722 8723 8724 8725 8726 8727 8728 8730
##    1    2    1    2    1    2    1    2    2    2    2    2    1
## 8732 8734 8737 8739 8740 8741 8742 8743 8744 8745 8746 8747 8749
##    2    1    2    2    2    1    2    2    1    2    2    1    2
## 8750 8751 8752 8754 8755 8756 8757 8758 8761 8762 8763 8764 8765
##    2    2    2    2    2    1    2    2    2    2    2    2    2
## 8767 8768 8769 8770 8771 8772 8773 8774 8776 8777 8778 8779 8780
##    2    2    1    2    2    1    2    1    2    2    2    2    1
## 8781 8782 8785 8787 8790 8791 8792 8793 8794 8795 8796 8797 8798
##    2    1    1    1    1    1    2    2    2    2    2    2    1
## 8800 8801 8802 8803 8804 8806 8809 8812 8814 8815 8816 8817 8818
##    2    2    1    1    2    1    2    2    1    1    2    1    1
## 8819 8821 8824 8825 8828 8829 8831 8832 8834 8835 8836 8838 8839
##    2    2    2    2    1    2    2    2    2    1    2    2    1
## 8840 8842 8843 8845 8846 8847 8848 8849 8850 8852 8853 8854 8855
```

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##    2    2    2    2    1    2    2    2    2    2    2    1    2
## 8856 8857 8858 8859 8860 8861 8862 8865 8866 8868 8869 8872 8873
##    2    2    2    2    2    1    1    1    2    1    2    2    2
## 8874 8875 8877 8878 8880 8882 8883 8884 8885 8886 8887 8890 8892
##    2    1    2    2    2    2    1    2    2    1    1    1    1
## 8893 8894 8896 8897 8898 8900 8903 8904 8905 8910 8911 8912 8914
##    1    2    2    2    2    2    2    1    2    2    2    2    2
## 8917 8918 8920 8921 8923 8924 8925 8926 8927 8928 8929 8930 8934
##    1    1    1    1    2    2    2    2    1    2    1    2    2
## 8936 8938 8939 8940 8941 8942 8946 8947 8953 8955 8956 8958 8962
##    2    2    2    2    2    2    2    2    2    1    2    1    2
## 8963 8966 8967 8968 8970 8971 8972 8973 8974 8975 8976 8977 8979
##    1    1    2    1    1    1    2    2    2    2    2    2    2
## 8980 8984 8986 8987 8988 8990 8992 8993 8994 8995 8996 8997 9001
##    1    1    2    2    2    2    1    1    2    2    2    2    2
## 9002 9005 9007 9008 9009 9011 9012 9013 9014 9016 9018 9020 9021
##    1    1    2    2    1    2    1    2    2    2    1    1    2
## 9022 9023 9024 9025 9027 9028 9031 9032 9034 9035 9036 9038 9039
##    1    2    2    2    2    2    2    1    1    2    2    1    2
## 9040 9041 9043 9044 9045 9046 9047 9048 9050 9052 9053 9054 9055
##    2    1    2    2    1    1    2    1    1    2    1    2    2
## 9056 9057 9058 9060 9061 9063 9064 9066 9070 9071 9073 9074 9075
##    2    1    1    1    2    1    2    1    2    2    2    2    2
## 9076 9077 9078 9080 9081 9082 9083 9085 9086 9087 9088 9089 9091
##    2    2    2    1    2    1    1    2    2    2    1    1    2
## 9092 9093 9094 9097 9098 9099 9101 9104 9106 9108 9109 9110 9111
##    1    2    1    1    2    2    2    2    2    2    1    1    2
## 9112 9113 9116 9117 9118 9119 9120 9121 9122 9124 9126 9127 9128
##    1    2    2    1    2    1    1    2    2    1    1    2    1
## 9129 9130 9131 9132 9133 9135 9136 9137 9138 9139 9140 9141 9142
##    1    1    1    2    2    2    2    1    2    1    2    1    2
## 9144 9145 9146 9147 9148 9149 9150 9151 9152 9153 9154 9155 9158
##    1    2    2    1    2    1    2    1    1    1    1    2    1
## 9160 9161 9163 9164 9165 9166 9167 9169 9173 9174 9175 9176 9177
##    2    1    1    2    2    1    2    2    1    2    1    2    2
## 9179 9180 9181 9183 9184 9186 9187 9188 9190 9191 9192 9194 9195
##    2    1    1    2    2    2    2    1    2    1    2    2    2
## 9197 9200 9205 9206 9207 9208 9210 9212 9213 9214 9215 9217 9219
##    2    1    2    2    2    1    2    2    2    1    2    2    2
## 9222 9223 9224 9226 9227 9228 9230 9231 9232 9233 9235 9236 9240
##    2    2    2    1    1    1    2    2    2    1    1    1    2
## 9241 9242 9244 9245 9247 9249 9251 9252 9254 9255 9256 9257 9259
##    2    2    1    1    1    2    2    2    1    2    1    2    2
## 9261 9262 9263 9264 9265 9266 9267 9268 9269 9270 9271 9272 9273
##    1    1    1    2    2    1    2    2    2    1    2    2    1
## 9274 9276 9277 9278 9280 9282 9283 9285 9288 9289 9292 9293 9294
##    1    1    1    2    2    2    2    2    2    2    2    2    2
## 9295 9296 9297 9298 9300 9301 9302 9303 9305 9306 9307 9309 9310
##    1    1    2    2    1    1    2    1    1    2    1    2    2
## 9311 9312 9313 9314 9315 9317 9319 9320 9323 9324 9325 9326 9327
##    2    2    2    1    1    2    2    1    1    2    2    2    2
## 9328 9330 9331 9332 9333 9335 9339 9340 9341 9342 9343 9344 9345
##    2    2    2    2    1    2    2    2    2    1    1    2    1
## 9346 9347 9348 9349 9350 9353 9354 9355 9356 9357 9358 9359 9360
```

```
##    1    2    2    2    2    1    1    1    1    2    2    2    2
## 9361 9363 9365 9366 9368 9369 9370 9375 9376 9377 9378 9381 9382
##    2    1    2    2    1    2    2    1    2    2    1    2    2
## 9384 9385 9386 9387 9389 9395 9397 9399 9400 9402 9405 9406 9407
##    2    2    1    2    2    2    2    2    1    2    1    1    1
## 9408 9409 9410 9414 9415 9418 9419 9420 9421 9422 9423 9424 9425
##    1    2    2    1    1    1    1    2    1    1    2    2    1
## 9426 9428 9430 9431 9432 9433 9434 9435 9437 9438 9439 9441 9442
##    2    2    2    2    2    2    1    1    2    1    2    1    1
## 9443 9444 9445 9447 9448 9450 9451 9453 9454 9456 9459 9461 9462
##    2    1    2    1    2    1    2    2    1    1    2    2    1
## 9466 9467 9468 9469 9470 9471 9473 9475 9476 9477 9479 9480 9482
##    2    2    2    1    1    2    1    2    2    1    1    1    2
## 9483 9484 9485 9486 9489 9490 9491 9492 9494 9495 9496 9497 9498
##    2    2    2    2    1    2    2    1    2    1    2    1    1
## 9502 9503 9504 9505 9509 9511 9513 9516 9517 9518 9520 9523 9524
##    2    1    2    1    2    2    2    2    2    2    2    1    2
## 9526 9527 9529 9531 9533 9534 9535 9536 9538 9539 9540 9541 9542
##    2    2    1    2    2    2    2    1    2    2    2    1    1
## 9546 9547 9549 9550 9551 9552 9553 9554 9558 9559 9561 9562 9563
##    1    2    1    1    2    2    1    1    2    1    2    2    1
## 9564 9565 9567 9568 9570 9571 9573 9574 9578 9579 9581 9584 9586
##    2    2    1    1    2    1    2    2    2    1    1    2    2
## 9587 9589 9592 9593 9594 9595 9596 9599 9600 9602 9603 9605 9607
##    2    1    2    2    2    2    1    2    2    2    2    1    1
## 9608 9609 9610 9611 9612 9615 9618 9621 9622 9623 9625 9627 9628
##    1    1    1    1    2    1    2    2    1    2    2    2    2
## 9629 9630 9631 9632 9633 9635 9636 9637 9638 9639 9640 9641 9642
##    2    2    1    2    2    1    2    2    1    2    1    2    1
## 9643 9644 9646 9647 9648 9650 9651 9652 9653 9654 9655 9659 9661
##    1    1    2    2    1    1    2    1    2    1    2    2    2
## 9662 9664 9665 9666 9667 9669 9672 9673 9678 9680 9681 9682 9683
##    2    1    2    2    2    2    2    2    2    1    2    1    2
## 9685 9686 9687 9688 9689 9690 9695 9697 9698 9700 9701 9702 9709
##    2    1    2    2    2    2    1    1    1    1    2    2    1
## 9711 9712 9714 9715 9716 9718 9719 9720 9721 9722 9724 9725 9726
##    1    1    2    2    1    2    1    2    2    2    1    1    2
## 9727 9728 9729 9730 9732 9735 9736 9737 9738 9741 9743 9745 9746
##    1    1    1    2    2    1    2    2    2    2    2    2    1
## 9747 9748 9749 9750 9751 9753 9755 9756 9758 9760 9761 9763 9764
##    1    2    2    2    1    1    2    2    1    2    2    2    1
## 9766 9767 9768 9770 9771 9772 9773 9774 9775 9777 9778 9779 9781
##    1    2    2    2    1    2    2    2    2    2    2    2    1
## 9783 9784 9786 9789 9790 9791 9795 9797 9799 9801 9802 9804 9805
##    1    2    2    1    2    1    2    2    2    2    2    2    1
## 9806 9808 9810 9812 9813 9814 9816 9817 9818 9819 9820 9822 9823
##    2    1    2    2    1    2    1    2    1    1    2    2    2
## 9825 9826 9828 9829 9831 9832 9833 9835 9836 9837 9838 9839 9843
##    2    2    2    1    1    2    2    2    1    1    1    2    1
## 9844 9845 9847 9848 9849 9850 9851 9853 9856 9859 9861 9862 9864
##    1    2    1    1    2    2    2    1    1    1    1    1    2
## 9865 9866 9867 9868 9869 9871 9872 9874 9875 9879 9880 9883 9885
##    2    2    2    1    2    2    2    1    1    1    2    2    1
## 9886 9888 9889 9890 9891 9892 9895 9896 9897 9898 9899 9900 9902
```

```
##     2     2     2     2     1     1     2     1     1     1     2     1     2
##  9905  9907  9909  9911  9913  9914  9916  9917  9919  9920  9921  9922  9924
##     1     1     1     1     1     2     2     2     2     2     1     2     2
##  9926  9927  9928  9929  9930  9931  9932  9933  9934  9935  9936  9937  9938
##     2     1     2     2     2     1     2     1     2     1     1     2     2
##  9939  9942  9943  9945  9946  9948  9950  9951  9952  9955  9956  9957  9958
##     2     2     1     2     1     1     2     2     2     2     2     2     2
##  9959  9960  9962  9963  9964  9965  9966  9967  9968  9969  9971  9972  9973
##     2     1     1     1     2     2     1     2     2     2     2     2     2
##  9974  9977  9980  9981  9982  9983  9984  9985  9987  9989  9991  9992  9993
##     1     1     1     2     2     2     2     1     2     1     2     1     2
##  9994  9995  9996  9998  9999 10000 10002 10003 10005 10006 10008 10009 10011
##     2     2     2     2     1     1     2     2     1     2     2     1     2
## 10012 10013 10015 10017 10019 10020 10021 10022 10023 10024 10026 10028 10030
##     2     1     2     2     2     2     2     2     2     2     2     2     2
## 10031 10032 10033 10034 10035 10037 10038 10041 10042 10043 10044 10046 10048
##     1     2     2     2     1     1     2     2     2     2     2     1     1
## 10049 10052 10053 10054 10056 10061 10062 10063 10064 10065 10066 10068 10069
##     2     1     2     2     1     2     2     1     2     2     2     1     2
## 10070 10071 10072 10073 10076 10077 10078 10079 10083 10084 10086 10087 10088
##     1     1     2     2     2     1     2     2     1     1     2     2     2
## 10089 10091 10093 10094 10095 10096 10098 10099 10100 10101 10102 10103 10104
##     1     2     1     2     2     2     1     2     1     1     2     2     2
## 10105 10106 10107 10108 10109 10110 10112 10113 10114 10116 10117 10118 10119
##     2     2     2     2     2     2     1     1     2     1     2     2     2
## 10121 10122 10123 10124 10126 10128 10130 10132 10133 10135 10137 10138 10139
##     1     1     2     1     1     2     2     1     2     2     1     2     2
## 10140 10141 10142 10143 10144 10145 10147 10148 10149 10150 10151 10153 10154
##     2     1     2     2     2     2     2     2     1     1     1     2     2
## 10155 10156 10157 10158 10159 10160 10162 10164 10166 10168 10169 10170 10171
##     1     1     1     2     2     1     2     2     2     2     2     1     1
## 10172 10174 10175 10178 10179 10180 10183 10184 10186 10187 10188 10190 10191
##     1     1     2     1     1     2     1     2     2     2     1     2     2
## 10193 10194 10195 10196 10197 10198 10199 10200 10201 10202 10203 10204 10205
##     1     1     1     1     2     1     2     1     2     1     2     2     2
## 10206 10207 10208 10211 10212 10214 10217 10219 10221 10222 10223 10225 10226
##     2     2     1     2     2     2     1     1     2     1     1     2     2
## 10227 10228 10229 10231 10235 10236 10237 10238 10240 10241 10242 10245 10246
##     1     1     2     2     1     1     1     2     1     2     2     2     2
## 10248 10249 10250 10251 10253 10254 10258 10259 10260 10261 10262 10263 10264
##     2     1     2     2     2     2     2     2     1     1     2     1     2
## 10267 10268 10270 10271 10272 10273 10274 10275 10277 10278 10279 10282 10283
##     1     2     2     2     2     1     1     2     2     1     2     2     2
## 10284 10285 10289 10290 10292 10293 10296 10297 10298 10299 10300 10301 10302
##     2     1     2     2     1     1     2     1     2     2     2     1     2
## 10304 10305 10307 10308 10313 10314 10316 10317 10318 10319 10323 10325 10326
##     1     2     2     2     2     1     2     1     1     2     2     2     2
## 10327 10328 10329 10330 10331 10334 10335 10336 10337 10338 10339 10340 10341
##     2     2     2     2     1     1     1     1     2     1     2     1     1
## 10343 10346 10349 10350 10351 10352 10353 10354 10355 10356 10358 10360 10361
##     2     2     1     1     2     2     2     2     1     1     1     2     2
## 10363 10364 10365 10366 10367 10368 10370 10371 10372 10373 10374 10375 10376
##     2     2     2     2     2     2     2     2     1     1     1     2     2
## 10377 10378 10379 10380 10381 10382 10383 10386 10387 10388 10389 10391 10392
```

```
##     1     1     1     2     2     1     2     1     2     2     2     2     1
## 10393 10397 10398 10399 10400 10401 10403 10404 10405 10406 10409 10410 10411
##     1     2     2     2     2     2     2     2     2     2     2     2     2
## 10412 10413 10416 10418 10419 10423 10424 10427 10428 10429 10431 10435 10438
##     2     2     2     2     2     1     2     2     1     1     1     1     1
## 10441 10442 10444 10448 10449 10451 10452 10453 10454 10455 10456 10458 10460
##     2     2     2     2     1     1     2     2     1     2     1     1     2
## 10461 10462 10463 10465 10467 10468 10470 10472 10473 10475 10477 10478 10479
##     2     2     1     1     2     2     2     2     2     2     2     2     1
## 10480 10482 10483 10485 10487 10488 10489 10494 10496 10497 10500 10502 10504
##     2     2     2     2     2     2     2     2     1     2     1     2     2
## 10507 10508 10509 10512 10513 10514 10517 10518 10519 10520 10521 10522 10523
##     1     2     2     1     2     1     2     1     2     2     1     1     2
## 10524 10526 10530 10531 10532 10533 10534 10536 10537 10538 10539 10540 10541
##     2     1     2     2     2     1     2     1     1     2     1     1     1
## 10543 10545 10546 10547 10549 10551 10552 10553 10554 10555 10556 10557 10559
##     2     1     2     2     1     2     2     1     2     2     2     1     1
## 10560 10562 10563 10564 10566 10568 10569 10570 10572 10574 10575 10576 10577
##     1     2     1     2     2     1     1     1     2     2     2     2     2
## 10578 10579 10580 10582 10583 10584 10585 10587 10588 10589 10591 10592 10593
##     2     2     2     1     2     2     2     2     2     1     2     1     2
## 10594 10595 10596 10599 10600 10601 10602 10603 10605 10607 10608 10609 10610
##     2     2     2     1     2     1     1     1     1     1     1     2     2
## 10611 10613 10614 10616 10618 10619 10620 10621 10622 10624 10625 10626 10627
##     2     2     2     2     2     1     2     2     2     2     2     1     1
## 10628 10629 10631 10632 10634 10635 10636 10638 10639 10640 10641 10642 10643
##     2     1     1     1     2     1     2     1     2     1     1     1     2
## 10644 10646 10647 10648 10649 10650 10652 10653 10654 10655 10658 10661 10663
##     2     2     1     2     2     1     1     1     1     2     1     2     1
## 10664 10666 10667 10668 10669 10672 10673 10675 10676 10677 10678 10679 10680
##     2     2     2     1     2     1     2     2     2     2     1     2     2
## 10682 10683 10684 10685 10686 10687 10688 10689 10691 10694 10695 10696 10697
##     1     1     2     2     1     2     2     1     2     2     1     1     1
## 10698 10702 10704 10706 10707 10708 10710 10711 10712 10713 10714 10715 10716
##     1     2     2     2     1     1     1     2     2     1     1     1     1
## 10718 10719 10720 10722 10723 10724 10725 10726 10727 10728 10729 10730 10732
##     1     1     1     2     1     2     2     1     1     2     1     2     1
## 10734 10735 10737 10738 10739 10740 10743 10744 10745 10746 10747 10748 10749
##     2     1     1     1     1     2     2     1     1     1     1     2     1
## 10750 10752 10753 10757 10758 10760 10762 10763 10764 10765 10766 10767 10768
##     1     1     2     2     1     1     1     1     2     1     1     2     2
## 10769 10770 10772 10775 10776 10778 10779 10781 10782 10784 10785 10786 10787
##     2     1     2     2     2     2     1     1     1     2     2     2     1
## 10788 10789 10790 10791 10792 10793 10794 10796 10797 10801 10802 10803 10804
##     2     1     2     2     1     2     2     1     2     2     1     2     1
## 10806 10809 10810 10811 10812 10814 10816 10817 10819 10820 10823 10824 10825
##     2     2     2     1     1     2     1     2     1     1     1     2     2
## 10826 10827 10829 10830 10831 10832 10833 10837 10840 10843 10844 10845 10846
##     1     2     2     1     2     1     2     2     2     1     2     2     1
## 10848 10849 10850 10853 10854 10855 10856 10857 10858 10860 10861 10862 10863
##     1     2     1     1     1     1     1     2     2     2     2     1     2
## 10864 10866 10868 10869 10871 10872 10874 10875 10876 10877 10878 10879 10880
##     2     1     1     1     2     2     2     2     1     2     1     2     2
## 10881 10882 10883 10884 10886 10889 10890 10891 10895 10897 10898 10899 10901
```

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##     1     2     2     1     2     1     1     2     2     2     2     2     1
## 10902 10903 10906 10907 10911 10912 10914 10915 10918 10920 10921 10922 10923
##     1     2     1     1     2     2     2     2     1     2     2     2     2
## 10924 10925 10927 10928 10930 10931 10932 10933 10934 10935 10936 10937 10938
##     1     2     2     2     2     1     2     1     2     2     1     2     2
## 10939 10942 10943 10944 10945 10946 10947 10948 10949 10950 10951 10952 10953
##     2     2     2     2     2     1     1     2     1     2     1     1     2
## 10954 10956 10957 10959 10960 10961 10962 10964 10966 10967 10969 10970 10973
##     2     2     1     1     2     1     1     2     2     2     2     2     2
## 10975 10976 10977 10978 10981 10983 10984 10989 10990 10992 10994 10995 10996
##     1     2     1     1     2     2     1     2     2     2     1     2     2
## 10997 10998 11001 11002 11004 11005 11006 11008 11010 11012 11013 11014 11016
##     2     2     1     2     1     2     2     1     1     1     2     2     2
## 11017 11018 11019 11020 11021 11022 11023 11025 11026 11027 11028 11029 11032
##     1     2     1     2     2     2     1     2     2     2     2     1     2
## 11034 11035 11036 11037 11038 11039 11040 11041 11044 11048 11052 11053 11054
##     2     2     2     1     1     1     1     2     2     1     2     2     2
## 11056 11057 11060 11062 11063 11064 11065 11066 11067 11068 11069 11070 11071
##     2     2     1     2     2     2     1     1     1     2     2     1     1
## 11073 11074 11075 11076 11079 11080 11081 11082 11084 11085 11086 11088 11090
##     1     1     1     2     1     2     1     2     2     1     2     2     2
## 11093 11094 11095 11097 11098 11099 11100 11102 11103 11104 11105 11106 11107
##     2     2     1     1     1     1     2     2     2     2     2     1     2
## 11108 11109 11110 11113 11114 11115 11118 11119 11120 11121 11122 11123 11124
##     2     1     2     2     2     1     2     1     1     2     2     2     2
## 11125 11126 11127 11128 11129 11131 11133 11134 11135 11136 11137 11138 11140
##     2     2     2     2     1     2     2     2     2     2     1     2     2
## 11141 11142 11143 11144 11146 11147 11149 11151 11152 11153 11154 11155 11156
##     2     2     1     2     1     1     1     2     2     1     2     2     1
## 11158 11159 11160 11161 11164 11165 11166 11167 11171 11172 11173 11174 11176
##     2     1     2     2     2     2     2     2     2     2     2     2     2
## 11178 11179 11181 11183 11185 11186 11187 11189 11192 11193 11195 11196 11197
##     2     2     2     1     2     2     2     2     2     1     1     1     2
## 11201 11203 11204 11206 11208 11209 11210 11212 11213 11214 11215 11217 11219
##     1     2     2     2     1     2     1     2     2     1     2     2     2
## 11220 11221 11223 11224 11225 11226 11228 11229 11230 11232 11234 11235 11237
##     1     2     1     2     1     1     1     2     2     2     1     1     2
## 11238 11239 11240 11242 11243 11244 11245 11246 11248 11249 11251 11252 11253
##     1     2     2     2     2     2     2     2     1     2     2     1     1
## 11254 11255 11256 11257 11258 11259 11260 11261 11265 11268 11271 11272 11273
##     1     1     2     1     2     1     2     2     1     2     1     2     1
## 11277 11278 11279 11280 11282 11284 11286 11287 11290 11291 11292 11294 11296
##     2     1     2     2     2     1     1     1     2     2     2     1     2
## 11297 11298 11299 11300 11301 11302 11304 11306 11307 11309 11310 11311 11312
##     1     1     2     1     2     2     2     2     2     1     2     1     1
## 11314 11315 11316 11317 11318 11319 11320 11322 11323 11325 11328 11329 11331
##     1     2     1     2     1     2     2     2     1     1     1     2     2
## 11334 11335 11337 11339 11340 11342 11344 11346 11347 11348 11349 11350 11351
##     2     1     2     1     1     1     1     1     1     2     1     2     2
## 11353 11354 11356 11359 11360 11361 11363 11365 11366 11368 11371 11372 11373
##     2     2     1     2     2     1     2     1     1     1     2     1     2
## 11374 11375 11376 11378 11379 11380 11383 11385 11386 11388 11390 11391 11393
##     2     2     2     1     2     1     2     2     2     2     1     1     1
## 11394 11395 11396 11398 11399 11400 11402 11403 11404 11406 11407 11408 11410
```

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##     1     1     2     1     1     2     2     1     2     2     2     1     2
## 11411 11412 11413 11415 11419 11420 11424 11425 11426 11428 11430 11431 11433
##     1     1     2     2     2     1     1     1     2     1     1     2     2
## 11434 11435 11436 11437 11438 11439 11442 11443 11445 11449 11450 11452 11454
##     1     1     2     1     1     1     2     2     1     2     2     2     2
## 11455 11456 11459 11460 11463 11464 11466 11467 11468 11469 11470 11472 11474
##     1     2     2     1     2     2     2     1     2     2     2     1     1
## 11475 11476 11477 11478 11479 11480 11482 11483 11484 11485 11486 11487 11488
##     2     2     2     1     2     2     2     2     2     2     2     1     2
## 11489 11491 11492 11493 11494 11495 11496 11501 11502 11503 11504 11505 11506
##     2     1     1     1     2     1     2     1     1     1     2     2     2
## 11508 11509 11510 11512 11513 11514 11516 11518 11519 11521 11522 11523 11524
##     2     2     1     1     2     2     2     1     1     1     1     1     1
## 11525 11526 11527 11528 11529 11531 11532 11535 11536 11540 11541 11544 11545
##     2     1     1     2     2     2     2     2     2     1     1     2     2
## 11546 11547 11549 11550 11552 11553 11554 11555 11556 11557 11559 11560 11561
##     2     2     2     1     2     1     2     2     1     1     2     2     1
## 11562 11563 11564 11566 11567 11568 11569 11571 11573 11576 11577 11578 11579
##     2     2     1     1     1     1     2     2     2     2     1     2     2
## 11580 11581 11584 11585 11586 11587 11588 11589 11592 11593 11594 11597 11599
##     1     2     2     1     2     2     1     2     1     1     2     2     2
## 11600 11601 11602 11603 11604 11605 11606 11607 11608 11609 11610 11611 11612
##     1     1     1     1     1     2     2     2     2     2     2     2     2
## 11613 11616 11617 11618 11619 11620 11621 11622 11623 11624 11626 11627 11628
##     1     2     2     1     2     1     1     2     1     1     2     1     2
## 11629 11632 11633 11634 11635 11638 11639 11640 11642 11643 11644 11646 11647
##     1     1     2     1     2     1     2     1     1     1     1     1     1
## 11648 11649 11651 11652 11654 11655 11656 11658 11659 11660 11662 11663 11664
##     1     2     2     2     2     2     2     2     1     2     2     2     1
## 11666 11667 11668 11670 11672 11673 11674 11675 11676 11677 11680 11683 11684
##     1     2     2     2     2     2     1     1     2     1     1     2     2
## 11685 11686 11687 11688 11689 11690 11691 11692 11693 11694 11695 11697 11698
##     1     2     2     1     2     2     1     2     1     1     2     1     1
## 11699 11700 11702 11703 11704 11705 11706 11707 11709 11712 11713 11714 11715
##     2     2     2     1     2     2     2     1     2     2     2     1     1
## 11716 11717 11718 11719 11720 11721 11723 11725 11726 11727 11729 11730 11731
##     2     2     2     2     1     2     2     1     1     2     2     2     2
## 11733 11735 11736 11737 11738 11739 11740 11741 11742 11743 11744 11745 11747
##     2     2     1     1     1     2     1     2     2     2     2     2     1
## 11748 11749 11750 11751 11752 11753 11755 11757 11758 11759 11760 11762 11763
##     2     2     2     2     1     2     2     1     2     1     1     2     1
## 11764 11765 11766 11767 11768 11769 11770 11772 11773 11774 11775 11776 11778
##     2     2     1     2     2     1     1     1     1     2     1     1     1
## 11779 11781 11782 11783 11785 11786 11787 11789 11791 11792 11794 11801 11802
##     1     1     1     2     1     1     2     1     1     2     1     2     2
## 11804 11805 11809 11810 11811 11812 11815 11816 11817 11820 11821 11822 11823
##     1     1     1     1     1     2     2     2     1     1     1     2     1
## 11824 11826 11828 11829 11834 11837 11838 11839 11840 11841 11842 11843 11844
##     2     2     2     1     2     1     1     2     2     2     2     1     2
## 11846 11847 11848 11850 11854 11855 11857 11858 11859 11860 11862 11864 11866
##     2     1     2     2     1     1     1     1     1     2     2     2     2
## 11867 11868 11870 11872 11875 11877 11879 11880 11881 11882 11883 11885 11886
##     2     1     2     2     2     1     2     1     2     2     1     2     1
## 11887 11888 11889 11890 11893 11894 11895 11896 11897 11898 11899 11902 11904
```

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##     2     2     2     2     2     2     2     2     2     1     2     1     2
## 11905 11908 11909 11910 11911 11913 11915 11916 11918 11919 11920 11921 11924
##     1     1     2     2     2     1     1     2     1     2     2     2     2
## 11925 11928 11930 11931 11932 11934 11939 11940 11941 11942 11943 11944 11945
##     1     1     2     2     1     1     2     2     2     2     1     2     2
## 11948 11951 11954 11955 11957 11958 11959 11960 11961 11963 11964 11965 11966
##     2     2     1     1     2     1     2     2     2     2     2     2     2
## 11969 11972 11974 11975 11976 11978 11980 11984 11985 11986 11989 11990 11991
##     1     2     2     2     2     1     2     1     1     1     1     2     2
## 11994 11995 11996 12000 12001 12002 12003 12004 12005 12006 12007 12009 12011
##     2     2     2     2     1     2     2     2     2     1     2     2     1
## 12012 12013 12014 12015 12017 12018 12019 12020 12021 12023 12024 12026 12027
##     2     2     2     2     2     2     1     2     2     2     2     2     2
## 12028 12029 12031 12033 12034 12037 12038 12040 12045 12046 12047 12052 12053
##     1     1     2     2     2     1     1     2     1     1     2     1     1
## 12054 12056 12057 12058 12059 12060 12062 12064 12065 12066 12067 12068 12070
##     2     2     2     1     1     2     2     2     1     1     1     2     2
## 12071 12073 12074 12075 12076 12078 12079 12080 12081 12082 12084 12085 12087
##     1     1     1     2     2     1     2     2     2     2     1     1     2
## 12088 12090 12091 12092 12093 12095 12096 12097 12098 12099 12100 12102 12104
##     2     1     2     2     2     1     1     2     1     2     2     2     2
## 12105 12106 12107 12108 12109 12110 12111 12114 12115 12117 12119 12120 12121
##     1     1     1     2     1     2     1     2     2     2     2     1     1
## 12122 12123 12124 12125 12127 12128 12129 12130 12131 12132 12133 12135 12137
##     1     1     2     2     1     2     1     1     2     2     2     1     2
## 12139 12141 12142 12143 12144 12145 12146 12147 12149 12150 12152 12153 12154
##     2     2     2     1     1     2     1     2     1     2     2     2     2
## 12155 12159 12160 12161 12165 12166 12168 12172 12173 12174 12175 12178 12180
##     2     1     2     1     1     1     2     2     2     2     2     2     2
## 12181 12182 12183 12184 12186 12187 12189 12190 12196 12197 12198 12199 12200
##     2     2     1     2     1     2     2     2     1     2     1     1     2
## 12201 12202 12204 12205 12206 12207 12208 12209 12210 12211 12212 12213 12214
##     2     2     1     1     2     2     2     2     2     2     2     2     1
## 12215 12216 12217 12218 12219 12220 12221 12222 12223 12224 12226 12227 12228
##     2     1     1     1     1     1     1     2     1     2     1     1     2
## 12229 12232 12233 12234 12235 12236 12237 12238 12239 12240 12241 12243 12244
##     1     1     2     2     2     2     2     2     2     1     2     1     2
## 12245 12246 12247 12251 12252 12254 12256 12258 12259 12260 12261 12262 12263
##     1     2     2     2     2     2     2     2     2     2     2     1     1
## 12264 12265 12267 12269 12272 12273 12275 12276 12279 12282 12283 12284 12285
##     1     2     1     2     2     2     2     2     2     2     2     2     2
## 12288 12292 12295 12296 12297 12299 12302 12303 12305 12306 12307 12308 12309
##     2     2     2     1     2     1     2     1     2     2     2     2     2
## 12310 12311 12312 12313 12314 12315 12316 12318 12319 12320 12321 12323 12324
##     2     2     2     2     2     2     1     2     1     1     1     1     1
## 12328 12333 12334 12335 12336 12338 12339 12340 12341 12342 12343 12344 12346
##     1     1     2     1     2     2     2     1     2     1     1     2     2
## 12347 12348 12349 12352 12353 12354 12356 12357 12359 12360 12361 12362 12363
##     1     2     1     1     1     2     2     2     2     2     2     1     2
## 12366 12367 12368 12369 12370 12371 12372 12374 12375 12376 12378 12379 12380
##     2     2     1     2     2     2     1     2     2     1     2     2     2
## 12385 12386 12389 12392 12394 12395 12397 12398 12399 12401 12404 12405 12406
##     1     1     2     2     1     2     1     2     2     2     2     2     1
## 12408 12409 12411 12413 12415 12417 12419 12420 12421 12422 12423 12424 12425
```

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##     2     2     2     2     2     2     2     2     2     2     2     1     2
## 12428 12429 12431 12433 12434 12435 12436 12439 12440 12443 12445 12449 12450
##     1     2     2     1     2     2     2     2     2     2     1     2     1
## 12452 12453 12454 12455 12456 12457 12459 12460 12461 12462 12464 12465 12466
##     2     1     1     1     1     2     1     2     2     1     1     2     2
## 12467 12468 12469 12470 12472 12473 12474 12475 12476 12478 12481 12484 12486
##     2     2     1     2     2     2     2     1     1     2     2     1     1
## 12488 12491 12492 12493 12494 12495 12496 12498 12499 12500 12501 12503 12504
##     2     2     1     2     1     2     2     1     1     1     1     2     2
## 12505 12506 12510 12511 12514 12516 12517 12518 12522 12524 12525 12526 12527
##     2     2     2     1     2     1     1     2     2     1     1     1     2
## 12528 12532 12533 12534 12535 12537 12539 12540 12541 12542 12543 12545 12546
##     2     2     2     1     1     1     2     1     1     1     1     2     1
## 12548 12549 12550 12551 12552 12555 12556 12557 12558 12561 12562 12564 12566
##     2     2     2     2     1     2     2     1     2     1     2     2     1
## 12567 12568 12569 12571 12572 12575 12577 12578 12579 12582 12586 12587 12588
##     2     1     1     2     1     1     1     2     1     1     2     2     1
## 12589 12590 12591 12592 12594 12596 12597 12598 12599 12600 12601 12602 12603
##     1     2     2     1     1     1     1     2     2     2     2     1     2
## 12604 12605 12606 12608 12609 12611 12612 12613 12614 12619 12620 12621 12622
##     2     2     1     2     1     2     2     2     2     2     1     1     2
## 12627 12629 12630 12633 12634 12635 12639 12641 12642 12644 12645 12646 12647
##     2     2     2     2     2     1     1     1     1     2     1     1     2
## 12648 12652 12653 12655 12656 12657 12658 12659 12660 12661 12666 12667 12668
##     2     1     2     2     2     2     2     1     2     2     1     1     2
## 12671 12672 12673 12676 12678 12679 12680 12682 12686 12687 12688 12690 12691
##     2     2     2     2     2     2     2     1     2     2     1     1     2
## 12696 12699 12701 12705 12707 12708 12710 12711 12712 12713 12715 12721 12722
##     2     2     2     2     2     1     1     1     2     1     1     2     2
## 12724 12725 12728 12730 12731 12734 12735 12736 12737 12738 12739 12741 12742
##     1     2     2     1     2     1     2     2     2     2     2     2     2
## 12743 12747 12748 12749 12750 12752 12753 12754 12755 12756 12759 12760 12761
##     2     2     2     2     2     2     1     2     2     2     2     2     1
## 12762 12764 12765 12766 12767 12768 12769 12770 12773 12774 12775 12777 12779
##     1     1     1     2     2     2     2     1     1     2     1     2     2
## 12781 12784 12785 12787 12791 12793 12794 12795 12797 12798 12800 12801 12803
##     2     1     2     2     1     2     1     1     2     2     2     2     1
## 12804 12808 12809 12810 12811 12812 12813 12815 12816 12818 12820 12821 12823
##     2     2     2     2     1     1     1     2     2     1     1     1     2
## 12827 12828 12829 12830 12831 12832 12833 12835 12836 12837 12838 12840 12841
##     1     1     2     2     2     1     2     1     2     2     1     2     2
## 12842 12843 12846 12848 12849 12851 12853 12854 12855 12856 12857 12858 12859
##     2     1     1     1     1     2     2     1     2     2     2     2     1
## 12860 12861 12862 12863 12864 12866 12867 12869 12874 12876 12877 12878 12879
##     2     2     2     1     2     2     2     2     1     2     2     2     2
## 12882 12883 12884 12886 12887 12888 12889 12890 12892 12893 12895 12897 12898
##     1     2     2     2     1     2     2     2     2     2     2     2     2
## 12899 12900 12902 12903 12904 12905 12907 12908 12910 12911 12912 12914 12915
##     1     1     2     2     2     2     1     2     2     2     2     1     2
## 12916 12917 12918 12919 12921 12923 12925 12926 12927 12928 12930 12931 12932
##     2     2     2     2     2     2     1     1     2     2     1     2     2
## 12933 12934 12936 12937 12938 12941 12942 12943 12944 12945 12947 12948 12949
##     1     2     2     2     1     1     2     1     2     2     2     2     1
## 12951 12952 12954 12955 12956 12957 12960 12961 12962 12963 12964 12967 12968
```

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##     1     2     2     1     2     1     2     2     2     2     2     1     2
## 12969 12972 12975 12977 12978 12979 12980 12981 12983 12984 12985 12989 12990
##     1     2     2     1     2     2     1     1     1     1     1     2     1
## 12991 12992 12993 12994 12997 12998 12999 13000 13001 13003 13005 13006 13009
##     1     2     2     2     2     2     1     2     2     2     2     1     2
## 13010 13013 13014 13015 13018 13020 13024 13025 13029 13030 13032 13033 13034
##     1     2     1     2     2     1     2     2     2     2     1     2     1
## 13035 13037 13038 13040 13041 13043 13044 13048 13049 13050 13052 13053 13054
##     2     2     2     2     1     1     2     1     2     2     1     2     2
## 13055 13056 13057 13058 13059 13060 13062 13063 13064 13065 13068 13070 13071
##     1     1     1     2     2     1     2     2     2     2     2     2     2
## 13072 13075 13076 13078 13079 13080 13082 13083 13084 13086 13089 13090 13092
##     2     2     2     2     2     2     2     2     2     2     2     1     1
## 13093 13094 13095 13096 13099 13101 13104 13105 13106 13108 13109 13111 13112
##     2     2     2     2     2     1     1     2     2     2     1     2     2
## 13113 13114 13116 13117 13118 13120 13121 13122 13124 13125 13127 13128 13129
##     2     2     2     1     2     2     2     2     2     2     2     2     2
## 13131 13132 13133 13136 13138 13139 13141 13142 13143 13144 13145 13146 13147
##     2     2     2     1     2     2     2     2     2     2     1     2     1
## 13148 13149 13152 13153 13155 13156 13157 13158 13159 13160 13162 13163 13165
##     2     2     2     2     2     2     1     1     1     1     2     1     1
## 13166 13168 13169 13170 13171 13173 13174 13175 13178 13179 13180 13181 13182
##     1     1     2     2     2     2     2     2     2     2     2     1     1
## 13183 13184 13185 13186 13188 13189 13190 13191 13192 13193 13196 13197 13198
##     1     2     2     1     2     2     1     2     2     1     2     1     2
## 13201 13202 13203 13205 13207 13208 13210 13211 13213 13214 13216 13217 13218
##     2     1     1     1     2     2     1     2     2     2     2     2     2
## 13221 13222 13223 13226 13227 13228 13229 13230 13232 13233 13234 13236 13237
##     1     1     1     1     2     2     2     2     1     1     2     2     1
## 13241 13242 13245 13246 13247 13248 13249 13250 13251 13252 13254 13256 13257
##     1     1     2     1     2     1     2     2     1     1     2     2     2
## 13258 13259 13260 13261 13262 13263 13267 13268 13269 13270 13271 13272 13273
##     2     2     1     2     2     2     2     2     2     1     1     2     2
## 13274 13275 13276 13277 13279 13282 13284 13285 13286 13288 13290 13291 13292
##     1     1     2     2     1     2     2     2     2     2     2     1     2
## 13293 13295 13296 13298 13299 13300 13301 13303 13304 13306 13307 13309 13310
##     2     1     2     2     1     2     2     1     2     1     1     1     2
## 13311 13313 13314 13315 13316 13317 13318 13320 13324 13328 13329 13330 13332
##     2     2     1     2     2     2     2     1     2     2     2     1     1
## 13333 13334 13337 13338 13339 13340 13341 13342 13344 13345 13346 13347 13348
##     1     2     1     1     2     2     2     1     2     1     1     1     2
## 13350 13353 13354 13355 13358 13360 13361 13362 13367 13368 13369 13371 13372
##     2     1     1     1     2     2     1     2     2     1     2     2     1
## 13373 13374 13376 13378 13381 13382 13384 13386 13387 13389 13390 13392 13393
##     2     2     2     2     2     2     2     2     2     1     1     2     2
## 13396 13398 13400 13401 13402 13405 13409 13412 13413 13414 13417 13418 13419
##     2     1     1     1     1     1     1     2     1     2     2     1     2
## 13420 13423 13424 13425 13426 13428 13430 13432 13434 13438 13440 13441 13442
##     2     2     1     2     1     1     2     1     2     1     2     1     2
## 13444 13447 13450 13452 13453 13454 13456 13457 13459 13460 13461 13464 13465
##     2     1     2     1     1     1     2     1     2     1     2     2     1
## 13467 13468 13470 13471 13473 13474 13475 13476 13477 13478 13479 13480 13481
##     2     2     1     1     2     1     2     1     1     1     1     1     2
## 13484 13489 13490 13491 13492 13493 13494 13495 13496 13497 13498 13500 13501
```

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##     2     2     1     2     2     1     2     1     2     1     2     1     1
## 13502 13504 13505 13506 13507 13508 13510 13511 13512 13513 13514 13517 13518
##     2     1     1     2     1     2     2     2     2     2     2     2     2
## 13519 13521 13522 13524 13526 13530 13532 13534 13535 13536 13537 13539 13540
##     2     1     2     2     1     2     2     2     1     2     1     1     2
## 13541 13542 13543 13544 13545 13547 13548 13549 13550 13552 13553 13554 13556
##     2     2     2     1     2     1     2     1     2     2     2     2     2
## 13558 13560 13561 13562 13564 13565 13566 13567 13570 13571 13572 13575 13577
##     2     1     2     1     1     2     2     2     2     2     2     1     2
## 13578 13580 13581 13584 13585 13586 13587 13588 13589 13591 13592 13593 13594
##     1     1     1     2     1     1     2     2     1     1     2     2     2
## 13595 13596 13597 13599 13600 13602 13603 13604 13605 13606 13607 13608 13609
##     2     1     2     2     2     1     2     2     2     2     2     2     1
## 13613 13614 13615 13616 13618 13620 13621 13622 13623 13624 13625 13626 13627
##     2     1     2     1     2     1     1     2     1     1     2     1     1
## 13628 13629 13630 13631 13632 13634 13635 13639 13640 13643 13646 13648 13649
##     2     2     2     2     2     2     2     1     2     2     2     2     2
## 13652 13653 13654 13655 13660 13661 13663 13666 13671 13672 13673 13674 13677
##     1     2     2     1     2     1     2     1     2     2     1     2     1
## 13678 13679 13680 13682 13683 13685 13686 13687 13688 13689 13690 13694 13695
##     2     1     1     2     1     2     2     2     1     1     1     1     2
## 13696 13697 13699 13700 13702 13703 13704 13705 13707 13708 13709 13711 13712
##     2     1     2     2     2     1     1     2     2     2     1     2     2
## 13713 13714 13715 13716 13720 13721 13722 13723 13724 13725 13726 13727 13728
##     1     2     2     1     2     2     2     1     1     1     1     1     2
## 13730 13731 13732 13733 13735 13737 13738 13739 13740 13741 13743 13745 13746
##     2     2     1     1     1     1     1     2     2     1     1     2     2
## 13747 13748 13749 13750 13751 13752 13754 13756 13758 13759 13760 13761 13762
##     1     2     2     2     2     1     1     1     1     2     2     1     2
## 13763 13764 13765 13766 13767 13768 13769 13774 13775 13776 13777 13779 13780
##     2     2     1     2     2     2     2     2     2     1     1     1     2
## 13781 13782 13783 13785 13787 13788 13789 13790 13793 13794 13796 13799 13802
##     2     2     2     2     2     2     1     2     2     2     2     1     2
## 13803 13805 13806 13808 13812 13813 13815 13816 13817 13818 13822 13824 13826
##     1     2     1     1     1     1     1     2     2     2     2     1     1
## 13827 13829 13830 13831 13832 13833 13834 13836 13837 13838 13840 13841 13842
##     2     2     2     2     2     2     2     1     2     2     1     2     2
## 13843 13844 13845 13847 13849 13850 13851 13852 13854 13857 13859 13860 13862
##     2     2     2     2     2     2     2     1     2     1     1     2     2
## 13863 13864 13866 13867 13868 13869 13872 13873 13875 13877 13879 13880 13882
##     2     1     1     1     2     1     2     2     2     2     1     2     2
## 13883 13885 13886 13888 13889 13890 13891 13892 13893 13895 13896 13897 13898
##     2     2     2     1     2     2     2     1     1     1     2     2     2
## 13901 13902 13904 13906 13907 13908 13909 13910 13912 13913 13916 13917 13919
##     2     1     2     1     2     1     2     1     2     1     2     2     2
## 13921 13922 13923 13924 13926 13927 13930 13931 13932 13933 13934 13935 13937
##     2     1     1     2     2     2     2     1     2     1     2     1     2
## 13938 13939 13941 13943 13945 13947 13949 13954 13955 13956 13957 13959 13963
##     1     2     1     2     1     1     2     2     1     2     2     1     1
## 13964 13965 13967 13968 13969 13974 13975 13976 13977 13979 13980 13981 13984
##     2     2     1     2     1     2     1     2     2     2     2     2     2
## 13986 13987 13988 13989 13990 13993 13994 13995 13996 13997 14000 14003 14005
##     2     2     2     1     1     2     2     2     1     2     2     2     1
## 14006 14008 14010 14012 14015 14016 14017 14018 14020 14023 14026 14027 14029
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##     2     2     2     2     1     2     1     2     1     1     2     1     2
## 14030 14033 14034 14036 14037 14042 14044 14045 14046 14047 14048 14049 14052
##     2     1     2     1     1     2     1     1     2     1     2     2     2
## 14053 14054 14055 14056 14057 14059 14060 14061 14062 14063 14064 14065 14068
##     1     2     2     1     2     1     2     2     2     1     1     2     2
## 14070 14071 14072 14073 14074 14075 14076 14077 14078 14080 14081 14082 14083
##     2     1     2     1     1     1     1     2     1     1     2     2     2
## 14085 14086 14087 14088 14091 14092 14093 14095 14096 14097 14098 14099 14100
##     2     2     1     1     2     2     2     1     1     2     1     1     1
## 14102 14103 14104 14105 14106 14107 14108 14111 14113 14114 14115 14116 14118
##     2     1     2     1     1     1     1     2     2     2     2     2     1
## 14119 14124 14125 14127 14131 14132 14133 14134 14135 14136 14138 14139 14141
##     1     1     1     2     1     1     2     1     2     2     2     2     2
## 14142 14144 14145 14148 14152 14153 14154 14155 14157 14158 14159 14160 14161
##     2     2     2     1     2     2     2     2     2     1     2     2     1
## 14162 14163 14165 14167 14168 14169 14170 14173 14174 14175 14178 14180 14181
##     2     1     2     1     2     1     2     2     2     1     1     2     2
## 14182 14183 14184 14185 14186 14187 14189 14190 14191 14193 14196 14197 14198
##     1     2     1     1     1     1     2     2     2     2     1     1     2
## 14199 14200 14202 14203 14204 14206 14208 14212 14214 14215 14217 14218 14219
##     1     2     2     2     1     2     2     1     1     1     1     2     1
## 14221 14223 14224 14225 14226 14227 14228 14229 14230 14231 14233 14234 14235
##     1     2     2     2     2     1     2     2     2     2     2     2     2
## 14236 14237 14238 14239 14240 14241 14242 14243 14244 14245 14246 14247 14248
##     2     2     1     2     1     2     2     2     1     1     2     2     2
## 14249 14251 14254 14258 14262 14264 14265 14267 14268 14269 14271 14272 14275
##     1     2     2     2     1     1     2     1     2     1     2     2     1
## 14278 14281 14286 14287 14289 14290 14291 14294 14296 14298 14300 14302 14307
##     2     2     1     2     1     2     1     2     2     2     1     1     1
## 14309 14311 14312 14313 14315 14317 14319 14320 14321 14323 14324 14325 14326
##     2     2     2     1     2     2     1     1     2     2     1     2     2
## 14327 14328 14329 14330 14333 14334 14336 14337 14338 14339 14340 14341 14342
##     2     1     1     1     1     1     1     2     2     1     1     2     2
## 14346 14349 14351 14354 14356 14357 14360 14361 14362 14363 14364 14365 14366
##     2     2     2     1     2     1     2     1     1     1     2     2     1
## 14367 14370 14372 14373 14375 14376 14377 14378 14379 14381 14383 14385 14387
##     1     2     1     1     2     1     1     1     2     1     2     2     2
## 14388 14389 14391 14392 14393 14394 14395 14396 14397 14398 14399 14400 14401
##     2     2     2     2     2     2     2     2     2     1     2     2     1
## 14403 14405 14408 14409 14411 14412 14414 14415 14416 14417 14418 14420 14422
##     1     1     2     2     1     2     1     2     2     2     2     2     2
## 14424 14427 14428 14429 14430 14431 14432 14434 14435 14436 14437 14438 14440
##     1     1     1     1     1     1     2     1     2     2     2     2     1
## 14441 14443 14444 14445 14446 14447 14449 14450 14451 14453 14456 14457 14458
##     2     2     2     1     1     1     2     2     2     2     2     2     2
## 14459 14460 14461 14462 14464 14466 14468 14469 14470 14471 14472 14473 14474
##     2     2     2     2     1     1     2     2     2     1     2     1     2
## 14475 14479 14483 14486 14487 14489 14490 14491 14492 14493 14494 14496 14497
##     2     2     2     2     2     2     1     2     1     2     1     1     2
## 14498 14499 14501 14503 14504 14505 14508 14509 14510 14511 14513 14514 14515
##     1     2     1     2     2     2     1     2     2     1     2     2     1
## 14516 14518 14519 14520 14521 14523 14524 14525 14526 14530 14531 14532 14533
##     2     1     2     1     2     2     2     1     1     1     1     1     2
## 14535 14536 14538 14540 14541 14542 14543 14546 14547 14548 14549 14550 14551
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##     1     2     1     2     2     1     1     2     1     2     2     1     2
## 14552 14554 14555 14556 14557 14558 14559 14560 14561 14562 14565 14566 14568
##     2     2     2     2     2     1     1     2     1     1     2     2     2
## 14569 14571 14573 14576 14578 14579 14581 14582 14583 14584 14585 14586 14587
##     2     2     1     2     2     1     2     2     2     2     1     2     1
## 14588 14589 14590 14592 14593 14595 14597 14598 14599 14600 14601 14603 14604
##     2     2     1     1     2     2     2     1     2     1     2     2     2
## 14608 14609 14611 14612 14613 14614 14615 14618 14619 14624 14628 14629 14630
##     1     2     1     2     1     2     2     2     2     1     1     2     2
## 14632 14633 14634 14638 14642 14643 14645 14646 14647 14648 14649 14651 14652
##     1     2     1     1     1     2     1     2     2     1     1     2     2
## 14653 14656 14658 14659 14660 14661 14662 14663 14664 14665 14666 14668 14670
##     1     1     2     2     2     2     1     2     2     1     2     2     1
## 14673 14675 14677 14679 14681 14682 14683 14687 14690 14691 14694 14697 14698
##     2     1     2     2     2     2     2     1     1     2     1     1     1
## 14699 14700 14701 14702 14703 14705 14708 14709 14710 14712 14713 14714 14715
##     2     1     1     2     2     1     2     2     1     2     2     2     2
## 14716 14721 14722 14727 14728 14731 14732 14733 14734 14735 14736 14738 14739
##     2     2     2     2     2     1     1     2     2     2     2     1     1
## 14741 14742 14744 14745 14746 14747 14750 14751 14752 14753 14756 14757 14759
##     1     1     2     2     2     2     2     2     1     2     2     1     1
## 14760 14761 14762 14765 14767 14768 14769 14772 14773 14775 14777 14778 14779
##     2     1     2     2     2     1     2     2     1     2     1     1     2
## 14780 14782 14783 14784 14785 14786 14787 14788 14790 14791 14793 14795 14798
##     2     2     1     2     2     1     1     2     1     1     1     2     1
## 14799 14800 14802 14804 14805 14808 14809 14810 14811 14812 14815 14818 14819
##     1     2     2     1     2     2     2     1     1     1     2     2     1
## 14822 14823 14824 14826 14827 14828 14829 14831 14832 14836 14837 14838 14841
##     1     2     2     1     1     2     1     2     1     1     2     1     2
## 14842 14845 14846 14847 14848 14850 14852 14853 14854 14856 14857 14858 14859
##     2     2     1     1     2     1     1     1     2     2     2     2     2
## 14861 14862 14863 14865 14866 14867 14868 14869 14870 14873 14874 14876 14877
##     2     1     1     1     1     1     1     2     1     1     2     2     1
## 14878 14879 14880 14881 14882 14883 14884 14885 14886 14888 14889 14890 14896
##     1     2     1     2     2     1     2     1     2     2     1     2     2
## 14897 14898 14899 14900 14904 14905 14907 14908 14909 14910 14911 14912 14913
##     2     2     2     2     1     1     2     2     1     2     1     1     2
## 14915 14916 14917 14920 14921 14923 14925 14927 14929 14930 14931 14932 14933
##     2     2     2     2     1     2     2     2     1     1     2     2     2
## 14936 14937 14938 14940 14941 14942 14943 14945 14948 14950 14951 14952 14953
##     2     2     1     2     2     2     2     2     2     1     2     2     2
## 14955 14956 14957 14958 14959 14960 14964 14965 14966 14967 14968 14970 14972
##     2     2     1     1     2     2     2     2     2     2     2     2     1
## 14974 14976 14979 14980 14981 14982 14984 14985 14987 14989 14990 14991 14993
##     2     2     2     1     2     1     2     2     1     2     2     1     2
## 14995 14998 14999 15003 15005 15006 15007 15008 15009 15010 15012 15017 15019
##     1     1     1     2     1     1     1     1     1     2     2     2     1
## 15020 15023 15025 15026 15028 15029 15030 15032 15033 15034 15035 15036 15037
##     1     1     2     2     1     1     2     2     1     2     2     2     2
## 15038 15040 15043 15044 15045 15047 15048 15049 15050 15051 15052 15053 15054
##     2     2     2     2     1     2     1     2     2     2     1     2     2
## 15056 15059 15060 15061 15064 15065 15067 15068 15069 15072 15073 15074 15075
##     2     2     2     2     2     1     1     2     2     2     2     2     2
## 15076 15078 15080 15081 15082 15084 15085 15086 15087 15088 15089 15090 15092
```

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##     1     2     2     1     2     1     2     1     2     1     2     1     1
## 15094 15095 15096 15098 15101 15102 15104 15105 15107 15108 15109 15111 15112
##     2     1     2     2     1     2     2     1     2     2     1     2     2
## 15113 15114 15116 15118 15120 15122 15123 15124 15125 15126 15127 15129 15130
##     2     1     1     2     2     2     2     2     2     1     2     2     2
## 15131 15134 15135 15136 15137 15138 15139 15140 15142 15143 15144 15145 15146
##     2     1     2     2     2     1     1     2     2     1     1     1     2
## 15147 15148 15149 15150 15153 15154 15156 15157 15158 15159 15161 15162 15164
##     2     2     1     1     2     1     2     2     2     2     1     1     1
## 15165 15167 15168 15169 15170 15171 15176 15177 15178 15179 15180 15181 15182
##     1     1     1     2     1     2     2     1     1     1     1     2     2
## 15184 15187 15189 15190 15191 15192 15193 15195 15196 15203 15204 15205 15206
##     2     1     1     1     2     2     1     2     1     1     1     2     2
## 15208 15209 15210 15211 15212 15213 15214 15215 15220 15222 15223 15224 15225
##     2     2     2     1     2     2     1     2     2     2     1     1     2
## 15227 15228 15230 15233 15234 15236 15237 15238 15239 15240 15241 15242 15243
##     2     2     2     1     2     1     2     1     2     2     2     2     1
## 15244 15245 15246 15247 15248 15250 15251 15253 15254 15255 15256 15257 15258
##     2     2     2     2     2     1     2     2     1     2     2     2     1
## 15259 15260 15261 15264 15267 15269 15270 15271 15274 15275 15276 15277 15278
##     1     2     2     1     1     2     2     2     2     2     2     1     1
## 15279 15280 15281 15283 15286 15287 15288 15289 15290 15293 15294 15295 15296
##     1     2     1     2     2     2     2     2     1     2     2     2     2
## 15297 15298 15299 15301 15302 15303 15306 15309 15310 15311 15312 15314 15315
##     2     2     2     2     2     2     2     2     2     1     2     2     2
## 15316 15317 15318 15321 15322 15323 15324 15325 15326 15327 15328 15329 15330
##     2     1     2     1     1     2     1     2     1     2     1     2     1
## 15331 15332 15334 15335 15336 15338 15339 15340 15341 15342 15343 15344 15345
##     2     1     2     1     2     1     1     2     2     2     2     2     2
## 15346 15347 15348 15349 15350 15351 15352 15353 15354 15355 15356 15359 15360
##     1     2     1     2     1     1     2     2     2     2     2     2     2
## 15362 15366 15367 15368 15370 15371 15373 15374 15375 15378 15380 15381 15382
##     2     2     1     1     1     2     1     2     2     2     1     2     1
## 15385 15386 15387 15388 15389 15390 15391 15392 15397 15398 15399 15401 15402
##     1     1     2     2     1     2     1     2     1     1     2     1     1
## 15403 15405 15407 15408 15409 15410 15411 15412 15413 15414 15416 15417 15418
##     1     2     2     2     1     1     2     2     1     2     1     1     1
## 15419 15420 15421 15422 15423 15424 15425 15426 15427 15428 15430 15431 15432
##     2     1     2     2     2     2     2     2     2     2     2     2     1
## 15434 15435 15436 15437 15438 15440 15442 15443 15444 15446 15448 15449 15450
##     2     2     2     1     2     1     1     2     1     1     2     1     2
## 15451 15454 15455 15456 15457 15458 15459 15460 15461 15462 15463 15464 15466
##     2     1     1     2     2     1     2     2     2     2     2     1     2
## 15467 15468 15472 15474 15477 15478 15479 15480 15481 15482 15483 15484 15485
##     1     2     1     2     1     2     2     2     2     1     2     2     2
## 15486 15487 15489 15490 15493 15494 15495 15496 15497 15500 15502 15503 15506
##     2     2     2     2     2     1     2     1     2     1     1     1     1
## 15507 15508 15509 15510 15511 15512 15514 15516 15517 15519 15521 15522 15523
##     1     2     1     1     2     2     2     2     1     2     2     2     2
## 15524 15526 15527 15529 15531 15532 15533 15534 15535 15537 15538 15539 15541
##     1     2     2     2     2     2     1     1     1     1     2     1     1
## 15542 15543 15544 15548 15549 15550 15551 15552 15553 15554 15555 15557 15558
##     1     2     1     1     2     1     1     2     2     2     1     2     1
## 15559 15560 15563 15564 15573 15575 15576 15577 15581 15582 15584 15585 15586
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##     2     2     1     2     1     2     1     1     2     2     2     2     2
## 15589 15592 15595 15596 15597 15598 15599 15601 15602 15603 15605 15607 15608
##     2     1     2     2     2     2     1     2     2     1     1     1     1
## 15612 15614 15615 15616 15618 15621 15622 15623 15624 15625 15626 15627 15628
##     2     1     1     2     2     2     2     1     1     1     2     2     1
## 15629 15630 15631 15632 15633 15634 15635 15636 15637 15638 15639 15642 15644
##     2     2     2     2     2     2     2     2     2     1     2     1     2
## 15645 15647 15648 15649 15650 15653 15654 15655 15656 15658 15659 15660 15661
##     2     2     2     1     1     2     2     2     1     2     1     2     1
## 15662 15664 15665 15666 15667 15669 15672 15673 15674 15675 15676 15677 15678
##     2     2     1     1     2     1     1     1     1     2     1     1     2
## 15679 15680 15681 15683 15685 15686 15687 15688 15689 15690 15691 15692 15693
##     2     2     2     1     2     1     2     2     1     1     1     2     2
## 15695 15696 15697 15698 15700 15701 15702 15704 15706 15707 15710 15711 15712
##     1     2     1     2     2     2     1     2     1     1     2     1     2
## 15713 15714 15715 15716 15717 15718 15720 15722 15723 15724 15725 15726 15729
##     2     2     2     2     1     1     2     1     2     2     2     2     2
## 15730 15732 15733 15734 15735 15736 15737 15738 15740 15741 15742 15744 15745
##     2     2     2     1     1     1     2     1     2     2     2     2     2
## 15746 15748 15749 15751 15752 15753 15756 15757 15758 15759 15760 15761 15762
##     1     2     2     2     2     2     2     2     2     2     2     1     2
## 15763 15764 15770 15771 15772 15773 15774 15775 15776 15777 15779 15783 15784
##     2     2     2     2     2     2     2     2     2     1     1     2     2
## 15785 15786 15787 15788 15790 15793 15794 15795 15796 15797 15798 15799 15800
##     2     1     2     1     2     2     2     1     1     1     1     1     1
## 15802 15803 15804 15805 15809 15810 15812 15813 15814 15815 15819 15822 15825
##     1     2     2     2     2     2     1     2     2     1     2     1     2
## 15826 15827 15828 15829 15831 15833 15834 15835 15836 15837 15838 15839 15840
##     2     2     1     1     1     2     1     2     2     1     1     1     2
## 15841 15842 15843 15844 15846 15850 15852 15854 15855 15857 15858 15859 15861
##     1     2     1     1     2     2     2     1     2     1     1     2     2
## 15863 15866 15868 15869 15870 15871 15872 15873 15876 15877 15878 15881 15882
##     2     2     1     2     2     2     1     2     2     2     2     2     1
## 15883 15884 15885 15887 15888 15890 15892 15894 15897 15898 15899 15900 15901
##     2     1     1     1     2     2     1     2     2     2     2     2     1
## 15903 15905 15906 15909 15913 15914 15917 15918 15919 15920 15921 15922 15923
##     2     2     2     2     2     1     2     1     2     1     1     2     2
## 15925 15929 15933 15934 15935 15936 15937 15940 15942 15943 15944 15949 15953
##     2     1     2     2     2     1     2     2     1     1     2     2     2
## 15955 15956 15958 15959 15960 15961 15962 15964 15965 15966 15970 15972 15975
##     2     2     1     2     2     1     2     1     1     1     1     1     1
## 15977 15978 15979 15980 15982 15983 15984 15986 15988 15990 15991 15992 15993
##     2     1     2     2     1     2     1     2     2     2     1     1     1
## 15994 15995 15998 15999 16000 16002 16003 16004 16005 16006 16007 16008 16009
##     1     2     1     2     2     1     1     1     2     1     2     1     1
## 16010 16015 16016 16017 16018 16020 16022 16023 16024 16026 16027 16030 16032
##     2     2     2     1     1     2     2     1     2     2     2     2     2
## 16033 16034 16037 16040 16041 16042 16043 16045 16046 16047 16049 16052 16053
##     2     2     2     1     2     2     1     2     1     1     2     1     2
## 16054 16055 16056 16058 16060 16061 16062 16063 16064 16065 16066 16068 16070
##     2     2     2     1     1     2     1     2     1     2     2     2     1
## 16071 16072 16073 16074 16075 16076 16077 16081 16083 16084 16087 16089 16090
##     1     1     2     2     1     2     1     2     1     2     2     2     1
## 16091 16094 16097 16099 16100 16101 16102 16103 16104 16105 16106 16107 16108
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##     2     2     2     1     1     1     2     2     1     1     2     2     1
## 16109 16110 16111 16112 16113 16114 16115 16117 16118 16120 16122 16124 16125
##     1     1     2     2     2     2     1     2     2     2     1     2     2
## 16126 16127 16128 16129 16130 16131 16133 16134 16136 16138 16140 16141 16142
##     2     2     1     1     2     2     2     1     1     2     2     2     1
## 16143 16145 16146 16147 16148 16150 16152 16157 16159 16163 16165 16166 16167
##     2     2     2     1     1     1     2     2     1     2     2     1     1
## 16168 16169 16170 16172 16174 16175 16176 16177 16178 16180 16181 16183 16184
##     1     2     2     2     1     1     1     1     2     2     1     2     1
## 16186 16187 16188 16189 16190 16191 16192 16193 16194 16196 16197 16198 16199
##     2     1     1     2     1     1     2     2     2     1     2     2     1
## 16201 16202 16204 16205 16206 16207 16208 16212 16214 16216 16217 16219 16221
##     1     1     1     1     2     2     2     2     1     2     1     2     2
## 16222 16223 16224 16225 16226 16227 16228 16229 16230 16232 16233 16234 16235
##     1     2     2     2     2     1     1     2     2     2     2     2     1
## 16236 16237 16240 16242 16244 16245 16247 16248 16249 16250 16251 16252 16254
##     2     2     1     2     2     1     2     1     1     1     2     2     2
## 16255 16256 16258 16259 16261 16263 16267 16268 16269 16270 16271 16272 16273
##     2     2     2     1     2     1     2     2     2     2     1     2     2
## 16275 16276 16277 16278 16279 16281 16285 16287 16291 16292 16293 16294 16295
##     2     1     2     2     1     1     2     1     2     1     1     1     1
## 16296 16298 16299 16300 16301 16303 16304 16306 16309 16311 16312 16318 16324
##     2     1     2     2     2     2     2     2     2     1     2     1     2
## 16325 16326 16329 16330 16331 16332 16336 16337 16338 16339 16340 16341 16342
##     1     2     2     1     1     2     1     2     2     2     1     1     1
## 16344 16346 16347 16348 16349 16350 16352 16354 16355 16356 16357 16358 16361
##     1     1     2     2     2     2     2     1     1     1     2     1     2
## 16362 16365 16366 16368 16370 16371 16372 16373 16374 16375 16376 16378 16379
##     2     2     2     2     2     1     1     2     2     2     2     2     2
## 16380 16381 16382 16383 16385 16386 16388 16389 16390 16391 16393 16394 16397
##     1     1     2     1     2     2     1     1     2     1     2     2     1
## 16399 16400 16403 16405 16406 16407 16408 16409 16411 16413 16416 16417 16418
##     2     1     1     2     2     2     2     2     1     1     2     2     1
## 16419 16420 16422 16423 16424 16426 16427 16428 16429 16430 16431 16432 16434
##     1     2     2     2     1     1     2     2     1     2     2     1     2
## 16435 16436 16437 16438 16439 16441 16442 16443 16445 16447 16448 16452 16453
##     2     2     2     1     2     2     2     2     1     2     1     2     1
## 16454 16455 16456 16457 16458 16461 16462 16463 16467 16468 16469 16470 16471
##     2     1     1     1     1     2     2     2     1     2     1     2     2
## 16472 16473 16474 16475 16476 16477 16478 16479 16481 16482 16483 16484 16485
##     2     1     2     2     1     1     2     2     1     2     2     2     2
## 16486 16487 16488 16489 16491 16492 16493 16494 16495 16496 16497 16498 16499
##     2     1     1     2     1     1     1     2     1     2     2     1     2
## 16501 16502 16503 16505 16506 16507 16508 16509 16511 16512 16513 16514 16515
##     2     2     2     2     1     1     2     1     2     2     1     1     1
## 16516 16517 16518 16519 16524 16527 16529 16530 16533 16534 16535 16536 16537
##     2     2     2     1     2     1     2     1     2     2     2     1     2
## 16538 16540 16541 16542 16543 16544 16545 16546 16547 16548 16549 16550 16551
##     2     1     1     1     1     1     2     2     1     2     1     2     1
## 16555 16558 16559 16561 16562 16567 16568 16569 16570 16572 16573 16575 16576
##     1     2     2     2     2     2     2     1     2     2     2     2     2
## 16579 16580 16582 16584 16586 16587 16589 16590 16591 16592 16593 16594 16595
##     2     2     1     2     1     2     2     2     2     2     1     2     2
## 16596 16598 16600 16601 16603 16604 16605 16606 16607 16608 16609 16610 16614
```

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##     2     2     2     1     2     2     1     1     2     2     2     2     2
## 16615 16618 16619 16621 16622 16624 16626 16627 16628 16629 16630 16632 16633
##     2     2     2     2     2     2     1     1     1     2     2     2     1
## 16634 16635 16637 16638 16639 16641 16642 16644 16647 16648 16649 16650 16653
##     2     1     2     2     2     1     1     1     2     2     2     1     2
## 16654 16655 16656 16658 16659 16661 16662 16666 16667 16669 16671 16673 16675
##     1     1     2     2     2     2     1     2     2     1     2     2     1
## 16676 16677 16678 16679 16680 16681 16682 16683 16684 16686 16688 16692 16693
##     2     1     2     2     2     1     1     2     2     1     1     1     2
## 16696 16698 16699 16700 16701 16702 16705 16706 16707 16708 16710 16711 16712
##     2     2     2     2     2     2     2     2     2     2     2     1     2
## 16714 16716 16718 16719 16720 16721 16726 16729 16731 16732 16734 16738 16739
##     2     1     2     2     2     1     2     1     1     2     2     1     1
## 16741 16742 16743 16744 16745 16746 16747 16748 16750 16751 16752 16753 16754
##     1     2     1     2     2     2     1     2     2     2     1     1     2
## 16756 16757 16760 16761 16762 16765 16767 16769 16770 16774 16775 16776 16777
##     2     2     2     2     2     2     1     1     2     1     1     2     2
## 16780 16781 16782 16783 16785 16788 16789 16790 16793 16795 16796 16797 16800
##     2     2     2     1     2     2     2     2     2     1     1     2     1
## 16802 16803 16804 16805 16806 16807 16808 16811 16813 16814 16815 16816 16817
##     2     1     2     1     2     2     2     1     1     1     1     2     2
## 16819 16820 16821 16823 16825 16826 16827 16828 16829 16830 16831 16832 16833
##     1     1     1     2     1     2     2     2     2     2     1     2     1
## 16834 16835 16836 16838 16839 16841 16843 16844 16845 16848 16849 16850 16851
##     2     1     2     1     1     1     2     1     1     2     2     1     2
## 16853 16854 16855 16856 16857 16858 16859 16860 16861 16864 16865 16866 16867
##     2     2     1     1     1     2     1     1     1     1     2     2     1
## 16868 16869 16872 16873 16874 16875 16876 16877 16880 16882 16884 16885 16886
##     1     1     1     1     2     1     2     2     2     2     1     2     2
## 16888 16889 16890 16891 16894 16895 16896 16897 16899 16900 16901 16905 16906
##     2     2     2     2     2     1     1     1     2     1     2     1     2
## 16907 16908 16910 16912 16913 16914 16915 16916 16917 16919 16920 16921 16923
##     1     1     2     1     2     2     2     1     2     2     1     2     1
## 16927 16928 16930 16932 16933 16934 16935 16938 16939 16940 16942 16943 16944
##     2     2     2     2     1     2     2     1     2     2     2     2     1
## 16945 16946 16948 16949 16950 16952 16953 16954 16955 16956 16957 16958 16960
##     1     1     2     2     1     1     2     2     1     2     2     2     2
## 16961 16962 16963 16964 16966 16967 16968 16970 16971 16972 16974 16975 16977
##     2     2     2     2     2     1     2     1     1     2     2     2     1
## 16978 16979 16981 16983 16984 16985 16986 16987 16988 16989 16990 16992 16993
##     2     1     2     2     2     1     1     2     2     2     1     1     1
## 16994 16995 16996 16997 16998 16999 17000 17002 17003 17004 17007 17010 17011
##     1     2     2     2     2     1     1     1     2     2     2     1     2
## 17012 17013 17014 17015 17016 17019 17021 17022 17023 17026 17028 17029 17030
##     2     2     2     2     2     2     2     2     2     1     1     2     2
## 17035 17036 17038 17039 17040 17041 17043 17044 17046 17049 17050 17052 17053
##     2     1     1     2     2     1     1     2     2     2     1     1     2
## 17056 17057 17058 17059 17061 17062 17064 17065 17070 17072 17073 17075 17076
##     1     1     1     1     2     2     2     2     2     2     2     2     2
## 17077 17078 17079 17080 17081 17083 17084 17085 17088 17091 17092 17093 17095
##     2     2     2     2     2     1     2     1     1     2     2     2     2
## 17096 17097 17098 17101 17103 17105 17107 17109 17112 17113 17114 17118 17122
##     1     2     1     2     2     1     2     2     2     2     2     1     2
## 17123 17124 17126 17127 17130 17131 17132 17133 17134 17135 17136 17137 17138
```

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##     1     1     2     2     1     2     1     1     2     2     2     1     2
## 17139 17141 17142 17143 17144 17145 17146 17152 17153 17154 17155 17158 17159
##     1     1     2     2     1     1     2     2     2     2     2     2     1
## 17160 17162 17163 17164 17166 17167 17169 17171 17173 17174 17175 17176 17178
##     1     1     2     2     2     2     1     2     1     1     1     2     2
## 17180 17182 17183 17184 17185 17186 17187 17189 17190 17191 17192 17194 17195
##     2     2     1     2     2     2     2     2     1     2     2     1     2
## 17197 17198 17200 17201 17202 17203 17204 17206 17208 17209 17210 17211 17212
##     1     2     1     2     1     2     2     1     1     2     1     2     2
## 17214 17215 17216 17217 17218 17219 17221 17222 17223 17224 17225 17226 17227
##     2     2     2     2     1     1     1     2     1     2     2     2     2
## 17228 17229 17230 17231 17233 17234 17236 17237 17239 17240 17241 17242 17246
##     2     2     1     2     1     1     2     1     1     1     1     2     1
## 17247 17248 17249 17250 17251 17252 17254 17255 17256 17257 17258 17259 17262
##     2     2     2     2     2     1     1     2     1     2     1     2     1
## 17263 17264 17268 17270 17271 17272 17274 17275 17277 17280 17281 17282 17283
##     2     2     1     1     1     2     1     2     2     1     2     1     2
## 17284 17285 17288 17289 17290 17292 17294 17295 17296 17297 17298 17299 17300
##     2     1     1     1     1     2     2     2     1     2     2     2     2
## 17303 17305 17307 17308 17309 17311 17312 17313 17315 17316 17317 17321 17322
##     2     2     2     1     1     1     2     2     1     2     1     2     2
## 17323 17324 17325 17326 17327 17328 17329 17331 17332 17336 17337 17338 17339
##     2     2     2     1     2     2     1     2     2     2     2     2     2
## 17340 17342 17343 17344 17346 17347 17348 17351 17352 17354 17355 17356 17357
##     1     2     1     2     1     1     1     2     1     1     2     2     2
## 17358 17359 17362 17363 17364 17367 17368 17371 17374 17376 17377 17378 17379
##     1     2     1     1     2     1     1     2     1     2     2     1     2
## 17380 17381 17382 17383 17384 17385 17387 17388 17389 17390 17391 17393 17394
##     2     1     1     2     1     1     2     2     2     2     2     2     1
## 17395 17396 17398 17399 17400 17401 17405 17407 17408 17409 17410 17411 17412
##     1     2     1     1     1     2     2     2     1     1     1     1     1
## 17414 17416 17419 17420 17423 17425 17428 17429 17430 17431 17437 17438 17439
##     1     2     2     1     1     2     1     2     1     2     2     2     2
## 17442 17443 17444 17445 17446 17447 17448 17450 17451 17453 17454 17455 17456
##     1     2     2     2     1     1     1     1     1     2     2     2     2
## 17457 17459 17460 17461 17462 17463 17464 17465 17466 17469 17471 17472 17473
##     2     2     2     2     2     1     1     2     2     2     1     1     2
## 17474 17475 17477 17478 17479 17480 17481 17482 17483 17484 17485 17486 17487
##     2     2     2     2     1     2     1     2     2     2     2     2     2
## 17488 17489 17490 17493 17494 17499 17500 17502 17503 17504 17505 17506 17508
##     1     2     2     2     1     2     2     2     1     1     1     2     2
## 17509 17510 17512 17513 17516 17517 17519 17521 17522 17523 17524 17525 17527
##     2     1     2     2     1     2     2     2     1     2     2     1     2
## 17528 17529 17531 17532 17536 17537 17542 17543 17544 17545 17546 17547 17549
##     1     2     2     1     1     2     1     1     2     2     1     1     2
## 17553 17554 17557 17558 17559 17560 17561 17562 17563 17565 17566 17567 17568
##     1     2     1     1     1     1     2     1     1     1     1     2     1
## 17569 17570 17572 17573 17574 17576 17578 17579 17581 17582 17584 17585 17586
##     1     2     2     1     1     2     1     2     1     2     2     2     1
## 17587 17588 17589 17590 17591 17592 17593 17595 17596 17598 17599 17601 17603
##     2     2     1     1     1     2     2     1     2     1     2     1     2
## 17606 17609 17610 17611 17612 17615 17616 17617 17618 17619 17622 17623 17624
##     2     2     2     2     1     2     2     2     1     2     2     2     2
## 17626 17627 17628 17629 17630 17635 17636 17638 17639 17640 17645 17648 17649
```

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##     1     2     2     1     2     2     1     2     2     1     1     1     2
## 17650 17652 17654 17656 17657 17659 17660 17661 17662 17663 17664 17666 17667
##     2     2     1     1     2     2     1     2     2     2     1     2     2
## 17668 17669 17670 17671 17672 17673 17676 17678 17679 17680 17681 17682 17683
##     2     2     1     2     2     1     2     2     2     2     2     2     1
## 17684 17685 17686 17687 17688 17689 17690 17693 17694 17695 17697 17698 17699
##     1     1     2     1     1     2     2     1     1     1     2     1     2
## 17700 17701 17702 17704 17705 17706 17707 17709 17711 17712 17714 17715 17716
##     2     2     2     2     2     2     2     2     2     1     2     2     2
## 17717 17718 17719 17720 17721 17722 17724 17725 17726 17729 17733 17734 17735
##     1     2     1     2     1     2     1     1     1     2     2     2     1
## 17736 17737 17739 17740 17741 17742 17745 17746 17749 17751 17752 17754 17756
##     2     2     2     1     2     1     1     1     1     2     1     2     1
## 17758 17760 17763 17764 17766 17767 17768 17769 17770 17771 17772 17773 17774
##     2     1     1     2     1     2     2     1     2     1     2     2     2
## 17776 17777 17779 17780 17781 17782 17783 17784 17787 17788 17789 17791 17792
##     1     1     1     2     1     1     1     1     1     2     2     2     1
## 17793 17795 17796 17798 17800 17802 17803 17804 17805 17806 17807 17810 17811
##     1     1     2     1     2     1     2     2     1     2     2     1     2
## 17812 17814 17817 17818 17819 17820 17821 17822 17824 17825 17826 17827 17829
##     2     2     2     1     2     2     1     2     2     1     1     1     2
## 17830 17831 17833 17835 17836 17838 17840 17841 17843 17844 17846 17847 17848
##     2     2     2     2     2     1     1     2     2     1     1     2     2
## 17850 17851 17854 17855 17858 17860 17861 17862 17863 17864 17865 17867 17868
##     2     1     1     2     1     2     1     2     2     2     2     1     2
## 17869 17870 17871 17872 17874 17877 17879 17881 17882 17883 17884 17885 17887
##     2     2     2     1     1     2     2     1     1     2     2     2     1
## 17888 17889 17890 17891 17892 17893 17894 17899 17900 17901 17902 17904 17905
##     2     1     1     1     2     2     1     2     2     1     2     1     1
## 17906 17907 17908 17909 17913 17915 17916 17917 17918 17920 17921 17922 17923
##     1     1     2     2     2     1     1     1     2     1     1     2     2
## 17924 17926 17929 17930 17931 17932 17934 17935 17937 17938 17940 17941 17942
##     1     2     2     1     2     1     2     2     2     2     2     2     1
## 17944 17945 17946 17948 17950 17952 17953 17954 17955 17956 17957 17958 17959
##     2     1     2     2     2     1     1     2     1     1     1     1     2
## 17960 17962 17963 17964 17965 17966 17968 17969 17970 17972 17973 17975 17977
##     1     2     2     1     1     2     2     2     2     2     1     2     2
## 17978 17980 17982 17983 17985 17986 17990 17991 17994 17995 17996 17997 17998
##     2     2     1     1     2     1     2     2     2     2     2     1     1
## 17999 18000 18001 18002 18003 18004 18006 18007 18008 18009 18011 18012 18013
##     1     2     2     2     1     2     1     2     2     1     2     1     1
## 18014 18016 18017 18018 18019 18020 18021 18023 18026 18027 18028 18029 18030
##     2     2     2     2     1     1     1     2     1     1     2     2     1
## 18031 18033 18034 18035 18036 18037 18040 18041 18042 18043 18045 18047 18048
##     2     2     1     2     2     1     2     2     1     2     2     2     2
## 18050 18051 18052 18054 18055 18056 18058 18059 18061 18062 18063 18064 18065
##     2     2     2     2     2     1     1     2     2     1     1     2     2
## 18066 18068 18069 18070 18072 18073 18075 18079 18080 18082 18086 18089 18090
##     2     2     2     2     2     2     1     2     2     1     2     1     1
## 18091 18092 18094 18095 18096 18097 18098 18100 18102 18103 18105 18106 18107
##     1     2     2     1     1     2     1     1     2     2     2     1     1
## 18108 18109 18114 18115 18116 18117 18118 18119 18121 18122 18124 18125 18128
##     2     1     1     2     2     1     2     2     2     1     1     2     1
## 18131 18132 18133 18139 18141 18142 18143 18145 18146 18147 18148 18149 18150
```

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##     2     2     1     2     1     1     2     1     2     1     2     1     2
## 18151 18154 18159 18160 18161 18162 18164 18165 18166 18167 18170 18174 18176
##     2     2     2     2     2     2     1     2     1     1     1     2     1
## 18177 18178 18179 18182 18183 18184 18187 18190 18191 18193 18194 18195 18196
##     1     2     2     1     2     2     1     2     2     1     2     1     2
## 18197 18202 18203 18204 18205 18206 18207 18208 18209 18210 18211 18213 18214
##     2     1     1     2     2     2     2     1     2     1     2     2     2
## 18215 18218 18220 18221 18224 18225 18228 18229 18231 18232 18233 18234 18235
##     2     2     2     1     2     1     1     2     2     2     2     1     1
## 18238 18241 18242 18244 18245 18247 18248 18249 18250 18252 18253 18256 18257
##     2     2     2     2     1     2     2     1     2     1     2     2     2
## 18259 18263 18265 18268 18270 18271 18272 18273 18274 18275 18276 18278 18279
##     1     1     1     1     1     1     2     1     2     2     2     1     2
## 18280 18283 18284 18287 18288 18291 18292 18293 18294 18295 18297 18298 18300
##     2     1     1     2     2     2     2     1     1     2     2     1     2
## 18301 18303 18304 18305 18306 18307 18308 18309 18310 18311 18312 18313 18316
##     1     1     2     1     2     1     1     1     2     1     1     1     2
## 18317 18318 18319 18322 18325 18326 18327 18328 18329 18330 18331 18332 18333
##     2     2     2     1     2     2     2     1     2     2     2     1     2
## 18337 18338 18339 18341 18343 18346 18347 18348 18350 18351 18352 18353 18354
##     2     2     1     2     2     2     2     1     1     2     2     2     1
## 18355 18356 18357 18361 18362 18364 18365 18366 18368 18370 18371 18372 18373
##     1     1     2     1     2     1     1     2     2     2     2     2     2
## 18374 18375 18376 18378 18379 18380 18385 18386 18387 18388 18390 18391 18393
##     2     2     2     1     1     2     1     2     2     2     2     1     2
## 18395 18398 18399 18401 18402 18403 18410 18412 18413 18415 18416 18418 18419
##     2     2     2     2     2     2     1     2     2     1     2     2     1
## 18420 18421 18423 18424 18425 18426 18427 18428 18429 18430 18431 18432 18434
##     1     1     2     2     2     2     2     2     1     1     1     1     1
## 18435 18436 18438 18439 18441 18442 18444 18445 18447 18448 18449 18452 18453
##     1     2     2     1     1     2     2     1     1     2     1     1     2
## 18454 18456 18457 18461 18462 18463 18464 18465 18468 18469 18470 18471 18472
##     2     1     1     2     2     2     2     2     1     2     1     2     2
## 18473 18477 18479 18482 18483 18484 18485 18486 18487 18489 18490 18491 18492
##     2     2     1     2     2     2     2     2     2     2     2     2     1
## 18493 18494 18495 18496 18497 18498 18499 18500 18501 18503 18507 18508 18510
##     2     2     1     1     2     1     1     1     2     2     2     1     2
## 18511 18512 18513 18515 18516 18517 18518 18520 18521 18522 18523 18524 18525
##     2     1     2     1     1     2     2     2     1     2     2     2     1
## 18527 18528 18529 18531 18533 18534 18535 18536 18538 18540 18542 18543 18546
##     1     1     2     1     2     1     1     1     2     2     1     2     1
## 18548 18549 18550 18551 18553 18554 18555 18556 18557 18560 18561 18562 18563
##     2     2     2     2     1     1     1     2     2     2     1     2     2
## 18564 18566 18567 18568 18569 18570 18572 18573 18574 18576 18577 18579 18581
##     1     2     1     2     1     1     2     1     1     1     2     2     2
## 18582 18584 18585 18586 18587 18588 18590 18591 18592 18593 18595 18596 18597
##     2     1     2     1     2     2     1     1     2     2     1     2     2
## 18599 18601 18604 18605 18606 18607 18610 18611 18612 18613 18614 18616 18618
##     1     2     1     2     2     2     2     2     1     1     2     2     1
## 18619 18620 18621 18626 18627 18628 18629 18630 18635 18636 18637 18638 18639
##     2     1     2     1     2     2     1     1     1     1     2     2     2
## 18641 18642 18643 18646 18647 18651 18652 18653 18654 18655 18656 18658 18659
##     2     2     1     1     2     2     2     2     1     1     1     2     2
## 18662 18663 18664 18665 18666 18667 18668 18669 18670 18671 18672 18673 18674
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##     1     2     1     2     1     2     2     2     2     2     2     2     2
## 18675 18677 18680 18681 18682 18684 18685 18686 18691 18692 18694 18697 18704
##     1     1     1     2     1     1     2     1     2     1     2     1     2
## 18705 18706 18708 18709 18711 18712 18713 18714 18716 18718 18719 18721 18723
##     1     2     1     2     1     2     2     1     2     1     1     2     2
## 18727 18728 18729 18730 18731 18732 18734 18735 18736 18737 18738 18740 18741
##     2     2     2     1     2     2     2     1     2     1     2     2     2
## 18743 18744 18745 18746 18747 18748 18750 18751 18752 18755 18756 18757 18758
##     2     2     2     2     2     2     2     1     1     2     2     2     2
## 18759 18760 18762 18765 18767 18768 18769 18772 18773 18774 18775 18777 18778
##     2     1     1     2     1     2     1     1     1     2     2     1     1
## 18779 18780 18781 18783 18784 18785 18786 18788 18789 18790 18791 18792 18793
##     2     2     2     2     1     1     1     1     2     1     1     1     2
## 18797 18798 18799 18800 18801 18805 18806 18807 18809 18810 18812 18813 18814
##     2     2     1     2     1     1     2     1     1     2     2     1     2
## 18815 18817 18818 18819 18823 18824 18827 18829 18830 18834 18835 18836 18837
##     1     1     2     2     1     1     2     2     2     2     2     2     2
## 18838 18840 18841 18842 18844 18846 18847 18848 18849 18850 18851 18852 18853
##     1     2     2     2     2     2     2     2     1     1     2     2     2
## 18854 18856 18858 18859 18860 18861 18862 18865 18866 18869 18874 18876 18878
##     1     1     1     1     1     1     2     2     2     1     1     2     1
## 18879 18880 18882 18885 18887 18888 18890 18891 18892 18894 18895 18897 18899
##     2     1     2     1     1     1     1     1     2     2     1     2     2
## 18900 18902 18903 18904 18905 18906 18907 18908 18909 18911 18912 18913 18914
##     2     1     1     2     1     2     2     1     1     2     1     2     1
## 18915 18916 18917 18919 18920 18921 18922 18923 18924 18925 18928 18929 18931
##     1     1     1     1     2     1     2     2     2     2     2     2     2
## 18934 18936 18937 18938 18939 18941 18942 18943 18944 18945 18947 18949 18951
##     2     2     2     1     1     2     2     1     1     1     1     2     1
## 18952 18953 18954 18955 18956 18957 18959 18960 18961 18962 18965 18966 18967
##     2     1     2     1     2     1     2     2     2     1     1     2     2
## 18968 18970 18971 18972 18974 18975 18977 18981 18982 18983 18985 18986 18987
##     1     2     1     1     2     2     2     2     2     2     1     2     2
## 18989 18990 18993 18994 18995 18999 19000 19001 19004 19005 19007 19008 19009
##     2     2     2     1     1     2     2     2     2     2     2     1     2
## 19010 19011 19012 19015 19017 19018 19020 19021 19022 19023 19025 19026 19028
##     2     2     2     2     2     2     2     2     1     2     2     2     2
## 19029 19030 19031 19032 19033 19034 19035 19037 19038 19040 19042 19043 19044
##     1     2     1     2     1     2     2     2     2     2     1     2     1
## 19045 19046 19048 19049 19050 19051 19052 19053 19054 19055 19058 19061 19063
##     2     1     2     2     1     2     1     2     1     2     2     2     1
## 19064 19066 19068 19069 19070 19072 19073 19074 19077 19079 19080 19082 19083
##     2     2     2     2     2     2     1     2     2     2     2     1     1
## 19085 19090 19092 19093 19095 19097 19098 19099 19100 19101 19102 19103 19111
##     2     1     2     1     1     2     1     2     2     2     1     2     1
## 19114 19115 19116 19118 19119 19120 19121 19122 19123 19125 19126 19127 19128
##     2     2     1     2     1     1     2     2     1     1     2     1     2
## 19130 19131 19132 19133 19136 19137 19138 19139 19140 19141 19142 19143 19144
##     2     1     2     1     1     1     2     2     2     2     2     2     1
## 19145 19147 19149 19150 19151 19152 19153 19155 19156 19157 19159 19161 19162
##     1     1     2     1     1     1     2     1     1     1     2     2     2
## 19166 19169 19171 19174 19176 19177 19178 19179 19180 19181 19185 19186 19187
##     1     2     1     2     2     2     2     2     1     2     1     2     2
## 19189 19190 19191 19192 19193 19195 19196 19201 19202 19203 19204 19205 19207
```

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##     2     2     2     2     2     2     1     2     2     1     2     2     2
## 19208 19209 19210 19212 19213 19214 19216 19218 19219 19220 19221 19227 19229
##     2     2     2     2     2     2     1     1     2     1     2     2     2
## 19231 19232 19235 19236 19239 19241 19242 19243 19245 19247 19248 19249 19250
##     1     2     1     2     2     2     2     1     2     1     2     2     1
## 19251 19254 19256 19257 19258 19261 19263 19266 19268 19270 19272 19273 19274
##     2     1     1     2     1     2     2     1     2     1     2     2     2
## 19275 19276 19279 19280 19281 19282 19285 19287 19288 19291 19292 19293 19294
##     2     1     1     1     1     2     2     2     2     2     2     2     2
## 19295 19297 19298 19299 19300 19301 19304 19305 19306 19307 19308 19309 19311
##     2     2     2     2     1     1     2     1     2     2     2     1     2
## 19312 19313 19315 19316 19317 19319 19321 19322 19324 19325 19326 19330 19331
##     1     2     2     2     1     1     1     2     2     2     2     1     2
## 19335 19336 19338 19339 19342 19343 19344 19350 19352 19353 19354 19355 19356
##     2     2     2     1     2     1     2     2     2     1     2     2     1
## 19357 19359 19360 19361 19364 19365 19367 19368 19371 19373 19376 19377 19378
##     2     2     2     2     1     1     2     1     1     2     1     2     1
## 19380 19381 19383 19385 19386 19387 19388 19389 19392 19393 19394 19395 19398
##     2     2     2     1     1     2     1     1     2     1     2     2     2
## 19400 19403 19404 19406 19407 19409 19411 19412 19414 19415 19417 19419 19423
##     1     2     2     2     1     2     2     1     1     2     2     2     1
## 19424 19425 19426 19429 19430 19431 19433 19434 19435 19437 19439 19440 19441
##     2     2     1     2     2     1     2     2     2     2     2     2     1
## 19442 19444 19445 19446 19447 19448 19450 19451 19454 19456 19458 19459 19460
##     2     2     2     1     2     1     1     2     2     2     1     2     1
## 19461 19462 19466 19468 19470 19478 19479 19480 19482 19483 19484 19485 19486
##     1     1     1     1     1     2     1     1     2     1     1     1     2
## 19487 19488 19490 19492 19493 19494 19495 19498 19499 19500 19502 19503 19506
##     1     2     1     2     1     1     1     1     1     2     2     2     2
## 19508 19509 19511 19513 19514 19516 19517 19518 19520 19522 19524 19525 19527
##     2     2     2     1     1     2     2     2     1     2     2     2     2
## 19528 19529 19530 19531 19532 19533 19534 19535 19536 19537 19539 19540 19543
##     1     1     2     2     2     1     2     2     2     2     2     2     2
## 19544 19546 19547 19550 19551 19552 19553 19554 19556 19558 19561 19563 19564
##     1     1     1     1     1     2     2     1     2     2     2     2     2
## 19565
##     2
```

```r
sampled_data_7<-sampled_data_6
sampled_data_7$kemans_cluster<-k2$cluster
sampled_data_7 <- sampled_data_7 %>%
  mutate(
    fuel = case_when(
      fuel_type_oil == "1" ~ "oil",
      fuel_type_coal == "1" ~ "coal",
      fuel_type_gas == "1" ~ "gas",
      TRUE ~ "other"
    )
  )
```

```r
ggplot(sampled_data_7, aes(x = as.factor(fuel), fill = as.factor(k2$cluster))) +
  geom_bar(position = "dodge", stat = "count") +
  labs(title = "Cluster Assignments by Categorical Variable",
       x = "Your Categorical Variable",
```

```
        y = "Count",
        fill = "Cluster") +
    theme_minimal()
```

Cluster Assignments by Categorical Variable
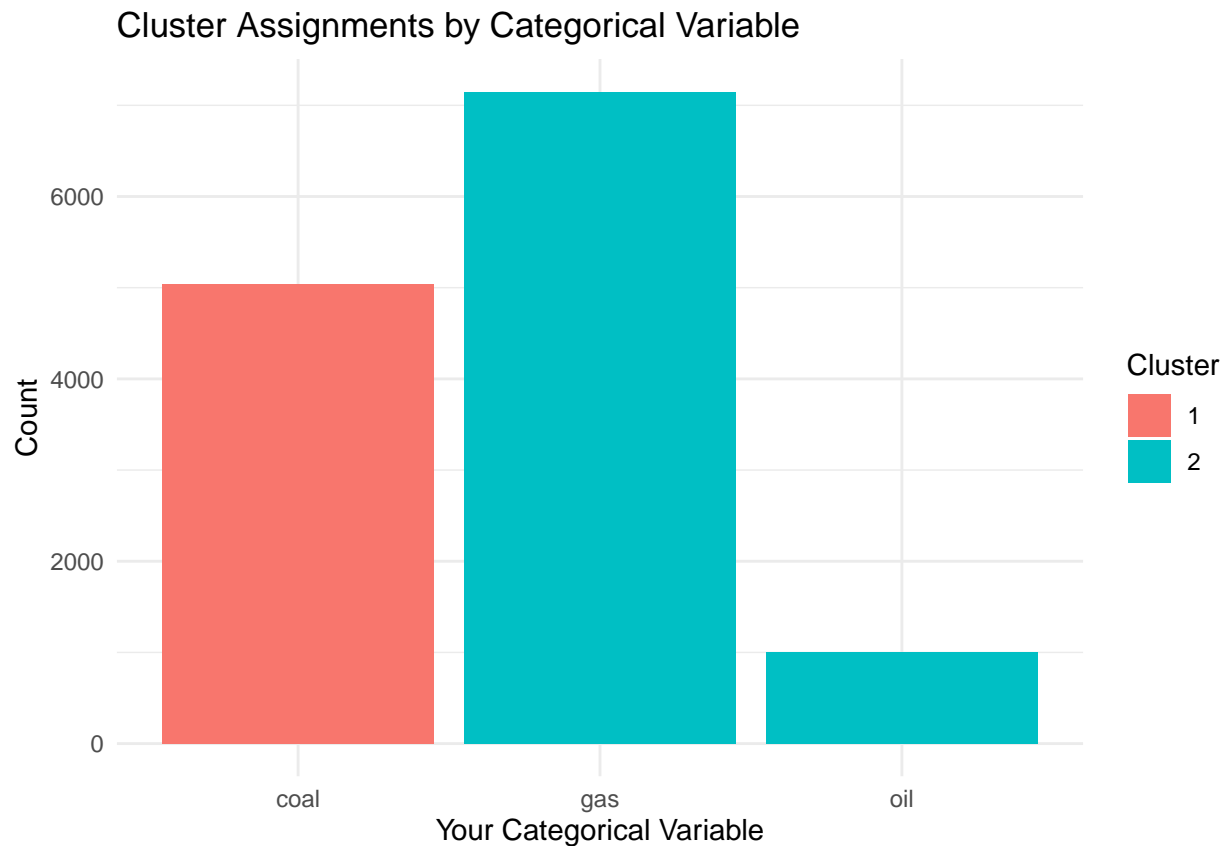

```
##not surprisingly, we see that fuel types tend to cluster together, so we will further investigate by

pudl_coal_scaled<-combined_pudl_scaled[combined_pudl_scaled$fuel_type_coal == 1, ]
##remove columns for fuel type "gas" and "oil"
pudl_coal_scaled <- pudl_coal_scaled[, -c(24:26)]
pudl_coal_scaled <- pudl_coal_scaled[, colSums(pudl_coal_scaled != 0) > 0, drop = FALSE]

pudl_oil_scaled<-combined_pudl_scaled[combined_pudl_scaled$fuel_type_oil == 1, ]
pudl_oil_scaled <- pudl_oil_scaled[, -c(4,24:26,29)]
pudl_oil_scaled <- pudl_oil_scaled[, colSums(pudl_oil_scaled != 0) > 0, drop = FALSE]

pudl_gas_scaled<-combined_pudl_scaled[combined_pudl_scaled$fuel_type_gas == 1, ]
pudl_gas_scaled <- pudl_gas_scaled[, -c(3,4, 24:26)]
pudl_gas_scaled <- pudl_gas_scaled[, colSums(pudl_gas_scaled != 0) > 0, drop = FALSE]


## kmeans cluster coal data
## determine optimal number of clusters
fviz_nbclust(pudl_coal_scaled, kmeans, method = "silhouette")
```

Optimal number of clusters
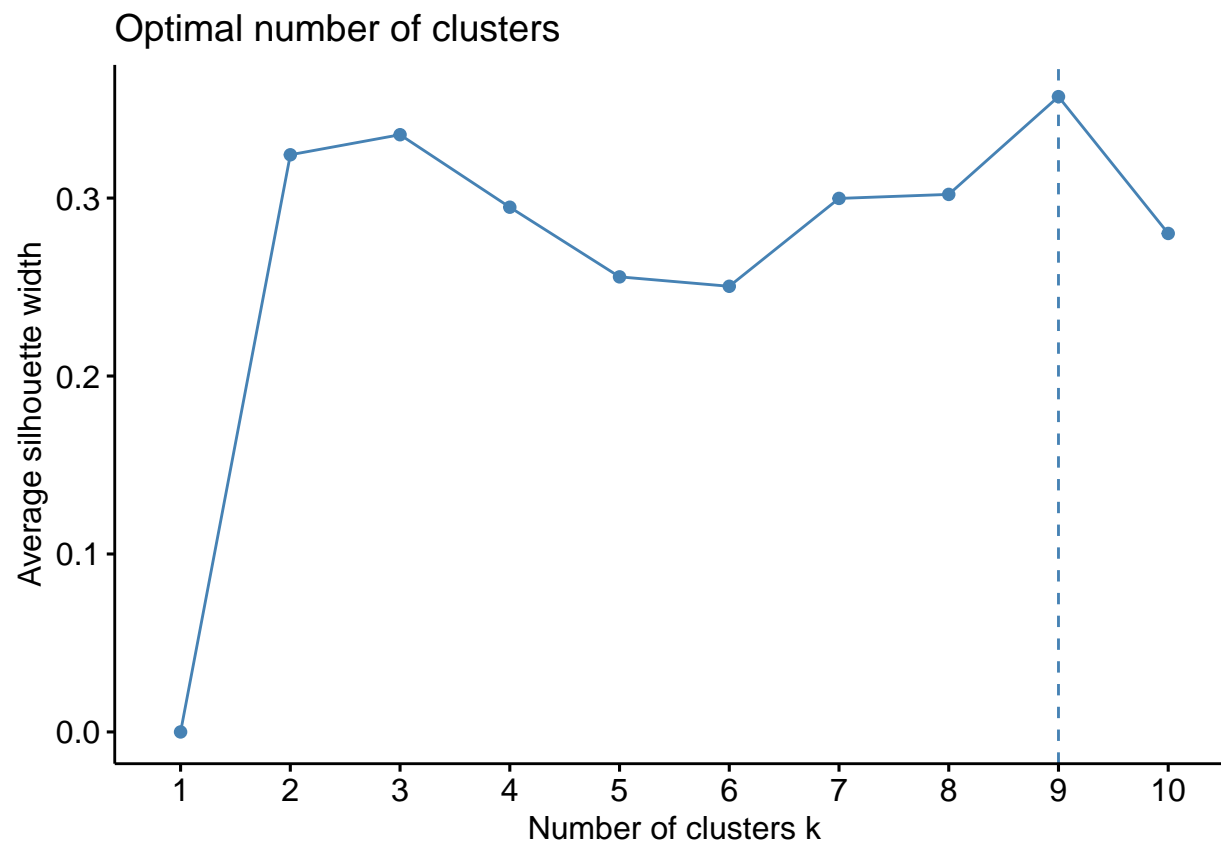

```
##best k = 9
```

```
set.seed(321)
k_coal <- kmeans(pudl_coal_scaled, centers = 9, nstart = 25)
k_coal$centers
```

```
##   fuel_received_units fuel_mmbtu_per_unit sulfur_content_pct ash_content_pct
## 1          -0.1854385           0.8398064         -0.2184181       0.3954451
## 2          -0.2642458           1.5025697          0.5421034       1.5849556
## 3          -0.2376126           1.4407472          2.6804959       1.3705567
## 4          -0.1137758           0.8673936          1.1260357       4.8067076
## 5          -0.1914148           1.4995167          2.2327430       1.1239367
## 6          -0.1753823           0.8432278         -0.2178096       0.4111528
## 7          -0.2516939           1.9308324          5.0511027      -0.5084120
## 8          -0.2252895           1.4858707          0.4604531       1.6016727
## 9          -0.1719978           0.8372612         -0.2121313       0.4059494
##   fuel_cost_per_mmbtu contract_type_C contract_type_NC contract_type_S
## 1         -0.11464968       0.8496868      0.013569937       0.1367432
## 2         -0.07962869       0.0000000      0.004282655       0.9957173
## 3         -0.10597061       0.8166667      0.005952381       0.1773810
## 4         -0.10562505       0.6666667      0.000000000       0.3333333
## 5         -0.09451898       0.8914027      0.000000000       0.1085973
## 6         -0.11509895       0.8183673      0.010204082       0.1714286
## 7         -0.10890813       0.5500000      0.016666667       0.4333333
## 8         -0.08136864       0.9918897      0.008110300       0.0000000
```

```
## 9        -0.11352254       0.8474576     0.002118644         0.1504237
##   energy_source_code_BIT energy_source_code_SUB energy_source_code_LIG
## 1            0.000000000             0.98329854             0.013569937
## 2            0.987152034             0.01070664             0.002141328
## 3            0.997619048             0.00000000             0.000000000
## 4            0.666666667             0.12000000             0.120000000
## 5            1.000000000             0.00000000             0.000000000
## 6            0.002040816             0.98571429             0.010204082
## 7            0.016666667             0.00000000             0.000000000
## 8            0.954582320             0.01946472             0.025141930
## 9            0.000000000             0.96610169             0.031779661
##   energy_source_code_PC energy_source_code_WC energy_source_code_SC
## 1             0.0000000           0.003131524            0.00000000
## 2             0.0000000           0.000000000            0.00000000
## 3             0.0000000           0.002380952            0.00000000
## 4             0.0000000           0.093333333            0.00000000
## 5             0.0000000           0.000000000            0.00000000
## 6             0.0000000           0.002040816            0.00000000
## 7             0.9833333           0.000000000            0.00000000
## 8             0.0000000           0.000000000            0.00081103
## 9             0.0000000           0.002118644            0.00000000
##   fuel_group_coal fuel_group_petroleum_coke primary_transportation_RV
## 1      1.00000000                 0.0000000               0.005219207
## 2      1.00000000                 0.0000000               0.252676660
## 3      1.00000000                 0.0000000               0.750000000
## 4      1.00000000                 0.0000000               0.200000000
## 5      1.00000000                 0.0000000               0.000000000
## 6      1.00000000                 0.0000000               0.000000000
## 7      0.01666667                 0.9833333               0.500000000
## 8      1.00000000                 0.0000000               0.178426602
## 9      1.00000000                 0.0000000               0.002118644
##   primary_transportation_TR primary_transportation_RR primary_transportation_TC
## 1                0.01252610               0.963465553               0.011482255
## 2                0.17987152               0.449678801               0.002141328
## 3                0.23333333               0.001190476               0.005952381
## 4                0.73333333               0.053333333               0.013333333
## 5                0.02941176               0.959276018               0.000000000
## 6                0.01428571               0.961224490               0.016326531
## 7                0.30000000               0.083333333               0.000000000
## 8                0.12165450               0.632603406               0.019464720
## 9                0.01483051               0.934322034               0.031779661
##   primary_transportation_WT primary_transportation_TP primary_transportation_GL
## 1                0.00000000               0.000000000               0.001043841
## 2                0.01284797               0.000000000               0.002141328
## 3                0.00000000               0.001190476               0.000000000
## 4                0.00000000               0.000000000               0.000000000
## 5                0.00000000               0.000000000               0.002262443
## 6                0.00000000               0.000000000               0.000000000
## 7                0.08333333               0.033333333               0.000000000
## 8                0.01054339               0.002433090               0.000000000
## 9                0.00000000               0.000000000               0.000000000
##     winter      fall     spring    summer
## 1 0.5229645 0.0000000 0.4770355 0.0000000
## 2 0.2162741 0.2783726 0.2398287 0.2655246
```

```
## 3 0.2678571 0.2535714 0.2500000 0.2285714
## 4 0.2400000 0.2400000 0.1866667 0.3333333
## 5 0.2963801 0.2081448 0.2036199 0.2918552
## 6 0.0000000 1.0000000 0.0000000 0.0000000
## 7 0.2500000 0.2333333 0.2333333 0.2833333
## 8 0.2522303 0.2351987 0.2635848 0.2489862
## 9 0.0000000 0.0000000 0.0000000 1.0000000
```

```
k_coal$size
```

```
## [1]  958  467  840   75  442  490   60 1233  472
```

```
fviz_cluster(k_coal, data = pudl_coal_scaled)
```


Cluster plot
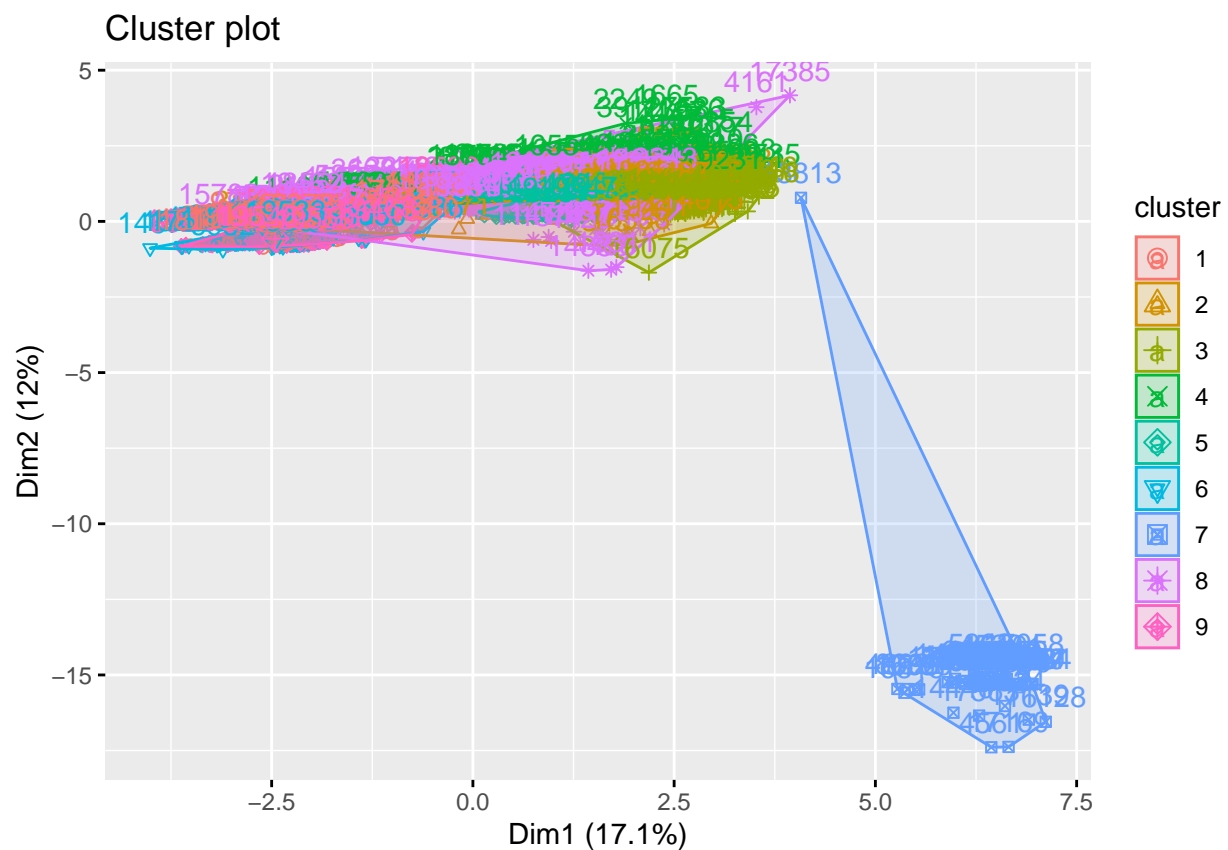
##within coal, we see that pertroleum coke stands apart as its own cluster (cluster 2), also with highe
##clusters 6-9 are primarily composed on Bit coal, with next highest mmbtu per unit collectively

##does not appear to be a strong seasonal trend in quantity received or price per unit, though this is

```
## kmeans cluster oil data
## determine optimal number of clusters
fviz_nbclust(pudl_oil_scaled, kmeans, method = "silhouette")
```

Optimal number of clusters
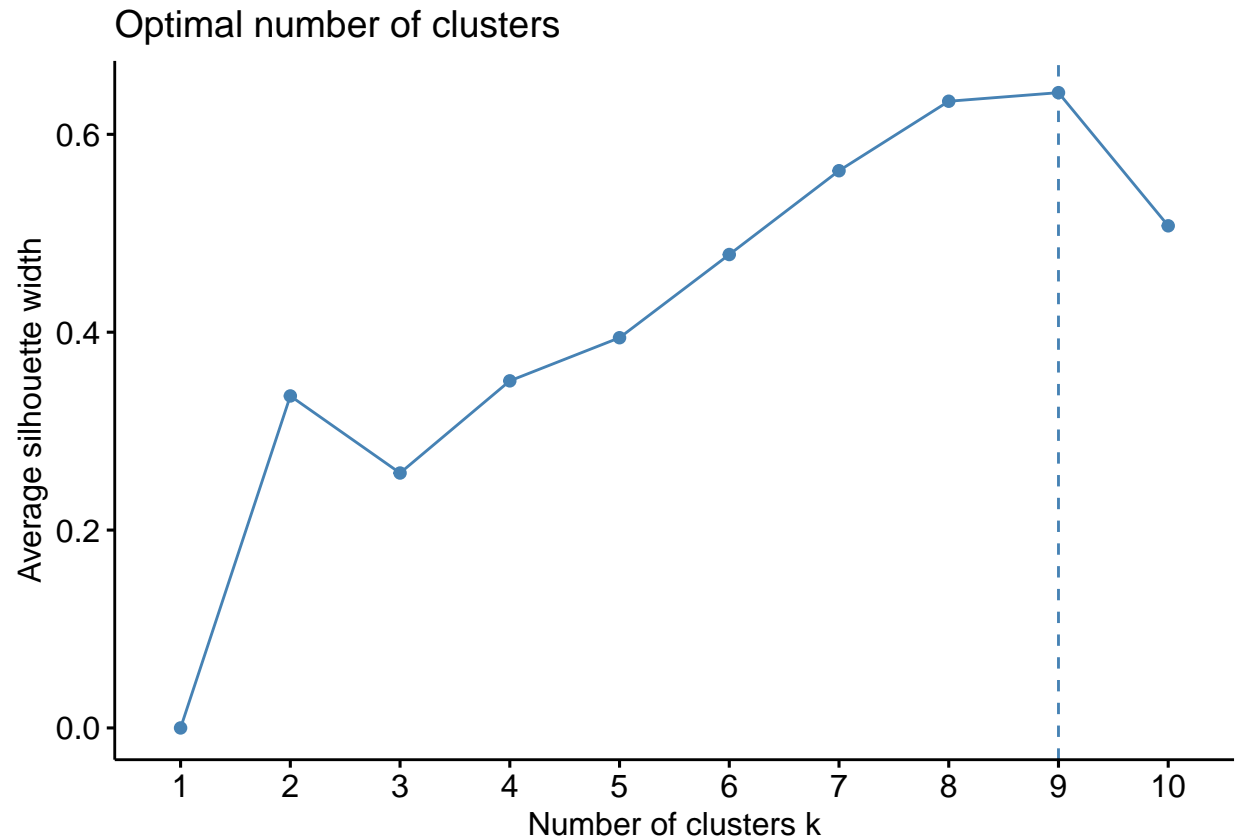
```
##best k = 9
```

```
set.seed(321)
k_oil <- kmeans(pudl_oil_scaled, centers = 9, nstart = 25)
k_oil$centers
```

```
##   fuel_received_units fuel_mmbtu_per_unit sulfur_content_pct
## 1          -0.2854787          -0.3361124        -0.409876296
## 2          -0.2837586          -0.3392263        -0.435924769
## 3          -0.2838395          -0.3350956        -0.417788401
## 4          -0.2843014          -0.3388064        -0.424412098
## 5          -0.2851505          -0.3383606        -0.443561438
## 6          -0.1791760          -0.2845793        -0.005030284
## 7          -0.2826064          -0.3374762        -0.431556083
## 8          -0.2811369          -0.3363068        -0.414808718
## 9          -0.2822382          -0.3394528        -0.448788752
##   fuel_cost_per_mmbtu contract_type_C contract_type_NC contract_type_S
## 1           0.2887266       0.0000000       0.00000000      1.00000000
## 2           0.3241986       0.9885057       0.01149425      0.00000000
## 3           0.2339583       0.0000000       0.00000000      1.00000000
## 4           0.2767056       0.0000000       0.00000000      1.00000000
## 5           0.3416200       1.0000000       0.00000000      0.00000000
## 6           0.1869107       0.9677419       0.00000000      0.03225806
## 7           0.2658280       1.0000000       0.00000000      0.00000000
## 8           0.2777538       0.0000000       0.00000000      1.00000000
```

```
## 9           0.2835611         1.0000000         0.00000000        0.00000000
##   energy_source_code_DFO energy_source_code_RFO energy_source_code_WO
## 1            0.9921875            0.000000000           0.000000000
## 2            1.0000000            0.000000000           0.000000000
## 3            0.9751553            0.018633540           0.000000000
## 4            0.9508197            0.024590164           0.024590164
## 5            1.0000000            0.000000000           0.000000000
## 6            0.0000000            1.000000000           0.000000000
## 7            0.9905660            0.000000000           0.009433962
## 8            0.9685535            0.018867925           0.012578616
## 9            0.9708738            0.009708738           0.009708738
##   energy_source_code_KER energy_source_code_JF primary_transportation_RV
## 1            0.000000000            0.00781250                0.00781250
## 2            0.000000000            0.00000000                0.02298851
## 3            0.000000000            0.00621118                0.00621118
## 4            0.000000000            0.00000000                0.02459016
## 5            0.000000000            0.00000000                0.02469136
## 6            0.000000000            0.00000000                0.06451613
## 7            0.000000000            0.00000000                0.01886792
## 8            0.000000000            0.00000000                0.01886792
## 9            0.009708738            0.00000000                0.01941748
##   primary_transportation_PL primary_transportation_TR primary_transportation_RR
## 1              0.007812500                0.9687500                  0.00000000
## 2              0.045977011                0.9080460                  0.00000000
## 3              0.012422360                0.9627329                  0.00000000
## 4              0.016393443                0.9344262                  0.00000000
## 5              0.037037037                0.8888889                  0.01234568
## 6              0.838709677                0.0000000                  0.01612903
## 7              0.009433962                0.9433962                  0.00000000
## 8              0.018867925                0.9119497                  0.00000000
## 9              0.038834951                0.9320388                  0.00000000
##   primary_transportation_WT    winter      fall    spring    summer
## 1              0.015625000 0.0000000 0.0000000 0.0000000 1.0000000
## 2              0.022988506 0.0000000 1.0000000 0.0000000 0.0000000
## 3              0.012422360 1.0000000 0.0000000 0.0000000 0.0000000
## 4              0.024590164 0.0000000 1.0000000 0.0000000 0.0000000
## 5              0.037037037 0.0000000 0.0000000 0.0000000 1.0000000
## 6              0.080645161 0.3225806 0.1451613 0.2419355 0.2903226
## 7              0.018867925 1.0000000 0.0000000 0.0000000 0.0000000
## 8              0.037735849 0.0000000 0.0000000 1.0000000 0.0000000
## 9              0.009708738 0.0000000 0.0000000 1.0000000 0.0000000
```

```r
k_oil$size
```

```
## [1] 128  87 161 122  81  62 106 159 103
```

```r
fviz_cluster(k_oil, data = pudl_oil_scaled)
```

Cluster plot
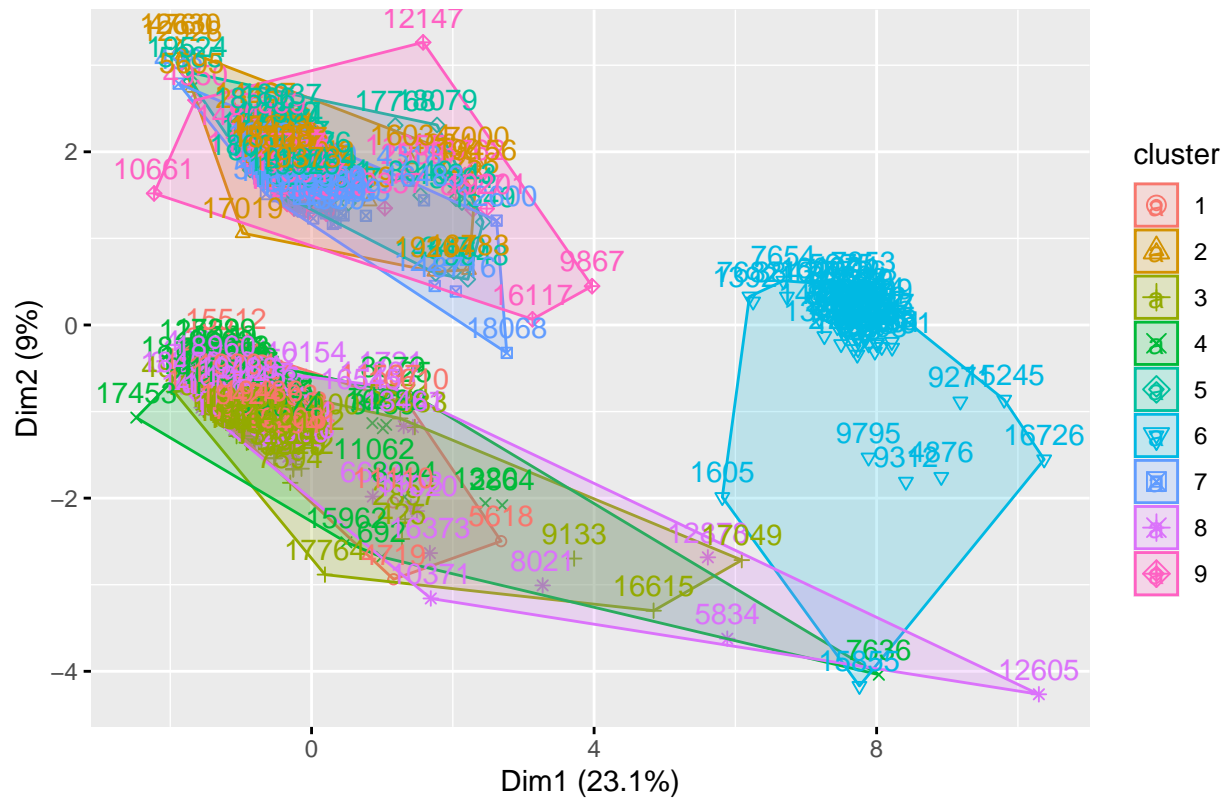
in oil, we see more strong association with season, where clusters 6 and 3 contain purchases made sole

we do not see substantial differences in units or cost between the cluster centroids

```
## kmeans cluster gas data
## determine optimal number of clusters
fviz_nbclust(pudl_gas_scaled, kmeans, method = "silhouette")
```

Optimal number of clusters
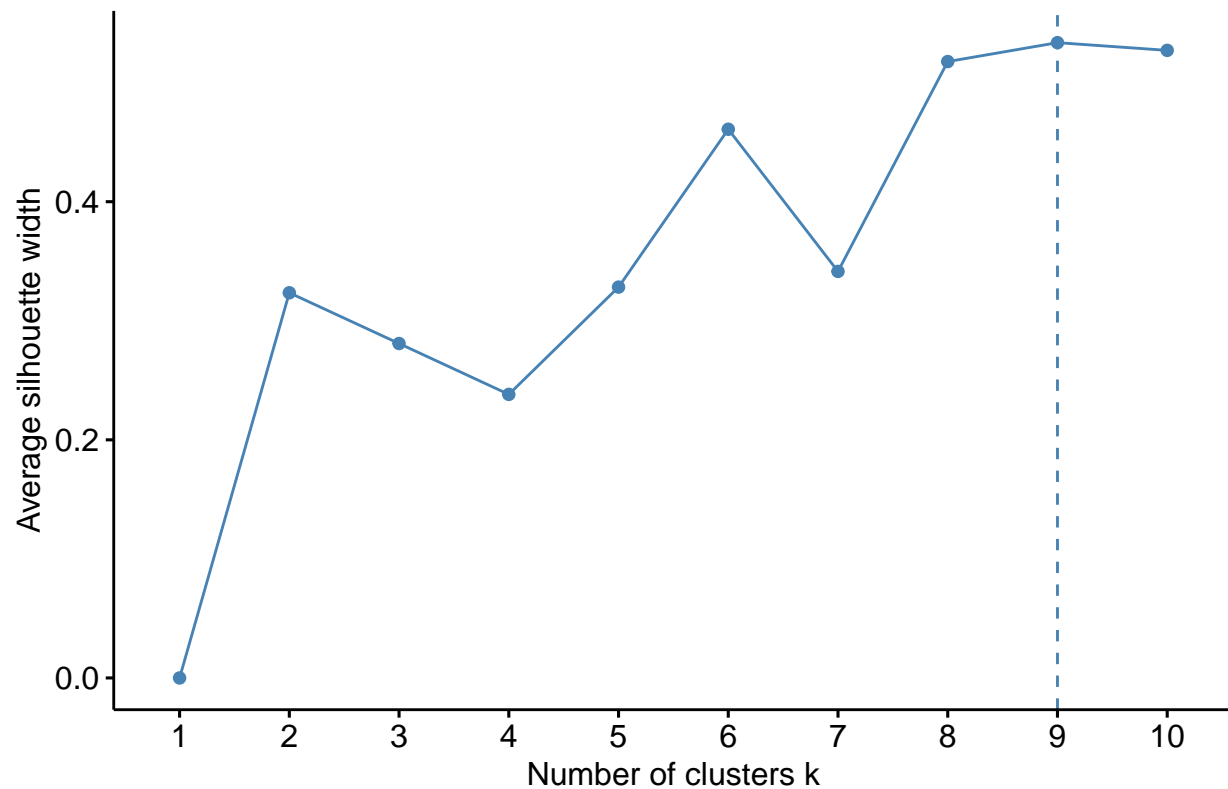
```
##best k = 9
```

```
set.seed(321)
k_gas <- kmeans(pudl_gas_scaled, centers = 9, nstart = 25)
k_gas$centers
```

```
##   fuel_received_units fuel_mmbtu_per_unit fuel_cost_per_mmbtu contract_type_C
## 1          9.84144645          -0.8204939         -0.04658318       0.5737705
## 2         -0.08848301          -0.8201504         -0.03549808       0.0000000
## 3         -0.10841239          -0.8198037         -0.02638713       1.0000000
## 4         -0.07085051          -0.8201077         -0.02885641       0.0000000
## 5          3.29843781          -0.8199291         -0.05472535       0.2809524
## 6         -0.11247392          -0.8200685         -0.03006807       0.0000000
## 7         -0.28862362          -0.8206483         44.29779384       0.2000000
## 8         -0.28028150          -0.8192843          7.97923764       0.2307692
## 9         -0.10346685          -0.8203095         -0.01405447       0.0000000
##   contract_type_NC contract_type_S energy_source_code_NG energy_source_code_PG
## 1      0.000000000       0.4262295             1.0000000           0.000000000
## 2      0.001576044       0.9984240             0.9992120           0.000000000
## 3      0.000000000       0.0000000             0.9953302           0.003335557
## 4      0.004590666       0.9954093             1.0000000           0.000000000
## 5      0.000000000       0.7190476             1.0000000           0.000000000
## 6      0.001633987       0.9983660             1.0000000           0.000000000
## 7      0.000000000       0.8000000             1.0000000           0.000000000
## 8      0.000000000       0.7692308             1.0000000           0.000000000
```

```
## 9       0.008961912          0.9910381           0.9985063                0.000746826
##    energy_source_code_OG energy_source_code_SGP fuel_group_natural_gas
## 1           0.0000000000           0.0000000000              1.0000000
## 2           0.0007880221           0.0000000000              0.9992120
## 3           0.0006671114           0.0006671114              0.9953302
## 4           0.0000000000           0.0000000000              1.0000000
## 5           0.0000000000           0.0000000000              1.0000000
## 6           0.0000000000           0.0000000000              1.0000000
## 7           0.0000000000           0.0000000000              1.0000000
## 8           0.0000000000           0.0000000000              1.0000000
## 9           0.0007468260           0.0000000000              0.9985063
##    fuel_group_other_gas primary_transportation_PL primary_transportation_TR
## 1          0.0000000000                 0.9344262                0.000000000
## 2          0.0007880221                 0.8684003                0.000000000
## 3          0.0046697799                 0.9006004                0.001334223
## 4          0.0000000000                 0.8569243                0.000000000
## 5          0.0000000000                 0.9452381                0.000000000
## 6          0.0000000000                 0.8733660                0.000000000
## 7          0.0000000000                 1.0000000                0.000000000
## 8          0.0000000000                 0.9230769                0.000000000
## 9          0.0014936520                 0.8625840                0.000000000
##    primary_transportation_RR    winter       fall    spring    summer
## 1              0.0000000000 0.2622951 0.2459016 0.1311475 0.36065574
## 2              0.0000000000 0.0000000 0.0000000 1.0000000 0.00000000
## 3              0.0000000000 0.2555037 0.2628419 0.2368245 0.24482989
## 4              0.0000000000 0.0000000 0.0000000 0.0000000 1.00000000
## 5              0.0000000000 0.2261905 0.2309524 0.2047619 0.33809524
## 6              0.0008169935 0.0000000 1.0000000 0.0000000 0.00000000
## 7              0.0000000000 0.2000000 0.4000000 0.2000000 0.20000000
## 8              0.0000000000 0.3461538 0.1538462 0.4230769 0.07692308
## 9              0.0000000000 1.0000000 0.0000000 0.0000000 0.00000000
```

```
k_gas$size
```

```
## [1]   61 1269 1499 1307  420 1224    5   26 1339
```

```
fviz_cluster(k_gas, data = pudl_gas_scaled)
```
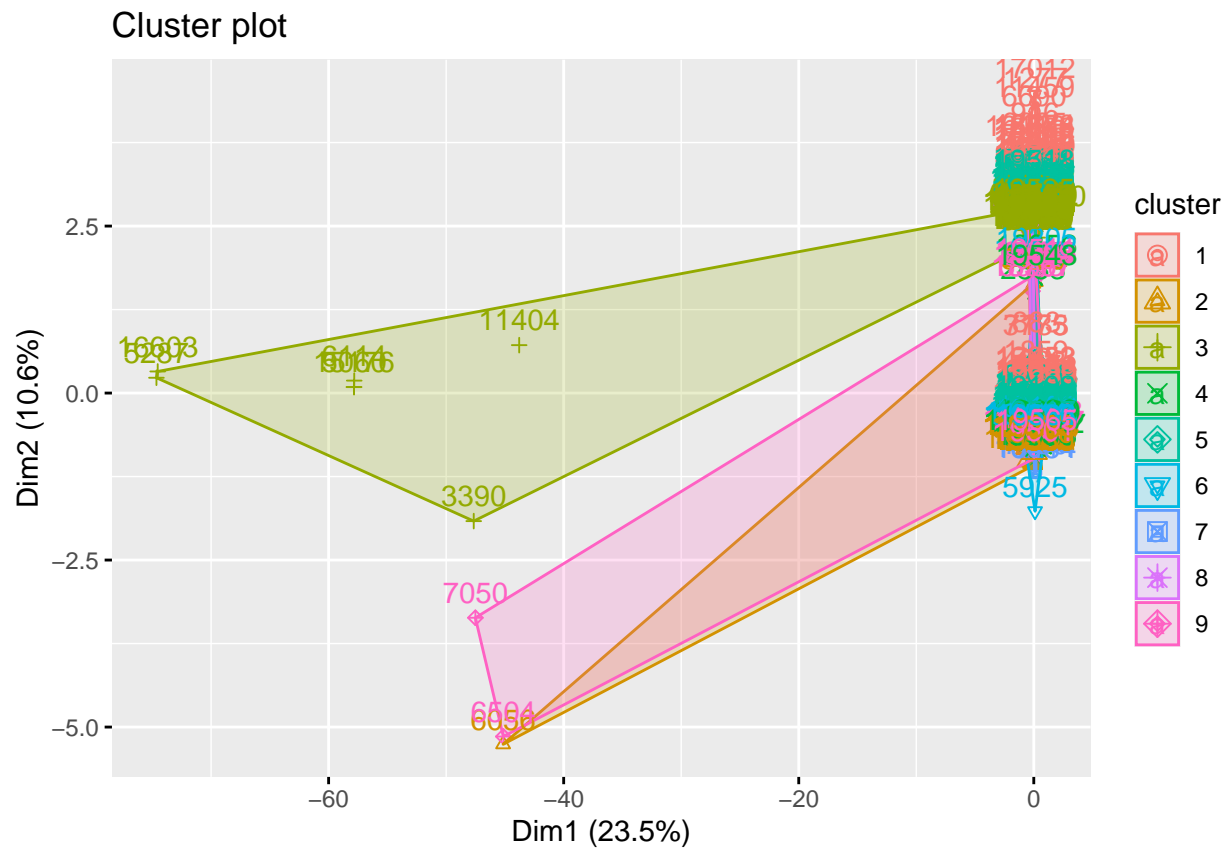
Cluster plot


```
combined_pudl_scaled<-as.data.frame(combined_pudl_scaled)
dbscan::kNNdistplot(combined_pudl_scaled, k=5)
abline(h=2.25, lty=20)
```
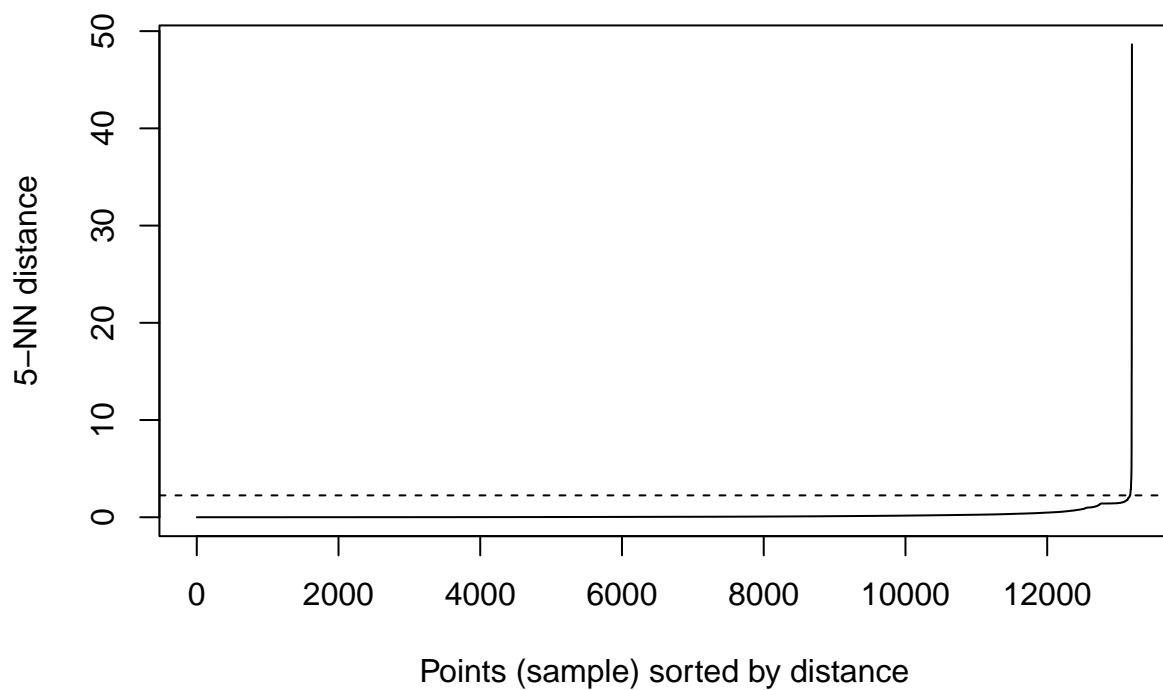
```
##optimal esp value = 2.25
```

```
set.seed(321)
db <- fpc::dbscan(combined_pudl_scaled, eps = 2.25, MinPts = 5)
fviz_cluster(db, combined_pudl_scaled,   stand = FALSE, frame = FALSE, geom = "point")
```

```
## Warning: argument frame is deprecated; please use ellipse instead.
```

Cluster plot
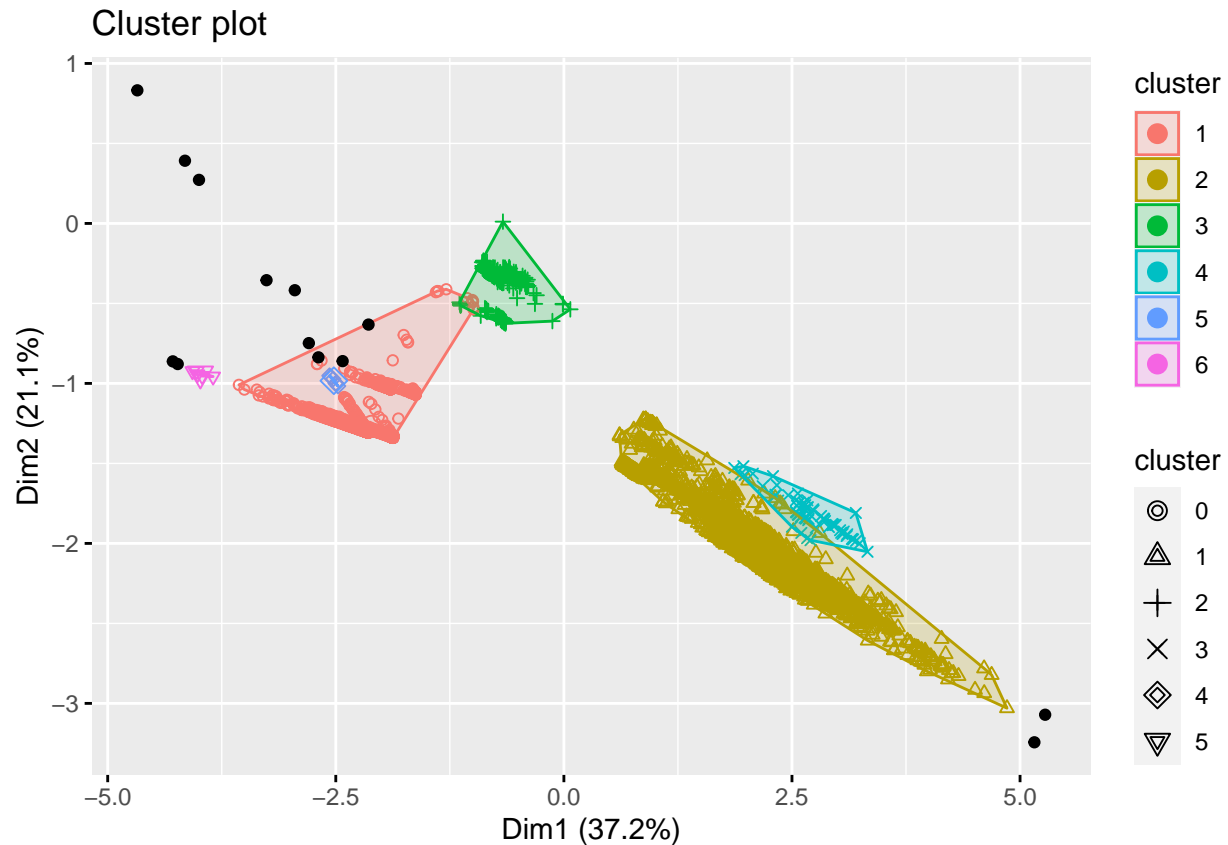

```r
print(db)
```

```
## dbscan Pts=13196 MinPts=5 eps=2.25
##         0    1    2    3   4 5 6
## border 13    1    3    0   0 1 4
## seed    0 7127 4973 1009 59 5 1
## total  13 7128 4976 1009 59 6 5
```

```r
db_clusters<-db$cluster
noise_points <- which(db_clusters == 0)
print(noise_points)
```

```
##  [1]    80    88   431   840  3660  5005  5522  6758  9327 10232 10625 11493
## [13] 12486
```

```r
selected_row_indices <- c( 80, 88, 431, 840, 3660, 5005, 5522, 6758 , 9327, 10232, 10625, 11493, 12486)
db_noise_points <- combined_pudl_scaled[rownames(combined_pudl_scaled) %in% as.character(selected_row_in
```

```r
db_cluster_centers <- aggregate(combined_pudl_scaled, by = list(db_clusters), FUN = mean)
print(db_cluster_centers)
```

```
##   Group.1 fuel_received_units fuel_mmbtu_per_unit sulfur_content_pct
## 1       0           2.9750349          -0.5880327          0.5113903
```

```
## 2        1      0.1698438       -0.8200711        -0.5073027
## 3        2     -0.2086815        1.2227382         0.7481971
## 4        3     -0.2770514       -0.3340732        -0.3999970
## 5        4     -0.2510632        1.9469380         5.0093980
## 6        5     -0.2658456       -0.8198039        -0.5073027
## 7        6     17.0059676       -0.8209726        -0.5073027
##    ash_content_pct fuel_cost_per_mmbtu contract_type_C contract_type_NC
## 1       0.2397962         21.48241755       0.4615385     0.0000000000
## 2      -0.6698115         -0.01559229       0.2317621     0.0030864198
## 3       1.1030509         -0.09966068       0.7972267     0.0072347267
## 4      -0.6698115          0.27492045       0.4321110     0.0009910803
## 5      -0.5809226         -0.10853864       0.5593220     0.0169491525
## 6      -0.6698115          9.50933884       0.0000000     0.0000000000
## 7      -0.6698115         -0.05300029       0.4000000     0.0000000000
##    contract_type_S energy_source_code_BIT energy_source_code_NG
## 1       0.5384615            0.07692308             0.8461538
## 2       0.7651515            0.00000000             0.9985971
## 3       0.1955386            0.59666399             0.0000000
## 4       0.5668979            0.00000000             0.0000000
## 5       0.4237288            0.00000000             0.0000000
## 6       1.0000000            0.00000000             1.0000000
## 7       0.6000000            0.00000000             1.0000000
##    energy_source_code_DFO energy_source_code_SUB energy_source_code_LIG
## 1             0.0000000              0.0000000             0.00000000
## 2             0.0000000              0.0000000             0.00000000
## 3             0.0000000              0.3856511             0.01487138
## 4             0.9187314              0.0000000             0.00000000
## 5             0.0000000              0.0000000             0.00000000
## 6             0.0000000              0.0000000             0.00000000
## 7             0.0000000              0.0000000             0.00000000
##    energy_source_code_RFO energy_source_code_WO energy_source_code_KER
## 1             0.00000000           0.000000000           0.0000000000
## 2             0.00000000           0.000000000           0.0000000000
## 3             0.00000000           0.000000000           0.0000000000
## 4             0.07135778           0.006937562           0.0009910803
## 5             0.00000000           0.000000000           0.0000000000
## 6             0.00000000           0.000000000           0.0000000000
## 7             0.00000000           0.000000000           0.0000000000
##    energy_source_code_PC energy_source_code_WC energy_source_code_PG
## 1                     0            0.07692308           0.0000000000
## 2                     0            0.00000000           0.0008417508
## 3                     0            0.00261254           0.0000000000
## 4                     0            0.00000000           0.0000000000
## 5                     1            0.00000000           0.0000000000
## 6                     0            0.00000000           0.0000000000
## 7                     0            0.00000000           0.0000000000
##    energy_source_code_OG energy_source_code_JF energy_source_code_SC
## 1           0.0000000000           0.000000000           0.0000000000
## 2           0.0004208754           0.000000000           0.0000000000
## 3           0.0000000000           0.000000000           0.0002009646
## 4           0.0000000000           0.001982161           0.0000000000
## 5           0.0000000000           0.000000000           0.0000000000
## 6           0.0000000000           0.000000000           0.0000000000
## 7           0.0000000000           0.000000000           0.0000000000
```

```
##    energy_source_code_SGP fuel_type_coal fuel_type_gas fuel_type_oil
## 1            0.0000000000      0.1538462     0.8461538             0
## 2            0.0001402918      0.0000000     1.0000000             0
## 3            0.0000000000      1.0000000     0.0000000             0
## 4            0.0000000000      0.0000000     0.0000000             1
## 5            0.0000000000      1.0000000     0.0000000             0
## 6            0.0000000000      0.0000000     1.0000000             0
## 7            0.0000000000      0.0000000     1.0000000             0
##    fuel_group_coal fuel_group_natural_gas fuel_group_petroleum
## 1        0.1538462              0.8461538                    0
## 2        0.0000000              0.9985971                    0
## 3        1.0000000              0.0000000                    0
## 4        0.0000000              0.0000000                    1
## 5        0.0000000              0.0000000                    0
## 6        0.0000000              1.0000000                    0
## 7        0.0000000              1.0000000                    0
##    fuel_group_petroleum_coke fuel_group_other_gas primary_transportation_RV
## 1                          0          0.000000000                0.00000000
## 2                          0          0.001402918                0.00000000
## 3                          0          0.000000000                0.19875402
## 4                          0          0.000000000                0.01982161
## 5                          1          0.000000000                0.50847458
## 6                          0          0.000000000                0.00000000
## 7                          0          0.000000000                0.00000000
##    primary_transportation_PL primary_transportation_TR primary_transportation_RR
## 1                 0.76923077              0.1538461538              0.0000000000
## 2                 0.87794613              0.0002805836              0.0001402918
## 3                 0.00000000              0.1051045016              0.6539389068
## 4                 0.07135778              0.8771060456              0.0019821606
## 5                 0.00000000              0.2881355932              0.0847457627
## 6                 1.00000000              0.0000000000              0.0000000000
## 7                 1.00000000              0.0000000000              0.0000000000
##    primary_transportation_TC primary_transportation_WT primary_transportation_TP
## 1                 0.0000000               0.000000000              0.0000000000
## 2                 0.0000000               0.000000000              0.0000000000
## 3                 0.0130627               0.003818328              0.0008038585
## 4                 0.0000000               0.025768087              0.0000000000
## 5                 0.0000000               0.084745763              0.0338983051
## 6                 0.0000000               0.000000000              0.0000000000
## 7                 0.0000000               0.000000000              0.0000000000
##    primary_transportation_GL    winter      fall    spring    summer
## 1               0.0000000000 0.2307692 0.3076923 0.3076923 0.1538462
## 2               0.0000000000 0.2575758 0.2428451 0.2415825 0.2579966
## 3               0.0006028939 0.2584405 0.2477894 0.2427653 0.2510048
## 4               0.0000000000 0.2844400 0.2160555 0.2745292 0.2249752
## 5               0.0000000000 0.2542373 0.2372881 0.2203390 0.2881356
## 6               0.0000000000 0.1666667 0.1666667 0.6666667 0.0000000
## 7               0.0000000000 0.8000000 0.0000000 0.2000000 0.0000000
```

##using DB scan, we again see that clusters align by fuel. In this case, 4 clusters are produced. In re

```
set.seed(321)
hc_ward_coal<-agnes(pudl_coal_scaled, method= "ward")
print(hc_ward_coal$ac)
```

```
## [1] 0.9986131
```

```
pltree(hc_ward_coal, cex = 0.6, hang = -1, main = "Dendogram of agnes, coal", labels=FALSE)
rect.hclust(hc_ward_coal, k=3, border = 1:3)
```

Dendogram of agnes, coal

pudl_coal_scaled
agnes (*, "ward")
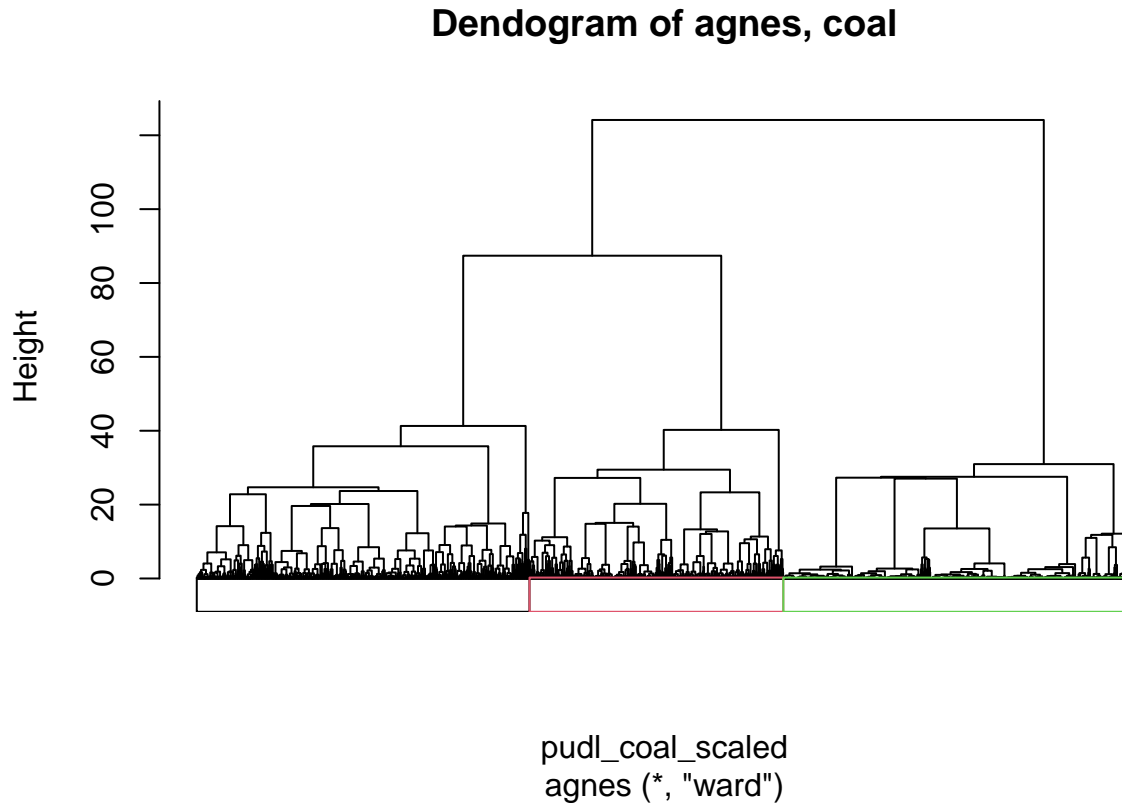
```
coal_clusters<- cutree(hc_ward_coal, k = 3)
coal_cluster1_indices <- which(coal_clusters == 1)
coal_cluster1_points <- pudl_coal_scaled[coal_cluster1_indices, ]
coal_cluster1_centroid <- colMeans(coal_cluster1_points, na.rm = TRUE)
coal_cluster1_centroid
```

```
##          fuel_received_units         fuel_mmbtu_per_unit            sulfur_content_pct
##                -0.2264063963                1.4459468297                0.4924952481
##                ash_content_pct           fuel_cost_per_mmbtu                contract_type_C
##                 1.6979271973               -0.0824596393                0.7371651786
##               contract_type_NC              contract_type_S          energy_source_code_BIT
##                 0.0066964286                0.2561383929                0.9291294643
##         energy_source_code_SUB       energy_source_code_LIG          energy_source_code_PC
##                 0.0234375000                0.0412946429                0.0000000000
##          energy_source_code_WC        energy_source_code_SC                fuel_group_coal
##                 0.0055803571                0.0005580357                1.0000000000
## fuel_group_petroleum_coke primary_transportation_RV primary_transportation_TR
##                 0.0000000000                0.1819196429                0.1484375000
## primary_transportation_RR primary_transportation_TC primary_transportation_WT
##                 0.5937500000                0.0189732143                0.0106026786
```

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```
## primary_transportation_TP primary_transportation_GL                 winter
##            0.0016741071            0.0000000000          0.2449776786
##                    fall                  spring                summer
##            0.2371651786            0.2555803571          0.2622767857
```

```
coal_clusters<- cutree(hc_ward_coal, k = 3)
coal_cluster2_indices <- which(coal_clusters == 2)
coal_cluster2_points <- pudl_coal_scaled[coal_cluster2_indices, ]
coal_cluster2_centroid <- colMeans(coal_cluster2_points, na.rm = TRUE)
coal_cluster2_centroid
```

```
##        fuel_received_units        fuel_mmbtu_per_unit         sulfur_content_pct
##              -0.1812331181               0.8470856542              -0.2244247243
##             ash_content_pct          fuel_cost_per_mmbtu             contract_type_C
##               0.3866814288              -0.1145906264               0.8386581470
##             contract_type_NC            contract_type_S     energy_source_code_BIT
##               0.0101171459               0.1512247071               0.0000000000
##     energy_source_code_SUB     energy_source_code_LIG      energy_source_code_PC
##               0.9994675186               0.0000000000               0.0000000000
##      energy_source_code_WC      energy_source_code_SC             fuel_group_coal
##               0.0005324814               0.0000000000               1.0000000000
## fuel_group_petroleum_coke primary_transportation_RV primary_transportation_TR
##               0.0000000000               0.0031948882               0.0063897764
## primary_transportation_RR primary_transportation_TC primary_transportation_WT
##               0.9664536741               0.0138445154               0.0000000000
## primary_transportation_TP primary_transportation_GL                 winter
##               0.0000000000               0.0005324814               0.2646432375
##                       fall                    spring                  summer
##               0.2561235357               0.2385516507               0.2406815761
```

```
coal_clusters<- cutree(hc_ward_coal, k = 3)
coal_cluster3_indices <- which(coal_clusters == 3)
coal_cluster3_points <- pudl_coal_scaled[coal_cluster3_indices, ]
coal_cluster3_centroid <- colMeans(coal_cluster3_points, na.rm = TRUE)
coal_cluster3_centroid
```

```
##        fuel_received_units        fuel_mmbtu_per_unit         sulfur_content_pct
##              -0.225101546               1.476691238               2.611360468
##             ash_content_pct          fuel_cost_per_mmbtu             contract_type_C
##               1.240759903              -0.102128636               0.808339429
##             contract_type_NC            contract_type_S     energy_source_code_BIT
##               0.004389173               0.187271397               0.954645208
##     energy_source_code_SUB     energy_source_code_LIG      energy_source_code_PC
##               0.000000000               0.000000000               0.043160205
##      energy_source_code_WC      energy_source_code_SC             fuel_group_coal
##               0.002194587               0.000000000               0.956839795
## fuel_group_petroleum_coke primary_transportation_RV primary_transportation_TR
##               0.043160205               0.502560351               0.193123628
## primary_transportation_RR primary_transportation_TC primary_transportation_WT
##               0.277980980               0.003657644               0.003657644
## primary_transportation_TP primary_transportation_GL                 winter
##               0.002194587               0.001463058               0.267739576
##                       fall                    spring                  summer
##               0.249451353               0.231163131               0.251645940
```

```

```
all_coal_centroids<-data.frame(coal_cluster1_centroid, coal_cluster2_centroid, coal_cluster3_centroid)

all_coal_centroids<-t(all_coal_centroids)

set.seed(321)
hc_ward_oil<-agnes(pudl_oil_scaled, method= "ward")
print(hc_ward_oil$ac)
```

```
## [1] 0.9975434
```

```
pltree(hc_ward_oil, cex = 0.6, hang = -1, main = "Dendogram of agnes, oil", labels=FALSE)
rect.hclust(hc_ward_oil, k=3, border = 1:3)
```


Dendogram of agnes, oil

pudl_oil_scaled
agnes (*, "ward")

```
oil_clusters<- cutree(hc_ward_oil, k = 3)
oil_cluster1_indices <- which(oil_clusters == 1)
oil_cluster1_points <- pudl_oil_scaled[oil_cluster1_indices, ]
oil_cluster1_centroid <- colMeans(oil_cluster1_points, na.rm = TRUE)
oil_cluster1_centroid
```

```
##       fuel_received_units      fuel_mmbtu_per_unit        sulfur_content_pct
##             -0.285739450             -0.336871806              -0.426129423
##       fuel_cost_per_mmbtu          contract_type_C           contract_type_NC
##              0.271555328              0.000000000               0.001890359
```

```
##           contract_type_S      energy_source_code_DFO    energy_source_code_RFO
##               0.998109641                 1.000000000               0.000000000
##        energy_source_code_WO    energy_source_code_KER     energy_source_code_JF
##               0.000000000                 0.000000000               0.000000000
## primary_transportation_RV primary_transportation_PL primary_transportation_TR
##               0.000000000                 0.000000000               1.000000000
## primary_transportation_RR primary_transportation_WT                    winter
##               0.000000000                 0.000000000               0.287334594
##                      fall                    spring                    summer
##               0.207939509                 0.272211720               0.232514178
```

```
oil_clusters<- cutree(hc_ward_oil, k = 3)
oil_cluster2_indices <- which(oil_clusters == 2)
oil_cluster2_points <- pudl_oil_scaled[oil_cluster2_indices, ]
oil_cluster2_centroid <- colMeans(oil_cluster2_points, na.rm = TRUE)
oil_cluster2_centroid
```

```
##           fuel_received_units       fuel_mmbtu_per_unit        sulfur_content_pct
##                  -0.22455863               -0.31316043               -0.19082544
##         fuel_cost_per_mmbtu            contract_type_C            contract_type_NC
##                   0.21809443                0.67883212                0.00000000
##              contract_type_S     energy_source_code_DFO    energy_source_code_RFO
##                   0.32116788                0.40145985                0.52554745
##        energy_source_code_WO    energy_source_code_KER     energy_source_code_JF
##                   0.05109489                0.00729927                0.01459854
## primary_transportation_RV primary_transportation_PL primary_transportation_TR
##                   0.14598540                0.52554745                0.09489051
## primary_transportation_RR primary_transportation_WT                    winter
##                   0.01459854                0.18978102                0.25547445
##                      fall                    spring                    summer
##                   0.21897810                0.29197080                0.23357664
```

```
oil_clusters<- cutree(hc_ward_oil, k = 3)
oil_cluster3_indices <- which(oil_clusters == 3)
oil_cluster3_points <- pudl_oil_scaled[oil_cluster3_indices, ]
oil_cluster3_centroid <- colMeans(oil_cluster3_points, na.rm = TRUE)
oil_cluster3_centroid
```

```
##           fuel_received_units       fuel_mmbtu_per_unit        sulfur_content_pct
##                   -0.2846187                -0.3381099                -0.4432403
##         fuel_cost_per_mmbtu            contract_type_C            contract_type_NC
##                    0.3028077                 1.0000000                 0.0000000
##              contract_type_S     energy_source_code_DFO    energy_source_code_RFO
##                    0.0000000                 1.0000000                 0.0000000
##        energy_source_code_WO    energy_source_code_KER     energy_source_code_JF
##                    0.0000000                 0.0000000                 0.0000000
## primary_transportation_RV primary_transportation_PL primary_transportation_TR
##                    0.0000000                 0.0000000                 1.0000000
## primary_transportation_RR primary_transportation_WT                    winter
##                    0.0000000                 0.0000000                 0.2915452
##                      fall                    spring                    summer
##                    0.2274052                 0.2711370                 0.2099125
```
```

```
all_oil_centroids<-data.frame(oil_cluster1_centroid, oil_cluster2_centroid, oil_cluster3_centroid)

all_oil_centroids<-t(all_oil_centroids)

set.seed(321)
hc_ward_gas<-agnes(pudl_gas_scaled, method= "ward")
print(hc_ward_gas$ac)
```

```
[1] 0.9997183
```

```
pltree(hc_ward_gas, cex = 0.6, hang = -1, main = "Dendogram of agnes, gas", labels=FALSE)
rect.hclust(hc_ward_gas, k=2, border = 1:2)
```

Dendogram of agnes, gas

pudl_gas_scaled
agnes (*, "ward")
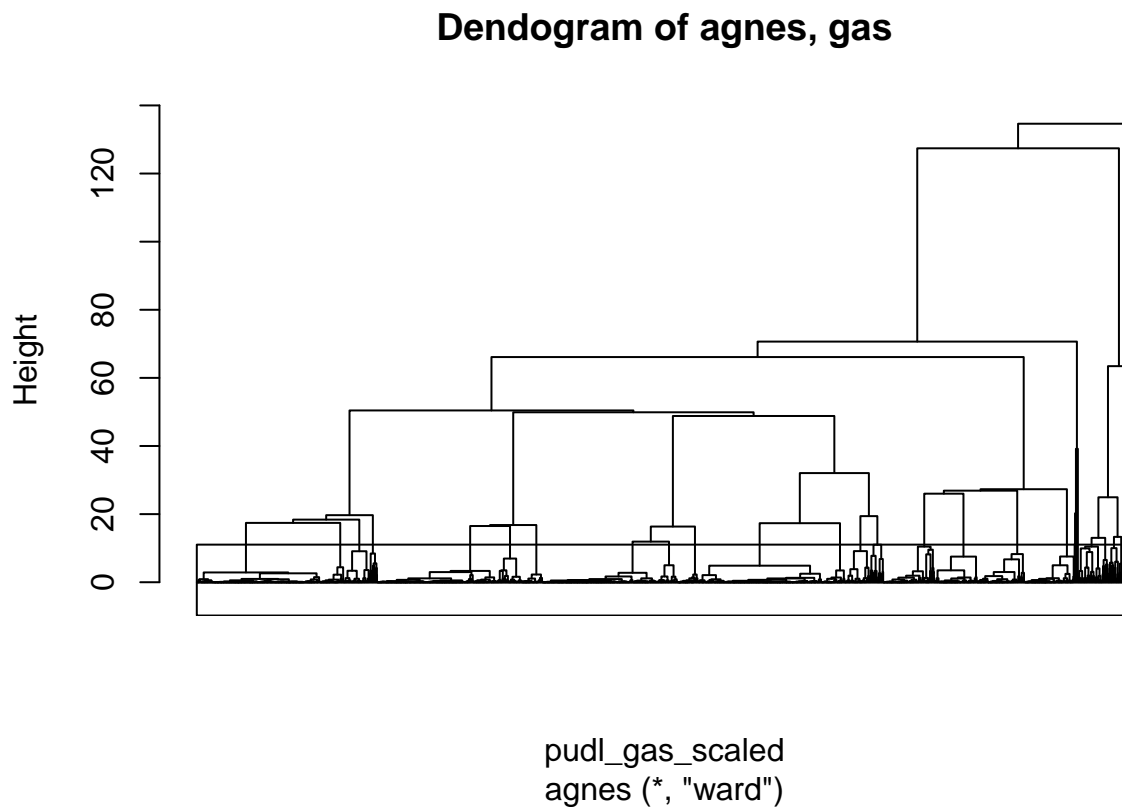
```
gas_clusters<- cutree(hc_ward_gas, k = 2)
gas_cluster1_indices <- which(gas_clusters == 1)
gas_cluster1_points <- pudl_gas_scaled[gas_cluster1_indices, ]
gas_cluster1_centroid <- colMeans(gas_cluster1_points, na.rm = TRUE)
gas_cluster1_centroid
```

```
##     fuel_received_units      fuel_mmbtu_per_unit      fuel_cost_per_mmbtu
##           0.1866798955            -0.8200720359             0.0084304969
##          contract_type_C          contract_type_NC          contract_type_S
##           0.2321253673             0.0030782146             0.7647964181
```

```
##       energy_source_code_NG       energy_source_code_PG       energy_source_code_OG
##               0.9986008115               0.0008395131               0.0004197565
##      energy_source_code_SGP       fuel_group_natural_gas       fuel_group_other_gas
##               0.0001399188               0.9986008115               0.0013991885
## primary_transportation_PL primary_transportation_TR primary_transportation_RR
##               0.8781306842               0.0002798377               0.0001399188
##                     winter                       fall                     spring
##               0.2577305163               0.2428991185               0.2419196866
##                     summer
##               0.2574506786
```

```
gas_clusters<- cutree(hc_ward_gas, k = 2)
gas_cluster2_indices <- which(gas_clusters == 2)
gas_cluster2_points <- pudl_gas_scaled[gas_cluster2_indices, ]
gas_cluster2_centroid <- colMeans(gas_cluster2_points, na.rm = TRUE)
gas_cluster2_centroid
```

```
##          fuel_received_units          fuel_mmbtu_per_unit          fuel_cost_per_mmbtu
##                   -0.2888144                   -0.8219319                   54.9770750
##               contract_type_C              contract_type_NC               contract_type_S
##                    0.0000000                    0.0000000                    1.0000000
##         energy_source_code_NG         energy_source_code_PG         energy_source_code_OG
##                    1.0000000                    0.0000000                    0.0000000
##        energy_source_code_SGP        fuel_group_natural_gas        fuel_group_other_gas
##                    0.0000000                    1.0000000                    0.0000000
## primary_transportation_PL primary_transportation_TR primary_transportation_RR
##                    1.0000000                    0.0000000                    0.0000000
##                       winter                         fall                       spring
##                    0.3333333                    0.0000000                    0.3333333
##                       summer
##                    0.3333333
```

```
all_gas_centroids<-data.frame(gas_cluster1_centroid, gas_cluster2_centroid)

all_gas_centroids<-t(all_gas_centroids)
```

```
set.seed(321)
hc_ward_all_fuel<-agnes(combined_pudl_scaled, method= "ward")
print(hc_ward_all_fuel$ac)
```

```
## [1] 0.9997024
```

```
pltree(hc_ward_all_fuel, cex = 0.6, hang = -1, main = "Dendogram of agnes, All Fuels", labels=FALSE)
rect.hclust(hc_ward_all_fuel, k=5, border = 1:5)
```

Dendogram of agnes, All Fuels
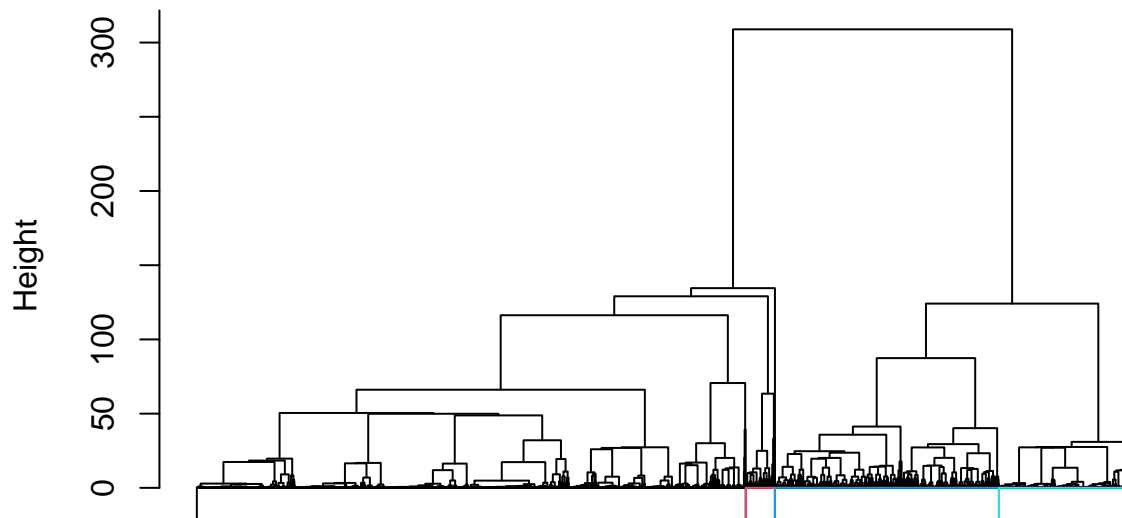
combined_pudl_scaled
agnes (*, "ward")

```
##cut tree where clusters are approximately same height
```

```
PUDL_clusters<- cutree(hc_ward_all_fuel, k = 6)
```

```
cluster1_indices <- which(PUDL_clusters == 1)
cluster1_points <- combined_pudl_scaled[cluster1_indices, ]
cluster1_centroid <- colMeans(cluster1_points, na.rm = TRUE)
cluster1_centroid
```

```
##       fuel_received_units      fuel_mmbtu_per_unit      sulfur_content_pct
##             -0.0751108952           -0.8200752516           -0.5073027491
##            ash_content_pct       fuel_cost_per_mmbtu          contract_type_C
##             -0.6698115025           -0.0270000428            0.2267103890
##           contract_type_NC          contract_type_S     energy_source_code_BIT
##              0.0032791772            0.7700104337            0.0000000000
##       energy_source_code_NG    energy_source_code_DFO    energy_source_code_SUB
##              0.9985094649            0.0000000000            0.0000000000
##      energy_source_code_LIG    energy_source_code_RFO     energy_source_code_WO
##              0.0000000000            0.0000000000            0.0000000000
##      energy_source_code_KER     energy_source_code_PC     energy_source_code_WC
##              0.0000000000            0.0000000000            0.0000000000
##       energy_source_code_PG     energy_source_code_OG     energy_source_code_JF
##              0.0008943211            0.0004471605            0.0000000000
##       energy_source_code_SC    energy_source_code_SGP              fuel_type_coal
##              0.0000000000            0.0001490535            0.0000000000
```

```
##         fuel_type_gas                    fuel_type_oil             fuel_group_coal
##          1.0000000000                     0.0000000000                0.0000000000
##    fuel_group_natural_gas           fuel_group_petroleum fuel_group_petroleum_coke
##          0.9985094649                     0.0000000000                0.0000000000
##       fuel_group_other_gas primary_transportation_RV primary_transportation_PL
##          0.0014905351                     0.0000000000                0.8734535698
## primary_transportation_TR primary_transportation_RR primary_transportation_TC
##          0.0002981070                     0.0001490535                0.0000000000
## primary_transportation_WT primary_transportation_TP primary_transportation_GL
##          0.0000000000                     0.0000000000                0.0000000000
##                winter                            fall                      spring
##          0.2603964823                     0.2434043822                0.2432553287
##                summer
##          0.2529438068
```

```r
cluster2_indices <- which(PUDL_clusters == 2)
cluster2_points <- combined_pudl_scaled[cluster2_indices, ]
cluster2_centroid <- colMeans(cluster2_points, na.rm = TRUE)
cluster2_centroid
```

```
##      fuel_received_units           fuel_mmbtu_per_unit            sulfur_content_pct
##            -0.2258417458                   1.4592509153                  1.4093957721
##           ash_content_pct             fuel_cost_per_mmbtu               contract_type_C
##             1.5000963360                  -0.0909710414                  0.7679645457
##           contract_type_NC               contract_type_S         energy_source_code_BIT
##             0.0056980057                   0.2263374486                  0.9401709402
##      energy_source_code_NG         energy_source_code_DFO         energy_source_code_SUB
##             0.0000000000                   0.0000000000                  0.0132953466
##      energy_source_code_LIG        energy_source_code_RFO          energy_source_code_WO
##             0.0234251345                   0.0000000000                  0.0000000000
##      energy_source_code_KER         energy_source_code_PC          energy_source_code_WC
##             0.0000000000                   0.0186767965                  0.0041152263
##       energy_source_code_PG         energy_source_code_OG          energy_source_code_JF
##             0.0000000000                   0.0000000000                  0.0000000000
##       energy_source_code_SC        energy_source_code_SGP                 fuel_type_coal
##             0.0003165559                   0.0000000000                  1.0000000000
##             fuel_type_gas                  fuel_type_oil                fuel_group_coal
##             0.0000000000                   0.0000000000                  0.9813232035
##    fuel_group_natural_gas           fuel_group_petroleum fuel_group_petroleum_coke
##             0.0000000000                   0.0000000000                  0.0186767965
##       fuel_group_other_gas primary_transportation_RV primary_transportation_PL
##             0.0000000000                   0.3206710984                  0.0000000000
## primary_transportation_TR primary_transportation_RR primary_transportation_TC
##             0.1677746122                   0.4571066793                  0.0123456790
## primary_transportation_WT primary_transportation_TP primary_transportation_GL
##             0.0075973409                   0.0018993352                  0.0006331117
##                   winter                           fall                     spring
##             0.2548274770                   0.2424817980                  0.2450142450
##                   summer
##             0.2576764799
```

```r
cluster3_indices <- which(PUDL_clusters == 3)
cluster3_points <- combined_pudl_scaled[cluster3_indices, ]
```

```r
cluster3_centroid <- colMeans(cluster3_points, na.rm = TRUE)
cluster3_centroid
```

```
##       fuel_received_units     fuel_mmbtu_per_unit       sulfur_content_pct
##             -0.1812331181            0.8470856542            -0.2244247243
##            ash_content_pct      fuel_cost_per_mmbtu           contract_type_C
##             0.3866814288           -0.1145906264             0.8386581470
##           contract_type_NC         contract_type_S     energy_source_code_BIT
##             0.0101171459            0.1512247071             0.0000000000
##        energy_source_code_NG   energy_source_code_DFO   energy_source_code_SUB
##             0.0000000000            0.0000000000             0.9994675186
##       energy_source_code_LIG   energy_source_code_RFO    energy_source_code_WO
##             0.0000000000            0.0000000000             0.0000000000
##       energy_source_code_KER    energy_source_code_PC    energy_source_code_WC
##             0.0000000000            0.0000000000             0.0005324814
##        energy_source_code_PG    energy_source_code_OG    energy_source_code_JF
##             0.0000000000            0.0000000000             0.0000000000
##        energy_source_code_SC   energy_source_code_SGP            fuel_type_coal
##             0.0000000000            0.0000000000             1.0000000000
##                fuel_type_gas            fuel_type_oil           fuel_group_coal
##             0.0000000000            0.0000000000             1.0000000000
##       fuel_group_natural_gas    fuel_group_petroleum fuel_group_petroleum_coke
##             0.0000000000            0.0000000000             0.0000000000
##         fuel_group_other_gas primary_transportation_RV primary_transportation_PL
##             0.0000000000            0.0031948882             0.0000000000
## primary_transportation_TR primary_transportation_RR primary_transportation_TC
##             0.0063897764            0.9664536741             0.0138445154
## primary_transportation_WT primary_transportation_TP primary_transportation_GL
##             0.0000000000            0.0000000000             0.0005324814
##                       winter                      fall                    spring
##             0.2646432375            0.2561235357             0.2385516507
##                       summer
##             0.2406815761
```

```r
cluster4_indices <- which(PUDL_clusters == 4)
cluster4_points <- combined_pudl_scaled[cluster4_indices, ]
cluster4_centroid <- colMeans(cluster4_points, na.rm = TRUE)
cluster4_centroid
```

```
##       fuel_received_units     fuel_mmbtu_per_unit       sulfur_content_pct
##             -0.2771541883           -0.3471732899            -0.4028943422
##            ash_content_pct      fuel_cost_per_mmbtu           contract_type_C
##             -0.6698115025            0.5220951321             0.4271938284
##           contract_type_NC         contract_type_S     energy_source_code_BIT
##             0.0009643202            0.5718418515             0.0000000000
##        energy_source_code_NG   energy_source_code_DFO   energy_source_code_SUB
##             0.0270009643            0.8939247830             0.0000000000
##       energy_source_code_LIG   energy_source_code_RFO    energy_source_code_WO
##             0.0000000000            0.0694310511             0.0067502411
##       energy_source_code_KER    energy_source_code_PC    energy_source_code_WC
##             0.0009643202            0.0000000000             0.0000000000
##        energy_source_code_PG    energy_source_code_OG    energy_source_code_JF
##             0.0000000000            0.0000000000             0.0019286403
```

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```
##      energy_source_code_SC     energy_source_code_SGP               fuel_type_coal
##             0.0000000000              0.0000000000                 0.0000000000
##             fuel_type_gas              fuel_type_oil               fuel_group_coal
##             0.0270009643              0.9729990357                 0.0000000000
##       fuel_group_natural_gas      fuel_group_petroleum   fuel_group_petroleum_coke
##             0.0270009643              0.9729990357                 0.0000000000
##       fuel_group_other_gas  primary_transportation_RV   primary_transportation_PL
##             0.0000000000              0.0192864031                 0.0945033751
## primary_transportation_TR  primary_transportation_RR   primary_transportation_TC
##             0.8534233365              0.0019286403                 0.0000000000
## primary_transportation_WT  primary_transportation_TP   primary_transportation_GL
##             0.0250723240              0.0000000000                 0.0000000000
##                   winter                      fall                       spring
##             0.2854387657              0.2160077146                 0.2777242044
##                   summer
##             0.2208293153
```

```r
cluster5_indices <- which(PUDL_clusters == 5)
cluster5_points <- combined_pudl_scaled[cluster5_indices, ]
cluster5_centroid <- colMeans(cluster5_points, na.rm = TRUE)
cluster5_centroid
```

```
##       fuel_received_units      fuel_mmbtu_per_unit          sulfur_content_pct
##                4.5024005               -0.8200760                  -0.5073027
##             ash_content_pct         fuel_cost_per_mmbtu             contract_type_C
##               -0.6698115               -0.0551753                   0.3195122
##             contract_type_NC           contract_type_S       energy_source_code_BIT
##                0.0000000                0.6804878                   0.0000000
##        energy_source_code_NG     energy_source_code_DFO      energy_source_code_SUB
##                1.0000000                0.0000000                   0.0000000
##        energy_source_code_LIG     energy_source_code_RFO       energy_source_code_WO
##                0.0000000                0.0000000                   0.0000000
##        energy_source_code_KER      energy_source_code_PC       energy_source_code_WC
##                0.0000000                0.0000000                   0.0000000
##         energy_source_code_PG      energy_source_code_OG       energy_source_code_JF
##                0.0000000                0.0000000                   0.0000000
##         energy_source_code_SC     energy_source_code_SGP               fuel_type_coal
##                0.0000000                0.0000000                   0.0000000
##             fuel_type_gas              fuel_type_oil               fuel_group_coal
##                1.0000000                0.0000000                   0.0000000
##       fuel_group_natural_gas      fuel_group_petroleum   fuel_group_petroleum_coke
##                1.0000000                0.0000000                   0.0000000
##       fuel_group_other_gas  primary_transportation_RV   primary_transportation_PL
##                0.0000000                0.0000000                   0.9512195
## primary_transportation_TR  primary_transportation_RR   primary_transportation_TC
##                0.0000000                0.0000000                   0.0000000
## primary_transportation_WT  primary_transportation_TP   primary_transportation_GL
##                0.0000000                0.0000000                   0.0000000
##                   winter                      fall                       spring
##                0.2097561                0.2365854                   0.2097561
##                   summer
##                0.3439024
```
```

```r
cluster6_indices <- which(PUDL_clusters == 6)
cluster6_points <- combined_pudl_scaled[cluster6_indices, ]
cluster6_centroid <- colMeans(cluster6_points, na.rm = TRUE)
cluster6_centroid
```

```
##          fuel_received_units        fuel_mmbtu_per_unit          sulfur_content_pct
##                   -0.2888144                 -0.8219319                  -0.5073027
##               ash_content_pct         fuel_cost_per_mmbtu              contract_type_C
##                   -0.6698115                 54.9770750                   0.0000000
##              contract_type_NC             contract_type_S         energy_source_code_BIT
##                    0.0000000                  1.0000000                   0.0000000
##        energy_source_code_NG       energy_source_code_DFO       energy_source_code_SUB
##                    1.0000000                  0.0000000                   0.0000000
##        energy_source_code_LIG       energy_source_code_RFO        energy_source_code_WO
##                    0.0000000                  0.0000000                   0.0000000
##        energy_source_code_KER        energy_source_code_PC        energy_source_code_WC
##                    0.0000000                  0.0000000                   0.0000000
##        energy_source_code_PG        energy_source_code_OG        energy_source_code_JF
##                    0.0000000                  0.0000000                   0.0000000
##        energy_source_code_SC       energy_source_code_SGP               fuel_type_coal
##                    0.0000000                  0.0000000                   0.0000000
##                fuel_type_gas               fuel_type_oil              fuel_group_coal
##                    1.0000000                  0.0000000                   0.0000000
##        fuel_group_natural_gas       fuel_group_petroleum fuel_group_petroleum_coke
##                    1.0000000                  0.0000000                   0.0000000
##        fuel_group_other_gas primary_transportation_RV primary_transportation_PL
##                    0.0000000                  0.0000000                   1.0000000
## primary_transportation_TR primary_transportation_RR primary_transportation_TC
##                    0.0000000                  0.0000000                   0.0000000
## primary_transportation_WT primary_transportation_TP primary_transportation_GL
##                    0.0000000                  0.0000000                   0.0000000
##                       winter                       fall                       spring
##                    0.3333333                  0.0000000                   0.3333333
##                       summer
##                    0.3333333
```

```r
all_centroids<-data.frame(cluster1_centroid, cluster2_centroid, cluster3_centroid, cluster4_centroid, c

all_centroids_pudl<-t(all_centroids)

##hierarchical clustering results in clusters primarily comprised of fuel types, with no strong tendency

## coal = clusters 2, 3. Between clusters 2 and 3, we see that the primary division is fuel type (bit,

##gas = clusters 1, 5, 6. Cluster 6 is gas, with very high fuel cost and primarily comprised of spot co

## oil = cluster 4. Primarily oil, with a small amount of natural gas. oil cost and fuel recieved are fa
```

```r
pca_result <- prcomp(combined_pudl_scaled)
summary(pca_result)
```

```
## Importance of components:
```

```
##                        PC1    PC2    PC3     PC4     PC5    PC6     PC7
## Standard deviation    1.9905 1.0119 0.9737 0.80292 0.64335 0.5832 0.50682
## Proportion of Variance 0.4602 0.1189 0.1101 0.07487 0.04807 0.0395 0.02983
## Cumulative Proportion  0.4602 0.5791 0.6892 0.76405 0.81212 0.8516 0.88145
##                         PC8     PC9    PC10    PC11    PC12    PC13    PC14
## Standard deviation    0.49878 0.49332 0.4741 0.28189 0.26590 0.23240 0.20144
## Proportion of Variance 0.02889 0.02826 0.0261 0.00923 0.00821 0.00627 0.00471
## Cumulative Proportion  0.91034 0.93861 0.9647 0.97394 0.98215 0.98842 0.99314
##                         PC15    PC16    PC17    PC18    PC19    PC20    PC21
## Standard deviation    0.11892 0.1059 0.08976 0.08229 0.08046 0.06133 0.04652
## Proportion of Variance 0.00164 0.0013 0.00094 0.00079 0.00075 0.00044 0.00025
## Cumulative Proportion  0.99478 0.9961 0.99701 0.99780 0.99855 0.99899 0.99924
##                         PC22    PC23    PC24    PC25    PC26    PC27    PC28
## Standard deviation    0.04332 0.03542 0.03485 0.02766 0.02071 0.01728 0.01490
## Proportion of Variance 0.00022 0.00015 0.00014 0.00009 0.00005 0.00003 0.00003
## Cumulative Proportion  0.99946 0.99960 0.99975 0.99983 0.99988 0.99992 0.99995
##                         PC29     PC30     PC31    PC32     PC33      PC34
## Standard deviation    0.01400 0.009861 0.009552 0.00940 2.254e-15 2.108e-15
## Proportion of Variance 0.00002 0.000010 0.000010 0.00001 0.000e+00 0.000e+00
## Cumulative Proportion  0.99997 0.999980 0.999990 1.00000 1.000e+00 1.000e+00
##                          PC35      PC36      PC37      PC38      PC39
## Standard deviation    1.317e-15 1.182e-15 5.513e-16 4.704e-16 2.353e-16
## Proportion of Variance 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
## Cumulative Proportion  1.000e+00 1.000e+00 1.000e+00 1.000e+00 1.000e+00
##                          PC40      PC41      PC42      PC43
## Standard deviation    1.887e-16 1.887e-16 1.887e-16 1.131e-16
## Proportion of Variance 0.000e+00 0.000e+00 0.000e+00 0.000e+00
## Cumulative Proportion  1.000e+00 1.000e+00 1.000e+00 1.000e+00
```

```
plot(pca_result, type = "l", main = "Scree Plot")
```

Scree Plot
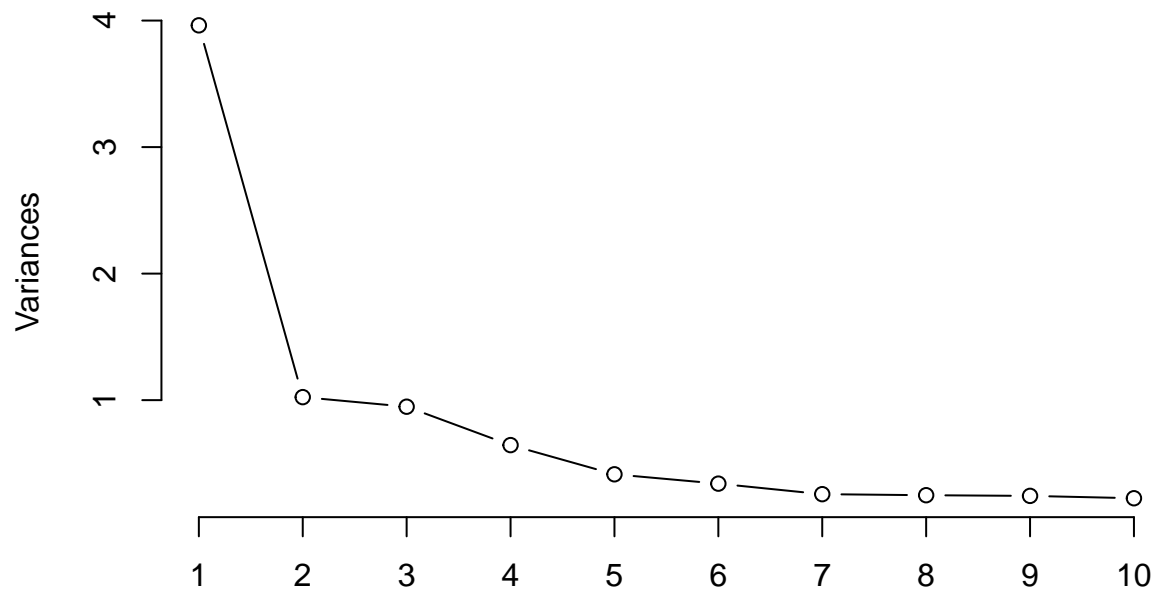

```r
loadings(pca_result)
```

```
## NULL
```

```r
print(loadings)
```

```
## function (x, ...)
## x$loadings
## <bytecode: 0x000002565f077148>
## <environment: namespace:stats>
```