Exercise 4

2024-04-05

Import Libraries

```
knitr::opts_chunk$set(tidy.opts=list(width.cutoff=60), format='latex', echo=TRUE)
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.4
## v forcats   1.0.0     v stringr   1.5.1
## v ggplot2   3.5.0     v tibble    3.2.1
## v lubridate 1.9.3     v tidyr     1.3.1
## v purrr     1.0.2
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(ggplot2)
library(lubridate)
library(arrow)
```

```
## Warning: package 'arrow' was built under R version 4.3.3
```

```
##
## Attaching package: 'arrow'
##
## The following object is masked from 'package:lubridate':
##
##     duration
##
## The following object is masked from 'package:utils':
##
##     timestamp
```

```
library(igraph)
```

```
##
## Attaching package: 'igraph'
##
## The following objects are masked from 'package:lubridate':
##
##     %--%, union
##
## The following objects are masked from 'package:dplyr':
##
##     as_data_frame, groups, union
##
## The following objects are masked from 'package:purrr':
```

```
##
##     compose, simplify
##
## The following object is masked from 'package:tidyr':
##
##     crossing
##
## The following object is masked from 'package:tibble':
##
##     as_data_frame
##
## The following objects are masked from 'package:stats':
##
##     decompose, spectrum
##
## The following object is masked from 'package:base':
##
##     union
```

Import Dataset

```
data_path = "/Users/lauray/Documents/GitHub/2024-ona-assignments/Exercise 3/672_project_data/app_data_s
applications = arrow::read_parquet(data_path)
attach(applications)
```

Adding gender to dataset

```
library(gender)

# get a list of first names without repetitions
examiner_names = applications %>%
  distinct(examiner_name_first)

examiner_names_gender = examiner_names %>%
  do(results = gender(.$examiner_name_first, method = "ssa")) %>%
  unnest(cols = c(results), keep_empty = TRUE) %>%
  select(
    examiner_name_first = name,
    gender,
    proportion_female
  )

examiner_names_gender
```

```
## # A tibble: 1,822 x 3
##    examiner_name_first gender proportion_female
##    <chr>               <chr>              <dbl>
##  1 AARON               male              0.0082
##  2 ABDEL               male              0
##  3 ABDOU               male              0
##  4 ABDUL               male              0
##  5 ABDULHAKIM          male              0
##  6 ABDULLAH            male              0
```

```
##  7 ABDULLAHI           male              0
##  8 ABIGAIL             female            0.998
##  9 ABIMBOLA            female            0.944
## 10 ABRAHAM             male              0.0031
## # i 1,812 more rows
```

```
gc()
```

```
##            used  (Mb) gc trigger  (Mb) limit (Mb) max used  (Mb)
## Ncells  1412540  75.5    2625580 140.3         NA  1731035  92.5
## Vcells 16188305 123.6   31136324 237.6      16384 31044745 236.9
```

```
# remove extra colums from the gender table
examiner_names_gender = examiner_names_gender %>%
  select(examiner_name_first, gender)

# joining gender back to the dataset
applications = applications %>%
  left_join(examiner_names_gender, by = "examiner_name_first")

# cleaning up
rm(examiner_names)
rm(examiner_names_gender)
gc()
```

```
##            used  (Mb) gc trigger  (Mb) limit (Mb) max used  (Mb)
## Ncells  4533934 242.2    8056292 430.3         NA  4553352 243.2
## Vcells 77803635 593.6  111731794 852.5      16384 79859751 609.3
```

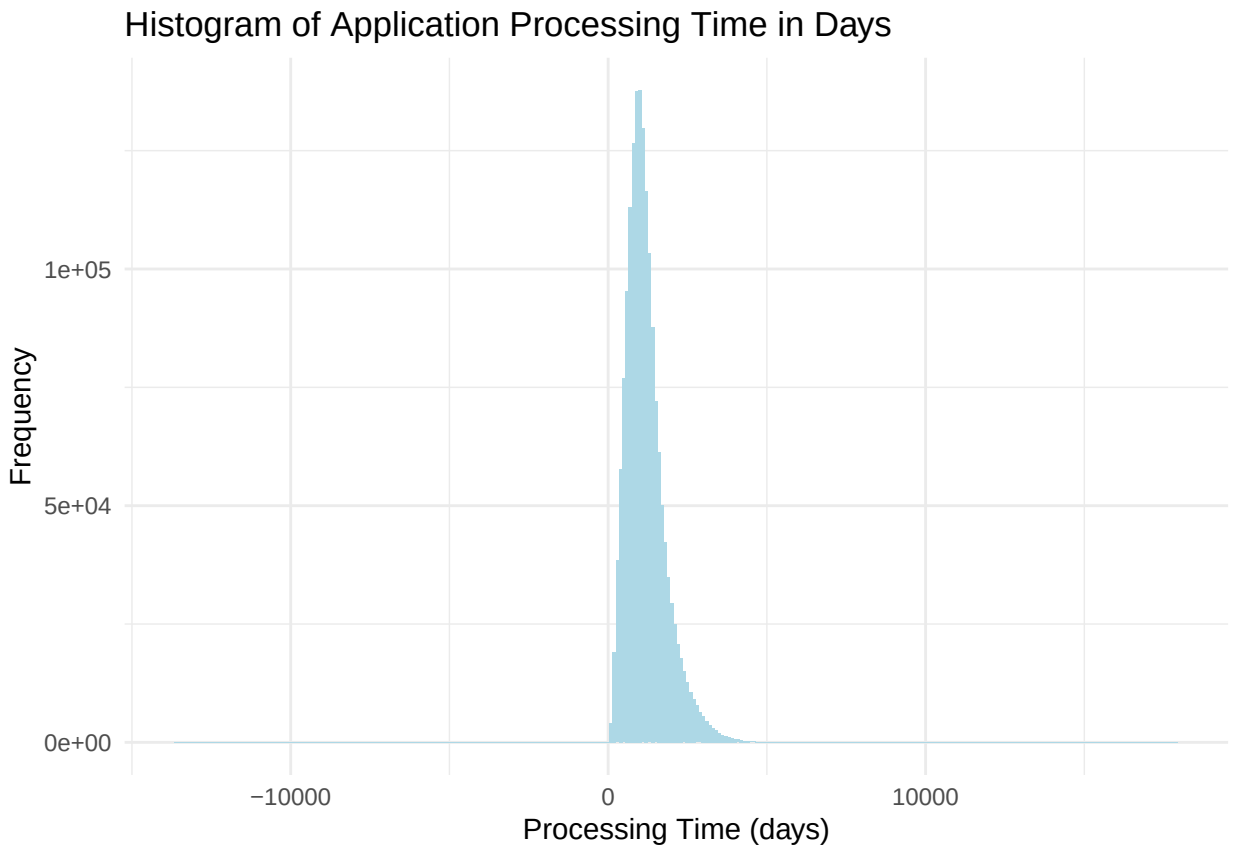
Add the column for Application processing time

```
# combine patent issue date & abandon_date as the final decision date
# decision_date = the earlier of patent_issue_date and abandon_date, ignoring NAs
applications$decision_date = pmin(applications$patent_issue_date, applications$abandon_date, na.rm = TRU

# Cannot get the application processing time when the decision date is missing
# drop NA in decision_date column
applications = drop_na(applications,decision_date)
attach(applications)
```

```
## The following objects are masked from applications (pos = 4):
##
##     abandon_date, appl_status_code, appl_status_date,
##     application_number, disposal_type, examiner_art_unit, examiner_id,
##     examiner_name_first, examiner_name_last, examiner_name_middle,
##     filing_date, patent_issue_date, patent_number, tc, uspc_class,
##     uspc_subclass
```

```
applications = applications %>%
  mutate(
    app_proc_time= as.numeric(ymd(decision_date) - ymd(filing_date)) # days
  )

# Histogram for the application processing days
ggplot(applications, aes(x = app_proc_time)) +
```

```
  geom_histogram(binwidth = 100, fill = "lightblue") +
  labs(title = "Histogram of Application Processing Time in Days",
       x = "Processing Time (days)",
       y = "Frequency") +
  theme_minimal()
```



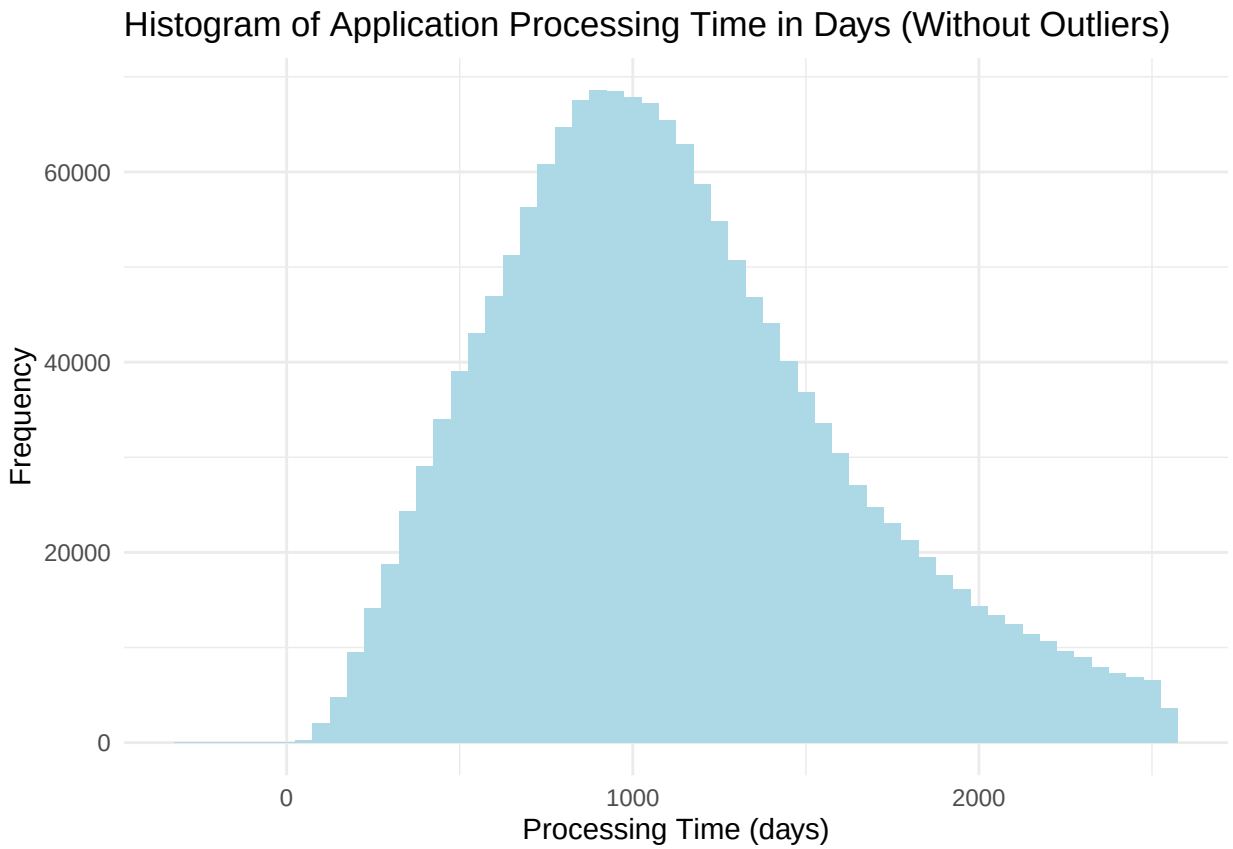

```
## Negative values in application processing time
# Calculate the total number of applications with negative processing times
neg_decision_date_counts = applications %>%
  filter(app_proc_time < 0) %>%
  summarise(total_negative_count = n())

neg_decision_date_counts
```

```
## # A tibble: 1 x 1
##   total_negative_count
##                  <int>
## 1                   35
```

```
# total negative count = 35
# small portion of the application processing time is negative
```

```
#Filter out the outliers to have a clearer distribution graph
# Calculate the IQR
Q1 = quantile(applications$app_proc_time, 0.25)
Q3 = quantile(applications$app_proc_time, 0.75)
IQR = Q3 - Q1
```

```r
# Define the upper and lower bounds for what is considered an outlier
upper_bound = Q3 + 1.5 * IQR
lower_bound = Q1 - 1.5 * IQR

# Filter out the outliers
applications_filtered = applications %>%
  filter(app_proc_time >= lower_bound & app_proc_time <= upper_bound)

# Now, create the histogram with the filtered data
ggplot(applications_filtered, aes(x = app_proc_time)) +
  geom_histogram(binwidth = 50, fill = "lightblue") +
  labs(title = "Histogram of Application Processing Time in Days (Without Outliers)",
       x = "Processing Time (days)",
       y = "Frequency") +
  theme_minimal()
```



The histogram shows the distribution of USPTO application processing times, peaking around 1000 days.

Choose closeness as the cenrtality measure

Reason: Examiners with high closeness centrality are typically better positioned to quickly receive and disseminate information across the network. This can lead to more efficient sharing of knowledge about patent laws, examination procedures, or technological advancements, potentially speeding up the examination process.
Closeness can facilitate easier collaboration among examiners. Those with higher centrality might find it easier to consult with colleagues, seek expert advice, or collaborate on complex cases, improving the quality and speed of patent examinations.

```
library(igraph)
edges_sample = read_csv("/Users/lauray/Documents/GitHub/2024-ona-assignments/Exercise 3/672_project_data
```

```
## Rows: 32906 Columns: 4
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr  (1): application_number
## dbl  (2): ego_examiner_id, alter_examiner_id
## date (1): advice_date
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
edges_sample = drop_na(edges_sample)
edges_sample = select(edges_sample, ego_examiner_id, alter_examiner_id)

g = graph_from_data_frame(edges_sample, directed = FALSE)

# Calculate closeness centrality
closeness_centrality = closeness(g)
centrality_df = data.frame(examiner_id = V(g)$name, closeness_centrality = closeness_centrality)
applications = merge(applications, centrality_df, by.x = "examiner_id", by.y = "examiner_id", all.x = TR

# many examiners do not have centrality
sum(is.na(applications$closeness_centrality))
```

```
## [1] 628526
```

```
# filter out the NAs on centrality measure
applications = drop_na(applications, closeness_centrality)
# Use the sample due to the computing complexity
set.seed(123)
applications = sample_n(applications, 50000)
attach(applications)
```

```
## The following object is masked _by_ .GlobalEnv:
##
##     closeness_centrality
##
## The following objects are masked from applications (pos = 3):
##
##     abandon_date, appl_status_code, appl_status_date,
##     application_number, decision_date, disposal_type,
##     examiner_art_unit, examiner_id, examiner_name_first,
##     examiner_name_last, examiner_name_middle, filing_date, gender,
##     patent_issue_date, patent_number, tc, uspc_class, uspc_subclass
##
## The following objects are masked from applications (pos = 5):
##
##     abandon_date, appl_status_code, appl_status_date,
##     application_number, disposal_type, examiner_art_unit, examiner_id,
##     examiner_name_first, examiner_name_last, examiner_name_middle,
##     filing_date, patent_issue_date, patent_number, tc, uspc_class,
##     uspc_subclass
```

Columns may affect the model result:

1. Examiner Art Unit: This relates to the specific technology or subject matter area that the examiner specializes in. Different art units may have varying complexities or average processing times.
2. USPC Class: Certain classes may inherently take longer to assess due to technical complexity or other factors.
3. Disposal Type: This indicates how an application was concluded (e.g., granted, abandoned). Different disposal types could be associated with different lengths of processing times.
4. Application Status Code: This reflects the current status of the application (e.g., pending, approved). The status could influence the processing time due to varying workflows and requirements at different stages.
5. TC (Technology Center): Each TC within the USPTO handles a broad area of technology and may have different workloads and processing speeds.
6. Gender: Gender may be included to explore demographic differences in processing times, which could reflect diverse work styles or systemic biases.

```r
# "examiner_art_unit","uspc_class","disposal_type","appl_status_code", "tc", "gender", "closeness_centr

# Subset the dataframe to include only the specified columns and y
selected_columns <- c("examiner_art_unit", "uspc_class", "disposal_type","appl_status_code", "tc", "app

applications_subset <- applications %>%
  select(all_of(selected_columns)) %>%
  drop_na()

# Convert categorical variables to dummy variables
categorical_columns <- c("gender", "examiner_art_unit", "uspc_class", "disposal_type","appl_status_code
applications_subset_matrix <- applications_subset %>%
  mutate(across(c(examiner_art_unit, uspc_class, disposal_type,appl_status_code, tc), factor)) %>%
  model.matrix(~ . - app_proc_time - 1, data = .)
applications_feature = as.data.frame(applications_subset_matrix)

y <- applications_subset$app_proc_time

set.seed(123)
lm_model <- lm(y~., data = applications_feature)
options(max.print = 10000)
summary(lm_model)
```

```
##
## Call:
## lm(formula = y ~ ., data = applications_feature)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5825.1  -361.6   -76.2   265.1  4327.6
##
## Coefficients: (4 not defined because of singularities)
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)             255.3807   619.2893   0.412 0.680065
## examiner_art_unit1600   574.5574   311.1562   1.847 0.064823 .
## examiner_art_unit1609   322.4477   606.5126   0.532 0.594977
## examiner_art_unit1611   838.6231   215.0148   3.900 9.62e-05 ***
## examiner_art_unit1612   809.4768   213.3648   3.794 0.000149 ***
## examiner_art_unit1613   642.3435   216.5838   2.966 0.003021 **
## examiner_art_unit1614   385.8490   210.3474   1.834 0.066610 .
## examiner_art_unit1615   650.4891   209.6980   3.102 0.001923 **
```

```
## examiner_art_unit1616  539.8059   208.5954   2.588 0.009662 **
## examiner_art_unit1617  757.7414   212.2870   3.569 0.000358 ***
## examiner_art_unit1618  888.4367   210.7721   4.215 2.50e-05 ***
## examiner_art_unit1619  569.6934   234.0608   2.434 0.014939 *
## examiner_art_unit1621  518.2868   212.4728   2.439 0.014719 *
## examiner_art_unit1622  470.4308   221.2096   2.127 0.033457 *
## examiner_art_unit1623  519.3070   210.2620   2.470 0.013522 *
## examiner_art_unit1624  334.5509   210.2457   1.591 0.111564
## examiner_art_unit1625  492.5869   210.0113   2.346 0.019005 *
## examiner_art_unit1626  276.4231   209.5793   1.319 0.187195
## examiner_art_unit1627  477.2924   215.1643   2.218 0.026542 *
## examiner_art_unit1628  612.1745   210.9308   2.902 0.003707 **
## examiner_art_unit1629  516.7494   213.2646   2.423 0.015395 *
## examiner_art_unit1631  568.7861   208.2553   2.731 0.006313 **
## examiner_art_unit1632  611.9804   210.3822   2.909 0.003629 **
## examiner_art_unit1633  696.6652   208.9441   3.334 0.000856 ***
## examiner_art_unit1634  592.0834   209.4003   2.828 0.004693 **
## examiner_art_unit1635  545.3185   210.5784   2.590 0.009611 **
## examiner_art_unit1636  438.3197   215.0577   2.038 0.041541 *
## examiner_art_unit1637  559.0332   210.1488   2.660 0.007813 **
## examiner_art_unit1638  468.7624   214.5366   2.185 0.028894 *
## examiner_art_unit1639  797.0959   222.2303   3.587 0.000335 ***
## examiner_art_unit1641  603.8100   210.3083   2.871 0.004093 **
## examiner_art_unit1642  606.7836   210.3338   2.885 0.003918 **
## examiner_art_unit1643  719.7031   209.2660   3.439 0.000584 ***
## examiner_art_unit1644  586.7346   208.0909   2.820 0.004810 **
## examiner_art_unit1645  576.5006   209.1081   2.757 0.005837 **
## examiner_art_unit1646  457.9494   208.9802   2.191 0.028432 *
## examiner_art_unit1647  495.1061   210.4096   2.353 0.018624 *
## examiner_art_unit1648  593.0548   209.1107   2.836 0.004569 **
## examiner_art_unit1649  627.0786   211.0111   2.972 0.002962 **
## examiner_art_unit1651  557.4059   210.3102   2.650 0.008043 **
## examiner_art_unit1652  568.0884   208.6353   2.723 0.006474 **
## examiner_art_unit1653  581.3950   210.1272   2.767 0.005662 **
## examiner_art_unit1654  507.8474   210.1609   2.416 0.015676 *
## examiner_art_unit1655  543.3689   211.0758   2.574 0.010048 *
## examiner_art_unit1656  497.9853   208.7423   2.386 0.017054 *
## examiner_art_unit1657  589.0450   210.5761   2.797 0.005155 **
## examiner_art_unit1658  500.7809   280.8517   1.783 0.074580 .
## examiner_art_unit1661  477.8381   248.1966   1.925 0.054206 .
## examiner_art_unit1662  545.5796   228.4152   2.389 0.016920 *
## examiner_art_unit1663  307.6863   230.1616   1.337 0.181286
## examiner_art_unit1671  665.9800   223.3190   2.982 0.002864 **
## examiner_art_unit1672  118.7680   230.2316   0.516 0.605953
## examiner_art_unit1673  285.8061   214.5542   1.332 0.182837
## examiner_art_unit1674  485.6722   215.5637   2.253 0.024262 *
## examiner_art_unit1675  319.0249   219.3627   1.454 0.145863
## examiner_art_unit1676  322.4055   268.7105   1.200 0.230214
## examiner_art_unit1677  674.0444   237.0215   2.844 0.004460 **
## examiner_art_unit1678  722.6112   222.9345   3.241 0.001191 **
## examiner_art_unit1709 -259.9163   607.7750  -0.428 0.668907
## examiner_art_unit1711  442.2976   209.6032   2.110 0.034850 *
## examiner_art_unit1712  529.1925   209.1795   2.530 0.011415 *
## examiner_art_unit1713  386.9430   209.5112   1.847 0.064771 .
```

```
## examiner_art_unit1714  434.7133   209.7585   2.072 0.038230 *
## examiner_art_unit1715  490.0398   211.3617   2.318 0.020427 *
## examiner_art_unit1716  737.1735   211.6298   3.483 0.000496 ***
## examiner_art_unit1717  531.0315   215.8096   2.461 0.013873 *
## examiner_art_unit1718  663.6646   238.9388   2.778 0.005479 **
## examiner_art_unit1721  372.8925   212.5713   1.754 0.079404 .
## examiner_art_unit1722  470.1282   210.1798   2.237 0.025305 *
## examiner_art_unit1723  396.1226   209.9715   1.887 0.059227 .
## examiner_art_unit1724  434.6597   210.2104   2.068 0.038671 *
## examiner_art_unit1725  453.7356   212.3484   2.137 0.032624 *
## examiner_art_unit1726  498.8205   214.7189   2.323 0.020177 *
## examiner_art_unit1727  729.8688   213.1797   3.424 0.000618 ***
## examiner_art_unit1728  559.5083   241.4829   2.317 0.020510 *
## examiner_art_unit1729 1003.7750   223.4580   4.492 7.07e-06 ***
## examiner_art_unit1731  288.0567   210.3475   1.369 0.170871
## examiner_art_unit1732  490.0262   209.6259   2.338 0.019411 *
## examiner_art_unit1733  519.0362   210.8033   2.462 0.013813 *
## examiner_art_unit1734  331.6151   209.5263   1.583 0.113500
## examiner_art_unit1735  669.5000   215.6715   3.104 0.001909 **
## examiner_art_unit1736  313.7145   210.6169   1.490 0.136362
## examiner_art_unit1741  305.4809   212.7771   1.436 0.151099
## examiner_art_unit1742  473.8312   209.9639   2.257 0.024030 *
## examiner_art_unit1743  462.2876   209.2315   2.209 0.027148 *
## examiner_art_unit1744  489.8430   210.2372   2.330 0.019813 *
## examiner_art_unit1745  364.1069   209.7726   1.736 0.082620 .
## examiner_art_unit1746  308.6052   210.3450   1.467 0.142346
## examiner_art_unit1747  806.8872   216.0316   3.735 0.000188 ***
## examiner_art_unit1751  243.7868   213.0865   1.144 0.252599
## examiner_art_unit1752  175.2236   217.5993   0.805 0.420675
## examiner_art_unit1753  193.1099   213.6412   0.904 0.366055
## examiner_art_unit1754  438.3989   211.3102   2.075 0.038023 *
## examiner_art_unit1755  217.6447   210.4595   1.034 0.301076
## examiner_art_unit1756  410.7867   211.1683   1.945 0.051745 .
## examiner_art_unit1757  349.9413   280.6519   1.247 0.212446
## examiner_art_unit1758 1281.2949   266.0349   4.816 1.47e-06 ***
## examiner_art_unit1759  296.1859   216.6930   1.367 0.171681
## examiner_art_unit1761  389.5462   209.0009   1.864 0.062350 .
## examiner_art_unit1762  325.1748   208.4165   1.560 0.118716
## examiner_art_unit1763  368.2498   211.6977   1.740 0.081953 .
## examiner_art_unit1764  517.2058   209.3257   2.471 0.013484 *
## examiner_art_unit1765  419.6627   208.6924   2.011 0.044341 *
## examiner_art_unit1766  449.5608   214.3440   2.097 0.035966 *
## examiner_art_unit1767  609.8886   214.2786   2.846 0.004426 **
## examiner_art_unit1768  630.1318   227.4811   2.770 0.005607 **
## examiner_art_unit1771  578.1951   210.3767   2.748 0.005992 **
## examiner_art_unit1772  524.8984   210.1935   2.497 0.012521 *
## examiner_art_unit1773  574.2169   209.3875   2.742 0.006102 **
## examiner_art_unit1774  493.5805   209.7637   2.353 0.018626 *
## examiner_art_unit1775  549.5692   209.4703   2.624 0.008703 **
## examiner_art_unit1776  612.3226   212.3897   2.883 0.003941 **
## examiner_art_unit1777  683.2665   212.6545   3.213 0.001314 **
## examiner_art_unit1778  614.2510   212.6069   2.889 0.003865 **
## examiner_art_unit1779  657.0617   218.6741   3.005 0.002660 **
## examiner_art_unit1781  739.5806   214.5937   3.446 0.000569 ***
```

```
## examiner_art_unit1782  972.9901   214.2764   4.541 5.62e-06 ***
## examiner_art_unit1783  909.2621   214.8182   4.233 2.31e-05 ***
## examiner_art_unit1784  691.3546   212.7475   3.250 0.001156 **
## examiner_art_unit1785  713.5649   212.3185   3.361 0.000778 ***
## examiner_art_unit1786  879.1316   211.5297   4.156 3.24e-05 ***
## examiner_art_unit1787  755.9621   211.7153   3.571 0.000356 ***
## examiner_art_unit1788  828.9592   212.7497   3.896 9.78e-05 ***
## examiner_art_unit1789 1051.9249   218.5686   4.813 1.49e-06 ***
## examiner_art_unit1791  695.0596   208.8306   3.328 0.000874 ***
## examiner_art_unit1792  634.2078   208.5330   3.041 0.002357 **
## examiner_art_unit1793  623.1494   208.6021   2.987 0.002816 **
## examiner_art_unit1794  835.8004   208.3666   4.011 6.05e-05 ***
## examiner_art_unit1795  694.8225   208.9664   3.325 0.000885 ***
## examiner_art_unit1796  626.3588   208.0199   3.011 0.002605 **
## examiner_art_unit1797  694.6623   207.5835   3.346 0.000819 ***
## examiner_art_unit1798  605.9149   218.3960   2.774 0.005533 **
## examiner_art_unit1799  647.9127   223.1861   2.903 0.003698 **
## examiner_art_unit2100 -607.3938   600.8268  -1.011 0.312056
## examiner_art_unit2111  338.3551   189.0648   1.790 0.073521 .
## examiner_art_unit2112  416.9533   194.7646   2.141 0.032295 *
## examiner_art_unit2113  417.8879   196.5843   2.126 0.033530 *
## examiner_art_unit2114  432.4577   197.9180   2.185 0.028892 *
## examiner_art_unit2115  148.9816   187.7442   0.794 0.427471
## examiner_art_unit2116  299.6715   186.1244   1.610 0.107392
## examiner_art_unit2117  267.7375   197.5028   1.356 0.175229
## examiner_art_unit2118  187.7704   239.8899   0.783 0.433787
## examiner_art_unit2121  479.1160   198.9677   2.408 0.016044 *
## examiner_art_unit2122  424.6113   208.9703   2.032 0.042168 *
## examiner_art_unit2123  595.6560   212.0679   2.809 0.004975 **
## examiner_art_unit2124  229.2513   208.3167   1.100 0.271123
## examiner_art_unit2125  283.4733   205.4371   1.380 0.167639
## examiner_art_unit2126  498.8301   206.7604   2.413 0.015843 *
## examiner_art_unit2127  477.5863   206.0900   2.317 0.020488 *
## examiner_art_unit2128  494.4355   209.4335   2.361 0.018239 *
## examiner_art_unit2129  305.9491   207.2139   1.476 0.139820
## examiner_art_unit2131  733.4373   194.7731   3.766 0.000166 ***
## examiner_art_unit2132  402.5521   199.9893   2.013 0.044135 *
## examiner_art_unit2133  511.4829   200.4066   2.552 0.010707 *
## examiner_art_unit2134  791.0624   195.8503   4.039 5.37e-05 ***
## examiner_art_unit2135  430.7415   199.7127   2.157 0.031026 *
## examiner_art_unit2136  674.5964   199.8875   3.375 0.000739 ***
## examiner_art_unit2137  611.6284   193.2628   3.165 0.001553 **
## examiner_art_unit2138  411.7407   197.9216   2.080 0.037502 *
## examiner_art_unit2139  691.1340   234.0689   2.953 0.003152 **
## examiner_art_unit2141  369.8259   195.6751   1.890 0.058765 .
## examiner_art_unit2142  515.3134   197.3283   2.611 0.009019 **
## examiner_art_unit2143  465.7067   198.2987   2.349 0.018853 *
## examiner_art_unit2144  558.7685   203.5424   2.745 0.006050 **
## examiner_art_unit2145  608.5765   202.5872   3.004 0.002666 **
## examiner_art_unit2146  247.4321   315.1797   0.785 0.432428
## examiner_art_unit2151  446.4164   203.1505   2.197 0.027993 *
## examiner_art_unit2152  332.2263   208.1354   1.596 0.110451
## examiner_art_unit2153  369.3498   197.9541   1.866 0.062071 .
## examiner_art_unit2154  300.8180   194.2435   1.549 0.121470
```

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## examiner_art_unit2155  237.4411   191.7658   1.238 0.215655
## examiner_art_unit2156  277.6047   196.9324   1.410 0.158652
## examiner_art_unit2157  464.7184   192.9448   2.409 0.016020 *
## examiner_art_unit2158  611.4274   198.6589   3.078 0.002087 **
## examiner_art_unit2159  361.6334   195.2139   1.852 0.063961 .
## examiner_art_unit2161  482.3090   193.1984   2.496 0.012548 *
## examiner_art_unit2162  265.8030   192.4286   1.381 0.167192
## examiner_art_unit2163  413.3904   193.5724   2.136 0.032719 *
## examiner_art_unit2164  467.2847   200.8738   2.326 0.020009 *
## examiner_art_unit2165  441.6438   194.5572   2.270 0.023213 *
## examiner_art_unit2166  701.8059   198.8575   3.529 0.000417 ***
## examiner_art_unit2167  494.5890   195.0428   2.536 0.011223 *
## examiner_art_unit2168  417.3341   194.9365   2.141 0.032290 *
## examiner_art_unit2169  554.6742   195.5111   2.837 0.004555 **
## examiner_art_unit2171  173.6115   203.6260   0.853 0.393886
## examiner_art_unit2172  260.4875   204.8979   1.271 0.203628
## examiner_art_unit2173  187.0057   206.2631   0.907 0.364604
## examiner_art_unit2174  448.8511   198.0057   2.267 0.023404 *
## examiner_art_unit2175  283.1035   198.8467   1.424 0.154533
## examiner_art_unit2176  446.7826   196.6652   2.272 0.023104 *
## examiner_art_unit2177  520.2413   198.5735   2.620 0.008799 **
## examiner_art_unit2178  583.4358   196.8051   2.965 0.003033 **
## examiner_art_unit2179  470.1275   201.9719   2.328 0.019933 *
## examiner_art_unit2181  319.5148   192.9790   1.656 0.097791 .
## examiner_art_unit2182  445.3424   191.9911   2.320 0.020367 *
## examiner_art_unit2183  549.7327   194.3753   2.828 0.004683 **
## examiner_art_unit2184  420.0809   192.5007   2.182 0.029098 *
## examiner_art_unit2185  464.2405   189.1749   2.454 0.014131 *
## examiner_art_unit2186  509.9975   196.0713   2.601 0.009296 **
## examiner_art_unit2187  510.8159   191.4672   2.668 0.007636 **
## examiner_art_unit2188  460.6211   194.4249   2.369 0.017834 *
## examiner_art_unit2189  512.7801   194.3069   2.639 0.008318 **
## examiner_art_unit2191  389.0404   199.6747   1.948 0.051377 .
## examiner_art_unit2192  650.1983   200.1074   3.249 0.001158 **
## examiner_art_unit2193  611.6089   195.7912   3.124 0.001787 **
## examiner_art_unit2194  561.0854   201.6642   2.782 0.005400 **
## examiner_art_unit2195  924.5728   203.3026   4.548 5.44e-06 ***
## examiner_art_unit2196  535.4020   212.8926   2.515 0.011911 *
## examiner_art_unit2197  502.6660   221.2552   2.272 0.023099 *
## examiner_art_unit2198  443.0447   224.3386   1.975 0.048287 *
## examiner_art_unit2199  445.1551   205.5509   2.166 0.030342 *
## examiner_art_unit2400   48.4817   418.3020   0.116 0.907731
## examiner_art_unit2411  118.3021   210.8688   0.561 0.574785
## examiner_art_unit2412  207.3435   203.3007   1.020 0.307789
## examiner_art_unit2413  477.9284   215.0154   2.223 0.026237 *
## examiner_art_unit2414  313.6304   208.1079   1.507 0.131804
## examiner_art_unit2416  762.6567   199.0021   3.832 0.000127 ***
## examiner_art_unit2419  707.7313   202.2724   3.499 0.000468 ***
## examiner_art_unit2421  165.6287   212.9190   0.778 0.436635
## examiner_art_unit2422 -206.1234   199.7371  -1.032 0.302090
## examiner_art_unit2423  227.8588   213.9560   1.065 0.286891
## examiner_art_unit2424  412.0616   212.0498   1.943 0.051995 .
## examiner_art_unit2425  308.1294   216.1873   1.425 0.154081
## examiner_art_unit2426  100.7398   225.2059   0.447 0.654644
```

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## examiner_art_unit2427  221.3335   211.5754   1.046 0.295511
## examiner_art_unit2431  549.8460   189.3115   2.904 0.003681 **
## examiner_art_unit2432  580.9301   195.3409   2.974 0.002942 **
## examiner_art_unit2433  593.8274   195.1015   3.044 0.002338 **
## examiner_art_unit2434  575.9902   192.2371   2.996 0.002735 **
## examiner_art_unit2435  392.4512   191.5734   2.049 0.040511 *
## examiner_art_unit2436  473.7679   187.0061   2.533 0.011299 *
## examiner_art_unit2437  533.2765   187.4126   2.845 0.004437 **
## examiner_art_unit2438  330.3655   202.2197   1.634 0.102330
## examiner_art_unit2439  675.0735   187.4405   3.602 0.000317 ***
## examiner_art_unit2441   50.4107   193.5951   0.260 0.794562
## examiner_art_unit2442  383.9869   194.6895   1.972 0.048581 *
## examiner_art_unit2443  369.4479   190.2112   1.942 0.052107 .
## examiner_art_unit2444  444.8625   192.1056   2.316 0.020578 *
## examiner_art_unit2445  588.3753   192.4750   3.057 0.002238 **
## examiner_art_unit2446  459.2329   203.6841   2.255 0.024161 *
## examiner_art_unit2447   21.8294   194.8788   0.112 0.910812
## examiner_art_unit2448  235.3729   191.7962   1.227 0.219753
## examiner_art_unit2449   19.4689   220.3179   0.088 0.929585
## examiner_art_unit2451  372.6452   193.0863   1.930 0.053621 .
## examiner_art_unit2452  390.9210   195.1213   2.003 0.045132 *
## examiner_art_unit2453  478.9063   188.8257   2.536 0.011209 *
## examiner_art_unit2454  158.1907   190.3063   0.831 0.405841
## examiner_art_unit2455  234.4813   191.2267   1.226 0.220132
## examiner_art_unit2456  444.9917   193.3946   2.301 0.021399 *
## examiner_art_unit2457  142.2297   189.8291   0.749 0.453710
## examiner_art_unit2458  342.3516   208.2266   1.644 0.100157
## examiner_art_unit2461  403.1176   200.3214   2.012 0.044189 *
## examiner_art_unit2462  487.3855   197.5555   2.467 0.013626 *
## examiner_art_unit2463  376.6081   200.0994   1.882 0.059829 .
## examiner_art_unit2464  363.1277   199.4393   1.821 0.068653 .
## examiner_art_unit2465  308.7149   199.6898   1.546 0.122119
## examiner_art_unit2466  572.6541   200.0373   2.863 0.004202 **
## examiner_art_unit2467  447.1972   198.7081   2.251 0.024421 *
## examiner_art_unit2468  601.2319   205.7963   2.921 0.003485 **
## examiner_art_unit2469  332.9274   196.9544   1.690 0.090963 .
## examiner_art_unit2471  255.0802   197.5981   1.291 0.196744
## examiner_art_unit2472  295.2107   201.6345   1.464 0.143177
## examiner_art_unit2473  381.2606   199.8383   1.908 0.056418 .
## examiner_art_unit2474  417.7367   199.1191   2.098 0.035918 *
## examiner_art_unit2475  420.7915   199.9560   2.104 0.035348 *
## examiner_art_unit2476  333.0429   198.4651   1.678 0.093336 .
## examiner_art_unit2477  591.0851   200.2113   2.952 0.003156 **
## examiner_art_unit2478  548.4849   199.6915   2.747 0.006023 **
## examiner_art_unit2479  317.4937   222.9654   1.424 0.154466
## examiner_art_unit2481 -101.7709   219.5695  -0.464 0.643007
## examiner_art_unit2482  822.7051   216.8551   3.794 0.000149 ***
## examiner_art_unit2483  286.7384   206.4870   1.389 0.164946
## examiner_art_unit2484 -180.3000   218.3462  -0.826 0.408949
## examiner_art_unit2485  180.7920   224.5901   0.805 0.420832
## examiner_art_unit2486  187.4687   208.6612   0.898 0.368958
## examiner_art_unit2487 -235.7971   210.3439  -1.121 0.262291
## examiner_art_unit2488 -193.0105   209.8538  -0.920 0.357715
## examiner_art_unit2491  462.5862   205.5397   2.251 0.024416 *
```

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## examiner_art_unit2492  615.0675   190.4780   3.229 0.001243 **
## examiner_art_unit2493  325.9615   194.7843   1.673 0.094246 .
## examiner_art_unit2494  558.9516   198.1864   2.820 0.004800 **
## examiner_art_unit2495  263.1686   212.2870   1.240 0.215099
## examiner_art_unit2496  225.7720   225.0621   1.003 0.315792
## examiner_art_unit2497  436.1564   233.1289   1.871 0.061368 .
## examiner_art_unit2498       NA         NA      NA       NA
## uspc_class008          155.3700   575.5405   0.270 0.787196
## uspc_class015         -224.4699   576.7206  -0.389 0.697117
## uspc_class023          -10.6103   617.8585  -0.017 0.986299
## uspc_class028          381.1268   809.0299   0.471 0.637578
## uspc_class029           86.0343   579.6733   0.148 0.882013
## uspc_class030          983.8736   808.6041   1.217 0.223704
## uspc_class034          579.4294   700.5982   0.827 0.408214
## uspc_class036          770.2119   809.5705   0.951 0.341415
## uspc_class044         -195.2192   579.8441  -0.337 0.736363
## uspc_class048          294.9854   578.8700   0.510 0.610343
## uspc_class051            9.2743   576.3864   0.016 0.987162
## uspc_class052          584.1706   700.4076   0.834 0.404261
## uspc_class053          -91.0036   808.3657  -0.113 0.910366
## uspc_class055         -186.5195   577.3752  -0.323 0.746661
## uspc_class060           -0.9977   639.3725  -0.002 0.998755
## uspc_class065          314.4748   574.5441   0.547 0.584143
## uspc_class068          266.7980   575.9271   0.463 0.643188
## uspc_class070          231.5394   707.9454   0.327 0.743625
## uspc_class071          -28.0291   582.3797  -0.048 0.961614
## uspc_class072           29.0323   700.0737   0.041 0.966921
## uspc_class073           -7.8988   660.1791  -0.012 0.990454
## uspc_class075          -67.6286   573.6656  -0.118 0.906157
## uspc_class082         -383.9994   808.9195  -0.475 0.634999
## uspc_class083          113.0429   808.6761   0.140 0.888828
## uspc_class095         -225.3092   574.6891  -0.392 0.695020
## uspc_class096         -203.9316   575.3316  -0.354 0.722997
## uspc_class099         -175.8528   579.5165  -0.303 0.761550
## uspc_class100            9.6772   808.5892   0.012 0.990451
## uspc_class101           90.2605   808.4435   0.112 0.911104
## uspc_class106          -30.0806   572.9400  -0.053 0.958129
## uspc_class117          140.1393   574.3755   0.244 0.807243
## uspc_class118          188.0913   573.3773   0.328 0.742882
## uspc_class119          357.8466   700.9953   0.510 0.609715
## uspc_class123         -302.6783   808.5489  -0.374 0.708148
## uspc_class127         -136.3030   597.5757  -0.228 0.819575
## uspc_class128            0.3593   639.9653   0.001 0.999552
## uspc_class131           26.6086   576.5146   0.046 0.963188
## uspc_class134          113.8396   573.2580   0.199 0.842590
## uspc_class136          199.8845   575.0215   0.348 0.728133
## uspc_class137           41.0104   702.5238   0.058 0.953450
## uspc_class141           11.5564   700.3156   0.017 0.986834
## uspc_class148           29.2587   572.3090   0.051 0.959227
## uspc_class149          421.5072   579.0725   0.728 0.466678
## uspc_class152          -40.7629   573.4345  -0.071 0.943330
## uspc_class156           71.4811   572.0576   0.125 0.900560
## uspc_class159          416.5142   639.7941   0.651 0.515042
## uspc_class162           30.4363   574.6286   0.053 0.957759
```

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## uspc_class164        -310.6596   577.7265  -0.538 0.590768
## uspc_class169        -624.3750   808.4472  -0.772 0.439933
## uspc_class174         256.4312   607.1608   0.422 0.672776
## uspc_class175         131.5115   808.8534   0.163 0.870842
## uspc_class180         424.7758  1001.3890   0.424 0.671432
## uspc_class181        -235.9111   708.3998  -0.333 0.739121
## uspc_class184         179.9760   808.9521   0.222 0.823941
## uspc_class192        -251.9463   808.8903  -0.311 0.755444
## uspc_class196        -231.7390   808.3549  -0.287 0.774359
## uspc_class201           6.8015   607.0597   0.011 0.991061
## uspc_class202         101.9708   592.3614   0.172 0.863326
## uspc_class203          82.9729   603.4010   0.138 0.890629
## uspc_class204         249.0454   573.0823   0.435 0.663875
## uspc_class205         201.9145   573.4215   0.352 0.724748
## uspc_class206         122.9071   660.5940   0.186 0.852402
## uspc_class208          22.0311   575.3059   0.038 0.969453
## uspc_class210        -103.1861   573.0176  -0.180 0.857095
## uspc_class216         140.0339   574.0701   0.244 0.807285
## uspc_class219        -261.8534   576.6305  -0.454 0.649752
## uspc_class220        -456.3981   808.8833  -0.564 0.572599
## uspc_class222         -65.8954   590.9972  -0.111 0.911221
## uspc_class228        -314.1746   574.4838  -0.547 0.584463
## uspc_class239        -163.4912   808.3179  -0.202 0.839714
## uspc_class241         296.8124   808.2583   0.367 0.713453
## uspc_class242        -243.2567   809.5846  -0.300 0.763819
## uspc_class249        -262.0398   589.9192  -0.444 0.656903
## uspc_class250         175.3443   660.4102   0.266 0.790619
## uspc_class252         -17.1637   572.6570  -0.030 0.976089
## uspc_class256         186.8983   814.9219   0.229 0.818602
## uspc_class257         139.6826   588.7519   0.237 0.812462
## uspc_class260         101.8458   702.2395   0.145 0.884688
## uspc_class261        -271.2221   575.3465  -0.471 0.637353
## uspc_class264         118.4757   572.2778   0.207 0.835992
## uspc_class266        -174.2392   574.5657  -0.303 0.761698
## uspc_class271          67.8072   813.1890   0.083 0.933546
## uspc_class280        -615.0193   815.0877  -0.755 0.450527
## uspc_class283        -263.5442   808.7547  -0.326 0.744529
## uspc_class293         599.6148   808.9684   0.741 0.458571
## uspc_class299         124.7550   700.4199   0.178 0.858634
## uspc_class300         -61.8097   808.7920  -0.076 0.939084
## uspc_class310        -258.0855   700.3229  -0.369 0.712485
## uspc_class313         543.7473   626.8427   0.867 0.385707
## uspc_class315        -195.4647   668.4505  -0.292 0.769971
## uspc_class320         380.8879   647.2294   0.588 0.556207
## uspc_class324         616.4025   618.3335   0.997 0.318830
## uspc_class326        -119.9157   709.8705  -0.169 0.865856
## uspc_class336        -198.6459   808.9202  -0.246 0.806017
## uspc_class340        -674.4094   809.9720  -0.833 0.405056
## uspc_class343        -137.9833   634.6600  -0.217 0.827888
## uspc_class345         780.7739   584.3030   1.336 0.181475
## uspc_class347          81.0073   700.8156   0.116 0.907978
## uspc_class348         672.8997   581.5201   1.157 0.247222
## uspc_class351        -407.7649   660.7791  -0.617 0.537174
## uspc_class355        -171.2109   700.5941  -0.244 0.806938
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## uspc_class356          33.7951   641.5503   0.053 0.957989
## uspc_class359         204.5418   700.4687   0.292 0.770283
## uspc_class360         176.1751   612.1877   0.288 0.773517
## uspc_class361        -132.7181   618.1424  -0.215 0.829999
## uspc_class362        -125.5616   702.3122  -0.179 0.858109
## uspc_class365        -303.6433   629.4556  -0.482 0.629531
## uspc_class366         -25.7482   573.9335  -0.045 0.964217
## uspc_class369         -75.2883   702.5810  -0.107 0.914663
## uspc_class370         248.9564   581.9983   0.428 0.668827
## uspc_class375         665.9933   583.0681   1.142 0.253368
## uspc_class379         176.0137   707.8565   0.249 0.803627
## uspc_class380         409.3979   581.7409   0.704 0.481595
## uspc_class381         757.5577   703.2678   1.077 0.281399
## uspc_class382         604.2605   621.2385   0.973 0.330723
## uspc_class385         -65.0358   700.5127  -0.093 0.926031
## uspc_class386         861.9154   590.5378   1.460 0.144423
## uspc_class398          17.5406   818.5633   0.021 0.982904
## uspc_class399        -360.2839   639.7769  -0.563 0.573343
## uspc_class403         -27.3011   648.1441  -0.042 0.966402
## uspc_class404        -837.7273   808.9317  -1.036 0.300396
## uspc_class405         -95.1176   700.6565  -0.136 0.892016
## uspc_class407         -76.4287   669.2318  -0.114 0.909077
## uspc_class409        1182.3086   814.6687   1.451 0.146711
## uspc_class414        -817.0214   808.5218  -1.011 0.312256
## uspc_class419         130.7244   595.1952   0.220 0.826158
## uspc_class420          48.1374   577.1910   0.083 0.933534
## uspc_class422         166.9723   572.8369   0.291 0.770683
## uspc_class423           0.4121   572.6781   0.001 0.999426
## uspc_class424          -2.9635   573.1454  -0.005 0.995875
## uspc_class425        -134.1354   573.1815  -0.234 0.814971
## uspc_class426         -14.8599   572.7353  -0.026 0.979301
## uspc_class427         129.4458   572.6994   0.226 0.821181
## uspc_class428        -111.2490   572.5000  -0.194 0.845925
## uspc_class429         122.8211   572.5885   0.215 0.830157
## uspc_class430         -18.5096   573.1378  -0.032 0.974237
## uspc_class432         -91.5007   808.4118  -0.113 0.909884
## uspc_class433         131.9267   627.0112   0.210 0.833352
## uspc_class435          49.5885   573.0098   0.087 0.931037
## uspc_class436          35.3073   573.2104   0.062 0.950885
## uspc_class438          77.4247   575.1264   0.135 0.892911
## uspc_class439         475.2178   815.6845   0.583 0.560166
## uspc_class442         -21.9788   574.3878  -0.038 0.969477
## uspc_class445         821.4710   821.5573   1.000 0.317367
## uspc_class446        -531.2362   709.3560  -0.749 0.453922
## uspc_class451         -18.5285   702.5537  -0.026 0.978960
## uspc_class454         500.9395   813.3635   0.616 0.537973
## uspc_class455         731.0511   613.2889   1.192 0.233261
## uspc_class463          58.6416   707.0190   0.083 0.933898
## uspc_class473          25.0925   618.0903   0.041 0.967618
## uspc_class492         714.0803   808.7465   0.883 0.377270
## uspc_class494        -153.6037   580.0817  -0.265 0.791167
## uspc_class501         -11.8242   573.9370  -0.021 0.983563
## uspc_class502          22.9367   573.0209   0.040 0.968071
## uspc_class503        -185.4556   579.2069  -0.320 0.748827
```

```
## uspc_class504          -20.2410   576.4140  -0.035 0.971988
## uspc_class505         -129.0158   589.2405  -0.219 0.826688
## uspc_class506          101.7475   584.4909   0.174 0.861804
## uspc_class507           90.3105   577.1234   0.156 0.875652
## uspc_class508          111.7456   575.1933   0.194 0.845962
## uspc_class510          -88.7413   573.6954  -0.155 0.877071
## uspc_class512           26.7016   618.0488   0.043 0.965540
## uspc_class514           17.8708   573.1585   0.031 0.975127
## uspc_class516          248.2958   579.5536   0.428 0.668343
## uspc_class518          790.6223   701.5137   1.127 0.259739
## uspc_class521           16.9833   575.1300   0.030 0.976442
## uspc_class522            1.4747   577.6374   0.003 0.997963
## uspc_class523           16.1270   573.7358   0.028 0.977575
## uspc_class524            7.2840   572.7449   0.013 0.989853
## uspc_class525          -85.6866   573.0169  -0.150 0.881131
## uspc_class526          -88.2323   573.4942  -0.154 0.877728
## uspc_class528          -55.2966   573.4666  -0.096 0.923183
## uspc_class530           15.9930   573.7787   0.028 0.977764
## uspc_class534          -89.1006   591.1726  -0.151 0.880199
## uspc_class536          -28.3303   573.9632  -0.049 0.960633
## uspc_class540           41.1444   578.2071   0.071 0.943272
## uspc_class544          -34.5063   576.2387  -0.060 0.952250
## uspc_class546         -108.6342   575.9368  -0.189 0.850390
## uspc_class548           -1.0096   575.5205  -0.002 0.998600
## uspc_class549         -259.5706   578.1600  -0.449 0.653463
## uspc_class552         -157.9114   582.6943  -0.271 0.786391
## uspc_class554         -201.4754   660.8949  -0.305 0.760480
## uspc_class556          -34.5901   587.4452  -0.059 0.953046
## uspc_class558         -115.7712   589.8168  -0.196 0.844389
## uspc_class560         -206.8958   578.1120  -0.358 0.720433
## uspc_class562         -190.6447   577.1539  -0.330 0.741161
## uspc_class564         -240.0729   577.3130  -0.416 0.677525
## uspc_class568         -186.3784   577.7140  -0.323 0.746989
## uspc_class570           -1.9691   601.4145  -0.003 0.997388
## uspc_class585         -140.9322   574.4374  -0.245 0.806195
## uspc_class588          259.4341   587.6052   0.442 0.658845
## uspc_class600          258.2782   591.6946   0.437 0.662472
## uspc_class601          195.1907   809.4827   0.241 0.809455
## uspc_class604         -187.1046   587.4720  -0.318 0.750114
## uspc_class606           90.5594   810.2151   0.112 0.911005
## uspc_class607         -801.6866   701.4276  -1.143 0.253072
## uspc_class623          385.1211   603.4244   0.638 0.523330
## uspc_class700           61.4005   579.0312   0.106 0.915551
## uspc_class701          277.4134   624.1564   0.444 0.656711
## uspc_class702          388.9470   577.3687   0.674 0.500535
## uspc_class703          396.9260   579.7264   0.685 0.493551
## uspc_class704          432.0676   673.4542   0.642 0.521156
## uspc_class705          696.7587   585.6301   1.190 0.234148
## uspc_class706          226.2980   582.9234   0.388 0.697861
## uspc_class707          324.5649   580.2862   0.559 0.575947
## uspc_class708          249.3255   582.3041   0.428 0.668529
## uspc_class709          624.8794   579.7186   1.078 0.281084
## uspc_class710          151.7888   580.9352   0.261 0.793875
## uspc_class711           21.6649   581.6079   0.037 0.970286
```

```
## uspc_class712          320.0571   582.2427   0.550 0.582530
## uspc_class713          392.3178   580.7933   0.675 0.499371
## uspc_class714          122.6739   582.9677   0.210 0.833333
## uspc_class715          625.4550   580.6946   1.077 0.281450
## uspc_class716          580.2832   816.1311   0.711 0.477077
## uspc_class717          456.7161   582.0930   0.785 0.432687
## uspc_class718          201.9238   583.0109   0.346 0.729084
## uspc_class719          385.5441   584.8931   0.659 0.509790
## uspc_class725          706.7848   587.2069   1.204 0.228736
## uspc_class726          213.2510   580.9419   0.367 0.713563
## uspc_class800          -28.0880   575.3786  -0.049 0.961066
## uspc_class977         -184.8090   640.5597  -0.289 0.772956
## uspc_class999          237.8665   808.5249   0.294 0.768608
## disposal_typeISS      -940.4396   263.6344  -3.567 0.000361 ***
## appl_status_code61     413.3580   224.0443   1.845 0.065047 .
## appl_status_code83      98.4294   311.1219   0.316 0.751724
## appl_status_code93     792.3084   231.5687   3.421 0.000623 ***
## appl_status_code94     267.6473   392.1706   0.682 0.494941
## appl_status_code95    1117.7383   291.7615   3.831 0.000128 ***
## appl_status_code98     194.1710   583.9996   0.332 0.739525
## appl_status_code120    206.5250   585.5632   0.353 0.724319
## appl_status_code135   1112.4170   593.3965   1.875 0.060846 .
## appl_status_code139    659.1876   583.8385   1.129 0.258880
## appl_status_code150   1306.1355   288.4804   4.528 5.98e-06 ***
## appl_status_code160    -72.5621   281.4903  -0.258 0.796579
## appl_status_code161    255.8308   117.4828   2.178 0.029441 *
## appl_status_code162    178.9647   234.1185   0.764 0.444622
## appl_status_code163   1587.0978   120.2092  13.203  < 2e-16 ***
## appl_status_code164    372.3078   120.3581   3.093 0.001980 **
## appl_status_code165    -81.0532   585.3024  -0.138 0.889861
## appl_status_code167   -209.5807   233.9465  -0.896 0.370339
## appl_status_code168    -25.7806   121.0506  -0.213 0.831349
## appl_status_code195   1395.6073   374.8900   3.723 0.000197 ***
## appl_status_code197   1892.0474   306.1684   6.180 6.48e-10 ***
## appl_status_code250   1277.7368   288.5935   4.427 9.56e-06 ***
## appl_status_code454   1238.2031   320.1272   3.868 0.000110 ***
## appl_status_code854   1013.4141   641.1811   1.581 0.113990
## tc1700                      NA         NA      NA       NA
## tc2100                      NA         NA      NA       NA
## tc2400                      NA         NA      NA       NA
## gendermale             -10.2479     6.6725  -1.536 0.124586
## closeness_centrality     3.4659    35.3987   0.098 0.922004
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 570.3 on 42490 degrees of freedom
## Multiple R-squared:  0.1881, Adjusted R-squared:  0.178
## F-statistic: 18.54 on 531 and 42490 DF,  p-value: < 2.2e-16
```

From the lm result:
The coefficient for closeness centrality is 3.4659 with a standard error of 35.3987. This result represents a very small and statistically insignificant association with application processing time (p-value = 0.922004). This analysis shows that an examiner's centrality does not have a significant impact on the time it takes to process patent applications.

```r
# set the formula
formula_interaction <- as.formula("y ~ . + gendermale*closeness_centrality")
set.seed(123)
lm_model_interaction <- lm(formula_interaction, data = applications_feature)
options(max.print = 10000)
summary(lm_model_interaction)
```

```
##
## Call:
## lm(formula = formula_interaction, data = applications_feature)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5825.7  -361.8   -76.1   265.5  4326.9
##
## Coefficients: (4 not defined because of singularities)
##                                Estimate Std. Error t value Pr(>|t|)
## (Intercept)                    250.5504   619.2518   0.405 0.685772
## examiner_art_unit1600          577.0806   311.1375   1.855 0.063640 .
## examiner_art_unit1609          324.5022   606.4736   0.535 0.592608
## examiner_art_unit1611          842.1582   215.0052   3.917 8.98e-05 ***
## examiner_art_unit1612          812.2998   213.3537   3.807 0.000141 ***
## examiner_art_unit1613          645.0321   216.5722   2.978 0.002899 **
## examiner_art_unit1614          389.2338   210.3379   1.851 0.064246 .
## examiner_art_unit1615          653.3274   209.6872   3.116 0.001836 **
## examiner_art_unit1616          542.4898   208.5845   2.601 0.009303 **
## examiner_art_unit1617          757.4006   212.2732   3.568 0.000360 ***
## examiner_art_unit1618          890.9336   210.7606   4.227 2.37e-05 ***
## examiner_art_unit1619          572.2592   234.0476   2.445 0.014487 *
## examiner_art_unit1621          510.4489   212.4810   2.402 0.016295 *
## examiner_art_unit1622          480.7582   221.2321   2.173 0.029779 *
## examiner_art_unit1623          521.0792   210.2495   2.478 0.013202 *
## examiner_art_unit1624          338.6290   210.2380   1.611 0.107254
## examiner_art_unit1625          478.4111   210.0707   2.277 0.022768 *
## examiner_art_unit1626          278.1255   209.5667   1.327 0.184468
## examiner_art_unit1627          479.6250   215.1522   2.229 0.025803 *
## examiner_art_unit1628          622.2921   210.9541   2.950 0.003181 **
## examiner_art_unit1629          518.4214   213.2517   2.431 0.015060 *
## examiner_art_unit1631          572.7830   208.2476   2.750 0.005953 **
## examiner_art_unit1632          614.7269   210.3712   2.922 0.003479 **
## examiner_art_unit1633          699.3035   208.9330   3.347 0.000818 ***
## examiner_art_unit1634          595.7709   209.3916   2.845 0.004440 **
## examiner_art_unit1635          547.8996   210.5671   2.602 0.009271 **
## examiner_art_unit1636          442.9664   215.0514   2.060 0.039422 *
## examiner_art_unit1637          546.2726   210.1943   2.599 0.009356 **
## examiner_art_unit1638          471.6158   214.5255   2.198 0.027925 *
## examiner_art_unit1639          801.0185   222.2211   3.605 0.000313 ***
## examiner_art_unit1641          606.6527   210.2975   2.885 0.003919 **
## examiner_art_unit1642          611.0632   210.3267   2.905 0.003671 **
## examiner_art_unit1643          722.9640   209.2563   3.455 0.000551 ***
## examiner_art_unit1644          589.4302   208.0800   2.833 0.004618 **
## examiner_art_unit1645          579.2858   209.0972   2.770 0.005601 **
## examiner_art_unit1646          466.0900   208.9908   2.230 0.025740 *
## examiner_art_unit1647          498.5205   210.4001   2.369 0.017822 *
```

```
## examiner_art_unit1648           595.8208   209.0999   2.849 0.004382 **
## examiner_art_unit1649           629.8885   211.0002   2.985 0.002835 **
## examiner_art_unit1651           560.7423   210.3005   2.666 0.007670 **
## examiner_art_unit1652           571.0374   208.6249   2.737 0.006200 **
## examiner_art_unit1653           584.5541   210.1171   2.782 0.005404 **
## examiner_art_unit1654           510.0478   210.1490   2.427 0.015225 *
## examiner_art_unit1655           546.5257   211.0656   2.589 0.009619 **
## examiner_art_unit1656           500.5517   208.7311   2.398 0.016486 *
## examiner_art_unit1657           591.5002   210.5645   2.809 0.004970 **
## examiner_art_unit1658           503.9041   280.8360   1.794 0.072772 .
## examiner_art_unit1661           481.1505   248.1838   1.939 0.052546 .
## examiner_art_unit1662           549.2158   228.4047   2.405 0.016196 *
## examiner_art_unit1663           309.9532   230.1483   1.347 0.178067
## examiner_art_unit1671           653.4786   223.3579   2.926 0.003439 **
## examiner_art_unit1672           121.2740   230.2187   0.527 0.598351
## examiner_art_unit1673           287.6026   214.5413   1.341 0.180075
## examiner_art_unit1674           487.9561   215.5515   2.264 0.023594 *
## examiner_art_unit1675           321.0814   219.3499   1.464 0.143260
## examiner_art_unit1676           325.7935   268.6963   1.212 0.225329
## examiner_art_unit1677           676.2687   237.0076   2.853 0.004328 **
## examiner_art_unit1678           725.5609   222.9229   3.255 0.001136 **
## examiner_art_unit1709          -257.4632   607.7362  -0.424 0.671828
## examiner_art_unit1711           444.4835   209.5912   2.121 0.033951 *
## examiner_art_unit1712           531.5787   209.1679   2.541 0.011045 *
## examiner_art_unit1713           389.6183   209.5001   1.860 0.062928 .
## examiner_art_unit1714           428.4464   209.7591   2.043 0.041102 *
## examiner_art_unit1715           492.4064   211.3499   2.330 0.019821 *
## examiner_art_unit1716           739.4107   211.6178   3.494 0.000476 ***
## examiner_art_unit1717           533.1542   215.7971   2.471 0.013492 *
## examiner_art_unit1718           666.6165   238.9260   2.790 0.005272 **
## examiner_art_unit1721           374.9087   212.5589   1.764 0.077775 .
## examiner_art_unit1722           471.9927   210.1674   2.246 0.024722 *
## examiner_art_unit1723           398.4882   209.9599   1.898 0.057713 .
## examiner_art_unit1724           436.9098   210.1985   2.079 0.037664 *
## examiner_art_unit1725           456.0131   212.3365   2.148 0.031751 *
## examiner_art_unit1726           501.0758   214.7067   2.334 0.019612 *
## examiner_art_unit1727           731.9207   213.1673   3.434 0.000596 ***
## examiner_art_unit1728           561.6090   241.4685   2.326 0.020034 *
## examiner_art_unit1729          1005.9221   223.4450   4.502 6.75e-06 ***
## examiner_art_unit1731           290.3174   210.3356   1.380 0.167515
## examiner_art_unit1732           493.0434   209.6155   2.352 0.018671 *
## examiner_art_unit1733           521.7868   210.7922   2.475 0.013314 *
## examiner_art_unit1734           334.1219   209.5149   1.595 0.110778
## examiner_art_unit1735           671.8599   215.6594   3.115 0.001838 **
## examiner_art_unit1736           319.3408   210.6146   1.516 0.129468
## examiner_art_unit1741           308.0104   212.7655   1.448 0.147722
## examiner_art_unit1742           476.2595   209.9524   2.268 0.023309 *
## examiner_art_unit1743           464.8913   209.2203   2.222 0.026287 *
## examiner_art_unit1744           491.9793   210.2251   2.340 0.019275 *
## examiner_art_unit1745           366.2750   209.7607   1.746 0.080791 .
## examiner_art_unit1746           310.4371   210.3325   1.476 0.139969
## examiner_art_unit1747           808.9919   216.0190   3.745 0.000181 ***
## examiner_art_unit1751           245.4394   213.0736   1.152 0.249369
## examiner_art_unit1752           178.0360   217.5879   0.818 0.413233
```

```
## examiner_art_unit1753           195.3280   213.6291   0.914 0.360547
## examiner_art_unit1754           440.8345   211.2986   2.086 0.036956 *
## examiner_art_unit1755           220.3144   210.4483   1.047 0.295160
## examiner_art_unit1756           412.7402   211.1559   1.955 0.050628 .
## examiner_art_unit1757           352.5183   280.6354   1.256 0.209071
## examiner_art_unit1758          1283.0977   266.0185   4.823 1.42e-06 ***
## examiner_art_unit1759           298.5022   216.6808   1.378 0.168330
## examiner_art_unit1761           391.3887   208.9885   1.873 0.061106 .
## examiner_art_unit1762           327.9501   208.4057   1.574 0.115584
## examiner_art_unit1763           370.8566   211.6863   1.752 0.079796 .
## examiner_art_unit1764           520.4123   209.3158   2.486 0.012913 *
## examiner_art_unit1765           422.8408   208.6825   2.026 0.042746 *
## examiner_art_unit1766           452.1838   214.3324   2.110 0.034887 *
## examiner_art_unit1767           612.9935   214.2680   2.861 0.004227 **
## examiner_art_unit1768           634.0247   227.4713   2.787 0.005318 **
## examiner_art_unit1771           580.4068   210.3647   2.759 0.005799 **
## examiner_art_unit1772           526.9998   210.1814   2.507 0.012167 *
## examiner_art_unit1773           576.9122   209.3765   2.755 0.005865 **
## examiner_art_unit1774           496.4831   209.7531   2.367 0.017938 *
## examiner_art_unit1775           552.7216   209.4603   2.639 0.008323 **
## examiner_art_unit1776           614.6113   212.3777   2.894 0.003806 **
## examiner_art_unit1777           685.9360   212.6432   3.226 0.001257 **
## examiner_art_unit1778           616.5717   212.5949   2.900 0.003731 **
## examiner_art_unit1779           659.8373   218.6625   3.018 0.002549 **
## examiner_art_unit1781           742.1679   214.5821   3.459 0.000543 ***
## examiner_art_unit1782           974.7847   214.2636   4.549 5.39e-06 ***
## examiner_art_unit1783           911.2794   214.8056   4.242 2.22e-05 ***
## examiner_art_unit1784           693.6549   212.7355   3.261 0.001112 **
## examiner_art_unit1785           716.0107   212.3068   3.373 0.000745 ***
## examiner_art_unit1786           881.6506   211.5182   4.168 3.08e-05 ***
## examiner_art_unit1787           758.6843   211.7042   3.584 0.000339 ***
## examiner_art_unit1788           831.3042   212.7378   3.908 9.33e-05 ***
## examiner_art_unit1789          1052.4832   218.5545   4.816 1.47e-06 ***
## examiner_art_unit1791           697.4297   208.8190   3.340 0.000839 ***
## examiner_art_unit1792           636.2115   208.5209   3.051 0.002282 **
## examiner_art_unit1793           625.8785   208.5912   3.001 0.002697 **
## examiner_art_unit1794           838.1915   208.3551   4.023 5.76e-05 ***
## examiner_art_unit1795           696.9899   208.9545   3.336 0.000852 ***
## examiner_art_unit1796           628.4552   208.0080   3.021 0.002518 **
## examiner_art_unit1797           697.0826   207.5721   3.358 0.000785 ***
## examiner_art_unit1798           608.5075   218.3841   2.786 0.005332 **
## examiner_art_unit1799           652.1151   223.1776   2.922 0.003480 **
## examiner_art_unit2100          -606.8843   600.7877  -1.010 0.312430
## examiner_art_unit2111           339.2034   189.0527   1.794 0.072784 .
## examiner_art_unit2112           418.0491   194.7524   2.147 0.031833 *
## examiner_art_unit2113           418.9782   196.5719   2.131 0.033060 *
## examiner_art_unit2114           433.7740   197.9057   2.192 0.028398 *
## examiner_art_unit2115           149.4976   187.7321   0.796 0.425842
## examiner_art_unit2116           300.4417   186.1125   1.614 0.106470
## examiner_art_unit2117           269.2473   197.4908   1.363 0.172782
## examiner_art_unit2118           188.2538   239.8743   0.785 0.432574
## examiner_art_unit2121           480.4470   198.9554   2.415 0.015746 *
## examiner_art_unit2122           426.9621   208.9587   2.043 0.041030 *
## examiner_art_unit2123           599.1563   212.0585   2.825 0.004724 **
```

```
## examiner_art_unit2124          230.6164   208.3038   1.107 0.268250
## examiner_art_unit2125          288.1882   205.4320   1.403 0.160672
## examiner_art_unit2126          494.8083   206.7529   2.393 0.016705 *
## examiner_art_unit2127          476.0760   206.0774   2.310 0.020883 *
## examiner_art_unit2128          497.8981   209.4242   2.377 0.017437 *
## examiner_art_unit2129          307.7140   207.2015   1.485 0.137526
## examiner_art_unit2131          734.3338   194.7607   3.770 0.000163 ***
## examiner_art_unit2132          403.2131   199.9764   2.016 0.043775 *
## examiner_art_unit2133          513.2872   200.3948   2.561 0.010429 *
## examiner_art_unit2134          791.8453   195.8378   4.043 5.28e-05 ***
## examiner_art_unit2135          431.7942   199.7001   2.162 0.030607 *
## examiner_art_unit2136          675.4047   199.8747   3.379 0.000728 ***
## examiner_art_unit2137          612.8194   193.2507   3.171 0.001520 **
## examiner_art_unit2138          413.2977   197.9096   2.088 0.036775 *
## examiner_art_unit2139          691.8823   234.0539   2.956 0.003117 **
## examiner_art_unit2141          370.8027   195.6627   1.895 0.058084 .
## examiner_art_unit2142          516.1918   197.3157   2.616 0.008898 **
## examiner_art_unit2143          466.8189   198.2862   2.354 0.018564 *
## examiner_art_unit2144          559.4833   203.5293   2.749 0.005982 **
## examiner_art_unit2145          609.7024   202.5745   3.010 0.002616 **
## examiner_art_unit2146          248.5551   315.1594   0.789 0.430312
## examiner_art_unit2151          455.8576   203.1707   2.244 0.024856 *
## examiner_art_unit2152          333.2187   208.1222   1.601 0.109368
## examiner_art_unit2153          370.5020   197.9417   1.872 0.061245 .
## examiner_art_unit2154          303.2626   194.2332   1.561 0.118453
## examiner_art_unit2155          238.4499   191.7537   1.244 0.213682
## examiner_art_unit2156          278.7897   196.9201   1.416 0.156856
## examiner_art_unit2157          466.0732   192.9330   2.416 0.015708 *
## examiner_art_unit2158          612.2060   198.6462   3.082 0.002058 **
## examiner_art_unit2159          362.5113   195.2015   1.857 0.063302 .
## examiner_art_unit2161          483.7479   193.1866   2.504 0.012282 *
## examiner_art_unit2162          267.3894   192.4170   1.390 0.164647
## examiner_art_unit2163          415.0407   193.5609   2.144 0.032019 *
## examiner_art_unit2164          469.0804   200.8620   2.335 0.019530 *
## examiner_art_unit2165          442.9529   194.5452   2.277 0.022799 *
## examiner_art_unit2166          703.1207   198.8452   3.536 0.000407 ***
## examiner_art_unit2167          496.3036   195.0312   2.545 0.010939 *
## examiner_art_unit2168          418.9214   194.9247   2.149 0.031629 *
## examiner_art_unit2169          555.7413   195.4988   2.843 0.004476 **
## examiner_art_unit2171          174.7720   203.6132   0.858 0.390702
## examiner_art_unit2172          262.6194   204.8863   1.282 0.199926
## examiner_art_unit2173          191.1383   206.2560   0.927 0.354085
## examiner_art_unit2174          451.5355   197.9956   2.281 0.022581 *
## examiner_art_unit2175          283.2186   198.8337   1.424 0.154338
## examiner_art_unit2176          448.5844   196.6537   2.281 0.022548 *
## examiner_art_unit2177          521.7517   198.5614   2.628 0.008601 **
## examiner_art_unit2178          584.3785   196.7926   2.970 0.002984 **
## examiner_art_unit2179          457.0149   202.0238   2.262 0.023691 *
## examiner_art_unit2181          320.5291   192.9668   1.661 0.096709 .
## examiner_art_unit2182          446.6993   191.9793   2.327 0.019980 *
## examiner_art_unit2183          550.7695   194.3630   2.834 0.004603 **
## examiner_art_unit2184          421.2292   192.4887   2.188 0.028651 *
## examiner_art_unit2185          465.2780   189.1630   2.460 0.013911 *
## examiner_art_unit2186          511.1198   196.0590   2.607 0.009138 **
```

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## examiner_art_unit2187           511.9608   191.4552   2.674 0.007497 **
## examiner_art_unit2188           461.6809   194.4126   2.375 0.017565 *
## examiner_art_unit2189           514.2323   194.2950   2.647 0.008132 **
## examiner_art_unit2191           390.8713   199.6630   1.958 0.050277 .
## examiner_art_unit2192           651.9110   200.0955   3.258 0.001123 **
## examiner_art_unit2193           612.8861   195.7790   3.130 0.001746 **
## examiner_art_unit2194           561.8874   201.6513   2.786 0.005332 **
## examiner_art_unit2195           926.0755   203.2902   4.555 5.24e-06 ***
## examiner_art_unit2196           536.4910   212.8791   2.520 0.011734 *
## examiner_art_unit2197           504.3032   221.2417   2.279 0.022647 *
## examiner_art_unit2198           444.2365   224.3245   1.980 0.047673 *
## examiner_art_unit2199           446.0082   205.5378   2.170 0.030016 *
## examiner_art_unit2400            48.9134   418.2747   0.117 0.906907
## examiner_art_unit2411           119.3129   210.8554   0.566 0.571497
## examiner_art_unit2412           207.6853   203.2875   1.022 0.306960
## examiner_art_unit2413           478.0631   215.0014   2.224 0.026185 *
## examiner_art_unit2414           314.3190   208.0945   1.510 0.130933
## examiner_art_unit2416           763.2142   198.9892   3.835 0.000126 ***
## examiner_art_unit2419           708.0940   202.2592   3.501 0.000464 ***
## examiner_art_unit2421           167.2963   212.9062   0.786 0.432004
## examiner_art_unit2422          -204.9928   199.7245  -1.026 0.304720
## examiner_art_unit2423           228.6729   213.9423   1.069 0.285142
## examiner_art_unit2424           413.0329   212.0363   1.948 0.051429 .
## examiner_art_unit2425           309.5493   216.1740   1.432 0.152167
## examiner_art_unit2426           101.9400   225.1917   0.453 0.650781
## examiner_art_unit2427           222.2928   211.5619   1.051 0.293392
## examiner_art_unit2431           550.5970   189.2993   2.909 0.003632 **
## examiner_art_unit2432           581.1190   195.3282   2.975 0.002931 **
## examiner_art_unit2433           594.3044   195.0888   3.046 0.002318 **
## examiner_art_unit2434           576.2927   192.2246   2.998 0.002719 **
## examiner_art_unit2435           408.6484   191.6656   2.132 0.033005 *
## examiner_art_unit2436           474.2182   186.9939   2.536 0.011216 *
## examiner_art_unit2437           533.7715   187.4005   2.848 0.004398 **
## examiner_art_unit2438           330.4097   202.2065   1.634 0.102262
## examiner_art_unit2439           675.4933   187.4283   3.604 0.000314 ***
## examiner_art_unit2441            51.2864   193.5828   0.265 0.791063
## examiner_art_unit2442           384.9880   194.6772   1.978 0.047984 *
## examiner_art_unit2443           370.5346   190.1993   1.948 0.051405 .
## examiner_art_unit2444           445.6306   192.0933   2.320 0.020353 *
## examiner_art_unit2445           589.1712   192.4627   3.061 0.002206 **
## examiner_art_unit2446           460.0175   203.6710   2.259 0.023911 *
## examiner_art_unit2447            22.6530   194.8663   0.116 0.907456
## examiner_art_unit2448           238.8478   191.7885   1.245 0.213002
## examiner_art_unit2449            20.2532   220.3037   0.092 0.926752
## examiner_art_unit2451           383.1929   193.1177   1.984 0.047235 *
## examiner_art_unit2452           391.9962   195.1090   2.009 0.044531 *
## examiner_art_unit2453           487.5014   188.8433   2.582 0.009840 **
## examiner_art_unit2454           164.8040   190.3115   0.866 0.386512
## examiner_art_unit2455           235.3845   191.2146   1.231 0.218331
## examiner_art_unit2456           445.5814   193.3822   2.304 0.021219 *
## examiner_art_unit2457           143.1594   189.8171   0.754 0.450735
## examiner_art_unit2458           347.9742   208.2246   1.671 0.094700 .
## examiner_art_unit2461           403.2697   200.3084   2.013 0.044095 *
## examiner_art_unit2462           488.2896   197.5430   2.472 0.013447 *
```

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## examiner_art_unit2463           376.7973   200.0864   1.883 0.059684 .
## examiner_art_unit2464           364.0493   199.4266   1.825 0.067936 .
## examiner_art_unit2465           308.9894   199.6768   1.547 0.121763
## examiner_art_unit2466           573.0885   200.0243   2.865 0.004171 **
## examiner_art_unit2467           447.6395   198.6952   2.253 0.024271 *
## examiner_art_unit2468           610.0800   205.8119   2.964 0.003036 **
## examiner_art_unit2469           333.7407   196.9418   1.695 0.090156 .
## examiner_art_unit2471           255.6095   197.5853   1.294 0.195788
## examiner_art_unit2472           295.3795   201.6213   1.465 0.142923
## examiner_art_unit2473           381.5937   199.8253   1.910 0.056187 .
## examiner_art_unit2474           418.3394   199.1062   2.101 0.035639 *
## examiner_art_unit2475           420.9588   199.9430   2.105 0.035263 *
## examiner_art_unit2476           333.3382   198.4522   1.680 0.093025 .
## examiner_art_unit2477           591.4894   200.1983   2.955 0.003133 **
## examiner_art_unit2478           548.8383   199.6785   2.749 0.005987 **
## examiner_art_unit2479           318.5268   222.9512   1.429 0.153102
## examiner_art_unit2481          -101.4869   219.5552  -0.462 0.643913
## examiner_art_unit2482           823.2597   216.8410   3.797 0.000147 ***
## examiner_art_unit2483           287.6281   206.4738   1.393 0.163612
## examiner_art_unit2484          -179.9990   218.3319  -0.824 0.409701
## examiner_art_unit2485           180.8992   224.5755   0.806 0.420526
## examiner_art_unit2486           187.6050   208.6476   0.899 0.368579
## examiner_art_unit2487          -234.9672   210.3304  -1.117 0.263944
## examiner_art_unit2488          -192.8812   209.8401  -0.919 0.358006
## examiner_art_unit2491           462.9361   205.5263   2.252 0.024299 *
## examiner_art_unit2492           615.5262   190.4656   3.232 0.001232 **
## examiner_art_unit2493           326.6747   194.7718   1.677 0.093507 .
## examiner_art_unit2494           559.5457   198.1736   2.824 0.004752 **
## examiner_art_unit2495           263.2051   212.2732   1.240 0.215006
## examiner_art_unit2496           226.8547   225.0478   1.008 0.313446
## examiner_art_unit2497           436.3519   233.1137   1.872 0.061235 .
## examiner_art_unit2498                 NA         NA      NA       NA
## uspc_class008                   156.8851   575.5033   0.273 0.785158
## uspc_class015                  -226.2604   576.6834  -0.392 0.694803
## uspc_class023                   -11.5627   617.8183  -0.019 0.985068
## uspc_class028                   383.7445   808.9778   0.474 0.635248
## uspc_class029                    86.8822   579.6355   0.150 0.880851
## uspc_class030                   984.2902   808.5514   1.217 0.223478
## uspc_class034                   580.0110   700.5525   0.828 0.407713
## uspc_class036                   770.4695   809.5177   0.952 0.341222
## uspc_class044                  -191.9346   579.8077  -0.331 0.740622
## uspc_class048                   296.6867   578.8327   0.513 0.608262
## uspc_class051                     9.9970   576.3489   0.017 0.986161
## uspc_class052                   584.4339   700.3619   0.834 0.404019
## uspc_class053                   -91.1766   808.3129  -0.113 0.910191
## uspc_class055                  -185.9993   577.3376  -0.322 0.747328
## uspc_class060                    -0.8011   639.3308  -0.001 0.999000
## uspc_class065                   315.5579   574.5068   0.549 0.582825
## uspc_class068                   267.8222   575.8897   0.465 0.641892
## uspc_class070                   252.0653   707.9447   0.356 0.721803
## uspc_class071                   -28.3487   582.3417  -0.049 0.961174
## uspc_class072                    29.3387   700.0280   0.042 0.966570
## uspc_class073                    -8.7076   660.1361  -0.013 0.989476
## uspc_class075                   -66.6887   573.6283  -0.116 0.907449
```

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## uspc_class082               -384.2179   808.8667  -0.475 0.634784
## uspc_class083                113.7815   808.6234   0.141 0.888100
## uspc_class095               -224.8899   574.6516  -0.391 0.695541
## uspc_class096               -203.5220   575.2941  -0.354 0.723513
## uspc_class099               -174.8611   579.4789  -0.302 0.762840
## uspc_class100                 11.8368   808.5369   0.015 0.988320
## uspc_class101                 91.5780   808.3909   0.113 0.909806
## uspc_class106                -29.0011   572.9028  -0.051 0.959627
## uspc_class117                144.0729   574.3401   0.251 0.801932
## uspc_class118                189.3399   573.3401   0.330 0.741220
## uspc_class119                358.8480   700.9497   0.512 0.608692
## uspc_class123               -305.5540   808.4970  -0.378 0.705486
## uspc_class127               -135.8687   597.5368  -0.227 0.820128
## uspc_class128                  1.1960   639.9236   0.002 0.998509
## uspc_class131                 28.0504   576.4773   0.049 0.961192
## uspc_class134                115.8834   573.2211   0.202 0.839791
## uspc_class136                200.9902   574.9842   0.350 0.726672
## uspc_class137                 42.5986   702.4782   0.061 0.951646
## uspc_class141                 11.8926   700.2699   0.017 0.986450
## uspc_class148                 29.7394   572.2717   0.052 0.958555
## uspc_class149                422.4720   579.0348   0.730 0.465630
## uspc_class152                -40.1094   573.3972  -0.070 0.944233
## uspc_class156                 72.3559   572.0204   0.126 0.899343
## uspc_class159                417.5028   639.7525   0.653 0.514017
## uspc_class162                 30.6909   574.5912   0.053 0.957403
## uspc_class164               -310.3847   577.6888  -0.537 0.591072
## uspc_class169               -623.6146   808.3945  -0.771 0.440460
## uspc_class174                258.5149   607.1217   0.426 0.670253
## uspc_class175                131.8639   808.8006   0.163 0.870491
## uspc_class180                427.2091  1001.3241   0.427 0.669641
## uspc_class181               -234.2485   708.3539  -0.331 0.740877
## uspc_class184                180.3662   808.8994   0.223 0.823554
## uspc_class192               -249.9973   808.8379  -0.309 0.757261
## uspc_class196               -229.6592   808.3026  -0.284 0.776316
## uspc_class201                  8.4209   607.0205   0.014 0.988932
## uspc_class202                102.6831   592.3229   0.173 0.862372
## uspc_class203                 83.5330   603.3617   0.138 0.889889
## uspc_class204                249.6963   573.0449   0.436 0.663031
## uspc_class205                202.8670   573.3842   0.354 0.723486
## uspc_class206                122.9815   660.5509   0.186 0.852304
## uspc_class208                 22.1951   575.2684   0.039 0.969224
## uspc_class210               -102.6529   572.9803  -0.179 0.857816
## uspc_class216                141.0169   574.0328   0.246 0.805947
## uspc_class219               -261.1250   576.5929  -0.453 0.650640
## uspc_class220               -456.9473   808.8306  -0.565 0.572112
## uspc_class222                -65.7099   590.9586  -0.111 0.911465
## uspc_class228               -313.0455   574.4465  -0.545 0.585790
## uspc_class239               -163.3078   808.2652  -0.202 0.839881
## uspc_class241                297.3186   808.2056   0.368 0.712968
## uspc_class242               -241.0672   809.5322  -0.298 0.765868
## uspc_class249               -260.5612   589.8810  -0.442 0.658695
## uspc_class250                176.1211   660.3672   0.267 0.789700
## uspc_class252                -15.4982   572.6200  -0.027 0.978408
## uspc_class256                189.0618   814.8691   0.232 0.816528
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## uspc_class257                142.0848   588.7142   0.241 0.809287
## uspc_class260                108.5562   702.1986   0.155 0.877142
## uspc_class261               -270.8165   575.3090  -0.471 0.637834
## uspc_class264                119.2182   572.2405   0.208 0.834968
## uspc_class266               -174.0557   574.5282  -0.303 0.761926
## uspc_class271                 70.9740   813.1369   0.087 0.930446
## uspc_class280               -613.8001   815.0347  -0.753 0.451396
## uspc_class283               -263.6965   808.7019  -0.326 0.744370
## uspc_class293                602.0232   808.9162   0.744 0.456739
## uspc_class299                124.9228   700.3742   0.178 0.858437
## uspc_class300                 -71.4886   808.7481  -0.088 0.929564
## uspc_class310               -257.8213   700.2773  -0.368 0.712748
## uspc_class313                544.3961   626.8018   0.869 0.385109
## uspc_class315               -194.3520   668.4070  -0.291 0.771229
## uspc_class320                382.3102   647.1874   0.591 0.554707
## uspc_class324                617.6935   618.2934   0.999 0.317786
## uspc_class326               -116.5998   709.8254  -0.164 0.869523
## uspc_class336               -197.3003   808.8676  -0.244 0.807293
## uspc_class340               -674.3936   809.9192  -0.833 0.405037
## uspc_class343               -136.4247   634.6189  -0.215 0.829791
## uspc_class345                775.8815   584.2680   1.328 0.184200
## uspc_class347                 83.2480   700.7704   0.119 0.905438
## uspc_class348                675.1913   581.4829   1.161 0.245586
## uspc_class351               -407.7704   660.7360  -0.617 0.537142
## uspc_class355               -169.4049   700.5487  -0.242 0.808923
## uspc_class356                 31.2092   641.5093   0.049 0.961199
## uspc_class359                210.1326   700.4265   0.300 0.764174
## uspc_class360                176.8045   612.1478   0.289 0.772716
## uspc_class361               -130.7169   618.1026  -0.211 0.832513
## uspc_class362               -124.7629   702.2664  -0.178 0.858993
## uspc_class365               -302.6739   629.4147  -0.481 0.630603
## uspc_class366                 -25.6009   573.8960  -0.045 0.964419
## uspc_class369                 -74.0521   702.5353  -0.105 0.916053
## uspc_class370                251.4243   581.9612   0.432 0.665722
## uspc_class375                668.7137   583.0311   1.147 0.251404
## uspc_class379                177.9659   707.8108   0.251 0.801482
## uspc_class380                411.4682   581.7035   0.707 0.479353
## uspc_class381                759.6182   703.2224   1.080 0.280061
## uspc_class382                610.9095   621.2034   0.983 0.325402
## uspc_class385                 -63.8053   700.4672  -0.091 0.927422
## uspc_class386                864.2590   590.4999   1.464 0.143309
## uspc_class398                 19.4557   818.5102   0.024 0.981036
## uspc_class399               -358.8101   639.7354  -0.561 0.574887
## uspc_class403                 -25.3029   648.1023  -0.039 0.968857
## uspc_class404               -837.2251   808.8789  -1.035 0.300654
## uspc_class405                 -96.6525   700.6111  -0.138 0.890277
## uspc_class407                 -74.7525   669.1884  -0.112 0.911057
## uspc_class409               1184.1438   814.6159   1.454 0.146058
## uspc_class414               -816.8049   808.4691  -1.010 0.312352
## uspc_class419                131.9263   595.1566   0.222 0.824575
## uspc_class420                 49.3593   577.1535   0.086 0.931847
## uspc_class422                167.9122   572.7997   0.293 0.769414
## uspc_class423                  0.4762   572.6407   0.001 0.999336
## uspc_class424                 -2.3405   573.1081  -0.004 0.996742
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## uspc_class425               -133.3345   573.1442  -0.233 0.816045
## uspc_class426                -13.2718   572.6983  -0.023 0.981511
## uspc_class427                130.5016   572.6622   0.228 0.819736
## uspc_class428               -110.2316   572.4628  -0.193 0.847307
## uspc_class429                123.8891   572.5513   0.216 0.828692
## uspc_class430                -17.1120   573.1007  -0.030 0.976180
## uspc_class432                -88.8403   808.3597  -0.110 0.912488
## uspc_class433                132.2786   626.9703   0.211 0.832903
## uspc_class435                 50.2842   572.9725   0.088 0.930068
## uspc_class436                 36.4565   573.1732   0.064 0.949285
## uspc_class438                 78.1536   575.0889   0.136 0.891902
## uspc_class439                476.7252   815.6315   0.584 0.558896
## uspc_class442                -20.4257   574.3507  -0.036 0.971631
## uspc_class445                823.7738   821.5042   1.003 0.315981
## uspc_class446               -529.6170   709.3101  -0.747 0.455270
## uspc_class451                -15.4455   702.5089  -0.022 0.982459
## uspc_class454                429.9879   813.7833   0.528 0.597237
## uspc_class455                733.0686   613.2494   1.195 0.231944
## uspc_class463                 60.3681   706.9732   0.085 0.931952
## uspc_class473                 24.8793   618.0500   0.040 0.967890
## uspc_class492                716.4417   808.6943   0.886 0.375664
## uspc_class494               -153.4760   580.0439  -0.265 0.791324
## uspc_class501                -11.2809   573.8996  -0.020 0.984317
## uspc_class502                 23.6546   572.9836   0.041 0.967070
## uspc_class503               -185.3587   579.1691  -0.320 0.748938
## uspc_class504                -21.5643   576.3767  -0.037 0.970155
## uspc_class505               -128.4089   589.2021  -0.218 0.827479
## uspc_class506                 97.3238   584.4553   0.167 0.867748
## uspc_class507                 90.2843   577.0858   0.156 0.875680
## uspc_class508                112.9325   575.1560   0.196 0.844336
## uspc_class510                -87.5631   573.6582  -0.153 0.878683
## uspc_class512                 28.7690   618.0091   0.047 0.962871
## uspc_class514                 19.2799   573.1214   0.034 0.973164
## uspc_class516                248.6395   579.5159   0.429 0.667891
## uspc_class518                772.8566   701.5023   1.102 0.270591
## uspc_class521                 12.9775   575.0946   0.023 0.981997
## uspc_class522                  3.5482   577.6003   0.006 0.995099
## uspc_class523                 14.5349   573.6988   0.025 0.979788
## uspc_class524                  6.6503   572.7076   0.012 0.990735
## uspc_class525                -85.4912   572.9796  -0.149 0.881393
## uspc_class526                -87.9762   573.4568  -0.153 0.878073
## uspc_class528                -55.0045   573.4292  -0.096 0.923583
## uspc_class530                 16.4303   573.7413   0.029 0.977154
## uspc_class534                -86.6460   591.1348  -0.147 0.883468
## uspc_class536                -26.4378   573.9262  -0.046 0.963259
## uspc_class540                 48.5671   578.1767   0.084 0.933056
## uspc_class544                -30.8185   576.2029  -0.053 0.957345
## uspc_class546               -109.9107   575.8995  -0.191 0.848644
## uspc_class548                  1.8662   575.4841   0.003 0.997413
## uspc_class549               -254.3246   578.1259  -0.440 0.660003
## uspc_class552               -156.3212   582.6566  -0.268 0.788477
## uspc_class554               -200.6005   660.8519  -0.304 0.761473
## uspc_class556                -34.7261   587.4069  -0.059 0.952859
## uspc_class558               -112.4787   589.7797  -0.191 0.848751
```

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## uspc_class560                -197.1016   578.0870  -0.341 0.733139
## uspc_class562                -181.7551   577.1267  -0.315 0.752816
## uspc_class564                -230.6603   577.2871  -0.400 0.689483
## uspc_class568                -198.4979   577.6958  -0.344 0.731147
## uspc_class570                  -1.8259   601.3753  -0.003 0.997578
## uspc_class585                -140.2835   574.4000  -0.244 0.807057
## uspc_class588                 258.3791   587.5670   0.440 0.660125
## uspc_class600                 259.0726   591.6561   0.438 0.661478
## uspc_class601                 195.0475   809.4299   0.241 0.809580
## uspc_class604                -185.3855   587.4341  -0.316 0.752319
## uspc_class606                  90.4865   810.1623   0.112 0.911070
## uspc_class607                -801.1937   701.3818  -1.142 0.253333
## uspc_class623                 385.9335   603.3851   0.640 0.522427
## uspc_class700                  59.6327   578.9938   0.103 0.917969
## uspc_class701                 277.3305   624.1157   0.444 0.656786
## uspc_class702                 387.5857   577.3313   0.671 0.502007
## uspc_class703                 396.4997   579.6886   0.684 0.493987
## uspc_class704                 434.1755   673.4108   0.645 0.519099
## uspc_class705                 698.0165   585.5921   1.192 0.233274
## uspc_class706                 227.4273   582.8856   0.390 0.696409
## uspc_class707                 326.6585   580.2489   0.563 0.573463
## uspc_class708                 250.7368   582.2664   0.431 0.666745
## uspc_class709                 626.9510   579.6814   1.082 0.279461
## uspc_class710                 153.7128   580.8978   0.265 0.791309
## uspc_class711                  23.4238   581.5704   0.040 0.967873
## uspc_class712                 321.8345   582.2051   0.553 0.580413
## uspc_class713                 394.4398   580.7560   0.679 0.497025
## uspc_class714                 124.5502   582.9302   0.214 0.830811
## uspc_class715                 627.3426   580.6572   1.080 0.279970
## uspc_class716                 581.7963   816.0781   0.713 0.475901
## uspc_class717                 458.2034   582.0553   0.787 0.431160
## uspc_class718                 204.0010   582.9735   0.350 0.726392
## uspc_class719                 387.9917   584.8557   0.663 0.507080
## uspc_class725                 708.6366   587.1690   1.207 0.227489
## uspc_class726                 216.0609   580.9050   0.372 0.709941
## uspc_class800                 -27.1848   575.3411  -0.047 0.962314
## uspc_class977                -185.1203   640.5179  -0.289 0.772570
## uspc_class999                 240.1032   808.4726   0.297 0.766480
## disposal_typeISS             -940.5785   263.6172  -3.568 0.000360 ***
## appl_status_code61            412.9804   224.0297   1.843 0.065275 .
## appl_status_code83             98.8220   311.1017   0.318 0.750751
## appl_status_code93            792.3740   231.5536   3.422 0.000622 ***
## appl_status_code94            265.7302   392.1457   0.678 0.498009
## appl_status_code95           1118.6486   291.7427   3.834 0.000126 ***
## appl_status_code98            193.4000   583.9616   0.331 0.740506
## appl_status_code120           211.3617   585.5280   0.361 0.718119
## appl_status_code135          1111.8442   593.3578   1.874 0.060962 .
## appl_status_code139           660.2270   583.8006   1.131 0.258099
## appl_status_code150          1306.5990   288.4616   4.530 5.93e-06 ***
## appl_status_code160           -73.0568   281.4720  -0.260 0.795210
## appl_status_code161           256.0081   117.4751   2.179 0.029318 *
## appl_status_code162           178.9440   234.1032   0.764 0.444644
## appl_status_code163          1587.5314   120.2014  13.207  < 2e-16 ***
## appl_status_code164           372.9626   120.3505   3.099 0.001943 **
```

```
## appl_status_code165              -79.2263   585.2647  -0.135 0.892321
## appl_status_code167             -209.9500   233.9313  -0.897 0.369465
## appl_status_code168              -25.1137   121.0430  -0.207 0.835638
## appl_status_code195             1396.1654   374.8656   3.724 0.000196 ***
## appl_status_code197             1892.5240   306.1485   6.182 6.40e-10 ***
## appl_status_code250             1277.8696   288.5747   4.428 9.53e-06 ***
## appl_status_code454             1238.1926   320.1063   3.868 0.000110 ***
## appl_status_code854             1012.8311   641.1393   1.580 0.114175
## tc1700                                NA         NA      NA       NA
## tc2100                                NA         NA      NA       NA
## tc2400                                NA         NA      NA       NA
## gendermale                      -8.3422     6.7135  -1.243 0.214027
## closeness_centrality             152.0131    68.0095   2.235 0.025411 *
## gendermale:closeness_centrality -203.9068    79.7142  -2.558 0.010532 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 570.3 on 42489 degrees of freedom
## Multiple R-squared:  0.1883, Adjusted R-squared:  0.1781
## F-statistic: 18.52 on 532 and 42489 DF,  p-value: < 2.2e-16
```

From lm with interaction model:

The model is statistically significant overall (p-value $<$ 2.2e-16), as shown by the F-statistic, but with a Multiple R-squared of 0.1883 and an Adjusted R-squared of 0.1781, it explains only a low proportion of the variance in processing times.

- closeness_centrality: The coefficient for closeness centrality has become significant (p-value = 0.025411) with a value of 152.0131, suggesting a positive relationship with processing times. This indicates that higher centrality within the examiner network is associated with longer processing times, a finding that contrasts with typical expectations and underscores the need for further investigation into how network dynamics influence workload and efficiency.

- gender:closeness_centrality: The interaction term between male gender and closeness centrality is notably significant (p-value = 0.010532), with a coefficient of -203.9068. This suggests that the effect of centrality on processing time is significantly modified by the examiner's gender. Specifically, increased centrality appears to lead to a larger reduction in processing times for male examiners than for their counterparts.