Record matching

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```
library(janitor)
library(Hmisc)
library(readxl)
library(writexl)
library(reclin2)
library(lubridate)
library(RecordLinkage)
library(dgof) # for statistical testing
library(fdm2id) # for predict that works for kmeans
library(ppclust) # for cmeans
library(tidyverse)
```

```
commune_region_lookup <- read_excel("04_Data/Outputs/region_service_commune.xlsx") %>%
  clean_names() %>%
  select(-geometry)
#chile.adm3 <- st_read("04_Data/CHL_adm_humdata/chl_admbnda_adm3_bcn_20211008.shp") %>%
#  mutate(commune_code = str_sub(ADM3_PCODE, start = 3, end = -1))

araucnorte_communes <- commune_region_lookup %>%
  filter(str_detect(health_service_name, "a Norte"))
araucsur_communes <- commune_region_lookup %>%
  filter(str_detect(health_service_name, "a Sur"))
```

```
chile_merged_raw <- read.csv("04_Data/Data_Chile_Merge.csv") %>% clean_names()

chile_merged <- chile_merged_raw %>%
  rename(sex_desc = sex,
         year = agno,
         school_code = rbd,
         school_check_code = dgv_rbd,
         school_name = nom_rbd,
         school_region_code = cod_reg_rbd,
         school_region_name_abr = nom_reg_rbd_a,
         school_province_code = cod_pro_rbd,
         school_commune_code = cod_com_rbd,
         school_commune_name = nom_com_rbd,
         school_dept_code = cod_deprov_rbd,
         school_dept_name = nom_deprov_rbd,
         school_dependency_code = cod_depe, # has categories 1-6, no1 and no2 here are no1 in grouped
         school_dependency_code_grouped = cod_depe2, # has categories 1-5
         school_rurality_code = rural_rbd,
         school_operation_status = estado_estab,
         teaching_code1 = cod_ense, # min = 10, max = 910, eg preschool, special education hearing impa
         teaching_code2 = cod_ense2, # subject matter coding, 1-8
         teaching_code3 = cod_ense3, # age based coding, 1-7
         grade_code1 = cod_grado, # grade of schooling, 1-10, 21-25, 31-34, nests in teaching_code1
         grade_code2 = cod_grado2, # equivalent grade of schooling for adult special education, 1-8, 99
         grade_letter = let_cur, # refers to the class within the grade, close to start of alphabet is
         course_timing = cod_jor, # time of day, morning, afternoon, both, night, no info
         course_type = cod_tip_cur, # 0 = simple course, 1-4 = combined course, 99 = no info
         course_descr = cod_des_cur, # Description of course (TP secondary education only). 0: Does not
         student_id = mrun,
         sex = gen_alu, # 0 = no info, 1 = male, 2 = female
         dob = fec_nac_alu_2, # The second one has DD
         age_june30 = edad_alu, # age at 30th June 2021
         special_needs_status = int_alu, # integrated student indicator, 0 = no, 1 = yes. Mostly no
         special_needs_code = cod_int_alu, # ADHD, blindness, etc. 0 = none. 105 = autism, 203 = ADHD.
         student_region_code = cod_reg_alu,
         student_commune_code = cod_com_alu,
         student_commune_name = nom_com_alu,
         economic_sector_code = cod_sec,
         economic_specialty_code = cod_espe,
         economic_branch_code = cod_rama,
         economic_profspec_code = cod_men,
         teaching_code_new = ens) %>%
  mutate(commune_code = ifelse(nchar(as.character(student_commune_code)) == 4,
                               paste0("0", as.character(student_commune_code)),
                               as.character(student_commune_code)))
```

```
clinical_large_raw <- read_excel("04_Data/dataset_ssas_2015_2021.xlsx") %>% clean_names
#describe(clinical_raw)

clinical_large <- clinical_large_raw %>%
  select(c(-procedence, -ethnicity, -education_level, -disability, -foster_care)) %>%
  # Fix the date columns
  mutate(dob_eng = ifelse(str_detect(date_of_birth, "/"), 1,
                   ifelse(str_detect(date_of_birth, "-"), 0, NA)),
         apt_eng = ifelse(str_detect(date_appointment, "/"), 1, ifelse(str_detect(date_appointment, "-"
         dob_day = ifelse(dob_eng == 1, as.integer(str_extract(date_of_birth, "^\\d+")),
                   ifelse(dob_eng == 0, as.integer(str_extract(date_of_birth, "^\\d+")), NA)),
         dob_month = ifelse(dob_eng == 1, as.integer(str_extract(date_of_birth, "(?<=/)\\d+(?=/)")),
                     ifelse(dob_eng == 0, str_extract(date_of_birth, "(?<=-)\\w+(?=-)"), NA)),
         dob_year = ifelse(dob_eng == 1, as.integer(str_extract(date_of_birth, "\\d+$")),
                    ifelse(dob_eng == 0, as.integer(str_extract(date_of_birth, "\\d+$")) + 2000, NA)),
         dob_month_eng = as.integer(ifelse(dob_month == "ene", 1,
                                    ifelse(dob_month == "abr", 4,
                                    ifelse(dob_month == "ago", 8,
                                    ifelse(dob_month == "sept", 9,
                                    ifelse(dob_month == "dic", 12, dob_month)))))),
         dob = make_date(year = dob_year, month = dob_month_eng, day = dob_day),
         apt_day = ifelse(apt_eng == 1, as.integer(str_extract(date_appointment, "^\\d+")),
                   ifelse(apt_eng == 0, as.integer(str_extract(date_appointment, "^\\d+")), NA)),
         apt_month = ifelse(apt_eng == 1, as.integer(str_extract(date_appointment, "(?<=/)\\d+(?=/)")),
                     ifelse(apt_eng == 0, str_extract(date_appointment, "(?<=-)\\w+(?=-)"), NA)),
         apt_year = ifelse(apt_eng == 1, as.integer(str_extract(date_appointment, "\\d+$")),
                    ifelse(apt_eng == 0, as.integer(str_extract(date_appointment, "\\d+$")) + 2000, NA)
         apt_month_eng = as.integer(ifelse(apt_month == "ene", 1,
                                    ifelse(apt_month == "abr", 4,
                                    ifelse(apt_month == "ago", 8,
                                    ifelse(apt_month == "sept", 9,
                                    ifelse(apt_month == "dic", 12, apt_month)))))),
         apt_date = make_date(year = apt_year, month = apt_month_eng, day = apt_day),
         age_june30 = trunc(time_length(interval(ymd(dob), ymd("2021-06-30")), unit = "year")),
         commune_name_upper = ifelse(comuna == "CHOL CHOL", "CHOLCHOL",
                        ifelse(comuna == "CURACAUTIN", "CURACAUTÍN",
                        ifelse(comuna == "PITRUFQUEN", "PITRUFQUÉN",
                        ifelse(comuna == "PUCON", "PUCÓN",
                        ifelse(comuna == "TOLTEN", "TOLTÉN",
                        ifelse(comuna == "VILCUN", "VILCÚN", comuna)))))),
         #commune_name_upper = comuna,
         ses_status = ifelse(socio_economic_level == "FONASA - A", 1,
                      ifelse(socio_economic_level == "FONASA - B", 2,
                      ifelse(socio_economic_level == "FONASA - C", 2,
                      ifelse(socio_economic_level == "FONASA - D", 2,
                      ifelse(socio_economic_level == "Private Health Insurance", 3,
                      ifelse(socio_economic_level %in% c("COLMENA GOLDEN CROSS", "RIO BLANCO", "CARABIN
         autism = 1,
         intdisab = 0,
         aut_rank = 1
         ) %>%
  left_join(commune_region_lookup, by = "commune_name_upper") %>%
  select(id, gender, commune_code, commune_name, commune_name_upper, health_service_name, region_name, 

aut_codes <- unique(clinical_large$codigo)

clinical_small_raw <- read_excel("04_Data/Dataset_Vill_2014_2021.xlsx", col_names = TRUE) %>% clean_name

clinical_small <- clinical_small_raw %>%
  rename("dob" = "fecha_nacimiento",
         "apt_date" = "fecha_ejecutada",
         "type_appointment" = "appoinment",
         "diagnosis" = "diagnostico_1") %>%
  mutate(gender = str_to_title(gender),
         autism = ifelse(cod_dg_1 %in% aut_codes |
                           cod_dg_2 %in% aut_codes |
                           cod_dg_3 %in% aut_codes, 1, 0),
         aut_rank = ifelse(cod_dg_1 %in% aut_codes, 1,
                    ifelse(cod_dg_2 %in% aut_codes, 2,
                    ifelse(cod_dg_3 %in% aut_codes, 3, NA))),
         age_june30 = trunc(time_length(interval(ymd(dob), ymd("2021-06-30")), unit = "year")),
         commune_name_upper = ifelse(comuna == "CHOL CHOL", "CHOLCHOL",
                        ifelse(comuna == "CURACAUTIN", "CURACAUTÍN",
                        ifelse(comuna == "PITRUFQUEN", "PITRUFQUÉN",
                        ifelse(comuna == "PUCON", "PUCÓN",
                        ifelse(comuna == "TOLTEN", "TOLTÉN",
                        ifelse(comuna == "VILCUN", "VILCÚN",
                        ifelse(comuna == "DIEGO DE ALMAGRO  (#)", "DIEGO DE ALMAGRO",
                        ifelse(comuna == "MACHALI", "MACHALÍ",
                        ifelse(comuna == "TEMUCO (##)", "TEMUCO", comuna))))))))),
         ses_status = ifelse(socio_economic_level == "FONASA - A", 1,
                      ifelse(socio_economic_level == "FONASA - B", 2,
                      ifelse(socio_economic_level == "FONASA - C", 2,
                      ifelse(socio_economic_level == "FONASA - D", 2,
                      ifelse(socio_economic_level == "Private Health Insurance", 3,
                      ifelse(socio_economic_level %in% c("COLMENA GOLDEN CROSS", "RIO BLANCO", "CARABINI
         ) %>%
  left_join(commune_region_lookup, by = "commune_name_upper") %>%
  #filter(autism == 1) %>%
  select(id, gender, commune_code, commune_name, commune_name_upper, health_service_name, region_name, s
```

```
## Warning in left_join(., commune_region_lookup, by = "commune_name_upper"): Each row in `x` is expecte
## i Row 2030 of `x` matches multiple rows.
## i If multiple matches are expected, set `multiple = "all"` to silence this
##   warning.
```

```
# Throws a warning because there are 2 records for Tocopila which is in two regions. Will keep both bec

intdisab_codes <- unique(c(clinical_small_raw$cod_dg_1, clinical_small_raw$cod_dg_2, clinical_small_raw$
  str_subset("F7") %>%
  sort()

clinical_small <- clinical_small %>%
  mutate(intdisab = ifelse(cod_dg_1 %in% intdisab_codes |
                             cod_dg_2 %in% intdisab_codes |
                             cod_dg_3 %in% intdisab_codes, 1, 0)) %>%
  rename("codigo" = "cod_dg_1") %>%
  select(c(-cod_dg_2, -cod_dg_3))

clinical <- rbind(clinical_large, clinical_small)

clinical_communes <- clinical %>% group_by(commune_code) %>% summarise() %>% arrange() %>%
  mutate(commune_in_school_data = ifelse(commune_code %in% unique(chile_merged$commune_code), 1, 0)) # A
```

Fixed the date columns because they were in English and Spanish. Redefined the age column to be age at 30th June 2021.

Get one row per person per commune to make matching more efficient. Take the earliest appointment for each person.

```
get.min.na <- function(x) ifelse( !all(is.na(x)), min(x, na.rm = TRUE), NA)
get.max.na <- function(x) ifelse( !all(is.na(x)), max(x, na.rm = TRUE), NA)

patients <- clinical %>%
  filter(commune_code %in% araucsur_communes$commune_code) %>%
  group_by(id, gender, dob, commune_name, region_name, ses_status) %>% # Maybe move SES back to here
  summarise(#ses_status = get.min.na(ses_status),
            autism = get.max.na(autism),
            #intdisab = get.max.na(intdisab),
            aut_rank = get.min.na(aut_rank)) %>%
  ungroup() %>%
  rename("student_commune_name" = "commune_name",
         "student_region_name" = "region_name",
         "sex_desc" = "gender") %>%
  rowid_to_column("row_id") %>%
  select(row_id,
         id,
         dob,
         sex_desc,
         student_commune_name,
         autism,
         ses_status,
         #intdisab,
         aut_rank) #, student_region_name) #, count)
```

```
## `summarise()` has grouped output by 'id', 'gender', 'dob', 'commune_name',
## 'region_name'. You can override using the `.groups` argument.
```

```
write_xlsx(patients, "04_Data/Outputs/patients.xlsx")

length(unique(patients$id))
```

```
## [1] 1688
```

```
patients_unique <- patients %>%
  group_by(id) %>%
  summarise(sex_desc = list(sex_desc),
            student_commune_name = list(student_commune_name),
            dob = list(dob),
            ses_status = list(ses_status))
write_csv(patients_unique, "04_Data/Outputs/patients_unique.csv") # can't write columns containing list
```

NB: there are 1688 unique ID's in patients and it's 1747 rows long because some people are represented in 2 communes.

Are all the records in the small dataset in the big one? No

```
clinical %>% filter(id %in% clinical_small$id)
```

```
## # A tibble: 3,558 x 20
##    id         gender commune_c~1 commu~2 commu~3 healt~4 regio~5 socio~6 ses_s~7
##    <chr>      <chr>  <chr>       <chr>   <chr>   <chr>   <chr>   <chr>     <dbl>
##  1 21282495-K Female 09109       Loncoc~ LONCOC~ Servic~ Región~ FONASA~       2
##  2 21282495-K Female 09109       Loncoc~ LONCOC~ Servic~ Región~ FONASA~       2
##  3 21294488-2 Male   09120       Villar~ VILLAR~ Servic~ Región~ Privat~       3
##  4 21294488-2 Male   09120       Villar~ VILLAR~ Servic~ Región~ Privat~       3
##  5 21294488-2 Male   09120       Villar~ VILLAR~ Servic~ Región~ Privat~       3
##  6 21341924-2 Male   09115       Pucón   PUCÓN   Servic~ Región~ FONASA~       2
##  7 21341924-2 Male   09115       Pucón   PUCÓN   Servic~ Región~ FONASA~       2
##  8 21341924-2 Male   09115       Pucón   PUCÓN   Servic~ Región~ FONASA~       2
##  9 21341924-2 Male   09115       Pucón   PUCÓN   Servic~ Región~ FONASA~       2
## 10 21341924-2 Male   09115       Pucón   PUCÓN   Servic~ Región~ FONASA~       2
## # ... with 3,548 more rows, 11 more variables: dob <date>, age_june30 <dbl>,
## #   apt_date <date>, hospital <chr>, medical_specialty <chr>,
## #   type_appointment <chr>, codigo <chr>, diagnosis <chr>, autism <dbl>,
## #   intdisab <dbl>, aut_rank <dbl>, and abbreviated variable names
## #   1: commune_code, 2: commune_name, 3: commune_name_upper,
## #   4: health_service_name, 5: region_name, 6: socio_economic_level,
## #   7: ses_status
```

Assume this is because the big clinical dataset only has people with autism, not ADHD.

Only try to link clinical data to records in the schools data for the Southern health service in Araucanía

(ARAUC) because that's where the clinical data is from.

```
school <- chile_merged %>%
  # mutate(commune_code = ifelse(nchar(as.character(student_commune_code)) == 4,
  #                              paste0("0", as.character(student_commune_code)),
  #                              as.character(student_commune_code))) %>%
  select(-student_commune_name) %>%
  left_join(commune_region_lookup, by = "commune_code") %>%
  filter(commune_code %in% araucsur_communes$commune_code) %>%
  #filter(health_service_name == "Servicio de Salud Araucanía Sur") %>% # This should be filtered eithe
  filter(age_june30 >= 6 & age_june30 <= 18, sex != 0) %>% # Could try without this filter to pick up e
  # filter only the communes represented in the clinical data here?
  mutate(autism = ifelse(special_needs_code == 105, 1, 0),
         #intdisab = 0,
         aut_rank = 1,
         dob = ymd(dob),
         ses_status = ifelse(school_fee == "", NA,
                      ifelse(school_fee == "GRATUITO", 1,
                      ifelse(school_fee == "$1.000 A $10.000", 2,
                      ifelse(school_fee == "$10.001 A $25.000", 2,
                      ifelse(school_fee == "$25.001 A $50.000", 2,
                      ifelse(school_fee == "$50.001 A $100.000", 2,
                      ifelse(school_fee == "MAS DE $100.000", 2,
                      ifelse(school_fee == "SIN INFORMACION", NA, NA))))))))) %>%
  filter(autism == 1) %>% # We only want to find additional autism cases in the clinical records, we do
  rename(student_commune_name = commune_name) %>%
  select(dob,
         sex_desc,
         student_commune_name,
         #commune_name,
         #health_service_name,
         autism,
         ses_status,
         #intdisab,
         aut_rank#,
         #student_region_name
  ) %>%
  rowid_to_column("id")
school[dim(school)[1]+1, ] <- c(dim(school)[1]+1, "2023-06-26", "Female", "Misc", 0, 3, 0)

# Do the commune names align well? Yes
table(sort(unique(patients$student_commune_name, sort(unique(school$student_commune_name)))))
```

```
##
##          Carahue        Cholchol           Cunco      Curarrehue          Freire
##               47               9              33              12              32
##        Galvarino          Gorbea         Lautaro        Loncoche       Melipeuco
##               22              21             106              89               5
##   Nueva Imperial Padre Las Casas       Perquenco      Pitrufquén           Pucón
##               81             148              19              47              95
##         Saavedra          Temuco Teodoro Schmidt          Toltén          Vilcún
##               14             603              12              18              60
##       Villarrica
##              274
```

```
sort(unique(patients$student_commune_name))
```

```
##  [1] "Carahue"         "Cholchol"        "Cunco"           "Curarrehue"
##  [5] "Freire"          "Galvarino"       "Gorbea"          "Lautaro"
##  [9] "Loncoche"        "Melipeuco"       "Nueva Imperial"  "Padre Las Casas"
## [13] "Perquenco"       "Pitrufquén"      "Pucón"           "Saavedra"
## [17] "Temuco"          "Teodoro Schmidt" "Toltén"          "Vilcún"
## [21] "Villarrica"
```

```
sort(unique(school$student_commune_name))
```

```
##  [1] "Carahue"         "Cholchol"        "Cunco"           "Curarrehue"
##  [5] "Freire"          "Galvarino"       "Gorbea"          "Lautaro"
##  [9] "Loncoche"        "Melipeuco"       "Misc"            "Nueva Imperial"
## [13] "Padre Las Casas" "Perquenco"       "Pitrufquén"      "Pucón"
## [17] "Saavedra"        "Temuco"          "Teodoro Schmidt" "Toltén"
## [21] "Vilcún"          "Villarrica"
```

Added a fake row at the end of school to have a ses=3 represented so that pairing works.

Perfect match in communes between patient and school dataset when both are filtered to only be communes in Arauc Sur health region.

Try manual linkage

```
patients_grouped <- patients %>%
  group_by(sex_desc,
           dob,
           student_commune_name) %>%
  summarise(count = n(),
            ids = list(id))
```

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

```
school_grouped <- school %>%
  group_by(sex_desc,
           dob,
           student_commune_name) %>%
  summarise(count = n(),
            #ids = list(rowid)
            ses = list(ses_status))
```

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

```
sort(unique(patients$student_commune_name))
```

```
##  [1] "Carahue"         "Cholchol"        "Cunco"           "Curarrehue"
##  [5] "Freire"          "Galvarino"       "Gorbea"          "Lautaro"
##  [9] "Loncoche"        "Melipeuco"       "Nueva Imperial"  "Padre Las Casas"
## [13] "Perquenco"       "Pitrufquén"      "Pucón"           "Saavedra"
## [17] "Temuco"          "Teodoro Schmidt" "Toltén"          "Vilcún"
## [21] "Villarrica"
```

```
sort(unique(school$student_commune_name))
```

```
##  [1] "Carahue"         "Cholchol"        "Cunco"           "Curarrehue"
##  [5] "Freire"          "Galvarino"       "Gorbea"          "Lautaro"
##  [9] "Loncoche"        "Melipeuco"       "Misc"            "Nueva Imperial"
## [13] "Padre Las Casas" "Perquenco"       "Pitrufquén"      "Pucón"
## [17] "Saavedra"        "Temuco"          "Teodoro Schmidt" "Toltén"
## [21] "Vilcún"          "Villarrica"
```

```
merged <- merge(school, patients, by = c("sex_desc", "dob", "student_commune_name"), all = FALSE)
merged %>% filter(!is.na(id.x) & !is.na(id.y)) # 205 matches
```

```
##     sex_desc        dob student_commune_name id.x autism.x ses_status.x
## 1     Female 2003-04-16             Loncoche  450        1            1
## 2     Female 2003-11-25               Temuco  437        1            2
## 3     Female 2005-12-07               Temuco  380        1            1
## 4     Female 2006-08-10              Lautaro  470        1            1
## 5     Female 2006-09-20               Freire  109        1            1
## 6     Female 2006-10-10      Padre Las Casas  263        1            1
## 7     Female 2008-05-20               Gorbea  187        1            1
## 8     Female 2008-06-21               Temuco  269        1            1
## 9     Female 2009-05-08               Temuco   57        1            1
## 10    Female 2009-06-22                Pucón  332        1            1
## 11    Female 2010-04-27               Temuco  426        1            1
## 12    Female 2011-04-20               Temuco  173        1            2
## 13    Female 2012-01-31           Villarrica  172        1            1
## 14    Female 2012-01-31           Villarrica  172        1            1
## 15    Female 2012-04-07                Pucón  425        1            1
## 16    Female 2012-05-28               Vilcún  214        1            1
## 17    Female 2012-06-18           Villarrica   41        1            1
## 18    Female 2012-09-13               Temuco  104        1            1
## 19    Female 2013-04-20            Galvarino  296        1            1
## 20    Female 2013-06-19               Temuco  267        1            1
## 21    Female 2013-08-30      Padre Las Casas  311        1            1
## 22    Female 2013-12-30           Villarrica  190        1            2
## 23    Female 2014-02-15               Temuco  105        1            1
## 24    Female 2014-10-09               Gorbea  419        1            1
## 25    Female 2014-10-16               Temuco  415        1            2
## 26    Female 2014-11-12               Temuco  351        1            1
## 27    Female 2014-12-11                Pucón   80        1            1
## 28    Female 2014-12-12               Temuco  464        1            1
## 29      Male 2003-01-27               Temuco  227        1            1
## 30      Male 2003-03-06               Temuco  465        1            1
## 31      Male 2003-06-14               Temuco   92        1            1
## 32      Male 2003-06-15               Temuco  165        1            1
## 33      Male 2003-06-29               Temuco   53        1            1
## 34      Male 2003-08-03               Temuco  313        1            1
## 35      Male 2003-10-21               Temuco  186        1            1
## 36      Male 2003-12-15               Temuco  389        1            1
## 37      Male 2004-03-05       Nueva Imperial  442        1            1
## 38      Male 2004-03-12               Temuco  133        1            1
## 39      Male 2004-07-07               Temuco  322        1            2
## 40      Male 2004-09-28             Loncoche  216        1            1
## 41      Male 2004-10-01               Freire  307        1            1
## 42      Male 2004-11-07               Temuco  362        1            1
## 43      Male 2004-12-25                Cunco  174        1            1
## 44      Male 2005-01-03               Temuco   39        1            2
## 45      Male 2005-01-09               Temuco   49        1            1
## 46      Male 2005-01-21               Temuco  202        1            1
## 47      Male 2005-05-24               Temuco   78        1            1
## 48      Male 2005-06-17               Temuco  123        1            1
## 49      Male 2005-06-17               Temuco  123        1            1
## 50      Male 2005-08-29               Temuco   70        1            1
## 51      Male 2005-09-06               Temuco  405        1            2
## 52      Male 2006-03-04               Temuco  147        1            1
## 53      Male 2006-03-22               Temuco   11        1            1
## 54      Male 2006-04-13      Padre Las Casas  301        1            1
## 55      Male 2006-09-09            Galvarino  434        1            1
## 56      Male 2006-09-19              Lautaro  219        1            1
## 57      Male 2006-10-06              Lautaro  448        1            1
## 58      Male 2006-10-10               Vilcún  478        1            1
## 59      Male 2006-10-27               Temuco  247        1            1
## 60      Male 2006-11-02      Padre Las Casas  176        1            2
## 61      Male 2006-11-06               Temuco  471        1            2
## 62      Male 2006-11-06               Temuco  471        1            2
## 63      Male 2007-01-08              Carahue  319        1            1
## 64      Male 2007-01-23           Villarrica  363        1            1
## 65      Male 2007-02-13               Temuco  235        1            1
## 66      Male 2007-03-22              Lautaro  265        1            1
## 67      Male 2007-04-09      Padre Las Casas   31        1            1
## 68      Male 2007-04-25              Lautaro  336        1            1
## 69      Male 2007-05-11               Temuco  355        1            1
## 70      Male 2007-06-16           Pitrufquén  358        1            1
## 71      Male 2007-08-20           Pitrufquén  237        1            1
## 72      Male 2007-11-06           Villarrica  295        1            1
## 73      Male 2007-12-28             Loncoche  130        1            1
## 74      Male 2008-01-28       Nueva Imperial   44        1            1
## 75      Male 2008-03-05                Pucón  420        1            1
## 76      Male 2008-03-14               Temuco  408        1            1
## 77      Male 2008-03-25               Temuco  289        1            1
## 78      Male 2008-03-25               Temuco  289        1            1
## 79      Male 2008-05-20      Padre Las Casas  100        1            1
## 80      Male 2008-06-18               Vilcún   55        1            1
## 81      Male 2008-08-24             Saavedra  158        1            1
## 82      Male 2008-10-10               Temuco  112        1            2
## 83      Male 2008-10-22           Villarrica   72        1            1
## 84      Male 2008-10-22           Villarrica   72        1            1
## 85      Male 2008-11-22       Nueva Imperial  467        1            1
## 86      Male 2008-12-06              Lautaro   22        1            1
## 87      Male 2008-12-21               Temuco  394        1            1
## 88      Male 2008-12-29               Temuco   93        1            1
## 89      Male 2009-01-07              Lautaro  361        1            1
## 90      Male 2009-01-12               Temuco   26        1            1
## 91      Male 2009-02-13                Pucón    3        1            1
## 92      Male 2009-02-26             Loncoche  168        1            1
## 93      Male 2009-04-23             Loncoche  314        1            1
## 94      Male 2009-04-23             Loncoche  314        1            1
## 95      Male 2009-08-05           Villarrica   60        1            1
## 96      Male 2009-08-05           Villarrica   60        1            1
## 97      Male 2009-08-14                Pucón  252        1            1
## 98      Male 2009-08-14                Pucón  252        1            1
## 99      Male 2009-08-29               Temuco  159        1             2
## 100     Male 2009-10-01               Temuco  328        1             1
## 101     Male 2009-10-26               Temuco  341        1             1
## 102     Male 2010-01-02               Freire  272        1             1
## 103     Male 2010-01-25      Padre Las Casas   73        1             2
## 104     Male 2010-02-21             Loncoche  180        1             1
## 105     Male 2010-02-26      Teodoro Schmidt  213        1             1
## 106     Male 2010-03-07              Lautaro  242        1             1
## 107     Male 2010-03-16               Gorbea  246        1             1
## 108     Male 2010-05-20           Villarrica  396        1             1
## 109     Male 2010-06-07               Temuco  476        1             1
## 110     Male 2010-06-08       Nueva Imperial  292        1             1
## 111     Male 2010-07-21             Cholchol  194        1             1
## 112     Male 2010-07-28               Freire  382        1             1
## 113     Male 2010-08-29           Villarrica  365        1             1
## 114     Male 2010-09-13      Padre Las Casas  312        1             1
## 115     Male 2010-10-12               Temuco  201        1             1
## 116     Male 2010-12-09                Pucón  346        1             1
## 117     Male 2010-12-09               Temuco  107        1             1
## 118     Male 2011-01-13           Villarrica   18        1             2
## 119     Male 2011-01-24               Temuco   87        1             1
## 120     Male 2011-02-11                Cunco  368        1             1
## 121     Male 2011-02-22               Temuco  139        1             1
## 122     Male 2011-03-03              Lautaro  228        1             1
## 123     Male 2011-04-13           Villarrica  275        1             1
## 124     Male 2011-04-13           Villarrica  275        1             1
## 125     Male 2011-06-13               Temuco  203        1             1
## 126     Male 2011-07-02              Lautaro  475        1             1
## 127     Male 2011-08-02              Carahue  113        1             1
## 128     Male 2011-09-06      Teodoro Schmidt  229        1             1
## 129     Male 2011-09-08               Temuco  277        1             1
## 130     Male 2011-10-27      Teodoro Schmidt  283        1             1
## 131     Male 2011-11-10               Freire  300        1             1
## 132     Male 2011-11-12      Padre Las Casas  278        1             1
## 133     Male 2012-01-11                Pucón  290        1             1
## 134     Male 2012-01-11                Pucón  290        1             1
## 135     Male 2012-03-06           Villarrica  243        1             1
## 136     Male 2012-03-12               Temuco  261        1             1
## 137     Male 2012-04-16               Temuco  472        1             1
## 138     Male 2012-05-29               Temuco    8        1             1
## 139     Male 2012-06-01      Padre Las Casas   66        1             1
## 140     Male 2012-06-02               Temuco  141        1             1
## 141     Male 2012-06-25            Galvarino  183        1             1
## 142     Male 2012-07-08               Temuco  315        1             1
## 143     Male 2012-07-16            Galvarino  152        1             1
## 144     Male 2012-07-29               Vilcún   16        1             1
## 145     Male 2012-09-07               Temuco  293        1             1
## 146     Male 2012-09-21                Cunco  264        1             1
## 147     Male 2012-10-13           Villarrica   45        1             1
## 148     Male 2012-10-13           Villarrica   45        1             1
## 149     Male 2012-10-18           Villarrica  392        1             1
## 150     Male 2012-11-03              Lautaro  443        1             1
## 151     Male 2012-11-05               Temuco  447        1             1
## 152     Male 2012-12-10           Pitrufquén  304        1          <NA>
## 153     Male 2012-12-25      Padre Las Casas   29        1            1
## 154     Male 2013-01-26               Gorbea  385        1            1
## 155     Male 2013-01-30          Pitrufquén   97        1            1
## 156     Male 2013-02-12               Temuco  366        1            1
## 157     Male 2013-02-25               Gorbea  294        1            1
## 158     Male 2013-02-27       Nueva Imperial   24        1            1
## 159     Male 2013-03-24           Villarrica  386        1            1
## 160     Male 2013-04-23               Toltén  350        1            1
## 161     Male 2013-05-20               Temuco  280        1            1
## 162     Male 2013-05-23              Lautaro  189        1            1
## 163     Male 2013-05-30           Villarrica  469        1            1
## 164     Male 2013-07-07               Vilcún  338        1            1
## 165     Male 2013-10-16               Vilcún  111        1            1
## 166     Male 2013-10-23           Pitrufquén  324        1            1
## 167     Male 2013-11-05           Villarrica  211        1            1
## 168     Male 2013-11-05           Villarrica  211        1            1
## 169     Male 2013-11-14               Temuco   71        1            1
## 170     Male 2014-02-19               Temuco  326        1            1
## 171     Male 2014-02-19               Temuco  326        1            1
## 172     Male 2014-02-19               Temuco  451        1            1
## 173     Male 2014-02-19               Temuco  451        1            1
## 174     Male 2014-04-17               Temuco  335        1            1
## 175     Male 2014-04-21               Temuco  129        1            1
## 176     Male 2014-05-06           Villarrica  271        1            1
## 177     Male 2014-05-17                Cunco  125        1            1
## 178     Male 2014-05-20               Temuco  287        1            1
## 179     Male 2014-05-24             Loncoche  407        1            1
## 180     Male 2014-06-02               Temuco  162        1            1
## 181     Male 2014-06-16               Temuco   77        1            1
## 182     Male 2014-07-07               Temuco  116        1            1
## 183     Male 2014-08-30            Galvarino    6        1            1
## 184     Male 2014-09-06               Temuco  145        1            1
## 185     Male 2014-09-06               Temuco  145        1            1
## 186     Male 2014-09-12             Loncoche  310        1            1
## 187     Male 2014-09-12             Loncoche  310        1            1
## 188     Male 2014-10-07               Temuco   98        1            1
## 189     Male 2014-10-07               Temuco   98        1            1
## 190     Male 2014-10-07               Temuco  118        1            1
## 191     Male 2014-10-07               Temuco  118        1            1
## 192     Male 2014-10-28               Temuco   15        1            1
## 193     Male 2014-11-02               Temuco  399        1            1
## 194     Male 2014-11-16              Lautaro   91        1            1
## 195     Male 2014-11-19                Pucón  357        1            1
## 196     Male 2014-12-29      Padre Las Casas  456        1            2
## 197     Male 2015-01-03           Villarrica  353        1            1
## 198     Male 2015-01-19               Vilcún  157        1            1
## 199     Male 2015-01-25      Padre Las Casas  270        1            1
## 200     Male 2015-02-02      Teodoro Schmidt  466        1            1
## 201     Male 2015-03-06       Nueva Imperial  458        1            1
## 202     Male 2015-03-10            Galvarino  181        1            1
## 203     Male 2015-03-11               Temuco  387        1            1
## 204     Male 2015-03-13               Temuco  256        1            1
## 205     Male 2015-05-02               Temuco  376        1            1
##     aut_rank.x row_id       id.y autism.y ses_status.y aut_rank.y
## 1            1     21 21282495-K         1            2          1
## 2            1     81 21449127-3         1            2          1
## 3            1    295 21994583-3         1            1          1
## 4            1    360 22183641-3         1            2          1
## 5            1    371 22213761-6         1            2          1
## 6            1    377 22234827-7         1            2          1
## 7            1    568 22724176-4         1            1          1
## 8            1    580 22752332-8         1            1          1
## 9            1    692 23021556-1         1            2          1
## 10           1    702 23054104-3         1            2          1
## 11           1    818 23310188-5         1            2          1
## 12           1    966 23624343-5         1            2          1
## 13           1   1063 23860402-8         1            1          1
## 14           1   1064 23860402-8         1            2          1
## 15           1   1081 23917587-2         1            2          1
## 16           1   1109 23959967-2         1            3          1
## 17           1   1120 23987283-2         1            1          1
## 18           1   1162 24064290-5         1            2          1
## 19           1   1253 24249709-0         1            1          1
## 20           1   1276 24307066-K         1            2          1
## 21           1   1303 24396036-3         1            2          1
## 22           1   1336 24495784-6         1            2          1
## 23           1   1353 24539730-5         1            1          1
## 24           1   1447 24763669-2         1            2          1
## 25           1   1451 24771215-1         1            2          1
## 26           1   1458 24797188-2         1            1          1
## 27           1   1470 24825751-2         1            2          1
## 28           1   1467 24824555-7         1            2          1
## 29           1     46 21338851-7         1            2          1
## 30           1     14 21251752-6         1            1          1
## 31           1     37 21319146-2         1            1          1
## 32           1     38 21319994-3         1            2          1
## 33           1     43 21332821-2         1            1          1
## 34           1     49 21354095-5         1            2          1
## 35           1     76 21417599-1         1            1          1
## 36           1     87 21464033-3         1            2          1
## 37           1    102 21520695-5         1            2          1
## 38           1    108 21543736-1         1            2          1
## 39           1    138 21619878-6         1            2          1
## 40           1    162 21670184-4         1            2          1
## 41           1    165 21679874-0         1            2          1
## 42           1    174 21700914-6         1            1          1
## 43           1    192 21737462-6         1            2          1
## 44           1    196 21748664-5         1            2          1
## 45           1    198 21750199-7         1            2          1
## 46           1    202 21759050-7         1            1          1
## 47           1    242 21859877-3         1            2          1
## 48           1    245 21867880-7         1            2          1
## 49           1    244 21862073-6         1            2          1
## 50           1    262 21921022-1         1            1          1
## 51           1    264 21925304-4         1            2          1
## 52           1    316 22065375-7         1            1          1
## 53           1    320 22079654-K         1            2          1
## 54           1    328 22095157-K         1            2          1
## 55           1    365 22204715-3        1            1          1
## 56           1    370 22211545-0        1            2          1
## 57           1    376 22226291-7        1            2          1
## 58           1    378 22237373-5        1            1          1
## 59           1    384 22245810-2        1            1          1
## 60           1    385 22249166-5        1            2          1
## 61           1    388 22253752-5        1            2          1
## 62           1    389 22253904-8        1            2          1
## 63           1    412 22300065-7        1            2          1
## 64           1    416 22312842-4        1            2          1
## 65           1    427 22327040-9        1            2          1
## 66           1    436 22356979-K        1            2          1
## 67           1    443 22370213-9        1            2          1
## 68           1    450 22386477-5        1            2          1
## 69           1    453 22395859-1        1            2          1
## 70           1    458 22426890-4        1            2          1
## 71           1    483 22491627-2        1            2          1
## 72           1    499 22549846-6        1            2          1
## 73           1    518 22592217-9        1            1          1
## 74           1    529 22637968-1        1            2          1
## 75           1    536 22663017-1        1            2          1
## 76           1    544 22670294-6        1            1          1
## 77           1    547 22678488-8        1            1          1
## 78           1    548 22678488-8        1            2          1
## 79           1    567 22723986-7        1            1          1
## 80           1    582 22755037-6        1            2          1
## 81           1    602 22805100-4        1            1          1
## 82           1    621 22838644-8        1            2          1
## 83           1    631 22852889-7        1            1          1
## 84           1    632 22852889-7        1            2          1
## 85           1    638 22881315-K        1            1          1
## 86           1    642 22891576-9        1            2          1
## 87           1    647 22901266-5        1            2          1
## 88           1    652 22907807-0        1            2          1
## 89           1    654 22915922-4        1            2          1
## 90           1    655 22920380-0        1            2          1
## 91           1    666 22945155-3        1            2          1
## 92           1    672 22958693-9        1            1          1
## 93           1    689 23006189-0        1            2          1
## 94           1    688 23006189-0        1            1          1
## 95           1    715 23093195-K        1            3          1
## 96           1    714 23093195-K        1            2          1
## 97           1    717 23099554-0        1            3          1
## 98           1    716 23099554-0        1            2          1
## 99           1    721 23111138-7        1            2          1
## 100          1    732 23136875-2        1            2          1
## 101          1    748 23157810-2        1            2          1
## 102          1    779 23216852-8        1            1          1
## 103          1    788 23233498-3        1            2          1
## 104          1    796 23258114-K        1            1          1
## 105          1    803 23266559-9        1            1          1
## 106          1    801 23263729-3        1            1          1
## 107          1    806 23273376-4        1            2          1
## 108          1    827 23330047-0        1            2          1
## 109          1    833 23343300-4        1            2          1
## 110          1    834 23346792-8        1            1          1
## 111          1    849 23378083-9        1            2          1
## 112          1    852 23386130-8        1            1          1
## 113          1    865 23410879-4        1            2          1
## 114          1    868 23423713-6        1            2          1
## 115          1    877 23448369-2        1            2          1
## 116          1    907 23506849-4        1            1          1
## 117          1    902 23501831-4        1            2          1
## 118          1    921 23534842-K        1            2          1
## 119          1    926 23543378-8        1            1          1
## 120          1    935 23559600-8        1            2          1
## 121          1    939 23567468-8        1            2          1
## 122          1    943 23574393-0        1            1          1
## 123          1    967 23625011-3        1            1          1
## 124          1    968 23625011-3        1            2          1
## 125          1    983 23667140-2        1            2          1
## 126          1    987 23683414-K        1            2          1
## 127          1    996 23713649-7        1            1          1
## 128          1   1005 23737580-7        1            2          1
## 129          1   1007 23740506-4        1            2          1
## 130          1   1030 23785220-6        1            1          1
## 131          1   1035 23794254-K        1            1          1
## 132          1   1036 23795374-6        1            1          1
## 133          1   1055 23843993-0        1            1          1
## 134          1   1056 23843993-0        1            2          1
## 135          1   1075 23896217-K        1            2          1
## 136          1   1076 23900150-5        1            3          1
## 137          1   1088 23929914-8        1            1          1
## 138          1   1112 23967787-8        1            1          1
## 139          1   1113 23968562-5        1            2          1
## 140          1   1114 23969130-7        1            2          1
## 141          1   1123 23994954-1        1            1          1
## 142          1   1130 24005478-7        1            1          1
## 143          1   1135 24014350-K        1            2          1
## 144          1   1142 24026293-2        1            2          1
## 145          1   1156 24058690-8        1            1          1
## 146          1   1169 24073081-2        1            2          1
## 147          1   1178 24092534-6        1            2          1
## 148          1   1179 24092534-6        1            3          1
## 149          1   1180 24093718-2        1            2          1
## 150          1   1196 24121753-1        1            1          1
## 151          1   1184 24107434-K        1            2          1
## 152          1   1202 24139241-4        1            2          1
## 153          1   1209 24152537-6        1            1          1
## 154          1   1220 24182326-1        1            2          1
## 155          1   1219 24180190-K        1            2          1
## 156          1   1223 24190413-K        1            2          1
## 157          1   1230 24204418-5        1            2          1
## 158          1   1235 24210618-0        1            1          1
## 159          1   1240 24230863-8        1            1          1
## 160          1   1254 24251559-5        1            1          1
## 161          1   1264 24281126-7        1            1          1
## 162          1   1266 24286764-5        1            1          1
## 163          1   1269 24291235-7         1            2          1
## 164          1   1284 24324822-1         1            1          1
## 165          1   1312 24417134-6         1            2          1
## 166          1   1316 24426016-0         1            2          1
## 167          1   1319 24447255-9         1            1          1
## 168          1   1320 24447255-9         1            2          1
## 169          1   1541 24989671-3         1            2          1
## 170          1   1355 24540729-7         1            2          1
## 171          1   1354 24540592-8         1            2          1
## 172          1   1355 24540729-7         1            2          1
## 173          1   1354 24540592-8         1            2          1
## 174          1   1376 24598516-9         1            1          1
## 175          1   1378 24599994-1         1            3          1
## 176          1   1383 24612954-1         1            2          1
## 177          1   1390 24627145-3         1            2          1
## 178          1   1392 24628839-9         1            1          1
## 179          1   1393 24629598-0         1            1          1
## 180          1   1397 24636672-1         1            2          1
## 181          1   1404 24653340-7         1            2          1
## 182          1   1424 24703686-5         1            1          1
## 183          1   1433 24729625-5         1            1          1
## 184          1   1437 24737432-9         1            1          1
## 185          1   1442 24743808-4         1            2          1
## 186          1   1440 24743750-9         1            1          1
## 187          1   1441 24743802-5         1            1          1
## 188          1   1446 24761476-1         1            2          1
## 189          1   1449 24766324-K         1            2          1
## 190          1   1446 24761476-1         1            2          1
## 191          1   1449 24766324-K         1            2          1
## 192          1   1453 24786561-6         1            1          1
## 193          1   1452 24786417-2         1            2          1
## 194          1   1460 24801153-K         1            2          1
## 195          1   1461 24806938-4         1            2          1
## 196          1   1482 24842142-8         1            3          1
## 197          1   1485 24851058-7         1            1          1
## 198          1   1491 24867787-2         1            3          1
## 199          1   1496 24878818-6         1            1          1
## 200          1   1500 24887657-3         1            1          1
## 201          1   1514 24923775-2         1            1          1
## 202          1   1513 24922934-2         1            2          1
## 203          1   1515 24926007-K         1            2          1
## 204          1   1517 24927693-6         1            1          1
## 205          1   1534 24972952-3         1            2          1
```

```
length(unique(merged$id.x))
```

```
## [1] 187
```

```
length(unique(merged$id.y))
```

```
## [1] 191
```

187 unique school records can be perfectly matched to clinical records, representing 191 patients.

Probabilistic record linkage

https://rpubs.com/ahmademad/RecordLinkage https://www.bristol.ac.uk/media-library/sites/cmm/migrated/documents/problinkage.pdf https://cran.r-project.org/web/packages/diyar/vignettes/links.html

Mismatch on ses is slightly higher weighted than match on everything. Unclear why and doesn't occur for epiWeights() below.

```
# Try supplying error information. Works better when sex_desc and dob are both in blocking as otherwise
# Still quick for whole school dataset
a2 <- compare.linkage(school,
                     #select(school, -ses_status),
                     select(patients, -row_id),
                     #select(patients, -ses_status),
                     blockfld = c("sex_desc", "dob"), # Block on sex and dob because we really want the
                     #blockfld = FALSE,
                     phonetic = FALSE,
                     strcmp = c(2), # Do string comparison on DOB
                     exclude = c(1) # Exclude the id column in both datasets
                     )
a2_pairs <- a2$pairs # Issue with ses matching here
b2 <- epiWeights(a2, e = c(0.01, # Default for DOB
                           0.01, # Default for sex
                           0.01, # Default for commune because we want a good match
                           0.01, # Keep small so autism in clinical (not intellectual disability) is pr
                           0.4, # Have more error for ses_status because it is loosely defined
                           #0.3, # Allow more mismatch intellectual disability status so that autism ma
                           0.01 # Allow some mismatch on whether autism is the primary diagnosis so we
))
summary(b2)
```

```
##
## Linkage Data Set
##
## 488 records in data set 1
## 1747 records in data set 2
## 312 record pairs
##
## 0 matches
## 0 non-matches
## 312 pairs with unknown status
##
##
## Weight distribution:
##
## [0.55,0.6] (0.6,0.65] (0.65,0.7] (0.7,0.75] (0.75,0.8] (0.8,0.85] (0.85,0.9]
##          6         66         35          0          0        120         85
```

```
allPairs2 <- getPairs(b2)
head(allPairs2, n = 20)
```

```
##      id         id        dob sex_desc student_commune_name autism ses_status
## 1   437        437 2003-11-25   Female               Temuco      1          2
## 2    81 21449127-3 2003-11-25   Female               Temuco      1          2
## 3
## 4   380        380 2005-12-07   Female               Temuco      1          1
## 5   295 21994583-3 2005-12-07   Female               Temuco      1          1
## 6
## 7   187        187 2008-05-20   Female               Gorbea      1          1
## 8   568 22724176-4 2008-05-20   Female               Gorbea      1          1
## 9
## 10  269        269 2008-06-21   Female               Temuco      1          1
## 11  580 22752332-8 2008-06-21   Female               Temuco      1          1
## 12
## 13  173        173 2011-04-20   Female               Temuco      1          2
## 14  966 23624343-5 2011-04-20   Female               Temuco      1          2
## 15
## 16  172        172 2012-01-31   Female           Villarrica      1          1
## 17 1063 23860402-8 2012-01-31   Female           Villarrica      1          1
## 18
## 19   41         41 2012-06-18   Female           Villarrica      1          1
## 20 1120 23987283-2 2012-06-18   Female           Villarrica      1          1
##    aut_rank    Weight
## 1         1
## 2         1 0.8882294
## 3
## 4         1
## 5         1 0.8882294
## 6
## 7         1
## 8         1 0.8882294
## 9
## 10        1
## 11        1 0.8882294
## 12
## 13        1
## 14        1 0.8882294
## 15
## 16        1
## 17        1 0.8882294
## 18
## 19        1
## 20        1 0.8882294
```

```r
classifyPairs2 <- emClassify(b2, threshold.upper = 1, threshold.lower = 0.8)
a2_pairs$weight <- classifyPairs2$Wdata
a2_pairs$pred <- classifyPairs2$prediction

a2_pairs_clean <- a2_pairs %>%
  rename(".x" = id1, ".y" = id2) %>%
  select(-is_match)

finalPairs2 <- getPairs(b2, max.weight = 1, min.weight = 0, single.rows = TRUE) # Take them all when bl

#kmeansRes2 <- classifyUnsup(a2, method = "kmeans")
#a2_pairs$pred <- kmeansRes2$prediction
# Works but prioritises ses over commune and doesn't use epiWeights found above so not that useful.
```

finalPairs2 is the same size as finalPairs and probably contains the same matches but was much quicker to run because of the blocking. Assume in kmeansRes2, N = not a match, L = likely a match.

```r
# reclin has a 1-1 matching fuction so regenerate the pairs using reclin so they're a pairs
# type object and can be passed to select_n_to_m

pairs <- pair_blocking(school, patients, on = c("sex_desc", "dob")) %>%
         mutate(student_commune_name = (school$student_commune_name[.x] == patients$student_commune_name
         #ses = get_num_diff(school$ses_status[.x], patients$ses_status[.y])$val
         ) %>%
  left_join(a2_pairs_clean, by = c(".x", ".y")) %>%
  select(c(-student_commune_name.x)) %>%
  rename("student_commune_name" = "student_commune_name.y")


matches <- select_n_to_m(pairs, threshold = 0.5, score = "weight", n = 1, m = 1, var = "match") %>%
  filter(match == TRUE) %>%
  rename("id" = ".x",
         "row_id" = ".y") %>%
  mutate(id = as.character(id))
```

```r
# Now add the matched clinical records to the school records
school_matched <- school %>%
  filter(student_commune_name != "Misc") %>%
  left_join(matches, by = "id") %>%
  rename(id.school = id,
         dob.school = dob.x,
         sex_desc.school = sex_desc.x,
         student_commune_name.school = student_commune_name.x,
         ses_status.school = ses_status.x,
         dob.matched = dob.y,
         sex_desc.matched = sex_desc.y,
         student_commune_name.matched = student_commune_name.y,
         ses_status.matched = ses_status.y) %>%
  select(c(-pred, -match)) %>%
  left_join(patients, by = "row_id") %>%
  rename(id.patient = row_id,
         patient_id = id,
         dob.patient = dob,
         sex_desc.patient = sex_desc,
         student_commune_name.patient = student_commune_name,
         ses_status.patient = ses_status) %>%
  select(id.school, id.patient, patient_id,
         dob.school, dob.patient, dob.matched,
         sex_desc.school, sex_desc.patient, sex_desc.matched,
         student_commune_name.school, student_commune_name.patient, student_commune_name.matched,
         ses_status.school, ses_status.patient, ses_status.matched,
         weight) %>%
  arrange(desc(weight))

write_csv(school_matched, "04_Data/Outputs/school_matched.csv")

#school_matched_yes <- school_matched %>% filter(!is.na(weight))
#school_matched_no <- school_matched %>% filter(is.na(weight))

# commune_nums <- data.frame(student_commune_name.school = sort(unique(school_matched$student_commune_n
#                            commune_num = c(1:length(unique(school_matched$student_commune_name.school
school_matched_small <- school_matched %>%
  mutate(matched = ifelse(is.na(patient_id), 0, 1),
         sex.school = ifelse(sex_desc.school == "Male", 1, ifelse(sex_desc.school == "Female", 2, NA)))
  merge(commune_region_lookup, by.x = "student_commune_name.school", by.y = "commune_name") %>% # doesn
  select(id.school, dob.school, sex_desc.school, sex.school, student_commune_name.school, commune_code,
```

```
# Now add the matched clinical records to the school records
patients_matched <- patients %>%
  left_join(matches, by = "row_id") %>%
  rename(id.patient = row_id,
         patient_id = id.x,
         dob.patient = dob.x,
         sex_desc.patient = sex_desc.x,
         student_commune_name.patient = student_commune_name.x,
         id = id.y,
         ses_status.patient = ses_status.x,
         dob.matched = dob.y,
         sex_desc.matched = sex_desc.y,
         student_commune_name.matched = student_commune_name.y,
         ses_status.matched = ses_status.y) %>%
  select(c(-pred, -match)) %>%
  left_join(school, by = "id") %>%
  rename(id.school = id,
         dob.school = dob,
         sex_desc.school = sex_desc,
         student_commune_name.school = student_commune_name,
         ses_status.school = ses_status) %>%
  select(id.school, id.patient, patient_id,
         dob.school, dob.patient, dob.matched,
         sex_desc.school, sex_desc.patient, sex_desc.matched,
         student_commune_name.school, student_commune_name.patient, student_commune_name.matched,
         ses_status.school, ses_status.patient, ses_status.matched,
         weight) %>%
  arrange(desc(weight))

write_csv(patients_matched, "04_Data/Outputs/patients_matched.csv")


patients_matched_small <- patients_matched %>%
  mutate(matched = ifelse(is.na(id.school), 0, 1),
         sex.patient = ifelse(sex_desc.patient == "Male", 1, ifelse(sex_desc.patient == "Female", 2, NA
  merge(commune_region_lookup, by.x = "student_commune_name.patient", by.y = "commune_name") %>%
  select(id.patient, dob.patient, sex_desc.patient, sex.patient, student_commune_name.patient, commune_
```

Consider whether the matched and unmatched school records are different

We hope they are not different

```
#library(coin)



#pt.sex <- oneway_test(sex.school ~ as.factor(matched), data = school_matched_small, distribution = app
#confint(pt.sex)
```

```
#ks.ses <- ks.test(data1$ses_status.school, data2$ses_status.school, alternative = "two.sided", simulat
#ks.ses

# SES
#data1 <- school_matched_yes %>% select(ses_status.school)
#data2 <- school_matched_no %>% select(ses_status.school)
#hist(data1$ses_status.school, breaks = 10)
#hist(data2$ses_status.school, breaks = 10)
#$data1 %>% group_by(ses_status.school) %>% summarise(count = n()) %>% mutate(freq = count/sum(count))
#data2 %>% group_by(ses_status.school) %>% summarise(count = n()) %>% mutate(freq = count/sum(count))
```

```
school_yes <- school_matched_small %>% filter(matched == 1) #%>% select(sex.school)
school_no <- school_matched_small %>% filter(matched == 0)

# Kolmogorov tests for our matched results
ks.school.sex <- ks.test(na.omit(school_yes$sex.school),
                         na.omit(school_no$sex.school),
                         alternative = "two.sided", simulate.p.value = TRUE)
ks.school.sex
```

```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  na.omit(school_yes$sex.school) and na.omit(school_no$sex.school)
## D = 0.011834, p-value = 1
## alternative hypothesis: two-sided
```

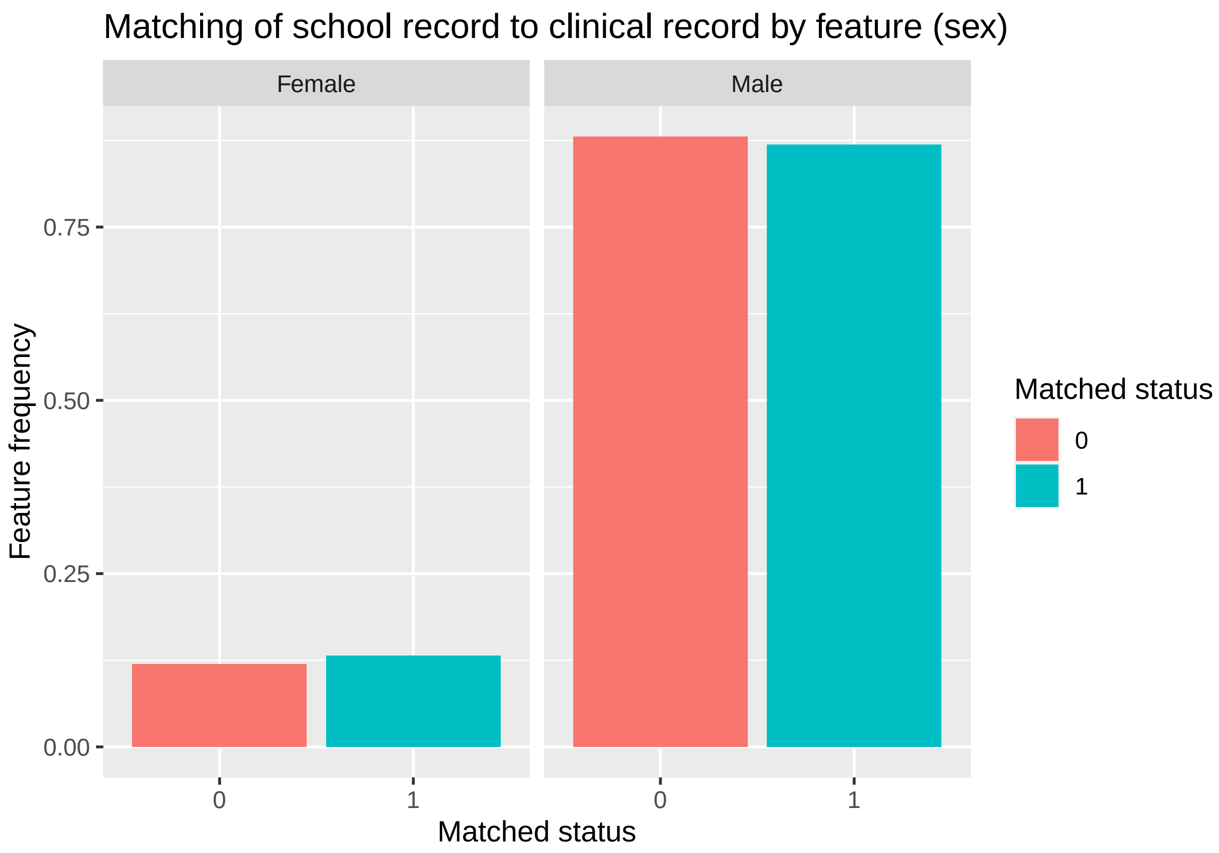
```
ks.school.ses_status <- ks.test(as.numeric(na.omit(school_yes$ses_status.school)),
                                as.numeric(na.omit(school_no$ses_status.school)),
                                alternative = "two.sided", simulate.p.value = TRUE)
ks.school.ses_status
```

```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  as.numeric(na.omit(school_yes$ses_status.school)) and as.numeric(na.omit(school_no$ses_status
## D = 0.087291, p-value = 0.3193
## alternative hypothesis: two-sided
```

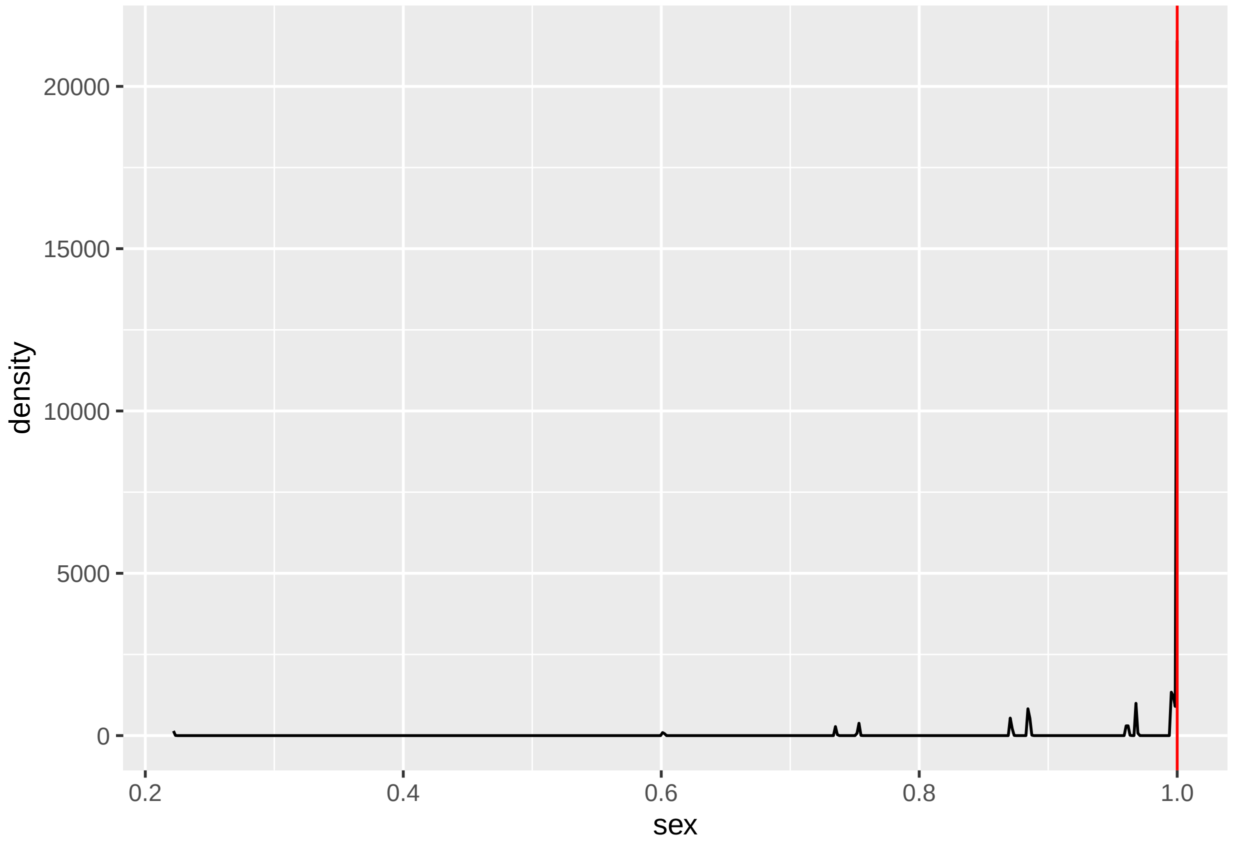
```
ks.school.commune_code<- ks.test(as.numeric(na.omit(school_yes$commune_code)),
                                 as.numeric(na.omit(school_no$commune_code)),
                                 alternative = "two.sided", simulate.p.value = TRUE)
ks.school.commune_code
```

```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  as.numeric(na.omit(school_yes$commune_code)) and as.numeric(na.omit(school_no$commune_code))
## D = 0.20101, p-value = 0.0001077
## alternative hypothesis: two-sided
```

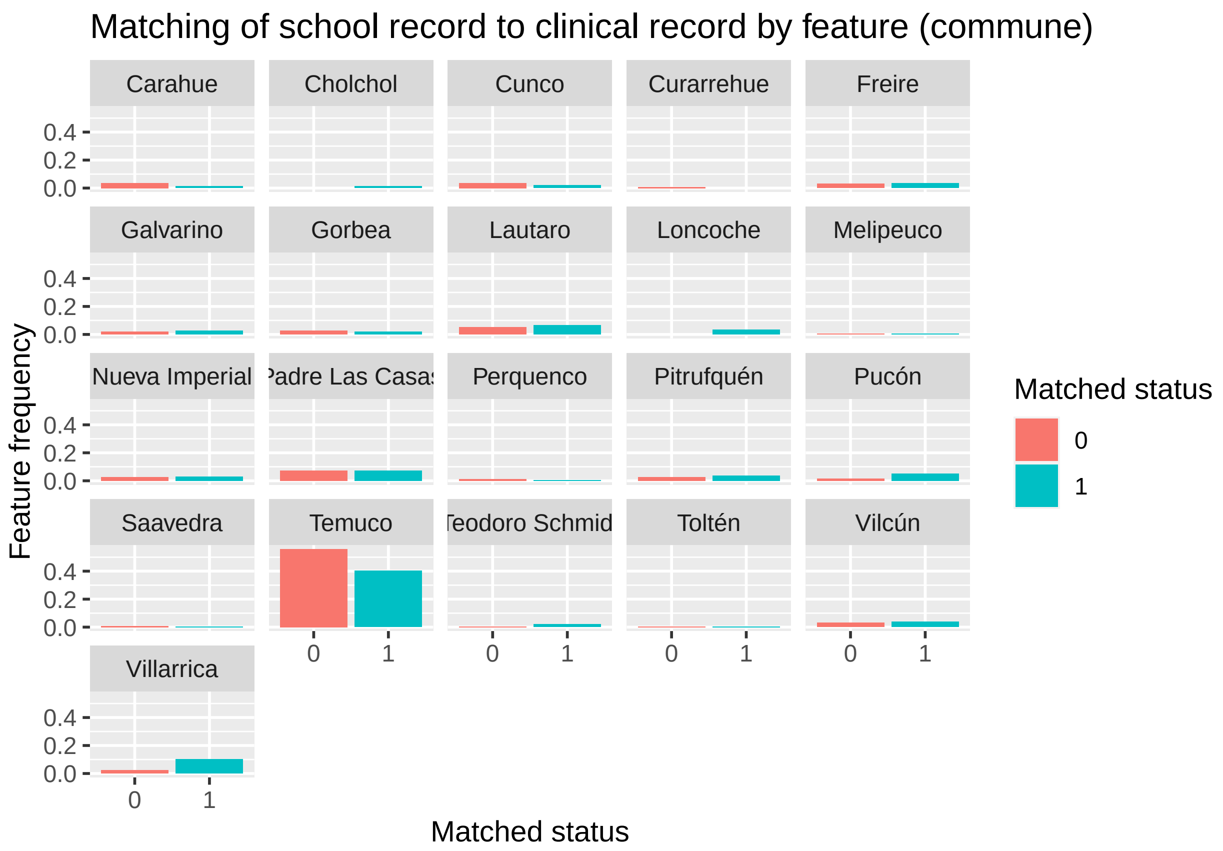
```
# Try manual Kolmogorov for SES
# bins <- unique(na.omit(school_matched_small$ses_status.school))
# ecdf.ses_status.yes <- ecdf(schoolyes$ses_status.school)
# ecdf.ses_status.yes(schoolyes$ses_status.school)
# ecdf.ses_status.no <- ecdf(schoolno$ses_status.school)
# plot(ecdf.ses_status.yes) ; plot(ecdf.ses_status.no)

# Kolmogorov tests with permutation distributions
set.seed(123)
nPerm <- 200 # change to 2000
ks_perm.school.pvals <- data.frame(sex = numeric(nPerm),
                                   commune_code = numeric(nPerm),
                                   ses_status = numeric(nPerm))

school_matched_small_perm <- school_matched_small

for (i in 1:nPerm) {
  #print(i)
  school_matched_small_perm$matched <- school_matched_small$matched[sample(nrow(school_matched_small))]
  school_perm_yes <- school_matched_small_perm %>% filter(matched == 1)
  school_perm_no <- school_matched_small_perm %>% filter(matched == 0)

  ks_perm.school.sex <- ks.test(na.omit(school_perm_yes$sex.school),
                                na.omit(school_perm_no$sex.school),
                                alternative = "two.sided")
  ks_perm.school.commune_code <- ks.test(as.numeric(na.omit(school_perm_yes$commune_code)),
                                        as.numeric(na.omit(school_perm_no$commune_code)),
                                        alternative = "two.sided")
  ks_perm.school.ses_status <- ks.test(as.numeric(na.omit(school_perm_yes$ses_status.school)),
                                       as.numeric(na.omit(school_perm_no$ses_status.school)),
                                       alternative = "two.sided")

  ks_perm.school.pvals$sex[i] <- ks_perm.school.sex$p.value
  ks_perm.school.pvals$commune_code[i] <- ks_perm.school.commune_code$p.value
  ks_perm.school.pvals$ses_status[i] <- ks_perm.school.ses_status$p.value
}

# Results for sex
school_match_yes.sex <- school_yes %>% group_by(sex.school) %>% summarise(count = n()) %>% mutate(freq =
school_match_no.sex <- school_no %>% group_by(sex.school) %>% summarise(count = n()) %>% mutate(freq = c
school_match.sex <- rbind(school_match_yes.sex, school_match_no.sex) %>%
  mutate(sex_desc = ifelse(sex.school == 1, "Male", ifelse(sex.school == 2, "Female", NA))) %>%
  arrange(sex_desc, matched)

ggplot(school_match.sex) +
  geom_col(aes(x = as.factor(matched), y = freq, fill = as.factor(matched))) +
  facet_wrap(~sex_desc) +
  labs(title = "Matching of school record to clinical record by feature (sex)",
       x = "Matched status",
       y = "Feature frequency",
       fill = "Matched status")
```



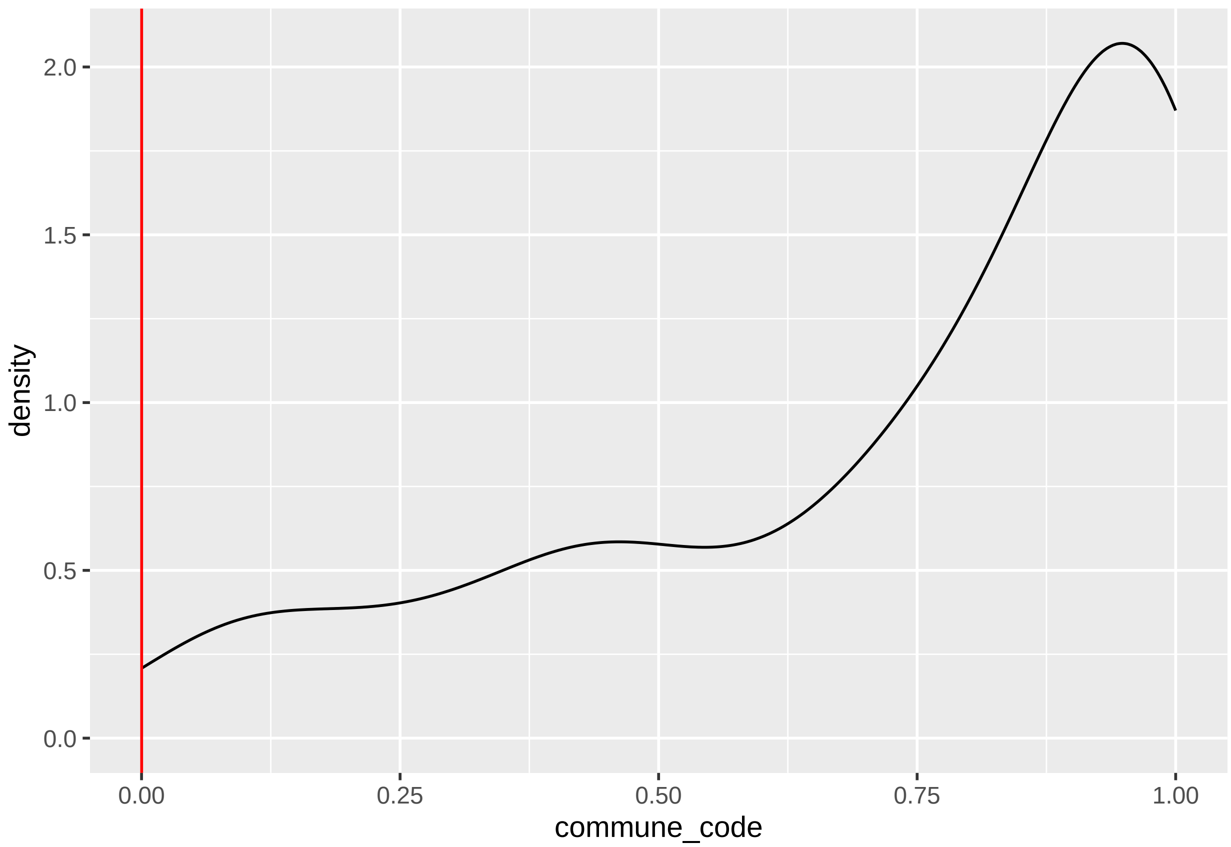
```
ggplot(ks_perm.school.pvals, aes(x = sex, y = after_stat(density))) +
  geom_density() +
  geom_vline(xintercept = ks.school.sex$p.value, color = "red")
```



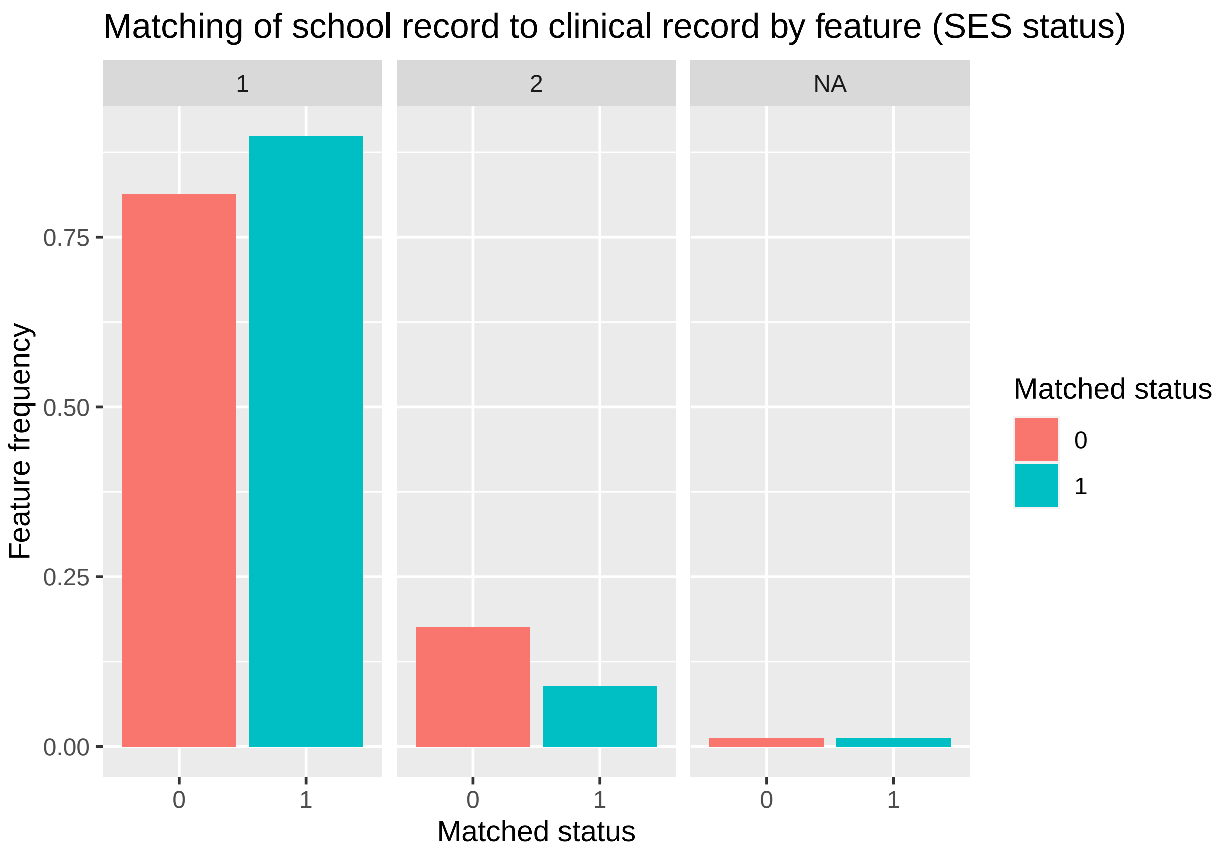
```
# Results for commune
school_match_yes.student_commune_name <- school_yes %>% group_by(student_commune_name.school) %>%
  summarise(count = n()) %>% mutate(freq = count/sum(count)) %>%
  # Would need to merge to a list of commune names and numbers if want to display all communes for all
  #merge(commune_, by = "commune_num", all = TRUE) %>%
  mutate(matched = 1)
school_match_no.student_commune_name <- school_no %>% group_by(student_commune_name.school) %>%
  summarise(count = n()) %>% mutate(freq = count/sum(count)) %>%
  #merge(commune_nums, by = "commune_num", all = TRUE) %>%
  mutate(matched = 0)

school_match.student_commune_name <- rbind(school_match_yes.student_commune_name, school_match_no.studen
  arrange(student_commune_name.school, matched)

ggplot(school_match.student_commune_name) +
  geom_col(aes(x = as.factor(matched), y = freq, fill = as.factor(matched))) +
  facet_wrap(~student_commune_name.school, scales = "fixed") +
  #facet_wrap(~student_commune_name.school, scales = "free") +
  labs(title = "Matching of school record to clinical record by feature (commune)",
       x = "Matched status",
       y = "Feature frequency",
       fill = "Matched status")
```



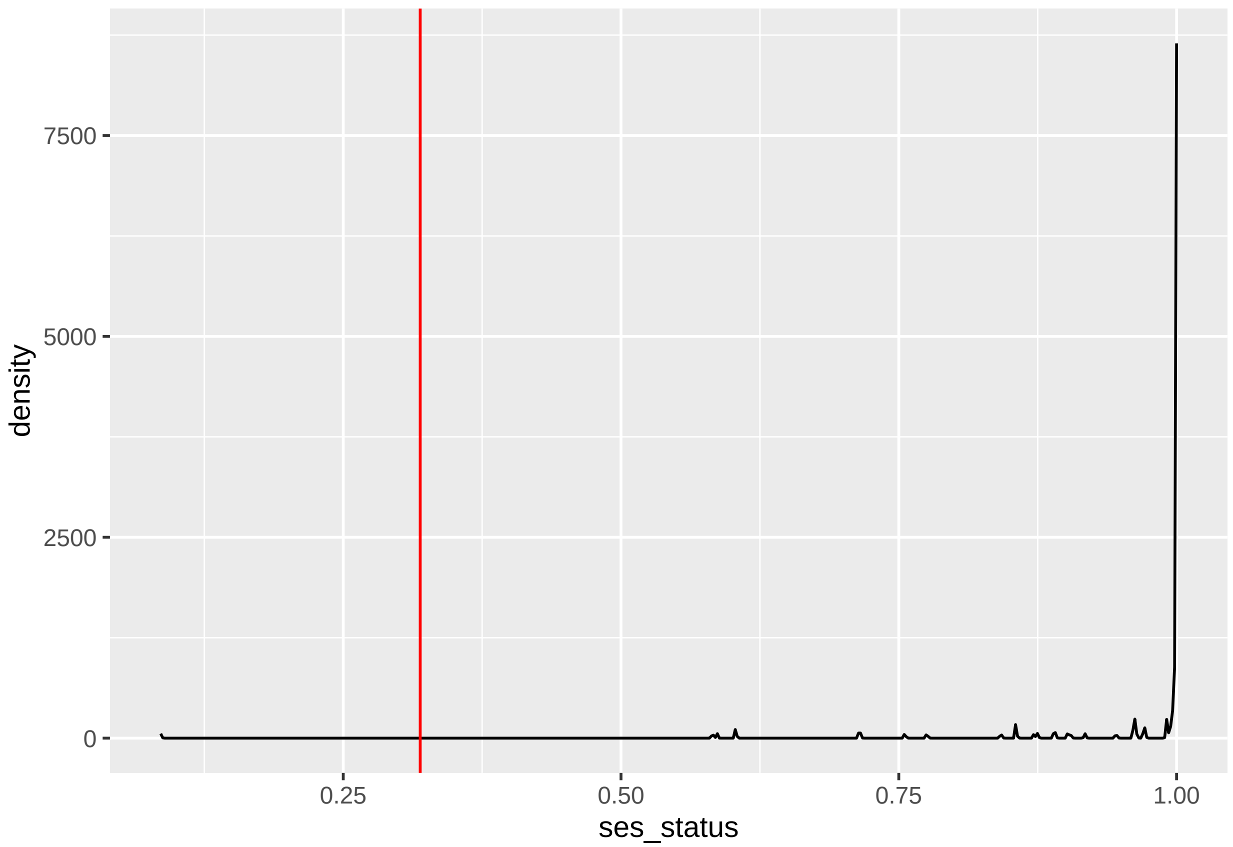
```r
# most of the difference in matched commune frequency is for Temuco which is the biggest commune.


ggplot(ks_perm.school.pvals, aes(x = commune_code, y = after_stat(density))) +
  geom_density() +
  geom_vline(xintercept = ks.school.commune_code$p.value, color = "red")
```



```r
# Results for ses status
school_match_yes.ses_status <- school_yes %>% group_by(ses_status.school) %>% summarise(count = n()) %>%
school_match_no.ses_status <- school_no %>% group_by(ses_status.school) %>% summarise(count = n()) %>%
school_match.ses_status <- rbind(school_match_yes.ses_status, school_match_no.ses_status) %>%
  arrange(ses_status.school, matched)

ggplot(school_match.ses_status) +
  geom_col(aes(x = as.factor(matched), y = freq, fill = as.factor(matched))) +
  facet_wrap(~ses_status.school) +
  labs(title = "Matching of school record to clinical record by feature (SES status)",
       x = "Matched status",
       y = "Feature frequency",
       fill = "Matched status")
```



```
ggplot(ks_perm.school.pvals, aes(x = ses_status, y = after_stat(density))) +
  geom_density() +
  geom_vline(xintercept = ks.school.ses_status$p.value, color = "red")
```



Bit easier to match SES status of 1 (probably more common)

Our matched/non-matched are not different by sex (p-value in Kolmog is same as most of distribution of permuted pvals) but are different by commune and ses status. Cohen's D test isn't suitable to compare the matched and un-matched because the data don't have standard deviations.

??Add commune maps here with size of sample for school and clinical?? Also size of other features.

```
patients_yes <- patients_matched_small %>% filter(matched == 1) #%>% select(sex.school)
patients_no <- patients_matched_small %>% filter(matched == 0)

# Kolmogorov tests for our matched results
ks.patients.sex <- ks.test(na.omit(patients_yes$sex.patient),
                         na.omit(patients_no$sex.patient),
                         alternative = "two.sided", simulate.p.value = TRUE)
ks.patients.sex
```

```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  na.omit(patients_yes$sex.patient) and na.omit(patients_no$sex.patient)
## D = 0.10094, p-value = 0.03123
## alternative hypothesis: two-sided
```

```
ks.patients.ses_status <- ks.test(as.numeric(na.omit(patients_yes$ses_status.patient)),
                                as.numeric(na.omit(patients_no$ses_status.patient)),
                                alternative = "two.sided", simulate.p.value = TRUE)
ks.patients.ses_status
```

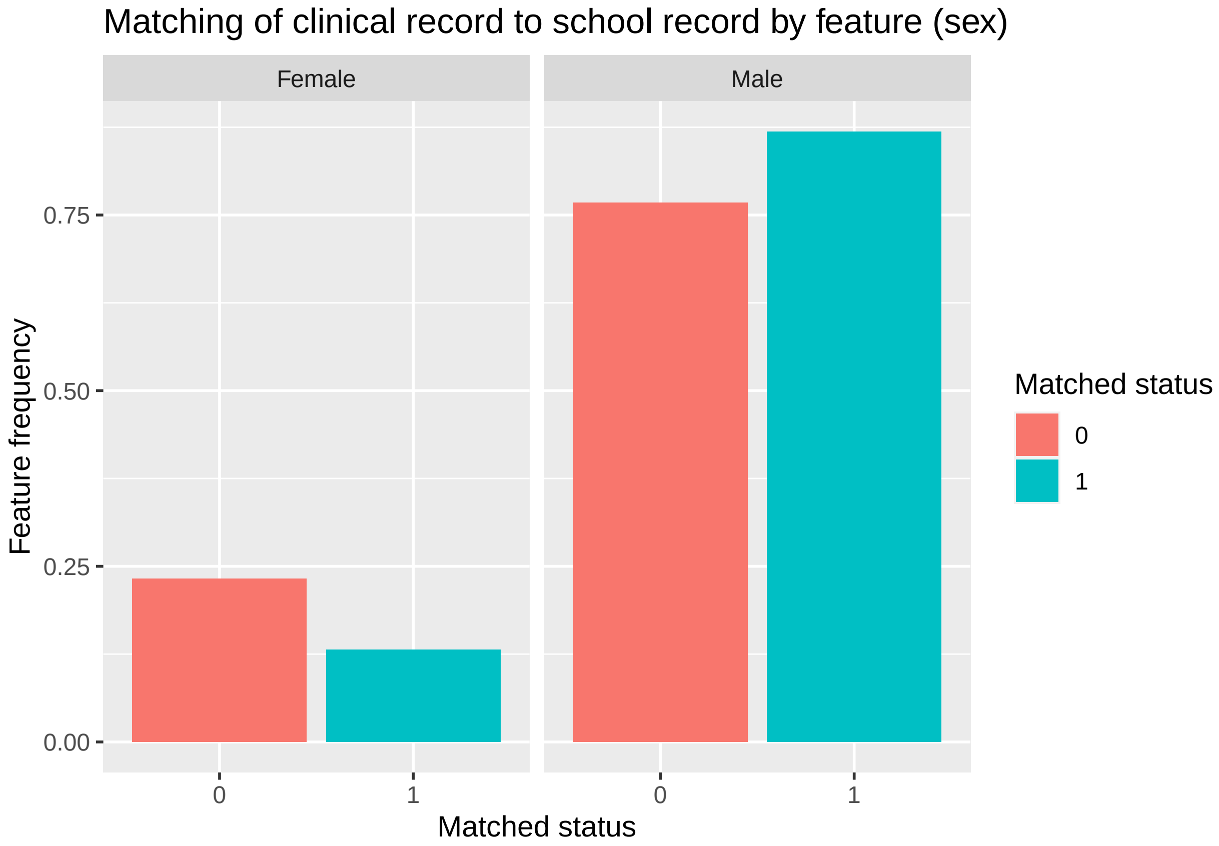
```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  as.numeric(na.omit(patients_yes$ses_status.patient)) and as.numeric(na.omit(patients_no$ses_st
## D = 0.05398, p-value = 0.5916
## alternative hypothesis: two-sided
```

```
ks.patients.commune_code<- ks.test(as.numeric(na.omit(patients_yes$commune_code)),
                                 as.numeric(na.omit(patients_no$commune_code)),
                                 alternative = "two.sided", simulate.p.value = TRUE)
ks.patients.commune_code
```

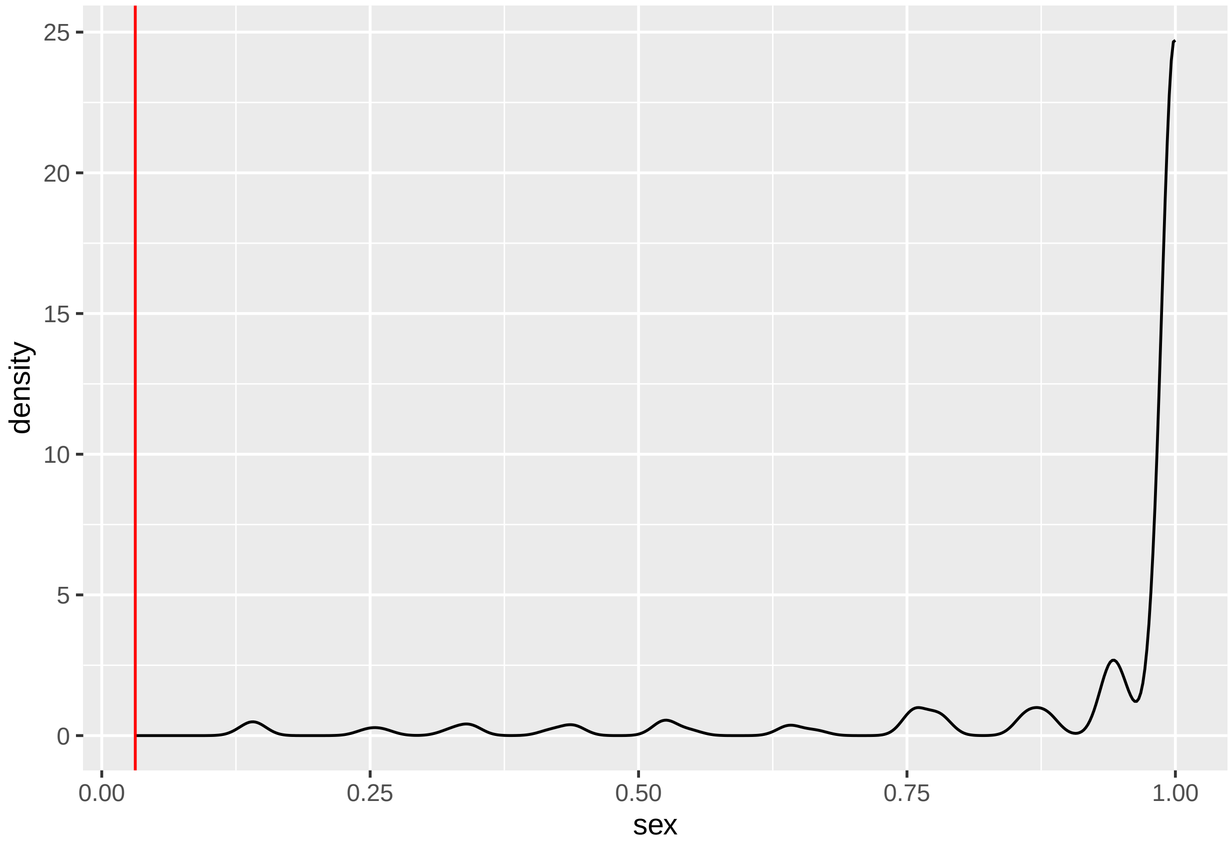
```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  as.numeric(na.omit(patients_yes$commune_code)) and as.numeric(na.omit(patients_no$commune_code
## D = 0.093189, p-value = 0.05772
## alternative hypothesis: two-sided
```

```
# Kolmogorov tests with permutation distributions
set.seed(123)
nPerm <- 200 # change to 2000
ks_perm.patients.pvals <- data.frame(sex = numeric(nPerm),
                                   commune_code = numeric(nPerm),
                                   ses_status = numeric(nPerm))

patients_matched_small_perm <- patients_matched_small

for (i in 1:nPerm) {
  #print(i)
  patients_matched_small_perm$matched <- patients_matched_small$matched[sample(nrow(patients_matched_sma
  patients_perm_yes <- patients_matched_small_perm %>% filter(matched == 1)
  patients_perm_no <- patients_matched_small_perm %>% filter(matched == 0)

  ks_perm.patients.sex <- ks.test(na.omit(patients_perm_yes$sex.patient),
                                na.omit(patients_perm_no$sex.patient),
                                alternative = "two.sided")
  ks_perm.patients.commune_code <- ks.test(as.numeric(na.omit(patients_perm_yes$commune_code)),
                                         as.numeric(na.omit(patients_perm_no$commune_code)),
                                         alternative = "two.sided")
  ks_perm.patients.ses_status <- ks.test(as.numeric(na.omit(patients_perm_yes$ses_status.patient)),
                                       as.numeric(na.omit(patients_perm_no$ses_status.patient)),
                                       alternative = "two.sided")

  ks_perm.patients.pvals$sex[i] <- ks_perm.patients.sex$p.value
  ks_perm.patients.pvals$commune_code[i] <- ks_perm.patients.commune_code$p.value
  ks_perm.patients.pvals$ses_status[i] <- ks_perm.patients.ses_status$p.value
}

# Results for sex
patients_match_yes.sex <- patients_yes %>% group_by(sex.patient) %>% summarise(count = n()) %>% mutate(
patients_match_no.sex <- patients_no %>% group_by(sex.patient) %>% summarise(count = n()) %>% mutate(fr
patients_match.sex <- rbind(patients_match_yes.sex, patients_match_no.sex) %>%
  mutate(sex_desc = ifelse(sex.patient == 1, "Male", ifelse(sex.patient == 2, "Female", NA))) %>%
  arrange(sex_desc, matched)
```

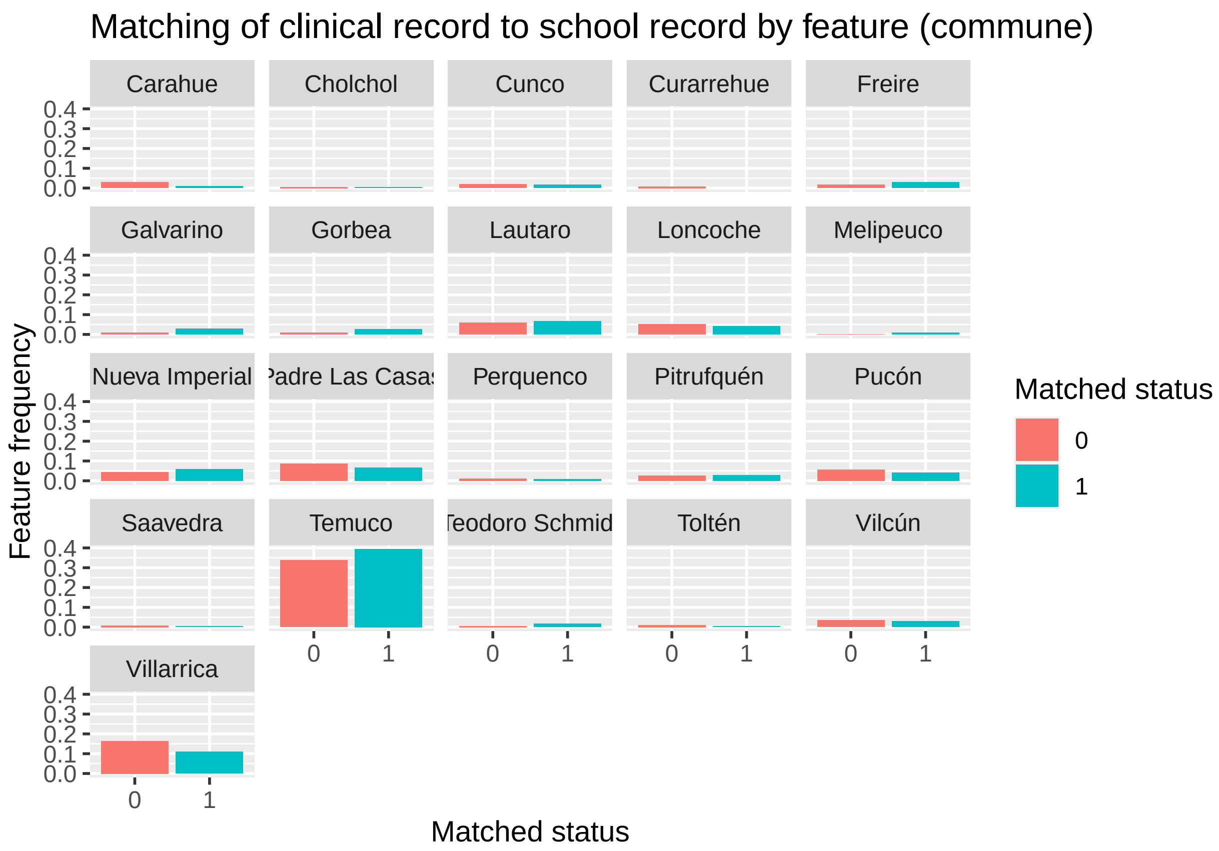
```
ggplot(patients_match.sex) +
  geom_col(aes(x = as.factor(matched), y = freq, fill = as.factor(matched))) +
  facet_wrap(~sex_desc) +
  labs(title = "Matching of clinical record to school record by feature (sex)",
       x = "Matched status",
       y = "Feature frequency",
       fill = "Matched status")
```



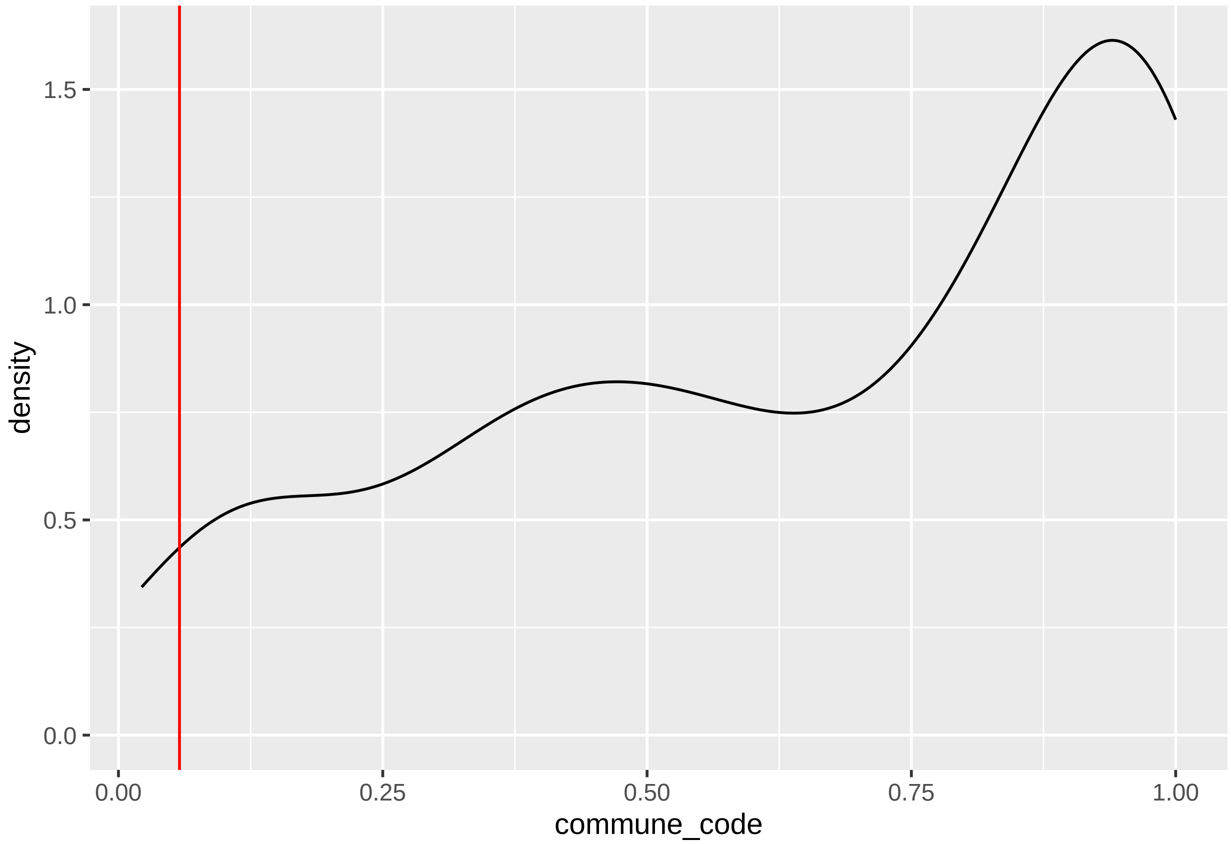
```
ggplot(ks_perm.patients.pvals, aes(x = sex, y = after_stat(density))) +
  geom_density() +
  geom_vline(xintercept = ks.patients.sex$p.value, color = "red")
```



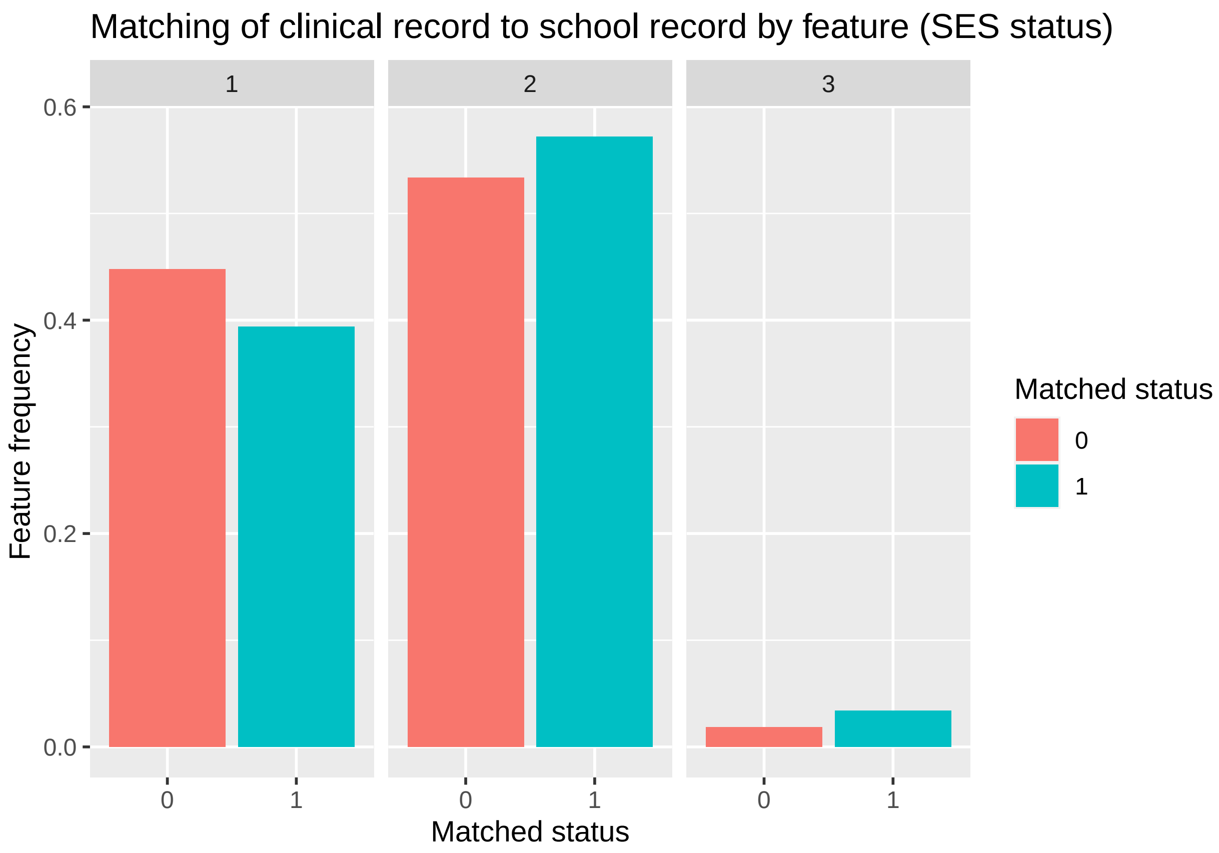
```
# Results for commune
patients_match_yes.student_commune_name <- patients_yes %>% group_by(student_commune_name.patient) %>%
  summarise(count = n()) %>% mutate(freq = count/sum(count)) %>%
  # Would need to merge to a list of commune names and numbers if want to display all communes for all
  #merge(commune_, by = "commune_num", all = TRUE) %>%
  mutate(matched = 1)
patients_match_no.student_commune_name <- patients_no %>% group_by(student_commune_name.patient) %>%
  summarise(count = n()) %>% mutate(freq = count/sum(count)) %>%
  #merge(commune_nums, by = "commune_num", all = TRUE) %>%
  mutate(matched = 0)

patients_match.student_commune_name <- rbind(patients_match_yes.student_commune_name, patients_match_no
  arrange(student_commune_name.patient, matched)

ggplot(patients_match.student_commune_name) +
  geom_col(aes(x = as.factor(matched), y = freq, fill = as.factor(matched))) +
  facet_wrap(~student_commune_name.patient, scales = "fixed") +
  #facet_wrap(~student_commune_name.school, scales = "free") +
  labs(title = "Matching of clinical record to school record by feature (commune)",
       x = "Matched status",
       y = "Feature frequency",
       fill = "Matched status")
```



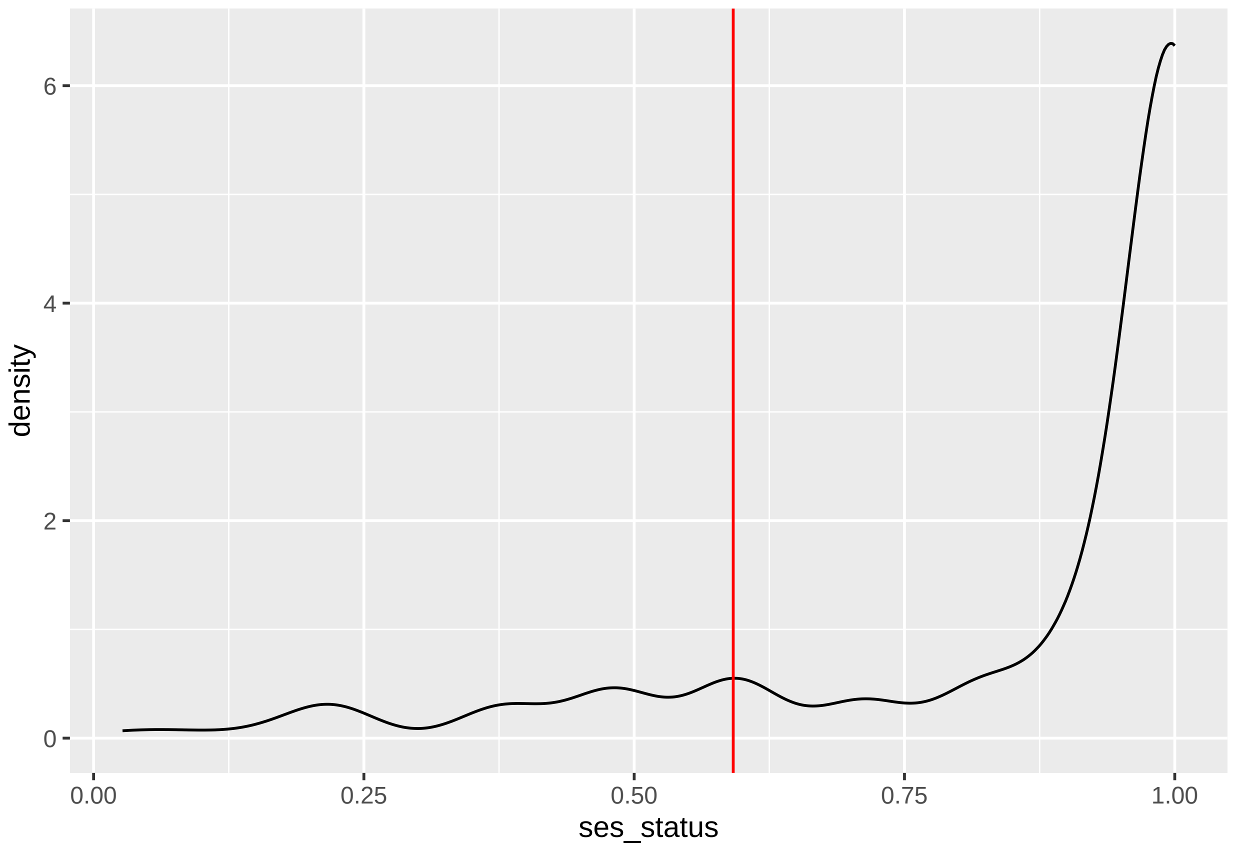
```
# most of the difference in matched commune frequency is for Temuco which is the biggest commune.


ggplot(ks_perm.patients.pvals, aes(x = commune_code, y = after_stat(density))) +
  geom_density() +
  geom_vline(xintercept = ks.patients.commune_code$p.value, color = "red")
```



```r
# Results for ses status
patients_match_yes.ses_status <- patients_yes %>% group_by(ses_status.patient) %>% summarise(count = n(
patients_match_no.ses_status <- patients_no %>% group_by(ses_status.patient) %>% summarise(count = n())
patients_match.ses_status <- rbind(patients_match_yes.ses_status, patients_match_no.ses_status) %>%
  arrange(ses_status.patient, matched)

ggplot(patients_match.ses_status) +
  geom_col(aes(x = as.factor(matched), y = freq, fill = as.factor(matched))) +
  facet_wrap(~ses_status.patient) +
  labs(title = "Matching of clinical record to school record by feature (SES status)",
       x = "Matched status",
       y = "Feature frequency",
       fill = "Matched status")
```



```
ggplot(ks_perm.patients.pvals, aes(x = ses_status, y = after_stat(density))) +
  geom_density() +
  geom_vline(xintercept = ks.patients.ses_status$p.value, color = "red")
```



Then quantify clinical records for ARAUC Sur that haven't been matched.

Need to bring in the missing communes so that ks test is better.

Dumping ground, don't use below here.

Record linkage using machine learning

Try linkage using ML, as done by Jan van der Laan here https://cran.r-project.org/web/packages/reclin2/vignettes/record_linkage_using_machine_learning.html

In reclin2 package, use ?identical() to see available matching algorithms.

The Jaro-Winkler distance is a string metric for measuring the edit distance between two sequences. It is a variant of the Jaro distance metric proposed by William E. Winkler in 1990 1. The Jaro-Winkler distance uses a prefix scale which gives more favorable ratings to strings that match from the beginning for a set prefix length. The higher the Jaro-Winkler distance for two strings is, the less similar the strings are. The score is normalized such that 0 means an exact match and 1 means there is no similarity 1.

Need to explore different comparator algorithms. Currently it's exact match. Would be good to do communes that are neighbours and ages off by 1.

Try bayesian linkage?

Follow Thomas Stringham https://arxiv.org/pdf/2003.04238.pdf who followed Sadinle https://arxiv.org/abs/1601.06630 Not doing this as limited value when not matching strings.