Biostat 203B Homework 4

Due Mar 9 @ 11:59PM

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Display machine information:

```
sessionInfo()
```

```
R version 4.4.2 (2024-10-31)
Platform: x86_64-pc-linux-gnu
Running under: Ubuntu 24.04.1 LTS

Matrix products: default
BLAS:   /usr/lib/x86_64-linux-gnu/blas/libblas.so.3.12.0
LAPACK: /usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.12.0

locale:
 [1] LC_CTYPE=C.UTF-8       LC_NUMERIC=C           LC_TIME=C.UTF-8
 [4] LC_COLLATE=C.UTF-8     LC_MONETARY=C.UTF-8    LC_MESSAGES=C.UTF-8
 [7] LC_PAPER=C.UTF-8       LC_NAME=C              LC_ADDRESS=C
[10] LC_TELEPHONE=C         LC_MEASUREMENT=C.UTF-8 LC_IDENTIFICATION=C

time zone: America/Los_Angeles
tzcode source: system (glibc)

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods   base

loaded via a namespace (and not attached):
 [1] compiler_4.4.2   fastmap_1.2.0    cli_3.6.4         tools_4.4.2
 [5] htmltools_0.5.8.1 rstudioapi_0.17.1 yaml_2.3.10      rmarkdown_2.29
 [9] knitr_1.49       jsonlite_1.9.0   xfun_0.50         digest_0.6.37
[13] rlang_1.1.5      evaluate_1.0.3
```

Display my machine memory.

```
memuse::Sys.meminfo()
```

```
Totalram:  7.686 GiB
Freeram:   6.247 GiB
```

Load database libraries and the tidyverse frontend:

```
library(bigrquery)
library(dbplyr)
library(DBI)
library(gt)
library(gtsummary)
library(tidyverse)
```

```
-- Attaching core tidyverse packages ----------------------- tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.1     v tibble    3.2.1
v lubridate 1.9.4     v tidyr     1.3.1
v purrr     1.0.4
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::ident()  masks dbplyr::ident()
x dplyr::lag()    masks stats::lag()
x dplyr::sql()    masks dbplyr::sql()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to beco
```

```
library(forcats)
library(stringr)
```

0.1 Q1. Compile the ICU cohort in HW3 from the Google BigQuery database

Below is an outline of steps. In this homework, we exclusively work with the BigQuery database and should not use any MIMIC data files stored on our local computer. Transform data as much as possible in BigQuery database and collect() the tibble **only at the end of Q1.7**.

0.1.1 Q1.1 Connect to BigQuery

Authenticate with BigQuery using the service account token. Please place the service account token (shared via BruinLearn) in the working directory (same folder as your qmd file). Do **not** ever add this token to your Git repository. If you do so, you will lose 50 points.

```r
# path to the service account token
satoken <- "biostat-203b-2025-winter-4e58ec6e5579.json"
# BigQuery authentication using service account
bq_auth(path = satoken)
```

Connect to BigQuery database `mimiciv_3_1` in GCP (Google Cloud Platform), using the project billing account `biostat-203b-2025-winter`.

```r
# connect to the BigQuery database `biostat-203b-2025-mimiciv_3_1`
con_bq <- dbConnect(
    bigrquery::bigquery(),
    project = "biostat-203b-2025-winter",
    dataset = "mimiciv_3_1",
    billing = "biostat-203b-2025-winter"
)
con_bq
```

```
<BigQueryConnection>
  Dataset: biostat-203b-2025-winter.mimiciv_3_1
  Billing: biostat-203b-2025-winter
```

List all tables in the `mimiciv_3_1` database.

```r
dbListTables(con_bq)
```

```
 [1] "admissions"        "caregiver"         "chartevents"
 [4] "d_hcpcs"           "d_icd_diagnoses"   "d_icd_procedures"
 [7] "d_items"           "d_labitems"        "datetimeevents"
[10] "diagnoses_icd"     "drgcodes"          "emar"
[13] "emar_detail"       "hcpcsevents"       "icustays"
[16] "ingredientevents"  "inputevents"       "labevents"
[19] "microbiologyevents" "omr"              "outputevents"
[22] "patients"          "pharmacy"          "poe"
[25] "poe_detail"        "prescriptions"     "procedureevents"
[28] "procedures_icd"    "provider"          "services"
[31] "transfers"
```

0.1.2 Q1.2 `icustays` data

Connect to the `icustays` table.

```r
# full ICU stays table
icustays_tble <- tbl(con_bq, "icustays") |>
  arrange(subject_id, hadm_id, stay_id) |>
  # show_query() |>
  print(width = Inf)
```

```
# Source:     SQL [?? x 8]
```

```
# Database:    BigQueryConnection
# Ordered by: subject_id, hadm_id, stay_id
   subject_id  hadm_id   stay_id first_careunit
        <int>    <int>     <int> <chr>
 1   10000032 29079034 39553978 Medical Intensive Care Unit (MICU)
 2   10000690 25860671 37081114 Medical Intensive Care Unit (MICU)
 3   10000980 26913865 39765666 Medical Intensive Care Unit (MICU)
 4   10001217 24597018 37067082 Surgical Intensive Care Unit (SICU)
 5   10001217 27703517 34592300 Surgical Intensive Care Unit (SICU)
 6   10001725 25563031 31205490 Medical/Surgical Intensive Care Unit (MICU/SICU)
 7   10001843 26133978 39698942 Medical/Surgical Intensive Care Unit (MICU/SICU)
 8   10001884 26184834 37510196 Medical Intensive Care Unit (MICU)
 9   10002013 23581541 39060235 Cardiac Vascular Intensive Care Unit (CVICU)
10   10002114 27793700 34672098 Coronary Care Unit (CCU)
   last_careunit                                       intime
   <chr>                                               <dttm>
 1 Medical Intensive Care Unit (MICU)                  2180-07-23 14:00:00
 2 Medical Intensive Care Unit (MICU)                  2150-11-02 19:37:00
 3 Medical Intensive Care Unit (MICU)                  2189-06-27 08:42:00
 4 Surgical Intensive Care Unit (SICU)                 2157-11-20 19:18:02
 5 Surgical Intensive Care Unit (SICU)                 2157-12-19 15:42:24
 6 Medical/Surgical Intensive Care Unit (MICU/SICU)    2110-04-11 15:52:22
 7 Medical/Surgical Intensive Care Unit (MICU/SICU)    2134-12-05 18:50:03
 8 Medical Intensive Care Unit (MICU)                  2131-01-11 04:20:05
 9 Cardiac Vascular Intensive Care Unit (CVICU)        2160-05-18 10:00:53
10 Coronary Care Unit (CCU)                            2162-02-17 23:30:00
   outtime              los
   <dttm>               <dbl>
 1 2180-07-23 23:50:47 0.410
 2 2150-11-06 17:03:17 3.89
 3 2189-06-27 20:38:27 0.498
 4 2157-11-21 22:08:00 1.12
 5 2157-12-20 14:27:41 0.948
 6 2110-04-12 23:59:56 1.34
 7 2134-12-06 14:38:26 0.825
 8 2131-01-20 08:27:30 9.17
 9 2160-05-19 17:33:33 1.31
10 2162-02-20 21:16:27 2.91
# i more rows
```

0.1.3 Q1.3 admissions data

Connect to the admissions table.

```
# # TODO
admissions_tble <- tbl(con_bq, "admissions") |>
```

```
  print(width = Inf)
```

```
# Source:   table<`admissions`> [?? x 16]
# Database: BigQueryConnection
   subject_id  hadm_id admittime          dischtime
        <int>    <int> <dttm>             <dttm>
 1   10106244 26713233 2147-05-09 10:34:00 2147-05-12 13:43:00
 2   13700703 20448599 2172-09-25 01:01:00 2172-10-03 13:25:00
 3   15443666 27961368 2168-12-30 23:30:00 2169-01-05 16:02:00
 4   16299919 26977065 2193-05-15 08:37:00 2193-05-17 16:03:00
 5   14149715 24191358 2181-10-25 19:37:00 2181-10-29 14:38:00
 6   14446098 20543394 2182-04-04 20:11:00 2182-05-07 19:00:00
 7   10584718 23485217 2165-02-12 15:41:00 2165-03-06 08:20:00
 8   12224488 25909420 2158-10-29 15:59:00 2158-11-01 15:45:00
 9   15845632 28189199 2124-10-05 02:44:00 2124-10-12 15:00:00
10   18131667 28337235 2195-11-18 02:58:00 2195-11-27 13:34:00
   deathtime          admission_type    admit_provider_id
   <dttm>             <chr>             <chr>
 1 NA                 DIRECT EMER.      <NA>
 2 NA                 OBSERVATION ADMIT <NA>
 3 NA                 OBSERVATION ADMIT <NA>
 4 NA                 OBSERVATION ADMIT <NA>
 5 NA                 OBSERVATION ADMIT P00230
 6 NA                 URGENT            P004G6
 7 2165-03-06 08:20:00 EW EMER.         P004G6
 8 NA                 EW EMER.          P004G6
 9 NA                 EW EMER.          P004G6
10 NA                 EW EMER.          P004G6
   admission_location                        discharge_location        insurance
   <chr>                                     <chr>                     <chr>
 1 PHYSICIAN REFERRAL                        HOME                      Private
 2 EMERGENCY ROOM                            HOME                      Private
 3 EMERGENCY ROOM                            HOME HEALTH CARE          Medicare
 4 EMERGENCY ROOM                            HOSPICE                   Medicare
 5 EMERGENCY ROOM                            SKILLED NURSING FACILITY Medicare
 6 TRANSFER FROM HOSPITAL                    SKILLED NURSING FACILITY Medicare
 7 TRANSFER FROM SKILLED NURSING FACILITY DIED                        Medicare
 8 WALK-IN/SELF REFERRAL                     HOME                      Medicare
 9 PHYSICIAN REFERRAL                        HOME                      Private
10 PHYSICIAN REFERRAL                        HOME HEALTH CARE          Medicare
   language marital_status race                  edregtime
   <chr>    <chr>          <chr>                 <dttm>
 1 English  SINGLE         WHITE                 NA
 2 English  MARRIED        WHITE                 2172-09-24 17:38:00
 3 English  SINGLE         BLACK/AFRICAN AMERICAN 2168-12-30 11:19:00
```

```
 4 English  WIDOWED        BLACK/AFRICAN AMERICAN 2193-05-15 04:36:00
 5 English  SINGLE         WHITE                  2181-10-25 08:48:00
 6 English  MARRIED        WHITE                  NA
 7 English  MARRIED        WHITE                  NA
 8 English  SINGLE         WHITE - OTHER EUROPEAN 2158-10-28 20:22:00
 9 English  MARRIED        WHITE                  2124-10-04 19:30:00
10 English  SINGLE         WHITE                  2195-11-17 21:04:00
   edouttime           hospital_expire_flag
   <dttm>                             <int>
 1 NA                                     0
 2 2172-09-25 03:07:00                    0
 3 2168-12-31 01:22:00                    0
 4 2193-05-15 14:27:00                    0
 5 2181-10-26 15:18:00                    0
 6 NA                                     0
 7 NA                                     1
 8 2158-10-29 18:01:00                    0
 9 2124-10-05 04:10:00                    0
10 2195-11-18 04:51:00                    0
# i more rows
```

0.1.4 Q1.4 `patients` data

Connect to the `patients` table.

```
# # TODO
patients_tble <- tbl(con_bq, "patients") |>
  print(width = Inf)
```

```
# Source:    table<`patients`> [?? x 6]
# Database: BigQueryConnection
   subject_id gender anchor_age anchor_year anchor_year_group dod
        <int> <chr>       <int>       <int> <chr>             <date>
 1   10078138 F              18        2110 2017 - 2019       NA
 2   10180372 M              18        2110 2008 - 2010       NA
 3   10686175 M              18        2110 2011 - 2013       NA
 4   10851602 F              18        2110 2014 - 2016       NA
 5   10902424 F              18        2110 2017 - 2019       NA
 6   11092326 M              18        2110 2008 - 2010       NA
 7   11289691 F              18        2110 2017 - 2019       NA
 8   11595073 M              18        2110 2011 - 2013       NA
 9   11739764 F              18        2110 2017 - 2019       NA
10   11776346 F              18        2110 2008 - 2010       NA
# i more rows
```

0.1.5 Q1.5 `labevents` data

Connect to the `labevents` table and retrieve a subset that only contain subjects who appear in `icustays_tble` and the lab items listed in HW3. Only keep the last lab measurements (by `storetime`) before the ICU stay and pivot lab items to become variables/columns. Write all steps in *one* chain of pipes.

```r
# Define the desired column order (ensuring subject_id and stay_id appear first)
column_order <- c("subject_id", "stay_id",
                  "bicarbonate", "chloride",
                  "creatinine", "glucose",
                  "potassium", "sodium",
                  "hematocrit", "wbc")

# Load labevents data from BigQuery and filter for relevant lab tests
labevents_tble <- tbl(con_bq, "labevents") |>

  # Keep only the selected lab test item IDs
  filter(itemid %in% c(50912, 50971, 50983, 50902,
                       50882, 51221, 51301, 50931)) |>

  # Select relevant columns for processing
  select(subject_id, storetime, itemid, valuenum) |>

  # Join with ICU stay data to get stay_id and admission time
  inner_join(
    select(icustays_tble, subject_id, stay_id, intime),
    by = "subject_id") |>

  # Keep only lab results recorded before ICU admission time
  filter(storetime < intime) |>

  # Group by subject, stay, and itemid to retain the most recent measurement
  group_by(subject_id, stay_id, itemid) |>
  slice_max(order_by = storetime) |>
  ungroup() |>  # Remove grouping for subsequent operations

  # Convert itemid numeric codes into meaningful lab test names
  mutate(itemid = case_when(
    itemid == 51301 ~ "wbc",
    itemid == 51221 ~ "hematocrit",
    itemid == 50983 ~ "sodium",
    itemid == 50971 ~ "potassium",
    itemid == 50931 ~ "glucose",
    itemid == 50912 ~ "creatinine",
    itemid == 50902 ~ "chloride",
```

```r
    itemid == 50882 ~ "bicarbonate"
  )) |>

  # Keep only necessary columns after renaming
  select(subject_id, stay_id, itemid, valuenum) |>

  # Convert from long format to wide format with mean aggregation for duplicates
  pivot_wider(names_from = itemid,
              values_from = valuenum,
              values_fn = mean) |>

  # Ensure the final column order follows the defined structure
  select(all_of(column_order)) |>

  # Arrange rows for better readability
  arrange(subject_id, stay_id) |>

  # Print the result with a wide display to prevent truncation
  print(width = Inf)
```

```
Warning: ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?

Warning: Missing values are always removed in SQL aggregation functions.
Use `na.rm = TRUE` to silence this warning
This warning is displayed once every 8 hours.

Warning: ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?
```

```
# Source:     SQL [?? x 10]
# Database:   BigQueryConnection
# Ordered by: subject_id, stay_id
     subject_id  stay_id bicarbonate chloride creatinine glucose potassium sodium
          <int>    <int>       <dbl>    <dbl>      <dbl>   <dbl>     <dbl>  <dbl>
 1    10000032 39553978          25       95        0.7     102       6.7    126
 2    10000690 37081114          26      100        1        85       4.8    137
 3    10000980 39765666          21      109        2.3      89       3.9    144
 4    10001217 34592300          30      104        0.5      87       4.1    142
 5    10001217 37067082          22      108        0.6     112       4.2    142
 6    10001725 31205490          NA       98        NA       NA       4.1    139
 7    10001843 39698942          28       97        1.3     131       3.9    138
 8    10001884 37510196          30       88        1.1     141       4.5    130
 9    10002013 39060235          24      102        0.9     288       3.5    137
10    10002114 34672098          18       NA        3.1      95       6.5    125
   hematocrit   wbc
        <dbl> <dbl>
```

```
1        41.1   6.9
2        36.1   7.1
3        27.3   5.3
4        37.4   5.4
5        38.1   15.7
6        NA     NA
7        31.4   10.4
8        39.7   12.2
9        34.9   7.2
10       34.3   16.8
# i more rows
```

```
# Check the number of rows
labevents_tble |>
  tally() |>
  pull(n)
```

```
Warning: ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?
ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?
```

```
[1] 88086
```

0.1.6 Q1.6 chartevents data

Connect to `chartevents` table and retrieve a subset that only contain subjects who appear in `icustays_tble` and the chart events listed in HW3. Only keep the first chart events (by `storetime`) during ICU stay and pivot chart events to become variables/columns. Write all steps in *one* chain of pipes.

```
# # TODO
# Define the desired column order (ensuring subject_id and stay_id appear first)
column_order <- c("subject_id", "stay_id",
                  "heart_rate",
                  "non-invasive_blood_pressure_systolic",
                  "non-invasive_blood_pressure_diastolic",
                  "temperature_fahrenheit",
                  "respiratory_rate")

# Load chartevents data from BigQuery and filter for relevant vital measurements
chartevents_tble <- tbl(con_bq, "chartevents") |>

  # Keep only the selected vital measurements item IDs
  filter(itemid %in% c(220045, 220179, 220180,
                       223761, 220210)) |>

  # Select relevant columns for processing
```

```r
  select(subject_id, storetime, itemid, valuenum) |>

  # Join with ICU stay data to get stay_id and ICU intime and outtime
  inner_join(
    select(icustays_tble, subject_id,
           stay_id, intime,outtime),
    by = "subject_id") |>

  # Keep only lab results recorded in ICU
  filter(storetime >= intime ) |>
  filter(storetime <= outtime ) |>

  # Group by subject, stay, and itemid to retain the earliest measurement
  group_by(subject_id, stay_id, itemid) |>
  slice_min(order_by = storetime) |>
  ungroup() |>  # Remove grouping for subsequent operations

  # Convert itemid numeric codes into meaningful lab test names
  mutate(itemid = case_when(
    itemid == 220045 ~ "heart_rate",
    itemid == 220179 ~ "non-invasive_blood_pressure_systolic",
    itemid == 220180 ~ "non-invasive_blood_pressure_diastolic",
    itemid == 223761 ~ "temperature_fahrenheit",
    itemid == 220210 ~ "respiratory_rate"
  )) |>

  # Keep only necessary columns after renaming
  select(subject_id, stay_id, itemid, valuenum) |>

  # Convert from long format to wide format with mean aggregation for duplicates
  pivot_wider(names_from = itemid,
              values_from = valuenum,
              values_fn = ~ round(mean(.), 1)) |>

  # Ensure the final column order follows the defined structure
  select(all_of(column_order)) |>

  # Arrange rows for better readability
  arrange(subject_id, stay_id) |>

  # Print the result with a wide display to prevent truncation
  print(width = Inf)
```

Warning: ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?

```
ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?

# Source:     SQL [?? x 7]
# Database:   BigQueryConnection
# Ordered by: subject_id, stay_id
   subject_id  stay_id heart_rate `non-invasive_blood_pressure_systolic`
        <int>    <int>      <dbl>                                  <dbl>
 1   10000032 39553978         91                                     84
 2   10000690 37081114         78                                    106
 3   10000980 39765666         76                                    154
 4   10001217 34592300       79.3                                    156
 5   10001217 37067082         86                                    151
 6   10001725 31205490         86                                     73
 7   10001843 39698942       124.                                    110
 8   10001884 37510196         49                                   174.
 9   10002013 39060235         80                                   98.5
10   10002114 34672098       110.                                    112
   `non-invasive_blood_pressure_diastolic` temperature_fahrenheit
                                     <dbl>                  <dbl>
 1                                      48                   98.7
 2                                    56.5                   97.7
 3                                     102                   98
 4                                    93.3                   97.6
 5                                      90                   98.5
 6                                      56                   97.7
 7                                      78                   97.9
 8                                    30.5                   98.1
 9                                      62                   97.2
10                                      80                   97.9
   respiratory_rate
              <dbl>
 1               24
 2             24.3
 3             23.5
 4               14
 5               18
 6               19
 7             16.5
 8               13
 9               14
10               21
# i more rows
```

```r
# Check the number of rows
chartevents_tble |>
```

```
  tally() |>
  pull(n)
```

Warning: ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?
ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?

[1] 94364

0.1.7   Q1.7 Put things together

This step is similar to Q7 of HW3. Using *one* chain of pipes |> to perform
following data wrangling steps: (i) start with the `icustays_tble`, (ii) merge in
admissions and patients tables, (iii) keep adults only (age at ICU intime >=
18), (iv) merge in the labevents and chartevents tables, (v) `collect` the tibble,
(vi) sort `subject_id`, `hadm_id`, `stay_id` and `print(width = Inf)`.

```
# # TODO
mimic_icu_cohort <- icustays_tble |>

  # Merge with admissions and patients tables
  left_join(select(admissions_tble, -subject_id), by = "hadm_id") |>

  # Merge with patients table
  left_join(patients_tble, by = "subject_id") |>

  # Keep only adults (age at ICU intime >= 18)
  mutate(age_intime = year(intime)- anchor_year + anchor_age) |>
  filter(age_intime >= 18) |>

  # Merge with labevents and chartevents tables
  left_join(labevents_tble, by = c("subject_id", "stay_id")) |>
  left_join(chartevents_tble, by = c("subject_id", "stay_id")) |>

  # Collect data into memory
  collect() |>

  # Sort by subject_id, hadm_id, stay_id
  arrange(subject_id, hadm_id, stay_id) |>

  # Print the full width to ensure readability
  print(width = Inf)
```

Warning: ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?
ORDER BY is ignored in subqueries without LIMIT

```
i Do you need to move arrange() later in the pipeline or use window_order() instead?
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ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?
ORDER BY is ignored in subqueries without LIMIT
i Do you need to move arrange() later in the pipeline or use window_order() instead?
```

```
# A tibble: 94,458 x 41
   subject_id  hadm_id   stay_id first_careunit
        <int>    <int>     <int> <chr>
 1   10000032 29079034 39553978 Medical Intensive Care Unit (MICU)
 2   10000690 25860671 37081114 Medical Intensive Care Unit (MICU)
 3   10000980 26913865 39765666 Medical Intensive Care Unit (MICU)
 4   10001217 24597018 37067082 Surgical Intensive Care Unit (SICU)
 5   10001217 27703517 34592300 Surgical Intensive Care Unit (SICU)
 6   10001725 25563031 31205490 Medical/Surgical Intensive Care Unit (MICU/SICU)
 7   10001843 26133978 39698942 Medical/Surgical Intensive Care Unit (MICU/SICU)
 8   10001884 26184834 37510196 Medical Intensive Care Unit (MICU)
 9   10002013 23581541 39060235 Cardiac Vascular Intensive Care Unit (CVICU)
10   10002114 27793700 34672098 Coronary Care Unit (CCU)
   last_careunit                                   intime
   <chr>                                           <dttm>
 1 Medical Intensive Care Unit (MICU)              2180-07-23 14:00:00
 2 Medical Intensive Care Unit (MICU)              2150-11-02 19:37:00
 3 Medical Intensive Care Unit (MICU)              2189-06-27 08:42:00
 4 Surgical Intensive Care Unit (SICU)             2157-11-20 19:18:02
 5 Surgical Intensive Care Unit (SICU)             2157-12-19 15:42:24
 6 Medical/Surgical Intensive Care Unit (MICU/SICU) 2110-04-11 15:52:22
 7 Medical/Surgical Intensive Care Unit (MICU/SICU) 2134-12-05 18:50:03
 8 Medical Intensive Care Unit (MICU)              2131-01-11 04:20:05
 9 Cardiac Vascular Intensive Care Unit (CVICU)    2160-05-18 10:00:53
10 Coronary Care Unit (CCU)                        2162-02-17 23:30:00
   outtime              los admittime           dischtime
   <dttm>              <dbl> <dttm>              <dttm>
 1 2180-07-23 23:50:47 0.410 2180-07-23 12:35:00 2180-07-25 17:55:00
 2 2150-11-06 17:03:17 3.89  2150-11-02 18:02:00 2150-11-12 13:45:00
 3 2189-06-27 20:38:27 0.498 2189-06-27 07:38:00 2189-07-03 03:00:00
 4 2157-11-21 22:08:00 1.12  2157-11-18 22:56:00 2157-11-25 18:00:00
 5 2157-12-20 14:27:41 0.948 2157-12-18 16:58:00 2157-12-24 14:55:00
 6 2110-04-12 23:59:56 1.34  2110-04-11 15:08:00 2110-04-14 15:00:00
 7 2134-12-06 14:38:26 0.825 2134-12-05 00:10:00 2134-12-06 12:54:00
 8 2131-01-20 08:27:30 9.17  2131-01-07 20:39:00 2131-01-20 05:15:00
 9 2160-05-19 17:33:33 1.31  2160-05-18 07:45:00 2160-05-23 13:30:00
10 2162-02-20 21:16:27 2.91  2162-02-17 22:32:00 2162-03-04 15:16:00
   deathtime           admission_type           admit_provider_id
```

```
   <dttm>              <chr>                       <chr>
1  NA                  EW EMER.                    P06OTX
2  NA                  EW EMER.                    P26QQ4
3  NA                  EW EMER.                    P06OTX
4  NA                  EW EMER.                    P3610N
5  NA                  DIRECT EMER.                P276OU
6  NA                  EW EMER.                    P32W56
7  2134-12-06 12:54:00 URGENT                      P67ATB
8  2131-01-20 05:15:00 OBSERVATION ADMIT           P49AFC
9  NA                  SURGICAL SAME DAY ADMISSION P8286C
10 NA                  OBSERVATION ADMIT           P46834
   admission_location    discharge_location insurance language marital_status
   <chr>                 <chr>              <chr>     <chr>    <chr>
1  EMERGENCY ROOM        HOME               Medicaid  English  WIDOWED
2  EMERGENCY ROOM        REHAB              Medicare  English  WIDOWED
3  EMERGENCY ROOM        HOME HEALTH CARE   Medicare  English  MARRIED
4  EMERGENCY ROOM        HOME HEALTH CARE   Private   Other    MARRIED
5  PHYSICIAN REFERRAL    HOME HEALTH CARE   Private   Other    MARRIED
6  PACU                  HOME               Private   English  MARRIED
7  TRANSFER FROM HOSPITAL DIED              Medicare  English  SINGLE
8  EMERGENCY ROOM        DIED               Medicare  English  MARRIED
9  PHYSICIAN REFERRAL    HOME HEALTH CARE   Medicare  English  SINGLE
10 PHYSICIAN REFERRAL    HOME HEALTH CARE   Medicaid  English  <NA>
   race                  edregtime           edouttime
   <chr>                 <dttm>              <dttm>
1  WHITE                 2180-07-23 05:54:00 2180-07-23 14:00:00
2  WHITE                 2150-11-02 11:41:00 2150-11-02 19:37:00
3  BLACK/AFRICAN AMERICAN 2189-06-27 06:25:00 2189-06-27 08:42:00
4  WHITE                 2157-11-18 17:38:00 2157-11-19 01:24:00
5  WHITE                 NA                  NA
6  WHITE                 NA                  NA
7  WHITE                 NA                  NA
8  BLACK/AFRICAN AMERICAN 2131-01-07 13:36:00 2131-01-07 22:13:00
9  OTHER                 NA                  NA
10 UNKNOWN               2162-02-17 19:35:00 2162-02-17 23:30:00
   hospital_expire_flag gender anchor_age anchor_year anchor_year_group
                  <int> <chr>       <int>       <int> <chr>
1                     0 F             52        2180 2014 - 2016
2                     0 F             86        2150 2008 - 2010
3                     0 F             73        2186 2008 - 2010
4                     0 F             55        2157 2011 - 2013
5                     0 F             55        2157 2011 - 2013
6                     0 F             46        2110 2011 - 2013
7                     1 M             73        2131 2017 - 2019
8                     1 F             68        2122 2008 - 2010
9                     0 F             53        2156 2008 - 2010
```

```
10                  0 M           56        2162 2020 - 2022
   dod         age_intime bicarbonate chloride creatinine glucose potassium
   <date>          <int>       <dbl>    <dbl>      <dbl>   <dbl>     <dbl>
 1 2180-09-09         52          25       95        0.7     102       6.7
 2 2152-01-30         86          26      100        1        85       4.8
 3 2193-08-26         76          21      109        2.3      89       3.9
 4 NA                 55          22      108        0.6     112       4.2
 5 NA                 55          30      104        0.5      87       4.1
 6 NA                 46          NA       98        NA       NA       4.1
 7 2134-12-06         76          28       97        1.3     131       3.9
 8 2131-01-20         77          30       88        1.1     141       4.5
 9 NA                 57          24      102        0.9     288       3.5
10 2162-12-11         56          18       NA        3.1      95       6.5
   sodium hematocrit   wbc heart_rate `non-invasive_blood_pressure_systolic`
    <dbl>      <dbl> <dbl>      <dbl>                                  <dbl>
 1    126       41.1   6.9        91                                     84
 2    137       36.1   7.1        78                                    106
 3    144       27.3   5.3        76                                    154
 4    142       38.1  15.7        86                                    151
 5    142       37.4   5.4      79.3                                    156
 6    139        NA    NA        86                                     73
 7    138       31.4  10.4      124.                                    110
 8    130       39.7  12.2        49                                   174.
 9    137       34.9   7.2        80                                   98.5
10    125       34.3  16.8      110.                                    112
   `non-invasive_blood_pressure_diastolic` temperature_fahrenheit
                                     <dbl>                  <dbl>
 1                                      48                   98.7
 2                                    56.5                   97.7
 3                                     102                   98
 4                                      90                   98.5
 5                                    93.3                   97.6
 6                                      56                   97.7
 7                                      78                   97.9
 8                                    30.5                   98.1
 9                                      62                   97.2
10                                      80                   97.9
   respiratory_rate
              <dbl>
 1               24
 2             24.3
 3             23.5
 4               18
 5               14
 6               19
 7             16.5
```

```
 8               13
 9               14
10               21
# i 94,448 more rows
```

0.1.8 Q1.8 Preprocessing

Perform the following preprocessing steps. (i) Lump infrequent levels into "Other" level for `first_careunit`, `last_careunit`, `admission_type`, `admission_location`, and `discharge_location`. (ii) Collapse the levels of `race` into `ASIAN`, `BLACK`, `HISPANIC`, `WHITE`, and `Other`. (iii) Create a new variable `los_long` that is `TRUE` when `los` is greater than or equal to 2 days. (iv) Summarize the data using `tbl_summary()`, stratified by `los_long`. Hint: `fct_lump_n` and `fct_collapse` from the `forcats` package are useful.

Hint: Below is a numerical summary of my tibble after preprocessing:

```
# Process mimic_icu_cohort data
mimic_icu_cohort <- mimic_icu_cohort |>
  mutate(
    first_careunit = fct_lump(first_careunit, n = 4),
    last_careunit = fct_lump(last_careunit, n = 4),
    admission_type = fct_lump(admission_type, n = 4),
    admission_location = fct_lump(admission_location, n = 3),
    discharge_location = fct_lump(discharge_location, n = 4)
    ) |>

  # Sort by subject_id, hadm_id, stay_id
  arrange(subject_id, hadm_id, stay_id) |>

  # Print the full width to ensure readability
  print(width = Inf)
```

```
# A tibble: 94,458 x 41
   subject_id  hadm_id  stay_id first_careunit
        <int>    <int>    <int> <fct>
 1   10000032 29079034 39553978 Medical Intensive Care Unit (MICU)
 2   10000690 25860671 37081114 Medical Intensive Care Unit (MICU)
 3   10000980 26913865 39765666 Medical Intensive Care Unit (MICU)
 4   10001217 24597018 37067082 Surgical Intensive Care Unit (SICU)
 5   10001217 27703517 34592300 Surgical Intensive Care Unit (SICU)
 6   10001725 25563031 31205490 Medical/Surgical Intensive Care Unit (MICU/SICU)
 7   10001843 26133978 39698942 Medical/Surgical Intensive Care Unit (MICU/SICU)
 8   10001884 26184834 37510196 Medical Intensive Care Unit (MICU)
 9   10002013 23581541 39060235 Cardiac Vascular Intensive Care Unit (CVICU)
10   10002114 27793700 34672098 Other
```

```
   last_careunit                                         intime
   <fct>                                                 <dttm>
 1 Medical Intensive Care Unit (MICU)                    2180-07-23 14:00:00
 2 Medical Intensive Care Unit (MICU)                    2150-11-02 19:37:00
 3 Medical Intensive Care Unit (MICU)                    2189-06-27 08:42:00
 4 Surgical Intensive Care Unit (SICU)                   2157-11-20 19:18:02
 5 Surgical Intensive Care Unit (SICU)                   2157-12-19 15:42:24
 6 Medical/Surgical Intensive Care Unit (MICU/SICU)      2110-04-11 15:52:22
 7 Medical/Surgical Intensive Care Unit (MICU/SICU)      2134-12-05 18:50:03
 8 Medical Intensive Care Unit (MICU)                    2131-01-11 04:20:05
 9 Cardiac Vascular Intensive Care Unit (CVICU)          2160-05-18 10:00:53
10 Other                                                 2162-02-17 23:30:00
   outtime               los admittime         dischtime
   <dttm>                <dbl> <dttm>          <dttm>
 1 2180-07-23 23:50:47 0.410 2180-07-23 12:35:00 2180-07-25 17:55:00
 2 2150-11-06 17:03:17 3.89  2150-11-02 18:02:00 2150-11-12 13:45:00
 3 2189-06-27 20:38:27 0.498 2189-06-27 07:38:00 2189-07-03 03:00:00
 4 2157-11-21 22:08:00 1.12  2157-11-18 22:56:00 2157-11-25 18:00:00
 5 2157-12-20 14:27:41 0.948 2157-12-18 16:58:00 2157-12-24 14:55:00
 6 2110-04-12 23:59:56 1.34  2110-04-11 15:08:00 2110-04-14 15:00:00
 7 2134-12-06 14:38:26 0.825 2134-12-05 00:10:00 2134-12-06 12:54:00
 8 2131-01-20 08:27:30 9.17  2131-01-07 20:39:00 2131-01-20 05:15:00
 9 2160-05-19 17:33:33 1.31  2160-05-18 07:45:00 2160-05-23 13:30:00
10 2162-02-20 21:16:27 2.91  2162-02-17 22:32:00 2162-03-04 15:16:00
   deathtime           admission_type            admit_provider_id
   <dttm>              <fct>                     <chr>
 1 NA                  EW EMER.                  P06OTX
 2 NA                  EW EMER.                  P26QQ4
 3 NA                  EW EMER.                  P06OTX
 4 NA                  EW EMER.                  P3610N
 5 NA                  Other                     P2760U
 6 NA                  EW EMER.                  P32W56
 7 2134-12-06 12:54:00 URGENT                    P67ATB
 8 2131-01-20 05:15:00 OBSERVATION ADMIT         P49AFC
 9 NA                  SURGICAL SAME DAY ADMISSION P8286C
10 NA                  OBSERVATION ADMIT         P46834
   admission_location      discharge_location insurance language marital_status
   <fct>                   <fct>              <chr>     <chr>    <chr>
 1 EMERGENCY ROOM          HOME               Medicaid  English  WIDOWED
 2 EMERGENCY ROOM          Other              Medicare  English  WIDOWED
 3 EMERGENCY ROOM          HOME HEALTH CARE   Medicare  English  MARRIED
 4 EMERGENCY ROOM          HOME HEALTH CARE   Private   Other    MARRIED
 5 PHYSICIAN REFERRAL      HOME HEALTH CARE   Private   Other    MARRIED
 6 Other                   HOME               Private   English  MARRIED
 7 TRANSFER FROM HOSPITAL  DIED               Medicare  English  SINGLE
 8 EMERGENCY ROOM          DIED               Medicare  English  MARRIED
```

```
 9 PHYSICIAN REFERRAL      HOME HEALTH CARE   Medicare  English  SINGLE
10 PHYSICIAN REFERRAL      HOME HEALTH CARE   Medicaid  English  <NA>
   race                    edregtime            edouttime
   <chr>                   <dttm>               <dttm>
 1 WHITE                   2180-07-23 05:54:00 2180-07-23 14:00:00
 2 WHITE                   2150-11-02 11:41:00 2150-11-02 19:37:00
 3 BLACK/AFRICAN AMERICAN  2189-06-27 06:25:00 2189-06-27 08:42:00
 4 WHITE                   2157-11-18 17:38:00 2157-11-19 01:24:00
 5 WHITE                   NA                   NA
 6 WHITE                   NA                   NA
 7 WHITE                   NA                   NA
 8 BLACK/AFRICAN AMERICAN  2131-01-07 13:36:00 2131-01-07 22:13:00
 9 OTHER                   NA                   NA
10 UNKNOWN                 2162-02-17 19:35:00 2162-02-17 23:30:00
   hospital_expire_flag gender anchor_age anchor_year anchor_year_group
                  <int> <chr>       <int>       <int> <chr>
 1                    0 F              52        2180 2014 - 2016
 2                    0 F              86        2150 2008 - 2010
 3                    0 F              73        2186 2008 - 2010
 4                    0 F              55        2157 2011 - 2013
 5                    0 F              55        2157 2011 - 2013
 6                    0 F              46        2110 2011 - 2013
 7                    1 M              73        2131 2017 - 2019
 8                    1 F              68        2122 2008 - 2010
 9                    0 F              53        2156 2008 - 2010
10                    0 M              56        2162 2020 - 2022
   dod        age_intime bicarbonate chloride creatinine glucose potassium
   <date>          <int>       <dbl>    <dbl>      <dbl>   <dbl>     <dbl>
 1 2180-09-09         52          25       95        0.7     102       6.7
 2 2152-01-30         86          26      100        1        85       4.8
 3 2193-08-26         76          21      109        2.3      89       3.9
 4 NA                 55          22      108        0.6     112       4.2
 5 NA                 55          30      104        0.5      87       4.1
 6 NA                 46          NA       98        NA       NA       4.1
 7 2134-12-06         76          28       97        1.3     131       3.9
 8 2131-01-20         77          30       88        1.1     141       4.5
 9 NA                 57          24      102        0.9     288       3.5
10 2162-12-11         56          18       NA        3.1      95       6.5
   sodium hematocrit   wbc heart_rate `non-invasive_blood_pressure_systolic`
    <dbl>      <dbl> <dbl>      <dbl>                                  <dbl>
 1    126       41.1   6.9         91                                     84
 2    137       36.1   7.1         78                                    106
 3    144       27.3   5.3         76                                    154
 4    142       38.1  15.7         86                                    151
 5    142       37.4   5.4       79.3                                    156
 6    139         NA    NA         86                                     73
```

```
 7    138       31.4  10.4     124.                                              110
 8    130       39.7  12.2      49                                               174.
 9    137       34.9   7.2      80                                                98.5
10    125       34.3  16.8     110.                                              112
    `non-invasive_blood_pressure_diastolic` temperature_fahrenheit
                                      <dbl>                   <dbl>
 1                                       48                    98.7
 2                                       56.5                  97.7
 3                                      102                    98
 4                                       90                    98.5
 5                                       93.3                  97.6
 6                                       56                    97.7
 7                                       78                    97.9
 8                                       30.5                  98.1
 9                                       62                    97.2
10                                       80                    97.9
    respiratory_rate
              <dbl>
 1               24
 2               24.3
 3               23.5
 4               18
 5               14
 6               19
 7               16.5
 8               13
 9               14
10               21
# i 94,448 more rows
```

```r
# Collapse race categories into ASIAN, BLACK, HISPANIC, WHITE, and Other
mimic_icu_cohort <- mimic_icu_cohort |>
  mutate(
    race = case_when(
      str_detect(race, regex("^ASIAN", ignore_case = TRUE)) ~ "ASIAN",
      str_detect(race, regex("^BLACK", ignore_case = TRUE)) ~ "BLACK",
      str_detect(race, regex("HISPANIC|LATINO", ignore_case = TRUE)) ~ "HISPANIC",
      str_detect(race, regex("^WHITE", ignore_case = TRUE)) ~ "WHITE",
      TRUE ~ "Other"  # Assign everything else to "Other"
    )
  )|>
  # Print the full width to ensure readability
  print(width = Inf)
```

```
# A tibble: 94,458 x 41
   subject_id  hadm_id  stay_id first_careunit
```

```
        <int>      <int>      <int> <fct>
 1    10000032 29079034 39553978 Medical Intensive Care Unit (MICU)
 2    10000690 25860671 37081114 Medical Intensive Care Unit (MICU)
 3    10000980 26913865 39765666 Medical Intensive Care Unit (MICU)
 4    10001217 24597018 37067082 Surgical Intensive Care Unit (SICU)
 5    10001217 27703517 34592300 Surgical Intensive Care Unit (SICU)
 6    10001725 25563031 31205490 Medical/Surgical Intensive Care Unit (MICU/SICU)
 7    10001843 26133978 39698942 Medical/Surgical Intensive Care Unit (MICU/SICU)
 8    10001884 26184834 37510196 Medical Intensive Care Unit (MICU)
 9    10002013 23581541 39060235 Cardiac Vascular Intensive Care Unit (CVICU)
10    10002114 27793700 34672098 Other
   last_careunit                                        intime
   <fct>                                                <dttm>
 1 Medical Intensive Care Unit (MICU)                   2180-07-23 14:00:00
 2 Medical Intensive Care Unit (MICU)                   2150-11-02 19:37:00
 3 Medical Intensive Care Unit (MICU)                   2189-06-27 08:42:00
 4 Surgical Intensive Care Unit (SICU)                  2157-11-20 19:18:02
 5 Surgical Intensive Care Unit (SICU)                  2157-12-19 15:42:24
 6 Medical/Surgical Intensive Care Unit (MICU/SICU) 2110-04-11 15:52:22
 7 Medical/Surgical Intensive Care Unit (MICU/SICU) 2134-12-05 18:50:03
 8 Medical Intensive Care Unit (MICU)                   2131-01-11 04:20:05
 9 Cardiac Vascular Intensive Care Unit (CVICU)         2160-05-18 10:00:53
10 Other                                                2162-02-17 23:30:00
   outtime               los admittime          dischtime
   <dttm>                <dbl> <dttm>             <dttm>
 1 2180-07-23 23:50:47 0.410 2180-07-23 12:35:00 2180-07-25 17:55:00
 2 2150-11-06 17:03:17 3.89  2150-11-02 18:02:00 2150-11-12 13:45:00
 3 2189-06-27 20:38:27 0.498 2189-06-27 07:38:00 2189-07-03 03:00:00
 4 2157-11-21 22:08:00 1.12  2157-11-18 22:56:00 2157-11-25 18:00:00
 5 2157-12-20 14:27:41 0.948 2157-12-18 16:58:00 2157-12-24 14:55:00
 6 2110-04-12 23:59:56 1.34  2110-04-11 15:08:00 2110-04-14 15:00:00
 7 2134-12-06 14:38:26 0.825 2134-12-05 00:10:00 2134-12-06 12:54:00
 8 2131-01-20 08:27:30 9.17  2131-01-07 20:39:00 2131-01-20 05:15:00
 9 2160-05-19 17:33:33 1.31  2160-05-18 07:45:00 2160-05-23 13:30:00
10 2162-02-20 21:16:27 2.91  2162-02-17 22:32:00 2162-03-04 15:16:00
   deathtime             admission_type              admit_provider_id
   <dttm>                <fct>                        <chr>
 1 NA                    EW EMER.                     P06OTX
 2 NA                    EW EMER.                     P26QQ4
 3 NA                    EW EMER.                     P06OTX
 4 NA                    EW EMER.                     P3610N
 5 NA                    Other                        P276OU
 6 NA                    EW EMER.                     P32W56
 7 2134-12-06 12:54:00 URGENT                         P67ATB
 8 2131-01-20 05:15:00 OBSERVATION ADMIT              P49AFC
 9 NA                    SURGICAL SAME DAY ADMISSION P8286C
```

```
10 NA                       OBSERVATION ADMIT              P46834
   admission_location       discharge_location insurance language marital_status
   <fct>                    <fct>              <chr>     <chr>    <chr>
 1 EMERGENCY ROOM           HOME               Medicaid  English  WIDOWED
 2 EMERGENCY ROOM           Other              Medicare  English  WIDOWED
 3 EMERGENCY ROOM           HOME HEALTH CARE   Medicare  English  MARRIED
 4 EMERGENCY ROOM           HOME HEALTH CARE   Private   Other    MARRIED
 5 PHYSICIAN REFERRAL       HOME HEALTH CARE   Private   Other    MARRIED
 6 Other                    HOME               Private   English  MARRIED
 7 TRANSFER FROM HOSPITAL   DIED               Medicare  English  SINGLE
 8 EMERGENCY ROOM           DIED               Medicare  English  MARRIED
 9 PHYSICIAN REFERRAL       HOME HEALTH CARE   Medicare  English  SINGLE
10 PHYSICIAN REFERRAL       HOME HEALTH CARE   Medicaid  English  <NA>
   race  edregtime           edouttime              hospital_expire_flag gender
   <chr> <dttm>              <dttm>                                <int> <chr>
 1 WHITE 2180-07-23 05:54:00 2180-07-23 14:00:00                       0 F
 2 WHITE 2150-11-02 11:41:00 2150-11-02 19:37:00                       0 F
 3 BLACK 2189-06-27 06:25:00 2189-06-27 08:42:00                       0 F
 4 WHITE 2157-11-18 17:38:00 2157-11-19 01:24:00                       0 F
 5 WHITE NA                  NA                                        0 F
 6 WHITE NA                  NA                                        0 F
 7 WHITE NA                  NA                                        1 M
 8 BLACK 2131-01-07 13:36:00 2131-01-07 22:13:00                       1 F
 9 Other NA                  NA                                        0 F
10 Other 2162-02-17 19:35:00 2162-02-17 23:30:00                       0 M
   anchor_age anchor_year anchor_year_group dod        age_intime bicarbonate
        <int>       <int> <chr>             <date>          <int>       <dbl>
 1         52        2180 2014 - 2016       2180-09-09         52          25
 2         86        2150 2008 - 2010       2152-01-30         86          26
 3         73        2186 2008 - 2010       2193-08-26         76          21
 4         55        2157 2011 - 2013       NA                 55          22
 5         55        2157 2011 - 2013       NA                 55          30
 6         46        2110 2011 - 2013       NA                 46          NA
 7         73        2131 2017 - 2019       2134-12-06         76          28
 8         68        2122 2008 - 2010       2131-01-20         77          30
 9         53        2156 2008 - 2010       NA                 57          24
10         56        2162 2020 - 2022       2162-12-11         56          18
   chloride creatinine glucose potassium sodium hematocrit  wbc heart_rate
      <dbl>      <dbl>   <dbl>     <dbl>  <dbl>      <dbl> <dbl>      <dbl>
 1       95        0.7     102       6.7    126       41.1   6.9         91
 2      100        1        85       4.8    137       36.1   7.1         78
 3      109        2.3      89       3.9    144       27.3   5.3         76
 4      108        0.6     112       4.2    142       38.1  15.7         86
 5      104        0.5      87       4.1    142       37.4   5.4       79.3
 6       98        NA       NA       4.1    139       NA     NA          86
 7       97        1.3     131       3.9    138       31.4  10.4       124.
```

```
8       88        1.1      141       4.5      130       39.7  12.2        49
9      102        0.9      288       3.5      137       34.9   7.2        80
10      NA        3.1       95       6.5      125       34.3  16.8       110.
   `non-invasive_blood_pressure_systolic`
                                    <dbl>
 1                                     84
 2                                    106
 3                                    154
 4                                    151
 5                                    156
 6                                     73
 7                                    110
 8                                    174.
 9                                     98.5
10                                    112
   `non-invasive_blood_pressure_diastolic` temperature_fahrenheit
                                     <dbl>                   <dbl>
 1                                      48                    98.7
 2                                      56.5                  97.7
 3                                     102                    98
 4                                      90                    98.5
 5                                      93.3                  97.6
 6                                      56                    97.7
 7                                      78                    97.9
 8                                      30.5                  98.1
 9                                      62                    97.2
10                                      80                    97.9
   respiratory_rate
              <dbl>
 1               24
 2               24.3
 3               23.5
 4               18
 5               14
 6               19
 7               16.5
 8               13
 9               14
10               21
# i 94,448 more rows
```

```r
# Step (iii): Create los_long variable
mimic_icu_cohort <- mimic_icu_cohort |>
  mutate(los_long = los >= 2) |>
  #collect() |>
  print(width = Inf)
```

```
# A tibble: 94,458 x 42
   subject_id  hadm_id   stay_id first_careunit
        <int>    <int>     <int> <fct>
 1   10000032 29079034 39553978 Medical Intensive Care Unit (MICU)
 2   10000690 25860671 37081114 Medical Intensive Care Unit (MICU)
 3   10000980 26913865 39765666 Medical Intensive Care Unit (MICU)
 4   10001217 24597018 37067082 Surgical Intensive Care Unit (SICU)
 5   10001217 27703517 34592300 Surgical Intensive Care Unit (SICU)
 6   10001725 25563031 31205490 Medical/Surgical Intensive Care Unit (MICU/SICU)
 7   10001843 26133978 39698942 Medical/Surgical Intensive Care Unit (MICU/SICU)
 8   10001884 26184834 37510196 Medical Intensive Care Unit (MICU)
 9   10002013 23581541 39060235 Cardiac Vascular Intensive Care Unit (CVICU)
10   10002114 27793700 34672098 Other
   last_careunit                                    intime
   <fct>                                            <dttm>
 1 Medical Intensive Care Unit (MICU)               2180-07-23 14:00:00
 2 Medical Intensive Care Unit (MICU)               2150-11-02 19:37:00
 3 Medical Intensive Care Unit (MICU)               2189-06-27 08:42:00
 4 Surgical Intensive Care Unit (SICU)              2157-11-20 19:18:02
 5 Surgical Intensive Care Unit (SICU)              2157-12-19 15:42:24
 6 Medical/Surgical Intensive Care Unit (MICU/SICU) 2110-04-11 15:52:22
 7 Medical/Surgical Intensive Care Unit (MICU/SICU) 2134-12-05 18:50:03
 8 Medical Intensive Care Unit (MICU)               2131-01-11 04:20:05
 9 Cardiac Vascular Intensive Care Unit (CVICU)     2160-05-18 10:00:53
10 Other                                            2162-02-17 23:30:00
   outtime              los admittime           dischtime
   <dttm>              <dbl> <dttm>              <dttm>
 1 2180-07-23 23:50:47 0.410 2180-07-23 12:35:00 2180-07-25 17:55:00
 2 2150-11-06 17:03:17 3.89  2150-11-02 18:02:00 2150-11-12 13:45:00
 3 2189-06-27 20:38:27 0.498 2189-06-27 07:38:00 2189-07-03 03:00:00
 4 2157-11-21 22:08:00 1.12  2157-11-18 22:56:00 2157-11-25 18:00:00
 5 2157-12-20 14:27:41 0.948 2157-12-18 16:58:00 2157-12-24 14:55:00
 6 2110-04-12 23:59:56 1.34  2110-04-11 15:08:00 2110-04-14 15:00:00
 7 2134-12-06 14:38:26 0.825 2134-12-05 00:10:00 2134-12-06 12:54:00
 8 2131-01-20 08:27:30 9.17  2131-01-07 20:39:00 2131-01-20 05:15:00
 9 2160-05-19 17:33:33 1.31  2160-05-18 07:45:00 2160-05-23 13:30:00
10 2162-02-20 21:16:27 2.91  2162-02-17 22:32:00 2162-03-04 15:16:00
   deathtime           admission_type      admit_provider_id
   <dttm>              <fct>               <chr>
 1 NA                  EW EMER.            P06OTX
 2 NA                  EW EMER.            P26QQ4
 3 NA                  EW EMER.            P06OTX
 4 NA                  EW EMER.            P3610N
 5 NA                  Other               P276OU
 6 NA                  EW EMER.            P32W56
 7 2134-12-06 12:54:00 URGENT              P67ATB
```

```
 8 2131-01-20 05:15:00 OBSERVATION ADMIT          P49AFC
 9 NA                  SURGICAL SAME DAY ADMISSION P8286C
10 NA                  OBSERVATION ADMIT          P46834
   admission_location     discharge_location insurance language marital_status
   <fct>                  <fct>              <chr>     <chr>    <chr>
 1 EMERGENCY ROOM         HOME               Medicaid  English  WIDOWED
 2 EMERGENCY ROOM         Other              Medicare  English  WIDOWED
 3 EMERGENCY ROOM         HOME HEALTH CARE   Medicare  English  MARRIED
 4 EMERGENCY ROOM         HOME HEALTH CARE   Private   Other    MARRIED
 5 PHYSICIAN REFERRAL     HOME HEALTH CARE   Private   Other    MARRIED
 6 Other                  HOME               Private   English  MARRIED
 7 TRANSFER FROM HOSPITAL DIED               Medicare  English  SINGLE
 8 EMERGENCY ROOM         DIED               Medicare  English  MARRIED
 9 PHYSICIAN REFERRAL     HOME HEALTH CARE   Medicare  English  SINGLE
10 PHYSICIAN REFERRAL     HOME HEALTH CARE   Medicaid  English  <NA>
   race  edregtime           edouttime           hospital_expire_flag gender
   <chr> <dttm>              <dttm>                             <int> <chr>
 1 WHITE 2180-07-23 05:54:00 2180-07-23 14:00:00                    0 F
 2 WHITE 2150-11-02 11:41:00 2150-11-02 19:37:00                    0 F
 3 BLACK 2189-06-27 06:25:00 2189-06-27 08:42:00                    0 F
 4 WHITE 2157-11-18 17:38:00 2157-11-19 01:24:00                    0 F
 5 WHITE NA                  NA                                     0 F
 6 WHITE NA                  NA                                     0 F
 7 WHITE NA                  NA                                     1 M
 8 BLACK 2131-01-07 13:36:00 2131-01-07 22:13:00                    1 F
 9 Other NA                  NA                                     0 F
10 Other 2162-02-17 19:35:00 2162-02-17 23:30:00                    0 M
   anchor_age anchor_year anchor_year_group dod        age_intime bicarbonate
        <int>       <int> <chr>             <date>          <int>       <dbl>
 1         52        2180 2014 - 2016       2180-09-09         52          25
 2         86        2150 2008 - 2010       2152-01-30         86          26
 3         73        2186 2008 - 2010       2193-08-26         76          21
 4         55        2157 2011 - 2013       NA                 55          22
 5         55        2157 2011 - 2013       NA                 55          30
 6         46        2110 2011 - 2013       NA                 46          NA
 7         73        2131 2017 - 2019       2134-12-06         76          28
 8         68        2122 2008 - 2010       2131-01-20         77          30
 9         53        2156 2008 - 2010       NA                 57          24
10         56        2162 2020 - 2022       2162-12-11         56          18
   chloride creatinine glucose potassium sodium hematocrit   wbc heart_rate
      <dbl>      <dbl>   <dbl>     <dbl>  <dbl>      <dbl> <dbl>      <dbl>
 1       95        0.7     102       6.7    126       41.1   6.9         91
 2      100        1        85       4.8    137       36.1   7.1         78
 3      109        2.3      89       3.9    144       27.3   5.3         76
 4      108        0.6     112       4.2    142       38.1  15.7         86
 5      104        0.5      87       4.1    142       37.4   5.4       79.3
```

```
6        98          NA          NA       4.1    139        NA   NA         86
7        97         1.3         131       3.9    138      31.4 10.4       124.
8        88         1.1         141       4.5    130      39.7 12.2        49
9       102         0.9         288       3.5    137      34.9  7.2        80
10       NA         3.1          95       6.5    125      34.3 16.8       110.
   `non-invasive_blood_pressure_systolic`
                                    <dbl>
1                                      84
2                                     106
3                                     154
4                                     151
5                                     156
6                                      73
7                                     110
8                                    174.
9                                    98.5
10                                    112
   `non-invasive_blood_pressure_diastolic` temperature_fahrenheit
                                     <dbl>                  <dbl>
1                                       48                   98.7
2                                     56.5                   97.7
3                                      102                   98
4                                       90                   98.5
5                                     93.3                   97.6
6                                       56                   97.7
7                                       78                   97.9
8                                     30.5                   98.1
9                                       62                   97.2
10                                      80                   97.9
   respiratory_rate los_long
              <dbl> <lgl>
1                24  FALSE
2              24.3  TRUE
3              23.5 FALSE
4                18  FALSE
5                14  FALSE
6                19  FALSE
7              16.5 FALSE
8                13  TRUE
9                14  FALSE
10               21  TRUE
# i 94,448 more rows
```

```r
mimic_icu_cohort <- mimic_icu_cohort |>
  select(-c("subject_id", "hadm_id", "stay_id",
            "intime", "outtime", "admittime","dischtime",
```

```
            "deathtime", "admit_provider_id", "edregtime",
            "edouttime", "anchor_age", "anchor_year",
            "anchor_year_group")) |>
  tbl_summary(by = "los_long")
```

```
14 missing rows in the "los_long" column have been removed.
The following errors were returned during `tbl_summary()`:
x For variable `dod` (`los_long = FALSE`) and "p75" statistic: * not defined
  for "Date" objects
```

```
# Now print the summary table output
mimic_icu_cohort
```

0.1.9 Q1.9 Save the final tibble

Save the final tibble to an R data file `mimic_icu_cohort.rds` in the
`mimiciv_shiny` folder.

```
# make a directory mimiciv_shiny
if (!dir.exists("mimiciv_shiny")) {
  dir.create("mimiciv_shiny")
}
# save the final tibble
mimic_icu_cohort |>
  write_rds("mimiciv_shiny/mimic_icu_cohort.rds", compress = "gz")
```

Close database connection and clear workspace.

```
if (exists("con_bq")) {
  dbDisconnect(con_bq)
}
rm(list = ls())
```

Although it is not a good practice to add big data files to Git, for grading
purpose, please add `mimic_icu_cohort.rds` to your Git repository.

0.2 Q2. Shiny app

Develop a Shiny app for exploring the ICU cohort data created in Q1. The app
should reside in the `mimiciv_shiny` folder. The app should contain at least two
tabs. One tab provides easy access to the graphical and numerical summaries
of variables (demographics, lab measurements, vitals) in the ICU cohort, using
the `mimic_icu_cohort.rds` you curated in Q1. The other tab allows user to
choose a specific patient in the cohort and display the patient's ADT and ICU
stay information as we did in Q1 of HW3, by dynamically retrieving the patient's
ADT and ICU stay information from BigQuery database. Again, do **not** ever
add the BigQuery token to your Git repository. If you do so, you will lose 50
points.

Characteristic	**TRUE** N = 46,337[1]
first_careunit	
Cardiac Vascular Intensive Care Unit (CVICU)	7,353 (16%)
Medical Intensive Care Unit (MICU)	9,837 (21%)
Medical/Surgical Intensive Care Unit (MICU/SICU)	6,667 (14%)
Surgical Intensive Care Unit (SICU)	6,434 (14%)
Other	16,046 (35%)
last_careunit	
Cardiac Vascular Intensive Care Unit (CVICU)	7,353 (16%)
Medical Intensive Care Unit (MICU)	9,837 (21%)
Medical/Surgical Intensive Care Unit (MICU/SICU)	6,667 (14%)
Surgical Intensive Care Unit (SICU)	6,434 (14%)
Other	16,046 (35%)
los	3.9 (2.7, 6.8)
admission_type	
EW EMER.	23,012 (50%)
OBSERVATION ADMIT	7,393 (16%)
SURGICAL SAME DAY ADMISSION	4,001 (8.6%)
URGENT	8,691 (19%)
Other	3,240 (7.0%)
admission_location	
EMERGENCY ROOM	17,058 (37%)
PHYSICIAN REFERRAL	11,013 (24%)
TRANSFER FROM HOSPITAL	13,904 (30%)
Other	4,362 (9.4%)
discharge_location	
DIED	6,884 (15%)
HOME	6,879 (15%)
HOME HEALTH CARE	10,620 (23%)
SKILLED NURSING FACILITY	8,785 (19%)
Other	13,092 (28%)
Unknown	77
insurance	
Medicaid	6,768 (15%)
Medicare	26,330 (58%)
No charge	5 (<0.1%)
Other	1,091 (2.4%)
Private	11,515 (25%)
Unknown	628
language	
American Sign Language	29 (<0.1%)
Amharic	14 (<0.1%)
Arabic	87 (0.2%)
Armenian	12 (<0.1%)
Bengali	22 (<0.1%)
Chinese	550 (1.2%)