Bios 6301: Assignment 8

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Due Tuesday, 16 November, 1:00 PM

$5^{n=day}$ points taken off for each day late.

30 points total.

Submit a single knitr file (named `homework8.rmd`), along with a valid PDF output file. Inside the file, clearly indicate which parts of your responses go with which problems (you may use the original homework document as a template). Add your name as `author` to the file's metadata section. Raw R code/output or word processor files are not acceptable.

Failure to name file `homework8.rmd` or include author name may result in 5 points taken off.

Question 1

15 points

Install the `readxl` package and run the following

```
library(readxl)
fn <- 'icd10.xlsx'
if(file.access(fn, mode = 4) == -1) {
    url <- "https://www.cdc.gov/nhsn/xls/icd10-pcs-pcm-nhsn-opc.xlsx"
    download.file(url, destfile = fn, mode = 'wb')
}
dat <- readxl::read_excel(fn, sheet = 2)
```

1. Show the class of `dat`. (1 point)

```
class(dat)
```

```
## [1] "tbl_df"     "tbl"        "data.frame"
```

2. Show the methods available for objects of the given class (if there are multiple classes, show methods for all classes). (3 points)

```
methods(,class(dat)[1])
```

```
##  [1] [             [[            [[<-          [<-           $
##  [6] $<-           as.data.frame coerce        initialize    names<-
## [11] Ops           row.names<-   show          slotsFromS3   str
## see '?methods' for accessing help and source code
```

```
methods(,class(dat)[2])
```

```
##  [1] [[<-        [<-         $<-         coerce      format      initialize
##  [7] Ops         print       show        slotsFromS3
## see '?methods' for accessing help and source code
```

```
methods(,class(dat)[3])
```

```
##  [1] [             [[            [[<-          [<-           $<-          
##  [6] aggregate     anyDuplicated anyNA         as.data.frame as.list      
## [11] as.matrix     by            cbind         coerce        dim          
## [16] dimnames      dimnames<-    droplevels    duplicated    edit         
## [21] format        formula       head          initialize    is.na        
## [26] Math          merge         na.exclude    na.omit       Ops          
## [31] plot          print         prompt        rbind         row.names    
## [36] row.names<-   rowsum        show          slotsFromS3   split        
## [41] split<-       stack         str           subset        summary      
## [46] Summary       t             tail          transform     type.convert 
## [51] unique        unstack       within        xtfrm        
## see '?methods' for accessing help and source code
```

3. If you call `print(dat)`, what print method is being dispatched? (1 point)

print.tbl

4. Set the class of `dat` to be a data.frame. (1 point)

```r
class(dat) = 'data.frame'
```

5. If you call `print(dat)` again, what print method is being dispatched? (1 point)

print.data.frame

Define a new generic function `nUnique` with the code below.

```r
nUnique <- function(x) {
    UseMethod('nUnique')
}
```

6. Write a default method for `nUnique` to count the number of unique values in an element. (2 points)

```r
nUnique.default <- function(x) {
  length(unique(x))
}
```

7. Check your function (2 points)

```r
nUnique(letters) # should return 26
```

```
## [1] 26
```

```r
nUnique(sample(10, 100, replace = TRUE)) # should return 10 (probably)
```

```
## [1] 10
```

8. Write a data.frame method for `nUnique` to operate on data.frame objects. This version should return counts for each column in a data.frame. (2 points)

```r
nUnique.data.frame <- function(x) {
  sapply(x,\(y) length(unique(y)))
}
```

9. Check your function (2 points)

```r
nUnique(dat)
```

```
##     Procedure Code Category            ICD-10-PCS Codes 
##                          39                        9697 
## Procedure Code Descriptions                 Code Status 
##                        9697                           4 
```

Question 2

15 points

Programming with classes. The following function will generate random patient information.

```
makePatient <- function() {
  vowel <- grep("[aeiou]", letters)
  cons <- grep("[^aeiou]", letters)
  name <- paste(sample(LETTERS[cons], 1), sample(letters[vowel], 1), sample(letters[cons], 1), sep='')
  gender <- factor(sample(0:1, 1), levels=0:1, labels=c('female','male'))
  dob <- as.Date(sample(7500, 1), origin="1970-01-01")
  n <- sample(6, 1)
  doa <- as.Date(sample(1500, n), origin="2010-01-01")
  pulse <- round(rnorm(n, 80, 10))
  temp <- round(rnorm(n, 98.4, 0.3), 2)
  fluid <- round(runif(n), 2)
  list(name, gender, dob, doa, pulse, temp, fluid)
}
```

1. Create an S3 class `medicalRecord` for objects that are a list with the named elements `name`, `gender`, `date_of_birth`, `date_of_admission`, `pulse`, `temperature`, `fluid_intake`. Note that an individual patient may have multiple measurements for some measurements. Set the RNG seed to `8` and create a medical record by taking the output of `makePatient`. Print the medical record, and print the class of the medical record. (5 points)

```
set.seed(8)
mr = makePatient()
names(mr) = c('name', 'gender', 'date_of_birth', 'date_of_admission',
              'pulse', 'temperature', 'fluid_intake')
class(mr) = 'medicalRecord'
print(mr)
```

```
## $name
## [1] "Yes"
##
## $gender
## [1] male
## Levels: female male
##
## $date_of_birth
## [1] "1977-05-03"
##
## $date_of_admission
## [1] "2013-06-09" "2013-07-02"
##
## $pulse
## [1] 79 78
##
## $temperature
## [1] 98.07 97.50
##
## $fluid_intake
## [1] 0.28 0.52
##
## attr(,"class")
```

```
## [1] "medicalRecord"
```

```
print(class(mr))
```

```
## [1] "medicalRecord"
```

2. Write a `medicalRecord` method for the generic function `mean`, which returns averages for pulse, temperature and fluids. Also write a `medicalRecord` method for `print`, which employs some nice formatting, perhaps arranging measurements by date, and `plot`, that generates a composite plot of measurements over time. Call each function for the medical record created in part 1. (5 points)

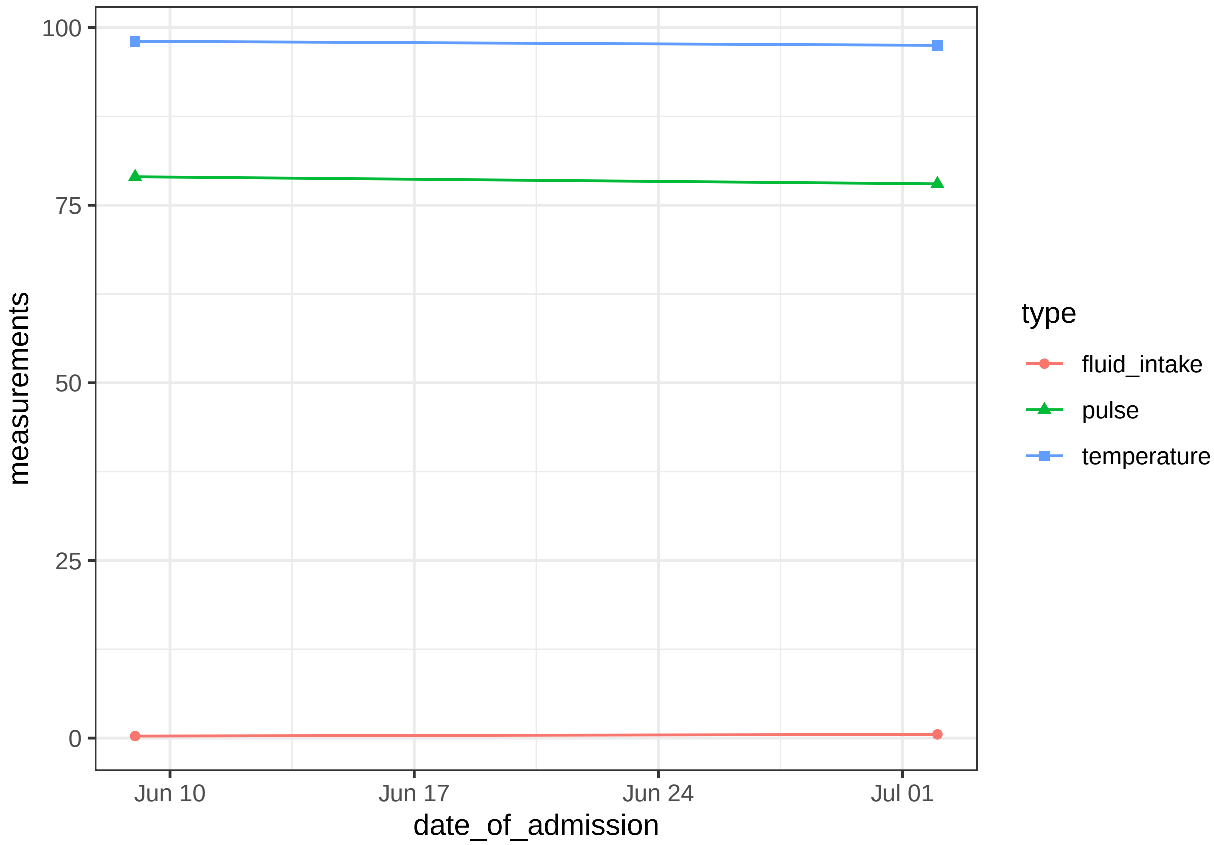
```
mean.medicalRecord <- function(mr){
    y = c(mean(mr$pulse),mean(mr$temperature),mean(mr$fluid_intake))
    names(y) = c('pulse', 'temperature', 'fluid_intake')
    y
}
mean(mr)
```

```
##        pulse  temperature fluid_intake
##       78.500       97.785        0.400
```

```
#arranging measurements by date, in a decreasing order
print.medicalRecord <- function(mr){
    y = do.call(cbind.data.frame, mr)
    y.arrange = y[order(y$date_of_admission,decreasing = T),]
    print(y.arrange)
}
print(mr)
```

```
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 2  Yes   male    1977-05-03        2013-07-02    78       97.50         0.52
## 1  Yes   male    1977-05-03        2013-06-09    79       98.07         0.28
```

```
# composite plot of measurements over time.
library(tidyr)
library(ggplot2)
plot.medicalRecord <- function(mr){
    y = do.call(cbind.data.frame, mr) %>% as_tibble %>%
      pivot_longer(5:7,names_to = 'type',values_to = "measurements")
    p = ggplot(y,aes(x=date_of_admission,
                     y=measurements,color=type)) +
      geom_point(aes(shape=type)) +
      geom_line() + theme_bw()
    print(p)
}
plot(mr)
```



3. Create a further class for a cohort (group) of patients, and write methods for `mean` and `print` which, when applied to a cohort, apply mean or print to each patient contained in the cohort. Hint: think of this as a "container" for patients. Reset the RNG seed to 8 and create a cohort of ten patients, then show the output for `mean` and `print`. (5 points)

```
set.seed(8)
cohort = list()
name = NULL
for (i in 1:10){
  mr = makePatient()
  names(mr) = c('name', 'gender', 'date_of_birth',
                'date_of_admission','pulse', 'temperature', 'fluid_intake')
  name = c(name,mr$name)
  cohort = c(cohort,list(mr))
}
names(cohort) = name
class(cohort) = 'cohort'
head(cohort)
```

```
## $Yes
## $Yes$name
## [1] "Yes"
##
## $Yes$gender
## [1] male
## Levels: female male
##
## $Yes$date_of_birth
```

```
## [1] "1977-05-03"
##
## $Yes$date_of_admission
## [1] "2013-06-09" "2013-07-02"
##
## $Yes$pulse
## [1] 79 78
##
## $Yes$temperature
## [1] 98.07 97.50
##
## $Yes$fluid_intake
## [1] 0.28 0.52
##
##
## $Fal
## $Fal$name
## [1] "Fal"
##
## $Fal$gender
## [1] male
## Levels: female male
##
## $Fal$date_of_birth
## [1] "1988-05-24"
##
## $Fal$date_of_admission
## [1] "2010-11-16" "2013-09-12" "2013-03-24"
##
## $Fal$pulse
## [1] 76 96 87
##
## $Fal$temperature
## [1] 98.23 98.75 98.21
##
## $Fal$fluid_intake
## [1] 0.18 0.96 0.10
##
##
## $Zog
## $Zog$name
## [1] "Zog"
##
## $Zog$gender
## [1] male
## Levels: female male
##
## $Zog$date_of_birth
## [1] "1988-12-14"
##
## $Zog$date_of_admission
## [1] "2013-03-25" "2013-07-29" "2013-10-27" "2010-02-24"
##
## $Zog$pulse
```

```
## [1] 69 75 80 84
##
## $Zog$temperature
## [1] 98.49 98.82 98.74 98.54
##
## $Zog$fluid_intake
## [1] 0.81 0.59 0.28 0.40
##
##
## $Yol
## $Yol$name
## [1] "Yol"
##
## $Yol$gender
## [1] male
## Levels: female male
##
## $Yol$date_of_birth
## [1] "1986-03-11"
##
## $Yol$date_of_admission
## [1] "2014-01-28" "2013-03-24" "2012-03-10" "2010-02-22" "2011-12-27"
## [6] "2012-11-26"
##
## $Yol$pulse
## [1] 69 78 87 84 89 92
##
## $Yol$temperature
## [1] 98.29 98.44 98.78 98.87 98.27 98.26
##
## $Yol$fluid_intake
## [1] 0.03 0.13 0.12 0.39 0.97 0.14
##
##
## $Yak
## $Yak$name
## [1] "Yak"
##
## $Yak$gender
## [1] female
## Levels: female male
##
## $Yak$date_of_birth
## [1] "1983-09-15"
##
## $Yak$date_of_admission
## [1] "2012-08-30" "2012-04-07" "2011-07-19" "2012-07-11"
##
## $Yak$pulse
## [1] 90 88 75 81
##
## $Yak$temperature
## [1] 98.58 97.53 98.58 99.11
##
```

```
## $Yak$fluid_intake
## [1] 0.26 0.29 0.60 0.66
##
##
## $Gaf
## $Gaf$name
## [1] "Gaf"
##
## $Gaf$gender
## [1] female
## Levels: female male
##
## $Gaf$date_of_birth
## [1] "1978-04-27"
##
## $Gaf$date_of_admission
## [1] "2012-04-24" "2010-07-19" "2012-08-06" "2013-08-21" "2011-05-03"
##
## $Gaf$pulse
## [1] 89 91 77 75 90
##
## $Gaf$temperature
## [1] 98.32 98.01 98.96 98.52 98.61
##
## $Gaf$fluid_intake
## [1] 0.42 0.47 0.74 0.62 0.36
```

```r
mean.cohort = function(cohort){
  lapply(cohort,function(x){
    class(x) ='medicalRecord'
    mean(x)
  })
}
mean(cohort)
```

```
## $Yes
##        pulse  temperature fluid_intake
##       78.500       97.785        0.400
##
## $Fal
##        pulse  temperature fluid_intake
##   86.3333333   98.3966667    0.4133333
##
## $Zog
##        pulse  temperature fluid_intake
##      77.0000      98.6475       0.5200
##
## $Yol
##        pulse  temperature fluid_intake
##   83.1666667   98.4850000    0.2966667
##
## $Yak
##        pulse  temperature fluid_intake
##      83.5000      98.4500       0.4525
##
```

```
## $Gaf
##       pulse  temperature fluid_intake
##      84.400       98.484        0.522
##
## $Kuw
##       pulse  temperature fluid_intake
##     76.5000      98.3800       0.3975
##
## $Mav
##       pulse  temperature fluid_intake
##     75.0000      98.3675       0.5225
##
## $Fel
##       pulse  temperature fluid_intake
##       73.00        98.36         0.15
##
## $Say
##       pulse  temperature fluid_intake
##       77.00        98.54         0.15
```

```
print.cohort <- function(cohort){
    invisible(lapply(cohort,function(x){
      class(x) ='medicalRecord'
      y = print(x)
    }))
}
print(cohort)
```

```
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 2  Yes   male    1977-05-03        2013-07-02    78       97.50         0.52
## 1  Yes   male    1977-05-03        2013-06-09    79       98.07         0.28
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 2  Fal   male    1988-05-24        2013-09-12    96       98.75         0.96
## 3  Fal   male    1988-05-24        2013-03-24    87       98.21         0.10
## 1  Fal   male    1988-05-24        2010-11-16    76       98.23         0.18
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 3  Zog   male    1988-12-14        2013-10-27    80       98.74         0.28
## 2  Zog   male    1988-12-14        2013-07-29    75       98.82         0.59
## 1  Zog   male    1988-12-14        2013-03-25    69       98.49         0.81
## 4  Zog   male    1988-12-14        2010-02-24    84       98.54         0.40
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 1  Yol   male    1986-03-11        2014-01-28    69       98.29         0.03
## 2  Yol   male    1986-03-11        2013-03-24    78       98.44         0.13
## 6  Yol   male    1986-03-11        2012-11-26    92       98.26         0.14
## 3  Yol   male    1986-03-11        2012-03-10    87       98.78         0.12
## 5  Yol   male    1986-03-11        2011-12-27    89       98.27         0.97
## 4  Yol   male    1986-03-11        2010-02-22    84       98.87         0.39
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 1  Yak female    1983-09-15        2012-08-30    90       98.58         0.26
## 4  Yak female    1983-09-15        2012-07-11    81       99.11         0.66
## 2  Yak female    1983-09-15        2012-04-07    88       97.53         0.29
## 3  Yak female    1983-09-15        2011-07-19    75       98.58         0.60
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 4  Gaf female    1978-04-27        2013-08-21    75       98.52         0.62
## 3  Gaf female    1978-04-27        2012-08-06    77       98.96         0.74
```

```
## 1  Gaf female    1978-04-27        2012-04-24    89       98.32         0.42
## 5  Gaf female    1978-04-27        2011-05-03    90       98.61         0.36
## 2  Gaf female    1978-04-27        2010-07-19    91       98.01         0.47
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 3  Kuw female    1980-11-07        2012-07-10    71       98.65         0.25
## 1  Kuw female    1980-11-07        2011-09-16    72       98.21         0.29
## 2  Kuw female    1980-11-07        2010-10-29    81       98.17         0.93
## 4  Kuw female    1980-11-07        2010-10-03    82       98.49         0.12
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 1  Mav female    1989-07-16        2012-03-02    63       99.07         0.01
## 2  Mav female    1989-07-16        2010-06-11    83       98.45         0.79
## 4  Mav female    1989-07-16        2010-04-19    88       98.00         0.50
## 3  Mav female    1989-07-16        2010-02-08    66       97.95         0.79
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 1  Fel   male    1985-08-16        2012-06-24    65       98.21         0.06
## 2  Fel   male    1985-08-16        2010-09-26    81       98.51         0.24
##   name gender date_of_birth date_of_admission pulse temperature fluid_intake
## 1  Say female    1974-09-22        2010-03-14    77       98.54         0.15
```