Working with categorical variables

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Review HW 5

Working with strings in R

What is a string?

A string is an ordered sequence of characters

- Strings are generally stored verbatim, and have no mathmatical meaning (ie math operations will return errors)
- In R, these are character objects
- Generally wrapped in ""
- In R, can use as.character to convert any value to character

Let’s try something

What’s the difference between these commands

```
a <- 1
b <- "1"
```

- What does each command do?
- Try str() on each

Let’s keep trying to break R

On your console, try these:

- a<-c(1,2,3)
- b<-c(“1”, “2”, “3”)
- c<-c(1, “2”, 3)
- d<-c(1, 2, “c”)

Let’s keep trying to break R

On your console, try these:

- a<-c(1,2,3)
- b<-c(“1”, “2”, “3”)
- c<-c(1, “2”, 3)
- d<-c(1, 2, “c”)

What happened? Why?

Let’s keep trying to break R

- a + a
- a + “a”
- a + b
- “a” == “A”
- a == “a”

Summary of strings in R

- R will coerce vectors to string when strings are included
- Strings are the most complex variable type in order: (logical, numeric, factor, character)
- Strings can only be compared to strings
- You should generally treat all categorical variables as strings in R (unless order matters! then use factor())

Working with strings in R

Stringr

The stringr package loads with tidyverse

```
library(tidyverse)
```

It has more powerful versions of base functions like:

- substr()
- grep()
- paste()
- strsplit()

Getting started

```
word <- "banana"
str_length(word)
```

```
## [1] 6
```

```
word %>% str_length()
```

```
## [1] 6
```

Pulling single characters from a string

```
word <- "banana"
word_length <- str_length(word)
word %>% str_sub(1, 1)
```

```
## [1] "b"
```

```
for (i in 1:word_length) {
    print(str_sub(word, i, i))
}
```

```
## [1] "b"
## [1] "a"
## [1] "n"
## [1] "a"
## [1] "n"
## [1] "a"
```

Pulling multiple characters

```
word <- "banana"
word %>% str_sub(1, 3)
```

```
## [1] "ban"
```

```
for (i in 1:word_length) {
    print(str_sub(word, 1, i))
}
```

```
## [1] "b"
## [1] "ba"
## [1] "ban"
## [1] "bana"
## [1] "banan"
## [1] "banana"
```

Substitution

```
str_sub(word, 1, 2) <- "surprise"
word
```

```
## [1] "surprisenana"
```

Indexing on strings, negative values

```
word
```

```
## [1] "surprisenana"
```

```
str_sub(word, -2, -1)
```

```
## [1] "na"
```

What happened here?

Some convenient functions

```
phrase <- "bananas are the tastiest"
toupper(phrase)
```

```
## [1] "BANANAS ARE THE TASTIEST"
```

```
tolower(toupper(phrase))
```

```
## [1] "bananas are the tastiest"
```

```
library(tools)
toTitleCase(phrase)
```

```
## [1] "Bananas are the Tastiest"
```

```
odd <- "   bananas are the tastiest     "
trimws(odd)
```

```
## [1] "bananas are the tastiest"
```

Splitting a string

```
str_split(phrase, pattern = " ")
```

```
## [[1]]
## [1] "bananas"  "are"      "the"      "tastiest"
```

```
str_split(phrase, pattern = "a")
```

```
## [[1]]
## [1] "b"        "n"        "n"        "s "       "re the t" "stiest"
```

Splitting a string to a fixed matrix

```
str_split_fixed(phrase, pattern = " ", n = 2)
```

```
##      [,1]      [,2]
## [1,] "bananas" "are the tastiest"
```

```
str_split_fixed(phrase, pattern = " ", n = 3)
```

```
##      [,1]      [,2]  [,3]
## [1,] "bananas" "are" "the tastiest"
```

```
str_split_fixed(phrase, pattern = " ", n = 4)
```

```
##      [,1]      [,2]  [,3]  [,4]
## [1,] "bananas" "are" "the" "tastiest"
```

Finding strings in strings

```
str_detect(phrase, "are")
```

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

```
str_detect(phrase, "scrumptious")
```

```
## [1] FALSE
```

```
str_detect(phrase, "nana")
```

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

Squishing strings together

```
str_c(phrase, "seriously")
```

```
## [1] "bananas are the tastiestseriously"
```

```
### oops
str_c(phrase, "seriously", sep = " ")
```

```
## [1] "bananas are the tastiest seriously"
```

```
### or
str_c(phrase, " seriously")
```

```
## [1] "bananas are the tastiest seriously"
```

```
## not this
str_c(phrase, "seriously", sep = "!!")
```

```
## [1] "bananas are the tastiest!!seriously"
```

But we usually work with vectors!

- This is true
- All of this works on vectors
- Like a vector of fruits!

But we usually work with vectors!

- This is true
- All of this works on vectors
- Like a vector of fruits!

```
fruit
```

```
##  [1] "apple"            "apricot"          "avocado"
##  [4] "banana"           "bell pepper"      "bilberry"
##  [7] "blackberry"       "blackcurrant"     "blood orange"
## [10] "blueberry"        "boysenberry"      "breadfruit"
## [13] "canary melon"     "cantaloupe"       "cherimoya"
## [16] "cherry"           "chili pepper"     "clementine"
## [19] "cloudberry"       "coconut"          "cranberry"
## [22] "cucumber"         "currant"          "damson"
## [25] "date"             "dragonfruit"      "durian"
## [28] "eggplant"         "elderberry"       "feijoa"
## [31] "fig"              "goji berry"       "gooseberry"
## [34] "grape"            "grapefruit"       "guava"
## [37] "honeydew"         "huckleberry"      "jackfruit"
## [40] "jambul"           "jujube"           "kiwi fruit"
## [43] "kumquat"          "lemon"            "lime"
## [46] "loquat"           "lychee"           "mandarine"
## [49] "mango"            "mulberry"         "nectarine"
## [52] "nut"              "olive"            "orange"
## [55] "pamelo"           "papaya"           "passionfruit"
## [58] "peach"            "pear"             "persimmon"
## [61] "physalis"         "pineapple"        "plum"
```

See, it works on vectors!

```
str_sub(fruit, 1, 2)
```

```
##  [1] "ap" "ap" "av" "ba" "be" "bi" "bl" "bl" "bl" "bl" "bo" "br" "ca" "ca"
## [15] "ch" "ch" "ch" "cl" "cl" "co" "cr" "cu" "cu" "da" "da" "dr" "du" "eg"
## [29] "el" "fe" "fi" "go" "go" "gr" "gr" "gu" "ho" "hu" "ja" "ja" "ju" "ki"
## [43] "ku" "le" "li" "lo" "ly" "ma" "ma" "mu" "ne" "nu" "ol" "or" "pa" "pa"
## [57] "pa" "pe" "pe" "pe" "ph" "pi" "pl" "po" "po" "pu" "qu" "ra" "ra" "ra"
## [71] "re" "ro" "sa" "sa" "st" "st" "ta" "ta" "ug" "wa"
```

Let’s see how many fruits use the word “fruit”

```
fruit %>% str_detect("fruit")
```

```
##  [1] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [12]  TRUE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [23] FALSE FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [34] FALSE  TRUE FALSE FALSE FALSE  TRUE FALSE FALSE  TRUE FALSE FALSE
## [45] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [56] FALSE  TRUE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [67] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE  TRUE FALSE FALSE
## [78] FALSE  TRUE FALSE
```

```
## How many?
fruit %>% str_detect("fruit") %>% sum()
```

```
## [1] 8
```

Let’s get those fruits that are called fruits

```
fruitfruits <- str_subset(fruit, "fruit")
```

Let's make them all one word

```
fruitfruits<-str_replace(

  fruitfruits,
  pattern = " ",
  replacement= "")

fruitfruits
```

```
## [1] "breadfruit"   "dragonfruit"  "grapefruit"   "jackfruit"
## [5] "kiwifruit"    "passionfruit" "starfruit"    "uglifruit"
```

Let's make them all two words

```
fruitfruits<-str_replace(

  fruitfruits,
  pattern = "fruit",
  replacement = " fruit")

fruitfruits
```

```
## [1] "bread fruit"   "dragon fruit"  "grape fruit"   "jack fruit"
## [5] "kiwi fruit"    "passion fruit" "star fruit"    "ugli fruit"
```

Using str_replace to handle NA

```r
melons <- str_subset(fruit, pattern = "melon")
melons[2] <- NA
melons
```

```
## [1] "canary melon" NA             "watermelon"
```

```r
# > [1] 'canary melon' NA 'watermelon'
str_replace_na(melons, "UNKNOWN MELON")
```

```
## [1] "canary melon"  "UNKNOWN MELON" "watermelon"
```

Moving on to some more practical examples

Returning to the Titanic

```
titanic <- read_csv("./data/titanic.csv")
```

A handy trick

```
tolower(names(titanic))
```

```
## [1] "survived"                  "pclass"
## [3] "name"                      "sex"
## [5] "age"                       "siblings/spouses aboard"
## [7] "parents/children aboard" "fare"
```

```
names(titanic) <- tolower(names(titanic))
```

Let's see what titles people used

```
titanic_titles <- titanic %>% separate(name, into = c("title", "name"), sep = "\\.")
## the \\ is there because . has a special meaning in regex (we'll come
## back to that)
titanic
```

```
## # A tibble: 887 x 8
##    survived pclass name  sex     age `siblings/spous~ `parents/childr~
##       <dbl>  <dbl> <chr> <chr> <dbl>            <dbl>            <dbl>
##  1        0      3 Mr. ~ male     22                1                0
##  2        1      1 Mrs.~ fema~    38                1                0
##  3        1      3 Miss~ fema~    26                0                0
##  4        1      1 Mrs.~ fema~    35                1                0
##  5        0      3 Mr. ~ male     35                0                0
##  6        0      3 Mr. ~ male     27                0                0
##  7        0      1 Mr. ~ male     54                0                0
##  8        0      3 Mast~ male      2                3                1
##  9        1      3 Mrs.~ fema~    27                0                2
## 10        1      2 Mrs.~ fema~    14                1                0
## # ... with 877 more rows, and 1 more variable: fare <dbl>
```

Titles on the Titanic

```
unique(titanic_titles$title)
```

```
##  [1] "Mr"           "Mrs"          "Miss"         "Master"
##  [5] "Don"          "Rev"          "Dr"           "Mme"
##  [9] "Ms"           "Major"        "Lady"         "Sir"
## [13] "Mlle"         "Col"          "Capt"         "the Countess"
## [17] "Jonkheer"
```

Who's Jonkheer? Who's the Countess?

```
grep("Jonkheer", titanic$name)
```

```
## [1] 819
```

```
grep("the Countess", titanic$name)
```

```
## [1] 756
```

grep and grepl

Both use regular expressions to match patterns in strings.

- grep() returns the index of matches (ie row number)
- grepl() retunrs TRUE or FALSE for matches
- Regular expressions (or regex) are super powerful and super confusing.
- Here's a cheatsheet (`https://www.rstudio.com/wp-content/uploads/2016/09/RegExCheatsheet.pdf`)
- Most of the time, we don't need to worry about regex. But special characters can trip you up.

Special characters in regex

`\^$.|?*+()[{"`

grep and grepl in practice

How many countesses are there?

```
table(grepl("the Countess", titanic$name))
```

```
##
## FALSE  TRUE
##   886     1
```

Who was she?!

```
titanic[grep("the Countess", titanic$name), ]
```

```
## # A tibble: 1 x 8
##   survived pclass name  sex     age `siblings/spous~ `parents/childr~  fare
##      <dbl>  <dbl> <chr> <chr> <dbl>            <dbl>            <dbl> <dbl>
## 1        1      1 the ~ fema~    33                0                0  86.5
```

```
titanic %>% filter(grepl("the Countess", titanic$name))
```

```
## # A tibble: 1 x 8
##   survived pclass name  sex     age `siblings/spous~ `parents/childr~  fare
##      <dbl>  <dbl> <chr> <chr> <dbl>            <dbl>            <dbl> <dbl>
## 1        1      1 the ~ fema~    33                0                0  86.5
```

Let's just get her title and name

```
titanic %>% filter(grepl("the Countess", titanic$name)) %>% select(name)
```

```
## # A tibble: 1 x 1
##   name
##   <chr>
## 1 the Countess. of (Lucy Noel Martha Dyer-Edwards) Rothes
```

Recoding - ifelse and case_when

The ifelse() function

ifelse() commands require the following:

1. test: a conditional statement that returns TRUE or FALSE
2. yes: a value assigned when test==TRUE
3. no: a value assigned when test==FALSE

if and else

```
a <- c(1, 2)
b <- c(1, 2)
if (a == b) {
    "equal!"
} else {
    "not equal!"
}
```

```
## [1] "equal!"
```

```
if (a != b) {
    "not equal!"
} else {
    "equal!"
}
```

```
## [1] "equal!"
```

What if we want a comparison of each element in the vector?

```
ifelse(a == b, "equal!", "not equal!")
```

```
## [1] "equal!" "equal!"
```

We can use this to do all kinds of neat things.

We're going to be cruel for a moment

Let's add "You died" to the front of any the name of any passenger who died

```
cruelty<-titanic%>%
  mutate(

    name =
      ifelse(
        survived == 0,
        str_c("You died", name, sep = " "),
        name)
  )%>%
  select(survived, name)
```

What did it do?

```
cruelty
```

```
## # A tibble: 887 x 2
##    survived name
##       <dbl> <chr>
##  1        0 You died Mr. Owen Harris Braund
##  2        1 Mrs. John Bradley (Florence Briggs Thayer) Cumings
##  3        1 Miss. Laina Heikkinen
##  4        1 Mrs. Jacques Heath (Lily May Peel) Futrelle
##  5        0 You died Mr. William Henry Allen
##  6        0 You died Mr. James Moran
##  7        0 You died Mr. Timothy J McCarthy
##  8        0 You died Master. Gosta Leonard Palsson
##  9        1 Mrs. Oscar W (Elisabeth Vilhelmina Berg) Johnson
## 10        1 Mrs. Nicholas (Adele Achem) Nasser
## # ... with 877 more rows
```

Let's add a new variable - child

```
kids<-titanic%>%
  mutate(

    child = ifelse(age<18,
                   "Child",
                   "Adult"))

table(kids$child)
```

```
##
## Adult Child
##   757   130
```

```
table(titanic$age<18)
```

```
##
## FALSE  TRUE
##   757   130
```

Let’s recode the variable sex

```
recode<-titanic%>%
  mutate(

    sex = ifelse(sex == "male",
                 "m",
                 "f"))
```

But what if we have more than one condition to evaluate?

Let's make a three category age variable: child, adult, elder

We could nest ifelse() commands:

```
age_recode<-titanic%>%
  mutate(age_cat =

           ifelse(age<18, "child",
                  ifelse(age>65,
                         "elder",
                         "adult")))

table(age_recode$age_cat)
```

```
##
## adult child elder
##   747   130    10
```

But that's hard to read and can get cumbersome with many categories

case_when() is a flexible approach to link together many conditional statements

```
age_recode2<-titanic%>%
  mutate(age_cat =

           case_when(
             age < 18 ~ "child",
             age >= 18 & age <= 65 ~ "adult",
             age >65 ~ "elder"

           ))

table(age_recode2$age_cat)
```

```
##
## adult child elder
##   747   130    10
```

A real example: HW 6

```
fe <- read_csv("./data/fe_1_25_19.csv")
unique(fe$`Subject's age`)
```

```
##   [1] "24"        "53"        "55"        "25"        "23"
##   [6] "45"        "20"        "29"        "31"        "19"
##  [11] "36"        "28"        "35"        NA          "26"
##  [16] "41"        "68"        "49"        "17"        "27"
##  [21] "44"        "50"        "43"        "38"        "21"
##  [26] "32"        "34"        "14"        "18"        "33"
##  [31] "15"        "22"        "1"         "57"        "88"
##  [36] "40"        "37"        "48"        "85"        "56"
##  [41] "42"        "52"        "46"        "63"        "16"
##  [46] "30"        "74"        "60"        "59"        "51"
##  [51] "69"        "13"        "10"        "47"        "66"
##  [56] "39"        "79"        "54"        "65"        "75"
##  [61] "20s"       "7"         "6"         "3"         "5"
##  [66] "11"        "72"        "58"        "71"        "12"
##  [71] "80"        "78"        "61"        "73"        "67"
##  [76] "70"        "77"        "76"        "8"         "9"
##  [81] "64"        "62"        "4"         "83"        "2"
##  [86] "89"        "60s"       "18-25"     "18 months" "46/53"
##  [91] "3 months"  "40s"       "30s"       "84"        "90"
##  [96] "50s"       "81"        "87"        "6 months"  "9 months"
## [101] "10 months" "86"        "92"        "2 months"  "7 months"
## [106] "82"        "8 months"  "91"        "3 days"    "55."
## [111] "20s-30s"   "95"        "101"       "107"       "40-50"
## [116] "25-30"     "97"        "24-25"     "93"        "45 or 49"
## [121] "25`"       "4 months"  "70s"       "11 mon"    "7 mon"
```

More messy data

```
unique(fe$`Subject's gender`)
```

```
## [1] "Female"      "Male"        NA            "Transgender" "Femalr"
## [6] "Transexual"  "White"
```

Data cleaning

- Data cleaning involves writing code to solve problems in the raw data.
- We write programs that search out and fix issues so that we can conduct needed analysis.
- NEVER modify the original data. Doing so is not reproducible or documented.