

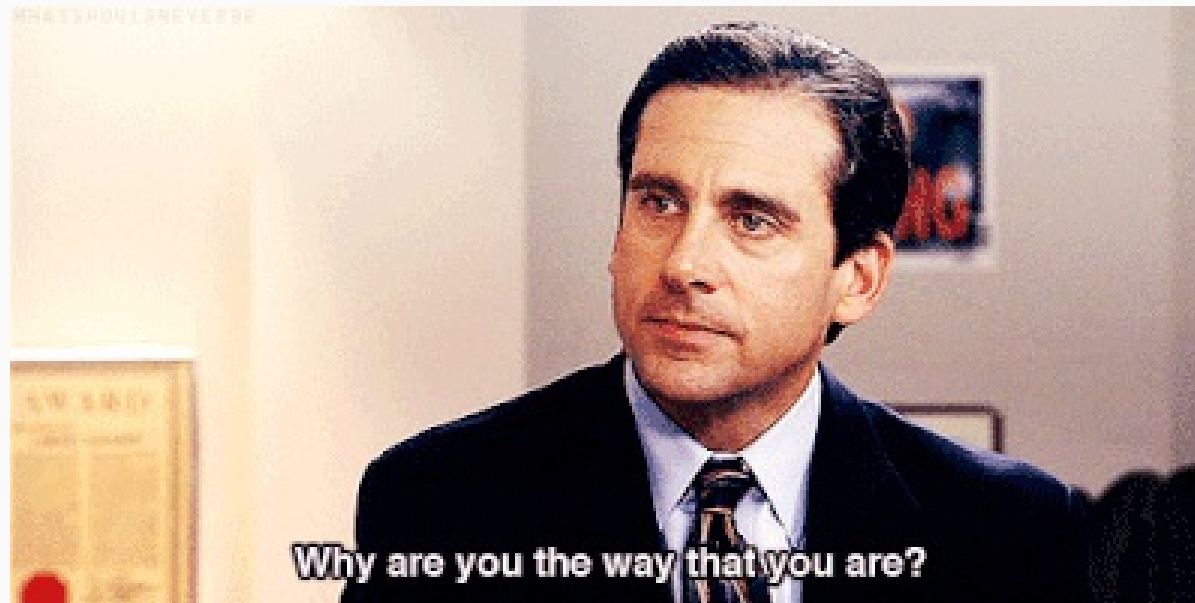
Data Analysis in R

Dealing (Learning to Love) With Factors

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2018-10-18 (updated: 2018-11-02)

Factors Are Frustrating To Novices



- Factors throw weird errors
- They get in the way of sorting (sometimes)

But Why Factors?

Categorical data types take on discrete values

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- Months of the Year
- Hair Color
- Likert Scales
- Political Party Affiliation
- etc

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Factors help R represent *categorical* variables

Factor Representation in R

Factors have a class of factor

```
race <- factor(x = c("white", "Non-white"))  
class(race)
```

```
## [1] "factor"
```

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```

Factors have "levels" which represent the values that the factor can take on

```
levels(race)
```

```
## [1] "Non-white" "white"
```

Coercion

You can make any vector/ column a factor using `factor` or `as.factor`

```
mtcars %>%  
  mutate(cyl_fact = factor(cyl)) %>%  
  select(cyl_fact, cyl)
```

```
## # A tibble: 32 x 2  
##   cyl_fact  cyl  
##   <fct>    <dbl>  
## 1 6        6  
## 2 6        6  
## 3 4        4  
## 4 6        6  
## 5 8        8  
## 6 6        6  
## 7 8        8  
## 8 4        4  
## 9 4        4  
## 10 6       6  
## # ... with 22 more rows
```


As always, it is best to be explicit

If you do not specify the levels R will alphabetise and set the order accordingly

```
months <- factor(c("Jan", "Feb", "Mar"))
```

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If you do not specify the levels R will alphabetise and set the order accordingly

```
months <- factor(c("Jan", "Feb", "Mar"))
```

```
months
```

```
## [1] Jan Feb Mar  
## Levels: Feb Jan Mar
```

Levels vs Labels, huh?

levels are the numeric representation of a factor

labels are the pretty name that it is given

Levels vs Labels, huh?

Levels are the numeric representation of a factor

Labels are the pretty name that it is given

Practically

Labels are nice for printing

Levels are for ordering and doing math

A Practical use case

Likert Scale

```
likert_agree <- c("Strongly Disagree", "Disagree", "Neither Agree/ Nor Disagree", "Agree", "Strongly Agree")
```

A Practical use case

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likert_agree <- c("Strongly Disagree", "Disagree", "Neither Agree/ Nor Disagree", "Agree", "Strongly Agree")
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We have some data

```
response_group <- data_frame(response = c(1, 2, 3, 4, 4, 4, 2, 3, 4))
```

A Practical use case

Likert Scale

```
likert_agree <- c("Strongly Disagree", "Disagree", "Neither Agree/ Nor Disagree", "Agree", "Strongly Agree")
```

We have some data

```
response_group <- data_frame(response = c(1, 2, 3, 4, 4, 4, 2, 3, 4))
```

And we want to do some analysis

```
mean(response_group$response)
```

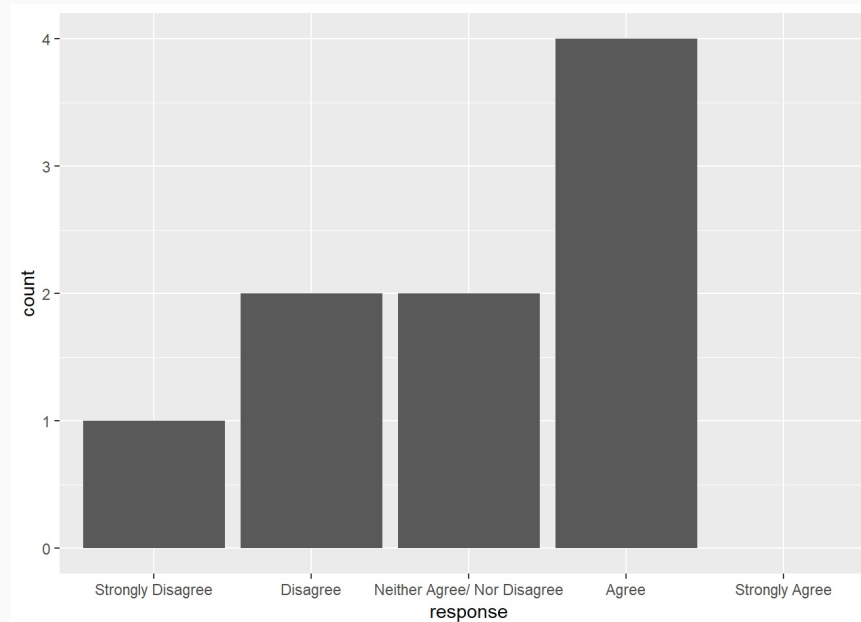
```
## [1] 3
```

A Practical Use Case

```
response_group %>%  
  mutate(response = factor(response,  
                             likert_agree,  
                             levels = 1:5)) %>%  
  count(response)
```

```
## # A tibble: 4 x 2  
##   response      n  
##   <fct>      <int>  
## 1 Strongly Disagree      1  
## 2 Disagree              2  
## 3 Neither Agree/ Nor Disagree 2  
## 4 Agree                4
```

```
ggplot(response_group, aes(response)) +  
  geom_bar() +  
  scale_x_discrete(drop = FALSE)
```



So how do we fix the defaults?

Enter the forcats package

- Tidyverse package¹
- (almost) All functions begin with the `fct_` prefix
- Designed to help make working with factors easier²

[1] Package Page [here](#)

[2] More details in Hadley Wickham's *R for Data Science* [here](#)

A Practical Example

An Extract from the [General Social Survey](#) is provided in `forcats`

```
gss_cat
```

```
## # A tibble: 21,483 x 9
##   year marital    age race rincome partyid  relig  denom  tvhours
##   <int> <fct>    <int> <fct> <fct>    <fct>   <fct> <fct>    <int>
## 1  2000 Never ma~   26 white $8000 to~ Ind,near~ Protes~ Southe~    12
## 2  2000 Divorced   48 white $8000 to~ Not str ~ Protes~ Baptis~    NA
## 3  2000 widowed    67 white Not appl~ Independ~ Protes~ No den~     2
## 4  2000 Never ma~   39 white Not appl~ Ind,near~ Orthod~ Not ap~     4
## 5  2000 Divorced   25 white Not appl~ Not str ~ None    Not ap~     1
## 6  2000 Married    25 white $20000 ~ Strong d~ Protes~ Southe~    NA
## 7  2000 Never ma~   36 white $25000 o~ Not str ~ Christ~ Not ap~     3
## 8  2000 Divorced   44 white $7000 to~ Ind,near~ Protes~ Luther~    NA
## 9  2000 Married    44 white $25000 o~ Not str ~ Protes~ Other     0
## 10 2000 Married    47 white $25000 o~ Strong r~ Protes~ Southe~     3
## # ... with 21,473 more rows
```

Let's take a peak

```
glimpse(gss_cat)
```

```
## Observations: 21,483
## Variables: 9
## $ year      <int> 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, ...
## $ marital   <fct> Never married, Divorced, widowed, Never married, Divor...
## $ age       <int> 26, 48, 67, 39, 25, 25, 36, 44, 44, 47, 53, 52, 52, 51...
## $ race      <fct> white, white, white, white, white, white, white, white, white...
## $ rincome   <fct> $8000 to 9999, $8000 to 9999, Not applicable, Not appl...
## $ partyid   <fct> Ind,near rep, Not str republican, Independent, Ind,nea...
## $ relig     <fct> Protestant, Protestant, Protestant, Orthodox-christian...
## $ denom     <fct> Southern baptist, Baptist-dk which, No denomination, N...
## $ tvhours   <int> 12, NA, 2, 4, 1, NA, 3, NA, 0, 3, 2, NA, 1, NA, 1, 7, ...
```

Let's Examine the Religion Section A Little Closer

```
gss_cat %>%  
  count(relig)
```

```
## # A tibble: 15 x 2  
##   relig          n  
##   <fct>        <int>  
## 1 No answer      93  
## 2 Don't know     15  
## 3 Inter-nondenominational 109  
## 4 Native american    23  
## 5 Christian      689  
## 6 Orthodox-christian   95  
## 7 Moslem/islam     104  
## 8 Other eastern     32  
## 9 Hinduism         71  
## 10 Buddhism        147  
## 11 Other           224  
## 12 None           3523  
## 13 Jewish          388  
## 14 Catholic       5124  
## 15 Protestant    10846
```

Enter forcats for aggregation

`fct_lump` will help us by grouping infrequent groups of our specification together

```
gss_cat %>%  
  mutate(relig = fct_lump(relig, n = 4)) %>%  
  count(relig)
```

```
## # A tibble: 5 x 2  
##   relig      n  
##   <fct>    <int>  
## 1 Christian    689  
## 2 None       3523  
## 3 Catholic    5124  
## 4 Protestant 10846  
## 5 Other      1301
```

`fct_other` will replace non-specified with others

```
gss_cat %>%  
  mutate(relig = fct_other(relig,  
                           keep = c("Christian", "Moslem/i  
  count(relig)
```

```
## # A tibble: 4 x 2  
##   relig      n  
##   <fct>    <int>  
## 1 Christian    689  
## 2 Moslem/islam  104  
## 3 Jewish      388  
## 4 other      20302
```

Some additional functions

`fct_collapse` can be used when you want to collapse a specific factor together

```
gss_cat %>%  
  count(partyid)
```

```
## # A tibble: 10 x 2  
##   partyid      n  
##   <fct>      <int>  
## 1 No answer    154  
## 2 Don't know     1  
## 3 Other party   393  
## 4 Strong republican 2314  
## 5 Not str republican 3032  
## 6 Ind,near rep  1791  
## 7 Independent  4119  
## 8 Ind,near dem  2499  
## 9 Not str democrat 3690  
## 10 Strong democrat 3490
```

```
gss_cat %>%  
  mutate(party_id_rd = fct_collapse(partyid,  
    Rep = c("Strong republican", "Not str republican"),  
    Dem = c("Strong democrat", "Not str democrat"),  
    Ind = c("Ind,near rep", "Independent", "Ind,near dem"))  
  count(party_id_rd)
```

```
## # A tibble: 6 x 2  
##   party_id_rd      n  
##   <fct>      <int>  
## 1 No answer    154  
## 2 Don't know     1  
## 3 Other party   393  
## 4 Rep          5346  
## 5 Ind          8409  
## 6 Dem          7180
```

We can also recode the levels completely

`fct_recode` will allow us to recode based on our own wishes

Syntax

```
data %>%  
  mutate( x = fct_recode(x,  
                        "New name1" = "Old Name1",  
                        "New name2" = "Old Name2"))
```

Example

```
gss_cat %>%  
  mutate( rincome = fct_recode(rincome,  
                              "Too much to say" = "Refused",  
                              "None" = "Not applicable")) %>%  
  select(rincome)
```

```
## # A tibble: 21,483 x 1  
##   rincome  
##   <fct>  
## 1 $8000 to 9999  
## 2 $8000 to 9999  
## 3 None  
## 4 None  
## 5 None  
## 6 $20000 - 24999  
## 7 $25000 or more  
## 8 $7000 to 7999  
## 9 $25000 or more  
## 10 $25000 or more  
## # ... with 21,473 more rows
```


Sometimes we want to change the ordering of factors

`fct_relevel` Reset the factor orders

`fct_inorder` Orders based on appearance in the data

`fct_infreq` Orders from most common to least common

`fct_rev` Reverses the orders of the levels

True Motivating Need

Modeling and analysis!!!

True Motivating Need

Modeling and analysis!!!

Analysis of Variance for Example...

```
aov(tvhours ~ rincome, data = gss_cat) %>%  
  summary()
```

```
##              Df Sum Sq Mean Sq F value Pr(>F)  
## rincome      15   4876    325.1    51.83 <2e-16 ***  
## Residuals 11321  71000     6.3  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
## 10146 observations deleted due to missingness
```

One Note

If you create a factor and you specify a value that is not in the levels you will get an NA silently!

```
my_vector <- c("Yes", "No", "Maybe")  
factor(my_vector, c("Yes", "No"))
```

```
## [1] Yes  No   <NA>  
## Levels: Yes No
```

One Note

If you create a factor and you specify a value that is not in the levels you will get an NA silently!

```
my_vector <- c("Yes", "No", "Maybe")  
factor(my_vector, c("Yes", "No"))
```

```
## [1] Yes No <NA>  
## Levels: Yes No
```

If you use `forcats::parse_factor` you will be passed an NA

```
parse_factor(my_vector, c("Yes", "No"))
```

```
## Warning: 1 parsing failure.  
## row # A tibble: 1 x 4 col      row    col expected      actual expected  <int> <int> <chr>          <chr> actual  
<-----> <-----> <-----> <-----> <-----> <-----> <-----> <-----> <-----> <----->  
## [1] Yes No <NA>  
## attr(,"problems")  
## # A tibble: 1 x 4  
##   row    col expected      actual  
##   <int> <int> <chr>      <chr>  
## 1      3 NA value in level set Maybe  
## Levels: Yes No
```

Aside History of Factors

R developed as a statistical computing environment

Statisticians do experiments (often in blocks)

Factors make sense in this context

Additionally, it saved memory because factors could be represented with numbers rather than characters

Recap

Factors are useful for

- Summarising Categorical Data
- Representing Categorical Data in Analysis
- Organising Graphs
- `forcats` provides a tidyverse approach to factors

Now let's code