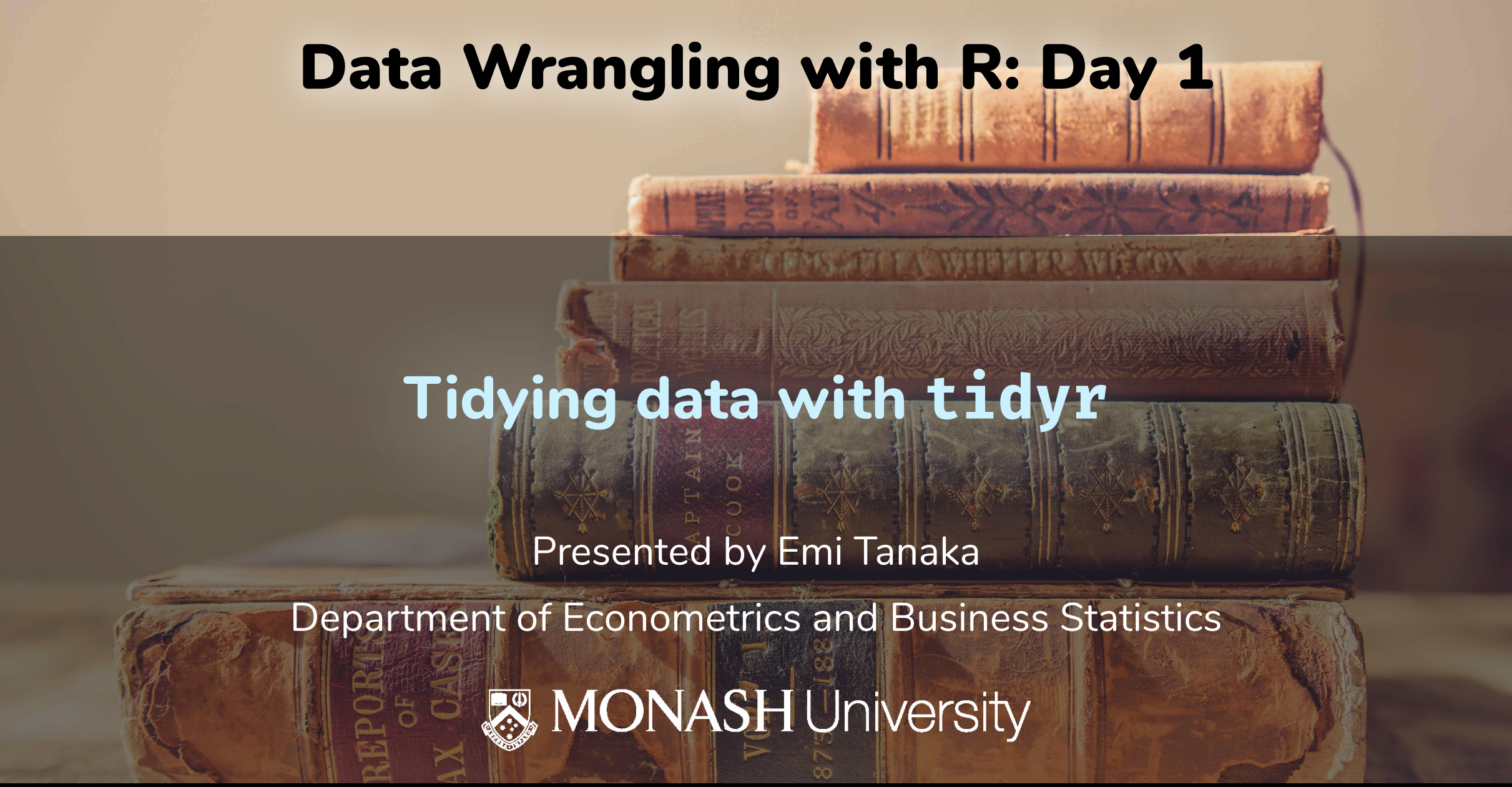
Data Wrangling with R: Day 1



Tidying data with `tidyr`

Presented by Emi Tanaka

Department of Econometrics and Business Statistics

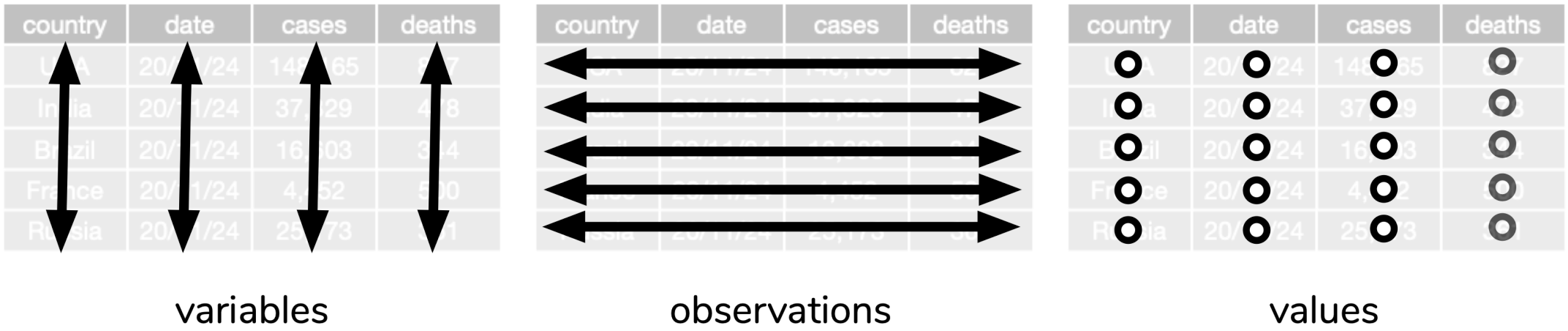
MONASH University

1st December 2020 @ Statistical Society of Australia | Zoom

Recall tidy data

Definition of a tidy data

- Each variable must have its own column
- Each observation must have its own row
- Each value must have its own cell



Is this tidy data? Part 1

Estimated residential population in December

state	2019	2018	2017
NSW	8130159	80366651	7919815
VIC	6655284	6528601	6387081
ACT	427892	423169	415874

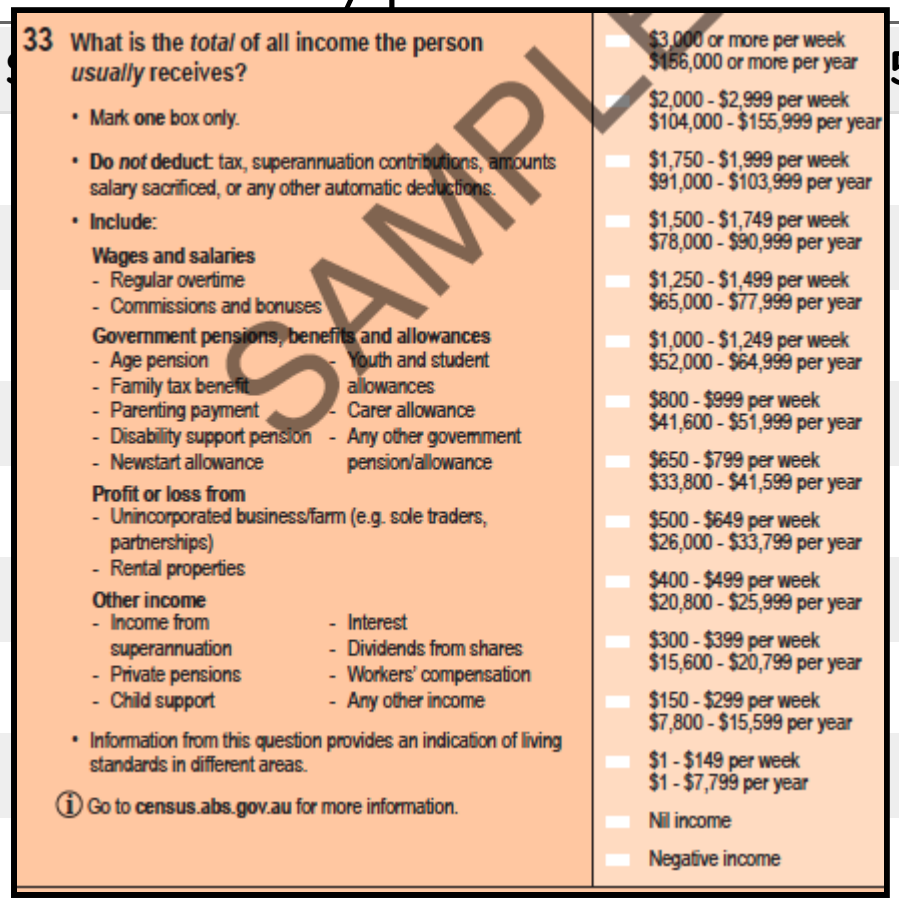
Estimated residential population in December

state	year	population
NSW	2019	8130159
NSW	2018	80366651
NSW	2017	7919815
VIC	2019	6655284
VIC	2018	6528601
VIC	2017	6387081
ACT	2019	427892
ACT	2018	423169
ACT	2017	415874

Values adapted from Australian Bureau of Statistics. (2020). Table 04. Estimated Resident Population, States and Territories [Time series spreadsheet]. National, state and territory population, Australia Mar 2020. Retrieved Nov 24, 2020. https://www.abs.gov.au/statistics/people/population/national-state-and-territory-population/mar-2020/310104.xls

Is this tidy data? Part 2

Total weekly personal income by age and sex from ABS 2016 Census



33 What is the *total* of all income the person *usually* receives?

- Mark **one** box only.
- **Do *not* deduct:** tax, superannuation contributions, amounts salary sacrificed, or any other automatic deductions.
- **Include:**

Wages and salaries
- Regular overtime
- Commissions and bonuses

Government pensions, benefits and allowances
- Age pension
- Family tax benefit
- Parenting payment
- Disability support pension
- Newstart allowance
- Youth and student allowances
- Carer allowance
- Any other government pension/allowance

Profit or loss from
- Unincorporated business/farm (e.g. sole traders, partnerships)
- Rental properties

Other income
- Income from superannuation
- Private pensions
- Child support
- Interest
- Dividends from shares
- Workers' compensation
- Any other income

- Information from this question provides an indication of living standards in different areas.

ⓘ Go to **census.abs.gov.au** for more information.

- $3,000 or more per week $156,000 or more per year
- $2,000 - $2,999 per week $104,000 - $155,999 per year
- $1,750 - $1,999 per week $91,000 - $103,999 per year
- $1,500 - $1,749 per week $78,000 - $90,999 per year
- $1,250 - $1,499 per week $65,000 - $77,999 per year
- $1,000 - $1,249 per week $52,000 - $64,999 per year
- $800 - $999 per week $41,600 - $51,999 per year
- $650 - $799 per week $33,800 - $41,599 per year
- $500 - $649 per week $26,000 - $33,799 per year
- $400 - $499 per week $20,800 - $25,999 per year
- $300 - $399 per week $15,600 - $20,799 per year
- $150 - $299 per week $7,800 - $15,599 per year
- $1 - $149 per week $1 - $7,799 per year
- Nil income
- Negative income

…	M_Neg_Nil_income_15_19_yrs	M_Neg_Nil_income_20_24_yrs	M_Neg_Nil_income_25_34_
…	109473	33797	253
…	88338	31685	213
…	63756	15815	8
…	24566	7007	7
…	36101	9806	7
…	7040	1320	9
…	2669	550	5
…	5515	2251	2
…			
…			
9	37	3	

STE Code

code	name
1	New South Wales
2	Victoria
3	Queensland
4	South Australia
5	Western Australia
6	Tasmania
7	Northern Territory
8	Australian Capital Territory
9	Other Territories

Is this tidy data? Part 3

Total weekly personal income by age and sex

state	group	count
New South Wales	M_Neg_Nil_income_15_19_yrs	109473
New South Wales	M_Neg_Nil_income_20_24_yrs	33797
New South Wales	M_Neg_Nil_income_25_34_yrs	25398
New South Wales	M_Neg_Nil_income_35_44_yrs	14472
New South Wales	M_Neg_Nil_income_45_54_yrs	15235
New South Wales	M_Neg_Nil_income_55_64_yrs	22736
New South Wales	M_Neg_Nil_income_65_74_yrs	15465
New South Wales	M_Neg_Nil_income_75_84_yrs	6576
New South Wales	M_Negtve_Nil_incme_85_yrs_ovr	2320
New South Wales	M_Neg_Nil_income_Tot	245480

Is this tidy data? Part 4

Total weekly personal income by age and sex

state	sex	income_min	income_max	age_min	age_max	count
New South Wales	M	-Inf	0	15	19	109473
New South Wales	M	-Inf	0	20	24	33797
New South Wales	M	-Inf	0	25	34	25398
New South Wales	M	-Inf	0	35	44	14472
New South Wales	M	-Inf	0	45	54	15235
New South Wales	M	-Inf	0	55	64	22736
New South Wales	M	-Inf	0	65	74	15465
New South Wales	M	-Inf	0	75	84	6576
New South Wales	M	-Inf	0	85	Inf	2320
New South Wales	M	1	149	15	19	41865

Is this tidy data? Part 5

U.S. historical crop yields by state

year	state	crop	yield
1900	Iowa	barley	28.5
1900	Kansas	barley	18.0
2000	Kansas	barley	35.0
1900	Iowa	wheat	14.4
1900	Kansas	wheat	18.2
2000	Iowa	wheat	47.0
2000	Kansas	wheat	37.0

U.S. historical crop yields by state

year	state	barley_yield	wheat_yield
1900	Iowa	28.5	14.4
1900	Kansas	18.0	18.2
2000	Kansas	35.0	37.0
2000	Iowa	NA	47.0

United States Department of Agriculture, National Agricultural Statistics Service. http://quickstats.nass.usda.gov/

Kevin Wright (2020). agridat: Agricultural Datasets. R package version 1.17

Is this tidy data? Part 6

U.S. historical crop yields by state

year	state	crop	metric	value
1900	Iowa	barley	yield	2.85e+01
1900	Iowa	barley	acres	6.20e+05
1900	Kansas	barley	yield	1.80e+01
1900	Kansas	barley	acres	1.27e+05
2000	Kansas	barley	yield	3.50e+01
2000	Kansas	barley	acres	7.00e+03
1900	Iowa	wheat	yield	1.44e+01
1900	Iowa	wheat	acres	1.45e+06
1900	Kansas	wheat	yield	1.82e+01
1900	Kansas	wheat	acres	4.29e+06

U.S. historical crop yields by state

year	state	barley_yield	wheat_yield	barley_acres	wheat_acres
1900	Iowa	28.5	14.4	620000	1450000
1900	Kansas	18.0	18.2	127000	4290000
2000	Kansas	35.0	37.0	7000	9400000
2000	Iowa	NA	47.0	NA	18000

year	state	crop	yield	acres
1900	Iowa	barley	28.5	620000
1900	Kansas	barley	18.0	127000
2000	Kansas	barley	35.0	7000
1900	Iowa	wheat	14.4	1450000
1900	Kansas	wheat	18.2	4290000
2000	Iowa	wheat	47.0	18000
2000	Kansas	wheat	37.0	9400000

United States Department of Agriculture, National Agricultural Statistics Service. http://quicksta

Kevin Wright (2020). agridat: Agricultural Datasets. R package version 1.17

Some signs of non-tidy data

1. Header has meaningful information

2. Cells have multiple values

Wide and long data formats

`wide`

id	x	y	z
1	a	c	e
2	b	d	f

`long`

id	key	val
1	x	a
2	x	b
1	y	c
2	y	d
1	z	e
2	z	f

- Transforming data from wide to long or vice versa is referred to as **pivotting**
- Sometimes the long form is referred to as **molten data**
- Some people may refer to transforming data from wide to long as **melting** the data and vice-versa as **casting**

Picture credit: Garrick Aden-Buie

Evolving language

- Earlier efforts to transform data from wide to long was in the `reshape`, first released on CRAN in 2005-08-05
- It was then superseded by `reshape2` released on CRAN in 2010-09-10
- Then finally `tidyr` released on CRAN in 2014-07-21 *v1.0.0 released 2019-09-12

Wide to long

- `reshape::melt` lifecycle retired
- `reshape2::melt` lifecycle retired
- `tidyr::gather` lifecycle retired
- **`tidyr::pivot_longer`***

Long to wide

- `reshape::cast` lifecycle retired
- `reshape2::dcast` lifecycle retired
- `tidyr::spread` lifecycle retired
- **`tidyr::pivot_wider`***

Hadley Wickham (2020). tidyr: Tidy Messy Data. R package version 1.1.2.

Hadley Wickham (2007). Reshaping Data with the reshape Package. Journal of Statistical Software, 21(12), 1-20

Pivotting data with `tidyr` Part 1

df_wide

state	2019	2018	2017
NSW	8130159	80366651	7919815
VIC	6655284	6528601	6387081
ACT	427892	423169	415874

```
pivot_longer(df_wide, cols = `2019`:`2017`,
             names_to = "year",
             values_to = "population")

pivot_wider(df_long, id_cols = state,
            names_from = year,
            values_from = population)
```

df_long

state	year	population
NSW	2019	8130159
NSW	2018	80366651
NSW	2017	7919815
VIC	2019	6655284
VIC	2018	6528601
VIC	2017	6387081
ACT	2019	427892
ACT	2018	423169
ACT	2017	415874

Values adapted from Australian Bureau of Statistics. (2020). Table 04. Estimated Resident Population, States and Territories [Time series spreadsheet]. National, state and territory population, Australia Mar 2020. Retrieved Nov 24, 2020. https://www.abs.gov.au/statistics/people/population/national-state-and-territory-population/mar-2020/310104.xls

Pivotting data with tidyr Part 2

table

```
data(census_2016_G17, package = "dwexercise")
```

wide format

```
as_tibble(census_2016_G17)
```

```
## # A tibble: 9 x 481
##   STE_CODE_2016 M_Neg_Nil_incom… M_Ne
##           <int>            <int>
## 1             1           109473
## 2             2            88338
## 3             3            63756
## 4             4            24566
## 5             5            36101
## 6             6             7040
## 7             7             2669
## 8             8             5515
```

long format

```
pivot_longer(census_2016_G17,
             cols = -STE_CODE_2016,
             names_to = "group",
             values_to = "count")
```

```
## # A tibble: 4,320 x 3
##    STE_CODE_2016 group
##            <int> <chr>
##  1             1 M_Neg_Nil_income_1
##  2             1 M_Neg_Nil_income_2
##  3             1 M_Neg_Nil_income_2
##  4             1 M_Neg_Nil_income_3
##  5             1 M_Neg_Nil_income_4
```

Pivotting data with `tidyr` Part 3

yield_long

year	state	crop	yield
1900	Iowa	barley	28.5
1900	Kansas	barley	18.0
2000	Kansas	barley	35.0
1900	Iowa	wheat	14.4
1900	Kansas	wheat	18.2
2000	Iowa	wheat	47.0
2000	Kansas	wheat	37.0

yield_wide

year	state	barley_yield	wheat_yield
1900	Iowa	28.5	14.4
1900	Kansas	18.0	18.2
2000	Kansas	35.0	37.0
2000	Iowa	NA	47.0

yield_long → yield_wide

```
pivot_wider(yield_long,
            id_cols = c(year, state),
            names_from = crop,
            values_from = yield,
            names_glue = "{crop}_yield")
```

United States Department of Agriculture, National Agricultural Statistics Service. http://quickstats.nass.usda.gov/

Kevin Wright (2020). agridat: Agricultural Datasets. R package version 1.17

Pivotting data with `tidyr` Part 4

yield_long

year	state	crop	yield
1900	Iowa	barley	28.5
1900	Kansas	barley	18.0
2000	Kansas	barley	35.0
1900	Iowa	wheat	14.4
1900	Kansas	wheat	18.2
2000	Iowa	wheat	47.0
2000	Kansas	wheat	37.0

yield_wide

year	state	barley_yield	wheat_yield
1900	Iowa	28.5	14.4
1900	Kansas	18.0	18.2
2000	Kansas	35.0	37.0
2000	Iowa	NA	47.0

yield_wide → yield_long

```
pivot_longer(yield_wide,
             cols = contains("yield"),
             names_to = "crop",
             names_pattern = "(.+)_yield",
             values_to = "yield",
             values_drop_na = TRUE)
```

United States Department of Agriculture, National Agricultural Statistics Service. http://quickstats.nass.usda.gov/

Kevin Wright (2020). agridat: Agricultural Datasets. R package version 1.17

Pivotting data with tidyr Part 5

crop_long

year	state	crop	metric	value
1900	Iowa	barley	yield	2.85e+01
1900	Iowa	barley	acres	6.20e+05
1900	Kansas	barley	yield	1.80e+01
1900	Kansas	barley	acres	1.27e+05
2000	Kansas	barley	yield	3.50e+01
2000	Kansas	barley	acres	7.00e+03
1900	Iowa	wheat	yield	1.44e+01
1900	Iowa	wheat	acres	1.45e+06
1900	Kansas	wheat	yield	1.82e+01
1900	Kansas	wheat	acres	4.29e+06

crop_wide

year	state	barley_yield	wheat_yield	barley_acres	wheat_acres
1900	Iowa	28.5	14.4	620000	1450000
1900	Kansas	18.0	18.2	127000	4290000
2000	Kansas	35.0	37.0	7000	9400000
2000	Iowa	NA	47.0	NA	18000

crop_long → crop_wide

```
pivot_wider(crop_long,
            names_from = c(crop, metric),
            values_from = value,
            names_glue = "{crop}_{metric}")
```

United States Department of Agriculture, National Agricultural Statistics Service. http://quickstats.nass.usda.gov/

Kevin Wright (2020). agridat: Agricultural Datasets. R package version 1.17

Pivotting data with `tidyr` Part 6

crop_long

year	state	crop	metric	value
1900	Iowa	barley	yield	2.85e+01
1900	Iowa	barley	acres	6.20e+05
1900	Kansas	barley	yield	1.80e+01
1900	Kansas	barley	acres	1.27e+05
2000	Kansas	barley	yield	3.50e+01
2000	Kansas	barley	acres	7.00e+03
1900	Iowa	wheat	yield	1.44e+01
1900	Iowa	wheat	acres	1.45e+06
1900	Kansas	wheat	yield	1.82e+01
1900	Kansas	wheat	acres	4.29e+06

crop_wide

year	state	barley_yield	wheat_yield	barley_acres	wheat_acres
1900	Iowa	28.5	14.4	620000	1450000
1900	Kansas	18.0	18.2	127000	4290000
2000	Kansas	35.0	37.0	7000	9400000
2000	Iowa	NA	47.0	NA	18000

crop_wide → crop_long

```
pivot_longer(crop_wide,
             names_to = c("crop", "metric"),
             names_pattern = "(.+)_(.+)",
             values_to = "value")
```

United States Department of Agriculture, National Agricultural Statistics Service. http://quickstats.nass.usda.gov/

Kevin Wright (2020). agridat: Agricultural Datasets. R package version 1.17

Pivotting data with tidyr Part 7

table

STE_CODE_2016	M_Neg_Nil_income_15_19_yrs	M_Neg_Nil_income_20_24_yrs	M_Neg_Nil_income_25_34_
1	109473	33797	253

```
census_2016_G17 %>%
  pivot_longer(cols = -STE_CODE_2016,
               names_to = c("sex", "income_min", "income_max", "age_min", "age_ma
               names_pattern = "^([FM])_(\\d+|Neg_Nil|Negtve_Nil|PI)_(\\d+|more|i
               values_to = "count",
               names_transform = list(
                 income_min = function(x) case_when(str_detect(x, "Neg") ~ -Inf,
                                                    TRUE ~ as.num
                 income_max = function(x) case_when(x %in% c("income", "incme") ~
                                                    x %in% "more" ~
                                                    TRUE ~
                 age_min = as.numeric,
                 age_max = function(x) ifelse(x=="", Inf, as.numeric(x)))) %>%
```

Extract values into multiple columns

Alternatively, we could pivot all column names except STE_CODE_2016 to a single column as in `table` and then extract the values from cells

```
census_2016_G17 %>%
  pivot_longer(cols = -STE_CODE_2016,
               names_to = "group",
               values_to = "value") %>%
  filter(!str_detect(group, "Tot"),
         !str_starts(group, "P")) %>%
  extract(group,
          into = c("sex", "income_min", "income_max", "age_min", "age_max"),
          regex = "^([FM])_(\\d+|Neg_Nil|Negtve_Nil|PI)_(\\d+|more|income|incme|N
          remove = TRUE) %>%
  mutate(income_min = case_when(str_detect(income_min, "Neg") ~ -Inf,
                                TRUE ~ as.numeric(income
         income_max = case_when(income_max %in% c("income", "incme") ~ 0,
```

Separate values into columns

pkg_dat

package	maintainer
dplyr	Hadley Wickham
magrittr	Lionel Henry
rlang	Lionel Henry
RVerbalExpressions	Tyler Littlefield
stringr	Hadley Wickham
tibble	Kirill Müller
tidyr	Hadley Wickham
tidyselect	Lionel Henry

🎯 separate maintainer name to columns, first name and last name

```
pkg_dat %>%
  separate(maintainer,
           into = c("first_name", "last_name"),
           sep = " ")
```

```
## # A tibble: 8 x 3
##   package            first_name last_name
##   <chr>              <chr>      <chr>
## 1 dplyr              Hadley     Wickham
## 2 magrittr           Lionel     Henry
## 3 rlang              Lionel     Henry
## 4 RVerbalExpressions Tyler      Littlefield
## 5 stringr            Hadley     Wickham
## 6 tibble             Kirill     Müller
## 7 tidyr              Hadley     Wickham
## 8 tidyselect         Lionel     Henry
```

Separate values into rows

author_dat

package	author
dplyr	Hadley Wickham, Romain François, Lionel Henry, Kirill Müller
magrittr	Lionel Henry, Stefan Milton Bache, Hadley Wickham
rlang	Lionel Henry, Hadley Wickham
RVerbalExpressions	Tyler Littlefield
stringr	Hadley Wickham
tibble	Kirill Müller, Hadley Wickham
tidyr	Hadley Wickham
tidyselect	Lionel Henry, Hadley Wickham

```
author_dat %>%
  separate_rows(author, sep = ", ")
```

```
## # A tibble: 16 x 2
##    package            author
##    <chr>              <chr>
##  1 dplyr              Hadley Wickham
##  2 dplyr              Romain François
##  3 dplyr              Lionel Henry
##  4 dplyr              Kirill Müller
##  5 magrittr           Lionel Henry
##  6 magrittr           Stefan Milton Bache
##  7 magrittr           Hadley Wickham
##  8 rlang              Lionel Henry
##  9 rlang              Hadley Wickham
## 10 RVerbalExpressions Tyler Littlefield
## 11 stringr            Hadley Wickham
## 12 tibble             Kirill Müller
## 13 tibble             Hadley Wickham
## 14 tidyr              Hadley Wickham
## 15 tidyselect         Lionel Henry
## 16 tidyselect         Hadley Wickham
```

Session Information

```
devtools::session_info()
```

```
## ─ Session info ─────────────────────────────────────────────────────────────
##  setting  value
##  version  R version 4.0.1 (2020-06-06)
##  os       macOS Catalina 10.15.7
##  system   x86_64, darwin17.0
##  ui       RStudio
##  language (EN)
##  collate  en_AU.UTF-8
##  ctype    en_AU.UTF-8
##  tz       Australia/Melbourne
##  date     2020-11-26
##
## ─ Packages ─────────────────────────────────────────────────────────────────
##  package     * version    date       lib source
##  agridat     * 1.17       2020-08-03 [1] CRAN (R 4.0.2)
##  anicon        0.1.0      2020-06-21 [1] Github (emitanaka/anicon@0b756df)
```