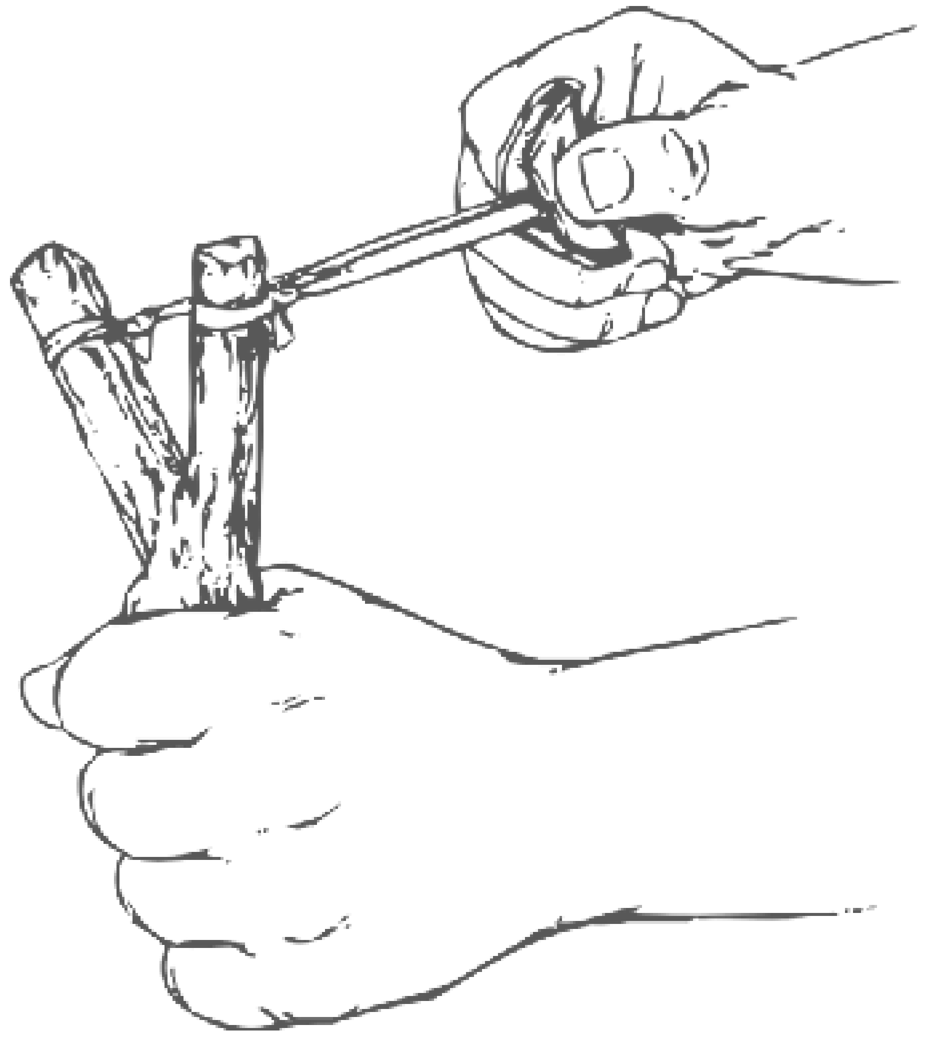
DATA ANALYSIS

DATA WRANGLING

LEARNING GOALS



- be able to read from and write data to files
- understand notion of tidy data
- be able to solve common problems of data preprocessing

DATA Input/Output

- use functions for readr package
- preferred data format is CSV (in this course)
- read data from file

```
fresh_raw_data <- read_csv("PATH/FILENAME_RAW_DATA.csv")
```

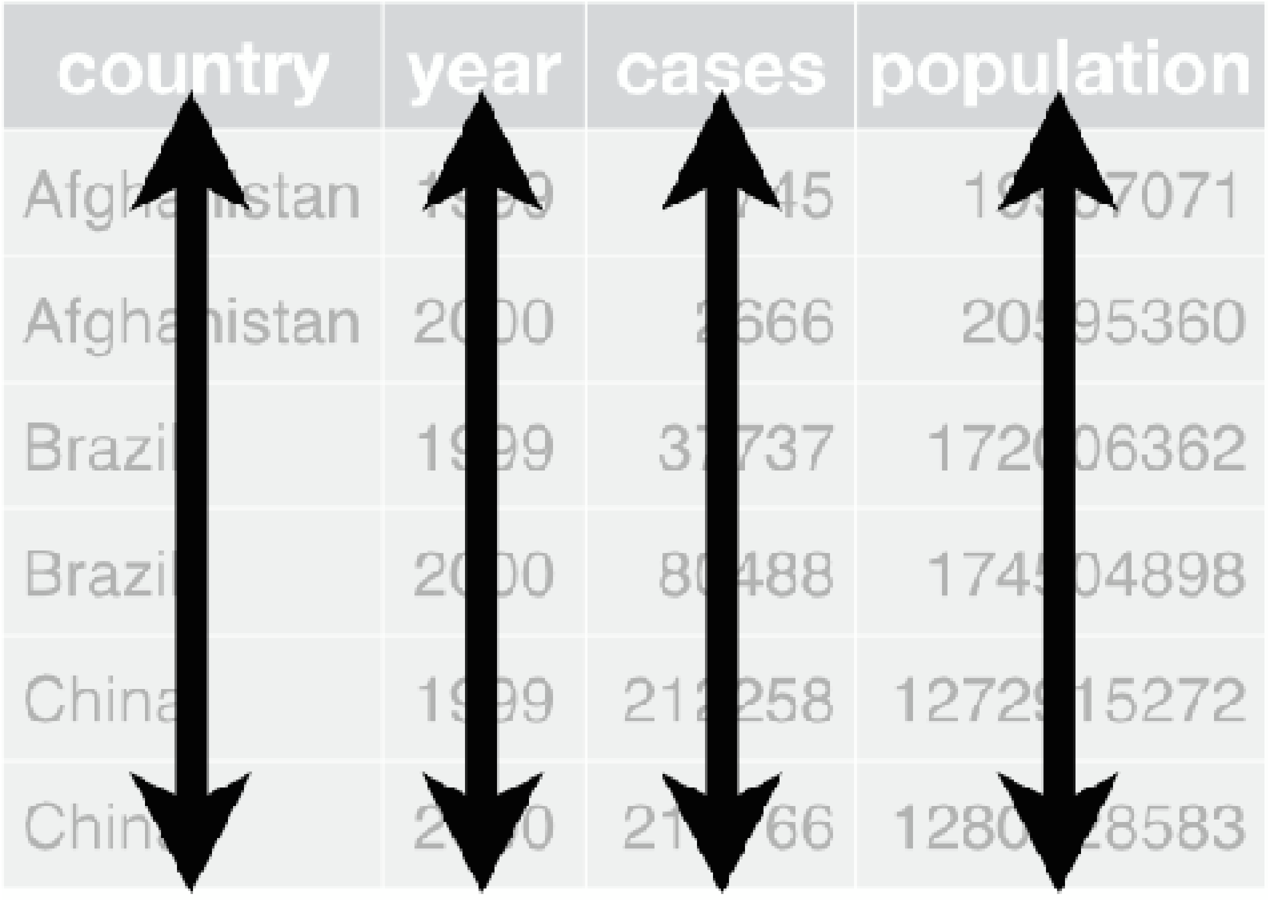
- write data to file

```
write_csv(processed_data, "PATH/FILENAME_PROCESSED_DATA.csv")
```

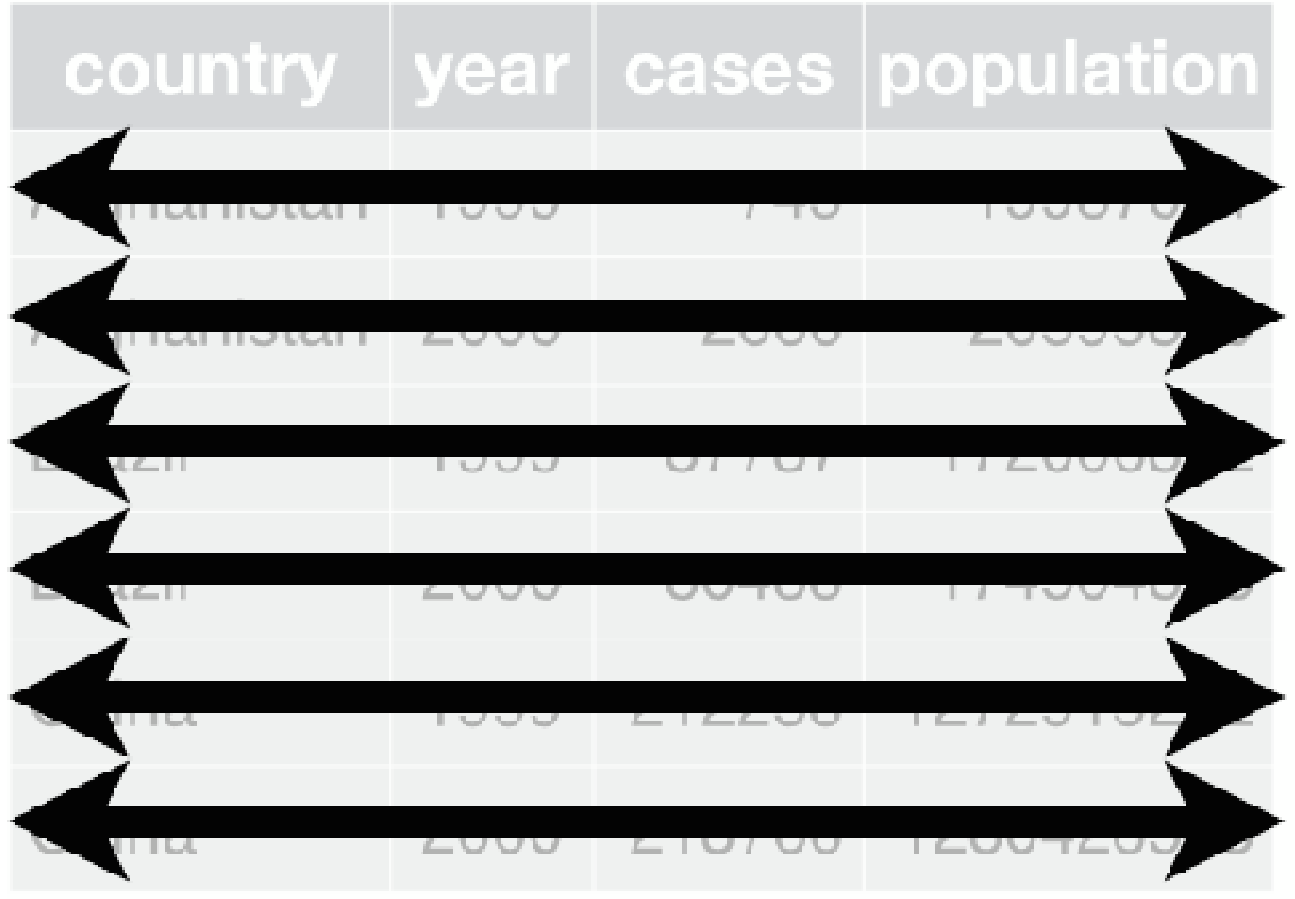
TIDY DATA

- data is tidy data if it satisfies three constraints:
  1. each variable forms a column
  2. each observation forms a row
  3. each type of observational unit forms a table

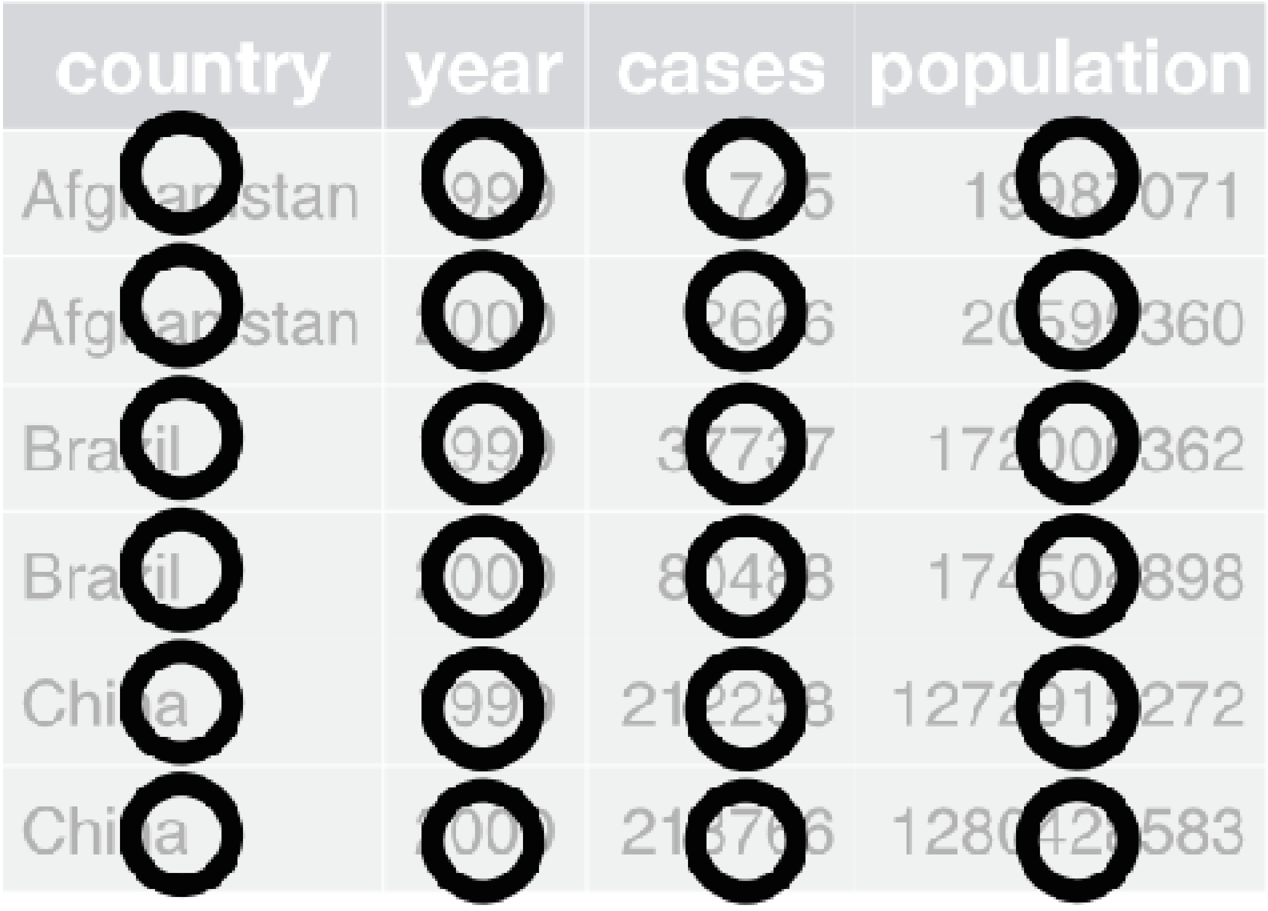
- data which is not tidy is messy
- data that satisfies 1 & 2 is almost tidy



variables



observations



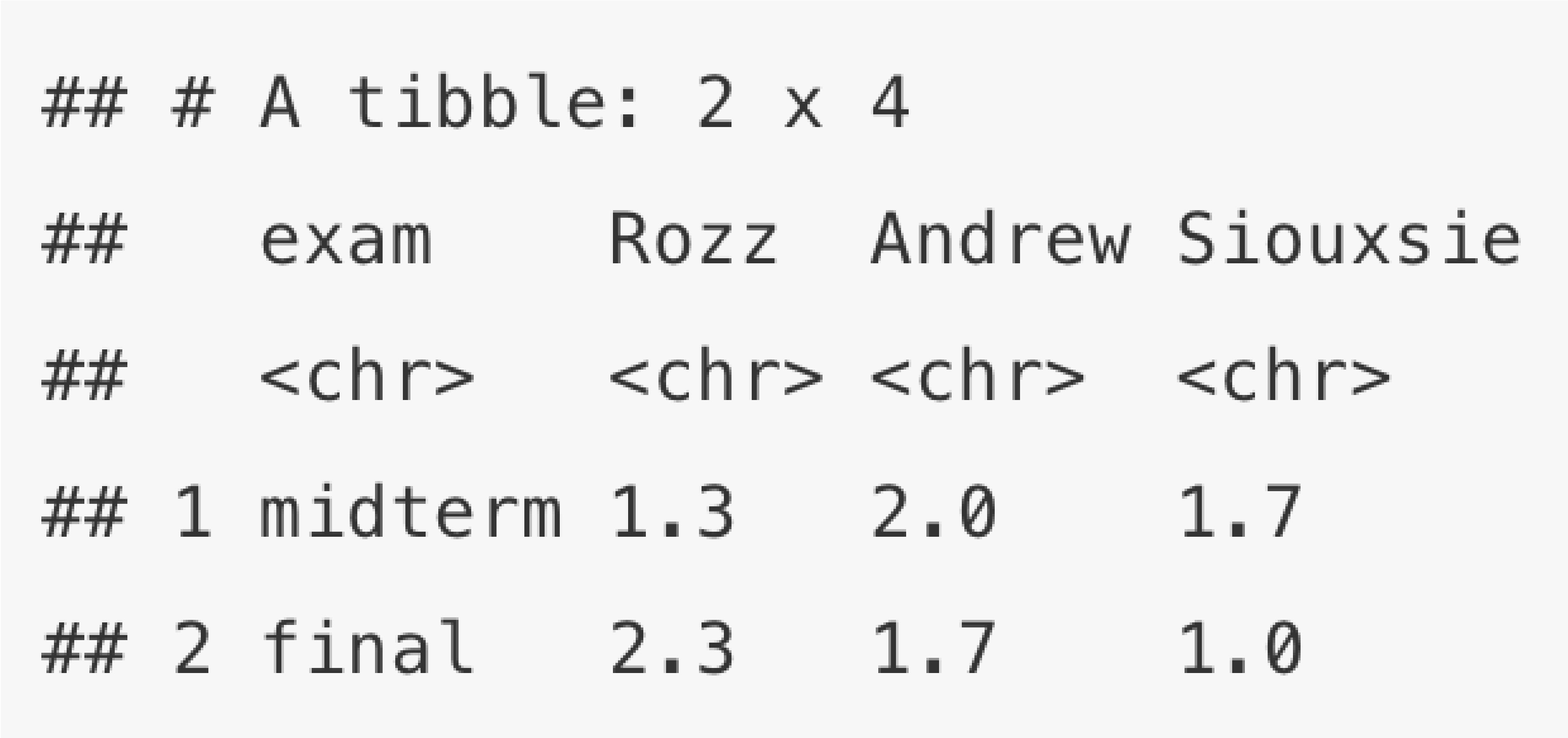
values

VISUALLY APPETIZING
BUT MESSY DATA

```r
exam_results_visual <- tribble(
  ~exam,       ~"Rozz",   ~"Andrew",   ~"Siouxsie",
  "midterm",   "1.3",     "2.0",       "1.7",
  "final"  ,   "2.3",     "1.7",       "1.0"
)
exam_results_visual
```

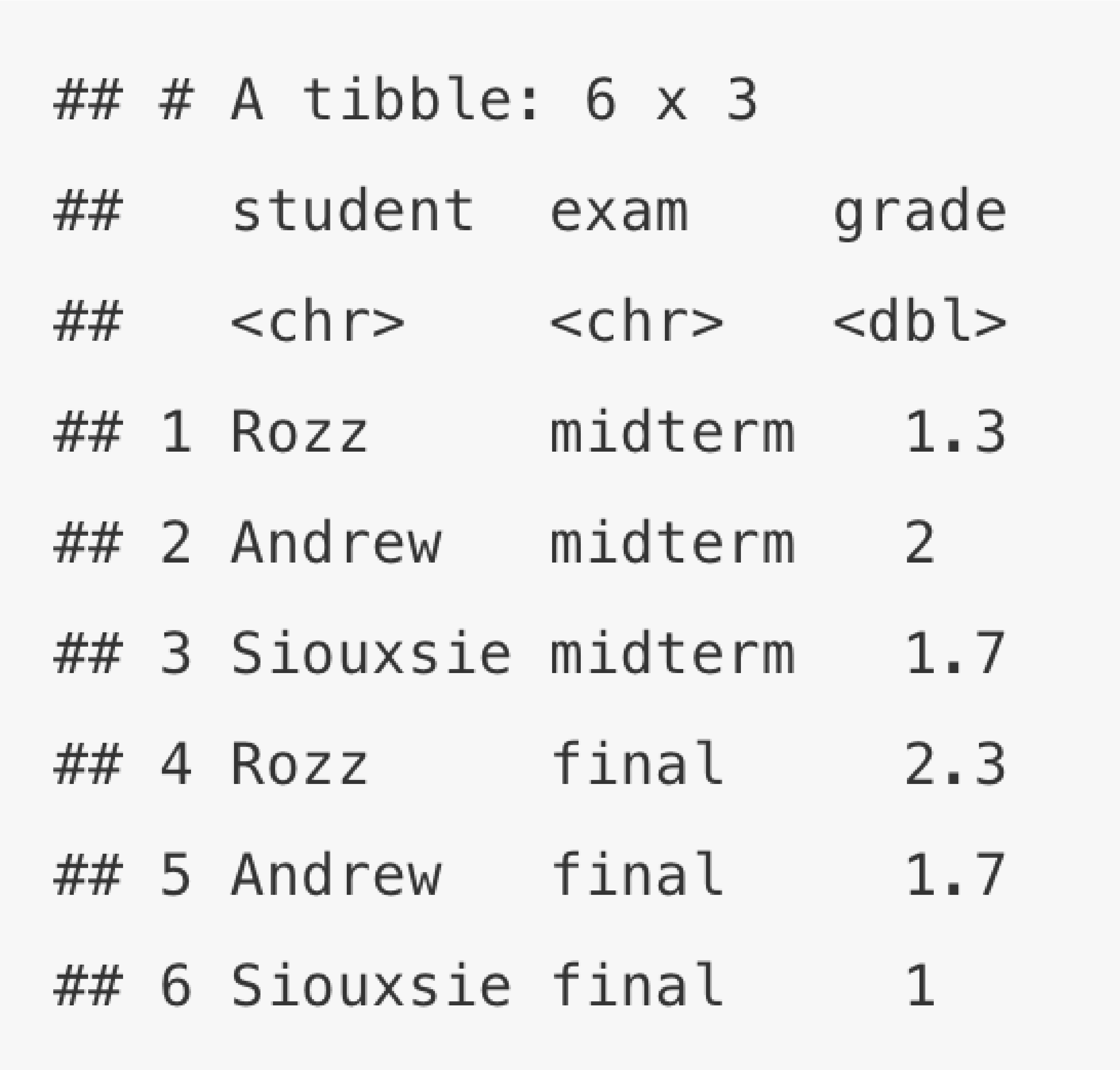
```
## # A tibble: 2 x 4
##   exam    Rozz  Andrew Siouxsie
##   <chr>   <chr> <chr>  <chr>
## 1 midterm 1.3   2.0    1.7
## 2 final   2.3   1.7    1.0
```

MESSY DATA



```
## # A tibble: 2 x 4
##   exam    Rozz  Andrew Siouxsie
##   <chr>   <chr> <chr>  <chr>
## 1 midterm 1.3   2.0    1.7
## 2 final   2.3   1.7    1.0
```

TIDY DATA



```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```

EXCURSION: MESSINESS FROM REDUNDANCY

```
## # A tibble: 6 x 4
##   student  stu_number exam    grade
##   <chr>    <chr>      <chr>   <dbl>
## 1 Rozz     666        midterm   1.3
## 2 Andrew   1969       midterm   2
## 3 Siouxsie 3.14       midterm   1.7
## 4 Rozz     666        final     2.3
## 5 Andrew   1969       final     1.7
## 6 Siouxsie 3.14       final     1
```

```
# same as before
exam_results_tidy <- tribble(
  ~student,    ~exam,      ~grade,
  "Rozz",      "midterm",  1.3,
  "Andrew",    "midterm",  2.0,
  "Siouxsie",  "midterm",  1.7,
  "Rozz",      "final",    2.3,
  "Andrew",    "final",    1.7,
  "Siouxsie",  "final",    1.0
)
# additional table with student numbers
student_numbers <- tribble(
  ~student,    ~student_number,
  "Rozz",      "666",
  "Andrew",    "1969",
  "Siouxsie",  "3.14"
)
```

```
full_join(exam_results_tidy, student_numbers, by = "student")
```

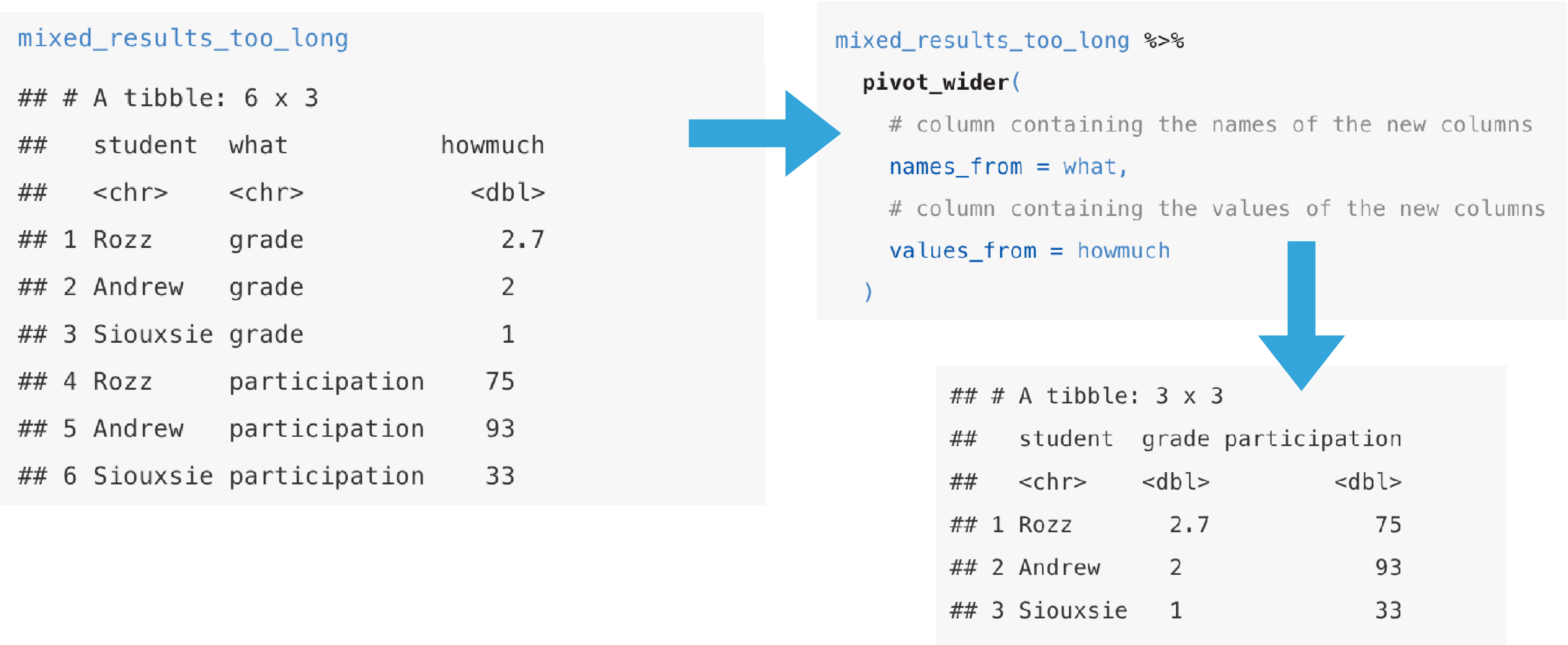
PIVOTING: LONGER

```
exam_results_visual <- tribble(
  ~exam,       ~"Rozz",   ~"Andrew",   ~"Siouxsie",
  "midterm",   "1.3",     "2.0",       "1.7",
  "final"   ,  "2.3",     "1.7",       "1.0"
)
```

```
exam_results_visual %>%
  pivot_longer(
    # pivot every column except the first
    cols = - 1,
    # name of new column which contains the
    # names of the columns to be "gathered"
    names_to = "student",
    # name of new column which contains the values
    # of the cells which now form a new column
    values_to = "grade"
  ) %>%
  # optional reordering of columns (to make
  # the output exactly like `exam_results_tidy`)
  select(student, exam, grade)
```

```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <chr>
## 1 Rozz     midterm 1.3
## 2 Andrew   midterm 2.0
## 3 Siouxsie midterm 1.7
## 4 Rozz     final   2.3
## 5 Andrew   final   1.7
## 6 Siouxsie final   1.0
```

PIVOTING: WIDER



```
mixed_results_too_long

## # A tibble: 6 x 3
##   student  what          howmuch
##   <chr>    <chr>           <dbl>
## 1 Rozz     grade             2.7
## 2 Andrew   grade             2
## 3 Siouxsie grade             1
## 4 Rozz     participation    75
## 5 Andrew   participation    93
## 6 Siouxsie participation    33
```

```
mixed_results_too_long %>%
  pivot_wider(
    # column containing the names of the new columns
    names_from = what,
    # column containing the values of the new columns
    values_from = howmuch
  )
```

```
## # A tibble: 3 x 3
##   student  grade participation
##   <chr>    <dbl>         <dbl>
## 1 Rozz       2.7            75
## 2 Andrew     2              93
## 3 Siouxsie   1              33
```

FILTERING ROWS

```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```

```
exam_results_tidy %>%
  # show only entries with grades better than 1.7
  filter(grade <= 1.7)
```

```
## # A tibble: 4 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Siouxsie midterm   1.7
## 3 Andrew   final     1.7
## 4 Siouxsie final     1
```

SELECTING COLUMNS

```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```

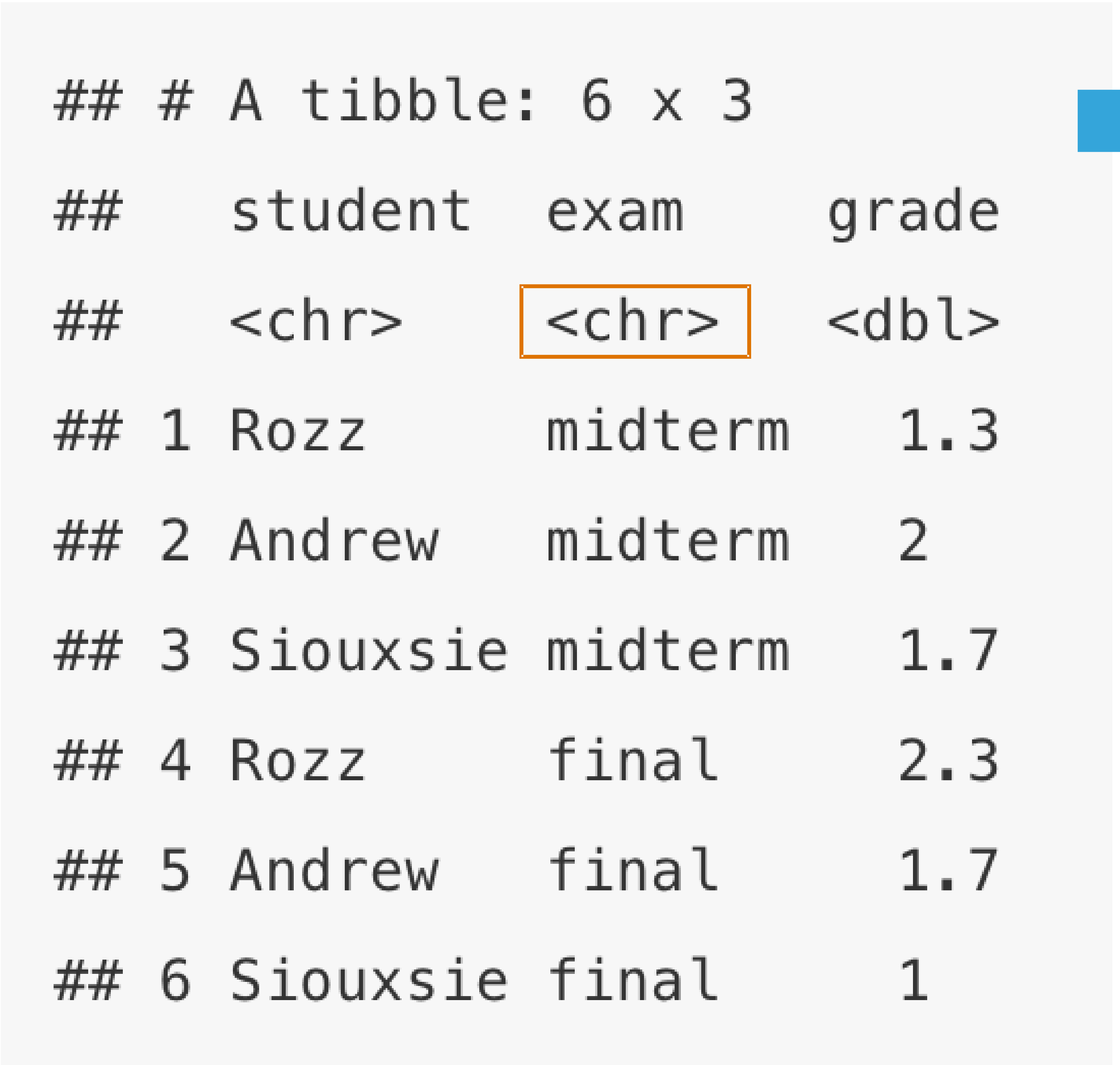
```
exam_results_tidy %>%
  select(grade, exam)

## # A tibble: 6 x 2
##   grade exam
##   <dbl> <chr>
## 1   1.3 midterm
## 2   2   midterm
## 3   1.7 midterm
## 4   2.3 final
## 5   1.7 final
## 6   1   final
```

TIDY SPECIFICATION OF COLUMNS TO SELECT

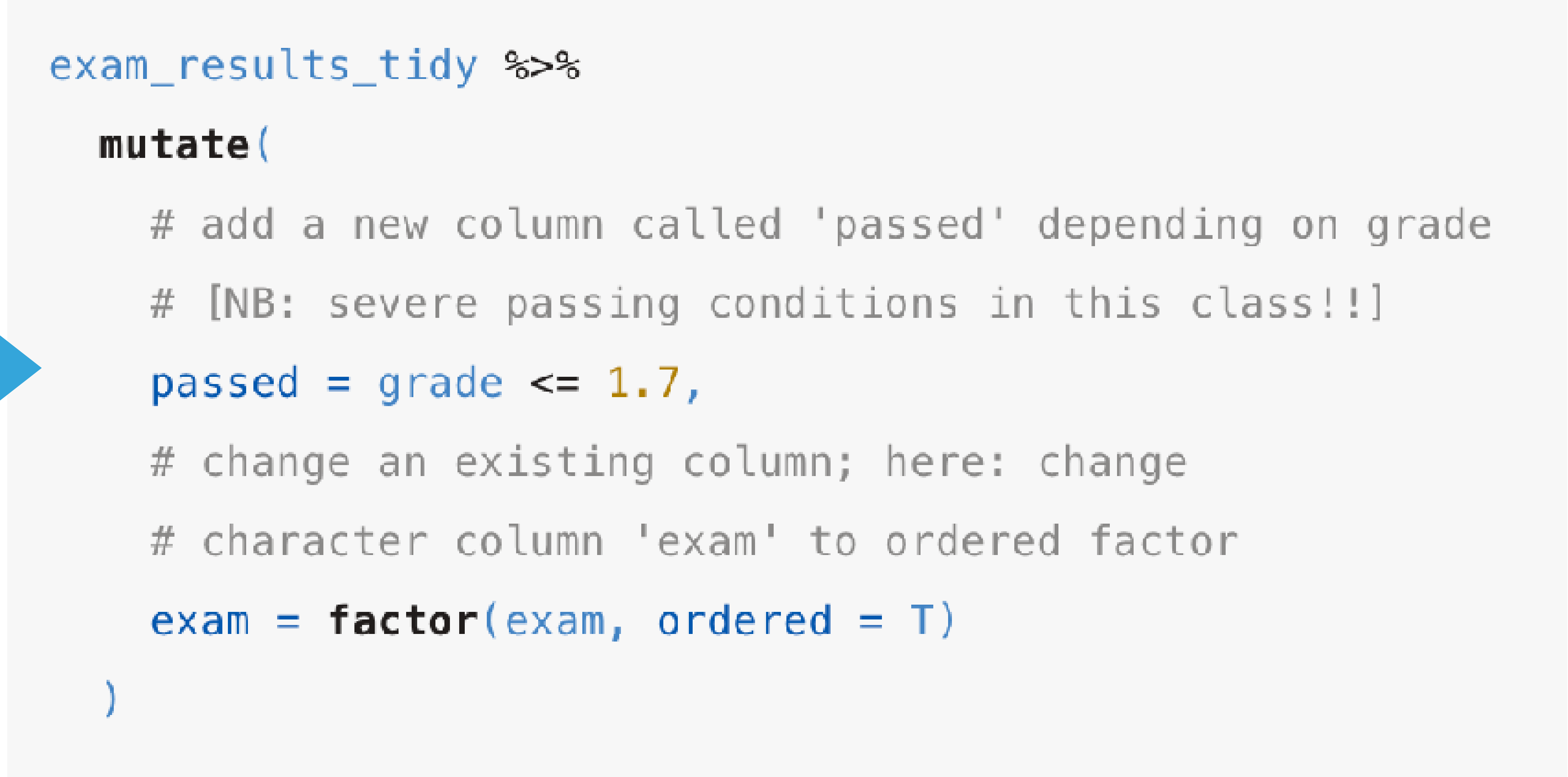
- from tidyselect package

```
# bogus code for illustration of possibilities!
SOME_DATA %>%
  select( ... # could be one of the following
        # all columns indexed 2, 3, ..., 10
        2:10
        # all columns except the one called "COLNAME"
        - COLNAME
        # all columns with names starting with "STRING"
       ... starts_with("STRING")
       # all columns with names ending with "STRING"
       ... ends_with("STRING")
       # all columns with names containing "STRING"
       ... contains("STRING")
       # all columns with names of the form "Col_i" with i = 1, ..., 10
       ... num_range("Col_", 1:10)
  )
```

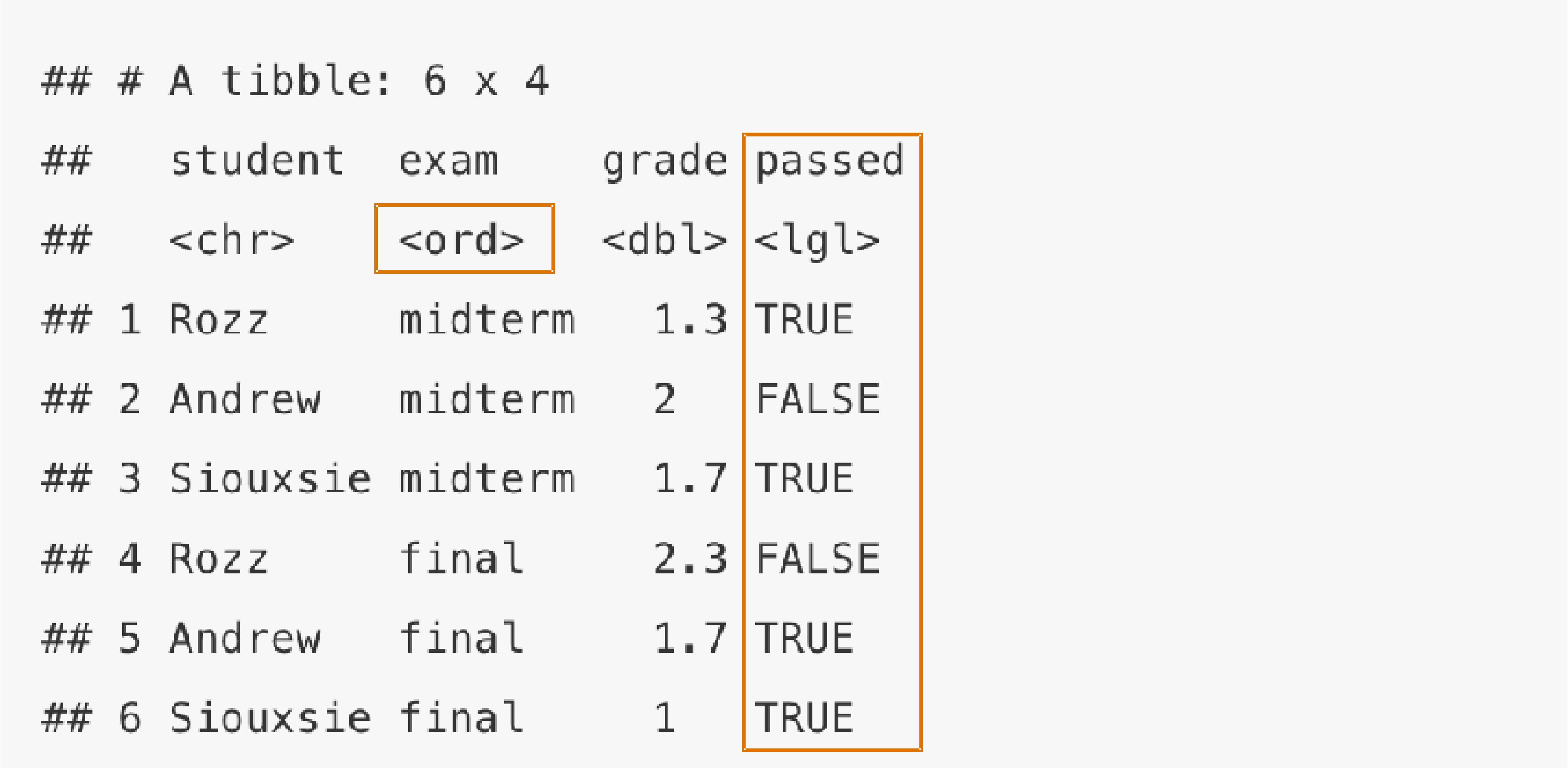
ADDING OR CHANGING COLUMNS



```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```

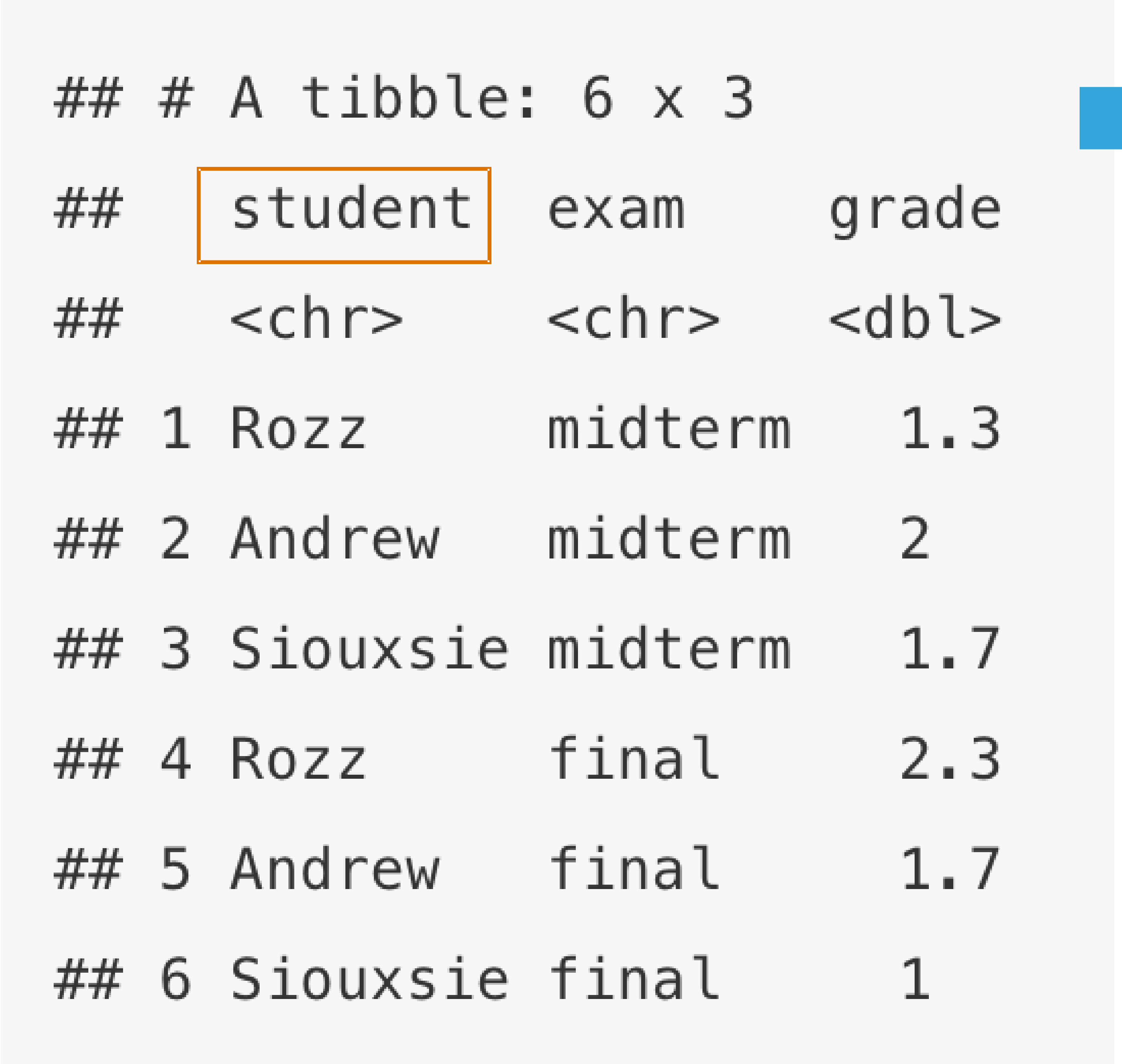


```
exam_results_tidy %>%
  mutate(
    # add a new column called 'passed' depending on grade
    # [NB: severe passing conditions in this class!!]
    passed = grade <= 1.7,
    # change an existing column; here: change
    # character column 'exam' to ordered factor
    exam = factor(exam, ordered = T)
  )
```

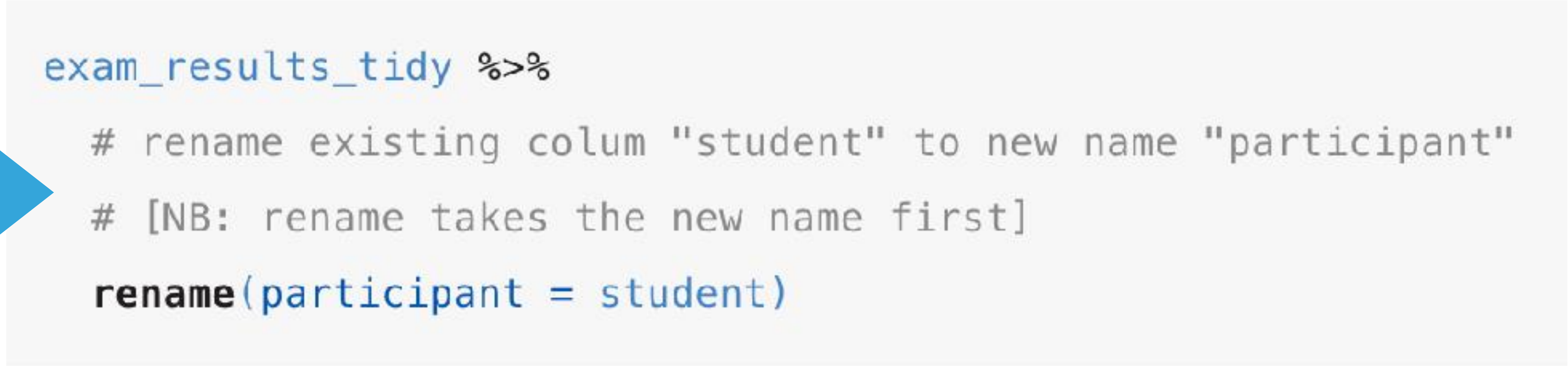


```
## # A tibble: 6 x 4
##   student  exam    grade passed
##   <chr>    <ord>   <dbl> <lgl>
## 1 Rozz     midterm   1.3 TRUE
## 2 Andrew   midterm   2   FALSE
## 3 Siouxsie midterm   1.7 TRUE
## 4 Rozz     final     2.3 FALSE
## 5 Andrew   final     1.7 TRUE
## 6 Siouxsie final     1   TRUE
```

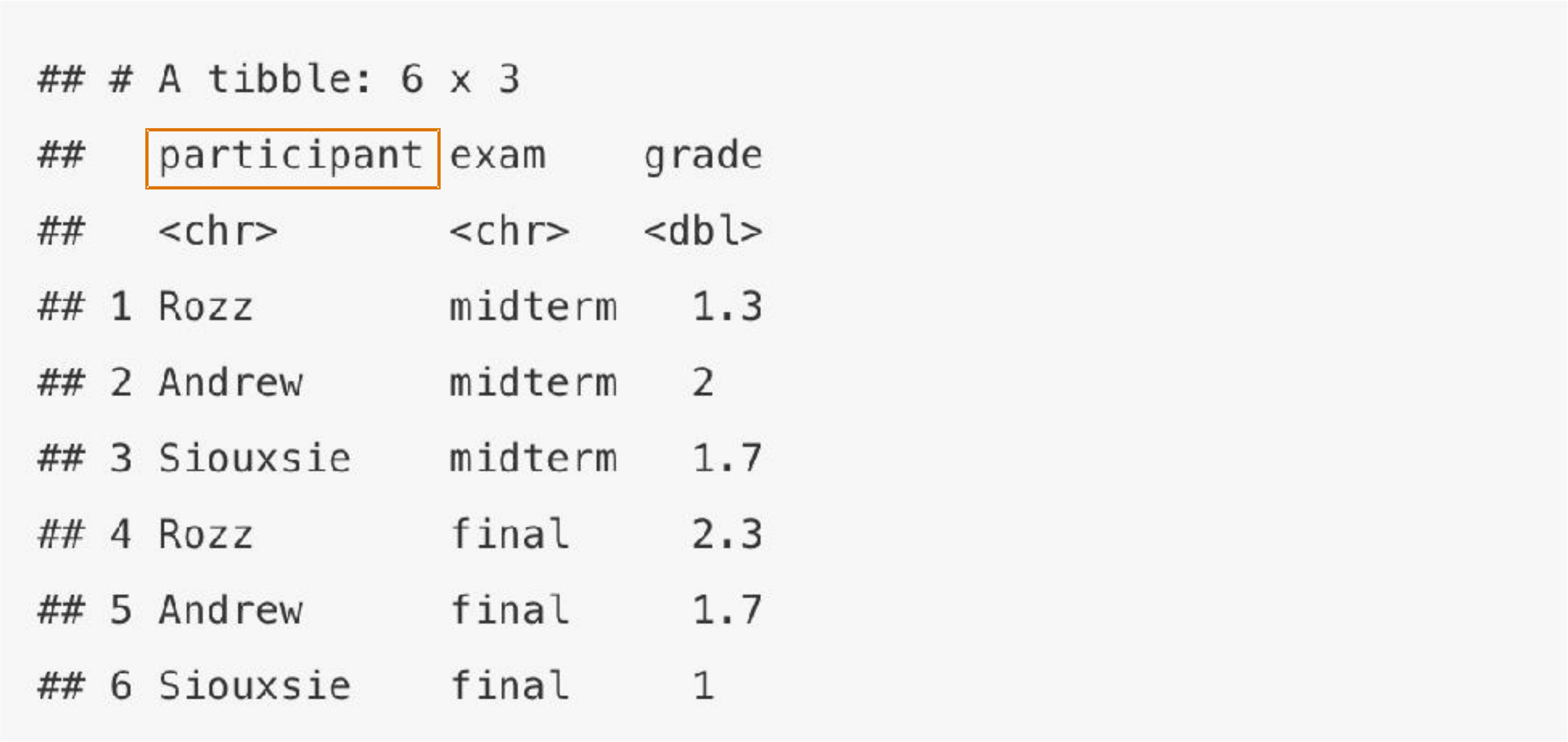
RENAMING COLUMNS



```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```



```
exam_results_tidy %>%
  # rename existing colum "student" to new name "participant"
  # [NB: rename takes the new name first]
  rename(participant = student)
```



```
## # A tibble: 6 x 3
##   participant exam    grade
##   <chr>       <chr>   <dbl>
## 1 Rozz        midterm   1.3
## 2 Andrew      midterm   2
## 3 Siouxsie    midterm   1.7
## 4 Rozz        final     2.3
## 5 Andrew      final     1.7
## 6 Siouxsie    final     1
```

SPLITTING COLUMNS

```
homework_results_untidy <-
  tribble(
    ~student,      ~results,
    "Rozz",        "1.0,2.3,3.0",
    "Andrew",      "2.3,2.7,1.3",
    "Siouxsie",    "1.7,4.0,1.0"
  )
```

```
homework_results_untidy %>%
  separate(
    # which column to split up
    col = results,
    # names of the new column to store results
    into = str_c("HW_", 1:3),
    # separate by which character / reg-exp
    sep = ",",
    # automatically (smart-)convert the type of the new cols
    convert = T
    )
```

```
## # A tibble: 3 x 4
##   student   HW_1  HW_2  HW_3
##   <chr>    <dbl> <dbl> <dbl>
## 1 Rozz       1     2.3   3
## 2 Andrew     2.3   2.7   1.3
## 3 Siouxsie   1.7   4     1
```

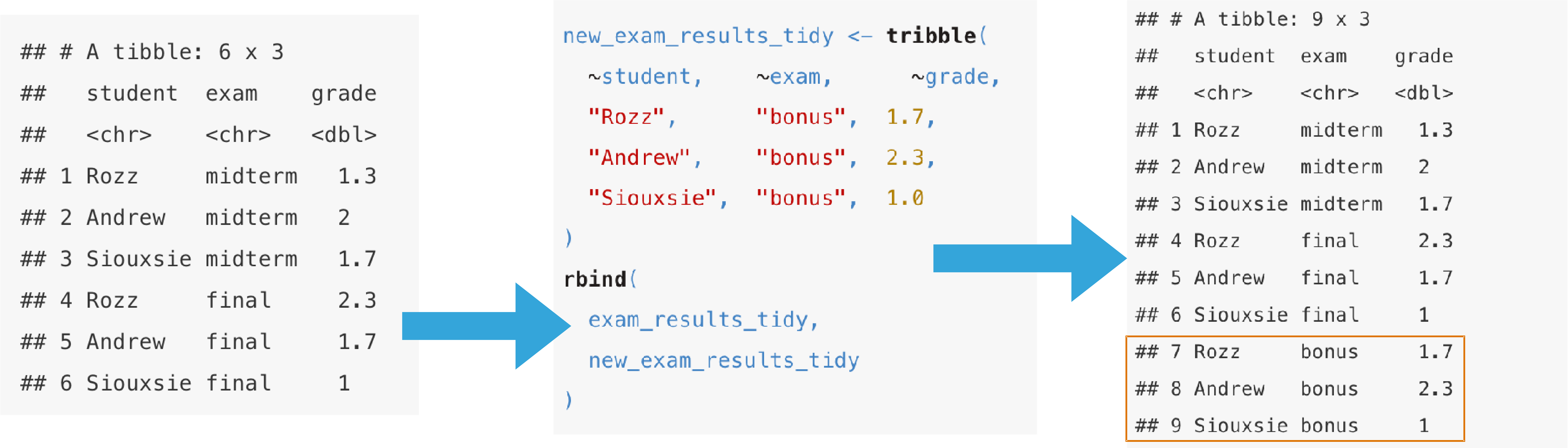
SORTING

```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```

```
exam_results_tidy %>%
  arrange(desc(student), grade)
```

```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Siouxsie final     1
## 2 Siouxsie midterm   1.7
## 3 Rozz     midterm   1.3
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Andrew   midterm   2
```

COMBINING DATA



```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```

```
new_exam_results_tidy <- tribble(
  ~student,    ~exam,     ~grade,
  "Rozz",      "bonus",   1.7,
  "Andrew",    "bonus",   2.3,
  "Siouxsie",  "bonus",   1.0
)
rbind(
  exam_results_tidy,
  new_exam_results_tidy
)
```

```
## # A tibble: 9 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
## 7 Rozz     bonus     1.7
## 8 Andrew   bonus     2.3
## 9 Siouxsie bonus     1
```

COMBINING DATA

```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```

```
# additional table with student numbers
student_numbers <- tribble(
  ~student,    ~student_number,
  "Rozz",      "666",
  "Andrew",    "1969",
  "Siouxsie",  "3.14"
)
full_join(exam_results_tidy, student_numbers, by = "student")
```

```
## # A tibble: 6 x 4
##   student  exam    grade student_number
##   <chr>    <chr>   <dbl> <chr>
## 1 Rozz     midterm   1.3 666
## 2 Andrew   midterm   2   1969
## 3 Siouxsie midterm   1.7 3.14
## 4 Rozz     final     2.3 666
## 5 Andrew   final     1.7 1969
## 6 Siouxsie final     1   3.14
```

GROUPED OPERATIONS: SUMMARIZE

```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```

```
exam_results_tidy %>%
  group_by(student) %>%
  summarise(
    student_mean = mean(grade)
  )

## # A tibble: 3 x 2
##   student  student_mean
##   <chr>           <dbl>
## 1 Andrew           1.85
## 2 Rozz             1.8
## 3 Siouxsie         1.35
```

GROUPED OPERATIONS: MUTATE

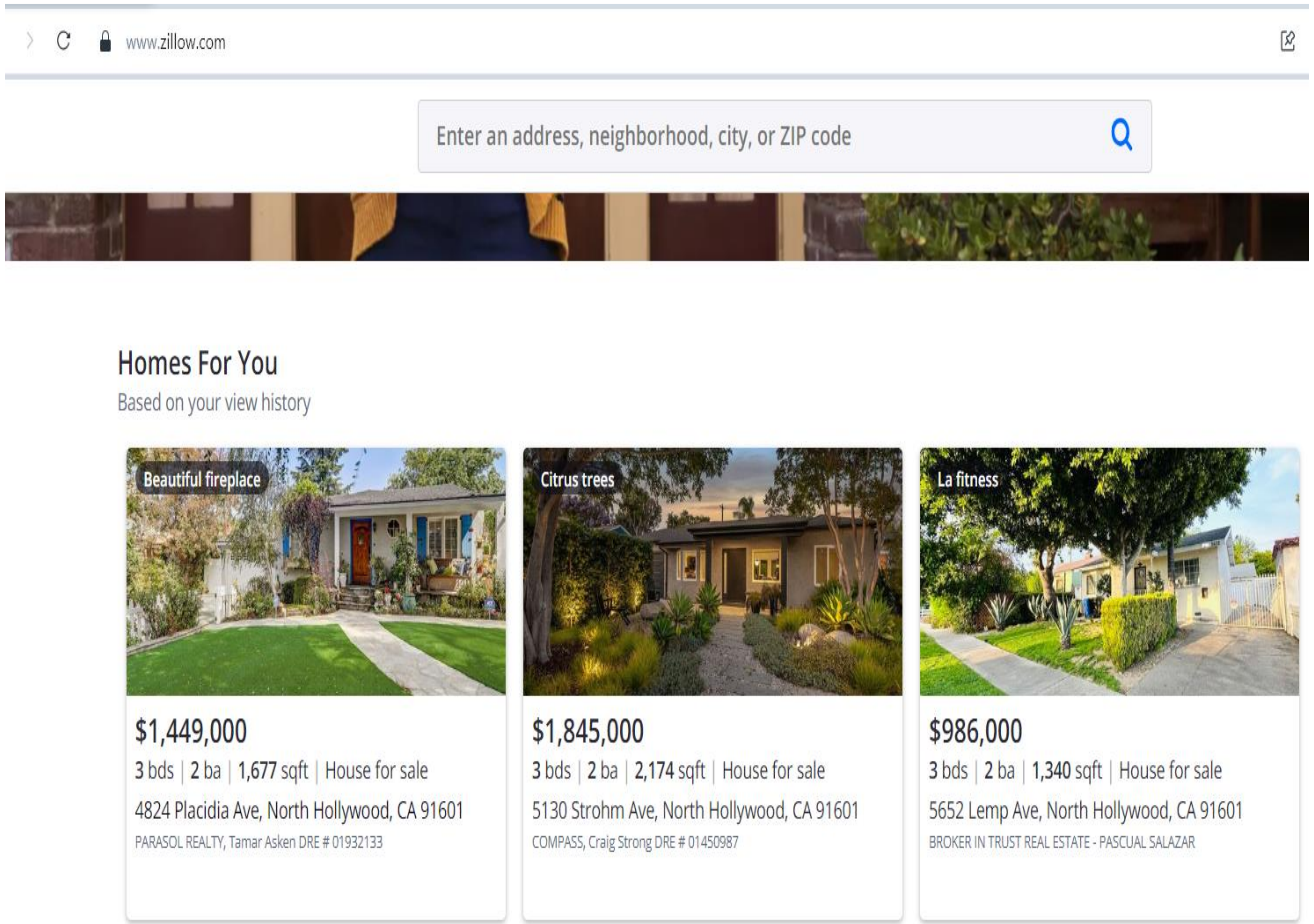
```
## # A tibble: 6 x 3
##   student  exam    grade
##   <chr>    <chr>   <dbl>
## 1 Rozz     midterm   1.3
## 2 Andrew   midterm   2
## 3 Siouxsie midterm   1.7
## 4 Rozz     final     2.3
## 5 Andrew   final     1.7
## 6 Siouxsie final     1
```

```
exam_results_tidy %>%
  group_by(student) %>%
  mutate(
    student_mean = mean(grade)
  )
```

```
## # A tibble: 6 x 4
## # Groups:   student [3]
##   student  exam    grade student_mean
##   <chr>    <chr>   <dbl>        <dbl>
## 1 Rozz     midterm   1.3         1.8
## 2 Andrew   midterm   2           1.85
## 3 Siouxsie midterm   1.7         1.35
## 4 Rozz     final     2.3         1.8
## 5 Andrew   final     1.7         1.85
## 6 Siouxsie final     1           1.35
```

CASE STUDY: Zillow Housing Data

- introduction:
  - provides housing price data at the metro, city and zipcode levels
- website:
  - www.zillow.com



www.zillow.com

Enter an address, neighborhood, city, or ZIP code

Homes For You

Based on your view history

Beautiful fireplace

$1,449,000

3 bds | 2 ba | 1,677 sqft | House for sale

4824 Placidia Ave, North Hollywood, CA 91601

PARASOL REALTY, Tamar Asken DRE # 01932133

Citrus trees

$1,845,000

3 bds | 2 ba | 2,174 sqft | House for sale

5130 Strohm Ave, North Hollywood, CA 91601

COMPASS, Craig Strong DRE # 01450987

La fitness

$986,000

3 bds | 2 ba | 1,340 sqft | House for sale

5652 Lemp Ave, North Hollywood, CA 91601

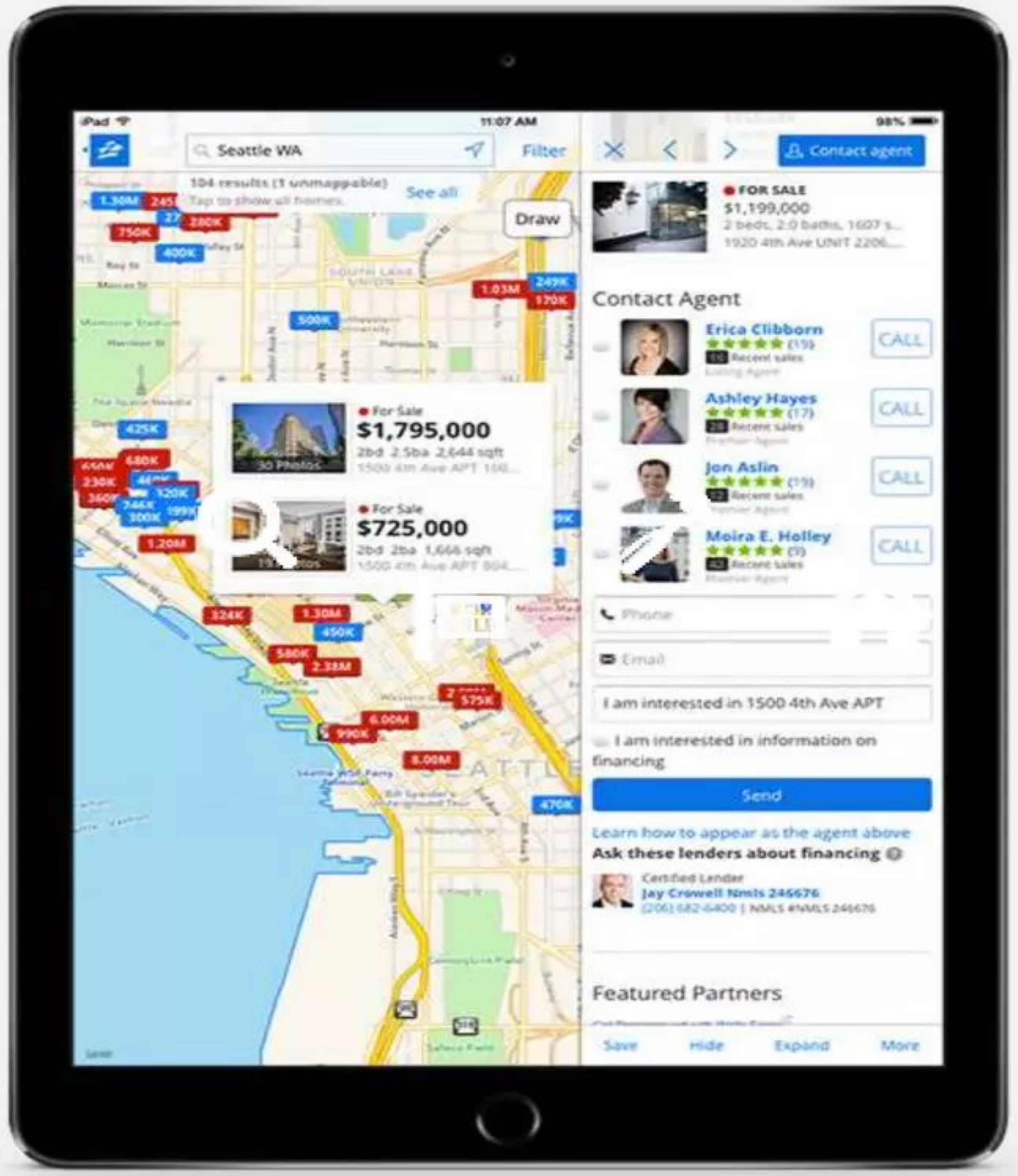
BROKER IN TRUST REAL ESTATE - PASCUAL SALAZAR

Zillow's marketplace

BUYERS & SELLERS

RENTERS

HOMEOWNERS



For Sale
$1,795,000
2bd 2.5ba 2,644 sqft

For Sale
$725,000
2bd 2ba 1,666 sqft

FOR SALE
$1,199,000

Contact Agent

Erica Clibborn CALL

Ashley Hayes CALL

Jon Aslin CALL

Moira E. Holley CALL

Phone

Email

I am interested in 1500 4th Ave APT

I am interested in information on financing

Send

Learn how to appear as the agent above

Ask these lenders about financing

Certified Lender
Jay Crowell Nmls 246676
(206) 682-6400 | NMLS #NMLS 246676

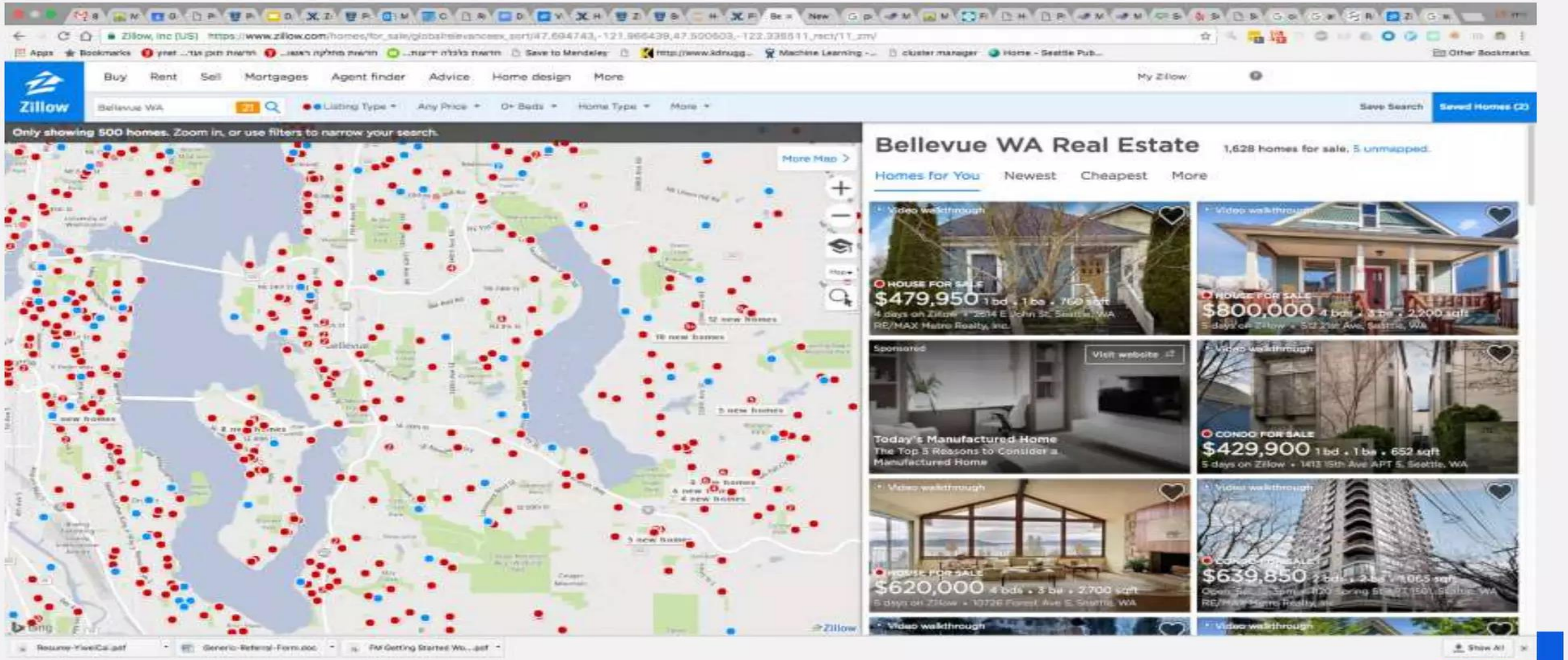
Featured Partners

REAL ESTATE AGENTS

PROPERTY MANAGERS & LANDLORDS

MORTGAGE PROVIDERS

For buyers



Only showing 500 homes. Zoom in, or use filters to narrow your search.

Bellevue WA Real Estate 1,628 homes for sale. 5 unmapped.

HOUSE FOR SALE
$479,950 1 bd · 1 ba · 760 sqft
4 days on Zillow · 2814 E John St, Seattle, WA
RE/MAX Metro Realty, Inc.

HOUSE FOR SALE
$800,000 4 bds · 3 ba · 2,200 sqft
5 days on Zillow · 512 21st Ave, Seattle, WA

Today's Manufactured Home
The Top 5 Reasons to Consider a Manufactured Home

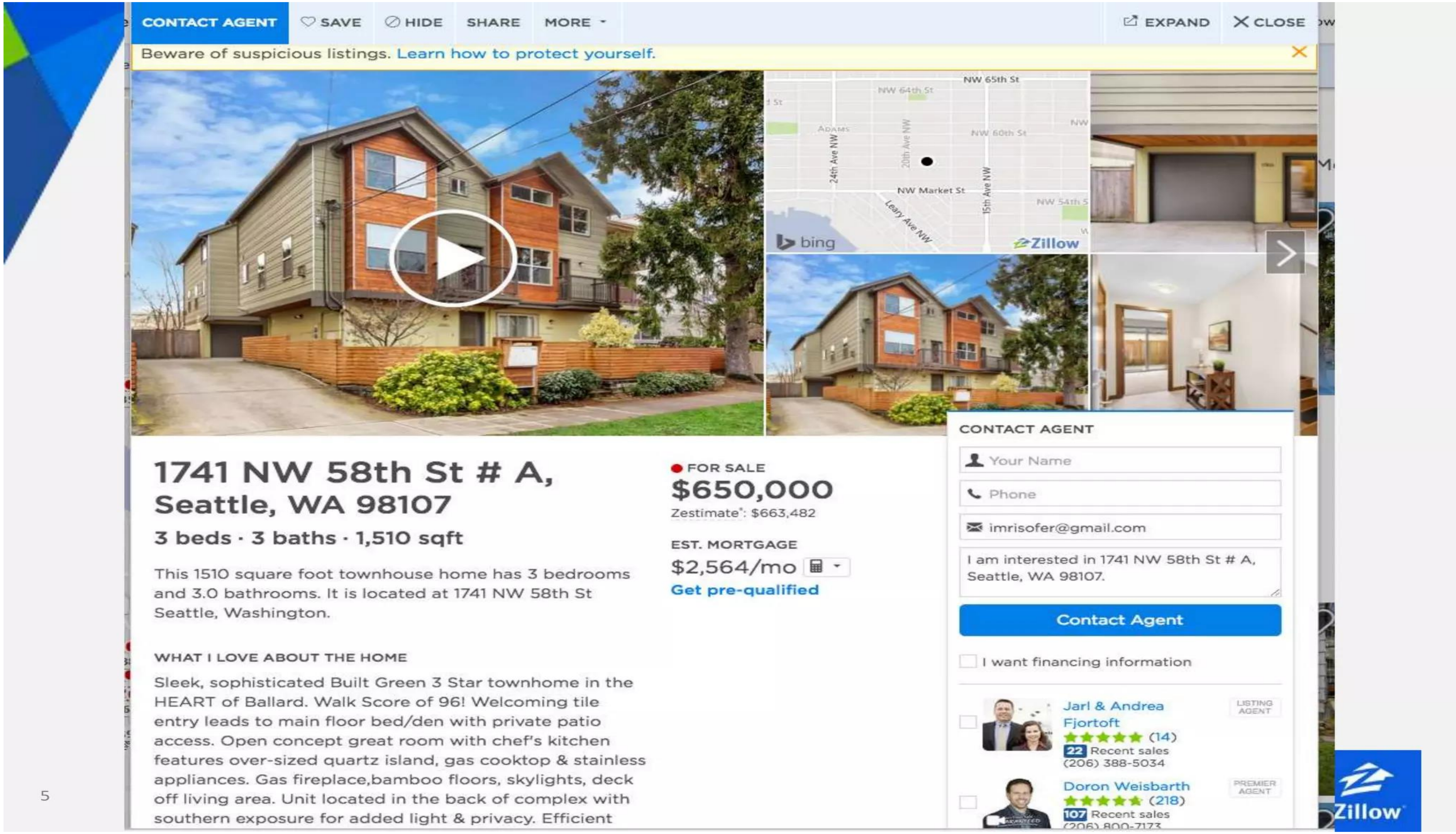
CONDO FOR SALE
$429,900 1 bd · 1 ba · 652 sqft
5 days on Zillow · 1413 15th Ave APT 5, Seattle, WA

HOUSE FOR SALE
$620,000 4 bds · 3 ba · 2,700 sqft
5 days on Zillow · 10726 Forest Ave S, Seattle, WA

CONDO FOR SALE
$639,850 2 bds · 2 ba · 1,065 sqft
Open: Sat 1-3pm · 1120 Spring St APT 1501, Seattle, WA
RE/MAX Metro Realty, Inc.

Resume-YiweiCai.pdf
Generic-Referral-Form.doc
PM Getting Started Wo....pdf

DATA ANALYSIS



Beware of suspicious listings. Learn how to protect yourself.

1741 NW 58th St # A, Seattle, WA 98107

3 beds · 3 baths · 1,510 sqft

● FOR SALE
$650,000
Zestimate®: $663,482

EST. MORTGAGE
$2,564/mo
Get pre-qualified

This 1510 square foot townhouse home has 3 bedrooms and 3.0 bathrooms. It is located at 1741 NW 58th St Seattle, Washington.

WHAT I LOVE ABOUT THE HOME

Sleek, sophisticated Built Green 3 Star townhome in the HEART of Ballard. Walk Score of 96! Welcoming tile entry leads to main floor bed/den with private patio access. Open concept great room with chef's kitchen features over-sized quartz island, gas cooktop & stainless appliances. Gas fireplace,bamboo floors, skylights, deck off living area. Unit located in the back of complex with southern exposure for added light & privacy. Efficient

CONTACT AGENT

Your Name
Phone
imrisofer@gmail.com
I am interested in 1741 NW 58th St # A, Seattle, WA 98107.

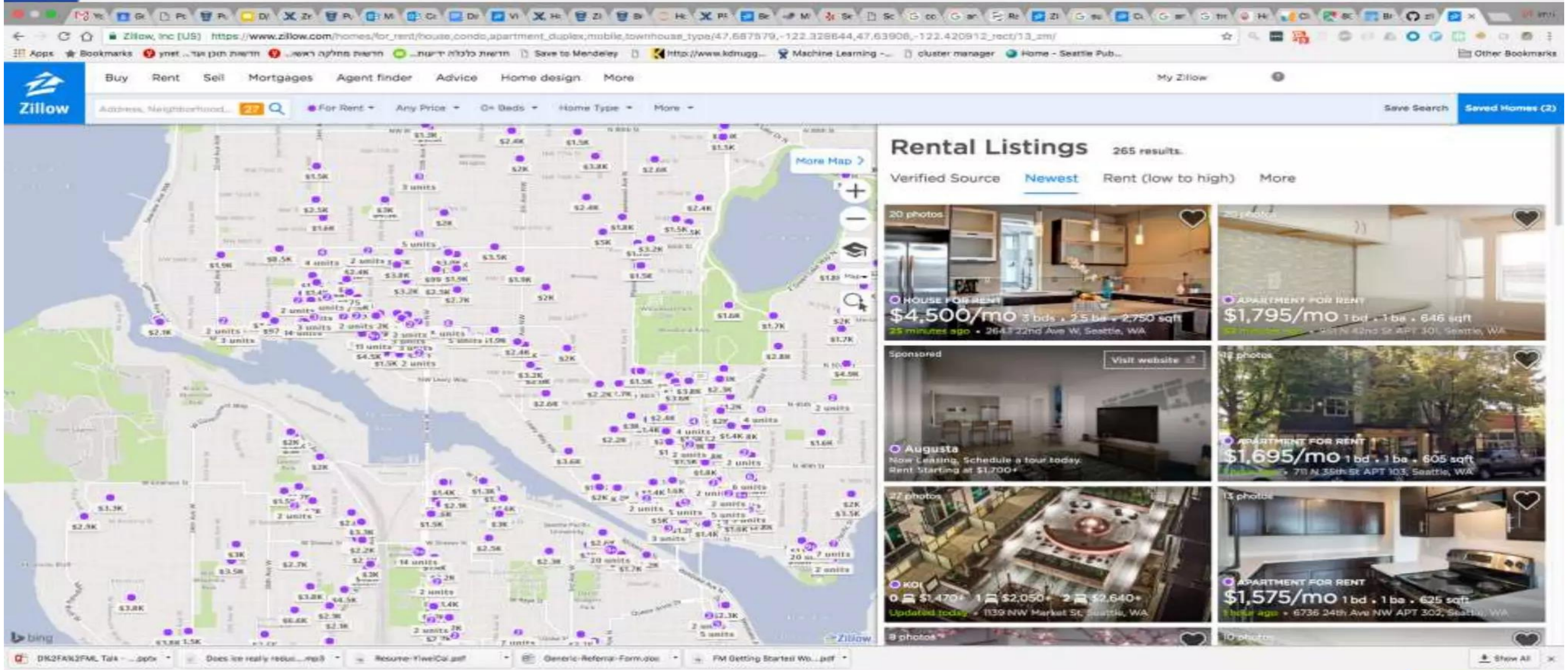
Contact Agent

□ I want financing information

□ Jarl & Andrea Fjortoft — LISTING AGENT
★★★★★ (14)
22 Recent sales
(206) 388-5034

□ Doron Weisbarth — PREMIER AGENT
★★★★★ (218)
107 Recent sales
(206) 800-7173

For renters



Rental Listings

265 results

Verified Source | Newest | Rent (low to high) | More

20 photos
HOUSE FOR RENT
$4,500/mo 3 bds · 2.5 ba · 2,750 sqft
25 minutes ago · 2643 22nd Ave W, Seattle, WA

APARTMENT FOR RENT
$1,795/mo 1 bd · 1 ba · 646 sqft
· N 42nd St APT 301, Seattle, WA

Sponsored
Visit website
Augusta
Now Leasing, Schedule a tour today.
Rent Starting at $1,700+

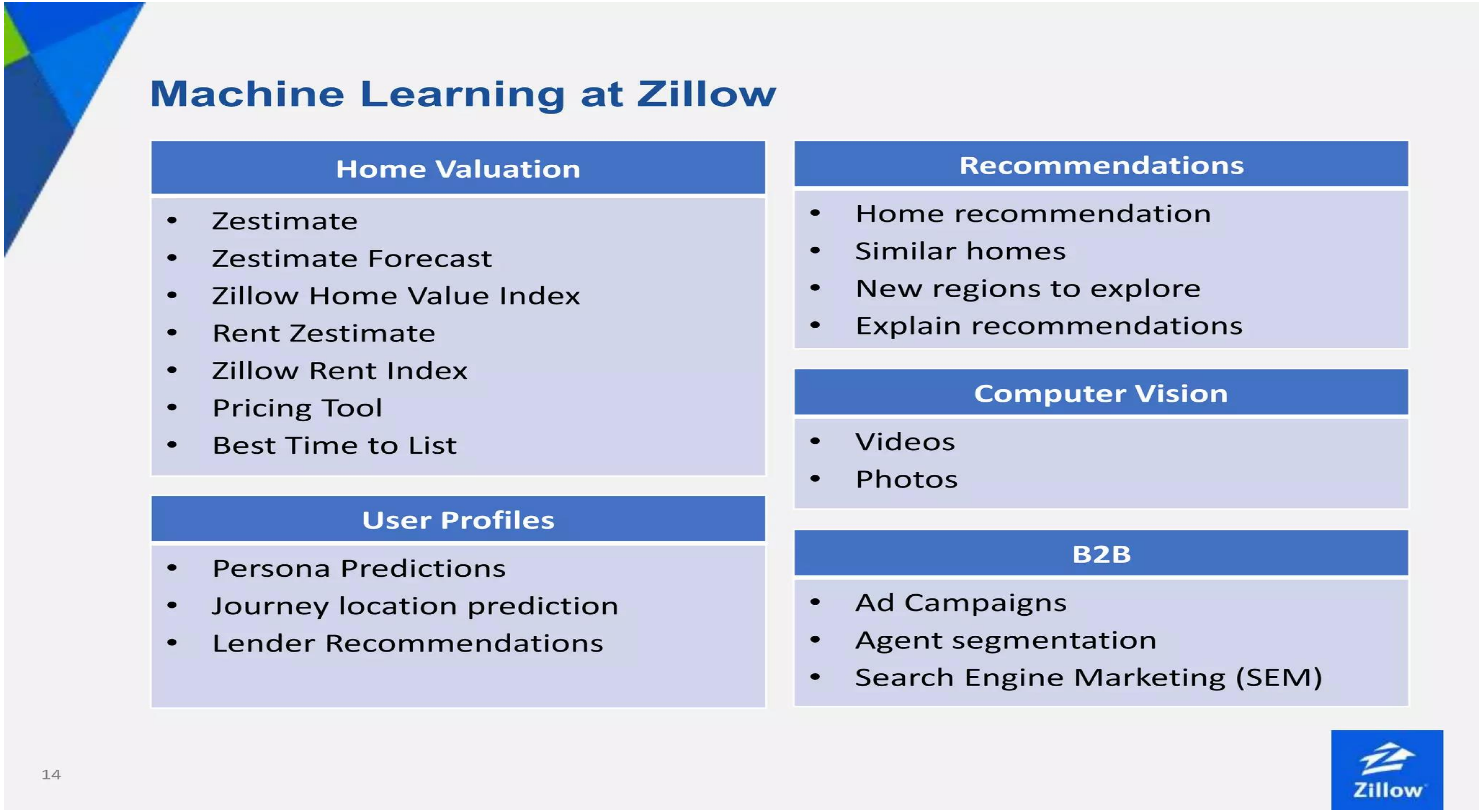
APARTMENT FOR RENT
$1,695/mo 1 bd · 1 ba · 605 sqft
· 711 N 35th St APT 103, Seattle, WA

27 photos
KOI
0 $1,470+ 1 $2,050+ 2 $2,640+
Updated today · 1139 NW Market St, Seattle, WA

13 photos
APARTMENT FOR RENT
$1,575/mo 1 bd · 1 ba · 625 sqft
1 hour ago · 6736 24th Ave NW APT 302, Seattle, WA

8 photos
10 photos

Data Science at Zillow



Machine Learning at Zillow

Home Valuation

- Zestimate
- Zestimate Forecast
- Zillow Home Value Index
- Rent Zestimate
- Zillow Rent Index
- Pricing Tool
- Best Time to List

User Profiles

- Persona Predictions
- Journey location prediction
- Lender Recommendations

Recommendations

- Home recommendation
- Similar homes
- New regions to explore
- Explain recommendations

Computer Vision

- Videos
- Photos

B2B

- Ad Campaigns
- Agent segmentation
- Search Engine Marketing (SEM)

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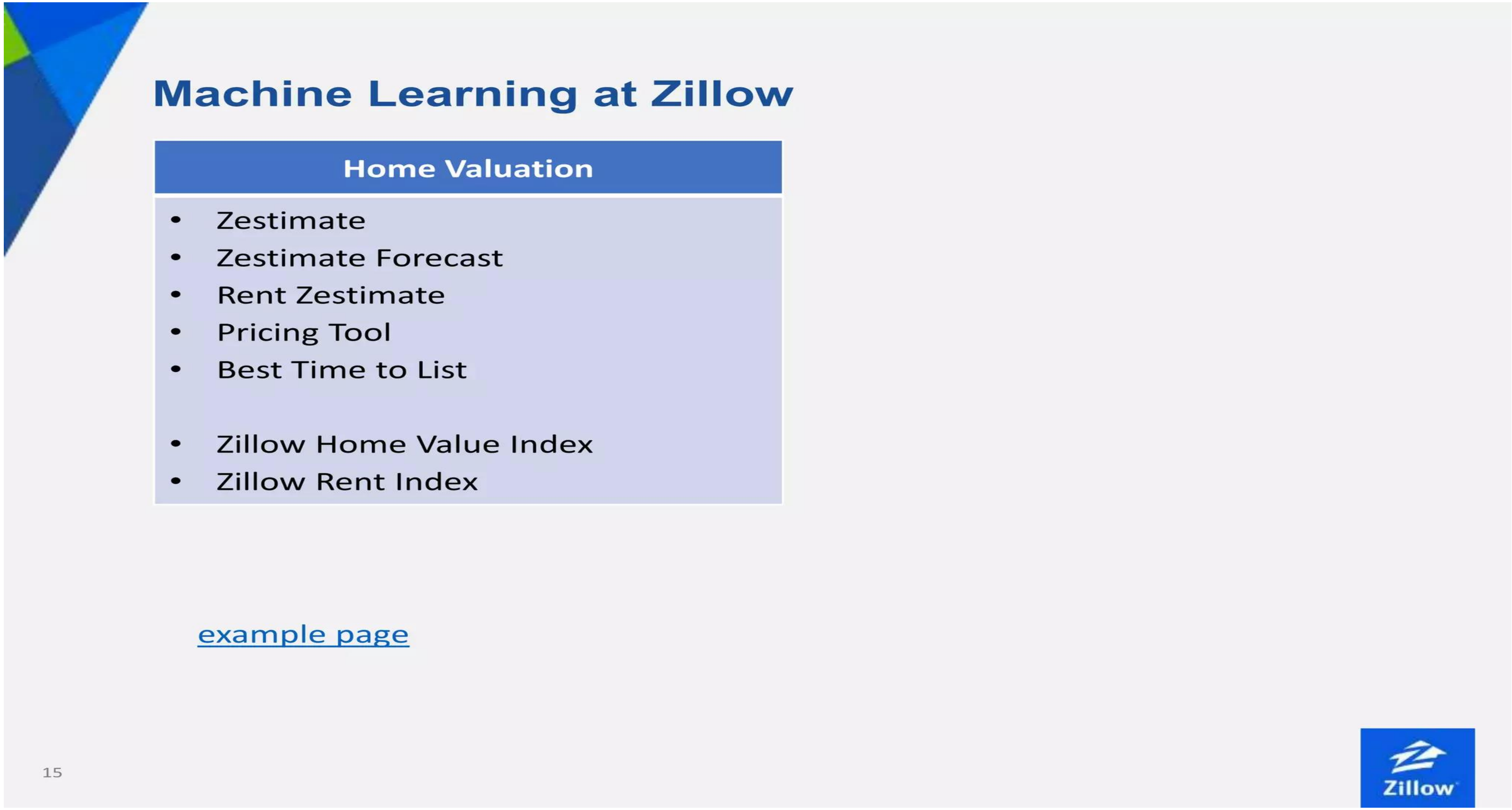
Zillow

Data Science at Zillow



Machine Learning at Zillow

Home Valuation
• Zestimate • Zestimate Forecast • Rent Zestimate • Pricing Tool • Best Time to List • Zillow Home Value Index • Zillow Rent Index

example page

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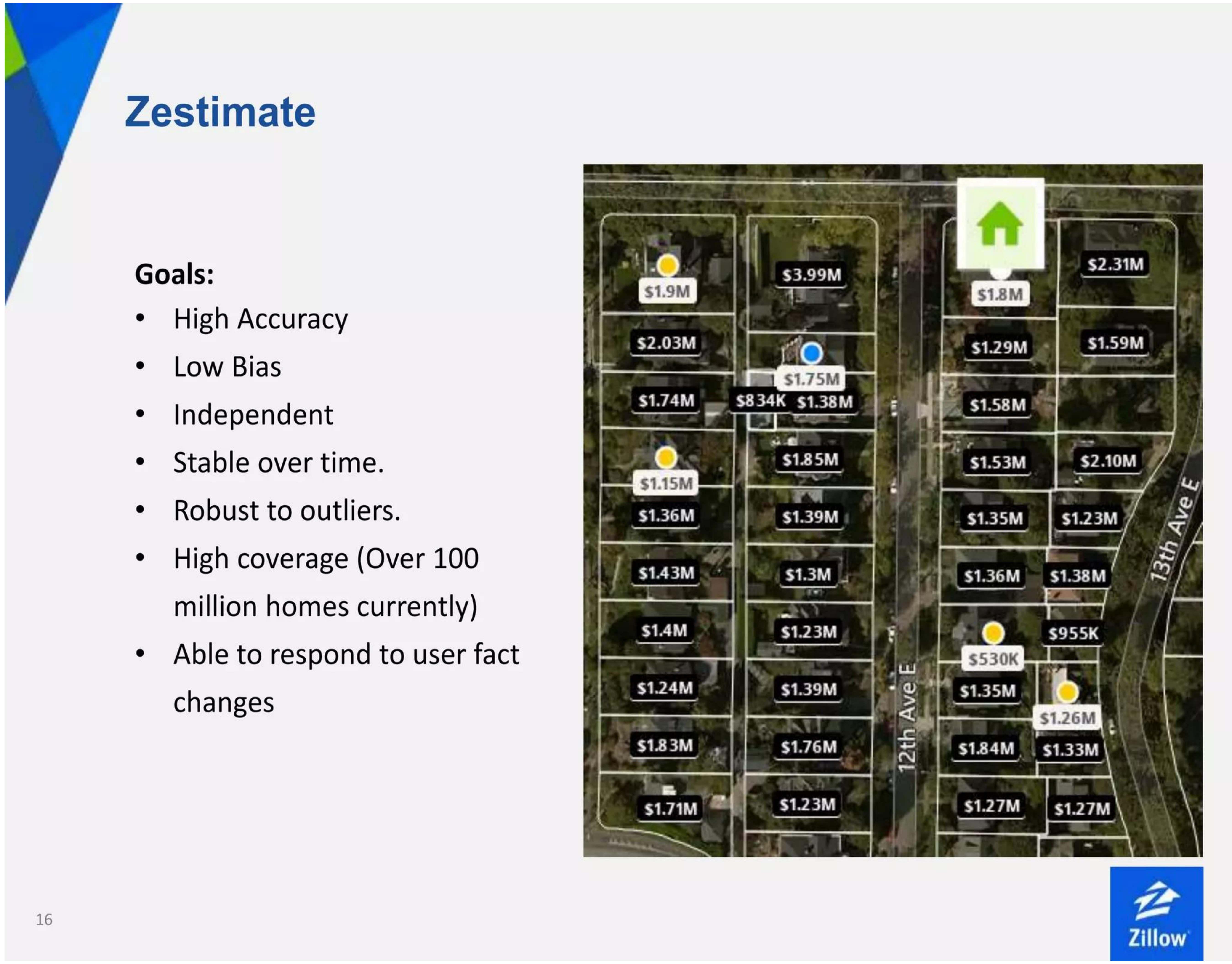
Data Science at Zillow

Zillow list of properties that are not on market and provide the estimates on those properties which they commonly referes to as Zestimate

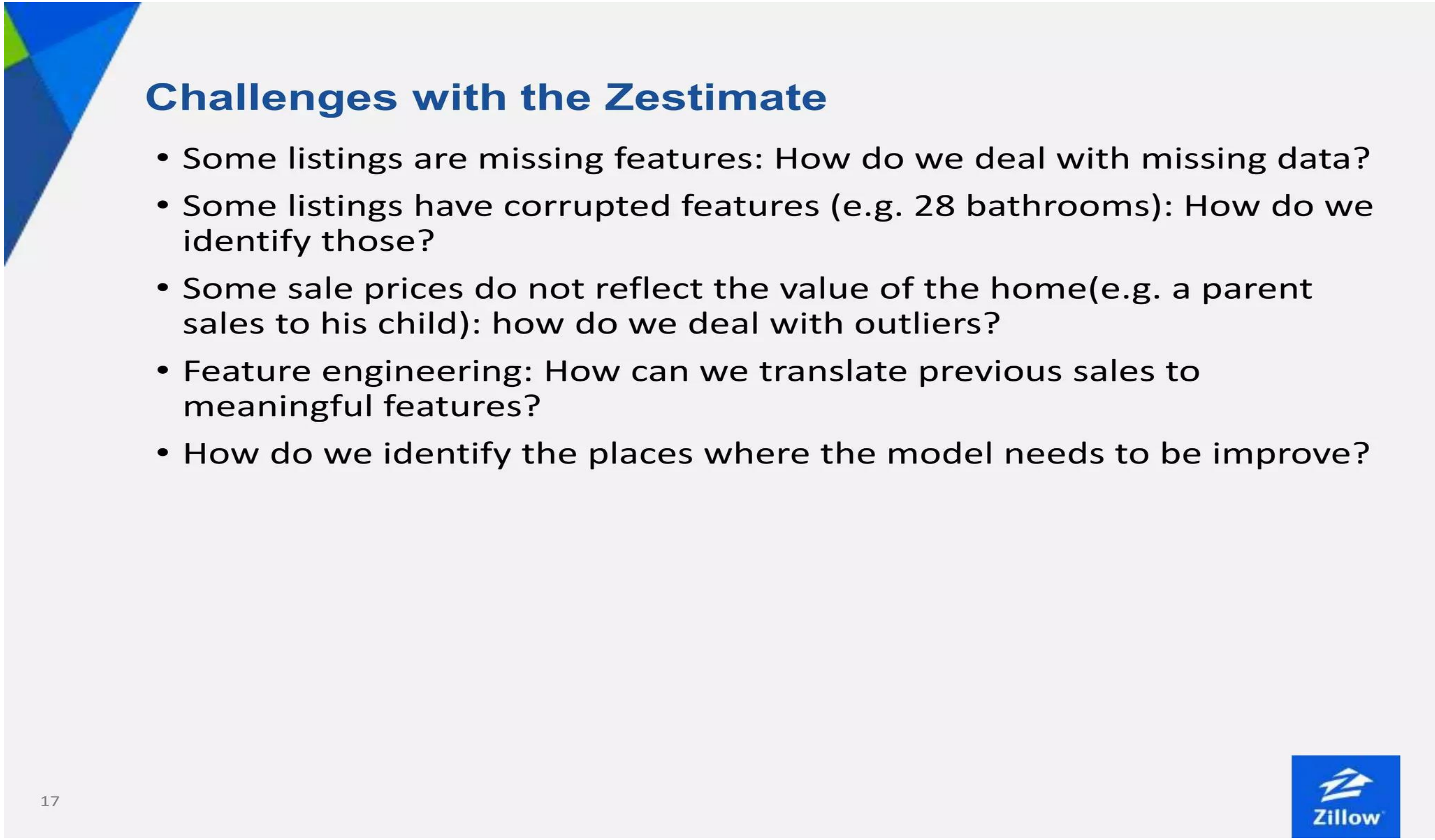


Zestimate

Goals:

- High Accuracy
- Low Bias
- Independent
- Stable over time.
- Robust to outliers.
- High coverage (Over 100 million homes currently)
- Able to respond to user fact changes

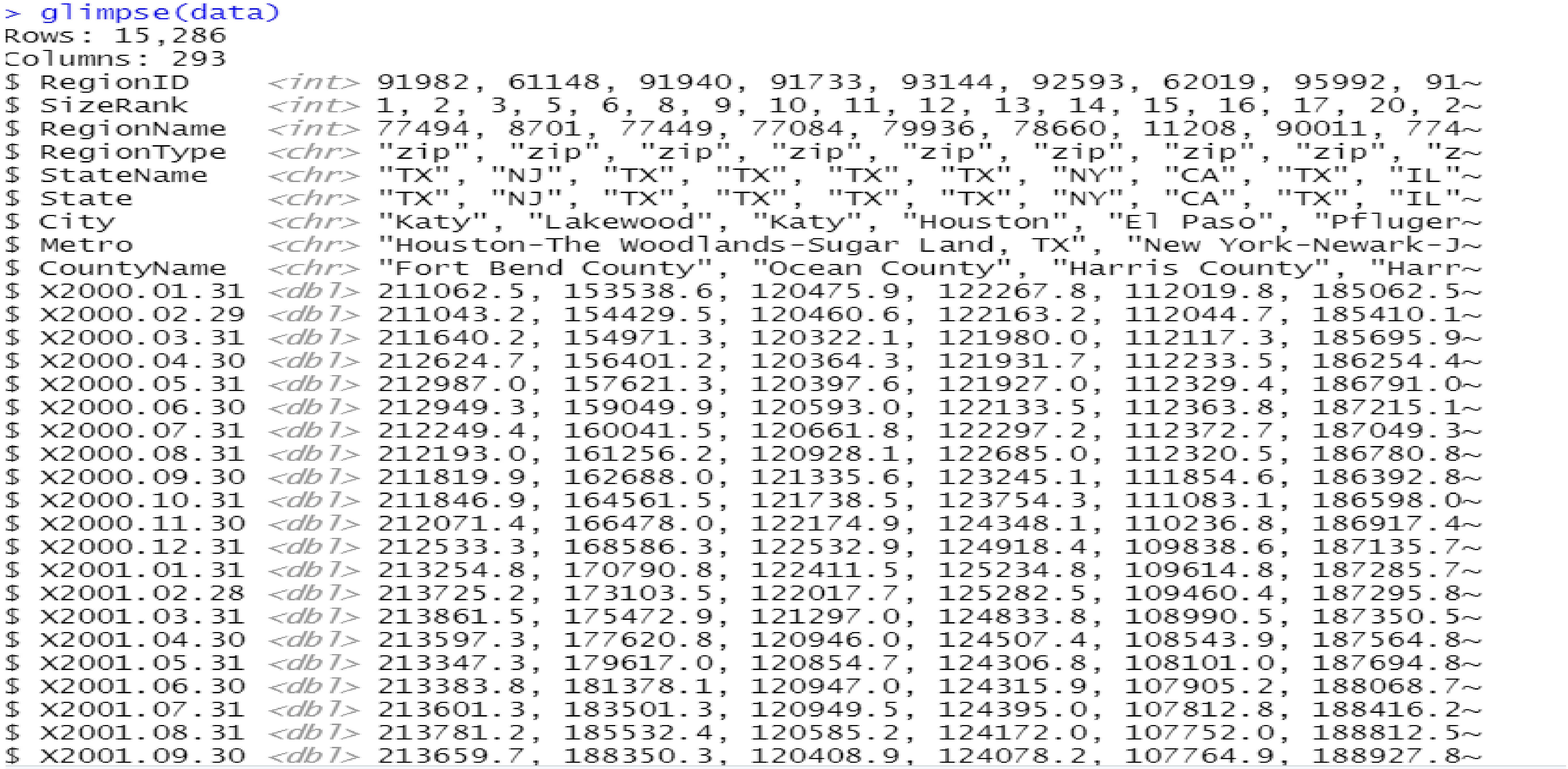
Data Science at Zillow



Challenges with the Zestimate

- Some listings are missing features: How do we deal with missing data?
- Some listings have corrupted features (e.g. 28 bathrooms): How do we identify those?
- Some sale prices do not reflect the value of the home(e.g. a parent sales to his child): how do we deal with outliers?
- Feature engineering: How can we translate previous sales to meaningful features?
- How do we identify the places where the model needs to be improve?

RAW DATA



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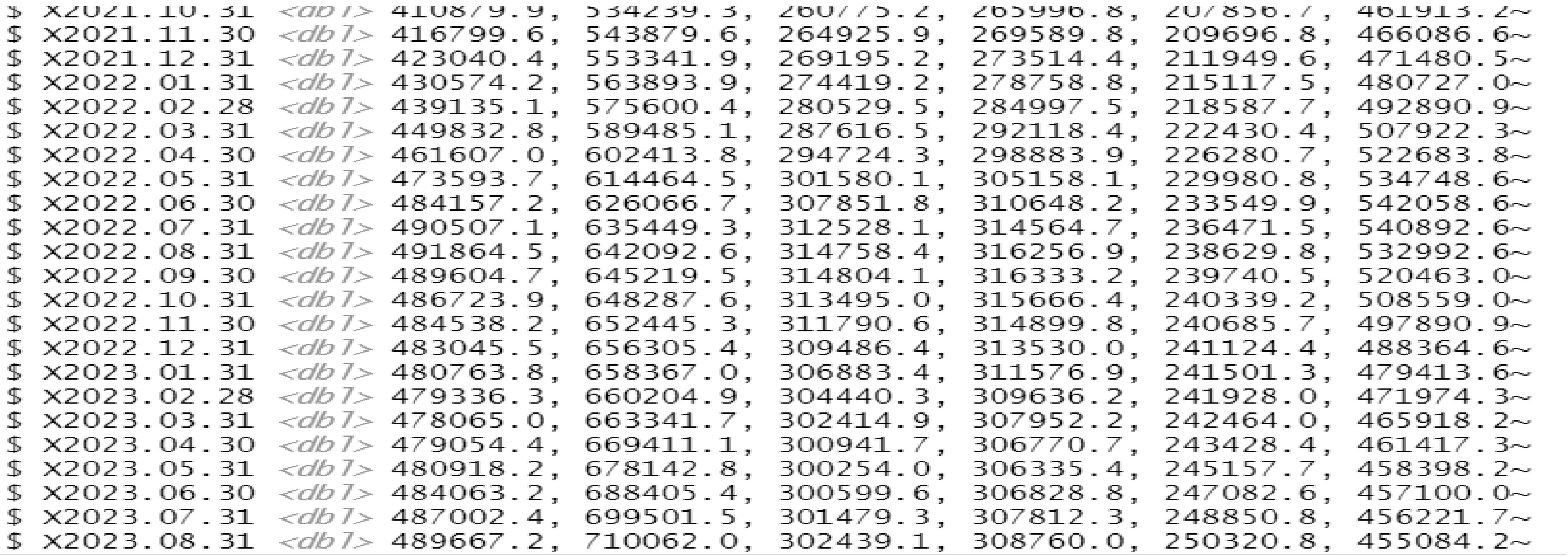

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Thank you for your listening!

“One who never asks
Either knows everything or nothing”
Malcolm S. Forbes