CHRISTOPHER PRENER, PH.D.
FALL, 2016

WEEK 03
LECTURE 03

QUANTITATIVE ANALYSIS

INITIAL DATA CLEANING

AGENDA

1. Missing Data
2. Recoding Data
3. Other Data Operations

1 MISSING DATA

"PERFECT" DATA

	make	price	mpg
1	AMC Concord	4,099	22
2	AMC Pacer	4,749	17
3	AMC Spirit	3,799	22
4	Buick Century	4,816	20
5	Buick Electra	7,827	15
6	Buick LeSabre	5,788	18
7	Buick Opel	4,453	26
8	Buick Regal	5,189	20
9	Buick Riviera	10,372	16
10	Buick Skylark	4,082	19
11	Cad. Deville	11,385	14
12	Cad. Eldorado	14,500	14
13	Cad. Seville	15,906	21
14	Chev. Chevette	3,299	29
15	Chev. Impala	5,705	16
16	Chev. Malibu	4,504	22

WHERE HAVE ALL THE DATA GONE?

	make	price	mpg	rep78	headroom
1	AMC Concord	4,099	22	3	2.5
2	AMC Pacer	4,749	17	3	3.0
3	AMC Spirit	3,799	22	.	3.0
4	Buick Century	4,816	20	3	4.5
5	Buick Electra	7,827	15	4	4.0
6	Buick LeSabre	5,788	18	3	4.0
7	Buick Opel	4,453	26	.	3.0
8	Buick Regal	5,189	20	3	2.0
9	Buick Riviera	10,372	16	3	3.5
10	Buick Skylark	4,082	19	3	3.5
11	Cad. Deville	11,385	14	3	4.0
12	Cad. Eldorado	14,500	14	2	3.5
13	Cad. Seville	15,906	21	3	3.0
14	Chev. Chevette	3,299	29	3	2.5
15	Chev. Impala	5,705	16	4	4.0
16	Chev. Malibu	4,504	22	3	3.5

FUNDAMENTAL QUESTION:

ARE MISSING VALUES RELATED TO THE UNDERLYING VALUES OF THE DATASET?

A THREAT TO GENERALIZABILITY

MISSING COMPLETELY AT RANDOM
MISSINGNESS IS NOT A FUNCTION OF EITHER OBSERVED OR UNOBSERVED FACTORS IN THE DATASET

NOT MISSING AT RANDOM

MISSING AT RANDOM

A THREAT TO GENERALIZABILITY

MISSING COMPLETELY AT RANDOM

"MCAR"

Example: *n* respondents have their depression symptoms scored, but a random subset of respondents do not have data on their emergency services use recorded.

A THREAT TO GENERALIZABILITY

MISSING COMPLETELY AT RANDOM

MISSING AT RANDOM
MISSINGNESS DEPENDS ON
OBSERVED FACTORS IN
THE DATASET

NOT MISSING AT RANDOM

A THREAT TO GENERALIZABILITY

Example: *n* respondents have their depression symptoms scored and only those with high depression scores have data on their emergency services use recorded.

A THREAT TO GENERALIZABILITY

MISSING COMPLETELY AT RANDOM

MISSING AT RANDOM

NOT MISSING AT RANDOM
MISSINGNESS DEPENDS ON UNOBSERVED FACTORS IN THE DATASET

A THREAT TO GENERALIZABILITY

Example: *n* respondents have their depression symptoms scored and are assessed for suicidality, but only respondents with high suicidality scores have their suicidality data entered in the dataset.

AN OUNCE OF PREVENTION...

- When you design your study and conduct it, work to ensure that missing data is minimized to every extent possible.
    - However, it is ethically important that missingness is allowed and methodologically important that it is anticipated - how will you account for refusals or “I don’t know” answers?
- Can you predict ahead of time who will refuse certain questions?
    - Be thorough in your design - try to eliminate unobserved sources of missingness, and try to collect data that may help predict missingness.

. . . AND A POUND OF CURE

- When (and not if!) you have missing data, begin by "declaring" data missing.
- Then look at the percentage of missing cases in a given variable - a quick rule of thumb is that we would like to have < 5% of *n* missing values per variable.
- There are advanced techniques for both assessing MCAR vs MAR and for "recovering" missing data (beyond scope of class).

MISSING DATA IN THE WILD

WE KNOW
N = 74

```
. use autoMissing.dta

. tabulate rep78

     Repair |
Record 1978 |      Freq.     Percent        Cum.
------------+-----------------------------------
          1 |          2        2.90        2.90
          2 |          8       11.59       14.49
          3 |         30       43.48       57.97
          4 |         18       26.09       84.06
          5 |         11       15.94      100.00
------------+-----------------------------------
      Total |         69      100.00
```

MISSING DATA IN THE WILD

```
. tabulate rep78, missing
```

Repair Record 1978	Freq.	Percent	Cum.
1	2	2.70	2.70
2	8	10.81	13.51
3	30	40.54	54.05
4	18	24.32	78.38
5	11	14.86	93.24
.	5	6.76	100.00
Total	74	100.00	

MISSING DATA IN THE WILD

```
. tabulate mpg, missing

     Mileage |
       (mpg) |      Freq.     Percent        Cum.
-------------+-----------------------------------
          12 |          2        2.70        2.70
          14 |          6        8.11       10.81
          15 |          2        2.70       13.51
          17 |          4        5.41       18.92
          18 |          9       12.16       31.08
          19 |          8       10.81       41.89
          20 |          3        4.05       45.95
          21 |          5        6.76       52.70
          22 |          5        6.76       59.46
          23 |          3        4.05       63.51
          24 |          4        5.41       68.92
          25 |          5        6.76       75.68
          26 |          3        4.05       79.73
          28 |          3        4.05       83.78
          29 |          1        1.35       85.14
          31 |          1        1.35       86.49
          34 |          1        1.35       87.84
          35 |          2        2.70       90.54
          41 |          1        1.35       91.89
     unknown |          4        5.41       97.30
not measured |          2        2.70      100.00
-------------+-----------------------------------
       Total |         74      100.00
```

MISSING DATA IN THE WILD

```
. tabulate mpg, missing nolabel

    Mileage |
      (mpg) |      Freq.     Percent        Cum.
------------+-----------------------------------
         12 |          2        2.70        2.70
         14 |          6        8.11       10.81
         15 |          2        2.70       13.51
         17 |          4        5.41       18.92
         18 |          9       12.16       31.08
         19 |          8       10.81       41.89
         20 |          3        4.05       45.95
         21 |          5        6.76       52.70
         22 |          5        6.76       59.46
         23 |          3        4.05       63.51
         24 |          4        5.41       68.92
         25 |          5        6.76       75.68
         26 |          3        4.05       79.73
         28 |          3        4.05       83.78
         29 |          1        1.35       85.14
         31 |          1        1.35       86.49
         34 |          1        1.35       87.84
         35 |          2        2.70       90.54
         41 |          1        1.35       91.89
         .a |          4        5.41       97.30
         .b |          2        2.70      100.00
------------+-----------------------------------
      Total |         74      100.00
```

MISSING DATA IN THE WILD

```
. tabulate trunk

Trunk space |
  (cu. ft.) |      Freq.     Percent        Cum.
------------+-----------------------------------
         -1 |          4        5.41        5.41
          5 |          1        1.35        6.76
          6 |          1        1.35        8.11
          7 |          3        4.05       12.16
          8 |          5        6.76       18.92
         10 |          5        6.76       25.68
         11 |          8       10.81       36.49
         12 |          3        4.05       40.54
         13 |          4        5.41       45.95
         14 |          4        5.41       51.35
         15 |          5        6.76       58.11
         16 |         12       16.22       74.32
         17 |          8       10.81       85.14
         18 |          1        1.35       86.49
         20 |          6        8.11       94.59
         21 |          2        2.70       97.30
         22 |          1        1.35       98.65
         23 |          1        1.35      100.00
------------+-----------------------------------
      Total |         74      100.00
```

MISSING DATA IN THE WILD

```
. tabulate turn

Turn Circle |
     (ft.)  |      Freq.     Percent        Cum.
------------+-----------------------------------
         31 |          1        1.35        1.35
         32 |          1        1.35        2.70
         33 |          2        2.70        5.41
         34 |          6        8.11       13.51
         35 |          6        8.11       21.62
         36 |          9       12.16       33.78
         37 |          4        5.41       39.19
         39 |          1        1.35       40.54
         40 |          6        8.11       48.65
         41 |          4        5.41       54.05
         42 |          7        9.46       63.51
         43 |         12       16.22       79.73
         44 |          3        4.05       83.78
         45 |          3        4.05       87.84
         46 |          3        4.05       91.89
         48 |          2        2.70       94.59
         51 |          1        1.35       95.95
        999 |          3        4.05      100.00
------------+-----------------------------------
      Total |         74      100.00
```

MISSING DATA IN THE WILD

HETENURE **HETENURE**

Location: 29-30 (width: 2; decimal: 0)

Variable Type: numeric

Question: ARE YOUR LIVING QUARTERS...

Value	*Label*	*Unweighted Frequency*	*%*
-1	BLANK	14852	9.8 %
1	OWNED OR BEING BOUGHT BY A HH MEMBER	94178	62.2 %
2	RENTED FOR CASH	40568	26.8 %
3	OCCUPIED WITHOUT PAYMENT OF CASH RENT	1710	1.1 %

Based upon 151308 valid cases out of 151308 total cases.

- Mean: 1.09
- Median: 1.00
- Mode: 1.00
- Minimum: -1.00
- Maximum: 3.00
- Standard Deviation: 0.83

MISSING VALUES IN STATA

```
misstable summarize [varlist]
```

```
. misstable summarize mpg rep78
```

```
                                                  Obs<.
                                        +------------------------------
             |                          | Unique
    Variable |     Obs=.     Obs>.     Obs<.   | values        Min          Max
-------------+--------------------------------+------------------------------
         mpg |                  6         68  |     19          12           41
       rep78 |          5                 69  |      5           1            5
-----------------------------------------------------------------------------
```

MISSING VALUES IN STATA

```
misstable tree [varlist], [frequency]
```

```
. misstable tree mpg rep78 trunk turn, frequency

  Nested pattern of missing values
         mpg      rep78      trunk       turn
  ---------------------------------------------
           6          0          0          0
                                              0
                                 0          0
                                              0
                      6          0          0
                                              0
                                 6          0
                                              6
          68          5          0          0
                                              0
                                 5          2
                                              3
                     63          4          0
                                              4
                                59          1
                                           58
  ---------------------------------------------
(number missing listed first)
```

MAY BE "MCAR"

MISSING VALUES IN STATA

```
. use http://www.stata-press.com/data/r13/studentsurvey, clear

. misstable tree dept age female, frequency

  Nested pattern of missing values
       dept         age      female
 ------------------------------------
          9           3           3
                                  0
                      6           0
                                  6
        116           0           0
                                  0
                    116           0
                                116
 ------------------------------------
(number missing listed first)
```

FUNDAMENTAL QUESTION:

AT THIS STAGE IN THE RESEARCH PROCESS, DO YOU NEED TO KNOW WHY DATA ARE MISSING?

MISSING VALUES IN STATA

1. The period (`.`) used to represent missing data; can be combined with letters a through z
2. `(all positive values) < . < ∞`
3. `(all positive values) < . < .a < .b < ⋯ < .z < ∞`

RECODING MISSING VALUES

```
recode varname oldVal = newVal [oldVal = newVal]
```

```
. use autoMissing.dta

. recode turn (999 = .)
(turn: 3 changes made)

. recode trunk (-1 = .a)
(trunk: 4 changes made)

. recode mpg (.a/.b = .)
(mpg: 6 changes made)
```

Tips:

- Apply value labels if using .a, .b, etc.
- Forward slash allows for a range of values to be recoded - i.e. all values between .a and .b

MISSING DATA WORKFLOW

1. Determine if missing data need to be recoded within variables.

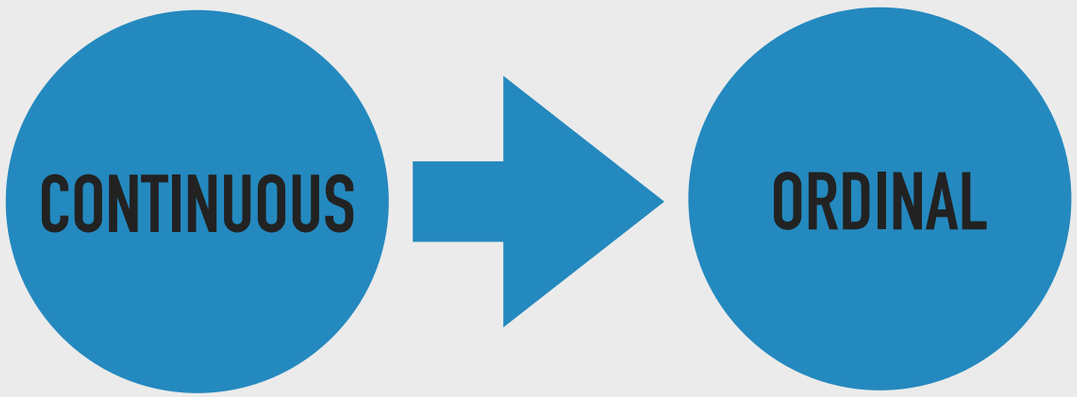
2. Determine if you want to preserve different types of missing data, or you only want to identify missing values without differentiating between them.

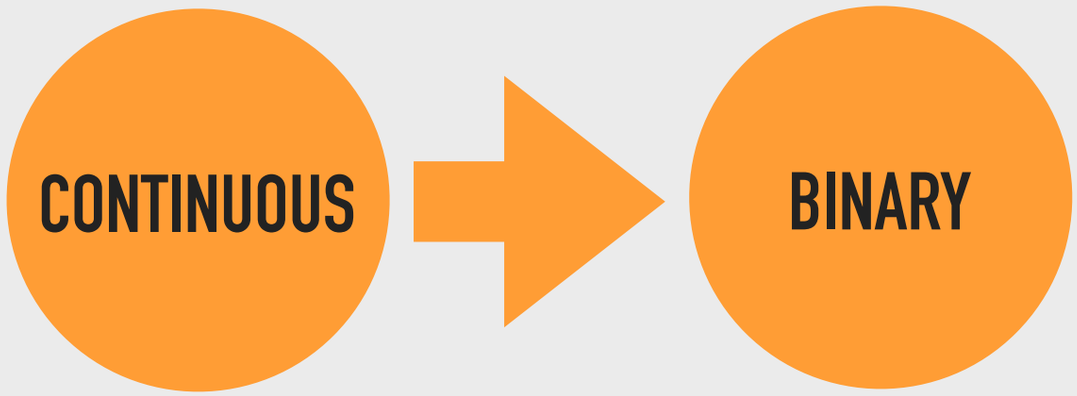
3. Recode values accordingly using the `recode` command.

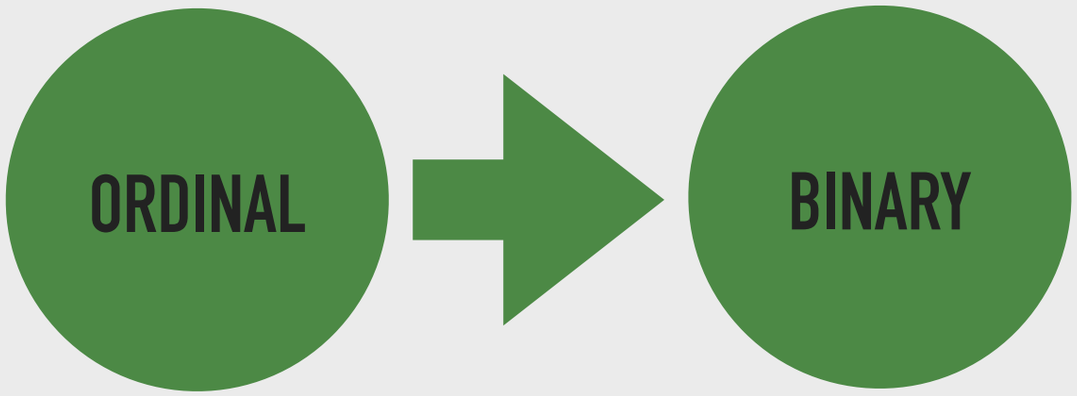
4. Use `misstable` commands to look for patterns in missingness.

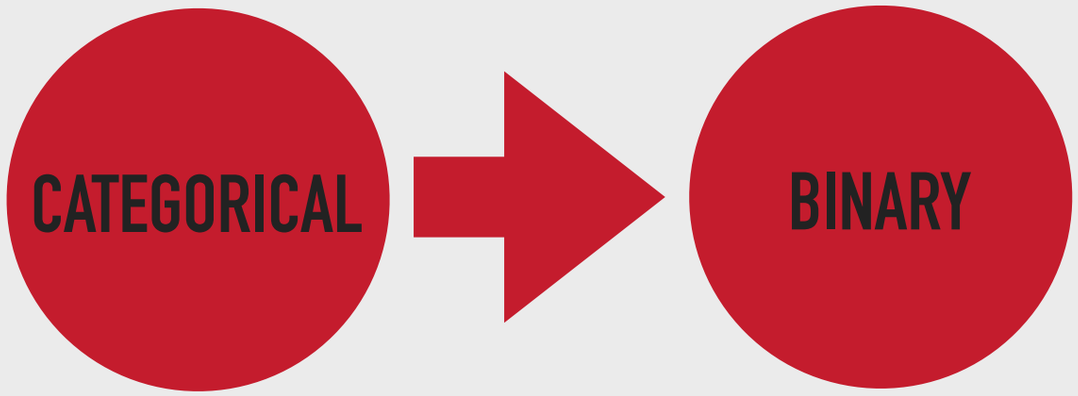
2 RECODING DATA

WHY RECODE?


CONTINUOUS
ORDINAL


CONTINUOUS
BINARY


ORDINAL
BINARY


CATEGORICAL
BINARY

STEP 1: GENERATE A NEW VARIABLE

```
generate newVar = oldVar
```

```
. generate mpgOrd = mpg
```

Tips:

- Use short, intuitive names (ex - `mpgOrd` for the ordinal version of `mpg`).
- Keep names short.

STEP 2: RECODE VALUES

```
recode varname oldVal = newVal [oldVal = newVal]

. recode mpgOrd (12/19 = 1) (20/29 = 2) (30/35 = 3) (41 = 4)
```

Tips:

- Wrap values in () for clarity and readability
- Forward slash allows for a range of values to be recoded - i.e. all values between 12 and 19 or all values between 20 and 29

STEP 2: RECODE VALUES

```
. generate mpgHigh = mpg

. recode mpgHigh (12/29 = 0) (30/41 = 1)
```

```
. generate mpgBin = mpgOrd

. recode mpgBin (1/3 = 0) (4 = 1)
```

STEP 3: DEFINE VALUE LABELS

```
label define lblName val [“]lbl[“] [[“]lbl[“]]
```

```
. label define mpgOrdVals 1 “< 20” 2 “20 to 29” 3 “30 to 39” 4 “>= 40”
```

Tips:

- Keep label name short but descriptive
- Keep values labels short but descriptive - what does this value represent or measure?

STEP 4: LABEL VALUES

```
label values varname lblName
```

```
. label values mpgOrd mpgOrdVals
```

STEP 5: LABEL VARIABLE

```
label variable varname “labelText”
```

```
. label variable mpgOrd “ordinal version of mpg”
```

Tips:

- Keep variable labels short but descriptive - what does this variable represent or measure?

3 OTHER DATA OPERATIONS

DROPPING VARIABLES

```
drop varlist
```

```
. drop mpg trunk
```

Tips:

- Use `drop` for removing *small* numbers of variables from datasets or for removing variables from *smaller* datasets.

KEEPING VARIABLES

```
keep varlist
```

```
. keep mpg trunk
```

Tips:

- Use keep for removing *large* numbers of variables from datasets or for removing variables from *larger* datasets.

REORDERING VARIABLES

```
order varlist [, first last before(varname) after(varname)]
```

```
. order mpg trunk, first
```

```
. order mpg trunk, last
```

```
. order mpg trunk, before(weight)
```

```
. order mpg trunk, after(weight)
```

SAVING DATA

```
save [“]filename.dta[“], replace
```

```
. save “mpgAug29.dta”, replace
```

Tips:

- Use short filenames
- Avoid spaces and special characters in filenames
- Use snake_case or camelCase to include multiple words
- Imply a logical order (use dates, numbers, etc.)
- Never call things final!

DOCUMENT DETAILS

Document produced by Christopher Prener, Ph.D for the Saint Louis University course SOC 5050: QUANTITATIVE ANALYSIS - APPLIED INFERENTIAL STATISTICS. See the course wiki and the repository README.md file for additional details.