# Programming in Stata

Erin Hengel

# Basic syntax

```
[prefix :] command [varlist] [=exp]
  [if] [in] [weight] [using filename]
  [, options]
```

Source: Social Science Computing Cooperative, University of Wisconsin, Madison

# Navigating within Stata

```
cd

mkdir

copy

pwd

dir/ls

erase

rmdir

shell
```

# Macros

Two different ways to define a macro

- `local` *`macroname`* `"text"/number/expression`
- `local` *`macroname`* `= "text"/number/expression`

What do each of the following macros contain?

```
local mymacro1   2 + 2
local mymacro2 = 2 + 2
```

How do I reference a macro named mymacro?

- Local macros: `` `mymacro’ ``
- Global macros: `$mymacro`

## Exercise

- Load the example `auto.dta` dataset (hint: see the help files for `sysuse`).

- Define a macro called controls which contains `mpg`, `rep78` and `headroom`.

- Regress `price` on `` `controls' `` for foreign vehicles and then again for domestic vehicles.

# Macro expressions

Compare and contrast the following commands

- `display "two plus two  = 2 + 2"`
- ``display "two plus two `= 2 + 2'"``

## Exercise

- Summarise **`mpg`**
- Use a macro expression to display

```
the mean of mpg is 2.1297
```

# Macro extended functions

Example

```
local tlab : variable label trunk

display “`lab'"
```

## Syntax

- `local` *macroname* `:` *extended macro function*

## Exercises

- Use a macro extended expression to display the variable label on **`make`** without first assigning it to a macro name (*hint*: the colon is equivalent to the equal sign in the earlier macro expression `` `=2+2' ``.

- Use a macro extended function to display the storage type (e.g., **`int`**, **`float`**, **`long`**, **`str1`**,…) of **`make`** (*hint*: see help **`extended_fcn`**).

- Use a macro extended function to return the value label associated to **`foreign`** when it equals 1.

Parsing strings

- Counting elements
- Returning parts of strings
- Replacing parts of strings

# Exercises

- Use a macro extended function to count the number of variables in the macro **`` `controls' ``**
- Use a macro extended function to display only the first variable in **`` `controls' ``**
- Use a macro extended function to replace the variable **`headroom`** with **`displacement`**

# Macro list functions

## Syntax

- `local` *macroname* `:` `list` *function*

- Extract unique elements of lists
- Alphabetise lists
- Compare and combine lists

Exercises

- Define a macro called animals exactly equal to the following text: “`cat dog cat parrot parrot`”. Use a macro list function to display only the unique elements in `` `animals' ``.

- Define a macro called groceries with the following elements in it: `pears apples strawberries yoghurt wine cheese`. Use a macro list function to alphabetise `` `groceries' ``. Display your alphabetised `` `groceries' ``.

- Define a macro called union which contains all members of `` `animals' `` and `` `groceries' ``. Use a macro list function to display its size.

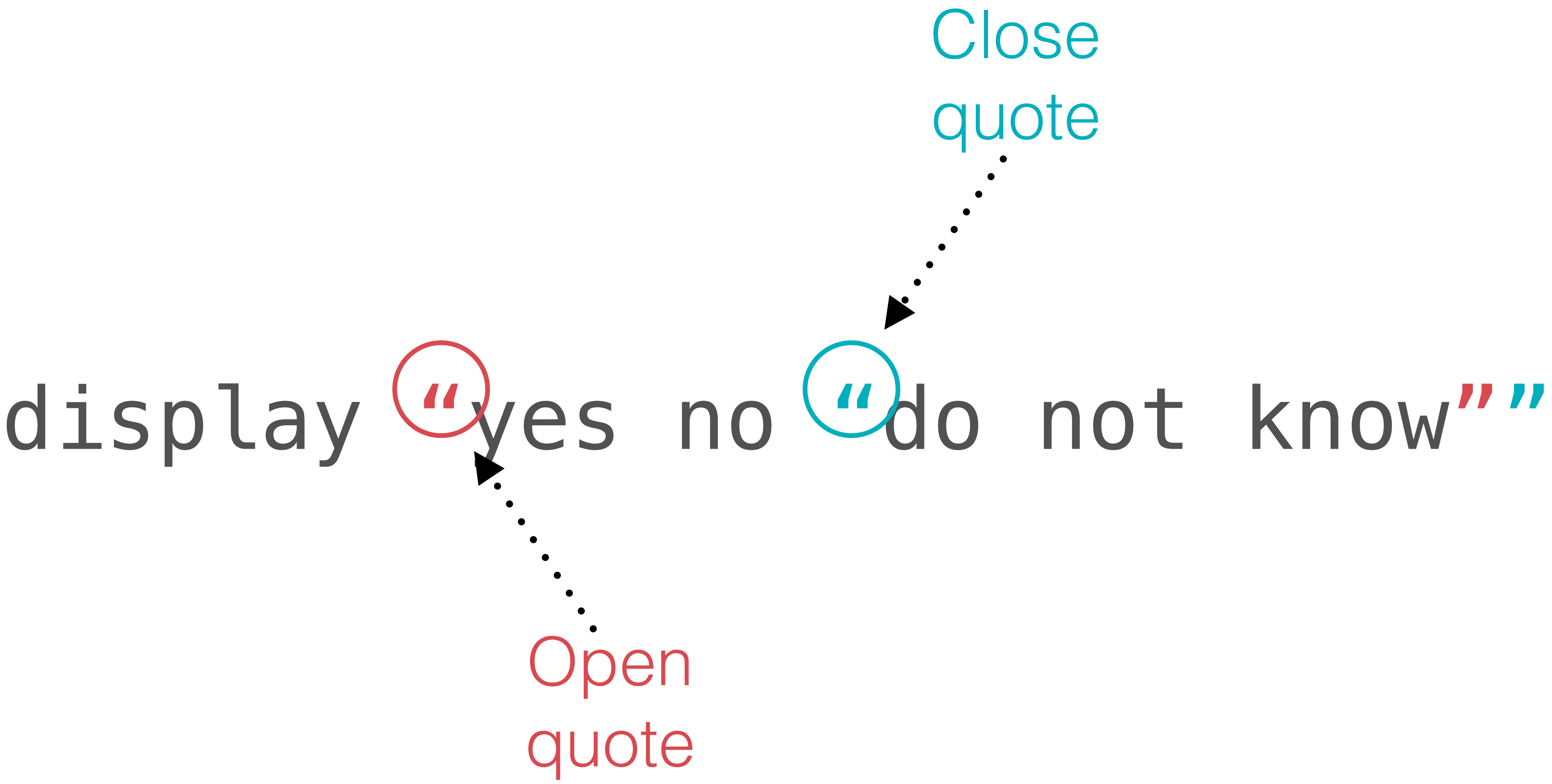
- Sort `` `union' `` and display the position of the element `wine` using a macro list function.

# Compound double quotes

Example

```
local answers yes no “do not know”

display “`answers’”
```



Close quote

```
display “yes no “do not know””
```

Open quote

Example

```
local answers yes no “do not know”

display `“`answers’”’
```

## Exercises

- Use a macro extended function to display all files in your current directory.

# `foreach` loop

Syntax

```
foreach thing in list {
    do something
}
```

## Exercises

- Loop over the list **`alpha`**, **`beta`** and **`gamma`** and display each in turn.
- Loop over the macro **`` `union' ``** and display each element in turn.

Syntax

```
foreach thing of listype list {
    do something
}
```

Example

```
foreach item of local union {
   display “`item’”
}
```

# Exercises

- Loop over the macro `` `controls' `` and summarise each in turn.

- Using a loop, create new variables for all items in `` `groceries' `` equal to a random number between 0 and 1 (*hint*: use the function `runiform()`).

- Using a loop, display the variable labels of all variables from `make` to `foreign` without typing the variable names individually.

- Using a loop, display all odd numbers between 3 and 13 (hint: see `help numlist`).

# `forvalues` loop

Syntax

```
forvalues i = range {
    do something
}
```

## Exercises

- Loop from 1 to 10 and display each number in turn.
- Using a loop, create 100 variables named `x1`, `x2`, …, `x100` each equal to a random draw from a standard normal distribution.
- Loop through every third `x` starting at `x3` (i.e., `x3`, `x6`, …, `x99`) and list its storage type.

# `while` loop

Syntax

```
while exp is true {
    do something
}
```

Example

```
local i = 1

while `i’ < 20 {

   display `i’

   local i = `i’ + 1

}
```

# Exercises

- Drop variables **`x1`** through **`x100`** and regenerate them with a **`while`** loop.

- Use **`while`** to display the numbers 1-20 but use an expansion operator to increment **`` `i' ``** (*hint*: scroll to the end of the pdf documentation on extended macro functions).

# `if` clauses

Syntax

```
if exp is true {
    do this
}
else {
    do that
}
```

## Example

```
local mymac = 7
if mod(`mymac’,2) == 1 {
   display `mymac’ “ is odd”
}
else {
   display `mymac’ “ is even”
}
```

## Exercises

- Redefine `` `mymac' `` so it’s equal to a random integer between 1 and 99 (*hint*: use **`runiform()*100`** to generate a random number between 1 and 100 and then find a function which will turn that number into an integer). Does your **`if`** clause still work?

# Indexing

Syntax

```
varname[i]
```

## Exercises

- Loop through all observations and display their make, price, mpg and rep78 in the following format

```
Buick Riviera
    Price $10,374 MPG 16 Repairs 3
```

(*hint*: check out `display`'s help files for the formatting and use `_N` where appropriate)

Stata’s constants

- **_N**: total number of observations
- **_n**: number of the current observation

Exercises

- Load `xtline1.dta` from the system example datasets. Keep only those observations that correspond to the first person. Generate `lagcal` equal to the lagged value of `calories`.

- Reload `xtline1.dta` and generate `lagcal` equal to the lagged value of `calories` for all people in the file (*hint*: use `by`).

- Using indices, create a variable which reverse the value of `day` (i.e., the last observation's `day` is linked to the first observation's `day`, the penultimate observation's `day` is linked to the second observation's `day`, etc.). Format your new variable appropriately.

program

Syntax

```
program progname {
    whatever your program does
end
```

## Exercises

- Create a program called `whatsmyname` which displays “`hello, my name is`”

Example

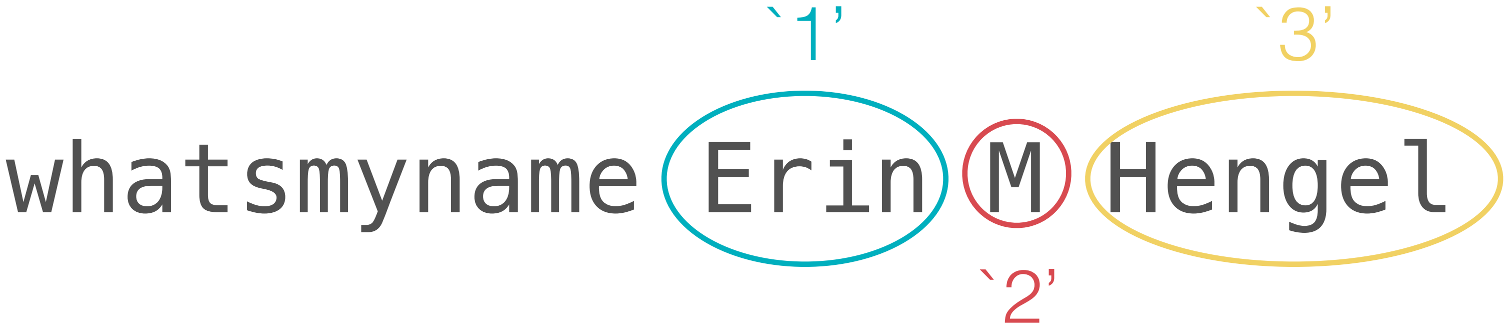
```
capture program drop myname

program whatsmyname

   display "hello my name is"

end
```

# Passing arguments



`1'

```
whatsmyname Erin M Hengel
```

`2'

`3'

| | |
|---|---|
| `*’ | All arguments |
| `0’ | All arguments (same as `*’) |
| `1’ | First argument |
| `2’ | Second argument |
| `3’ | Third argument |
| … | … |

## Exercises

- Modify **`whatsmyname`** to include names the user types in.
- What happens if the user doesn’t type in any names?

# Automatically loaded do-files (ado-files)

Stata looks for programs according to this hierarchy

1. Built-in commands
2. Defined programs
3. PLUS folder
    - downloaded user-defined programs from SSC
4. PERSONAL folder
    - saved programs you’ve made
5. Current directory

When should I use do-files, programs within do-files and ado-files?

1. Never use Stata interactively.
2. Use do-files for sequential analysis.
3. Store programs in do-files if blocks of code will be used more than once.
4. Store ado-files in a project directory if it's specific to that project (e.g., customised for a particular dataset) but used by more than one do-file.
5. Store ado-files in your PERSONAL ado-directory for programs specific to you but used in various projects.
6. Store ado-files in the SITE ado-directory for programs your team will use.
7. Submit your ado-file to Boston College Statistical Software Components (SSC) if you think other people will want to use it, too.

Source: Adapted from Stata NetCourse 151: Indtroduction to Stata Programming

## Exercises

- Save **`whatsmyname`** as an ado-file in your current directory.
- Change **`whatsmyname.ado`** to display the last name then the first name. Did it work? Why not?
- Now change **`whatsmyname.ado`** back. Did it work? Why not?

Example

```
discard

whatsmyname Iko Hengel
```

# Writing a help-file

- If you use a program regularly, a simple help-file isn’t a bad idea.
- help-files are just text-files saved with the same name as the ado-file it “help” and an .sthlp ending.
- Keep it in the same directory as its corresponding ado-file.

Source: Adapted from Stata NetCourse 151: Indtroduction to Stata Programming

## Exercises

- Write a simple help-file for `whatsmyname.ado` and save it. Does it come up when you type `help whatsmyname` in the console?

# Version control

- Start every do-file and ado-program with `version` *`vnum`*
- Stata changes, so some features which worked one way in one version don’t work that same way in another version
- Including `version` *`vnum`* tells Stata which version to use when interpreting the do-file or program so it does what you want it to do
- Use a version marker comment
  - `*! myprogram 20 Feb 2014 version 13.1`

Source: Adapted from Stata NetCourse 151: Indtroduction to Stata Programming

## Exercises

- Modify `whatsmyname` so it includes the version of Stata you coded it in and an appropriate version marker.

# Organising do-files

# Organising do-files: Stata’s method

- One directory per project.
- No analysis should be done interactively.
- All do-files create logs
- Separate dataset creation do-files from analysis do-files, naming the former cr*.do and the latter an*.do.
- do-file execution is organised by a master.do which lists the do-files in the order that they are run

```
do file1
do file2
…
```

- Once a do-file has been listed in master.do, it is never, ever edited again. Instead, add more do-files.

Source: Adapted from Stata NetCourse 151: Indtroduction to Stata Programming

## Organising do-files: Erin's method for database creation

- Don't alter the raw data or accidentally save over it. The only `save` command is at the end!
  - `preserve`
  - `temporary files`
- Start easy, don't plan too much and test often.
  - `assert`
  - `confirm`
- Once satisfied with the end product, throw it all away and recode the entire thing from scratch.

Source: Adapted from Stata NetCourse 151: Indtroduction to Stata Programming

# Introducing Mata

## Should I use Mata?

- Probably not
- But if you are familiar with R or Matlab or just love linear algebra, thinking in matrix terms may be easier for you
- Or if you really need to speed up your code

Source: Adapted from Stata NetCourse 151: Indtroduction to Stata Programming

## How do I use it?

- Just type **`mata`** in the prompt or within your do-file to invoke a Mata session.
- Type **`end`** to quit Mata.

Source: Adapted from Stata NetCourse 151: Indtroduction to Stata Programming

## Example

```
mata
emat = 7 + 3
emat
emat = “Iko” + “Hengel”
emat
```

Example

```
emat = (“Iko”,”Hengel”)

emat = (21\08)

mmat = (17\06)

vmat = (25,03\03,11)

emat, mmat, vmat
```

Example

```
ivmat = invsym(vmat)

ivmat*vmat

vmat[1,2]

ivmat[1,1]*vmat[2,2]
```

## Example

```
function add(a,b) return(a+b)

add(vmat,ivmat)

add(“Iko”,”Hengel”)
```

Least squares regression: regress `price` on `mpg` and `rep78`

- Load data while still in Stata
- Create a vector of ones
- Drop missing values and variables we aren’t using
- Start Mata

# Example

```
y = st_data(.,”price")

X = st_data(.,(“mpg”,”rep78”,”ones”))

b = invsym(X’X)*X'y

e = y − X*b

n = rows(X)

k = cols(X)

s2 = (e’e)/(n−k)

V = s2*invsym(X'X)
```

Turn this into a Mata function:

```
mata:

mata clear

void leastsquaresmata()

{

    calculations

    st_numscalar(“e(mpg)",b[1,1])

 }
```

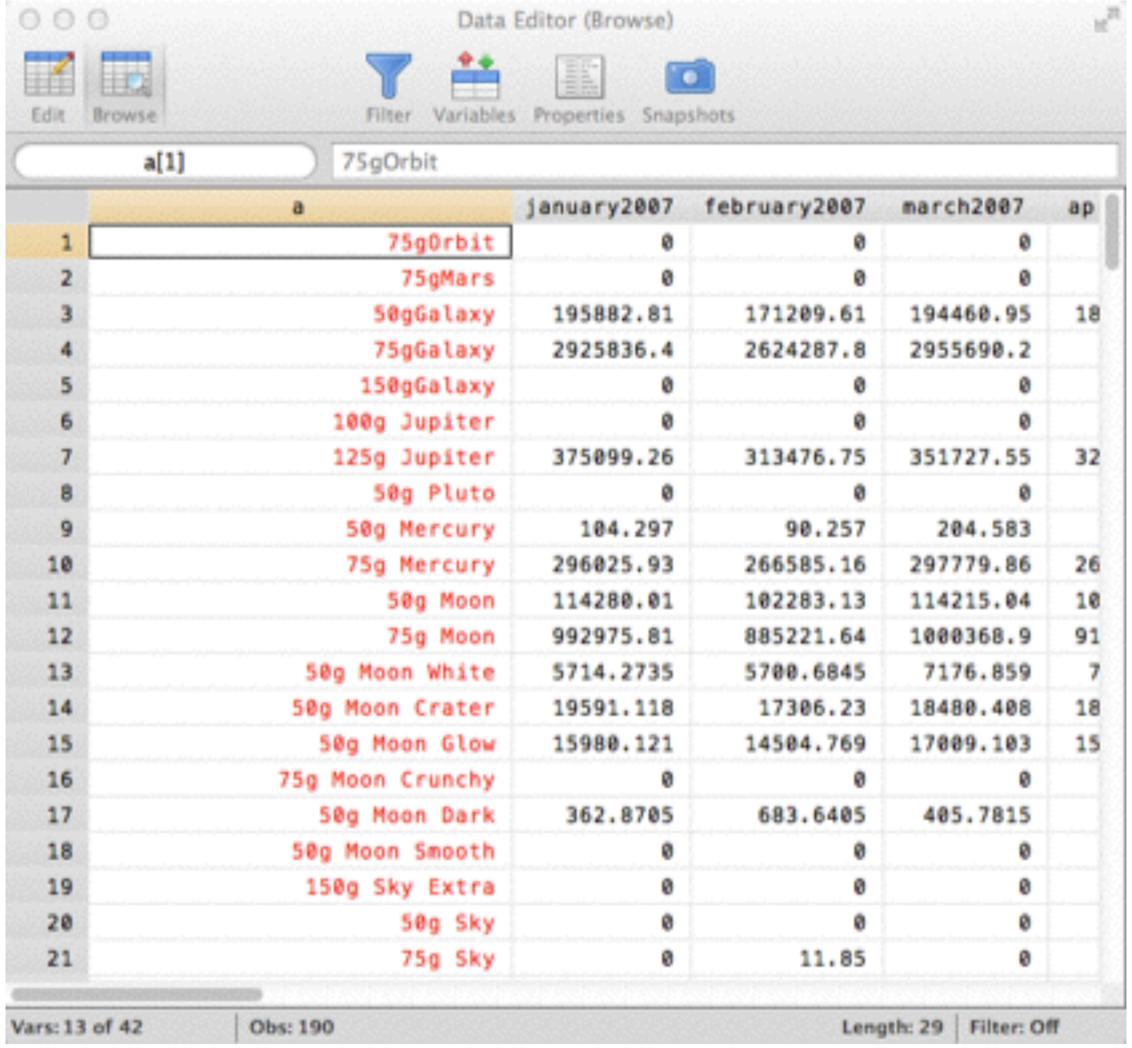
# Exercises

- Modify the Mata function so that it accepts any independent variables

# Reshaping data

# Wide data

- ✦ Few observations.
- ✦ Many variables.
- ✦ One variable uniquely identifies each observation.
- ✦ Many variables contain data across one dimension.



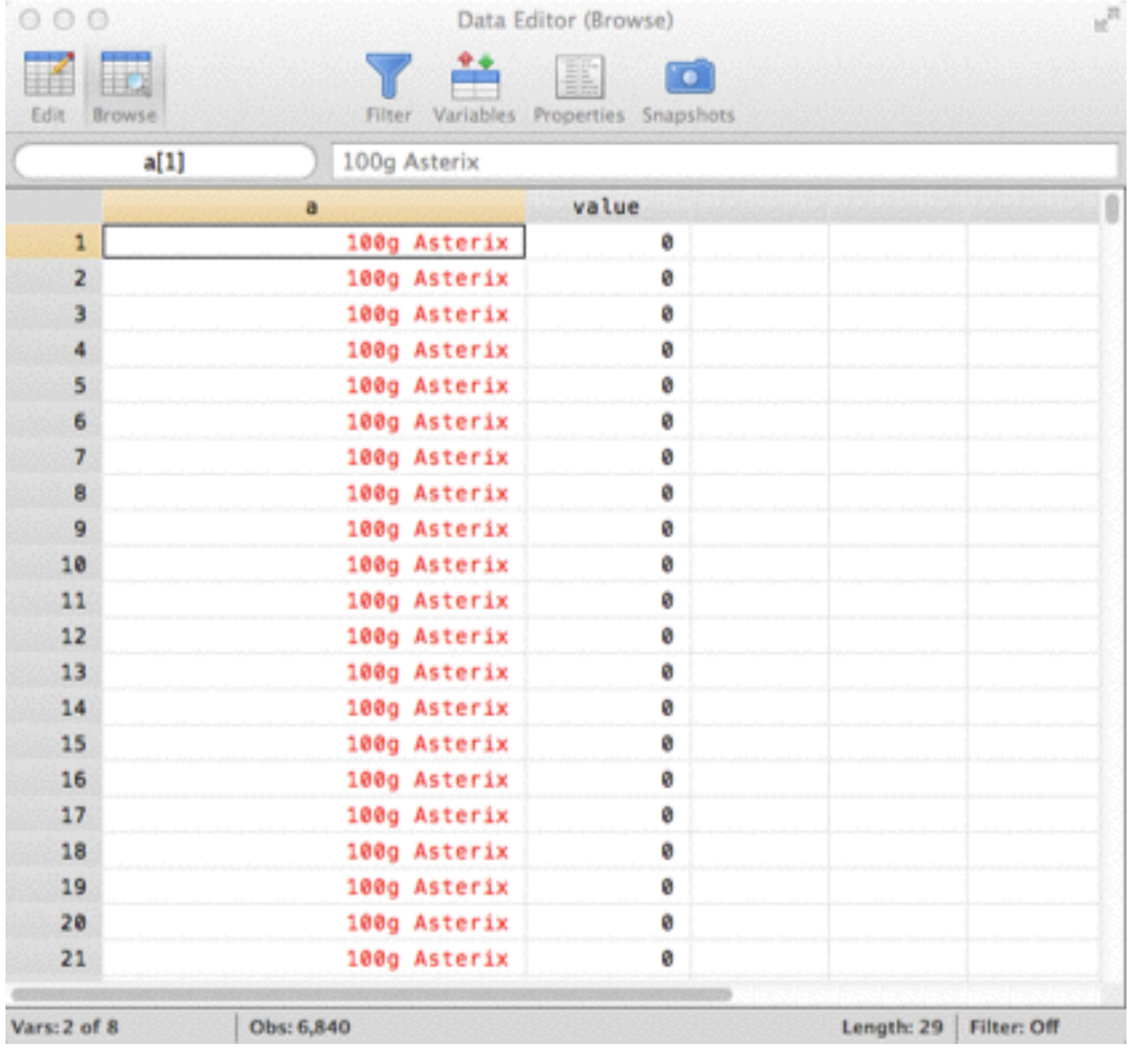
a[1] 75gOrbit

|  | a | january2007 | february2007 | march2007 | ap |
|---|---|---|---|---|---|
| 1 | 75gOrbit | 0 | 0 | 0 |  |
| 2 | 75gMars | 0 | 0 | 0 |  |
| 3 | 50gGalaxy | 195882.81 | 171209.61 | 194460.95 | 18 |
| 4 | 75gGalaxy | 2925836.4 | 2624287.8 | 2955690.2 |  |
| 5 | 150gGalaxy | 0 | 0 | 0 |  |
| 6 | 100g Jupiter | 0 | 0 | 0 |  |
| 7 | 125g Jupiter | 375099.26 | 313476.75 | 351727.55 | 32 |
| 8 | 50g Pluto | 0 | 0 | 0 |  |
| 9 | 50g Mercury | 104.297 | 90.257 | 204.583 |  |
| 10 | 75g Mercury | 296025.93 | 266585.16 | 297779.86 | 26 |
| 11 | 50g Moon | 114280.01 | 102283.13 | 114215.04 | 10 |
| 12 | 75g Moon | 992975.81 | 885221.64 | 1000368.9 | 91 |
| 13 | 50g Moon White | 5714.2735 | 5700.6845 | 7176.859 | 7 |
| 14 | 50g Moon Crater | 19591.118 | 17306.23 | 18480.408 | 18 |
| 15 | 50g Moon Glow | 15980.121 | 14504.769 | 17009.103 | 15 |
| 16 | 75g Moon Crunchy | 0 | 0 | 0 |  |
| 17 | 50g Moon Dark | 362.8705 | 683.6405 | 405.7815 |  |
| 18 | 50g Moon Smooth | 0 | 0 | 0 |  |
| 19 | 150g Sky Extra | 0 | 0 | 0 |  |
| 20 | 50g Sky | 0 | 0 | 0 |  |
| 21 | 75g Sky | 0 | 11.85 | 0 |  |

Vars: 13 of 42 | Obs: 190 | Length: 29 | Filter: Off

# Long data

- ✦ Many observations.
- ✦ Few variables.
- ✦ No variable uniquely identifies each observation.
- ✦ Each variable contains data over multiple dimensions.



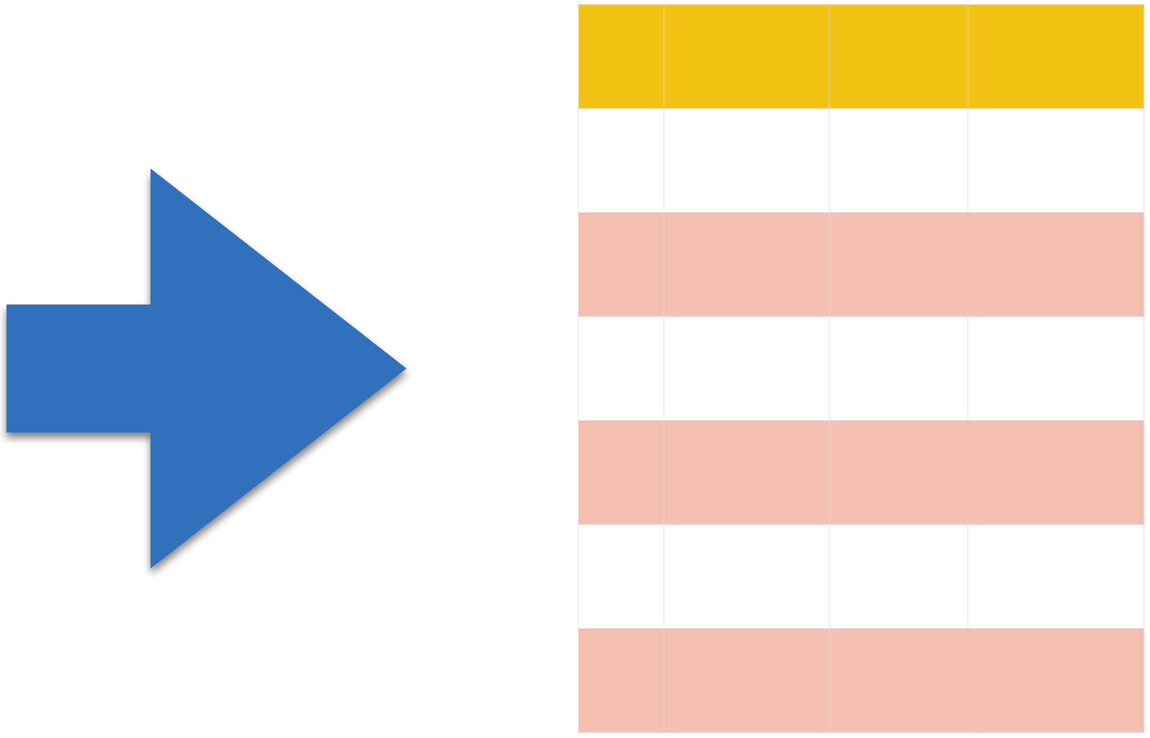
a[1] 100g Asterix

| | a | value |
|---|---|---|
| 1 | 100g Asterix | 0 |
| 2 | 100g Asterix | 0 |
| 3 | 100g Asterix | 0 |
| 4 | 100g Asterix | 0 |
| 5 | 100g Asterix | 0 |
| 6 | 100g Asterix | 0 |
| 7 | 100g Asterix | 0 |
| 8 | 100g Asterix | 0 |
| 9 | 100g Asterix | 0 |
| 10 | 100g Asterix | 0 |
| 11 | 100g Asterix | 0 |
| 12 | 100g Asterix | 0 |
| 13 | 100g Asterix | 0 |
| 14 | 100g Asterix | 0 |
| 15 | 100g Asterix | 0 |
| 16 | 100g Asterix | 0 |
| 17 | 100g Asterix | 0 |
| 18 | 100g Asterix | 0 |
| 19 | 100g Asterix | 0 |
| 20 | 100g Asterix | 0 |
| 21 | 100g Asterix | 0 |

Vars: 2 of 8 | Obs: 6,840 | Length: 29 | Filter: Off

# From wide to long

| id | sex | inc80 | inc81 |
|---|---|---|---|
| 1 | 0 | 5000 | 5500 |
| 2 | 1 | 2000 | 2200 |
| 3 | 0 | 3000 | 2000 |

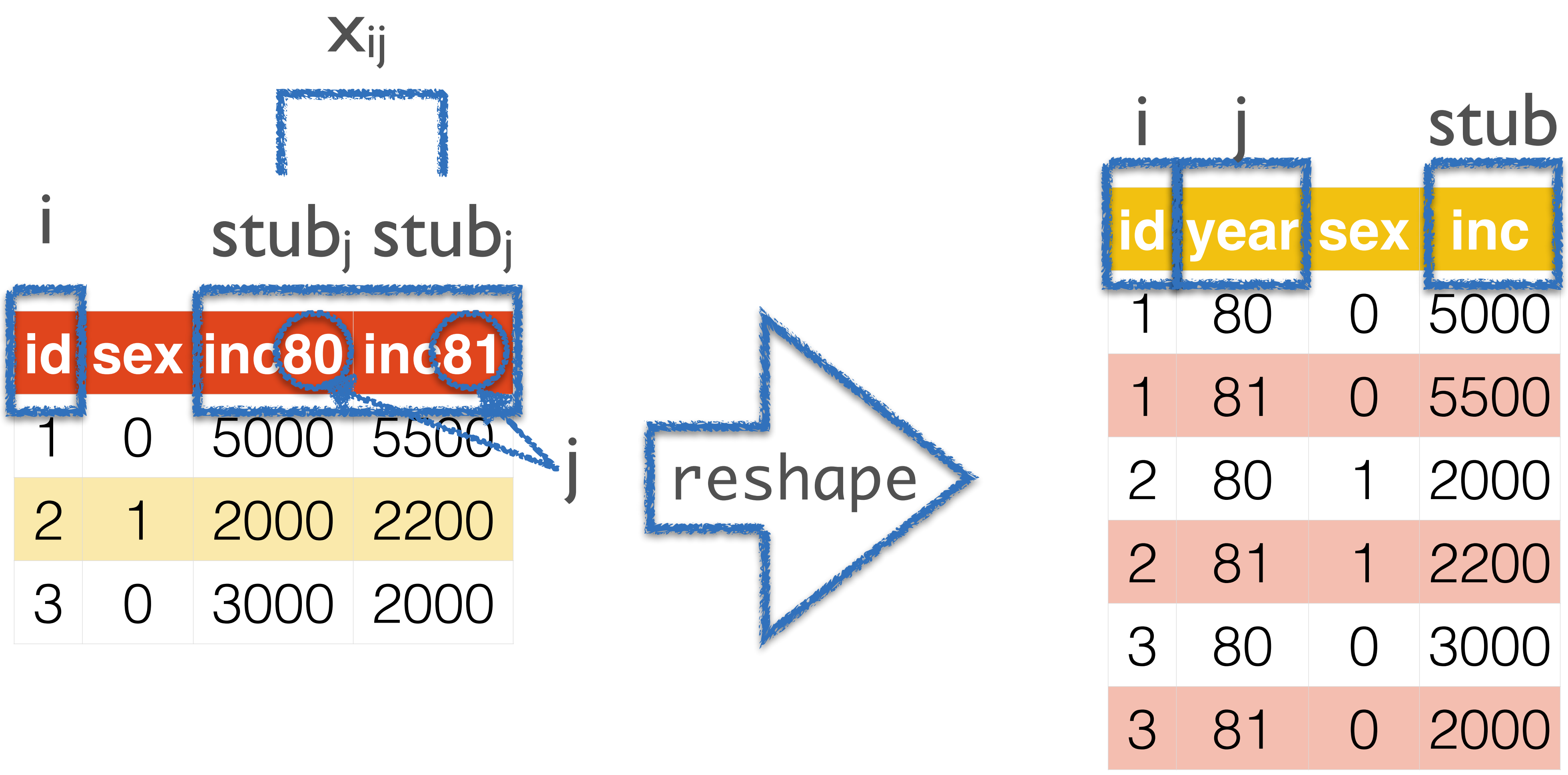


# From wide to long

| id | sex | inc80 | inc81 |
|---|---|---|---|
| 1 | 0 | 5000 | 5500 |
| 2 | 1 | 2000 | 2200 |
| 3 | 0 | 3000 | 2000 |

| id | year | sex | inc |
|---|---|---|---|
| 1 | 80 | 0 | 5000 |
| 1 | 81 | 0 | 5500 |
| 2 | 80 | 1 | 2000 |
| 2 | 81 | 1 | 2200 |
| 3 | 80 | 0 | 3000 |
| 3 | 81 | 0 | 2000 |

# Syntax: wide to long



| id | sex | inc80 | inc81 |
|---|---|---|---|
| 1 | 0 | 5000 | 5500 |
| 2 | 1 | 2000 | 2200 |
| 3 | 0 | 3000 | 2000 |

| id | year | sex | inc |
|---|---|---|---|
| 1 | 80 | 0 | 5000 |
| 1 | 81 | 0 | 5500 |
| 2 | 80 | 1 | 2000 |
| 2 | 81 | 1 | 2200 |
| 3 | 80 | 0 | 3000 |
| 3 | 81 | 0 | 2000 |

```
reshape long stub, i(i) j(j)
```

# Exercise

- Load **reshape1** (using **webuse**) and drop **ue80**, **ue81** and **ue82**.

```
webuse reshape1, clear
drop ue*
```

- Is the data long or wide? Convert to the other form.

```
reshape long inc, i(id) j(year)
```

- Use a shortcut to convert the data back again.

```
reshape wide
```

# Exercise

- Load **reshape1** again, but don't drop anything.

```
webuse reshape1
```

- Reshape from wide to long.

```
reshape long inc ue, i(id) j(year)
```

- Use a shortcut to convert it back to long.

```
reshape long inc ue, i(id) j(year)
```

# Exercise

- Load **reshape2** from the web.

```
webuse reshape2
```

- Try to reshape from wide to long.

```
reshape long inc ue, i(id) j(year)
```

- Why did you get an error?

# Exercise

- Load **reshape1** from the web and drop **ue81**.

```
webuse reshape1
drop ue81
```

- Reshape from wide to long.

```
reshape long inc ue, i(id) j(year)
```

- How did **reshape** handle the missing **ue81**?

- Convert the data back again. What happens to **ue81**?

```
reshape wide
```

# Exercise

- Load `reshape3` from the web.

```
webuse reshape3
```

- Reshape from wide to long.

```
reshape long inc@r ue, i(id) j(year)
```

# Exercise

- Load `reshape4` from the web.

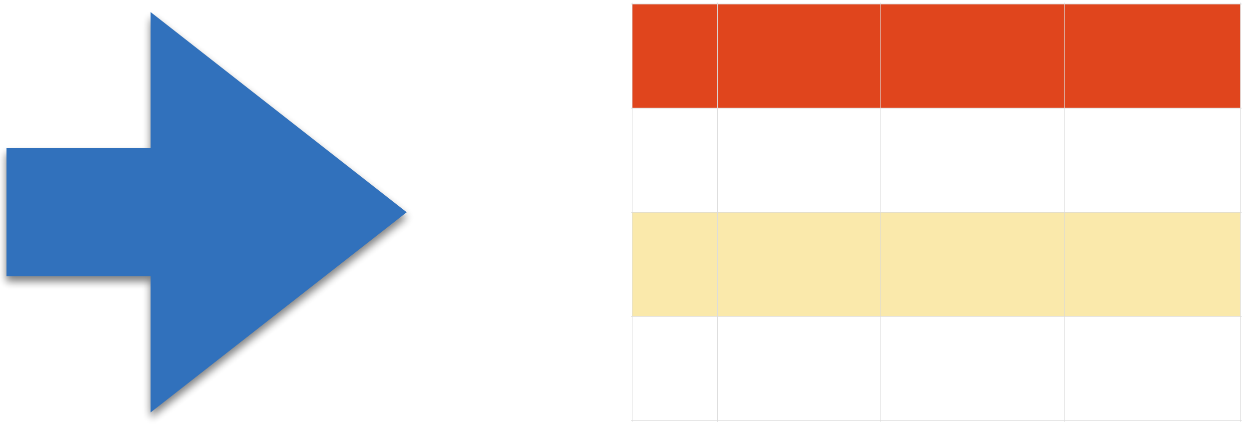
```
webuse reshape4
```

- Reshape from wide to long.

```
reshape long inc, i(id) j(sex) string
```

# From long to wide

| id | sex | kids | inc |
|---|---|---|---|
| 1 | f | 0 | 9000 |
| 1 | m | 0 | 2000 |
| 2 | f | 1 | 7000 |
| 2 | m | 1 | 1000 |
| 3 | f | 2 | 3000 |
| 3 | m | 2 | 8000 |

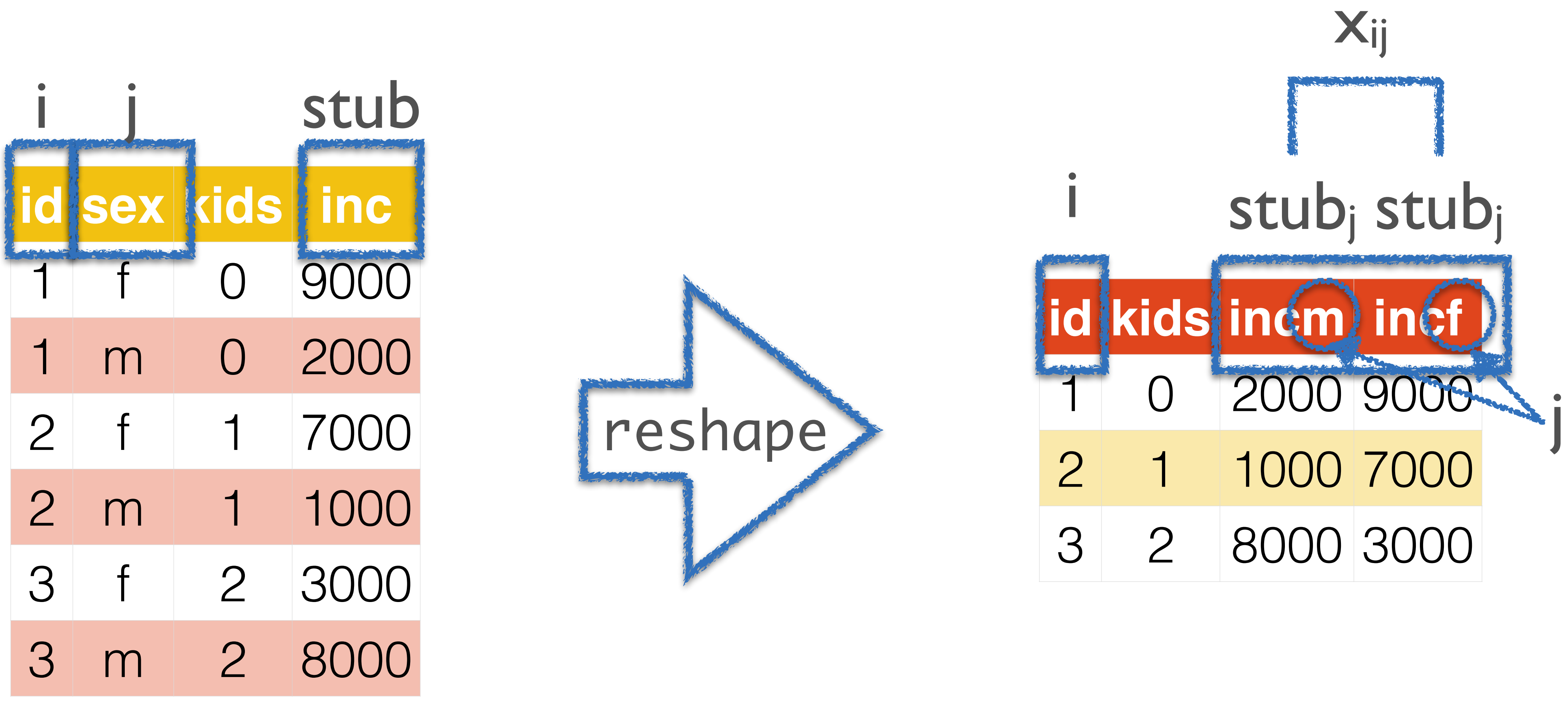


# From long to wide

| id | sex | kids | inc |
|---|---|---|---|
| 1 | f | 0 | 9000 |
| 1 | m | 0 | 2000 |
| 2 | f | 1 | 7000 |
| 2 | m | 1 | 1000 |
| 3 | f | 2 | 3000 |
| 3 | m | 2 | 8000 |

| id | kids | incm | incf |
|---|---|---|---|
| 1 | 0 | 2000 | 9000 |
| 2 | 1 | 1000 | 7000 |
| 3 | 2 | 8000 | 3000 |

# Syntax: long to wide



| id | sex | kids | inc |
|---|---|---|---|
| 1 | f | 0 | 9000 |
| 1 | m | 0 | 2000 |
| 2 | f | 1 | 7000 |
| 2 | m | 1 | 1000 |
| 3 | f | 2 | 3000 |
| 3 | m | 2 | 8000 |

| id | kids | incm | incf |
|---|---|---|---|
| 1 | 0 | 2000 | 9000 |
| 2 | 1 | 1000 | 7000 |
| 3 | 2 | 8000 | 3000 |

```
reshape wide stub, i(i) j(j)
```

# Exercise

- Load **`reshape6`** from the web.

```
webuse reshape6
```

- Reshape from long to wide.

```
reshape wide inc ue, i(id) j(year)
```

- Why did you get an error?

# Exercise

- Load **reshapexp1** from the web.

```
webuse reshapexp1
```

- Try to reshape from long to wide.

```
reshape wide inc ue, i(id) j(year)
```

- Why did you get an error?

# `reshape` isn't working…

- Wide to long: does `i` uniquely identify every observation?

```
tabulate i
return list
```

# `reshape` isn’t working…

- Long to wide: within each `i`, is there only one `j`?

```
egen unique = group(id year)
tabulate unique
return list
```

# `reshape` isn’t working…

- Long to wide: do you mention all variables which vary within `i`?

- Either way: are `i` or `j` string variables?

- Type `reshape error`.

# Collapsing data

# Why do we want to do this?

- Collapsing data is Stata’s version of pivot tables.
- It’s a quick and dirty way to make graphs and tables.

# Exercise

- Create a dataset with the mean `volume` for each `date`.

```
collapse volume, by(date)
```

- Create a dataset with the mean `volume` and `value` for each `date`.

```
collapse volume value, by(date)
```

- Create a dataset with total `volume` and `value` for each `date` and `manufacturer`.

```
collapse volume value, by(date manufacturer)
```

- Create a dataset with the median `value` per `segment`.

```
replace value = . if value == 0
collapse (median) value, by(segment)
```

# Exercise

- Create a dataset with the count of `value` and `volume` by `year` and `barsize`.

```
recode date             ///
   (564/575 = 2007)     ///
   (576/587 = 2008)     ///
   (588/599 = 2009)     ///
   (600/611 = 2010)     ///
   (612/623 = 2011)     ///
   (624/635 = 2012)     ///
   (nonmissing = 2013), ///
   generate(year)
collapse (count) volume value, by(barsize year)
```

- Create a dataset with the standard deviation of `volume` and minimum of `value` for each brand per `year`; retain the `manufacturer` variable.

```
collapse (first) manufacturer (sd) value, by(brand year)
```

# Schemes

# What is a scheme?

- Schemes define the overall look of a graph.
- Within a scheme file, define graph colours, text sizes, backgrounds, etc.
- Stata’s default schemes are ugly, but we can change that

# How do I make a scheme?

- Create a new file called `myscheme-scheme.scheme` and save it in your personal ado folder.
- Each entry in a scheme file specifies how a particular attribute of a graph element looks.
- First line should always be `#include s2color`.
- `help scheme` describes how to create your own schemes.
- `help scheme entries` lists all possible definitions to include in `myscheme-scheme.scheme`.

# Exercise

- Colour graph titles blue.

```
color heading blue
```

- Make graph titles very large.

```
gsize heading large
```

- Colour graph subtitles grey and put them in the north-east corner.

```
color subheading gs10
clockdir subtitle_position 1
```

- Colour the first plot orange.

```
color p1 orange
```

# Exercise

- Colour the background black.

```
color background black
```

- Colour grid-lines as RGB 200 200 200.

```
color major_grid “200 200 200"
```

- Make x-axis labels horizontal.

```
anglestyle vertical_tick horizontal
```

- Place graph legends in the south-east corner.

```
clockdir legend_position 4
```