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Programming in Stata

Stata Self-Learning Course

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Introduction to Programming in Stata

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A quick look at the Stata manual

- "The real power of Stata is not revealed until you program it." *Stata User's Guide Release 16, p.184*
- Two program languages:
  - ado
  - Mata
- Both languages can interact with each other
- Today, we will focus on the first, ado

What are programs?

- In Stata, programs look as follows:

```
program progname
    commands
end
```

- You have to run the program definition once[1]
- If you then type *progname*, the commands defined in the program are run
- All Stata commands you know from do-files can be used in programs

[1] or store the file with the definition as ado-file in the ado-directory

Why should you program Stata?

- Programs are routines which can be adjusted and applied to different situations
  - E.g., if you have your own table style, you could write a program for this instead of adjusting it to every dataset
- Sometimes, there are no good commands for the statistical problem you have
  - E.g., if you want to adjust your standard errors in a specific way
  - Very useful in combination with Mata
- In any case, you will understand better how Stata works, how commands are written, and how to solve errors

Passing arguments to programs

- Most programs use arguments:

  regress life_expectancy income

- Here, regress is the *progname*, and life_expectancy and income are the arguments
- The arguments are passed to the program with locals

Local	Content
`0‘	Exactly what was typed, including typed blanks etc.
`1‘	The first argument
`2‘	The second argument
`*‘	All arguments without double quotes and with proper blanks

- The arguments can also be named using args

Overview of temporary objects

- Sometimes you need intermediate variables, matrices or estimations for calculations or other purposes
- In programs, two issues might emerge:
  - You have to make sure that the name you give to the object does not already exist
  - Once you are done with the process, you don't need the object anymore, it is in your way
- Sometimes, preserve and restore can be helpful, but if the program also has permanent outputs, this might not be what you need
- Locals have traits which would solve these issues, but they can only store a certain kind of information

Overview of temporary objects

- For programming, you can use temporary objects which work similar to locals
- There are different types of temporary objects
  - tempvar
  - tempname
  - tempfile
- Used as command, all create temporary names, which then can be used to create objects which will be deleted after the program ends

What exactly is Stata doing?

- To find out how your (or any other) program is working, you can use set trace on and run the program
- Stata will then display you every single working step
- This is very time- and space-consuming, so remember to turn it off using set trace off
- The command is very useful to detect where in the routine an error occurred

Creating your own (e)return lists

- Like the standard Stata programs, results from self-written programs can be stored in r(), e(), or s()
- For this, you can specify the class of the programm as rclass, eclass, or sclass
  - rclass: return list for most commands
  - eclass: return list for estimation commands (for a recommended convention, see [P] eclass)
  - sclass: special return list for locals in subroutines (see next topic)

Running subroutines

- A topic very related to storage is the use of subroutines
- You can run not only Stata commands, but also your own programs within programs
- Note that locals are truly local to programs: You can use a local only within the program in which it was created, not in nested programs/subroutines
- Most of the time, this is very convenient: You do not have to check whether this local name was used in any other nested program
- Sometimes, you might want to transfer the content of a local to another program – use globals or sreturn for this

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Advanced Programming

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Introduction to the syntax

- Last lecture, you were familiarized with arguments and program classes
- But there is more information we can pass to programs (if, in, weights, options…), take for example

  reg income age sex if country == "France"
- How can we interpret the user‘s input in a meaningful way?
- How can we assure that the user only specifies reasonable input?
- For this, we can tell Stata which elements should be accepted by the program, using the syntax command

Introduction to the syntax

- In this example, regress needs at least one variable, and we want to allow the user to specify if/in specifications
- Thus, the syntax command would read as follows*:

```
syntax varlist(min=1) [if] [in]
```

- This specification ***demands*** at least one variable and ***allows*** if and in specifications optionally
- If the user now types

```
reg income age sex if country == "France"
```

syntax creates the following locals:

`varlist'	income age sex
`if'	if country == "France"
`in'	*(empty)*

* The real regress command also allows for weights and options, this is a simplified version

Introduction to the syntax

```
syntax varlist(min=1) [if] [in]
```

- In this example, varlist is the input/argument
- There are three types of arguments which can be used for the syntax command: varlist, namelist, and anything
- Both varlist and namelist have subtypes, but the respective local will always be `varlist‘/`namelist‘

Type	Subtype	Comment	Local
varlist	varlist	List of existing variables	varlist
	varname	Abbrev. for varlist(max=1)	
	newvarlist	List of names for new variables	
	newvarname	Abbrev. for newvarlist(max=1)	
namelist	namelist	List of names for matrices/locals/variables	namelist
	name	Abbrev. for name(max=1)	
anything		Any input (commas need to be in quotes)	anything

Parsing

- The syntax command is part of the ***parsing*** process
- This process describes the break-down of the user‘s entry into meaningful elements and conversion into a meaningful structure
- For example, syntax stores the elements passed to the command before if/in or other special elements in `varlist‘
- You can define your own parsing rules using gettoken and tokenize

Helpful options and commands

- The marksample command can be used after syntax to generate a temporary indicator variable marking the observations which should be used (e.g. according to if)
- Remember that quietly suppresses the Stata output but still stores the results in r() etc. if applicable

Options with the syntax command

- Another type of input are options, e.g.

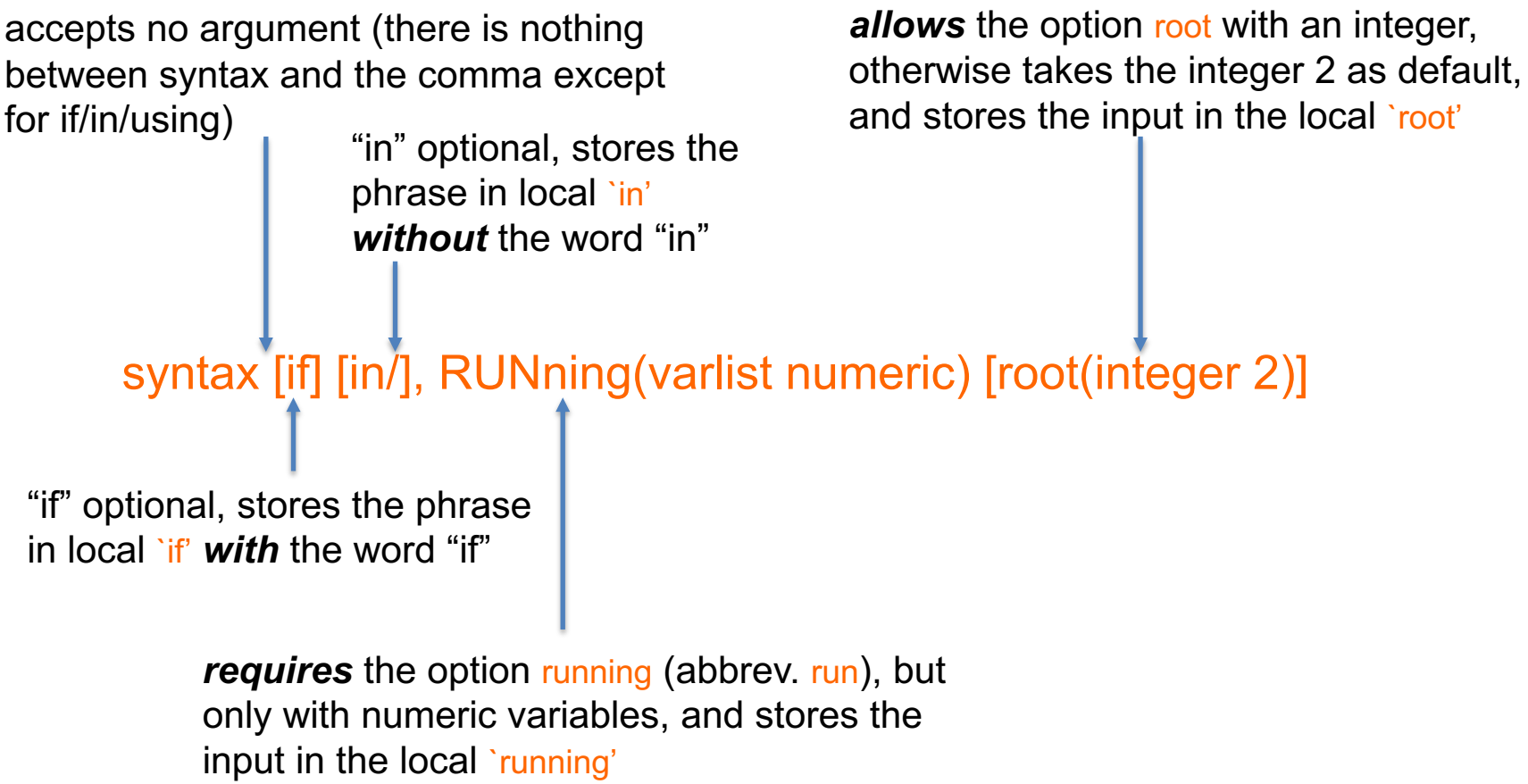
  reg income age sex if country == "France", ***vce(cluster district)***

- The syntax command allows you to program your own options, e.g.

  syntax varlist(min=1) [if] [in], vce(namelist)

- You can specify options to be mandatory (no brackets) or optional (squared brackets)
- You can define abbreviations (abbreviation in caps)
- You can have options which are only words (e.g. replace) and options which require input (e.g. vce)
- For the latter, an input type is needed (varlist, numlist etc.) which can be amended by constraints (numeric, min/max etc.)

Options with the syntax command



More helpful options and commands

- Program options
  - The byable option lets the program accept the by prefix
  - The sortpreserve option tells Stata to restore the previous sorting after the program ends
- Remember that quietly suppresses the Stata output but still stores the results in r() etc. if applicable

A remark on error messages

- The syntax command comes with its own error messages for misspecification of the program syntax
- However, it might be useful to write your own error messages or warnings to prevent mistakes
- We have done this before using display and exit, but you can also include the pre-defined error codes using error
- To have the output printed red, type display in red

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Applied Programming

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From the code to the program

- If you write your own program, you will seldomly write it „top to bottom“
- Most of the time, you will already have some code which you want to generalize
- Hence, you need to think how you make it adaptable to a wider setting, e.g.
  - change variable names to locals/tempvars
  - run loops over variables/groups/levels
- Also think about how the user will use the program
  - make it as general as possible (allow as many options/variable types as reasonable)
  - still, only allow input/options which make sense
  - write meaningful error checks and messages

Useful thoughts/checks

If you write a program, think about:

- Do you want to put something to the return/ereturn list?
- What input do you need? What should be specified or chosen by the user?
- Can the syntax command take care of it?
- Do you need error checks?
- Where might if-branches be needed?
- After running the program, will the dataset/working space be the same except for the required changes?

Useful commands/procedures

- Confirm types/classes etc.

  confirm
- Count words/elements/arguments

  wordcount() local w: word count
- Count distinct levels

  unique levelsof `var', local(w)
- String functions and extended macro functions

  help string function help macro
- Expand local lists during loops
- Use temporary objects