

Principles of Programming in Econometrics

Introduction, structure, and advanced programming techniques

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Separate lecture slides

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Overview

Principles of Programming in Econometrics

D0: Syntax, example 2⁸

D1: Structure, scope

D2: Numerics, packages

D3: Optimisation, speed

Day 3: Optimisation

9.30 Optimization (minimize)

- ▶ Idea behind optimization
- ▶ Gauss-Newton/Newton-Raphson
- ▶ Stream/order of function calls
- ▶ Standard deviations
- ▶ Restrictions
- ▶ Speed

13.30 Practical

- ▶ Regression: Maximize likelihood
- ▶ GARCH-M: Intro and likelihood

Optimisation

- ▶ Theory: What is (to be) done
- ▶ Inputs
- ▶ Practice/implementation
- ▶ Standard errors
- ▶ Transformations

Solve

Remember:

$$r(y; \theta) = \mathbf{0}$$

Use function `scipy.optimize.least_squares`, with basic syntax

```
import scipy.optimize as opt

#####
### vF= fnFunc0(vP)
def fnFunc0(vP):
    vF= ...           // k 1D vector, should be 0 at solution
    return vF

res= opt.least_squares(fnFunc0, x0)
print ("Nonlin LS returns ", res.message, "\nParameters ", res.x)
```

Solve II

```
import scipy.optimize as opt
res= opt.least_squares(fnFunc0, x0)
print ("Nonlin LS returns", res.message, "\nParameters", res.x)
```

- ▶ General idea similar to minimize
- ▶ Solves *nonlinear* least squares problems
- ▶ Again, extra arguments can easily be passed through Lambda function:
fnFunc1L= lambda vP: fnFunc1(vP, a1, a2),
where fnFunc1L(vP) is the lambda function calling the original fnFunc1(vP, a1, a2) which depends on multiple arguments.
- ▶ Further options available, check [manual](#).

Example: Solve Macro

Given the parameters $\theta = (p_H, \nu_1)$, depending on input $y = (\sigma_1, \sigma_2)$, a certain system describes the equilibrium in an economy if

$$r(y; \theta) = \begin{pmatrix} p_H^{-\frac{1}{\sigma_1}} \nu_1 + p_H^{-\frac{1}{\sigma_2}} (1 - \nu_1) - 2 \\ p_H^{\frac{\sigma_1 - 1}{\sigma_1}} \nu_1 + \nu_1 - p_H - \frac{1}{2} \end{pmatrix} = \mathbf{0}.$$

For the solution to be sensible, it should hold that $0 < \nu_1 < 1$ and $p_H \neq 0$.

If $y = (2, 2)$, what are the optimal values of $\theta = (p_H, \nu_1)$?

Solution: $\hat{\theta} = (0.25, .5)$