

# **Effective Programming Practices for Economists**

## **Scientific Computing**

### **Introduction to making code fast**

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# What do we mean by speedup

- Same calculations
- Same language
- Faster execution

# Speed can vary within a language

```
>>> def my_sum(numbers):  
...     out = 0  
...     for number in numbers:  
...         out += number  
...     return out  
  
>>> numbers = list(range(10_000))  
  
>>> %timeit my_sum(numbers)
```

128  $\mu$ s  $\pm$  1.65  $\mu$ s

```
>>> %timeit sum(numbers)
```

28.5  $\mu$ s  $\pm$  275 ns

- In this simple example, the speed difference is 4.5x
- Speed differences of 100x are common, more is possible
- It gets really slow if you do not use libraries as intended

# Python can be really fast

- Numba uses the same technology as Julia (llvm)
- JAX uses technologies Julia dreams of and is even developing them further
- State of the art AI is trained in Python
- We have beat Fortran code with Python code several times

# Only optimize bottlenecks

We should forget about small efficiencies, say about 97% of the time: premature optimization is the root of all evil (Donald Knuth)

- Typically, runtime is concentrated in a few sections of code
- Making the rest faster will not change overall runtime
- Important: Learn how to find those sections!

# Process

If it doesn't work, it doesn't matter how fast it doesn't work (Mich Ravera)

- Get it to run
- Get it right
- Find the bottleneck
- Speed up the bottleneck on one core
- Think about parallelization
- Repeat