28.5.24

Making Python code go *fast*

Identifying bottlenecks, and most common ways to make something faster

Preemptive optimisation is the root of all evil

Contents

- Profiling
- How to make code faster
- Workshop

Identifying bottlenecks, a.k.a. profiling

Quick

```
from timeit import timeit

total_time = timeit("fib(30)", number=iterations, globals=globals())
```

Serious

```
python -m cProfile -o output_file -s cumulative myscript.py

snakeviz output_file.prof
```

Fundamentals of going faster

- Make each step faster
  - Numba / JIT
  - Caching
  - Big brain coding
- Share running of steps across many different workers
  - Parallelism
  - Concurrency

Make each step go faster

Numba + JIT

- Pay more the very first time to pay *a lot* less every time after that

```
def go_fast(a):
    # Using lots of numpy function
    # Don’t use other libraries
```

Numba + JIT

- Pay more the very first time to pay *a lot* less every time after that

```
from numba import jit


@jit(nopython=True)
def go_fast(a):
    # Using lots of numpy function
    # Don’t use other libraries
```

Caching

- Save outputs of commonly called functions

```
def fib(n):
    if n == 0:
    return 0
    if n == 1:
    return 1
    return fib(n-1) + fib(n-2)
```

Caching

- Save outputs of commonly called functions

```
from functools import lru_cache


@lru_cache(maxsize=None)
def fib(n):
     if n == 0:
     return 0
     if n == 1:
     return 1
     return fib(n-1) + fib(n-2)
```

Big brain coding

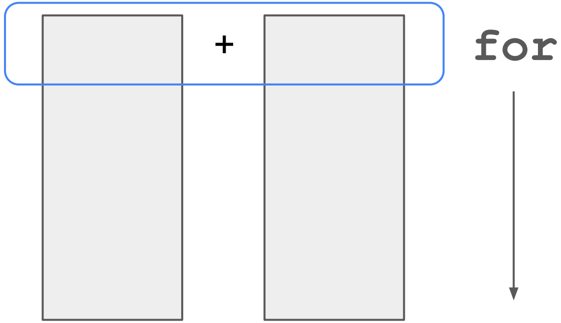
- Totally outside scope of this clinic
- Python wrappers on C++
- Random knowledge you accumulate as you code
  - Python 3.11 is faster than 3.10
  - Better to work in a manner that performs functions on memory already in CPU cache
  - Avoid sequential pandas concatenations
  - etc.

Distribute steps

Parallelism

- ‘Free’ parallelism
  - Numpy using SIMD instructions
  - Other C-backed libraries

No fancy code - if using numpy aim to use library functions and think in element-wise operations where possible.



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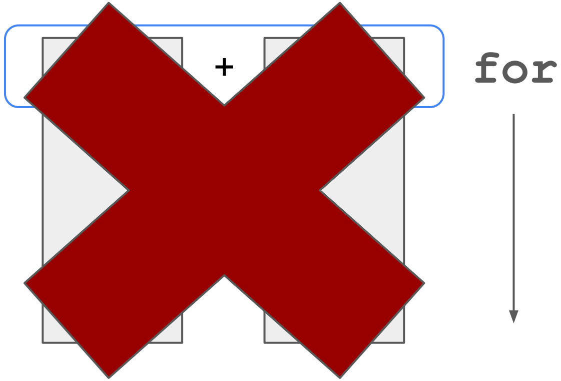

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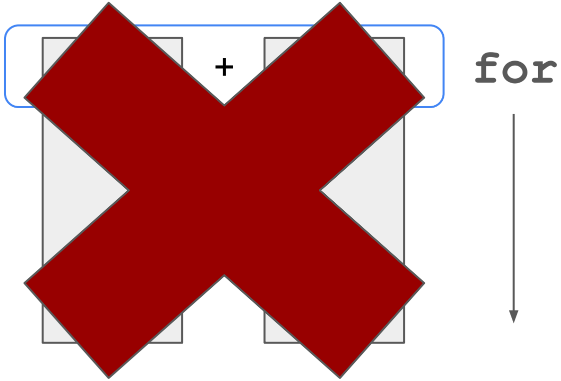

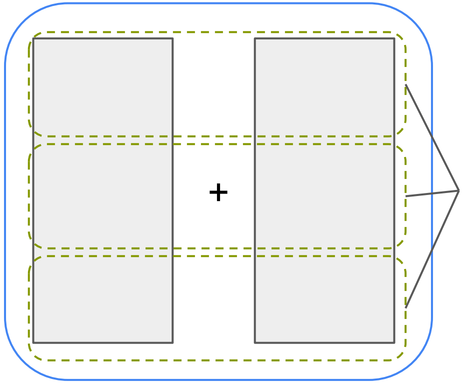

Processed in parallel by SIMD and other C optim.

Parallelism

- Manual parallelism
  - `multiprocessing` library
  - In general can also do multi-threading but this doesn’t work with python

```
results = []

for el in iterable:

    results.append(func(el))
```

Parallelism

- Manual parallelism
  - `multiprocessing` library
  - In general can also do multi-threading but this doesn’t work with python

```
from multiprocessing import Pool

with Pool(threads) as p:

    results = p.map(func, iterable)
```

Concurrency

- Outside scope of today
  - In reality a bit easier than parallelism
- Do stuff while CPU is waiting for data to be read/received from disk or network