Parallel Python

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Reusing this material

Partners

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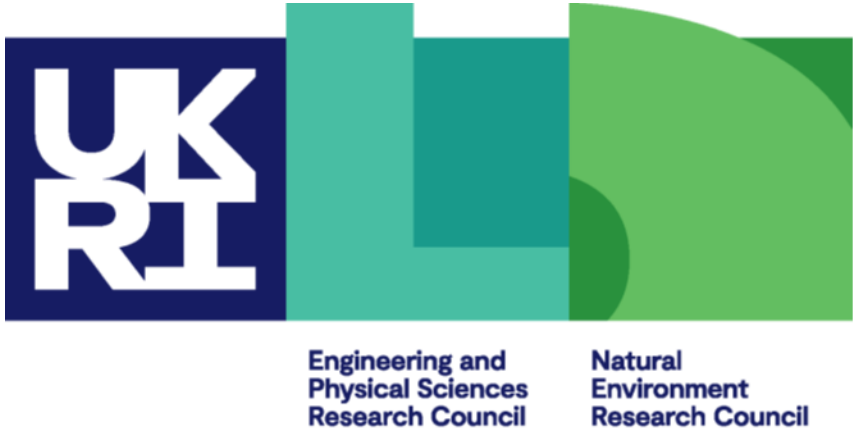

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Recap on parallelism

- Two main types of parallelism
- Shared memory parallelism
  - Single node
  - Mainly thread based
  - Single program generates set of workers (threads)
- Distributed memory parallelism
  - Can work inside a node but also enables parallelisation across nodes
  - Mainly uses message passing programming approaches (i.e. MPI)
  - Workers are individual processes (program)
  - Collaborate to reduce runtime/host large amounts of data

Parallelism in Python

- Python has a number of built in options for parallelisation
- `threading` library
  - Create python threads (workers) from functions
  - Can `.start()` and `.join()` them

```
import threading

def thread_function(name):
    …

if __name__ == "__main__":

    threads = list()
    for index in range(3):
        x = threading.Thread(target=thread_function, args=(index,))
        threads.append(x)
        x.start()

    for index, thread in enumerate(threads):
        thread.join()
```

- Python global interpreter lock (GIL) restricts parallelism
  - An create many threads, but only one executes at a time, regardless of available hardware

Parallelism in Python

- `multiprocessing` library
  - Enables generation of multiple process workers
  - Not restricted by the GIL
- Can create `Process`, similar to `Thread`:

```
from multiprocessing import Process

def f(name):
    print('hello', name)

if __name__ == '__main__':
    p = Process(target=f, args=('bob',))
    p.start()
    p.join()
```

- Share data between processes using Queues or Pipes

```
from multiprocessing import Process, Queue
def f(q):
    q.put([42, None, 'hello'])
if __name__ == '__main__':
    q = Queue()
    p = Process(target=f, args=(q,))
    p.start()
    print(q.get())    # prints "[42, None, 'hello']"
    p.join()
```

```
from multiprocessing import Process, Pipe
def f(conn):
    conn.send([42, None, 'hello'])
    conn.close()
if __name__ == '__main__':
    parent_conn, child_conn = Pipe()
    p = Process(target=f, args=(child_conn,))
    p.start()
    print(parent_conn.recv())   # prints "[42, None,
'hello']"
    p.join()
```

Parallelism in Python

- Multiprocessing in Python is more suited to distributed or concurrent rather than parallel computing
  - Communication mechanisms aren't as high performance
  - Don't map on to high performance interconnects
- Implicit parallelism
  - numpy provide access to parallel blas libraries
  - scipy can interface with other parallel maths libraries
- Native code interfacing
  - Call C/Fortran/C++/etc… code from Python to provide some parallel functionality
- mpi4py
  - Direct message passing interface for Python
  - https://github.com/EPCCed/archer2-python/tree/master/lectures/dev-mpi4py