

PEP: 371 - Birth of the Multiprocessing in Python

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Python before MultiProcessing

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- Python interpreter required thread safe mechanism
- Global Interpreter Lock.
- Lock only enabled single statement executions (single threading)

Python's multiprocessing Package

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- multiprocessing introduced in version 2.6.
- Able to run multiple tasks w/ either local or remote concurrency, side-stepping the global interpreter lock.

MultiThreading vs. MultiProcessing P1

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- Multithreading - exists one process, and each thread exists in this process as well.
- Bad: Could lead to race conditions, synchronization errors.

MultiThreading vs. MultiProcessing P2

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- MultiProcessing - each process is separate is completely independent.
- No memory shared, so no race conditions.

Basics of Multiprocessing

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- Usage of two or more central processing units within a single system's systems
- Parallel execution of multiple processors.

Why Use Multiprocessing

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- Improves performance.
- Running multiple tasks at the same time.

Benchmark Results

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- Results how increase of up to three times speed in programs
- Speed really shows as processes/iterations increase.

Basic Classes in Package

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- Comes with many built in options for creating a parallel application.
- Process, Queue, Lock Classes.

Process Class

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- In Multiprocessing, processes are spawned by created a Process Object.
- Once the process object has been instantiated, a start method must be called.
- The Start method is called once per process object and start's the process's activity.

Example - Process Class Usage

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```
from multiprocessing import Process

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

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

Queue Class

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- Queues are thread and process safe.
- Essentially like a queue data structure - FIFO implementation (first tasks added are first retrieved).
- Allows for communication between processes.

Example - Queue Class Usage

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```
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()
```

Pool Class

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- Manages parallel-processing tasks.
- Instantiated with certain # of tasks, all operations limited to that #.

Example - Pool Class Usage

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```
def cube(x):  
    return x**3  
  
pool = mp.Pool(processes=6)  
results = pool.map(cube, range(1,7))  
print(results)  
  
[1, 8, 27, 64, 125, 216]
```

Drawbacks

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- Sharing data is tedious.
- Must copy every message to send; retrieval is costly.

Drawback Work Arounds 1

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- Workaround: shared memory and server processing.
- Shared memory: Uses Value and Array Classes.

Drawback Work Arounds 2

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- Server Processes.
- Uses Manager Class, hold and manipulates objects using proxies.
- Slower than shared memory.

Open Issues

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- No remote connection capabilities.
- Must enable the remote security mechanisms.
- Some minor APIs have not been implemented.

OS Restrictions

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- Windows lacks `os.fork()`.
- Users must protect “entry point” of the program processes.

```
__name__ == '__main__'
```

- Above code allows safe importing of modules and inner function.

Conclusion

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- MultiProcessing is a crucial addition to the standard library.
- Dramatically increased speed in programs.
- Spawned many other innovations for Python.