# Multithreading in Python | Set 1

This article covers the basics of multithreading in Python programming language. Just like multiprocessing, multithreading is a way of achieving multitasking. In multithreading, the concept of **threads** is used.

Let us first understand the concept of **thread** in computer architecture.

**Thread**

In computing, a **process** is an instance of a computer program that is being executed. Any process has 3 basic components:

- An executable program.
- The associated data needed by the program (variables, work space, buffers, etc.)
- The execution context of the program (State of process)

A **thread** is an entity within a process that can be scheduled for execution. Also, it is the smallest unit of processing that can be performed in an OS (Operating System).

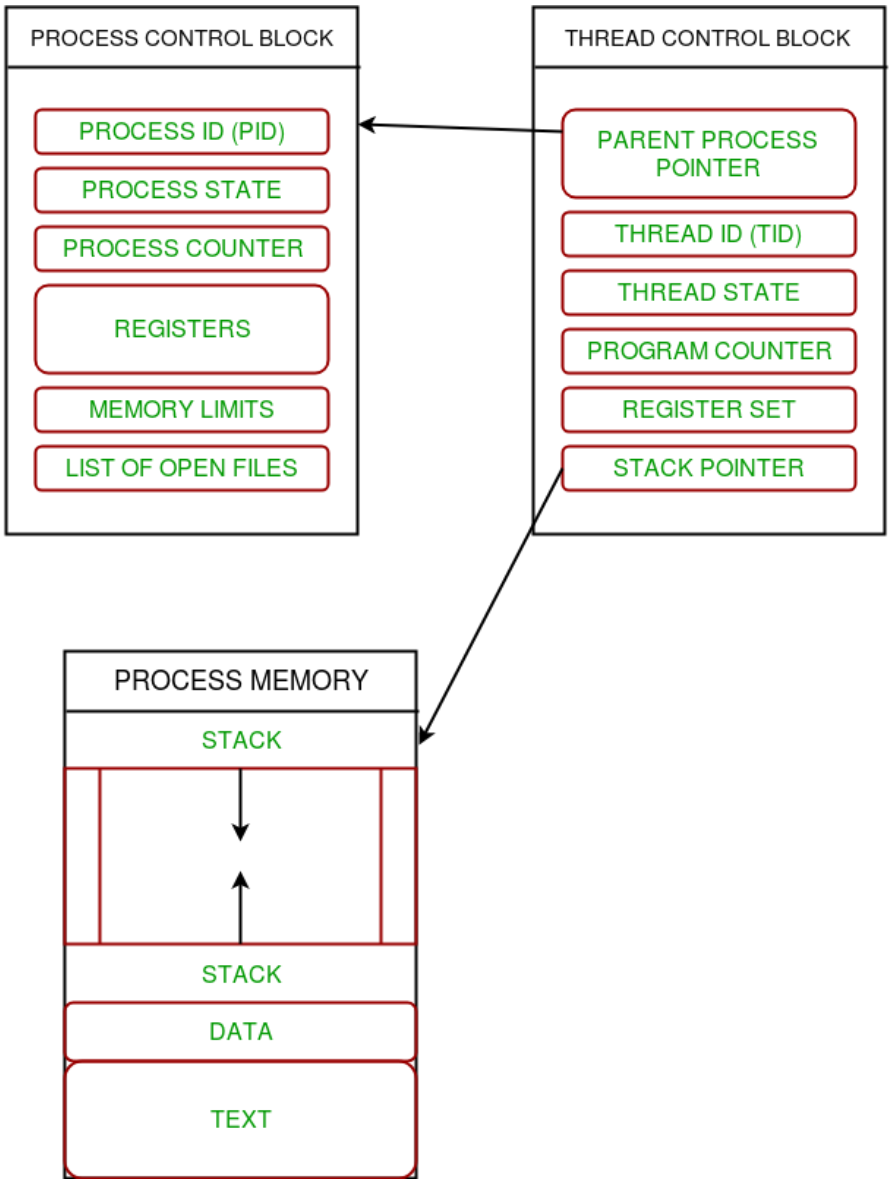


In simple words, a **thread** is a sequence of such instructions within a program that can be executed independently of other code. For simplicity, you can assume that a thread is simply a subset of a process!

A thread contains all this information in a **Thread Control Block (TCB)**:

- **Thread Identifier:** Unique id (TID) is assigned to every new thread
- **Stack pointer:** Points to thread's stack in the process. Stack contains the local variables under thread's scope.
- **Program counter:** a register which stores the address of the instruction currently being executed by thread.
- **Thread state:** can be running, ready, waiting, start or done.
- **Thread's register set:** registers assigned to thread for computations.
- **Parent process Pointer:** A pointer to the Process control block (PCB) of the process that the thread lives on.

Consider the diagram below to understand the relation between process and its thread:

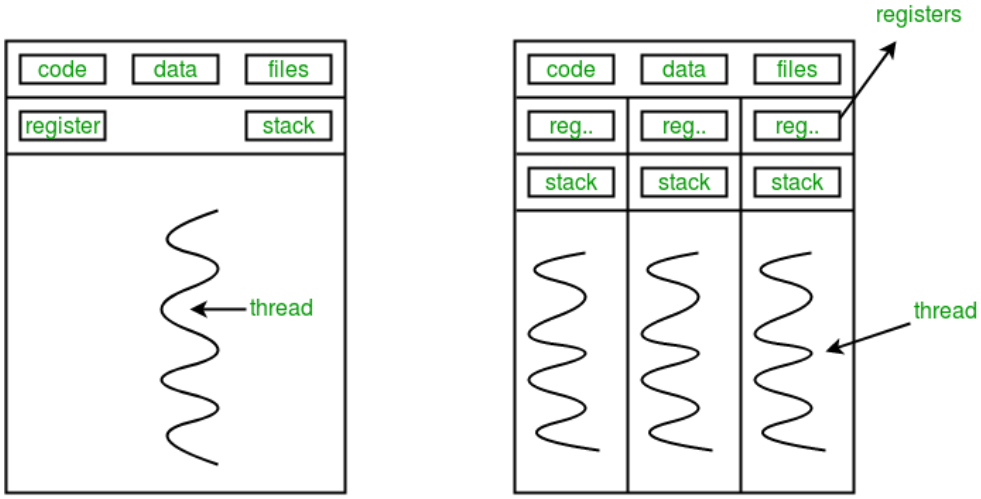



**Multithreading**

Multiple threads can exist within one process where:

- Each thread contains its own **register set** and **local variables (stored in stack)**.
- All thread of a process share **global variables (stored in heap)** and the **program code**.

Consider the diagram below to understand how multiple threads exist in memory:



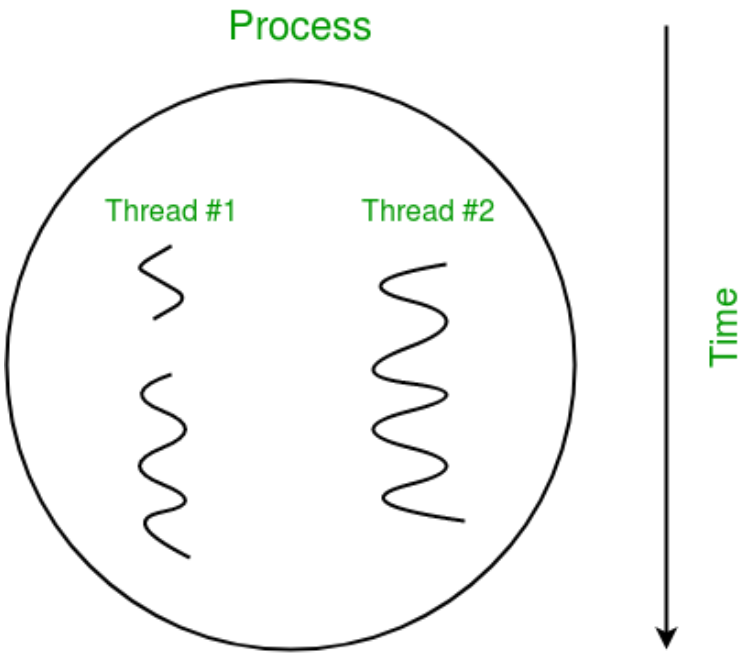

single-threaded process multithreaded process

**Multithreading** is defined as the ability of a processor to execute multiple threads concurrently.

*In a simple, single-core CPU, it is achieved using frequent switching between threads. This is termed as **context switching**. In context switching, the state of a thread is saved and state of another thread is loaded whenever any interrupt (due to I/O or manually set) takes place. Context switching takes place so frequently that all the threads appear to be running parallelly (this is termed as **multitasking**).*



Consider the diagram below in which a process contains two active threads:




**Multithreading in Python**

In Python, the **threading** module provides a very simple and intuitive API for spawning multiple threads in a program.

Let us consider a simple example using threading module:

```
# Python program to illustrate the concept
# of threading
# importing the threading module
import threading

def print_cube(num):
    """
    function to print cube of given num
    """
    print("Cube: {}".format(num * num * num))

def print_square(num):
    """
    function to print square of given num
    """
    print("Square: {}".format(num * num))

if __name__ == "__main__":
    # creating thread
    t1 = threading.Thread(target=print_square, args=(10,))
    t2 = threading.Thread(target=print_cube, args=(10,))

    # starting thread 1
    t1.start()
    # starting thread 2
    t2.start()

    # wait until thread 1 is completely executed
    t1.join()
    # wait until thread 2 is completely executed
    t2.join()

    # both threads completely executed
    print("Done!")
```

```
Square: 100
Cube: 1000
Done!
```

Let us try to understand the above code:

- To import the threading module, we do:

  ```
  import threading
  ```

- To create a new thread, we create an object of **Thread** class. It takes following arguments:
  - **target**: the function to be executed by thread
  - **args**: the arguments to be passed to the target function

  In above example, we created 2 threads with different target functions:

  ```
  t1 = threading.Thread(target=print_square, args=(10,))
  t2 = threading.Thread(target=print_cube, args=(10,))
  ```

- To start a thread, we use **start** method of **Thread** class.

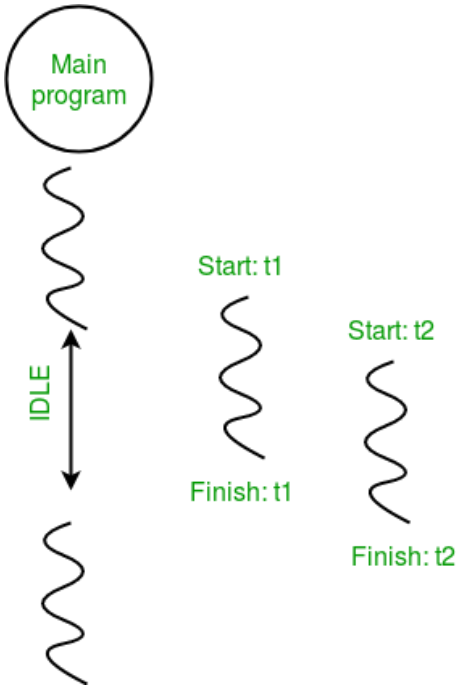
  ```
  t1.start()
  t2.start()
  ```

- Once the threads start, the current program (you can think of it like a main thread) also keeps on executing. In order to stop execution of current program until a thread is complete, we use **join** method.

```
t1.join()
t2.join()
```

As a result, the current program will first wait for the completion of **t1** and then **t2**. Once, they are finished, the remaining statements of current program are executed.

Consider the diagram below for a better understanding of how above program works:




Consider the python program given below in which we print thread name and corresponding process for each task:



```
# Python program to illustrate the concept
# of threading
import threading
import os

def task1():
    print("Task 1 assigned to thread: {}".format(threading.current_thread().name))
    print("ID of process running task 1: {}".format(os.getpid()))

def task2():
    print("Task 2 assigned to thread: {}".format(threading.current_thread().name))
    print("ID of process running task 2: {}".format(os.getpid()))

if __name__ == "__main__":

    # print ID of current process
    print("ID of process running main program: {}".format(os.getpid()))

    # print name of main thread
```

```
    print("Main thread name: {}".format(threading.main_thread().name))

    # creating threads
    t1 = threading.Thread(target=task1, name='t1')
    t2 = threading.Thread(target=task2, name='t2')

    # starting threads
    t1.start()
    t2.start()

    # wait until all threads finish
    t1.join()
    t2.join()
```

```
ID of process running main program: 11758
Main thread name: MainThread
Task 1 assigned to thread: t1
ID of process running task 1: 11758
Task 2 assigned to thread: t2
ID of process running task 2: 11758
```

Let us try to understand the above code:

- We use **os.getpid()** function to get ID of current process.

  ```
  print("ID of process running main program: {}".format(os.getpid()))
  ```

  As it is clear from the output, the process ID remains same for all threads.

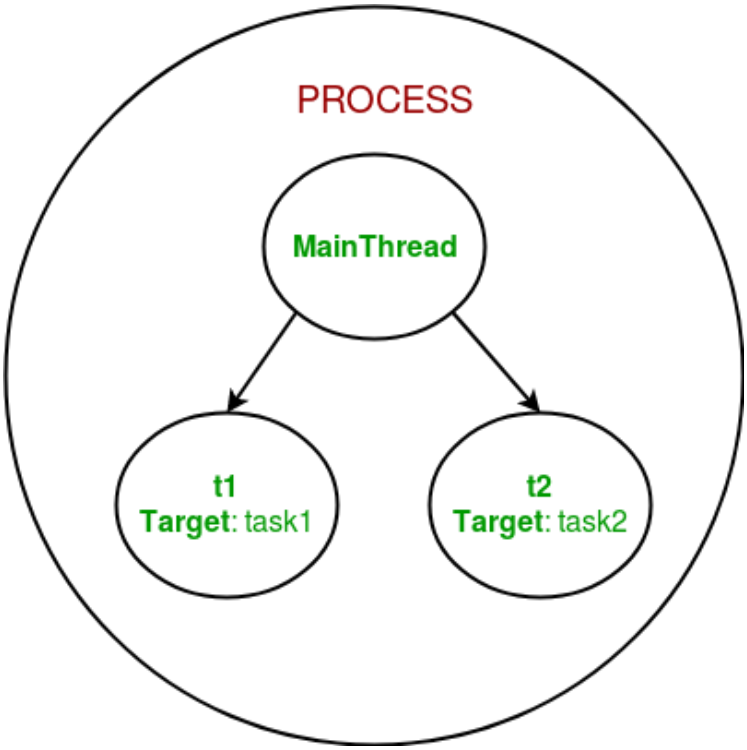
- We use **threading.main_thread()** function to get the main thread object. In normal conditions, the main thread is the thread from which the Python interpreter was started. **name** attribute of thread object is used to get the name of thread.

  ```
  print("Main thread name: {}".format(threading.main_thread().name))
  ```

- We use the **threading.current_thread()** function to get the current thread object.

  ```
  print("Task 1 assigned to thread: {}".format(threading.current_thread().name))
  ```

The diagram given below clears the above concept:




So, this was a brief introduction to multithreading in Python. The next article in this series covers **synchronization between multiple threads**.

Multithreading in Python | Set 2 (Synchronization)

This article is contributed by **Nikhil Kumar**. If you like GeeksforGeeks and would like to contribute, you can also write an article using contribute.geeksforgeeks.org or mail your article to contribute@geeksforgeeks.org. See your article appearing on the GeeksforGeeks main page and help other Geeks.

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