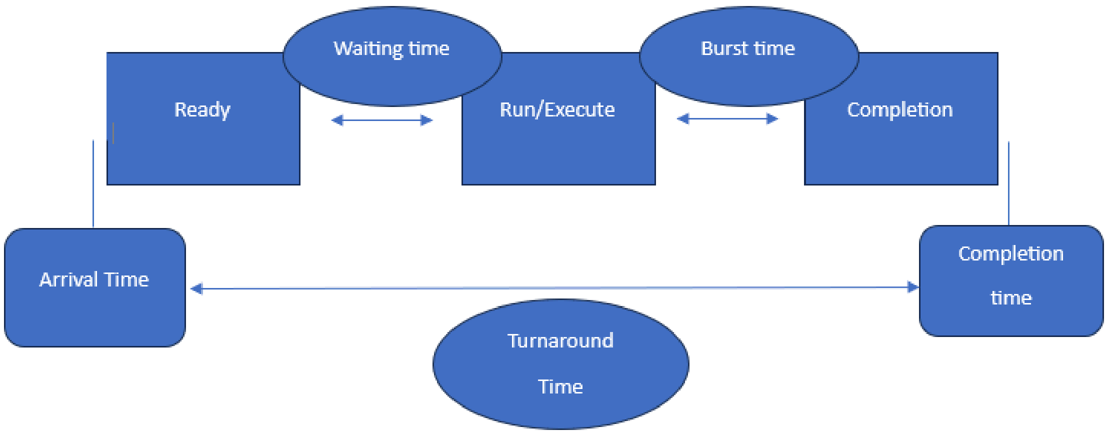
<u>Explaining waiting time and turn around time in process scheduling:</u>

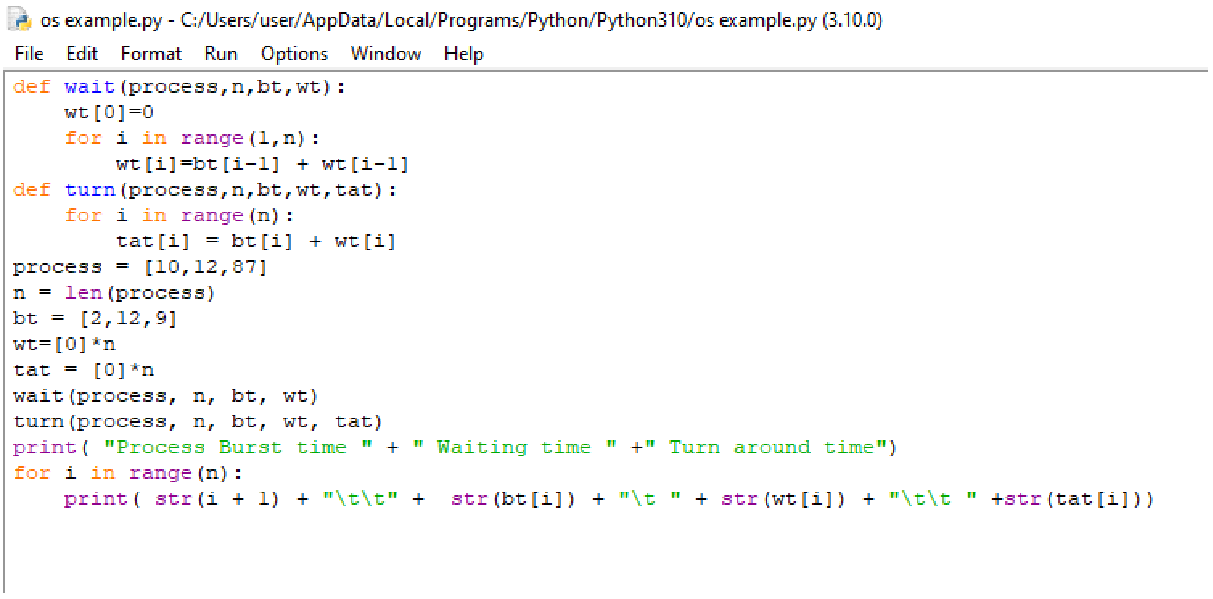
First of all, to understand waiting time and turn around time, we have to understand the basic definition of some other time concepts in process scheduling.

1. Arrival time- The time instance when a process enters the ready queue and is awaiting execution by the CPU.It is generally taken to be zero in certain programs for easier calculation.
2. Completion time- The time instance when a process finishes execution and is no longer being processed by the CPU.It can also be defined as the time instance that marks the end of the life of the given process.
3. **Turn around time- The difference between the Completion time and Arrival time instances is called Turnaround time. Hence, it denotes the complete lifetime of a process, from the ready phase to the completion of the execution phase. Turnaround time = Completion Time - Arrival time**
4. **Waiting time- As the process is ready, it has to wait for a specific time period in order to run or execute, as a set of processes are ready in the same queue. This time period is called the waiting time.**
5. Burst time- As the process begins execution, the time interval after which the process ends its execution is termed as the burst time. Thus, burst time marks the duration of the execution phase of the process.

Note: **Burst time + Waiting time = Turnaround time = Completion time - Arrival time**

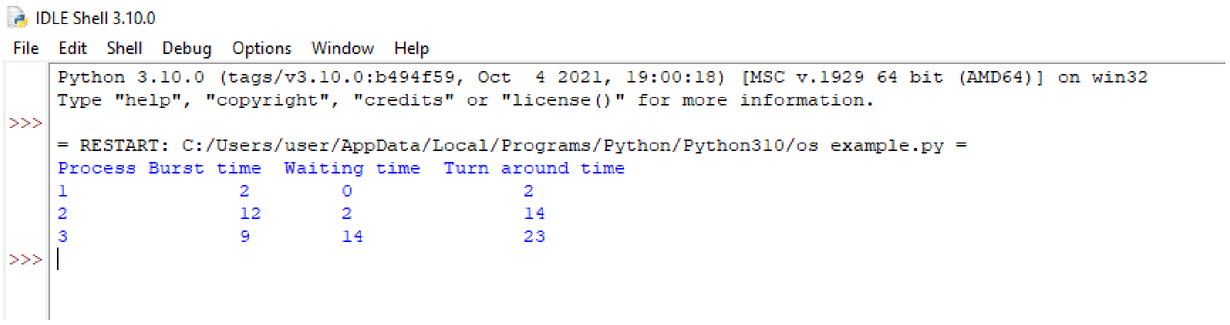


Example: Program that takes processes and their respective burst times as inputs and orders it's waiting time and turnaround time in the form of a table:
Code-


os example.py - C:/Users/user/AppData/Local/Programs/Python/Python310/os example.py (3.10.0)
File Edit Format Run Options Window Help

```
def wait(process,n,bt,wt):
    wt[0]=0
    for i in range(1,n):
        wt[i]=bt[i-1] + wt[i-1]
def turn(process,n,bt,wt,tat):
    for i in range(n):
        tat[i] = bt[i] + wt[i]
process = [10,12,87]
n = len(process)
bt = [2,12,9]
wt=[0]*n
tat = [0]*n
wait(process, n, bt, wt)
turn(process, n, bt, wt, tat)
print( "Process Burst time " + " Waiting time " +" Turn around time")
for i in range(n):
    print( str(i + 1) + "\t\t" +  str(bt[i]) + "\t " + str(wt[i]) + "\t\t " +str(tat[i]))
```

Output-



```
    Python 3.10.0 (tags/v3.10.0:b494f59, Oct  4 2021, 19:00:18) [MSC v.1929 64 bit (AMD64)] on win32
    Type "help", "copyright", "credits" or "license()" for more information.
>>>
    = RESTART: C:/Users/user/AppData/Local/Programs/Python/Python310/os example.py =
    Process Burst time  Waiting time  Turn around time
    1               2       0               2
    2               12      2               14
    3               9       14              23
>>> |
```

Here, it can be noted that, for the first process, waiting time is 0, as the arrival time is conveniently assumed to be 0 for the processes, and that only for the first process, the execution happens as soon as the process reaches the ready state.
For the further process, it can be noted that their respective waiting times are nothing but the turnaround time of the process before them. This is because:

1. Turnaround time(i)=Burst time(i) + waiting time(i)
   That means, Turnaround time(i-1)= Burst time(i-1) + waiting time(i-1)
   .
2. And, waiting time(i) = waiting time(i-1) + Burst time(i-1)

Thus, from 1 and 2: Waiting time(i) = Turnaround time(i-1)

Moreover, it can also be derived from the result that:
Turnaround time for the first process = Burst time of the first process , as its waiting time=0.
Turnaround time for the remaining processes in order can be simply expressed as the sum of the burst times till that process.

That is, Turnaround time(i) = $\sum$ (n=1 to i) (Burst time_n), where Burst time_n denotes the burst time of the n th process.

For example, in the above table, if we observe the turnaround time of the third process:
Turnaround time(3)= Burst time(1) + burst time(2) + burst time(3) = 2 + 12 + 9 = 23.
Hence, for calculation of turnaround time, it is enough to have the information of the burst times of the processes alone.