Fundamentals of Computer Engineering

(EECE7205)

Projet 2

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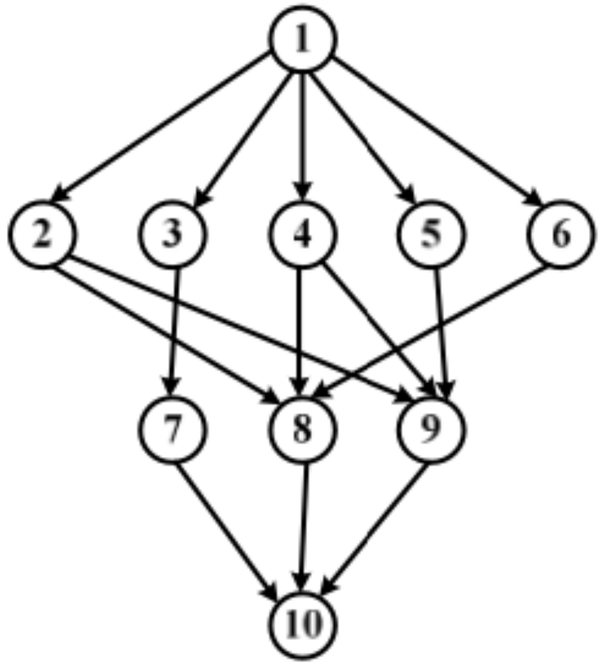
First Input

(a) figure of the input example including its task graph and its execution time table

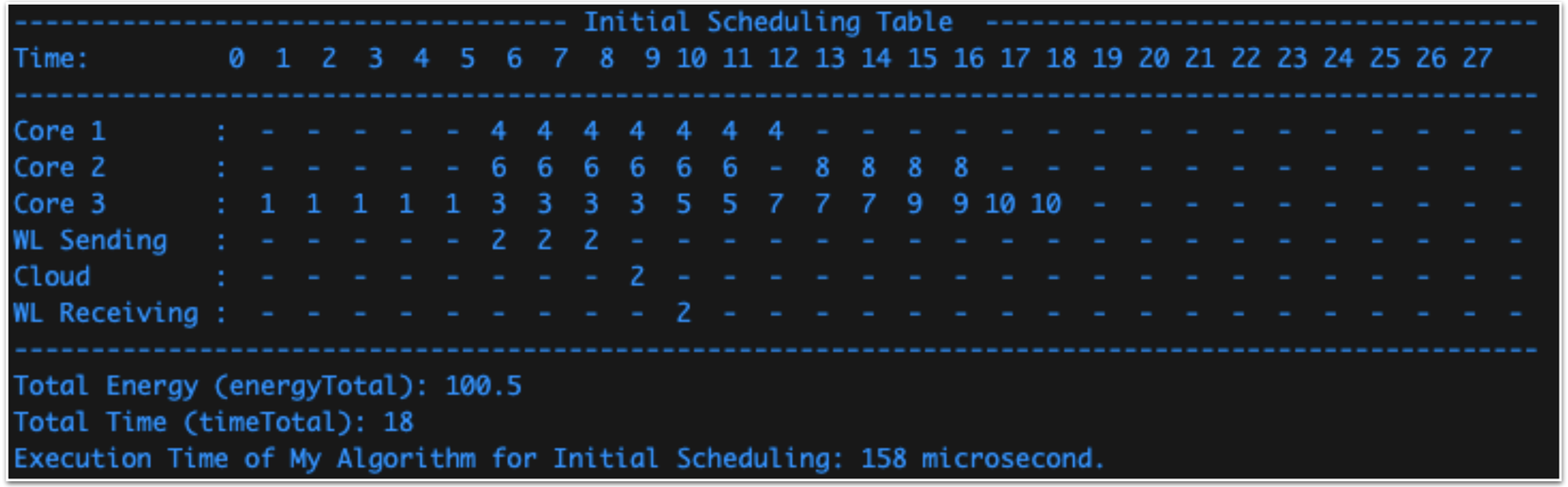


Task	Core1	Core2	Core3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	7	4	2

$$1 \le i \le N, \begin{cases} T_i^s = 3 \\ T_i^c = 1 \\ T_i^r = 1 \end{cases}$$

First Input

(b) My program output for initial scheduling and energy consumption



```
---------------------------------- Initial Scheduling Table  ----------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
-----------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  4  4  4  4  4  4  4  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Core 2       :  -  -  -  -  -  6  6  6  6  6  6  -  8  8  8  8  -  -  -  -  -  -  -  -  -  -  -  -
Core 3       :  1  1  1  1  1  3  3  3  3  5  5  7  7  7  9  9 10 10  -  -  -  -  -  -  -  -  -  -
WL Sending   :  -  -  -  -  -  2  2  2  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Cloud        :  -  -  -  -  -  -  -  -  2  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Receiving :  -  -  -  -  -  -  -  -  -  2  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-----------------------------------------------------------------------------------------------
Total Energy (energyTotal): 100.5
Total Time (timeTotal): 18
Execution Time of My Algorithm for Initial Scheduling: 158 microsecond.
```

	Core 1	Core 2	Core 3	Cloud
Task 1			20	1.5
Task 2				
Task 3			16	
Task 4	7			
Task 5			8	
Task 6		12		
Task 7			12	
Task 8		8		
Task 9			8	
Task 10			8	
Sum	7	20	72	1.5
			Total	100.5

- My program's found initial scheduling exactly matches the initial scheduling in the paper.
- When I manually calculated the energy consumption for each task, I found that Core 1 consumed 7, Core 2 consumed 20, Core 3 consumed 72, and the Cloud consumed 1.5, resulting in a total energy consumption of 100.5.
- Execution time of my algorithm for Initial Scheduling is 158 microsecond.

First Input

(c) My program output for final scheduling and energy consumption

```
------------------------------------ Final Assignment Table ------------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
------------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  5  5  5  5  5  -  -  -  -  8  8  8  8  8  8  -  -  -  -  -  -  -  -
Core 2       :  -  -  -  -  -  -  -  -  -  -  -  -  9  9  9  -  -  -  -  -  -  -  -  -  -  -  -  -
Core 3       :  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Sending   :  1  1  1  2  2  2  4  4  4  6  6  6  3  3  3  7  7  7  -  - 10 10 10  -  -  -  -  -
Cloud        :  -  -  -  1  -  -  2  -  -  4  -  -  6  -  -  3  -  -  7  -  -  -  - 10  -  -  -  -
WL Receiving :  -  -  -  -  1  -  -  2  -  -  4  -  -  6  -  -  3  -  -  7  -  -  -  - 10  -  -  -
------------------------------------------------------------------------------------------------
Total Energy (energyTotal): 27.5
Total Time (timeTotal): 25
Execution Time of My Algorithm for Final Scheduling: 1117 microsecond.
```

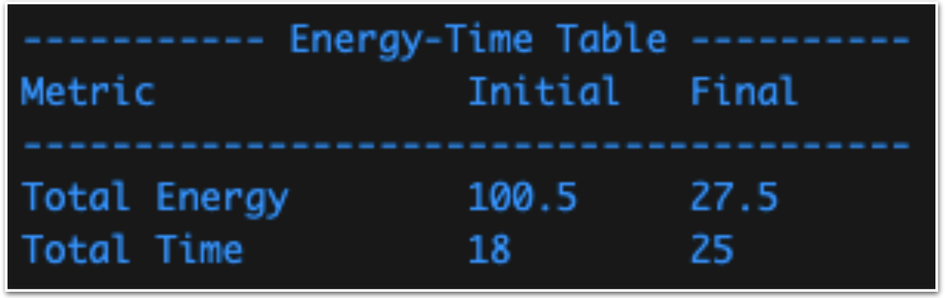
	Core 1	Core 2	Core 3	Cloud
Task 1				1.5
Task 2				1.5
Task 3				1.5
Task 4				1.5
Task 5	5			
Task 6				1.5
Task 7				1.5
Task 8	6			
Task 9		6		
Task 10				1.5
Sum	11	6	0	10.5
				Total 27.5

- For the final scheduling, my program reduced the total energy consumption to 27.5 while also calculating the TotalTime value as 25.
- Upon manual inspection, the energy consumption was confirmed to be 11 for Core 1, 6 for Core 2, and 10.5 for the Cloud, totaling 27.5.
- Execution time of my algorithm for Final Scheduling is 1117 microsecond.

First Input

(d) Summary of Etotal, Ttotal for both case.

- Total time (T_total) and total energy (E_total) for both the initial and final scheduling is as follows:
- Initial Scheduling:
  - Total Energy (E_total): 100.5
  - Total Time (T_total): 18
- Final Scheduling:
  - Total Energy (E_total): 27.5
  - Total Time (T_total): 25
- This summary indicates that while the final scheduling increased the total time of operations, it significantly reduced the total energy consumption compared to the initial scheduling.
- Thus, by transferring our tasks that occur on local cores to the cloud, we actually achieve an energy saving of about 70% while only extending our process by 7 units of time



```
---------- Energy-Time Table ----------
Metric              Initial   Final
---------------------------------------
Total Energy        100.5     27.5
Total Time          18        25
```

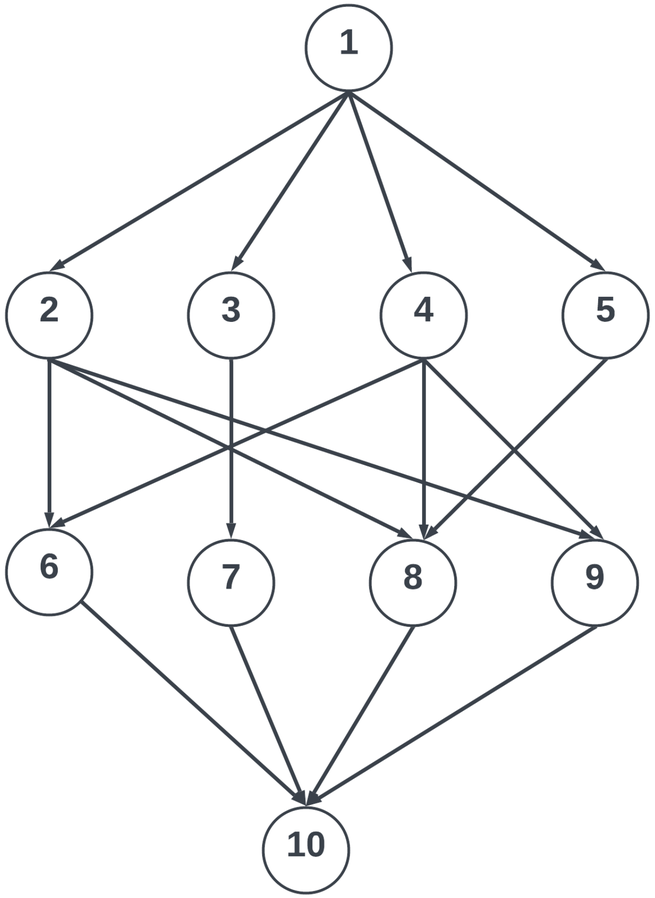
First Input

Differing Initial Scheduling Results Compared to Reference Paper

- For the first set of input values, the Initial Schedule I obtained was an exact match with the one in the paper.
- However, if Task-1 had been assigned to the Cloud instead of Core 3, there would have been no difference in the Initial Scheduling, and our total energy value would have dropped from 100.5 to 82.
- This choice makes sense because both solutions are feasible.
- Yet, the output generated by my program completely coincides with the output in the paper, and no discrepancy is found.

Second Input

(a) figure of the input example including its task graph and its execution time table



Task	Core1	Core2	Core3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	7	4	2

$$1 \le i \le N, \begin{cases} T_i^s = 3 \\ T_i^c = 1 \\ T_i^r = 1 \end{cases}$$

Second Input

(b) My program output for initial scheduling and energy consumption

```
---------------------------------- Initial Scheduling Table ----------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
----------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  5  5  5  5  5  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Core 2       :  -  -  -  -  -  4  4  4  4  4  9  9  9  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Core 3       :  1  1  1  1  1  2  2  2  2  2  6  6  6  6  8  8 10 10  -  -  -  -  -  -  -  -  -  -
WL Sending   :  -  -  -  -  -  3  3  3  7  7  7  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Cloud        :  -  -  -  -  -  -  -  -  3  -  -  7  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Receiving :  -  -  -  -  -  -  -  -  -  3  -  -  7  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
----------------------------------------------------------------------------------------------
Total Energy (energyTotal): 96
Total Time (timeTotal): 18
Execution Time of My Algorithm for Initial Scheduling: 152 microsecond.
```

	Core 1	Core 2	Core 3	Cloud
Task 1			20	
Task 2			20	
Task 3				1.5
Task 4		10		
Task 5	5			
Task 6			16	
Task 7				1.5
Task 8			8	
Task 9		6		
Task 10			8	
Sum	5	16	72	3
			Total	96

- When I manually calculated the energy consumption for each task, I found that Core 1 consumed 5, Core 2 consumed 16, Core 3 consumed 72, and the Cloud consumed 3, resulting in a total energy consumption of 96.
- Execution time of my algorithm for Initial Scheduling is 152 microsecond.

Second Input

(c) My program output for final scheduling and energy consumption

```
------------------------------------ Final Assignment Table ------------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
------------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  4  4  4  4  4  4  4  -  -  8  8  8  8  8  8  -  -  -  -  -  -  -  -
Core 2       :  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Core 3       :  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Sending   :  1  1  1  3  3  3  5  5  5  2  2  2  7  7  7  9  9  9  6  6  6 10 10 10  -  -  -  -
Cloud        :  -  -  -  1  -  -  3  -  -  5  -  -  2  -  -  7  -  -  9  -  -  6  -  - 10  -  -  -
WL Receiving :  -  -  -  -  1  -  -  3  -  -  5  -  -  2  -  -  7  -  -  9  -  -  6  -  - 10  -  -
------------------------------------------------------------------------------------------------
Total Energy (energyTotal): 25
Total Time (timeTotal): 26
Execution Time of My Algorithm for Final Scheduling: 1168 microsecond.
```

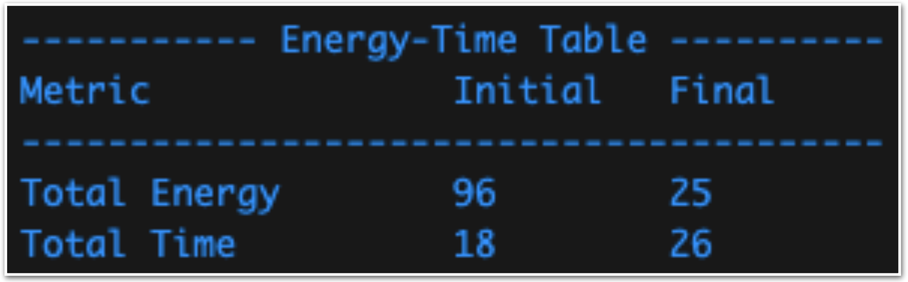
	Core 1	Core 2	Core 3	Cloud
Task 1				1.5
Task 2				1.5
Task 3				1.5
Task 4	7			
Task 5				1.5
Task 6				1.5
Task 7				1.5
Task 8	6			
Task 9				1.5
Task 10				1.5
Sum	13	0	0	12
			Total	25

- For the final scheduling, my program reduced the total energy consumption to 25 while also calculating the TotalTime value as 26.
- Upon manual inspection, the energy consumption was confirmed to be 13 for Core 1,and 12 for the Cloud, totaling 25.
- Execution time of my algorithm for Final Scheduling is 1168 microsecond.

Second Input

(d) Summary of Etotal, Ttotal for both case.

- Total time (T_total) and total energy (E_total) for both the initial and final scheduling is as follows:
- Initial Scheduling:
  - Total Energy (E_total): 96
  - Total Time (T_total): 18
- Final Scheduling:
  - Total Energy (E_total): 25
  - Total Time (T_total): 26
- This summary indicates that while the final scheduling increased the total time of operations, it significantly reduced the total energy consumption compared to the initial scheduling.
- Thus, by transferring our tasks that occur on local cores to the cloud, we actually achieve an energy saving of about 81% while only extending our process by 8 units of time

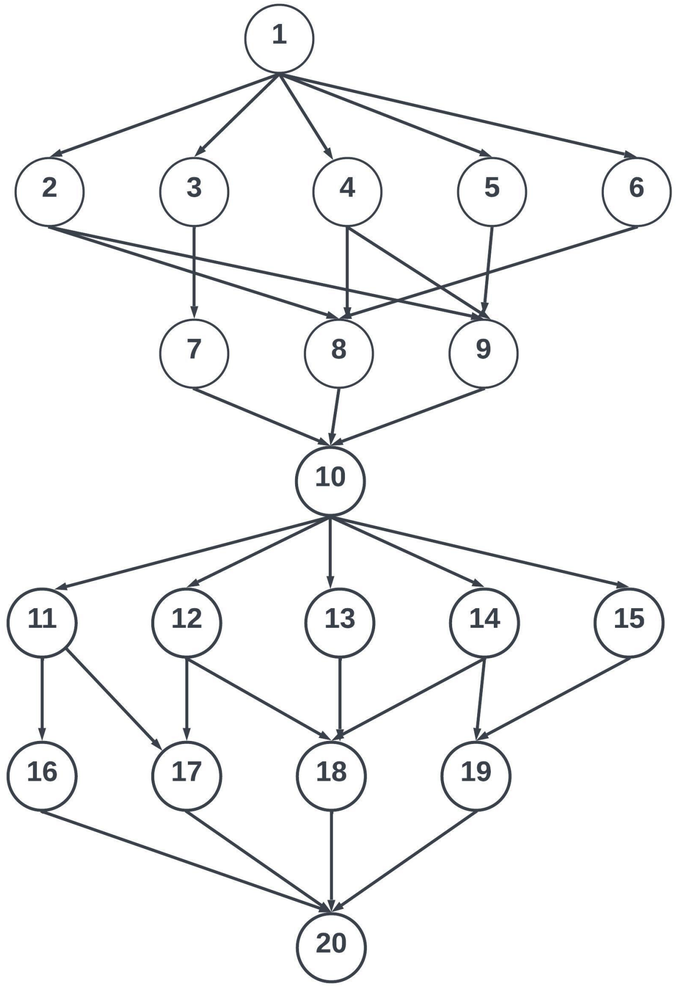


---------- Energy-Time Table ----------

Metric	Initial	Final
Total Energy	96	25
Total Time	18	26

Third Input

(a) figure of the input example including its task graph and its execution time table



TaskID	Core 1	Core 2	Core 3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	5	3	2
11	4	3	2
12	5	2	1
13	6	3	2
14	6	3	2
15	5	3	2
16	7	2	1
17	7	5	4
18	8	6	3
19	5	4	3
20	4	3	2

Third Input

(b) My program output for initial scheduling and energy consumption

```
---------------------------------- Initial Scheduling Table  ----------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
-----------------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  4  4  4  4  4  4  4  -  -  -  -  -  -  - 11 11 11 11  - 19 19 19 19 19  -  -  -
Core 2       :  -  -  -  -  -  -  6  6  6  6  6  6  -  8  8  8  8  -  - 13 13 13  - 17 17 17 17 17  -  -  -  -
Core 3       :  1  1  1  1  1  3  3  3  3  5  5  7  7  7  9  9 10 10 14 14 12 15 15 18 18 18 16  - 20 20  -
WL Sending   :  -  -  -  -  -  2  2  2  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Cloud        :  -  -  -  -  -  -  -  -  2  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Receiving :  -  -  -  -  -  -  -  -  -  2  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-----------------------------------------------------------------------------------------------------
Total Energy (energyTotal): 169.5
Total Time (timeTotal): 30
Execution Time of My Algorithm for Initial Scheduling: 254 microsecond.
```

	Core 1	Core 2	Core 3	Cloud
Task 1			20	
Task 2				1.5
Task 3		16		
Task 4	7			
Task 5		8		
Task 6		12		
Task 7		12		
Task 8	8			
Task 9		8		
Task 10		8		
Task 11	4			
Task 12		4		
Task 13		6		
Task 14		8		
Task 15		8		
Task 16		4		
Task 17	10			
Task 18		12		
Task 19	5			
Task 20		8		
Sum	16	36	116	1.5
Total				169.5

- When I manually calculated the energy consumption for each task, I found that Core 1 consumed 16, Core 2 consumed 36, Core 3 consumed 116, and the Cloud consumed 1.5, resulting in a total energy consumption of 169.5.
- Execution time of my algorithm for Initial Scheduling is 254 microsecond.

Third Input

(c) My program output for final scheduling and energy consumption

```
------------------------------------ Final Assignment Table  ------------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
-------------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  5  5  5  5  5  -  -  -  -  8  8  8  8  8  8  -  -  -  -  - 15 15 15 15 15 19 19 19 19 19  -  -  -  -  -  -  -  -  -  -  -
Core 2       :  -  -  -  -  -  -  -  -  -  -  -  -  9  9  9  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Core 3       :  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Sending   :  1  1  1  2  2  2  4  4  4  6  6  6  3  3  3  7  7  7  -  - 10 10 10 14 14 14 11 11 11 12 12 12 13 13 13 17 17 17 18 18 18  -  -  -  -  -
Cloud        :  -  -  -  1  -  -  2  -  -  4  -  -  6  -  -  3  -  -  7  -  -  -  - 10  -  - 14  -  - 11  -  - 12  -  - 13  -  - 17  -  - 18  -  -  -  -
WL Receiving :  -  -  -  -  1  -  -  2  -  -  4  -  -  6  -  -  3  -  -  7  -  -  -  - 10  -  - 14  -  - 11  -  - 12  -  - 13  -  - 17  -  - 18  -  -  -
-------------------------------------------------------------------------------------------------
Total Energy (energyTotal): 58.5
Total Time (timeTotal): 45
Execution Time of My Algorithm for Final Scheduling: 3764 microsecond.
```

- For the final scheduling, my program reduced the total energy consumption to 58.5 while also calculating the TotalTime value as 45.
- Execution time of my algorithm for Final Scheduling is 3764 microsecond.
- As you can see here, our previous T_initial value was 30. Here, the T_max value would be 45.
- As illustrated in this example, since the T value cannot exceed 45, our final scheduling algorithm has arranged the final scheduling so as not to exceed 45.

Third Input

(c) My program output for final scheduling and energy consumption

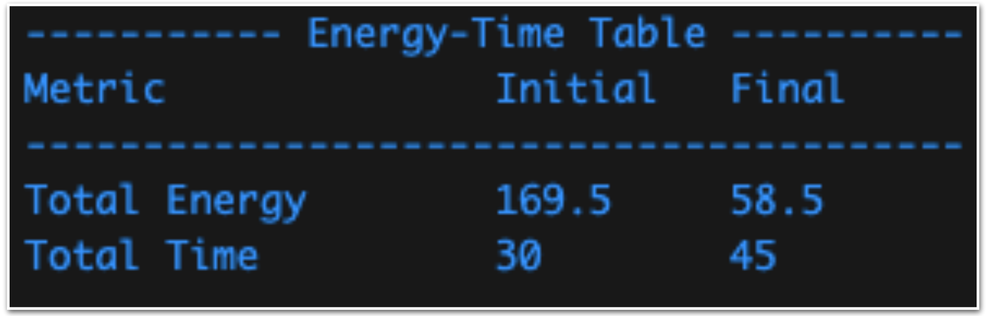
- For the final scheduling, my program reduced the total energy consumption to 58.5 while also calculating the TotalTime value as 45.
- Upon manual inspection, the energy consumption was confirmed to be 21 for Core 1, 6 for Core 2, 12 for Core 3, and 19.5 for the Cloud, totaling 58.5.

	Core 1	Core 2	Core 3	Cloud
Task 1				1.5
Task 2				1.5
Task 3				1.5
Task 4				1.5
Task 5	5			
Task 6				1.5
Task 7				1.5
Task 8	6			
Task 9		6		
Task 10				1.5
Task 11				1.5
Task 12				1.5
Task 13				1.5
Task 14				1.5
Task 15	5			
Task 16			4	
Task 17				1.5
Task 18				1.5
Task 19	5			
Task 20			8	
Sum	21	6	12	19.5
Total				58.5

Third Input

(d) Summary of Etotal, Ttotal for both case.

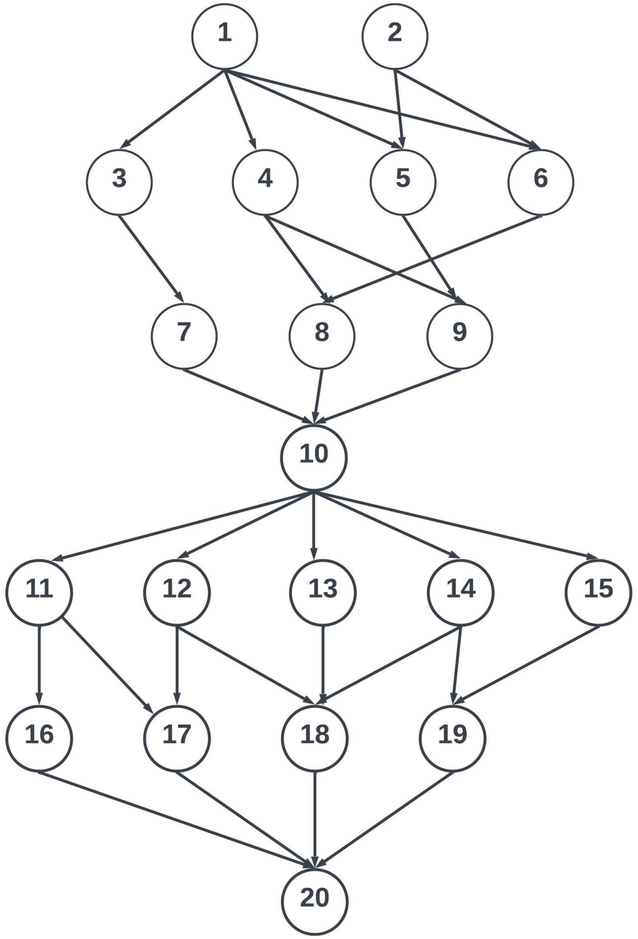
- Total time (T_total) and total energy (E_total) for both the initial and final scheduling is as follows:
- Initial Scheduling:
  - Total Energy (E_total): 169.5
  - Total Time (T_total): 30
- Final Scheduling:
  - Total Energy (E_total): 58.5
  - Total Time (T_total): 45
- This summary indicates that while the final scheduling increased the total time of operations, it significantly reduced the total energy consumption compared to the initial scheduling.
- Thus, by transferring our tasks that occur on local cores to the cloud, we actually achieve an energy saving of about 65%.



```
---------- Energy-Time Table ----------
Metric              Initial   Final
---------------------------------------
Total Energy        169.5     58.5
Total Time          30        45
```

Fourth Input

(a) figure of the input example including its task graph and its execution time table



TaskID	Core 1	Core 2	Core 3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	5	3	2
11	4	3	2
12	5	2	1
13	6	3	2
14	6	3	2
15	5	3	2
16	7	2	1
17	7	5	4
18	8	6	3
19	5	4	3
20	4	3	2

Fourth Input

(b) My program output for initial scheduling and energy consumption

```
---------------------------------- Initial Scheduling Table  ----------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
-----------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  5  5  5  5  5  -  -  -  -  -  - 11 11 11 11  - 19 19 19 19 19  -  -  -
Core 2       :  -  -  -  -  -  4  4  4  4  4  8  8  8  8  -  - 13 13 13  - 17 17 17 17 17  -  -  -  -
Core 3       :  1  1  1  1  1  3  3  3  3  7  7  7  9  9 10 10 14 14 12 15 15 18 18 18 16  - 20 20  -
WL Sending   :  2  2  2  -  -  6  6  6  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Cloud        :  -  -  -  2  -  -  -  -  6  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Receiving :  -  -  -  -  2  -  -  -  -  6  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-----------------------------------------------------------------------------------------------
Total Energy (energyTotal): 159
Total Time (timeTotal): 28
Execution Time of My Algorithm for Initial Scheduling: 260 microsecond.
```

- When I manually calculated the energy consumption for each task, I found that Core 1 consumed 14, Core 2 consumed 34, Core 3 consumed 108, and the Cloud consumed 3, resulting in a total energy consumption of 159.
- Execution time of my algorithm for Initial Scheduling is 260 microsecond.

	Core 1	Core 2	Core 3	Cloud
Task 1			20	
Task 2				1.5
Task 3			16	
Task 4		10		
Task 5	5			
Task 6				1.5
Task 7			12	
Task 8		8		
Task 9			8	
Task 10			8	
Task 11	4			
Task 12			4	
Task 13		6		
Task 14			8	
Task 15			8	
Task 16			4	
Task 17		10		
Task 18			12	
Task 19	5			
Task 20			8	
Sum	14	34	108	3
Total				159

Fourth Input

(c) My program output for final scheduling and energy consumption

```
------------------------------------ Final Assignment Table  ------------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
-------------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  4  4  4  4  4  4  4  7  7  7  7  7  7  7  7  -  -  -  -  - 11 11 11 11 19 19 19 19 19  -  -  -  -  -  -  -  -  -
Core 2       :  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  9  9  9  -  -  -  -  -  -  - 15 15 15  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Core 3       :  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  - 16  -  -  -  -  -  -  -  -  - 20 20  -
WL Sending   :  1  1  1  2  2  2  3  3  3  5  5  5  6  6  6  8  8  8  -  - 10 10 10 14 14 14 12 12 12 13 13 13 17 17 17 18 18 18  -  -  -  -  -
Cloud        :  -  -  -  1  -  -  2  -  -  3  -  -  5  -  -  6  -  -  8  -  -  -  - 10  -  - 14  -  - 12  -  - 13  -  - 17  -  - 18  -  -  -  -
WL Receiving :  -  -  -  -  1  -  -  2  -  -  3  -  -  5  -  -  6  -  -  8  -  -  -  - 10  -  - 14  -  - 12  -  - 13  -  - 17  -  - 18  -  -  -
-------------------------------------------------------------------------------------------------
Total Energy (energyTotal): 66
Total Time (timeTotal): 42
Execution Time of My Algorithm for Final Scheduling: 3696 microsecond.
```

- For the final scheduling, my program reduced the total energy consumption to 66 while also calculating the TotalTime value as 42.
- Execution time of my algorithm for Final Scheduling is 3696 microsecond.
- As you can see here, our previous T_initial value was 28. Here, the T_max value would be 42.
- As illustrated in this example, since the T value cannot exceed 42, our final scheduling algorithm has arranged the final scheduling so as not to exceed 42.

Fourth Input

(c) My program output for final scheduling and energy consumption

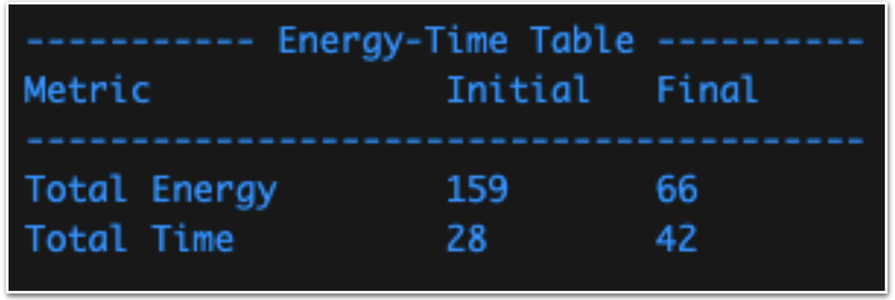
- For the final scheduling, my program reduced the total energy consumption to 66 while also calculating the TotalTime value as 42.
- Upon manual inspection, the energy consumption was confirmed to be 24 for Core 1, 12 for Core 2, 12 for Core 3, and 18 for the Cloud, totaling 66.

	Core 1	Core 2	Core 3	Cloud
Task 1				1.5
Task 2				1.5
Task 3				1.5
Task 4	7			
Task 5				1.5
Task 6				1.5
Task 7	8			
Task 8				1.5
Task 9		6		
Task 10				1.5
Task 11	4			
Task 12				1.5
Task 13				1.5
Task 14				1.5
Task 15		6		
Task 16			4	
Task 17				1.5
Task 18				1.5
Task 19	5			
Task 20			8	
Sum	24	12	12	18
Total				66

Fourth Input

(d) Summary of Etotal, Ttotal for both case.

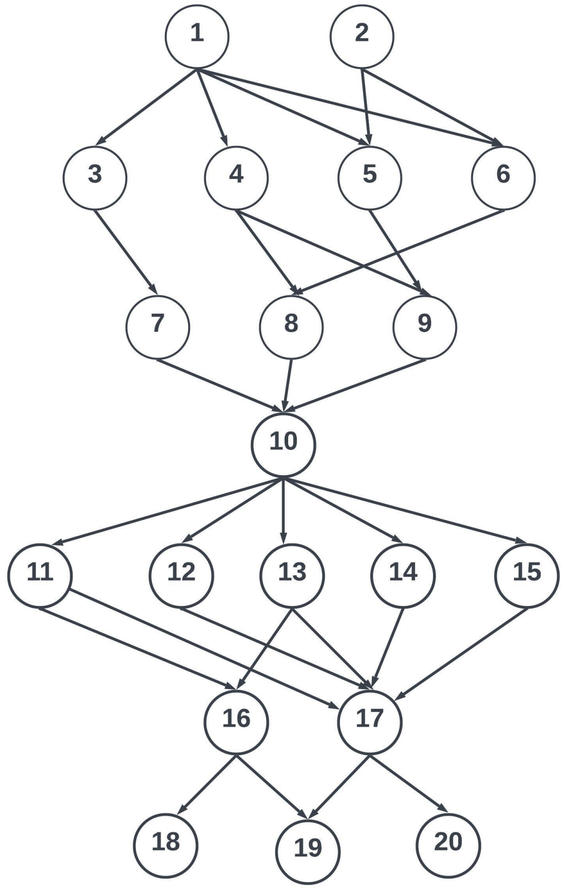
- Total time (T_total) and total energy (E_total) for both the initial and final scheduling is as follows:
- Initial Scheduling:
  - Total Energy (E_total): 159
  - Total Time (T_total): 28
- Final Scheduling:
  - Total Energy (E_total): 66
  - Total Time (T_total): 42
- This summary indicates that while the final scheduling increased the total time of operations, it significantly reduced the total energy consumption compared to the initial scheduling.
- Thus, by transferring our tasks that occur on local cores to the cloud, we actually achieve an energy saving of about 58%.



```
---------- Energy-Time Table ----------
Metric              Initial   Final
---------------------------------------
Total Energy        159       66
Total Time          28        42
```

Fifth Input

(a) figure of the input example including its task graph and its execution time table



TaskID	Core 1	Core 2	Core 3
1	9	7	5
2	8	6	5
3	6	5	4
4	7	5	3
5	5	4	2
6	7	6	4
7	8	5	3
8	6	4	2
9	5	3	2
10	5	3	2
11	4	3	2
12	5	2	1
13	6	3	2
14	6	3	2
15	5	3	2
16	7	2	1
17	7	5	4
18	8	6	3
19	5	4	3
20	4	3	2

Fifth Input

(b) My program output for initial scheduling and energy consumption

```
---------------------------------- Initial Scheduling Table  ----------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
-------------------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  5  5  5  5  5  -  -  -  -  -  -  - 11 11 11 11  -  -  -  -  - 20 20 20 20  -
Core 2       :  -  -  -  -  -  4  4  4  4  4  8  8  8  8  -  - 13 13 13 12 12 16 16  -  - 19 19 19 19  -
Core 3       :  1  1  1  1  1  3  3  3  3  7  7  7  9  9 10 10 14 14 15 15  - 17 17 17 17 18 18 18  -  -
WL Sending   :  2  2  2  -  -  6  6  6  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Cloud        :  -  -  -  2  -  -  -  -  6  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Receiving :  -  -  -  -  2  -  -  -  -  6  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-------------------------------------------------------------------------------------------------------
Total Energy (energyTotal): 164
Total Time (timeTotal): 29
Execution Time of My Algorithm for Initial Scheduling: 259 microsecond.
```

- When I manually calculated the energy consumption for each task, I found that Core 1 consumed 13, Core 2 consumed 40, Core 3 consumed 108, and the Cloud consumed 3, resulting in a total energy consumption of 164.
- Execution time of my algorithm for Initial Scheduling is 259 microsecond.

	Core 1	Core 2	Core 3	Cloud
Task 1			20	
Task 2				1.5
Task 3			16	
Task 4		10		
Task 5	5			
Task 6				1.5
Task 7			12	
Task 8		8		
Task 9			8	
Task 10			8	
Task 11	4			
Task 12		4		
Task 13		6		
Task 14			8	
Task 15			8	
Task 16		4		
Task 17			16	
Task 18			12	
Task 19		8		
Task 20	4			
Sum	13	40	108	3
Total				164

Fifth Input

(c) My program output for final scheduling and energy consumption

```
------------------------------------ Final Assignment Table  ------------------------------------
Time:         0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
-------------------------------------------------------------------------------------------------
Core 1       :  -  -  -  -  -  4  4  4  4  4  4  4  7  7  7  7  7  7  7  7  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Core 2       :  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  9  9  9  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Core 3       :  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Sending   :  1  1  1  2  2  2  3  3  3  5  5  5  6  6  6  8  8  8  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
Cloud        :  -  -  -  1  -  -  2  -  -  3  -  -  5  -  -  6  -  -  8  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
WL Receiving :  -  -  -  -  1  -  -  2  -  -  3  -  -  5  -  -  6  -  -  8  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
-------------------------------------------------------------------------------------------------
Total Energy (energyTotal): 65
Total Time (timeTotal): 41
Execution Time of My Algorithm for Final Scheduling: 3686 microsecond.
```

- For the final scheduling, my program reduced the total energy consumption to 65 while also calculating the TotalTime value as 41.
- Execution time of my algorithm for Final Scheduling is 3686 microsecond.

Fifth Input

(c) My program output for final scheduling and energy consumption

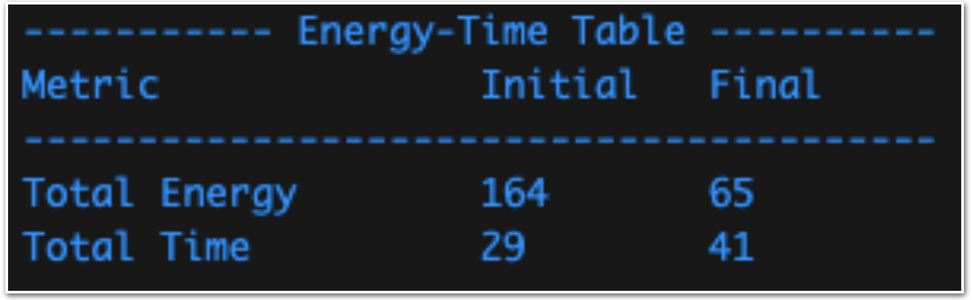
- For the final scheduling, my program reduced the total energy consumption to 65 while also calculating the TotalTime value as 41.
- Upon manual inspection, the energy consumption was confirmed to be 19 for Core 1, 28 for Core 2, and 18 for the Cloud, totaling 65.

	Core 1	Core 2	Core 3	Cloud
Task 1				1.5
Task 2				1.5
Task 3				1.5
Task 4	7			
Task 5				1.5
Task 6				1.5
Task 7	8			
Task 8		6		
Task 9				1.5
Task 10				1.5
Task 11		4		
Task 12				1.5
Task 13				1.5
Task 14				1.5
Task 15		6		
Task 16		4		
Task 17				1.5
Task 18				1.5
Task 19		8		
Task 20	4		8	
Sum	19	28	0	18
Total				65

Fifth Input

(d) Summary of Etotal, Ttotal for both case.

- Total time (T_total) and total energy (E_total) for both the initial and final scheduling is as follows:
- Initial Scheduling:
  - Total Energy (E_total): 164
  - Total Time (T_total): 29
- Final Scheduling:
  - Total Energy (E_total): 65
  - Total Time (T_total): 41
- This summary indicates that while the final scheduling increased the total time of operations, it significantly reduced the total energy consumption compared to the initial scheduling.
- Thus, by transferring our tasks that occur on local cores to the cloud, we actually achieve an energy saving of about 61%.



```
---------- Energy-Time Table ----------
Metric              Initial   Final
---------------------------------------
Total Energy        164       65
Total Time          29        41
```

Thanks