Lab Assignment 1

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Device Specification:
CPU: AMD Ryzen9 5900H, internal GPU: 512mB, Shared GPU: 7.7GB
WIFI: MediaTek Wi-Fi 6 MT7921 Wireless LAN Card
RAM: 16GB
Storage: 954GB
OS Specification:
All commands were run on Windows Subsystem for Linux on Windows 10. With the version
WSL version: 2.0.14.0
Kernel version: 5.15.133.1-1
Programme Version:
Python 3.10.12
Wget 1.21.2

Experiments are done using python scripts using multithreading and invoking 'wget' command through script. Delay, and from delay throughput, is calculated by measuring the time between when the download is starting and it is ending. Data for delay and throughput vs all other factors are stored in csv files. From the csv file analysis is done in jupyter notebook file.

Choice of factors and levels:
Download File size = [1B, 1kB, 10kB, 100kB, 500kB, 1MB, 10MB, 100MB, 500MB]
downloadSpeedLimit = [500k, 1M, 1.5M, 2M, infinity]
noOfConDownloads = [1, 3, 5, 7]
timeOfDay = ["4PM", "8PM", "10AM"]

1. **Selection of levels in Simple Design:**

First arbitrarily selecting Download File Size, number of Concurrent Downloads, Time of the day factor levels and finding the highest Throughput in which Download Speed Limit. Then selecting the best number of Concurrent Downloads and checking the highest TP across all levels and selecting the best one and so on.

Time	4PM									1
	8PM									1

		1B	1kB	10kB	100kB	500kB	1MB	10MB	100MB	500MB
	10AM									1
Concurrent Download number	1			1						
	3	1	1	1	1	1	1	1	1	1
	5			1						
	7			1						
Speed Limit	inf			1						
	2M			1						
	1.5M	1	1	1	1	1	1	1	1	1
	1M			1						
	500k			1						

2. Selection of levels of factors in Full Factorial Design:

In this experiment all the levels of all factors are taken into account. Total 9*5*4*3 = 540.

		1B	1kB	10kB	100kB	500kB	1MB	10MB	100M	500M
Time	4PM	1	1	1	1	1	1	1	1	1
	8PM	1	1	1	1	1	1	1	1	1
	10AM	1	1	1	1	1	1	1	1	1
Concurrent Download number	1	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1	1
	5	1	1	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1	1	1
Speed Limit	inf	1	1	1	1	1	1	1	1	1
	2M	1	1	1	1	1	1	1	1	1
	1.5M	1	1	1	1	1	1	1	1	1
	1M	1	1	1	1	1	1	1	1	1
	500k	1	1	1	1	1	1	1	1	1

										B	B

3. Fractional Factorial Design:

For fractional factorial 2 extreme levels of each factors are taken. 1B and 500MB for download File Size, 500kB and Infinite for Download Speed Limit, 1 and 7 for number of concurrent downloads and 8PM and 10AM for time of the day.

		1B	1kB	10kB	100kB	500kB	1MB	10MB	100MB	500MB
Time	4PM									
	8PM	1								1
	10AM	1								1
Concurrent Download number	1	1								1
	3									
	5									
	7	1								1
Speed Limit	inf	1								1
	2M									
	1.5M									
	1M									
	500k	1								1

Conduct the experiments and plot the following:
(a) Observed throughput as a function of the most influential factor
(b) Time taken for whole experiment as a experiment design chosen

Part - a: Observed throughput as a function of the most influential factor

For calculating the most influential factor the sum of throughputs across all other factors are taken into consideration, then the difference of maximum and minimum throughput gives the deviation of throughput for that factor. The most deviation for a factor says that the factor is most influential.

Deviation of Throughput (factor) = max(sum of TPs across all levels of the factor) -
min(sum of TPs across all levels of the factor)

We are interested in the maximum deviation of TP.

From the full factorial design experiment we can conclude that the most influential factor was time of the day.

```
Variation of maximum and minimum value of Throughput for the factor File Size is:
65612971633.21719
Variation of maximum and minimum value of Throughput for the factor Download Speed Limit is:
3119800510.01523
Variation of maximum and minimum value of Throughput for the factor No. of Concurrent Downloads is:
1777216583.6555328

Variation of maximum and minimum value of Throughput for the factor time of Day is:

79606888134.5473
```

Plotting the graph of throughput vs time of the day:
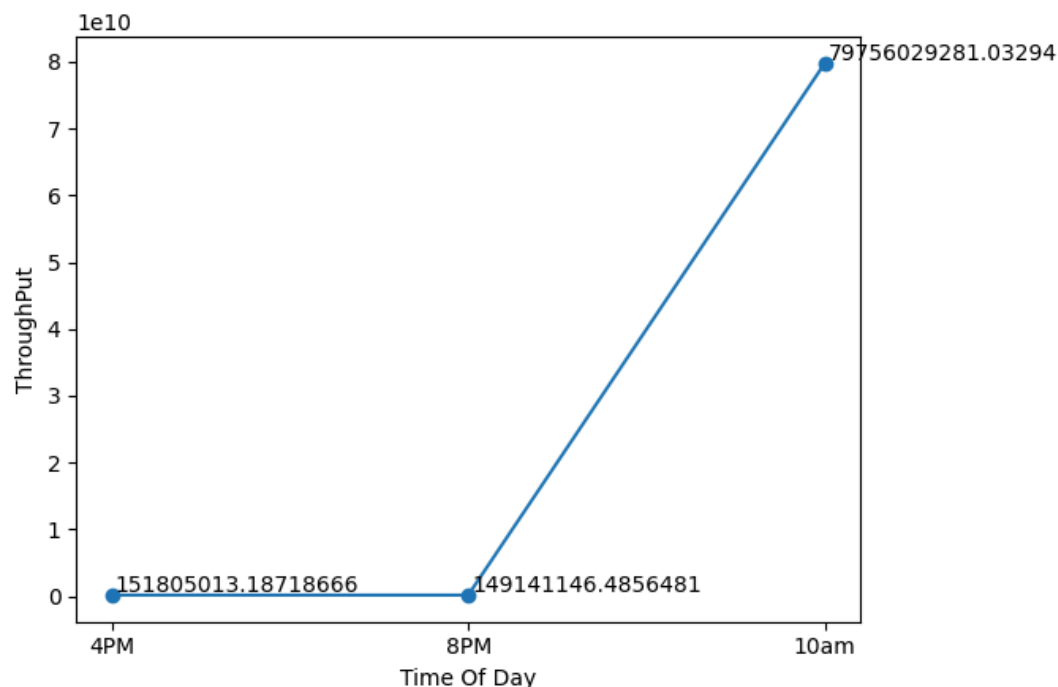
Part - b: Time taken for whole experiment as a experiment design chosen

We can use the 'time' command to get the total time taken to execute the python program of Simple design, Full factorial and fractional Factorial design. This is the complete time of downloading writing to hard disk, calculating throughput and delay and writing that to csv hence overall time taken for the experiment. For different time of the day the average of the total times are taken.
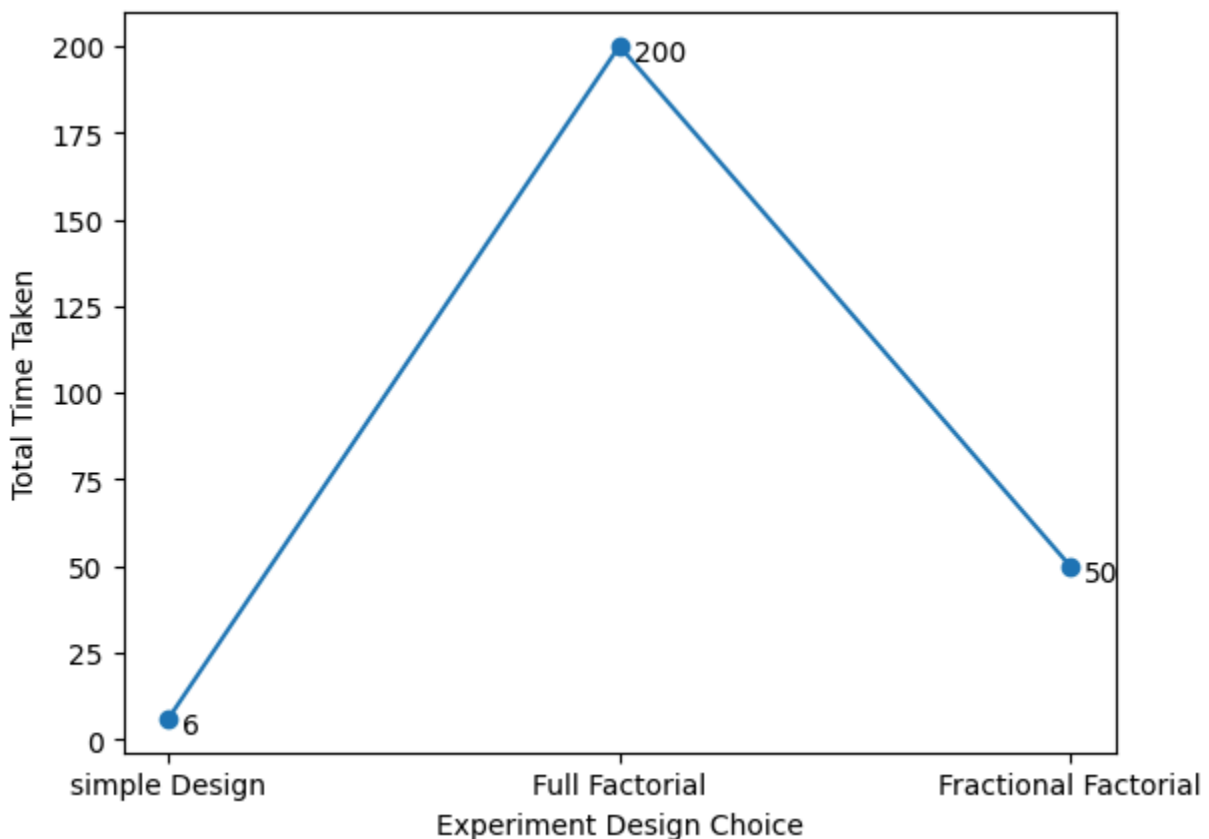
Total time taken as a experiment design choice:
Average time taken for Simple Design : 6 min
Average time taken for Full Factorial Design : 200 min
Average time taken for Fractional Factorial Design : 50 min

Plotting Total time taken as a experiment design choice vs experiment design:

Inferences and Conclusion:
The most influential factor being Time of the day is significant because during 10AM the hostel wifis are sitting idle because not many students are using the hostel wifi. But at 4PM or 8PM the wifis are handling many requests hence the service to one device falls significantly.
Number of concurrent downloads does not affect because speed of data writing to the hard disk is significantly higher than throughput.

Regarding total time of completion for different experiment design choices, the time is dependent on the number of sub-experiments.
Number of sub-experiments performed in simple design case: 9+5+4+3 = 21
Number of sub-experiments performed in Full Factorial: 9*5*4*3 = 540
Number of sub-experiments performed in Fractional Factorial: 2*2*2*2 = 16

Although in fractional factorial the number of sub-experiments are less, but the 500MB file at download speed limit = 500kB and number of concurrent downloads 7 has been taken. Which means the maximum amount of downloads at lowest possible throughputs are included into the experiment of Fractional design.
In simple design when we are checking for one factor other factors are not extreme. That's why there is the experiment completion time difference for simple design and fractional factorial design.