Performance evaluation: Homework 1

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1 Question 1

To highlight the variability of the response with the same input parameters, we queried 1000 times the simulator with the same values:

- Requests per second: 1
- Access points: 1
- Servers: 1

We can see through boxes plots (Figure 2) that the different responses are fluctuating up to a certain margin.

2 Question 2

When fixing the *access points* and *servers* to 1, the different response metrics vary with respect to the request per seconds, as can bee seen on Figure 3.
On the aforementioned graphs of Figure 3, the averages and standard deviations over 10 simulations are plotted in respectively dark and light green.

3 Question 3

To test the efficiency of the proposed solution, we plot the throughput theta (i.e. number of successful download requests completed per second) for different 2^k, with $k = 0, 1, 2, 3$, number of servers on Figure 4. We can see on this same figure that starting with 1 access point and doubling to 2 increase the number successful download requests per second. *However this solution cannot be applied independently of the other parameter*. Indeed, if we start at 2 access points doubling to 4 will trigger a congestion collapse near 400 requests per second. So a better solution should take into account the other parameters rather than solely the number of access points.

4 Question 4

We get some insight on the system by plotting $f(A, S)$:

$$f(A, S) = (\theta_{C_1}, \theta_{C_2}, ..., \theta_{C_{1000}})$$

To be more readable, each plot (Figure 6 and Figure 7) contains 10 curves: for a given number of access point we plot A, we varied S from 1 to 10 and for each pair (A,S) (10 pairs) we plot θ in function of number requests per second. More simply a plot is composed of:

$$f(A, 1), ..., f(A, 10)$$

Now let $g(C)$ be the function that gives us the number of access points and servers to have a linear growth in throughput.
From the plot of Figure 6 and Figure 7 we can identify for a given number of requests per second what is the minimal number of access points and servers to deliver linear throughput. Indeed, in each plot the number of successful download requests start growing linearly and break to sub-linear growth at a given point (we marked it by a vertical line on the plot).
Now to build the function g, each breaking point identify a moment when we need to increase resources allocated for the system, we summarize this in Table 1.
So we can define a multi-part function:

$$g(c) = \begin{cases} a = 1, s = 1 & \text{if } 1 \geq c > 55 \\ a = 2, s = 1 & \text{if } 55 \geq c > 105 \\ a = 3, s = 1 & \text{if } 105 \geq c > 175 \\ a = 4, s = 1 & \text{if } 175 \geq c > 235 \\ a = 5, s = 1 & \text{if } 235 \geq c > 300 \\ a = 6, s = 2 & \text{if } 300 \geq c > 355 \\ a = 7, s = 2 & \text{if } 355 \geq c > 425 \\ a = 8, s = 2 & \text{if } 425 \geq c > 475 \\ a = 9, s = 2 & \text{if } 475 \geq c > 545 \\ a = 10, s = 2 & \text{if } 545 \geq c > 595 \\ a = 10, s = 3 & \text{if } 595 \geq c \geq 1000 \end{cases}$$

When we reach 10 access points and 3 servers, increasing the number of servers doesn't improve the throughput. So we can't avoid the last breakpoint of the data near 595 simultaneous request per second. We plot in Figure 5 the result we obtained using our function on 10 different simulation (light green is standard deviation, dark green the average).

If we had unlimited access point and servers, we could extrapolate our simulation data to have a formula for unbounded C. Indeed a linear model fits pretty well to the number of access points. Also simply looking at the number of servers we see that we add one server every 5 access points. So we could have this formula:

$$g(c) = (floor(0.015 * c), ceil(0.015 * c/5))$$

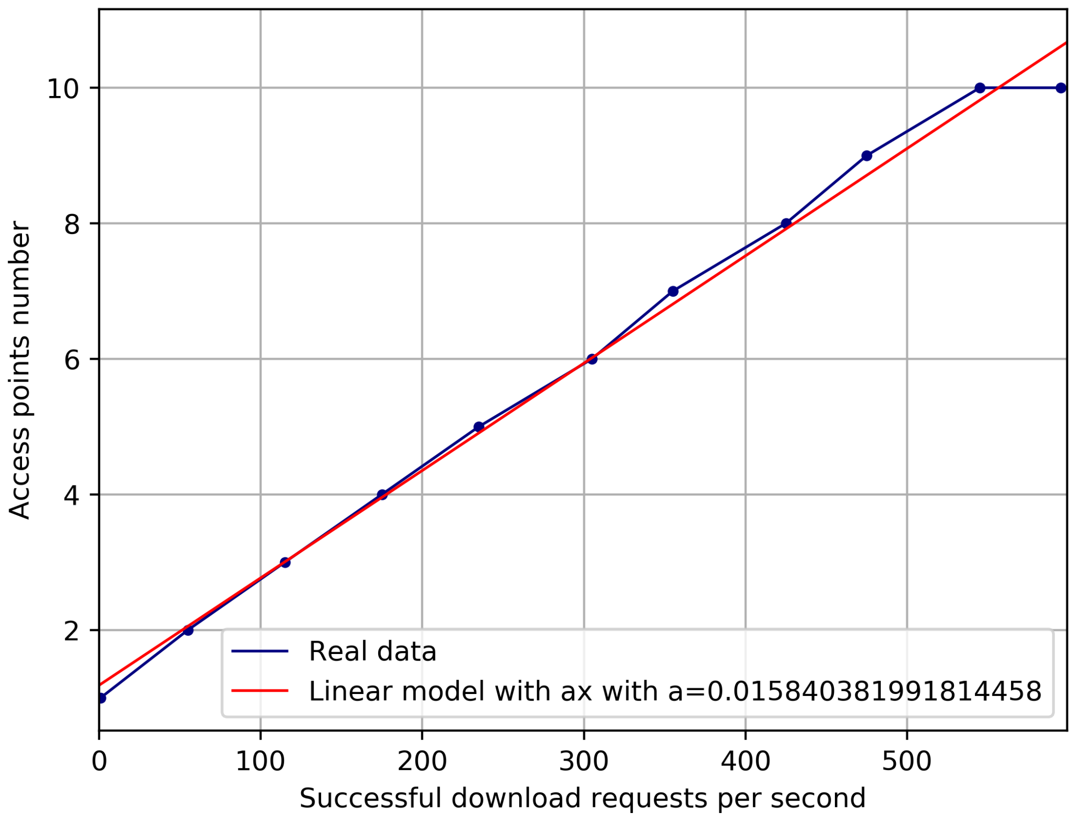

Figure 1: Plots Question 4: Result obtained using or multi-part function

C	0-55	55-105	105-175	175-235	235-300	300-355	355-425	425-475	475-545	545-595	595-1000
A	1	2	3	4	5	6	7	8	9	10	10
S	1	1	1	1	1	2	2	2	2	2	3

Table 1: Minimal number of access points and servers in function of number of requests per second to achieve a linear throughput

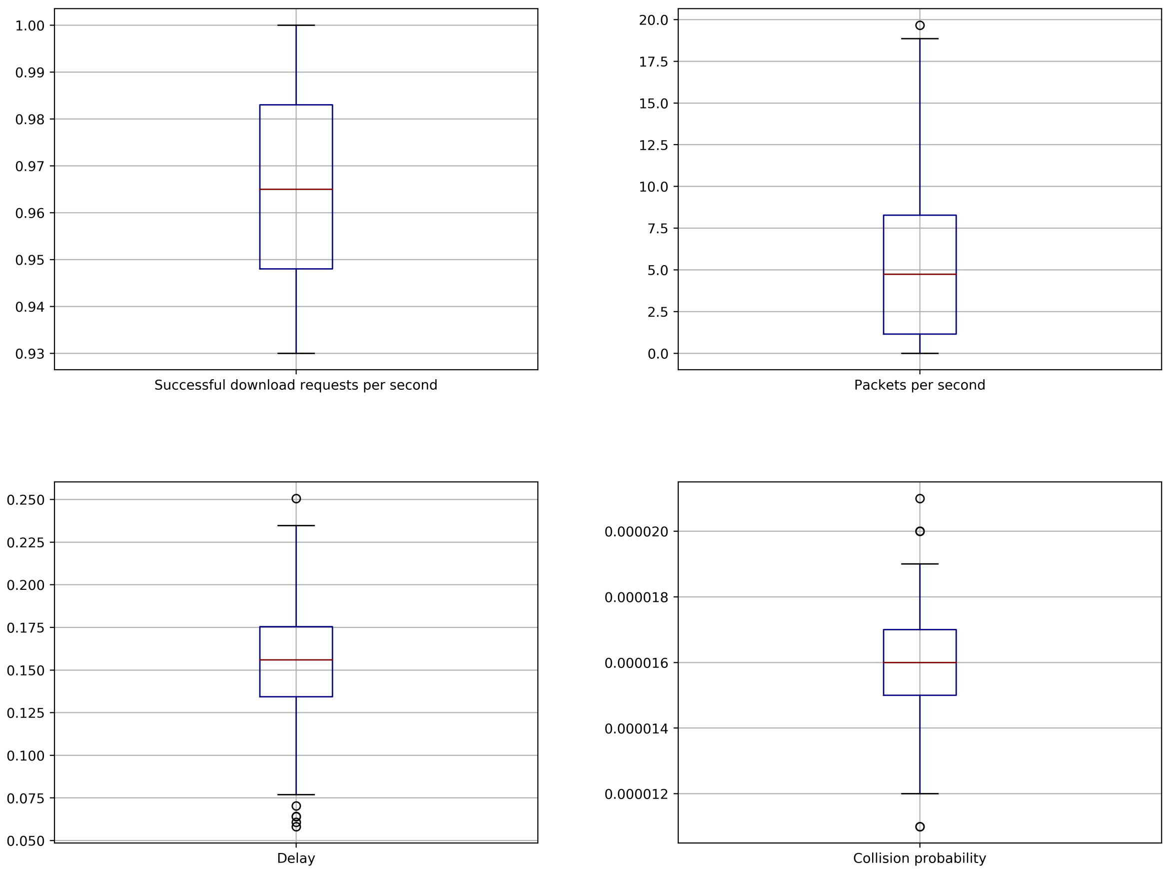

Figure 2: Plots Question 1

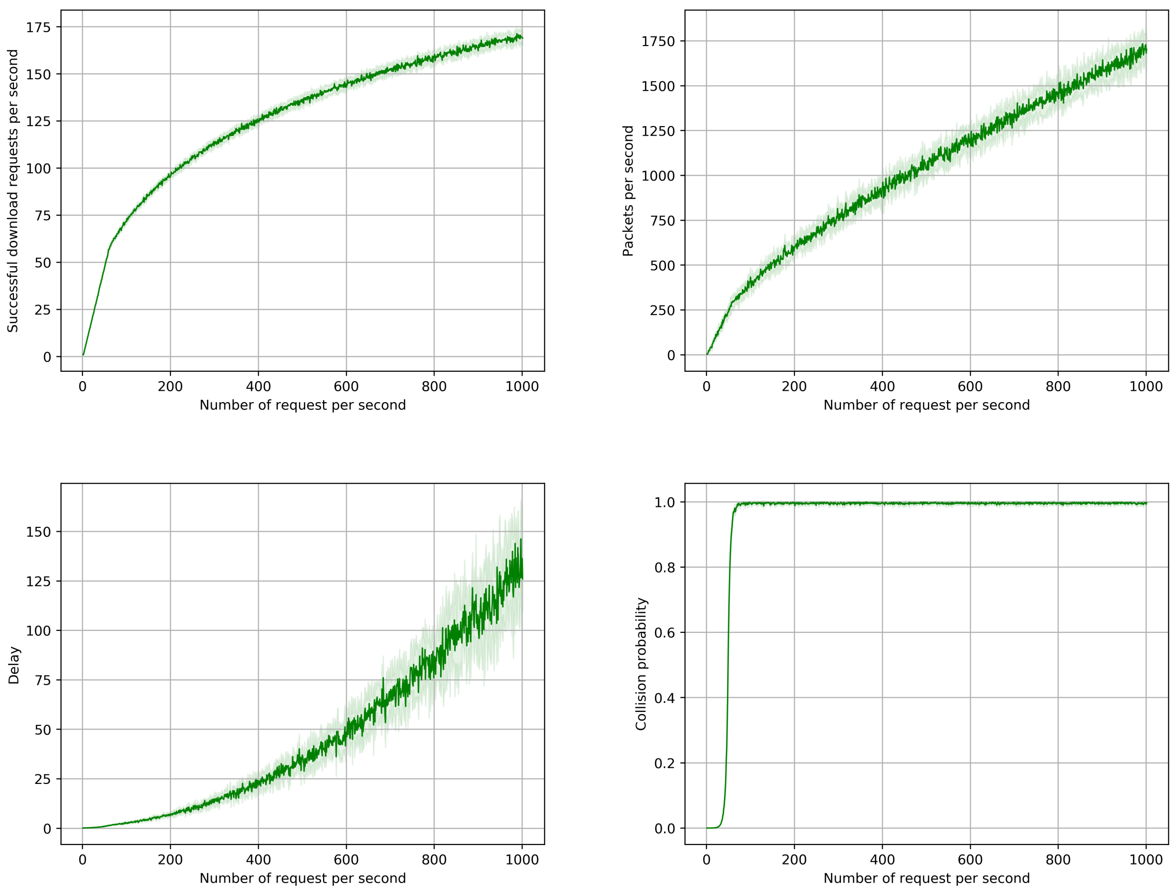

Figure 3: Plots Question 2

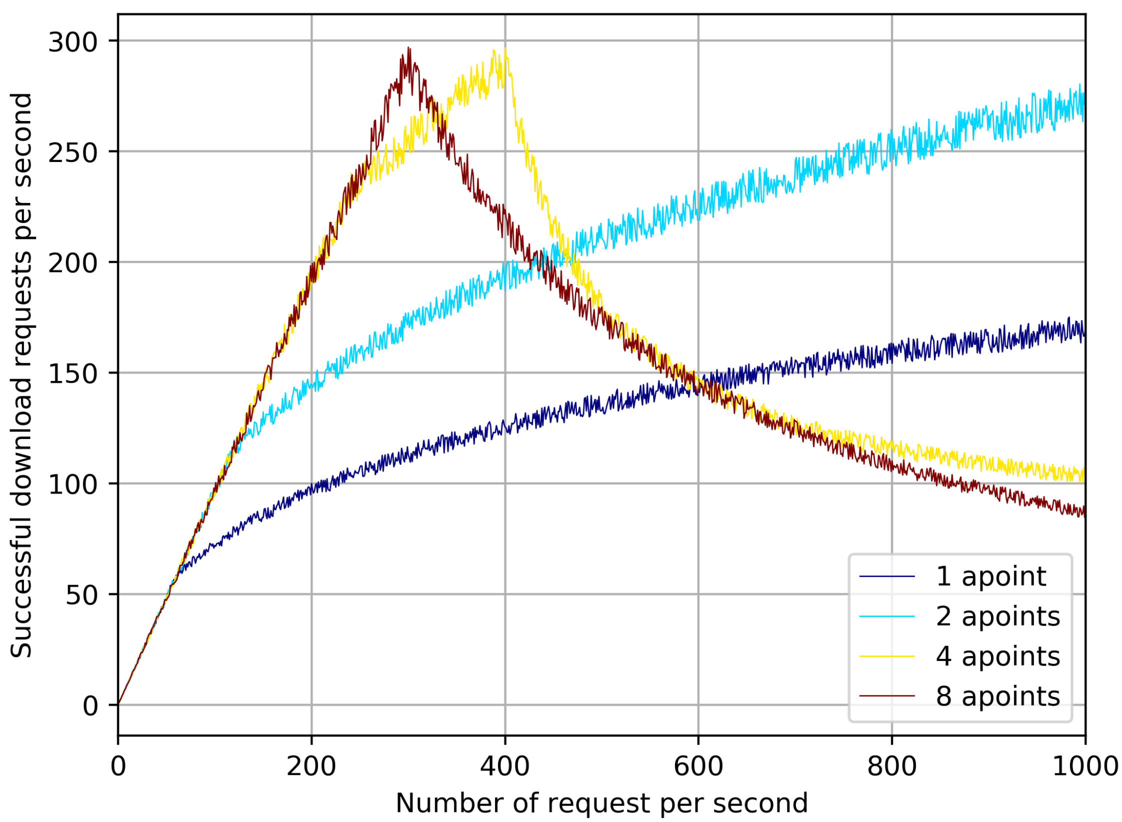

Figure 4: Plots Question 3

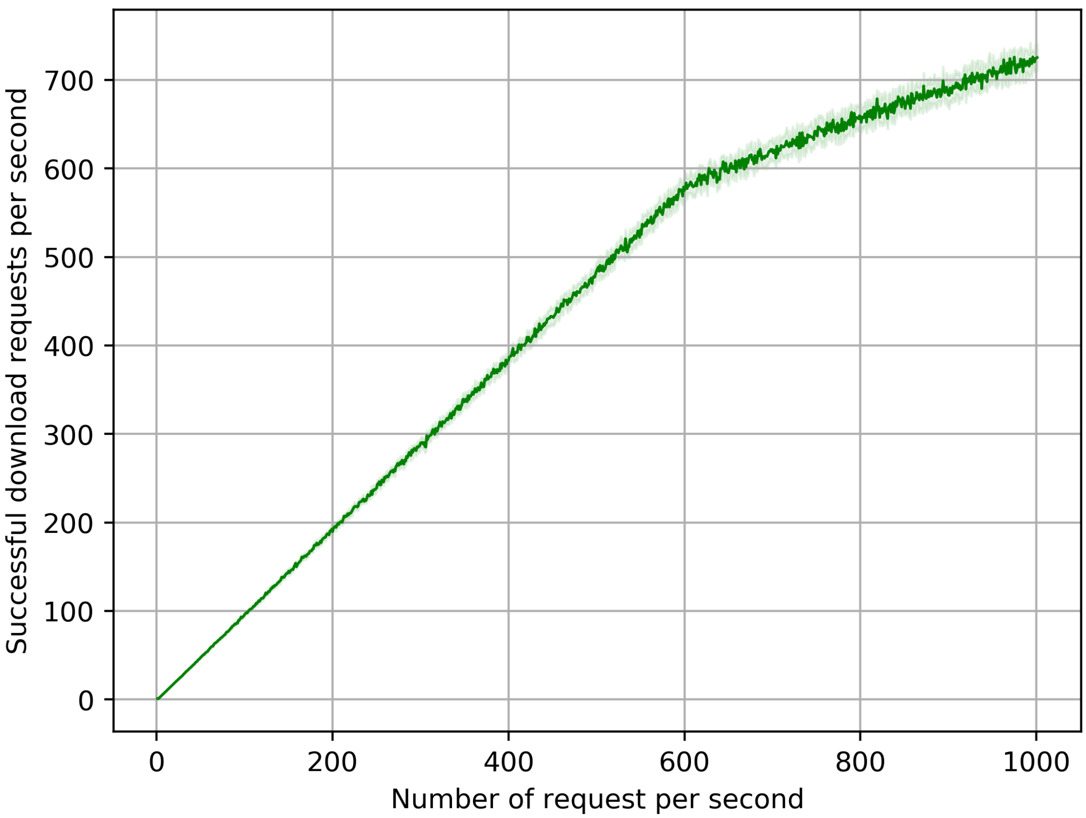

Figure 5: Plots Question 4: Result obtained using or multi-part function

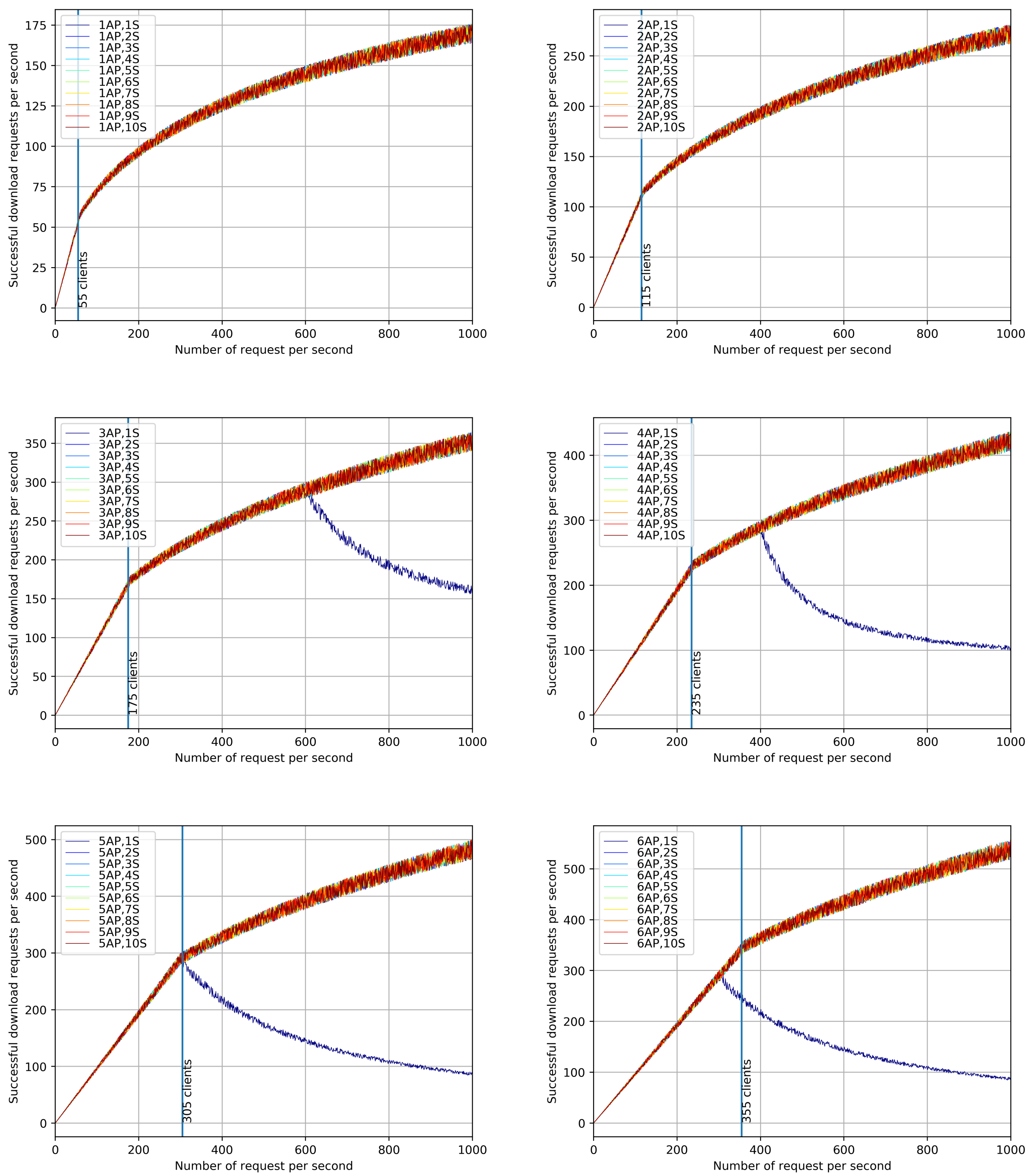

Figure 6: Plots Question 4 - Access points from 1 to 6

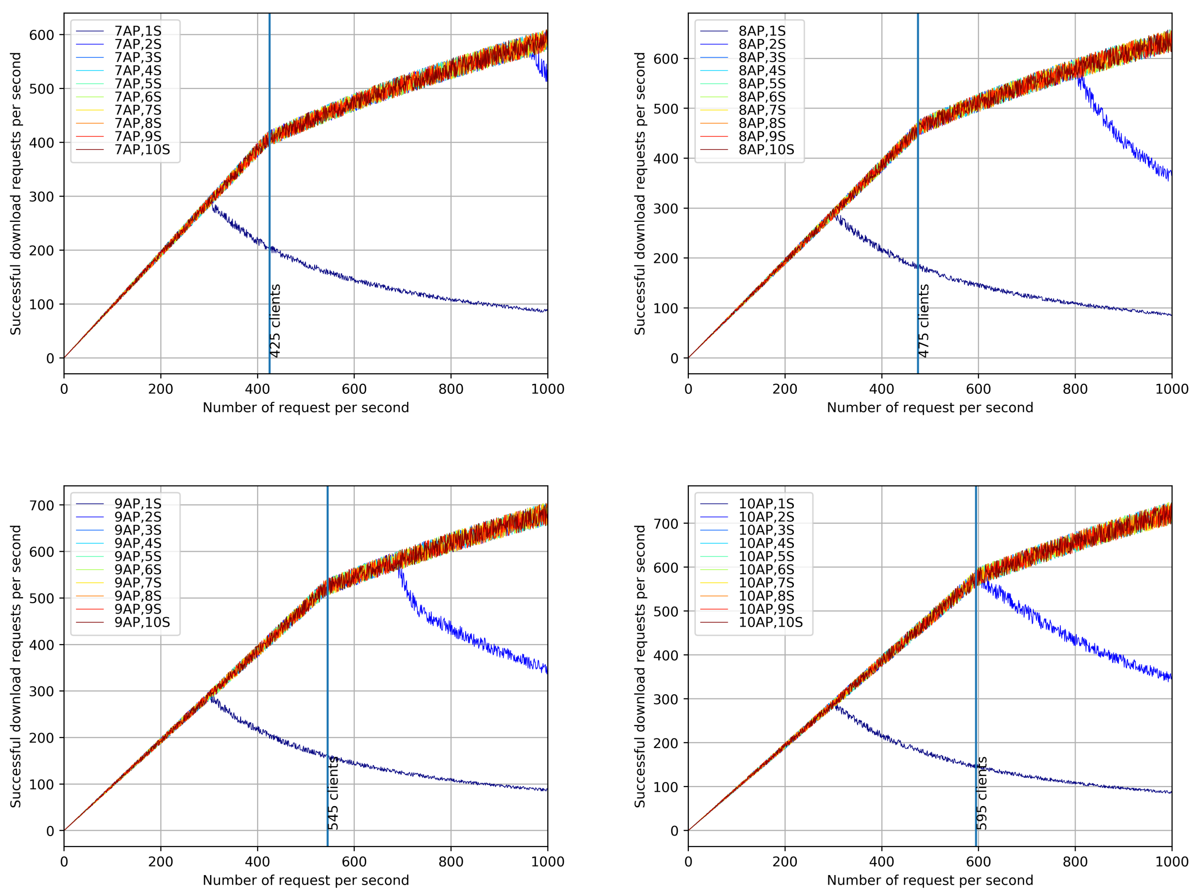

Figure 7: Plots Question 4 - Apoints from 7 to 10