CS-201 Homework 2

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1-In the first algorithm, upper bound time complexity is O(n), since algorithm depends on just one loop with n iteration.

In the second algorithm, upper bound time complexity is also O(n). However, there is a different situation in here. This algorithm works way faster than first one if the conditions are satisfied and condition is dependent on the relation between a and p. To find and upper bound, we take the worst case scenario which is that there is never an *i* such that $a^i = 1(mod\ p)$. In this case, algorithm works same as the algorithm 1 and therefore its upper bound time complexity is O(n).

In the third algorithm, n is divided to half at each call and function only calls itself for once in each call. Therefore, its time complexity is O(logn).

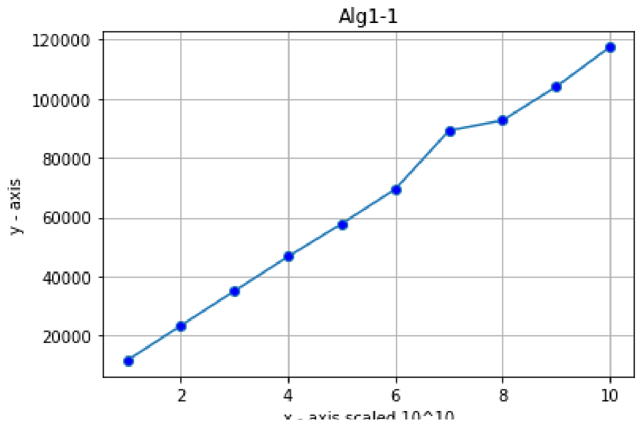
2-Computer Properties

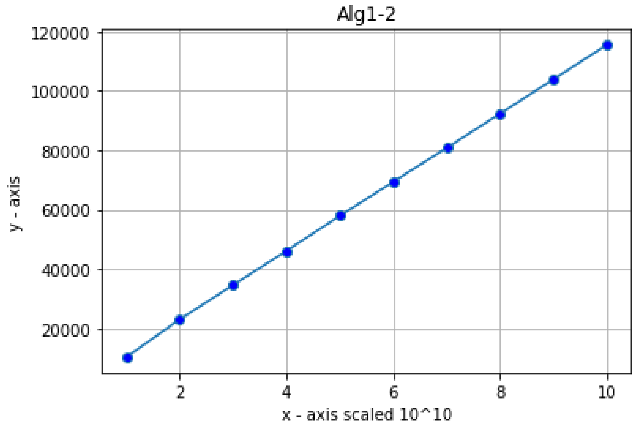
Processor	Intel(R) Core(TM) i7-10510U CPU @ 1.80GHz 2.30 GHz
Installed RAM	8.00 GB (7.79 GB usable)
Device ID	60F64CBD-67D8-437A-9BBF-F3D9C6FBC7BA
Product ID	00330-52725-31209-AAOEM
System type	64-bit operating system, x64-based processor

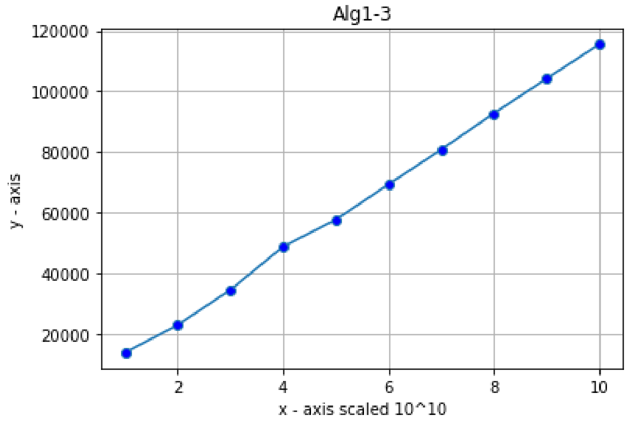
For all tests, a is fixed to 10000.

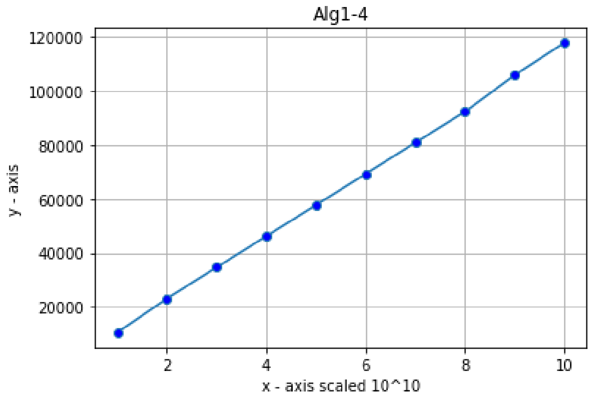
Algorithm 1

N	P=107	P=1003	P=10	P=100
1*10^10	11682	10402	13969	10467
2*10^10	23428	23090	23089	23089
3*10^10	35105	34685	34643	34633
4*10^10	46709	46191	48896	46179
5*10^10	57796	57965	57733	57689
6*10^10	69435	69439	69390	69267
7*10^10	89211	80844	80836	80825
8*10^10	92702	92363	92764	92282
9*10^10	103995	103943	104206	105848
10*10^10	117406	115509	115517	117860



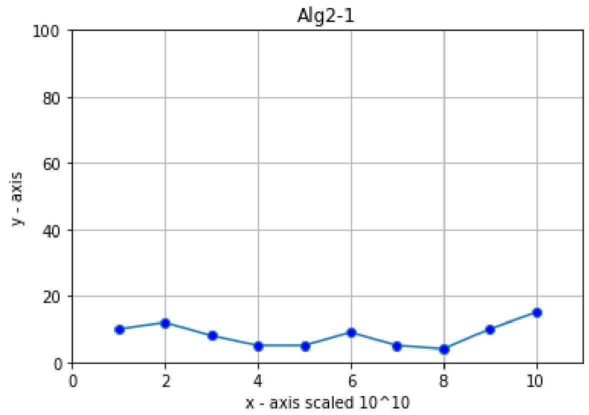


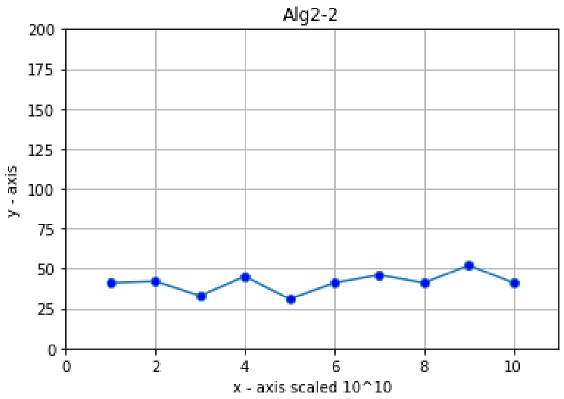


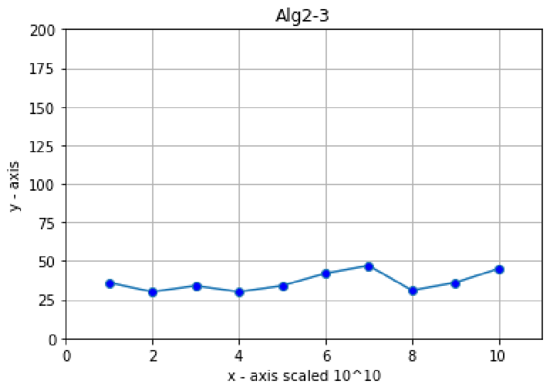


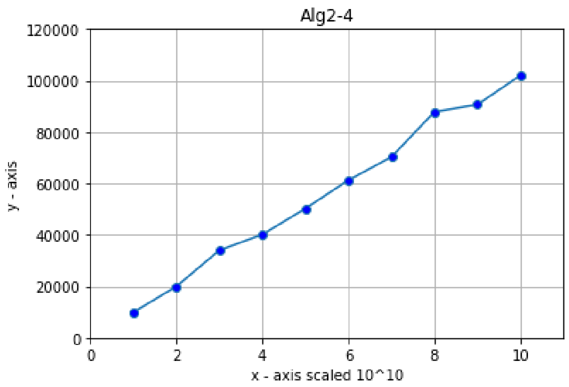
Algorithm 2

n	p=107	p=1003	p=10003	p=10
1*10^10	10	41	36	9940
2*10^10	12	42	30	19975
3*10^10	8	33	34	34051
4*10^10	5	45	30	40187
5*10^10	5	31	34	50279
6*10^10	9	41	42	61283
7*10^10	5	46	47	70299
8*10^10	4	41	31	87863
9*10^10	10	52	36	90701
10*10^10	15	41	45	102058





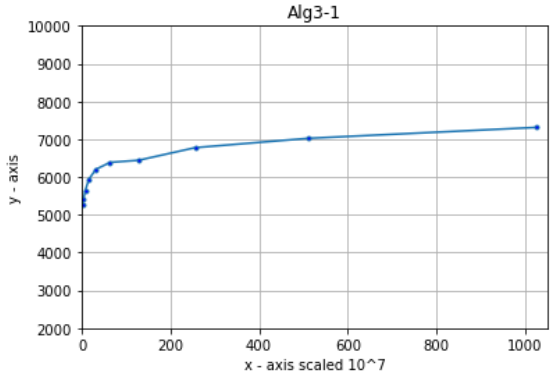


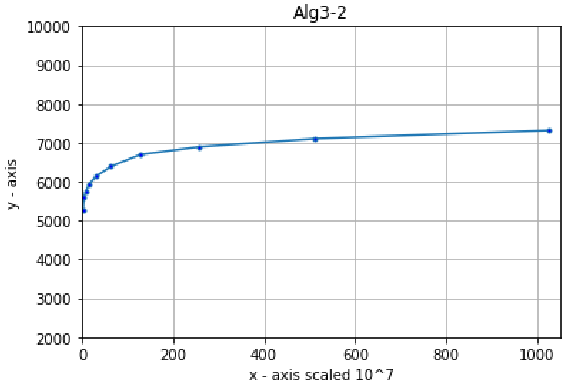


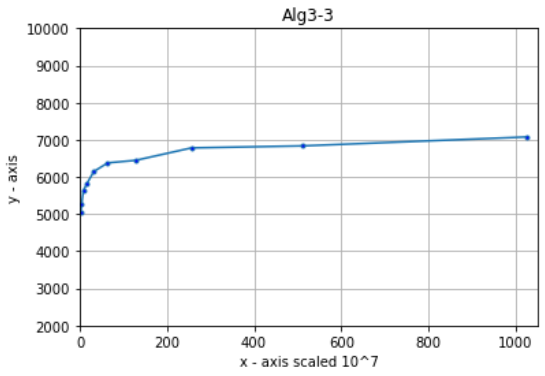
Algorithm 3

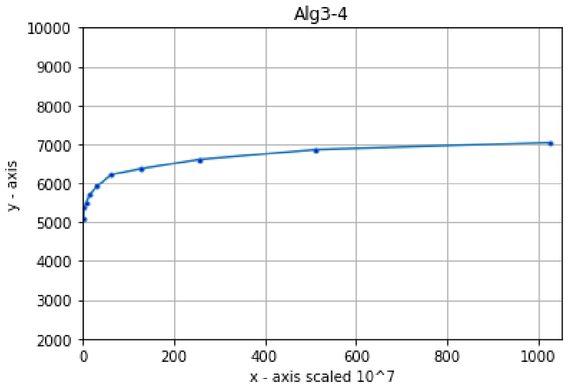
To show time complexity more accurate, algorithm 3 is called 10^7 times for every value.

N	P=107	P=1003	P=10	P=100
(2^1) *10^7	5254	5277	5058	5070
(2^2) *10^7	5428	5588	5262	5380
(2^3) *10^7	5641	5741	5627	5485
(2^4) *10^7	5943	5947	5816	5710
(2^5) *10^7	6203	6146	6145	5925
(2^6) *10^7	6388	6396	6379	6221
(2^7) *10^7	6442	6698	6446	6371
(2^8)*10^7	6777	6895	6781	6609
(2^9) *10^7	7024	7109	6836	6863
(2^10)*10^7	7311	7321	7075	7044


Alg3-1
y - axis
x - axis scaled 10^7


Alg3-2
y - axis
x - axis scaled 10^7


Alg3-3
y - axis
x - axis scaled 10^7


Alg3-4
y - axis
x - axis scaled 10^7