2.

(a) parallelized code

(b) By using block partition, scalability can be nondeterministic. The speedup can be sub-linear, linear or super-linear depends on particular key. Actually, it's a matter of luck. I will analyze these three scenarios from fundamental origin and convince you with specific data.

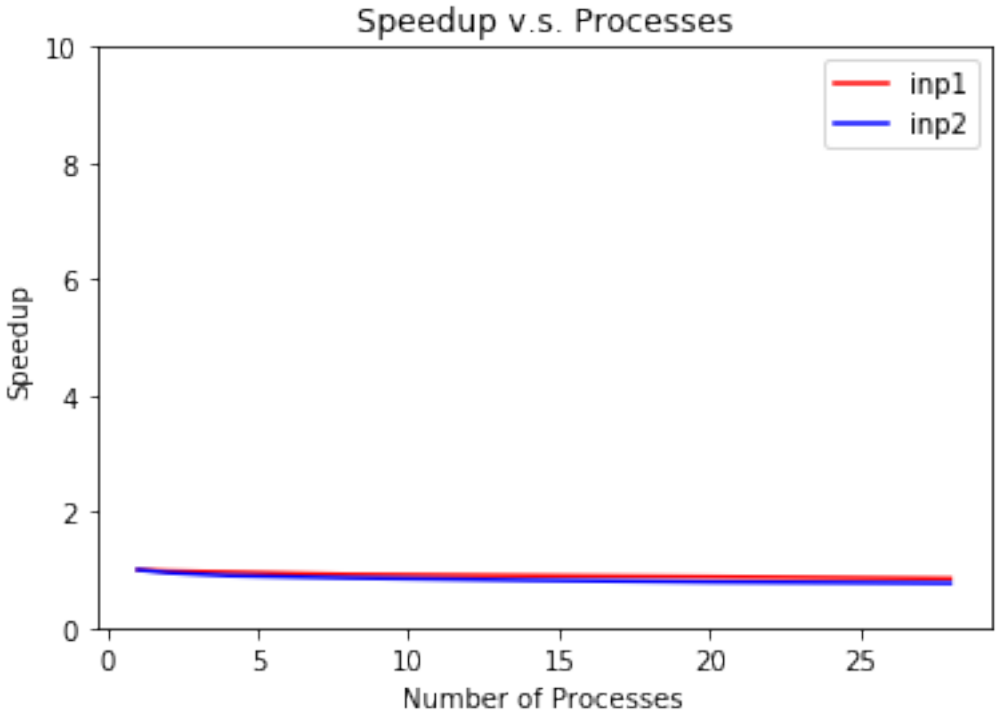
There are totally 2^{32} possible keys, we distribute them to p equal parts and give each processor one part.

Then processor i (i from 0 to p-1) will take care of the scope from $2^{32} \times \frac{i}{p}$ to $2^{32} \times \frac{i+1}{p} - 1$.

Moreover, each processor's workload is a factor of 1/p as before.

a. Sub-linear

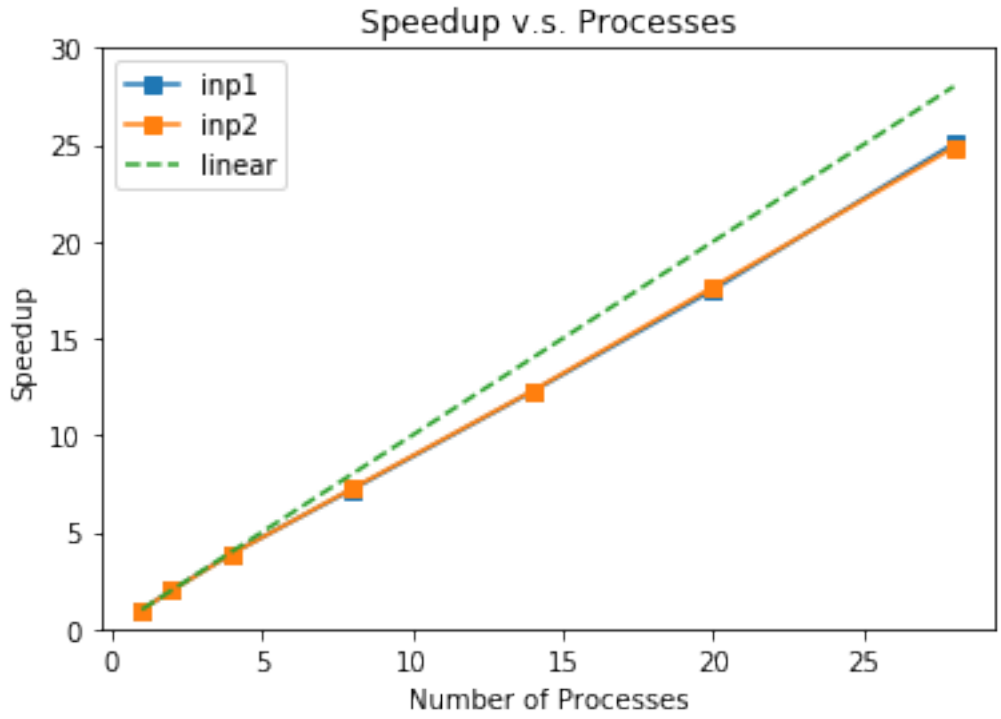
If my key locates in interval $[0, \frac{2^{32}}{p}]$, it will be found in processor 0 by trying as many times as before, which means other processors are wasting of time. Thus, no matter how many processors we have, they cannot shorten our decryption time. I choose the key 101010 in both inp1.txt and inp2.txt. The results are shown in below: speedup decreases a little due to overhead created by communication between processors as number of thread increases.



b. Linear

When key $= 2^{32} - 1$, the speedup can be linear for either number of processors. It can be understood as the number of attempts to reach the last one will be a factor of $\frac{1}{p}$ compared with initial case. Note that in tests of linear and super-linear scenarios, I truncate the scope of key to $[0, 2^{24}]$. It saves computation resources and has not much influence on our observation of these scenarios.

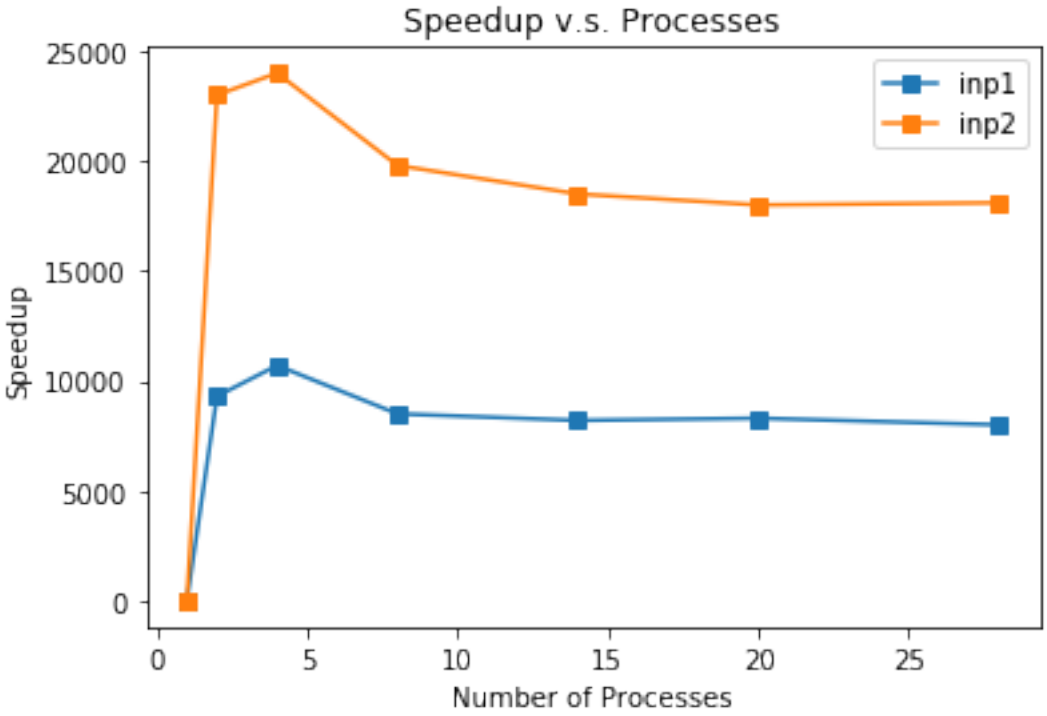
In the figure below, key = $2^{24} - 1 = 16777215$. We can see linear relations for both files.



c. Super-Linear

If key locates near the starting points of one processor other than 0, it takes less time to be found soon by this processor. Then we achieve super-liner speedup.

I choose key = $2^{23} + 3 = 8388611$ and the results are shown in the figure below. This key has same distance from a certain processor when p is even, so we can expect similar execution time for any even p. We can see that the figure has great agreement on above analysis.



(c) Such dramatic fluctuation of speedup can be attribute the our partition strategy. In order to improve current situation, I suggest to use cyclic partition. The advantage is as stated below: As $n >> p$, unless key locates at beginning few numbers, we can achieve nearly linear speedup. The reason is that the number of attempts to reach either number will be reduced by a factor of $\frac{1}{p}$. It's also a smooth process.