CS420 Project1

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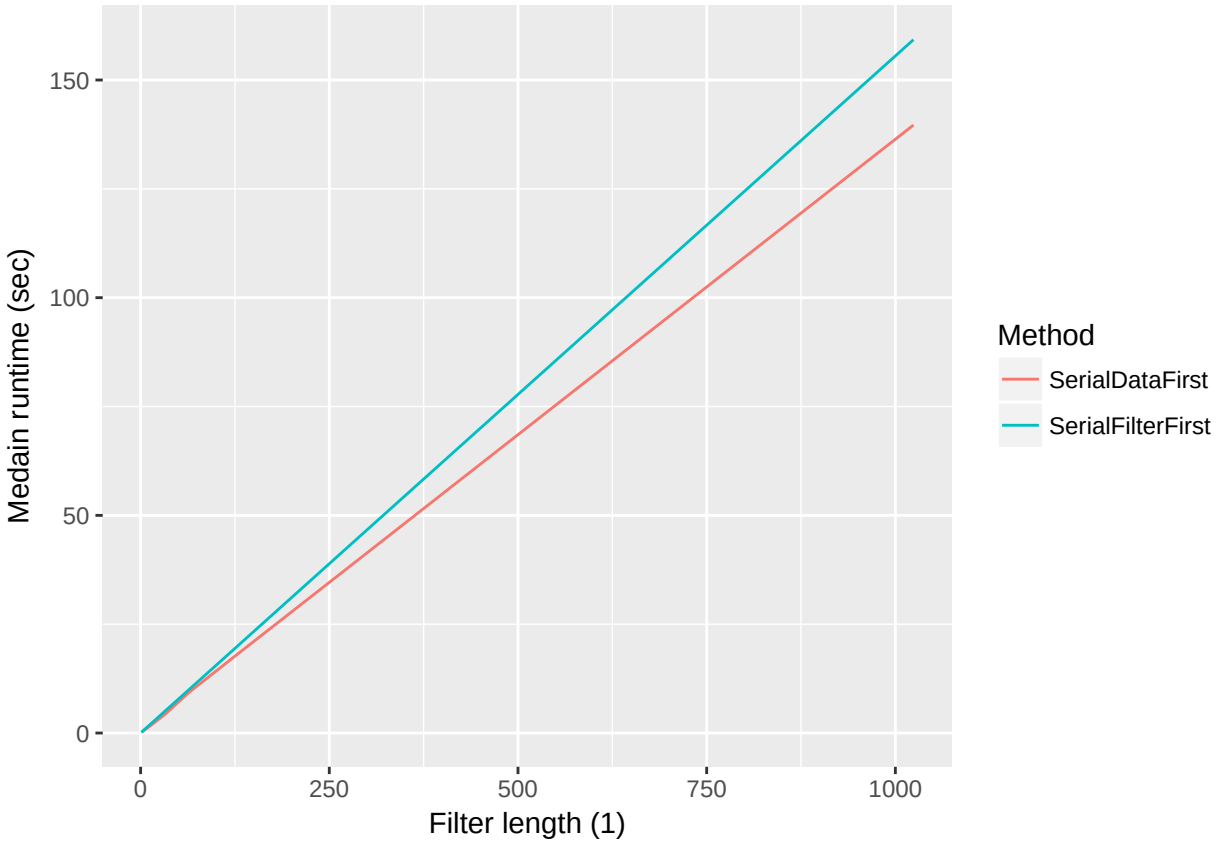
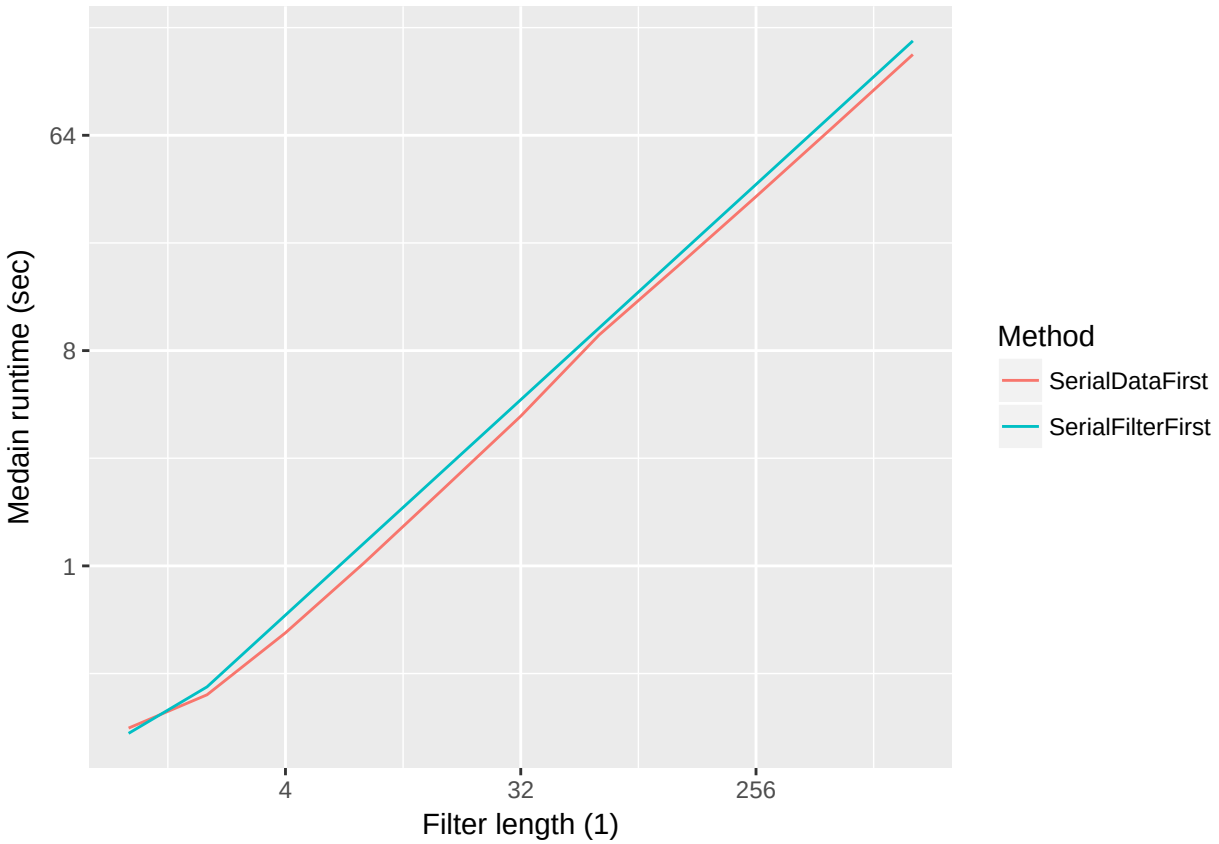
February 20, 2018

Loop Efficiency

a. Here is the plot of runtime vs filter size:

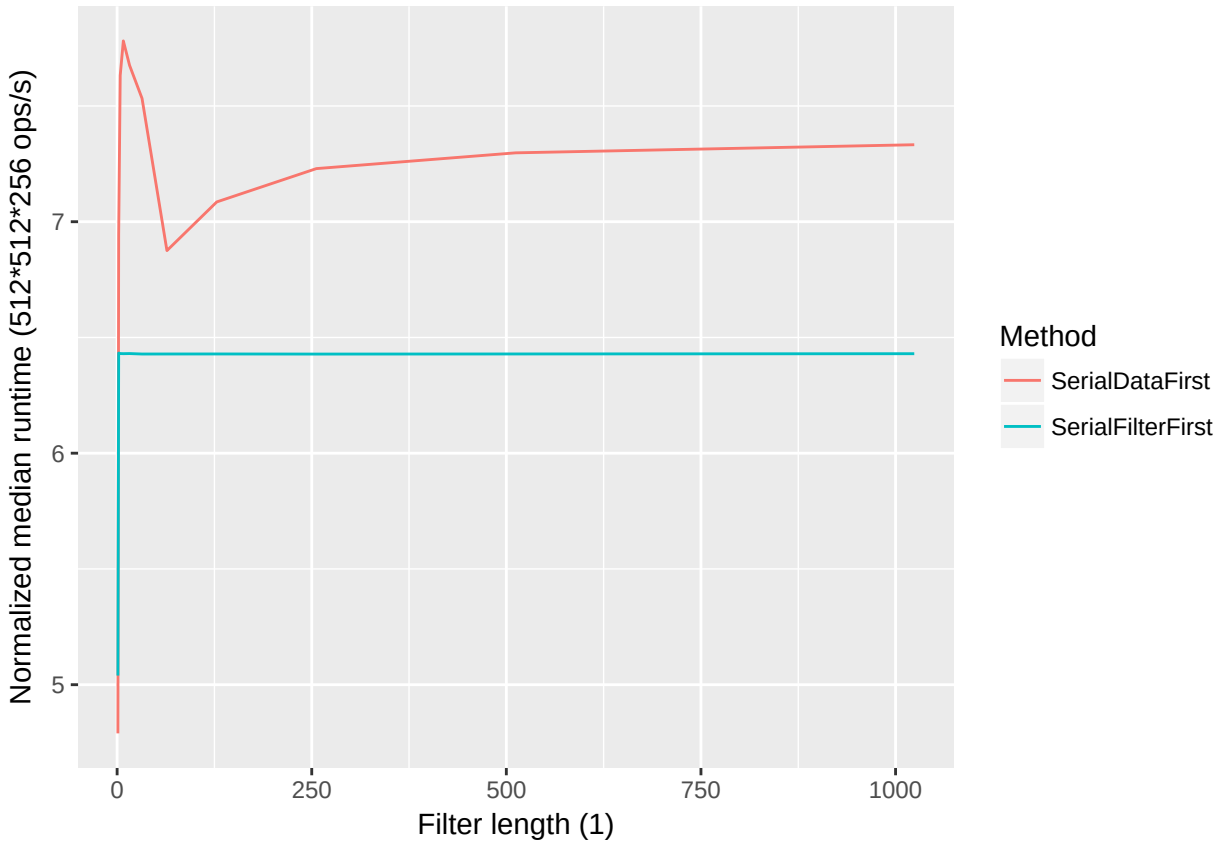


And here a log-log version plot of it:

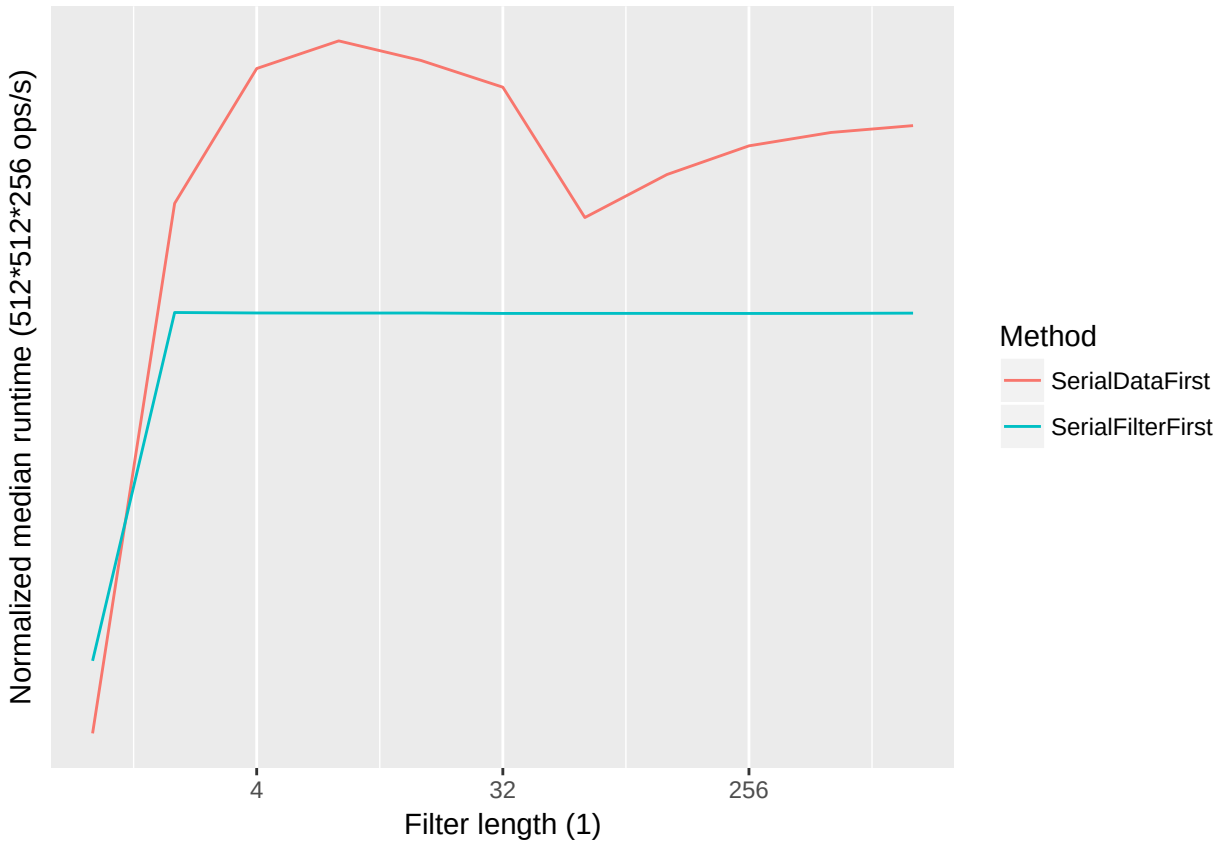


We can see that when filter length bigger than 1, function `serialDataFirst` costs less time.

b. In the implemented functions, total number of operations is approximatly `filter_length * data_length`. Since `data_length` doesn't change, we normalized the runtime by `filter_length / runtime`. Then here is the plot of normalized runtime vs filter length.



And here is a log-log version plot:

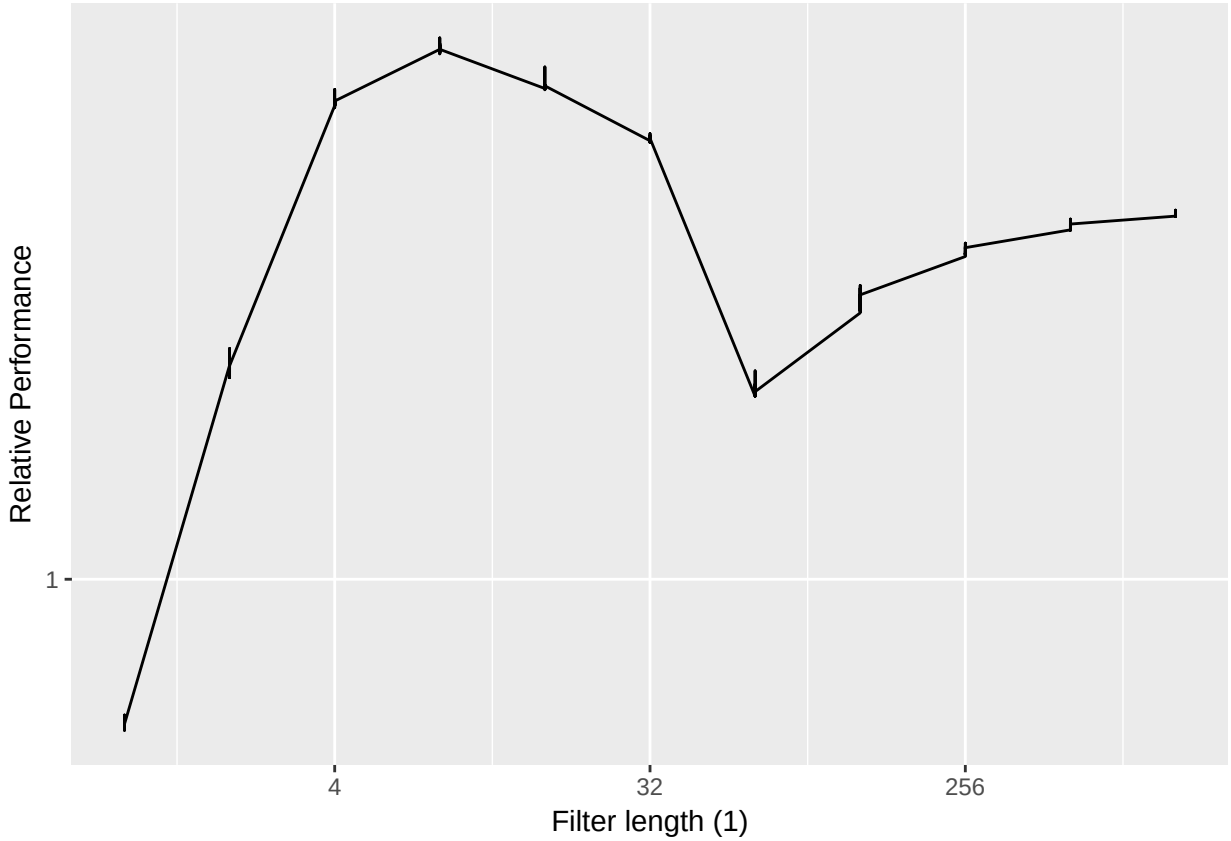


We can see here that when `filter length` > 1, function `serialDataFirst` can run more operations per second.

c. It is more efficient to have data in the outer loop. Because here `data length` is very big `512*512*256` and `filter length` is relative tiny at most `1024`. So it is likely that when you fix a filter element and scan the data, data can not be totally read into memory(cache) meanwhile the filter can when you fix a data point and scan the filter. That will cause a different operation speed and then putting data out side will be faster.

But when filter size is equal to 1, serialFilterFirst is faster. This is because of the loop overhead. When you put data outside you will keep jumping statment between inner and outer loop, and this will slow down the program.

d. We divide time of `serialFilterFirst` by that of `serialDataFirst` to get the relative performance, and the log-log plot is like below.



The trend is complex, we can say that the relative performance is grossly follow an oscillation decline. As `filter length` goes up, it will be more and more near to `data length` and therefore we can suppose relative performance tend to be 1, which create a trend of decline. But locally, when you increase `filter length` by 1, the total jump of statments between inner and outer loop increased by 1 for `serialFilterFirst` vs 0 for `serialDataFirst`. This create a locally increase trend of relative performance. So the total change is an oscillation decline.

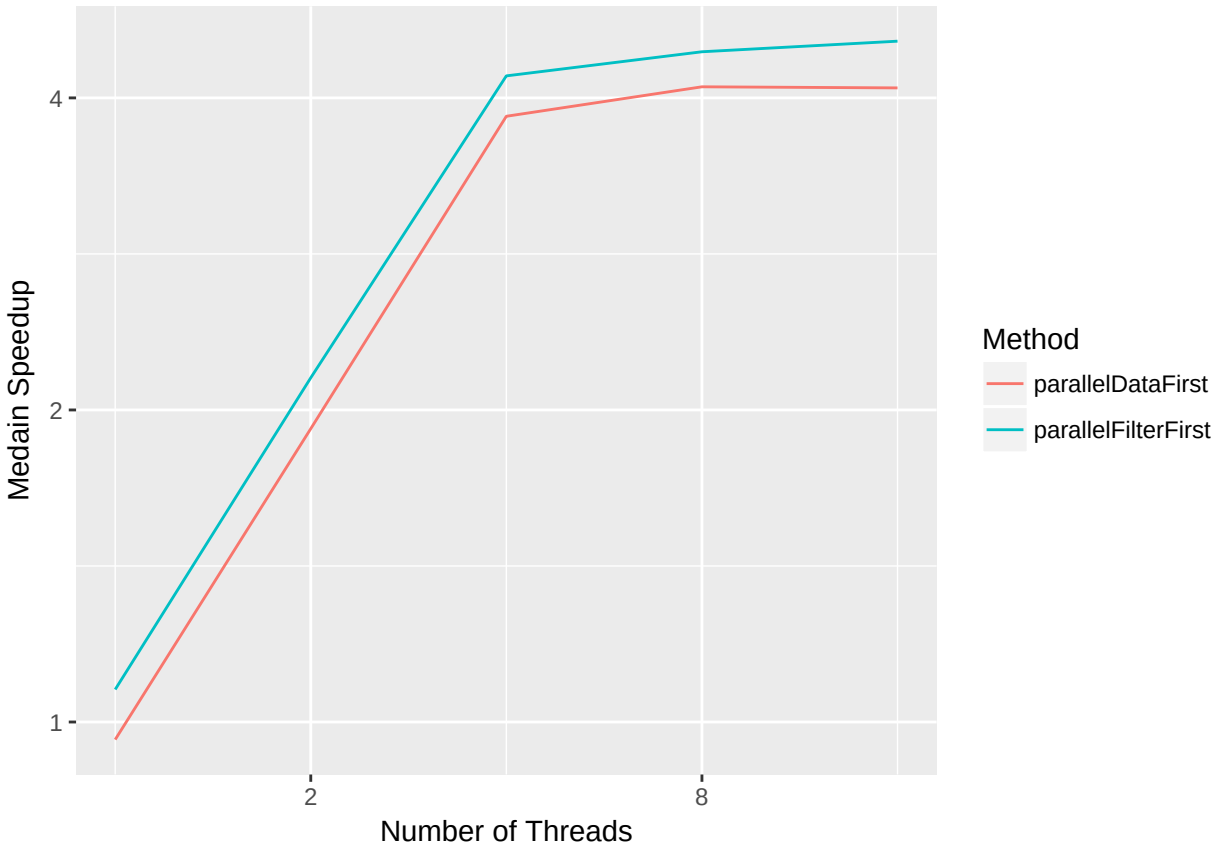
Loop Parallelism

1.

a. See the code
b. See the code

2.

a. Here is the plot for speed up.



b. The speedup increase approximatly linear before threads 4, slightly increase between 4 and 8, and tailed off after 8. This is strong scaling because the total problem size never change. This program is run on c5.2xlarge which has 8 cores, so ideally speedup curve will increase linearly up to 8 threads because it has 8 independent computing centers and then curve will be sharply tailed off.

3.

a. For the absolute time, `parallelDataFirst` is still faster because the problem mentioned above(Loop Efficiency 1.c.) still holds. But as the plot above, `parallelFilterFirst` have a higher speedup, maybe this is because filter size is small and when you devide them you will reduce the jumps of statment more than deviding larger data. Or because that filter is small, so deviding them will make them able to be held in higher cache and therefore higher speed.

b. fff

c. ggg

An Optimized Version

a. ppp
b. qqq