Comparing Throughput CDF's of 3 System Configurations

March 22^{nd}, 2017

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Summary

In this report, we compare the Cumulative Distribution Functions (CDF's) of the Throughput of three different system configurations. All three configurations have the same settings for:

$$Frequency - 2700000$$
$$Hyp\ Sched - CFQ$$
$$VM\ Sched - NOOP$$
$$Threads - 64$$
$$Mode - Fread$$

While the file and record sizes for the three system settings were:

$$File\ Size - 64 \quad Record\ Size - 32 \tag{1}$$
$$File\ Size - 1024 \quad Record\ Size - 32 \tag{2}$$
$$File\ Size - 1024 \quad Record\ Size - 512 \tag{3}$$

Most notably, from this in-depth comparison, it appears that our independently drawn samples from the systems are not always conforming to the same underlying distribution. If this trend continues, then it will prohibit the effective modelling goals of the VarSys project.

Source Data

For each of these system configurations we have 3 independently gathered sets of data:

- The *First* **40** runs collected for the VarSys data mid-last year.
- The *Second* set of **40** runs collected December of last year.
- The newest, *True* set of **420** runs collected two weeks ago.

Figures and Plots

For each of the three system configurations, there is 1 figure followed by 3 plots:

1. The **Paired KS Solved for Alpha Graph** shows the trials *first*, *second*, and *true* as nodes with the edges between them being the result of solving the KS Two Sample test for alpha (see explanation in item 4 below). This will be followed by the 'Confidence' interpretation below.

2. The **CDF Comparison Plot** shows the Throughput CDF's of each of the *first*, *second*, and *true* data sets. Each CDF plot also has a red-tinted cloud [1] of the possible positions that the *true* CDF could take on when collecting 40 sample subsets.

3. The **Kolmogorov-Smirnov (KS) Difference Plot** shows the decrease in KS difference [2] between a subsapmle and the *true* CDF with increasing subsample size (x-axis).

4. The **Confidence in KS Difference Plot** shows what happens when we take the typical KS test for difference:

$$\text{KS Diff} > c(\alpha)\sqrt{\frac{n_1 + n_2}{n_1 \cdot n_2}}$$

$$\text{where } c(\alpha) = \sqrt{-\frac{1}{2} ln\left(\frac{\alpha}{2}\right)}$$

   and use our knowledge of n_1, n_2 and the KS Difference to solve for the minimum alpha such that this inequality holds. Giving us:

$$\alpha \quad > \quad 2 \cdot e^{-2 \cdot \left(\frac{\text{KS Diff}}{\sqrt{\frac{n_1+n_2}{n_1 \cdot n_2}}}\right)^2}$$

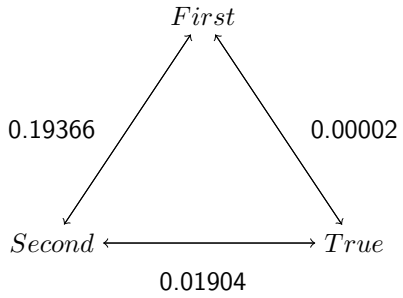
   This final plot shows $100 \cdot (1 - \alpha)$, or the approximate confidence, in percentage, that the two distributions being compared are different. This data was collected by comparing the CDF's of 100 random subsamples of size <x-axis> to the *true* CDF. The corresponding y-values are displayed in shaded regions by percentile.Ideally we want this quantity to go to zero.

[1] The clouds were generated by taking 10,000 random 40 sample subsets of the (*true*) 420, calculating the CDF's of each subset, then calculating the percentiles of possible *true* CDF values based on the sapmle CDF's.

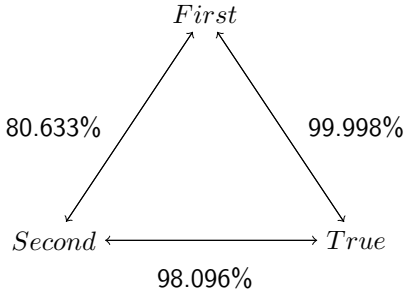
[2] The two-sample KS Difference is simply the maximum difference between the two CDF's of the samples. From this difference, a test is performed to determine if the two distributions are different.

System Setting #1: File Size 64 and Record Size 32

Paired KS Solved for Alpha:



Translated to confidence in paired difference:



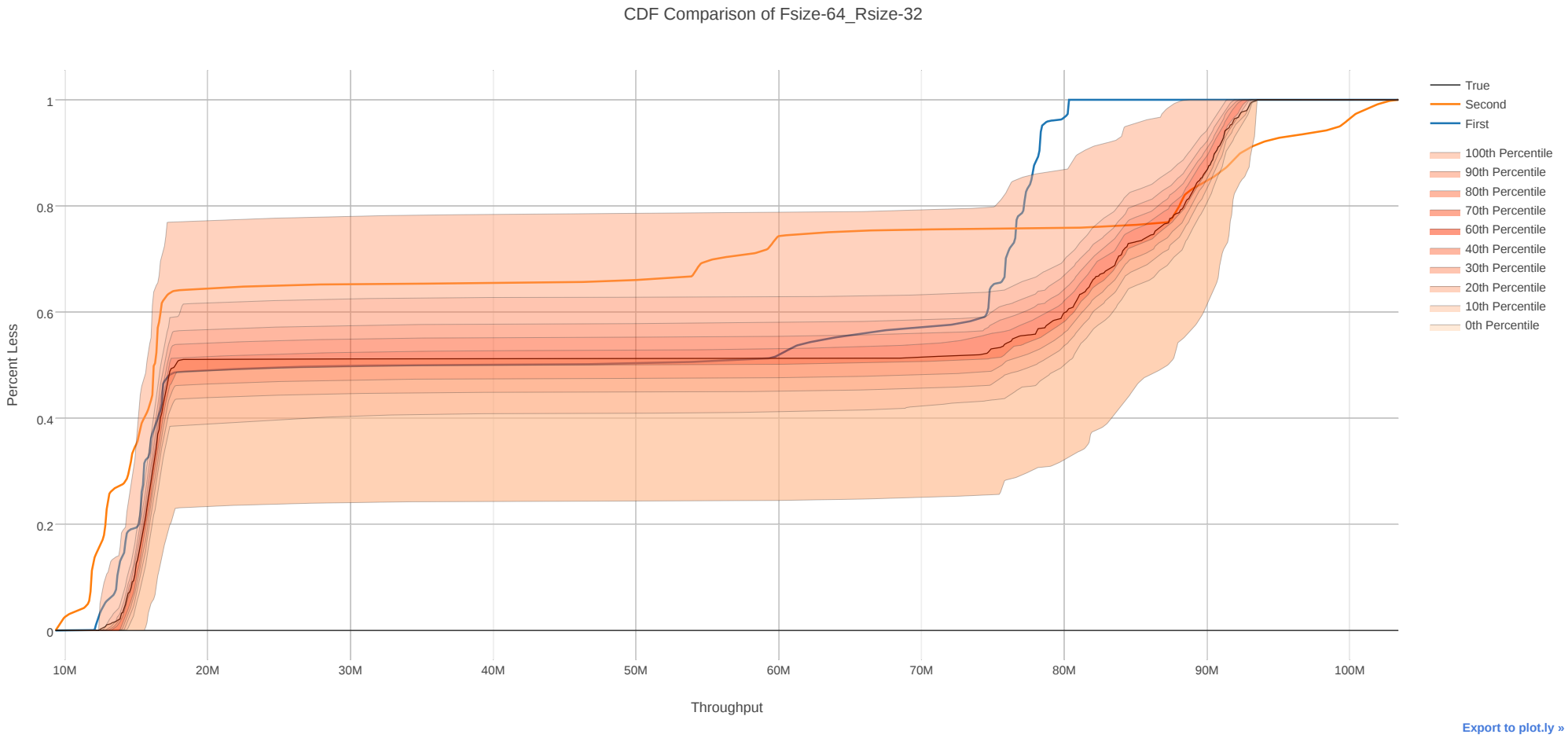


Figure 1: In this CDF comparison, the *first* CDF exceeds the reasonable bounds of *true* the most, followed closely by *second*.

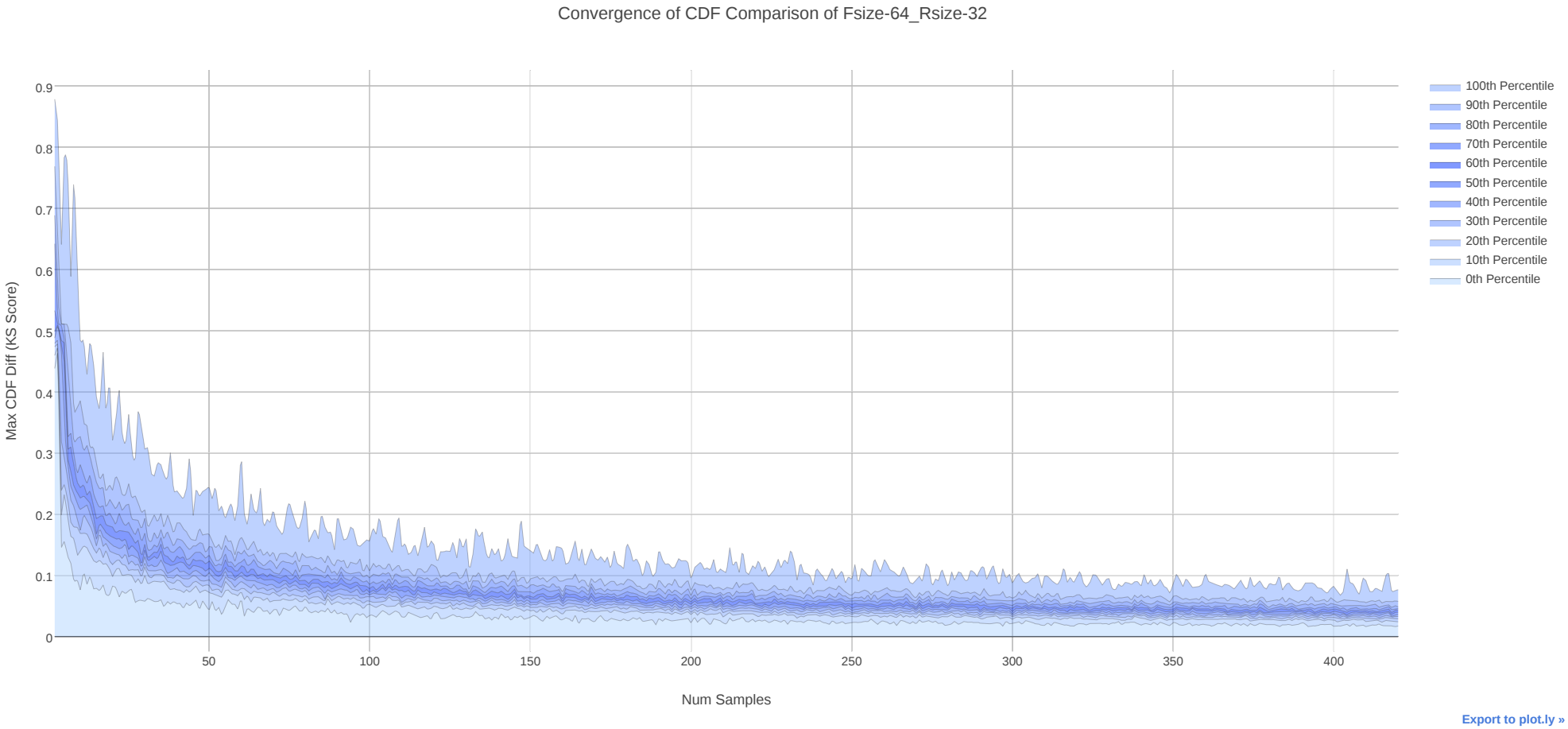


Figure 2: In this KS Difference Plot, notice that most of the convergence happens with approximately 30 samples from the true distribution. This trend is common across all three system settings.

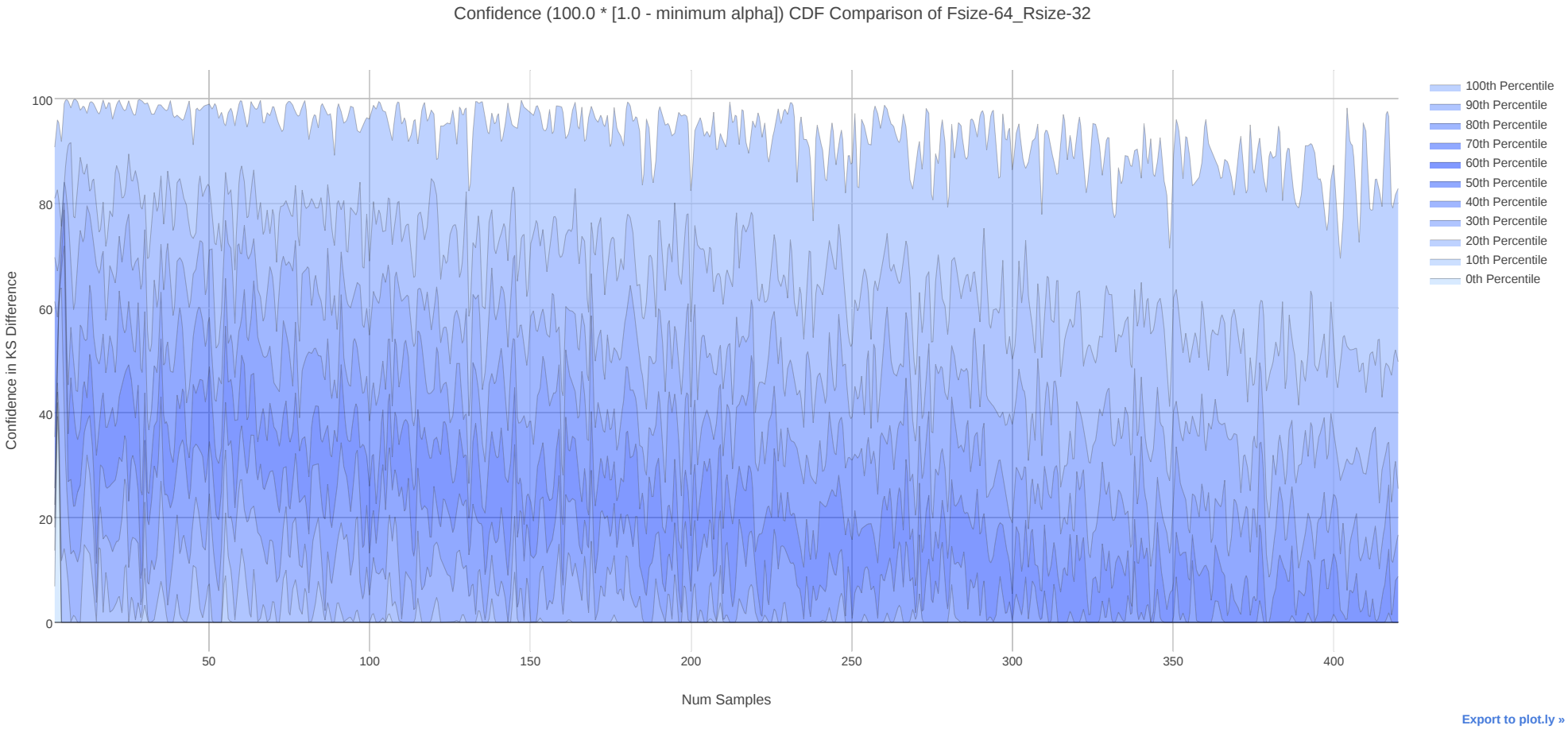
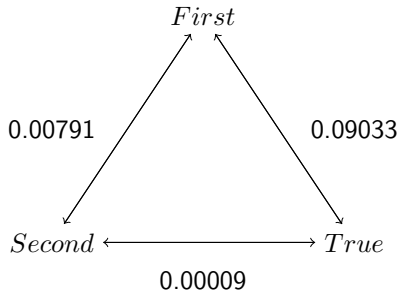


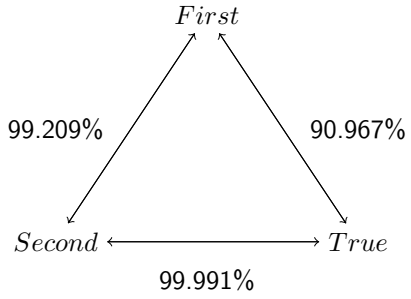
Figure 3: In this Confidence in KS Difference plot notice that we do not guarantee large improvements in confidence even with hundreds of samples from the distribution. This may seem to contradict the decreasing KS difference as seen in *figure 2*, but the slower decrease in confidence is due to the fact that the KS-difference test becomes more strict with increasingnly large sample sizes.

System Setting #2: File Size 1024 and Record Size 32

Paired KS Solved for Alpha:



Translated to confidence in paired difference:



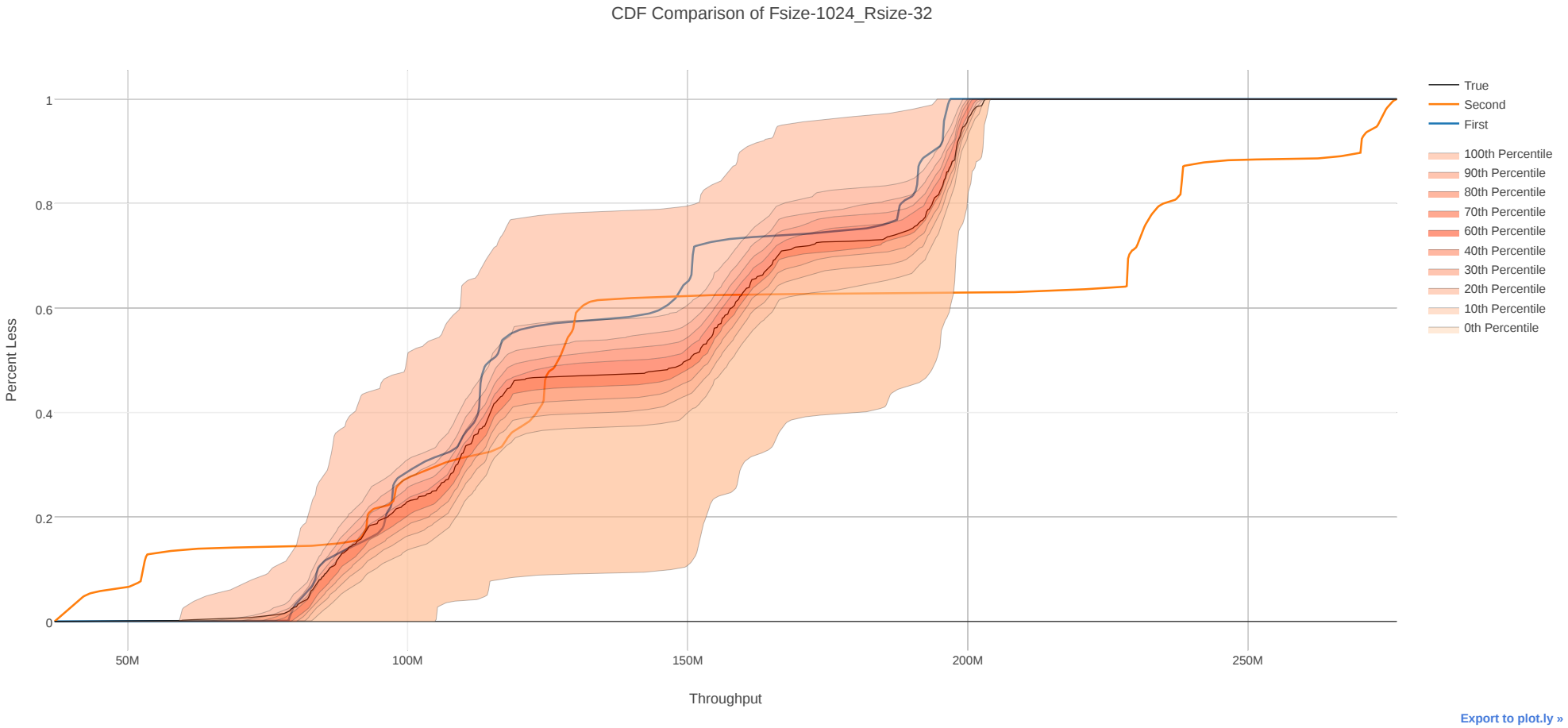


Figure 4: In this CDF comparison, the *second* CDF is most notably an outlier. This is reflected in the solved alpha graph above.

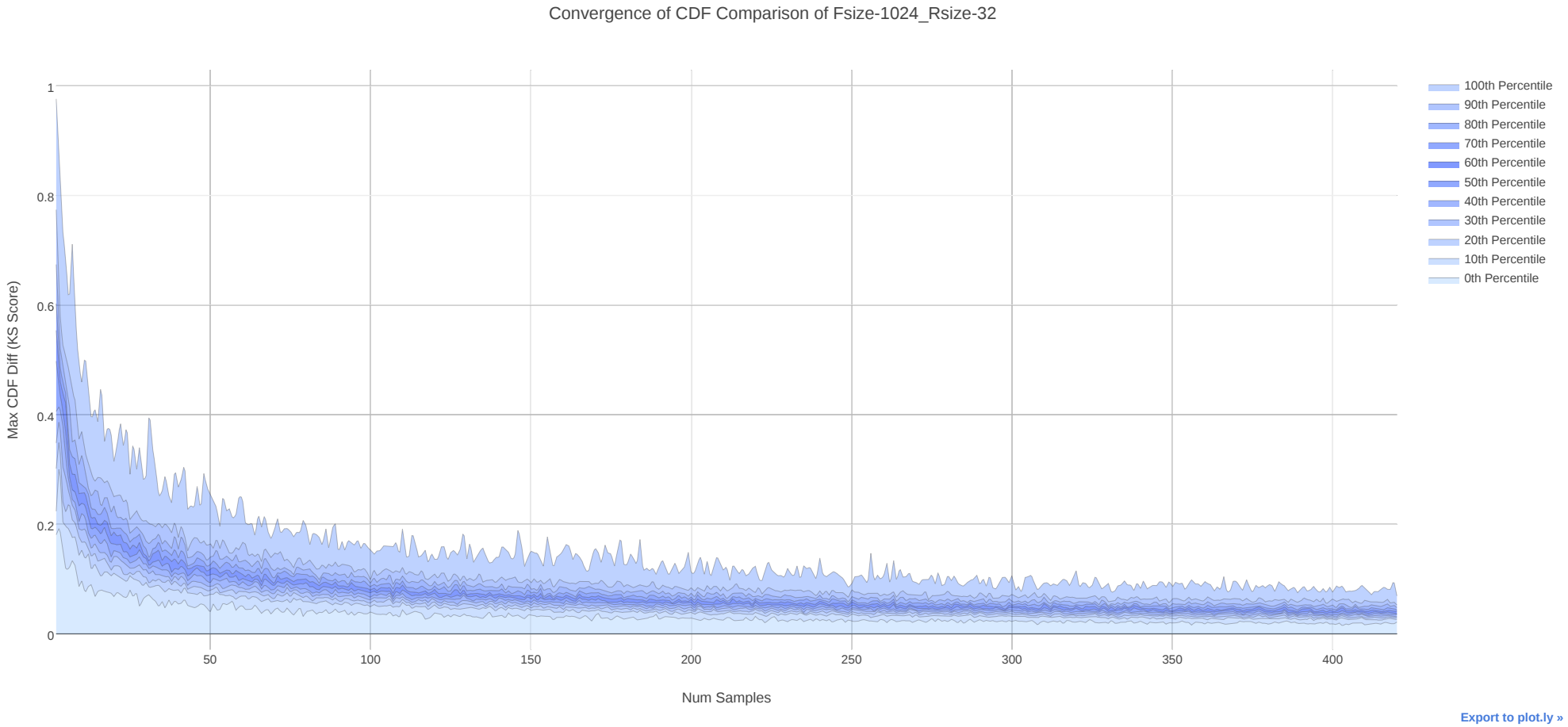


Figure 5: This KS Difference Plot follows similar trends to the previous.

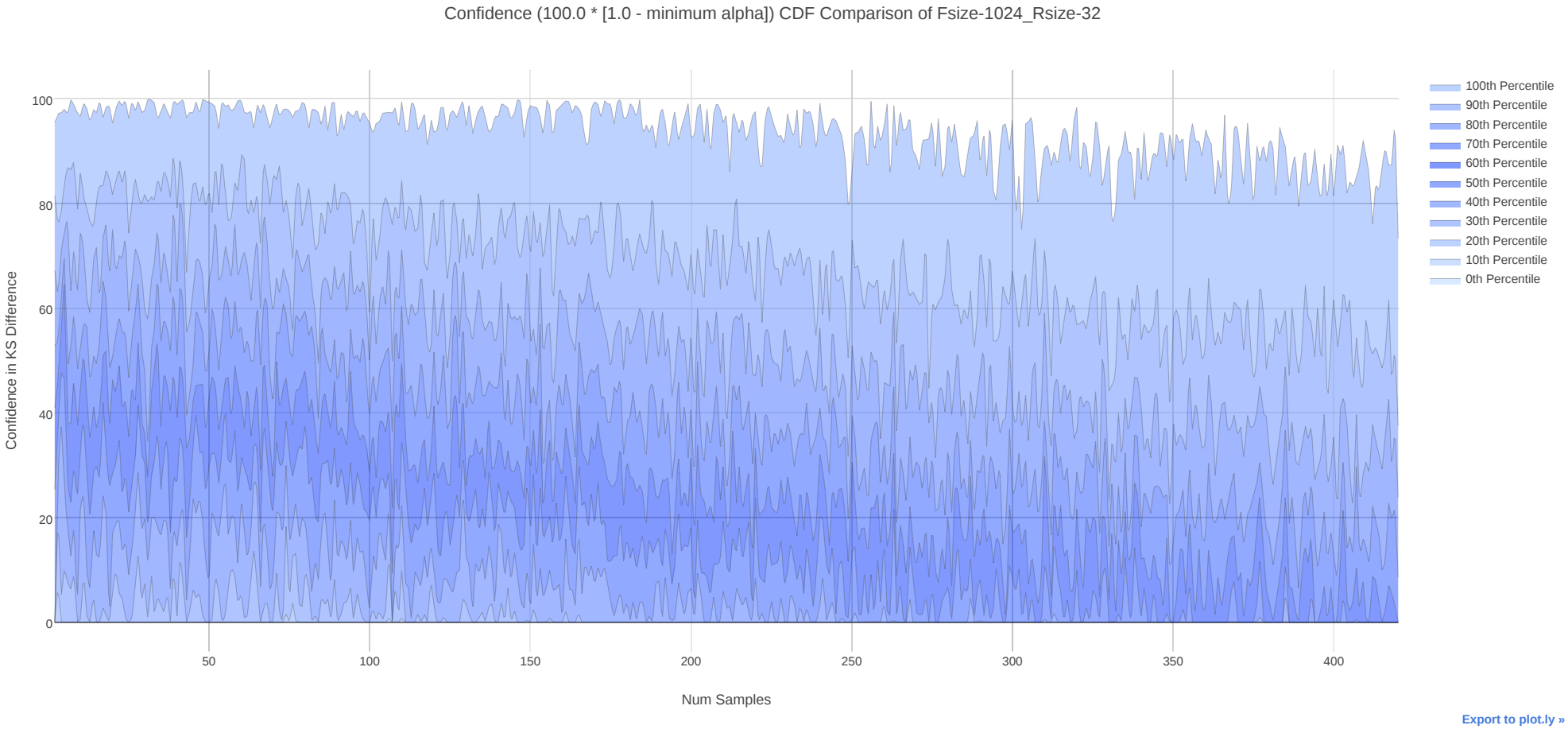
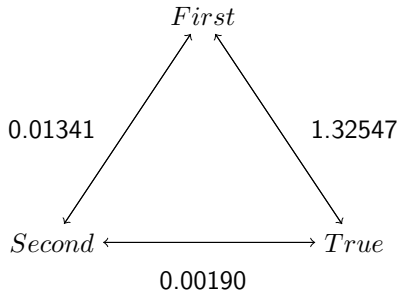


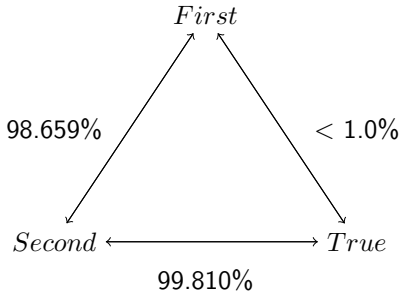
Figure 6: This Confidence in KS Difference plot follows similar trends to the previous.

System Setting #3: File Size 1024 and Record Size 512

Paired KS Solved for Alpha:



Translated to confidence in paired difference:



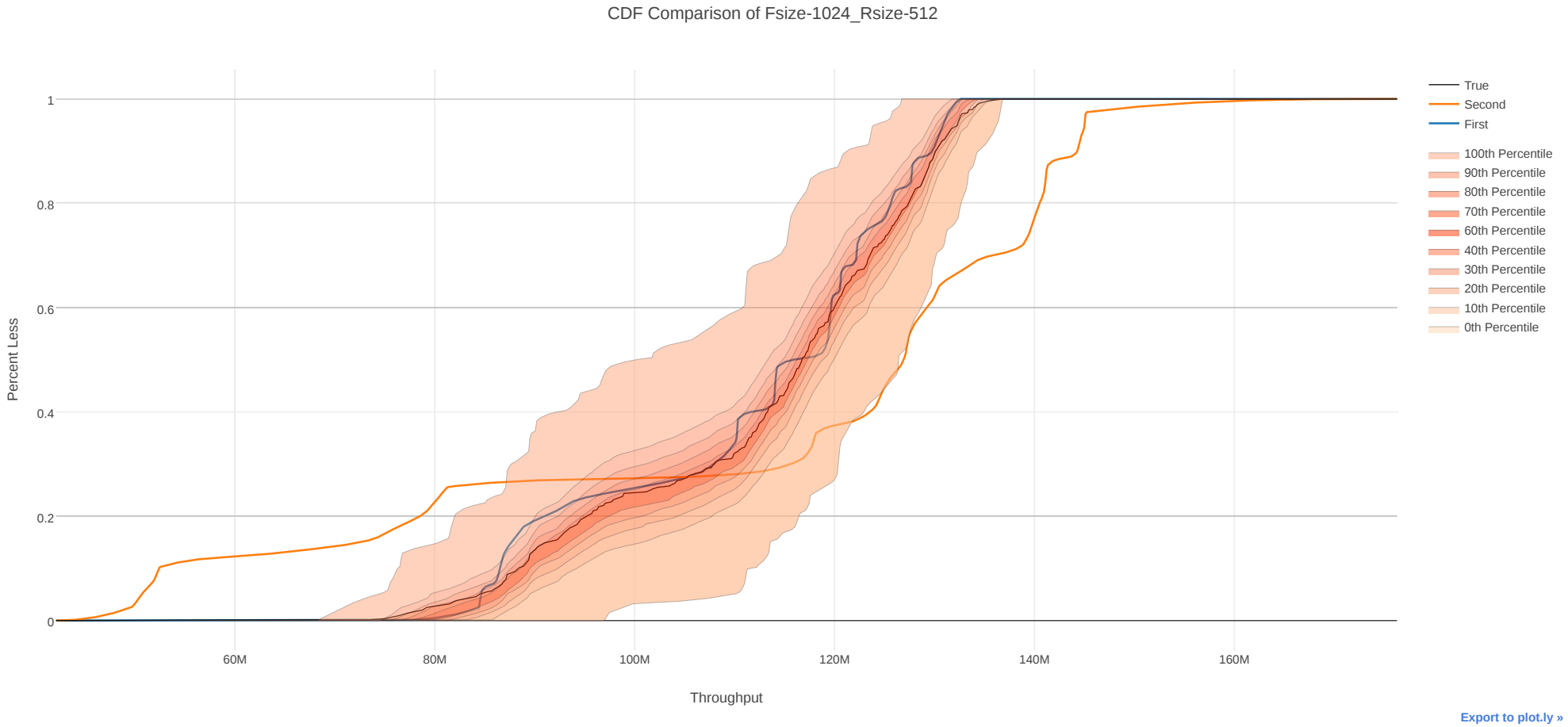


Figure 7: In this CDF comparison, the *second* CDF is once again the extreme outlier.

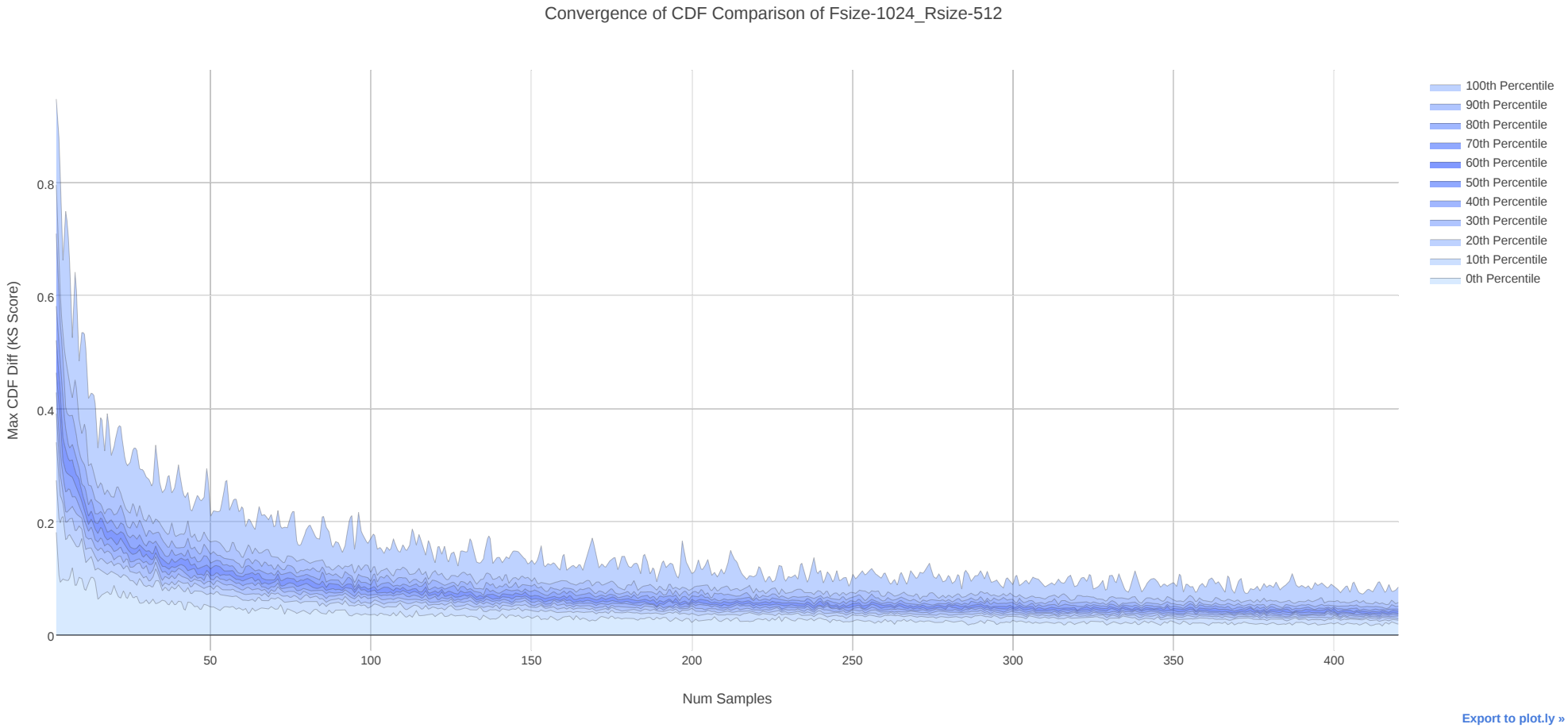


Figure 8: This KS Difference Plot follows similar trends to the previous 2.

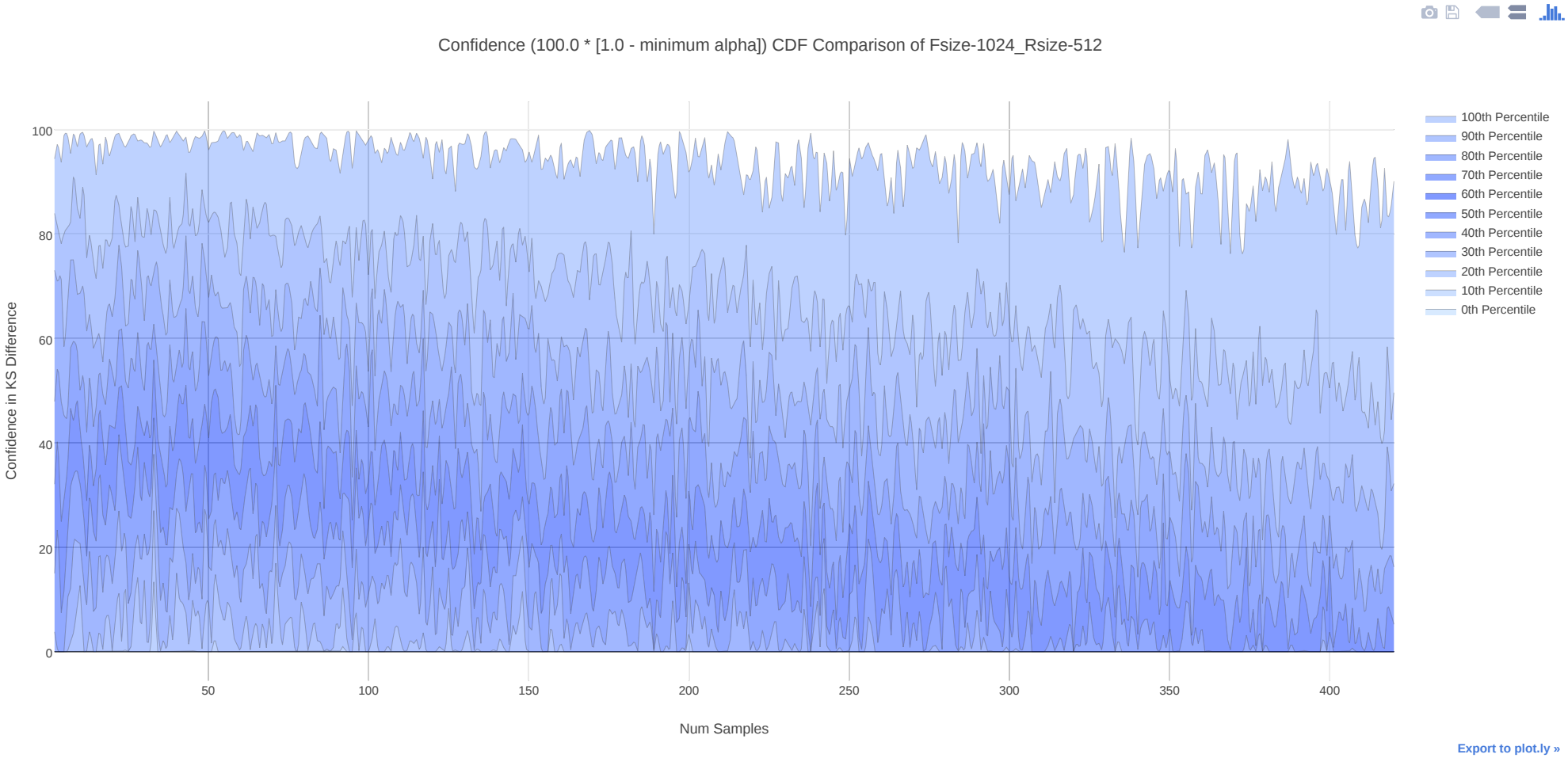


Figure 9: This Confidence in KS Difference plot follows similar trends to the previous 2.