APPENDIX

A. Experiments on Parameter Setting

Effect of # levels. We conduct experiments on the choice of the number of levels for M4 and the straw-man solution. As shown in Figure 1, choosing $\#\ lv = 4$ gives the best accuracy and a comparatively good speed for M4. So we design the M4 to have four levels. As shown in Figure 2, choosing $\#\ lv = 3$ gives a close to the best accuracy and a comparatively good speed for the straw-man solution. So we design the straw-man solution to have three levels.

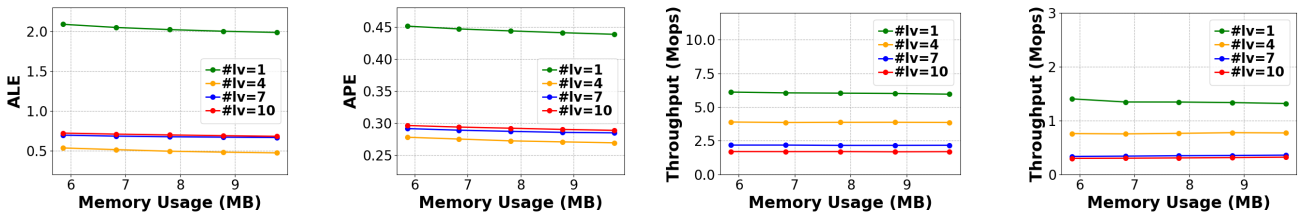
Effect of *w*. As shown in Figure 3, the optimal performance is achieved when $w = 3$. We conduct experiments on different M4-*META*s on various datasets. Altering the hash number w, we find that $w = 3$ and $w = 4$ yield similar accuracy. Since M4 with $w = 3$ runs faster than $w = 4$, we select $w = 3$ as our default setting.

Effect of *p*. As shown in Figure 4, M4 performs consistently regardless of the value of p. We query $p = 0.5, 0.75, 0.95$, and 0.99 respectively on different M4-*META* on various datasets. Results indicate that the accuracy under different settings of p is similar and follows a consistent trend. Users can set p to an arbitrary value. We default $p = 0.5$ for conducting other experiments.

B. Experiments on Speed

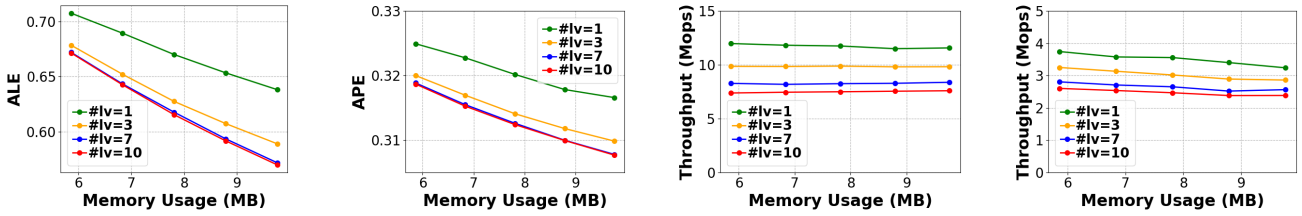
Insertion Throughput. As shown in Figure 5, the experimental results demonstrate that the insertion throughput of M4 is lower than the straw-man solution. Specifically on the three real-world datasets, the insertion throughput of M4 is 1.24×, 1.40×, and 1.92× lower on average than those of the straw-man solution.

Query Throughput. As shown in Figure 6, the experimental results demonstrate that the query throughput of M4 is also lower than the straw-man solution. Specifically on the three real-world datasets, the query throughput of M4 is 1.33×, 1.17×, and 2.05× lower on average than those of the straw-man solution.



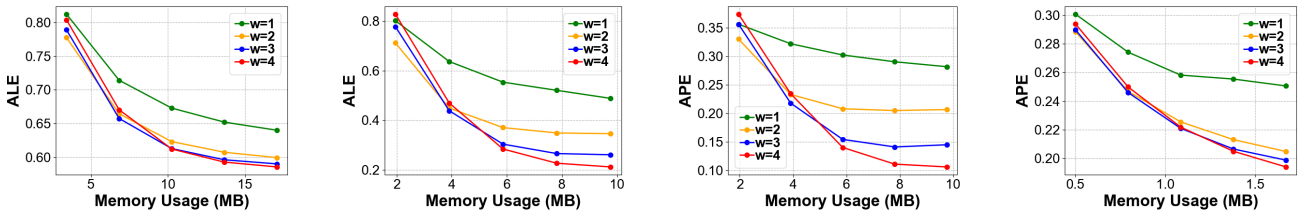
(a) ALE. (b) APE. (c) Insertion throughput. (d) Query throughput.

Fig. 1: Effect of the number of levels on accuracy of M4.



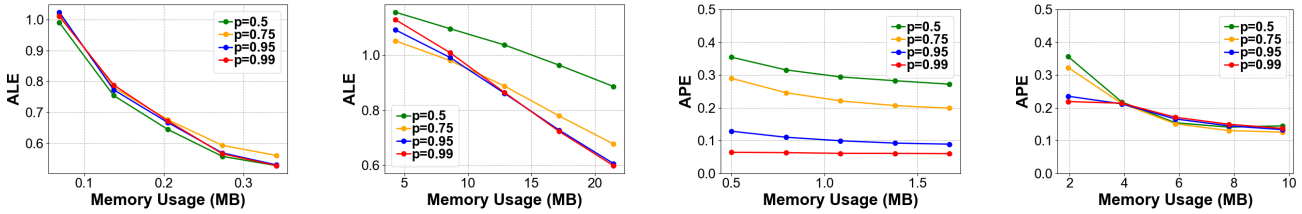
(a) ALE. (b) APE. (c) Insertion throughput. (d) Query throughput.

Fig. 2: Effect of the number of levels on accuracy of Straw-man.



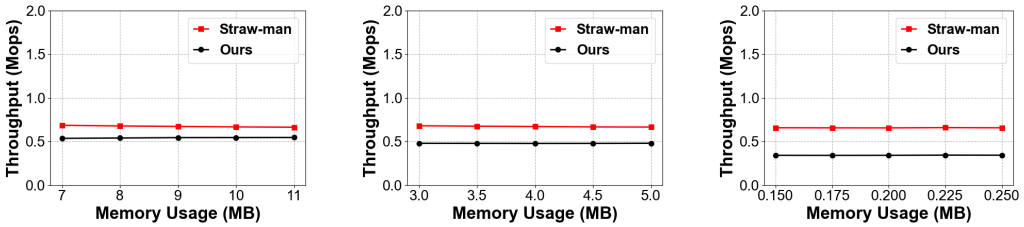
(a) M4-DDSketch on CAIDA. (b) M4-t-digest on MAWI. (c) M4-t-digest on MAWI. (d) M4-mReqSketch on IMC.

Fig. 3: Effect of w on accuracy.



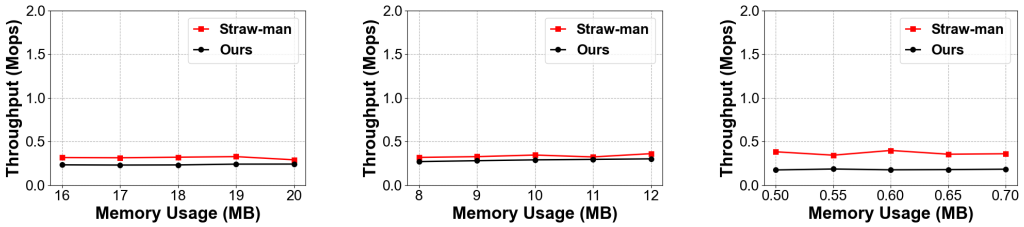
(a) M4-DDSketch on IMC. (b) M4-mReqSketch on CAIDA. (c) M4-mReqSketch on IMC. (d) M4-t-digest on MAWI.

Fig. 4: Effect of p on accuracy.



(a) CAIDA. (b) MAWI (c) IMC

Fig. 5: Insertion throughput on different datasets.



(a) CAIDA (b) MAWI (c) IMC

Fig. 6: Query throughput on different datasets.