A Performance Comparison of General Purpose Multi-Dimensional In-Memory Indexes – All Results

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1. INTRODUCTION

This document contains all TinSpin[1] test results from the test runs between November 2016 and January 2017.

2. INDEXES

The following index implementations were tested:

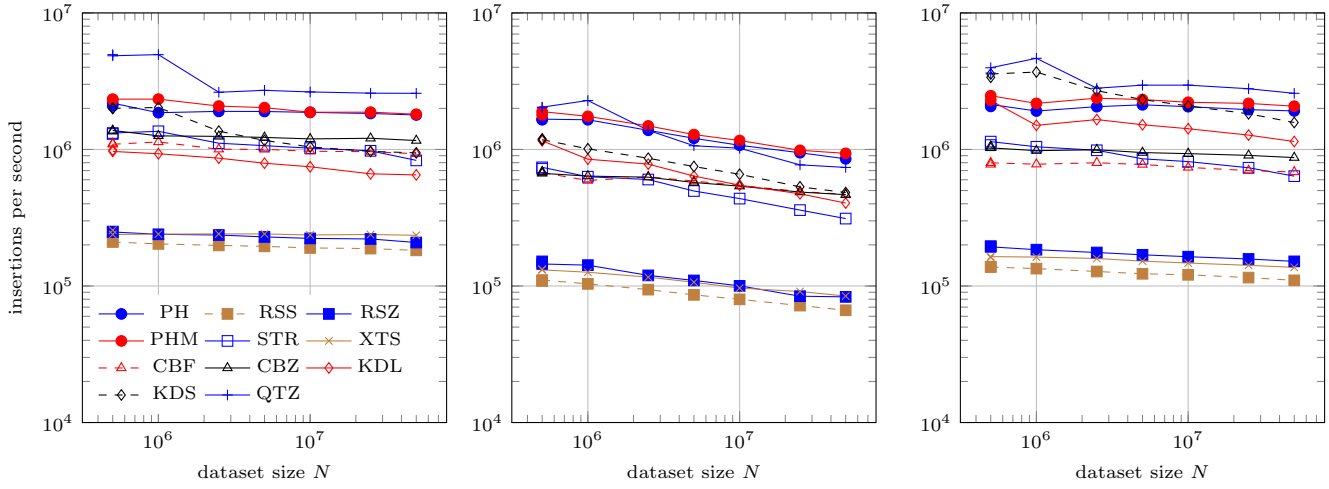
- CBF CritBit tree by J. Fager[2]
- CBZ CritBit tree by T. Zäschke[3]
- KDL KD-Tree by Levy[4]
- KDS KD-Tree by Savarese[5]
- PH/PHM PH-Tree by T. Zäschke et al.[6]
- QTZ Quadtree by T. Zäschke[3]
- RSS R*Tree by N. Beckmann et al[7], optimized for in-memory use by T. Zäschke
- RSZ R*Tree by T. Zäschke[3]
- STRZ R*Tree by T. Zäschke[3]
- XTS X-Tree by S. Berchtold et al[7], optimized for in-memory use by T. Zäschke

[1] http://www.tinspin.org
[2] https://github.com/jfager/functional-critbit
[3] http://www.tinspin.org
[4] http://home.wlu.edu/~levys/software/kd/
[5] https://www.savarese.com/software/libssrckdtree-j/
[6] http://www.phtree.org
[7] http://chorochronos.datastories.org

3. RESULTS

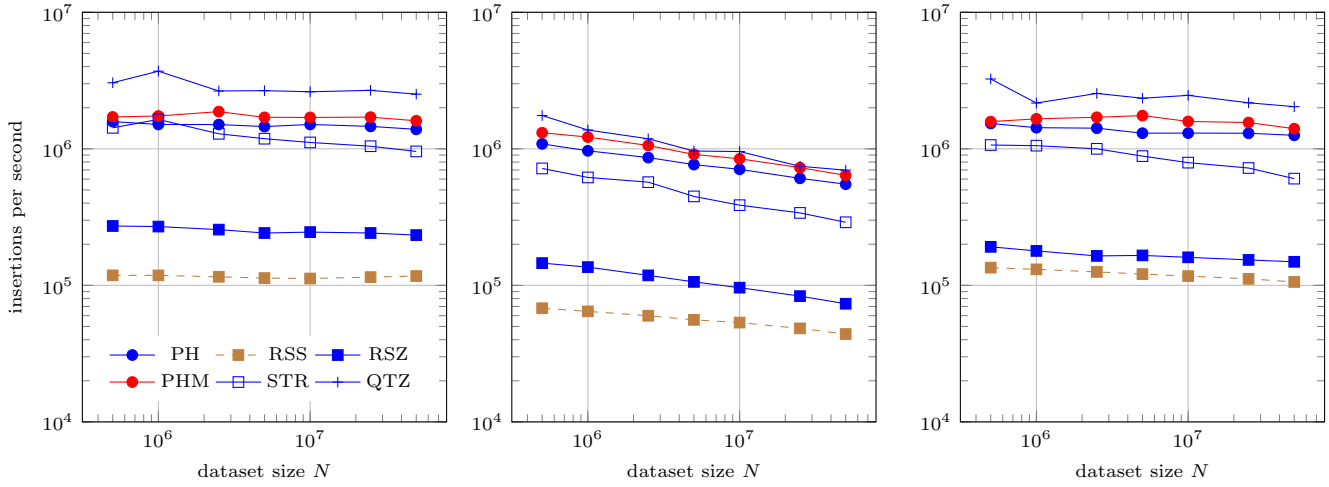
Results are shown on in the following order:

- Insertion: Figures 1 – 6
- Memory usage: Figures 7 – 12
- Window queries: Figures 13 – 20
- Exact match queries (point queries): Figures 21 – 26
- kNN queries: Figures 27 – 38
- Update: Figures 39 – 44
- Remove: Figures 45 – 50



(a) Alps OSM-P (b) CUBE-P (c) CLUSTER-P

Figure 1: Insertion rates for the OSM, CUBE and CLUSTER datasets



(a) OSM-R (b) CUBE-R (c) CLUSTER-R

Figure 2: Insertion rates for the OSM, CUBE and CLUSTER datasets

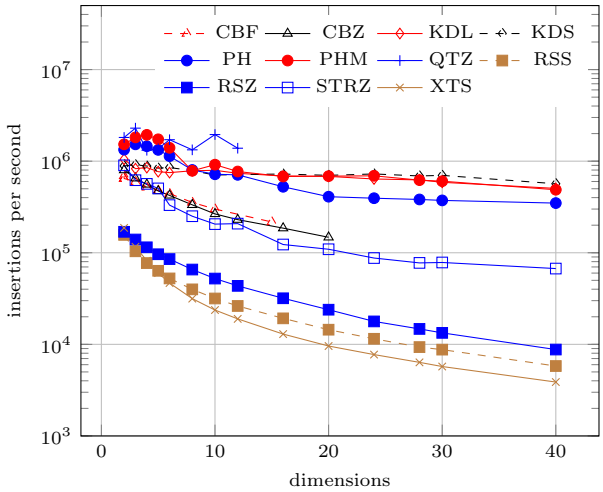


Figure 3: DIM: Insertion rates for CU-P

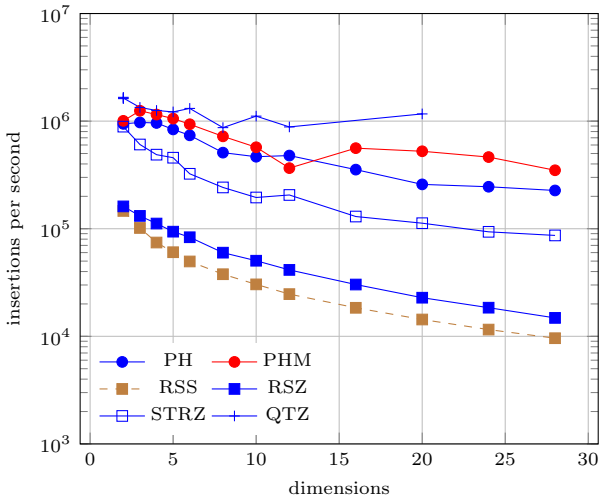


Figure 4: DIM: Insertion rates for CU-R

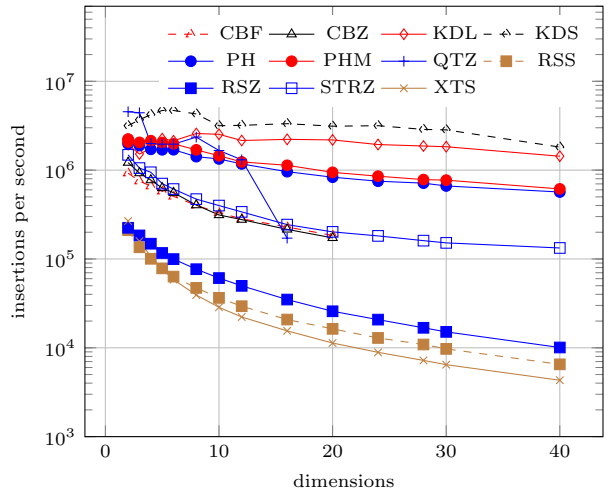


Figure 5: DIM: Insertion rates for CL-P

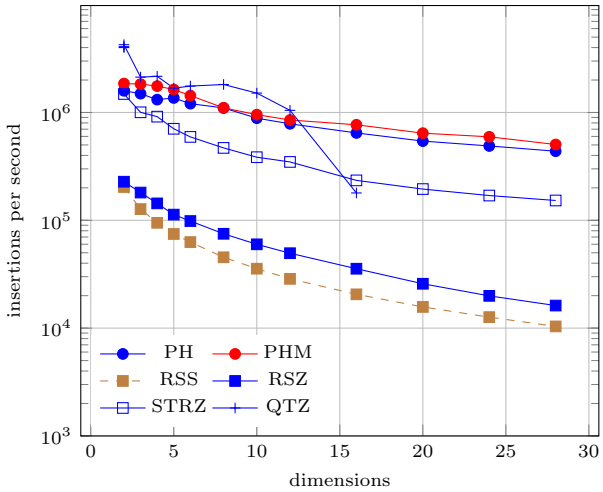
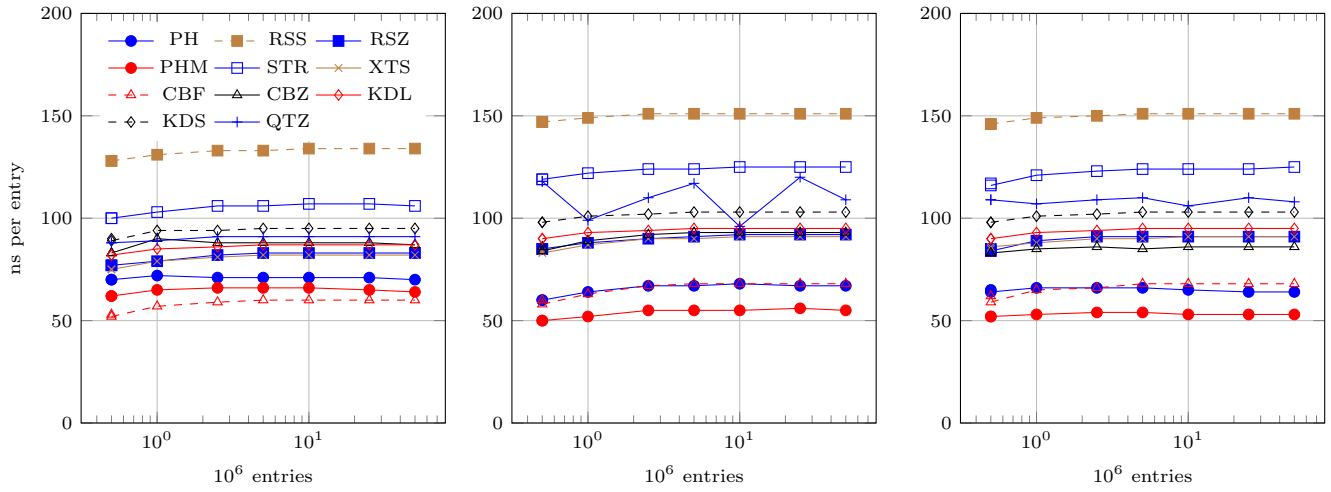
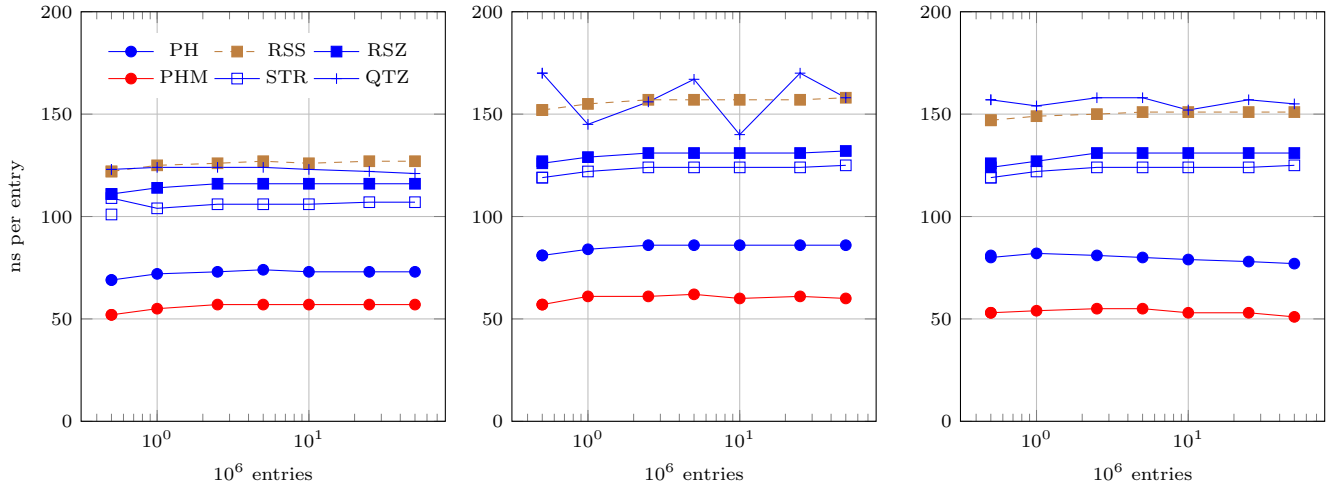


Figure 6: DIM: Insertion rates for CL-R



(a) Alps OSM-P (b) CUBE-P (c) CLUSTER-P

Figure 7: Memory usage per point entry for the OSM Alps, CUBE and CLUSTER datasets



(a) Alps OSM-R (b) CUBE-R (c) CLUSTER-R

Figure 8: Memory usage per rectangle entry for the OSM Alps, CUBE and CLUSTER datasets

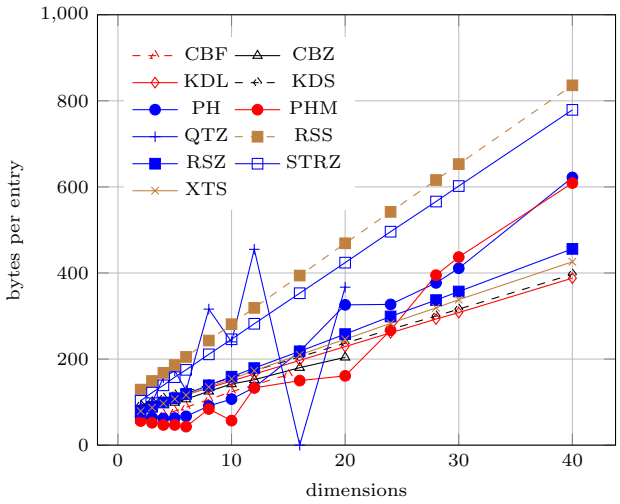


Figure 9: DIM: Memory usage per point for CU-P

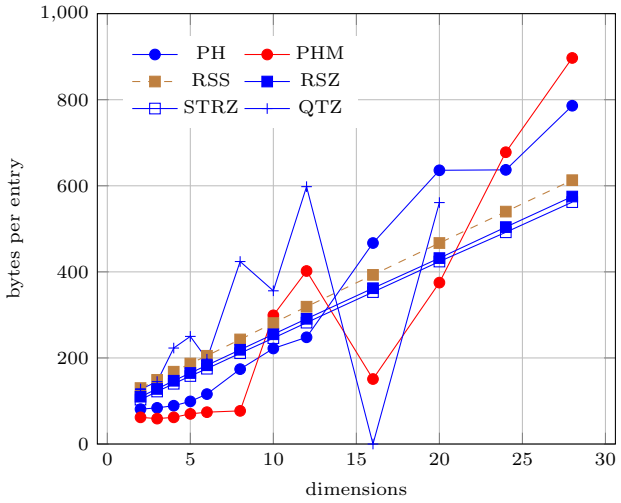


Figure 10: DIM: Memory usage per rectangle for CU-R

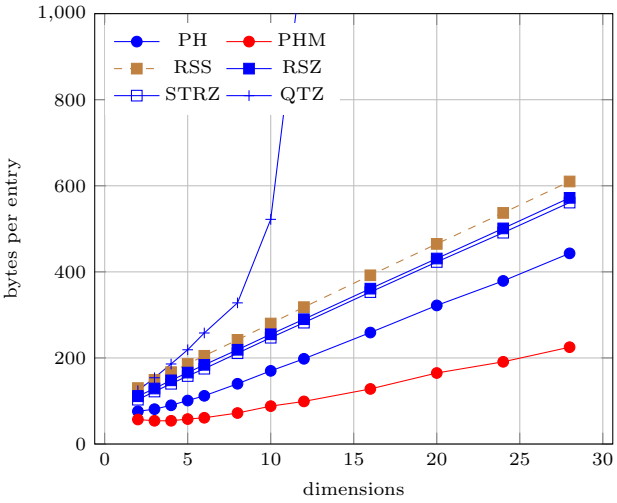


Figure 12: DIM: Memory usage per rectangle for CL-R

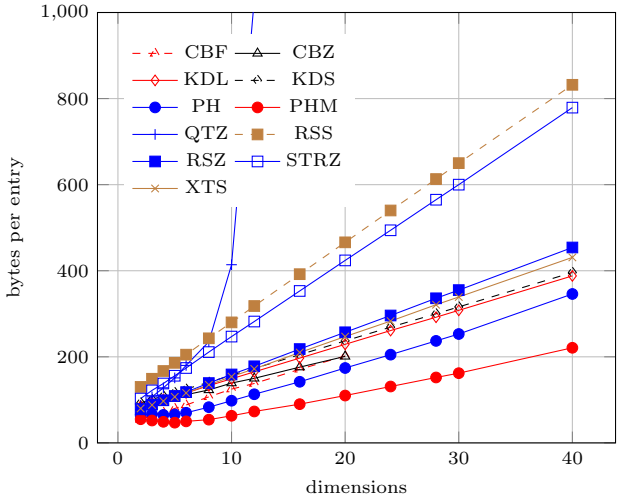
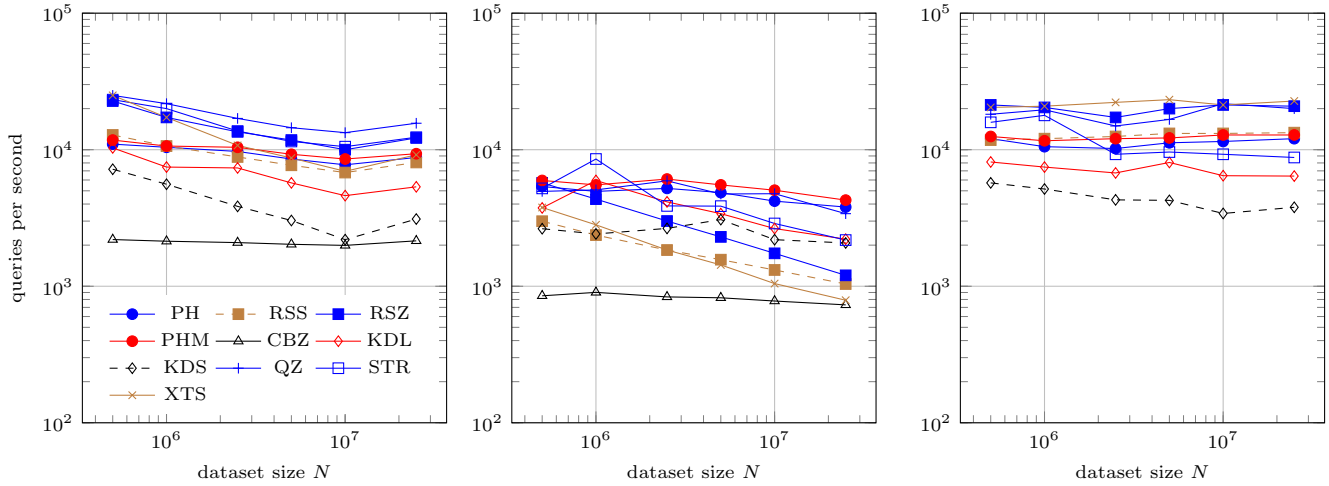
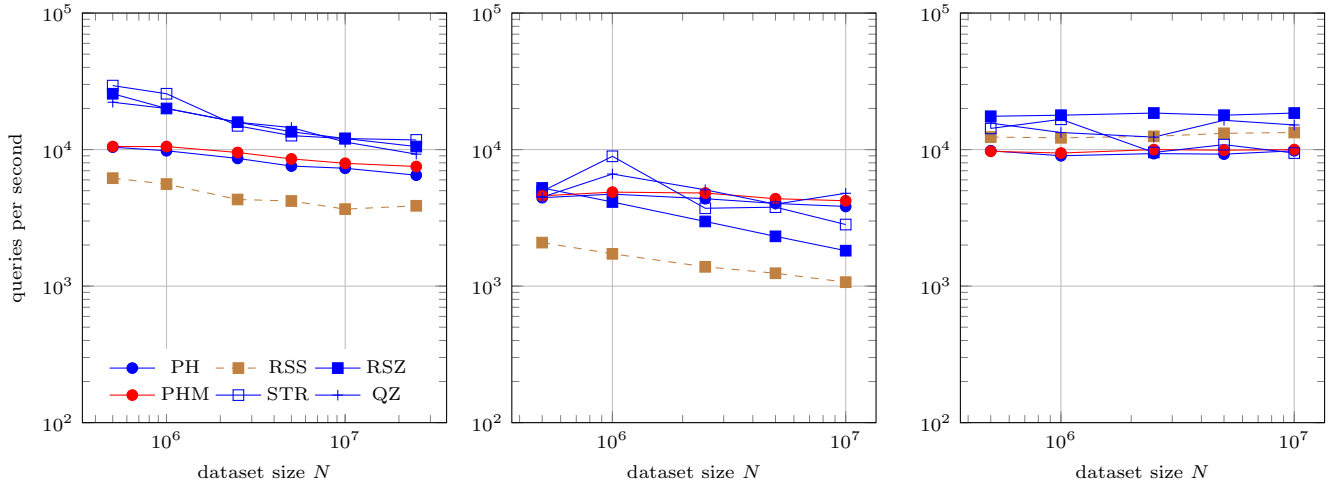


Figure 11: DIM: Memory usage per point for CL-P



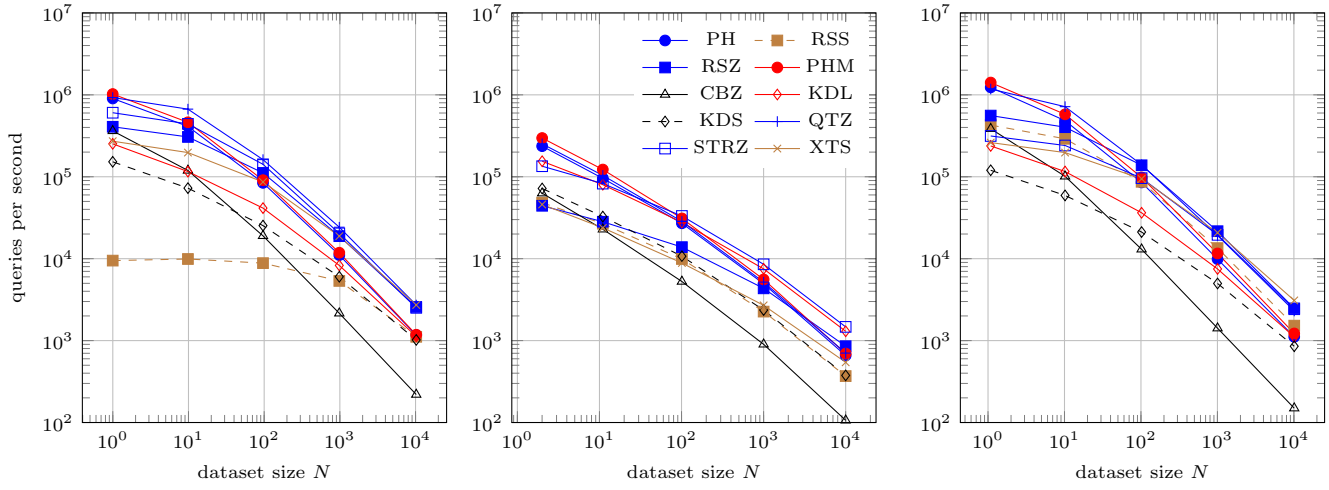
(a) 2D OSM-P (b) 3D CUBE-P (c) 3D CLUSTER-P

Figure 13: Window query rates for the OSM, CUBE and CLUSTER datasets



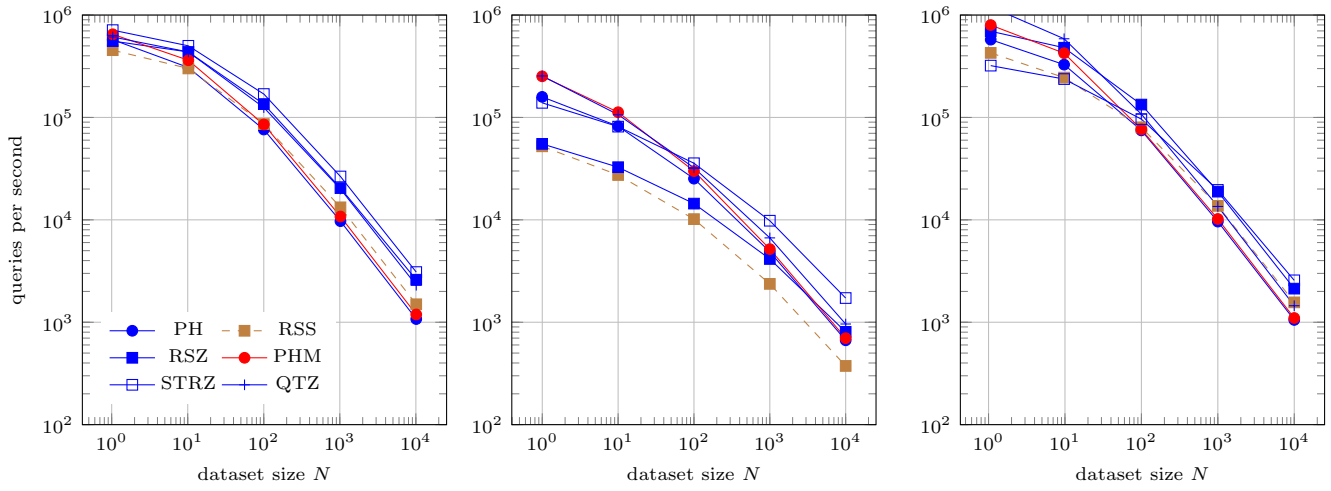
(a) Alps OSM-R (b) CUBE-R (c) CLUSTER-R

Figure 14: Window query rates for the OSM, CUBE and CLUSTER datasets



(a) 2D OSM-P (b) 3D CUBE-P (c) 3D CLUSTER-P

Figure 15: Varying query result size with the OSM Alps, CUBE and CLUSTER datasets



(a) Alps OSM-R (b) CUBE-R (c) CLUSTER-R

Figure 16: Varying query result size with the OSM Alps, CUBE and CLUSTER datasets

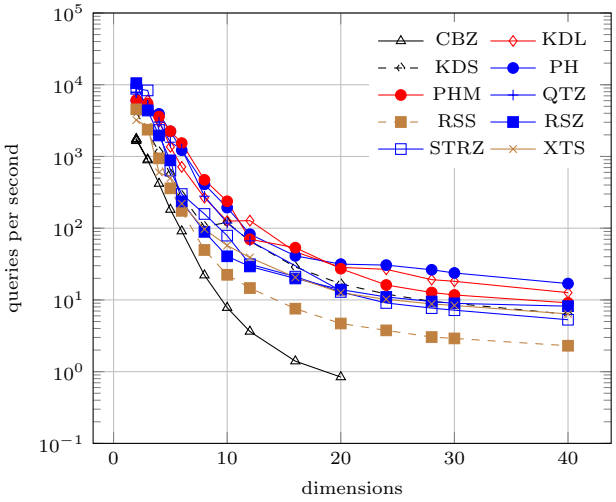


Figure 17: DIM: Window query rates for CU-P

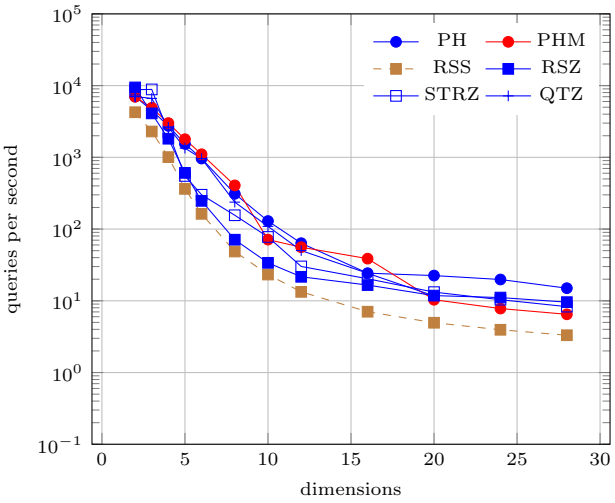


Figure 18: DIM: Window query rates for CU-R

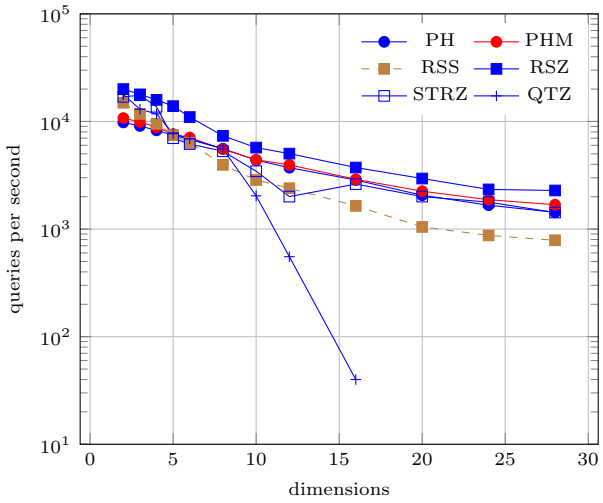


Figure 20: DIM: Window query rates for CL-R

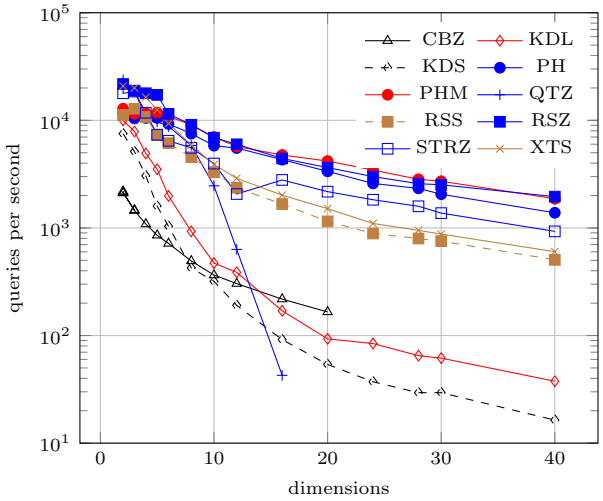
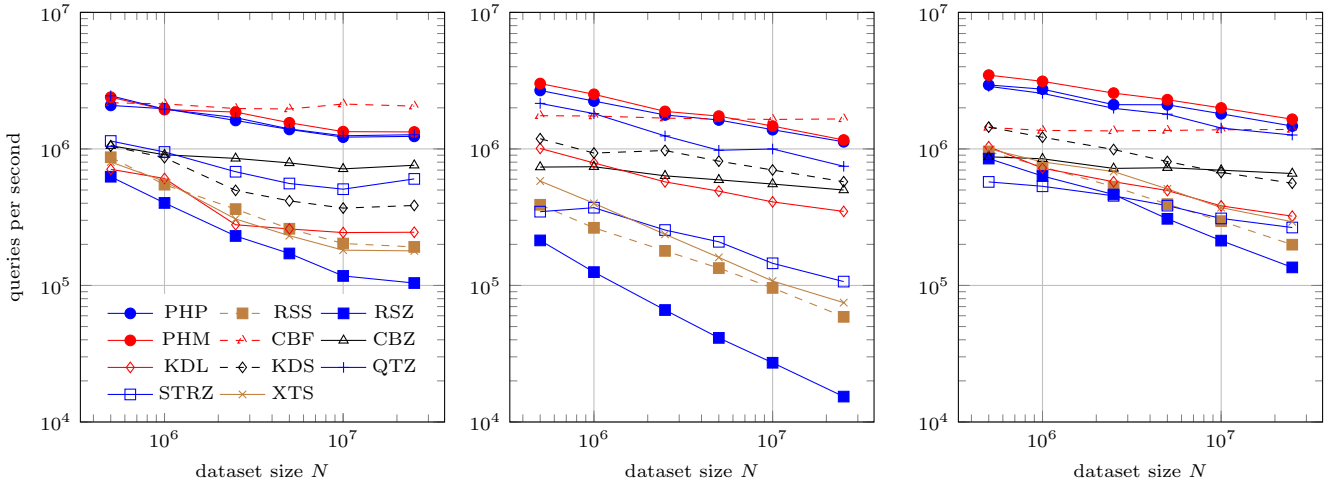
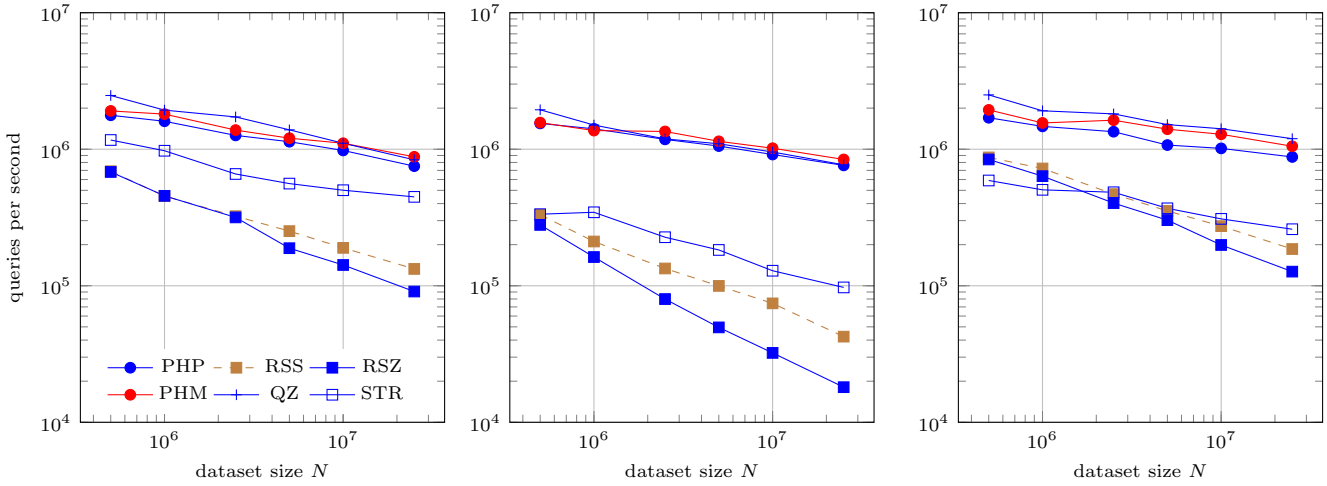


Figure 19: DIM: Window query rates for CL-P



(a) 2D OSM-P (b) 3D CUBE-P (c) 3D CLUSTER-P

Figure 21: Exact match query rates for the OSM, CUBE and CLUSTER datasets



(a) 2D OSM-R (b) 3D CUBE-R (c) 3D CLUSTER-R

Figure 22: Exact match query rates for the OSM, CUBE and CLUSTER datasets

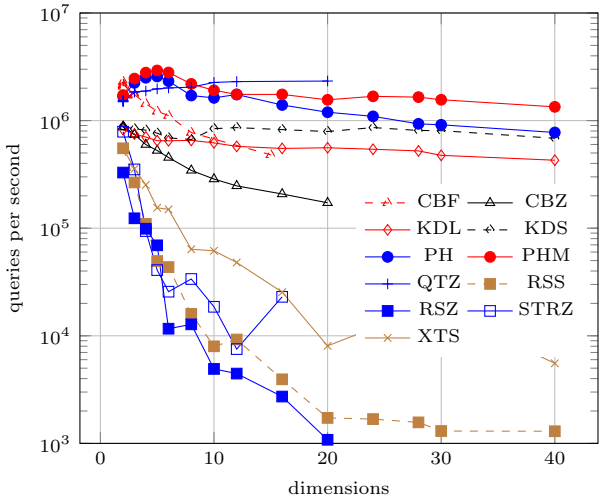


Figure 23: DIM: Exact match query rates for CU-P

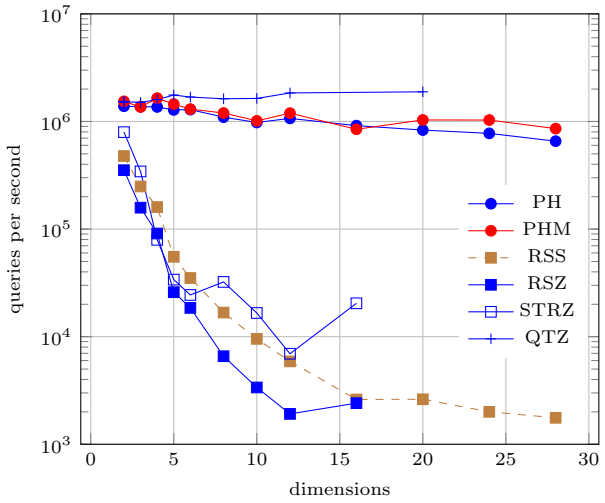


Figure 24: DIM: Exact match query rates for CU-R

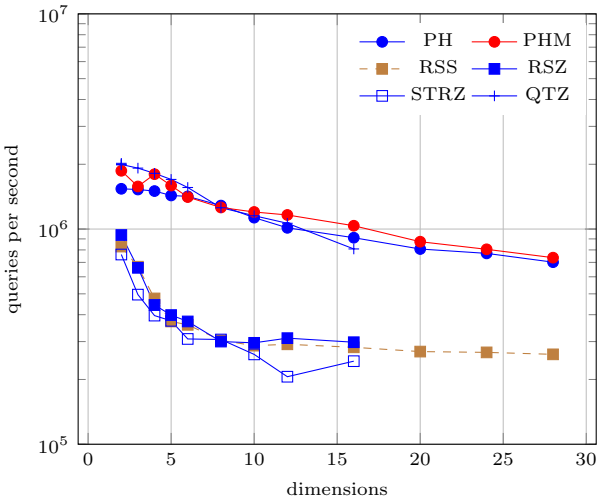


Figure 26: DIM: Exact match query rates for CL-R

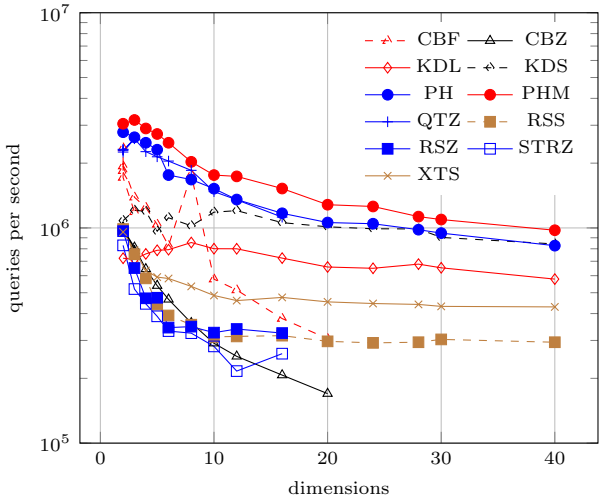
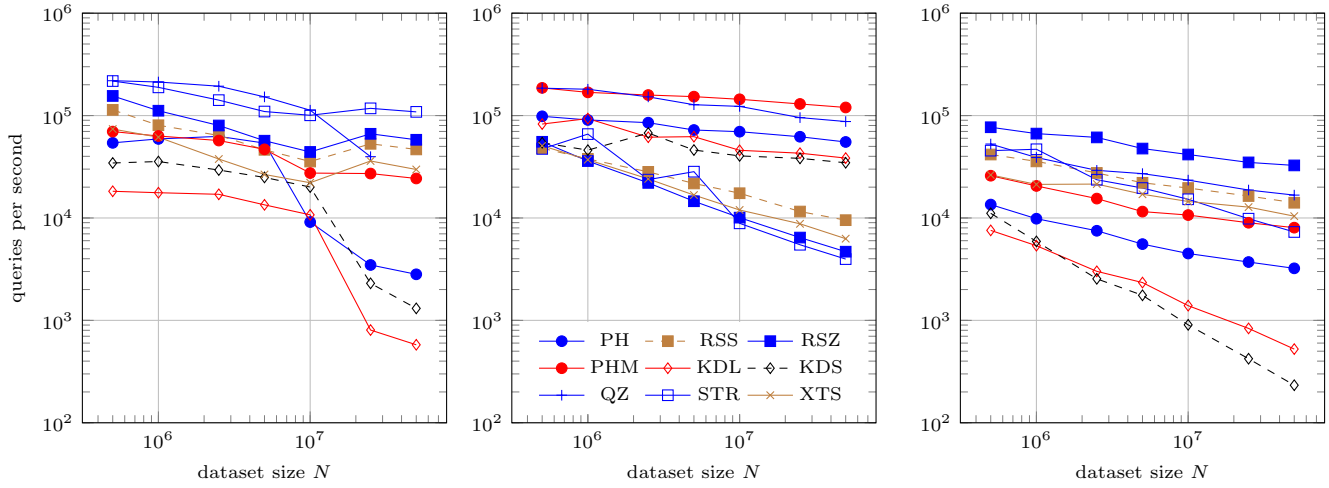
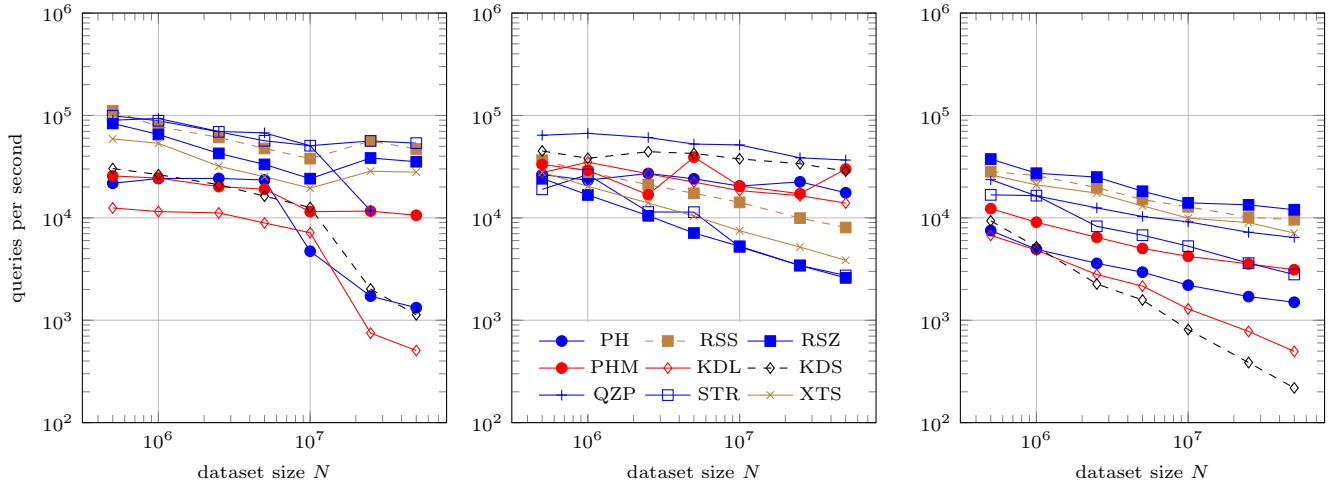


Figure 25: DIM: Exact match query rates for CL-P



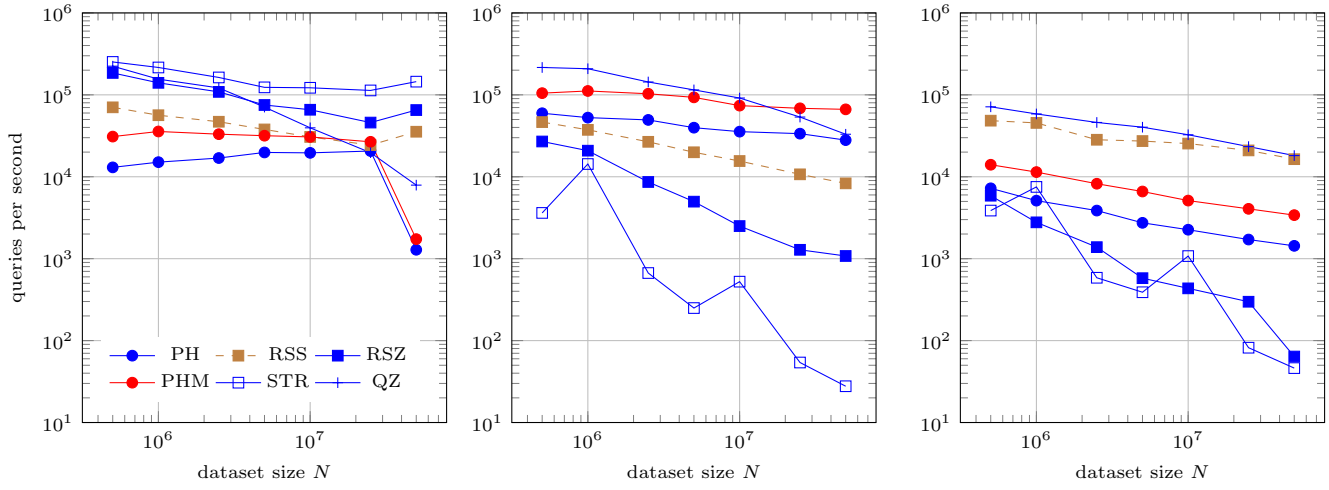
(a) 2D OSM-P (b) 3D CUBE-P (c) 3D CLUSTER-P

Figure 27: 1NN query rates for the OSM, CUBE and CLUSTER datasets



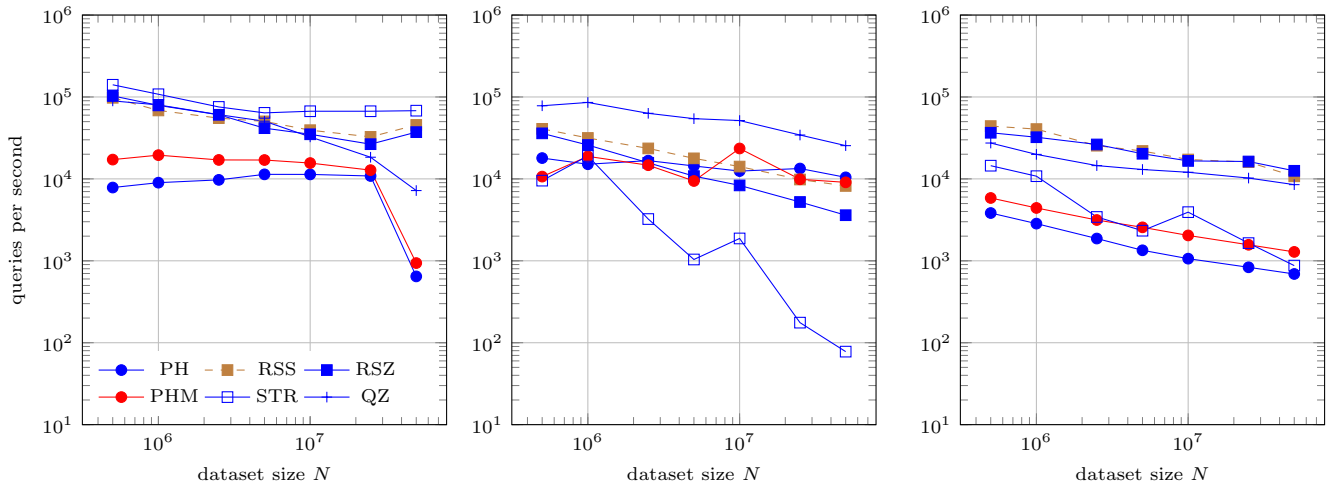
(a) 2D OSM-P (b) 3D CUBE-P (c) 3D CLUSTER-P

Figure 28: 10NN query rates for the OSM, CUBE and CLUSTER datasets



(a) OSM-R (b) CUBE-R (c) CLUSTER-R

Figure 29: 1NN query rates for the OSM, CUBE and CLUSTER datasets



(a) OSM-R (b) CUBE-R (c) CLUSTER-R

Figure 30: 10NN query rates for the OSM, CUBE and CLUSTER datasets

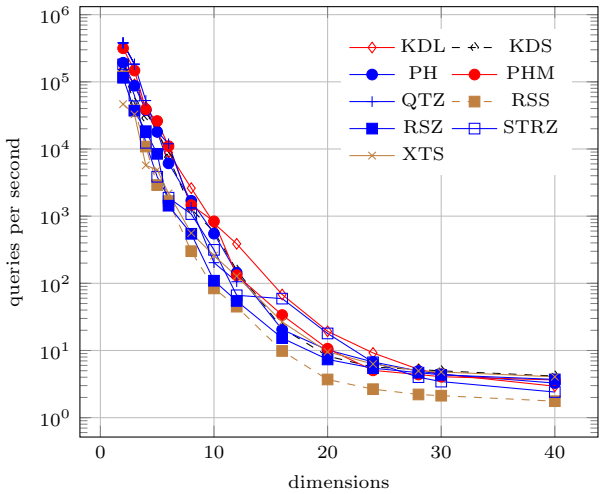


Figure 31: DIM: 1-NN query rates for CU-P

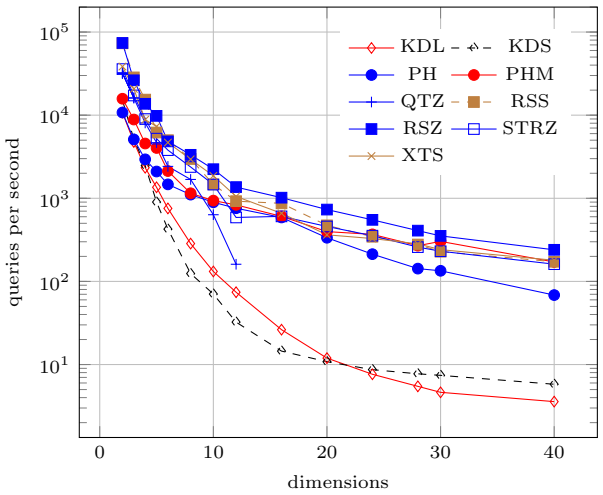


Figure 34: DIM: 10-NN query rates for CL-P

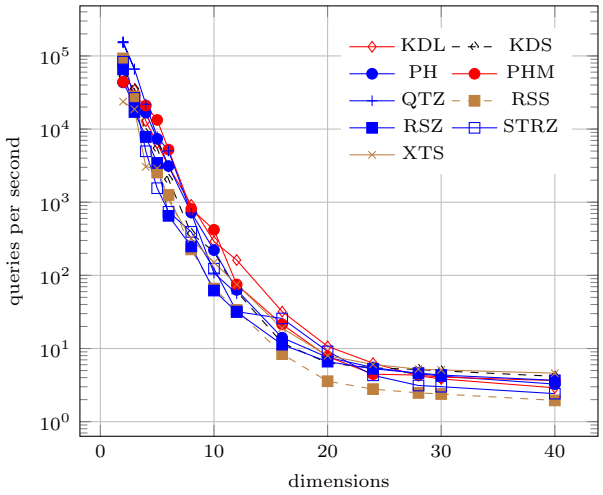


Figure 32: DIM: 10-NN query rates for CU-P

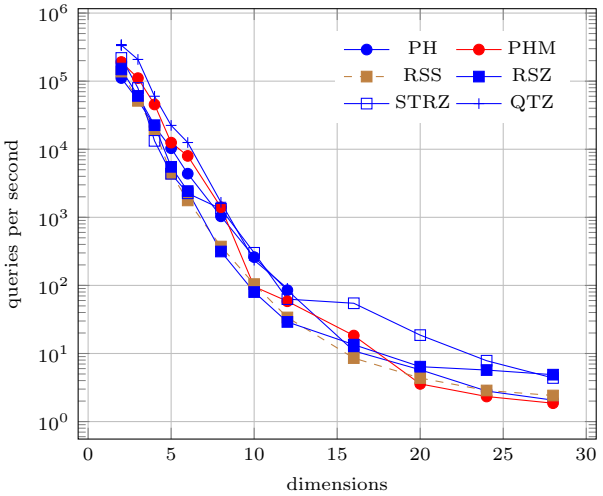


Figure 35: DIM: 1-NN query rates for CU-R

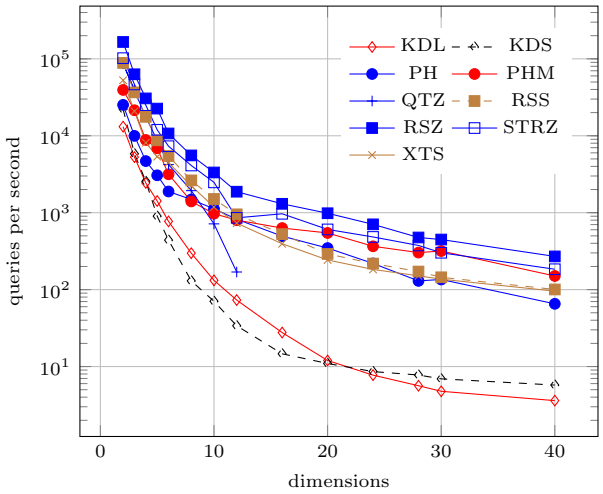


Figure 33: DIM: 1-NN query rates for CL-P

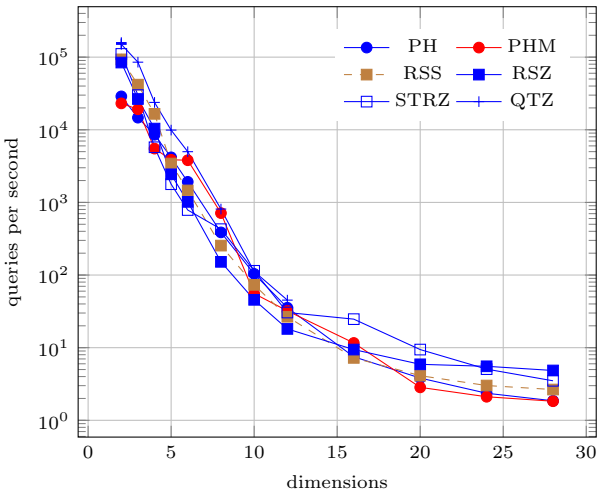


Figure 36: DIM: 10-NN query rates for CU-R

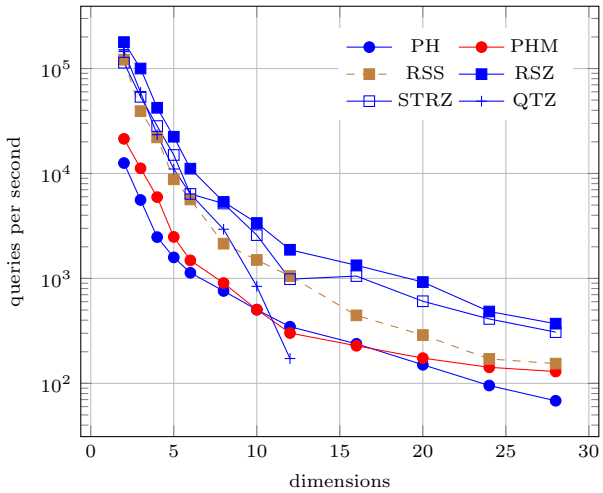


Figure 37: DIM: 1-NN query rates for CL-R

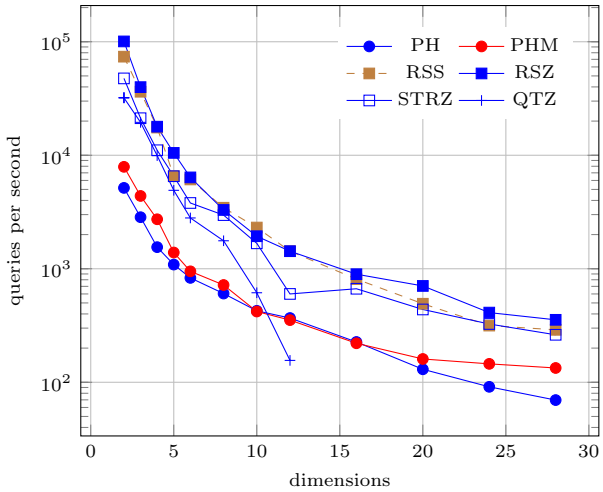
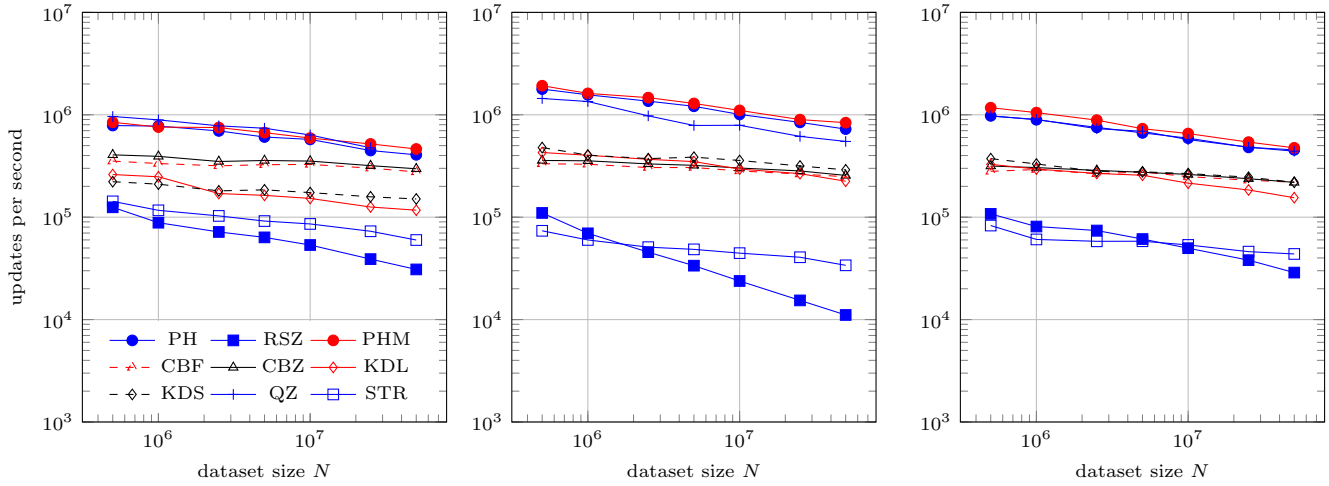
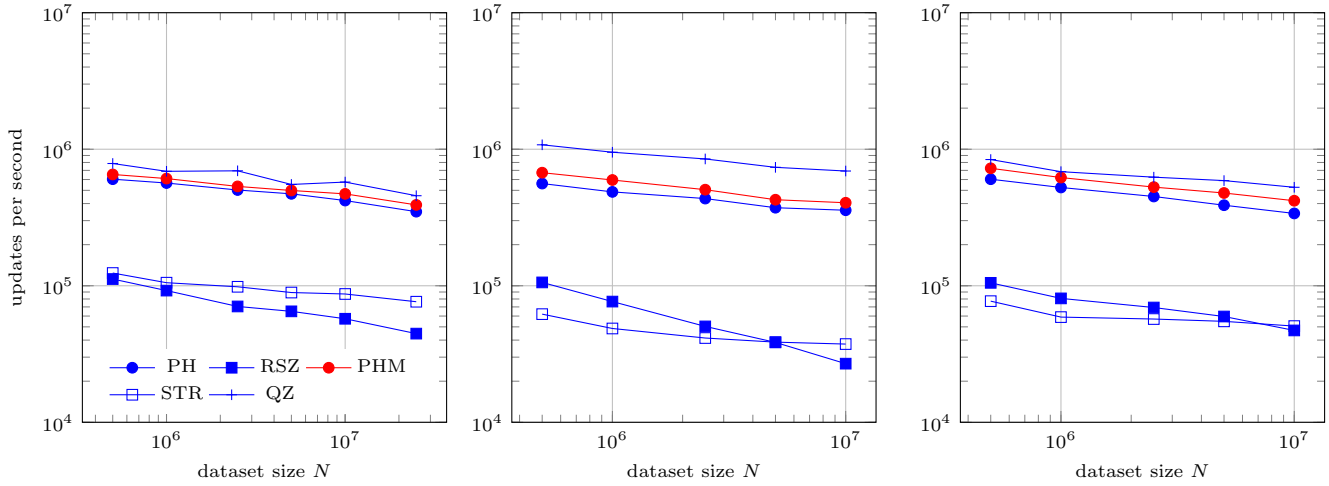


Figure 38: DIM: 10-NN query rates for CL-R



(a) 2D OSM-P (b) 3D CUBE-P (c) 3D CLUSTER-P

Figure 39: Update rates for the OSM Alps, CUBE and CLUSTER datasets



(a) 2D OSM-R (b) 3D CUBE-R (c) 3D CLUSTER-R

Figure 40: Update rates for the OSM Alps, CUBE and CLUSTER datasets

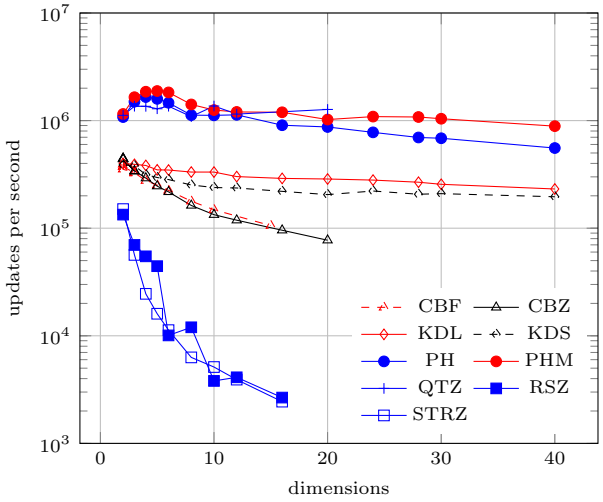


Figure 41: DIM: Update rates for CU-P

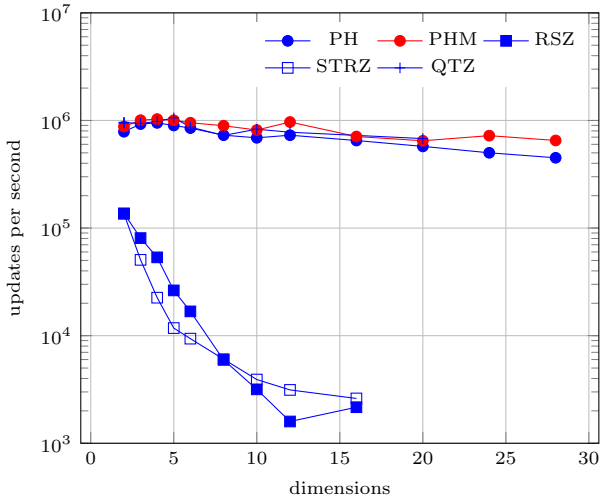


Figure 42: DIM: Update rates for CU-R

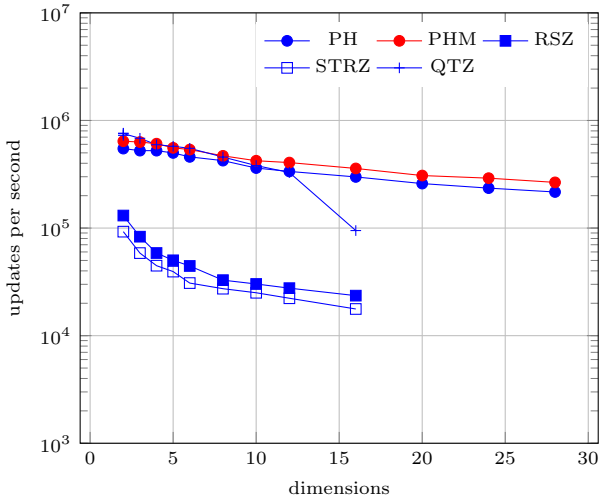


Figure 44: DIM: Update rates for CL-R

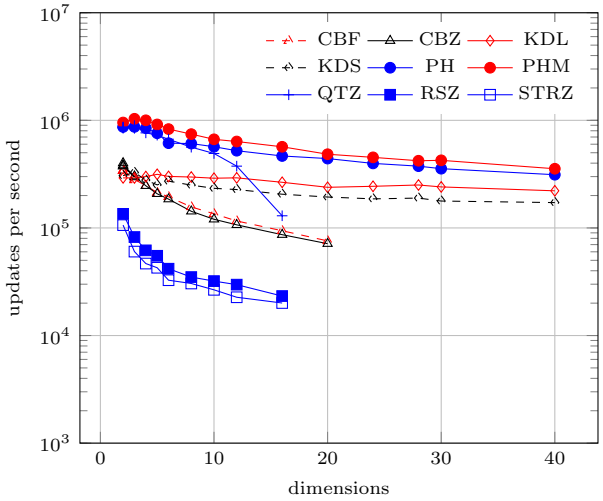
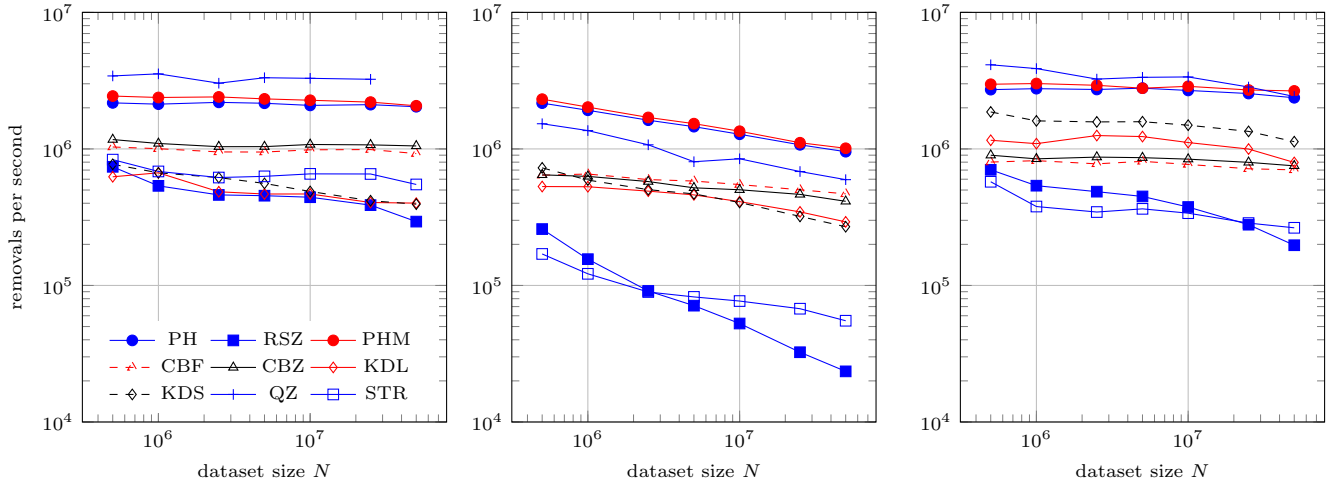
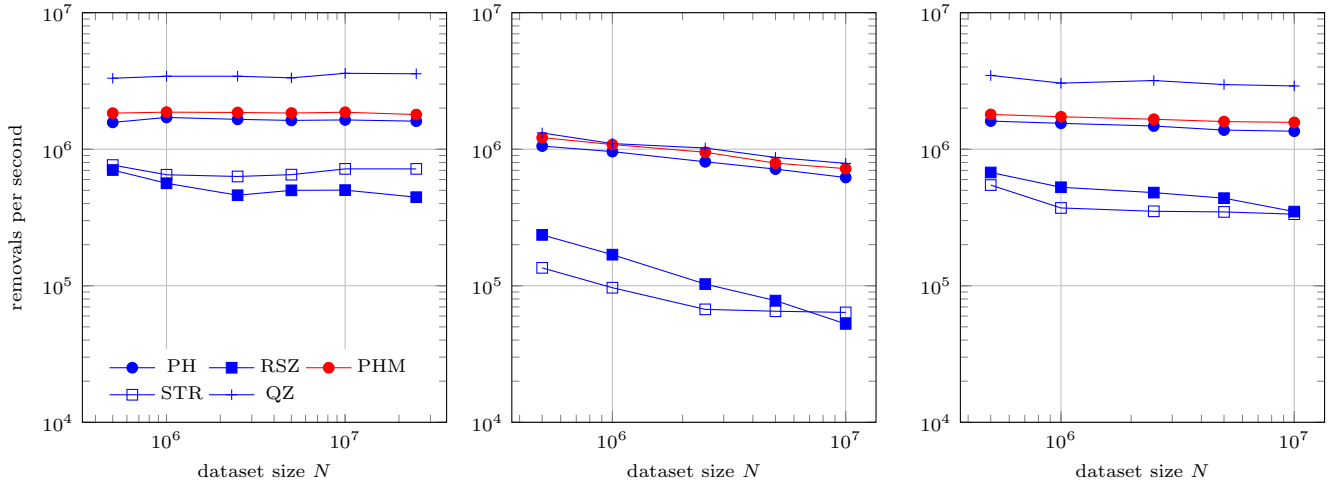


Figure 43: DIM: Update rates for CL-P



(a) 2D OSM-P (b) 3D CUBE-P (c) 3D CLUSTER-P

Figure 45: Removal rates for the OSM Alps, CUBE and CLUSTER datasets



(a) 2D OSM-R (b) 3D CUBE-R (c) 3D CLUSTER-R

Figure 46: Removal rates for the OSM Alps, CUBE and CLUSTER datasets

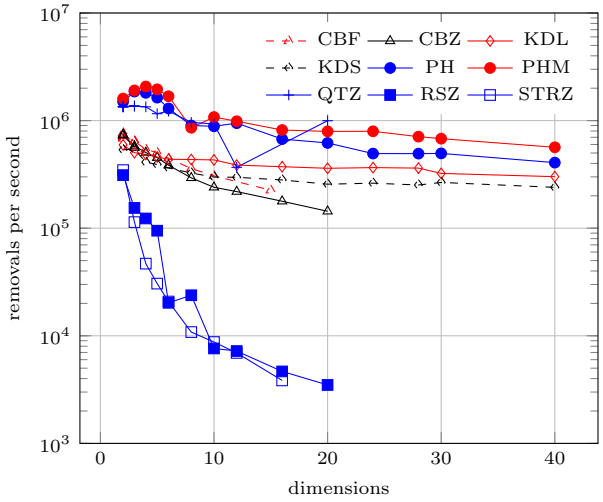


Figure 47: DIM: Removal rates for CU-P

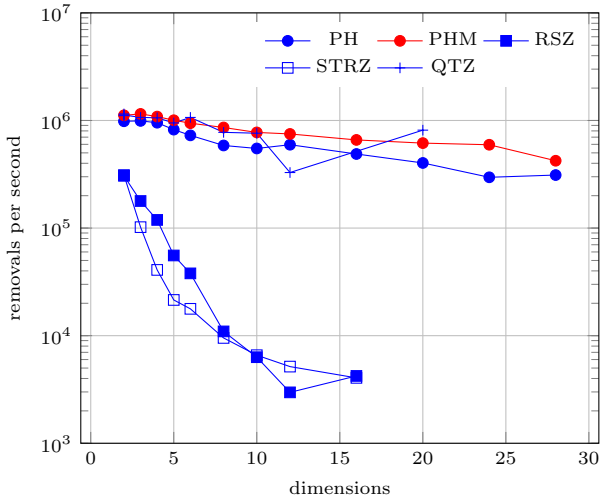


Figure 48: DIM: Removal rates for CU-R

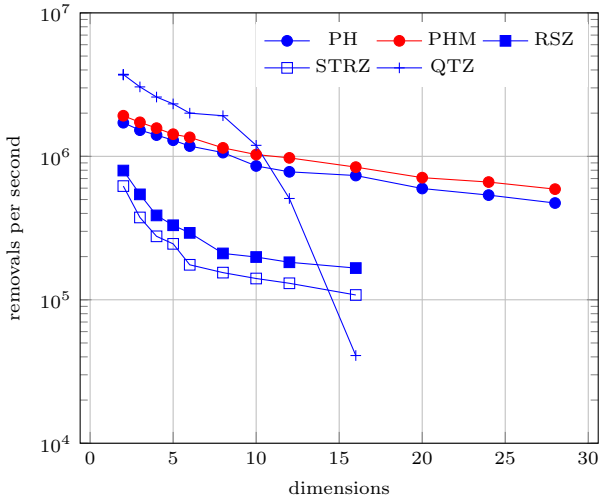


Figure 50: DIM: Removal rates for CL-R

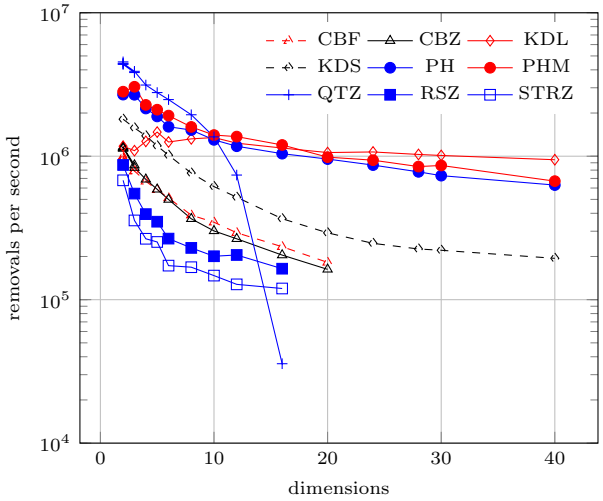


Figure 49: DIM: Removal rates for CL-P