StreamBox-HBM: Stream Analytics on High Bandwidth Hybrid Memory

The first stream analytics engine optimized for 3D Memory + DRAM on real hardware

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1. Motivation
- Performance demands of Stream analytics
  - High throughput: hundreds MRec/s
  - Low latency: sub second delay

- Hybrid Memory: 3D memory + DRAM
  - 3D memory: high bandwidth, small capacity; no latency benefit (unlike: SRAM+DRAM); same as DRAM w/o high parallelism / sequential access

• How can stream analytics use hybrid memory?

2. Parallel Sort for Grouping
- Grouping performs poorly on 3D memory
- Known duals of Grouping: Hash vs. Sort
  - DRAM: Hash is the best
  - 3D mem: Sort outperforms Hash with
    - Abundant bandwidth
    - High task parallelism
    - Wide SIMD (AVX-512)
    - Sequential access

3. Only use 3D mem for in-mem index
- 3D mem is capacity limited
- Minimize the use of precious capacity while exploiting the high bandwidth

4. Balance two limited resources
- 3D mem capacity and DRAM bandwidth
- Dynamically place data based on pressures

5. Key results
- Comparing to Flink
  - YSB
    - 5-10x

6. Lessons
- If you want to use 3D memory to speed up applications, consider all of the following:
  - Apps
  - High task parallelism
  - Wide SIMD (avx512)
  - Sequential mem access
  - Packed data structure
  - Runtime
  - Thread pool + custom task scheduler
  - Custom mem allocator
  - OS kernel
  - Cheap VM (hugs pages)
  - RDMA networks bypass kernel, free CPU
  - Hybrid Memory
  - DRAM

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