Simply Top Talkers

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Motivation and Outline

- Need to understand and correctly handle dominant aspects within the overall flow of traffic
  - Top-k Problem
  - Optimize peering relationships (top autonomous systems)
  - Analyze congestion cases (top hosts)
- Technical challenge
  - Compute sorted top-n views from very large numbers of flow information records
  - No possibility to store individual counters per aspect components
- This presentation
  - Propose and analyze simple techniques to compute top-k listings for single and composed traffic aspects
  - Show that the techniques are suitable for in-memory aggregation databases

Related Work

- E. D. Demaine, A. Lopez-Ortiz, and J. I. Munro. Frequency estimation of internet packet streams with limited space. In *Proceedings of the 10th Annual European Symposium on Algorithms*, pages 348–360, 2002.

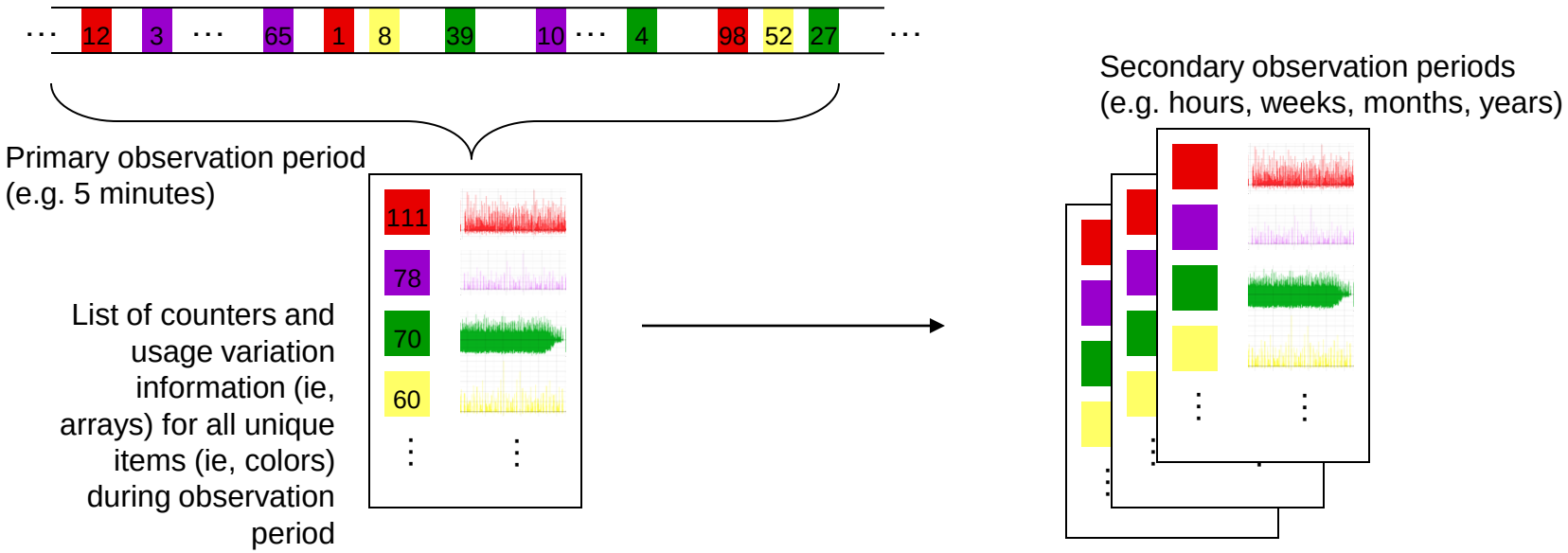
- C. Estan and G. Varghese. New directions in traffic measurement and accounting: Focusing on the elephants, ignoring the mice. *ACM Trans. Comput. Syst.*, 21(3):270–313, 2003.

- Metwally A, Agrawal D, El Abbadi A (2005) Efficient computation of frequent and top-k elements in data streams. In: Proceeding of the 2005 international conference on database theory (ICDT'05), Edinburgh, UK, pp 398–412

- X. Dimitropoulos, P. Hurley, and A. Kind: Probabilistic Lossy Counting: An Efficient Algorithm for Finding Heavy Hitters," ACM SIGCOMM Computer Communication Review, Jan. 2008.

- X. Dimitropoulos, M. Stoecklin, P. Hurley, and A. Kind: The Eternal Sunshine of the Sketch Data Structure," Elsevier Computer Networks, 2008.

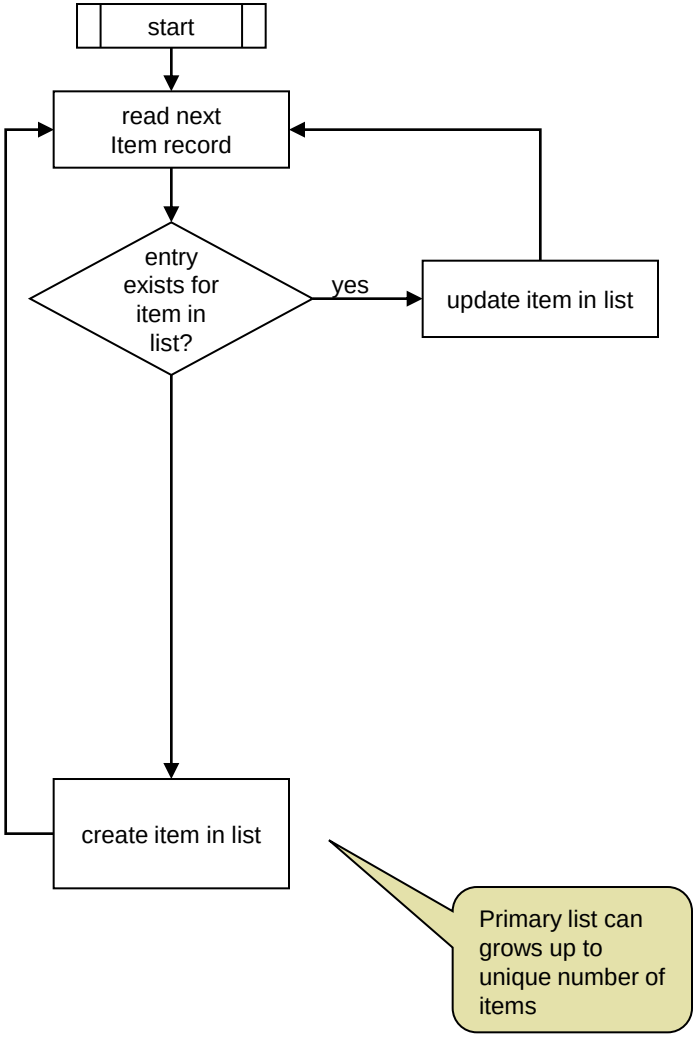
Top-k Problem



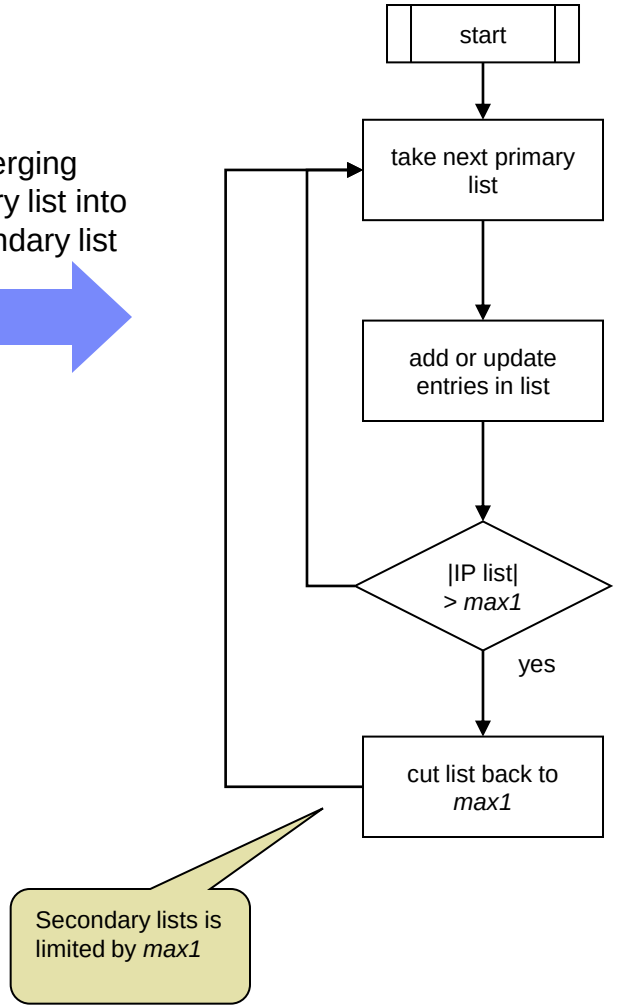
- Large number of unique items per observation period
  - Large alphabet
  - Counters and usage arrays don't fit into memory

- How to cut back sorted list?
  - Correct ordering
  - Correct volume information for each item
  - Reduce the cost of inserting new items (that anyway would not make it into the sorted top-k list)

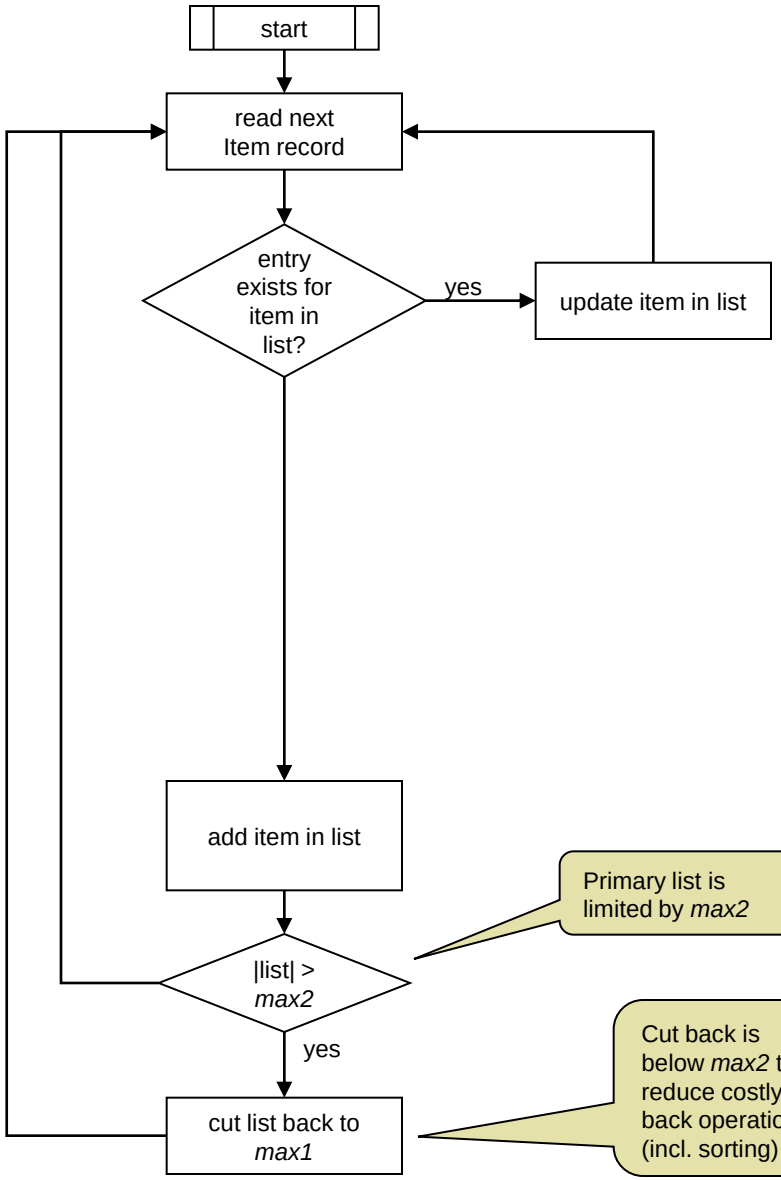
One Threshold Scheme (*max1*)



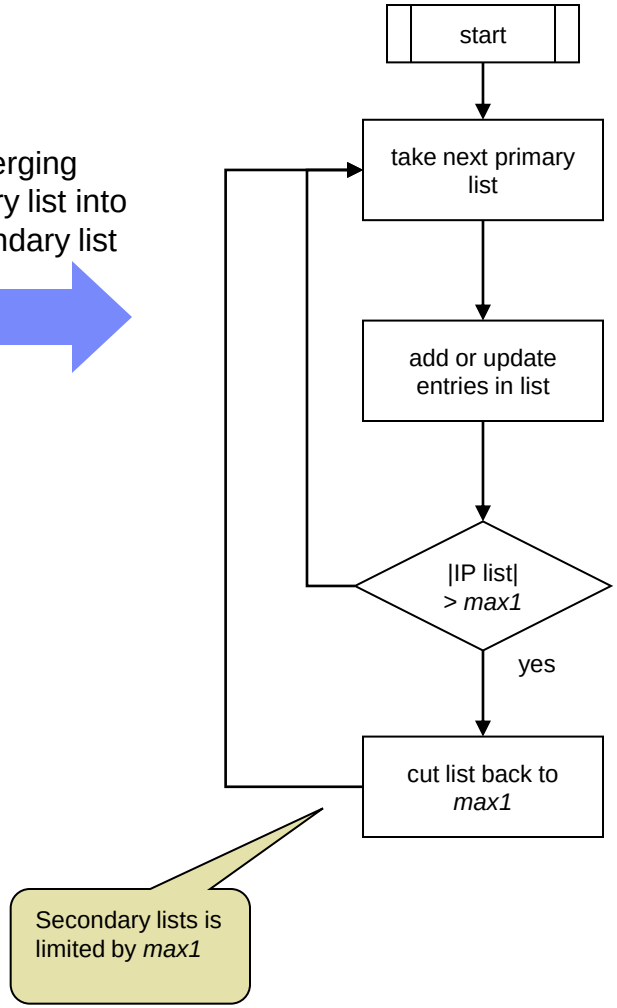
Merging primary list into secondary list



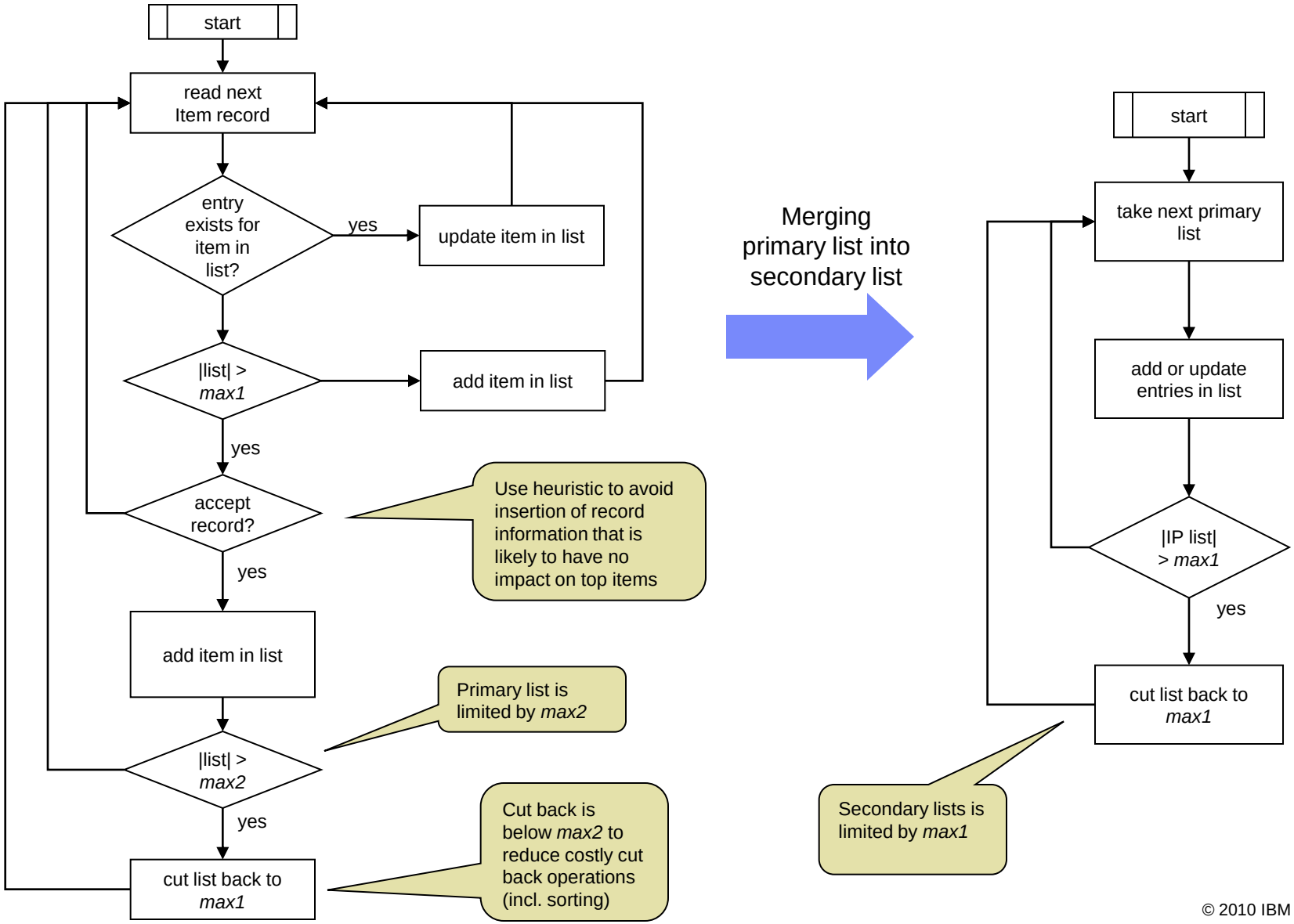
Two Threshold Scheme (*max1*, *max2*)



Merging primary list into secondary list



Two Threshold Scheme (*max1*, *max2*) with Heuristic



Heuristics

- 0. Exact

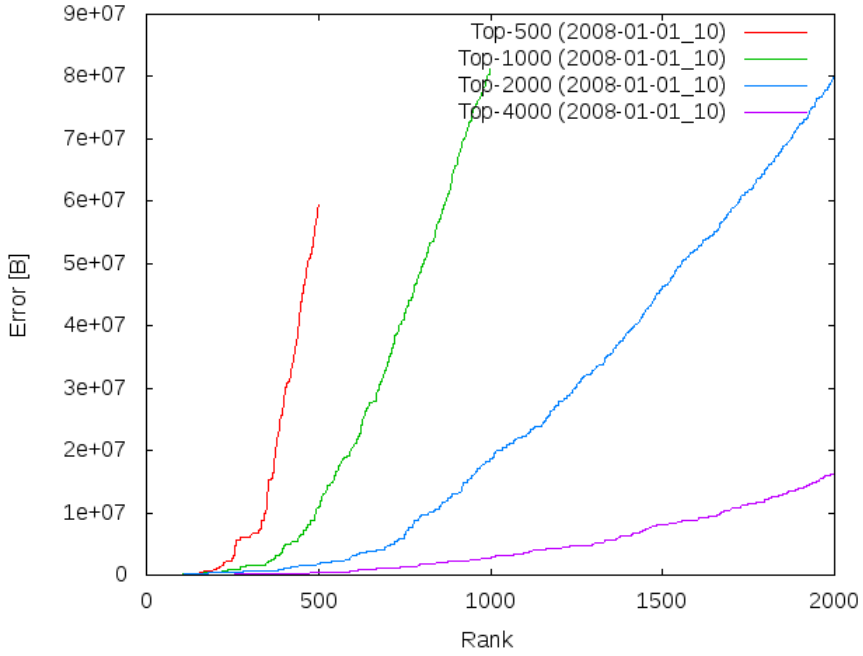
- max1,max2 style:
- No Heuristic
- Short duration (< 1 second)
- Low Packet count in one flow (< 4 pkts)
- Bytes < total_bytes_seen/total_flows_seen (averaging)

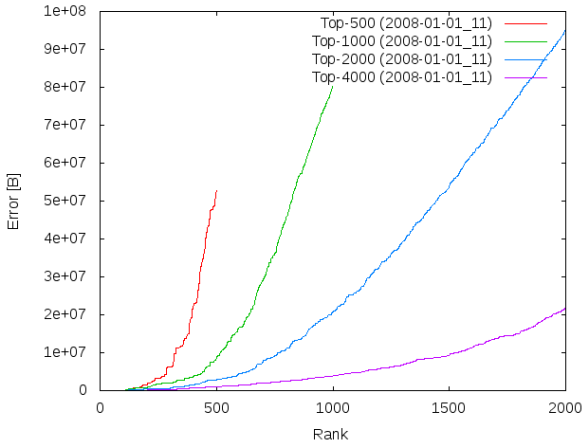
- These heuristics are very simple and more importantly ‘cheap’ to implement memory and cpu wise.

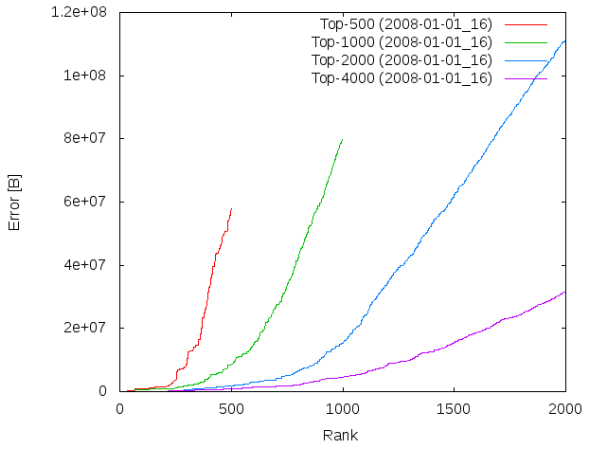
Data Set

- We picked three days of data collected at one of the IBM datacenters
- Did an expensive query: calculate the exact top K entries
- Fortunately there are machines with large amounts of memory and number of cores…
- Then we applied the defined heuristics to the data set, which run in near real-time as we don't need a lot of memory or cpu power to store all the entries
- One of the biggest advantages of course is that one can almost stay in-cache when one has proper cpu's (4 or 8 MiB cache per core)
- results on next slides….
- Note that the dataset represents several Petabytes of network traffic, the 'error' rate in comparison is thus effectively very low…..

Error rate for Top K without heuristic

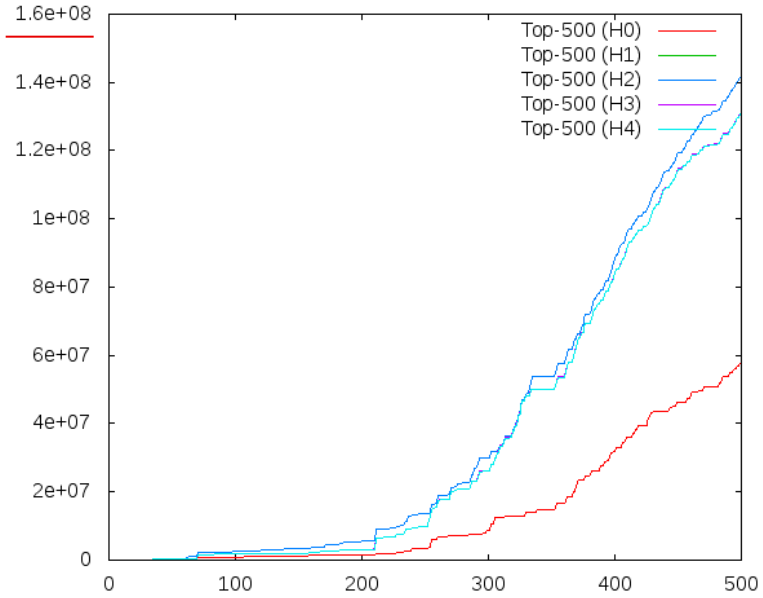


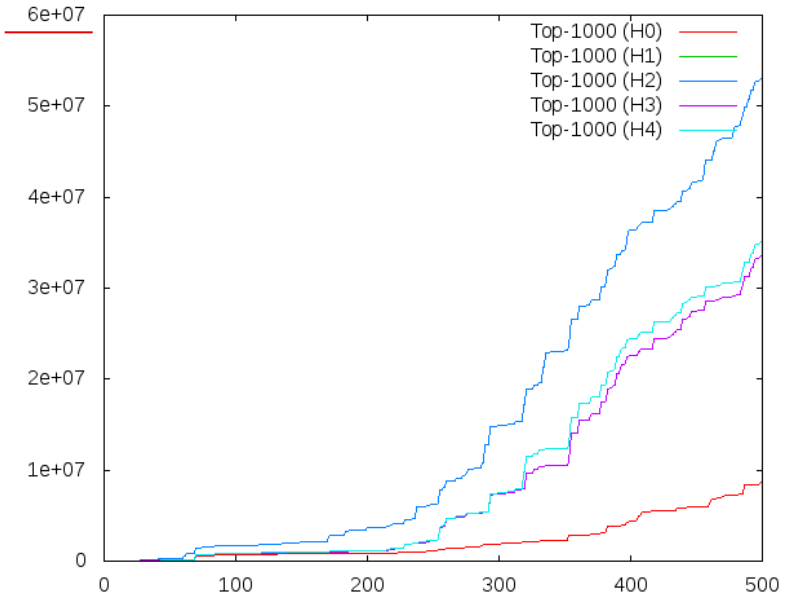


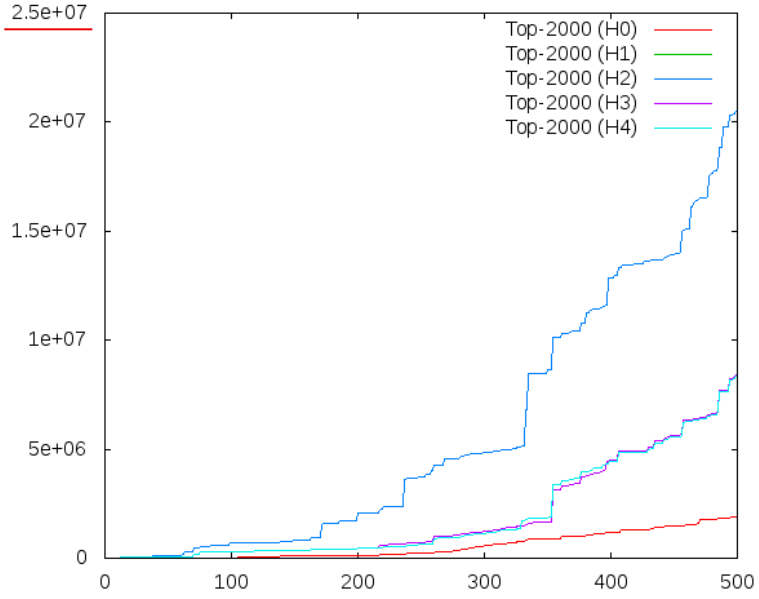


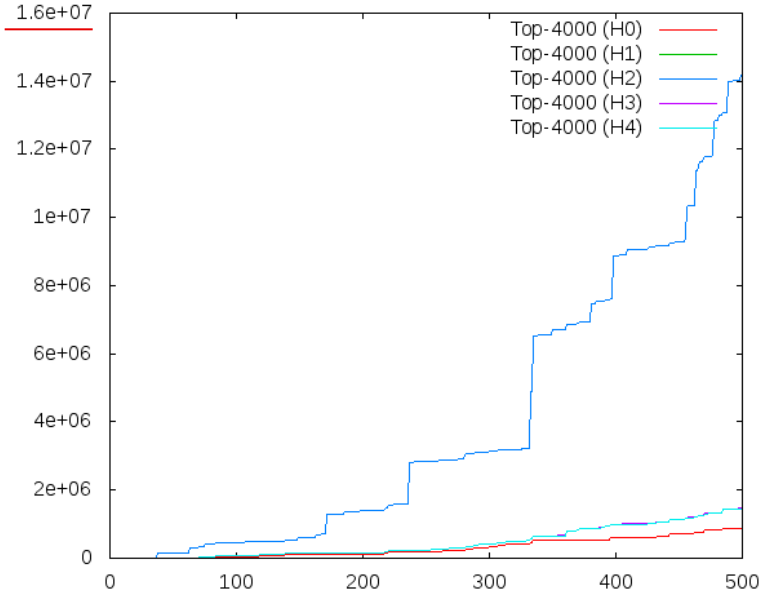
Amount of bytes that are not seen for top X items

Error rate for Top K when applying various heuristics









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Conclusion

- Simple heuristics and thus cheap processing:
  - Differences are minimal for this ‘datacenter’ dataset, other datasets, eg for an enterprise network seem to prefer the ‘bytes < avg’ heuristic a bit more, which makes sense as it is hard to get in the top K unless you can at least beat the average.

- Two thresholds
  - max2 = 2 * max1
  - Correct order up to k = X * max1

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