Limitations of data reuse in streaming iterative algorithms

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STREAMING ITERATIVE ALGORITHMS

Traverse all data
High degree of parallelism

Can we reorder computation to exploit data reuse and save I/O?

SCALE-OUT PROBLEMS

MapReduce

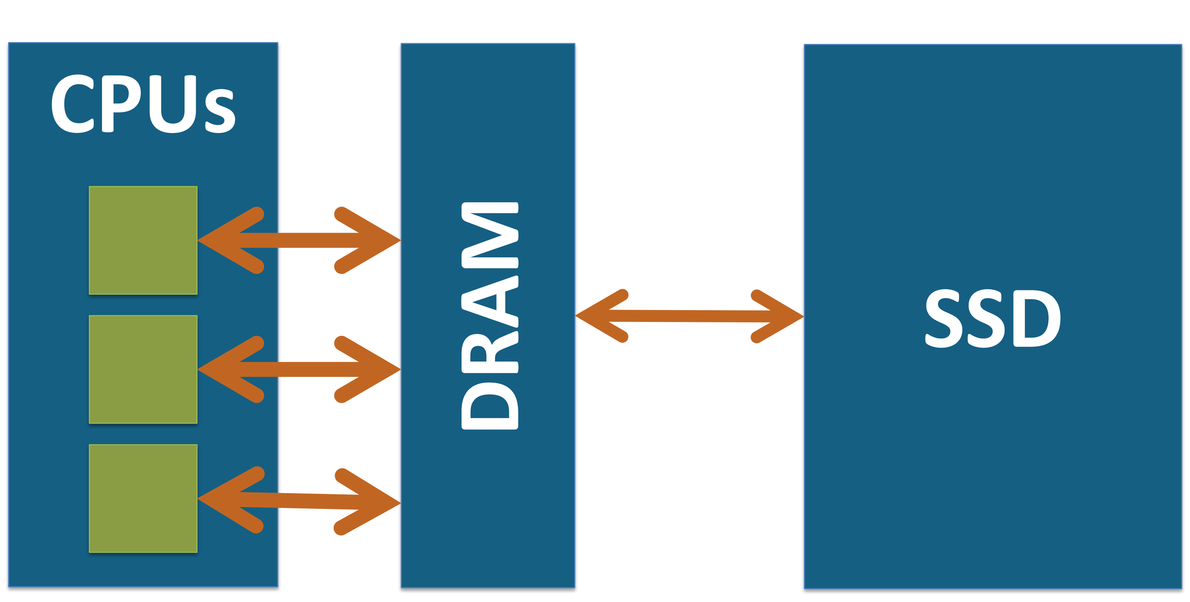
Restrictive programming model

In-memory systems

High cost
Low fault-tolerance

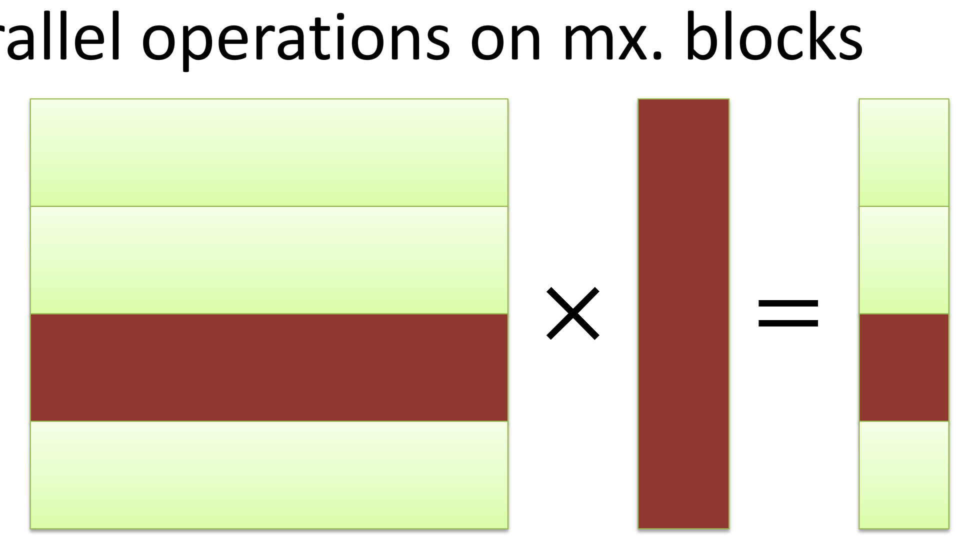
Scale up!

Increase capacity with SSDs
Big data, small memory
Manage I/O explicitly
Exploit application knowledge



PROGRAMMING MODEL & IMPLEMENTATION

Parallel operations on mx. blocks

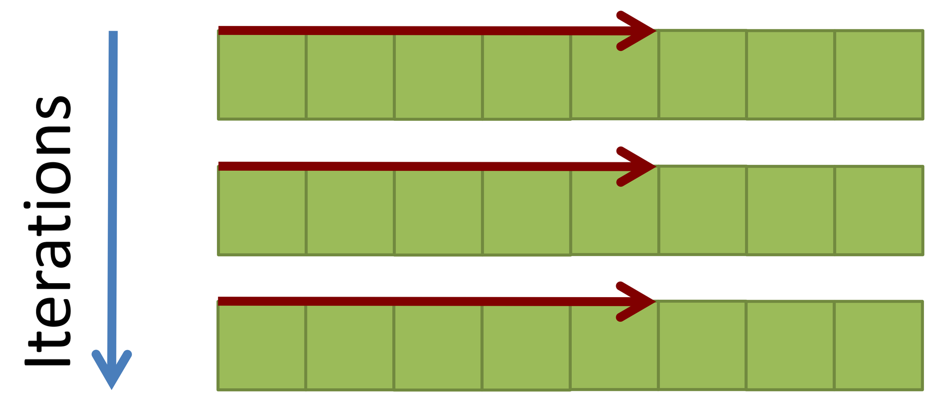


Blockus system; based on Presto, a distributed execution engine for R

SCHEDULING POLICIES

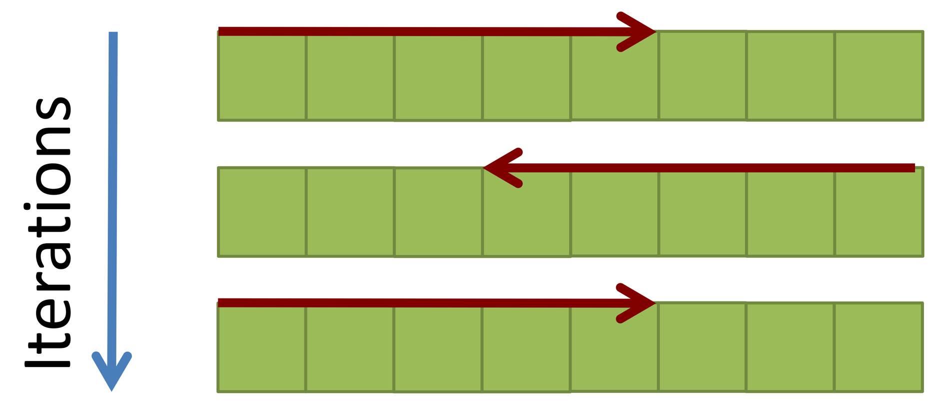
Default

Traverse data in fixed order
Corresponds to for loop



Reversing

Reverse traversal in every iteration
Reuse final blocks of prev. iteration

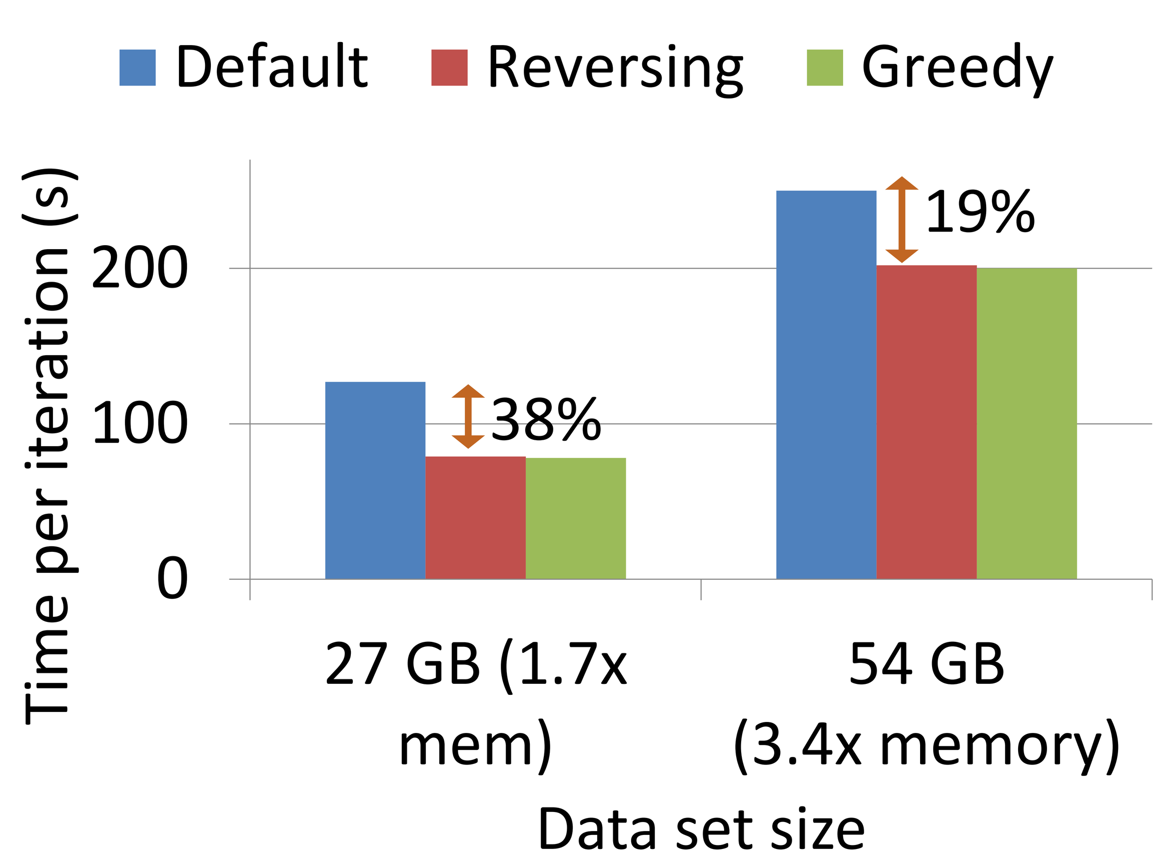


Greedy

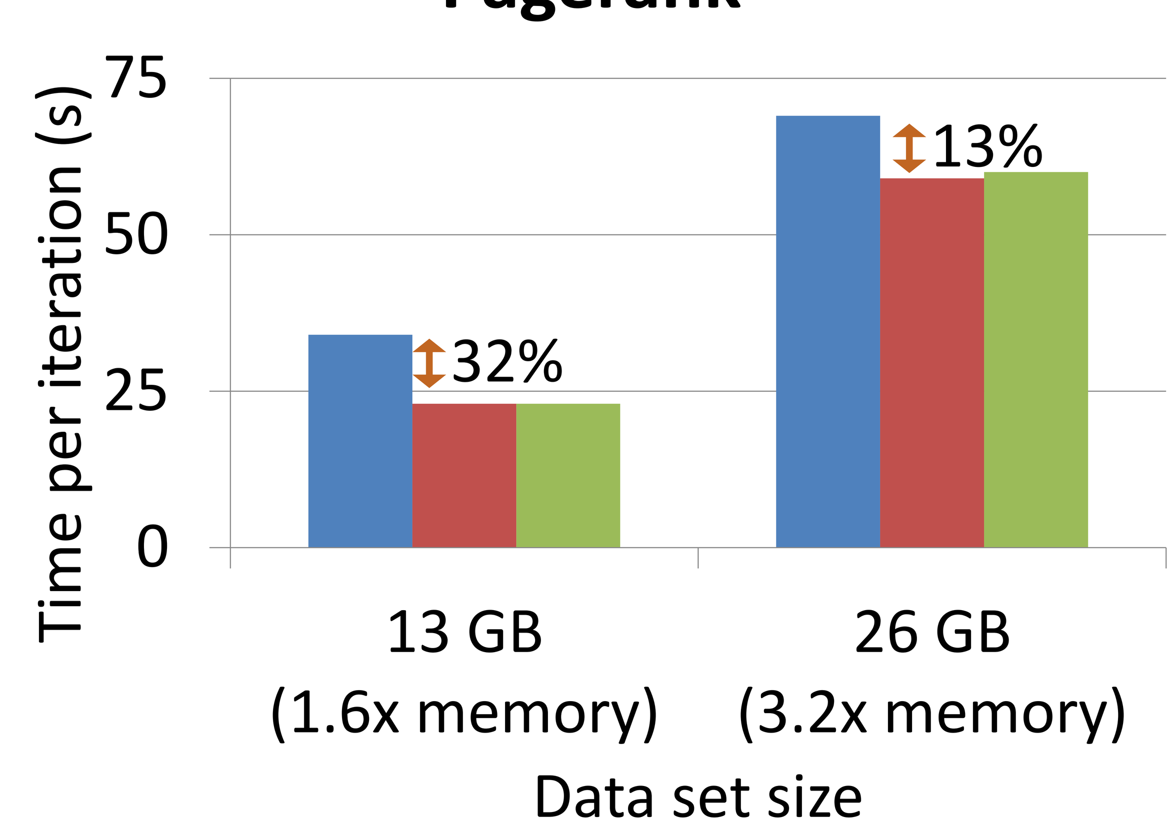
Keep track of in-memory data
Schedule task with least I/O

RESULTS I.

K-means



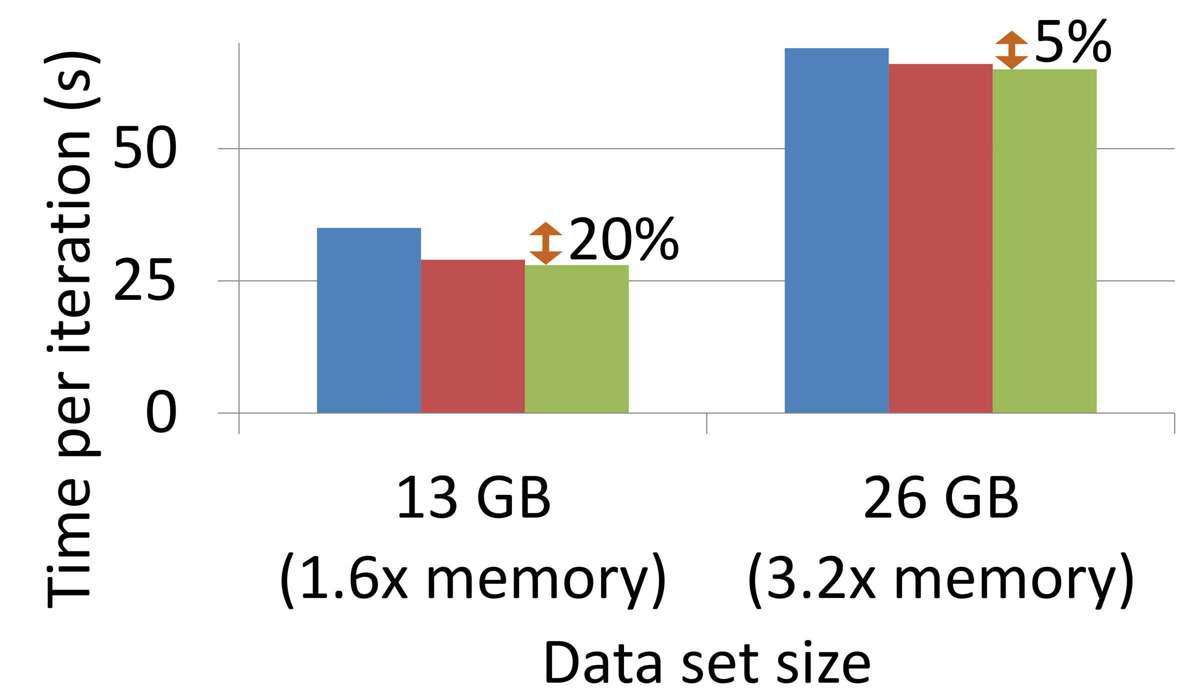
Pagerank



Simple computation structure
Reuse all memory contents

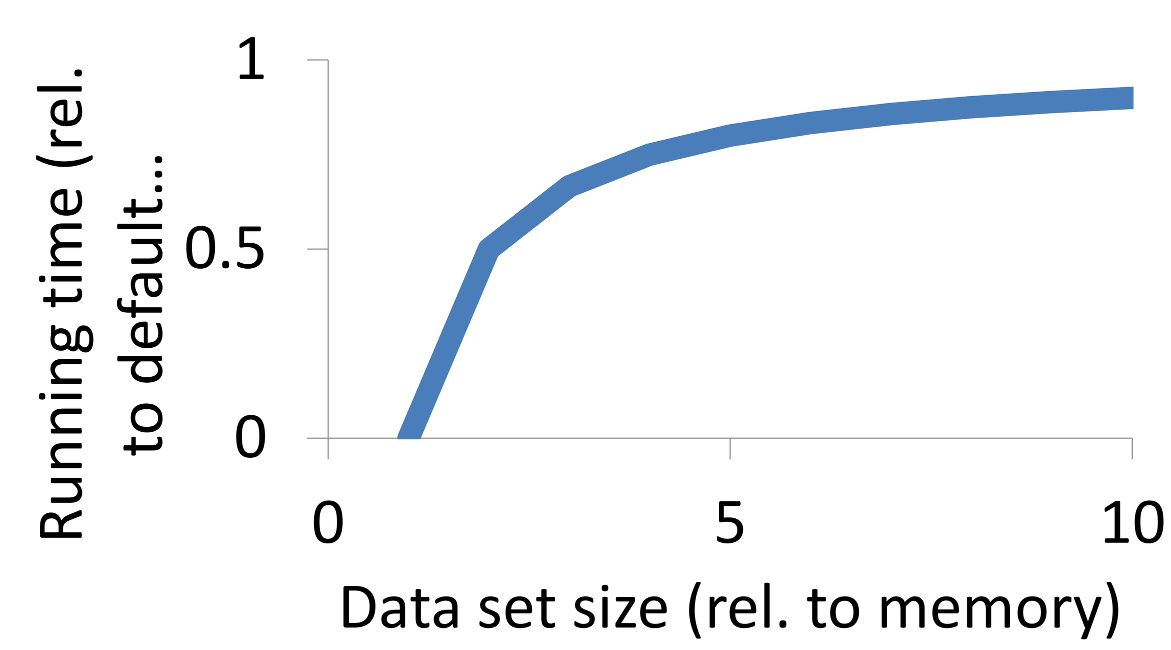
RESULTS II.

Conjugate gradient method



Multiple operations per iteration
Less reordering, less reuse

RUNNING TIME IMPROVEMENT SCALING



CONCLUSIONS

$$\text{speedup} \sim \frac{1}{\text{datasize}}$$

Computation reordering does not scale to big data sizes for streaming iterative algorithms

FUTURE WORK

DAG execution model
Data dependent access pattern
Asynchronous algorithms (conv. vs. I/O)
Caching policies

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