Exploiting Iterative-ness for Parallel ML Computations

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ITERATIVE ML

- Iterative fitting of model parameters
  - Assume a model describes input data
    - "Learn" model parameters that fit data
  - The algorithm is usually iterative
    - Refine intial guess until params converge
- Parallel computation for big problems
  - Partition input data among workers
  - Workers share model parameters
  - One approach: BSP + parameter server
    - Barrier synch each iteration

EXPLOITING ITERATIVE-NESS

- Often, each iteration read/writes same params
  - Can tune system with access pre-knowledge
    - Data placement to reduce network traffic
    - Data placement to reduce remote NUMA accesses
    - Static structures to reduce locking / marshaling
    - Static cache contents to reduce eviction costs
    - Informed prefetching
- Ways to obtain per-iteration access sequences
  - Explicit virtual iteration
    - Efficient, but requires more programmer effort
  - Explicit identification of iteration boundaries
    - Less effort, but more performance overhead

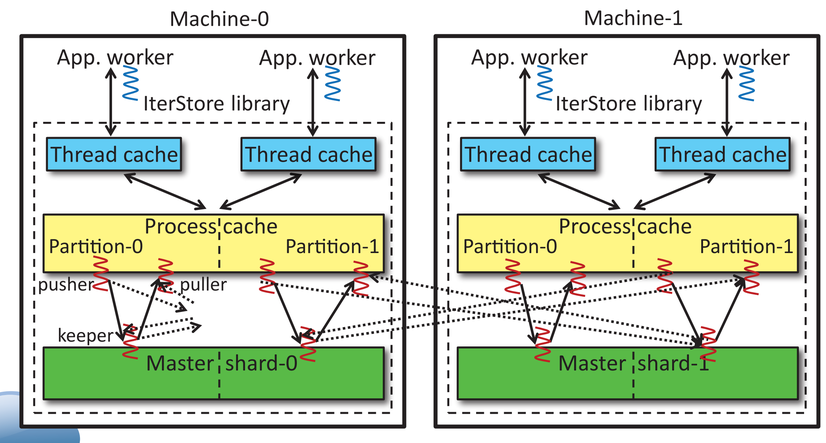
```
// Original
init_params()
ps.clock()
do {
  do_iteration()
  ps.clock()
} while (not stop)
```

```
// Gather in first iter
init_params()
ps.clock()
do {
  if (first iteration)
    ps.start_gather(real)
  do_iteration()
  if (first iteration)
    ps.finish_gather()
  ps.clock()
} while (not stop)
```

```
// Gather in virtual iter
ps.start_gather(virtual)
do_iteration()
ps.finish_gather()
init_params()
ps.clock()
do {
  do_iteration()
  ps.clock()
} while (not stop)
```

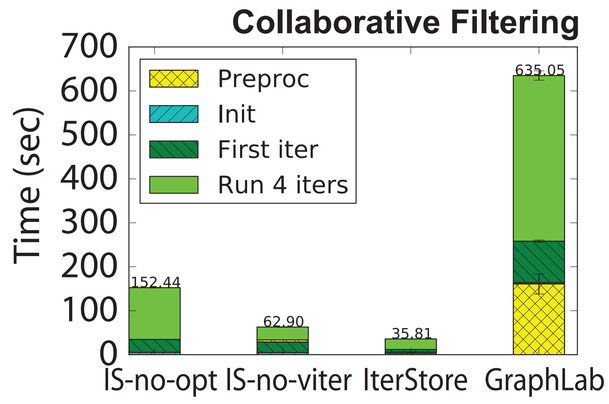
ITERSTORE

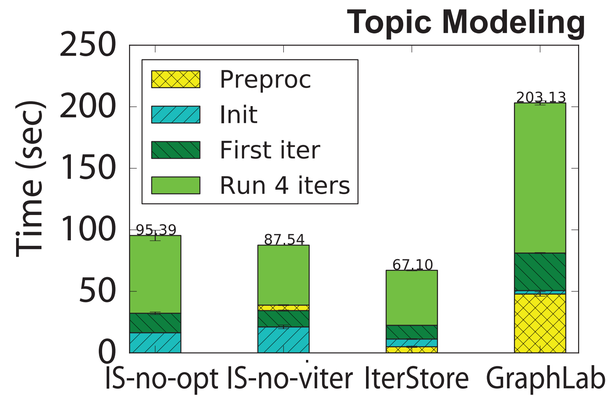
- A parameter server that exploits iterative-ness
  - With READ, UPDATE, and CLOCK interface
  - An improved version of LazyTable

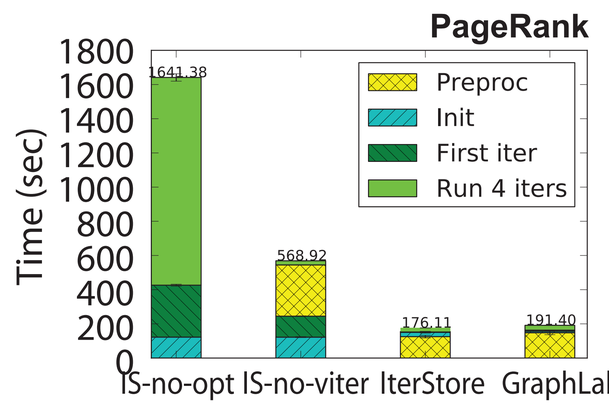


EXPERIMENTAL RESULTS

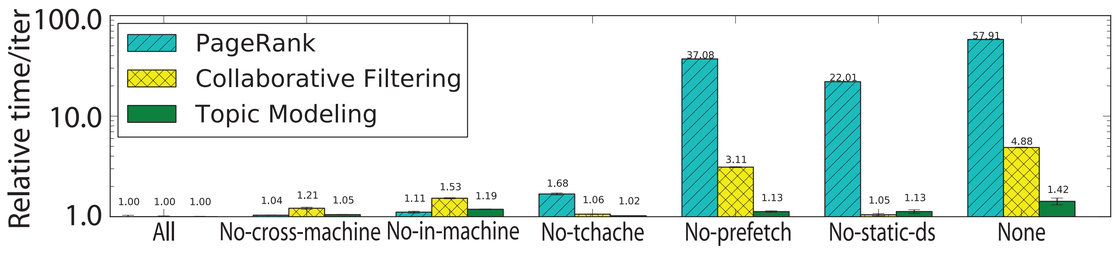
- Hardware setup
  - 8 nodes, each with 64 cores and 128 GB memory
  - connected via Infiniband network (40Gbps)
- Overall performance:

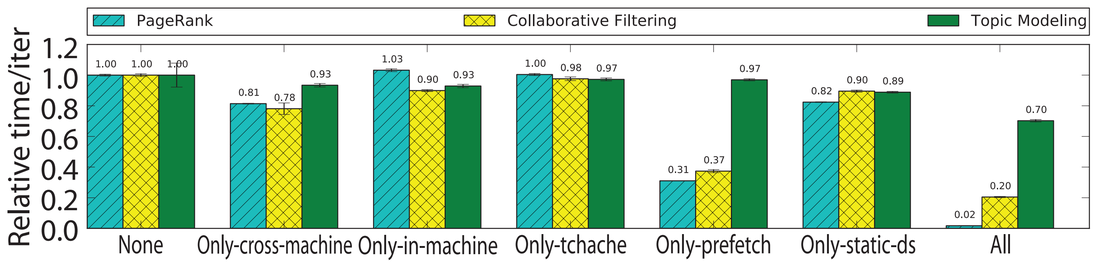






- Optimization effectiveness break-down:





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