

MongoDB profiler deep dive

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Overview

1. Basic profiler use
2. Advanced profiler with aggregation framework
3. Response time analysis with profiler and aggregation framework.
4. Profile and time-series data



What is the profiler?

Your most important performance diagnosis tool

- Captures metadata about what operations ran on the system
- Saves data into capped collection
- Designed for basic performance analysis
- In the spirit of < instrument everything >
- Very interesting advanced analysis possible
 - Aggregation
 - Historical/Time-series analysis
 - Operational monitoring



Using the profiler

- Turn it on, leave it.
- Development cycle
- Production debugging
- Overall performance management
- Find candidates, pull out query, use explain()
 - Rinse and Repeat

```
while true:  
    bad_statements = find_candidates()  
    for statement in bad_statements:  
        statement.explain()
```



Using the profiler; Example

```
$> db.setProfilingLevel(2);
{ "was" : 0, "slowms" : 100, "ok" : 1 }

$> db.testme.save({"name":"Kenny"});

$> db.system.profile.find().pretty()
{
  "ts" : ISODate("2013-02-11T18:45:06.857Z"),
  "op" : "insert",
  "ns" : "test.testme",
  "keyUpdates" : 0,
  "numYield" : 0,
  "lockStats" : {..},
  "millis" : 0,
  "client" : "127.0.0.1",
  "user" : "" }
```

example: <https://gist.github.com/kgorman/4756589>



Annotated

```
{
  "ts" : ISODate("2012-09-14T16:34:00.010Z"), // date it occurred
  "op" : "query", // the operation type
  "ns" : "game.players", // the db and collection
  "query" : { "total_games" : 1000 }, // query document
  "ntoreturn" : 0, // # docs returned with limit()
  "ntoskip" : 0, // # of docs to skip()
  "nscanned" : 959967, // number of docs scanned
  "keyUpdates" : 0, // updates of secondary indexes
  "numYield" : 1, // # of times yields took place
  "lockStats" : { ... }, // subdoc of lock stats
  "nreturned" : 0, // # docs actually returned
  "responseLength" : 20, // size of doc
  "millis" : 859, // how long it took
  "client" : "127.0.0.1", // client asked for it
  "user" : "" // the user asking for it
}
```

example: <https://gist.github.com/kgorman/4957922>



Important Profiler Attributes

ts:	timestamp of the operation
ns:	namespace of the db and collection accessed
op:	the operation type
nreturned:	the number of documents being returned
nscanned:	the number of document scanned to return the result
moved:	if the operation caused a move
millis:	the total time in milliseconds that the operation took
keyupdates:	the number of indexes that required update

<http://docs.mongodb.org/manual/reference/database-profiler/>



What to look for

- fastMod
 - Good! Fastest possible update. In-place atomic operator (\$inc,\$set)
- nreturned vs nscanned
 - If nscanned != nreturned, you may have opportunity to tune. Indexing.
- key updates
 - Secondary indexes. Minimize them
 - ~10% reduction in performance for each secondary index
- moved & nmoved
 - Documents grow > padding factor
 - You can't fix it other than to pad yourself manually
 - db.collection.stats() shows padding
 - usePowerOf2Sizes
- nreturned; high number of them
 - cardinality
 - Just pure I/O



What doesn't it show

- IndexOnly
 - Very fast, use explain() instead of profiler
- I/O
 - Page accesses
 - Page calls
 - Random I/O
 - Data density/locality
 - <https://jira.mongodb.org/browse/SERVER-3546> (track I/O)
- Plans
 - Only explain() shows the full plan(s)



Profiler Analysis - FCS

```
$>db.system.profile.find({"op":"query","ns":"test.testme"}).pretty();
{
  "ts" : ISODate("2013-02-11T19:53:16.302Z"),
  "op" : "query",
  "ns" : "test.testme",
  "query" : { "name" : 1 },
  "ntoreturn" : 0,
  "ntoskip" : 0,
  "nscanned" : 32001,           // why scanning so many?
  "keyUpdates" : 0,
  "numYield" : 0,
  "lockStats" : {...},
  "nreturned" : 1,             // just to return 1
  "responseLength" : 56,
  "millis" : 29,               // slow!
  "client" : "127.0.0.1",
  "user" : ""
}
```



Profiler Analysis - FCS

```
$> db.testme.find({ "name": 1 }).explain()
{
  "cursor" : "BasicCursor",
  "isMultiKey" : false,
  "n" : 1,
  "nscannedObjects" : 32001,
  "nscanned" : 32001,
  "nscannedObjectsAllPlans" : 32001,
  "nscannedAllPlans" : 32001,
  "scanAndOrder" : false,
  "indexOnly" : false,
  "nYields" : 0,
  "nChunkSkips" : 0,
  "millis" : 14,
  "indexBounds" : {
    ...
  },
  ...
}
```

// Basic

// WTF!



Profiler Analysis - FCS

```
$> db.testme.ensureIndex({"name":-1});
$> db.testme.find({"name":1}).explain()
{
  "cursor" : "BtreeCursor name_-1",           // Btree
  "isMultiKey" : false,
  "n" : 1,
  "nscannedObjects" : 1,
  "nscanned" : 1,
  "nscannedObjectsAllPlans" : 1,
  "nscannedAllPlans" : 1,
  "scanAndOrder" : false,
  "indexOnly" : false,
  "nYields" : 0,
  "nChunkSkips" : 0,
  "millis" : 0,
  "indexBounds" : {
    "name" : [
      [
        1,           // w00t!
        1
      ]
    ]
  },
  ...
}
```



Profiler Analysis - FCS

```
$>db.system.profile.find({"op":"query","ns":"test.testme"}).pretty();
{
  "ts" : ISODate("2013-02-11T20:00:52.015Z"),
  "op" : "query",
  "ns" : "test.testme",
  "query" : { "name" : 1 },
  "ntoreturn" : 0,
  "ntoskip" : 0,
  "nscanned" : 1,
  "keyUpdates" : 0,
  "numYield" : 0,
  "lockStats" : {...},
  "nreturned" : 1,
  "responseLength" : 56,
  "millis" : 1,
  "client" : "127.0.0.1",
  "user" : ""
}
```

// w00t!

// /me gets a raise



Profiler Analysis - Moved

```
$> db.system.profile.find({"op":"update"}).pretty();
{
  "ts" : ISODate("2013-02-11T20:50:36.882Z"),
  "op" : "update",
  "ns" : "test.testme",
  "query" : {
    "name" : 1
  },
  "updateobj" : { "$set" : { "desc" : <somelargevalue> } },
  "nscanned" : 1,
  "moved" : true,
  "nmoved" : 1,
  "nupdated" : 1,
  ...
  "millis" : 22,
}
```



Profiler Analysis - helpful queries

// last few entries

show profile

// sort by natural order (time in)

db.system.profile.find({}).sort({\$natural:-1})

// anything > 20ms

db.system.profile.find({"millis":{\$gt:20}})

// single coll order by response time

db.system.profile.find({"ns":"test.foo"}).sort({"millis":-1})

// anything thats moved

db.system.profile.find({"moved":true})

// large scans

db.system.profile.find({"nscanned":{\$gt:10000}})

// anything doing range or full scans

db.system.profile.find({"nreturned":{\$gt:1}})

example: <https://gist.github.com/kgorman/c5774670feb7436f4d69>



Going Deeper with Profiler Analytics

- In prod environment profiler has lots of data
- Prioritize tuning opportunities
- Prioritize performance issues
- Aggregation, summarization required
 - Enter Aggregation Framework
 - <http://docs.mongodb.org/manual/core/aggregation/>



Aggregation Framework - Example

```
> db.system.profile.aggregate(  
  { $group :  
    { _id : "$op",  
      count:{$sum:1},  
      "max response time":{$max:"$millis"},  
      "avg response time":{$avg:"$millis"}  
    }  
  });  
  
{  
  "result" : [  
    { "_id" : "command", "count" : 1, "max response time" : 0, "avg response time" : 0 },  
    { "_id" : "query", "count" : 12, "max response time" : 571, "avg response time" : 5 },  
    { "_id" : "update", "count" : 842, "max response time" : 111, "avg response time" : 40 },  
    { "_id" : "insert", "count" : 1633, "max response time" : 2, "avg response time" : 1 }  
  ],  
  "ok" : 1  
}  
  
// focus on updates first, then queries, then inserts
```



Aggregation Framework - Example

```
// response time by operation type
db.system.profile.aggregate(
{ $group : {
  _id : "$op",
  count:{$sum:1},
  "max response time":{$max:"$millis"},
  "avg response time":{$avg:"$millis"}
}});
```

```
// slowest by namespace
db.system.profile.aggregate(
{ $group : {
  _id : "$ns",
  count:{$sum:1},
  "max response time":{$max:"$millis"},
  "avg response time":{$avg:"$millis"}
}},
{$sort: {
  "max response time":-1}
});
```

```
// slowest by client
db.system.profile.aggregate(
{$group : {
  _id : "$client",
  count:{$sum:1},
  "max response time":{$max:"$millis"},
  "avg response time":{$avg:"$millis"}
}},
{$sort: {
  "max response time":-1}
});
```

```
// summary moved vs non-moved
db.system.profile.aggregate(
{ $group : {
  _id : "$moved",
  count:{$sum:1},
  "max response time":{$max:"$millis"},
  "avg response time":{$avg:"$millis"}
}});
```

example: <https://gist.github.com/kgorman/995a3aa5b35e92e5ab57>



Response time analysis

- Response time analysis techniques come from Oracle community circa 2000-2004.
- Response time = service time + queue time (`time_to_complete` + `time_waiting_in_queue`)
- Each document in profile collection a couple response time attributes.
 - `millis`
 - `timeAcquiring`
 - `timeLocked`
- The only true measure of response time in MongoDB
- Aids in prioritization of tuning opportunities. Finding the bang for the buck, or the immediate performance problem.



Definitions:

`system.profile.lockStats.timeLockedMicros`

The time in microseconds the operation held a specific lock. For operations that require more than one lock, like those that lock the `localdatabase` to update the *oplog*, then this value may be longer than the total length of the operation (i.e. `millis`.)

`system.profile.lockStats.timeAcquiringMicros`

The time in microseconds the operation spent waiting to acquire a specific lock.

`system.profile.millis`

The time in milliseconds for the server to perform the operation. This time does not include network time nor time to acquire the lock.



Response time analysis

```
$>db.system.profile.aggregate(  
  [  
    { $project : {  
      "op" : "$op",  
      "millis" : "$millis",  
      "timeAcquiringMicrosrMS" : { $divide : [ "$lockStats.timeAcquiringMicros.r", 1000 ] },  
      "timeAcquiringMicroswMS" : { $divide : [ "$lockStats.timeAcquiringMicros.w", 1000 ] },  
      "timeLockedMicrosrMS" : { $divide : [ "$lockStats.timeLockedMicros.r", 1000 ] },  
      "timeLockedMicroswMS" : { $divide : [ "$lockStats.timeLockedMicros.w", 1000 ] } }  
    },  
    { $project : {  
      "op" : "$op",  
      "millis" : "$millis",  
      "total_time" : { $add : [ "$millis", "$timeAcquiringMicrosrMS", "$timeAcquiringMicroswMS" ]  
  
      "timeAcquiringMicrosrMS" : "$timeAcquiringMicrosrMS",  
      "timeAcquiringMicroswMS" : "$timeAcquiringMicroswMS",  
      "timeLockedMicrosrMS" : "$timeLockedMicrosrMS",  
      "timeLockedMicroswMS" : "$timeLockedMicroswMS" }  
    },  
    { $group : {  
      _id : "$op",  
      "average response time" : { $avg : "$millis" },  
      "average response time + acquire time" : { $avg : "$total_time" },  
      "average acquire time reads" : { $avg : "$timeAcquiringMicrosrMS" },  
      "average acquire time writes" : { $avg : "$timeAcquiringMicroswMS" },  
      "average lock time reads" : { $avg : "$timeLockedMicrosrMS" },  
      "average lock time writes" : { $avg : "$timeLockedMicroswMS" } }  
    }  
  ]  
)
```

https://gist.github.com/kgorman/92e66e2a0b8cc3686fa4#file-aggregation_response_time.js



Response time analysis

```
{
  "_id" : "insert",
  "average response time" : 0.07363770250368189,           // time executing
  "average acquire time reads" : 0,
  "average acquire time writes" : 5.623796023564078,       // time waiting
  "average lock time reads" : 0,
  "average lock time writes" : 0.25491826215022123         // time in lock.. woah.
}

{
  "_id" : "update",
  "average response time" : 0.23551171393341552,           // time executing.. moves?
  "average acquire time reads" : 0,
  "average acquire time writes" : 10.261996300863133,       // lots of waiting
  "average lock time reads" : 0,
  "average lock time writes" : 0.3795672009864362           // time in lock.. again!
}
```



Why is this useful?

- Detailed analysis of where the time goes
- Deep understanding of locking overhead
- Exposure to concurrency internals
- See potential problem before you are dead

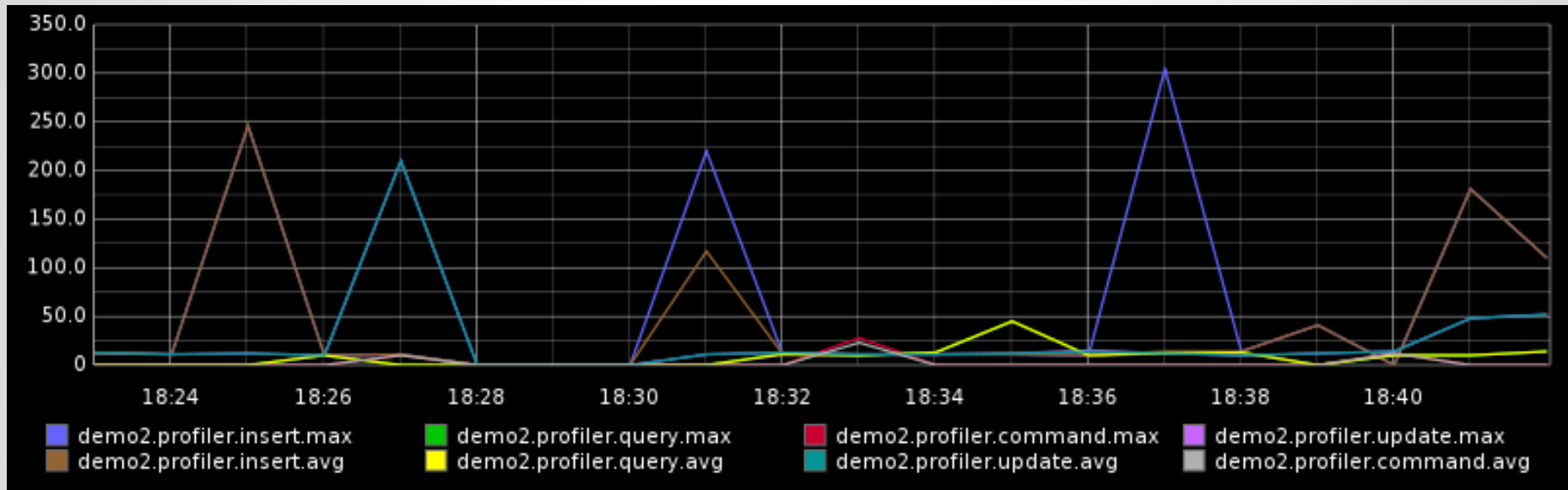


Profiler and time-series

- Turn on profiling
- Pull delta response time data from db.system.profile in aggregate in a loop
- Push to your favorite graphing/time-series program
- <https://github.com/kgorman/slum>



Profiler and time-series



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