SOPHIA: Online Reconfiguration of Clustered NoSQL Databases for Time-Varying Workloads

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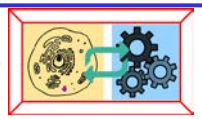

Wednesday "Big-Data Programming Models & Frameworks" 2:20 pm

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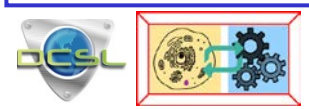
Why Do Online Tuning of NoSQL Databases?

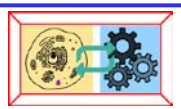
- Database Management Systems (DBMS) have a plethora of performance-related parameters
- The exact setting of these parameters determines the DBMS performance
- The optimal setting is specific to the application
- Application characteristics change over time and a desirable configuration may become sub-optimal

Our Target: Clustered NoSQL Databases (Examples: Cassandra, Redis, MongoDB, ScyllaDB)



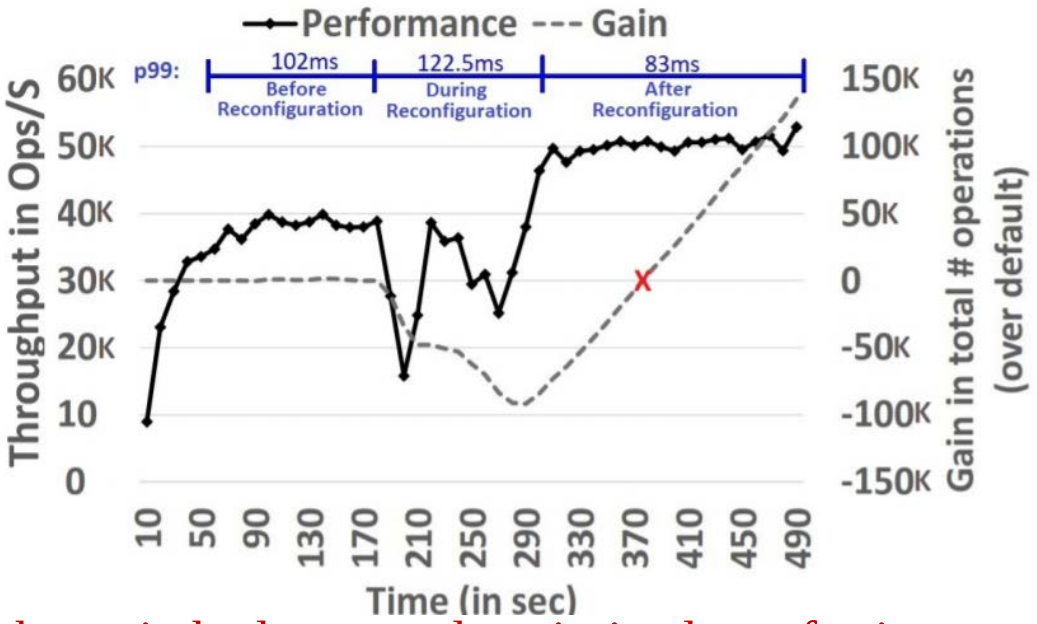
Challenges of Online Tuning

1. Large configuration parameter search space.
   - Complex interdependencies exist among the parameters
2. A new workload pattern does not necessarily mean switch to new configuration
   - Performance degradation during reconfiguration process
   - New workload pattern may be shortlived
3. Data availability must be maintained during reconfiguration
   - Many parameters need server restart
   - Staggered restart of servers needed through a distributed protocol to meet availability *and* consistency requirements

Look Before You ~~Leap~~ Change

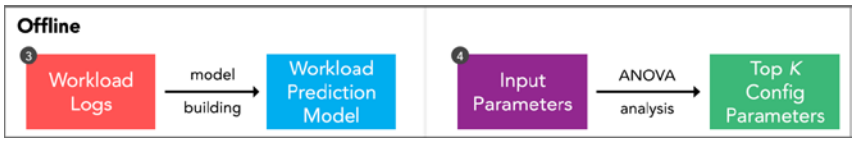
Cassandra DBMS, MG-RAST production trace
 # servers = 2,
Replication Factor (RF) = 2
Consistency Level (CL) = 1

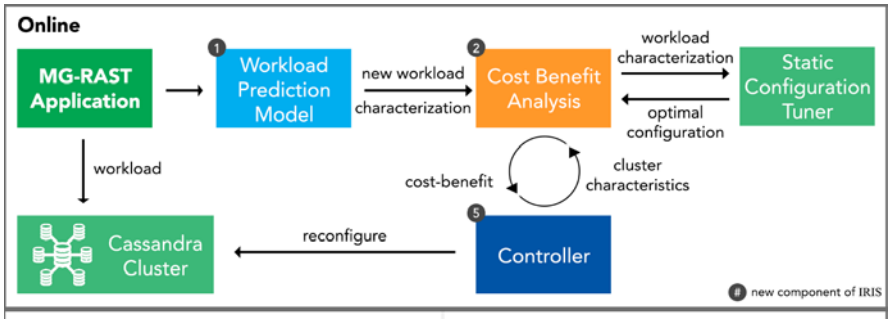


- The default configuration can be switched to a read-optimized one for increase in throughput (40Kops/s → 50Kops/s)
- Temporary throughput loss due to transient unavailability of server instances as they undergo reconfiguration, one instance at a time
- The dashed line gives the gain over time in terms of the total # operations served relative to the default configuration
  - There is a cross-over point such that if the new workload pattern lasts greater than this threshold then it is worthwhile reconfiguring

Technical Contributions: SOPHIA

1. We show that today's state-of-the-art static tuners ***degrade*** throughput below the default configuration and degrade data availability
2. SOPHIA performs cost-benefit analysis to achieve long-horizon optimized performance for clustered NoSQL DBMS in the face of dynamic workload changes
3. SOPHIA executes a distributed protocol to gracefully switch over the cluster to the new configuration while meeting data consistency and availability guarantees





Evaluation

- We implement and evaluate SOPHIA on two NoSQL databases, Cassandra and Redis

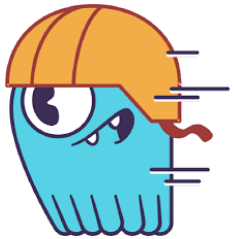
- We use three application traces:

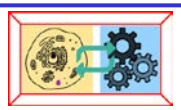
1. MG-RAST: largest metagenomics portal hosted at Argonne

2. Bus-tracking application trace, and

3. Data analytics jobs as would be submitted to an HPC cluster

- We show improvements over
  1. Default configuration
  2. Static optimized
  3. Naïve reconfiguration
  4. Commercial auto-tuning NoSQL database (ScyllaDB)





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Talk and Poster Info

Track: “Big-Data Programming Models & Frameworks”, July 10th (Wednesday), 2:20-3:40 pm, Track II

Poster Session: July 10th (Wednesday), 6:00-7:30 pm