DSAIL Overview

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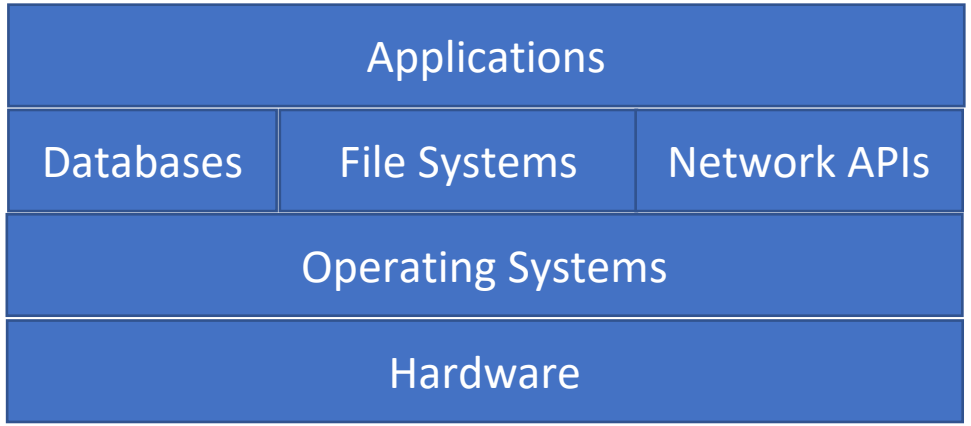
DSAIL

Data Systems and AI Lab

Amazon Science Hub Symposium, Dec 7 2022

Computer Systems is About Reusable Abstractions



Building A System From Scratch For Every Use Case Is Not Economical

Trends:

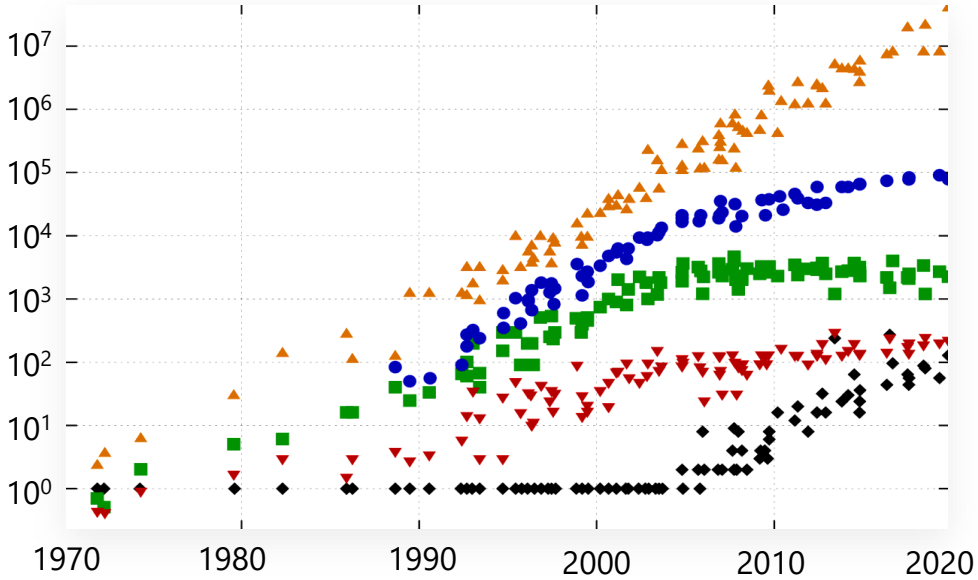
End of Moore's law

Explosion of data

Heterogeneity

Demanding applications

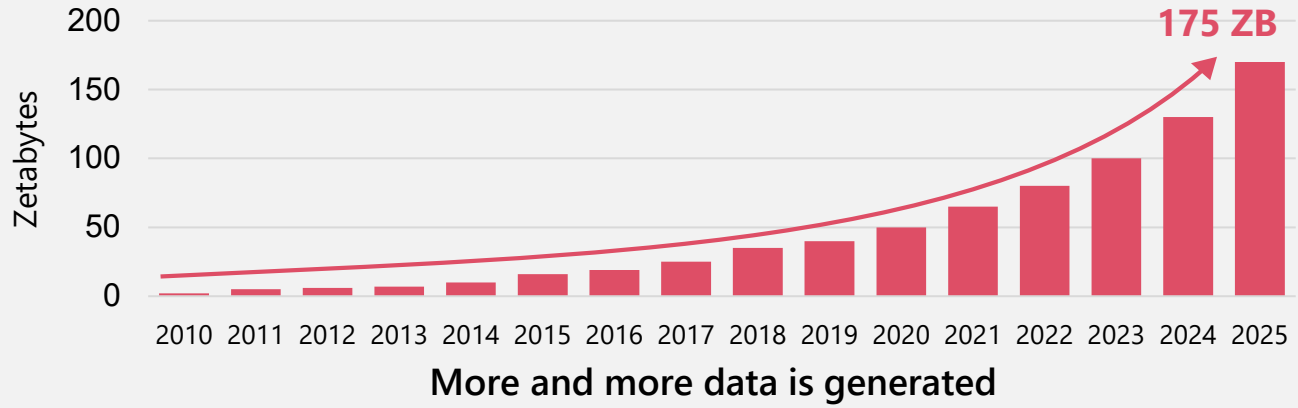
48 Years of Microprocessor Trend Data



IDC's Global DataSphere Forecast

https://github.com/karlrupp/microprocessor-trend-data

Annual Size of the Global Datasphere



IDC's Global DataSphere Forecast

Specialization Can Lead to Better Performance

Databases

Transactional DB
(e.g., H-Store)

Analytics DB
(e.g., Snowflake)

Streaming DB
(e.g., Streambase)

Networks

Data Centers

Internet

Cellular

"One size does not fit all"

But each specialized system requires years to develop, only addresses some of the use cases

ML To The Rescue?

"Instance Optimization"

Instance-optimized System

- System self-adjusts to a given operating conditions
- **Goal:** Get as close as possible to the performance of a system built from scratch for a single use case

Learned components

- Self-adjust to the given data and workload
- Beyond what a human can do
- Components are designed to be adjustable and might deeply embed learning
- Examples: Learned indexes, Learned scheduling, Learned video compression…

Example:

e.g., Learned Indexes for a disk-based K/V Store

Google Bigtable

Self-tuning (Industry Today)

- Automatically tune parameters
- E.g., advisor selects configurations, materialized views, sort/partition keys

Microsoft SQL Server

amazon REDSHIFT

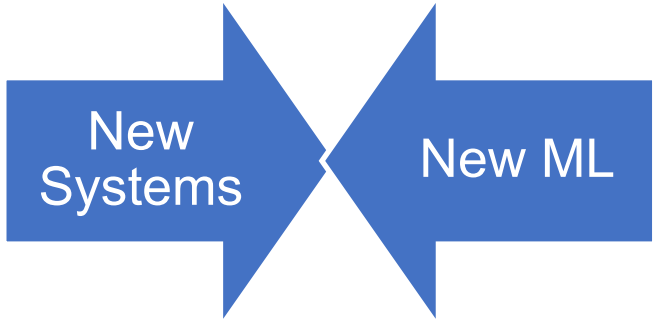
Automatic tuning

09/28/2020 • 12 minutes to read • +13

Applies to: SQL Server 2017 (14.x) and later, Azure SQL Database

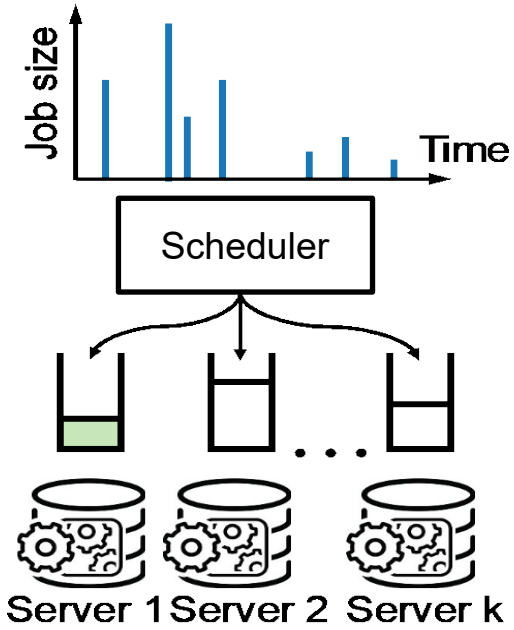
Amazon Redshift announces Automatic Table Optimization

Posted On: Dec 9, 2020



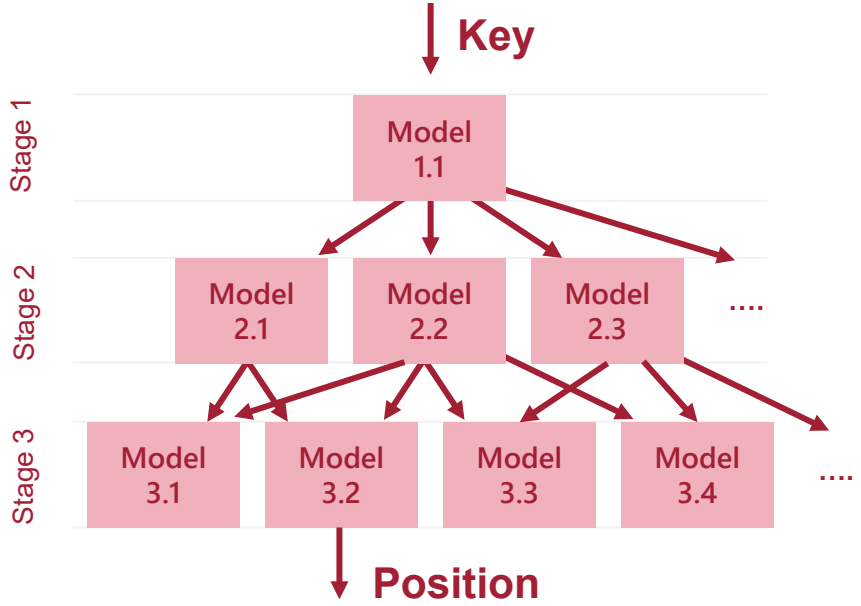
Cluster Scheduling

RL algorithms for stochastic systems



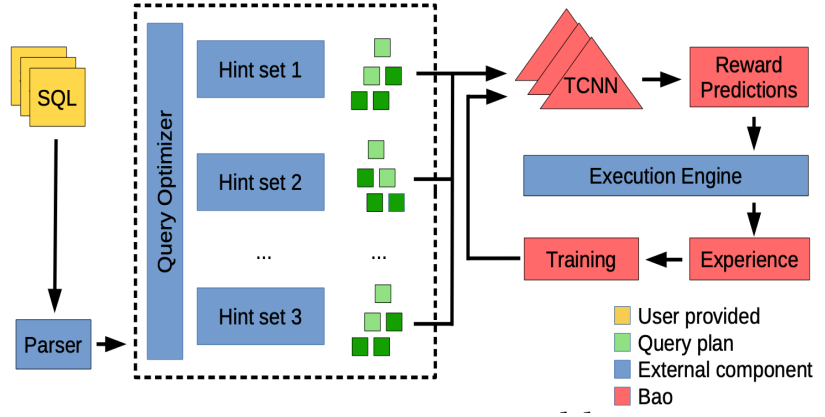
Learned Indexes

Small, cache-efficient models (recursive model index)



DB Query Planning

Steer, don't replace!



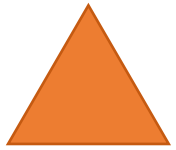
DSAIL

Data Systems and AI Lab

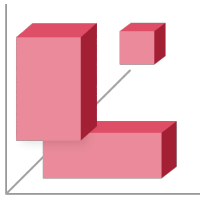
- Using ML algorithms to enhance data systems through “instance optimization”
- Developing new ML algorithms for “instance optimized” data systems

DSAIL: Instance-Optimizing a Range of Systems

Indexes



Multi-Dim Indexes



SQL Query Optimizer

Bloom-Filter

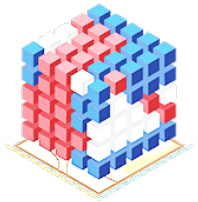
Range-Filter

Sorting

Hash-Map

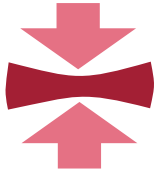
DNA-Search

(Partial) Materialization



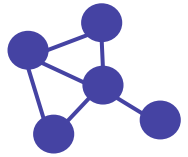
Join

Compression

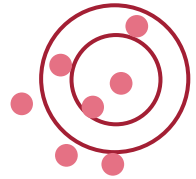


Caching

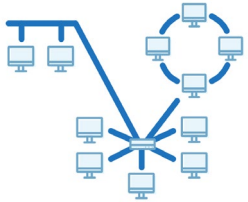
Scheduling



Sketches



Topology Design



Placement

Traffic Engineering

Congestion Control

Capacity Planning

Compiler

... and more