Learning to Drive Software-Defined Storage

Jian Huang Daixuan Li **Jinghan Sun**

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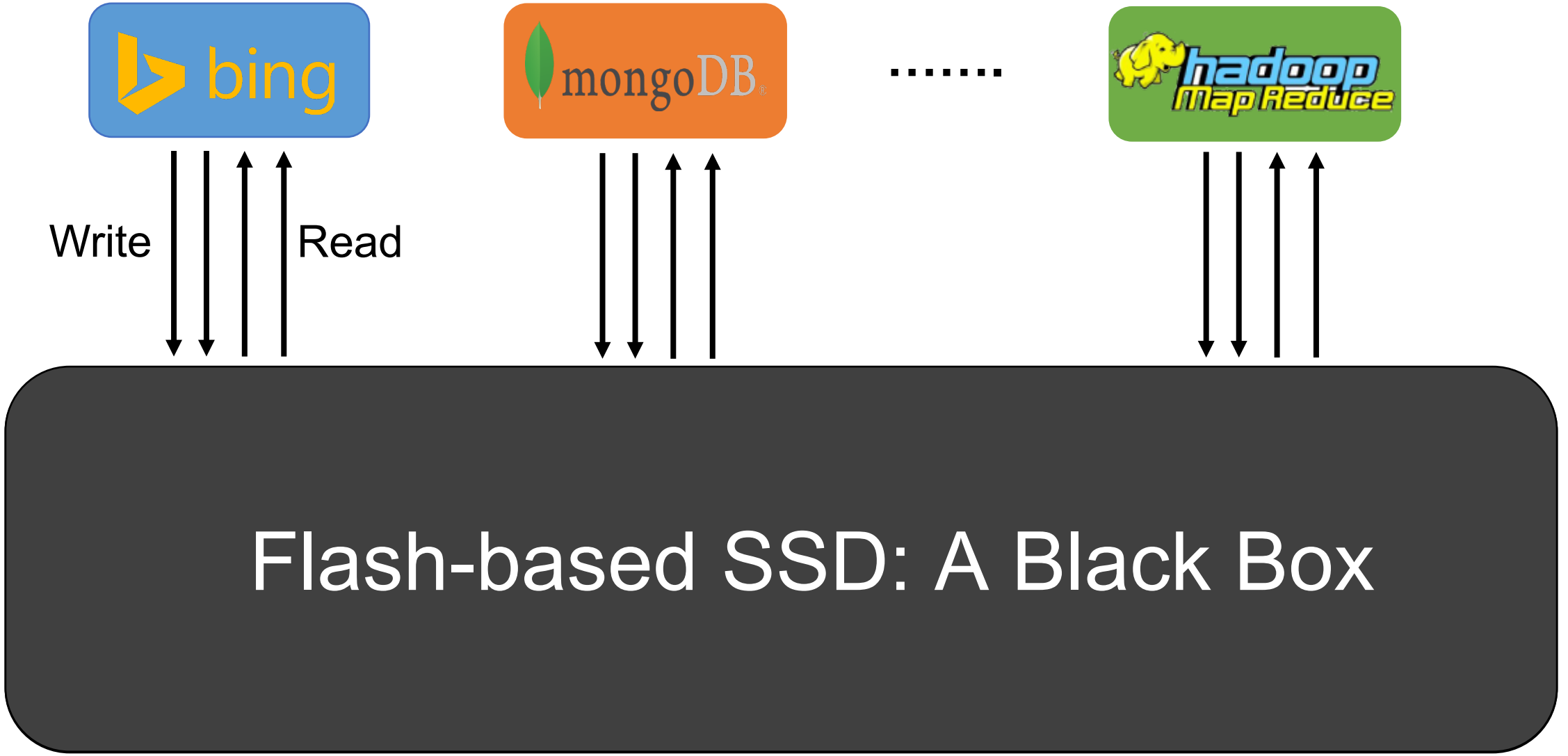
What is Software-Defined Storage?



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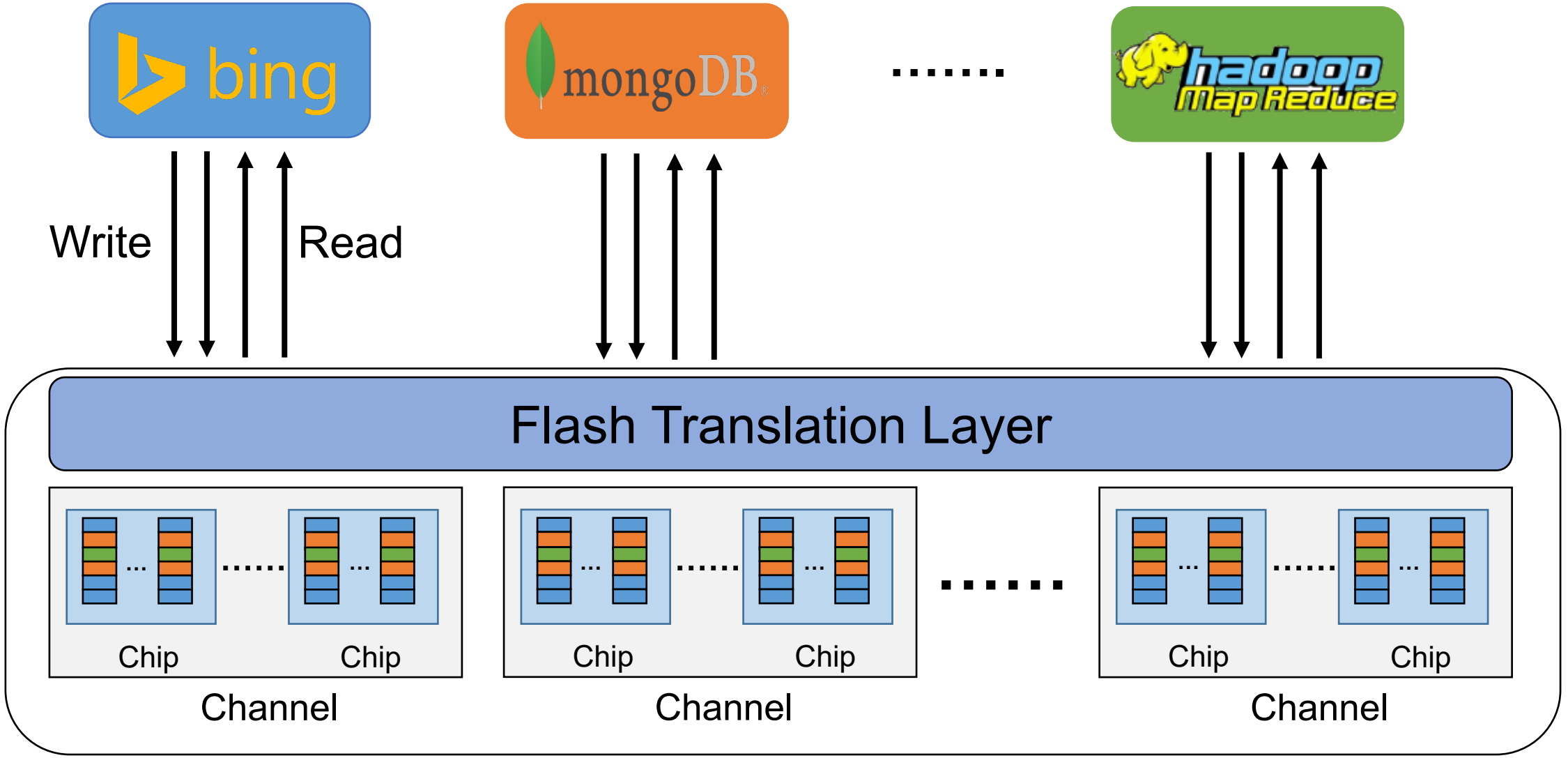

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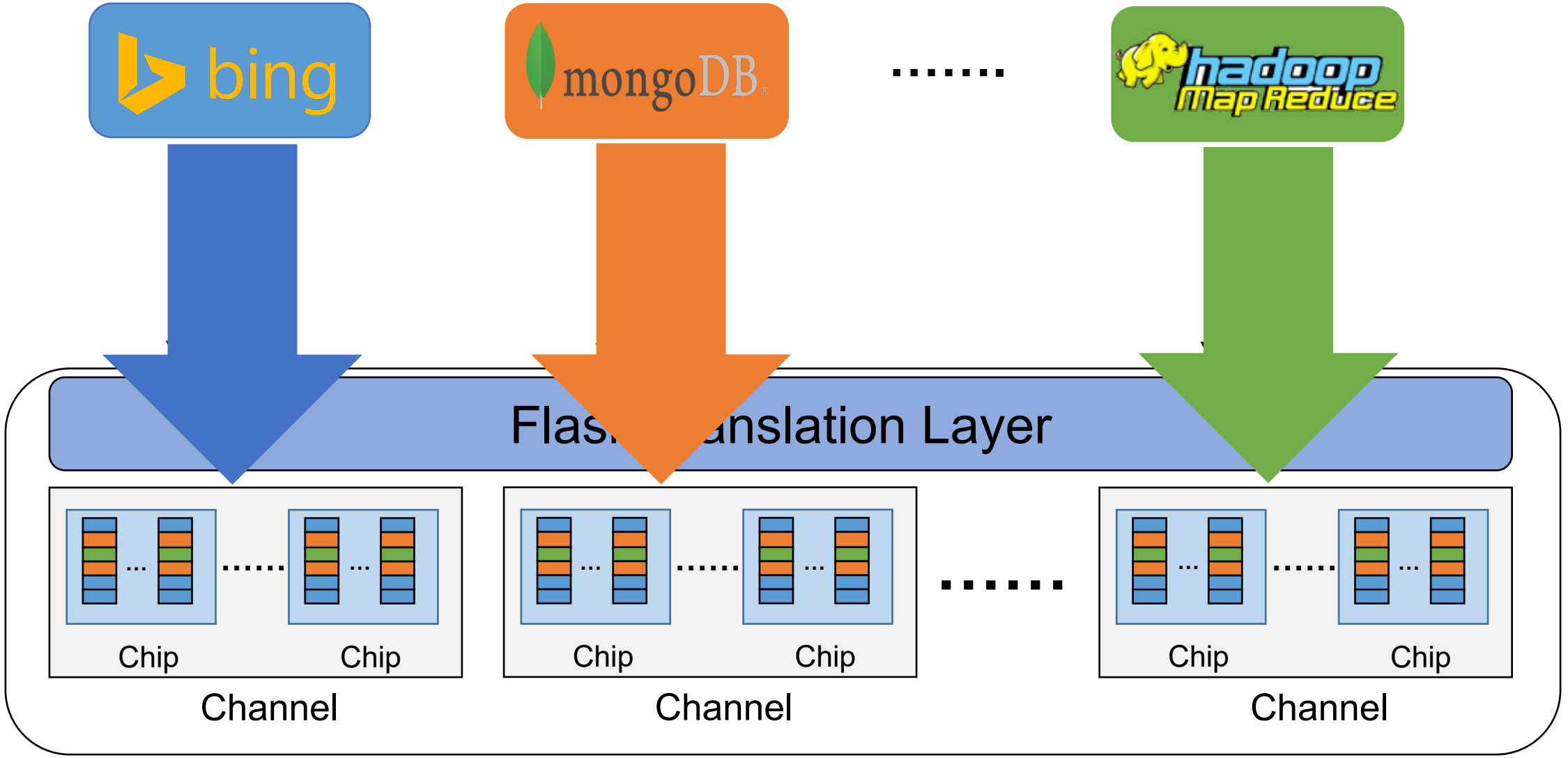


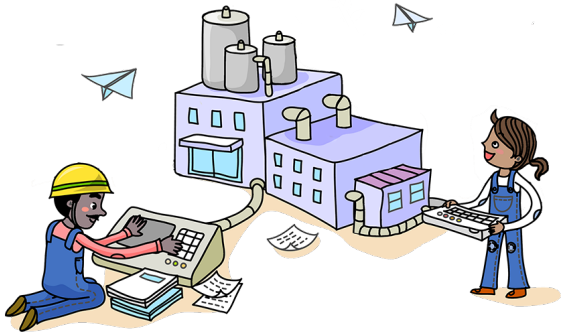
Benefits of Software-Defined Storage

Predictable Performance

+

Improved Storage Utilization

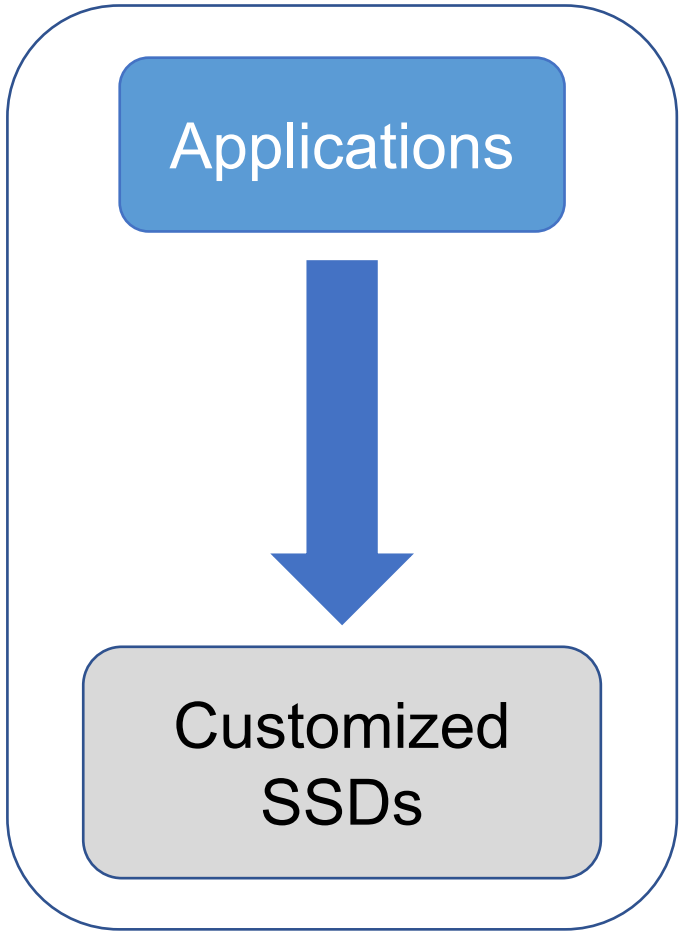
+



Mature Manufacturing Technologies

Software-Defined SSDs

Challenges of Building Software-Defined Storage



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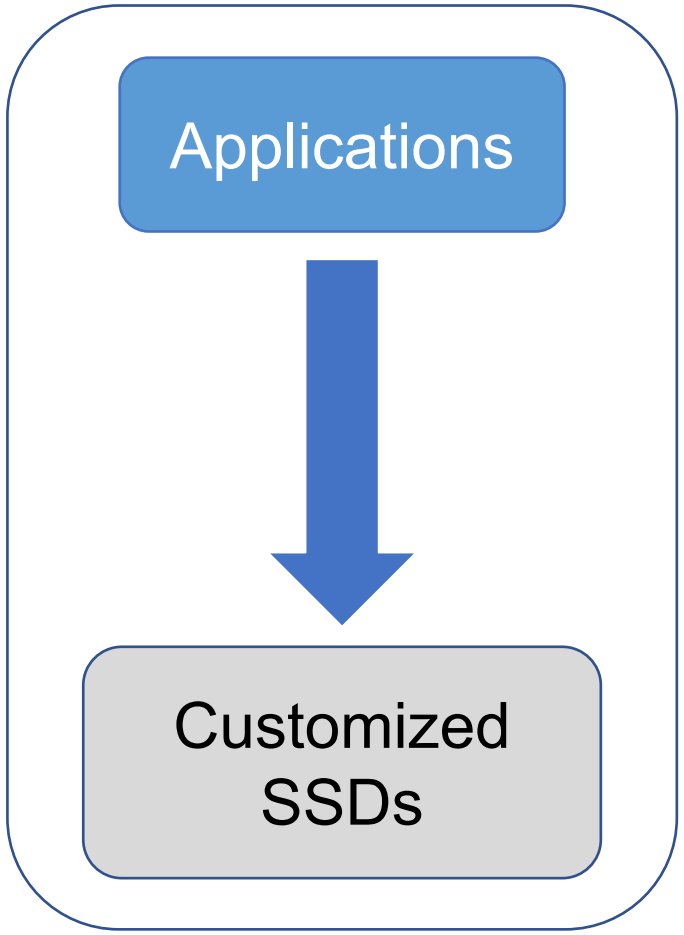
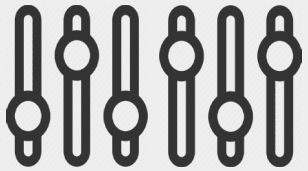
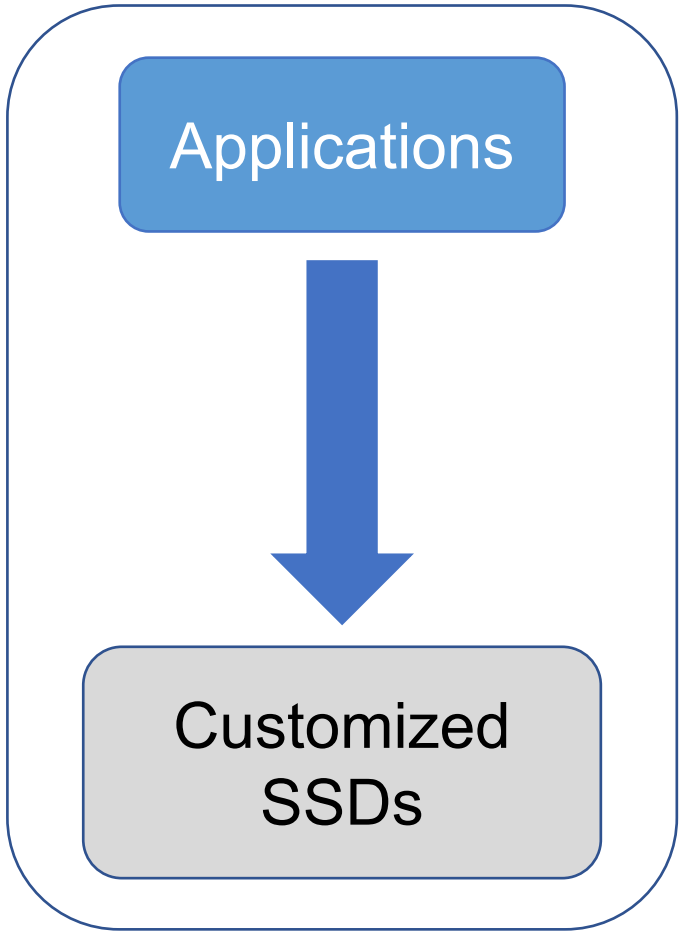
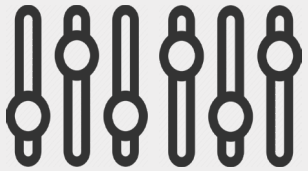




A large set of device parameters to tune

Challenges of Building Software-Defined Storage





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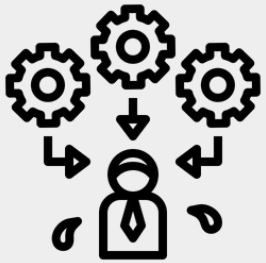
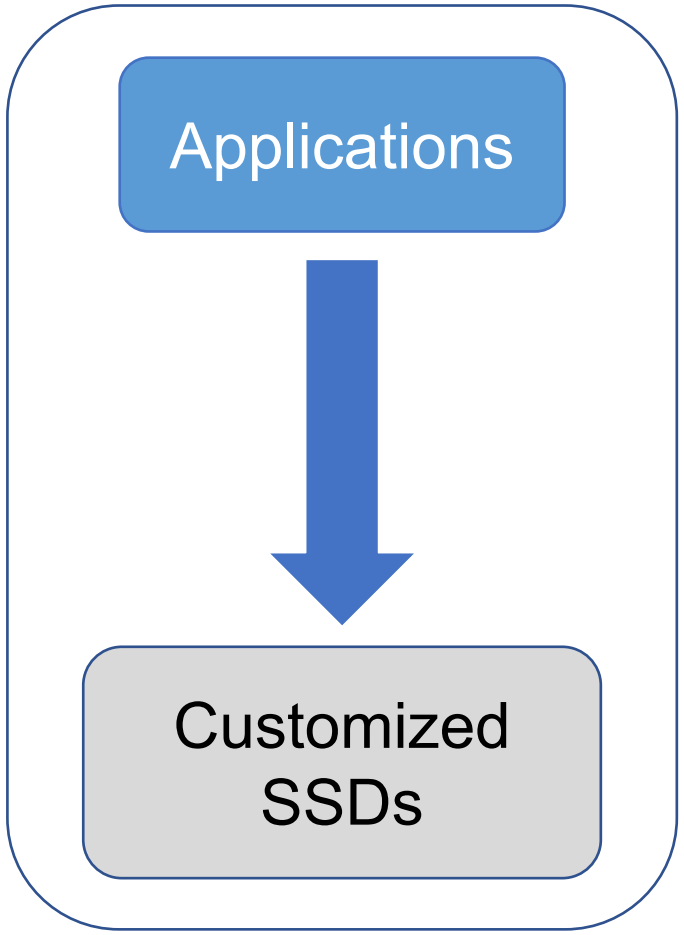
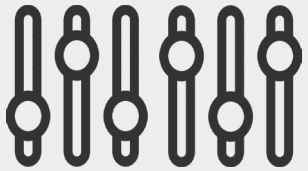


Hard to manually identify optimized device parameters for different applications

Challenges of Building Software-Defined Storage





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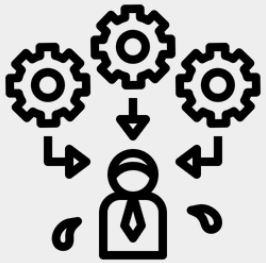

Hard to manually identify optimized device parameters for different applications

Traditional testing method has a very long tuning time

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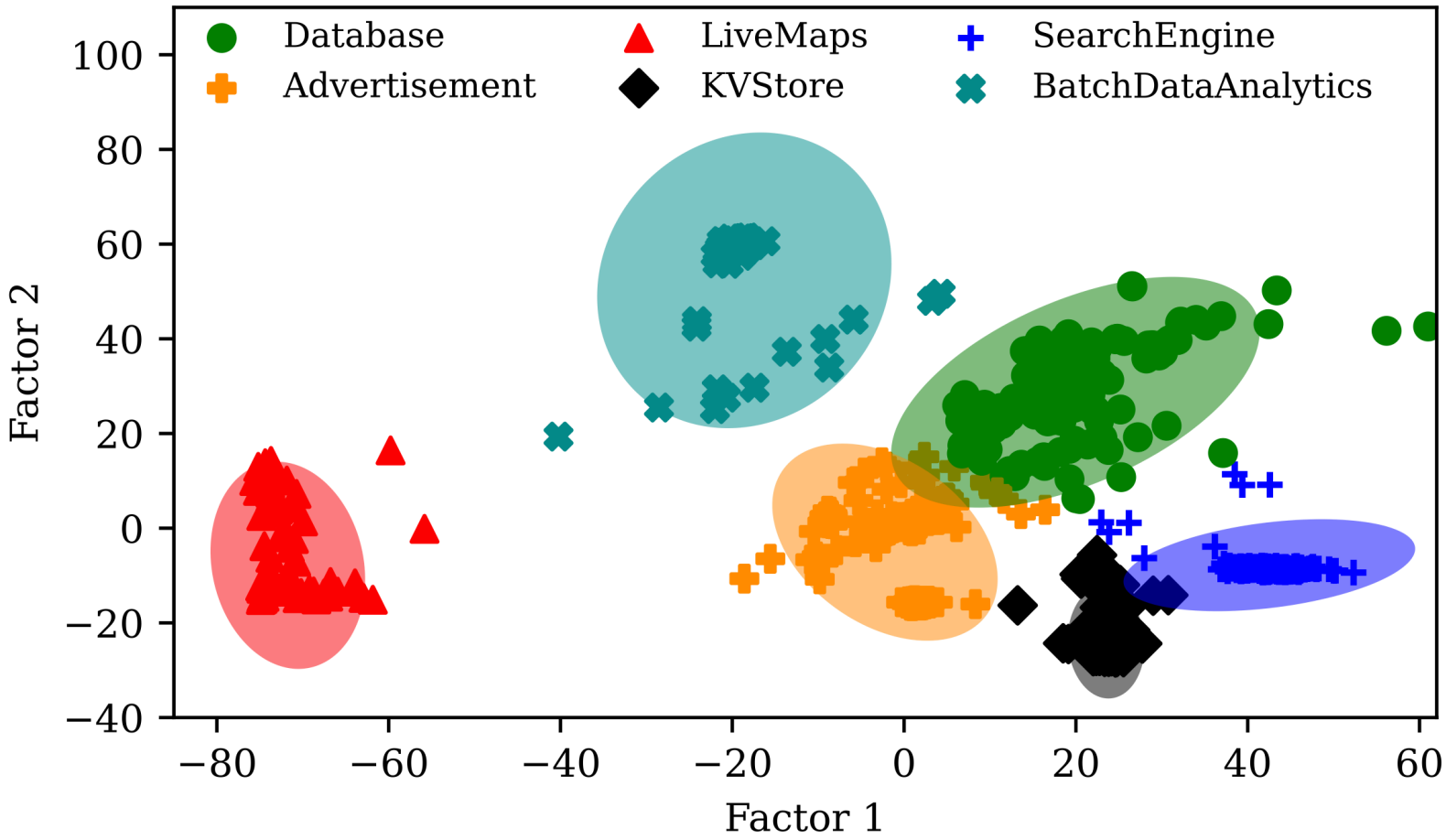

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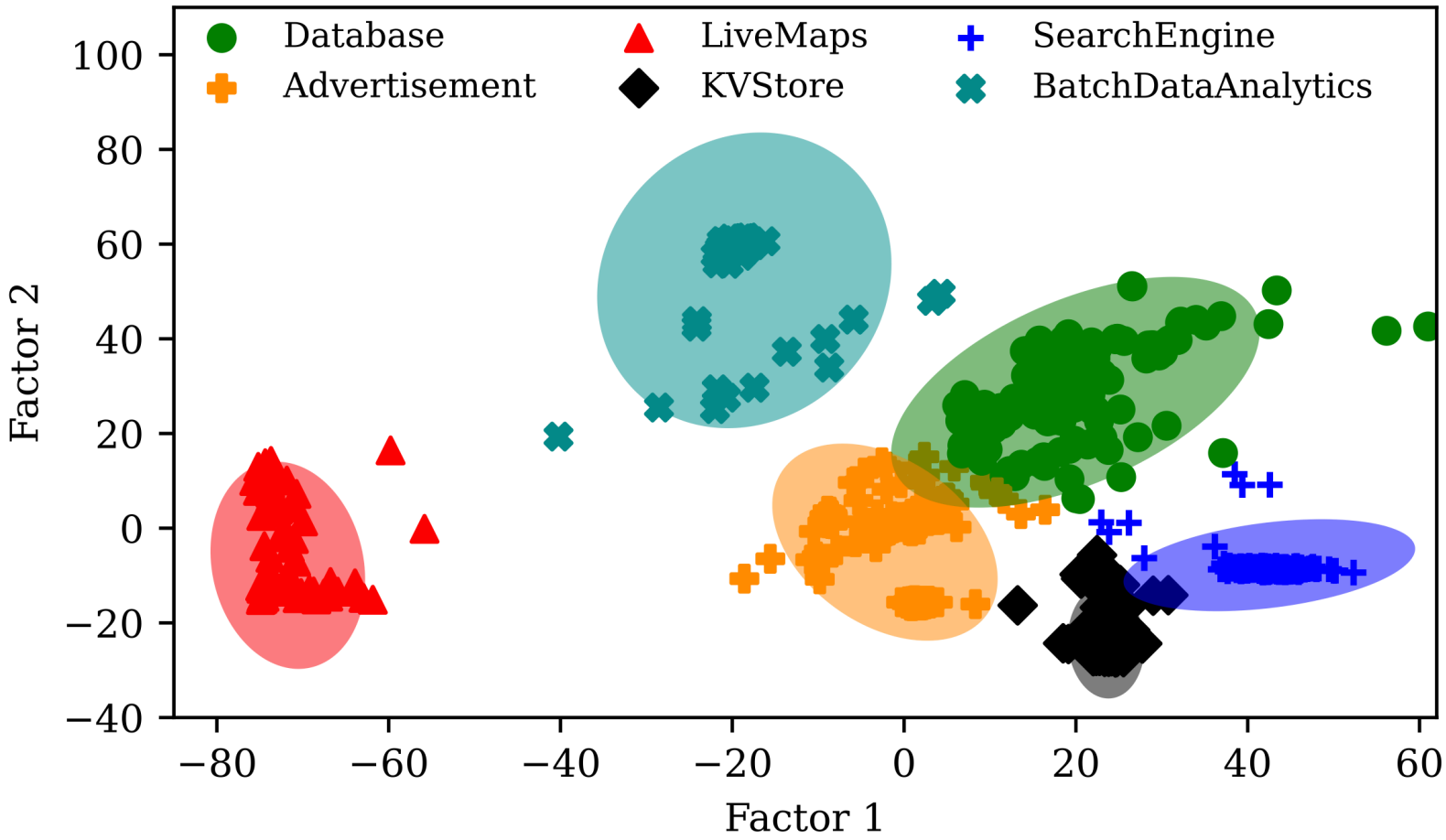

The learning-based apporach to developing software-defined storage is promising

The Workflow of Learning Optimized SSD Configurations

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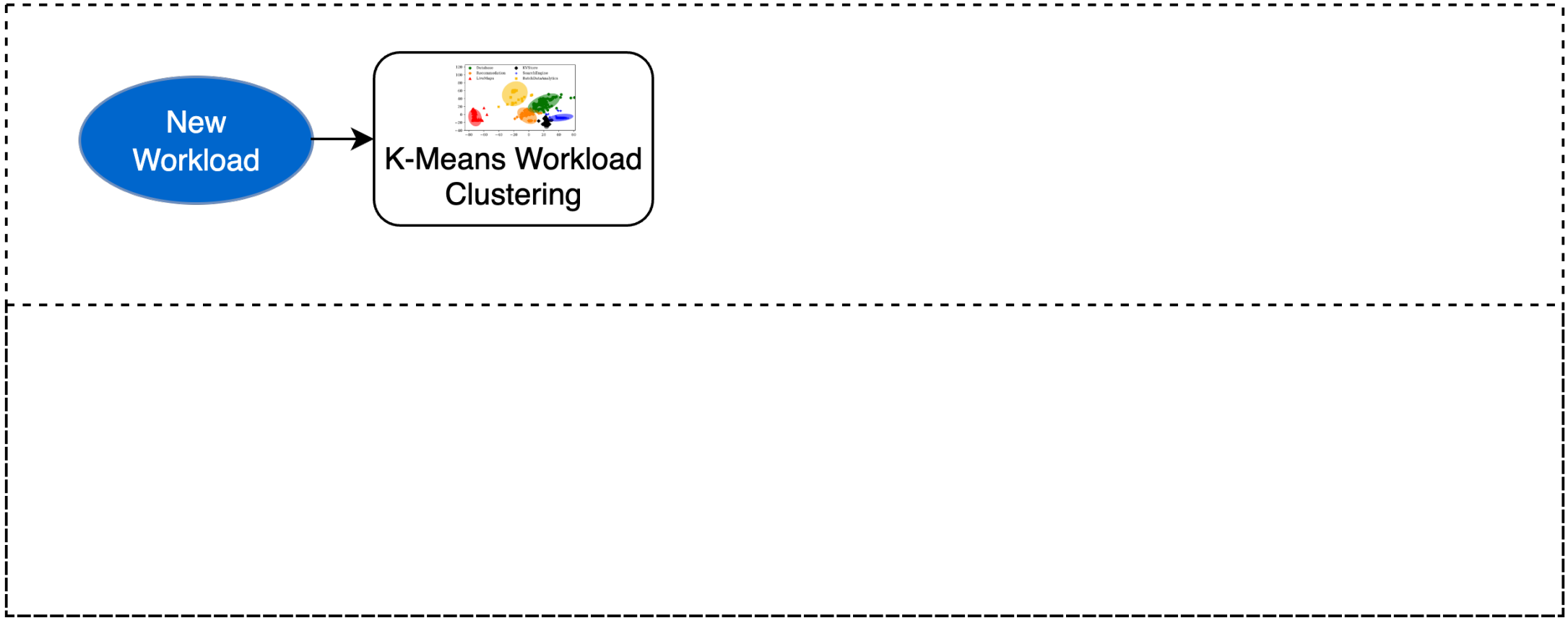

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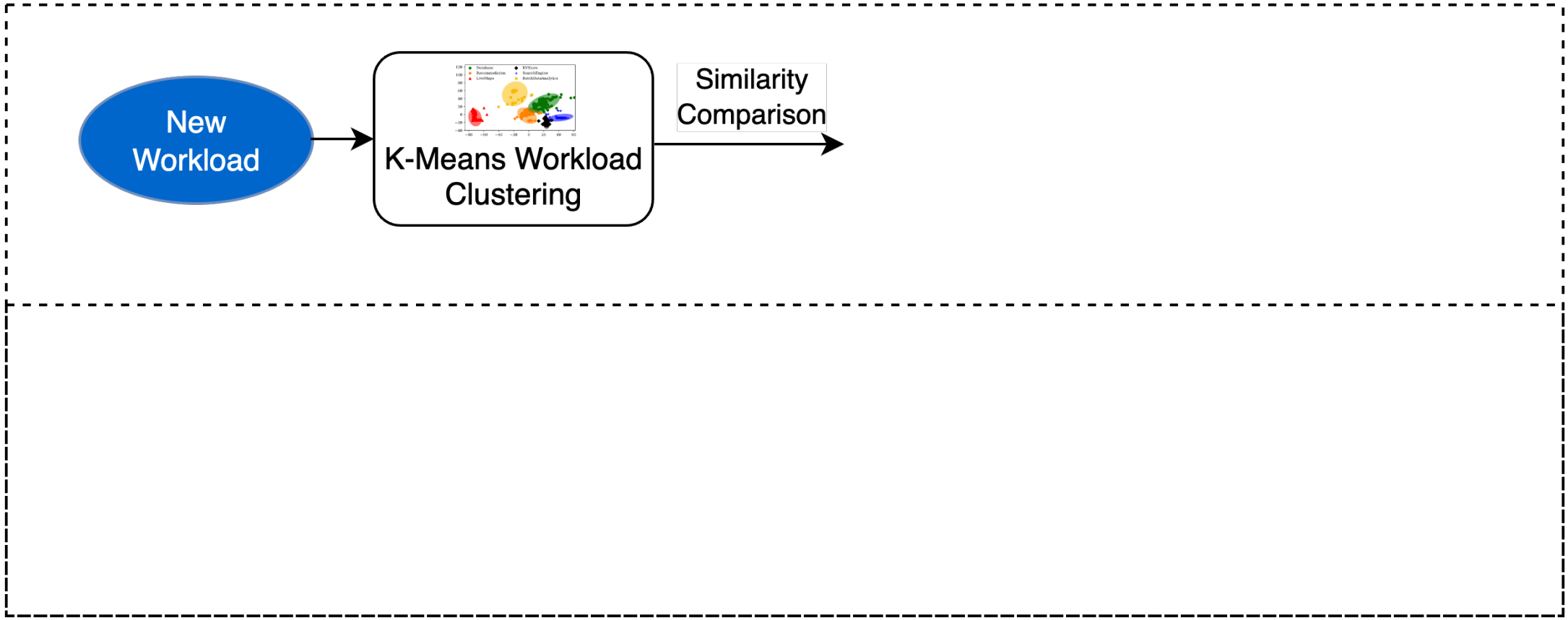

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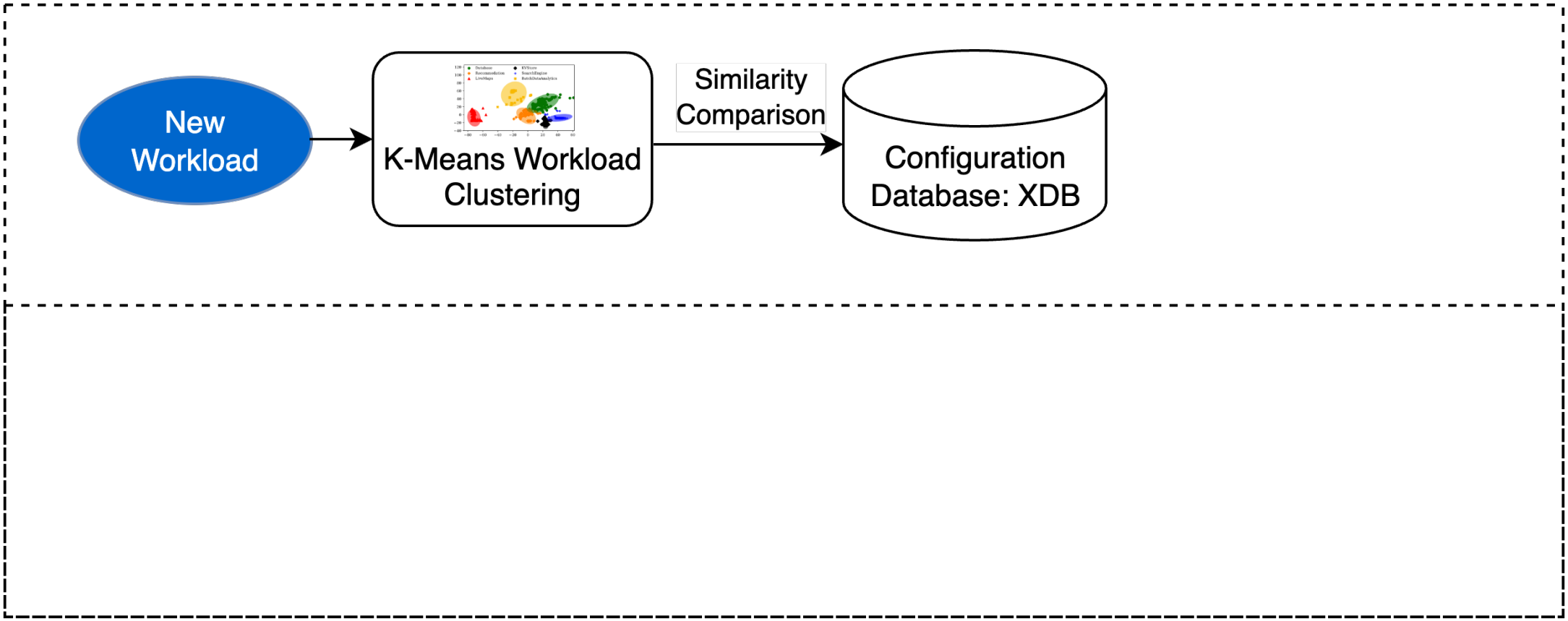

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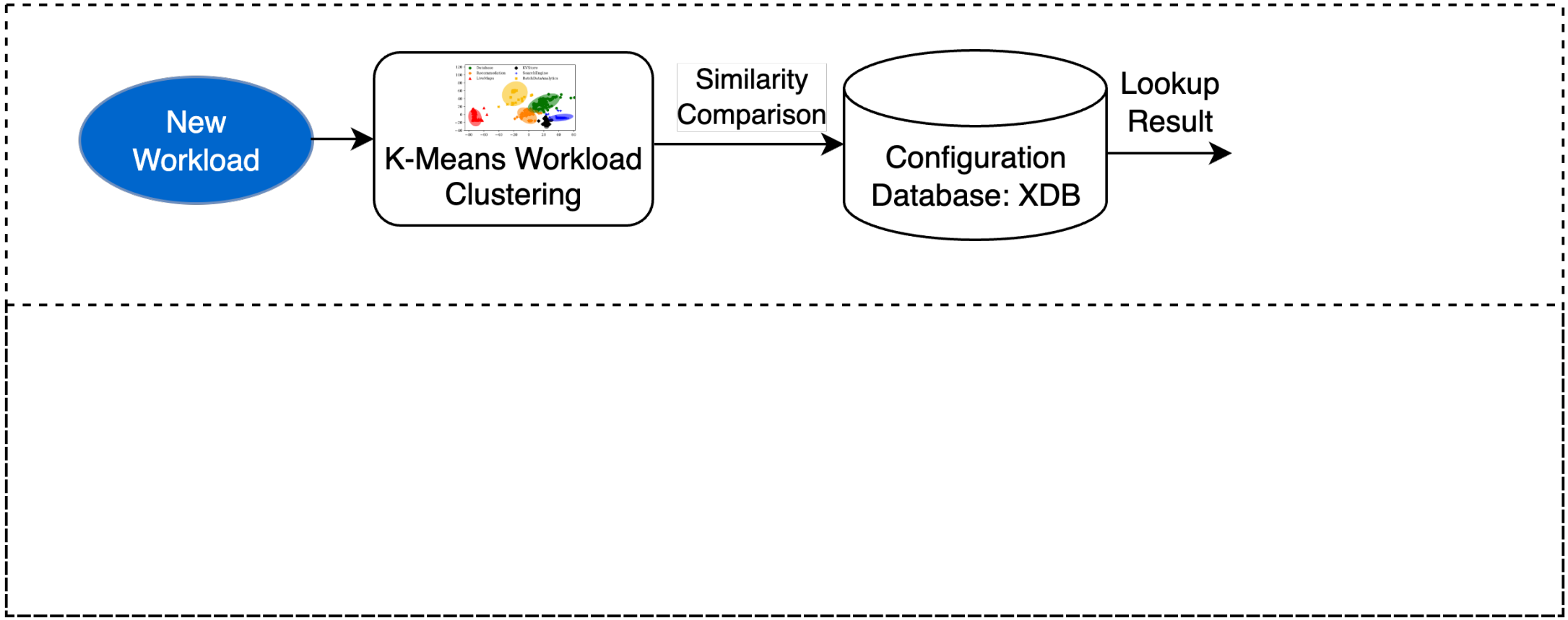

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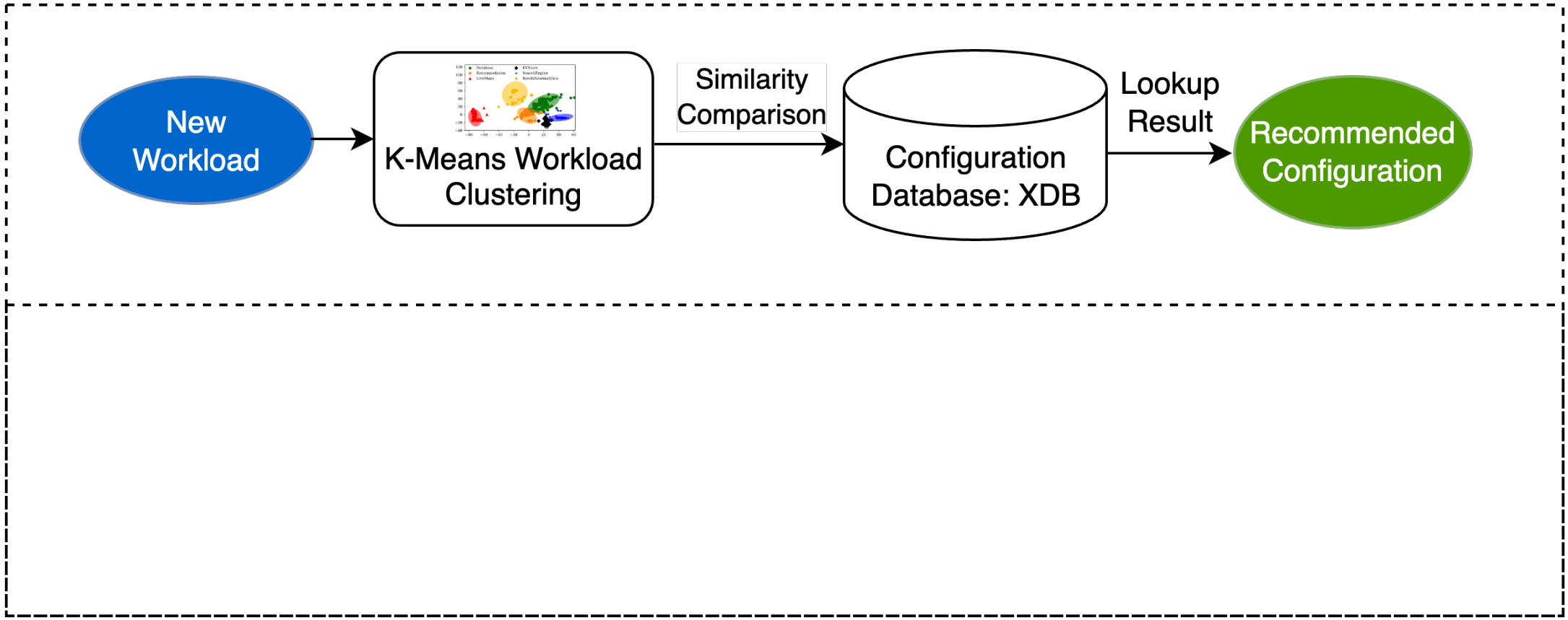

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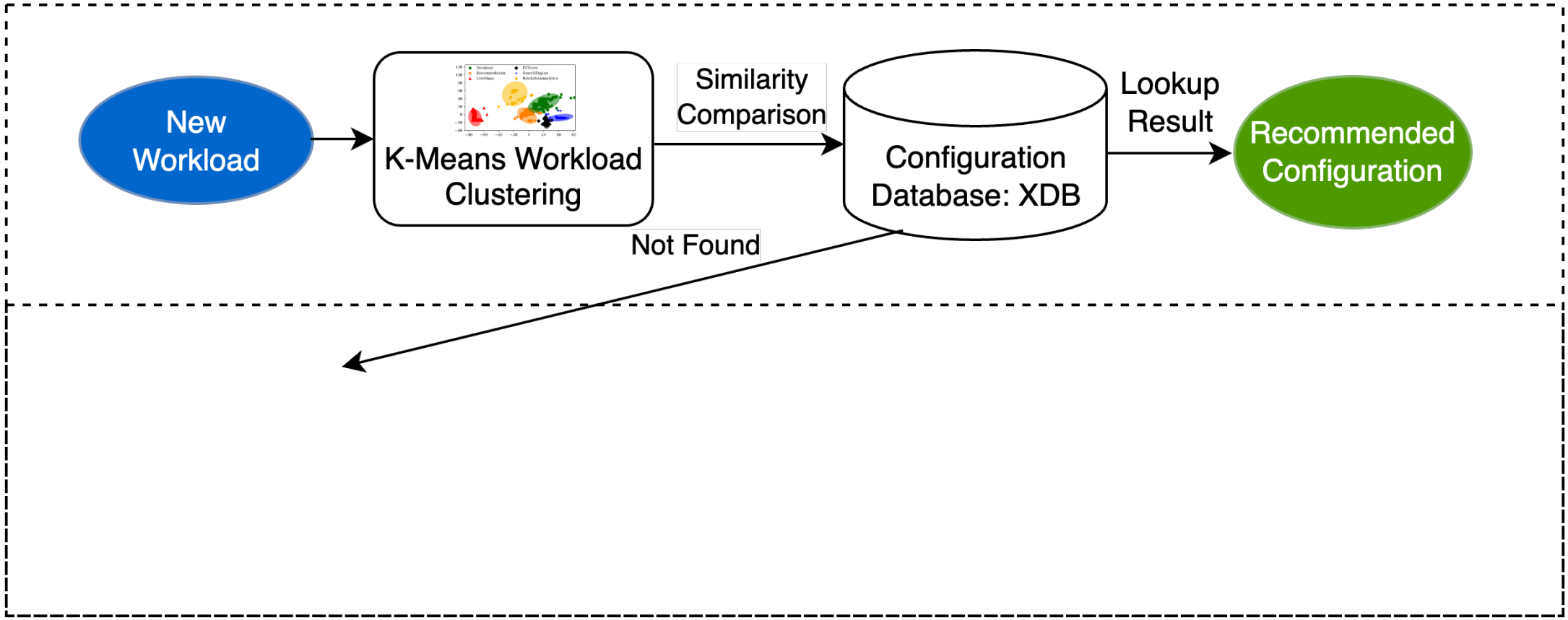

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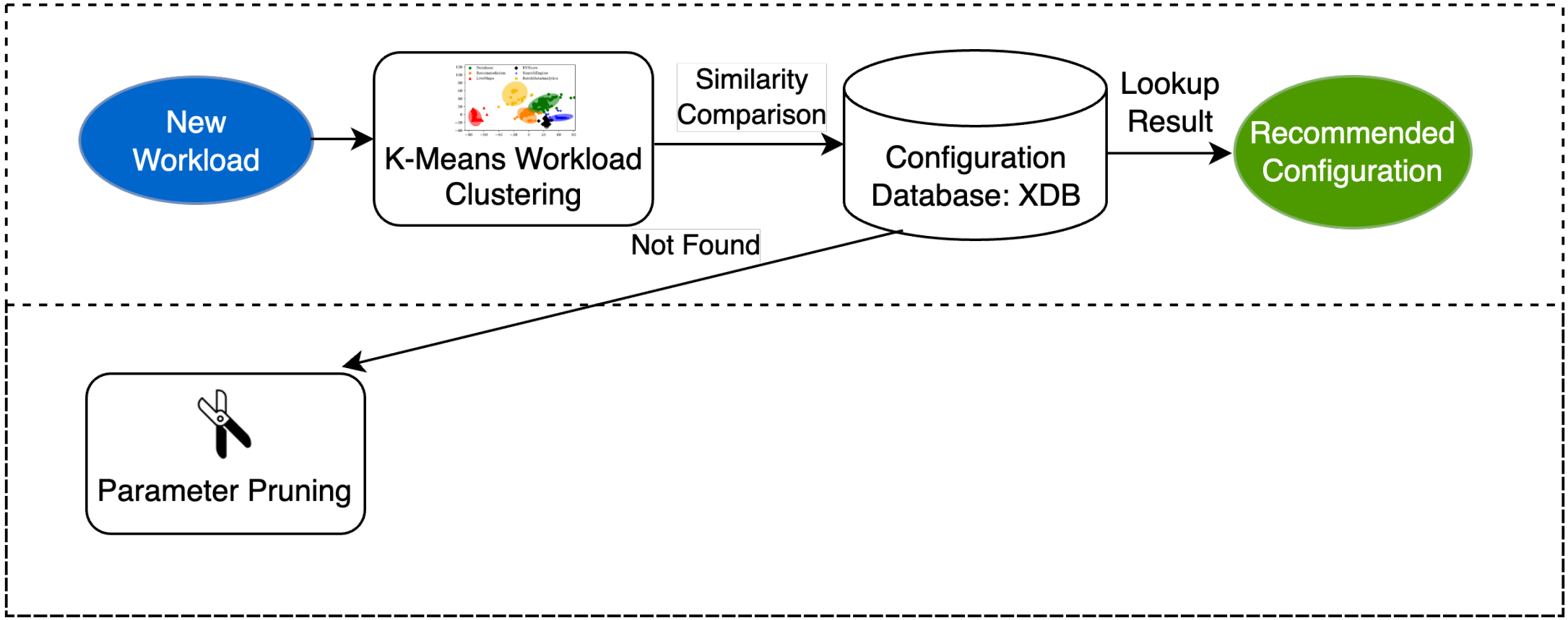

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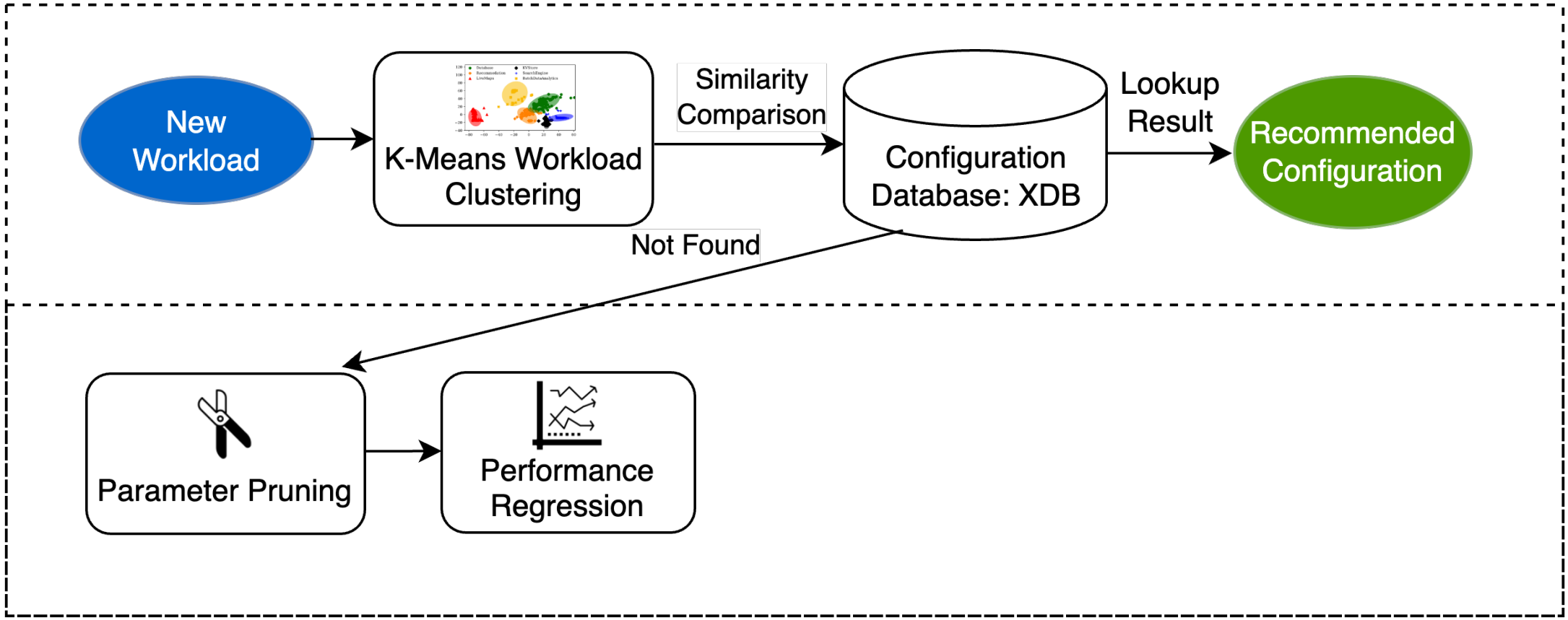

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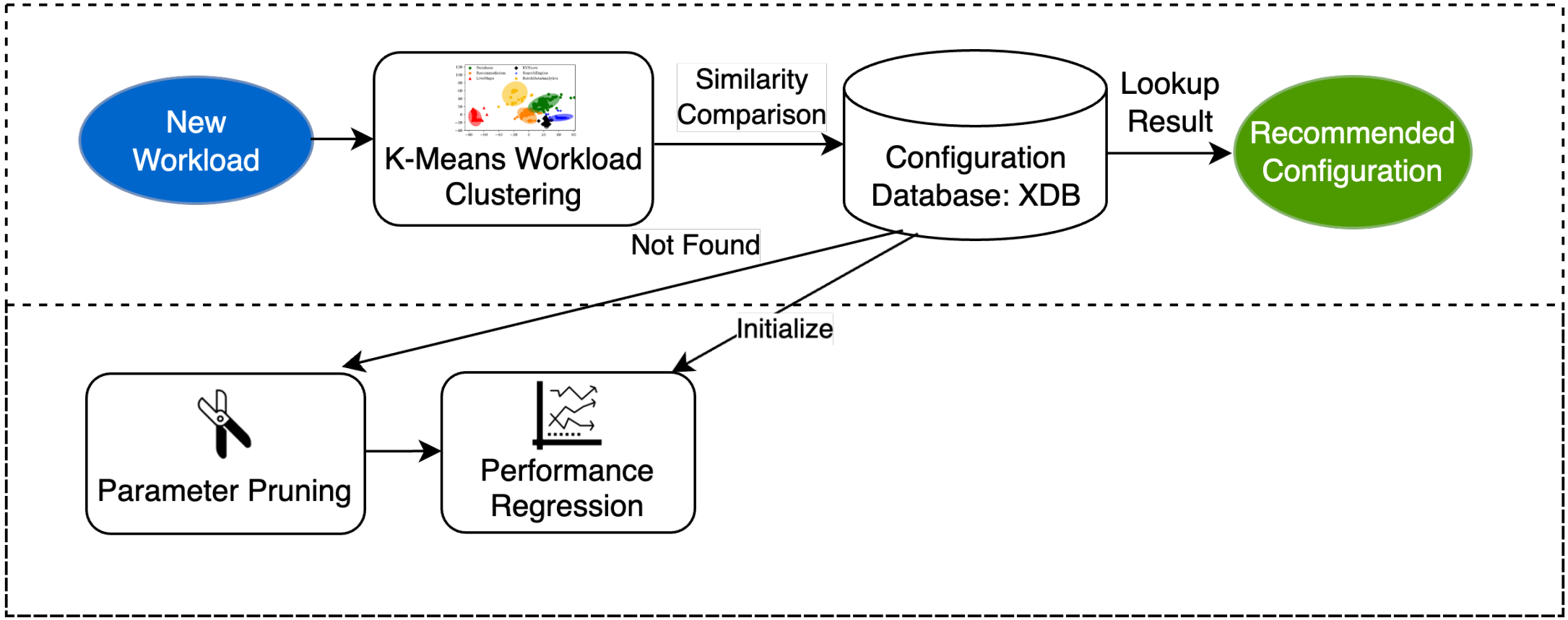

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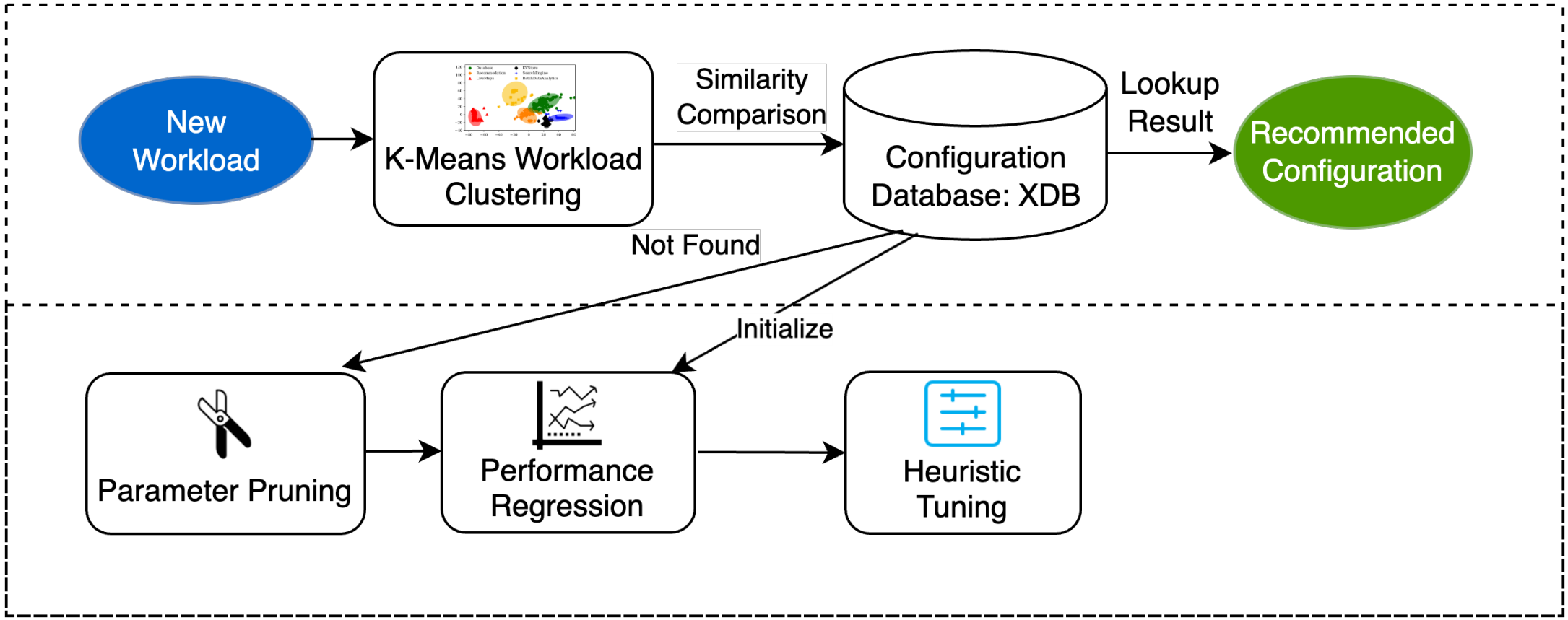

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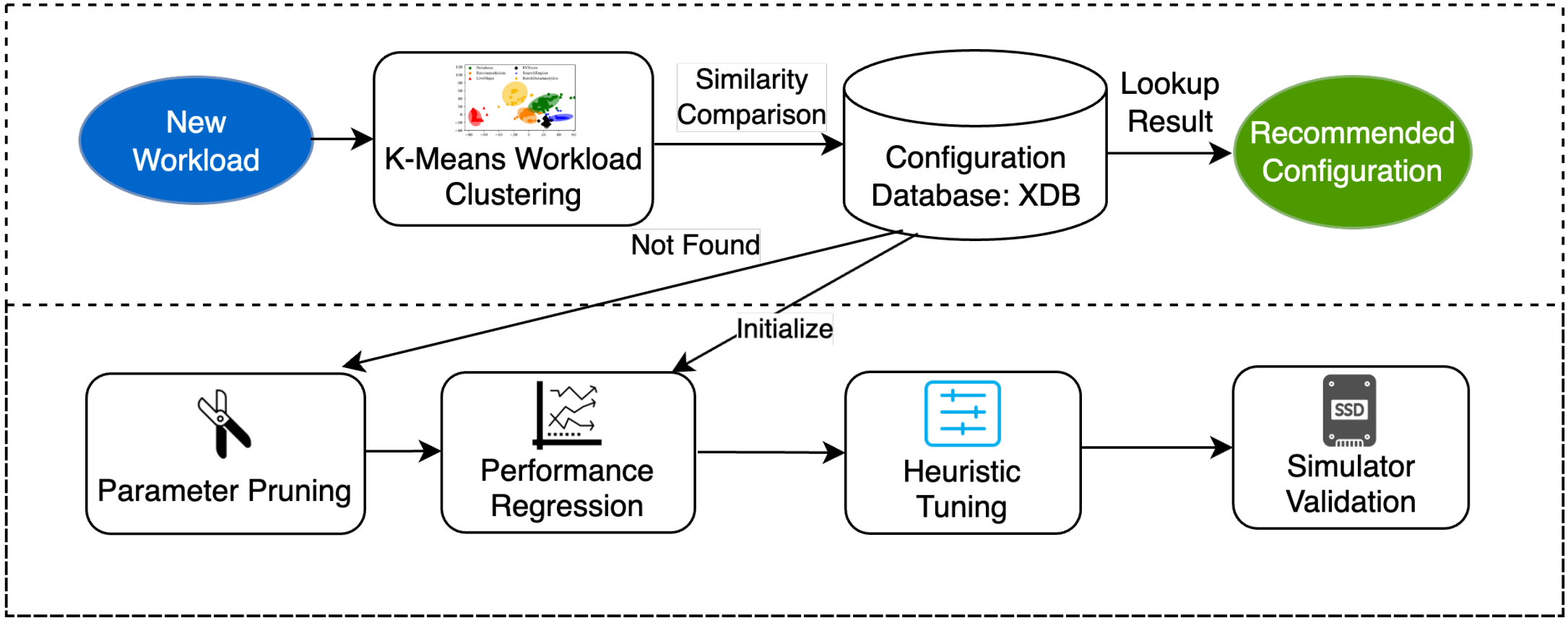

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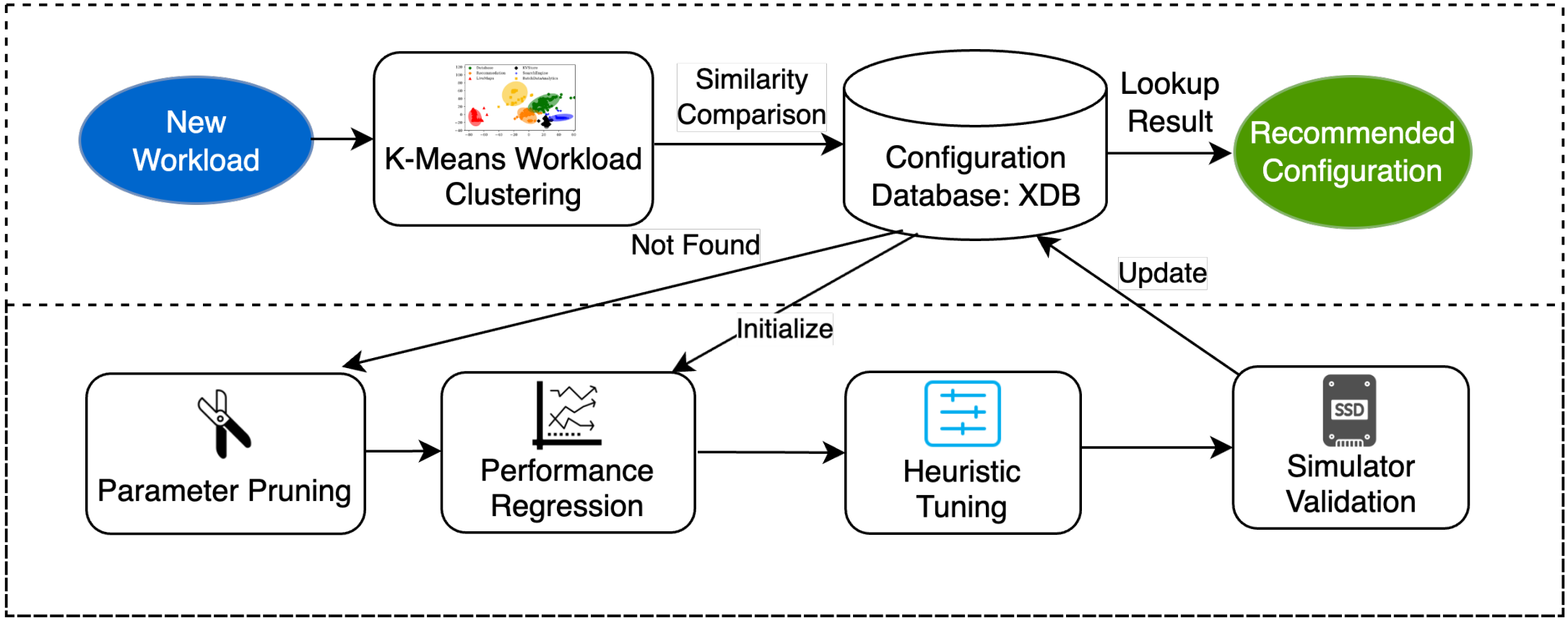

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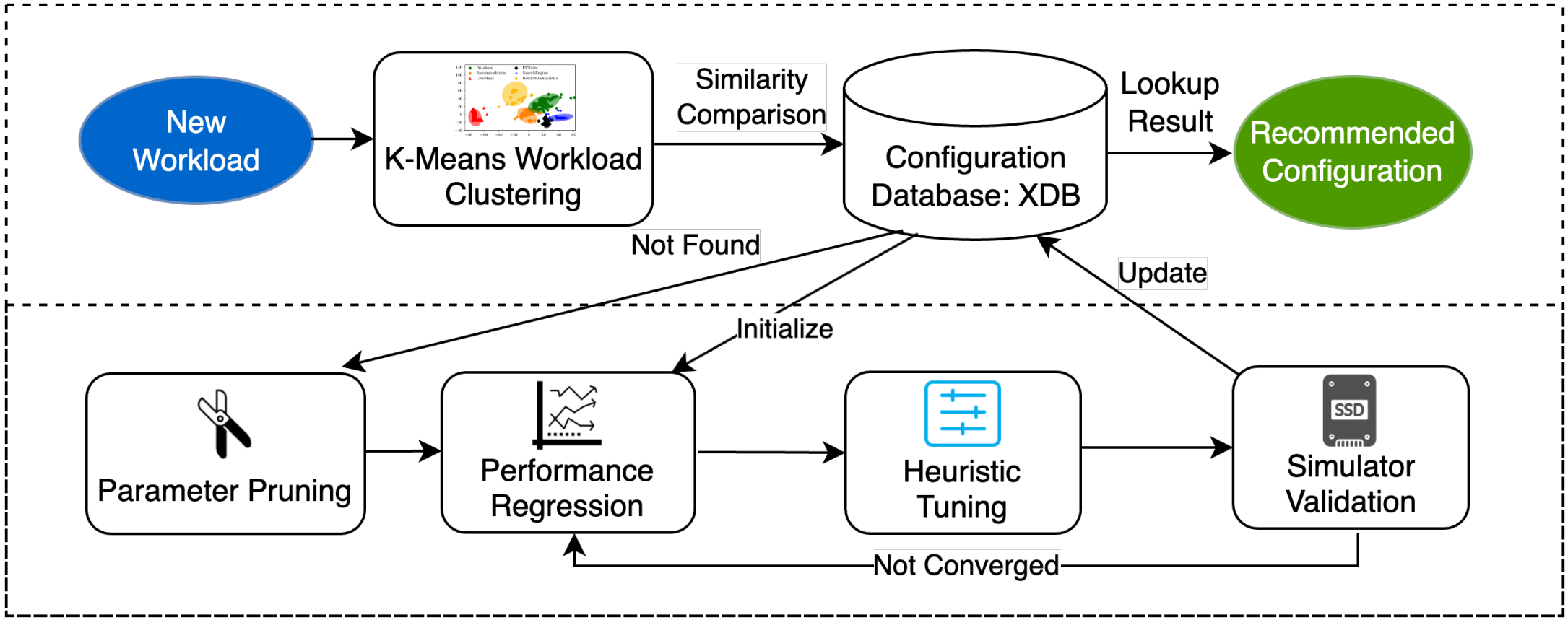

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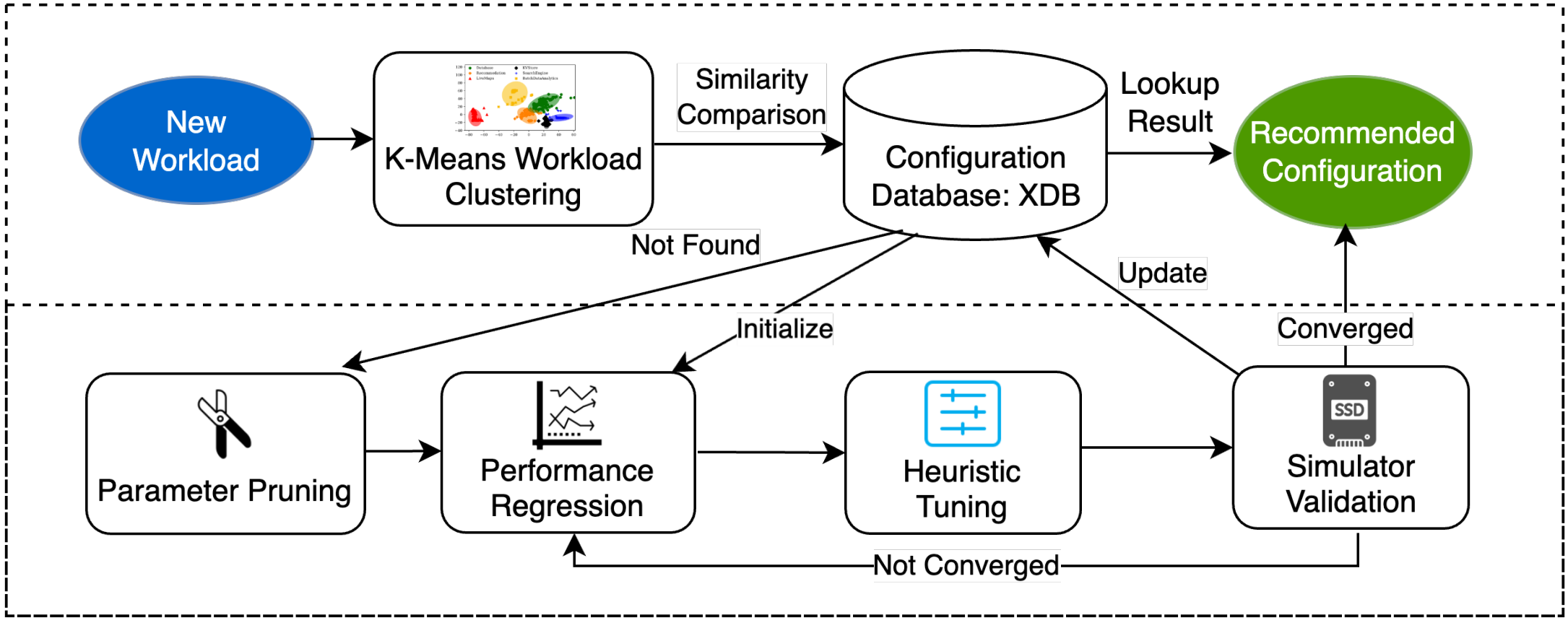
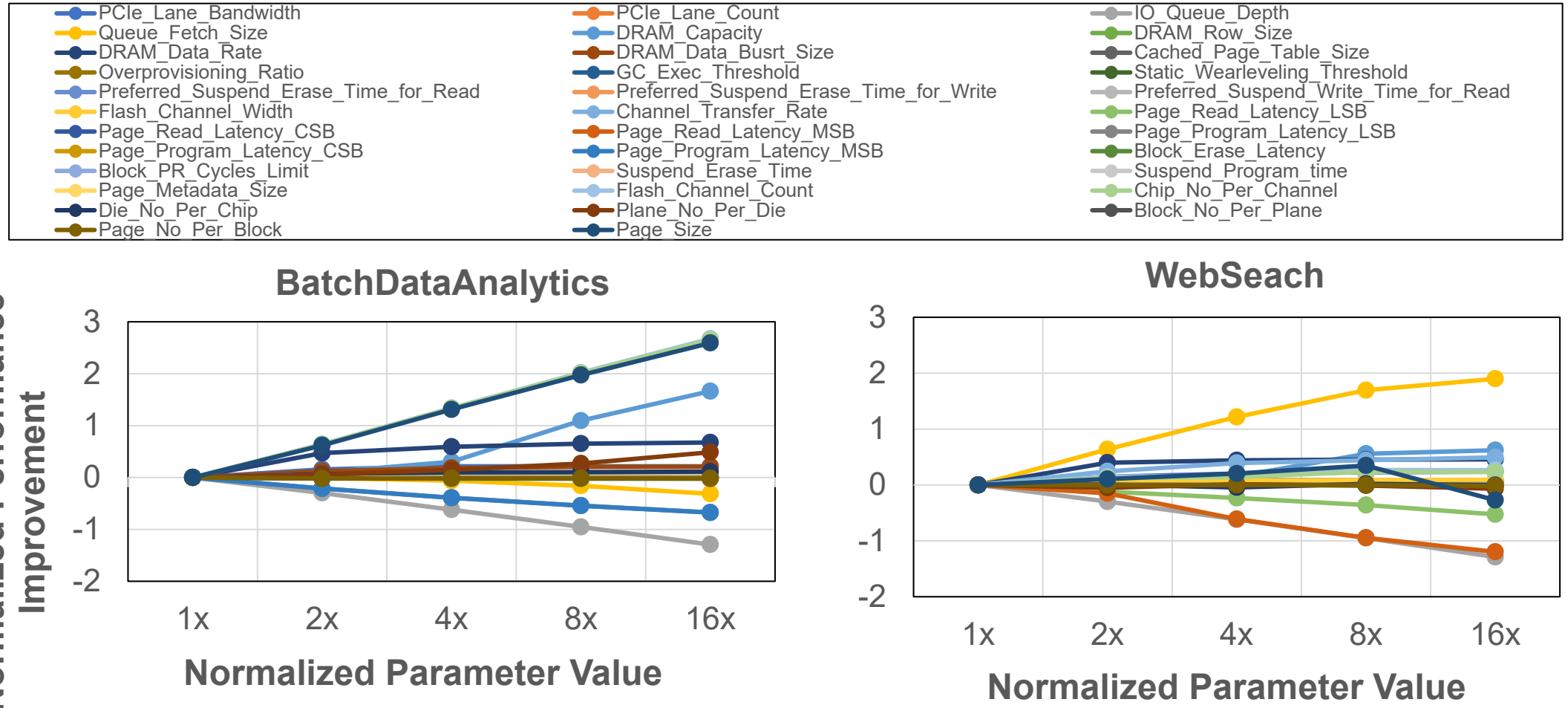


Parameter Pruning for Reduced Search Space and Training Overhead



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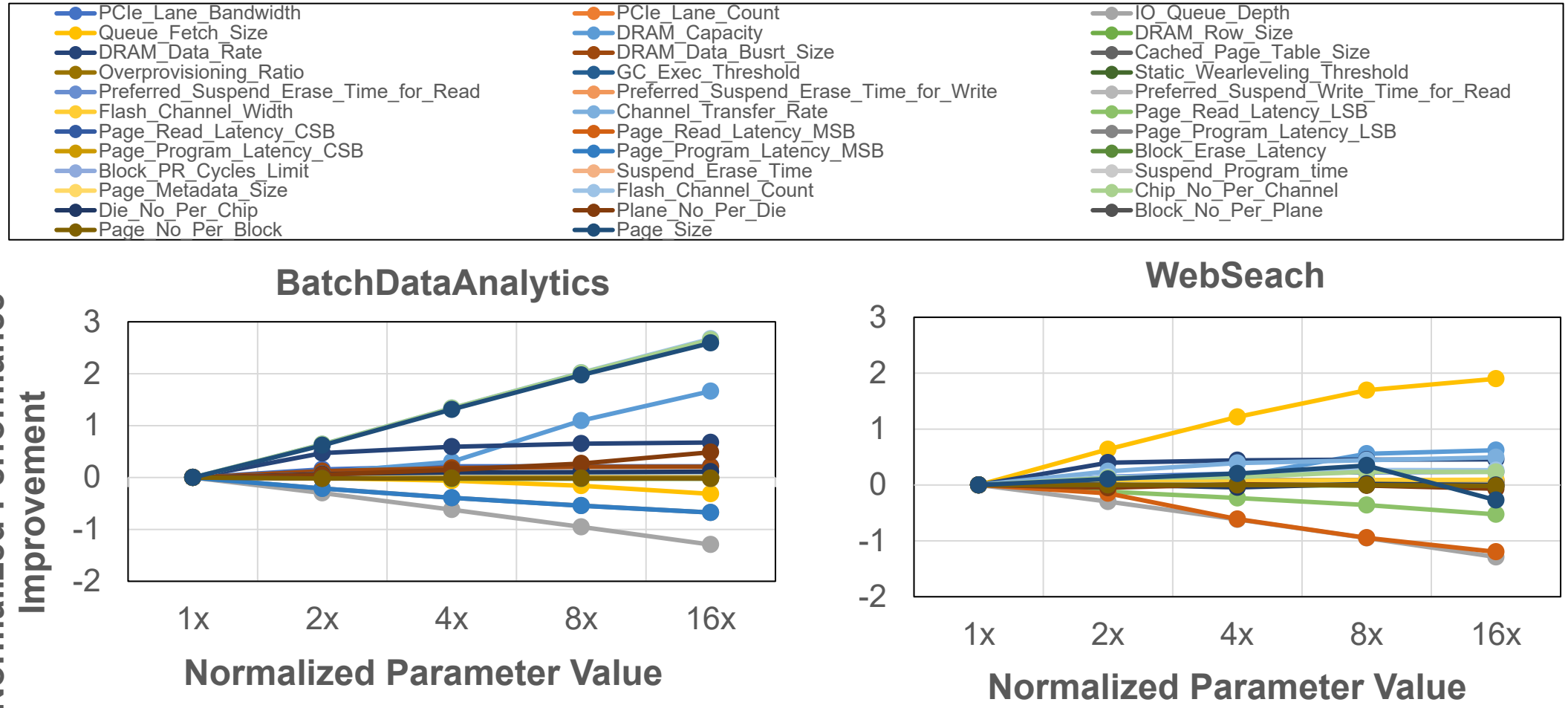

We remove 45% of the parameters with parameter pruning

Performance Benefit of Learned SSD Configurations

Target Workload

Test Workload: Normalized Performance	Recomm	BatchAnalytics	WebSearch	CloudStorage	LiveMaps
Recomm	**1.25/1.26**	1.19/1.21	0.99/1.04	1.10/1.13	1.18/1.17
BatchAnalytics	1.14/1.13	**1.26/1.27**	1.14/1.15	1.08/1.08	1.12/1.11
WebSearch	0.87/0.88	0.75/0.76	**1.61/1.61**	1.01/1.00	1.00/1.00
CloudStorage	1.34/1.36	1.21/1.22	1.04/1.05	**1.48/1.46**	1.15/1.14
LiveMaps	1.16/1.16	1.04/1.06	0.97/0.98	1.07/1.07	**1.24/1.23**

Performance Benefit of Learned SSD Configurations

Target Workload

Test Workload / Normalized Performance	Recomm	BatchAnalytics	WebSearch	CloudStorage	LiveMaps
Recomm	**1.25/1.26**	1.19/1.21	0.99/1.04	1.10/1.13	1.18/1.17
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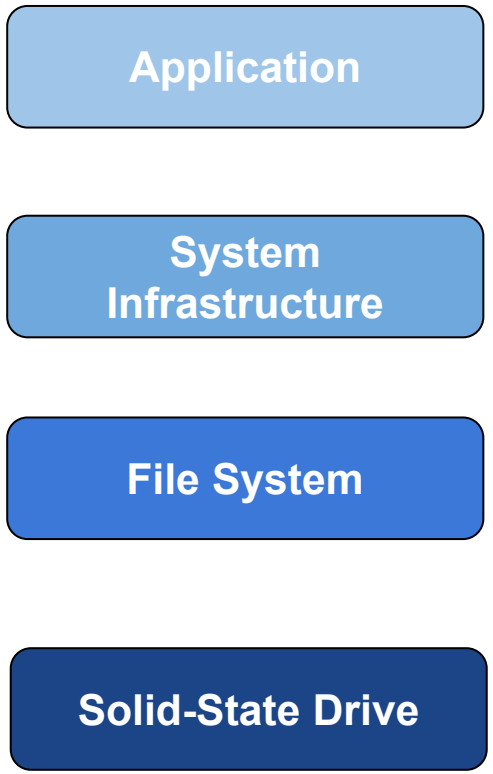
WebSearch	0.87/0.88	0.75/0.76	**1.61/1.61**	1.01/1.00	1.00/1.00
CloudStorage	1.34/1.36	1.21/1.22	1.04/1.05	**1.48/1.46**	1.15/1.14
LiveMaps	1.16/1.16	1.04/1.06	0.97/0.98	1.07/1.07	**1.24/1.23**

We improve 1.37x for target workloads and 1.08x for non-target workloads

Building A Learning-based Storage Ecosystem



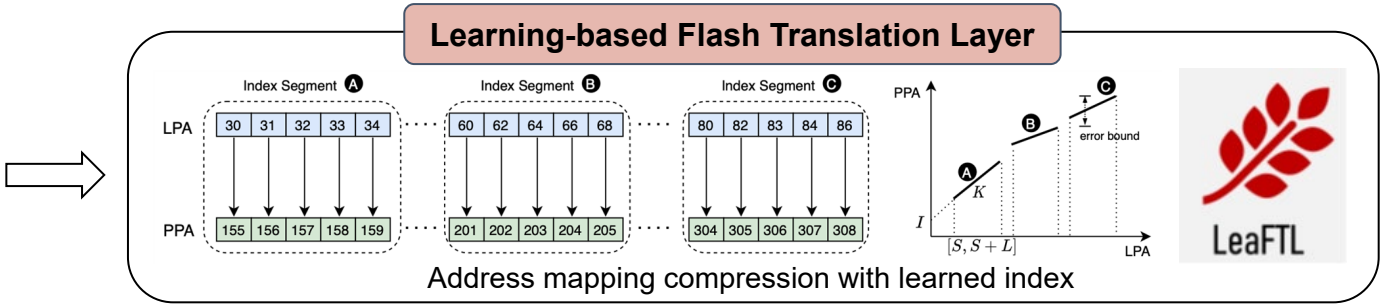
Building A Learning-based Storage Ecosystem

Application

System Infrastructure

File System

Solid-State Drive



LeaFTL (ASPLOS ‘23)

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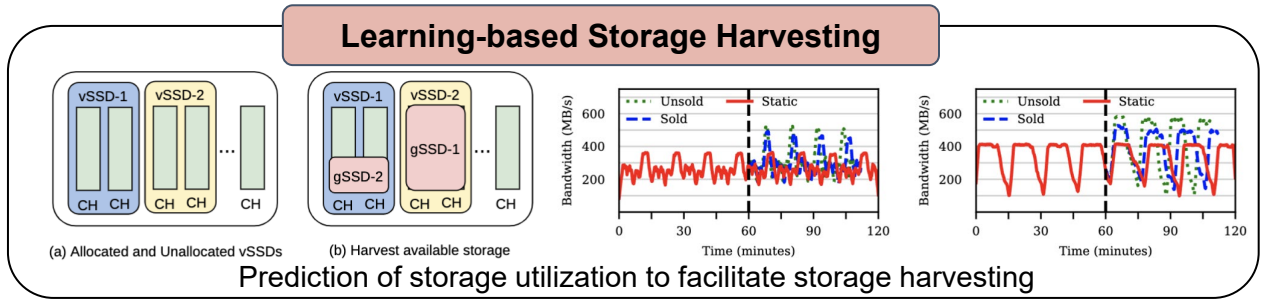

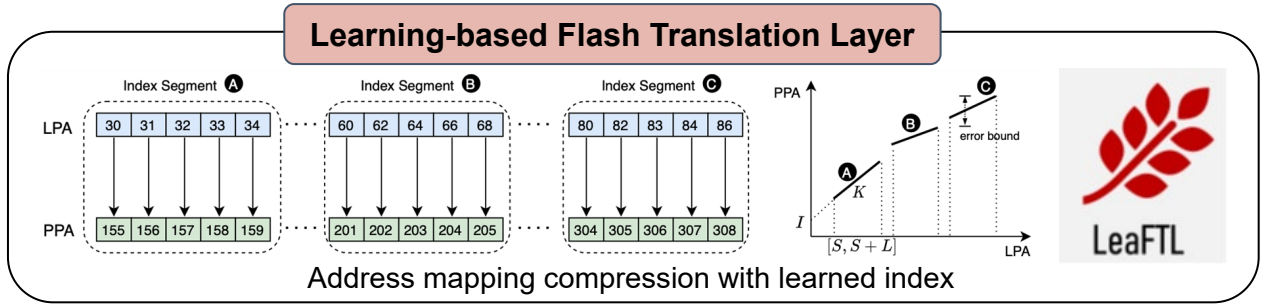

BlockFlex (OSDI '22)

LeaFTL (ASPLOS '23)

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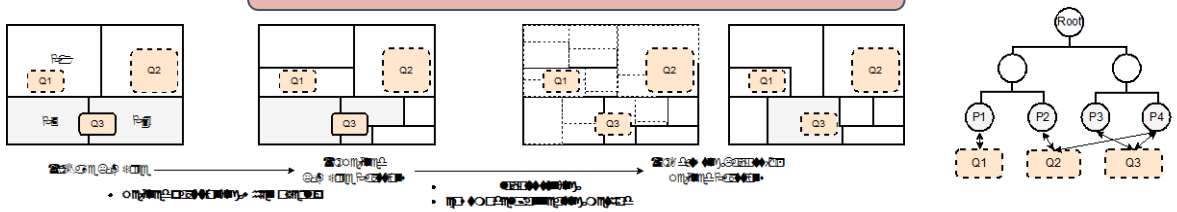
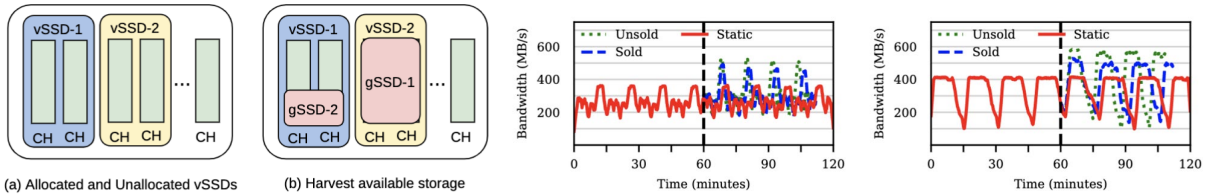
Learning-based Spatial Indexing



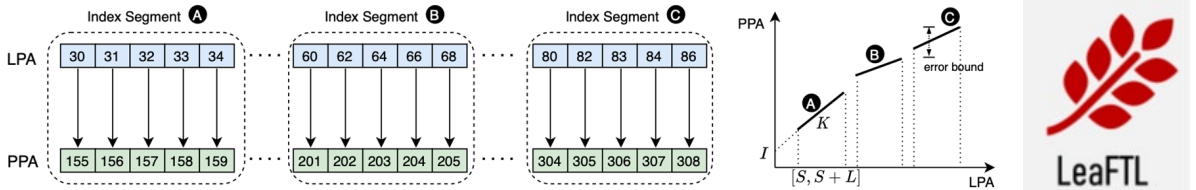
Query-aware methods to optimize data partitioning for spatial datasets

Learning-based Storage Harvesting



Prediction of storage utilization to facilitate storage harvesting

Learning-based Flash Translation Layer



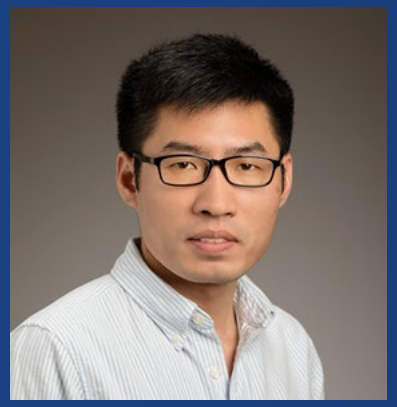
Address mapping compression with learned index

Learning-based Spatial Indexing (Coming soon)

BlockFlex (OSDI '22)

LeaFTL (ASPLOS '23)

Thank You!



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