Microsoft

# Monitor and optimize operational resources in Azure SQL

Introduction to performance monitoring, understand performance problems, and proper configuration options

# Objective

Monitor activity and compare to a baseline

Explore maintenance tasks related to performance

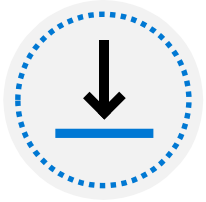
Identify major causes of performance problems

Configure databases and resources for optimal performance

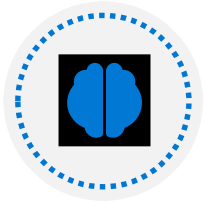
# Describe performance monitoring

# Objectives

Understand methods to review potential performance issues



Learn how to collect metrics for an established baseline

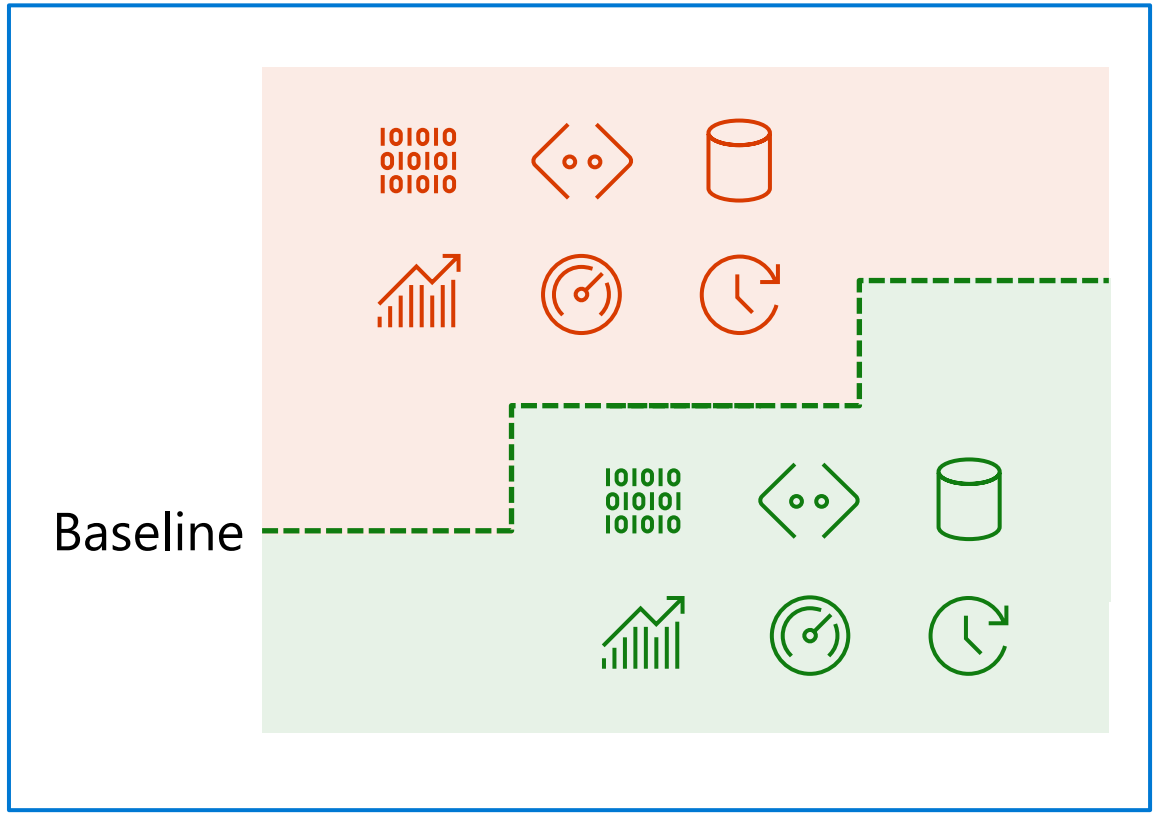


Understand Extended Events and Azure Intelligent Insights

# What is a baseline?

## A baseline

A general set of metrics around performance and utilization that allow you to easily separate performance anomalies from normal usage patterns



# Establishing a baseline

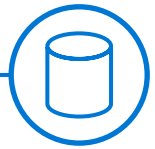
Having a baseline of system performance data allows you to make better decisions for performance tuning

You can separate code problems from simple increased utilization

You may also proactively allocate more compute resources as your workload increases over time

# Performance on an Azure Virtual Machine

Built-in tool in the Windows operating system



Collect detailed, granular performance data about SQL Server and Windows operations

Group Performance Monitor counters together to easily gather and analyze performance data

Data can be easily exported to archive

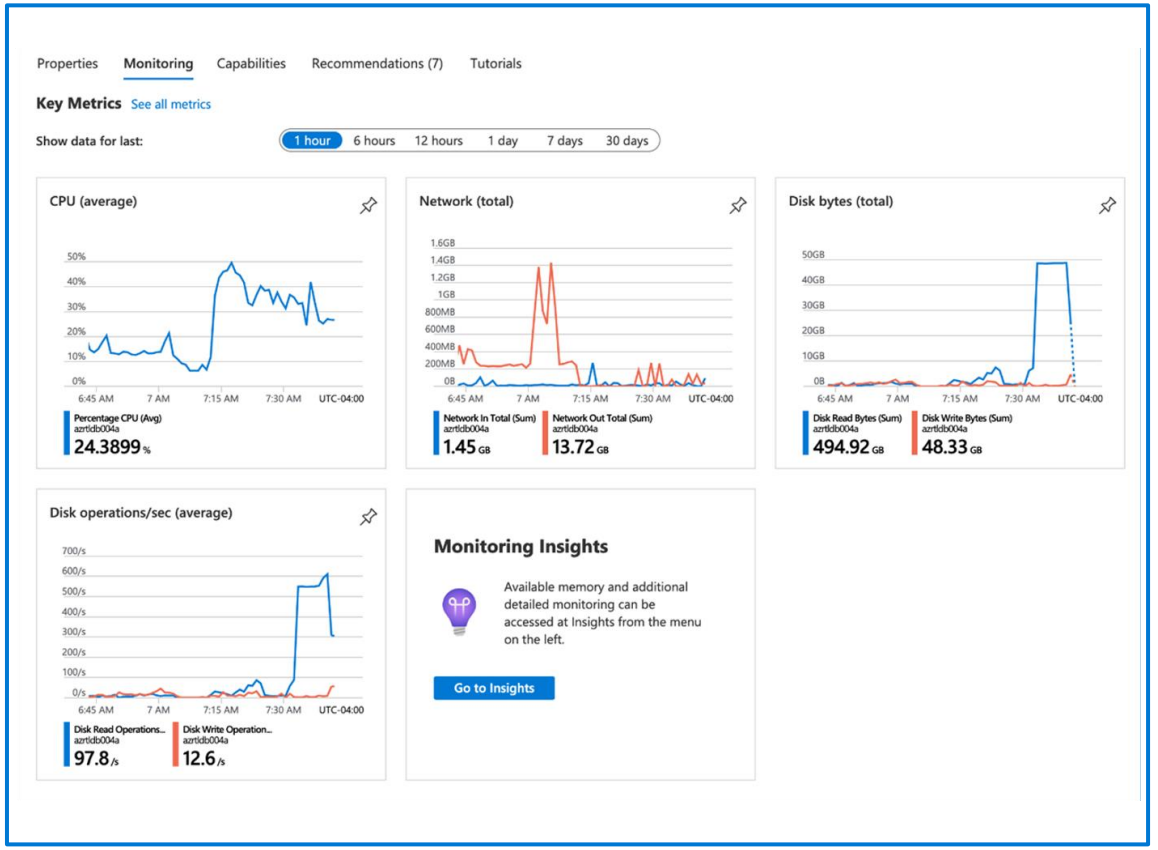
# Performance monitoring tools – Azure Monitor

All Azure resources collect a set of metrics through the Azure Monitor service

Enhanced data may be collected through the Azure Monitoring Insights for virtual machine resources

Data is stored in Azure Log Analytics

Metrics available to monitor will vary depending on the type of resource



# Review of Azure metric alerts

## Overview

Azure has a built-in alerting system that allows you to create alerts

The alerts can be configured:

- In a static manner
- In a dynamic fashion using Dynamic Thresholds

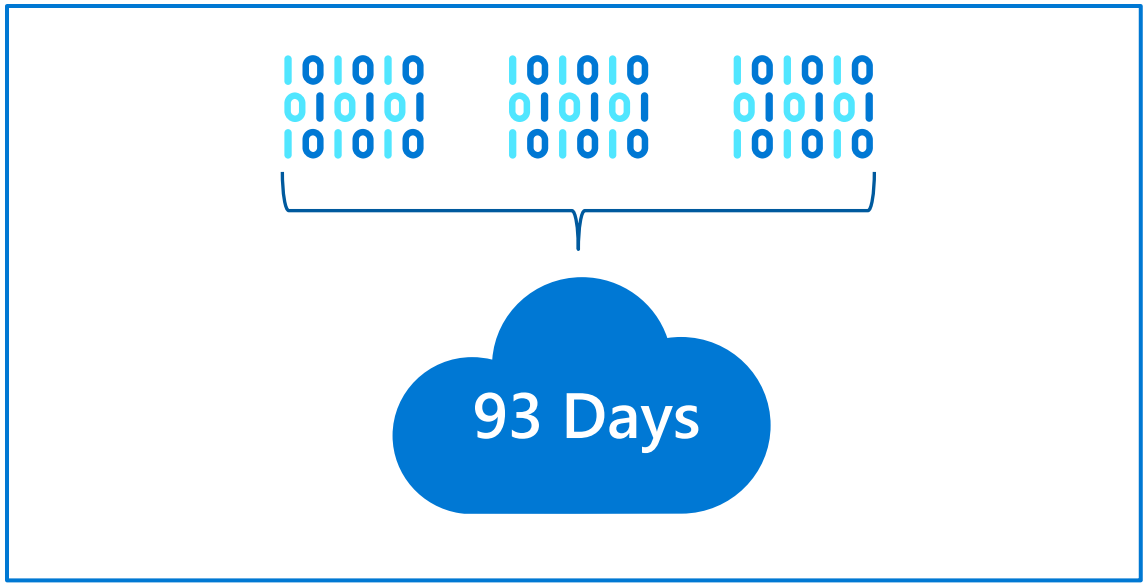
## Creating metric alerts

Metric alerts can be defined on IaaS or PaaS resources

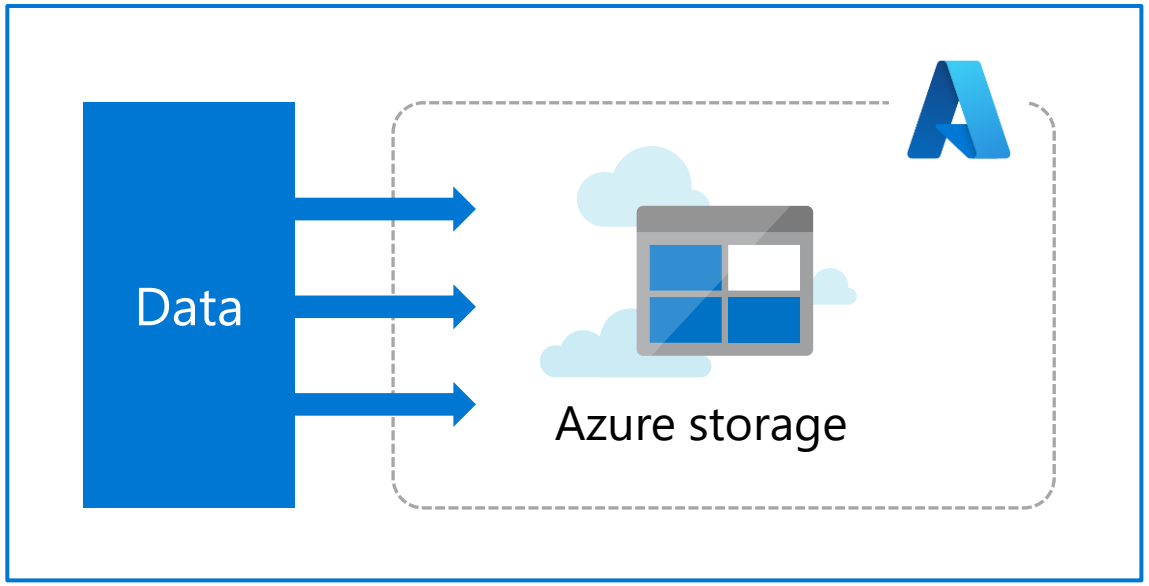
Alerts can be scoped by:

- VM
- Subscription
- Resource Group

# Reviewing performance data history




Azure Monitor stores data from **93 days**, which covers three months of data




You may archive data to Azure storage for historical analysis

# SQL Server metrics that matter

| | |
|---|---|
| Processor(_Total)% Processor Time | Paging File(_Total)% Usage |
| PhysicalDisk(_Total)\Avg. Disk sec/Read and Avg. Disk sec/Write | System\Processor Queue Length |
| SQLServer:Buffer Manager\Page life expectancy | |
| SQLServer:SQL Statistics\Batch Requests/sec | |
| SQLServer:SQL Statistics\SQL Compilations/sec and SQL Re-Compilations/sec | |

# What are Extended Events?

A lightweight and extensive diagnostic system that is built into the SQL Server engine

- **Extended Events are supported on all the Azure SQL platforms**
- **Event sessions can be used to trace activity within the database which can help you troubleshoot issues like:**
  - Blocking and deadlocking performance issues
  - Identify long-running queries
  - Observing Memory Pressure in your database
- **The Extended Event framework allows you to filter your data collection**

# What can I monitor with Extended Events?

- Extended events cover all aspects of the database engine. Specifically they are divided into four channels:

| Admin | Operational | Analytical | Debug |
| --- | --- | --- | --- |
| Events targeted for end users and administrators, like a deadlock report | Used for analysis and diagnosis of common problems, like an Availability Group failover | Commonly used for tracing query execution | Used in conjunction with Microsoft support. May not be fully documented |

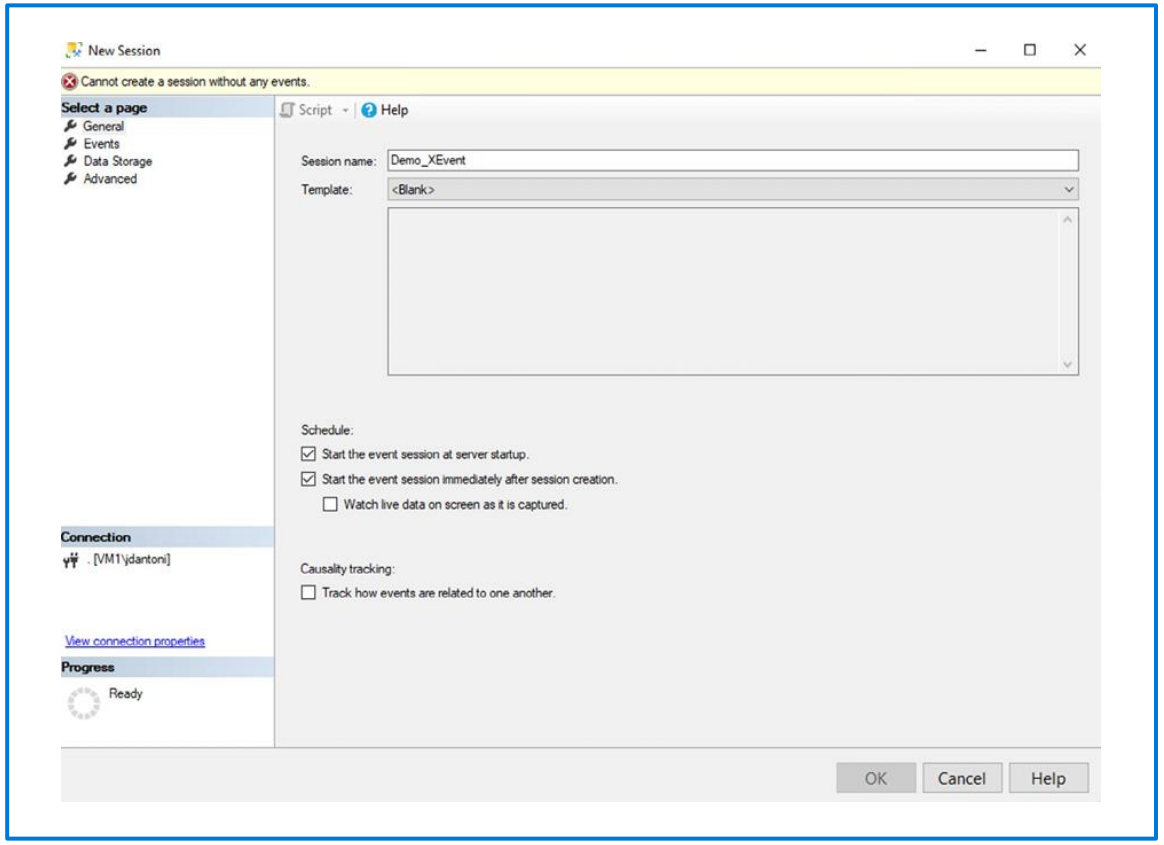
- Events can be groups together into sessions for easier monitoring

# How to create an Extended Events session

SSMS has a wizard to create an Extended Events session

SSMS also includes predefined templates for monitoring specific resources

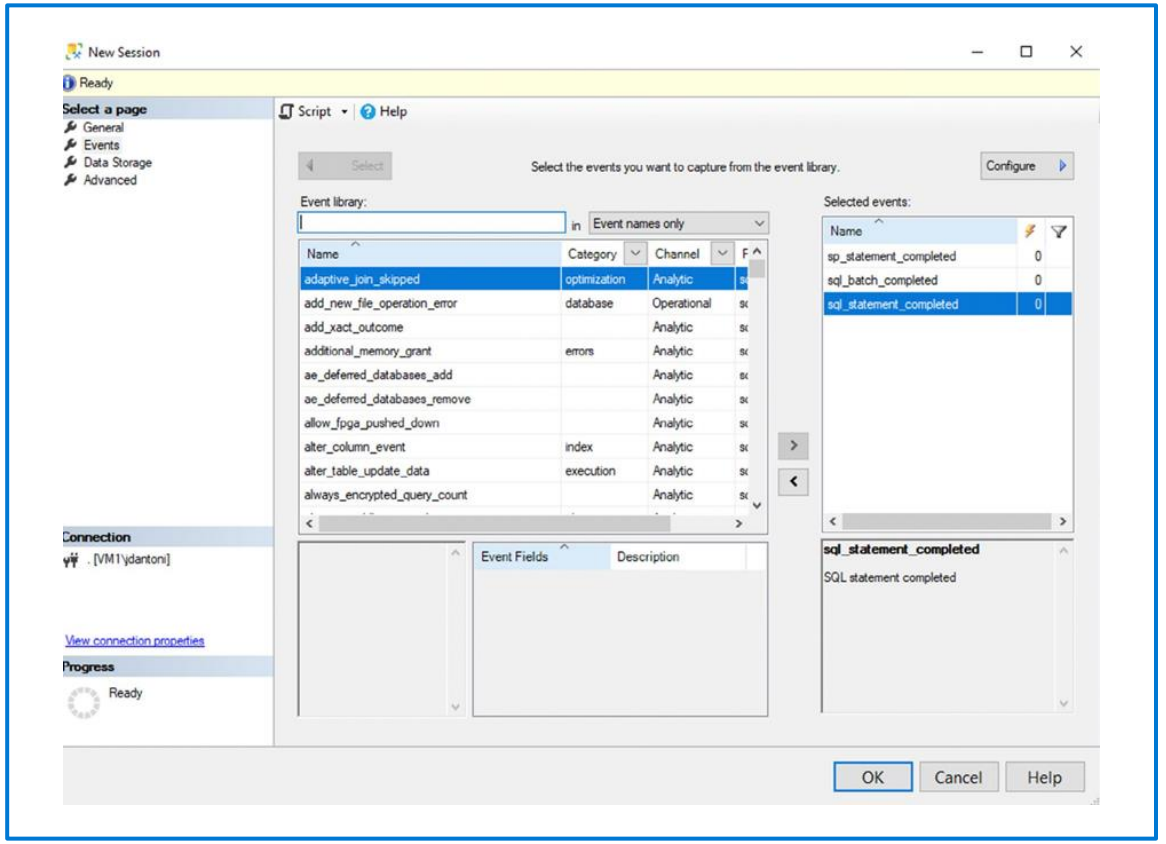
You can also use T-SQL which is more common for advanced administrators



# Extended Events components

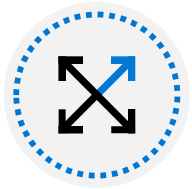
Event Sessions consists of events and targets

Events represent the engine action you are capturing and include fields that can both be filtered and select individually

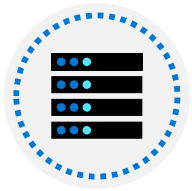


# Extended Events storage

Events are persisted to disk for further analysis



There are multiple targets depending on the nature of your data collection



The most commonly used storage target is the event file, which writes the file to a local disk

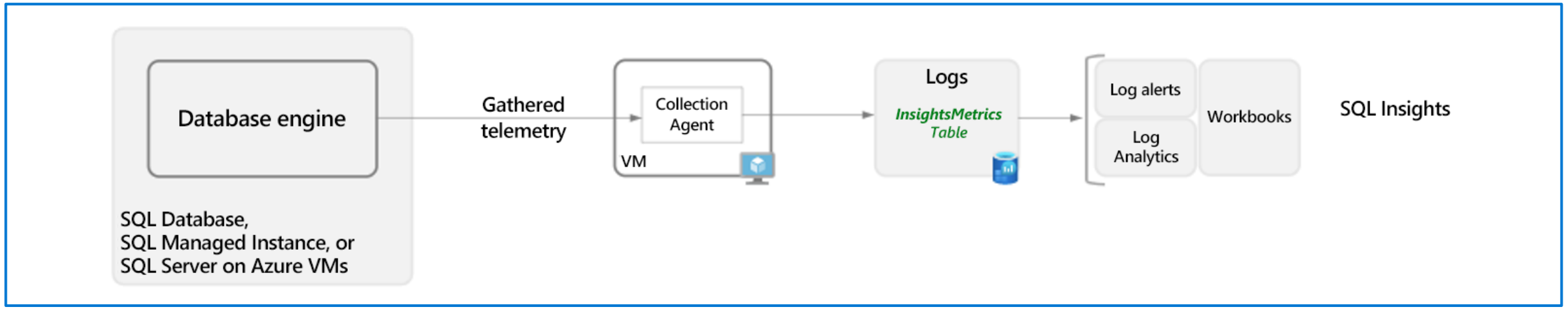
You can also use the ring buffer, a non-persistent area of memory to perform real-time analysis of an event session

# Extended Events with T-SQL

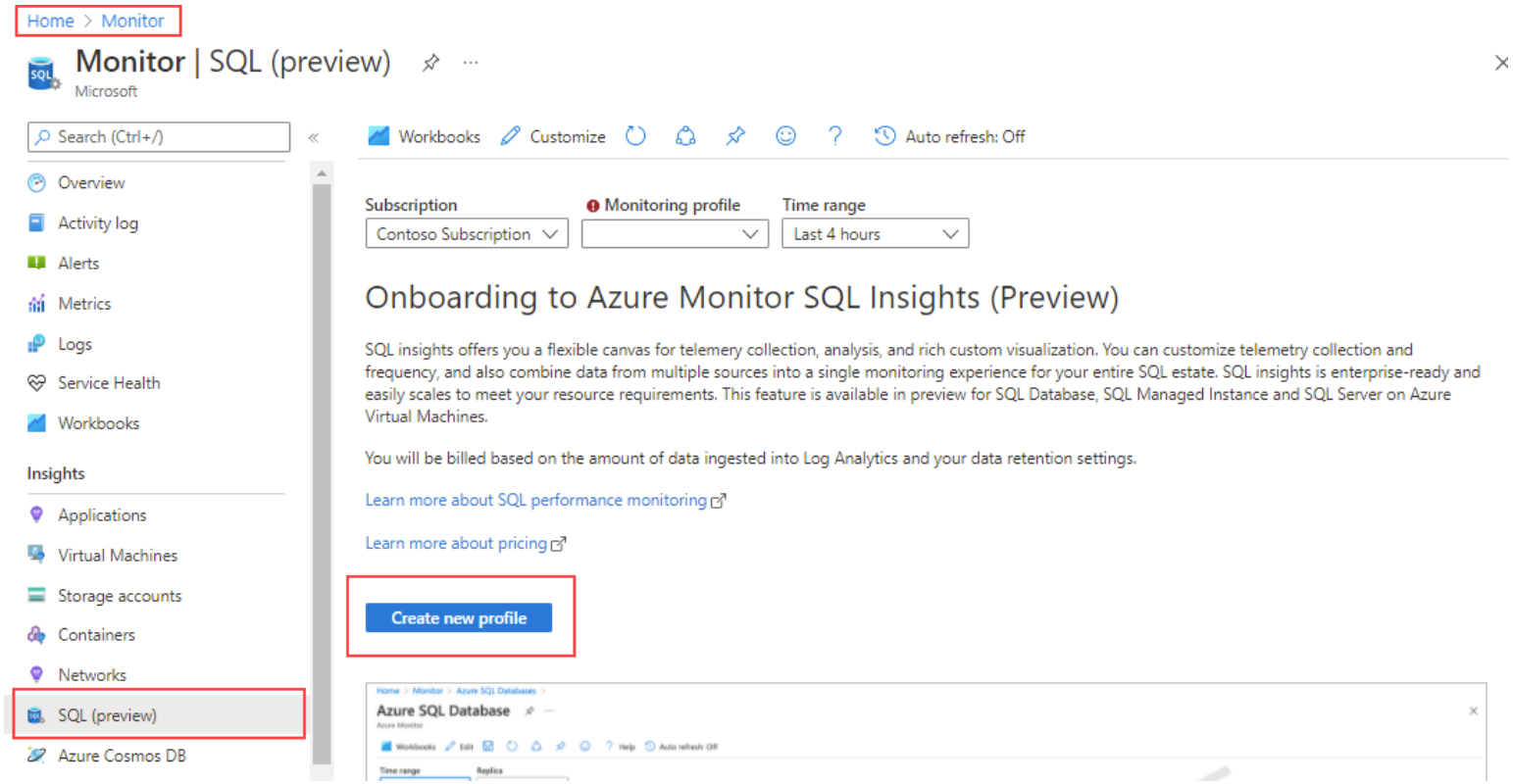
```
CREATE EVENT SESSION test_session
ON SERVER
    ADD EVENT sqlos.async_io_requested,
    ADD EVENT sqlserver.lock_acquired
    ADD TARGET package0.etw_classic_sync_target
        (SET default_etw_session_logfile_path =
        N'C:\demo\traces\sqletw.etl' )
    WITH (MAX_MEMORY=4MB, MAX_EVENT_SIZE=4MB);
GO
```

# Azure SQL Insights

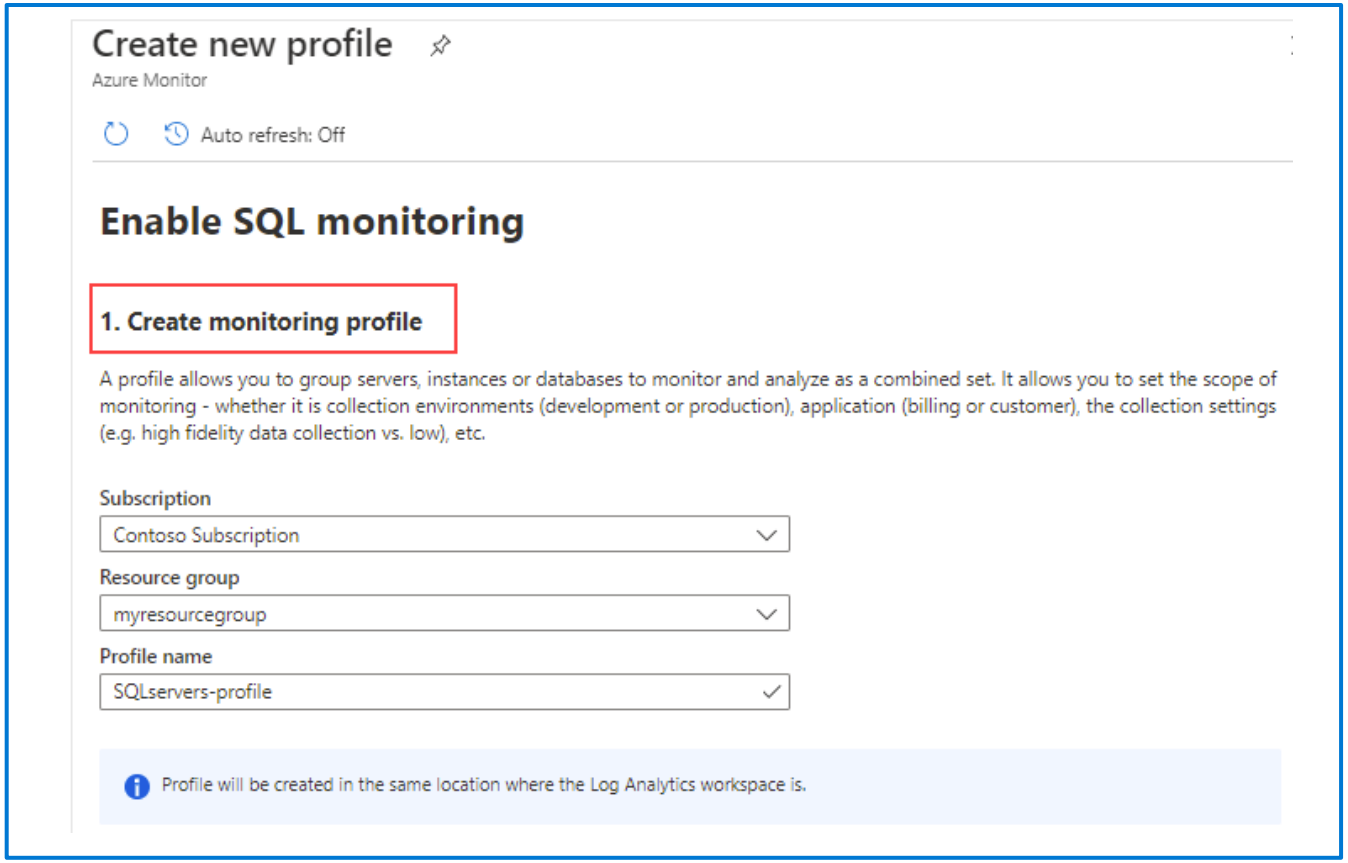
1. Monitoring profile can include SQL Database, SQL Managed Instance, and SQL Server on Azure VMs
2. Collection agent is installed on a dedicated virtual machine that will monitor and remotely collect data from your SQL servers
3. Insight metrics are stored in Azure Log Analytics
4. Access performance data from the SQL Insights workbook template, or directly from the monitoring logs

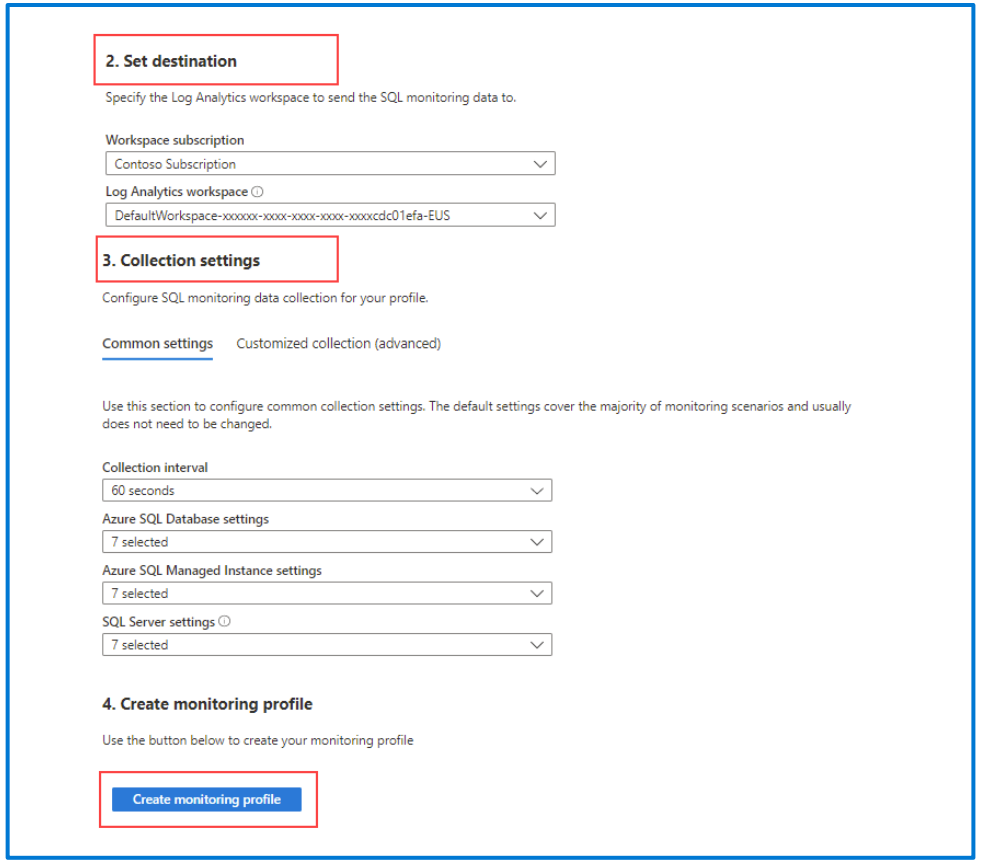


# Azure SQL Insights – Creating a new profile



# Azure SQL Insights – Creating a new profile cont'd



# Azure SQL Insights limitations

**Limited support** or **No support** for the following components:

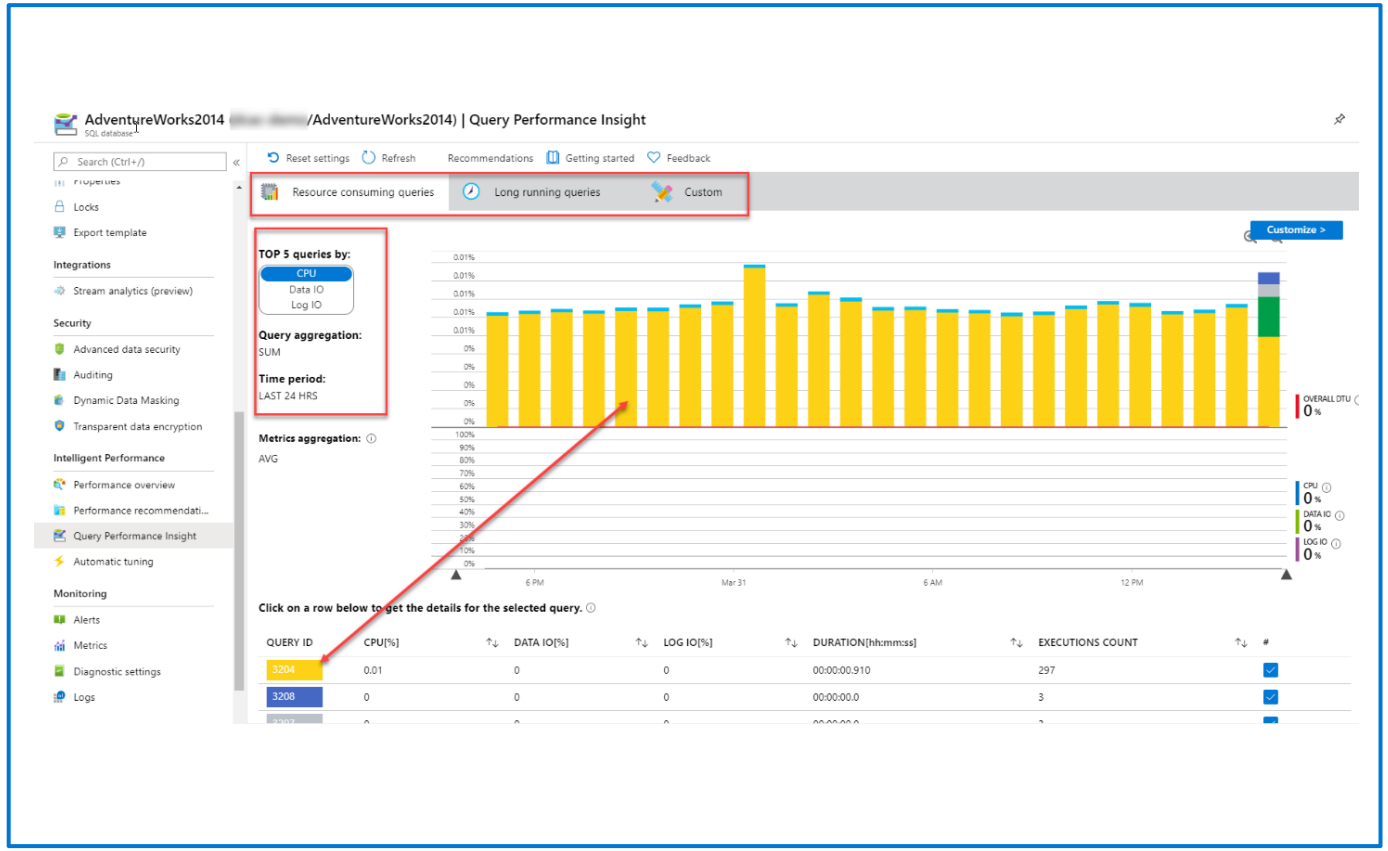
- Non-Azure instances
- Azure SQL Database elastic pools
- Azure SQL Database running on Basic, S0, S1, and S2 service tiers
- Azure SQL Database serverless tier
- Multiple secondary replicas
- Authentication with Azure Active Directory. Only SQL authentication is supported

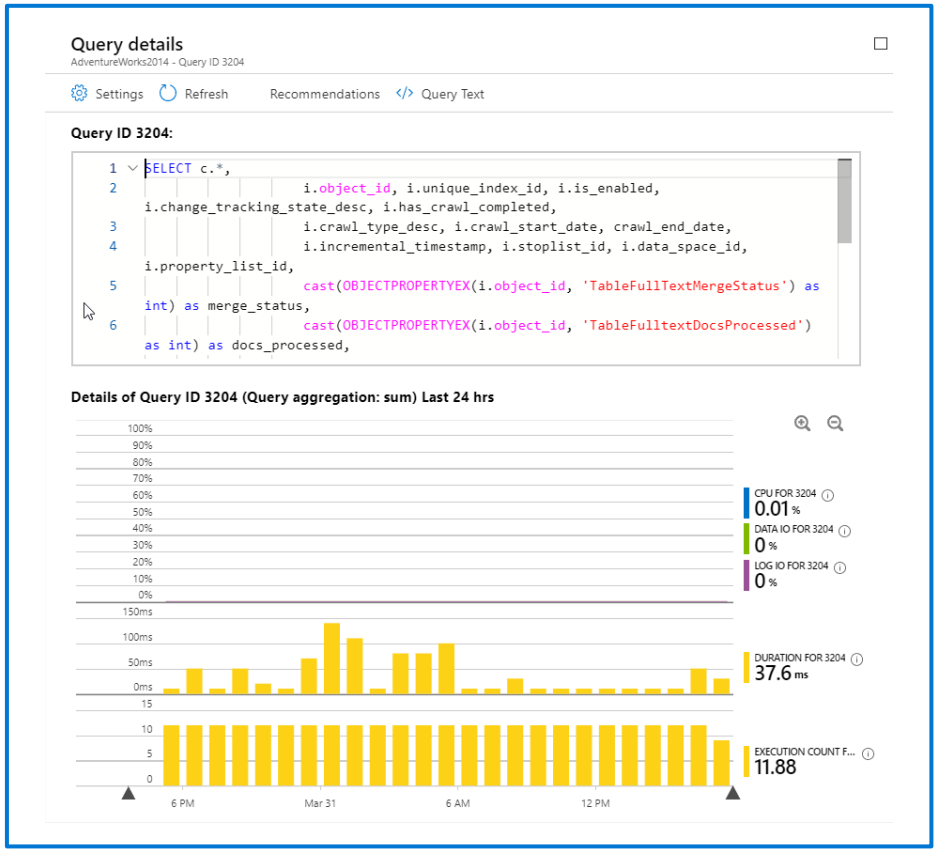
# Query Performance Insights

**Query Performance Insight Allows you…**

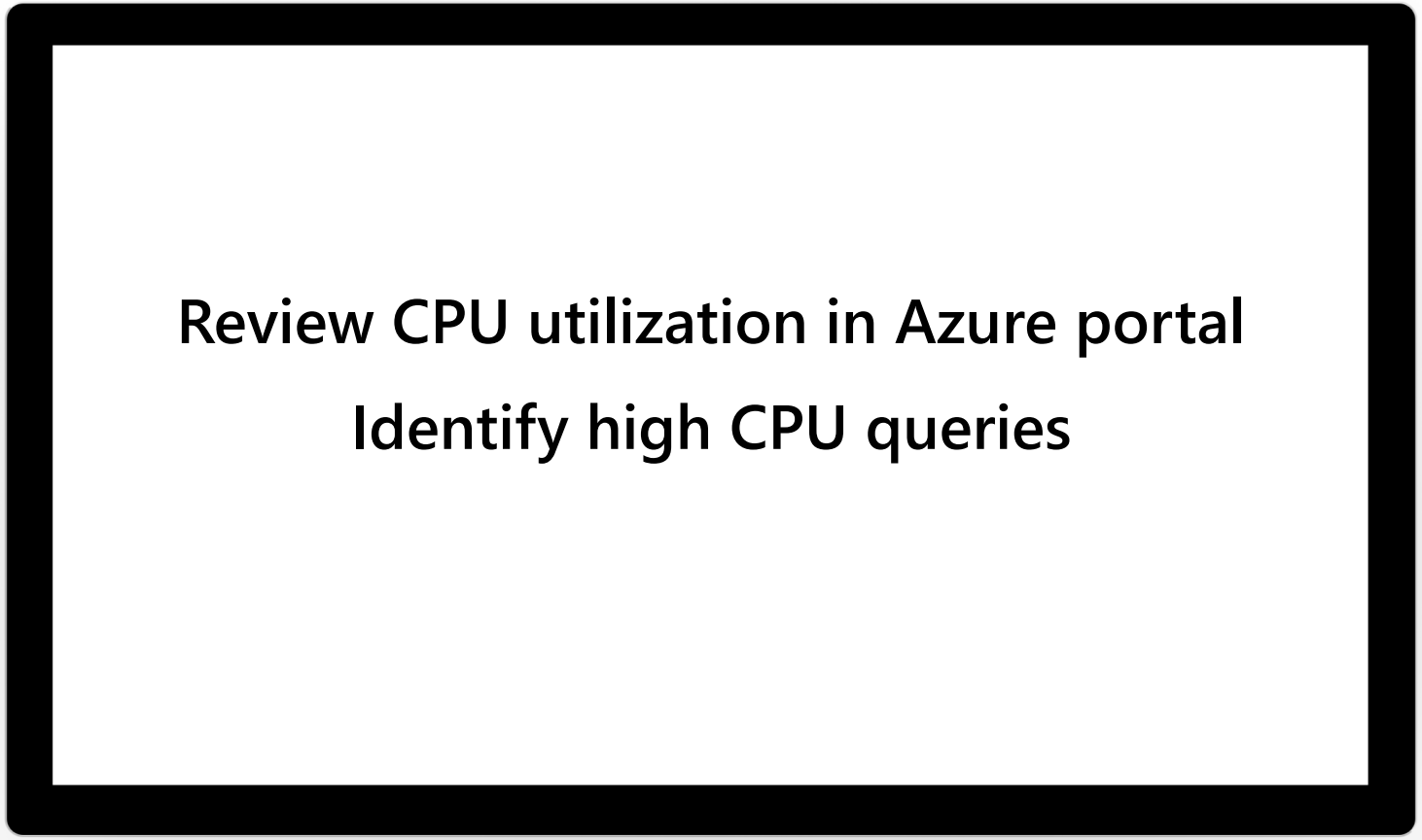
- Allows DBAs to quickly identity expensive queries
- You can drill into individual queries
- You can combine the Query Performance Insight dashboard with Query Store data to quickly identify the most expensive execution plan

# Query Performance Insights



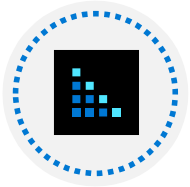



# Instructor led labs: Isolate performance problems through monitoring



# Configure SQL Server resources for optimal performance

# Objectives



Understand your options for configuration of Azure Storage

Learn how to configure TempDB data files in SQL Server


Learn how to choose the right type of VM for SQL Server workloads

Understand the use cases and configuration of Resource Governor in SQL Server

# Azure Storage

Azure Storage is a scalable, secure storage platform that meets a variety of application data storage needs beyond just VM storage.

SQL Server can use three types of Azure Storage:

### Blob Storage

Can be used for database backups

### File Storage

File shares that can be used for Failover Cluster Instances

### Disk Storage

Managed block storage that is used to provide storage to VMs

# Azure Managed Disks

- Azure VMs use Managed Disks for their storage
- SQL Server VMs should use either Premium SSD or Ultra Disk for optimal performance

**Azure Managed Disks are offered in four types:**

### Ultra Disk

Support high-IO workloads for mission critical databases with extremely low latency

### Premium SSD

High-throughput and low latency and can meet the needs of most database workloads running in the cloud

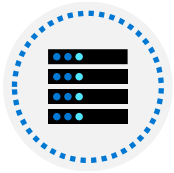
### Standard SSD

Designed for lightly used dev/test workloads or web servers that do a small amount of IO and require predictable latency

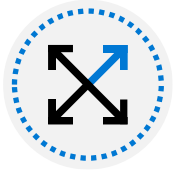
### Standard HDD

Suitable for backups and file storage that is infrequently accessed

# Striping disks for maximum throughput



Disks are striped with no redundancy at the operating system level

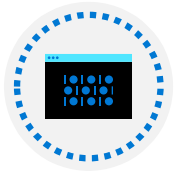


This allows for you volumes to have the sum of IOPS and data size

For **Premium SSDs** it can be beneficial to scale both IOPs and storage volume

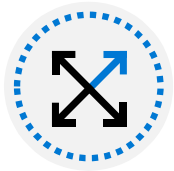
For **Ultra Disk**, you can scale IOPs, throughput, and maximum size independently on a single disk

# SQL Server storage best practices

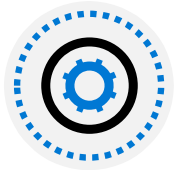


Create a separate volume for data and transaction log files

Enable read caching on the data file volume



Do not enable any caching on the log file volume



Use the D: drive (the locally attached SSD) for TempDB files

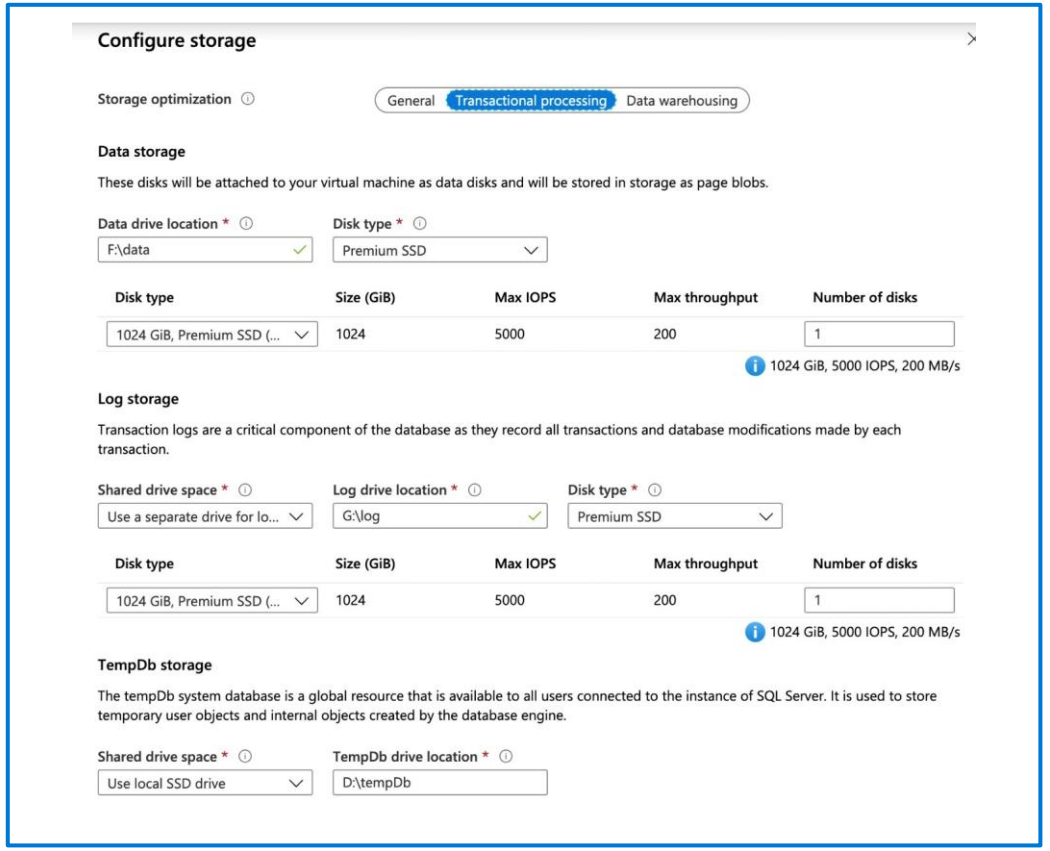
Enable instant file initialization to reduce the impact of file-growth activities

# Azure SQL VM resource provider

The SQL VM resource provider can configure storage based on your workload

You specify the number of IOPs and data volume your database requires and the provider will allocate the disks and configure them in the O/S

You can also configure TempDB on the D: drive

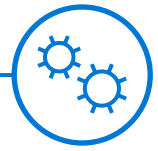


# TempDB configuration

SQL Server uses TempDB for many internal operations

The I/O performance of TempDB can be critical to the performance of the SQL Server

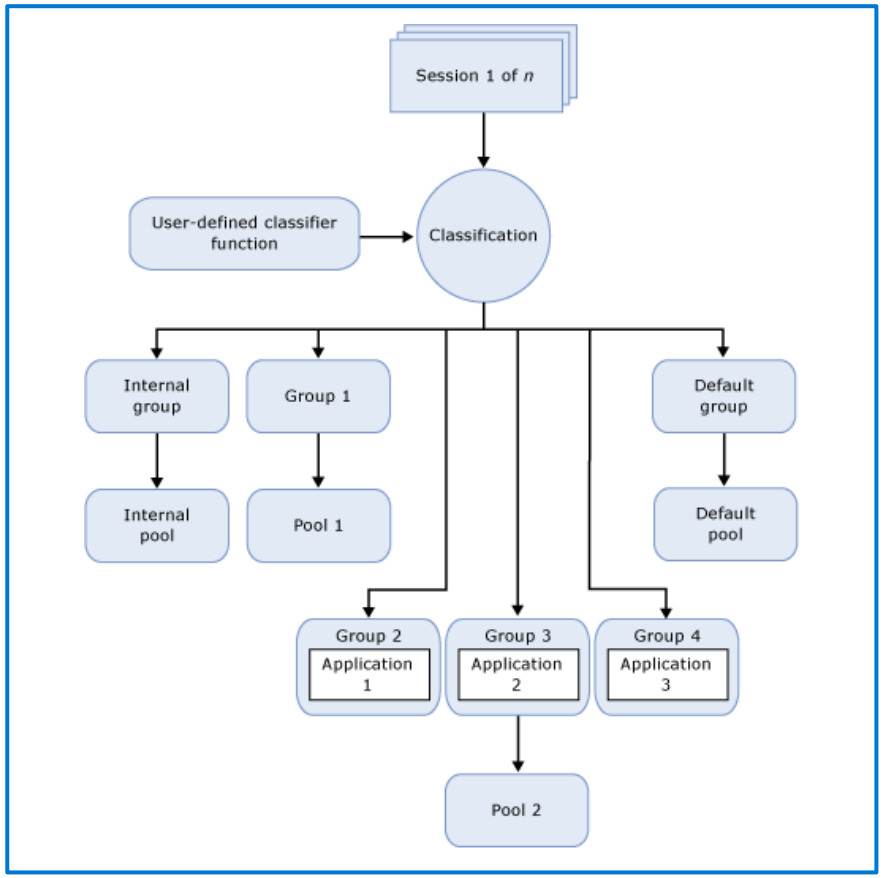
TempDB should have the same number of data files as the server has CPU cores, up to 8



The data files should all be the same size and have the same autogrowth settings

# Resource Governor

- Allows to balance conflicting workloads that have different resource demands at different times
- Workloads are divided into resource pools which allow you to limit CPU, memory, and IOPs for user sessions
- Workloads are classified using a classifier function

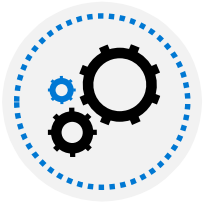



## Resource Governor components:

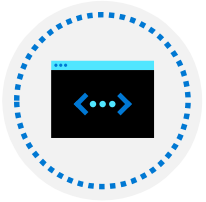
| Resource pool | Workload group | Classification |
| --- | --- | --- |

# Configure databases for optimal performance

# Objectives



Understand database scoped configuration options



Understand the features of Intelligent Query Processing (IQP)

Explore the automatic tuning feature in Azure

Understand related maintenance tasks related to indexing and statistics

# SQL Server maintenance activities

Databases need regular maintenance activities. Some common examples of these activities include:

- **Database Backups**
- **Database Consistency Checks**
- **Index Maintenance**
- **Statistics Updates**

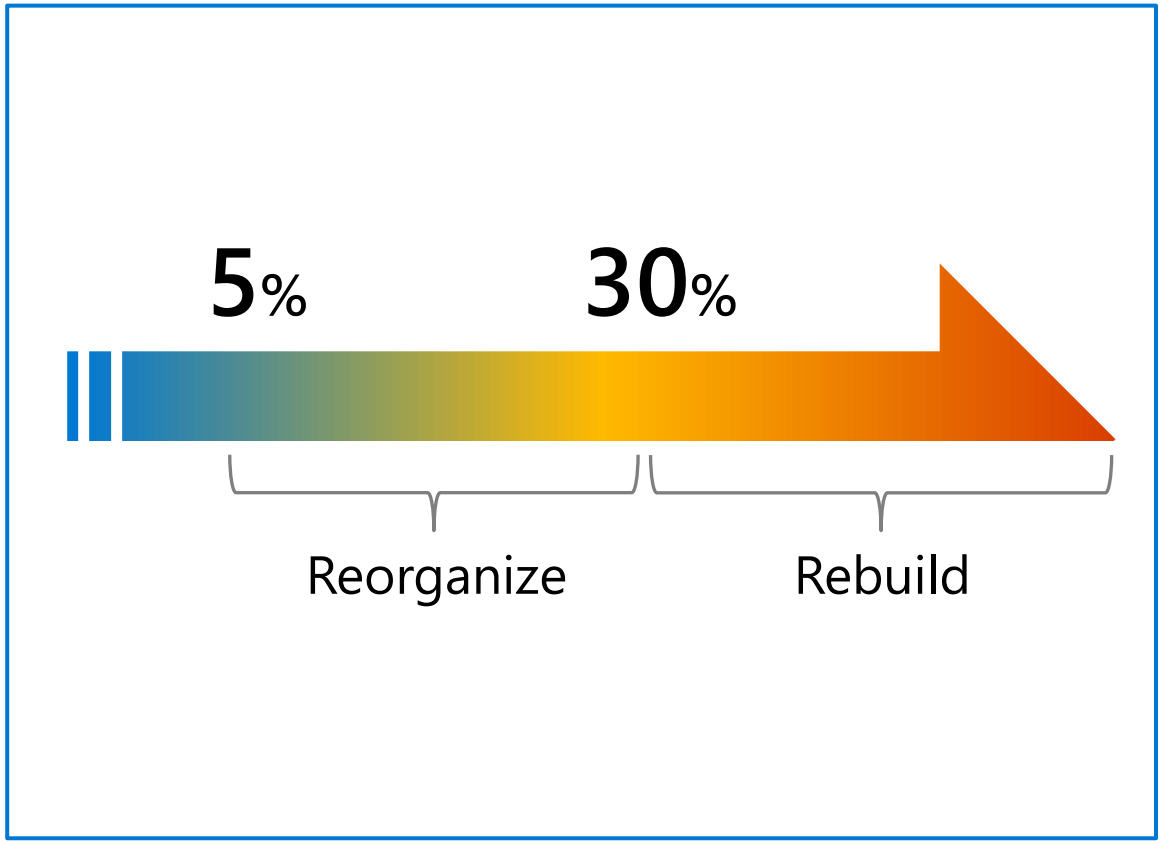
# Fragmentation in data files

- Fragmentation in database files can occur within indexes or tables
  - As data is inserted and updated, records can move into pages which no longer match the physical ordering of the data pages on the disk
    - Fragmentation can degrade the performance of queries
      - Fragmentation can be reduced by **reorganizing** or **rebuilding indexes**

# Index maintenance tasks

## Indexes should be regularly rebuilt and reorganized as they reach defined levels of fragmentation

SQL Server and Azure SQL support resumable index maintenance as well as online index rebuilds to allow your workload to continue as maintenance operations occur



# Index maintenance tasks – REORGANIZE vs. REBUILD

| Reorganize | Rebuild |
| --- | --- |
| • Physically reorder the leaf-level index pages to match the logical sorted order of the leaf nodes | • Drops and recreates the pages of the index |
| • Compacts the index pages based on the index's fill factor setting | • Causes the statistics to be updated |
| • It is an **online** activity | • Can be either online or offline |
| | • When fragmentation is greater than **30%** |
| `ALTER INDEX ALL ON Production.Product REORGANIZE` | `ALTER INDEX ALL ON Production.Product REBUILD` |

# Index maintenance tasks on SQL Server

Since you have the full surface area of Windows and SQL Server (including the SQL Server Agent) you can use the Agent to perform maintenance activities

If you are migrating from on-premises your maintenance activities should be the same as your on-premises workloads

You can use **SQL Agent** or **Task Scheduler** to create custom maintenance jobs

# Index maintenance tasks on Azure SQL Database

While the Azure platform performs activities like consistency checks and backups, index and statistics maintenance are still the responsibility of the DBA

Azure SQL Database does not have the SQL Server Agent, but there are other options for scheduling tasks:

- Azure Automation Runbooks
- Azure SQL Elastic Jobs
- SQL Agent Job from SQL Server in an Azure VM

# Index maintenance tasks on Azure SQL Managed Instance

Azure SQL Managed Instance includes the **SQL Agent** and the MSDB database

This means you can used scheduled tasks like on-premises servers or Azure VMs

Any tasks that need to access the file system will need to be modified as that is not supported

# Statistics maintenance tasks

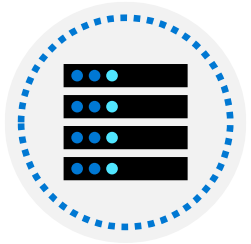

The database engine uses statistics on columns and indexes to build execution plans

It is important that statistics be kept up to date for all objects

SQL Server defaults to having auto-update statistics on

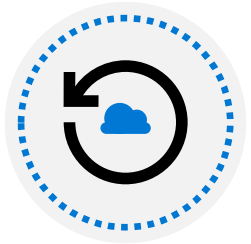
The database engine uses a sliding scale to determine the number of modifications required to kick off a statistics update

# Database scoped configuration options



**Databases have two types of configuration options, which are defined based on how they are set:**

- Database Scoped Configuration options are configured using ALTER DATABASE SCOPED CONFIGURATION syntax
- Database options are configured using ALTER DATABASE SET syntax



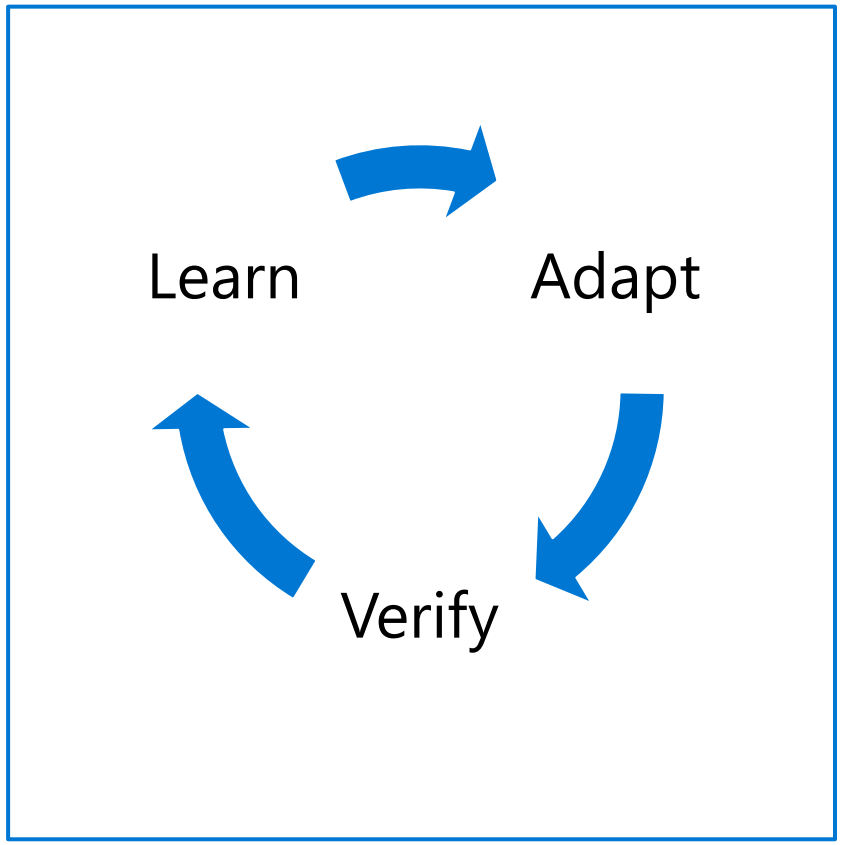
**Options include recovery model, isolation level, automatic tuning, and the Intelligent Query Processing features**

# Automatic tuning

SQL Server and Azure SQL Database have an automatic tuning features that uses the query store for a data source

This can be helpful for sudden unexpected query execution plan changes that cause regressions in performance

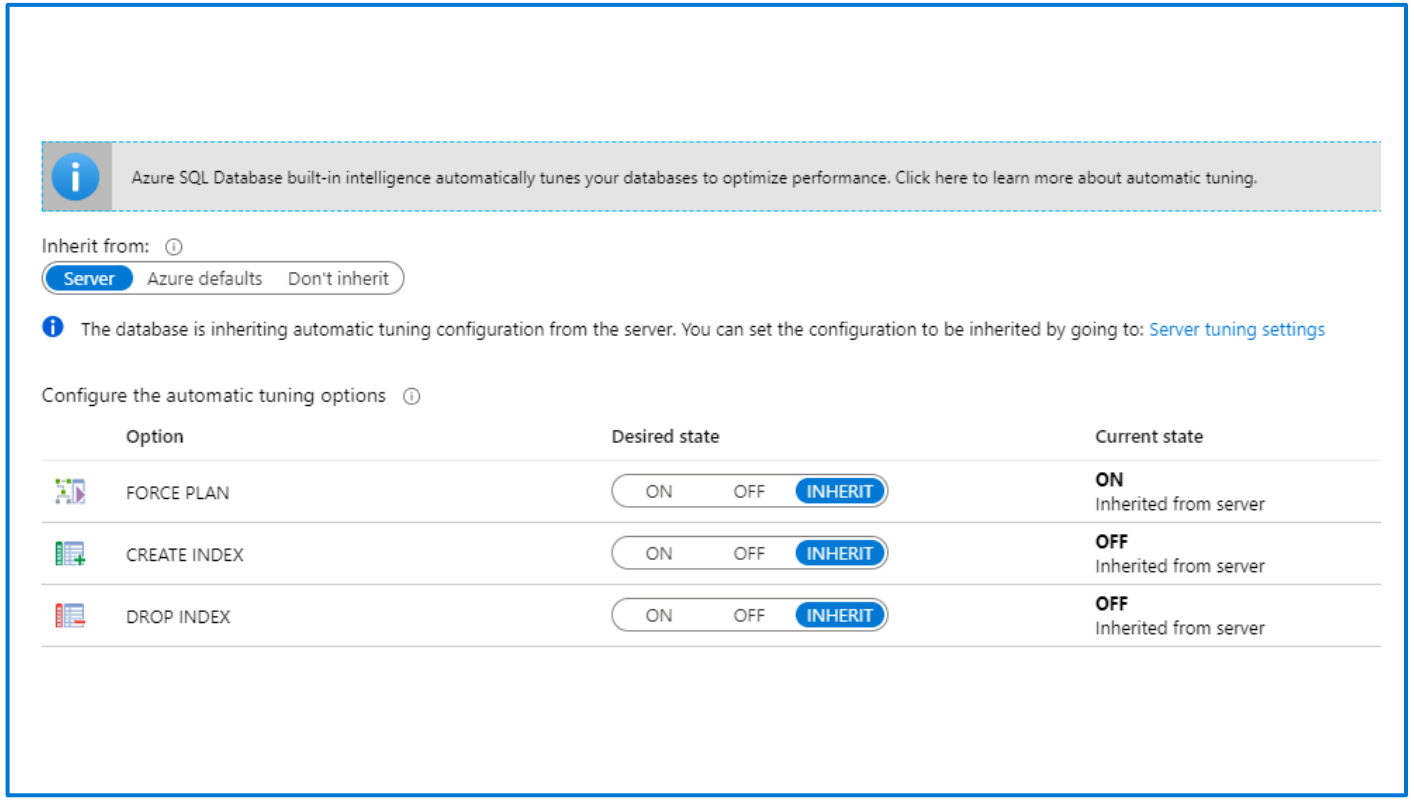
Automatic tuning will revert to the last known good execution plan after fifteen executions of a significantly regressed query



# Automatic index management

Azure SQL Database supports index analysis through automatic index management

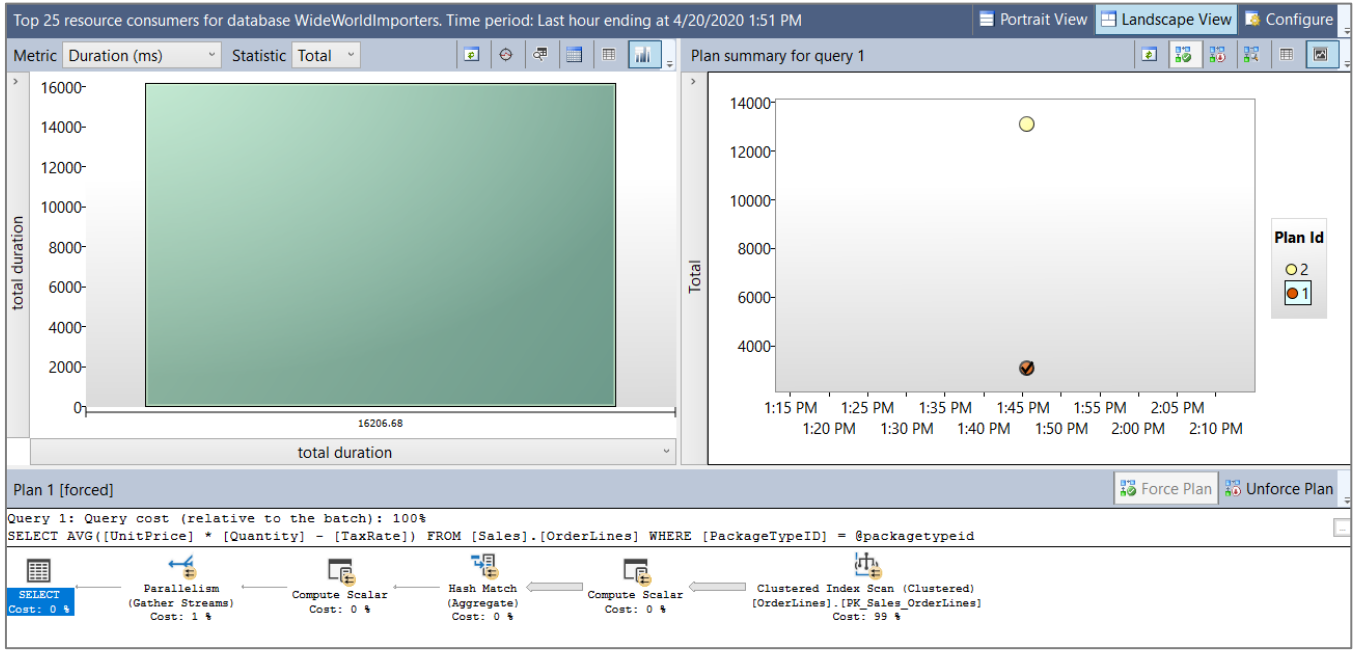
This feature can add and remove indexes, in addition to forcing a better execution plan in the event of a regression



# Automatic plan correction

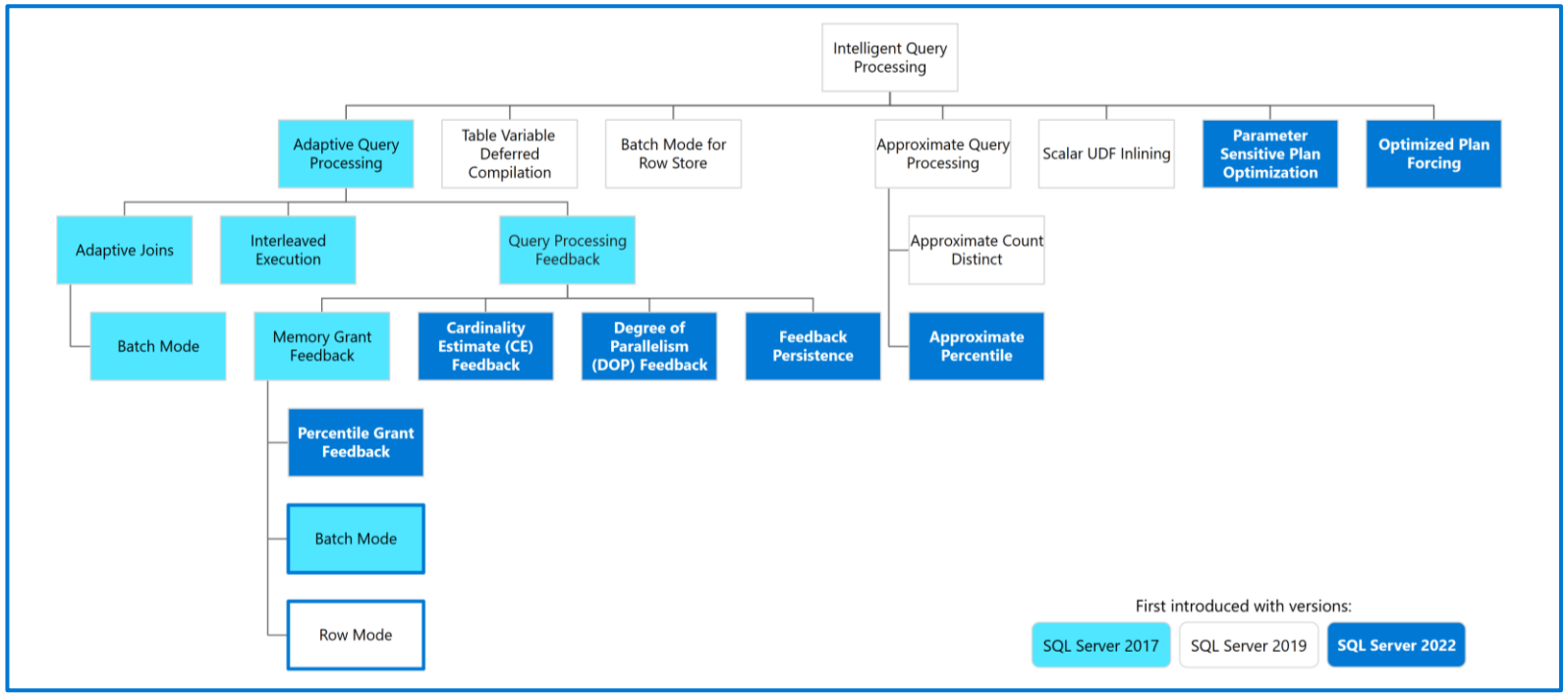
Identifies when query execution plans have regressed in their performance

ALTER DATABASE [<Database Name>] SET AUTOMATIC_TUNING (FORCE_LAST_GOOD_PLAN = ON);

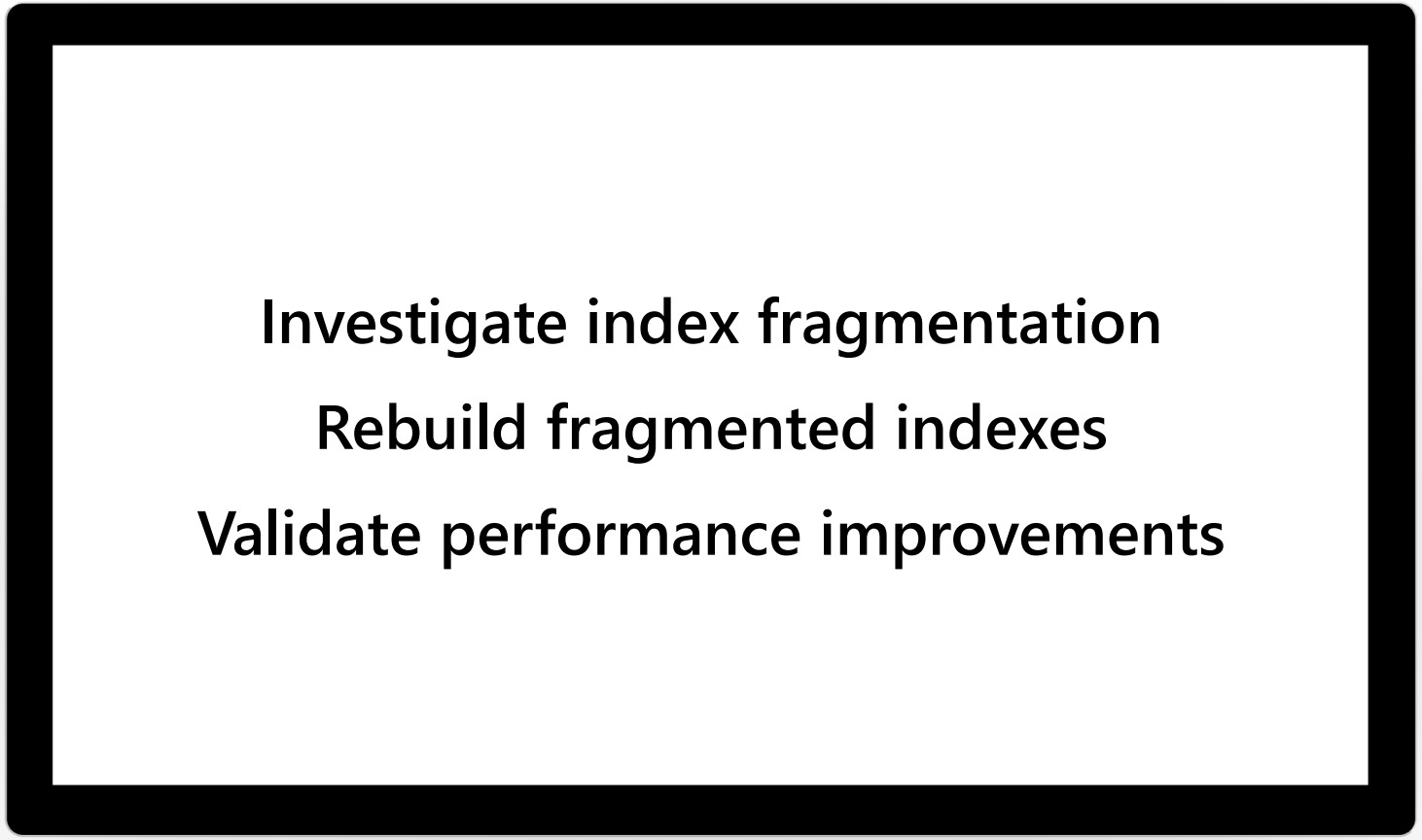


# Intelligent Query Processing (IQP)

Intelligent query processing is a family of features that allows the database engine to make better choices to provide better overall performance.



# Instructor led labs: Detect and correct fragmentation issues



# Summary

**Describe performance monitoring:**

- Understanding methods to review potential performance issues
- Identify critical Azure metrics
- Explore Azure SQL Insights

**Configure SQL Server resources for optimal performance:**

- Understand your options and configuration for Azure Storage
- Learn how to configure TempDB data files in SQL Server
- Understand Resource Governor in SQL Server

**Configure databases for optimal performance:**

- Understand Database Scoped Configuration Options
- Understand related maintenance tasks related to indexing and statistics
- Obtain knowledge on the auto-tuning feature in Azure