Microsoft

Non-Clustered Index Types

Agenda

- Unique Index
- Filter Index
- Index with Computed Columns

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Unique Index

Unique Index

- Ensures **uniqueness** of column values in a table (data integrity).
- Useful for columns that **must not contain duplicates**,
  - **Example**: NationalIDNumber , Email
- Can be **single-column or multi-column** (combinations must be unique)
  - **Example of multicolumn**: LastName and DepartmentID
- Can be **clustered or non-clustered**.
- Helps **query optimizer** by providing additional info for efficient execution plans.

Usage

EmployeeID	Name	Dept	NationalID
101	Ali	IT	NID123
102	Sarah	CS	NID124
103	Omer	Physics	NID125
104	Ben	Math	NID126

Creating Index:

```
CREATE UNIQUE INDEX UX_Employees_NID
ON Employees(NationalIDNumber);
```

Query

```
SELECT * FROM Employees WHERE
NationalIDNumber = 'NID124';
```

SQL Server searches the **unique index** → finds exact row → retrieves data quickly.

How it works:

- On Insert, SQL Server checks leaf nodes of the unique index.
- If NationalID exists, insertion fails (error).
- If not: insertion succeeds, row added in B+ tree leaf node.

Unique Constraint vs Unique Index

Unique Constraints:

- No concept of filtered or covering index. Only applied to the column
- Tied to table definition
- ALTER TABLE …

Unique Index:

- Supports **filtered indexes** and **included columns**
- **Can be included or dropped independent of the table**
- DROP INDEX <index_name> ON <db.schema.tablename>;

Question

What should happen if Unique constraint is applied to an existing column with non-unique values?

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Filtered Index

Filtered Index

Non-clustered index that is created on a subset of rows in a table, defined by a filter condition (WHERE clause).

- **Subset of data** → Index only rows you care about
  - Example: WHERE **EndDate** IS NOT NULL
- **Sparse columns** → Great for columns with mostly NULL values.
- **Heterogeneous categories** → When table has categories (e.g., Product types), create index only for specific category.
- **Range queries** → Dates, prices, amounts where only a certain range matters.
  - Example: WHERE ID > 2 AND ID < 5

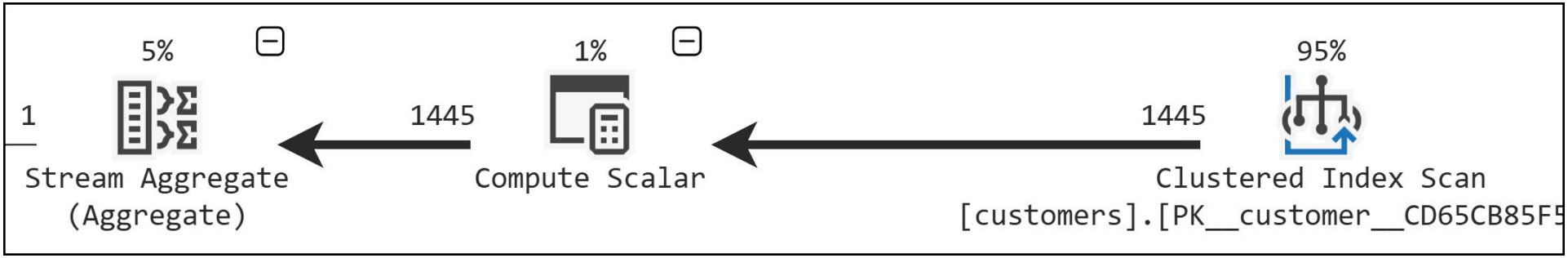
Filtered Index – Architecture

- It’s a **non-clustered index** → built on **only rows that meet condition**.
- Has **key columns + optional included columns** (just like normal non-clustered index).
- Automatically stores **clustered key (or RID in heap)** as row locator.
- Storage is smaller → because it ignores unneeded rows.

Example: Filtered Indexes (cont…)

```
SELECT
    SUM(CASE
            WHEN phone IS NULL
               THEN 1
               ELSE 0
          END) AS [Has Phone],
    SUM(CASE
            WHEN phone IS NULL
               THEN 0
               ELSE 1
          END) AS [No Phone]
FROM
    sales.customers;
```

Example: Filtered Indexes (cont...)



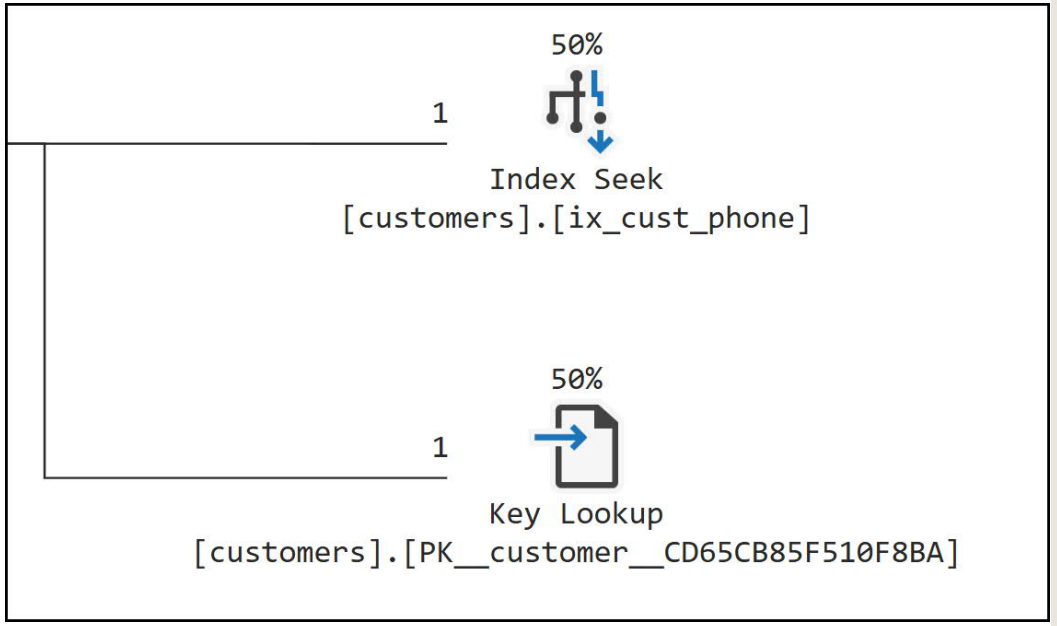
Example: Filtered Indexes (cont…)

```
CREATE INDEX ix_cust_phone
  ON sales.customers(phone)
WHERE
  phone IS NOT NULL;
```

```
SELECT
    first_name,
    last_name,
    phone
FROM
    sales.customers
WHERE phone = '(281) 363-3309';
```

Query Plan!

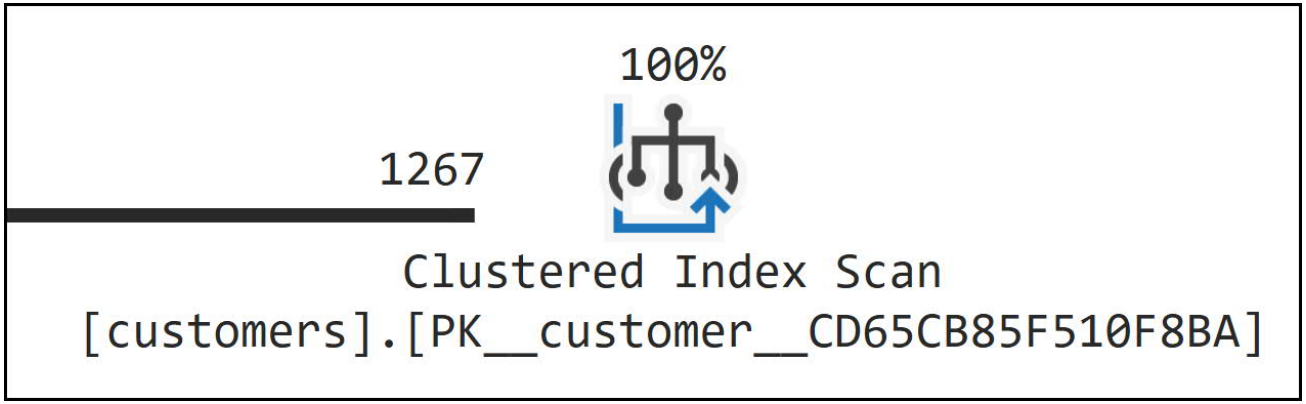
```
SELECT
    first_name,
    last_name,
    phone
FROM
    sales.customers
WHERE
  phone = '(281) 363-3309';
```



Updated Query

```
SELECT
    first_name,
    last_name,
    phone
FROM
    sales.customers
WHERE phone is null;
```

Why???



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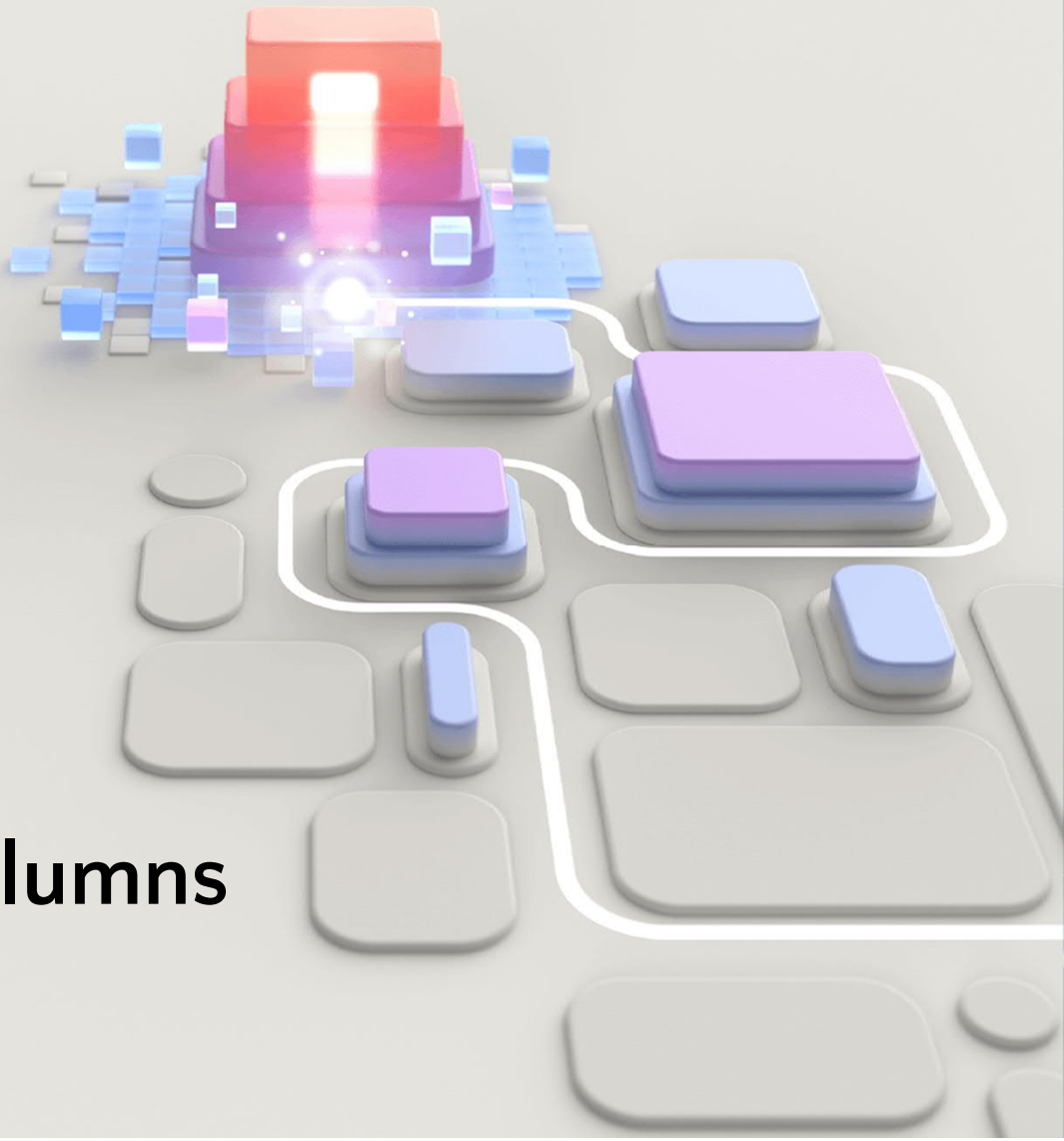


Index with Computed Columns

Index with Computed Columns

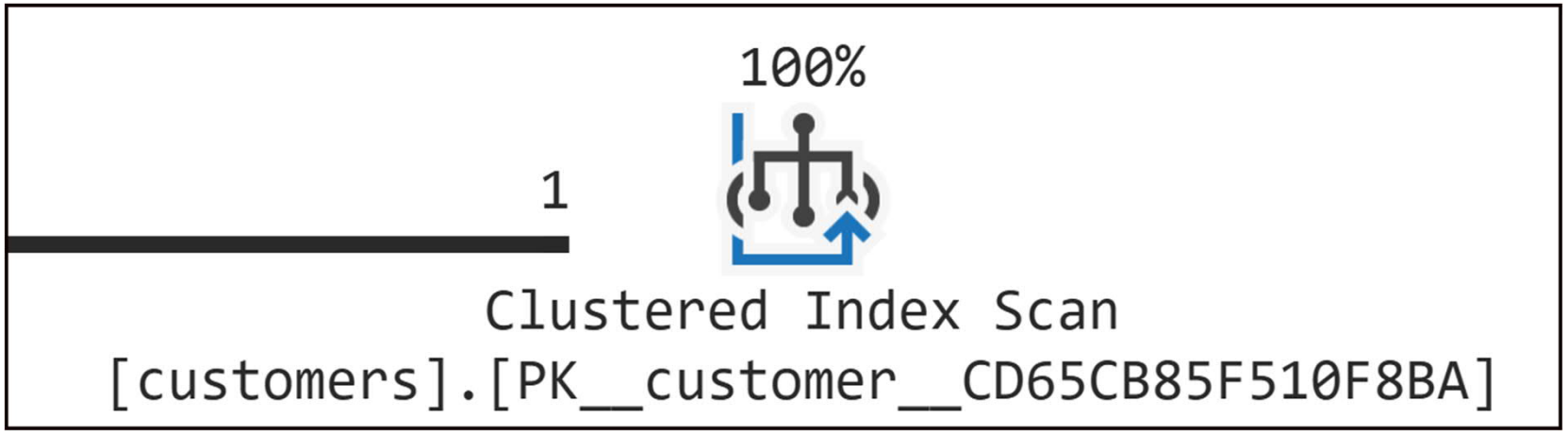
- Improve query performance when queries filter, sort, or join based on **computed expressions**.
- Allows **deterministic and precise computed columns** to be indexed like regular columns.
- Useful when frequently querying **calculated values** derived from table columns, avoiding repeated computation.

Problem Domain:

- Queries depend on expressions like
  - *TotalPrice = Quantity * UnitPrice*
  - or string/date manipulations.
- Without an index, SQL Server must **compute the value on the fly** for every row resulting in slower queries.

Example: Query with computed column index

```
SELECT  first_name, last_name, email
FROM sales.customers
WHERE
    substring(email, 0, CHARINDEX('@', email, 0)) =
    garry.espinoza';
```



Example (cont...)

```
ALTER TABLE sales.customers
   ADD email_alias AS
       SUBSTRING(email, 0, CHARINDEX('@',
email, 0) );
```

```
CREATE INDEX ix_email_alias
ON sales.customers(email_alias);
```

Example (cont...)

```
CREATE INDEX ix_email_alias
ON sales.customers(email_alias);
```

Updated Query using computed column:

```
SELECT   first_name, last_name, email
FROM     sales.customers
WHERE    email_alias = 'garry.espinoza';
```

Example (cont...)