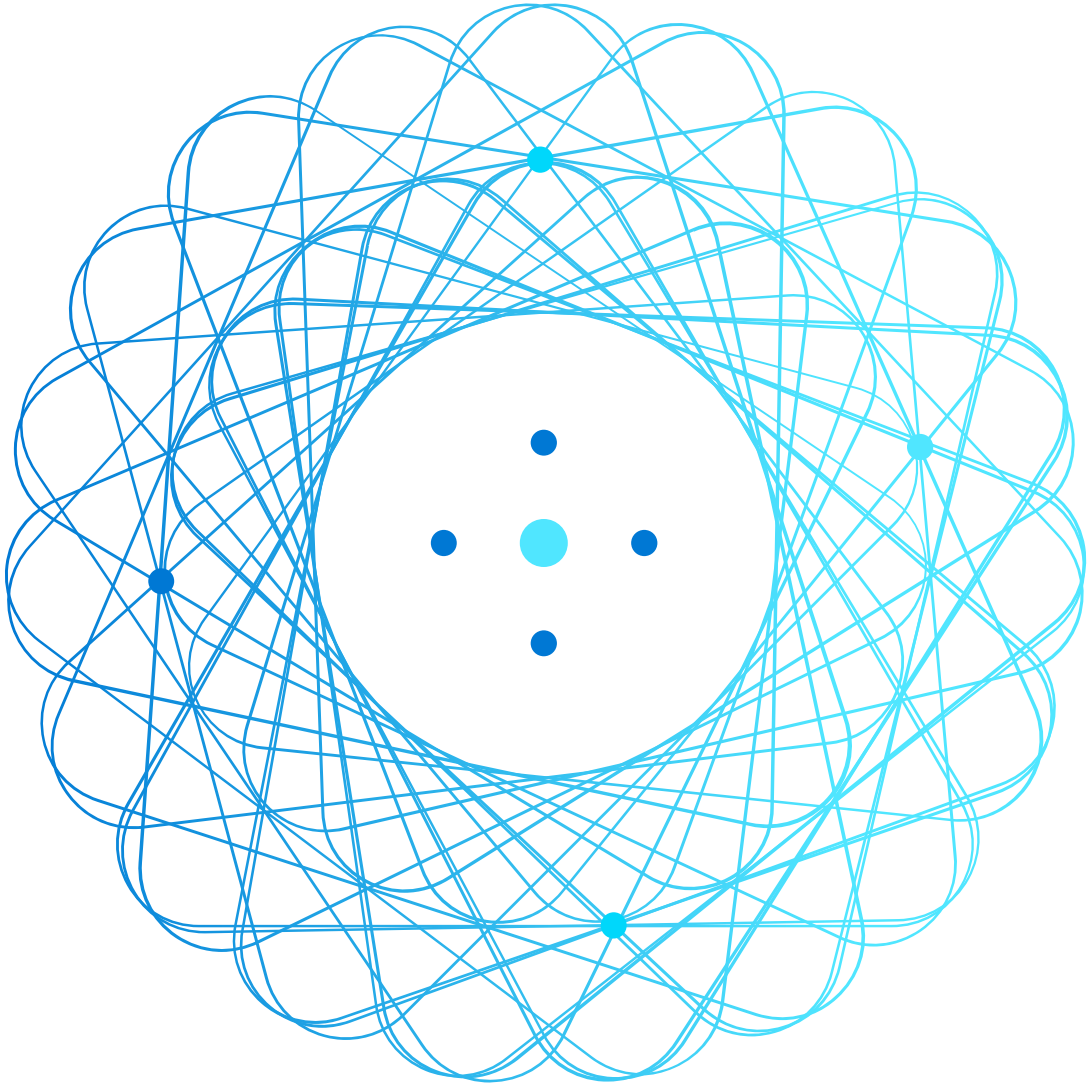
Microsoft Azure

Work with data warehouses using Azure Synapse Analytics



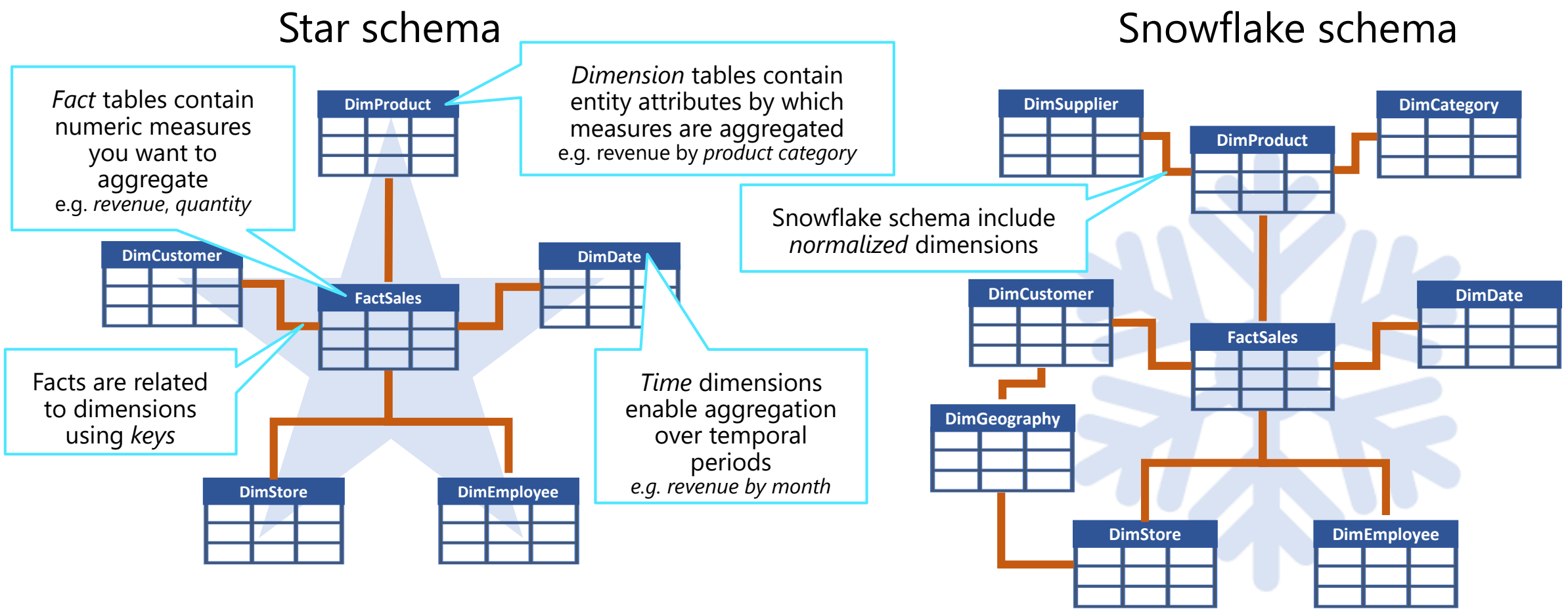
Agenda

Analyze data in a relational data warehouse

Load data into a relational data warehouse

Analyze data in a relational data warehouse

Design a data warehouse schema



Dimension keys

Surrogate key

- Uniquely identifies an instance of a dimension entity (i.e. a row)
- Usually a simple integer value
- Must be unique in the dimension table

Alternate key

- Identifies an entity in the operational source system
- Often a *business* key (e.g. a product code or customer ID) or a *natural* key (e.g. a datetime value in a time dimension)
- Can be duplicated in the dimension table to represent the same entity at different points in time

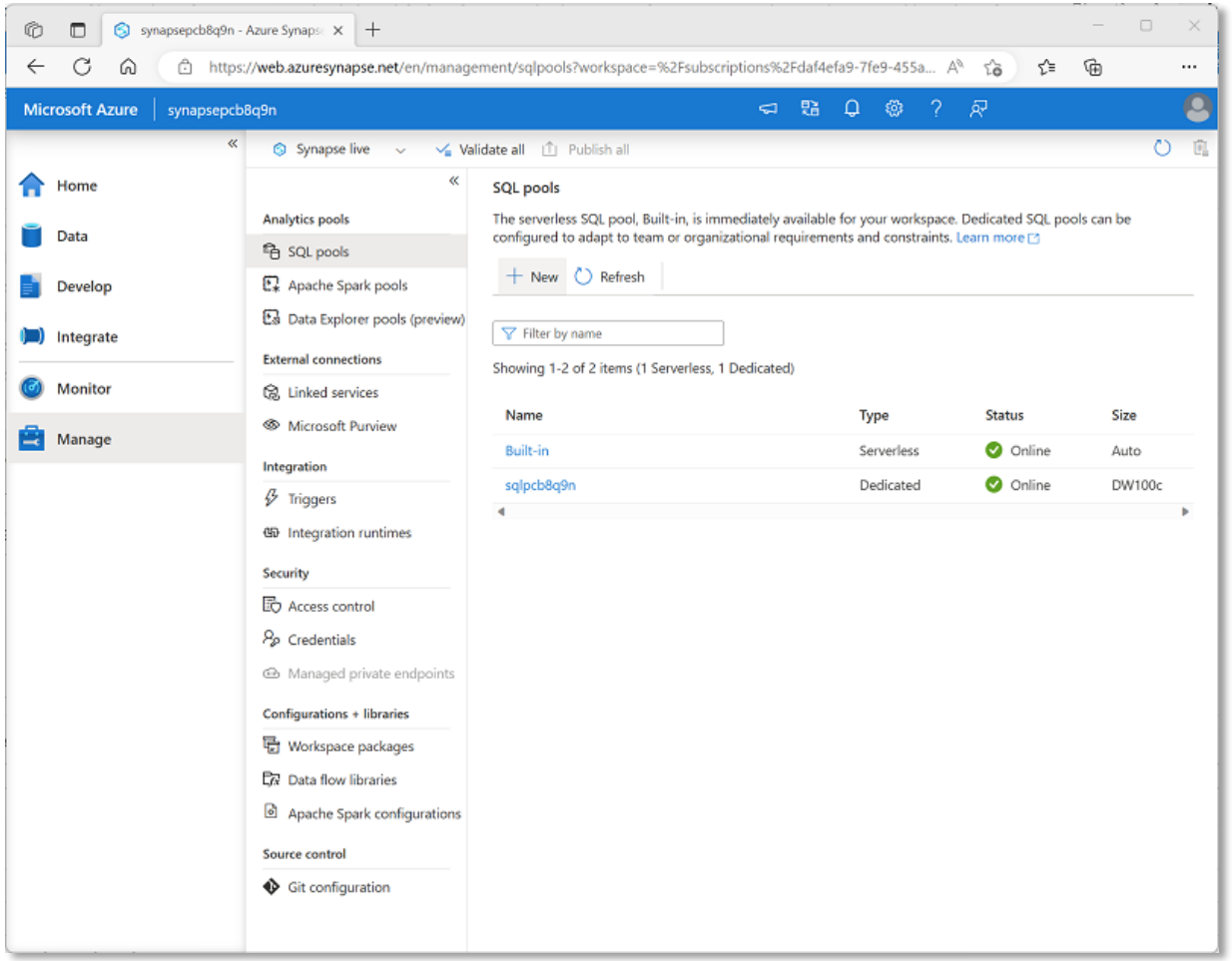
CustomerKey	CustomerAltKey	Name	Email	Street	City	PostalCode	CountryRegion
123	I-543*	Navin Jones	navin1@contoso.com	1 Main St.	Seattle	90000	United States
124	R-589	Mary Smith	mary2@contoso.com	234 190th Ave	Buffalo	50001	United States
125	I-321	Antoine Dubois	antoine1@contoso.com	2 Rue Jolie	Paris	20098	France
126	I-543*	Navin Jones	navin1@contoso.com	24 125th Ave.	New York	50000	United States
...	...	...	...	...	...	...	...

* *This customer moved from Seattle to New York, so a new record with the same alternate key but a new surrogate key was added.*

Create a relational data warehouse in Azure Synapse Analytics

Create a *dedicated* SQL pool

- Specify name and size
- Pause and resume pool as needed
- The pool provides a relational database instance in which you can create, load, and query tables



Considerations for creating data warehouse tables

Data integrity constraints

- Foreign key and unique constraints are not supported
- You must implement logic to ensure referential integrity between facts and dimensions

Indexes

- The default index type is CLUSTERED COLUMNSTORE – use this in most cases
- For field types not supported in COLUMNSTORE indexes, use a CLUSTERED index on appropriate columns

Data distribution

- Use **hash** distribution to distribute fact tables across compute nodes
- Use **replicated** distribution for small dimension tables to avoid data shuffling; but for dimension tables too large to store on each compute node, use **hash** distribution
- Use **round-robin** distribution for staging tables to evenly distribute data across compute nodes

```
CREATE TABLE schema.table_name
(
  column_name DATA_TYPE, NULLABILITY,
  ...
)
WITH
(
  DISTRIBUTION = HASH(column_name)
               | REPLICATE
               | ROUND_ROBIN,
  INDEX_TYPE
)
```

External tables

Use external tables to define table metadata for files in a data lake

- Data is managed independently from the table
- Useful for reading data into staging tables directly from the data lake

```
CREATE EXTERNAL DATA SOURCE StagedFiles
WITH (
    LOCATION = 'https://…/file/location'
);
GO

CREATE EXTERNAL FILE FORMAT ParquetFormat
WITH (
    FORMAT_TYPE = PARQUET,
    DATA_COMPRESSION =
            'org.apache.hadoop.io.compress.SnappyCodec'
);
GO

CREATE EXTERNAL TABLE dbo.ExternalStageProduct
(
    ProductID NVARCHAR(10) NOT NULL,
    ProductName NVARCHAR(200) NOT NULL,
    …
)
WITH
(
    DATA_SOURCE = StagedFiles,
    LOCATION = folder_name/*.parquet',
    FILE_FORMAT = ParquetFormat
);
GO
```

Knowledge check

In which of the following table types should an insurance company store details of customer attributes by which claims will be aggregated?

- ❑ Staging table
- ☑ Dimension table
- ❑ Fact table

You create a dimension table for product data, assigning a unique numeric key for each row in a column named ProductKey. The ProductKey is only defined in the data warehouse. What kind of key is ProductKey?

- ☑ A surrogate key
- ❑ An alternate key
- ❑ A business key

What distribution option would be best for a sales fact table that will contain billions of records?

- ☑ HASH
- ❑ ROUND_ROBIN
- ❑ REPLICATE

Load data into a relational data warehouse

Load staging tables

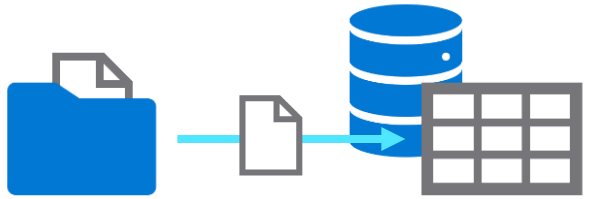
Use an external table to query files in the data lake

Staged data is read directly from files

```
CREATE EXTERNAL TABLE dbo.ExternalStageProduct
(
    ProductID NVARCHAR(10) NOT NULL,
    ProductName NVARCHAR(200) NOT NULL,
    …
)
WITH
(
    DATA_SOURCE = StagedFiles,
    LOCATION = folder_name/*.parquet',
    FILE_FORMAT = ParquetFormat
);
GO
```

or

Use COPY to load data from files into the database



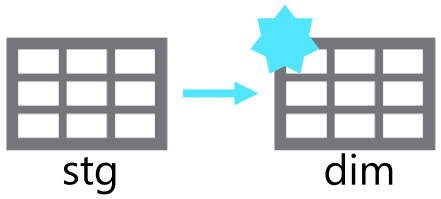
Staged data is loaded into database

Best practice for optimal load performance

```
COPY INTO dbo.StageProduct
    (ProductID, ProductName, …)
FROM 'https://mydatalake…/data/products/*.parquet'
WITH
(
    FILE_TYPE = 'PARQUET',
    MAXERRORS = 0,
    IDENTITY_INSERT = 'OFF'
);
```

Load dimension tables from staging tables

Use CREATE TABLE AS to create a new table



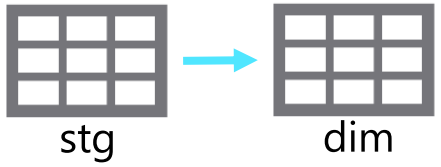
No support for IDENTITY surrogate key generation

Use a UNION to combine staged and existing data, then rename tables to replace old table with new one

```
CREATE TABLE dbo.DimProduct
WITH
(
    DISTRIBUTION = REPLICATE,
    CLUSTERED COLUMNSTORE INDEX
)
AS
SELECT ROW_NUMBER() OVER(ORDER BY ProdID) AS ProdKey,
       ProdID AS ProdAltKey,
       ProductName,
       ProductCategory,
       Color,
       Size,
       ListPrice,
       Discontinued
FROM dbo.StageProduct;
```

or

Use INSERT.. SELECT to load an existing table



Supports IDENTITY surrogate key in dimension table

Easier to implement for repeated loads than CTAS

```
INSERT INTO dbo.DimCustomer
SELECT CustomerNo AS CustomerAltKey,
       CustomerName,
       EmailAddress,
       Phone,
       StreetAddress,
       City,
       PostalCode,
       CountryRegion
FROM dbo.StageCustomers
```

Load time dimensions

- Initialize the table with the required timespan
- Extend by adding new rows periodically as required

Scripting this in SQL may be time-consuming in a dedicated SQL pool – it may be more efficient to prepare the data in Microsoft Excel or an external script and import it using the COPY statement

```
-- Create a temporary table for the dates we need
CREATE TABLE #TmpStageDate (DateVal DATE NOT NULL)

-- Populate the temp table with a range of dates
DECLARE @StartDate DATE
DECLARE @EndDate DATE
SET @StartDate = '2019-01-01'
SET @EndDate = '2022-12-31'
DECLARE @LoopDate DATE
SET @LoopDate = @StartDate
WHILE @LoopDate <= @EndDate
BEGIN
    INSERT INTO #TmpStageDate VALUES
    (
        @LoopDate
    )
    SET @LoopDate = DATEADD(dd, 1, @LoopDate)
END

-- Insert the dates and calculated attributes into the dimension table
INSERT INTO dbo.DimDate
SELECT  CAST(CONVERT(VARCHAR(8), DateVal, 112) AS int) , -- date key
        DateVal, -- date alt key
        Day(DateVal)  -- day number of month
        -- ,other derived temporal fields as required
FROM #TmpStageDate
GO
```

Load slowly changing dimension tables

Types of slowly changing dimensions

Type 0: No changes allowed

DateKey	DateAltKey	Day	Month	Year
20230101	01-01-2023	Sunday	January	2023

Type 1: Changes made inline in dimension row

StoreKey	StoreAltKey	StoreName
123	EH199J	~~High Street Store~~ Town Central Store

Type 2: Changes result in a new version of the dimension entity (a new row)

CustomerKey	CustomerAltKey	Name	Address	City	DateFrom	DateTo	IsCurrent
1211	jo@contoso.com	Jo Smith	9999 Main St	Seattle	20190101	20230105	False
2996	jo@contoso.com	Jo Smith	1234 9th Ave	Boston	20230106		True

Load slowly changing dimension tables

Loading techniques

Combine INSERT and UPDATE statements

```
-- New customers
INSERT INTO dbo.DimCustomer
SELECT stg.*
FROM dbo.StageCustomers AS stg
WHERE NOT EXISTS
    (SELECT * FROM dbo.DimCustomer AS dim
     WHERE dim.CustomerAltKey = stg.CustNo);

-- Type 1 updates (name)
UPDATE dbo.DimCustomer
SET CustomerName = stg.CustomerName
FROM dbo.StageCustomers AS stg
WHERE dbo.DimCustomer.CustomerAltKey = stg.CustNo;

-- Type 2 updates (StreetAddress)
INSERT INTO dbo.DimCustomer
SELECT stg.*
FROM dbo.StageCustomers AS stg
JOIN dbo.DimCustomer AS dim
ON stg.CustNo = dim.CustomerAltKey
AND stg.StreetAddress <> dim.StreetAddress;
```

or

Use the MERGE statement

```
MERGE dbo.DimProduct AS tgt
    USING (SELECT * FROM dbo.StageProducts) AS src
    ON src.ProductID = tgt.ProductBusinessKey
WHEN MATCHED THEN
    -- Type 1 updates
    UPDATE SET
        tgt.ProductName = src.ProductName,
        tgt.ProductCategory = src.ProductCategory
        tgt.Color = src.Color,
        tgt.Size = src.Size,
        tgt.ListPrice = src.ListPrice,
        tgt.Discontinued = src.Discontinued
WHEN NOT MATCHED THEN
     -- New products
    INSERT VALUES
        (src.ProductID,
         src.ProductName,
         src.ProductCategory,
         src.Color,
         src.Size,
         src.ListPrice,
         src.Discontinued);
```

Perform post-load optimization

Rebuild indexes

```
ALTER INDEX ALL ON dbo.DimProduct REBUILD
```

Update statistics

```
CREATE STATISTICS productcategory_stats
ON dbo.DimProduct (ProductCategory);
```

Exercise: Load data into a data warehouse

Use the hosted lab environment provided, or view the lab instructions at the link below:

https://aka.ms/mslearn-load-data-into-warehouse

Knowledge check

In which order should you load tables in the data warehouse?

- [x] Staging tables, then dimension tables, then fact tables
- [ ] Staging tables, then fact tables, then dimension tables
- [ ] Dimension tables, then staging tables, then fact tables

Which command should you use to load a staging table with data from files in the data lake?

- [x] COPY
- [ ] LOAD
- [ ] INSERT

When a customer changes their phone number, the change should be made in the existing row for that customer in the dimension table. What type of slowly changing dimension is this?

- [ ] Type 0
- [x] Type 1
- [ ] Type 2

Further reading

Work with Data Warehouses using Azure Synapse Analytics
https://aka.ms/mslearn-synapse-data-warehouse