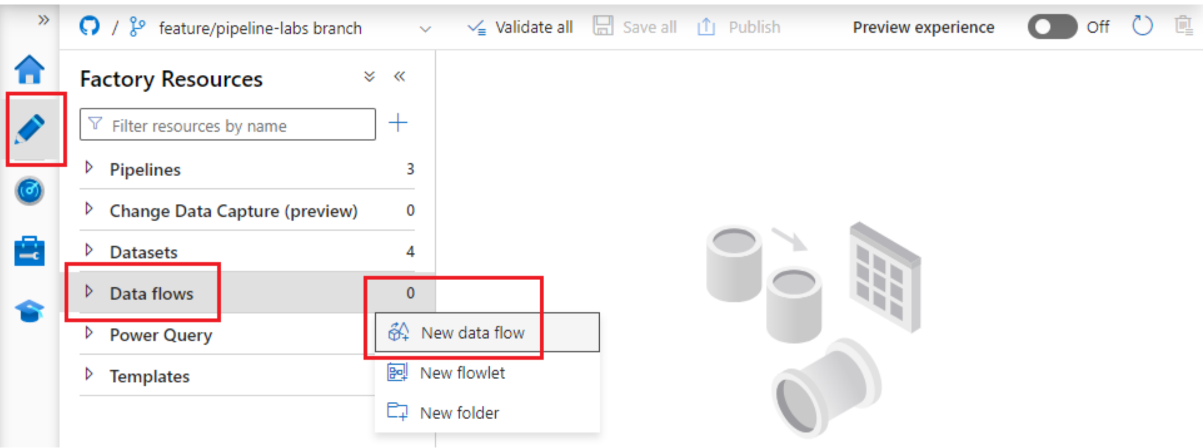
Lab 4 – Author a data flow

In this lab you will use an Azure Data Factory data flow to implement a familiar data warehousing process: maintaining a dimension table.

Lab 4.1 – Enable data flow debugging

Data flows are debugged using on-demand Apache Spark clusters. Provisioning a cluster takes a few moments, so start this lab by switching "Data flow debug" on for your ADF Studio session.

1. Navigate to ADF Studio's authoring canvas, then use the "Data flows Actions" menu to create a new dataflow.



2. The data flow design surface appears, with the usual "Properties" flyout on the right. Name the data flow "UpdateProductDimension" and dismiss the flyout.

3. Above the data flow canvas a "Data flow debug" toggle switch is visible. When you the move the switch to the right, the "Turn on data flow debug" flyout appears – click "OK" to accept the default options and to start provisioning the debug cluster.

While the debug cluster is warming up, continue with Lab 4.2.

Lab 4.2 – Create a delimited data lake dataset

The product dimension we will be building later in the lab will combine information from the Product, ProductSubcategory and ProductCategory files into a three-tier hierarchy. Reading data from those files in the data lake requires a dataset, but the binary dataset we have been using is not sufficient for the purpose – ADF must parse file data into columns to make each file available as a stream of records.

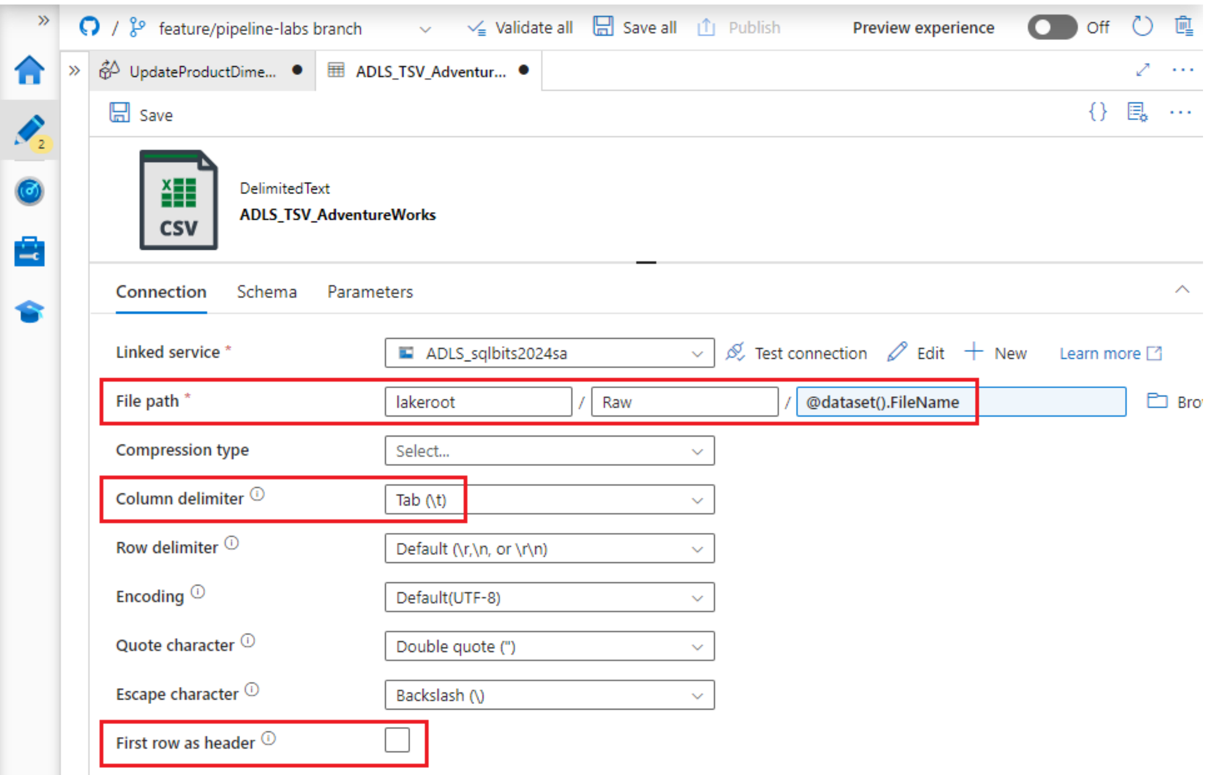
1. Create the new dataset as follows:

   - Choose the "Azure Data Lake Storage Gen2" data store.
   - Choose the "DelimitedText" file format. (The dataset must be created from scratch rather than cloned, because file format is not editable in a dataset clone).
   - Name the dataset "ADLS_TSV_AdventureWorks", and select your data lake linked service.
   - Leave the other options with their default values – we need to define a dataset parameter before we can properly complete them – and click OK.
   - Save the new dataset.

2. Define a dataset parameter called "FileName".

3. Configure options on the dataset's "Connection" tab:

   - Set the **File path** components to use the "lakeroot" file system, the "Raw" directory and the filename specified by the dataset parameter created in step 2.
   - Set **Column delimiter** to "Tab (\t)" – recall from Lab 2.4 that the files downloaded from GitHub are tab-separated, despite their ".csv" extensions.
   - Ensure that **First row as header** is unchecked – the files have no header row.



DelimitedText
ADLS_TSV_AdventureWorks

Linked service *: ADLS_sqlbits2024sa
File path *: lakeroot / Raw / @dataset().FileName
Compression type: Select...
Column delimiter: Tab (\t)
Row delimiter: Default (\r,\n, or \r\n)
Encoding: Default(UTF-8)
Quote character: Double quote (")
Escape character: Backslash (\)
First row as header: □

4. Verify that the dataset has been correctly configured by using the "Preview data" button to the right of the file path (not visible in the screenshot). You will be prompted for a filename parameter value – remember that, using the expression given in the screenshot, this must include the extension, e.g. "Product**.tsv**".

5. Save and close the new dataset definition.

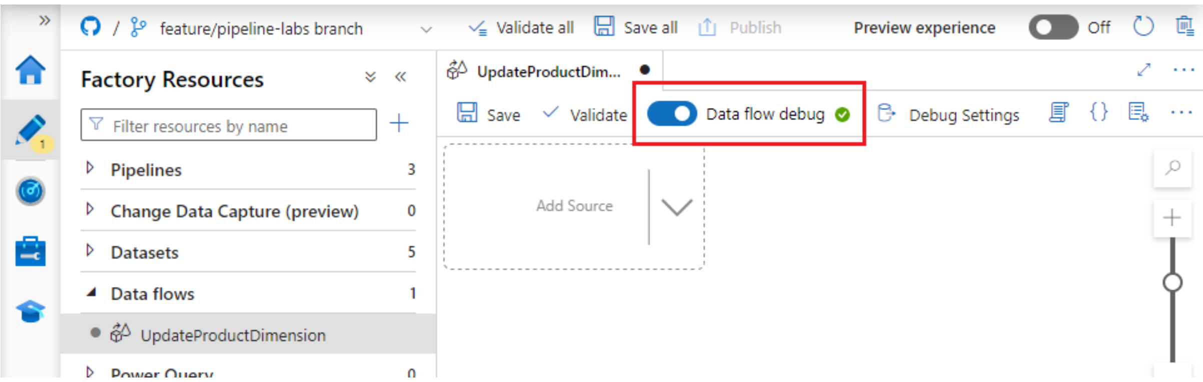
Lab 4.3 – Combine data lake datasets

The product dimension will combine product, subcategory, and category information to support different aggregations of facts that have a product attribute. An equivalent query to join three tables together in a SQL database would be:

```
SELECT
  p.ProductID
, p.[Name] AS Product
, sc.[Name] AS SubCategory
, c.[Name] AS Category
FROM dbo.Product p
  LEFT JOIN dbo.ProductSubcategory sc
    ON sc.ProductSubcategoryId = p.ProductSubcategory
  LEFT JOIN dbo.ProductCategory c ON c.ProductCategoryId = sc.ProductCategoryID
```

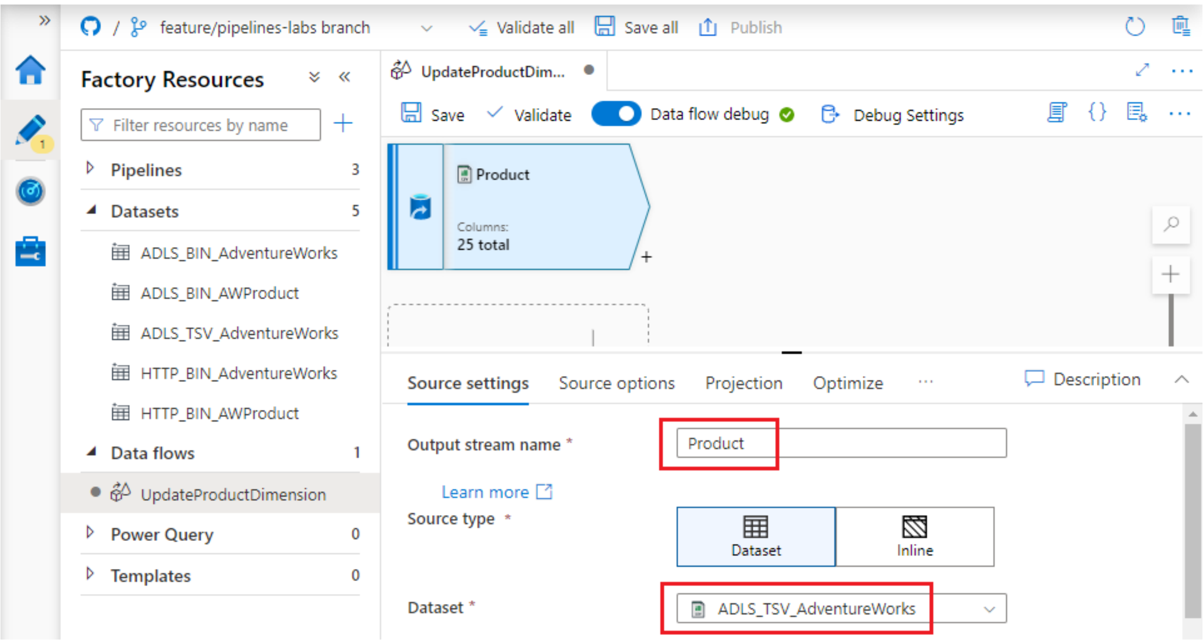
In this section you will use a data flow to produce this result in Azure Data Factory.

1. Return to the data flow you created in Lab 4.1 and check that the debug cluster has been successfully provisioned. When the cluster is available, a tick mark in a green circle appears to the right of the "Data flow debug" slider.



If the cluster is not ready yet, wait for it to finish warming up.

2. Click the "Add source" tile on the data flow canvas. On the source transformation's **Source settings** tab, change its "Output stream name" to "Product" and select the "ADLS_TSV_AdventureWorks" dataset.



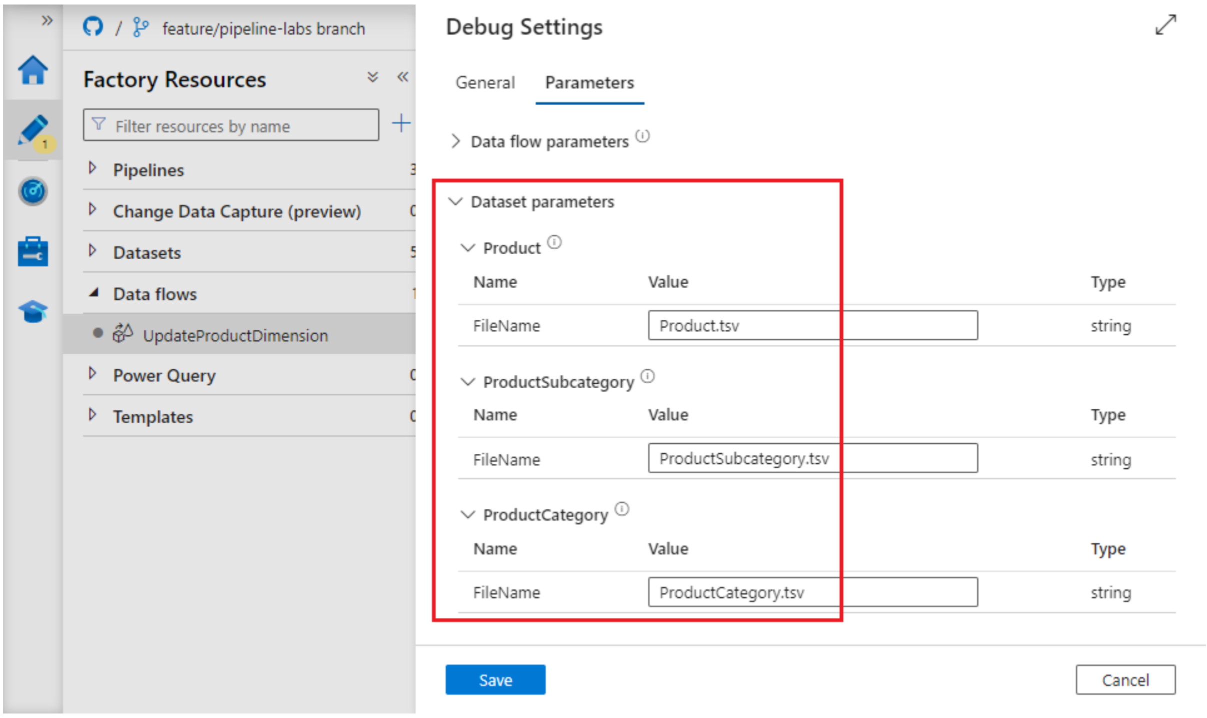
Output stream name * Product

Source type * Dataset

Dataset * ADLS_TSV_AdventureWorks

3. Repeat step 2 to add two more source transformations below "Product". Name one "ProductSubcategory" and the other "ProductCategory" – both should also use the "ADLS_TSV_AdventureWorks dataset.

4. At execution time, source dataset parameter values are specified from **outside** a data flow. To configure them during debug, click “Debug settings” in the data flow canvas header bar and choose the “Parameters” tab. Each dataset parameter appears in the “Dataset parameters” section – set each one appropriately and click “Save”.



Debug Settings

General | Parameters

Data flow parameters

Dataset parameters

Product

Name	Value	Type
FileName	Product.tsv	string

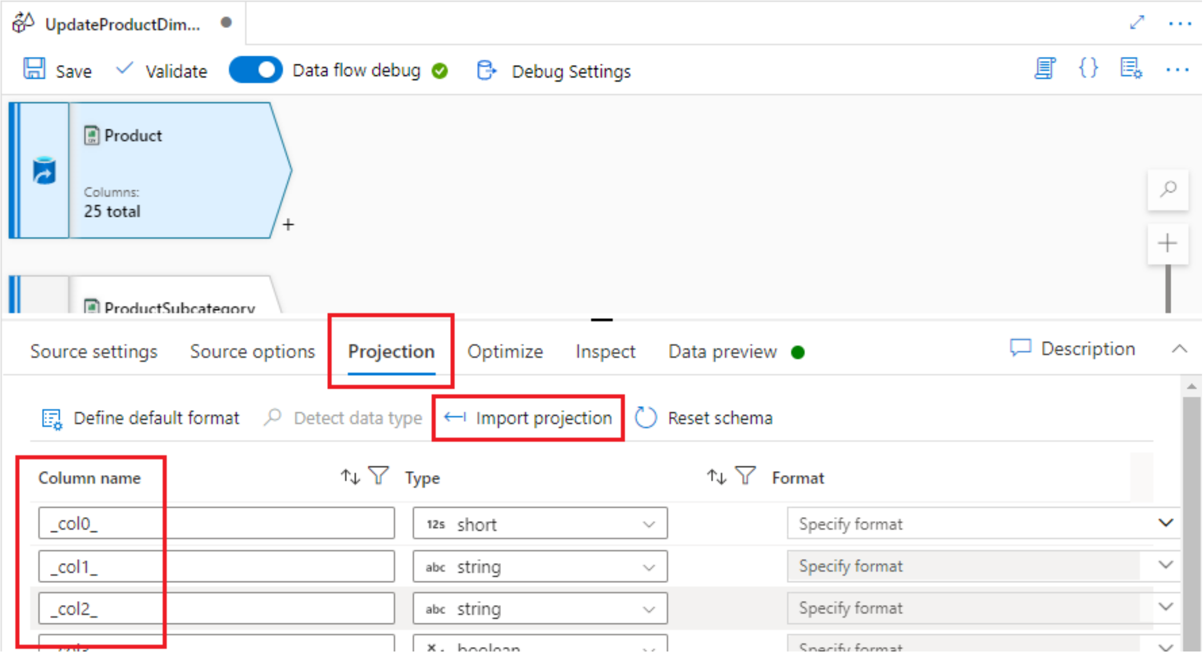
ProductSubcategory

Name	Value	Type
FileName	ProductSubcategory.tsv	string

ProductCategory

Name	Value	Type
FileName	ProductCategory.tsv	string

5. Return to the “Product” source transformation, select its “Projection” configuration tab and click “Import projection”. After a few moments, a schema will be inferred from the source file and presented in the tab.

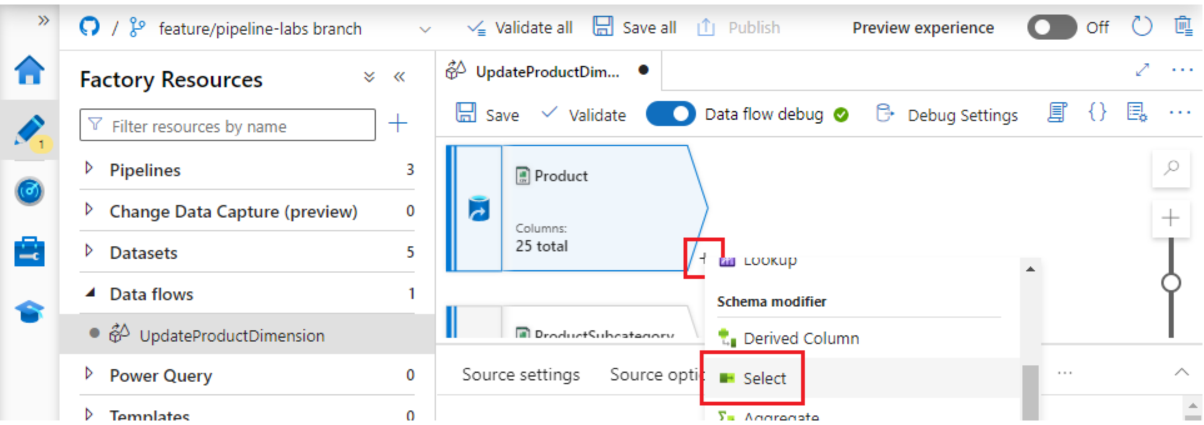


Column name	Type	Format
col0	short	Specify format
col1	string	Specify format
col2	string	Specify format
	boolean	Specify format

6. Notice that column names are autogenerated and not meaningful, because the source file contains no column headers. The projection tab is editable, so you can change column names and types as required. In the case of Product

- Rename “_col0_” to “ProductId” and ensure its type is “integer”
- Rename “_col1_” to “Product” and ensure its type is “string”
- Rename “_col18_” to “SubcategoryId” and ensure its type is “integer”

7. Use the “+” button at the bottom right of the “Product” transformation to append a “Select” transformation. The transformation allows you to remove and rename columns, without changing their types – remove all of the “_col…” named columns, leaving only the three columns you renamed in step 6.

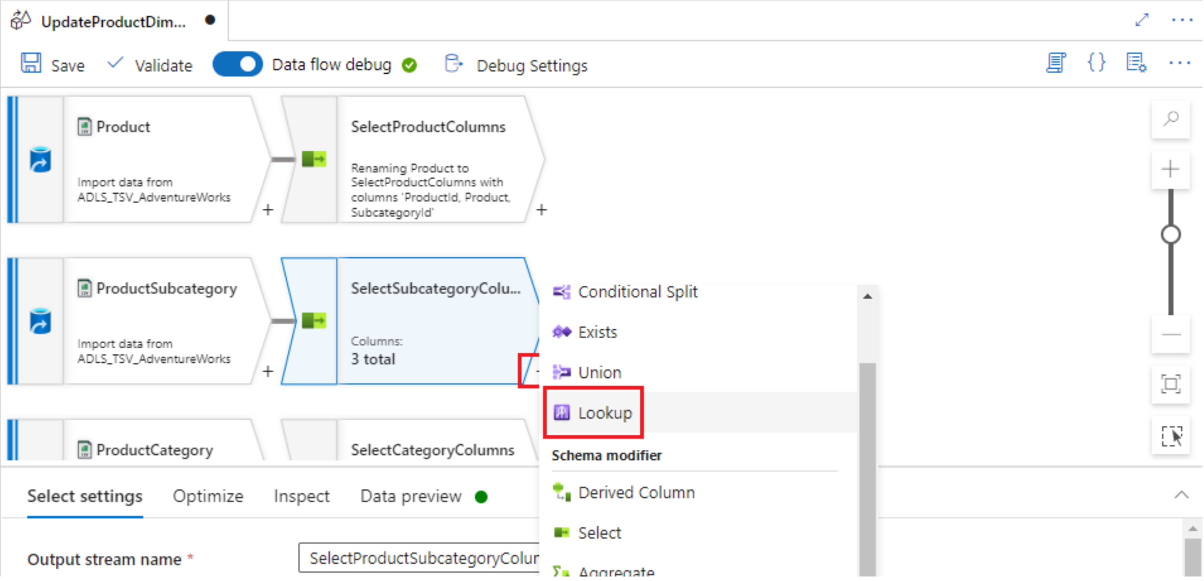


8. Repeat steps 5, 6 & 7 for the “ProductSubcategory” and “ProductCategory” source transformations. The names and types of columns to be retained for product subcategory are:
   - Rename “_col0_” to “SubcategoryId” and ensure its type is “integer”
   - Rename “_col1_” to “CategoryId” and ensure its type is “integer”
   - Rename “_col2_” to “Subcategory” and ensure its type is “string”

   The names and types of columns to be retained for product category are:
   - Rename “_col0_” to “CategoryId” and ensure its type is “integer”
   - Rename “_col1_” to “Category” and ensure its type is “string”

   You now have three parallel streams, loading and modifying data from the three source files.

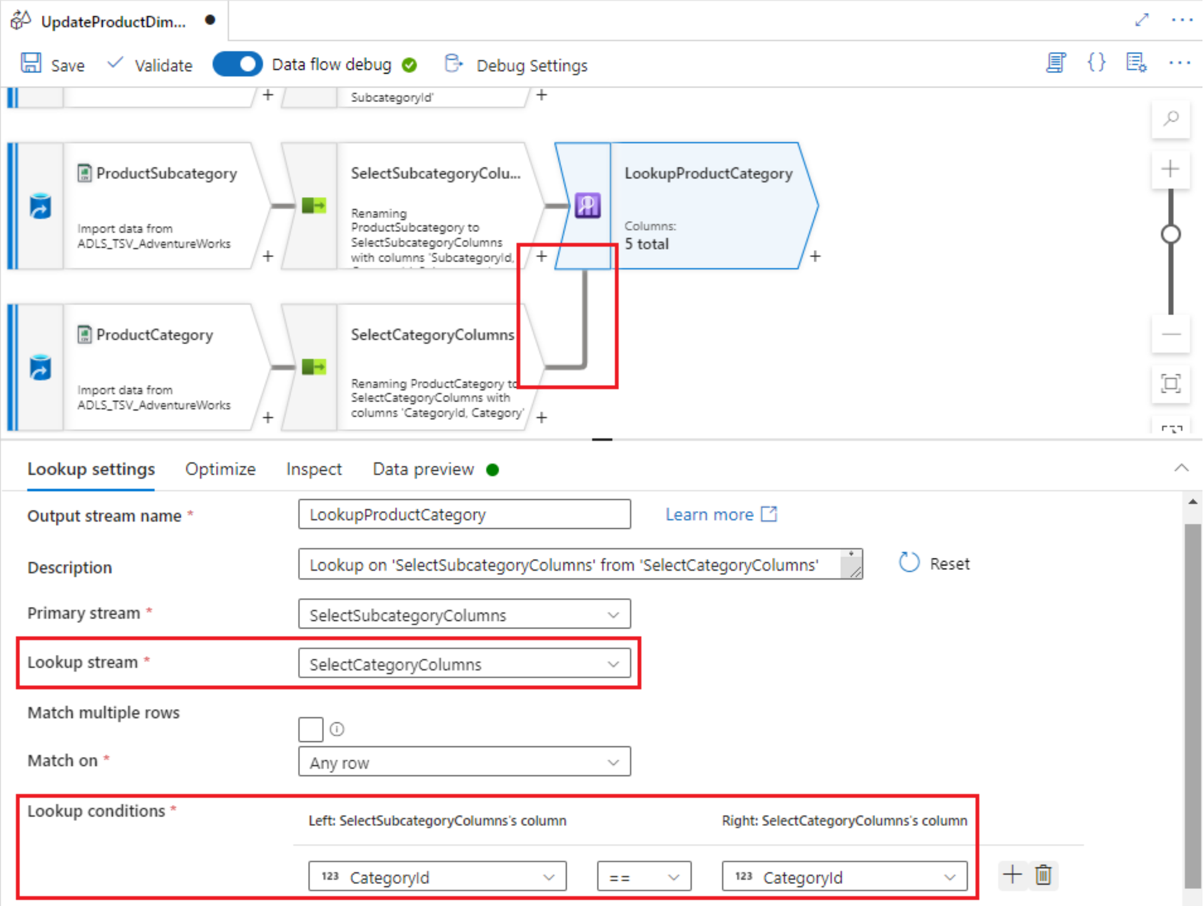
9. You can combine data into the Product stream from the other two streams using the data flow “Lookup” transformation. First, click the small “+” button below the Product Subcategory stream’s Select transformation, then select “Lookup” from the popup menu.



Output stream name * SelectProductSubcategoryColur

10. On the **Lookup settings** tab, name the transformation then set “Lookup stream” to use product category columns. (You can choose from any of the other five previous transformations, so take care to pick the ProductCategory stream’s Select transformation, and not the earlier Source for the stream).

    “Lookup conditions” specifies the fields to compare from each transformation and the operator to compare them with – choose the streams’ respective CategoryId fields. Notice that the lookup relationship also appears on the data flow canvas.


UpdateProductDim...
Save
Validate
Data flow debug
Debug Settings
Subcategoryld'
ProductSubcategory
Import data from ADLS_TSV_AdventureWorks
SelectSubcategoryColu...
Renaming ProductSubcategory to SelectSubcategoryColumns with columns 'SubcategoryId,
LookupProductCategory
Columns: 5 total
ProductCategory
Import data from ADLS_TSV_AdventureWorks
SelectCategoryColumns
Renaming ProductCategory to SelectCategoryColumns with columns 'CategoryId, Category'
Lookup settings
Optimize
Inspect
Data preview
Learn more
Reset

Output stream name * LookupProductCategory

Description: Lookup on 'SelectSubcategoryColumns' from 'SelectCategoryColumns'

Primary stream * SelectSubcategoryColumns

Lookup stream * SelectCategoryColumns

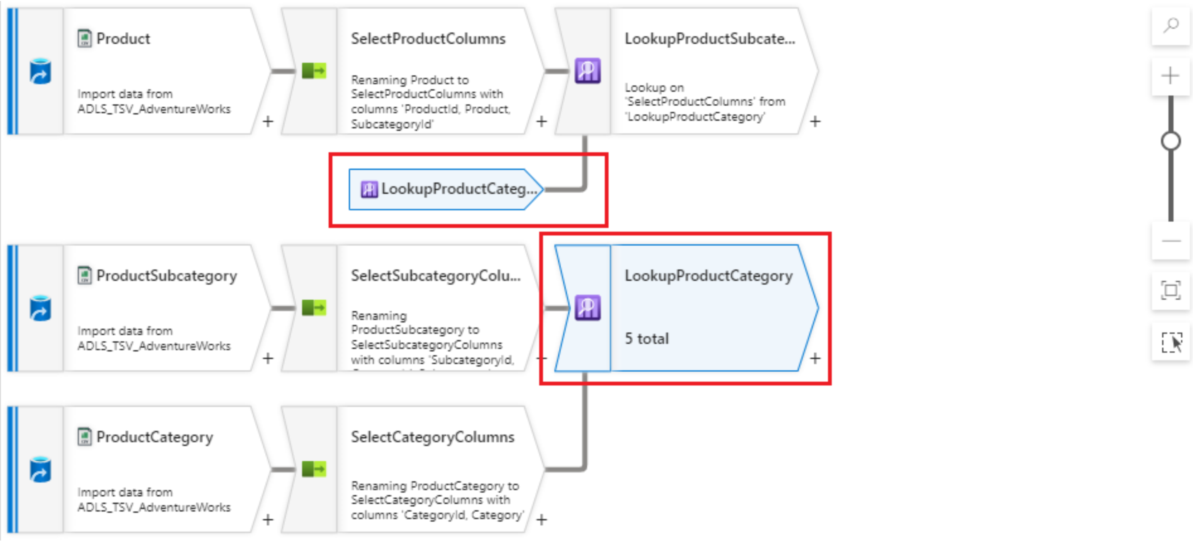
Match multiple rows □

Match on * Any row

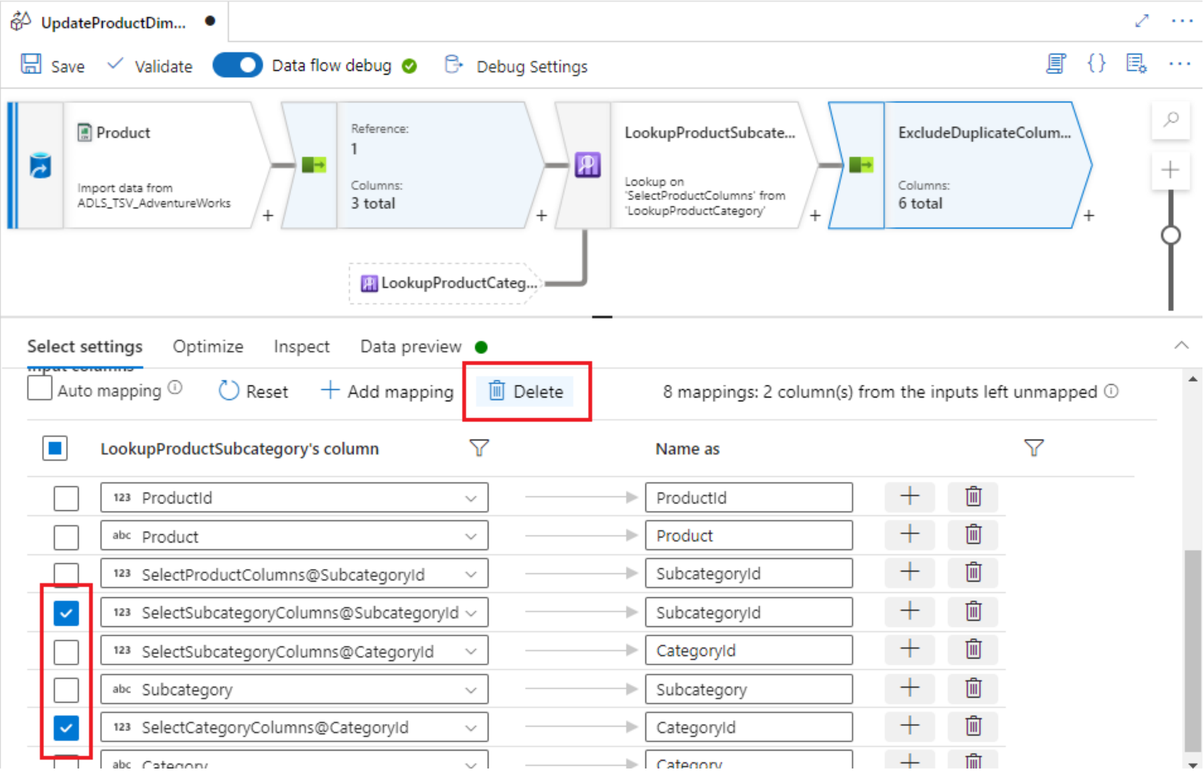
Lookup conditions *

Left: SelectSubcategoryColumns's column		Right: SelectCategoryColumns's column
123 CategoryId	==	123 CategoryId

11. Add a second “Lookup” activity, this time on the Product stream, performing a lookup against the ProductCategory lookup’s output, based on matching SubcategoryId. This time the canvas displays a “reference node” instead of showing a direct link between the two transformations. This is just for readability – when you hover over either the reference node or the transformation it refers to, both light up in blue to indicate that they represent the same transformation.


Product
Import data from ADLS_TSV_AdventureWorks
SelectProductColumns
Renaming Product to SelectProductColumns with columns 'ProductId, Product, SubcategoryId'
LookupProductSubcate...
Lookup on 'SelectProductColumns' from 'LookupProductCategory'
LookupProductCateg...
ProductSubcategory
Import data from ADLS_TSV_AdventureWorks
SelectSubcategoryColu...
Renaming ProductSubcategory to SelectSubcategoryColumns with columns 'SubcategoryId,
LookupProductCategory
5 total
ProductCategory
Import data from ADLS_TSV_AdventureWorks
SelectCategoryColumns
Renaming ProductCategory to SelectCategoryColumns with columns 'CategoryId, Category'

12. Open the new Lookup transformation’s “Inspect” tab to view the set of columns present in the combined stream – notice it includes two copies of each of the join fields, one from each stream participating in the lookup. Clean this up with another Select transformation.

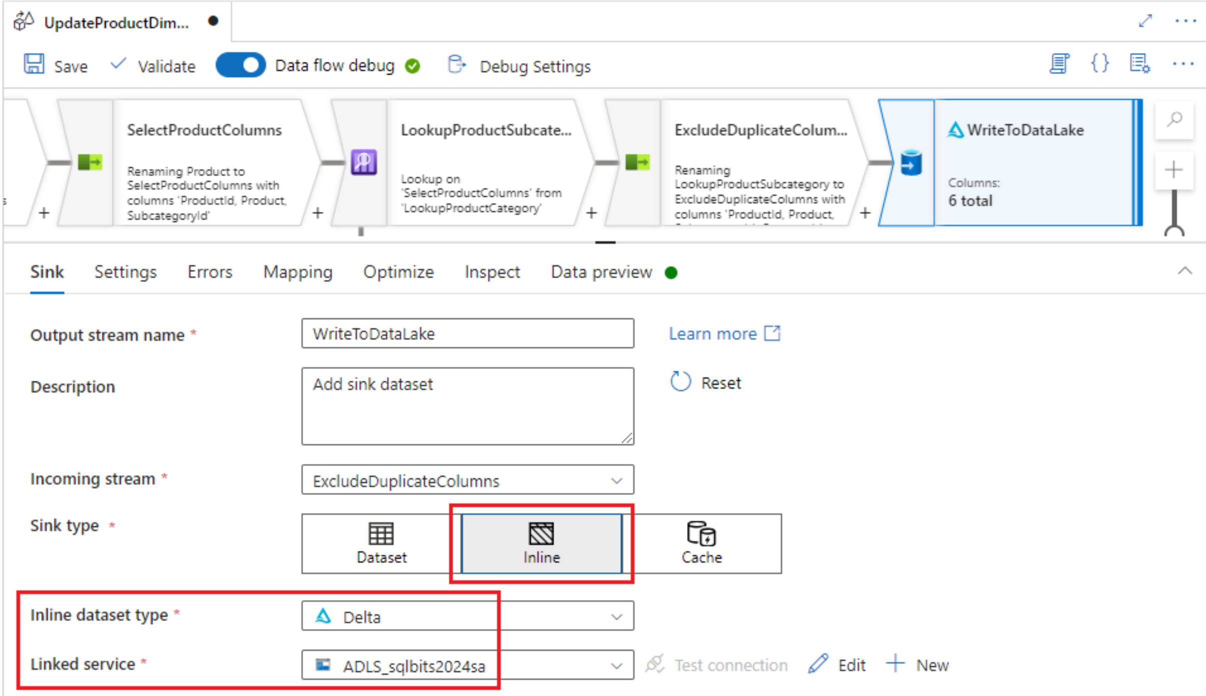


☐ Auto mapping

8 mappings: 2 column(s) from the inputs left unmapped

■	LookupProductSubcategory's column	Name as
☐	123 ProductId	ProductId
☐	abc Product	Product
☐	123 SelectProductColumns@SubcategoryId	SubcategoryId
☑	123 SelectSubcategoryColumns@SubcategoryId	SubcategoryId
☐	123 SelectSubcategoryColumns@CategoryId	CategoryId
☐	abc Subcategory	Subcategory
☑	123 SelectCategoryColumns@CategoryId	CategoryId
☐	abc Category	Category

13. Finally, write the transformed dimension data back to the data lake using a “Sink” transformation. Add the transformation in the usual way, using the small “+” button after the duplicate removal transformation. Sink is at the bottom of the list on the popup menu.



Output stream name * WriteToDataLake

Description: Add sink dataset

Incoming stream * ExcludeDuplicateColumns

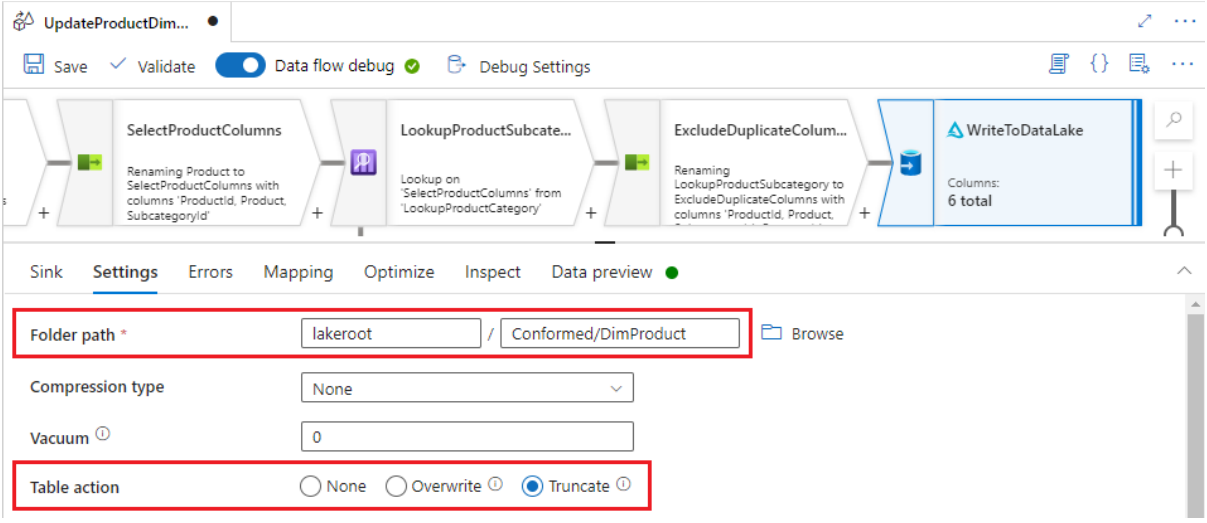
Sink type * Inline

Inline dataset type * Delta

Linked service * ADLS_sqlbits2024sa

You haven't yet created a dataset to use as the data flow sink – we will use an inline dataset instead. Inline datasets aren't reusable by other data flows or pipelines, but avoid clutter when reusability is not required. Select "Sink type" = "Inline" and choose "Delta" from the "Inline dataset type" dropdown. Delta is a Parquet-based storage format which supports ACID transactions on top of column-oriented, highly compressible data storage.

14. Specify the sink "Folder path" on the transformation's "Settings" tab (Delta is a multi-file storage format, so folder path identifies the folder **containing** those files). Choose the "lakeroot" file system and enter "Conformed/DimProduct" as the folder path. Select the "Truncate" table action, to allow previous versions of the output to be replaced at each execution of the data flow.


UpdateProductDim...
Save
Validate
Data flow debug
Debug Settings
SelectProductColumns
Renaming Product to SelectProductColumns with columns 'ProductId, Product, SubcategoryId'
LookupProductSubcate...
Lookup on 'SelectProductColumns' from 'LookupProductCategory'
ExcludeDuplicateColum...
Renaming LookupProductSubcategory to ExcludeDuplicateColumns with columns 'ProductId, Product,
WriteToDataLake
Columns:
6 total
Sink
Settings
Errors
Mapping
Optimize
Inspect
Data preview
Browse

Folder path * lakeroot / Conformed/DimProduct

Compression type: None

Vacuum ⓘ 0

Table action: ○ None ○ Overwrite ⓘ ● Truncate ⓘ

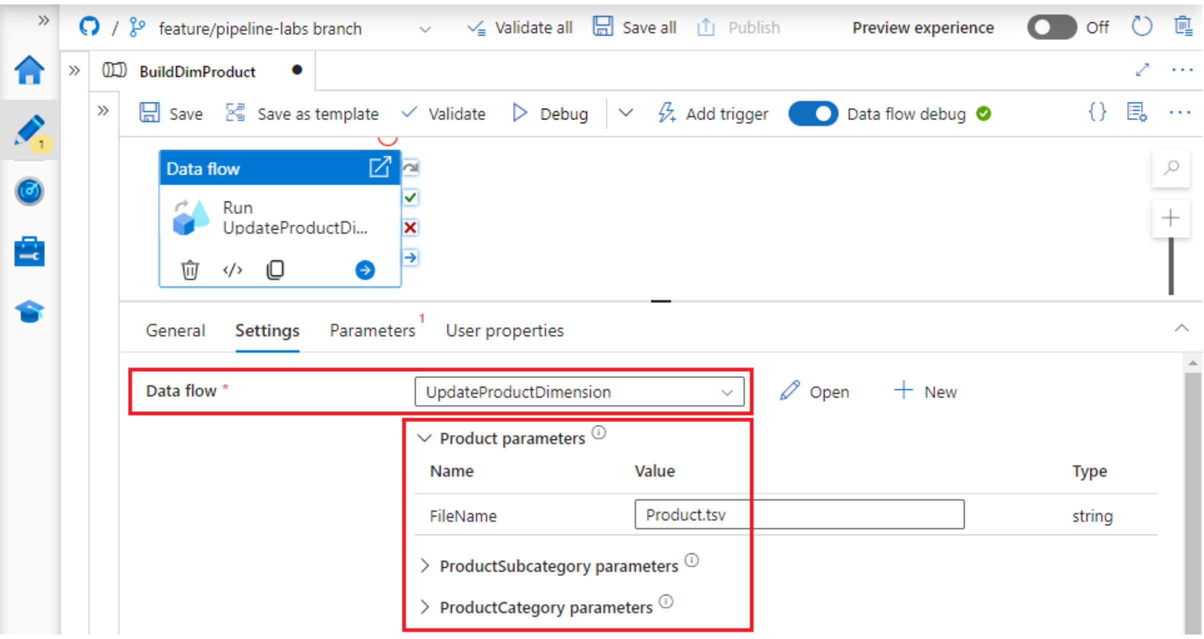
15. Click "Save all" to commit your data flow to the factory's attached GitHub repository.

Lab 4.4 – Run the data flow

Data flows are executed by ADF pipelines. To run your data flow, create a pipeline for it.

1. Create a new ADF pipeline.

2. Expand the "Move & transform" group in the activity toolbox, then drag a "Data flow" activity onto the pipeline canvas. Name the activity appropriately, then on its "Settings" tab:
   - choose the data flow you created in Lab 4.3
   - provide dataset parameter values (identifying files to be loaded by each source transformation).



Data flow * UpdateProductDimension

Product parameters

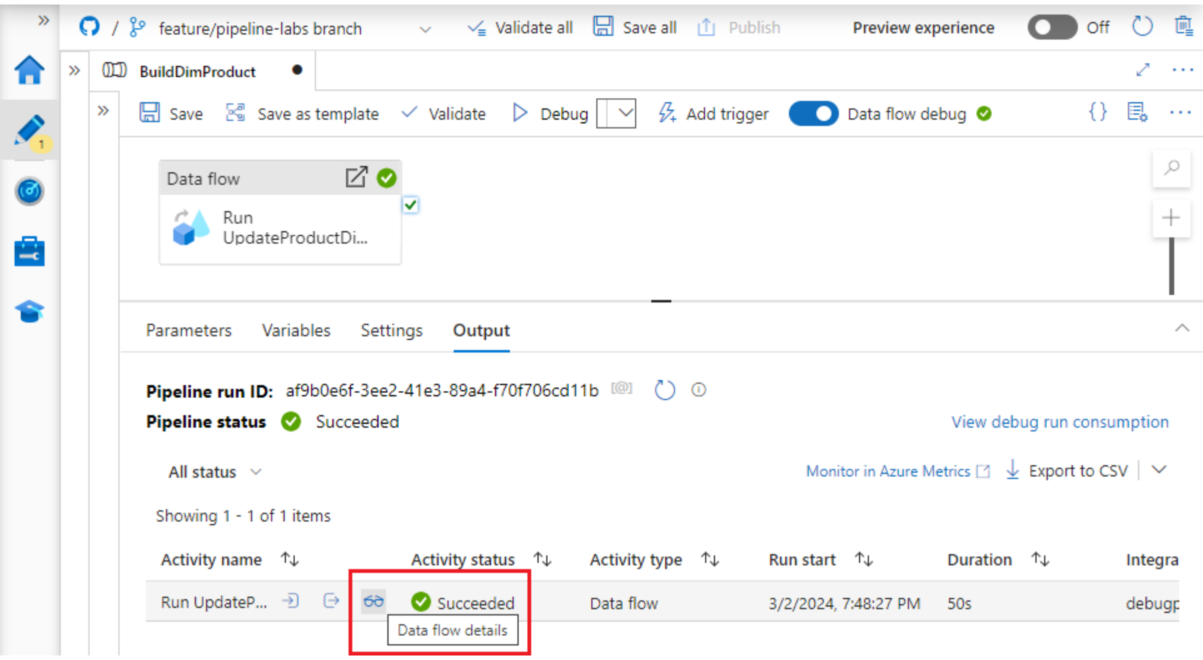
Name	Value	Type
FileName	Product.tsv	string

ProductSubcategory parameters

ProductCategory parameters

3. Click "Debug" to run the pipeline in debugging mode. As when developing data flows, a Spark cluster is required to execute pipelines containing data flow activities – you can use your ADF Studio debug session to run pipelines in debugging mode.

4. When the pipeline has finished running, a row of data appears in its "Output" pane for the Data flow activity. Hover over the activity's name to reveal the "Details" button ("glasses" icon).



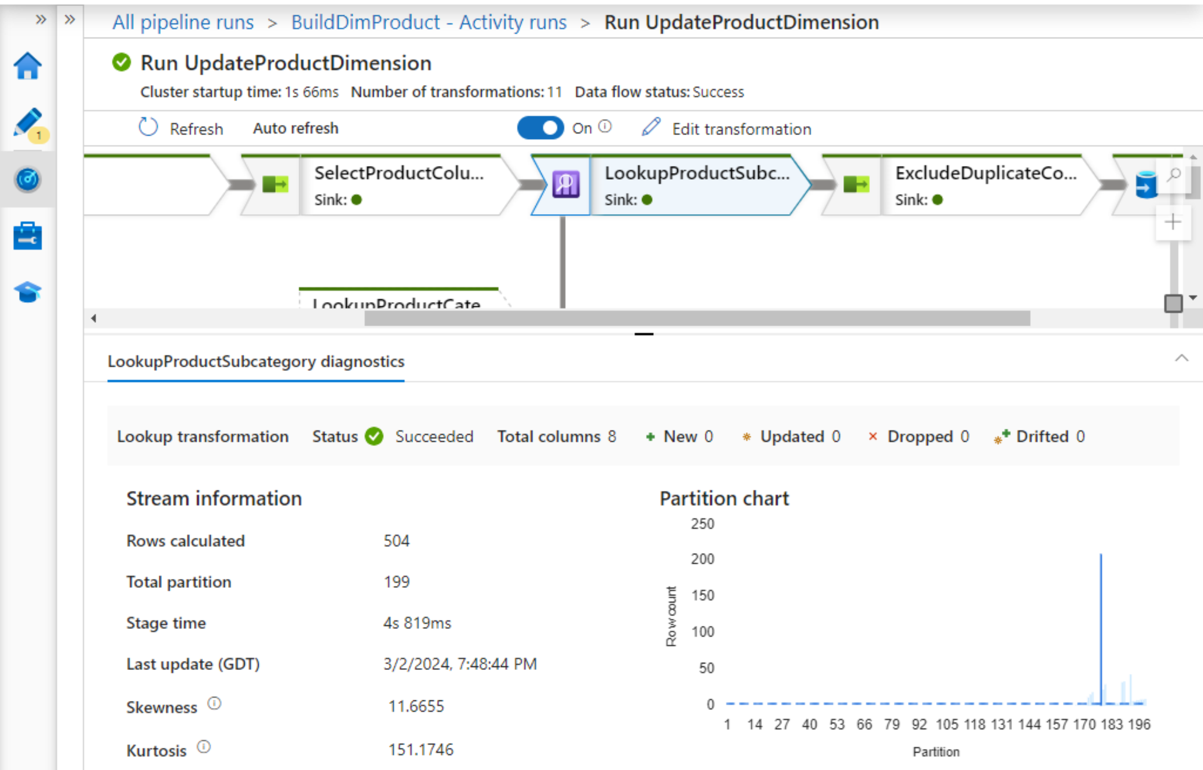
Pipeline run ID: af9b0e6f-3ee2-41e3-89a4-f70f706cd11b

Pipeline status ✓ Succeeded

Showing 1 - 1 of 1 items

Activity name	Activity status	Activity type	Run start	Duration	Integra
Run UpdateP...	✓ Succeeded	Data flow	3/2/2024, 7:48:27 PM	50s	debugp

5. Click the “Data flow details” button to open an interactive visualisation of more detailed data flow performance information. Selecting different transformations allows you to see the number of rows processed by a transformation, how quickly, and how the Spark cluster partitioned data for parallel processing. (For larger datasets, you can configure dataset distribution yourself to optimise Spark executor partitioning, via each transformation’s “Optimize” tab in the data flow editor).



Run UpdateProductDimension

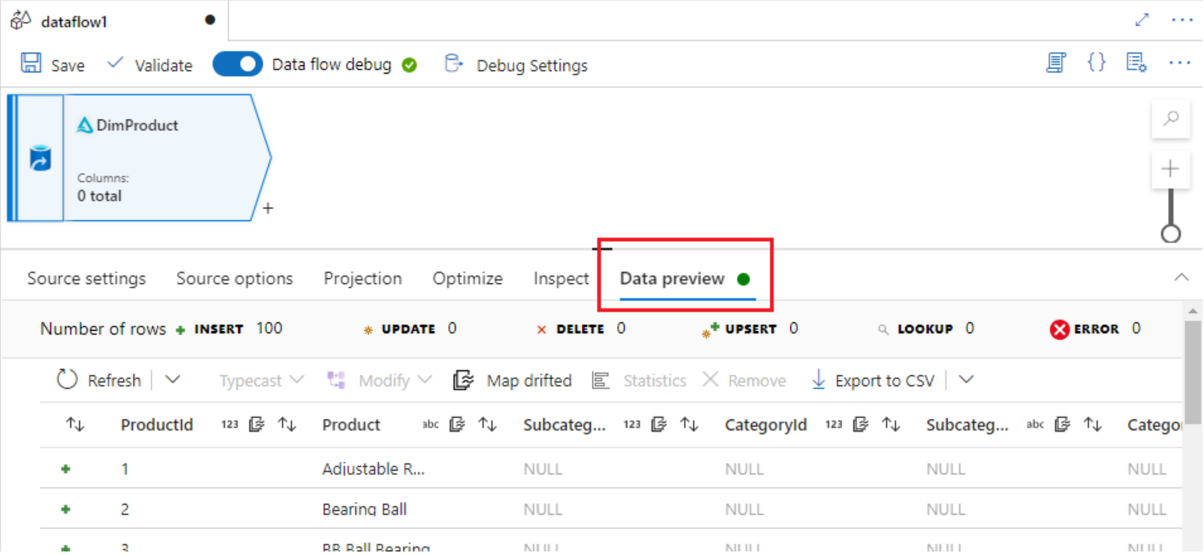
Cluster startup time: 1s 66ms Number of transformations: 11 Data flow status: Success

Lookup transformation Status ✓ Succeeded Total columns 8 New 0 Updated 0 Dropped 0 Drifted 0

Stream information

Rows calculated	504
Total partition	199
Stage time	4s 819ms
Last update (GDT)	3/2/2024, 7:48:44 PM
Skewness	11.6655
Kurtosis	151.1746

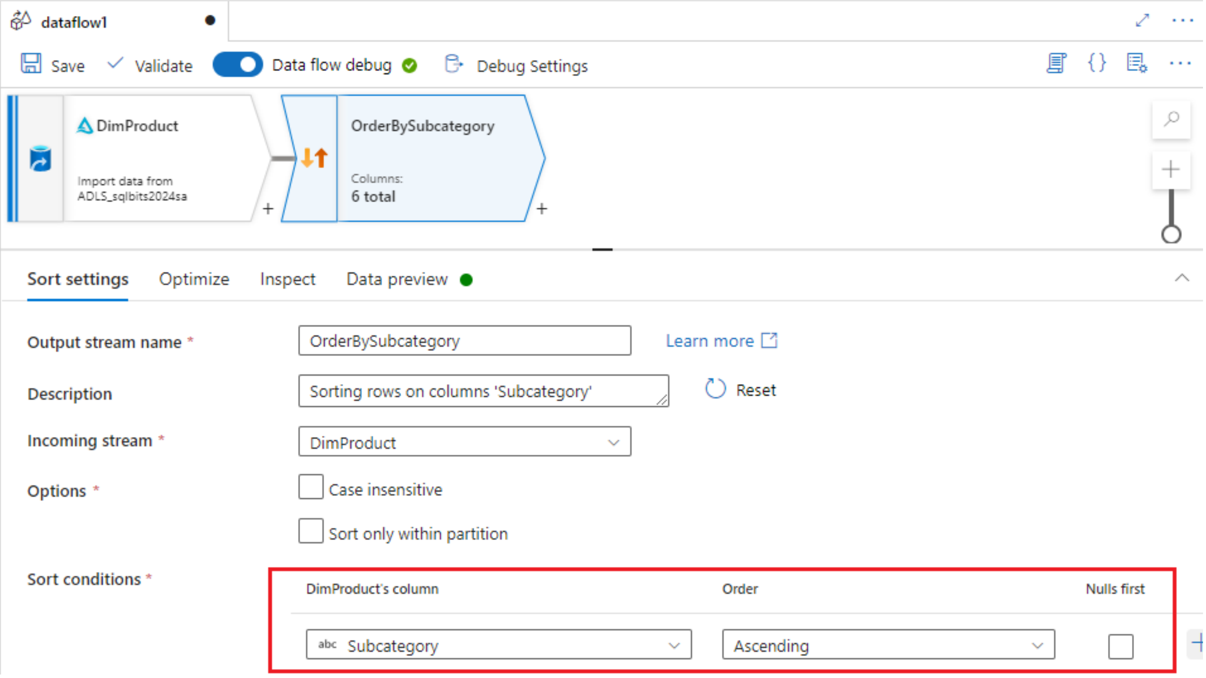
6. Finally, you may wish to inspect the product dimension data written to your data lake. You can view the collection of files in the relevant Delta folder, but you cannot read them directly. To inspect dimension contents, create a new data flow using the output folder as an inline Delta source, then inspect data on the source’s “Data preview” tab:



Number of rows + INSERT 100 UPDATE 0 × DELETE 0 UPSERT 0 LOOKUP 0 ERROR 0

	ProductId	Product	Subcateg...	CategoryId	Subcateg...	Catego
+	1	Adjustable R...	NULL	NULL	NULL	NULL
+	2	Bearing Ball	NULL	NULL	NULL	NULL
+	3	BB Ball Bearing	NULL	NULL	NULL	NULL

When you preview data in this way, you may see very few subcategory and category values – this is because not every product in the source data is linked to a subcategory. To assure yourself that the lookups are correctly implemented, add a Sort transformation to your data flow, ordering the output by Subcategory **without** nulls first. If the sort column dropdown is empty, import the table schema explicitly via the Source transformation's "Projection" tab.



Output stream name * OrderBySubcategory

Description Sorting rows on columns 'Subcategory'

Incoming stream * DimProduct

Options * □ Case insensitive □ Sort only within partition

Sort conditions *

DimProduct's column	Order	Nulls first
abc Subcategory	Ascending	□

Lab 4.5 – Further work

This lab introduced concepts essential to the creation of a basic ADF data flow, but there is much more to learn. When using the popup menu to add Select, Lookup and Sink transformations you will have noticed that many more transformations exist. Data flows have their own expression language which supports powerful, complex data transformations. Flowlets allow you to create reusable data flow components which can be used by multiple data flows.

Start to broaden your knowledge by:

- using some of the other transformation types

- using the “Derived Column” transformation to begin to explore the data flow expression language.

Recap

In Lab 4 you:

- created an ADF data flow
- used Data flow debug to import file schemas (using “Import projection”)
- created a pipeline to execute your data flow
- used Data flow debug to run the pipeline in ADF Studio.