

Hands-on tutorials

Prepare Training Data for Machine Learning with Minimal Code



Prepare Training Data for Machine Learning with Minimal Code: Hands-on tutorials

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Prepare Training Data for Machine Learning with Minimal Code

AWS experience	Beginner
Time to complete	30 minutes
Cost to complete	See Amazon SageMaker AI pricing to estimate cost for this tutorial.
Services used	Amazon SageMaker AI Data Wrangler
Last updated	March 7, 2023

Overview

In this tutorial, you will learn how to prepare data for machine learning (ML) using [Amazon SageMaker AI Data Wrangler](#).

Amazon SageMaker AI Data Wrangler reduces the time it takes to aggregate and prepare data for ML from weeks to minutes. Using SageMaker AI Data Wrangler, you can simplify the process of data preparation and feature engineering and complete each step of the data preparation workflow, including data selection, cleansing, exploration, and visualization from a single visual interface.

In this tutorial, you will use Amazon SageMaker AI Data Wrangler to prepare data to train a rental prediction model. You will use a version of the Brazil house rental dataset found in the Kaggle Data Repository. The data consists of thousands of records, each containing thirteen different features including area, rooms, parking, and other attributes. In addition, each record includes the target feature called rent amount. You will upload the data into Amazon Simple Storage Service (Amazon S3), create a new SageMaker AI Data Wrangler flow, transform the data, check the data for bias, and lastly save the output to Amazon S3 to be used later for ML training.

What you will accomplish

In this guide, you will:

- Visualize and analyze data to understand key relationships
- Apply transformations to clean up the data and generate new features
- Automatically generate notebooks for repeatable data preparation workflows

Prerequisites

Before starting this tutorial, you will need:

- An AWS account: If you don't already have an account, follow the [Setting Up Your AWS Environment](#) getting started guide for a quick overview.

Implementation

Step 1: Set up your Amazon SageMaker AI Studio domain

With Amazon SageMaker AI, you can deploy a model visually using the console or programmatically using either SageMaker AI Studio or SageMaker AI notebooks. In this tutorial, you deploy the model programmatically using a SageMaker AI Studio notebook, which requires a SageMaker AI Studio domain.

An AWS account can have only one SageMaker AI Studio domain per Region. If you already have a SageMaker AI Studio domain in the US East (N. Virginia) Region, follow the [SageMaker AI Studio setup guide](#) to attach the required AWS IAM policies to your SageMaker AI Studio account, then skip Step 1, and proceed directly to Step 2.

If you don't have an existing SageMaker AI Studio domain, continue with Step 1 to run an AWS CloudFormation template that creates a SageMaker AI Studio domain and adds the permissions required for the rest of this tutorial.

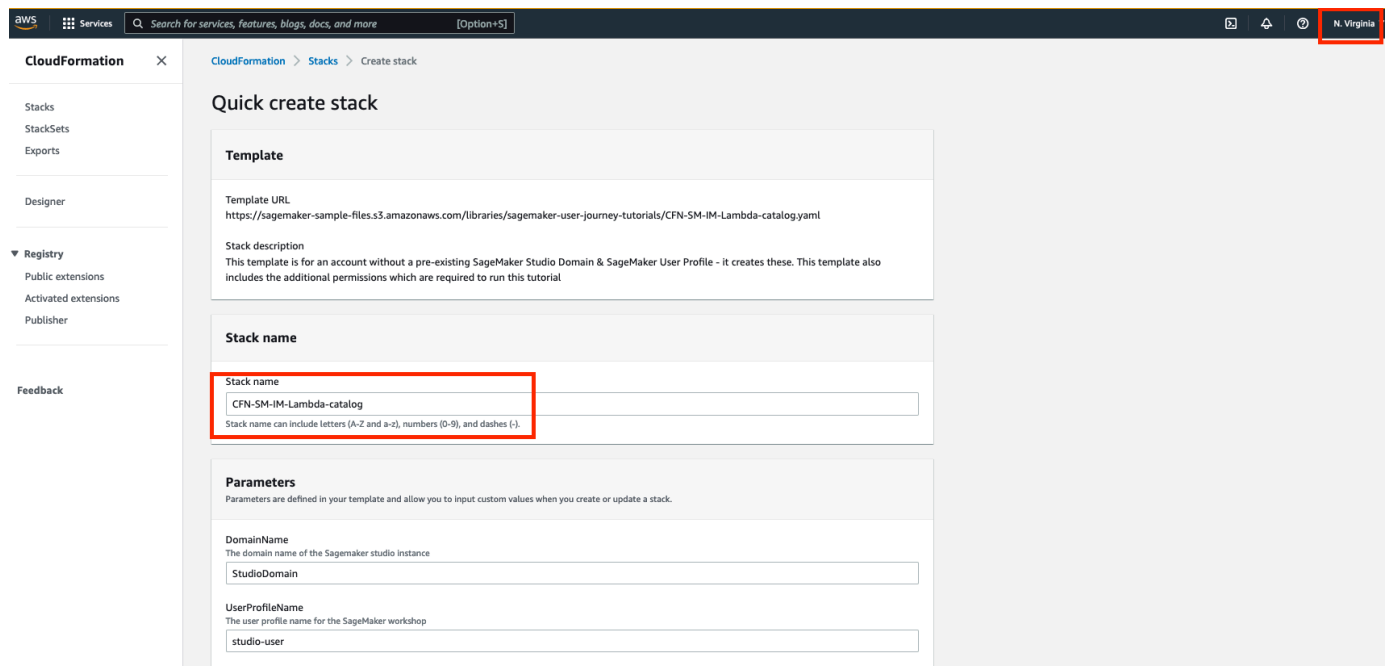
Choose the [AWS CloudFormation stack](#) link. This link opens the AWS CloudFormation console and creates your SageMaker AI Studio domain and a user named **studio-user**. It also adds the required permissions to your SageMaker AI Studio account. In the CloudFormation console, confirm that **US East (N. Virginia)** is the **Region** displayed in the upper right corner. **Stack name** should be **CFN-SM-IM-Lambda-catalog**, and should not be changed. This stack takes about 10 minutes to create all the resources.

This stack assumes that you already have a public VPC set up in your account. If you do not have a public VPC, see [VPC with a single public subnet](#) to learn how to create a public VPC.

1. Create the stack

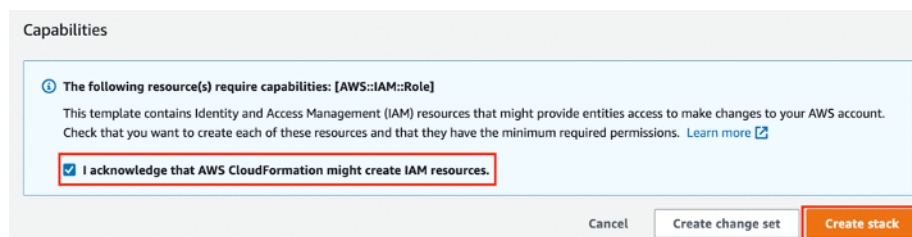
Choose the [AWS CloudFormation stack](#) link. This link opens the AWS CloudFormation console and creates your SageMaker AI Studio domain and a user named **studio-user**. It also adds the required permissions to your SageMaker AI Studio account. In the CloudFormation console, confirm that **US East (N. Virginia)** is the **Region** displayed in the upper right corner. **Stack name** should be **CFN-SM-IM-Lambda-catalog**, and should not be changed. This stack takes about 10 minutes to create all the resources.

This stack assumes that you already have a public VPC set up in your account. If you do not have a public VPC, see [VPC with a single public subnet](#) to learn how to create a public VPC.



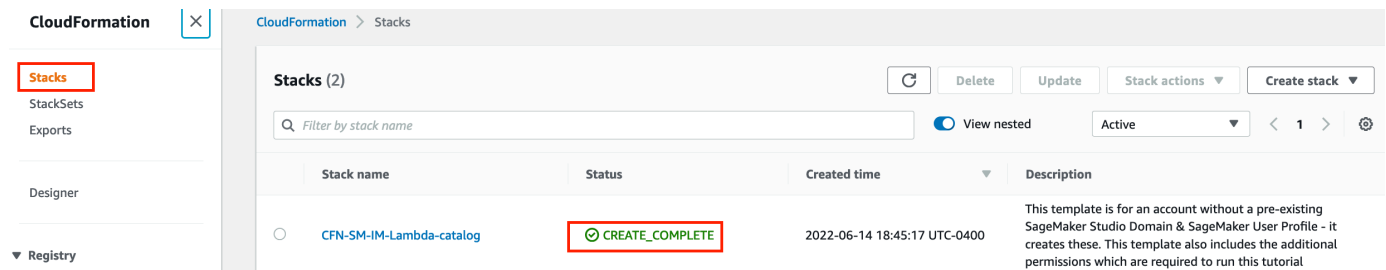
2. Acknowledge IAM resource creation

Select **I acknowledge that AWS CloudFormation might create IAM resources**, and then choose **Create stack**.



3. Monitor stack creation progress

On the **CloudFormation** pane, choose **Stacks**. It takes about 10 minutes for the stack to be created. When the stack is created, the status of the stack changes from **CREATE_IN_PROGRESS** to **CREATE_COMPLETE**.



Step 2: Create a new SageMaker AI Data Wrangler flow

SageMaker AI accepts data from a wide variety of sources, including Amazon S3, Amazon Athena, Amazon Redshift, Snowflake, Databricks, and SaaS data sources. In this step, you will create a new SageMaker AI Data Wrangler flow using the Kaggle Brazil house rental dataset stored in Amazon S3. This dataset contains demographic and financial information about homes along with a target column indicating the rental amount of the property.

1. Open SageMaker AI Studio

Enter **SageMaker AI Studio** into the console search bar, and then choose **SageMaker AI Studio**.

The screenshot shows the AWS Services search interface. The search bar at the top contains the text 'sagemaker studio'. Below the search bar, the results are categorized into 'Services' and 'Features'. The 'Services' section lists four items: Nimble Studio, Amazon SageMaker, Application Composer, and AWS Glue DataBrew. The 'Features' section lists four items: SageMaker Studio, Notebooks, SageMaker Canvas, and Autopilot. The 'SageMaker Studio' feature is highlighted with a red rectangular box.

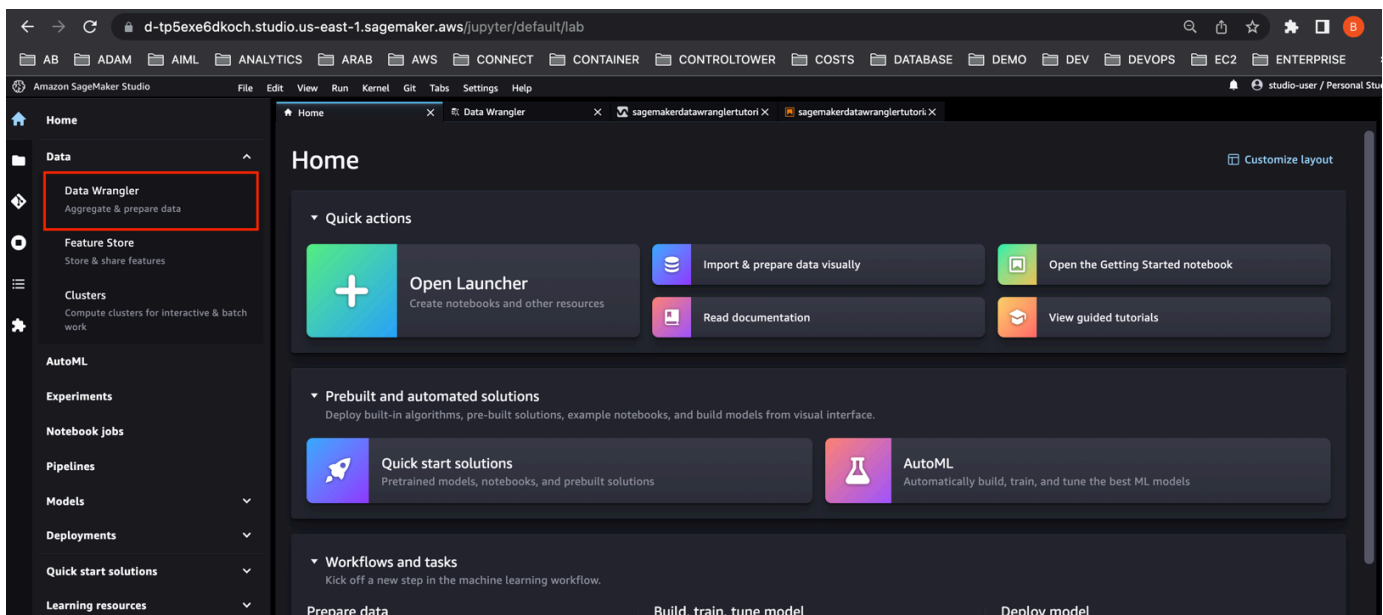
2. Open Studio

Choose **US East (N. Virginia)** from the Region dropdown list on the upper right corner of the SageMaker AI console. Browse to the **Getting Started** section in the left-hand navigation and then choose **Studio**. Then select the studio-user profile and then choose the **Open Studio** button.



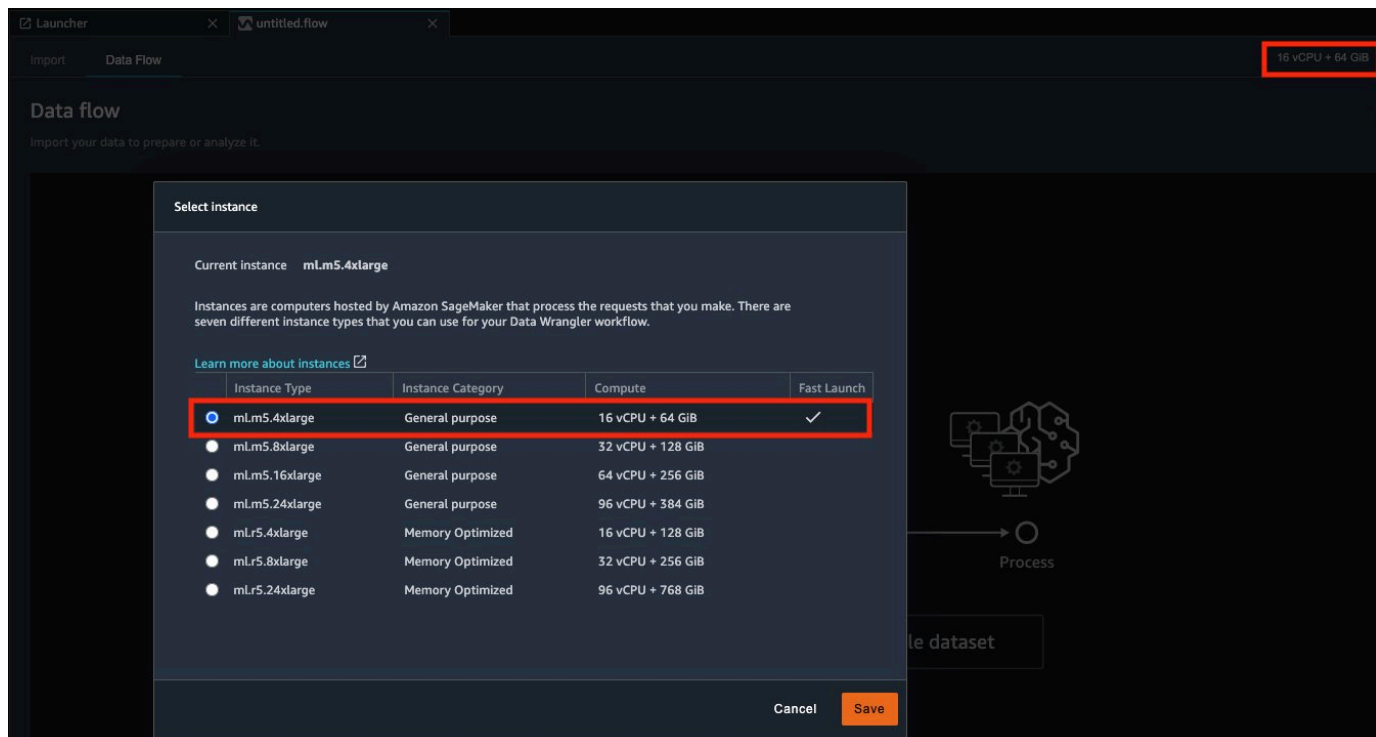
3. Start Data Wrangler

Open the **SageMaker AI Studio** interface. On the navigation bar, choose **Data Wrangler** on the left-hand side, and then choose the **Import Data** button.



4. Choose instance type

Note that you can change the Flow's compute instance type using the upper right button showing the current Compute instance. You may decide to change the compute instance type based on your scenario's dataset size and can scale it up or down when your requirements change. For the purposes of this tutorial, you can use the default **ml.m5.4xlarge**.



The screenshot shows the Amazon SageMaker Data Flow console. A 'Select instance' dialog box is open, displaying a table of instance types. The 'mL.m5.4xlarge' instance is selected, and its specifications (16 vCPU + 64 GiB) are highlighted in a red box. The 'Fast Launch' checkbox is checked. The current instance is 'mL.m5.4xlarge'.

Instance Type	Instance Category	Compute	Fast Launch
<input checked="" type="radio"/> mL.m5.4xlarge	General purpose	16 vCPU + 64 GiB	<input checked="" type="checkbox"/>
<input type="radio"/> mL.m5.8xlarge	General purpose	32 vCPU + 128 GiB	<input type="checkbox"/>
<input type="radio"/> mL.m5.16xlarge	General purpose	64 vCPU + 256 GiB	<input type="checkbox"/>
<input type="radio"/> mL.m5.24xlarge	General purpose	96 vCPU + 384 GiB	<input type="checkbox"/>
<input type="radio"/> mL.r5.4xlarge	Memory Optimized	16 vCPU + 128 GiB	<input type="checkbox"/>
<input type="radio"/> mL.r5.8xlarge	Memory Optimized	32 vCPU + 256 GiB	<input type="checkbox"/>
<input type="radio"/> mL.r5.24xlarge	Memory Optimized	96 vCPU + 768 GiB	<input type="checkbox"/>

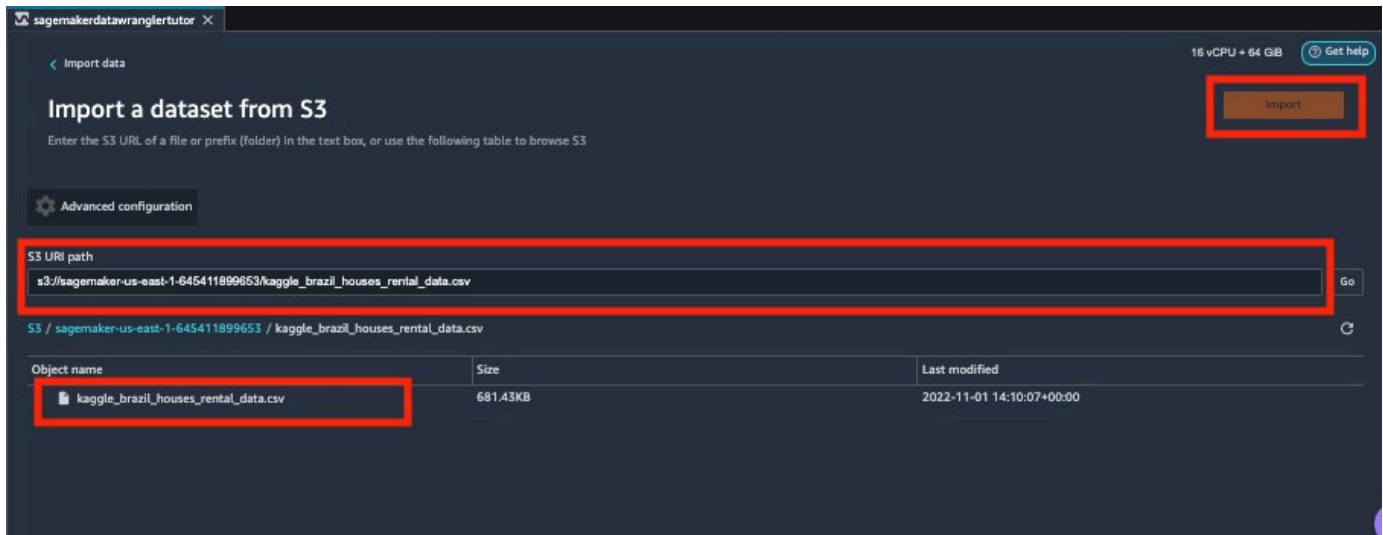
5. Import data from S3

In the **Data Import** tab, under **Import data**, choose **Amazon S3**.

The screenshot shows the 'Create connection' page in Amazon SageMaker Data Wrangler. The 'Data sources' section is active, displaying a search bar and a list of available data sources. The 'Amazon S3' source is highlighted with a red box. Below it, there is a section for 'Set up new data sources' with 42 options, including Amplitude, CircleCI, Datadog, DocuSign Monitor, Domo, Dynatrace, Facebook Ads, Facebook Page Insights, Freshdesk, GitHub, GitLab, Google Ads, Google Analytics, Google Analytics v4, Google Search Console, Infor Nexus, Instagram Ads, Jira Cloud, LinkedIn Ads, Mailchimp, and Marketo.

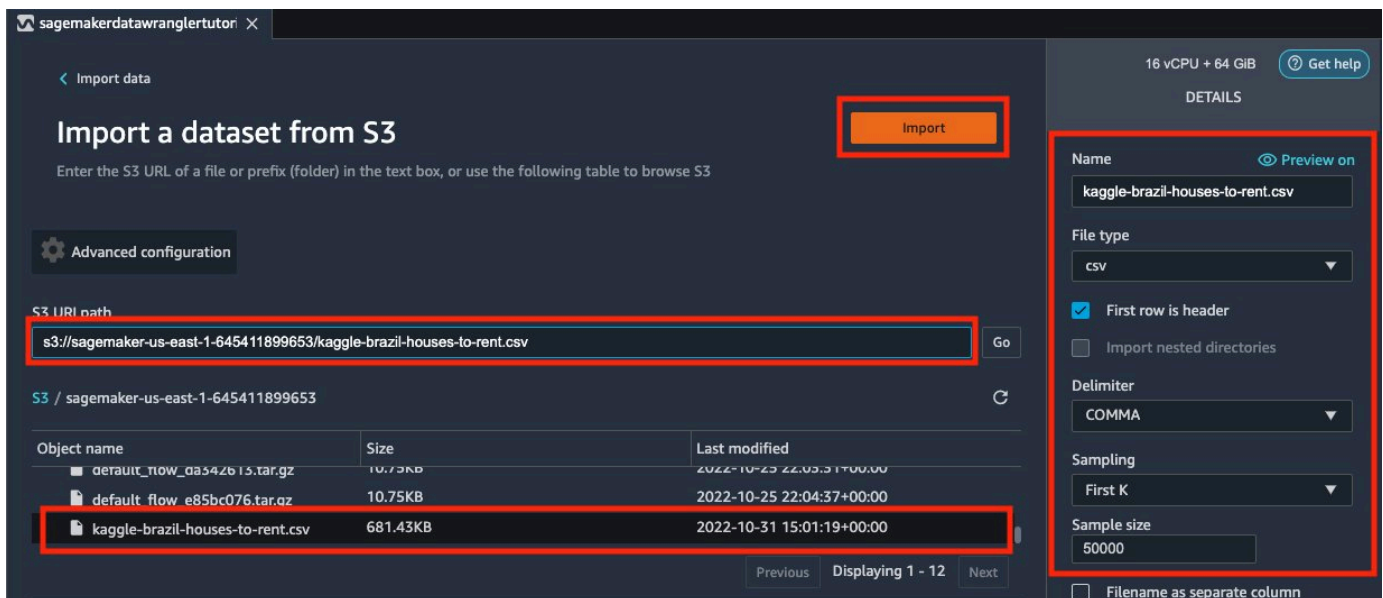
6. Specify S3 location

In the S3 URI Path field, enter **s3://sagemaker-sample-files/datasets/tabular/brazil_houses/kaggle_brazil_houses_rental_data.csv**, and then choose **Go**. Under **Object name**, select **kaggle_brazil_houses_rental_data.csv**.



7. Import the dataset

In the S3 import details panel, note that you can change the default delimiter and the sampling method when necessary. For the purposes of this tutorial, you can use the default **comma delimiter** and **First K sampling method**. Then choose **Import**.

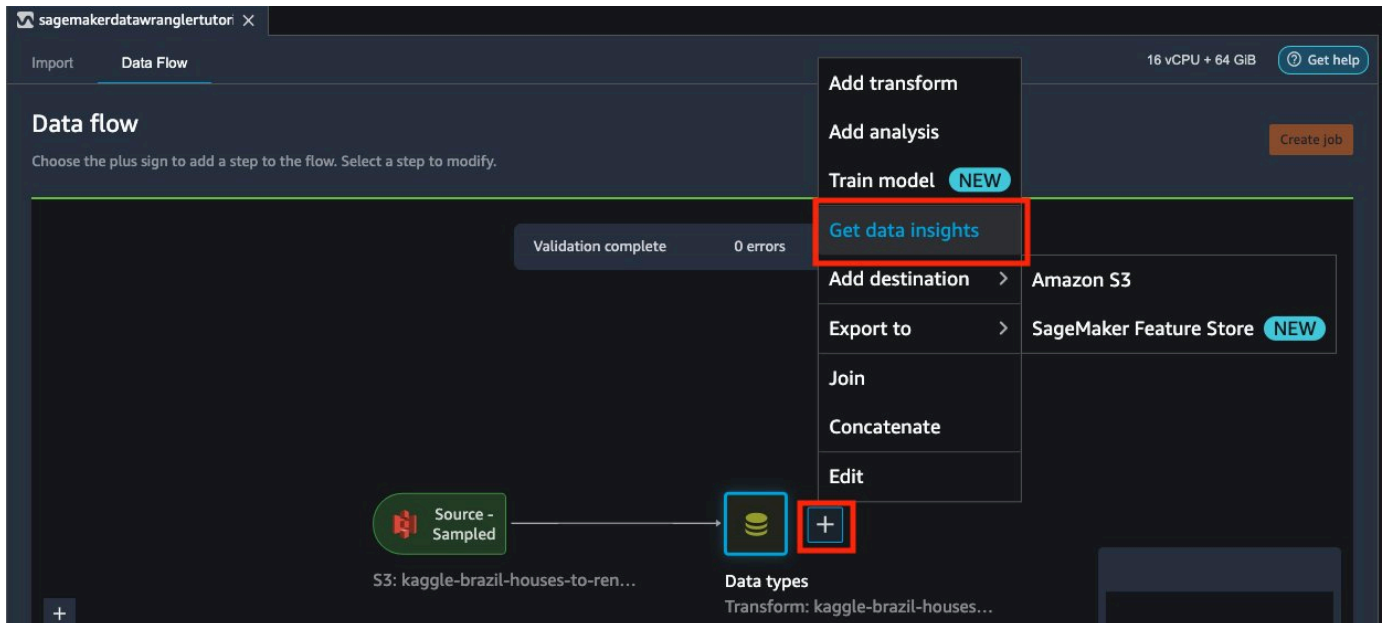


Step 3: Explore the data

In this step, you use SageMaker AI Data Wrangler to assess and explore the quality of the training dataset for building machine learning models. Use the Data Quality and Insights report feature to understand your dataset quality, and then use the Quick Model feature to estimate the expected prediction quality and the predictive power of the features in your dataset.

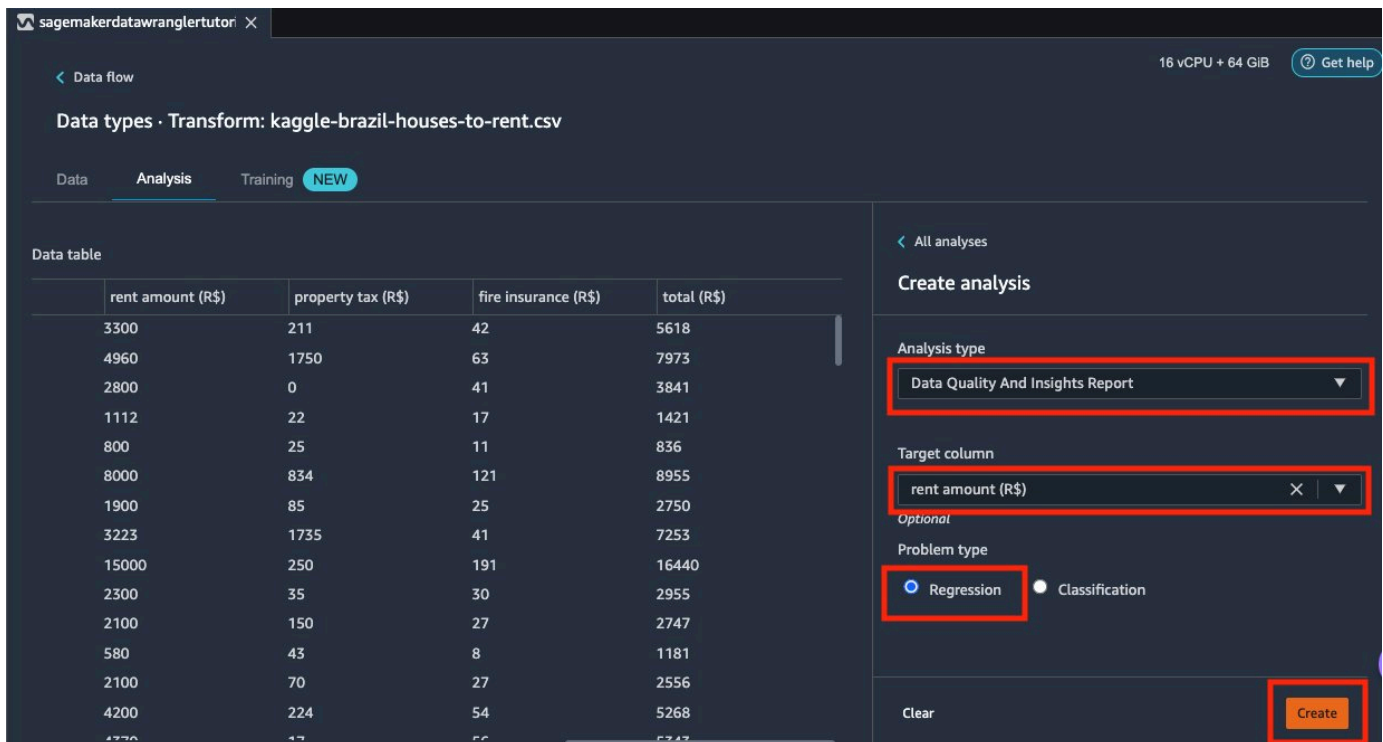
1. Generate data insights

When exploring your dataset, begin by using the Data Quality and Insights report to help you quickly understand your dataset, identify possible issues, and focus your attention on the most important areas to improve the data. On the **Data flow** tab, in the data flow diagram, choose the **+ icon**, then choose **Add analysis**. Then choose **Get data insights**.



2. Set analysis parameters

From the **Data Insights** pane, choose **rent amount** as the Target column. Then choose **Regression** as the **Problem type**. Then choose **Create**.



The screenshot shows the Amazon SageMaker Data Wrangler interface. On the left, a data table is displayed with the following columns: rent amount (R\$), property tax (R\$), fire insurance (R\$), and total (R\$). The table contains 15 rows of data. On the right, the 'Create analysis' configuration panel is visible, with the following settings:

- Analysis type: Data Quality And Insights Report
- Target column: rent amount (R\$)
- Optional: (empty)
- Problem type: Regression (selected), Classification

The 'Create' button is highlighted in orange.

	rent amount (R\$)	property tax (R\$)	fire insurance (R\$)	total (R\$)
	3300	211	42	5618
	4960	1750	63	7973
	2800	0	41	3841
	1112	22	17	1421
	800	25	11	836
	8000	834	121	8955
	1900	85	25	2750
	3223	1735	41	7253
	15000	250	191	16440
	2300	35	30	2955
	2100	150	27	2747
	580	43	8	1181
	2100	70	27	2556
	4200	224	54	5268

3. View insights report

You may need to wait a minute while the report is generated. Once completed, review the Data Quality and Insights report sections to improve the dataset further before building the ML model. For this specific dataset, the Data Insights report has highlighted two possible issues: the first is related to **duplicate rows** in the dataset and the second is related to possible **target leakage** such that one feature is highly correlated with the output and may indicate a duplicate of the target **rent** column. The report can also be downloaded to a PDF file and shared with colleagues on your team.

The screenshot shows the Amazon SageMaker Data Wrangler interface. At the top, it displays the transform name 'kaggle-brazil-houses-to-rent.csv' and the target column 'rent amount (R\$)'. The dataset type is 'Regression' and the date is 'October 31, 2022 at 10:43 AM CDT'. A download icon is visible in the top right corner.

SUMMARY

Dataset statistics

Key	Value	Feature type	Count
Number of features	13	numeric	8
Number of rows	10692	categorical	2
Missing	0%	text	0
Valid	100%	datetime	0
Duplicate rows	5.65%	binary	2
		unknown	0

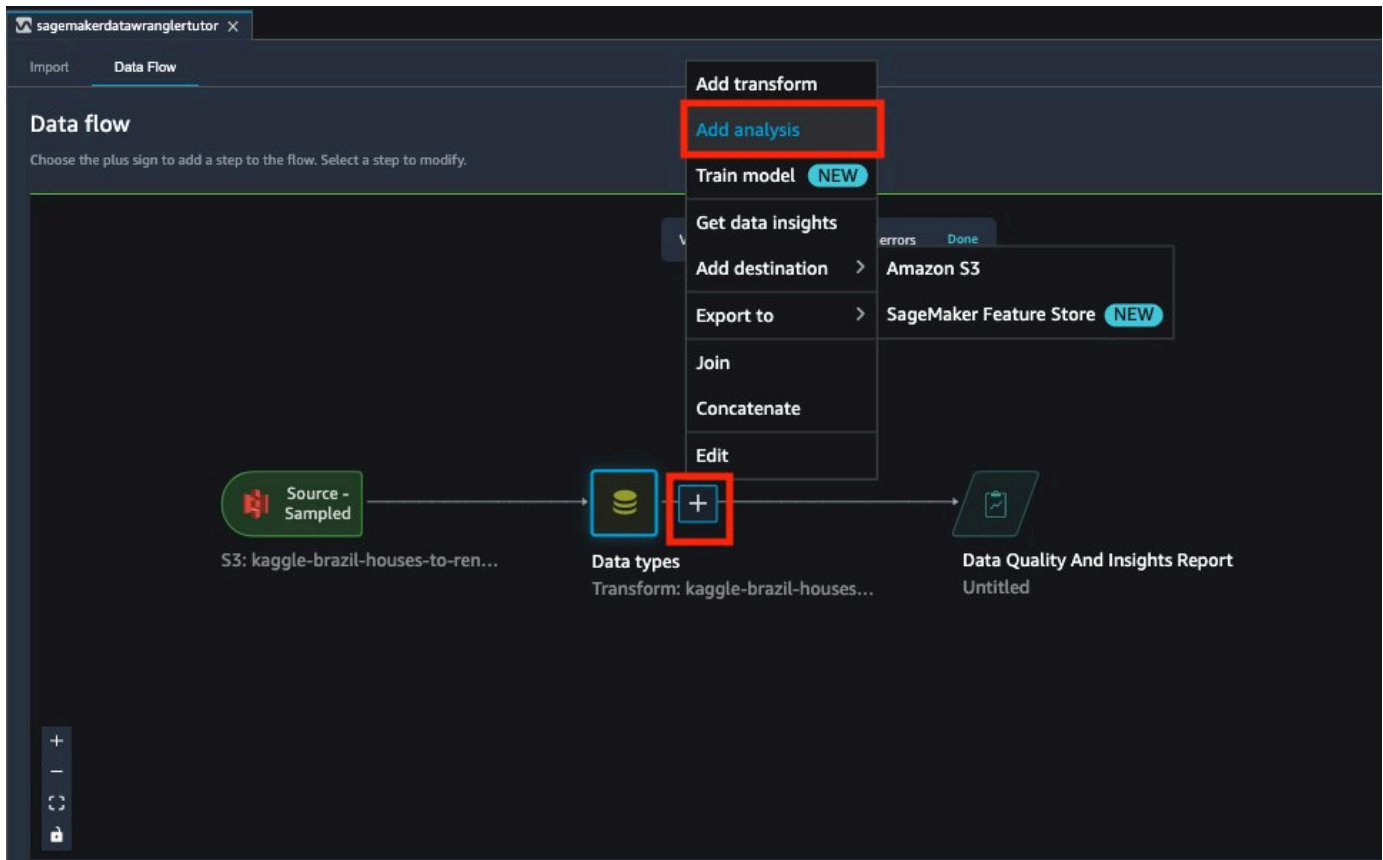
High Priority Warnings

2 high severity warnings were detected. See the list below.

- Duplicate rows** (High)
We found that 5.65% of the data are duplicate. Some data sources could include valid duplicates and in other cases these duplicates could point to problems in data collection. Duplicate samples resulting from faulty data collection, could derail machine learning processes that rely on splitting to independent training and validation folds. For example quick model scores, prediction power estimation and automatic hyper parameter tuning. Duplicate samples could be removed from the dataset using the **Drop duplicates** transform under **Manage rows**.
- Target leakage** (High)
The feature **fire insurance (R\$)** predicts the target extremely well on it's own. A feature this predictive often indicates an error called target leakage. The cause is typically data that is not available at time of prediction. For example, a duplicate of the target column in the dataset can result in target leakage. Alternatively, if the machine learning task is "easy", then a single feature can have legitimately high prediction power. If you think that a single feature is very highly predictive, you don't need to do anything further. However, if you think there's target leakage, we recommended that you remove the highly predictive column from the dataset using the **Drop column** transform under **Manage columns**.

4. Create an analysis

For further data analysis and exploration, you can create additional analytical artifacts including correlation matrices, histograms, scatter plots, and summary statistics as well as custom visualizations. For example, choose the **+ icon**, then choose **Add analysis**.



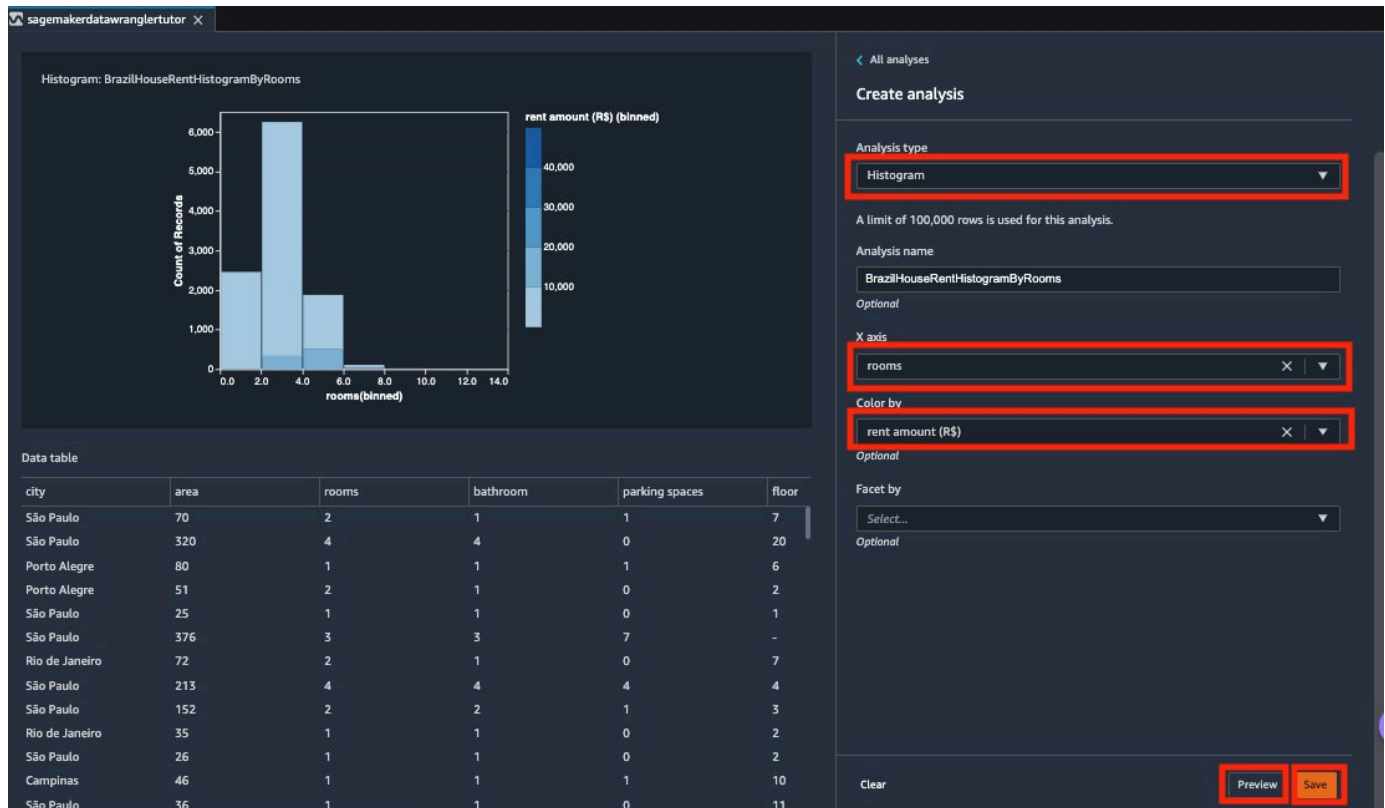
5. Create a histogram

Under the **Create analysis** panel, for **Analysis type**, select **Histogram** and name it **RentHistogramByRooms**. For **X axis**, select **rooms**.

For **Color by**, select **Rent amount**.

Choose **Preview** to generate a **histogram** of the **rent amount** field, color-coded by the **rooms** variable.

Choose **Save** to save this analysis to the data flow.



6. Create a Quick Model

Next, to gain higher confidence that the underlying data has some predictive power, we are going to create a Quick Model. Under the **Create analysis** pane, for **Analysis type**, choose **Quick Model** and name it **RentQuickModel**.

Then for **Label**, select **rental amount** and then choose **Preview**.

The **Quick Model** may take several minutes to complete, then the pane shows a brief overview of the Random Cut Forest model built and trained with default hyperparameters. The model generated also displays some statistics, including the Mean Square Error (MSE) score and feature importance to help you evaluate the quality of the dataset. Choose **Save**.

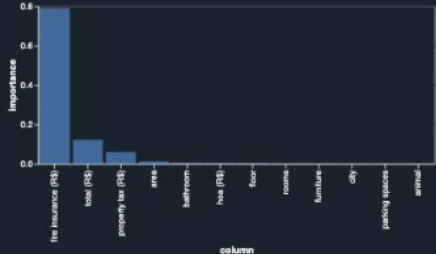
sagemakerdatawranglertutor X

Data types - Transform: kaggle-brazil-houses-to-rent.csv

Data Analysis Training **NEW**

Quick Model: BrazilHouseRentQuickModel

We train a random forest with 10 trees on 7514 observations and measure prediction quality on the remaining 3178 observations. For classification, we use stratified sampling for both the training dataset and the test dataset. For stratified sampling, we divide your data into groups based on the labels in your dataset. For both your training and test datasets, we choose a random sample that is proportional to the dataset that you provide. For example, if you have a dataset about cars with 25% of the cars being minivans, 50% being SUVs, and 25% being sedans, the training and test datasets will have the same proportion of minivans, SUVs, and sedans. The Random Forest is trained with the default hyper parameters. There is minimal preprocessing of the features before the model is trained. The model achieved an mse of 6.17e+05 on the test set. We use Gini importance scores as feature importance scores. For more information, see documentation.



Data table

city	area	rooms	bathroom	parking spaces	floor	animal
São Paulo	70	2	1	1	7	accept
São Paulo	320	4	4	0	20	accept
Porto Alegre	80	1	1	1	6	accept
Porto Alegre	51	2	1	0	2	accept
São Paulo	25	1	1	0	1	not ac
São Paulo	376	3	3	7	-	accept
Rio de Janeiro	72	2	1	0	7	accept
São Paulo	213	4	4	4	4	accept
São Paulo	152	2	2	1	3	accept
Rio de Janeiro	35	1	1	0	2	accept
São Paulo	26	1	1	0	2	accept
Campinas	46	1	1	1	10	accept
São Paulo	36	1	1	0	11	accept
São Paulo	55	1	1	1	2	accept
São Paulo	100	2	2	2	24	accept
Campinas	330	4	6	6	-	accept
São Paulo	110	2	2	1	1	accept
Rio de Janeiro	88	2	3	1	9	not ac
Rio de Janeiro	56	2	1	0	8	accept

All analyses

Create analysis

Analysis type: Quick Model

A limit of 100,000 rows is used for this analysis. You can use the Quick Model feature to provide a rough estimate of the expected predicted quality and the predictive power of the features in your dataset. We don't recommend using a quick model to fine tune the data preprocessing pipeline or to optimize feature selection.

Analysis name: BrazilHouseRentQuickModel

Optional

Label: rent amount (R\$)

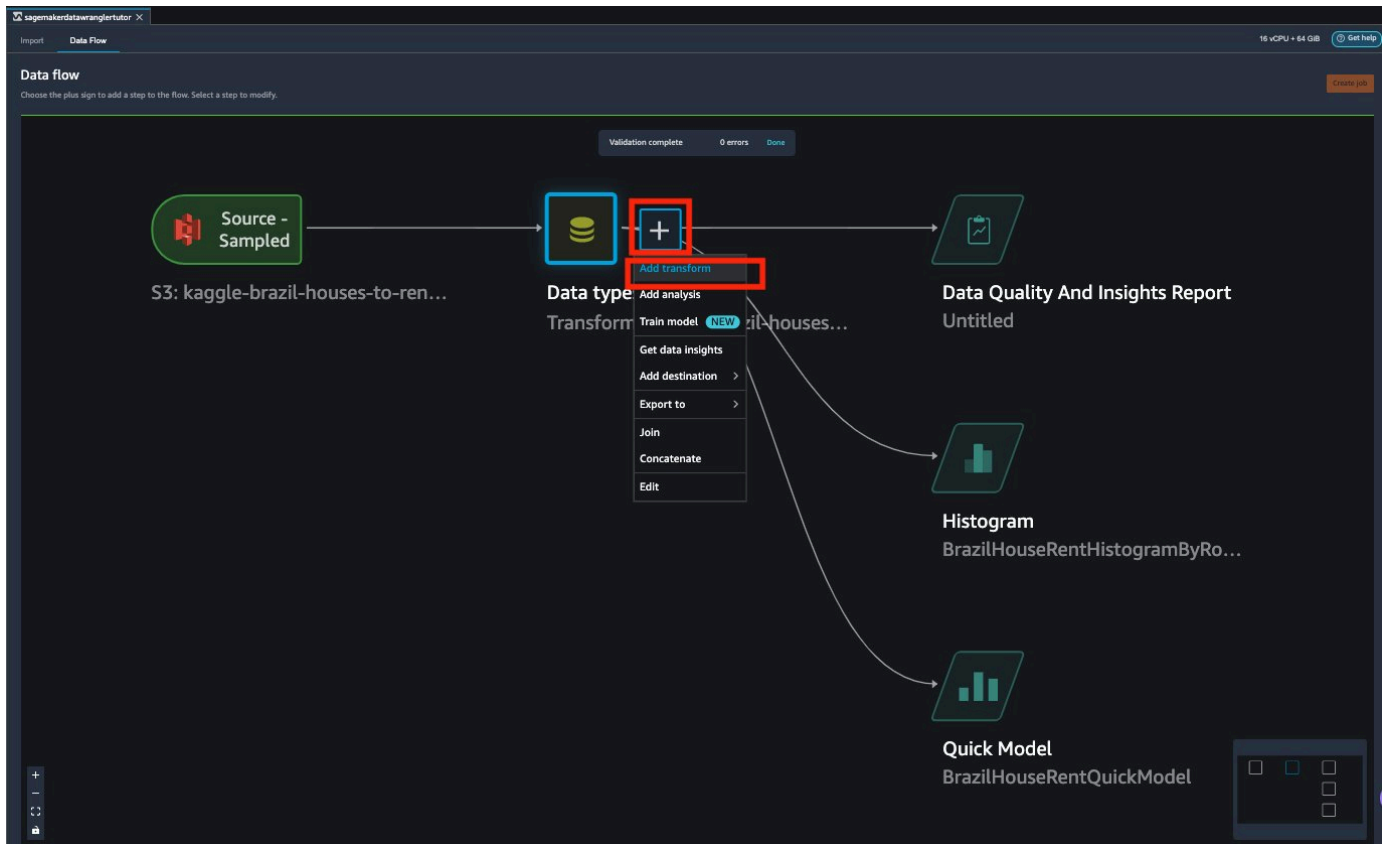
Clear Preview Save

Step 4: Add transformations to the data flow

SageMaker AI Data Wrangler simplifies data processing by providing a visual interface with which you can add a wide variety of pre-built transformations. You can also write your custom transformations when necessary using SageMaker AI Data Wrangler. In this step, you change the type of a string column, rename columns, and drop unnecessary columns using the visual editor.

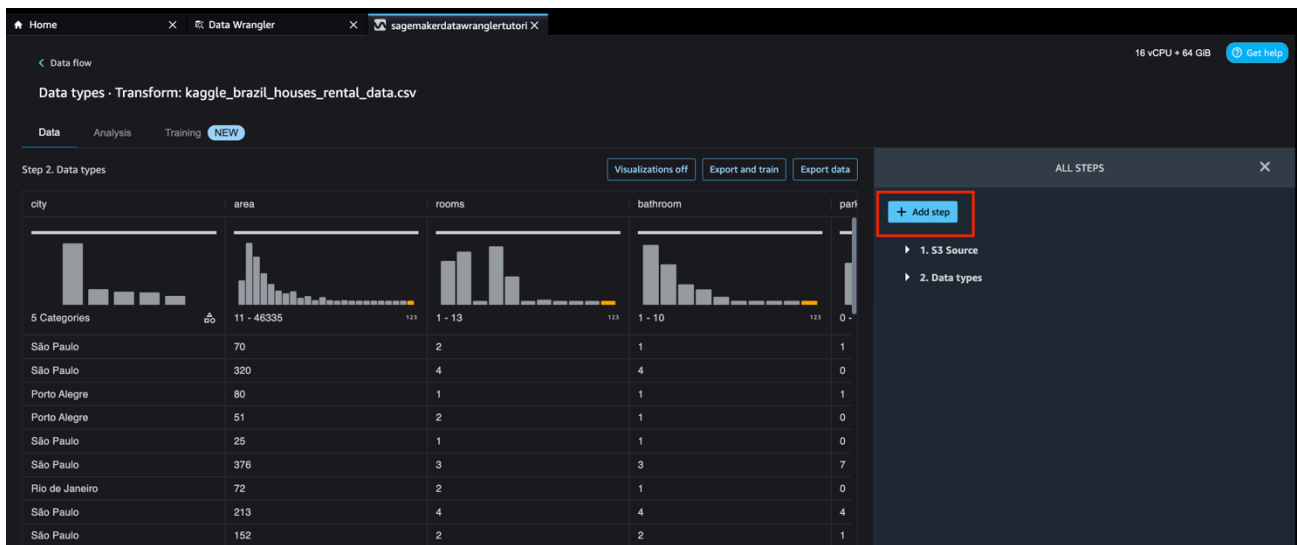
1. Open Data Wrangler flow

To navigate to the data flow diagram, choose **Data flow**. On the data flow diagram, choose the **+ icon**, then **Add transform**.



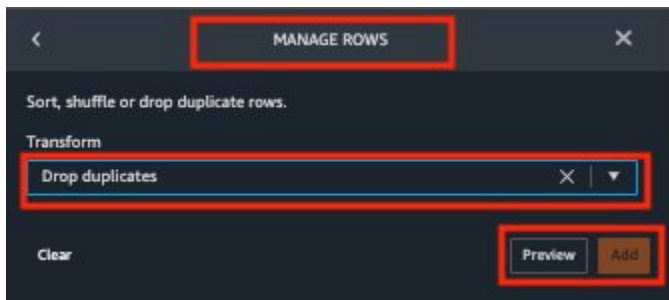
2. Add a transformation

Under the **ALL STEPS** pane, choose **Add step**.



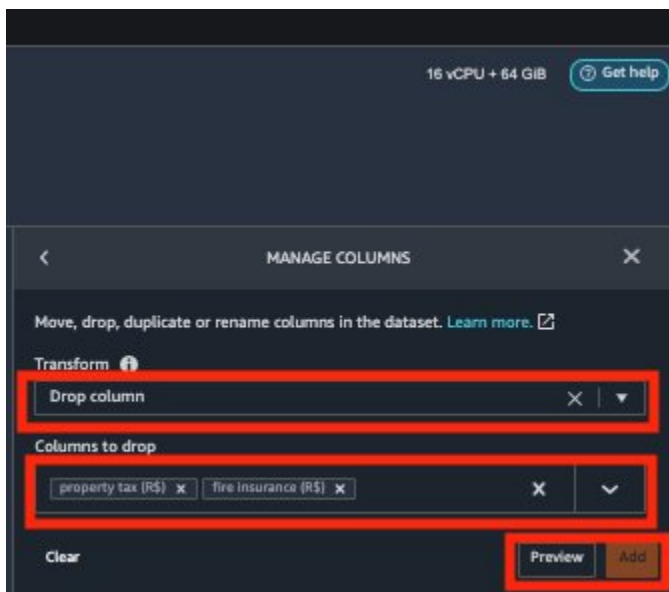
3. Remove duplicates

The first step is following the Data Insights Report recommendations regarding high risk items and removing the duplicate rows. So as the first transform step, choose **Manage Rows**, and then select the **Drop duplicates** operation. Then choose **Preview** and **Save**.



4. Select columns to drop

Second, we are going to remove the dataset features highlighted as possible sources of target leakage and not appropriate for a machine learning model predicting the rental amount. From the **ADD TRANSFORM** list, choose **Manage columns**. Then choose **Drop column** and choose **property tax** and **fire insurance**. Choose **Preview** then **Save**.



5. Change column type

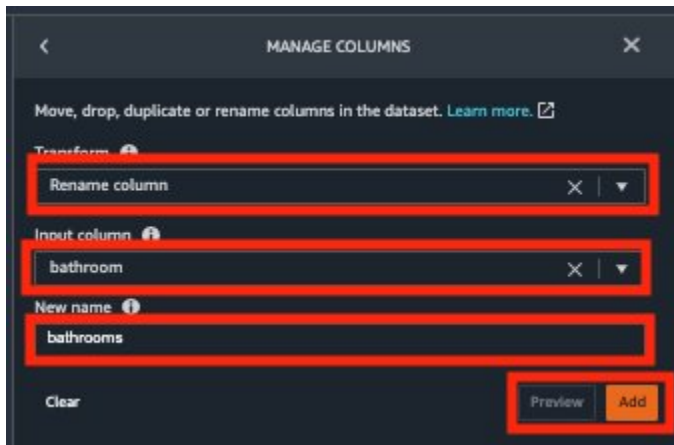
Next, change the data type of the **floor** column from **string** to **long**. Machine learning models can benefit from using numerically typed columns and this step will allow us to perform further processing later on.



6. Update column names

Then rename several columns to improve the readability of the input data set and later analysis.

From the **ADD TRANSFORM** list, choose **Manage columns**. Then choose **Rename column**. Then choose **bathroom** as the input column and **bathrooms** as the output column. Choose **Preview** then **Save**. Repeat this renaming column process for **hoa** [originally from **hoa (R\$)**], **rent** [originally from **rent amount (R\$)**], and **total** [originally from **total (R\$)**].



Step 5: Add categorical encoding and numeric scaling transformations to data flow

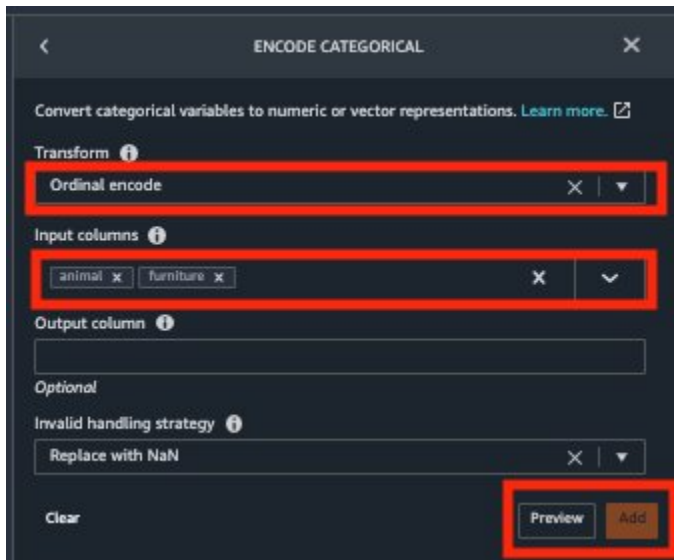
In this step, you encode categorical variables and scale numerical variables. Categorical encoding transforms string data type categories into numerical features. It's a common preprocessing task because the numerical features can be used in a wide variety of machine learning model types.

1. Configure encoding

In the dataset, the rental property's **animal** and **furniture** classification is represented by various strings. In this step, you convert these string values to a binary representation, 0 or 1.

Under the **ALL STEPS** pane, choose **+ Add step**. From the **ADD TRANSFORM** list, choose **Encode categorical**. SageMaker AI Data Wrangler provides three transformation types: Ordinal encode, One hot encode, and Similarity encode.

Under the **ENCODE CATEGORICAL** pane, for **Transform**, use the default **Ordinal encode**. For **Input** columns, select **animal** and **furniture**. Ignore the **Invalid handling strategy** box for this tutorial. Choose **Preview**, then **Add**.



2. Configure scaling

To scale the numerical columns area and floor, apply a scaler transformation to normalize the distribution of the data in these columns:

Under the **ALL STEPS** pane, Choose **+ Add step**. From the **ADD TRANSFORM** list, choose **Process numeric**. For **Scaler**, select the default option **Standard scaler**. For **Input** columns, select **area** and **floor**. Choose **Preview**, and then **Add**.

<
ADD TRANSFORM
×

Q Search transforms

CUSTOM

Custom formula
Define a new column using a Spark SQL expression to query data in the current dataframe.

Custom transform
Use Pyspark, Pandas, or Pyspark (SQL) to define custom transformations.

STANDARD

Balance data
Balance the data for binary classification problems using random oversampling, random undersampling or SMOTE.

Dimensionality Reduction
For the top K principal components, trains a model to project vectors to a lower dimensional space.

Encode categorical
Convert categorical variables to numeric or vector representations.

Featurize date/time
Encode date/time values to numeric and vector representations.

Featurize text
Generate vector representations from natural language text.

Format string
Clean and prepare strings using standard string formatting operations.

Group by
Add an aggregated column after group by as a new column.

Handle missing
Replace, drop, or add indicators for missing values.

Handle outliers
Remove or replace outlier numeric and categorical values.

Handle structured column
Flatten JSON and perform other operations on structured data

Manage columns
Move, drop, duplicate or rename columns in the dataset.

Manage rows
Sort, shuffle or drop duplicate rows.

Manage vectors
Expand or create vector columns.

<
PROCESS NUMERIC
×

Transform numeric values to improve machine learning model performance. [Learn more](#) 🔗

Transform

Scale values
×
▼

Scaler

Standard scaler
×
▼

Rescale the column to have unit standard deviation.

Input columns

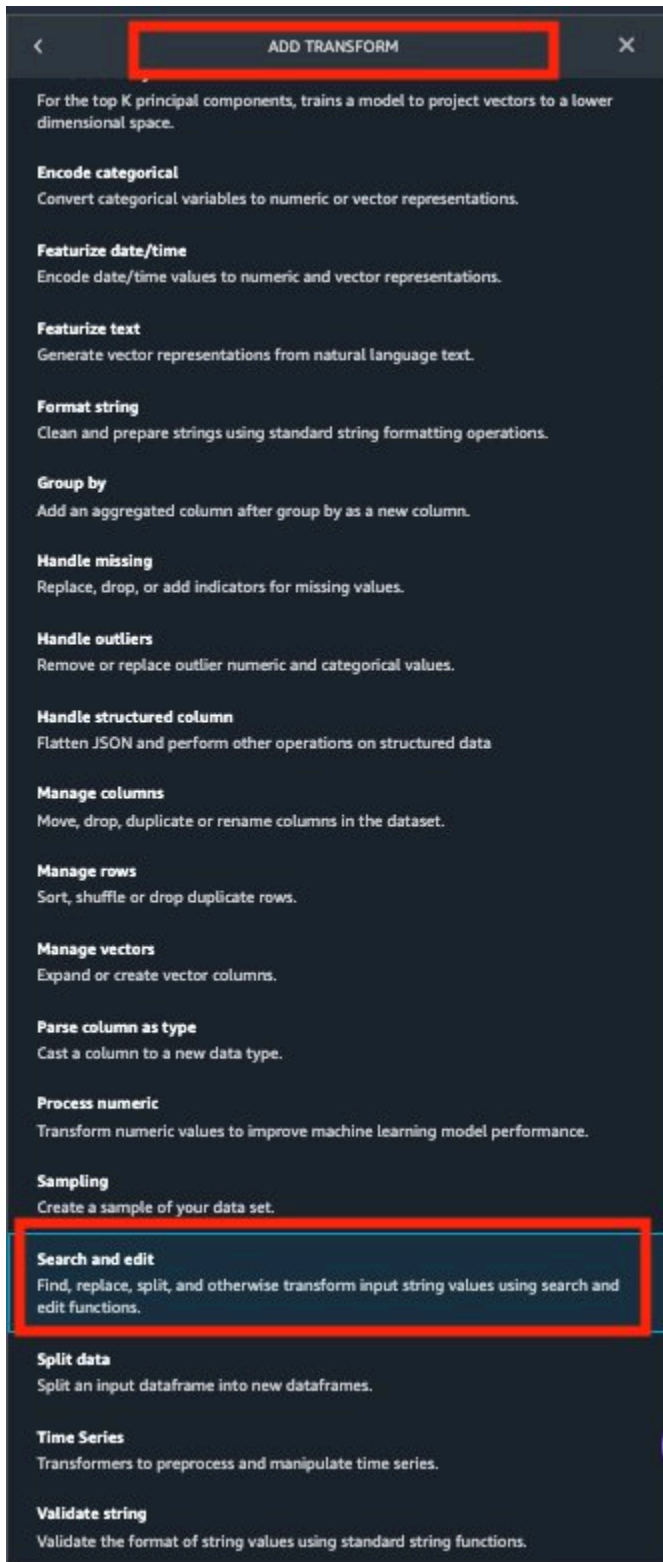
floor ▼
area ▼

▼
▼

3. Choose transformation type

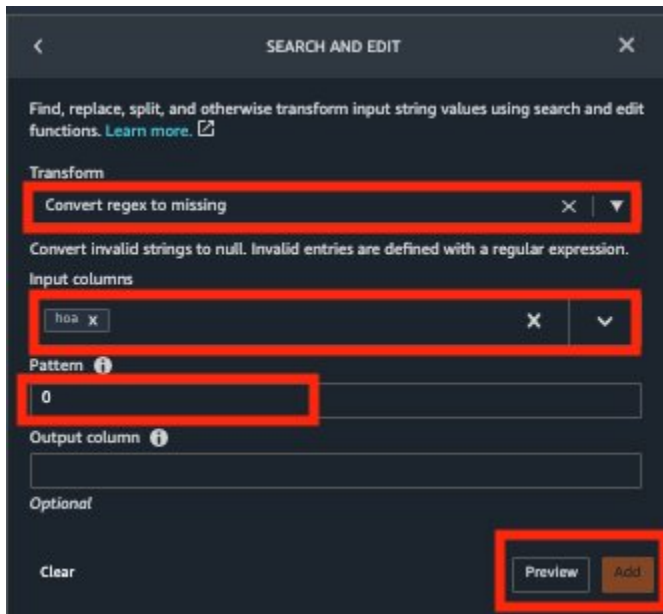
Finally, we will follow another recommendation from the Data Insight report and replace the 0s in the Home Owner Association (hoa) feature with **NaN** because they indicate missing data and should not be treated as valid inputs that might skew the model.

Under the **ALL STEPS** pane, choose **+ Add step**. From the **ADD TRANSFORM** list, choose **Search and edit**.



4. Replace zero values

Choose **Convert regex to missing**. Choose **hoa** as the **Input** column, specify **0** as the **Pattern**. Click **Preview**, and then choose **Add**.



Step 6: Check for data bias

In this step, check your data for bias using Amazon SageMaker AI Clarify, which provides you with greater visibility into your training data and models so you can identify and limit bias and better explain predictions.

1. Create a bias report

Choose **Data flow** in the upper left to return to the data flow diagram. Choose the **+ icon**, **Add analysis**.

In the **Create analysis** pane, for **Analysis type**, select **Bias Report**.

For **Analysis name**, enter **RentalDataBiasReport**.

For **Select the column your model predicts (target)**, select **rent**. Then select **Threshold** as the predicted column type since this is a regression problem.

Specify **3000** as the **predicted threshold** which corresponds to the average of the **rent** column in the dataset. Then select **city** as the column to analyze for bias because we are interested in whether the dataset is imbalanced and over-represents some cities instead of others.

Then for **Choose bias metrics**, keep the default selections. Then choose **Check for bias** and then **Save**.

< All analyses

Create analysis

Analysis type
Bias Report

A limit of 100,000 rows is used for this analysis.

Analysis name
RentalDataBiasReport

Optional

Select the column your model predicts (target)
rent

Is your predicted column a value or threshold?
 Value Threshold

Predicted threshold
3000

Select the column to analyze for bias
city

Is your column a value or threshold?
 Value Threshold

Column value(s) to analyze for bias
Enter column value(s)

Optional

Choose bias metrics
 Class imbalance (CI)
 Difference in Positive Proportions in Labels (DPL)
 JS divergence (JS)
 Conditional Demographic Disparity in Labels (CDDL)

To measure CDDL, select a column in the dataset to be used as the group variable.
Select...

Optional

Would you like to analyze additional metrics?
 Yes No

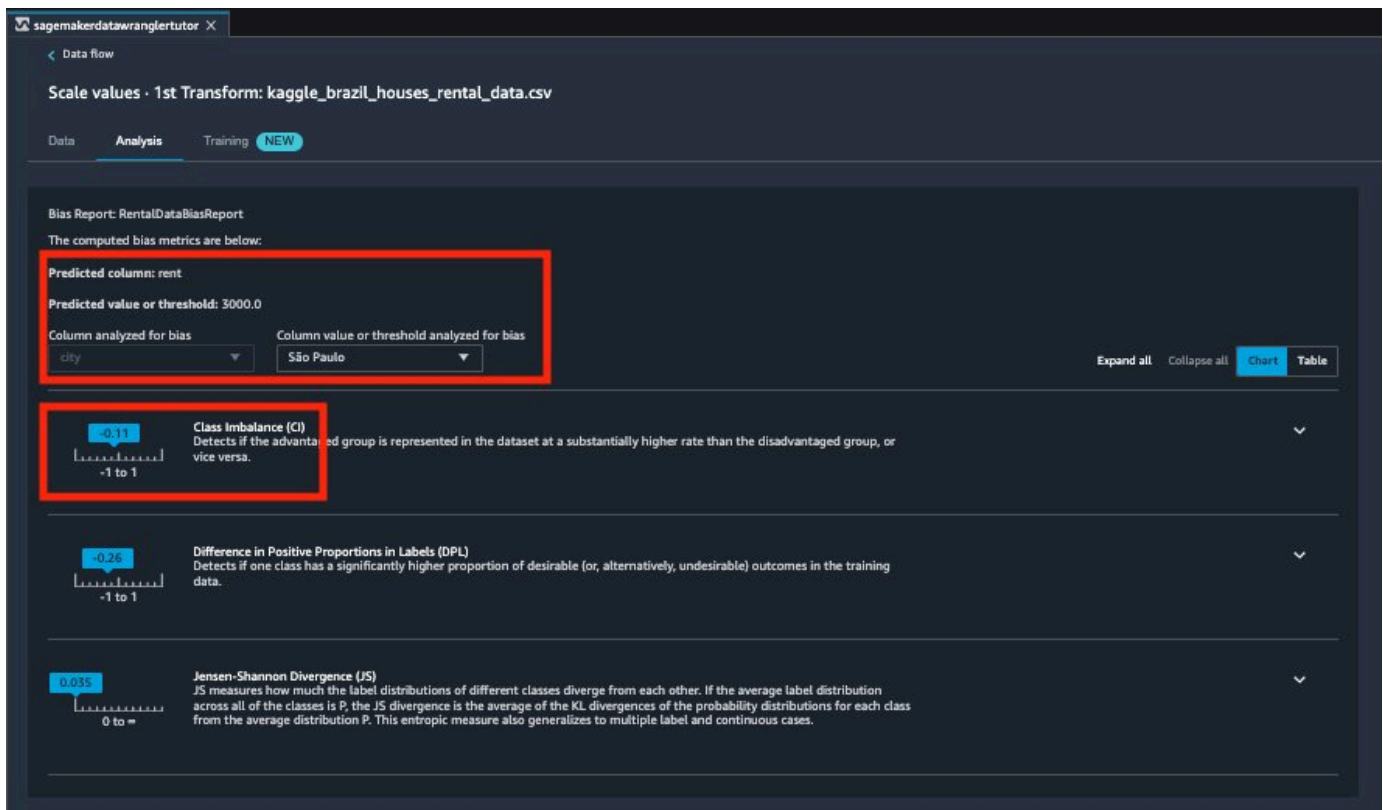
Clear

2. Review bias metrics

After several seconds, SageMaker AI Clarify generates a report, which shows how the target and feature columns score on a number of bias-related metrics including Class Imbalance (CI) and Difference in Positive Proportions in Labels (DPL).

In this case, the data is slightly biased with regards to rents in Sao Paulo (-0.11), and increasingly skewed for the cities of Rio de Janeiro (0.72), Belo Horizonte (0.77), and Porto Alegre (0.78).

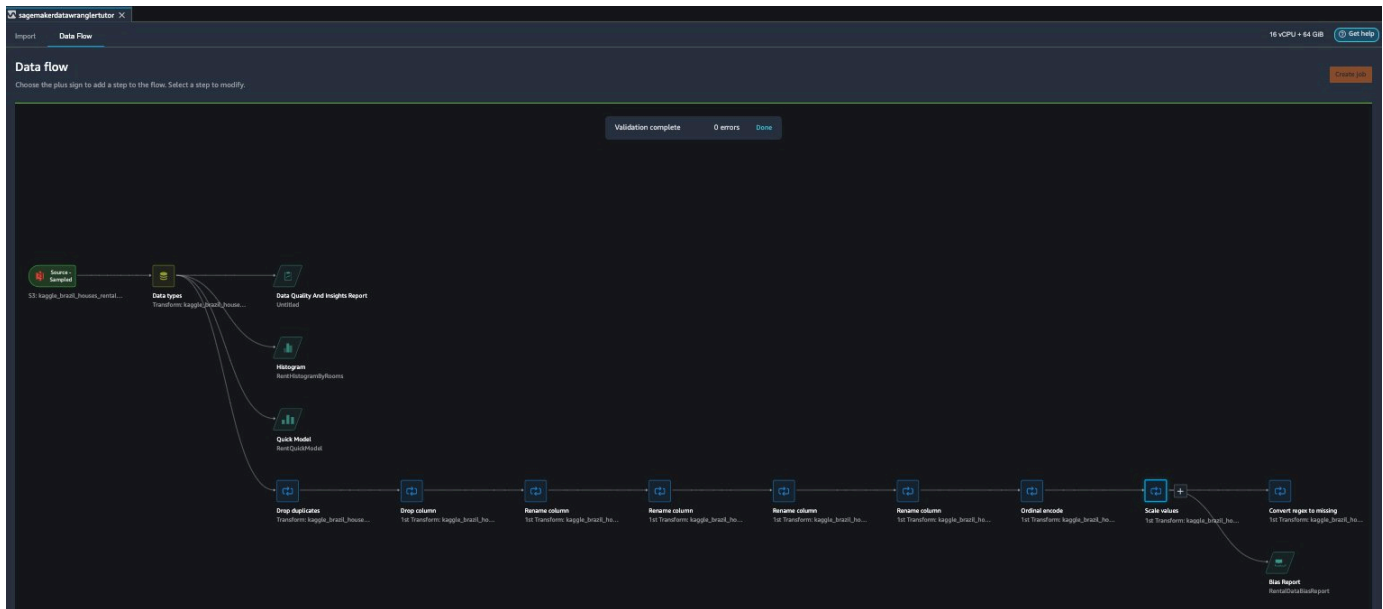
Based on this report, you might consider a bias remediation method, such as using SageMaker AI Data Wrangler's built-in SMOTE transformation. For the purpose of this tutorial, skip the remediation step. Choose **Save** to save the bias report to the data flow.



Step 7: Review, integrate, and export your data flow

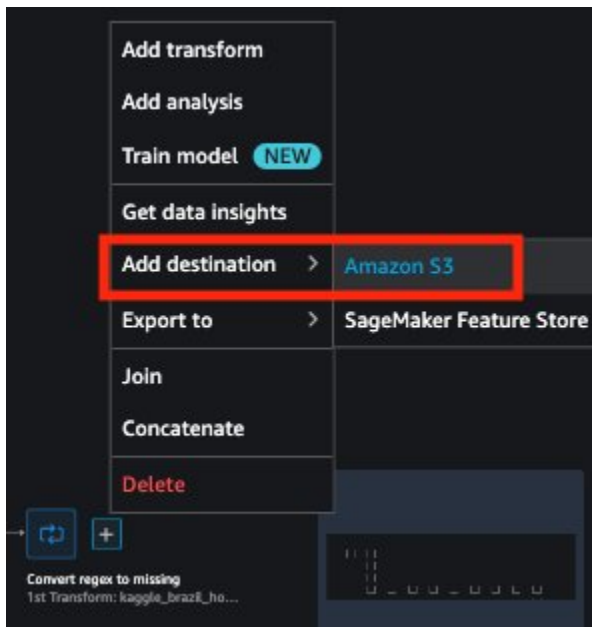
1. View your data flow

From the **Data Flow** tab, review your end-to-end data flow graph including the data source, analytical artifacts, and data transformations. You can easily navigate, view, modify, and delete data flow steps iteratively.



2. Export to Amazon S3

Data Wrangler further streamlines the automation process of exporting the output of the data flow to a persistent destination and can orchestrate the schedule of the flow's execution. First, set the storage destination to Amazon S3.



3. Specify output settings

Then specify the output dataset name (**kaggle_brazil_houses_rental_data_dw_processed.csv**) and the Amazon S3 location as your preferred S3 bucket. Then choose **Add destination**.



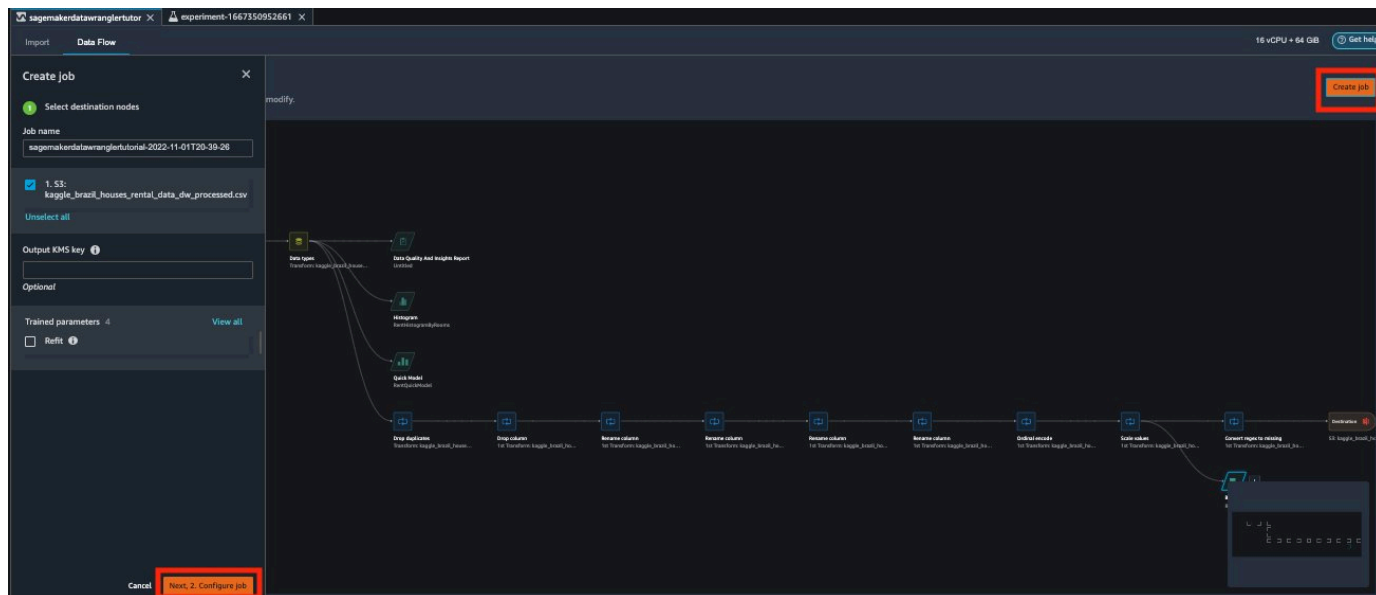
The screenshot shows a dark-themed dialog box titled "Add a destination" with a close button (X) in the top right corner. The dialog is for "Amazon S3". It contains the following fields and controls:

- Dataset name:** A text input field containing "kaggle_brazil_home_rentals_data_processed.csv".
- File type:** A dropdown menu set to "CSV (*.c...)".
- Delimiter:** A dropdown menu set to "Comma...".
- Compression:** A dropdown menu set to "None".
- Amazon S3 location:** A text input field containing "s3://sagemaker-us-east-1-645411899653/" and a "Browse" button to its right.

At the bottom of the dialog, there are two buttons: "Cancel" and "Add destination".

4. Create job

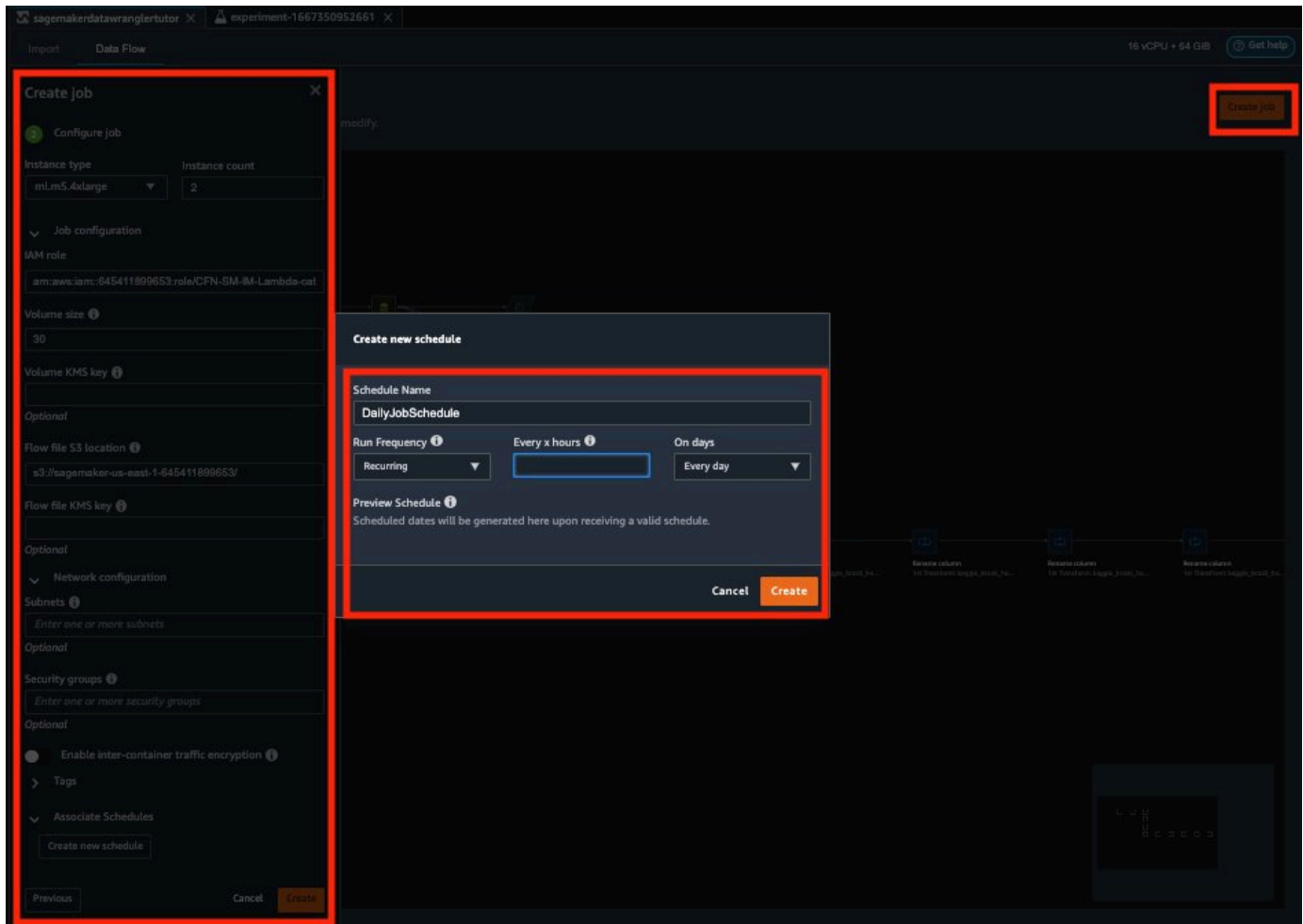
Lastly, create the scheduled job that will export the data flow output to Amazon S3 by choosing the **Create job** button from the **Data Flow** diagram pane, and then choosing **Configure job**.



The screenshot displays the Amazon SageMaker Data Flow console. On the left, a 'Create job' sidebar is visible, showing a job name 'sagemakerdatawanglertutorial-2022-11-01T20-39-26' and a selected destination node '1. S3: kaggle_brazil_houses_rental_data_dw_processed.csv'. The main workspace shows a data flow graph with nodes for 'Data Open', 'Data Quality and Insights Report', 'Histograms', 'Quick Model', and a series of 'Drop columns' nodes. A 'Next, 2. Configure job' button is highlighted in red at the bottom left of the sidebar. A 'Create job' button is also highlighted in red in the top right corner of the console.

5. Configure job

Then you can decide on the job instance type, instance count, the job's IAM security role, and the job schedule.

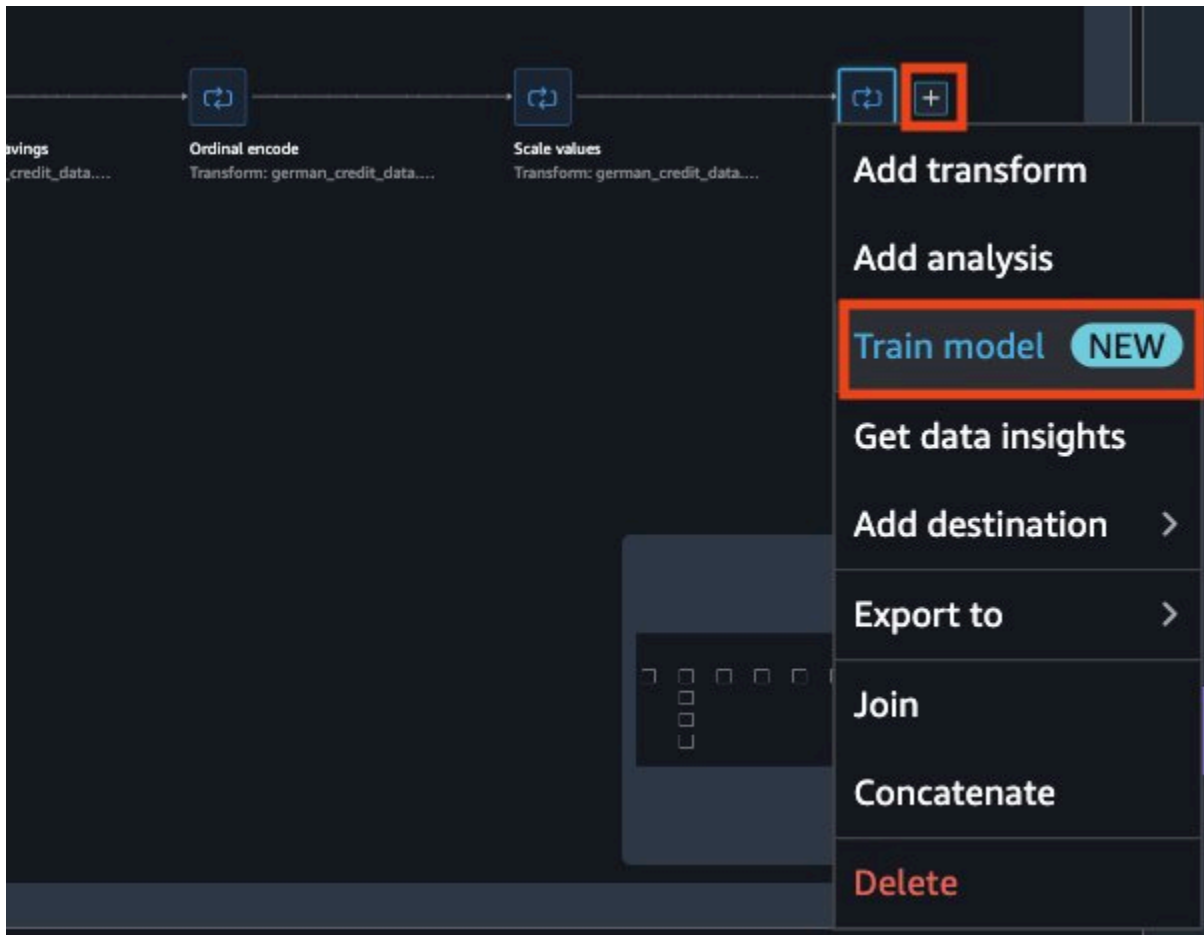


Step 8: SageMaker AI Autopilot integration

You can also integrate your data flow with [SageMaker AI Autopilot](#) which automates key tasks of training and deploying a machine learning model.

1. Open model training

From the **Data Flow** tab, choose the **+ icon** and then choose **Train model**.



2. Configure and start Autopilot experiment

Choose **Export and Train** to export the Data Wrangler flow and associate its output with the Autopilot Experiment input.

Choose the **S3 location** where the Data Wrangler flow saved the processed input dataset and specify the **target** column as **rent** for the Autopilot model.

Specify the Autopilot **Training method**. You can choose Ensembling, Hyperparameter Optimization, or Auto. For the purposes of this tutorial, choose **Auto**.

For **Deployment**, select the machine learning problem type as **Regression** with the object metric as **MSE**.

Confirm the Autopilot Experiment deployment settings and then choose **Create experiment**.

This action launches a SageMaker AI Autopilot job that inspects the input data, generates and evaluates multiple ML models, and then selects the best model for subsequent deployment according to the desired performance metric (such as MSE in this tutorial).

The Autopilot job may take several minutes to run and complete. Autopilot provides full visibility into how the models were selected, trained, and tuned through a visual leaderboard and programmatic APIs. Finally, Autopilot explains how models make predictions using feature attribution and explainability statistics using SageMaker AI Clarify.

The screenshot displays the SageMaker AI Autopilot job interface for 'Experiment-1667350952661'. The 'Best model endpoint' is 'Experiment-1667350952661-7c9ada956c654fc3a47131e2621a59c9'. The 'Best model' is 'Experiment-16673509526619b15sg8l-010-d83aa984' with an Objective MSE of 328196.75, MAE of 184.006, RMSE of 559.49, R2 of 0.973, and Algorithm of XGBoost. A table below shows a list of models with their respective Objective MSE, Status, and Start time.

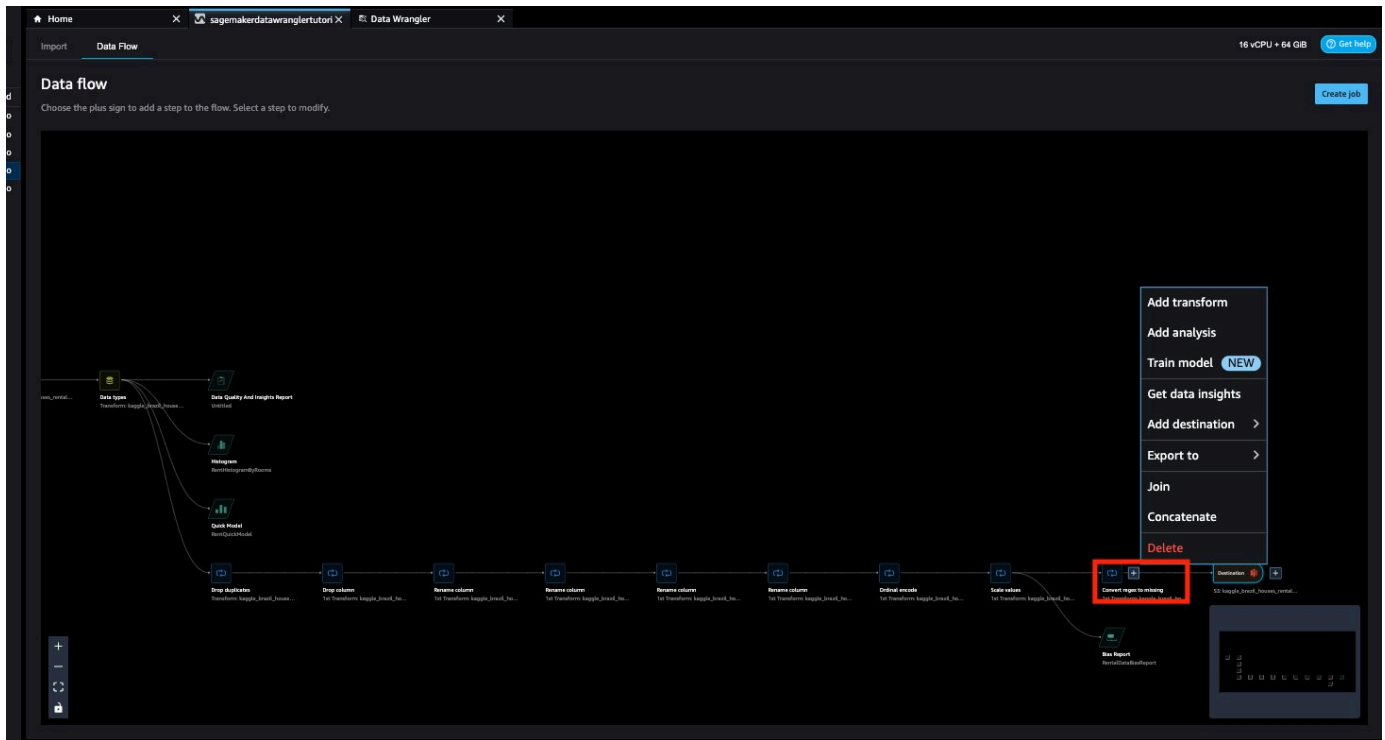
Model name	Objective: Mse	Status	Start time
Experiment-16673509526619b15sg8l-010-d83aa984	328196.75	Completed	35 minutes ago
Experiment-16673509526619b15sg8l-022-92...	366718048	Completed	32 minutes ago
Experiment-16673509526619b15sg8l-044-3f...	340098080	Completed	27 minutes ago
Experiment-16673509526619b15sg8l-031-85...	325408864	Completed	30 minutes ago
Experiment-16673509526619b15sg8l-026-f5...	320702976	Completed	32 minutes ago
Experiment-16673509526619b15sg8l-024-97...	310899936	Completed	32 minutes ago
Experiment-16673509526619b15sg8l-037-a8...	164719440	Completed	29 minutes ago

Step 9: SageMaker AI Pipeline integration

Data Wrangler can also be integrated with SageMaker AI Inference Pipelines to process data at the time of inference, thereby streamlining the steps between data processing and model inference. When you export one or more steps from the data flow to an inference endpoint, Data Wrangler creates a Jupyter notebook that you can use to define, instantiate, customize, run, and manage the inference pipeline.

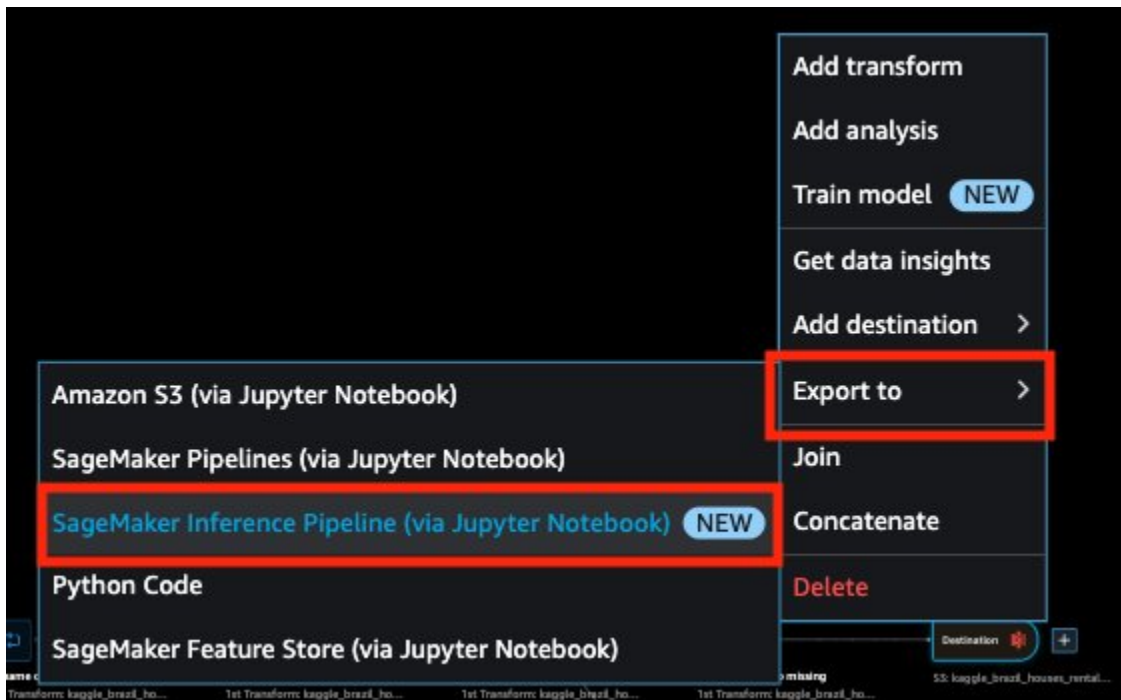
1. Create an inference endpoint

To create the inference endpoint, choose the + next to the final transformation step (Convert regex to missing) and choose **Export to**, and then choose **SageMaker AI Inference Pipeline (via Jupyter Notebook)**. Then inspect and run that Jupyter notebook.



2. (Optional) Export your data flow

You can optionally export your Data Wrangler data flow to a Jupyter notebook to run the flow steps as a SageMaker AI Processing job.



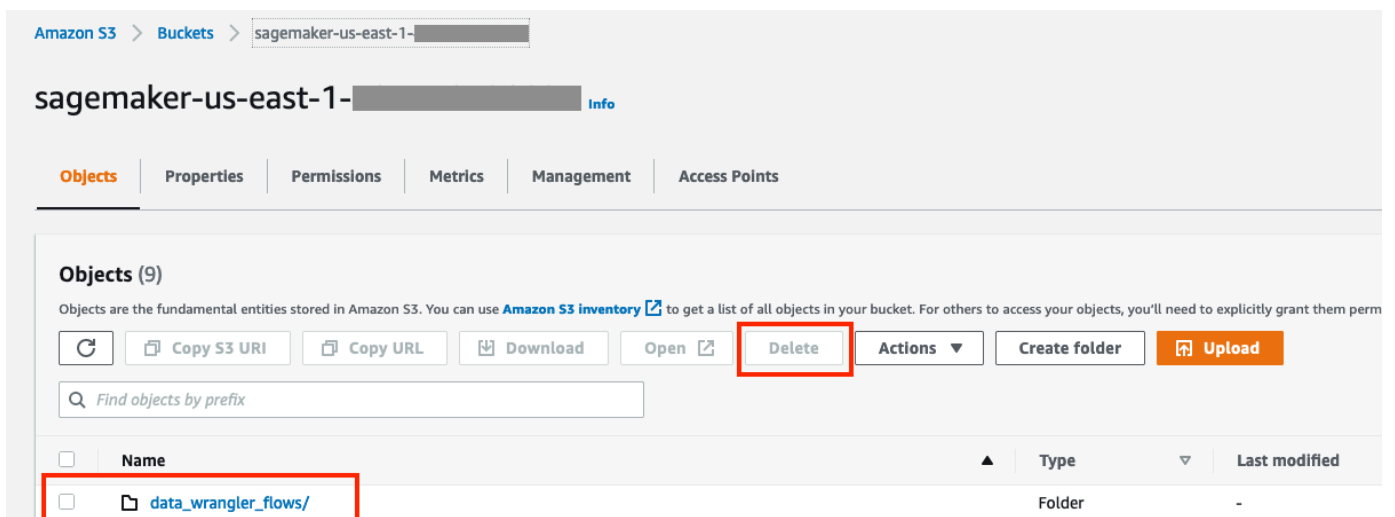
Clean up resources

It is a best practice to delete resources that you are no longer using so that you don't incur unintended charges.

1. Empty and delete S3 bucket

To delete the S3 bucket, do the following:

- Open the Amazon S3 console. On the navigation bar, choose **Buckets**, **sagemaker-<your-Region>-<your-account-id>**, and then select the checkbox next to **data_wrangler_flows**. Then, choose **Delete**.
- In the **Delete objects** dialog box, verify that you have selected the proper object to delete and enter **permanently delete** into the **Permanently delete objects** confirmation box.
- Once this is complete and the bucket is empty, you can delete the **sagemaker-<your-Region>-<your-account-id>** bucket by following the same procedure again.



2. Delete Studio apps

The Data Science kernel used for running the notebook image in this tutorial will accumulate charges until you either stop the kernel or perform the following steps to delete the apps. For more information, see [Shut Down Resources](#) in the **Amazon SageMaker AI Developer Guide**.

To delete the SageMaker AI Studio apps, do the following: On the SageMaker AI Studio console, choose **studio-user**, and then delete all the apps listed under **Apps** by choosing **Delete app**. Wait until the **Status** changes to **Deleted**.

Amazon SageMaker > Control Panel

User Details

General details about this user profile.

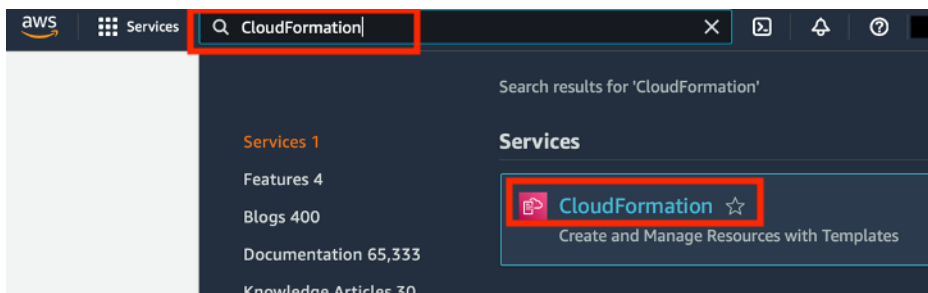
App name	Status	App type	Created	Action
datascience-1-0-ml-t3-medium-1abf3407f667f989be9d86559395	Ready	KernelGateway	Sat Apr 09 2022 15:25:16 GMT-0400 (Eastern Daylight Time)	Delete app
default	Ready	JupyterServer	Sat Apr 09 2022 15:22:55 GMT-0400 (Eastern Daylight Time)	Delete app

Delete the Studio domain

- If you used an existing SageMaker AI Studio domain, proceed directly to the conclusion section.
- If you ran the CloudFormation template to create a new SageMaker AI Studio domain, continue with the following steps to delete the domain, user, and the resources created by the CloudFormation template.

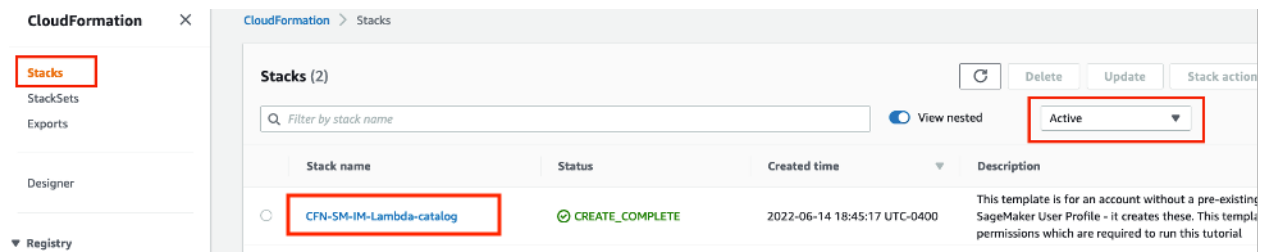
1. Open CloudFormation

To open the CloudFormation console, enter **CloudFormation** into the AWS console search bar, and choose **CloudFormation** from the search results.



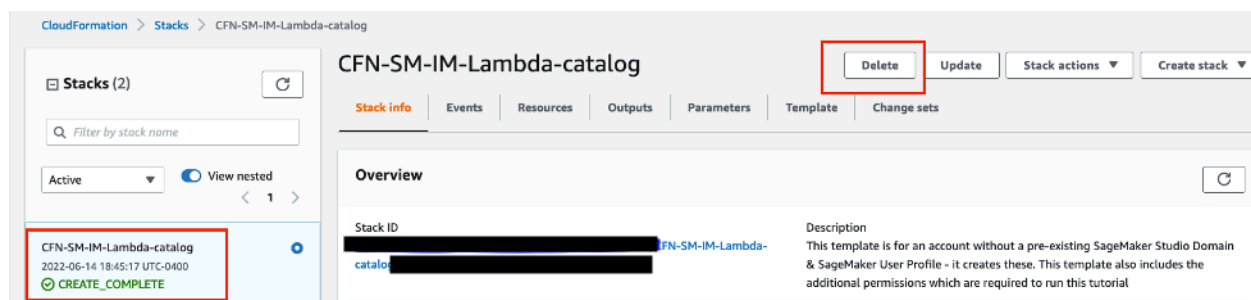
2. Choose the stack

In the **CloudFormation** pane, choose **Stacks**. From the status dropdown list, select **Active**. Under **Stack name**, choose **CFN-SM-IM-Lambda-catalog** to open the stack details page.



3. Delete the stack

On the **CFN-SM-IM-Lambda-catalog** stack details page, choose **Delete** to delete the stack along with the resources it created.



Conclusion

Congratulations! You have completed the **Prepare Training Data for Machine Learning with Minimal Code** tutorial.

You have successfully used Amazon SageMaker AI Data Wrangler to prepare data for training a machine learning model. SageMaker AI Data Wrangler offers 300+ preconfigured data transformations, such as convert column type, one-hot encoding, impute missing data with mean or median, re-scale columns, and date/time embeddings, so you can transform your data into formats that can be effectively used for models without writing a single line of code.