



Microsoft Ignite





Getting started on your health-tech journey

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Agenda

-
- Introduction to HealthTech - evolution through the decades [5]
 - RAI Principles in Health [1]
 - Architecting your first Responsible AI Health Pipeline in AML using Cardiovascular risk [7]
 - Demo [7]
 - Q&A [10]

Why go to the GP when you could send your health avatar instead?

🕒 Fri 26 Apr 2019 | [Iain Buchan](#)



4 Decades of Health-Tech and The Decade Ahead

1980s / 90s → 2000s : Clinical Audit & Governance

- Evidence Based Medicine
- 1-way: research → practice
- Hand-crafted models & scarce data

2010s : Learning Health Systems

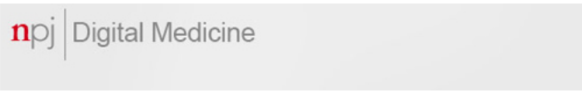
- Electronic Health Records and Big Data
- 2-way: research <-> practice
- Models start to be learned from fuller data

2020s : Precision & Population Health Systems

- Personalization & Well Being
- Privacy & Bias
- Population Health & Smart Cities

Digital Biomarkers

Journal List > NPJ Digit Med > v.2, 2019 > PMC6841669



NPJ Digit Med

NPJ Digit Med. 2019; 2: 108. PMCID: PMC6841669
Published online 2019 Nov 8. doi: [10.1038/s41746-019-0182-1](https://doi.org/10.1038/s41746-019-0182-1) PMID: [31728415](https://pubmed.ncbi.nlm.nih.gov/31728415/)

GPS mobility as a digital biomarker of negative symptoms in schizophrenia: a case control study

[Colin A. Depp](#),^{1,2} [Jesse Bashem](#),² [Raeanne C. Moore](#),^{1,2} [Jason L. Holden](#),¹ [Tanya Mikhael](#),³ [Joel Swendsen](#),⁴ [Philip D. Harvey](#),⁵ and [Eric L. Granholm](#)^{1,2}

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Associated Data

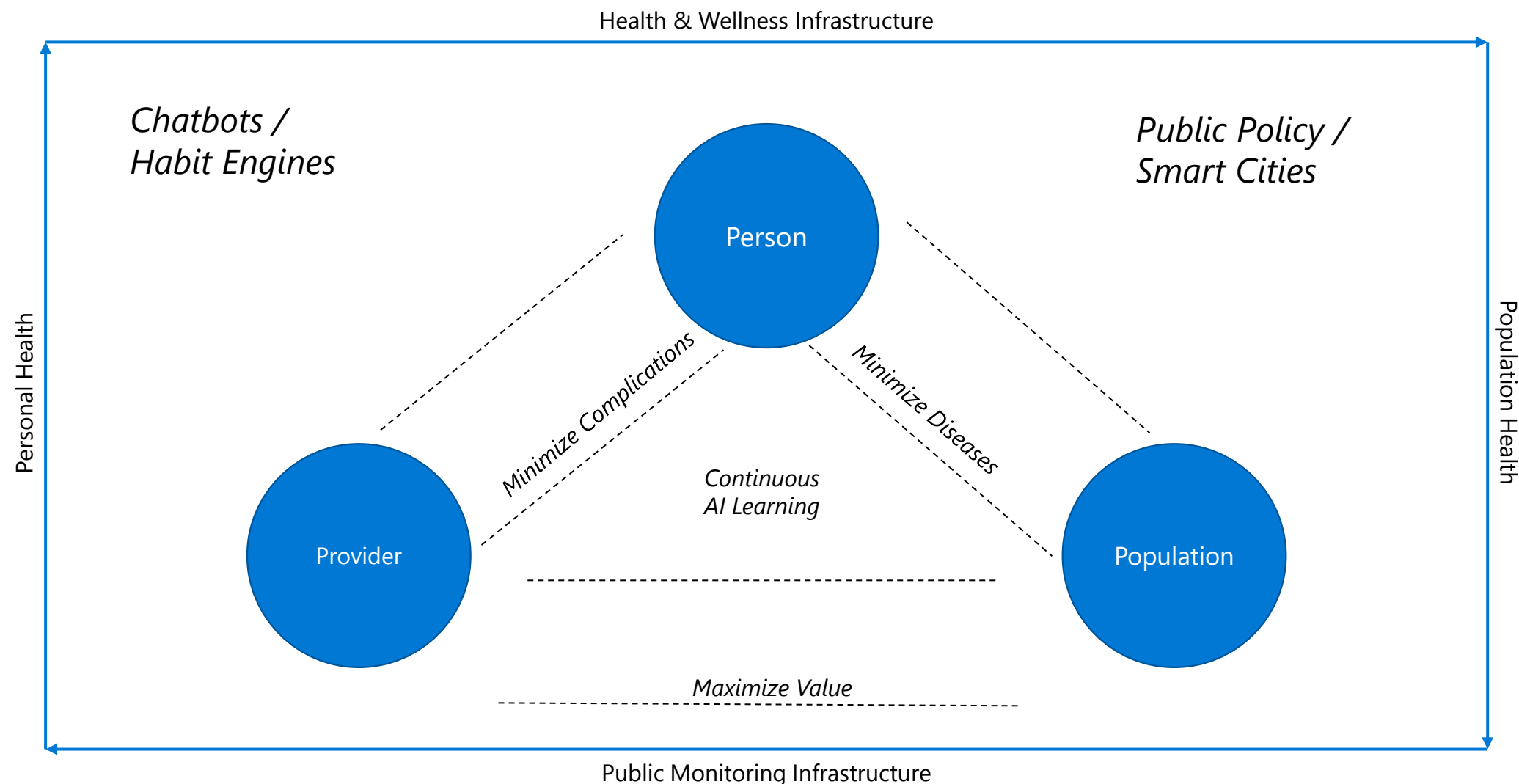
- [Supplementary Materials](#)
- [Data Availability Statement](#)

Abstract [Go to:](#)

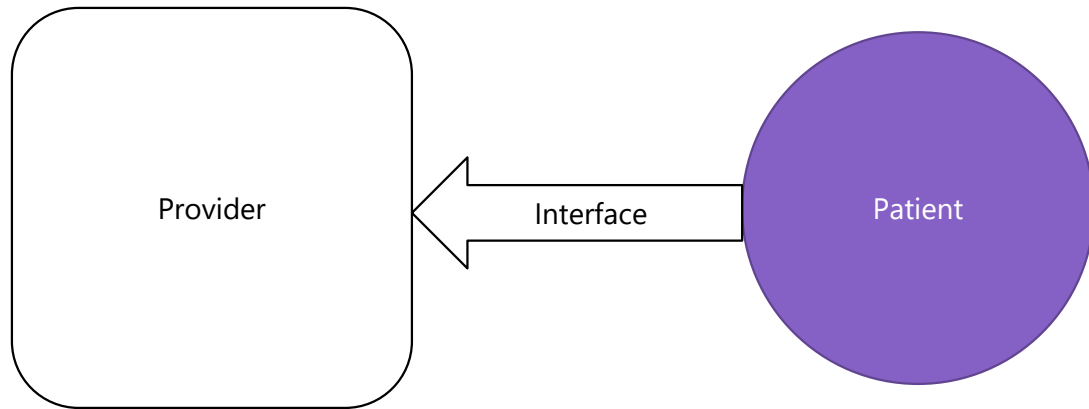
Mobility is an important correlate of physical, cognitive, and mental health in chronic illness, and can be measured passively with mobile phone global positional satellite (GPS) sensors. To date, GPS data have been reported in a few studies of schizophrenia, yet it is unclear whether these data correlate with concurrent momentary reports of location, vary by people with schizophrenia and healthy comparison subjects, or associate with symptom clusters in schizophrenia. A total of 142 participants with schizophrenia ($n = 86$) or healthy comparison subjects ($n = 56$) completed 7 days of ecological momentary assessment (EMA) reports of location and behavior, and simultaneous GPS locations were tracked every five minutes. We found that GPS-derived indicators of average distance travelled overall and distance from home, as well as percent of GPS samples at home were highly correlated with EMA reports of location at the day- and week-averaged level. GPS-based mobility indicators were lower in schizophrenia with medium to large effect sizes. Less GPS mobility was related to greater negative symptom severity, particularly diminished motivation, whereas greater GPS mobility was weakly associated with more community functioning. Neurocognition, depression, and positive symptoms were not associated with mobility indicators. Therefore, passive GPS sensing could provide a low-burden proxy measure of important outcomes in schizophrenia, including negative symptoms and possibly of functioning. As such, passive GPS sensing could be used for monitoring and timely interventions for negative symptoms in young persons at high risk for schizophrenia.

Subject terms: Health care, Medical research

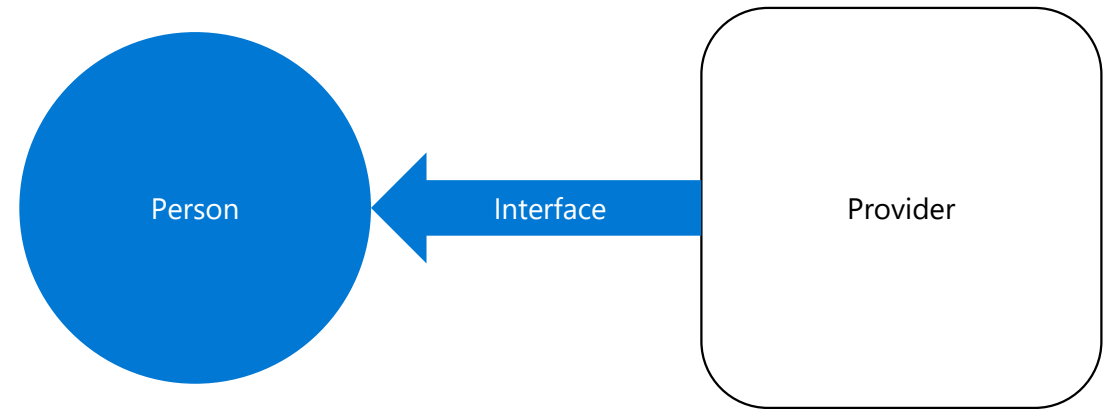
Health Stakeholder Relationships



Crossing the Trust-chasm



Clinic-centred supply chain
Episodic Treatments



Person –centred supply chain
Preventive / Journey

Responsible AI Principles

- **Fairness**

- AI systems should treat all people fairly

- **Inclusiveness**

- AI systems should empower everyone and engage people

- **Reliability & Safety**

- AI systems should perform reliably and safely

- **Transparency**

- AI systems should be understandable

- **Privacy & Security**

- AI systems should be secure and respect privacy

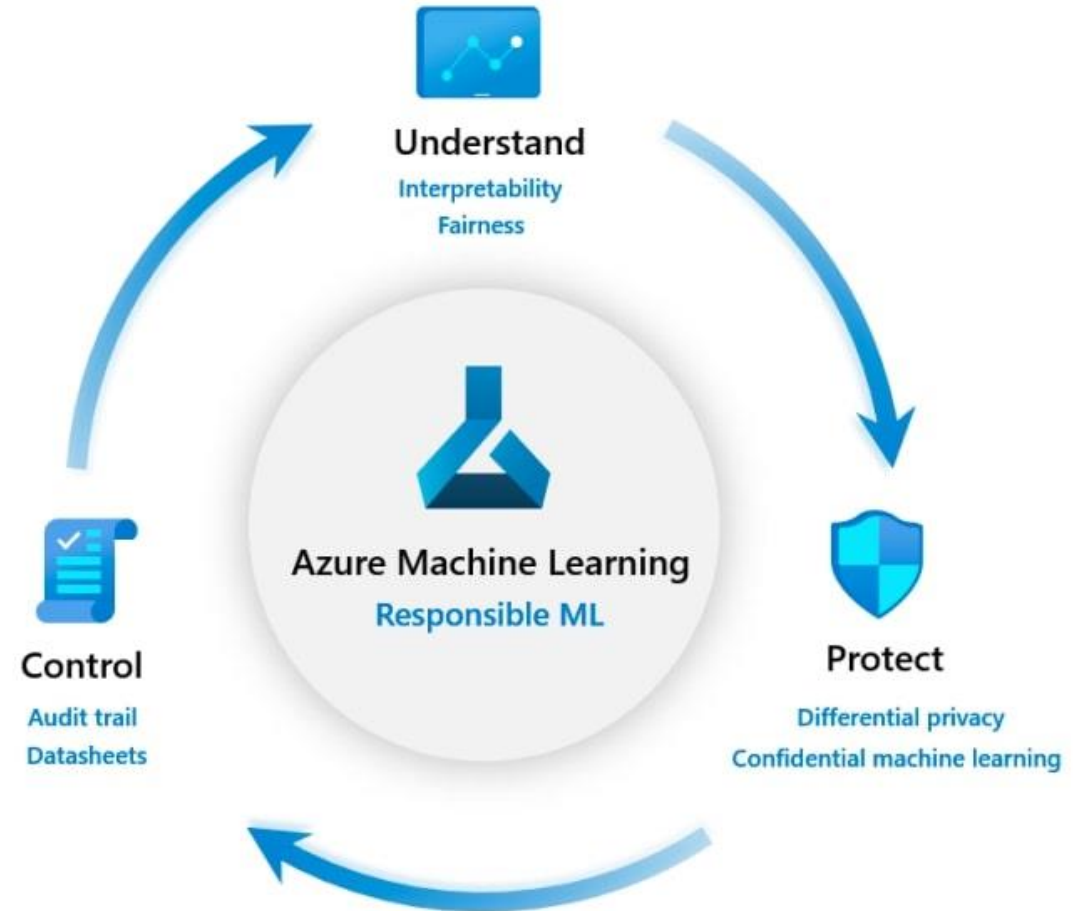
- **Accountability**

- AI systems should have algorithmic accountability

Responsible ML

Responsible ML encompasses the following values and principles:

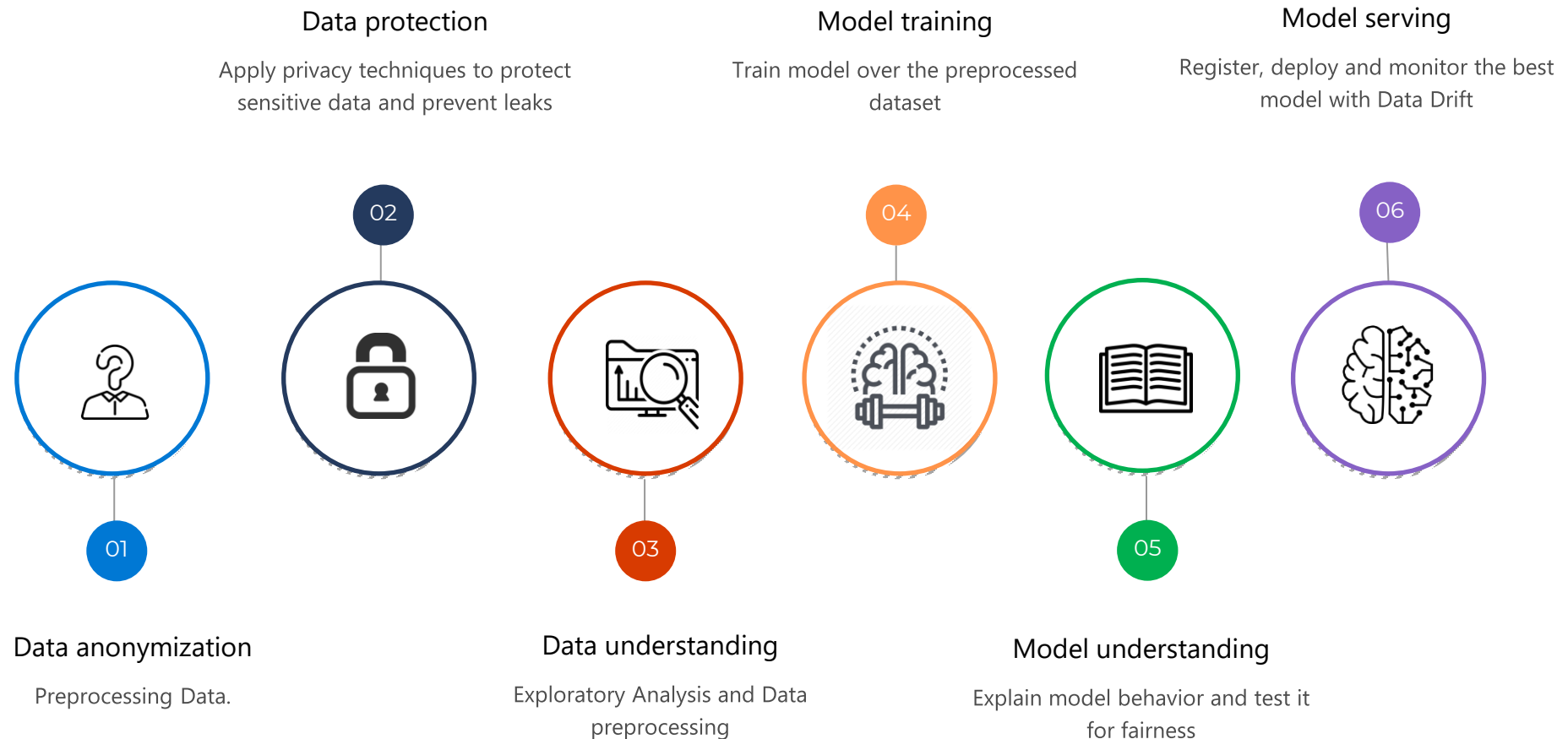
- Understand machine learning models
- Protect people and their data
- Control the end-to-end machine learning process



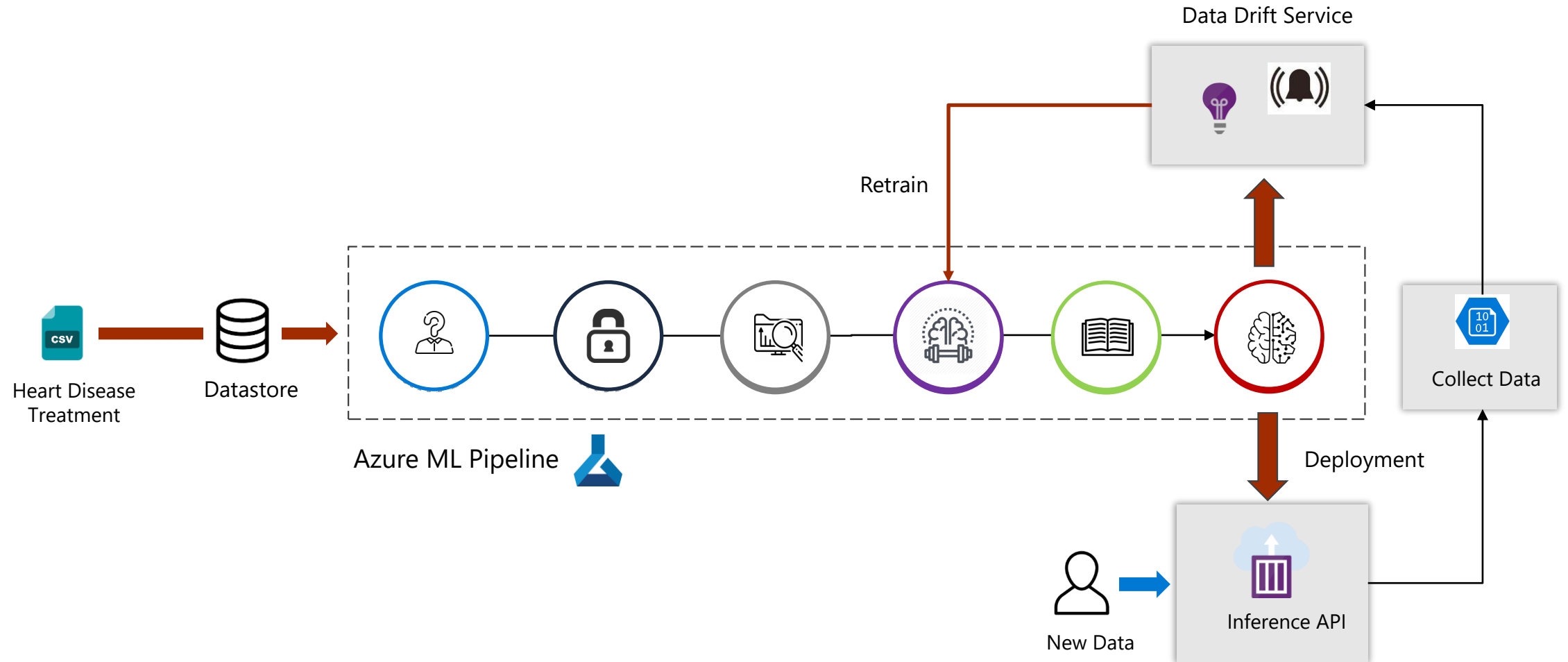
Responsible ML Healthcare

Goal: Detect if a person is suitable for receiving a treatment for heart disease.

Use Azure Machine Learning as a tool to cover all the Machine Learning and Responsible AI workflow

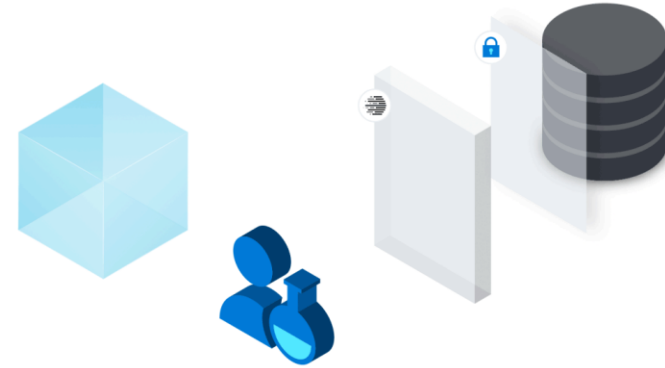


Process Diagram

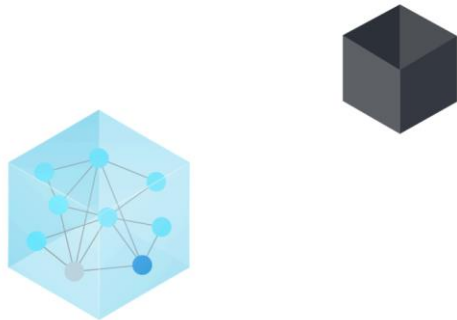




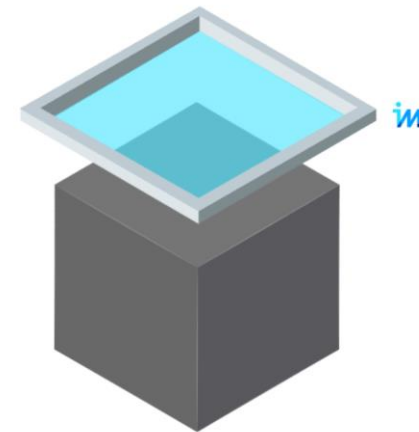
Data Anonymization



Differential Privacy

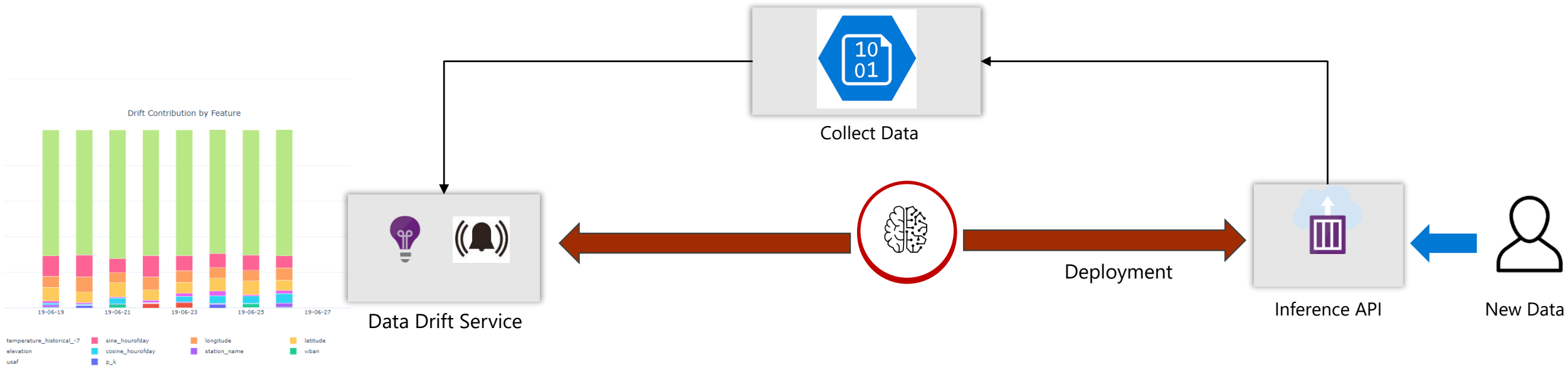


Fairness Detection



Explainable AI

Model deployment

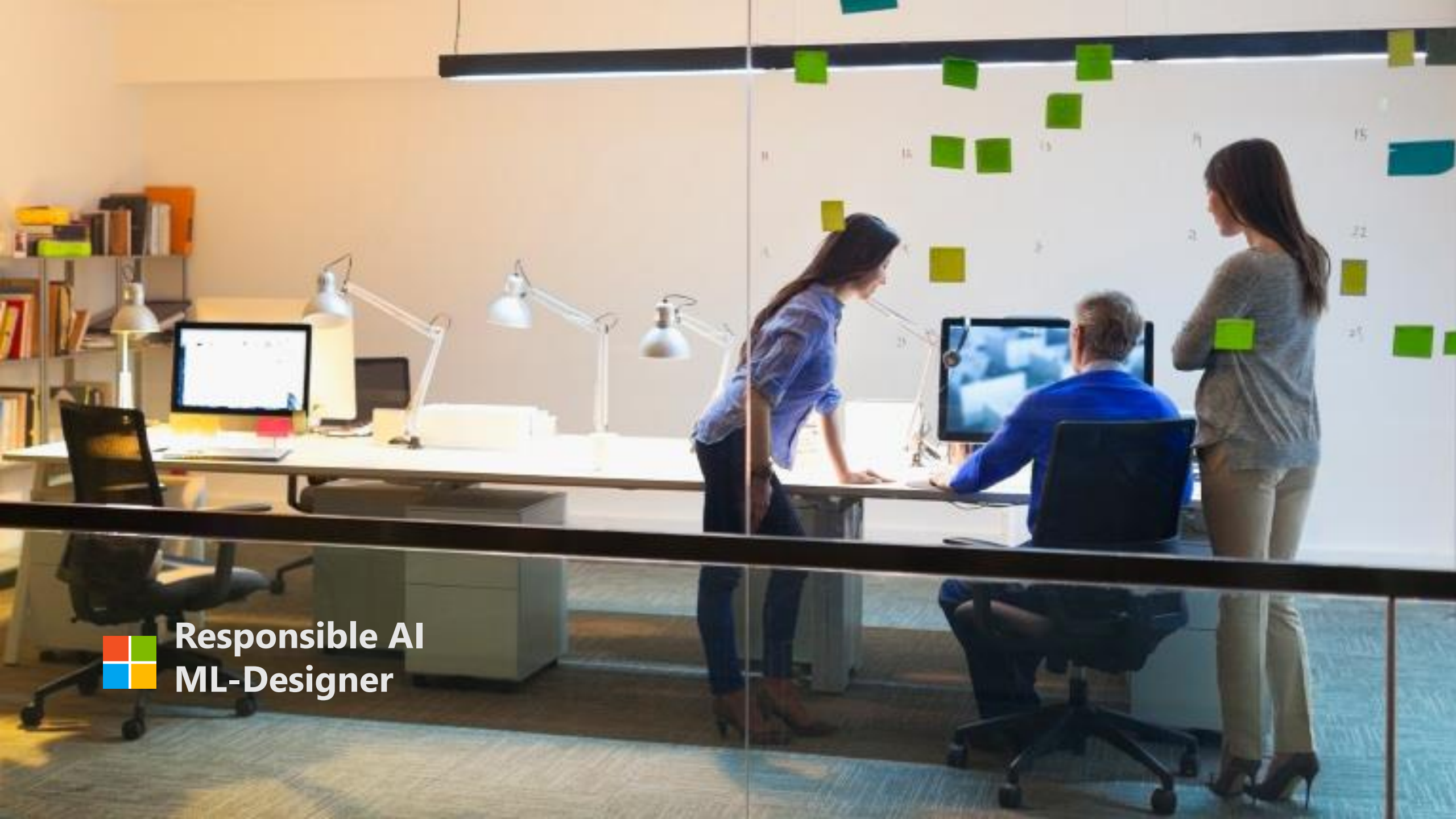


Demo

Lee Stott

Q&A

Lee Stott
Siddhartha Chaturvedi

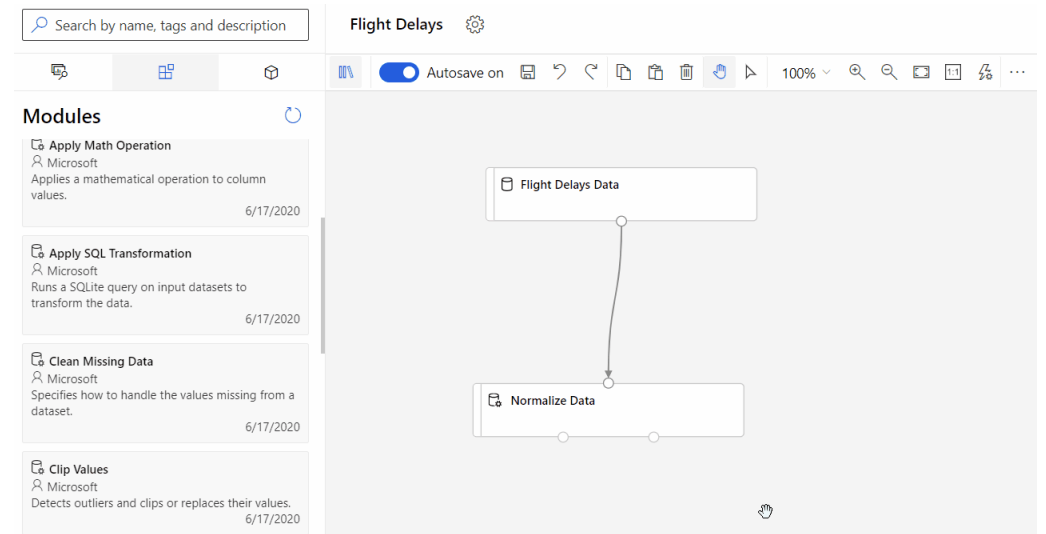


**Responsible AI
ML-Designer**

ML Designer

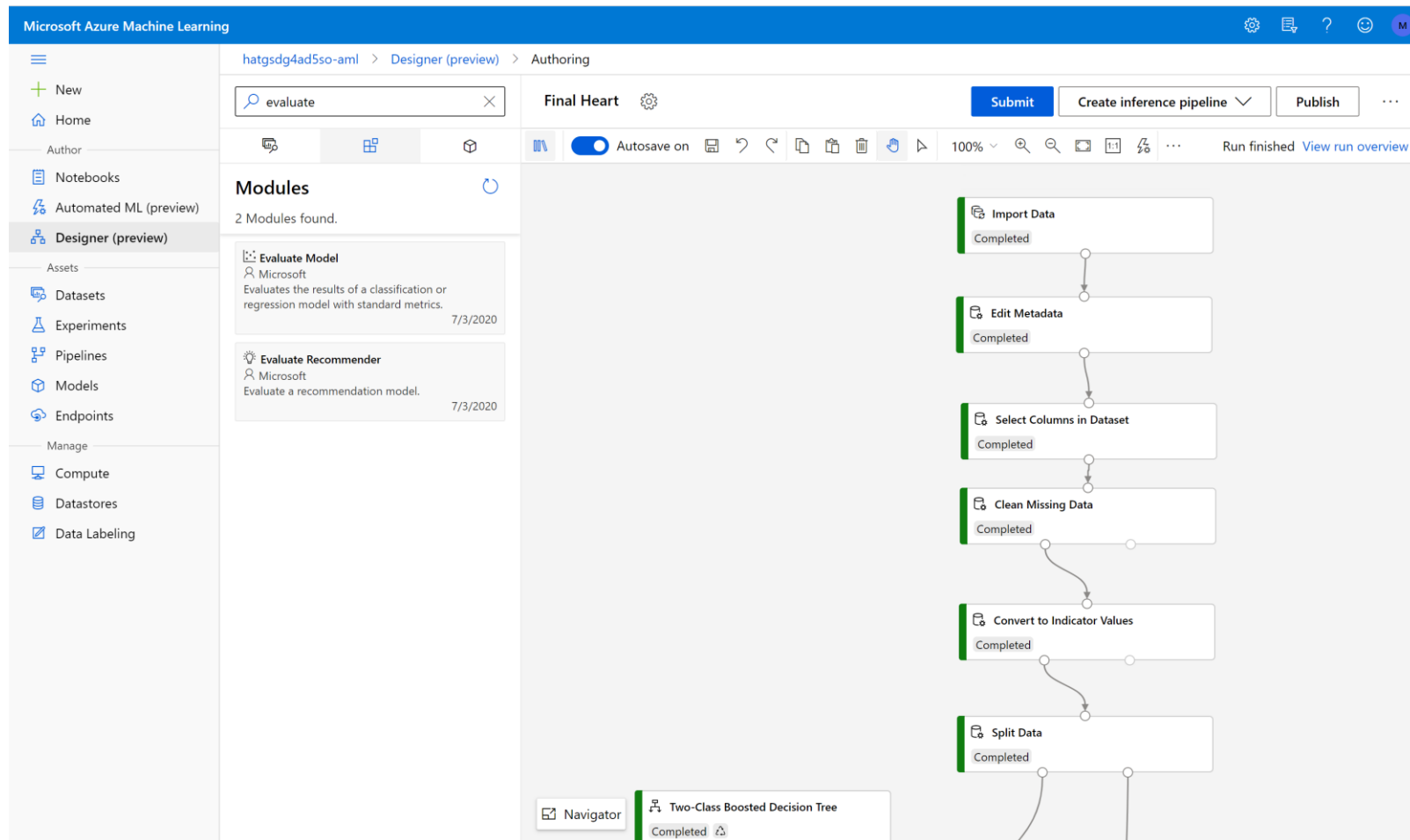
Azure ML Designer lets you visually connect datasets and modules on an interactive canvas to define machine learning workflows. With the designer we can:

- Drag-and-drop datasets and modules onto the canvas
- Connect the modules to create an azure machine learning pipeline using the visual editor
- Submit a pipeline run using the compute resources in your Azure Machine Learning workspace.
- Deploy a real-time inference pipeline to a real-time endpoint to make predictions on new data in real-time.



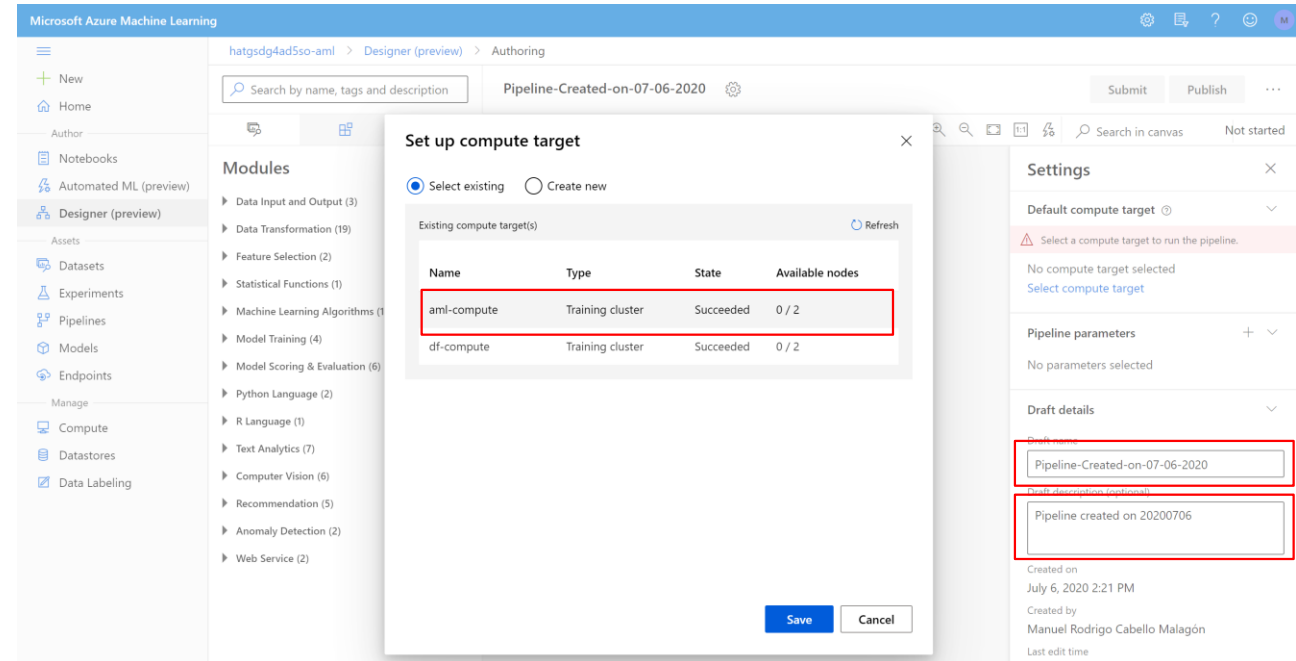
ML Designer

- Before training our model, we need to prepare our dataset, making some transformations



ML Designer

- In this case we will use the ML-Designer to build an end2end machine learning workflow to predict if a patient will receive a treatment for heart disease or not.
- First of all we need to set up a compute target to execute our pipeline.
- (optional) Introduce the pipeline name and description.



ML Designer

- Add an import module data and select the Dataset "**complete_patients_dataset**" from the Datastore

The screenshot displays the Microsoft Azure Machine Learning Designer interface. The left sidebar shows the navigation menu with options like New, Home, Author, Notebooks, Automated ML (preview), Designer (preview), Assets, Datasets, Experiments, Pipelines, Models, Endpoints, Manage, Compute, Datastores, and Data Labeling. The main workspace is titled 'hatsgdg4ad5so-aml > Designer (preview) > Authoring'. The 'Modules' panel on the left lists various data input and output modules, with 'Import Data' highlighted by a red box. The 'Import Data' module configuration panel on the right shows the 'Data source' set to 'Datastore'. The 'Datastore' dropdown is also highlighted by a red box, showing 'workspaceblobstore' as the selected option. The 'Path' field is set to 'heart-disease/complete_patients_dataset.csv' and is also highlighted by a red box. The 'Preview schema' button is visible below the path field. The interface includes a top bar with 'Final Heart' and 'Submit'/'Publish' buttons, and a bottom bar with 'Autosave on' and a draft autosave timestamp.

ML Designer

- Convert some integer columns to categorical values using the Edit Metadata module

The screenshot displays the Microsoft Azure Machine Learning Designer interface. The left sidebar contains navigation options: New, Home, Author (Notebooks, Automated ML (preview), Designer (preview)), Assets (Datasets, Experiments, Pipelines, Models, Endpoints), and Manage (Compute, Datastores, Data Labeling). The main workspace shows a pipeline with the 'Final Heart' module selected. The 'Edit Metadata' configuration panel is open on the right, showing the 'Parameters' tab. A red box highlights the 'Column names' field, which contains the text 'chest_pain_type,rest_ecg,sex,diabetic,pregnant,smoker,asthmatic'. Below this, the 'Data type' is set to 'Integer' and the 'Categorical' checkbox is checked. The 'Fields' are set to 'Unchanged'. The 'New column names' field is empty. At the bottom of the configuration panel, there are sections for 'Run settings', 'Comment', and 'Module information'. A 'Navigator' button is visible at the bottom left of the workspace.

ML Designer

- Select the final columns that we will consider in our dataset to train our model. We will use the **Select Columns in Dataset module**

The screenshot displays the Microsoft Azure Machine Learning Designer interface. The left sidebar contains navigation options: New, Home, Author (Notebooks, Automated ML (preview), Designer (preview)), Assets (Datasets, Experiments, Pipelines, Models, Endpoints), and Manage (Compute, Datastores, Data Labeling). The main workspace shows the 'hatgsdg4ad5so-aml' project in 'Designer (preview)' mode, with the 'Authoring' tab active. A search bar at the top of the workspace contains the text 'evaluate'. Below the search bar, the 'Modules' panel lists two modules: 'Evaluate Model' and 'Evaluate Recommender'. The 'Select Columns in Dataset' module is currently selected, and its configuration panel is open. The 'Parameters' tab is active, showing a text box for 'Column names' containing a list of features: 'age,sex,chest_pain_type,resting_blood_pressure,cholesterol,fasting_blood_sugar,rest_ecg,max_heart_rate_achieved,exercise_induced_angina,st_depression,st_slope,num_major_vessels,thalassemia,diabetic,pregnant,smoker,asthmatic,target'. Below this text box is a checkbox labeled 'Regenerate output'. The right sidebar of the configuration panel includes tabs for 'Parameters', 'Outputs + logs', 'Details', 'Metrics', 'Child runs', 'Images', 'Snapshot', and 'Raw JSON'. At the bottom of the configuration panel, there are sections for 'Run settings', 'Comment', and 'Module information', each with a right-pointing arrow.

ML Designer

- In this step we clean missing values from dataset using the **Clean Missing Data module**. In this case, we will remove the entire row if some value of the columns is missed.

The screenshot displays the Microsoft Azure Machine Learning Designer interface. The left sidebar contains navigation options: New, Home, Author, Notebooks, Automated ML (preview), Designer (preview), Assets, Datasets, Experiments, Pipelines, Models, Endpoints, Manage, Compute, Datastores, and Data Labeling. The main workspace shows a search bar with 'evaluate' and a list of modules: Evaluate Model and Evaluate Recommender. The 'Clean Missing Data' module is selected, and its configuration panel is open. The configuration panel includes tabs for Parameters, Outputs + logs, Details, Metrics, Child runs, Images, Snapshot, and Raw JSON. The 'Columns to be cleaned' field is highlighted with a red box and contains the following column names: age, sex, chest_pain_type, resting_blood_pressure, cholesterol, fasting_blood_sugar, rest_ecg, max_heart_rate_achieved, exercise_induced_angina, st_depression, st_slope, num_major_vessels, thalassemia, diabetic, pregnant, smoker, and asthmatic. The 'Minimum missing value ratio' is set to 0.0, and the 'Maximum missing value ratio' is set to 1.0. The 'Cleaning mode' is set to 'Remove entire row'. The 'Regenerate output' checkbox is unchecked. The 'Run settings', 'Comment', and 'Module information' sections are also visible.

Microsoft Azure Machine Learning

hatgsdg4ad5so-aml > Designer (preview) > Authoring

evaluate

Final Heart

Submit Create inference pipeline Publish

Autosave on

Run finished View run overview

Modules

2 Modules found.

Evaluate Model
Microsoft
Evaluates the results of a classification or regression model with standard metrics.
7/3/2020

Evaluate Recommender
Microsoft
Evaluate a recommendation model.
7/3/2020

Clean Missing Data

Parameters Outputs + logs Details Metrics Child runs Images Snapshot Raw JSON

Columns to be cleaned *

Column names:
age, sex, chest_pain_type, resting_blood_pressure, cholesterol, fasting_blood_sugar, rest_ecg, max_heart_rate_achieved, exercise_induced_angina, st_depression, st_slope, num_major_vessels, thalassemia, diabetic, pregnant, smoker, asthmatic

Minimum missing value ratio *

0.0

Maximum missing value ratio *

1.0

Cleaning mode *

Remove entire row

Regenerate output

Run settings

Comment

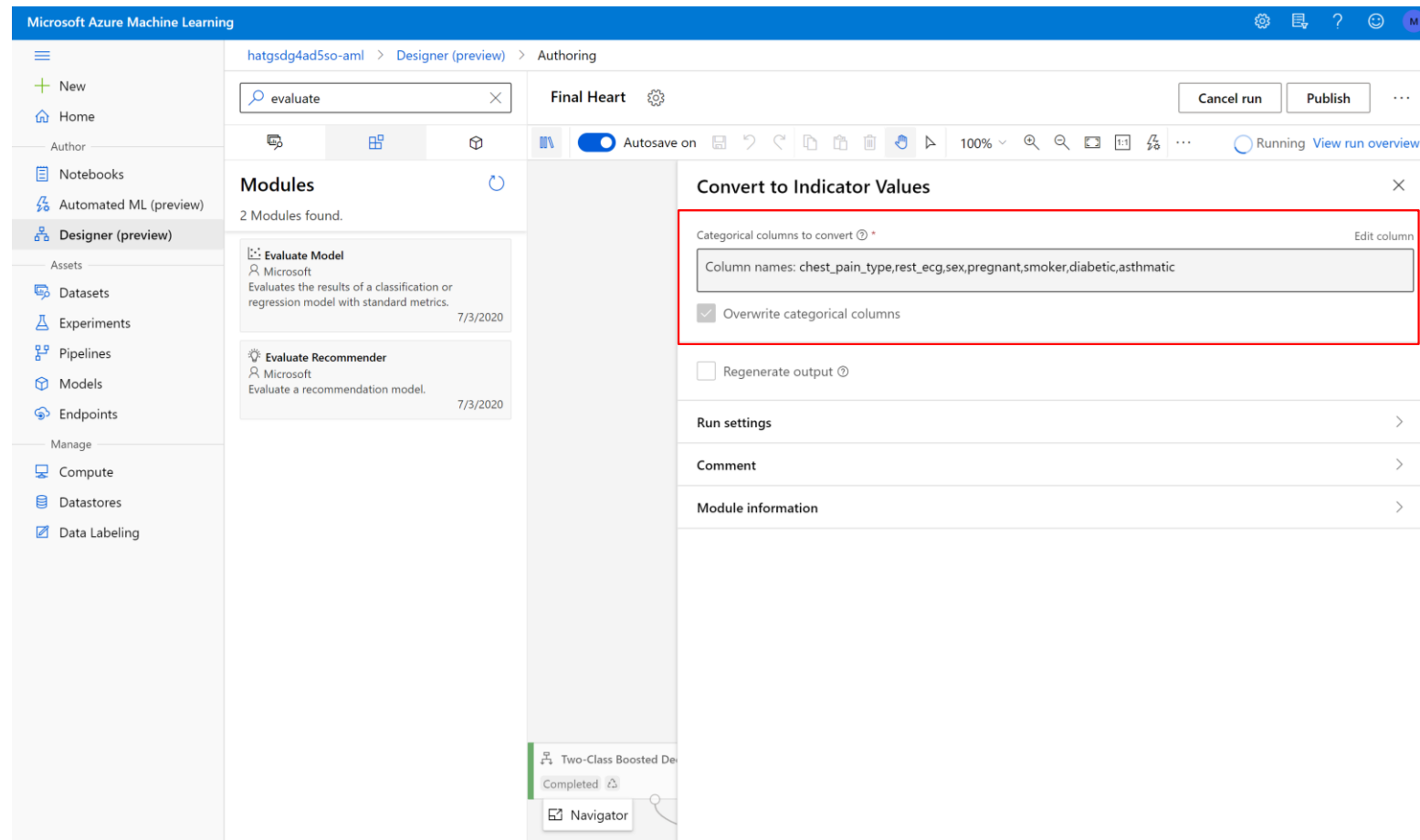
Module information

Completed

Navigator

ML Designer

- We transform our categorical columns using one hot encoding, in this case, we will use **the convert to indicator module**



ML Designer

- We split our dataset into training and test, taking 80% for training and 20% for testing,

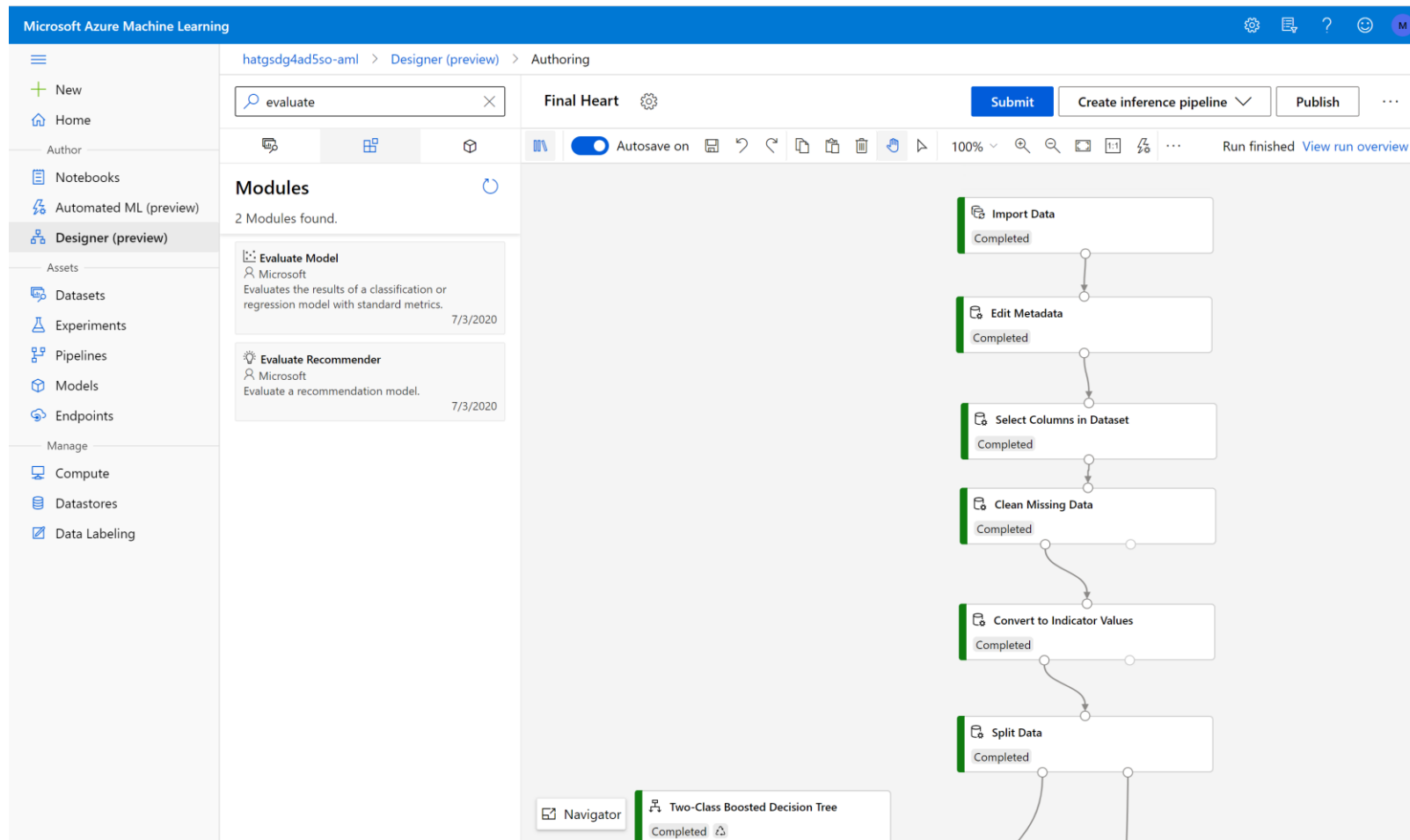
The screenshot displays the Microsoft Azure Machine Learning Designer interface. The left sidebar contains navigation options: New, Home, Author, Notebooks, Automated ML (preview), Designer (preview), Assets, Datasets, Experiments, Pipelines, Models, Endpoints, Manage, Compute, Datastores, and Data Labeling. The main workspace shows a search bar with 'evaluate' and a list of modules: Evaluate Model and Evaluate Recommender. The 'Split Data' module is selected, and its configuration panel is open on the right. The configuration panel includes the following settings:

- Splitting mode: Split Rows
- Fraction of rows in the first output dataset: 0.8
- Randomized split: ☒
- Random seed: 0
- Stratified split: False
- Regenerate output: ☐

Below the configuration panel, there are sections for Run settings, Comment, and Module information. The bottom of the interface shows a 'Two-Class Boosted Decision Tree' module with a 'Completed' status and a 'Navigator' button.

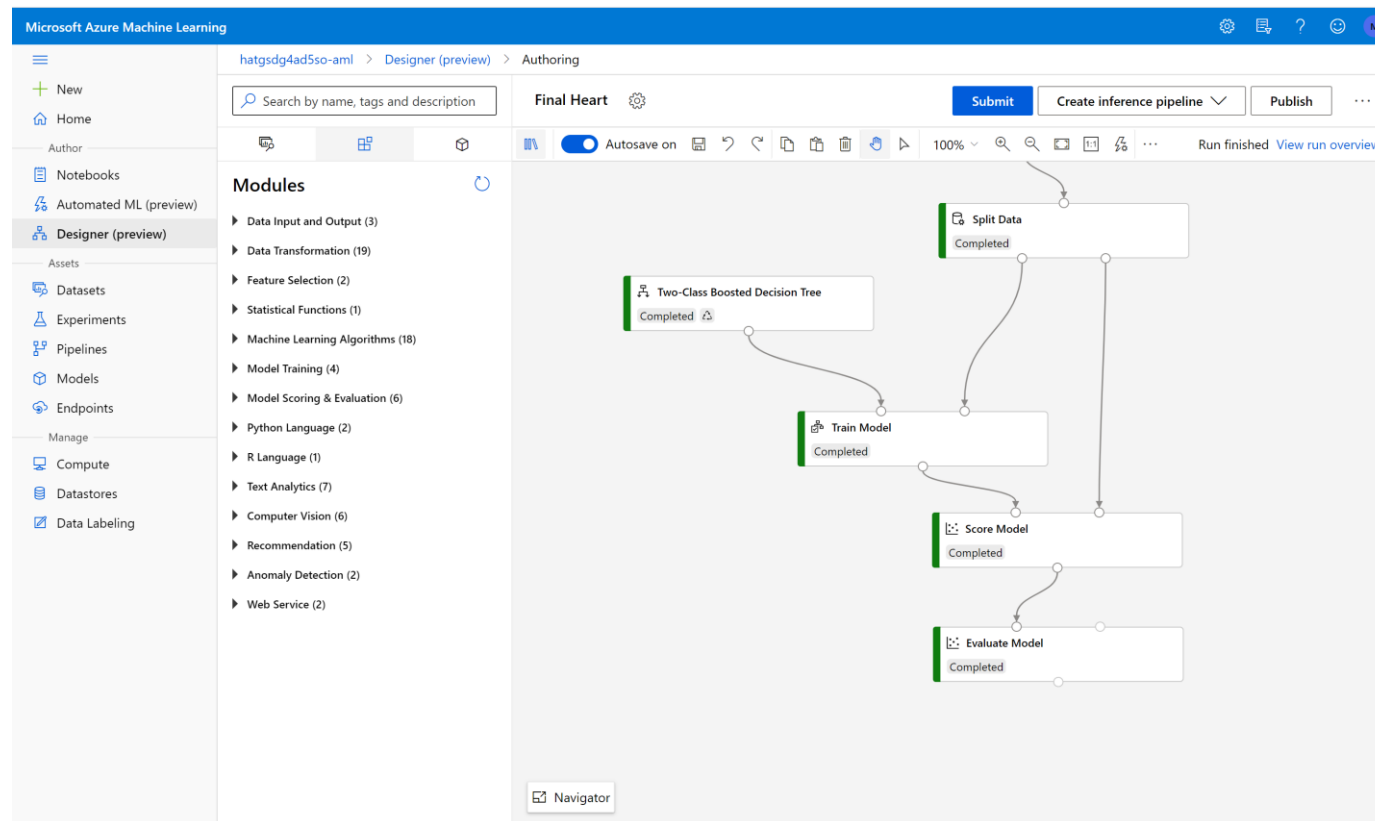
ML Designer

- Before training our model, we need to prepare our dataset, making some transformations



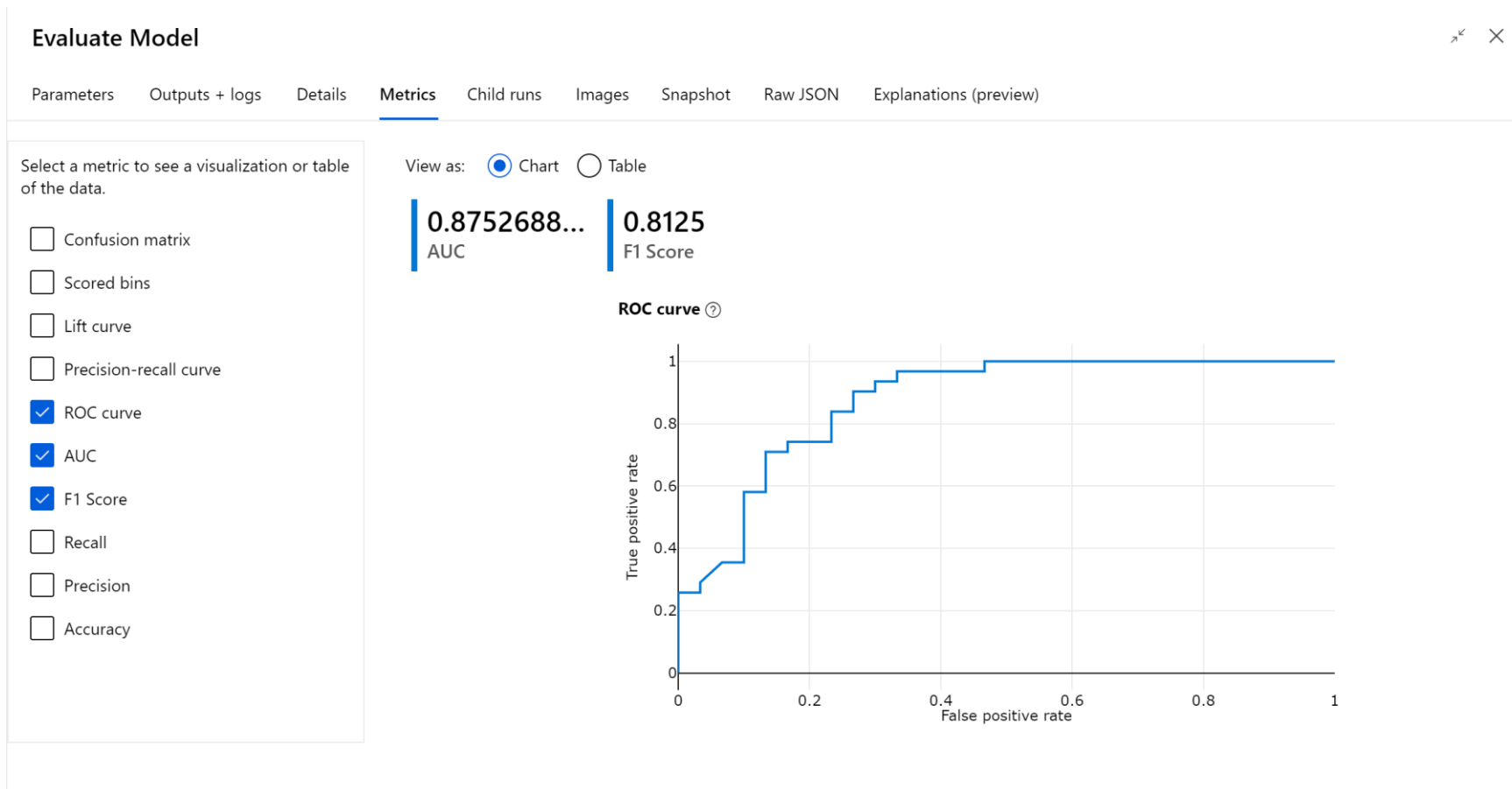
ML Designer

- Once we have splitted our dataset into training and testing, we must select a Machine Learning algorithm to start the training process
- In this case we have selected a classification algorithm: **“Two-class boosted decision tree”** because we want to predict if a patient is going to receive a treatment or not.
- In the train module we must to select the “target” column
- In the score model module we make predictions over our trained model using the testing dataset.



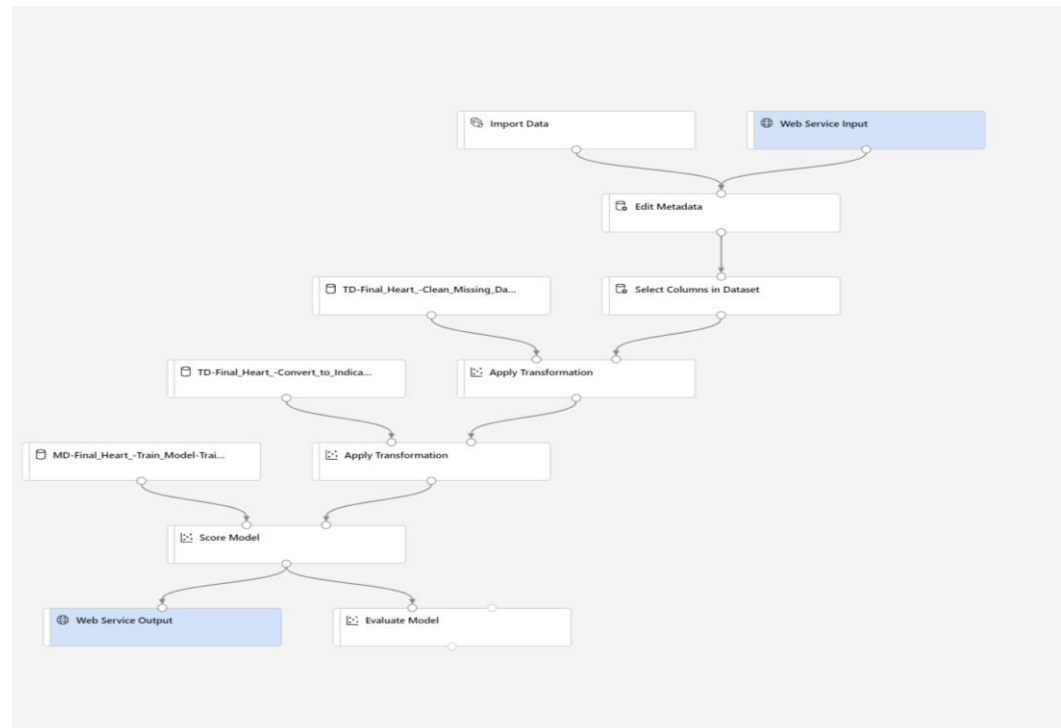
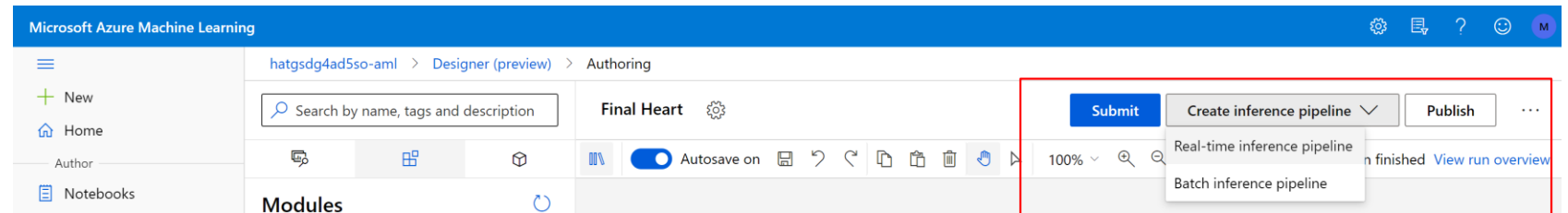
ML Designer

- After finish our ML workflow, we add the evaluate module to see the performance of our model.
- In the metrics tab appears the most common metrics of a classification problem: AUC, F1 Score, Precision, recal...



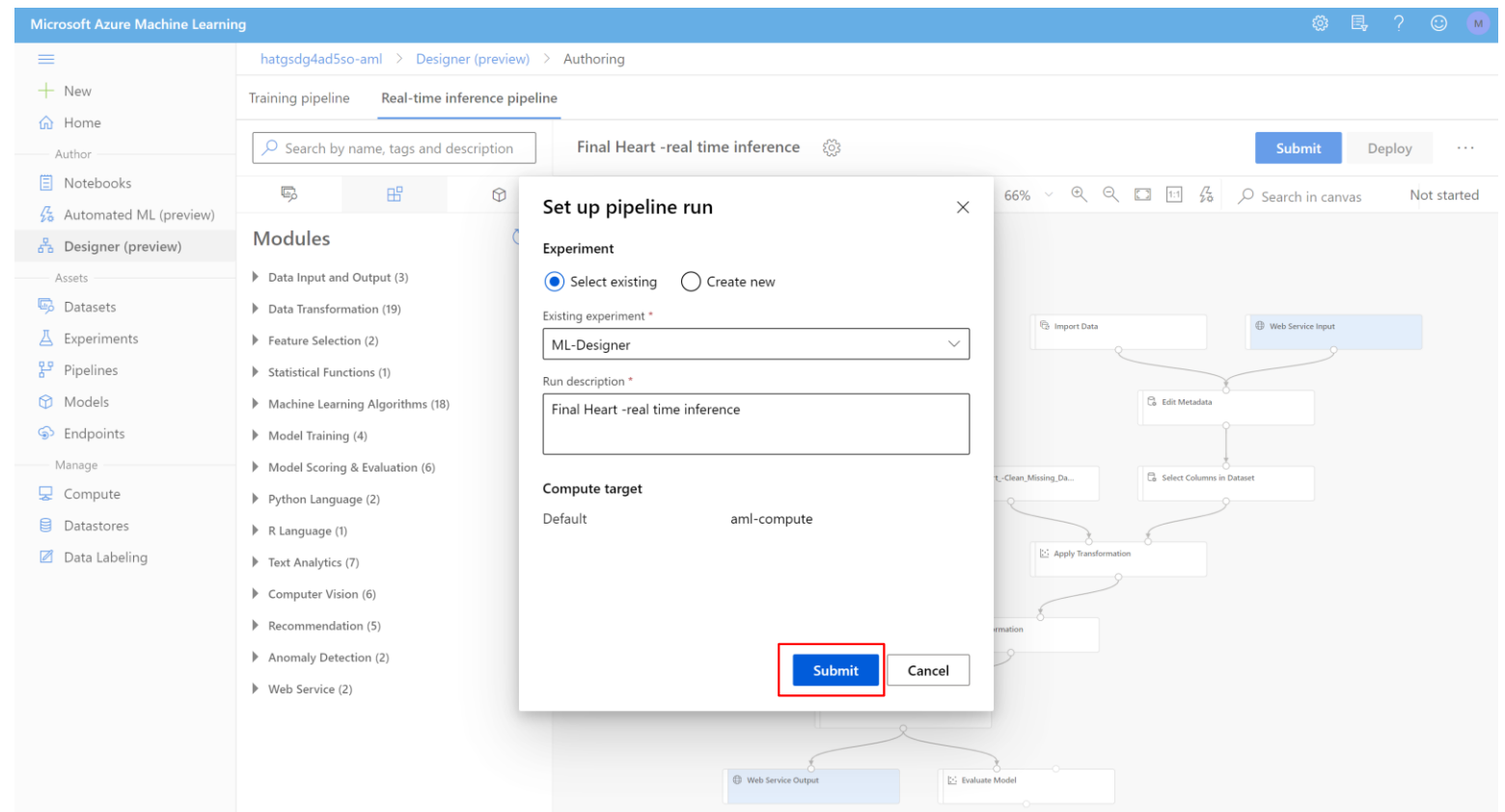
ML Designer (Inference)

- Once we have finished our training pipeline, we can create a real-time inference pipeline
- Azure Machine Learning Studio makes some transformation to convert our train pipeline into an inference pipeline



ML Designer (Inference)

- Before deploying our real-time service we need to submit the inference pipeline.



ML Designer (Deployment)

- We can convert our inference pipeline into a real-time endpoint.
- Before deploying our service we must create a inference clustering (AKS).
- Once we have created our inference pipeline, we can select it to deploy the web service.

Microsoft Azure Machine Learning

hatgsdg4ad5so-aml > Designer (preview) > Authoring

Training pipeline Real-time inference pipeline

Search by name, tags and description

Submit Deploy

Run finished [View run overview](#)

Set up real-time endpoint

☒ Deploy new real-time endpoint ☐ Replace an existing real-time endpoint

Real-time endpoint name *

final-heart--real-time-inference

Endpoint description (optional)

Compute target

Existing compute target(s) Refresh

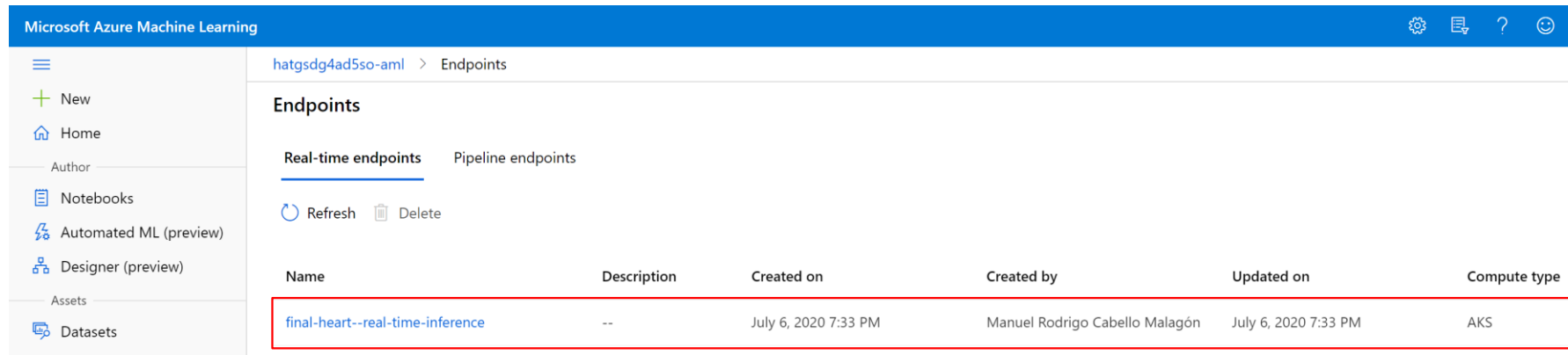
Compute target name	Node count	Region	Status ↓
aks-inference	1	centralus	Succeeded

Deploy Cancel

Navigator Web Service Output Evaluate Model Completed

ML Designer (Deployment)

- In the endpoint sections, our new service will appear, click on it to get information about how to consume the web service.



The screenshot shows the Microsoft Azure Machine Learning web interface. The left sidebar contains navigation links: Home, Notebooks, Automated ML (preview), Designer (preview), and Datasets. The main area is titled 'Endpoints' and shows a table of endpoints. The table has columns for Name, Description, Created on, Created by, Updated on, and Compute type. One endpoint, 'final-heart--real-time-inference', is highlighted with a red box.

Name	Description	Created on	Created by	Updated on	Compute type
final-heart--real-time-inference	--	July 6, 2020 7:33 PM	Manuel Rodrigo Cabello Malagón	July 6, 2020 7:33 PM	AKS

ML Designer (Deployment)

- Into the details endpoint we can obtain information about how to consume our module through API.
- In the test tab, we can test our model introducing the values for inference. In the test results sections the predicted value appears with the scored labels and the scored probabilities

The screenshot displays the Microsoft Azure Machine Learning web interface. The left sidebar contains navigation options: New, Home, Author, Notebooks, Automated ML (preview), Designer (preview), Assets, Datasets, Experiments, Pipelines, Models, Endpoints, Manage, Compute, Datastores, and Data Labeling. The 'Endpoints' section is selected.

The main panel shows the details for the endpoint 'final-heart--real-time-inference' under the 'Test' tab. The 'Input data to test real-time endpoint' section lists various input fields with their corresponding values:

- age: 63
- sex: 1
- chest_pain_type: 3
- resting_blood_pressure: 145
- cholesterol: 233
- fasting_blood_sugar: 1
- rest_ecg: 0
- max_heart_rate_achieved: 150

A red box highlights the 'Test' button. To the right, the 'Test result' section shows the output in a 'raw' format. The JSON response includes 'Results' and 'WebServiceOutput0'. A red box highlights the 'Scored Labels' and 'Scored Probabilities' in the output:

```
{
  "Results": {
    "WebServiceOutput0": [
      {
        "age": 63,
        "resting_blood_pressure": 145,
        "cholesterol": 233,
        "fasting_blood_sugar": 1,
        "max_heart_rate_achieved": 150,
        "exercise_induced_angina": 0,
        "st_depression": 2.3,
        "st_slope": 0,
        "num_major_vessels": 0,
        "thalassemia": 1,
        "target": 1,
        "sex-0": 0,
        "sex-1": 1,
        "chest_pain_type-0": 0,
        "chest_pain_type-1": 0,
        "chest_pain_type-2": 0,
        "chest_pain_type-3": 1,
        "rest_ecg-0": 1,
        "rest_ecg-1": 0,
        "rest_ecg-2": 0,
        "pregnant-0": 1,
        "pregnant-1": 0,
        "diabetic-0": 0,
        "diabetic-1": 1,
        "asthmatic-0": 1,
        "asthmatic-1": 0,
        "smoker-0": 1,
        "smoker-1": 0,
        "Scored Labels": 1,
        "Scored Probabilities": 0.9871730543907223
      }
    ]
  }
}
```