



Microsoft Ignite





Getting started on your health-tech journey

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Agenda

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



Are reimagining medicine. Novartis focuses on innovative medicines as well as generics and biosimilars. They are a leading global medicines company powered by data and digital.

Harnessing the power of science to push boundaries, develop breakthrough treatments and deliver them directly to the millions of people.

<https://www.novartis.com/>



FindMeCure:“Bringing Clinical Trials Closer to Patients”

<https://www.findmecure.com/>

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

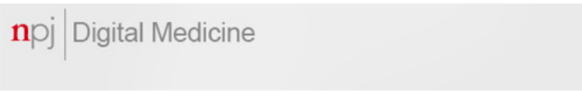
- Electronic Health Records and Big Data
- 2-way: research <-> practice
- Models start to be learned from fuller data

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. 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}

► [Author information](#) ► [Article notes](#) ► [Copyright and License information](#) [Disclaimer](#)

Associated Data

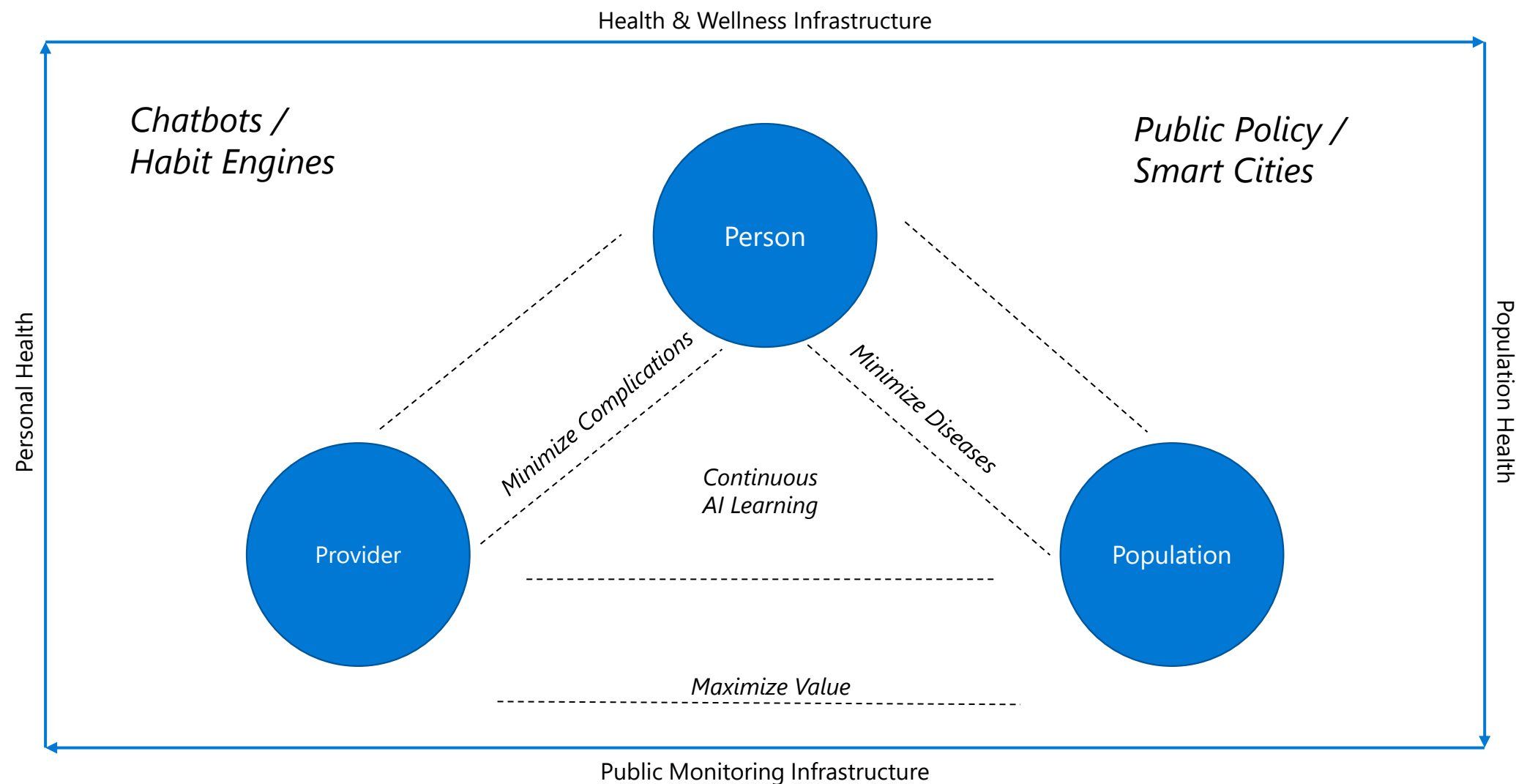
- [Supplementary Materials](#)
- [Data Availability Statement](#)

Abstract [Go to:](#)

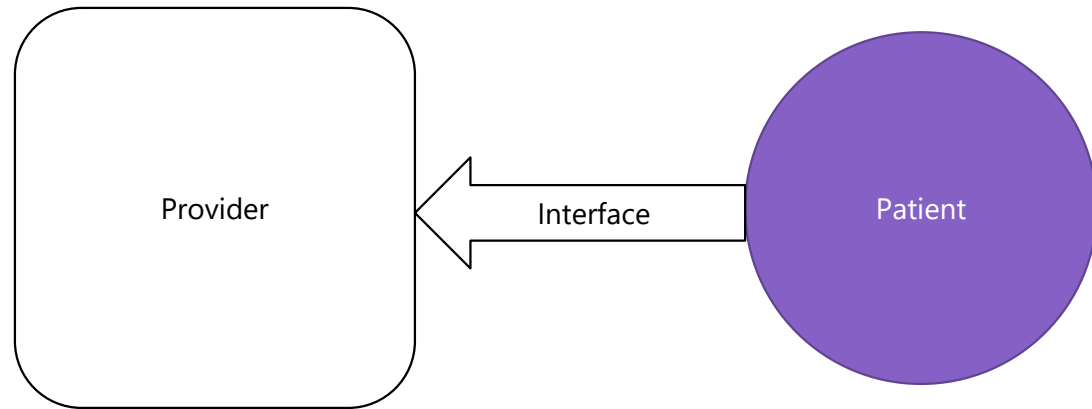
Mobility is an important correlate of physical, cognitive, and mental health in chronic illness, and can be measured passively with mobile phone global positional satellite (GPS) sensors. To date, GPS data have been reported in a few studies of schizophrenia, yet it is unclear whether these data correlate 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

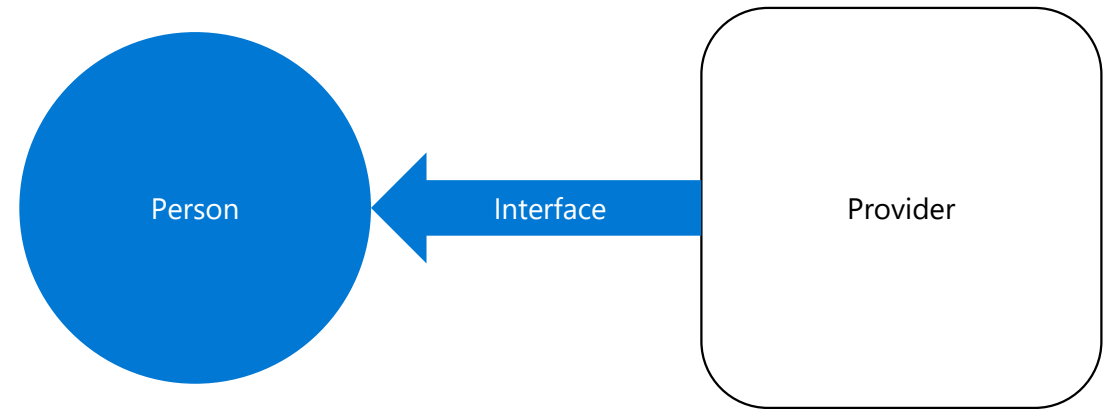
Health Stakeholder Relationships



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**

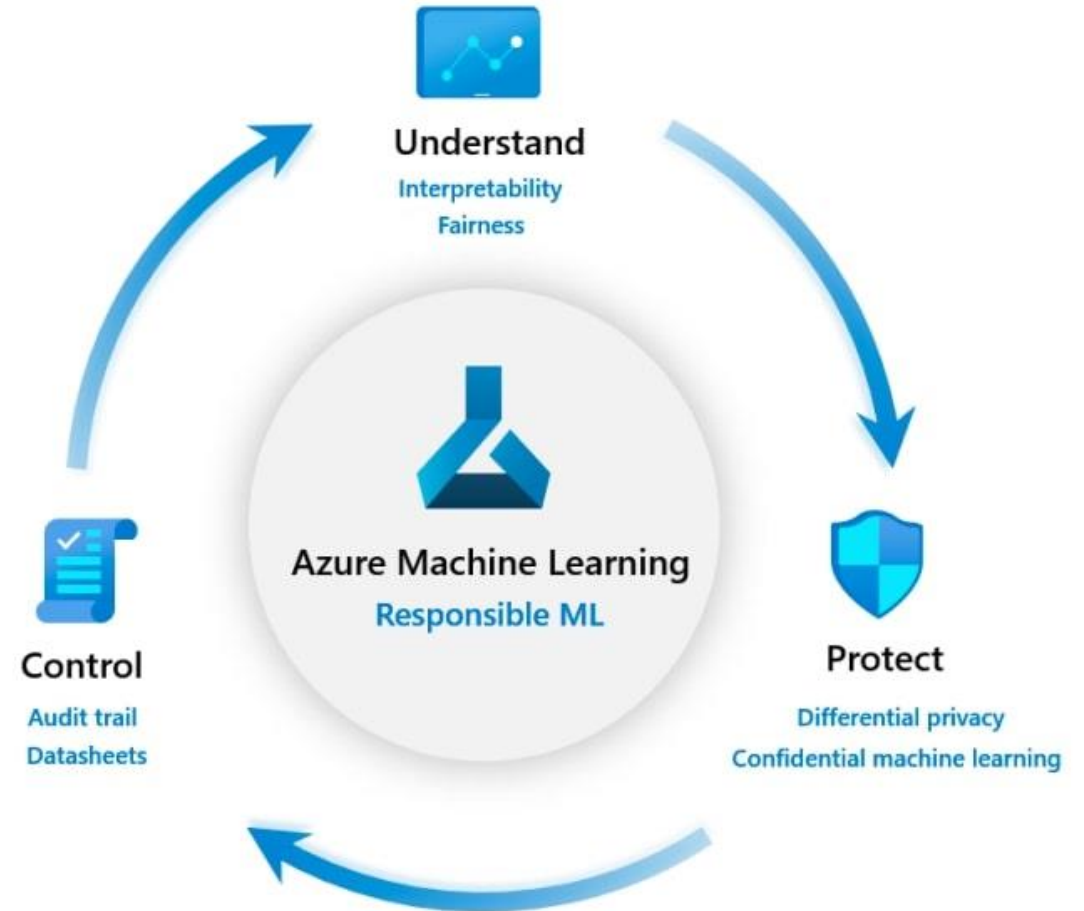
- AI systems should have algorithmic accountability

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

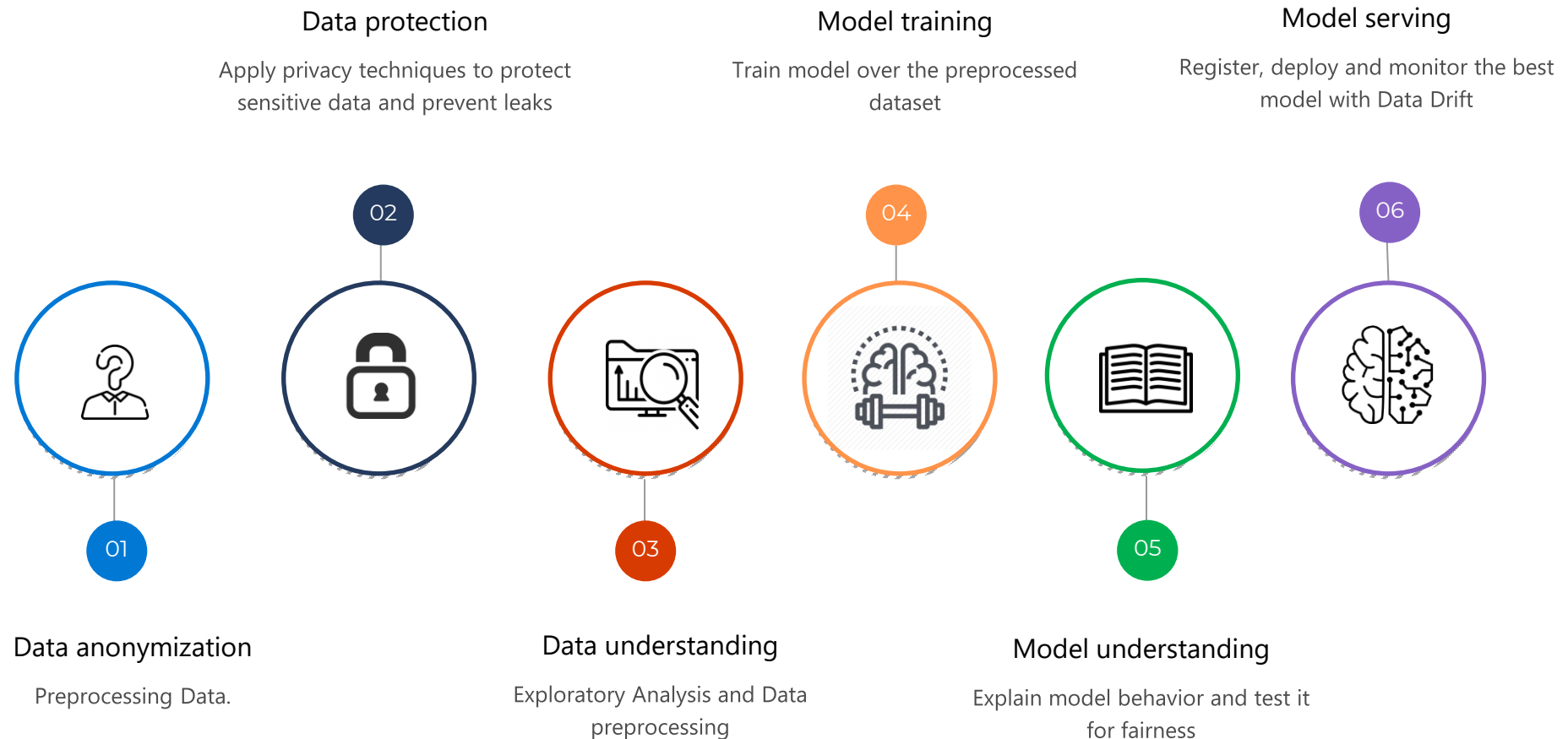
<http://aka.ms/responsibleML>



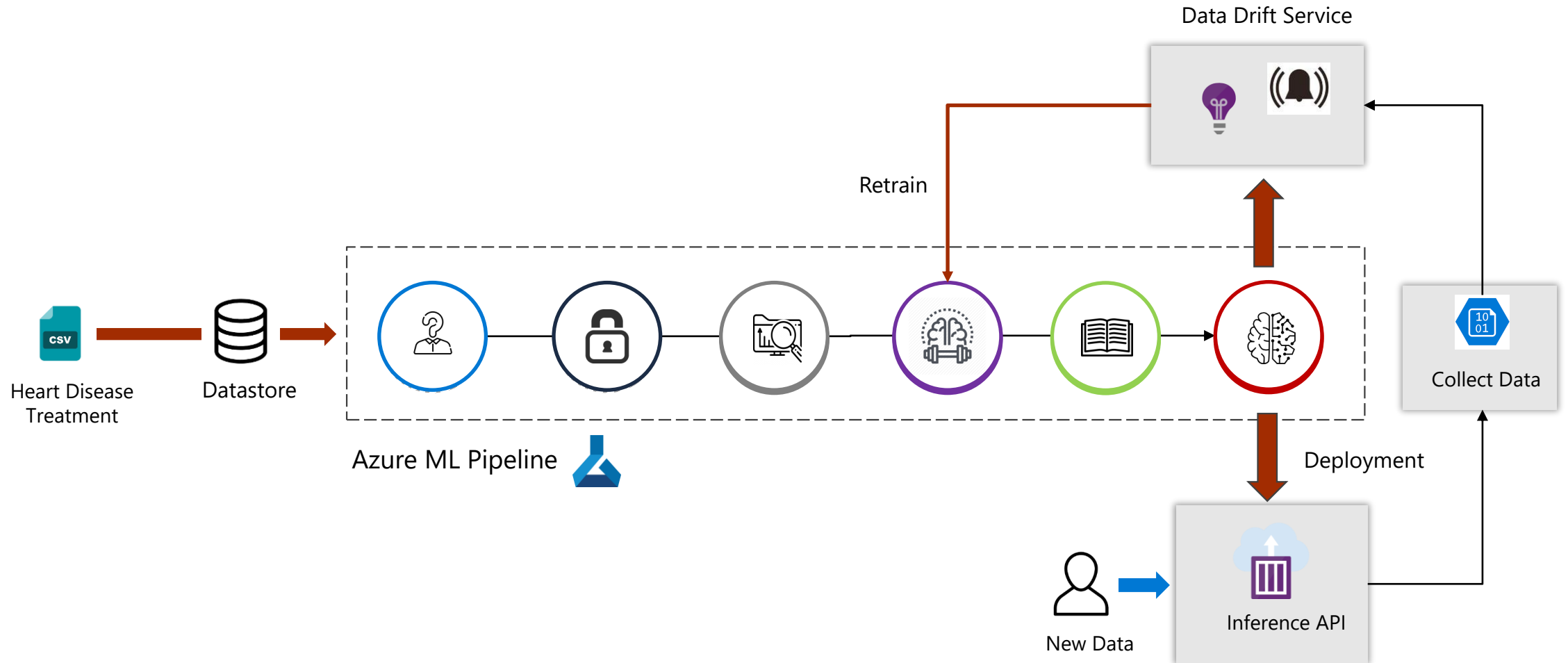
Responsible ML Healthcare

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



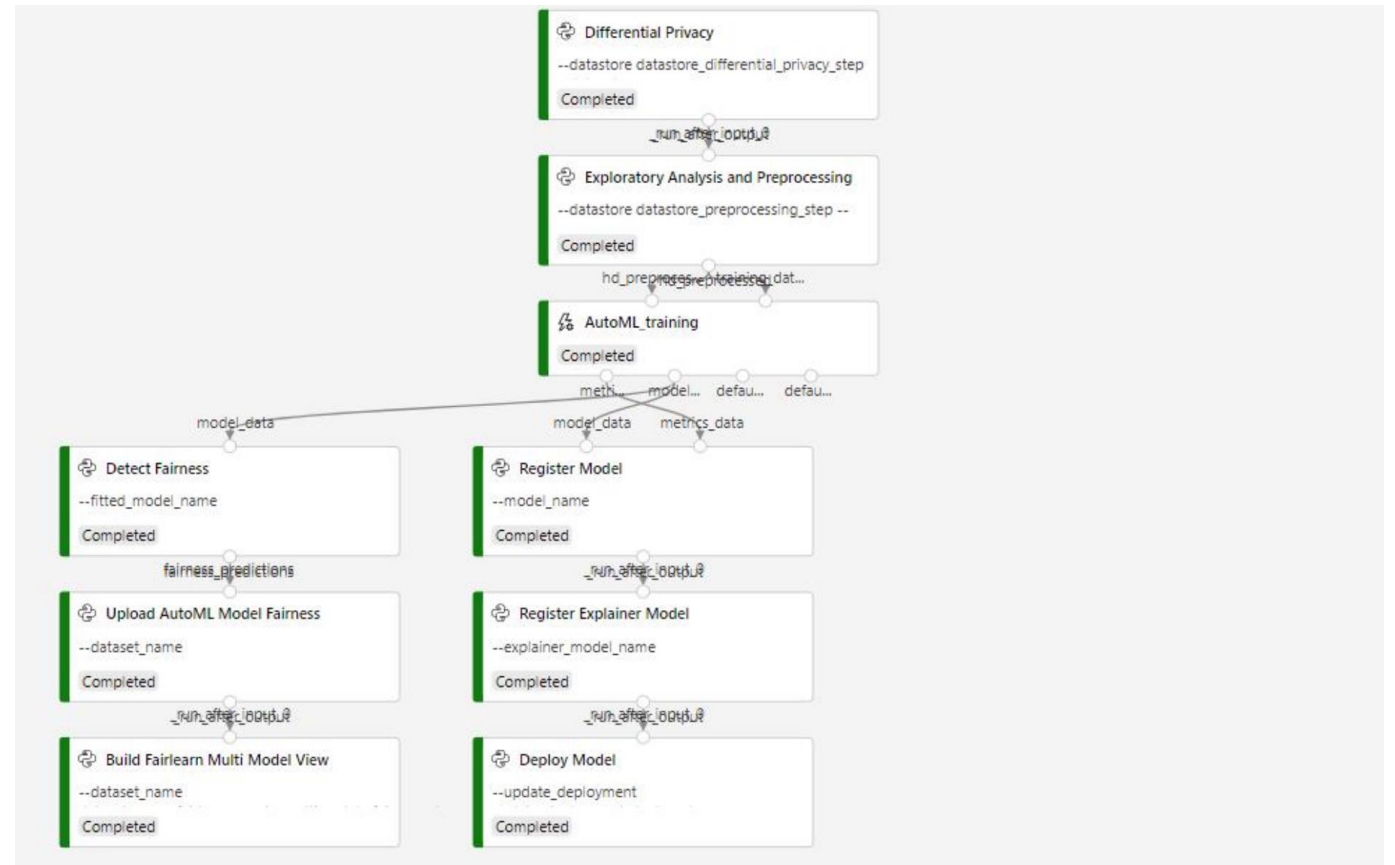
Process Diagram



<http://github.com/leestott/ResponsibleAI>

Azure ML Pipeline

- An Azure Machine Learning pipeline is an independently executable workflow of a complete machine learning task
- It performs a complete logical workflow with an ordered sequence of steps.
- We have developed a programatic pipeline creation based on the described “machine learning workflow”
 - Data Protection
 - Exploratory Analysis and Preprocessing
 - AutoML training
 - Fairness detection
 - Model explanation
 - Model deployment



Data anonymization

- For data anonymization process we use **Presidio** to remove Personal Identifiable Information from different Text columns of our dataset.
- We detect main entities such as names, locations and remove them from dataset.
- After this step the Data scientists could make the exploratory analysis without see sensible information about patients.

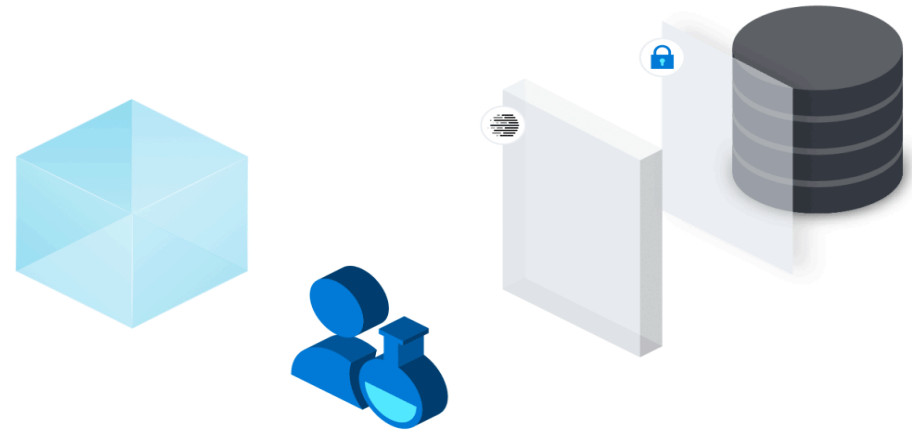


Data Anonymization
Presidio

<https://github.com/Microsoft/presidio>

Differential Privacy

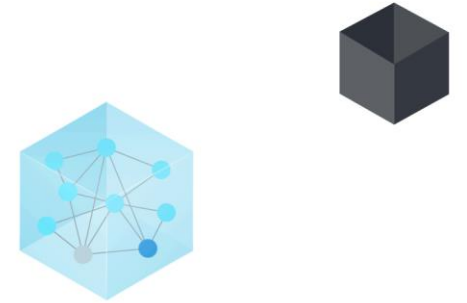
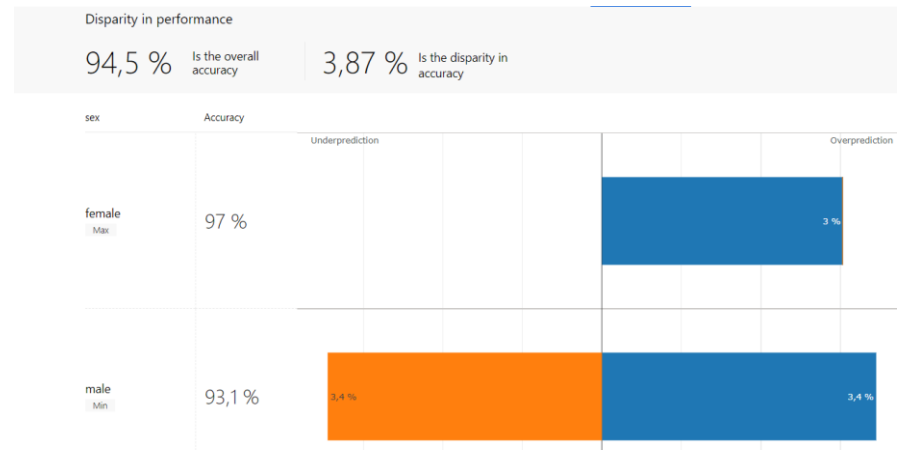
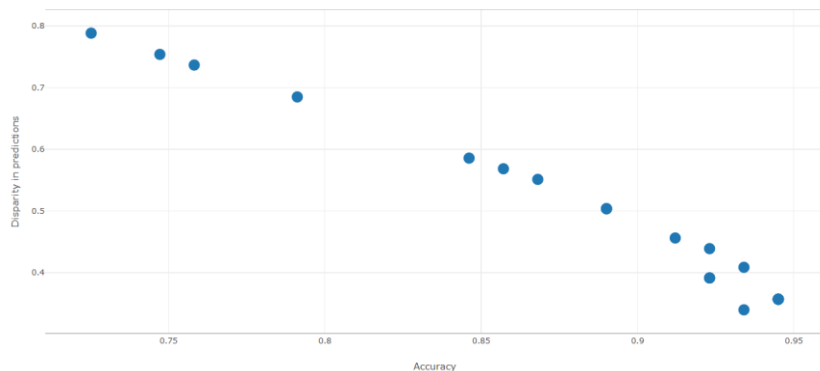
- In this step, we apply differential privacy techniques, which injects precise levels of statistical noise in data to limit the disclosure of sensitive information
- Identify data leaks and intelligently limit repeat queries to manage exposure risk.
- We have integrate the results of add noise to our data in Azure Machine Learning Workspace.



Differential Privacy
Add noise to our data in Azure Machine Learning Workspace.

Fairness detection

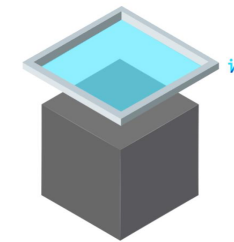
- In this Azure ML Step we use FairLearn to assess the system's fairness and mitigate any observed unfairness issues.
- We use the fitted automl from the previous step to detect any unfairness over the sensitive features like: gender, pregnant, smoker, diabetic that could be important to decide if a Patient receive a treatment or not.
- Enable the mitigation of unfairness using the Fairlearn GridSearch algorithm with Demographic parity for gender.



Fairness Detection

Fairlearn

<https://fairlearn.org>



Model explainability

- In this step, we explain our model using Interpret ML. Enabling the capability of explain our AutoML model is important during two main phases.
- **Training:** We activate the AutoML explanation option to verify hypotheses and build trust stakeholders.
- **Inference:** We extract our model explainability for local explanations in order to have transparency around deployed models to know how the model is working and how its decisions are treating and impacting patients

Interpret ML

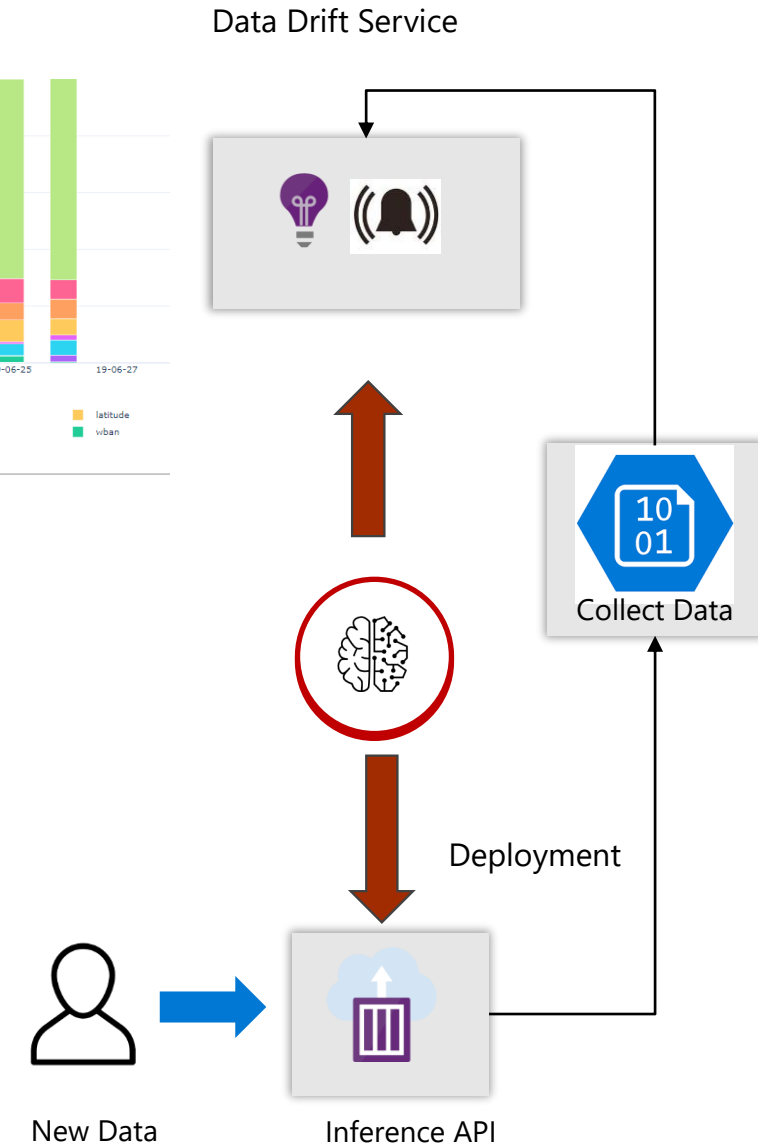
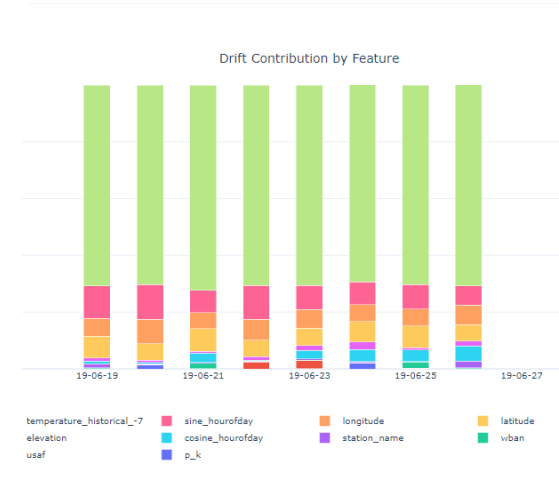
<https://interpret.ml/>



Model deployment

During this step, we register a new version of our model and we prepare it for deployment, doing the following tasks:

- Deploy the last version of our model with his explanation model.
- Create a Docker image with all the logic to obtain predictions with the local explainability
- Deploy our Docker image in an ACI
- Start collecting data and logs in application insight.
- Activate Data Drift service to monitor the inputs of the deployed model and compare this data to the training dataset in order to measure the magnitude of data drift.

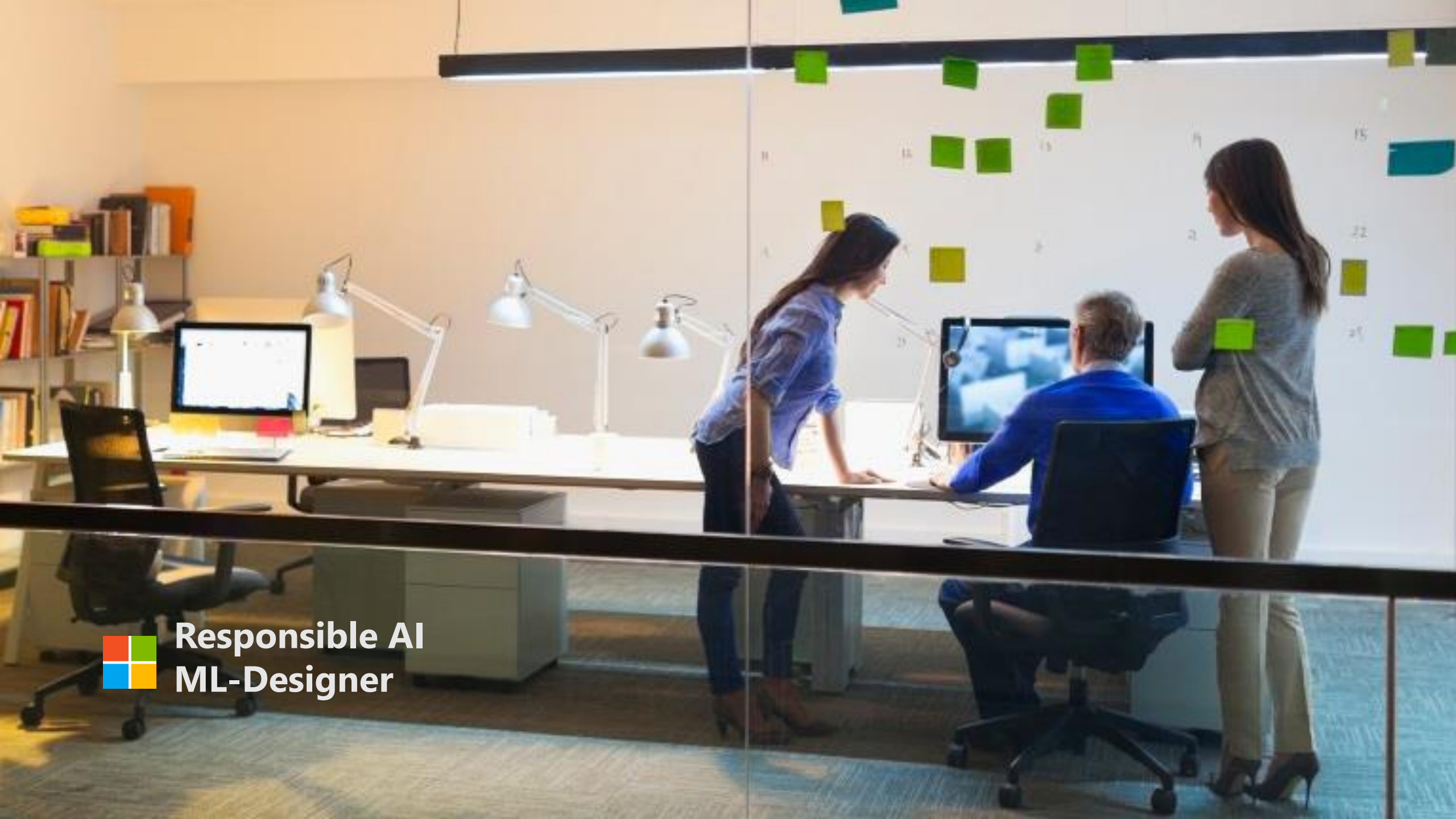


Demo

Lee Stott

Q&A

Lee Stott

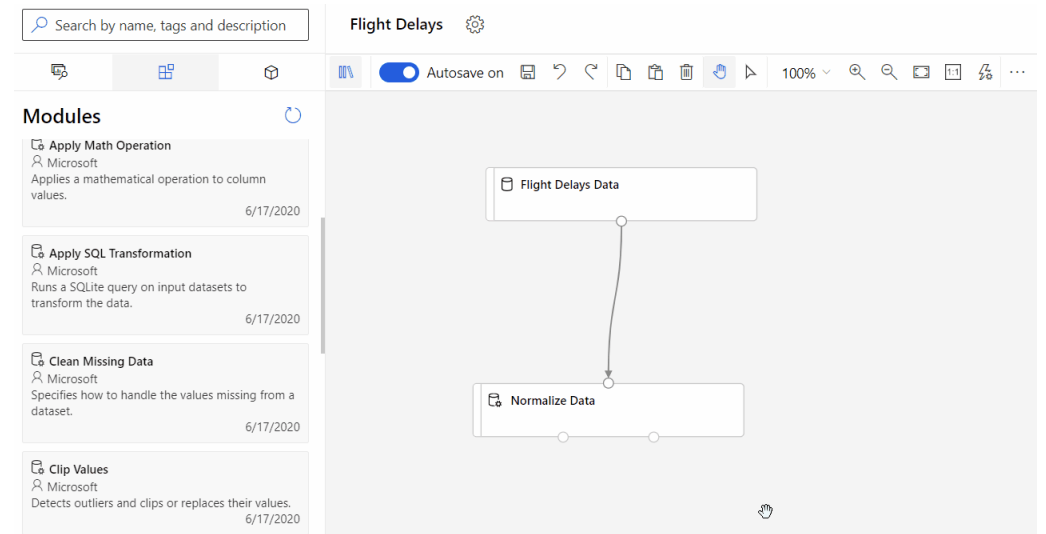


**Responsible AI
ML-Designer**

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

The screenshot displays the Microsoft Azure Machine Learning Designer interface. The top navigation bar shows the breadcrumb path: `hatgsdg4ad5so-aml > Designer (preview) > Authoring`. The left sidebar contains navigation options: **New**, **Home**, **Author**, **Notebooks**, **Automated ML (preview)**, **Designer (preview)** (selected), **Assets**, **Datasets**, **Experiments**, **Pipelines**, **Models**, **Endpoints**, **Manage**, **Compute**, **Datastores**, and **Data Labeling**.

The central pane is titled **Modules** and shows a search for `evaluate`. Two modules are listed:

- 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)

The right pane displays a vertical pipeline flowchart with the following modules, all marked as **Completed**:

- Import Data
- Edit Metadata
- Select Columns in Dataset
- Clean Missing Data
- Convert to Indicator Values
- Split Data

At the bottom, a **Navigator** pane shows the **Two-Class Boosted Decision Tree** model as **Completed**. The top right of the interface includes buttons for **Submit**, **Create inference pipeline**, and **Publish**, along with a status indicator **Run finished** and a link to [View run overview](#).

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.

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 canvas shows a pipeline named 'Pipeline-Created-on-07-06-2020'. A 'Set up compute target' dialog box is open, showing a table of existing compute targets. The table has columns: Name, Type, State, and Available nodes. Two targets are listed: 'aml-compute' and 'df-compute', both of type 'Training cluster' and state 'Succeeded', with 0/2 available nodes. The 'aml-compute' row is highlighted with a red border. The 'Settings' panel on the right shows the 'Default compute target' dropdown, a warning message 'Select a compute target to run the pipeline.', and the 'Draft details' section with fields for 'Draft name' (Pipeline-Created-on-07-06-2020) and 'Draft description (optional)' (Pipeline created on 20200706), both highlighted with red borders.

| Name | Type | State | Available nodes |
|-------------|------------------|-----------|-----------------|
| aml-compute | Training cluster | Succeeded | 0 / 2 |
| df-compute | Training cluster | Succeeded | 0 / 2 |

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, and Assets. The central pane shows the 'Modules' list, where the 'Import Data' module is highlighted with a red box. The right pane shows the configuration for the 'Import Data' module, with the 'Data source' set to 'Datastore'. The 'Datastore' dropdown is also highlighted with 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 with a red box. The 'Preview schema' button is visible below the path field.

Microsoft Azure Machine Learning

hatsgdg4ad5so-aml > Designer (preview) > Authoring

Search by name, tags and description

Final Heart

Submit Publish

Autosave on

100%

Draft autosaved on 7/6/2020, 2:33:14 F

Modules

Data Input and Output (3)

- Enter Data Manually**
Microsoft
Enables entering and editing small datasets by typing values.
7/3/2020
- Export Data**
Microsoft
Writes a dataset to cloud-based storage in Azure, such as Azure blob storage, Azure Data Lake Stor...
7/3/2020
- Import Data**
Microsoft
Load data from web URLs or from various cloud-based storage in Azure, such as Azure SQL...
7/3/2020

Data Transformation (19)

Feature Selection (2)

Statistical Functions (1)

Machine Learning Algorithms (18)

Model Training (4)

Model Scoring & Evaluation (6)

Import Data

Data source *

Datastore

Datastore *

workspaceblobstore

Path *

heart-disease/complete_patients_dataset.csv

To include files in subfolders, append '/*' after the folder name like so: '{Folder}//*'.

Validated

Preview schema

Regenerate output

Run settings

Comment

Module information

ML Designer

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

The screenshot displays the Microsoft Azure Machine Learning ML Designer interface. The top navigation bar shows the breadcrumb path: `hatgsdg4ad5so-aml > Designer (preview) > Authoring`. The left sidebar contains navigation options: New, Home, Author, Notebooks, Automated ML (preview), Designer (preview) (selected), Assets, Datasets, Experiments, Pipelines, Models, Endpoints, Manage, Compute, Datastores, and Data Labeling. The main workspace is titled `Final Heart` and includes a search bar with `evaluate` and buttons for `Cancel run` and `Publish`. Below the search bar is a toolbar with icons for Autosave, Undo, Redo, Copy, Paste, Delete, and Run, along with a zoom level of 100%. The `Modules` pane on the left shows two modules: `Evaluate Model` and `Evaluate Recommender`. The `Edit Metadata` module is selected, and its configuration pane on the right is visible. The configuration pane has tabs for `Parameters`, `Outputs + logs`, `Details`, `Metrics`, `Child runs`, `Images`, `Snapshot`, and `Raw JSON`. The `Parameters` tab is active, showing a list of columns to be edited. 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`, the `Categorical` checkbox is checked, and the `Fields` are set to `Unchanged`. The `New column names` field is empty. At the bottom of the configuration pane, there is a checkbox for `Regenerate output` and sections for `Run settings`, `Comment`, and `Module information`.

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 word 'evaluate'. Below the search bar, two modules are listed: 'Evaluate Model' and 'Evaluate Recommender'. The 'Select Columns in Dataset' module is selected, and its configuration panel is open on the right. 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 for '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 right sidebar are sections for 'Run settings', 'Comment', and 'Module information'.

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**

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 'Convert to Indicator Values' module is selected, and its configuration panel is open on the right. The configuration panel includes a text box for 'Categorical columns to convert' with the value 'chest_pain_type,rest_ecg,sex,pregnant,smoker,diabetic,asthmatic', a checked checkbox for 'Overwrite categorical columns', and a 'Regenerate output' checkbox. The bottom of the interface shows a 'Two-Class Boosted Decision Tree' model in a 'Completed' state and a 'Navigator' button.

Microsoft Azure Machine Learning

hatgsdg4ad5so-aml > Designer (preview) > Authoring

evaluate

Final Heart

Cancel run Publish ...

Autosave on

Running 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

Convert to Indicator Values

Categorical columns to convert * Edit column

Column names: chest_pain_type,rest_ecg,sex,pregnant,smoker,diabetic,asthmatic

☒ Overwrite categorical columns

☐ Regenerate output

Run settings >

Comment >

Module information >

Two-Class Boosted Decision Tree
Completed

Navigator

ML Designer

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

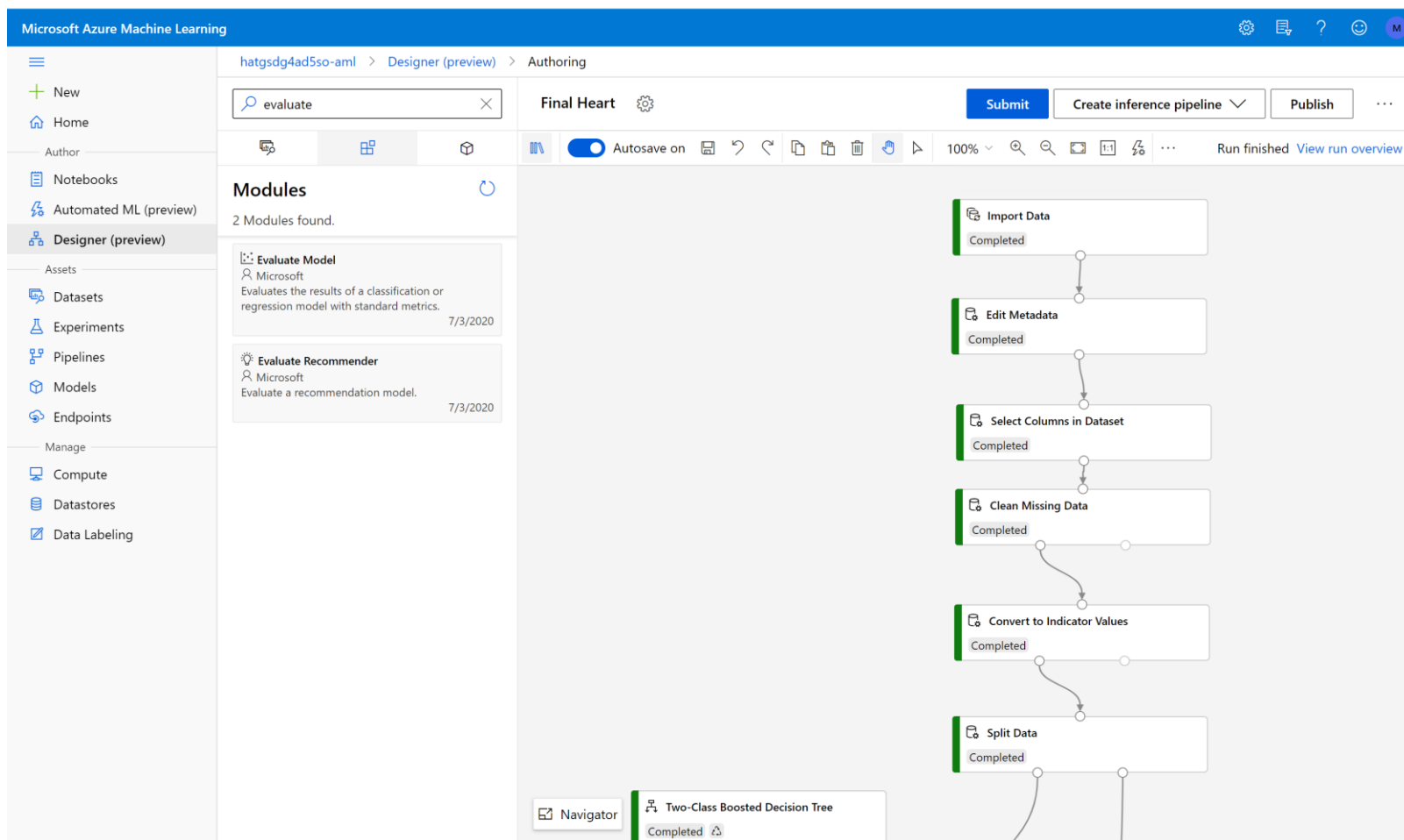
The screenshot displays the Microsoft Azure Machine Learning Designer interface. The left sidebar contains navigation options: New, Home, Author, Notebooks, Automated ML (preview), Designer (preview), Assets, Datasets, Experiments, Pipelines, Models, Endpoints, Manage, Compute, Datastores, and Data Labeling. The main workspace shows a pipeline with a 'Two-Class Boosted Decision Tree' module. The 'Modules' pane on the right lists 'Evaluate Model' and 'Evaluate Recommender'. The 'Split Data' module is highlighted, 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: ☐

The 'Run settings', 'Comment', and 'Module information' sections are also visible at the bottom of the configuration panel.

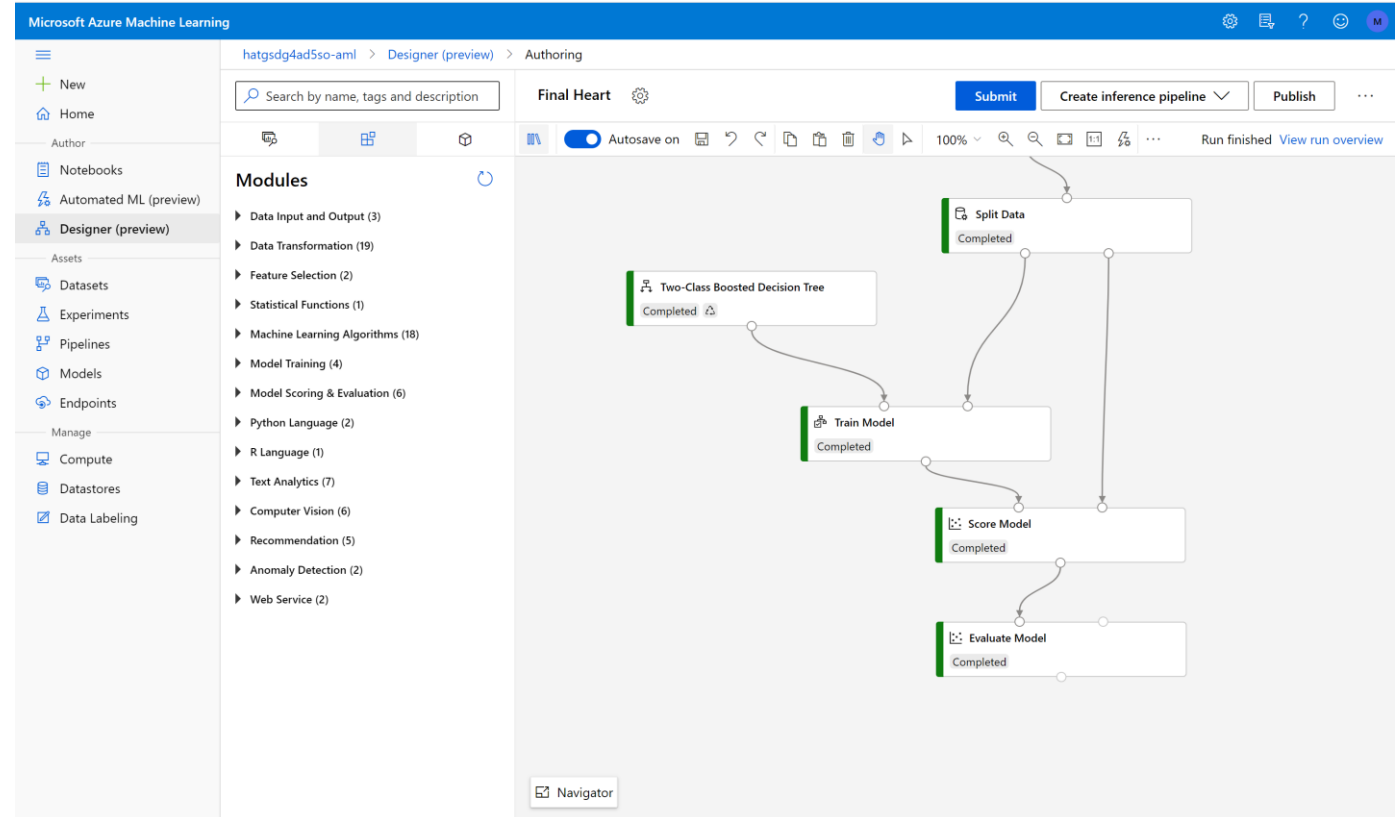
ML Designer

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



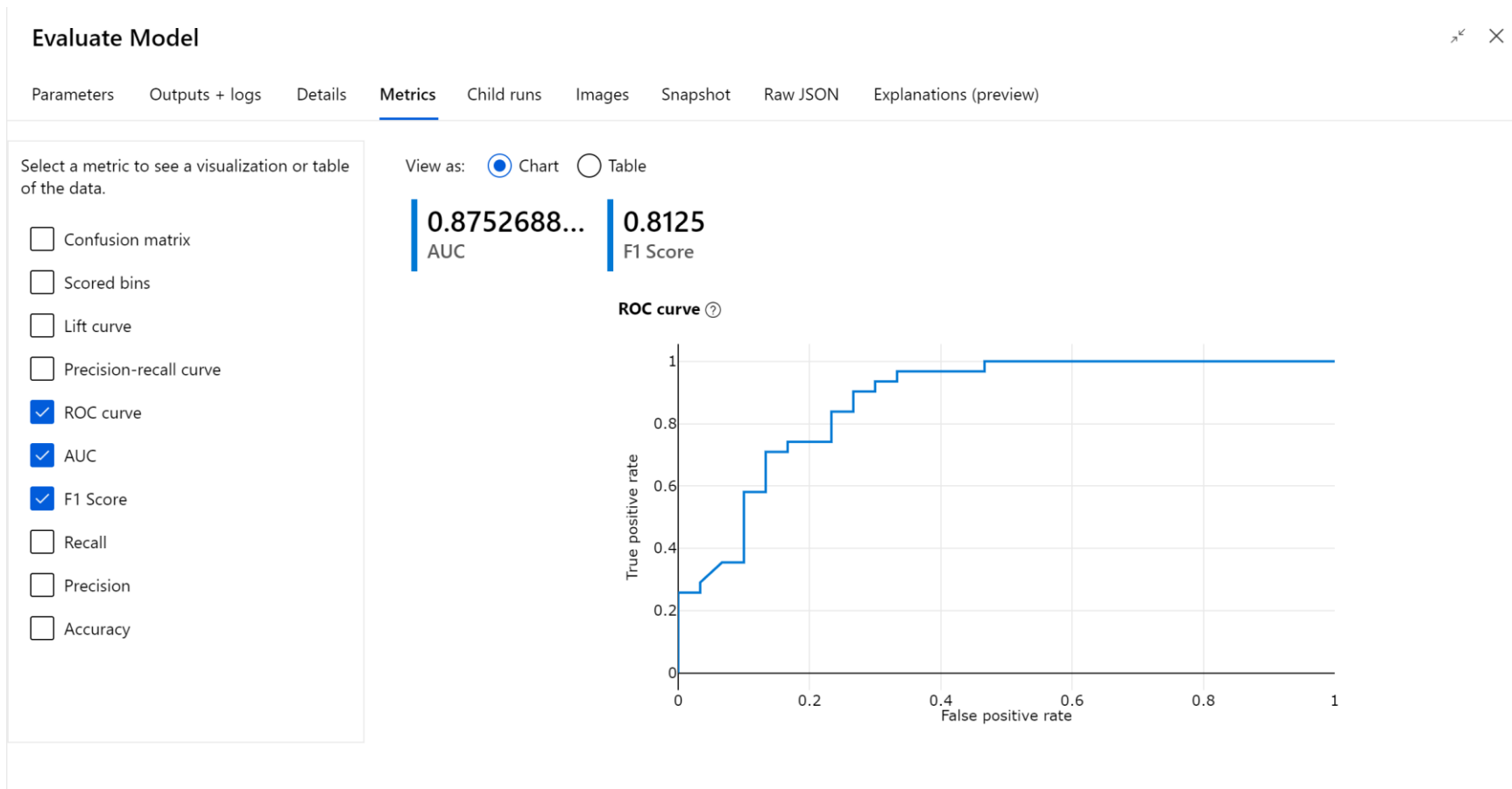
ML Designer

- 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.



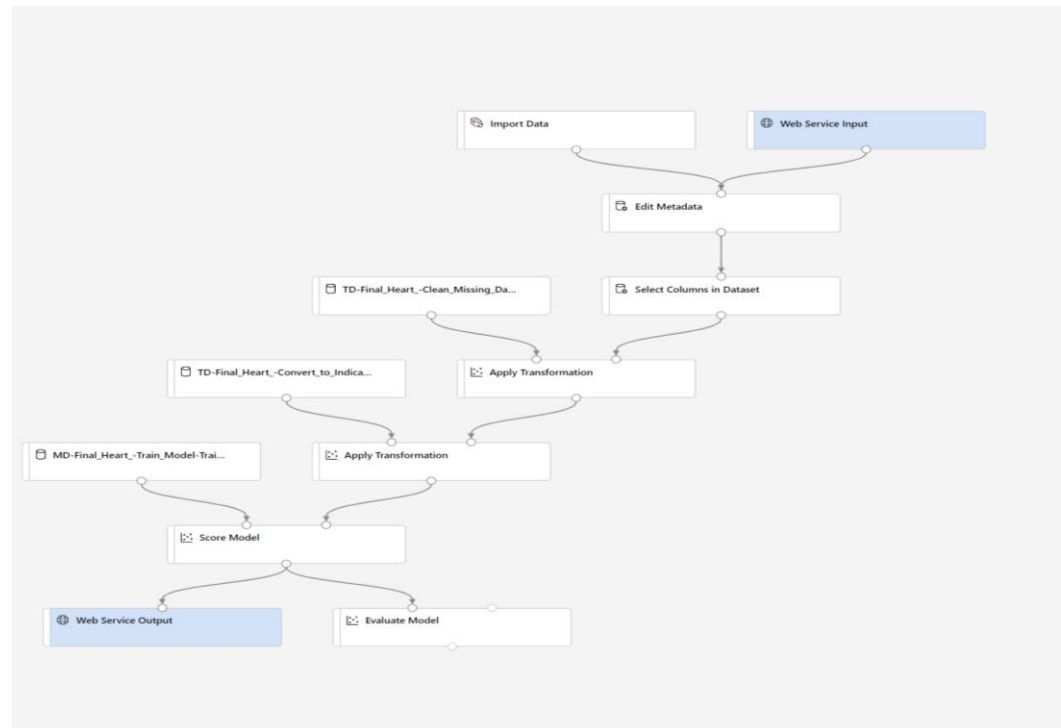
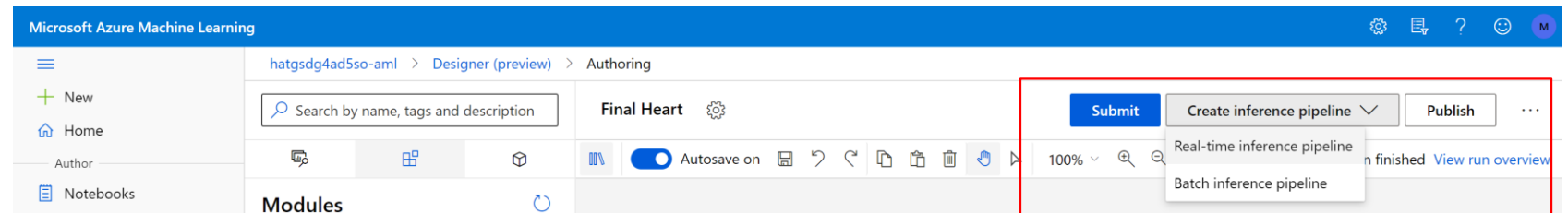
ML Designer

- 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...



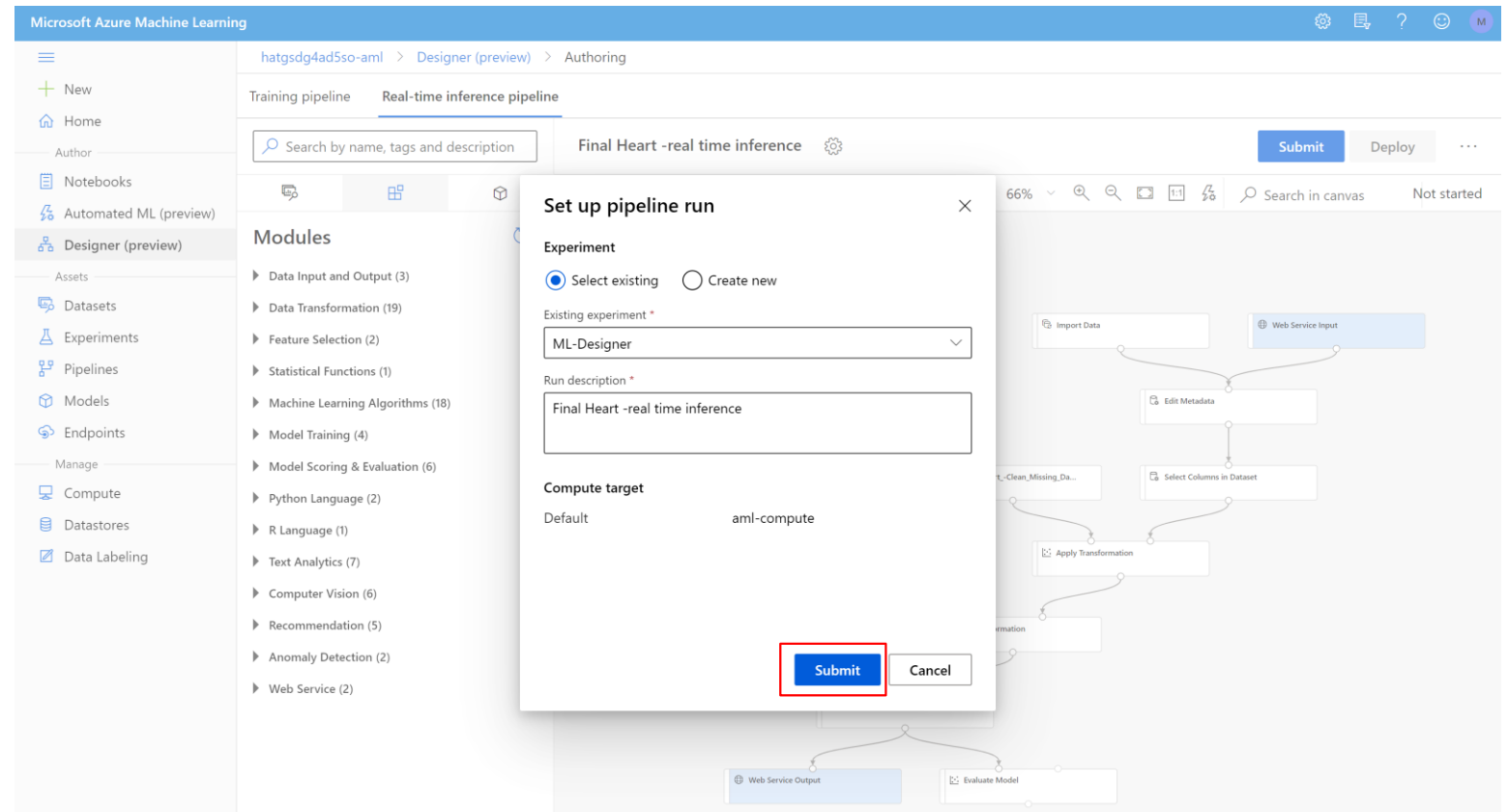
ML Designer (Inference)

- 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

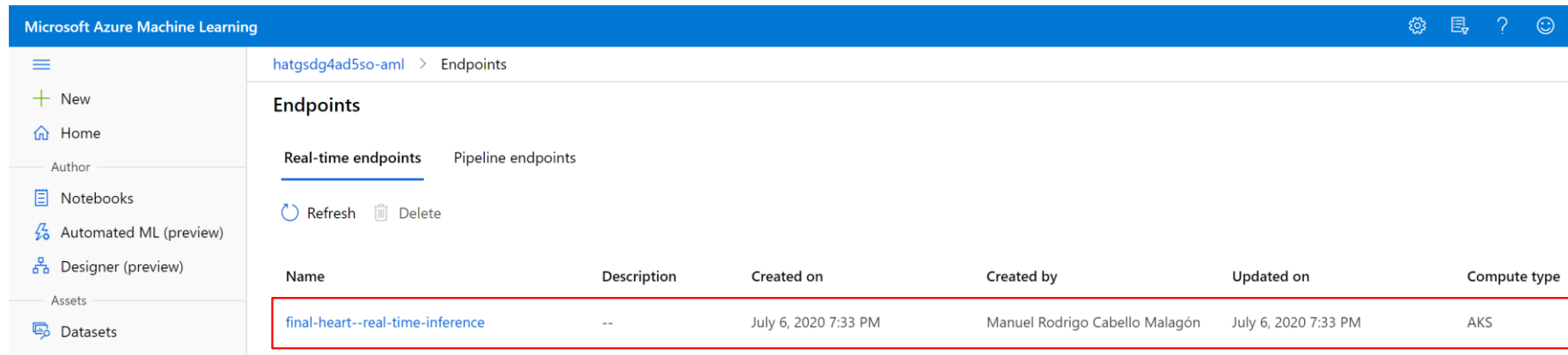
| Compute target name | Node count | Region | Status ↓ |
|---------------------|------------|-----------|-----------|
| aks-inference | 1 | centralus | Succeeded |

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.



Microsoft Azure Machine Learning

hatgsdg4ad5so-aml > Endpoints

Endpoints

Real-time endpoints Pipeline endpoints

Refresh Delete

| 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 breadcrumb path is 'hatgsdg4ad5so-aml > Endpoints > final-heart--real-time-inference'. Below the breadcrumb, there are tabs for 'Details', 'Test', and 'Consume'. The 'Test' tab is active.

Under the 'Test' tab, there is a section titled 'Input data to test real-time endpoint' with a 'Test' button. Below this, a dropdown menu shows 'WebServiceInput0'. The input fields are as follows:

- 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

On the right side, there is a 'Test result' section with 'parsed' and 'raw' tabs. The 'raw' tab is selected, showing a JSON response. The response is:

```
{
  "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
      }
    ]
  }
}
```

Useful Web Links & Resources

Responsible ML

<http://aka.ms/responsibleML>

Azure Machine Learning

<https://docs.microsoft.com/en-us/azure/machine-learning/how-to-monitor-datasets>

Videos Demos

AI Show

https://www.youtube.com/watch?time_continue=240&v=Ts6tB2p97ek&feature=emb_logo

Dev Relations Webinar

https://www.youtube.com/watch?time_continue=9&v=vR7N4aUXmaQ&feature=emb_logo

[InterpretML AI Show \(video\)](#)

[Fairlearn AI Show \(video\)](#)

Fairlearn

<http://Fairlean.org>

<http://github.com/fairlearn>

https://www.microsoft.com/en-us/research/uploads/prod/2020/05/Fairlearn_whitepaper.pdf

- [Fairlearn open source](#)
- [Fairlearn whitepaper](#)
- [Fairness Assessment in AzureML, concept](#)
- [Fairness Assessment in AzureML, how-to](#)
- [Fairlearn case study](#)

Data Drift

<https://docs.microsoft.com/en-us/azure/machine-learning/how-to-monitor-datasets>

Github Repo

Health demo

<https://github.com/leestott/ResponsibleAI>

Responsible AI Airflit

<https://github.com/microsoft/ResponsibleAI-Airlift>

Data Annonymization

<https://github.com/Microsoft/presidio>

[Presidio Features](#)

[Presidio Input and Output](#)

[API Spec](#)

[The Technology Stack](#)

[Architecture](#)

Interpret ML <https://interpret.ml/>

<https://docs.microsoft.com/en-us/azure/machine-learning/how-to-machine-learning-interpretability-aml>

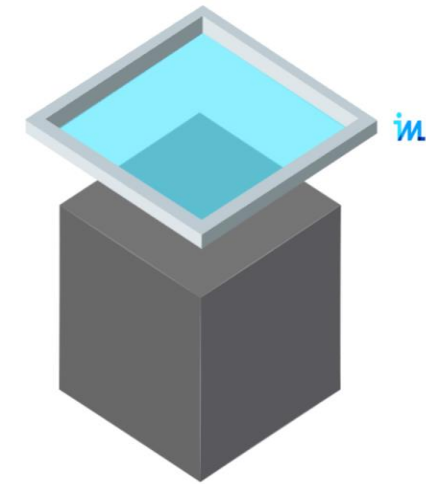
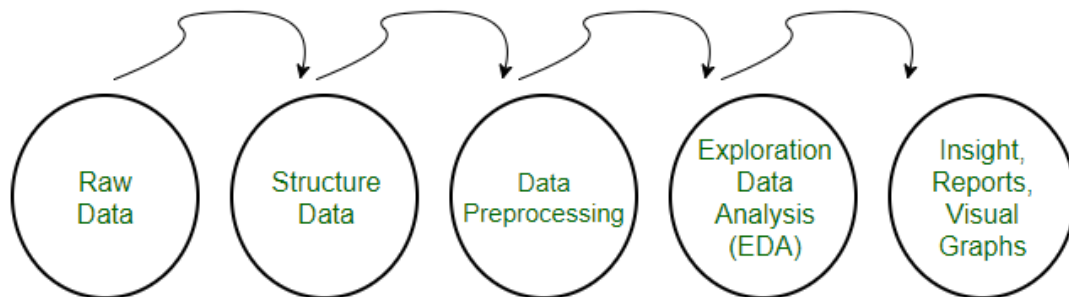
<http://interpret.ml>

<https://github.com/interpretml/interpret>

- [InterpretML open source](#)
- [Interpretability in AzureML, concept](#)
- [Interpretability in AzureML, how-to](#)
- [InterpretML case study](#)

Exploratory analysis and preprocessing

- This step launches the following tasks:
 - Perform initial investigations on data to discover patterns, spot anomalies and check assumptions with the help of summary statistics and graphical representations.
 - Preprocess all the dataset:
 - Handle null values
 - Encode categorical and text values.
 - Normalize data.
 - Feature engineering



Explainable AI
Interpret ML
<https://interpret.ml/>