**Microsoft Azure AI Fundamentals (AI-900)**

*Get started with AI on Azure*

What is AI?

AI is the creation of software that imitates human behaviors and capabilities.

AI Workloads in Azure

* Machine learning - “Teach" a computer model to make prediction and draw conclusions.
* Anomaly detection - Automatically detect errors or unusual activity in a system.
* Computer vision - To interpret the world visually through cameras, video, and images.
* NLP - To interpret written or spoken language, and respond in kind.
* Conversational AI - The capability of a software "agent" to participate in a conversation.

Machine learning in Microsoft Azure:

Azure Machine Learning provides the following features and capabilities:

* **Automated ML:** Enables non-experts to quickly create an effective ML model from data.
* **Azure Ml designer:** A GUI enabling no-code development of ML solutions.
* **Data and compute management:** Cloud-based data storage and compute resources.
* **Pipelines:**  Define pipelines to orchestrate model training, deployment, and management.

Anomaly detection in Microsoft Azure:

A software system to monitor credit card transactions and detect unusual usage patterns that might indicate fraud. Or an application that tracks activity in an automated production line and identifies failures.

* In Microsoft Azure, the ***Anomaly Detector service*** provides an API to create anomaly detection solutions.

Computer Vision in Microsoft Azure:

Microsoft Azure provides the following cognitive services for computer vision solutions:

* **Computer Vision:** Analyze images and video, extract descriptions, tags, objects, text.
* **Custom Vision :**  To train custom image classification and object detection models.
* **Face :**  The Face service enables you to build face detection solutions.
* **Form Recognizer :** To extract information from scanned forms and invoices.

NLP in Microsoft Azure:

NLP is the area of AI that deals with creating software that understands written and spoken language.

* Analyze and interpret text in documents, email messages, and other sources.
* Interpret spoken language, and synthesize speech responses.
* Automatically translate spoken or written phrases between languages.
* Interpret commands and determine appropriate actions.

In Microsoft Azure, you can use the following cognitive services to build NLP solutions:

* **Text Analytics** : To analyze text documents and extract key phrases,detect entities

(such as places, dates, and people), and evaluate sentiment

* **Translator Text** : To translate text between more than 60 languages.
* **Speech** : To recognize and synthesize speech, and to translate spoken languages.
* **LUIS** : Train a language model that can understand spoken or text-cmd’s.

Conversational AI in Microsoft Azure:

Solutions where AI agents participate in conversations with humans. Most commonly, conversational AI solutions use bots to manage dialogs with users.

* Customer support for products or services.
* Reservation systems for restaurants, airlines, and other appointment based businesses.
* Health care consultations and self-diagnosis.
* Home automation and personal digital assistants.

To create conversational AI solutions on Microsoft Azure, you can use the following services:

* **QnA Maker :** This cognitive service enables you to quickly build a knowledge base of

questions and answers to form the basis of a dialog between a human & an AI.

* **Azure Bot Service :** This service provides a platform for creating, publishing, and

managing bots. Use the Bot Framework to create a bot and manage it with Azure Bot Service - integrating back-end services like QnA Maker and LUIS, and connecting to channels for web chat, email and others.

Understand responsible AI:

At Microsoft, AI software development is guided by a set of six principles.

* Fairness : Should treat all people fairly (loan application)
* Reliability & Safety: Should be reliable (autonomous vehicle)
* Privacy & Security :
* Inclusiveness : AI should bring benefits to all parts of the society.
* Transparency: User should be full aware of the purpose, working,limit of the system.
* Accountability: Designer/Dev should work within a framework of governance & principle.

*Use visual tools to create ML models with Azure Machine Learning*

Objectives:

Use automated machine learning in Azure Machine Learning

Create a Regression Model.

Create a Classification Model.

Create a Clustering Model

Use automated machine learning in Azure Machine Learning:

To use Azure Machine Learning, you create a workspace in your Azure subscription. You can then use this workspace to manage data, compute resources, code, models, and other artifacts related to your machine learning workloads.

1. Create an Azure Machine Learning workspace.
2. Create compute resources: There are 4 kind of computer resources.

* Compute instance : Development workstation VMs .
* Compute Clusters : Scaleable clusters of VMs
* **Inference Clusters: Deployment targets for predictive services.**
* Attached Compute: Links to existing compute resources (ie Vms, dataBricks ctr)

1. Explore Data ⇒ Create Dataset.
2. Train a ML model. (Azure AutoML supports supervised; Classification, Regression, Time Series Forecasting.)
3. Run an automated ML experiment: In Azure ML, operations you run are called experiment.

* Target column: This is the label the model will be trained to predict.
* Task type: Regression (the model will predict a numeric value).
* Primary metric: Select **Normalized root mean squared error(**for regression**)**
* Explain best model: Selected - this option causes automated ML to calculate feature importance for the best model.
* Blocked algorithms: Block all other than **RandomForest** and **LightGBM**.
* Exit criterion:

- Training job times (hours): experiment to end after given time.

- Metric Score Threshold : experiment end when get a error threshold.

* Enable featurization: Selected - Causes Azure ML to automatically preprocess the features before training.

1. Review the best model: The best model is identified based on the evaluation metric you specified (Normalized root mean squared error). The difference between the predicted and actual value (known as the residuals) indicates the amount of error in the model. Select View all other metrics to see values of other possible evaluation metrics for a regression model.Select the Metrics tab and select the **residuals** and **predicted\_true** charts if they are not already selected. ⇒ The Predicted vs. True chart should show a diagonal trend in which the predicted value correlates closely to the true value. The Residual Histogram ⇒ shows the frequency of residual value ranges. Residuals represent variance between predicted and true values.
2. Deploy model as a service: In Azure Machine Learning, you can deploy a service as an **Azure Container Instances (ACI)** or to an **Azure Kubernetes Service (AKS) cluster**. For production scenarios, **an AKS deployment is recommended, for which you must create an inference cluster compute target**.

You need following information to connect to your deployed service from a client application.

* The REST endpoint for your service.
* The Primary Key for your service.

1. Test the Deployed Service: You need to use endpoint and key with your notebook to connect with your deployed service.

Regression Model in Azure Machine Learning:

To use Azure Machine Learning, you create a workspace in your Azure subscription first. After that follow all the above steps.

**Evaluate a Regression Model:**

* Mean Absolute Error (MAE): The average difference between predicted values and true values. This value is based on the same units as the label. **The lower this value is, the better the model is predicting.**
* Root Mean Squared Error (RMSE): The square root of the mean squared difference between predicted and true values. The result is a metric based on the same unit as the label (dollars). When compared to the MAE (above), a larger difference indicates greater variance in the individual errors (for example, with some errors being very small, while others are large).
* Relative Squared Error (RSE): A relative metric **between 0 and 1** **based on the square of the differences** between predicted and true values. **The closer to 0 this metric is, the better the model is performing.** Because this metric is relative, it can be used to compare models where the labels are in different units.
* Relative Absolute Error (RAE): A relative metric **between 0 and 1** based on the absolute differences between predicted and true values. **The closer to 0 this metric is, the better the model is performing.** Like RSE, this metric can be used to compare models where the labels are in different units.
* Coefficient of Determination (R2): This metric is more commonly referred to as R-Squared, and summarizes how much of the variance between predicted and true values is explained by the model. **The closer to 1 this value is, the better the model is performing.**

**Create an Inference pipeline:**

After creating and running a pipeline to train the model, you need a second pipeline that performs the same data transformations for new data, and then uses the trained model to inference (in other words, predict) label values based on its features.

Classification Model in Azure Machine Learning:

1. Create an Azure Machine Learning workspace.
2. Create compute resources.
3. Explore data.

* Create a dataset.
* Create a pipeline.
* Add transformation.
* Run the pipeline.

1. Create a run training pipeline.
2. Evaluate a classification model.
3. Create an inference pipeline.
4. Deploy a predictive service.

**Evaluate a Classification Model:**

* **Average classification accuracy**: representing the proportion of correctly classified observations.
* **Confusion matrix**: which is 2x2 table showing four parameters, including the number of true positives, true negatives, false negatives and false positives.
* **Precision, Recall and Specificity**: which are three major performance metrics describing a predictive classification model.
* **ROC curve**: which is a graphical summary of the overall performance of the model, showing the proportion of true positives and false positives at all possible values of probability cutoff.
* **Area Under the Curve (AUC):** summarizes the overall performance of the classifier. The larger the area under the curve (which can be any value from 0 to 1), the better the model is performing.

Clustering Model in Azure Machine Learning:

**Evaluate a Clustering Model:**

* **Average Distance to Other Center**: This indicates how close, on average, each point in the cluster is to the centroids of all other clusters.
* **Average Distance to Cluster Center**: This indicates how close, on average, each point in the cluster is to the centroid of the cluster.
* **Number of Points:** The number of points assigned to the cluster.
* **Maximal Distance to Cluster Center**: The maximum of the distances between each point and the centroid of that point’s cluster. If this number is high, the cluster may be widely dispersed. This statistic in combination with the Average Distance to Cluster Center helps you determine the cluster’s spread.

*Computer Vision with Azure Machine Learning*

Objectives:

Analyze images with the Computer Vision service.

Classify images with the Custom Vision service.

Detect objects in images with the Custom Vision service.

Detect and analyze faces with the Face service.

Read text with the Computer Vision service.

Analyze receipts with the Form Recognizer service.

Azure resources for Computer Vision:

To use the Computer Vision service, you need to create a resource for it in your Azure subscription. You can use either of the following resource types:

* **Computer Vision**: A specific resource for the Computer Vision service. Use this resource type if you don't intend to use any other cognitive services, or if you want to track utilization and costs for your Computer Vision resource separately.
* **Cognitive Services:** A general cognitive services resource that includes Computer Vision along with many other cognitive services; such as Text Analytics, Translator Text, and others. Use this resource type if you plan to use multiple cognitive services and want to simplify administration and development.

Azure Computer Vision service performs a wide range of analytical tasks.

* Describing an image. (A large white building in a city)
* Tagging visual features(skyscraper)
* Detecting objects. (show location)
* Detecting brands.
* Detecting faces.
* Categorizing an image.
* Optical character recognition(detect printed/handwritten texts).
* Detecting domain-specific content

When categorizing image, Computer Vision service supports two specialized domain models:

**Celebrities** - The service includes a model that has been trained to identify thousands of well-known celebrities from the worlds of sports, entertainment, and business.

**Landmarks** - The service can identify famous landmarks, such as the Taj Mahal and the Statue of Liberty.

Evaluation on IMage Classification:

**Precision: I**f the model predicted that 10 images are oranges, of which eight were actually oranges, then the precision is 0.8 (80%).

**Recall:** What percentage of class predictions did the model correctly identify? For example, if there are 10 images of apples, and the model found 7 of them, then the recall is 0.7 (70%).

**Average Precision (AP):** An overall metric that takes into account both precision and recall).

To use your model, client applications need this info: **Project ID, MOdel name, Prediction Endpoint, Prediction key**.

Object detection in Azure:

Object detection model returns the following information:

* The class of each object identified in the image.
* The probability score of the object classification (which you can interpret as the confidence of the predicted class being correct)
* The coordinates of a bounding box for each object.

Object detection vs. image classification:

* Image classification is a machine learning based form of computer vision in which a model is trained to categorize images based on the primary subject matter they contain. Object detection goes further than this to classify individual objects within the image, and to return the coordinates of a bounding box that indicates the object's location.

If you choose to create a Custom Vision resource, you will be prompted to choose training, prediction, or both - and it's important to note that if you choose "both", then two resources are created - one for training and one for prediction.

Image tagging:

Before you can train an object detection model, you must tag the classes and bounding box coordinates in a set of training images. Additionally, after tagging and training with an initial dataset, the Computer Vision service can use smart tagging to suggest classes and bounding boxes for images you add to the training dataset.