Predict from IoT

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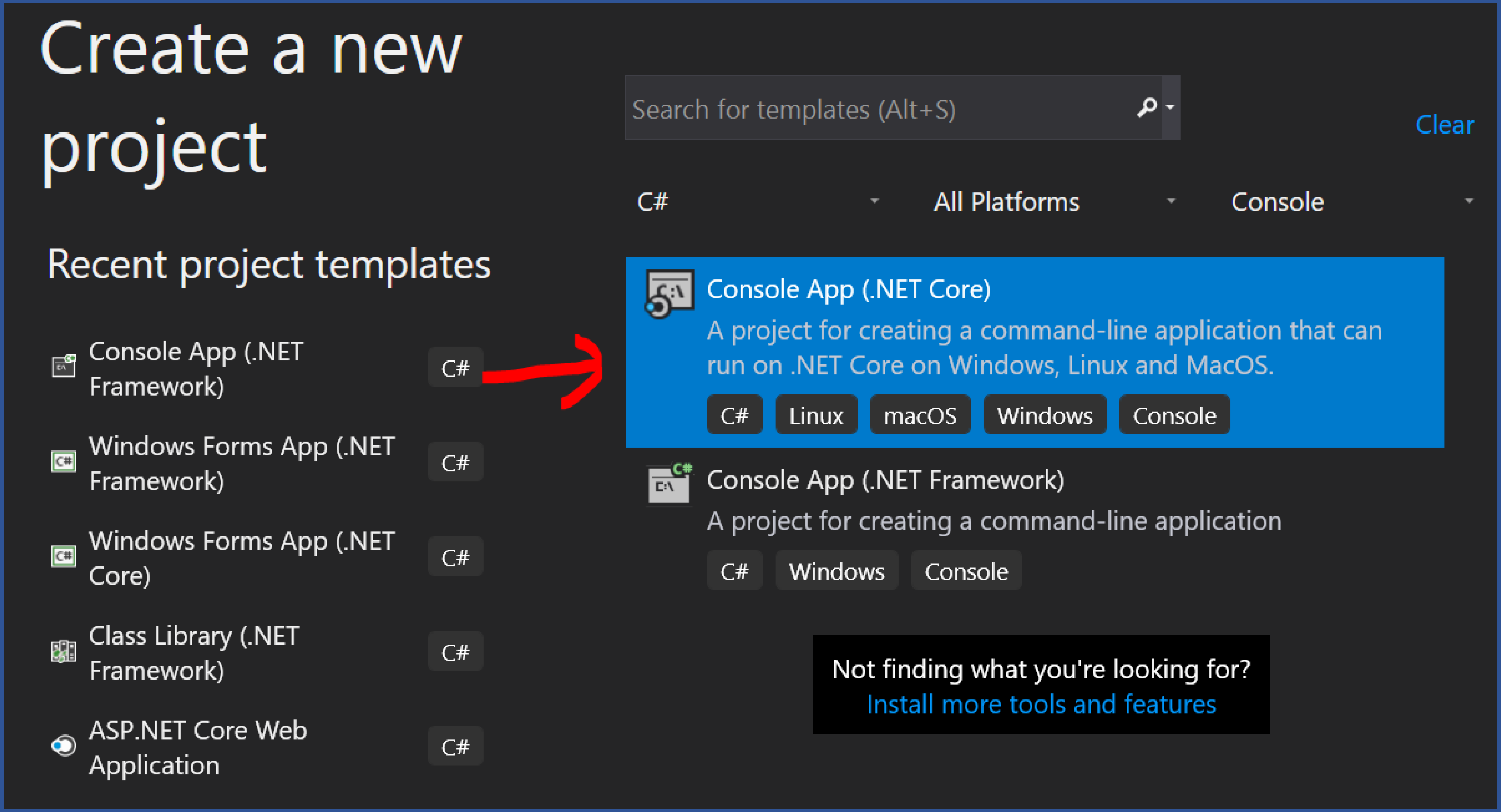
Create new .NET CORE console project



Create a new project

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- Windows Forms App (.NET Core) C#
- Class Library (.NET Framework) C#
- ASP.NET Core Web Application C#

Console App (.NET Core)
A project for creating a command-line application that can run on .NET Core on Windows, Linux and MacOS.
C# Linux macOS Windows Console

Console App (.NET Framework)
A project for creating a command-line application
C# Windows Console

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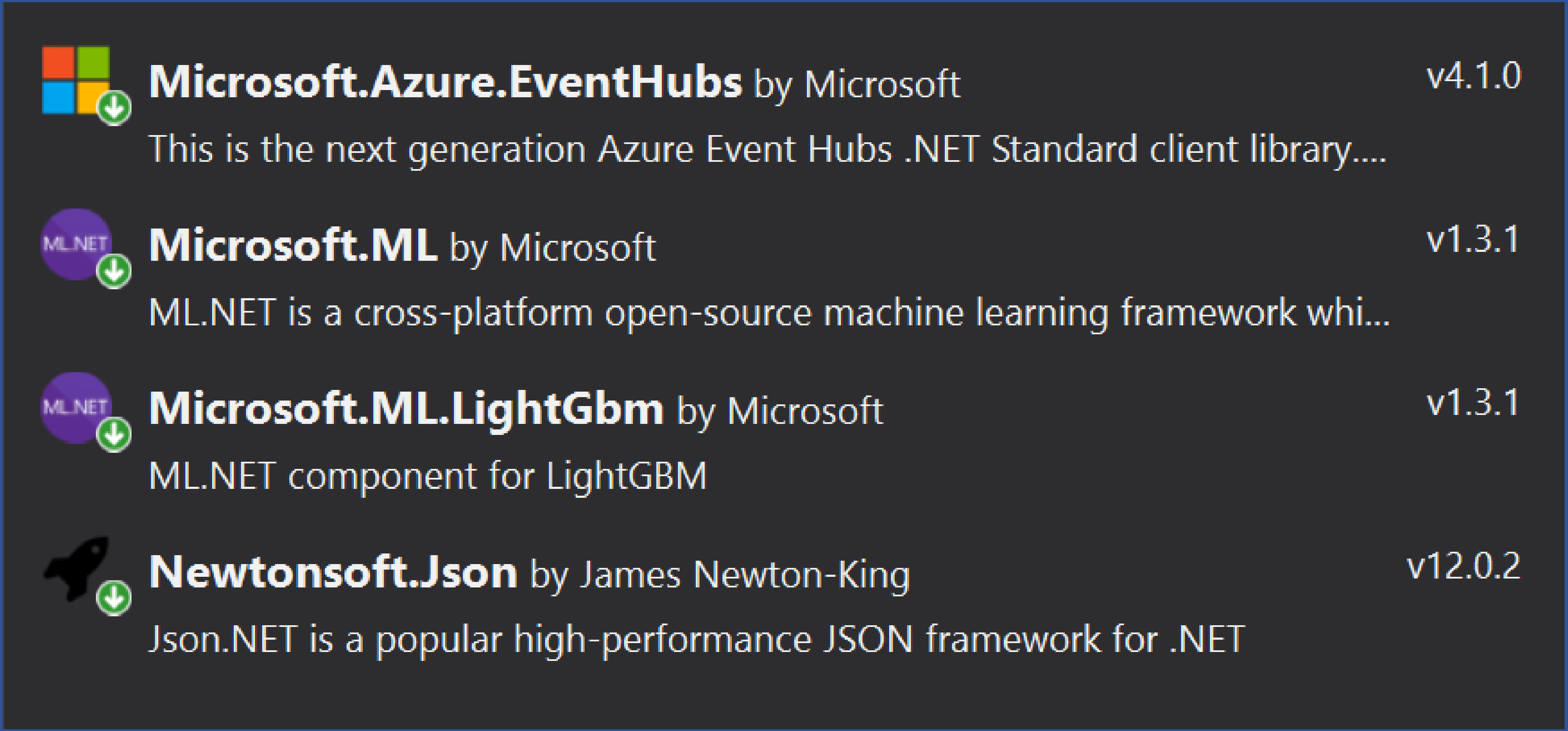
Add NuGet



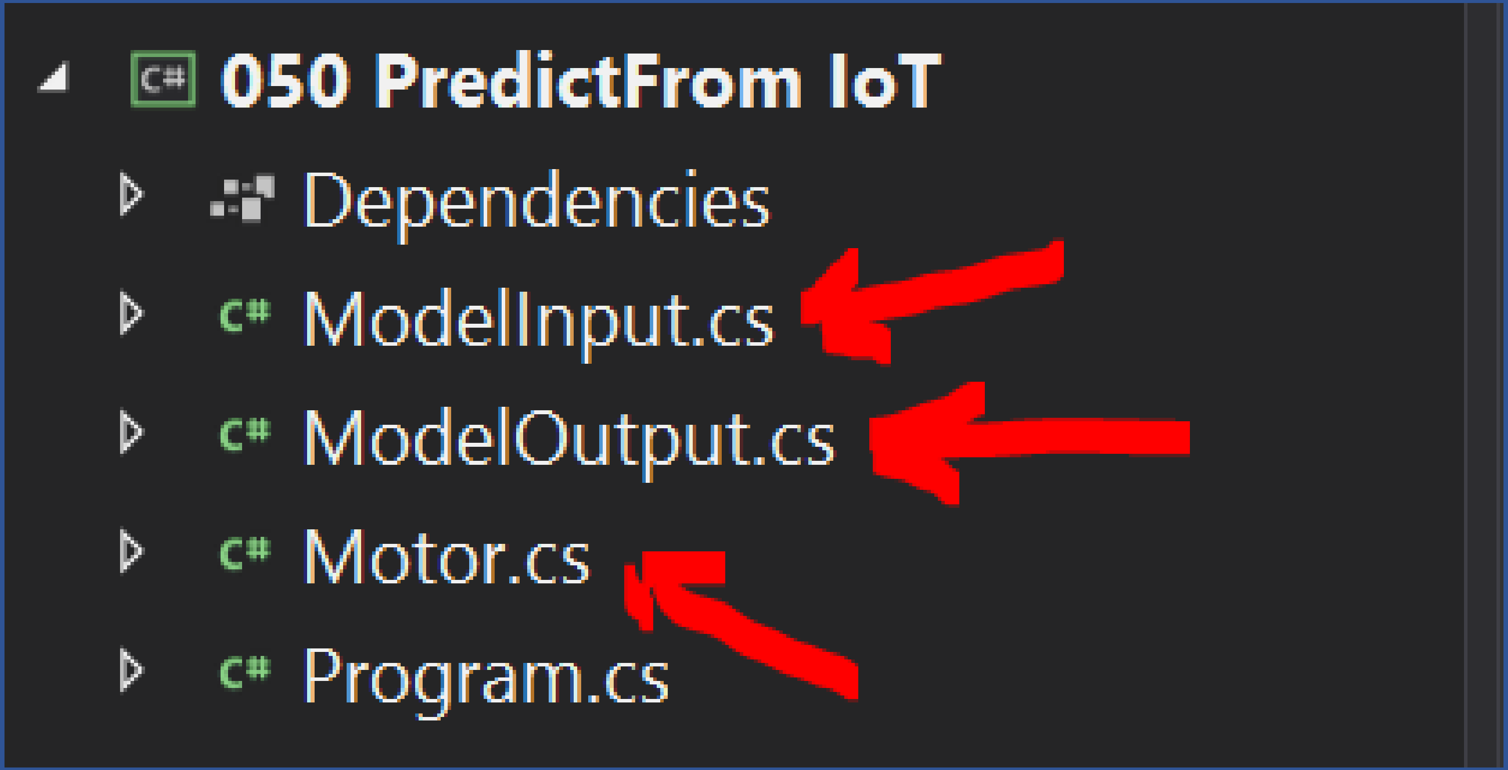
Microsoft.Azure.EventHubs by Microsoft v4.1.0
This is the next generation Azure Event Hubs .NET Standard client library....

Microsoft.ML by Microsoft v1.3.1
ML.NET is a cross-platform open-source machine learning framework whi...

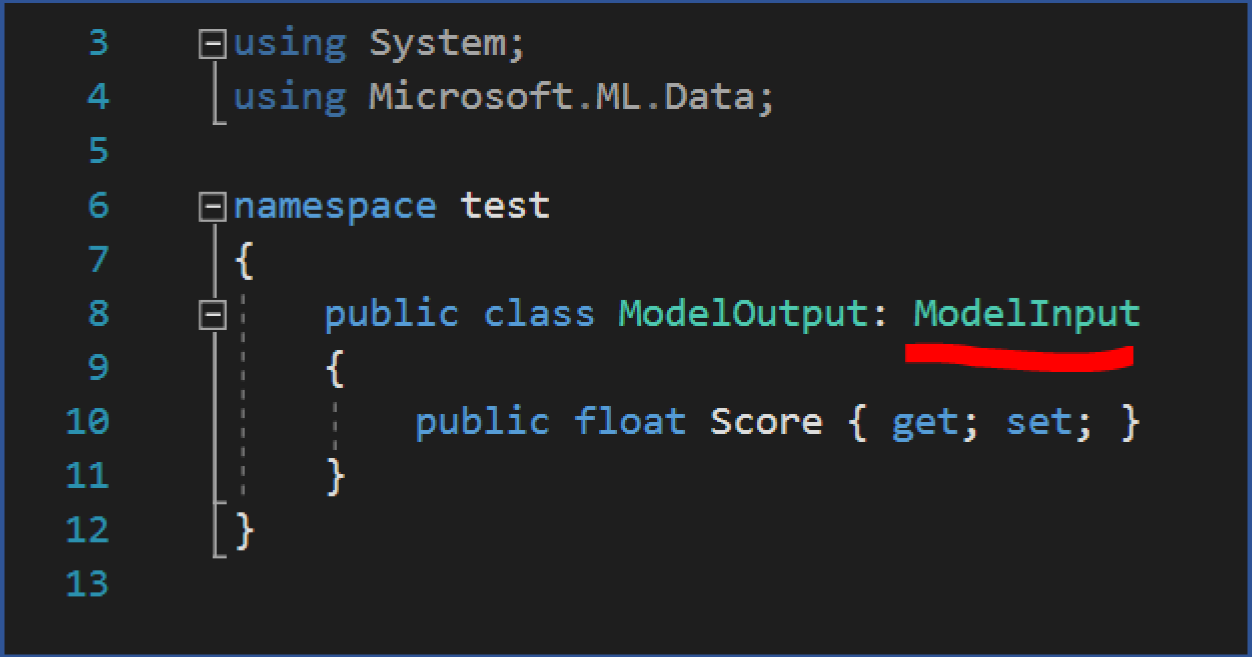
Microsoft.ML.LightGbm by Microsoft v1.3.1
ML.NET component for LightGBM

Newtonsoft.Json by James Newton-King v12.0.2
Json.NET is a popular high-performance JSON framework for .NET

Copy data models to project

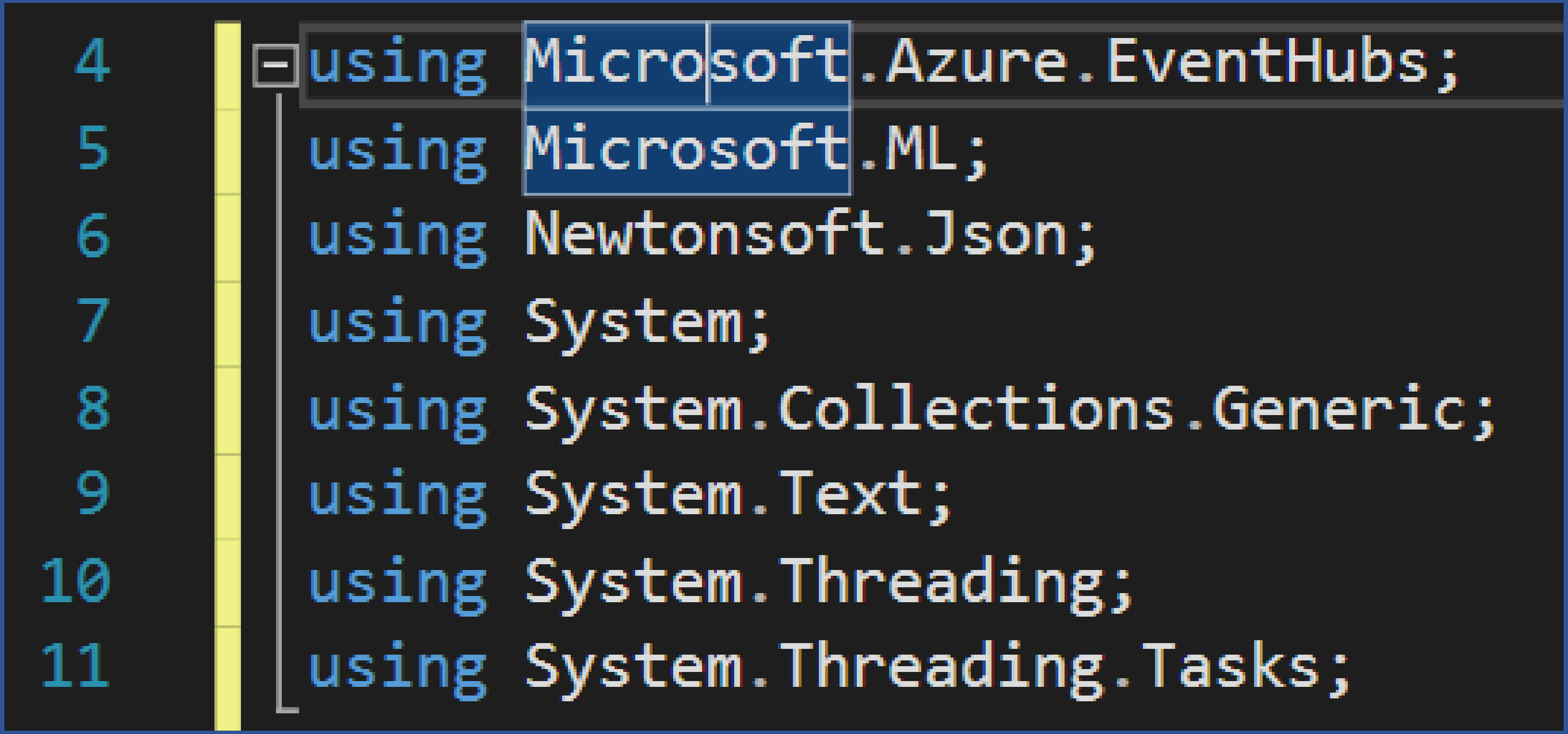


Add base class reference



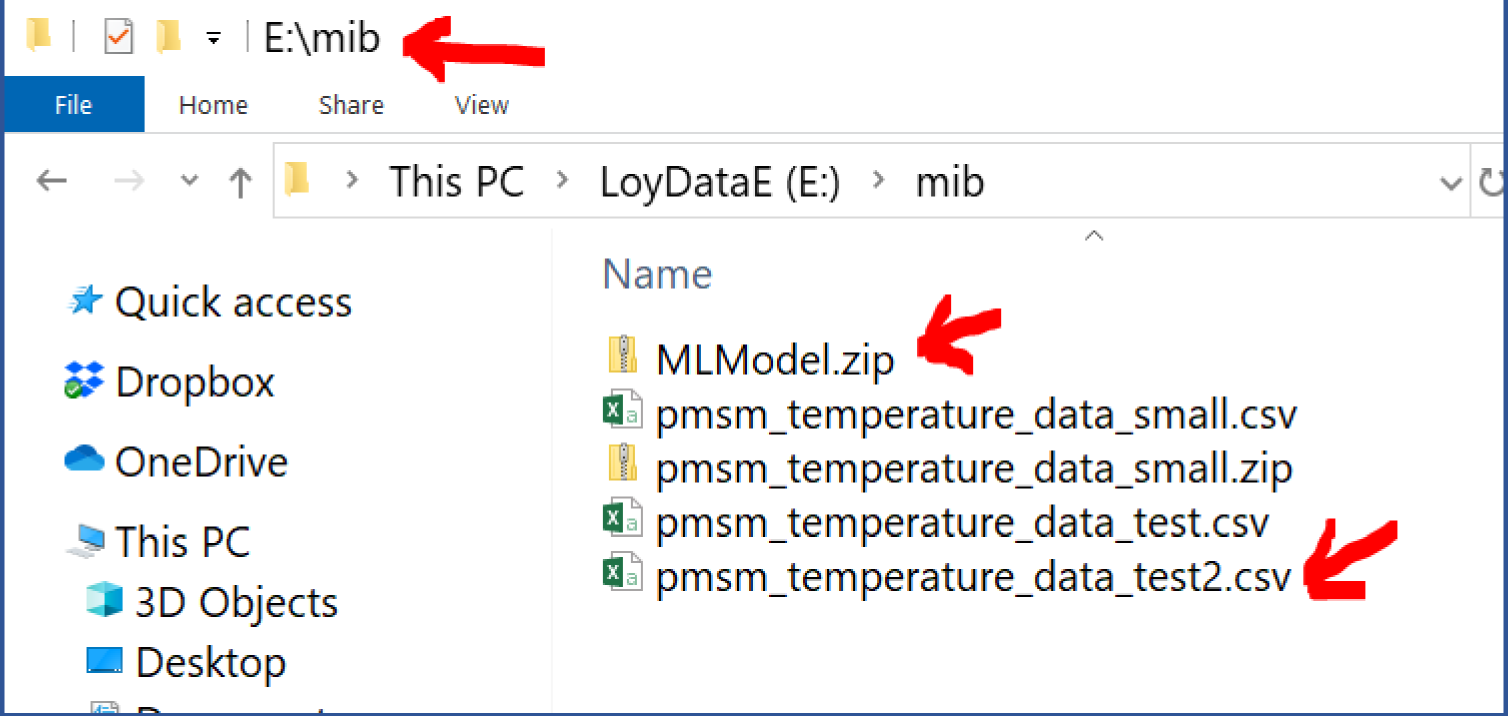
```
using System;
using Microsoft.ML.Data;

namespace test
{
    public class ModelOutput: ModelInput
    {
        public float Score { get; set; }
    }
}

```

Add using to Program



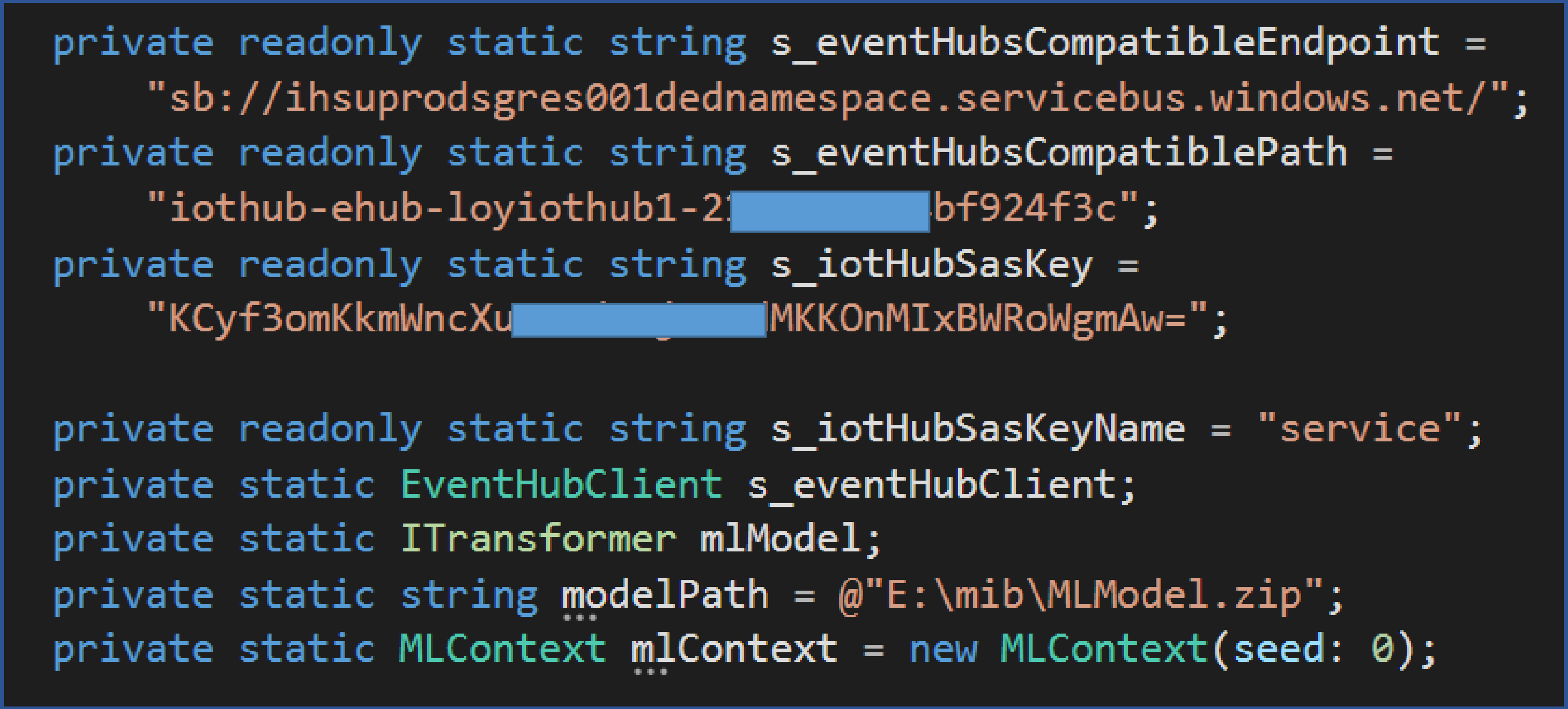
```
using Microsoft.Azure.EventHubs;
using Microsoft.ML;
using Newtonsoft.Json;
using System;
using System.Collections.Generic;
using System.Text;
using System.Threading;
using System.Threading.Tasks;
```

Add ML Model and test data to mib folder



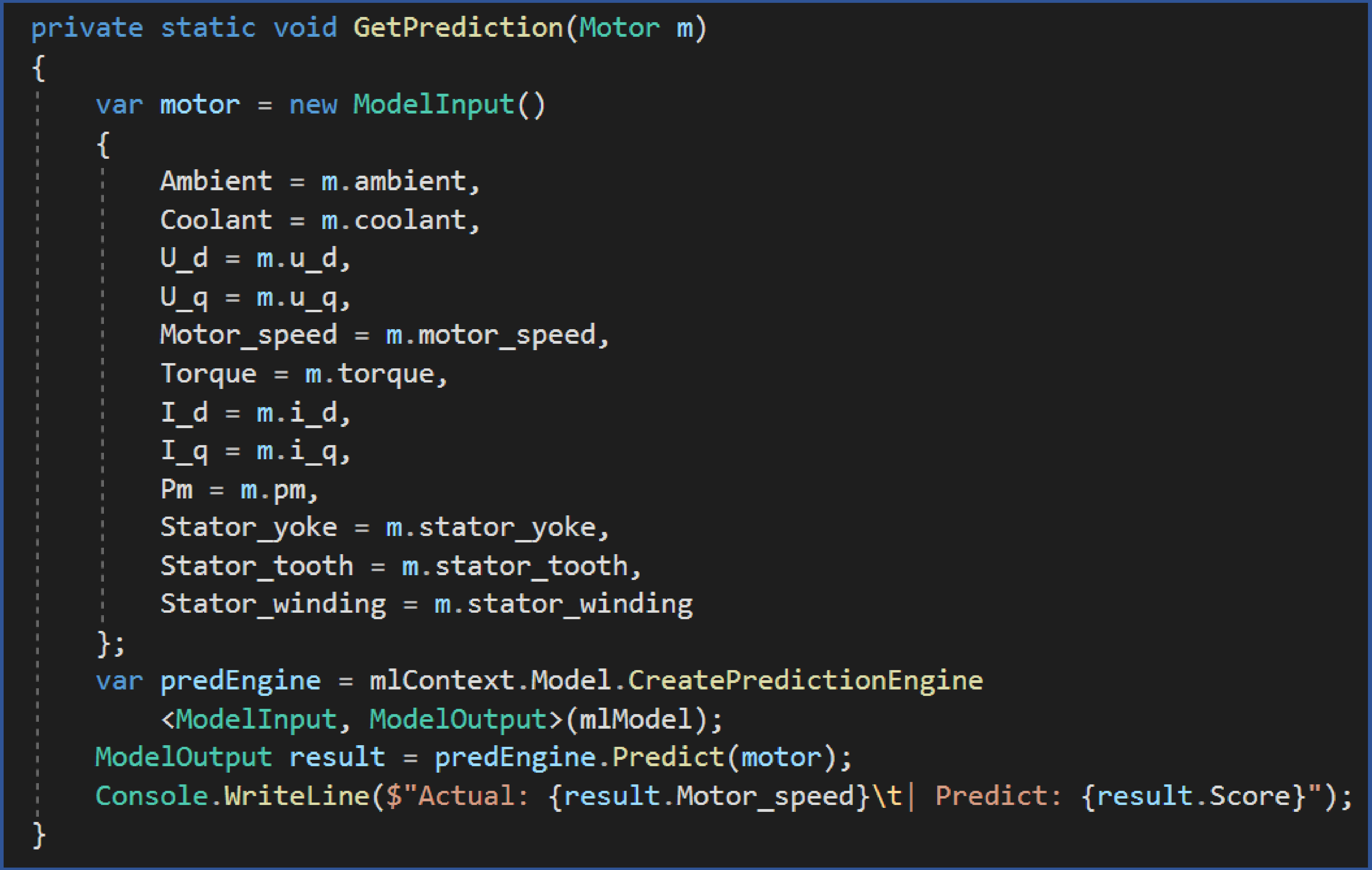
MLModel.zip
pmsm_temperature_data_small.csv
pmsm_temperature_data_small.zip
pmsm_temperature_data_test.csv
pmsm_temperature_data_test2.csv

Add class fields



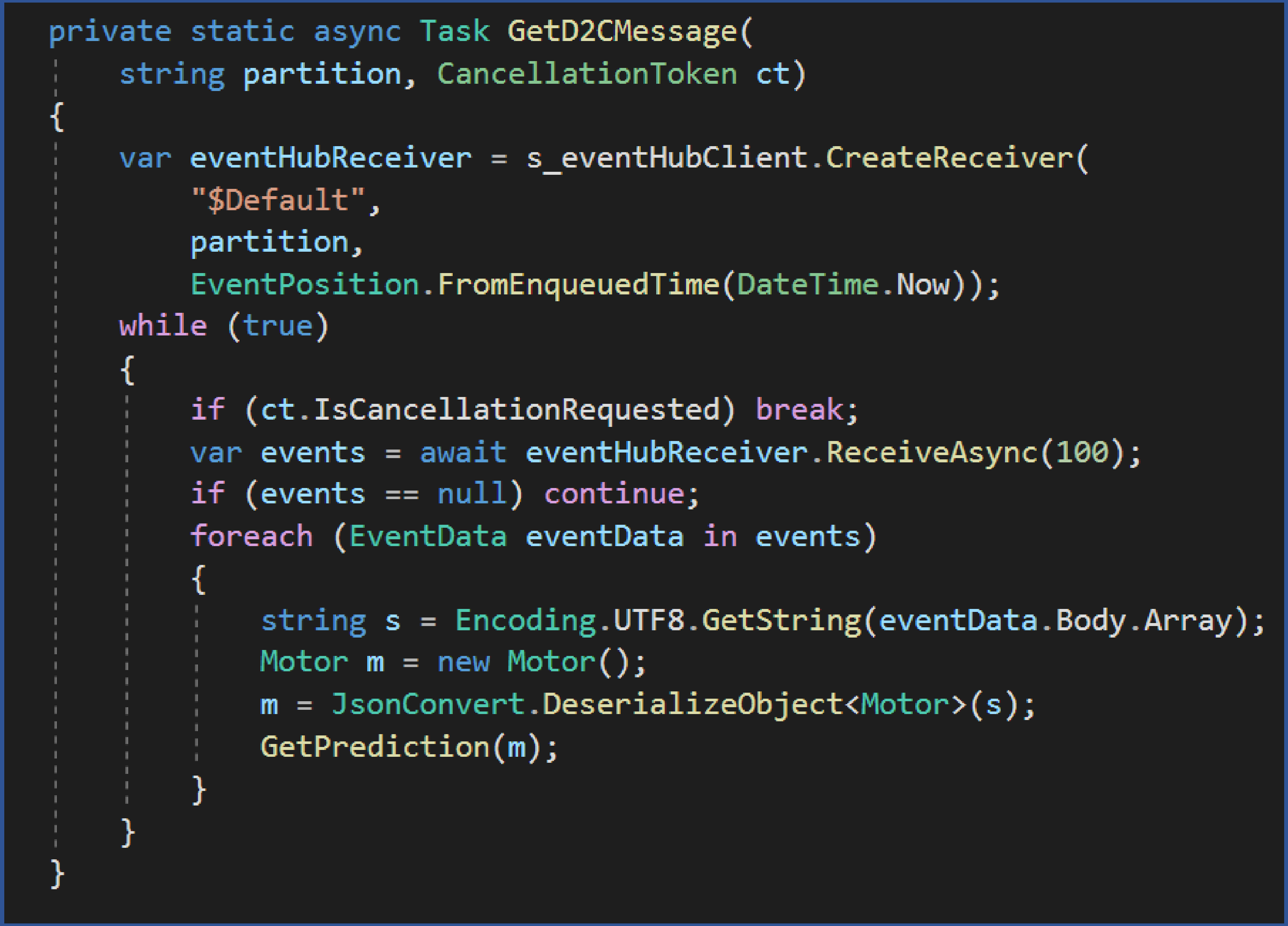
```
private readonly static string s_eventHubsCompatibleEndpoint =
    "sb://ihsuprodsgres001dednamespace.servicebus.windows.net/";
private readonly static string s_eventHubsCompatiblePath =
    "iothub-ehub-loyiothub1-2[redacted]bf924f3c";
private readonly static string s_iotHubSasKey =
    "KCyf3omKkmWncXu[redacted]MKKOnMIxBWRoWgmAw=";

private readonly static string s_iotHubSasKeyName = "service";
private static EventHubClient s_eventHubClient;
private static ITransformer mlModel;
private static string modelPath = @"E:\mib\MLModel.zip";
private static MLContext mlContext = new MLContext(seed: 0);
```

Add method GetPrediction



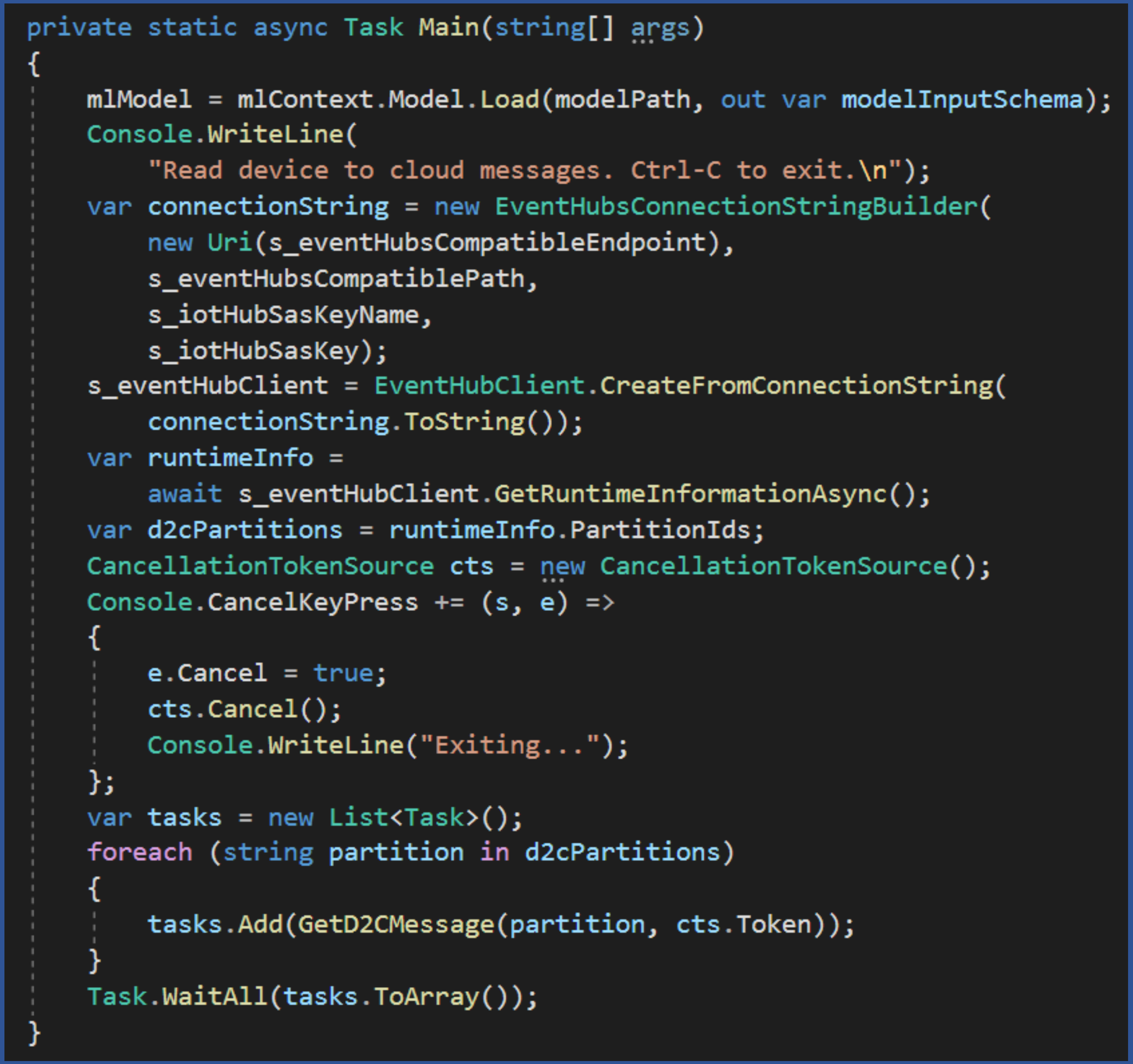
```
private static void GetPrediction(Motor m)
{
    var motor = new ModelInput()
    {
        Ambient = m.ambient,
        Coolant = m.coolant,
        U_d = m.u_d,
        U_q = m.u_q,
        Motor_speed = m.motor_speed,
        Torque = m.torque,
        I_d = m.i_d,
        I_q = m.i_q,
        Pm = m.pm,
        Stator_yoke = m.stator_yoke,
        Stator_tooth = m.stator_tooth,
        Stator_winding = m.stator_winding
    };
    var predEngine = mlContext.Model.CreatePredictionEngine
        <ModelInput, ModelOutput>(mlModel);
    ModelOutput result = predEngine.Predict(motor);
    Console.WriteLine($"Actual: {result.Motor_speed}\t| Predict: {result.Score}");
}
```

Add method GetD2CMessage



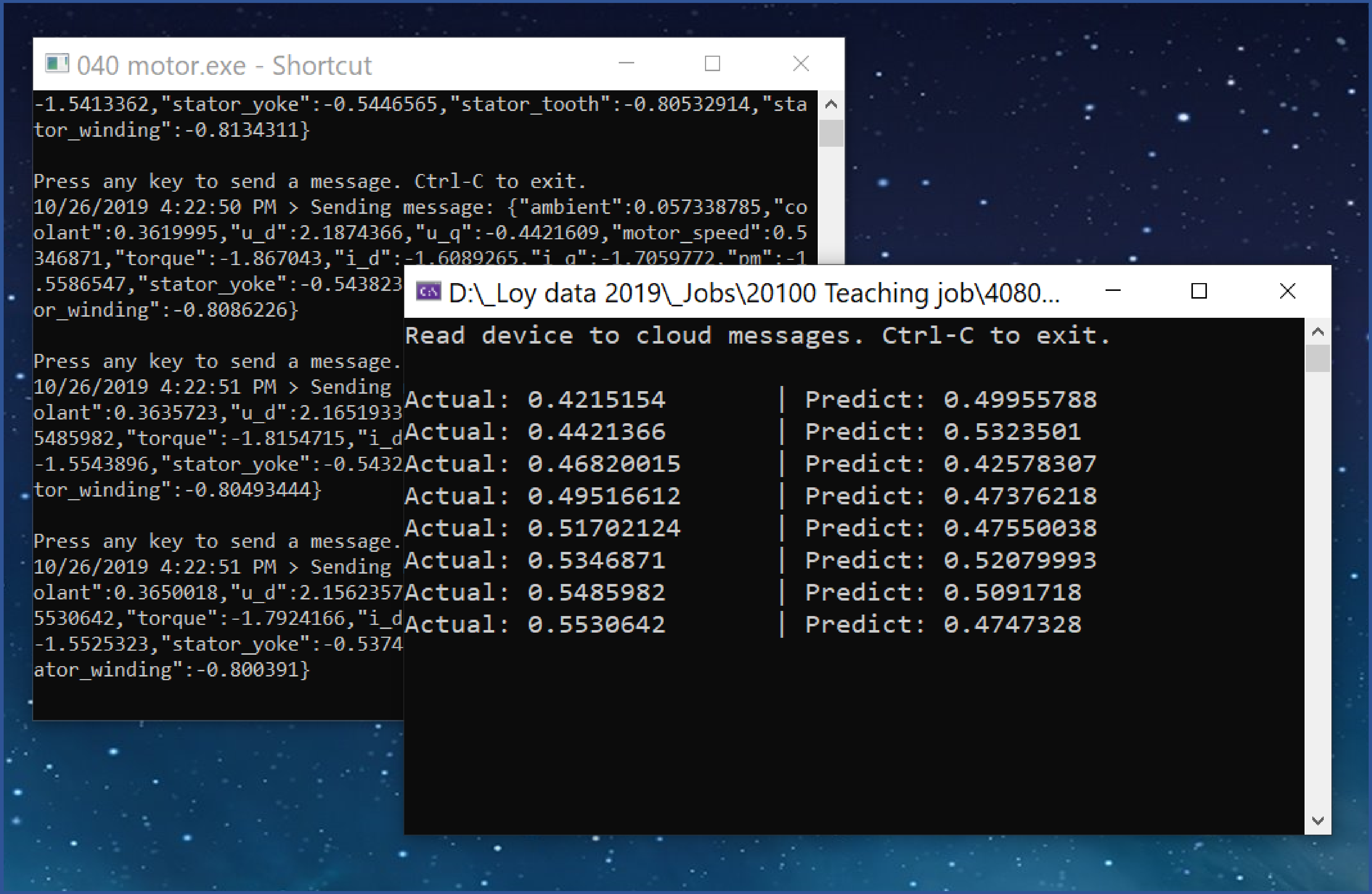
```csharp
private static async Task GetD2CMessage(
    string partition, CancellationToken ct)
{
    var eventHubReceiver = s_eventHubClient.CreateReceiver(
        "$Default",
        partition,
        EventPosition.FromEnqueuedTime(DateTime.Now));
    while (true)
    {
        if (ct.IsCancellationRequested) break;
        var events = await eventHubReceiver.ReceiveAsync(100);
        if (events == null) continue;
        foreach (EventData eventData in events)
        {
            string s = Encoding.UTF8.GetString(eventData.Body.Array);
            Motor m = new Motor();
            m = JsonConvert.DeserializeObject<Motor>(s);
            GetPrediction(m);
        }
    }
}
```

Add code to Main



```
private static async Task Main(string[] args)
{
    mlModel = mlContext.Model.Load(modelPath, out var modelInputSchema);
    Console.WriteLine(
        "Read device to cloud messages. Ctrl-C to exit.\n");
    var connectionString = new EventHubsConnectionStringBuilder(
        new Uri(s_eventHubsCompatibleEndpoint),
        s_eventHubsCompatiblePath,
        s_iotHubSasKeyName,
        s_iotHubSasKey);
    s_eventHubClient = EventHubClient.CreateFromConnectionString(
        connectionString.ToString());
    var runtimeInfo =
        await s_eventHubClient.GetRuntimeInformationAsync();
    var d2cPartitions = runtimeInfo.PartitionIds;
    CancellationTokenSource cts = new CancellationTokenSource();
    Console.CancelKeyPress += (s, e) =>
    {
        e.Cancel = true;
        cts.Cancel();
        Console.WriteLine("Exiting...");
    };
    var tasks = new List<Task>();
    foreach (string partition in d2cPartitions)
    {
        tasks.Add(GetD2CMessage(partition, cts.Token));
    }
    Task.WaitAll(tasks.ToArray());
}
```

Run program and verify the result



```
-1.5413362,"stator_yoke":-0.5446565,"stator_tooth":-0.80532914,"sta
tor_winding":-0.8134311}

Press any key to send a message. Ctrl-C to exit.
10/26/2019 4:22:50 PM > Sending message: {"ambient":0.057338785,"co
olant":0.3619995,"u_d":2.1874366,"u_q":-0.4421609,"motor_speed":0.5
346871,"torque":-1.867043,"i_d":-1.6089265,"i_q":-1.7059772,"pm":-1
.5586547,"stator_yoke":-0.543823
or_winding":-0.8086226}

Press any key to send a message.
10/26/2019 4:22:51 PM > Sending
olant":0.3635723,"u_d":2.1651933
5485982,"torque":-1.8154715,"i_d
-1.5543896,"stator_yoke":-0.5432
tor_winding":-0.80493444}

Press any key to send a message.
10/26/2019 4:22:51 PM > Sending
olant":0.3650018,"u_d":2.1562357
5530642,"torque":-1.7924166,"i_d
-1.5525323,"stator_yoke":-0.5374
ator_winding":-0.800391}
```

```
Read device to cloud messages. Ctrl-C to exit.

Actual: 0.4215154        | Predict: 0.49955788
Actual: 0.4421366        | Predict: 0.5323501
Actual: 0.46820015       | Predict: 0.42578307
Actual: 0.49516612       | Predict: 0.47376218
Actual: 0.51702124       | Predict: 0.47550038
Actual: 0.5346871        | Predict: 0.52079993
Actual: 0.5485982        | Predict: 0.5091718
Actual: 0.5530642        | Predict: 0.4747328
```

What's next?