

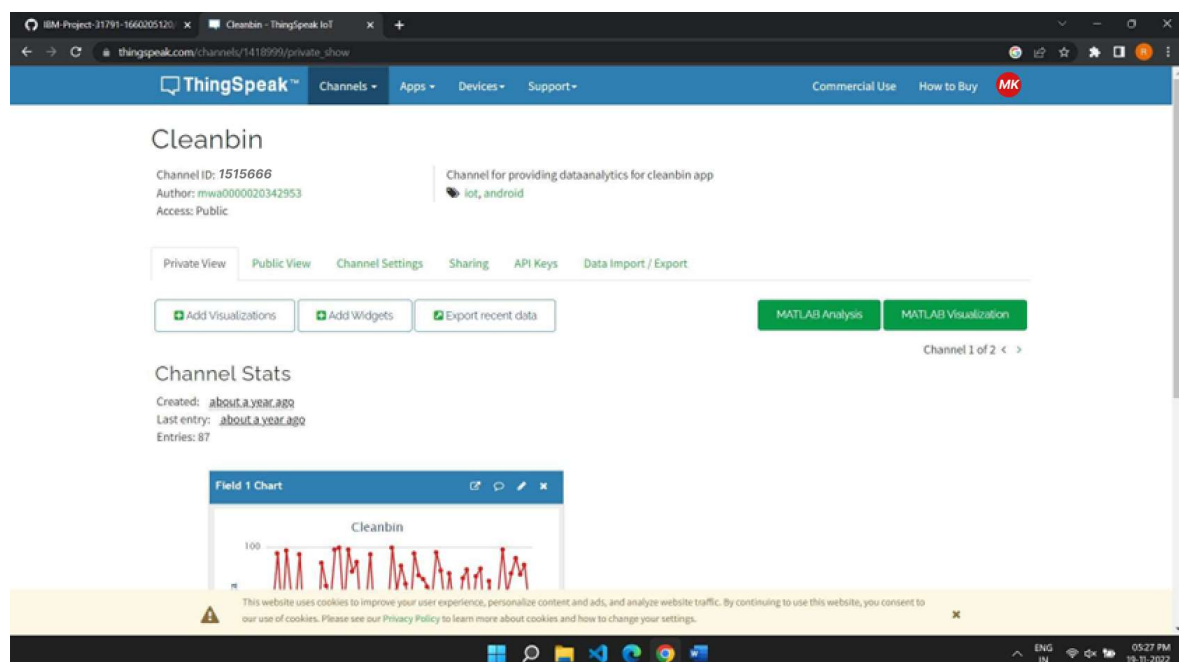
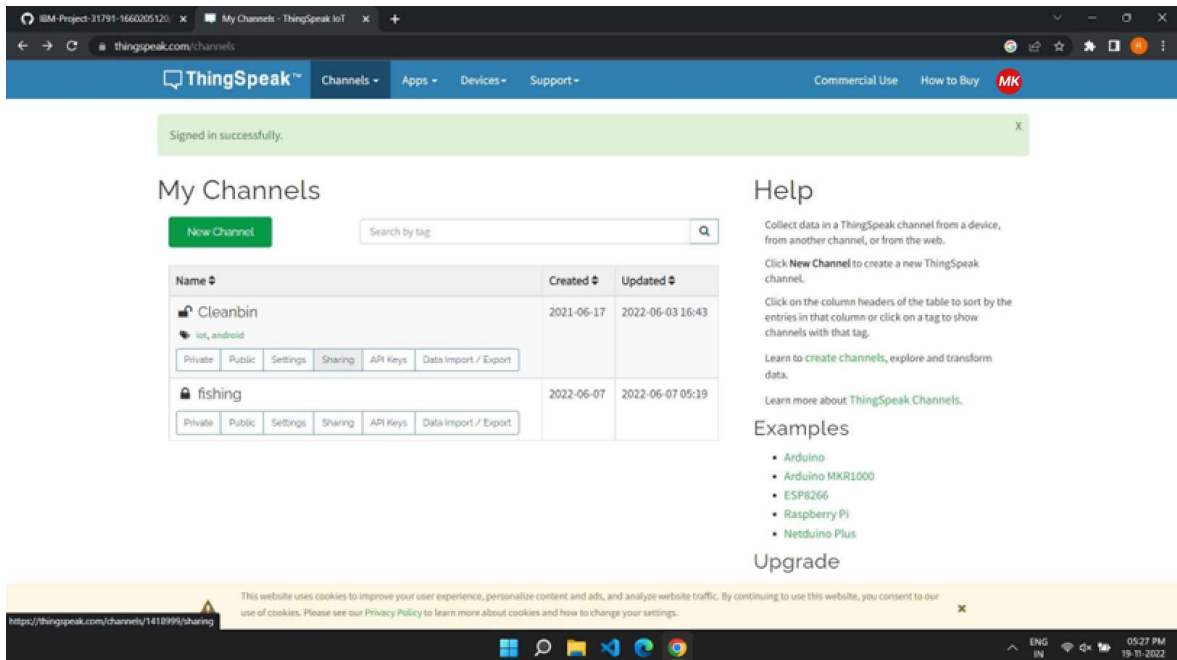
## SPRINT 3

Team ID	PNT2022TMID47771
Project Name	Smart Waste Management System for Metropolitan Cities

As an extra innovative functionality we have decided to implement a feature that will forecast the level of the bin that is expected to be filled in the next hour.

Since **Stream Analytics in IBM** has been **deprecated** and stream analytics is not available for (Lite / Student) plans in **IBM Watson IoT** we have used a free streaming platform **ThingSpeak**.

The data from the SmartBin is sent to the ThingSpeak server. We have created a channel for it.



We have also sent some data to the channel and tested it.

We have deployed a MATLAB code in the ThingSpeak channel which performs a Time Series analysis on the stream data in the channel.

The code has been attached in the directory.

The screenshot shows the ThingSpeak MATLAB Analysis interface for a channel named 'ibm'. The MATLAB code is as follows:

```
1 import matlab.net.*
2 import matlab.net.http.*
3 [X,T] = thingspeakRead(1418999,'Fields',[1],'NumPoints',85)
4
5 T=round2cell(X');
6 trainFcn = 'trainlm';
7 feedbackDelays = 1:10;
8 hiddenLayerSize = 10;
9 net = narnet(feedbackDelays,hiddenLayerSize,'open',trainFcn);
10
11 [x,xi,ai,t] = preparets(net,[],[],T);
12
13 net.divideParam.trainRatio = 70/100;
14 net.divideParam.valRatio = 15/100;
15 net.divideParam.testRatio = 15/100;
16 net.trainParam.showWindow = 0;
17
18 [net,tr] = train(net,x,t,xi,ai);
19
20
21 y = net(x,xi,ai);
22 e = gsubtract(t,y);
23 performance = perform(net,t,y);
24
```

The right sidebar shows the channel details for 'ibm':

- Name: fishing
- Channel ID: 1760335
- Access: Private
- Read API Key: TVNtK8YyQa7XLU9U
- Write API Key: 9SV75UAIE9GA12AG
- Fields: 1: dist

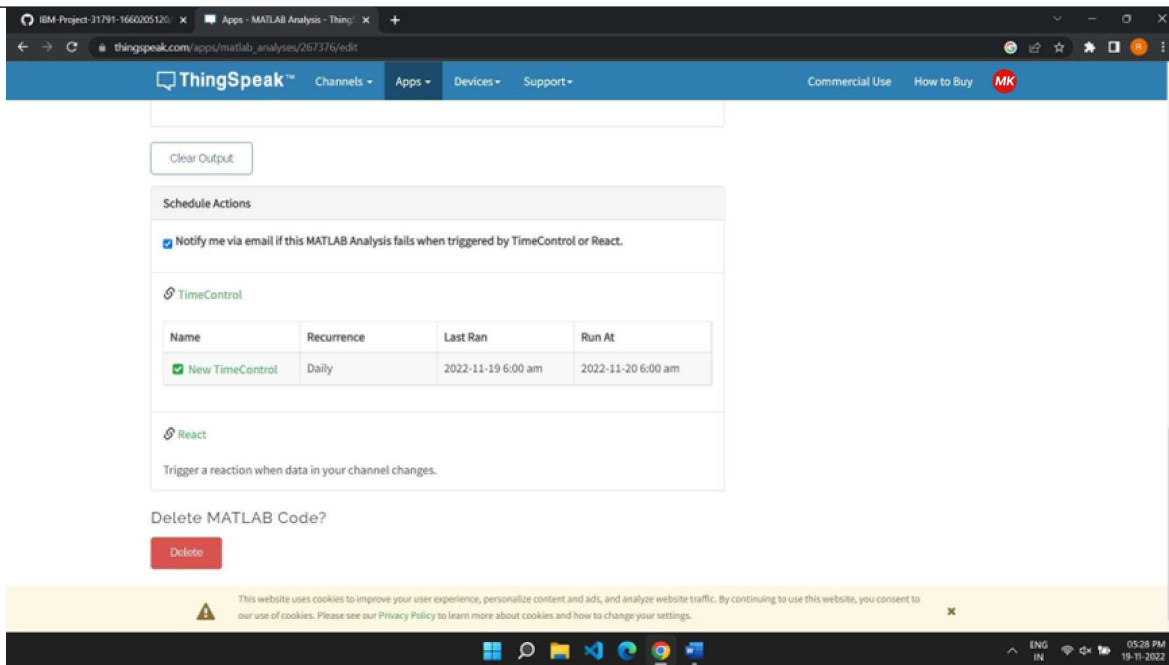
The screenshot shows the ThingSpeak MATLAB Analysis interface for a channel named 'ibm'. The MATLAB code is as follows:

```
17 [net,tr] = train(net,x,t,xi,ai);
18
19
20
21 y = net(x,xi,ai);
22 e = gsubtract(t,y);
23 performance = perform(net,t,y);
24
25 nets = removedelay(net);
26 nets.name = [net.name ' - Predict One Step Ahead'];
27
28 [xs,xis,ais,ts] = preparets(nets,[],[],T);
29 ys = nets(xs,xis,ais);
30 stepAheadPerformance = perform(nets,ts,ys);
31 b = stepAheadPerformance / 10^floor(log10(stepAheadPerformance))
32 var=b;
33
34
35 r = RequestMessage;
36 str1='https://node-red-xtmf-2022-10-10.eu-gb.mybluemix.net/updateforecast?val='
37 str2=string(var)
38 str=append(str1,str2)
39 uri = URI(str);
40 resp = send(r,uri);
41 status = resp.StatusCode
42
```

The right sidebar shows the channel details for 'ibm':

- Read API Key: 441V3CP2ZF161RA
- Write API Key: 8Q80H81N2828Y78
- Fields: 1: data

The MATLAB analysis has been scheduled to run in frequent intervals of time (similar to a CRON JOB in UNIX), thus forecasting the level of waste in the bin.



**The details of the algorithm are,**

**ALGORITHM USED:** Time Series prediction algorithm using Deep Learning Neural networks

**Neural Network used:** Non-Linear Auto-regressive Neural Network

We have trained a nonlinear autoregressive (NAR) neural network and predicted new time series data. Predicting a sequence of values in a time series is also known as a *multistep prediction*. Closed-loop networks can perform multistep predictions. When external feedback is missing, closed-loop networks can continue to predict by using internal feedback. In NAR prediction, the future values of a time series are predicted only from the past values of that series.

Training Data: 70 % Testing Data: 15 % Validation Data: 15 %

Diagrammatic representation of the neural network :

