H2O Machine Learning & Deep Learning London Workshop

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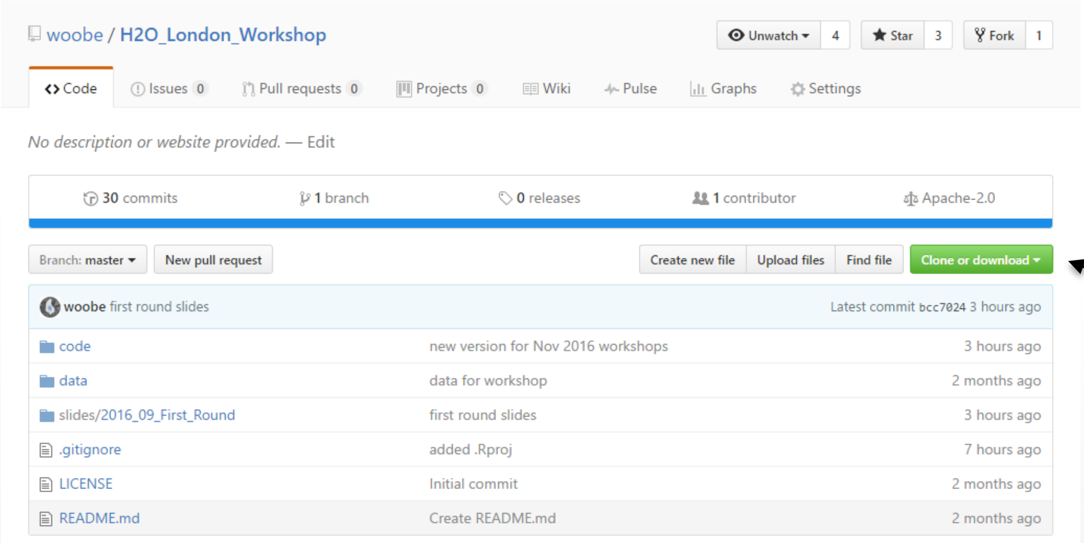
Data Science for IoT Meetup
Barclays Eagle Venture Labs
21st & 24th November, 2016

Download Data & Code for Workshop

- Please go to

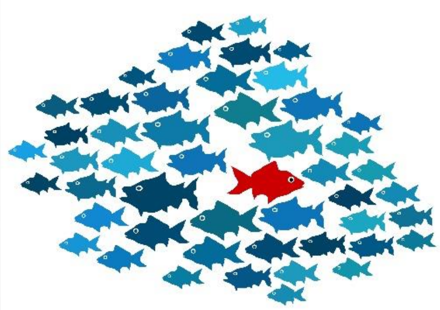
bit.ly/h2o_iot_workshop1



Example 2:
Anomaly Detection

Anomaly (Outlier) Detection

- Definition
  - Identification of items, events or observations which do not conform to an expected pattern or other items in a dataset.



- Use Cases
  - Bank Fraud
  - Monitoring Manufacturing Lines
  - Machine Learning
    - Separate dataset and build different models

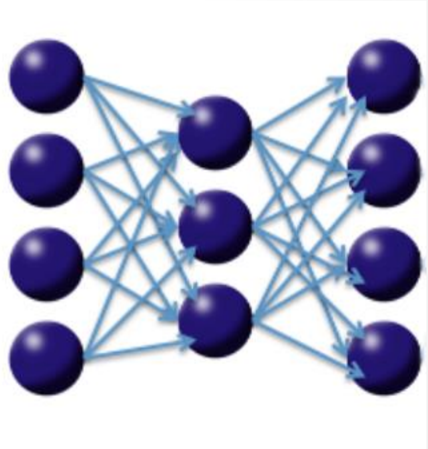
Photo credit: www.dbta.com

Deep Autoencoder for Anomaly Detection

- Consider the following three-layer neural network with one hidden layer and the same number of input neurons (features) as output neurons.

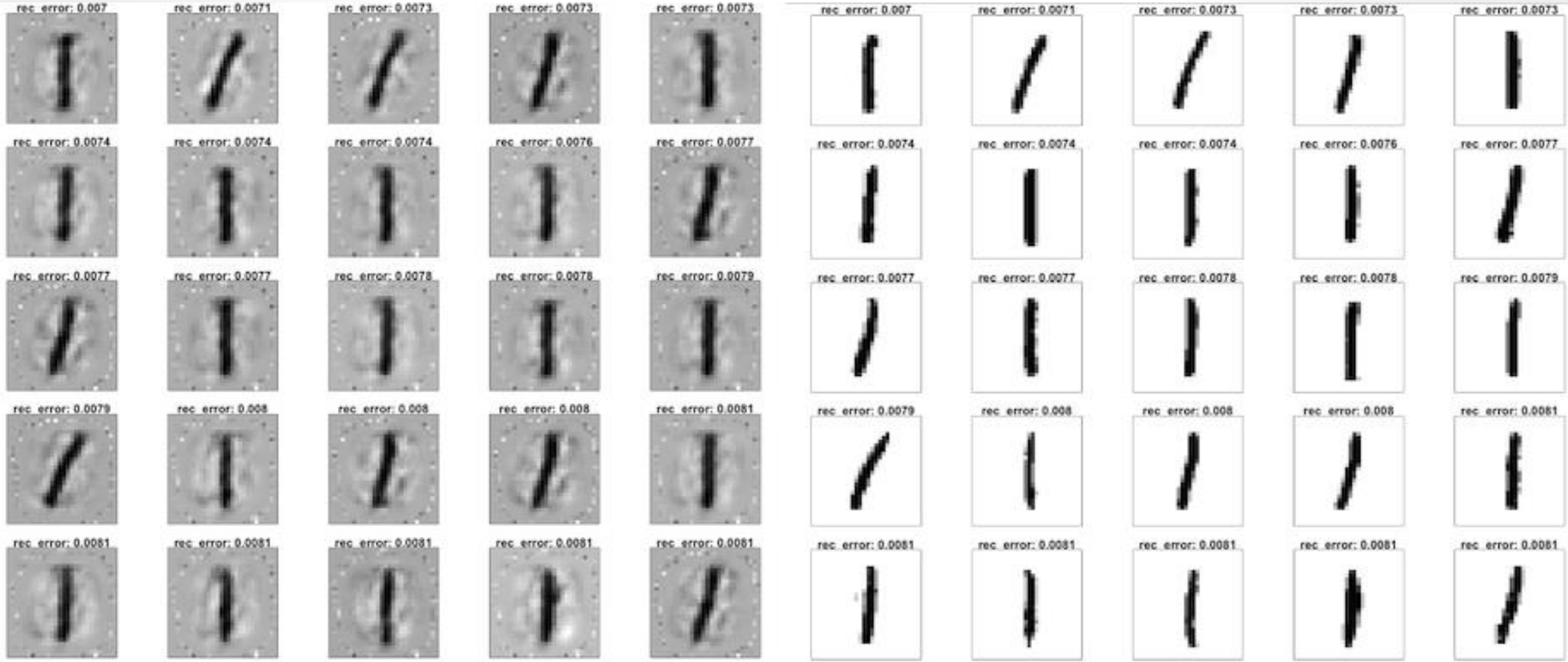
- The loss function is the mean squared error (MSE) between the input and the output. Hence, the network is forced to learn the identity via a nonlinear, reduced representation of the original data.
  - e.g. High MSE = potential outliers

- Such an algorithm is called a **deep autoencoder**.



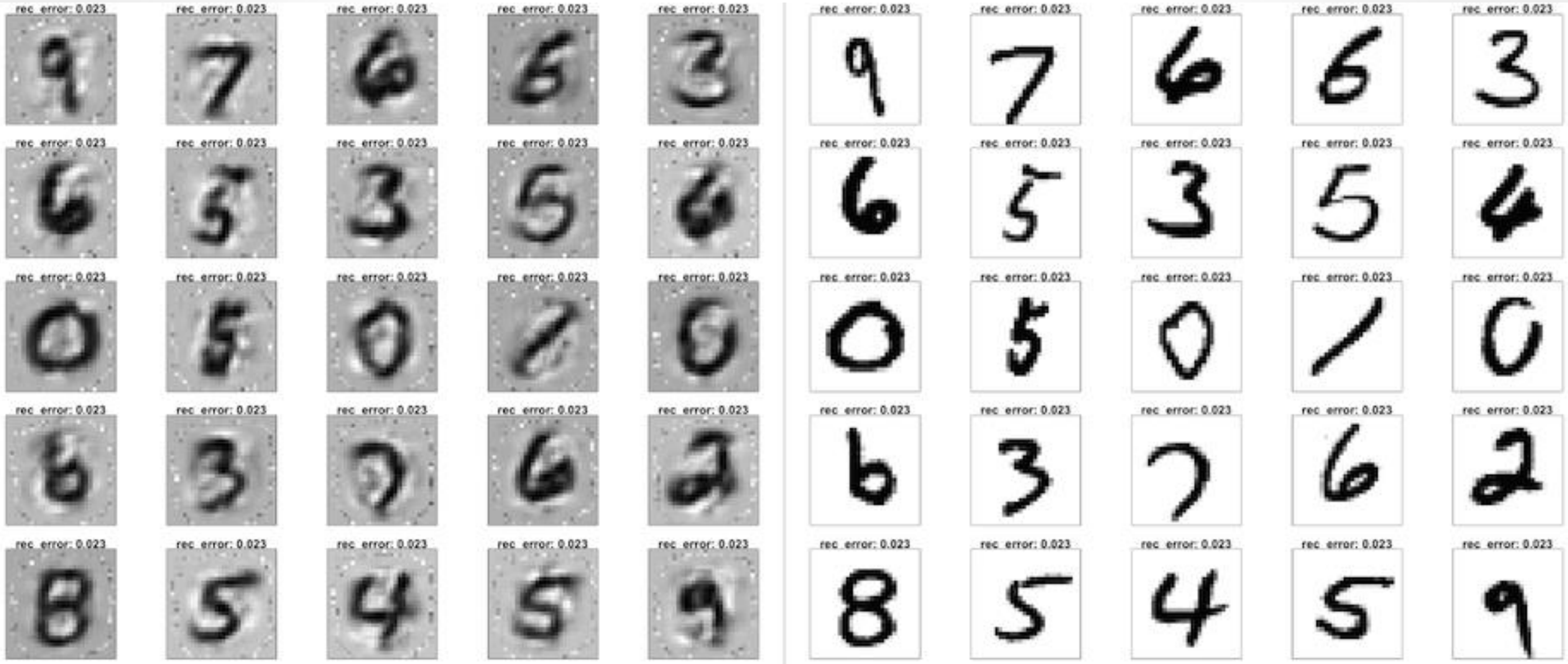
https://github.com/h2oai/h2o-training-book/blob/master/hands-on_training/anomaly_detection.md

MNIST Example – The Good Ones



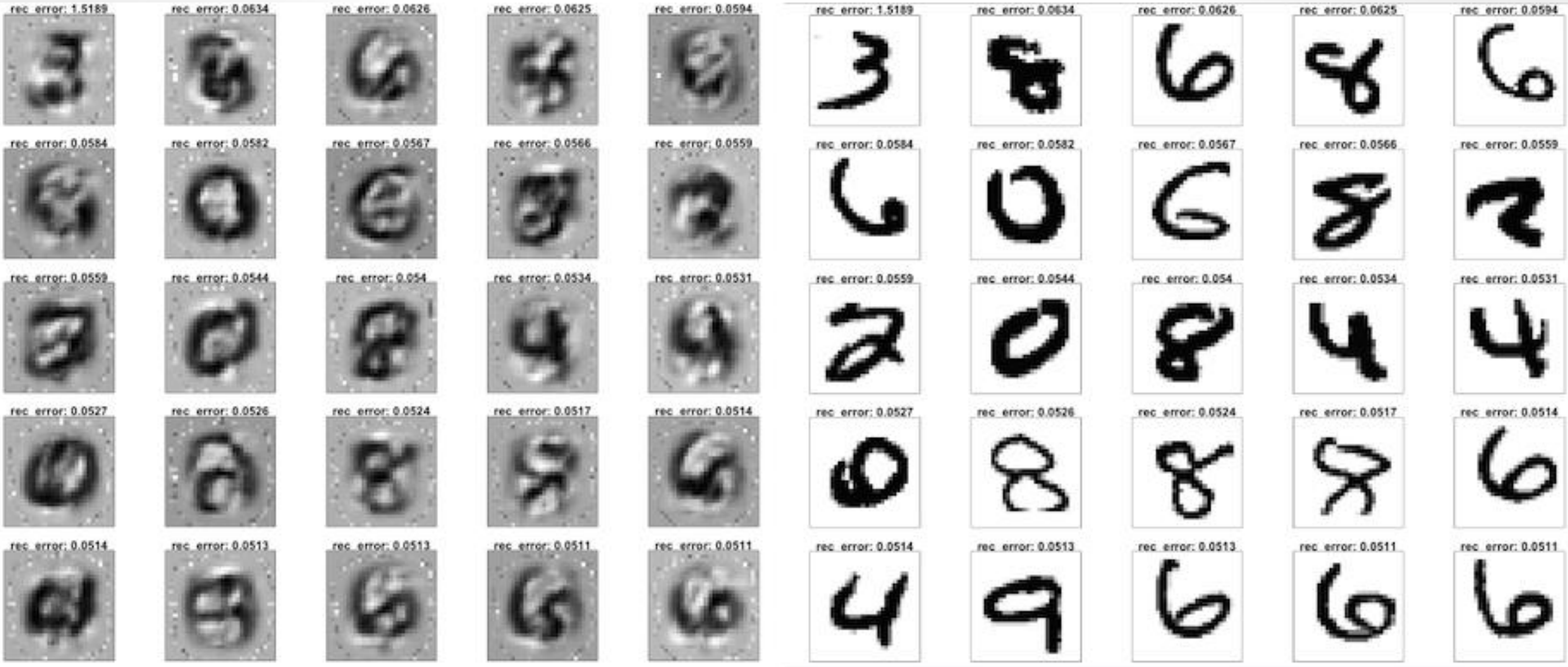
Samples with Low Mean Squared Error (MSE)

MNIST Example – The Bad Ones



Samples with High Mean Squared Error (MSE)

MNIST Example – The Ugly Ones



Samples with Highest Mean Squared Error (MSE)

use_case_2_anomaly_detection.R

```r
# -----------------------------------------------------------
# Step 8: Using Deep Learning for Anomaly Detection
# -----------------------------------------------------------

# Start and connect to a local H2O cluster
library(h2o)
h2o.init(nthreads = -1)

# Import data from a local CSV file
mtcar <- read.csv("./data/auto_design.csv")
mtcar$gear <- as.factor(mtcar$gear)
mtcar$carb <- as.factor(mtcar$carb)
mtcar$cyl  <- as.factor(mtcar$cyl)
mtcar$vs   <- as.factor(mtcar$vs)
mtcar$am   <- as.factor(mtcar$am)
mtcar$ID   <- 1:nrow(mtcar)

# Print it out
print(mtcar)

# Convert R data frame into H2O data frame
h2o_mtcar  <- as.h2o(mtcar)
```

```
> print(mtcar)
                     X  mpg cyl  disp   hp   drat      wt    qsec vs am gear carb ID
1            Mazda RX4 21.0   6 160.0  110   3.90   2.620   16.46  0  1    4    4  1
2        Mazda RX4 Wag 21.0   6 160.0  110   3.90   2.875   17.02  0  1    4    4  2
3           Datsun 710 22.8   4 108.0   93   3.85   2.320   18.61  1  1    4    1  3
4       Hornet 4 Drive 21.4   6 258.0  110   3.08   3.215   19.44  1  0    3    1  4
5    Hornet Sportabout 18.7   8 360.0  175   3.15   3.440   17.02  0  0    3    2  5
6              Valiant 18.1   6 225.0  105   2.76   3.460   20.22  1  0    3    1  6
7           Duster 360 14.3   8 360.0  245   3.21   3.570   15.84  0  0    3    4  7
8            Merc 240D 24.4   4 146.7   62   3.69   3.190   20.00  1  0    4    2  8
9             Merc 230 22.8   4 140.8   95   3.92   3.150   22.90  1  0    4    2  9
10            Merc 280 19.2   6 167.6  123   3.92   3.440   18.30  1  0    4    4 10
11           Merc 280C 17.8   6 167.6  210 800.00 900.000 1000.00  1  0    4    4 11
12          Merc 450SE 16.4   8 275.8  180   3.07   4.070   17.40  0  0    3    3 12
13          Merc 450SL 17.3   8 275.8  180   3.07   3.730   17.60  0  0    3    3 13
14         Merc 450SLC 15.2   8 275.8  180   3.07   3.780   18.00  0  0    3    3 14
15  Cadillac Fleetwood 10.4   8 472.0  205   2.93   5.250   17.98  0  0    3    4 15
16 Lincoln Continental 10.4   8 460.0  215   3.00   5.424   17.82  0  0    3    4 16
17   Chrysler Imperial 14.7   8 440.0  230   3.23   5.345   17.42  0  0    3    4 17
18            Fiat 128 32.4   4 780.0 2100 400.00 200.000  700.00  1  1    4    1 18
19         Honda Civic 80.4  10  75.7  100   4.93   1.615  150.52  1  1    4    2 19
20      Toyota Corolla 33.9   4  71.1   65   4.22   1.835   19.90  1  1    4    1 20
21       Toyota Corona 21.5   4 120.1   97   3.70   2.465   20.01  1  0    3    1 21
22    Dodge Challenger 15.5   8 318.0  150   2.76   3.520   16.87  0  0    3    2 22
23         AMC Javelin 15.2   8 304.0  150   3.15   3.435   17.30  0  0    3    2 23
24          Camaro Z28 13.3   8 350.0  245   3.73   3.840   15.41  0  0    3    4 24
25    Pontiac Firebird 19.2   8 400.0  175   3.08   3.845   17.05  0  0    3    2 25
26           Fiat X1-9 27.3   4  79.0   66   4.08   1.935   18.90  1  1    4    1 26
27       Porsche 914-2 26.0   4 120.3   91   4.43   2.140   16.70  0  1    5    2 27
28        Lotus Europa 30.4   4  95.1  113   3.77   1.513   16.90  1  1    5    2 28
29      Ford Pantera L 15.8   8 351.0  264   4.22   3.170   14.50  0  1    5    4 29
30        Ferrari Dino 19.7   6 900.0  700   3.62 200.770  150.50  0  1    5    6 30
31       Maserati Bora 15.0   8 301.0  335   3.54   3.570   14.60  0  1    5    8 31
32          Volvo 142E 21.4   4 121.0  109   4.11   2.780   18.60  1  1    4    2 32
```

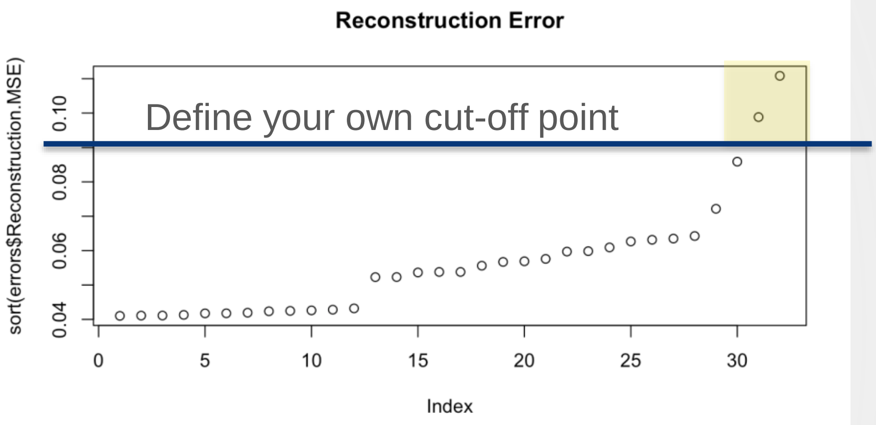
use_case_2_anomaly_detection.R

Build a Deep Autoencoder

```r
# ---------------------------------------------------------------------------
# Training an unsupervised deep neural network with autoencoder
# ---------------------------------------------------------------------------

# Use a bigger DNN
model <- h2o.deeplearning(x = 1:10,
                          training_frame = h2o_mtcar,
                          autoencoder = TRUE,
                          activation = "RectifierWithDropout",
                          hidden = c(50, 50, 50),
                          epochs = 100)

# Calculate reconstruction errors (MSE)
errors <- h2o.anomaly(model, h2o_mtcar, per_feature = FALSE)
print(errors)
errors <- as.data.frame(errors)

# Plot
plot(sort(errors$Reconstruction.MSE), main = "Reconstruction Error")

# Outliers (define 0.09 as the cut-off point)
row_outliers <- which(errors > 0.09) # based on plot above
mtcar[row_outliers,]
```

Look at the MSE

Define cut-off




```
> row_outliers <- which(errors > 0.09) # based on plot above
> mtcar[row_outliers,]
           X  mpg cyl  disp   hp drat  wt qsec vs am gear carb ID
11 Merc 280C 17.8   6 167.6  210  800 900 1000  1  0    4    4 11
18  Fiat 128 32.4   4 780.0 2100  400 200  700  1  1    4    1 18
```

Outliers identified

Thanks!

- Organisers & Contributors
  - Ajit Jaokar
  - Sibanjan Das
- Key Resources
  - docs.h2o.ai
  - github.com/h2oai/h2o-meetups
- Slides & Code
  - bit.ly/h2o_iot_workshop1
- Contact
  - joe@h2o.ai
  - @matlabulous
  - github.com/woobe