Unsupervised Machine Learning Models to Predict Anomalous Data Quality Periods

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Problem Statement

- ARM produces a large amount of data (>1PB).
  - More than can be looked at by hand
- ARM data quality is a key priority
- Machine learning is a promising approach to tackle the problem
- Supervised machine learning has challenges with training data for detecting instrument malfunctions.
- Unsupervised learning potentially sidesteps this problem.
  - Exploit statistical relations between parameters in the data.

- This talk will discuss our recently proposed approach to address data quality using machine learning.

Machine Learning

- Machine learning :
  - solve problems by analyzing data without explicitly programming in solutions – often referred to as learning from the data
- Broadly split into 2 categories (Supervised and Unsupervised):
- Supervised learning fits a model to relate input data, to labeled output data
  - Given y, x, fit y=f(x)
  - This requires creating a labeled training set relating the input and the outputs.
  - This can be very expensive and time consuming.
- Unsupervised learning
  - Fit y=f(x) given only x.

Unsupervised Machine Learning

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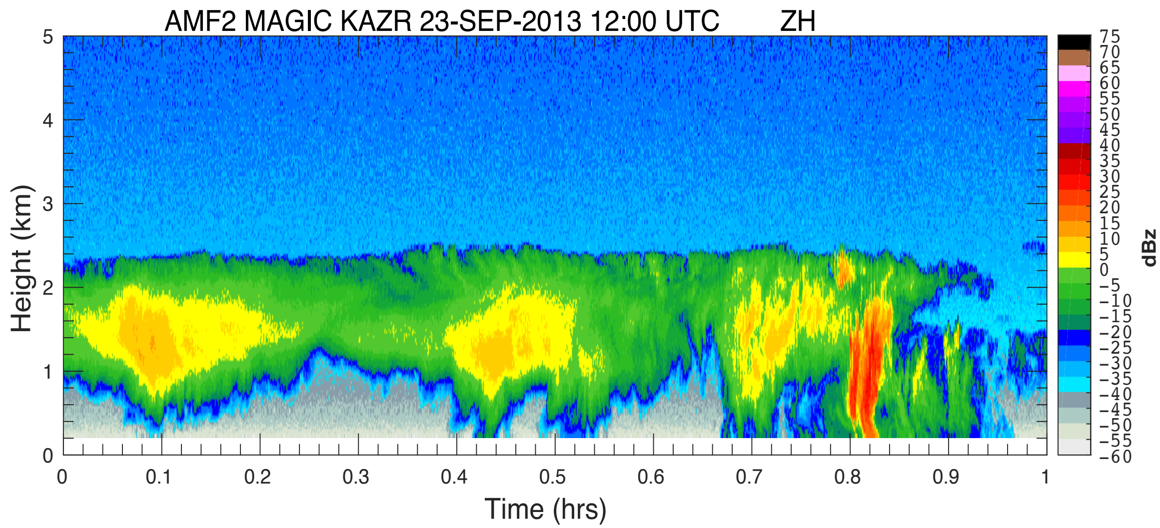
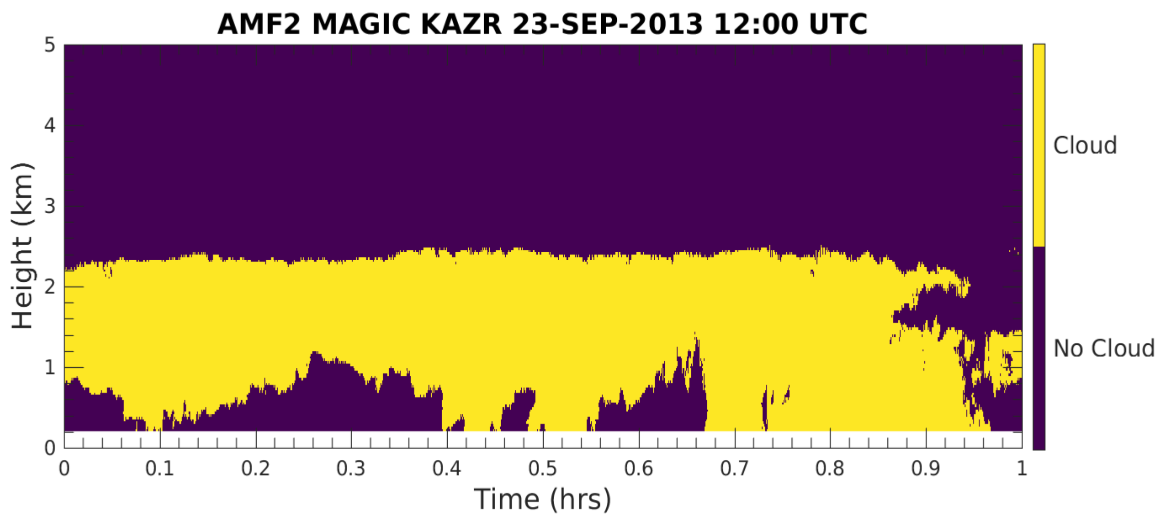
- We plan to utilize a variation on unsupervised clustering.
- Break data up into N statistically different groups
  - Not predefined, but data driven
- Clusters represent statistical modes of operational returns.
- Use in cluster fits to detect anomalies.

- One of the largest challenges in unsupervised clustering:
  - You can’t force certain clusters.
  - You can always find N clusters. Doesn’t mean they are statistically independent.

AMF2 MAGIC KAZR Toy Example





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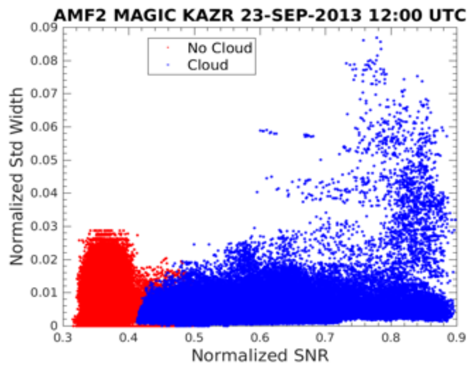

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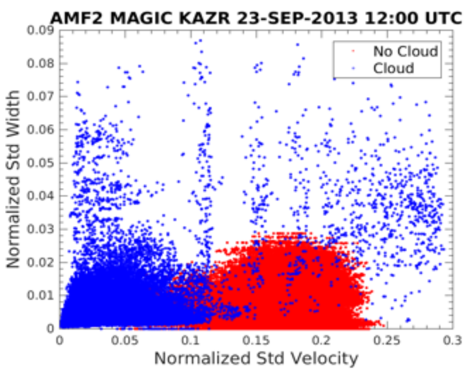

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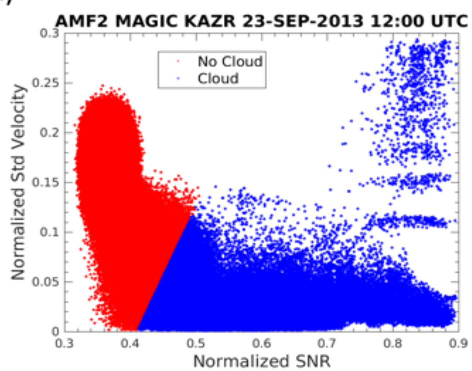

(c)

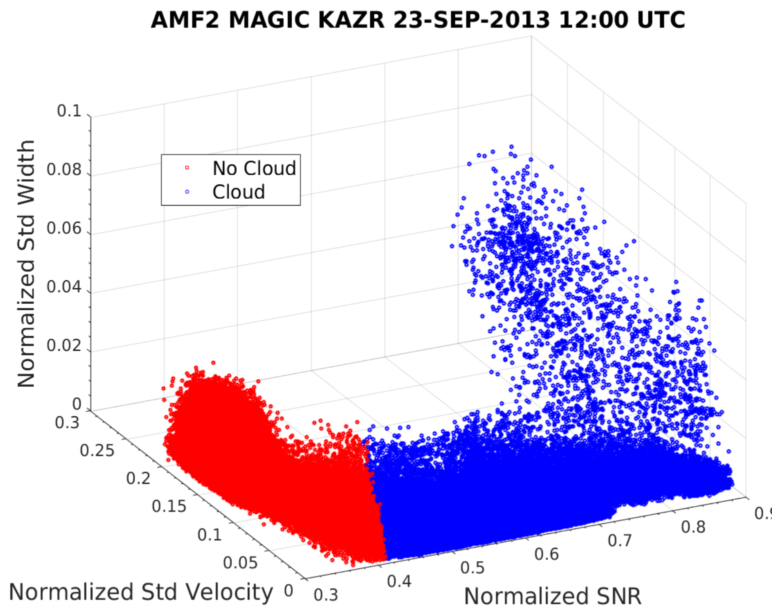

Figure 5: Classification Surface as a function of three input variables.

Proposed Method

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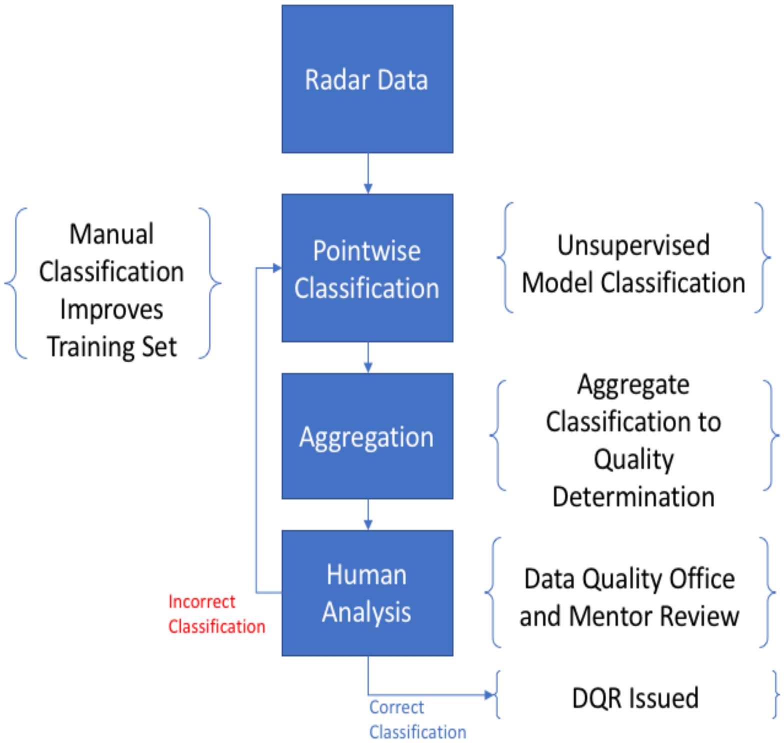
- Unsupervised clustering to detect statistically independent clusters.
  - “typical operating regimes”
- Data Clustering for initial pointwise classification
  - Clustering on a graph/b-matching
- Region based aggregation
  - Convert point estimates into time periods.
- Human-in-loop review to tweak hyper-parameters and verify.
- Envisioned as a way to make data quality review more effective – focus on likely problematic times.
- Test set will use the Oliktok KAZR radar



Timeline

- Interviews for the position have concluded
- *September 2018*: Preliminary implementation completed.
- *December 2018*: Evaluation of performance, and DQ table completed for testing on OLI KAZR. ADI integration if requested.
- *May 2019***:** Work with ARM staff to transition code to infrastructure. Preparation of technical report.

Questions?

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Deliverables

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- The source code required to run the analysis set up on ARM's Stratus system.
- Results of running model on a period of Oliktok KAZR data. This will be in the form of an evaluation dataset released to the ARM ADC.
- A technical report describing and assessing the implemented algorithm.