ACG - New Orleans, LA

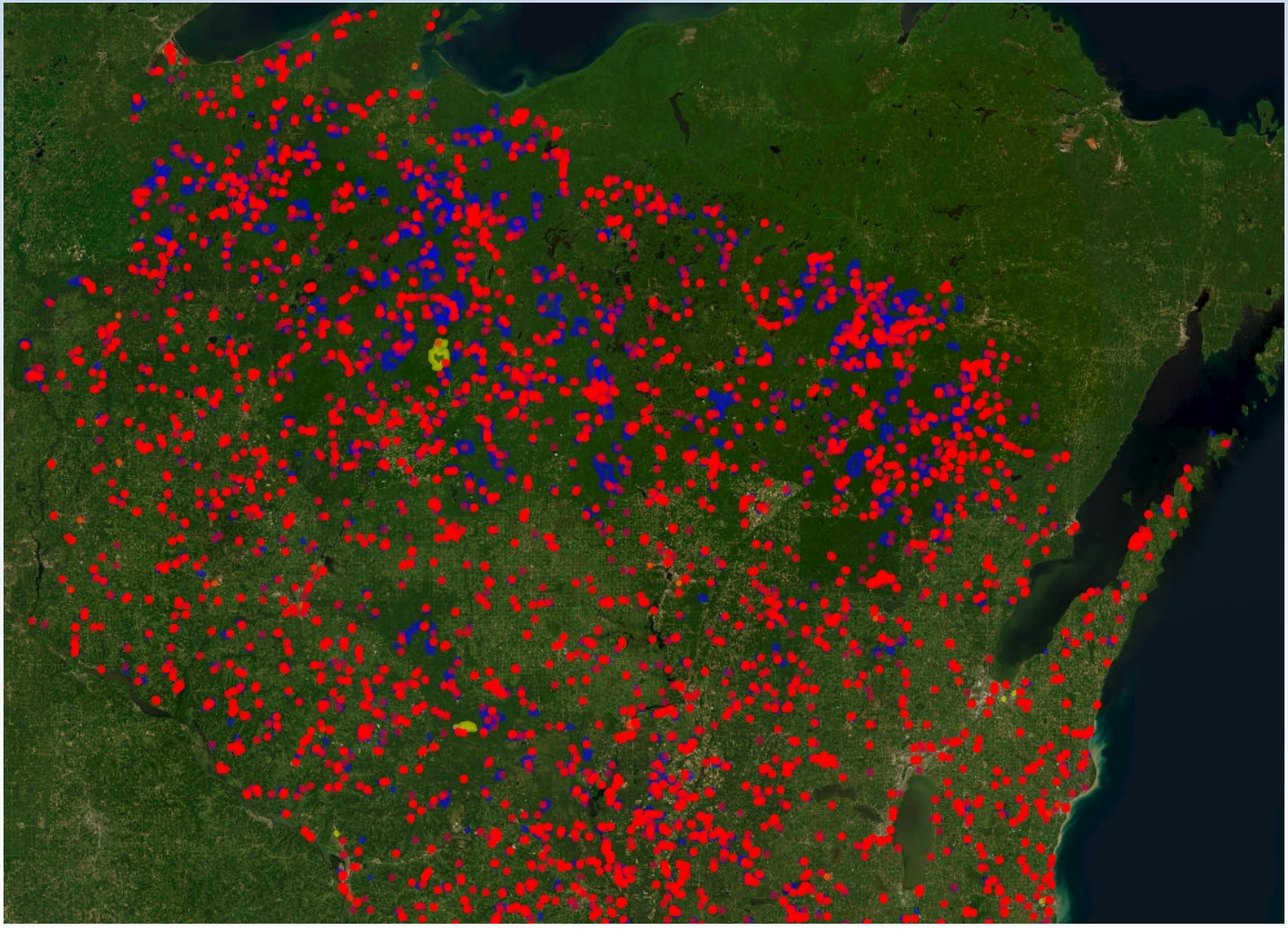
May 8-10, 2023

RFAnalytic

Studies – Machine Learning - Network Development Methods

2020 Census might not be what you think it is

Red dots – 0 population census block
Blue dots – 0 household census blocks

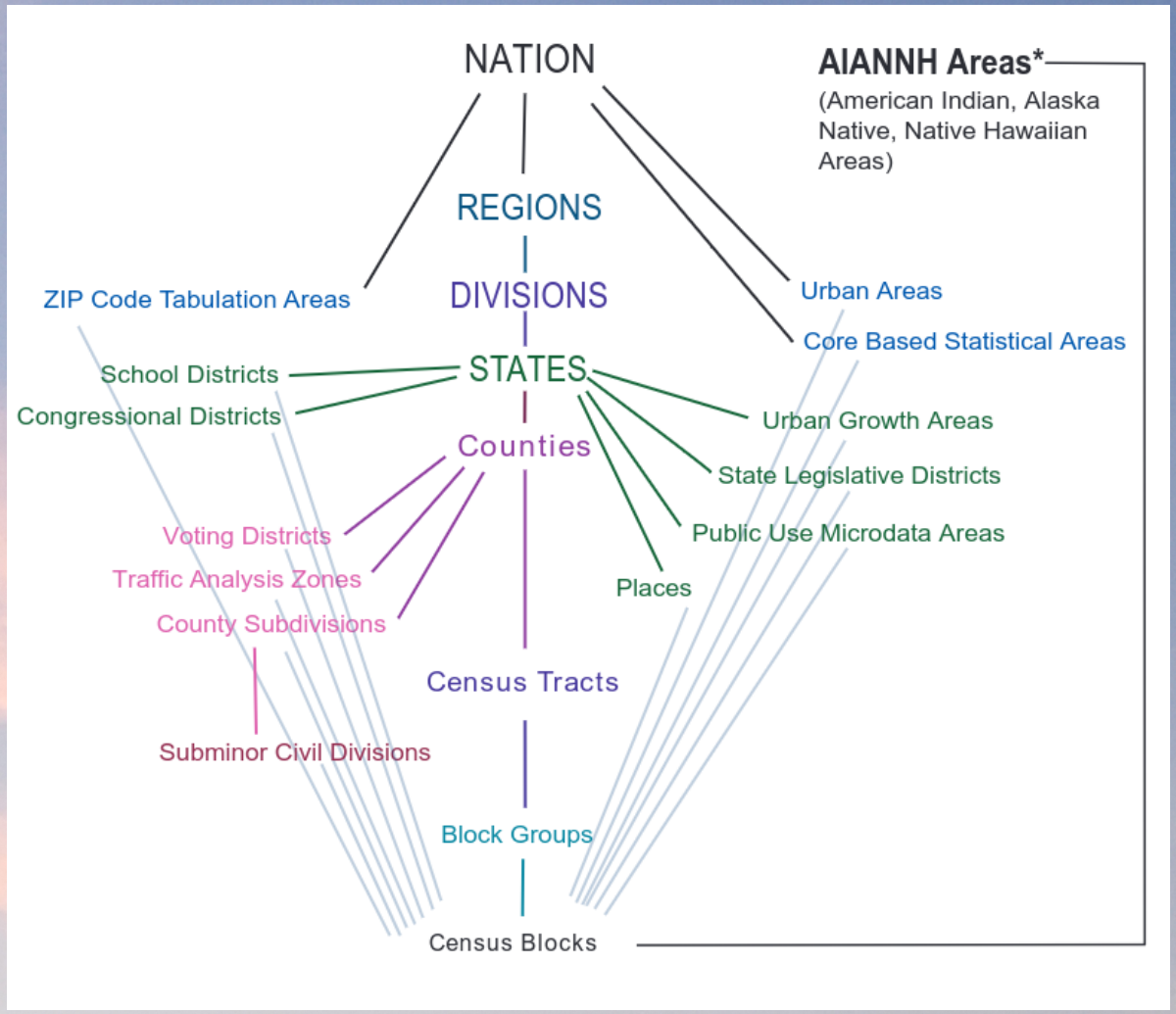


Noisy Data

"Noise" has been added to protect your privacy

The explanation is 3 pages – worth reading

https://www.census.gov/content/dam/Census/library/factsheets/2021/protecting-the-confidentiality-of-the-2020-census-redistricting-data.pdf



https://www2.census.gov/geo/pdfs/reference/geodiagram.pdf

Noisy Data – less useful – still relevant

- It would be desireable to use census block population and household data
  - But... it is not accurate on a small scale (cell coverage)
- Data is still relevant – such as for counting population for license compliance
  - Use to your advantage – avoid the 0’s
- Option – purchase private data
  - 2016 Pitney Bowes study, Census block level from 2010 U.S. Census, updated based on more recent information
  - https://www.fcc.gov/sites/default/files/t-mobile-drive-test-methodology-01082021.pdf
- Use other sources of data correlated to population

Machine Learning for Network Planning

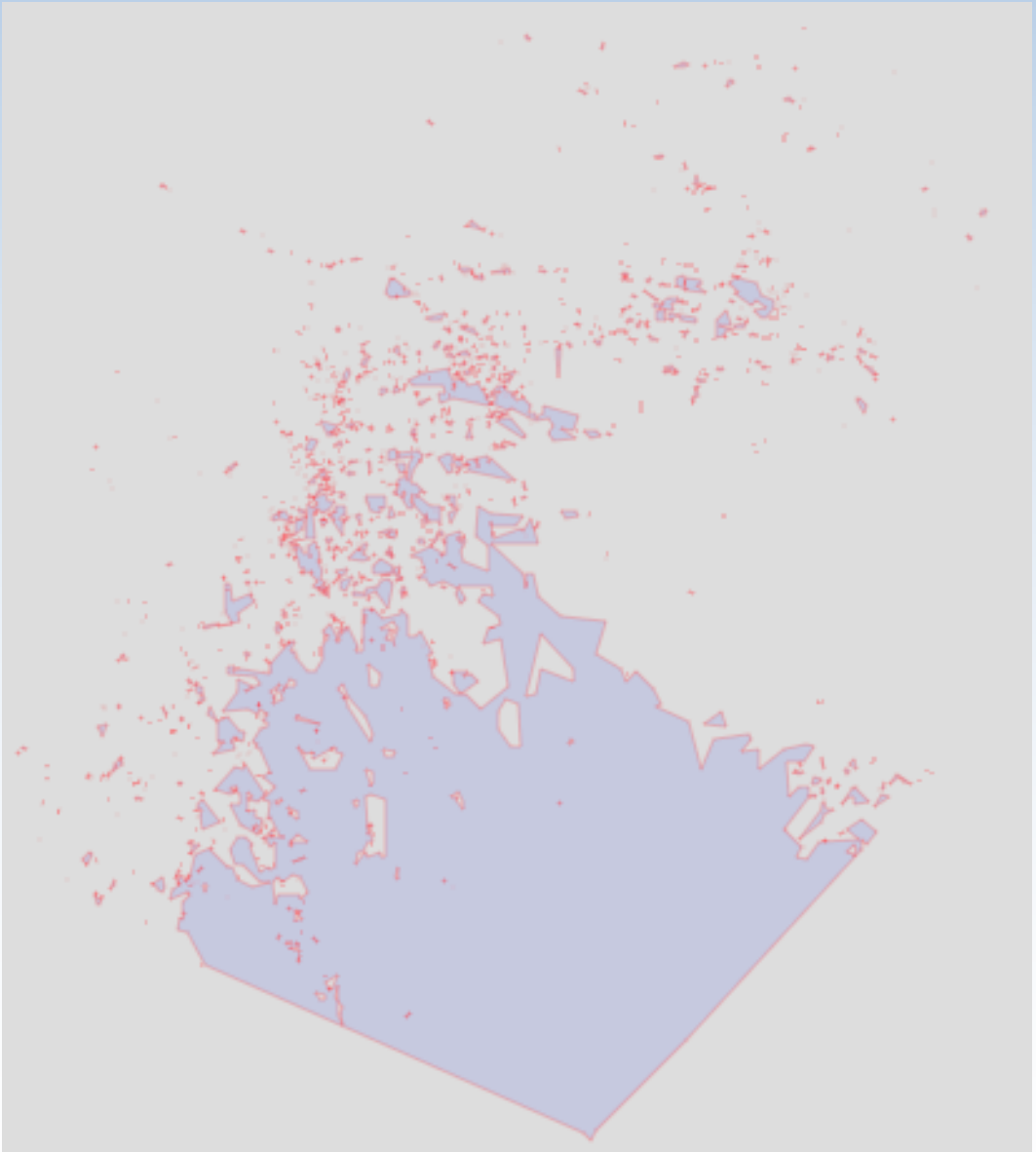
New Machine Learning methods improve decision making

- Find or create “features” from performance data that support machine learning
  - mean up-link path-loss
  - mean CQI values,
  - CQI “0” counts
  - mean Timing Advance distance from tower
  - Bearer drop rates
- Reduce impact of technology specific attributes for site development
- Reduced engineering details – for other groups to review
  - Use radio coverage plots – a different way
- Reinforce decision making from previous methods

RFA

Best Server data is useful

- Area of study restricted
  - Operational coverage
  - Predicted coverage
- Easily explained to nontechnical staff
- Predicted allows – “what if”
  - Especially for modifying a network

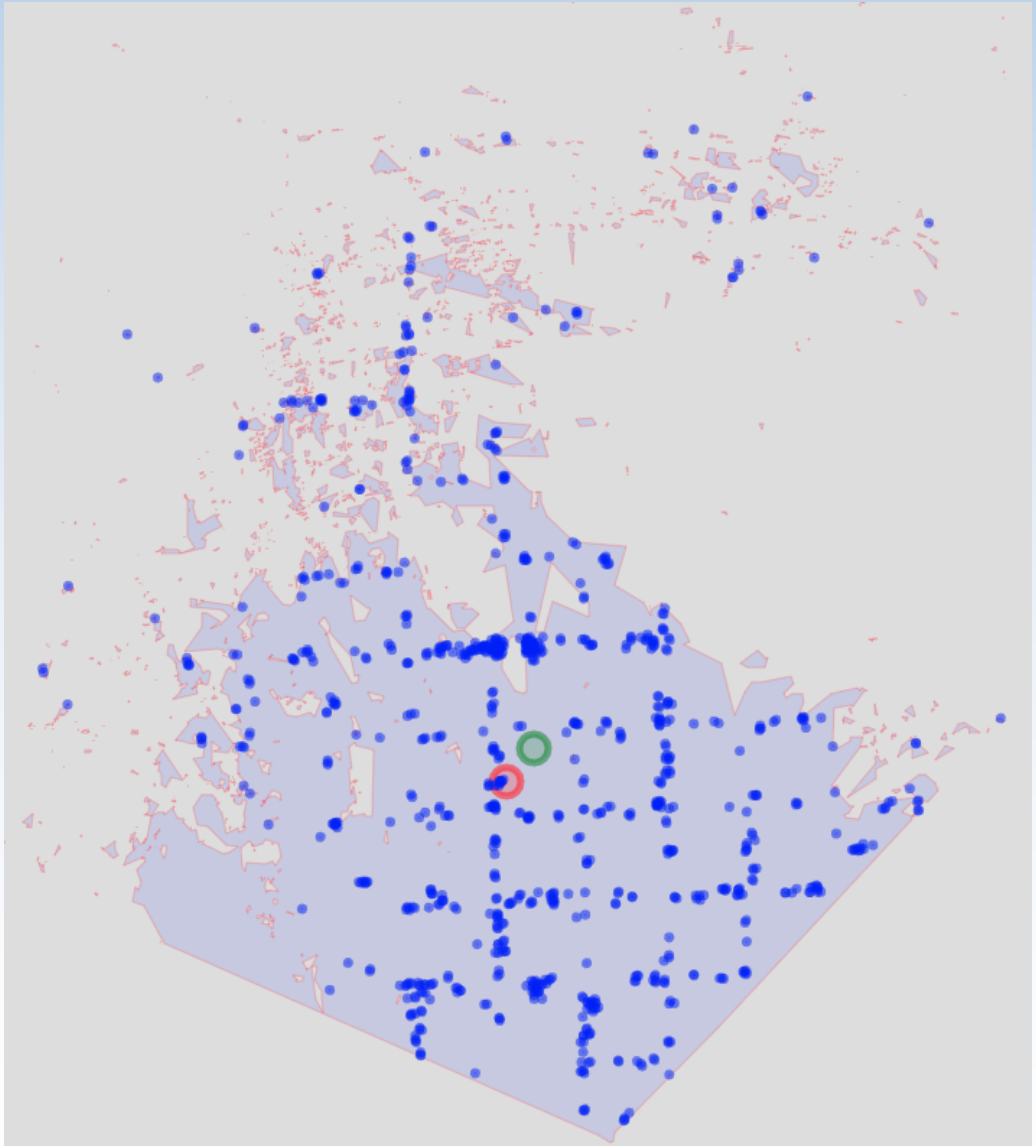


Best Server data is Very useful – with other data

- Small blue dots – rooftops
  - Machine learned from satellite images
- Red circle – centroid of best server area
- Green circle – centroid of rooftops

Reduced to Machine Learning variables

- Take care to curate training data!
  - Cell type / Morphology important
- Area of best server shape
- Number of rooftops
- Mean distance to area centroid (from site)
- Mean distance to rooftop centroid (from site)

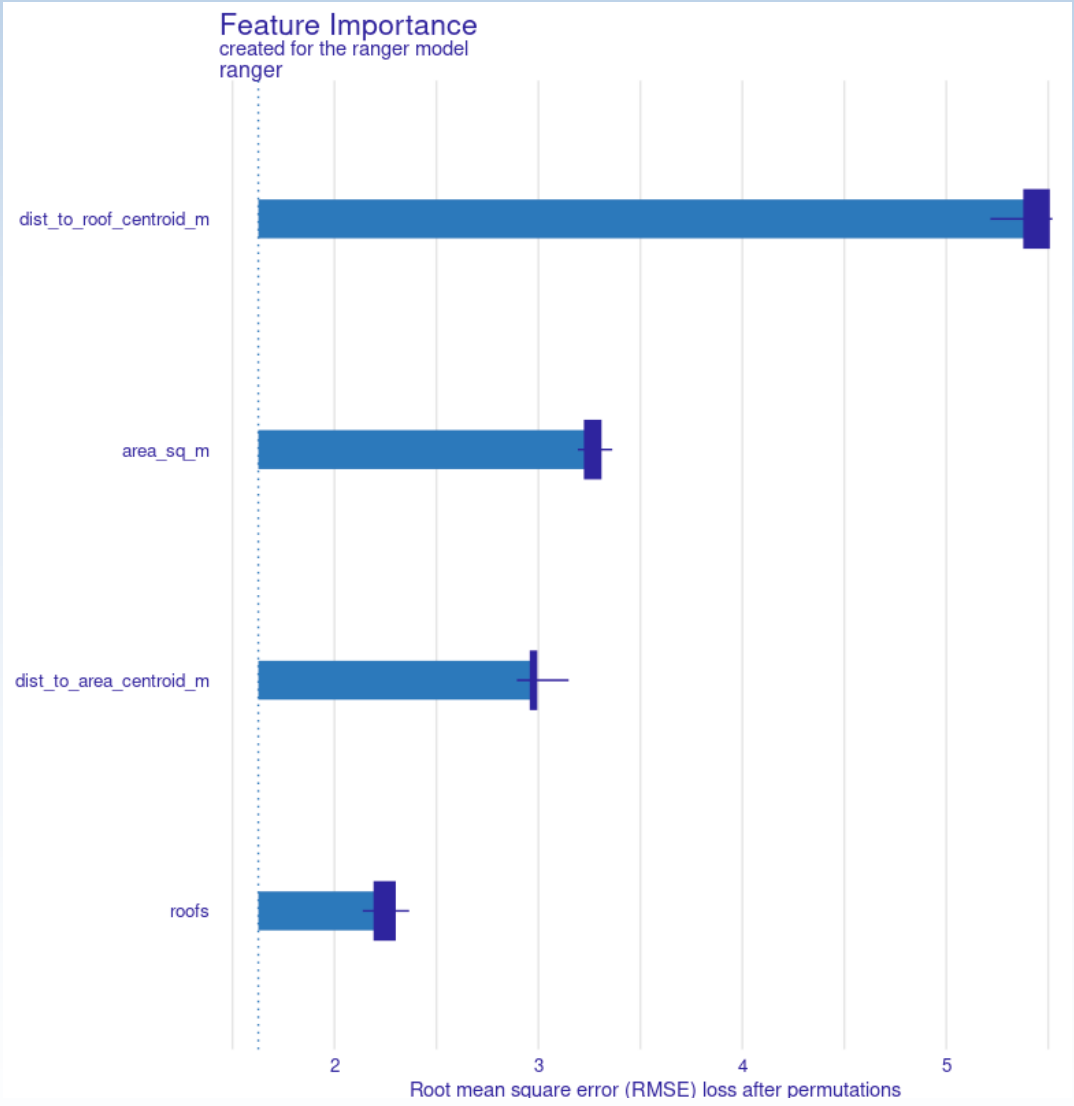


The mean (average) **Timing Advance** was best related
To the created features

Many math models were tested, and the best selected

.rmse	mse	r^2
1.626544	2.645644	0.887122

.rmse = Root Mean Square Error - lower numbers are better
. mse = Mean Squared Error - small numbers are better
R^2 = “R Squared” 1.0 is max > 0.8 is meaningful

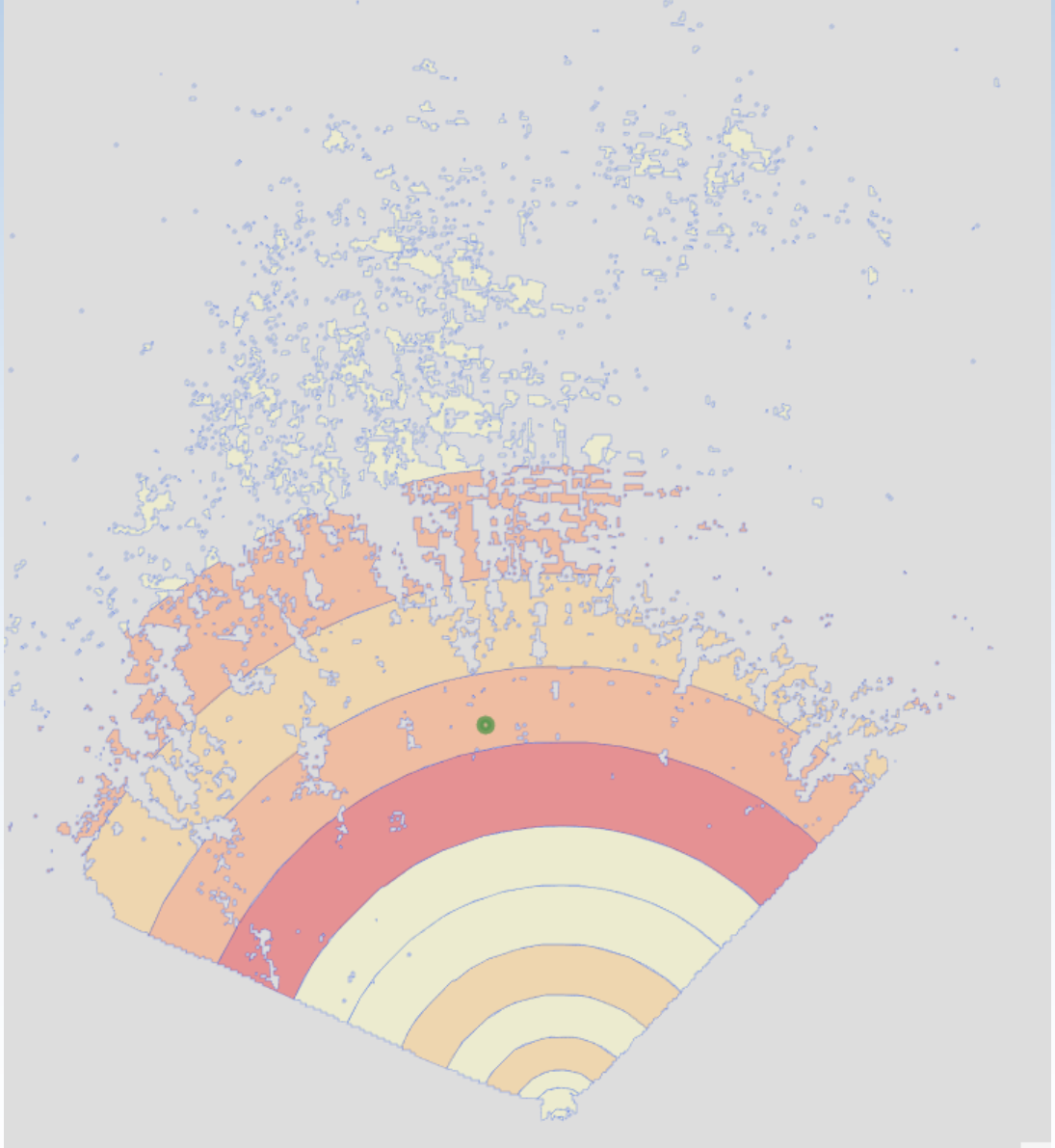


Timing Advance shown as % of cell activity

red	<= 25%
orange	> 25% and <= 50%
dark yellow	> 50% and <= 75%
light yellow	> 75%

Quality visualizations of data make for better understanding

- Bridges technical topics with staff members
- Improves “inside selling” for project funding



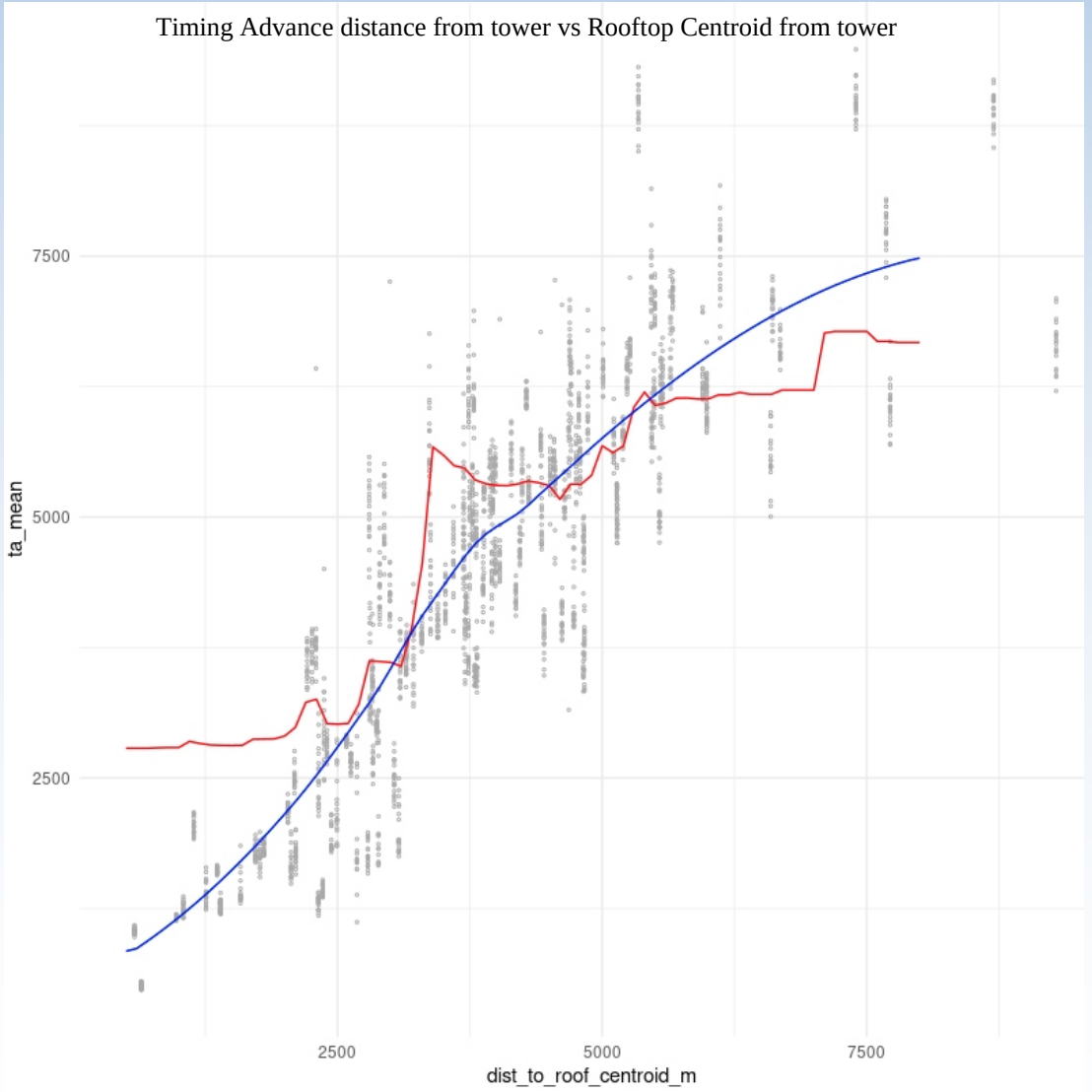
Red = Machine Learning Model
Blue = Simpler – Loess Model

The simpler model does a better job of prediction

Take away:

Regardless of prediction model used…..
Rooftop centroid of a cell is related to the average
Timing Advance distance from a cell tower

In general cells with Timing Advance distances near
The tower perform better than cells with Timing Advance
Further from the tower



Further Study

- Incorporate terrain and clutter data
  - USGS – terrain data open source
  - Lidar – open source – extreme detail – but data intensive
  - Create special use case rasters - score “every rooftop”
  - Combine population with rooftop data
  - Tax parcel data (some states freely available)
- Parallel processing help with large data sets
- Simple models may better explain your data than complex Machine Learning models
- Improve Timing Advance prediction to determine distribution of traffic (vs mean)
- Use similar methods to determine impact of repeaters in networks

RFA

Thank you

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