MISO

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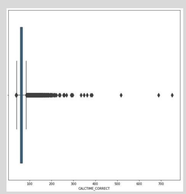
PHASE 1

MISO or Midcontinent Systems Operator is a regional transmission operator. In addition to managing the grid for 15 US states and the Canadian province of Manitoba, MISO also manages the energy market and partners with stakeholders to plan the grid of the future.

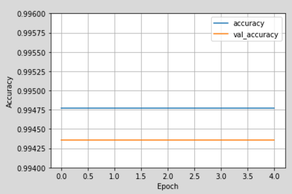
Problem Statement: How different constraints affect MISO's solve time algorithm?

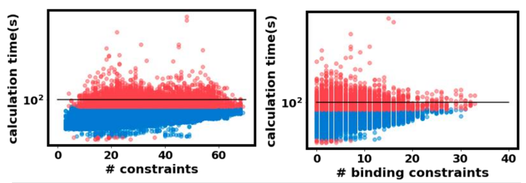


On the left is MISO's solve time algorithm.
It has 10,344 outliers in total with 10,325 of them having an outlier that is above the normal time (approximately 99%)

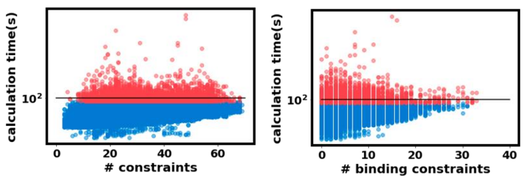
Solution = Leveraging Deep Learning with Tensorflow to identify when a given input would require extended compute.

This information was used to generate a recommendation to the MISO team wherein they were able to redirect high compute-predicted solves to a separate GPU-enabled cluster, which enabled them to minimize solve bottlenecking





IQR / Box Plot



Z-Score

The red dots represent the outliers. We looked for data points which were too far from zero.

We determined:

1. Simple outlier methods or even a 100 cutoff seems enough to determine outliers for now
2. Not a strong dependence of outliers for constraints and binding constraints count

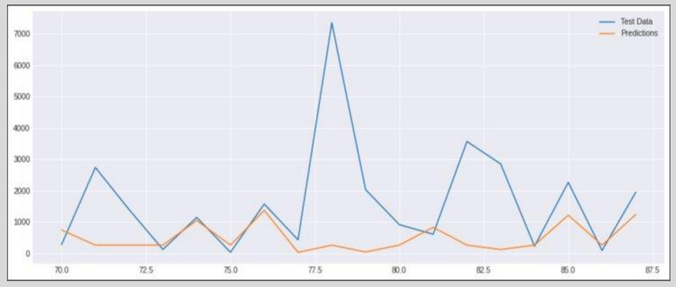
CURRENT RESEARCH

We are currently comparing a series of vital factors that may influence an individual's decision to purchase an electric vehicle.

Using techniques such as ARIMA - Autoregressive integrated moving average and Deep Learning Time-Series approaches within Tensorflow, we were able to determine a possible correlation between every we metric mined.

High confidence intervals: Historical sales and exogenous variables are highly uncorrelated. Most of variables - socioeconomic, number of income, etc - are white noise and demonstrate a high loss.

Despite the complicated set of tracked information, the latent features generated during the hidden layers were unable to effectively predict registrations over an extended timeframe.



PHASE 2

Problem Statement: How does increasing EV proliferation impact future grid operations?
To analyze our problem statement, our team thought of two research questions to guide us.

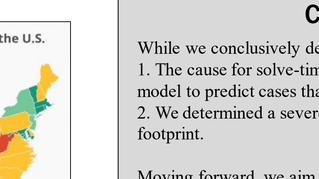
Research Question #1: What is the **current** and **future expected** distribution of electric vehicles across MISO's footprint?

We researched some parameters and factors that we believe affect distribution of EVs. These are listed below:

- Sales and Registration
- Geospatial and Socio-economic
- # Vehicle Charging Station
- Household Income and Income per Capita
- Gas Prices vs EV

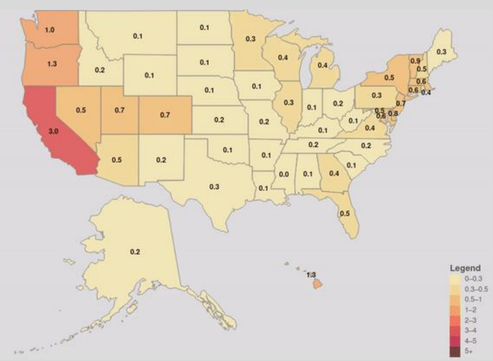
Our research relied on publicly available data. The resources we found most helpful were government sources such as the U.S. Energy Information Administration. These were credible and trustworthy sources. Due to this, we had to do a lot of data cleaning to do. Our final dataset contained information for the states that fall under the MISO region.

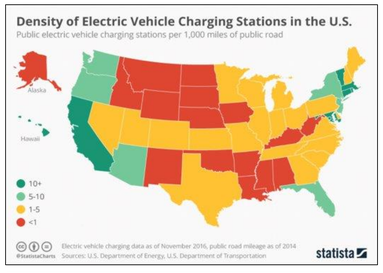
Region	State	# of EV Registrations	Percent of total EVs	Region percent of Total EVs	MISO's Region Distribution of EV
North	North Dakota	220	0.02%	1.24%	17.66%
	Minnesota	10,380	1.00%		
	Iowa	2,260	0.22%		
Central	Wisconsin	6,310	0.62%	5.58%	68.57%
	Michigan	10,620	1.00%		
	Illinois	26,000	2.60%		
	Indiana	6,990	0.70%		
	Missouri	6,740	0.66%		
South	Arkansas	1,330	0.13%	0.40%	13.76%
	Louisiana	1,950	0.19%		
	Mississippi	780	0.08%		
Total		73,580	7.22%		100%



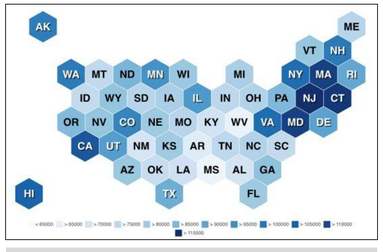
Research Question #2: What do the **daily** charging load profiles look like on an hourly basis? What does this translate to in terms of load?

We analyzed data of load profiles across the US from years 2016 to 2018.





Number of Vehicle Charging Stations



Household and Income per Capita

CONCLUSION & FUTURE GOALS

While we conclusively determined the following:
1. The cause for solve-time inefficiency was database structure lagtime. We also developed a model to predict cases that may take additional amounts of time.
2. We determined a severe lack of correlation within the variables we tracked within MISO's footprint.

Moving forward, we aim to find representative, consistent and reliable data sources, and additionally look into multimodal techniques for time-series prediction to present a feature set that can reliably predict the trend for EV sales.

We hope that the extended extent of knowledge obtained by what we discover allows MISO to better plan for the EV-enabled future we expect to live soon.