



**UA Summit**<sup>®</sup>

**May 10 - 12, 2022** | New Orleans, LA

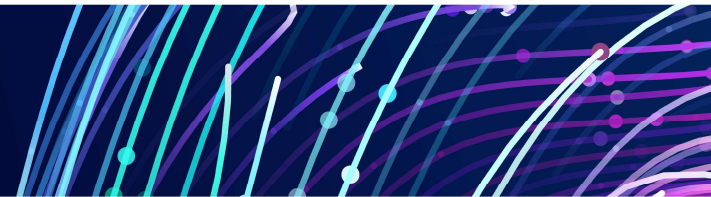
Hosted by **Entergy**

# **Metrics & Adoption of AI/ML Outage Prediction Technology**

**Presented by: CPS Energy, Luis Selvera**

# Agenda

- CPS Energy
- Outage Prediction
- Metrics
- Adoption
- Q&A



# HOW WE SERVE BY THE NUMBERS <sup>1</sup>

**14%** of our annual revenue goes to the City of San Antonio's General Fund

Largest Municipally Owned Electric & Natural Gas Utility in the U.S.

**1<sup>st</sup>** in Solar Power Production in Texas & **5<sup>th</sup>** in the Nation <sup>2</sup>

**2<sup>nd</sup>** in Wind Power Production in Texas



**897K** Electric

**371K** Gas  
Our Customers



**\$361M**

Annual Payment to the City  
27.1% of CoSA's FY2022 General  
Fund



**162**

Years of Serving  
San Antonio



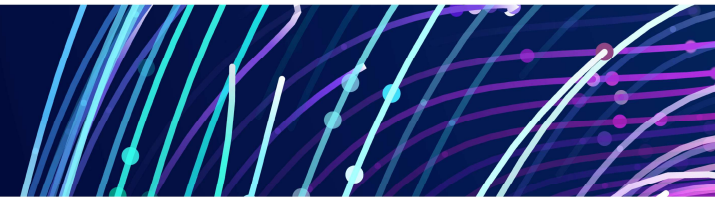
**\$420 M**  
Local & Diverse  
Spend in FY2022



**~3,000**  
Employees

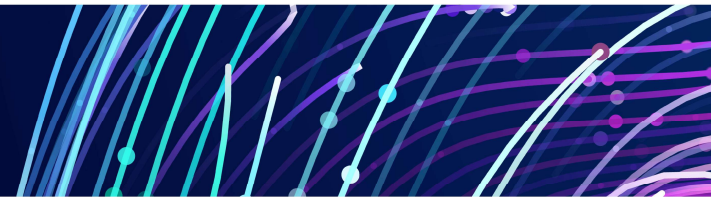
# CPS Energy

- What moves the electric utility of the 7th largest city in the U.S.? People
- For years, CPS Energy has invested in development of local talent, local technology development, city growth, employees, infrastructure that is setting the stage for continued success.



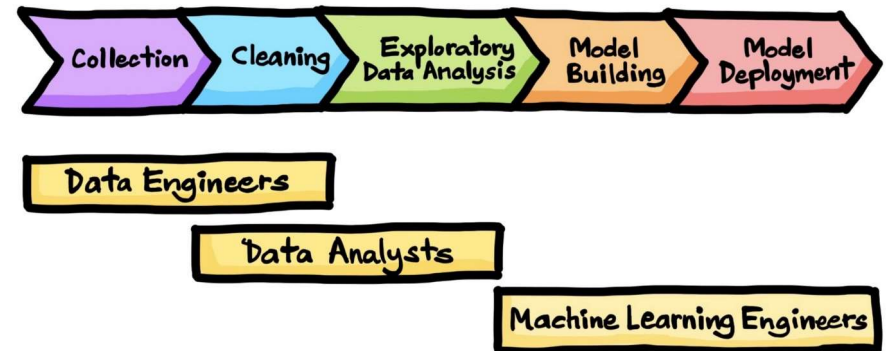
# The Need for Data Driven Solutions

- The combination of data management and analytics enables us to take a system-wide view of our operations, allowing us to run more efficiently and lower costs
- Allows us to better serve their customers by turning data into actual intelligence
- With the right data analytics solution in place, we can manage our data and, most importantly, use this information to benefit the customer experience

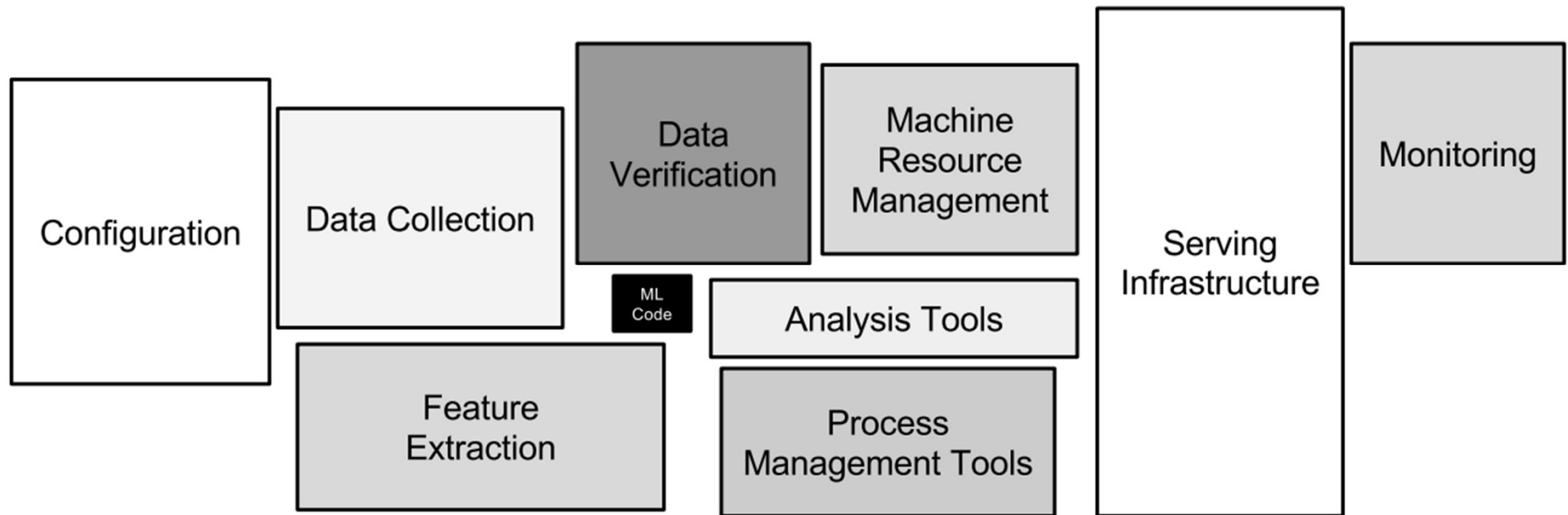


# Data

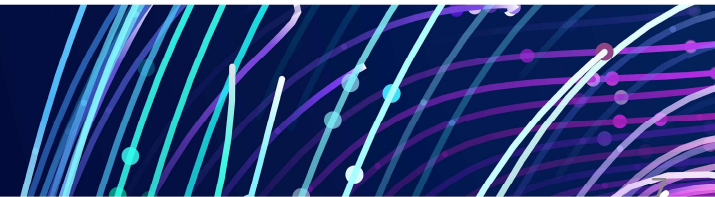
- Before thinking of ML, we need data
- Growing on data maturity enables data for multiple use cases
- Data readiness accelerates the process of implementing solutions



# Real-World ML Systems

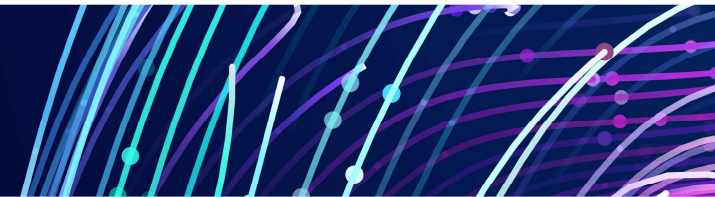


Source: "Hidden Technical Debt in Machine Learning Systems", Sculley et al, 2015.



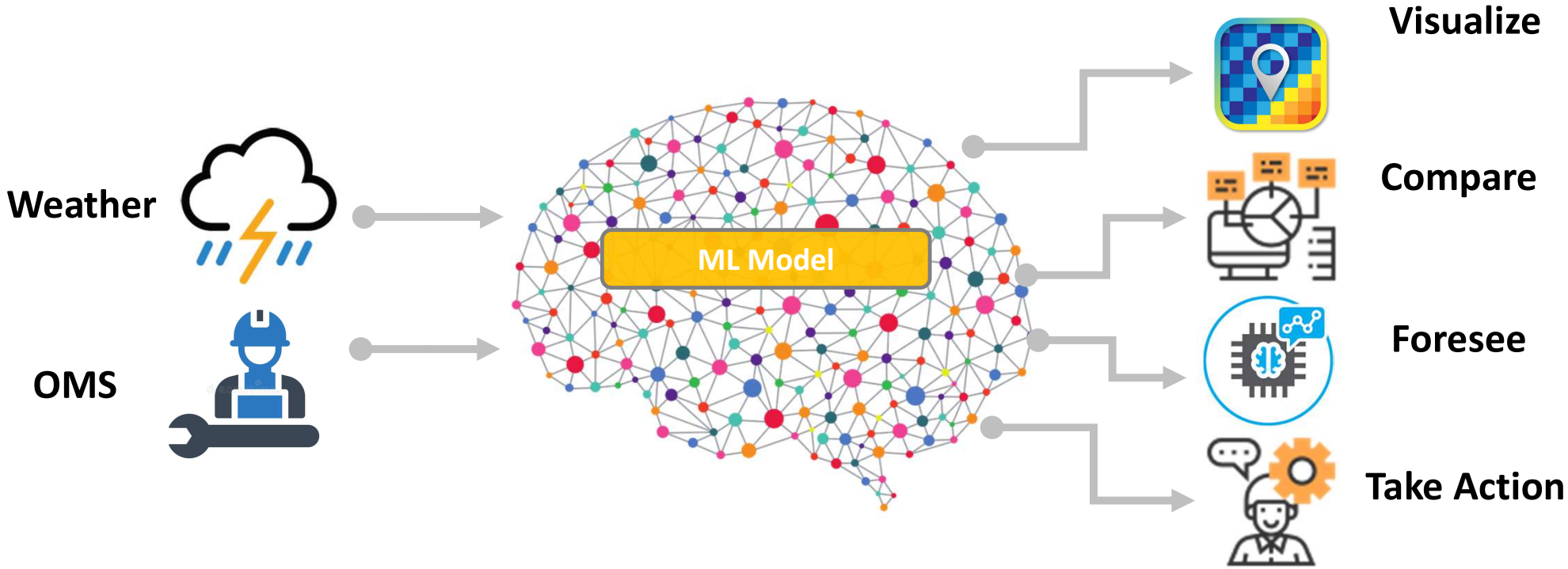
# Outage Prediction Tool

- Weather events are always presenting challenges for utility companies
- Acting quickly to get services back up is critical for keeping satisfied customers
- Developed model to predict number of weather-related outage operations/events for better crew planning and

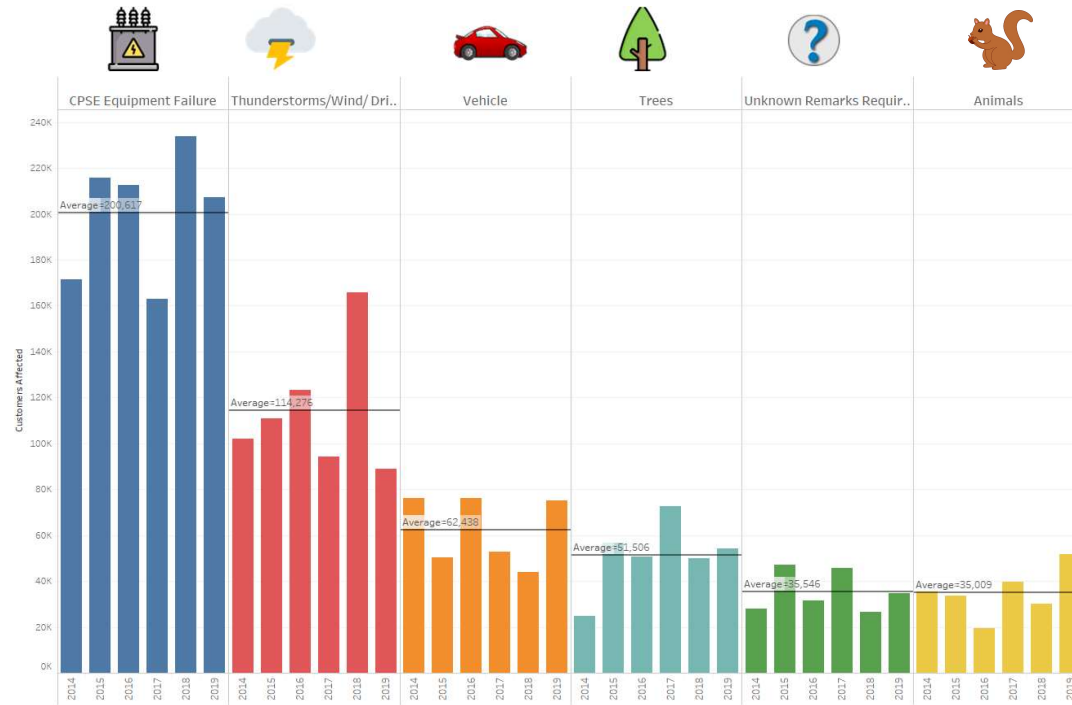




# Analytics to Intelligence (A<sup>2</sup>I)



# Key Causes For Outages

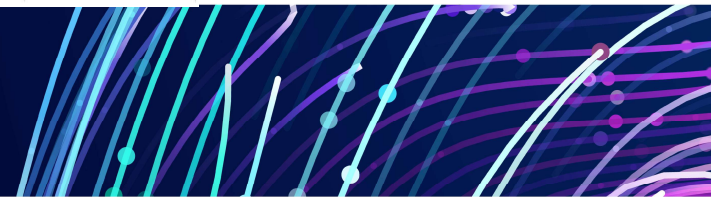


Source: Annual EDS Metrics Report



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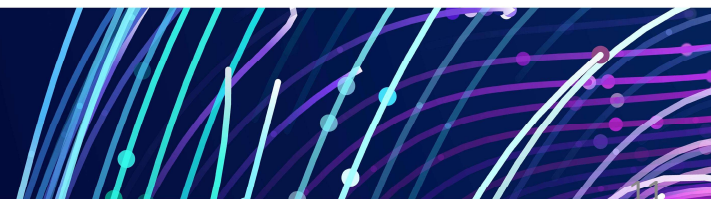
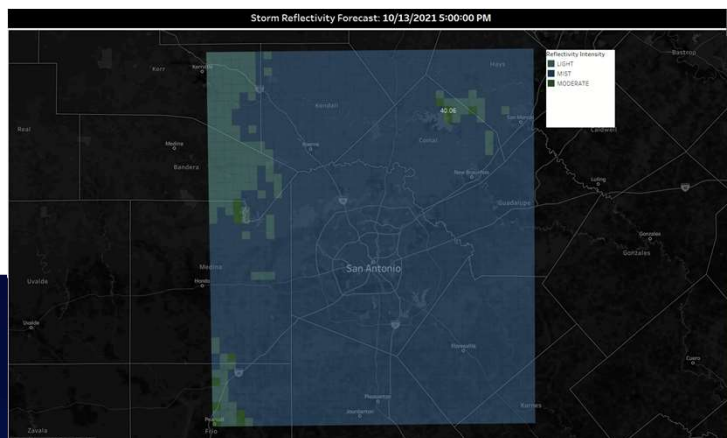
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# Data

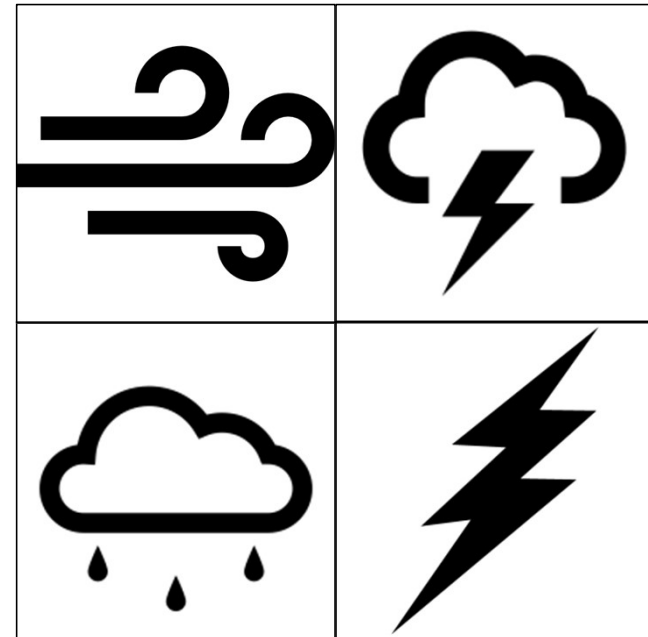
Hour (Central Daylight Time)	Mon 11 AM	Mon 1 PM	Mon 4 PM	Mon 7 PM	Mon 10 PM	Tue 1 AM	Tue 4 AM	Tue 7 AM	Tue 10 AM
Weather Condition									
Weather	T-Storms	T-Storms Possible	Partly Cloudy	T-Storms Possible	Partly Cloudy	Partly Cloudy	Partly Cloudy	Partly Cloudy	Partly Cloudy
Temperature (°F)	84	78	82	79	72	68	66	66	74
Wind Direction	E	SE	SSE	SSE	SE	SE	SSE	SE	SSE
Wind Speed/Gusts (mph)	5	11	14 G 24	11	8	8	8	9	13 G 23
Precipitation Chance(%) (%)	-	25	-	32	-	-	-	-	-
Precipitation Type	-	Rain	-	Rain	-	-	-	-	-
Precip Amount (Rain:in., Snow:in.)	-	Rain 0.13	None	Rain 0.04	None	None	None	None	None
24 Hr Snow/Ice Accum (in.) (11AM-11AM)	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

- Training data from 2014-2019 :
  1. DTN weather actuals (wind, gust, etc.)
  2. NOAA NEXRAD (reflectivity)
  3. OMS outage actuals (target variable)
- Data for predictions:
  1. DTN weather forecasts up to 18 hours ahead
  2. NOAA HRRR sub-hourly (reflectivity) forecast up to 18 hours ahead
- Predict number of outage operations up to 18 hours ahead at city level



# Weather Driven Outages

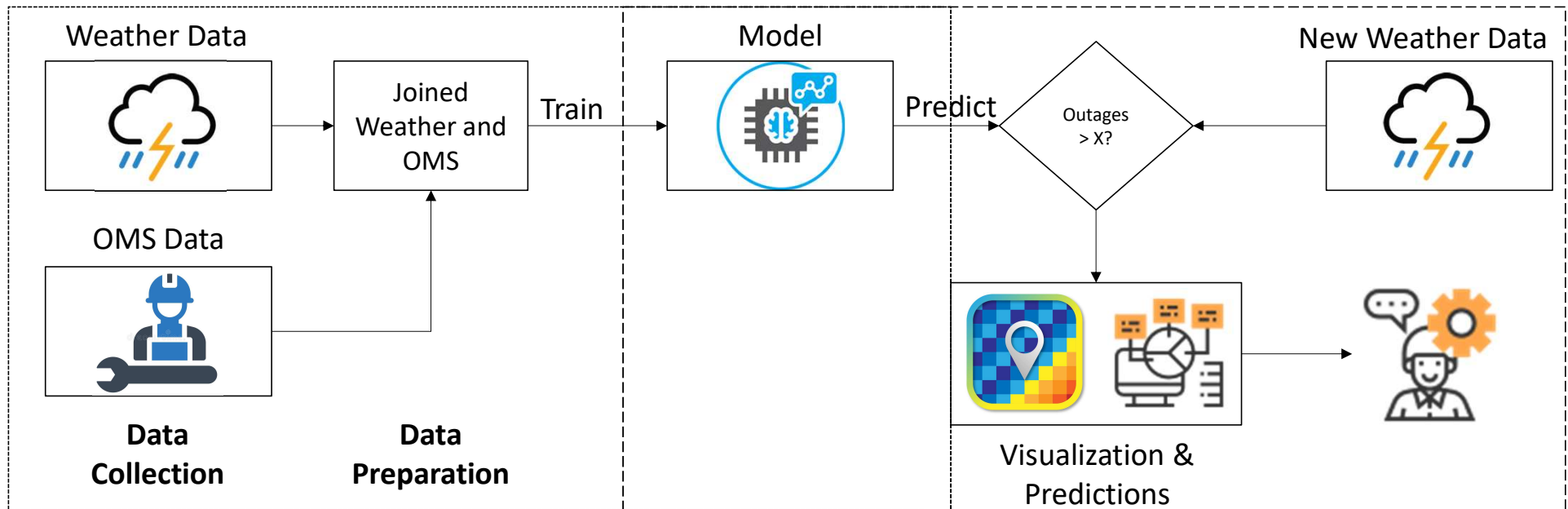
- Sustained outages only (> 5 mins)
- Only weather driven outages:
  - Wind
  - Thunderstorm
  - Lighting
  - Drizzle
- Remove incorrect outage records:
  - Ticket created in error
  - False outage



# Outage Prediction Architecture

## Training Stage

## Prediction Stage

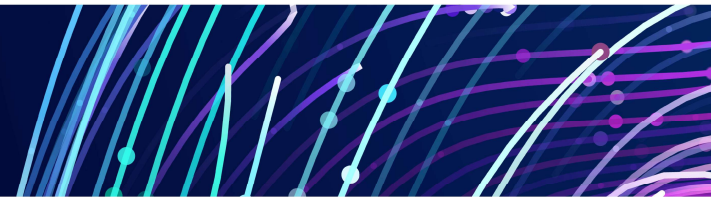


# Metrics

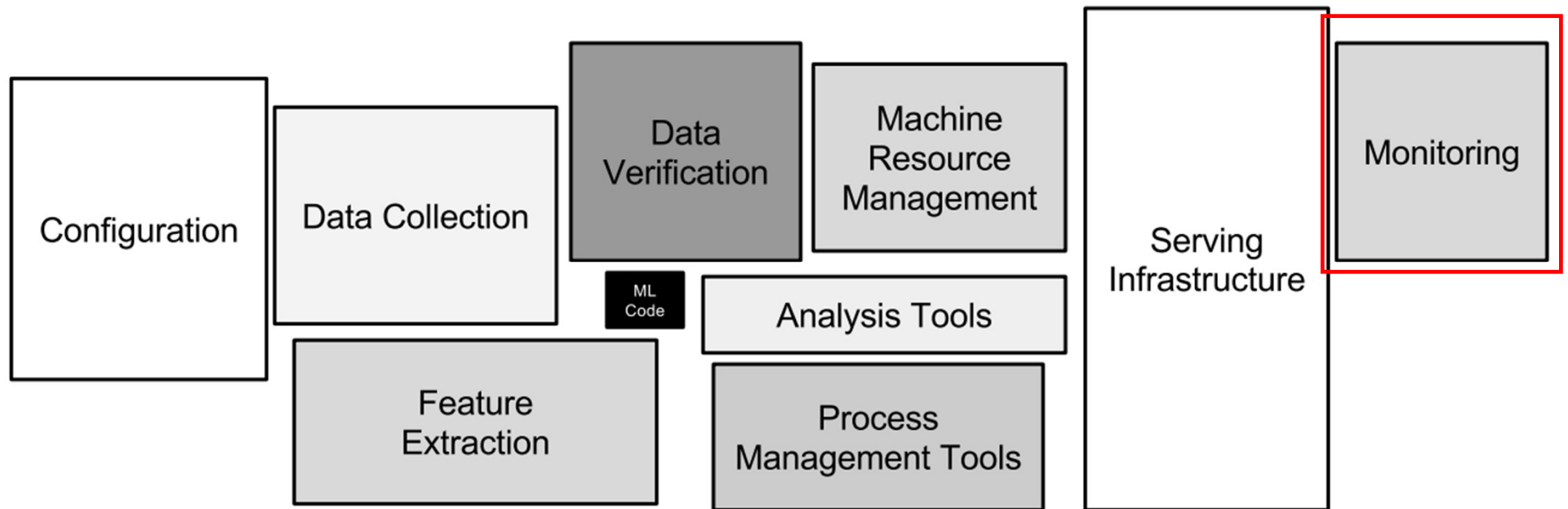


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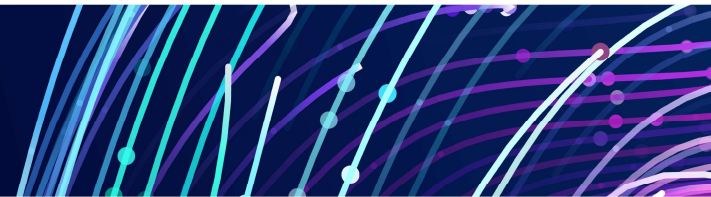
# Real-World ML Systems



Source: "Hidden Technical Debt in Machine Learning Systems", Sculley et al, 2015.

# Model Evaluation

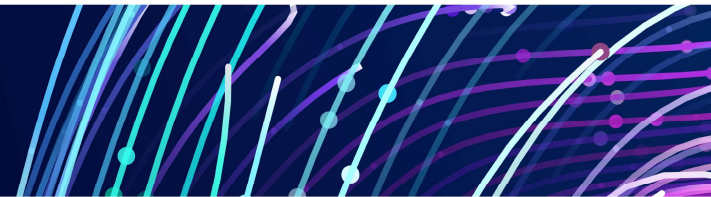
- Does it actually work? Can we trust its predictions?
- Estimate performance of a model on future data
- ML model ought to be able to give accurate predictions in order to create real value for the organization.



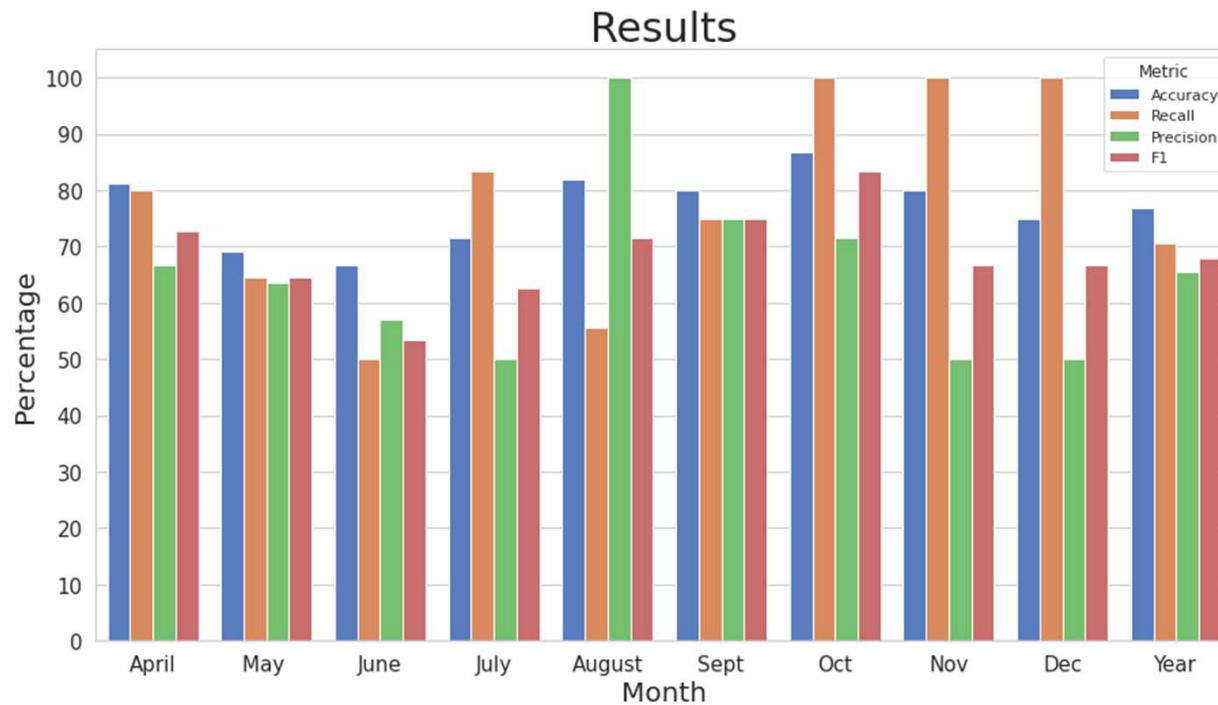


# ML Metrics

- Classification
  - Detection of high number of outages events
  - Confusion Matrix: TP, FP, TN, FN
  - Accuracy, recall, precision, F1-score
- Regression
  - Accuracy in number of outages predicted
  - How close prediction is against the real value
  - Error, MAE, MSE/RMSE

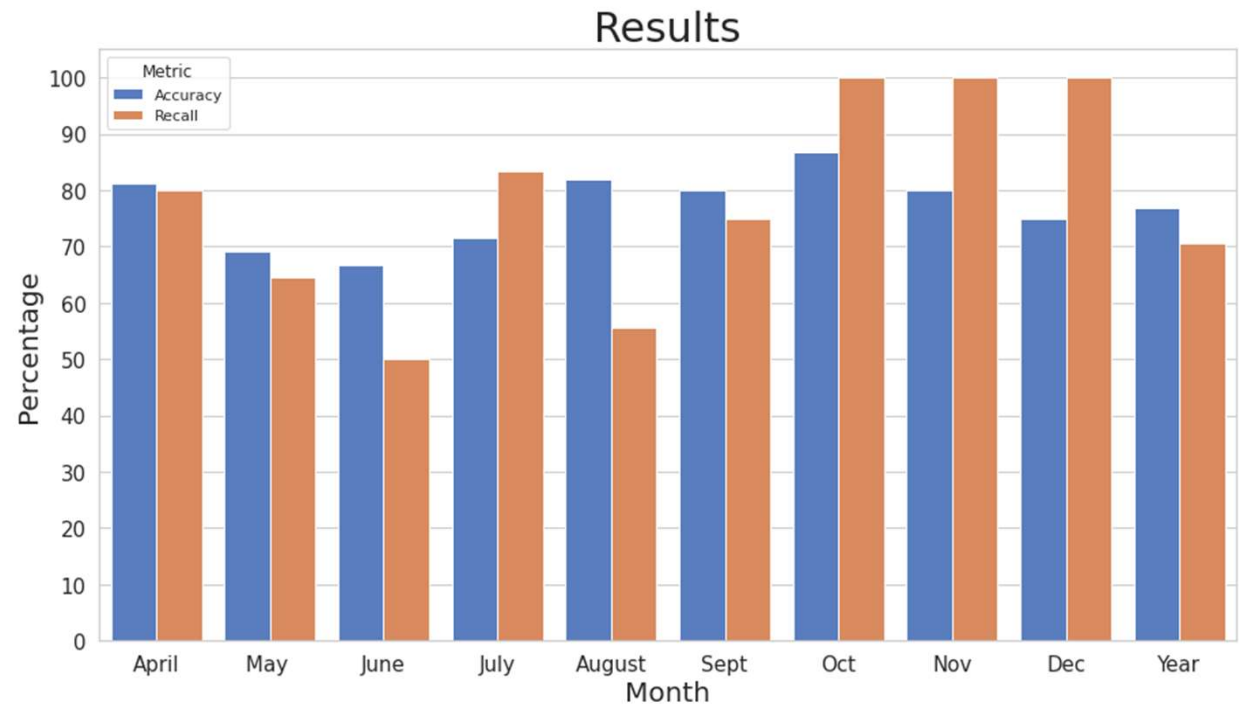


# ML Metrics



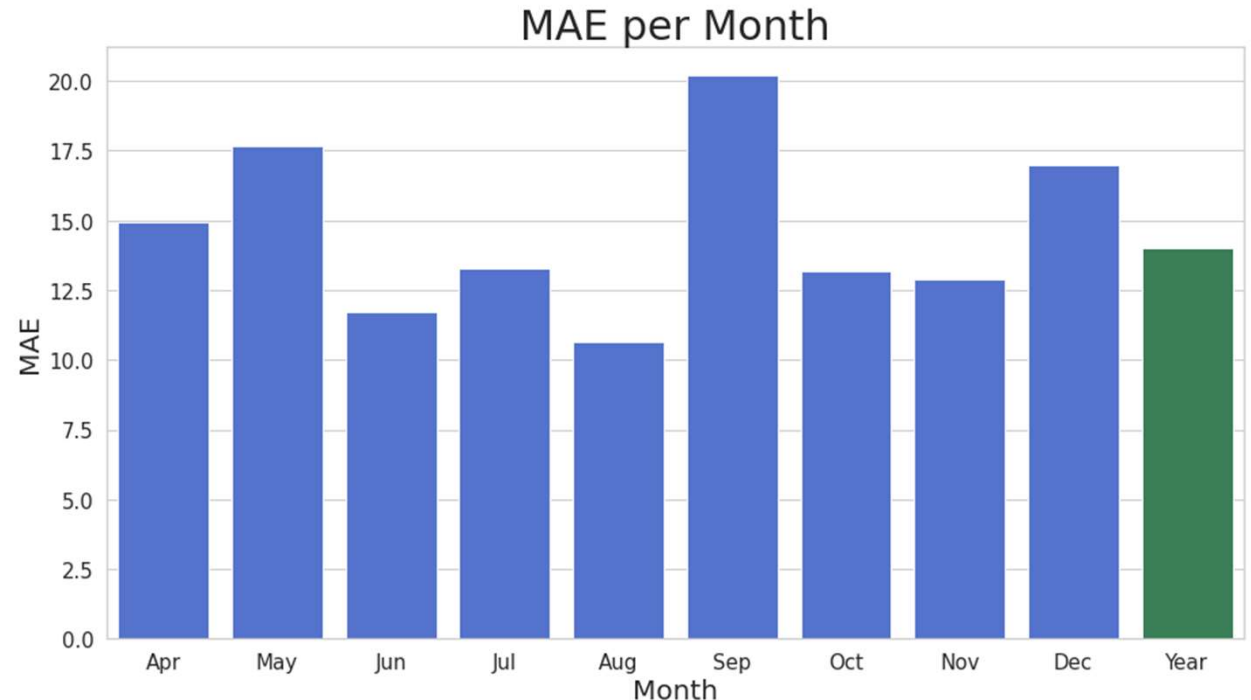
# Classification Performance

- Of the events we care about, we predicted 71% correctly.
- Including all events, we are 77% accurate.



# Regression Performance

- Of the events we care about, we have error of 14 for the year.
- September highest error with 21.

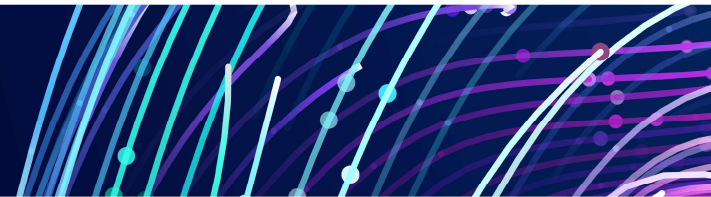


# Adoption



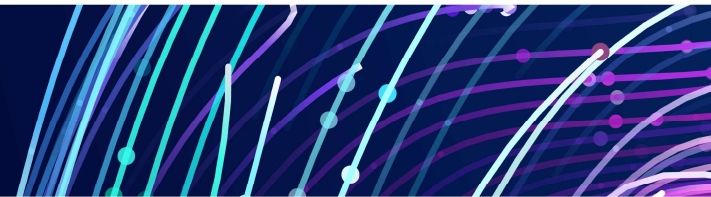
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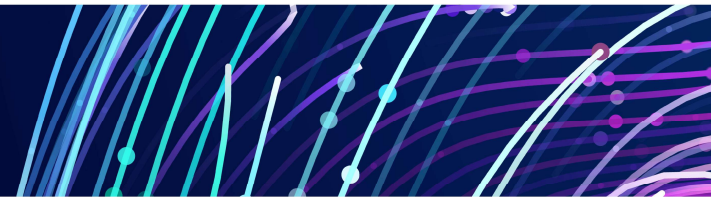
# Pre-hypercare

- Identify Project Change Champion:
  - Primary point of contact on the business side
  - Knowledgeable on process and key benefits/philosophy behind the change
- Readily digestible accessible documentation:
  - Routes the users to the correct location where they can learn about tool
  - Allows us to focus on resolving issues



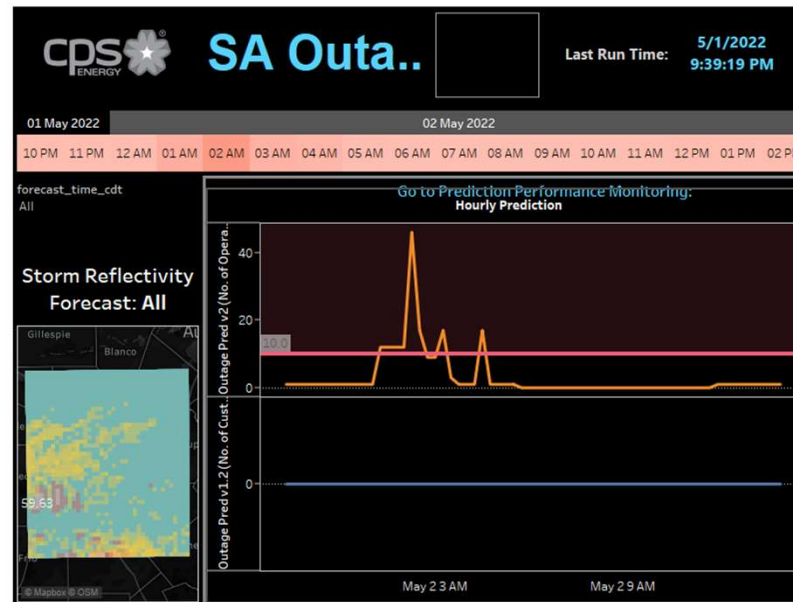
# System Stability

- Solution complete: Has our team delivered on all agreed scope (requirements)
- Automate to create efficiencies: Automate alerts to get the right information to the right people
- Product metrics: Reports on product performance to ensure delivery of high-quality product
- Solution stable: Report on number of incidents and problems and reliability of the system



# Email Alerts

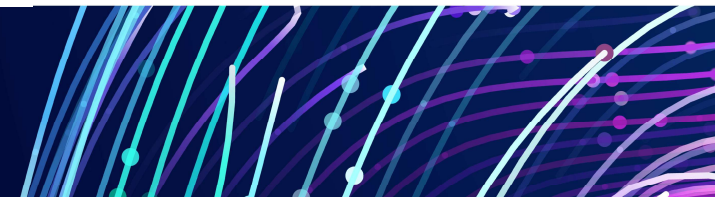
Outage Pred v2 (No. of Operations) was above or equal to 10.



[Manage my alerts](#) | [Remove me from this alert](#) | [Add me to this alert](#)



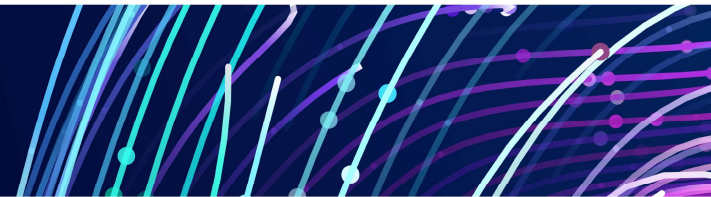
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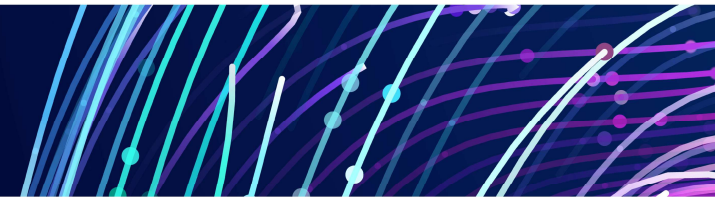
# Report Incidents and Problems

- Data fed to a learning system from various upstream producers should be monitored.
- Similarly, any failure of the ML system should be reported down-stream to all consumers.
- Keep logs of incidents
- Sources of failed runtimes:
  - Data not provided
  - Cluster down due to maintenance or outage



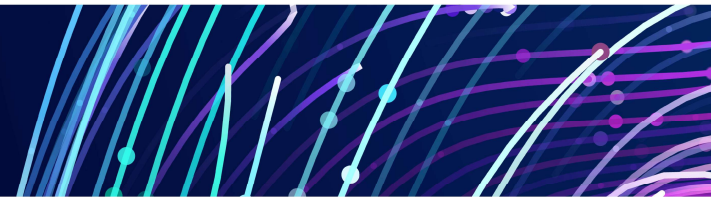
# Change Management

- Incorporate members of our team with members of the business team
- Keep stakeholders informed: define standard ways that business leaders and other partners will be updated
- Solution being used: agree to meet periodically



# Post Go-Live Support

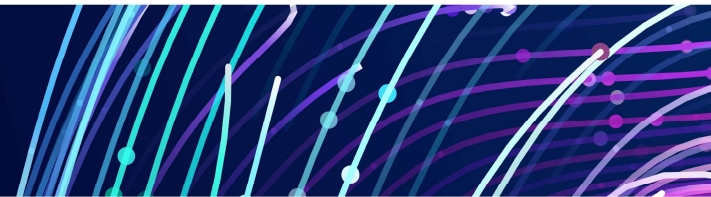
- Hypercare:
  - Provide ongoing support
- User Adoption:
  - Proactively communicate changes
  - Resolve any challenges to ensure adoption and engagement
- Solving for Growing Business Needs:
  - Partner with customer to understand evolving business needs
  - Tailor product and service offerings accordingly



# Issue with Email Alerts

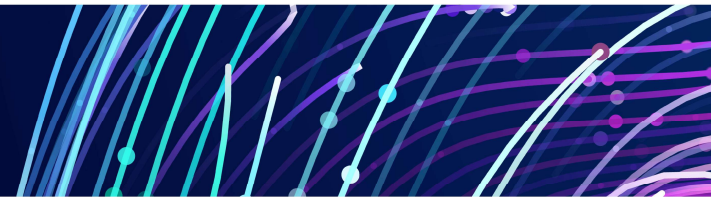
- Alert if number of outages greater than 10
- Constant alerts sent too many email
- After many emails, alert start being less meaningful
- No way to alert that no threat is present anymore

tableau_analytics@cpsenergy.com Data alert - Outage Prediction v2.0 Outage Pred v2 (No. of Operations) was above or	2/3/2022
tableau_analytics@cpsenergy.com Data alert - Outage Prediction v2.0 Outage Pred v2 (No. of Operations) was above or	2/2/2022
tableau_analytics@cpsenergy.com Data alert - Outage Prediction v2.0 Outage Pred v2 (No. of Operations) was above or	2/2/2022
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tableau_analytics@cpsenergy.com Data alert - Outage Prediction v2.0 Outage Pred v2 (No. of Operations) was above or	2/2/2022
tableau_analytics@cpsenergy.com Data alert - Increase in Outages Factor Change was above or equal to 5.	2/2/2022
tableau_analytics@cpsenergy.com Data alert - Outage Prediction v2.0 Outage Pred v2 (No. of Operations) was above or	2/2/2022



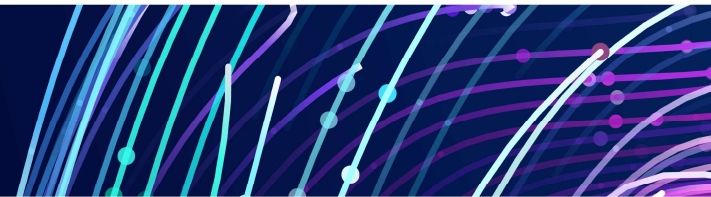
# Email Alerts: Alert Changes Only

- Only alert when there is an increase or decrease in number of outages predicted
- If there are no dramatic changes, no email alert is sent
- Reduced number of emails significantly while still keeping team alert
- Next step: anomaly detection using statistical process control to alert when number scale up or scale down using



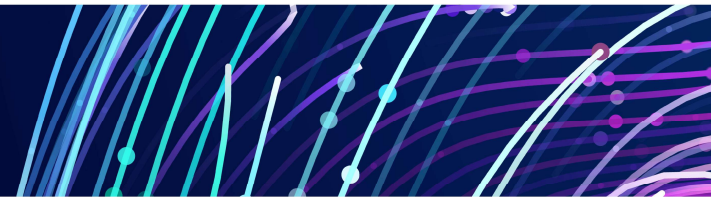
# Communication

- Business cares about are metrics, but what do these metrics really mean for them? Can they identify the real value?
- Sharing model metrics in a clear and concise way increases business trust in the tool
- Transparent communication on results allows more openness to uncertainties
- Keeping constant communication increased feedback and raised awareness of the tool's usefulness

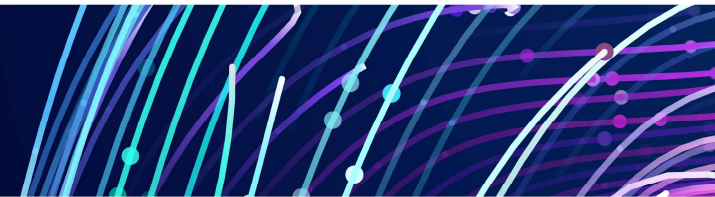
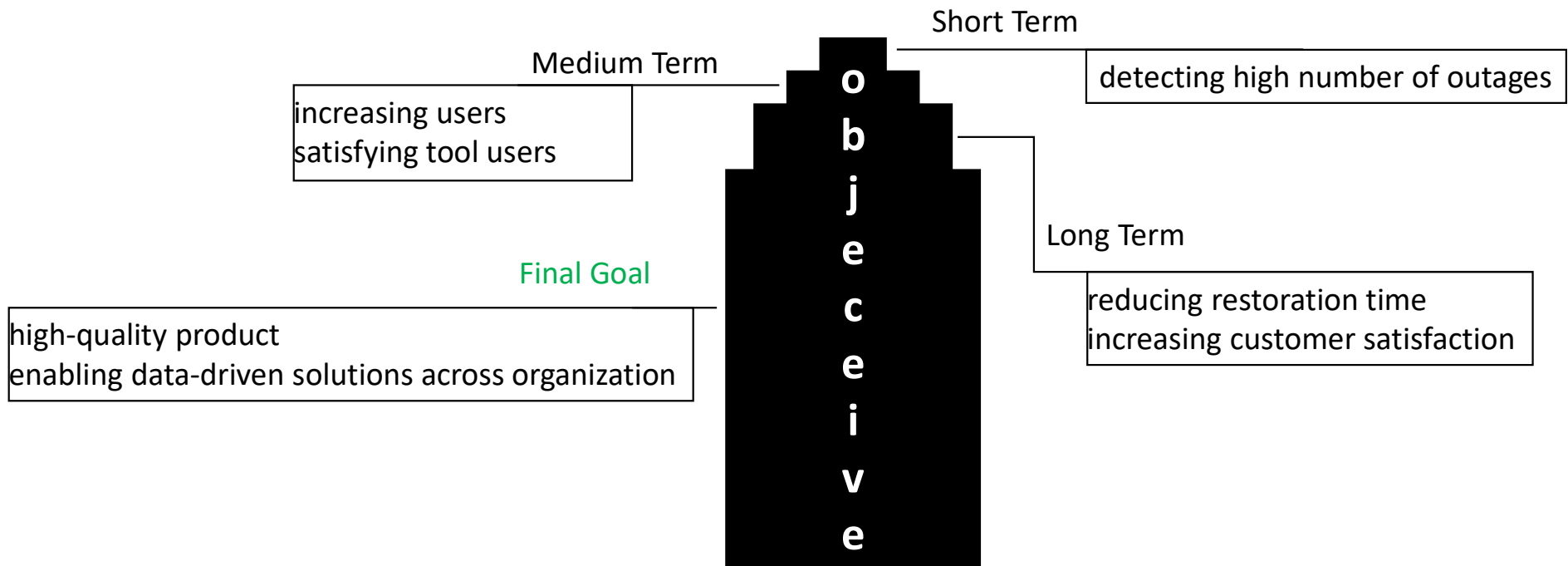


# Solving for Growing Business Needs

- Business has desire to predict number of customers affected
- Number of outages does not precisely translate to number of customers affected
- Some operations affect more customers than others
- Similar to preparing crew to repair outages, we can prepare call center staff to attend calls



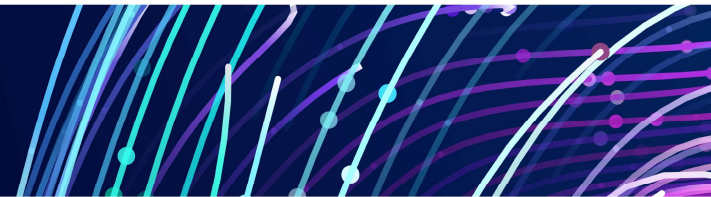
# Goals





# Conclusion

- Thinking differently about existing processes in itself represents significant progress
- Building a new, intelligent workflow requires input from everyone involved in these operations, removing siloes
- We cannot implement this kind of system and then toss it over the fence to the operational departments
- They'll trust the new process more if they know that their voice really counts

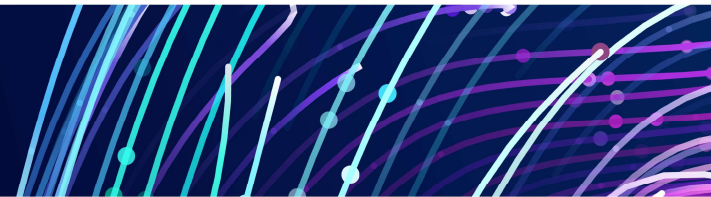


# Questions



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# THANKS FOR ATTENDING

*Please fill out an evaluation form and drop it in the collection basket located at the back of the room.*

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