



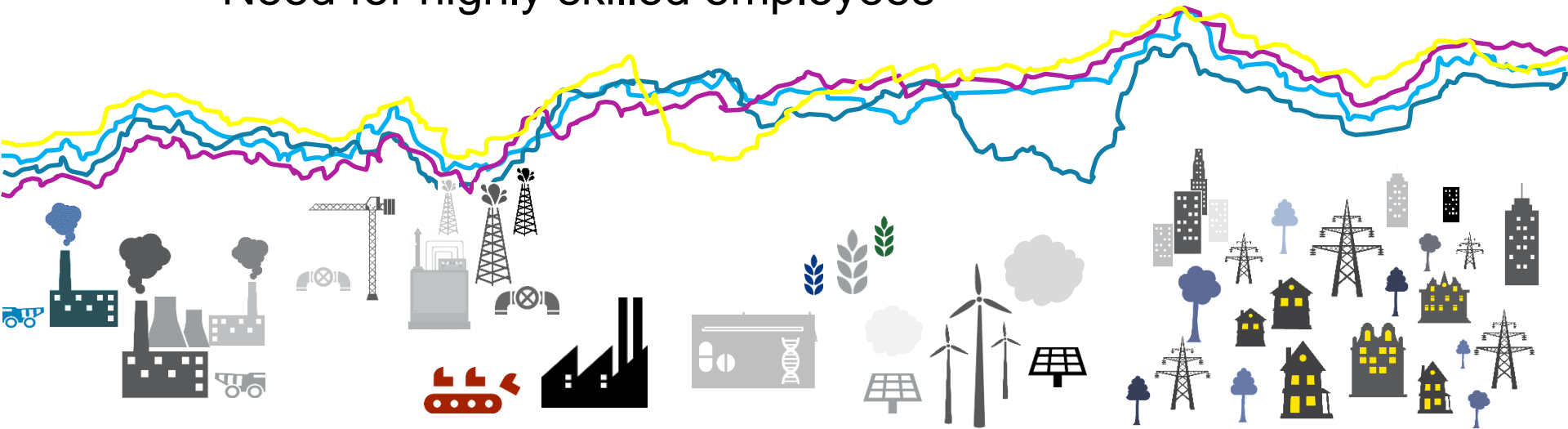
# PI System for Big Data in the Classroom

Presented by **Erica Trump, PhD**



# Need for Data Science in Curricula

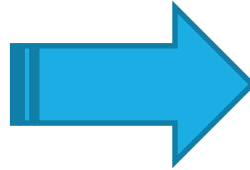
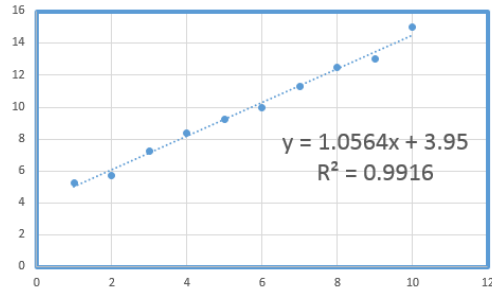
- Companies own terabytes of data
- Sensor-based data generated rapidly
- Value lies in making data actionable
  - Need for highly skilled employees



# Evolving STEM Curricula: Data Education

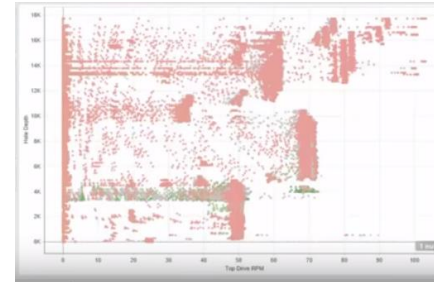
## Traditional Approach

- Problem solving based on models
- Analysis of small datasets using basic statistics
- Simple data visualization



## Data Science Approach

- Complex, real-world data
- Advanced analytical tools
- Interactive visualizations that aid in analysis



# PI and Data Science

## Big Data

Time Series



Relational



Unstructured



GIS



## PI to Deliver Time-Series Data

- Live, time-series data seamlessly delivered to students
  - Many data sources on campus
    - Shared services and utilities
    - Buildings
    - IoT and lab-based sensors
  - Collaborations with industry
  - Hosted data and data sharing with other universities

# Data Flow through the PI System

The diagram illustrates the data flow through the PI System, showing the progression from data collection to delivery and integration with various applications and external systems.

**Data Sources (Left):**

- PLC1, SCADA 1, PLC2, SCADA 2, IPC 1, IPC 2, Instrument, IoT Gateway, Instrument, Controllers

**PI System Stages (Center):**

- Collect:** Receives data from the sources.
- Enhance:** Processes and enhances the collected data.
- Deliver:** Distributes the enhanced data to various applications.

**Applications (Right):**

- Analytics
- ERP
- Asset Reliability
- Geospatial
- LIMS

**External Systems (Far Right):**

- sas
- SAP
- Microsoft SQL Server
- esri

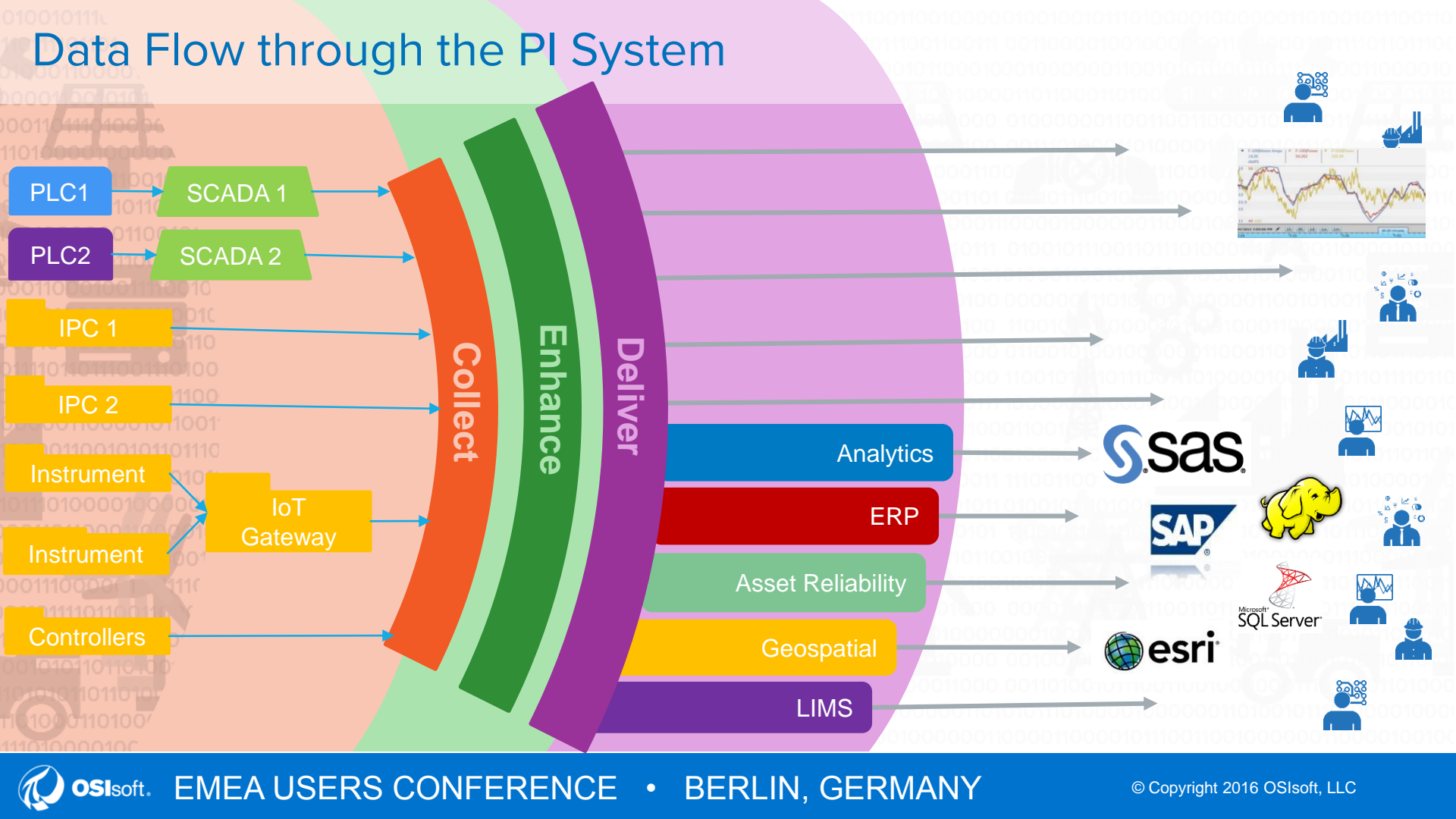
**User Interfaces (Far Right):**

- Dashboard with charts and maps
- Icons representing users and data visualization

**Footer:**

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# Toolbox for Data Science



# PI Integrator for Business Analytics



- PI System data integrated with sophisticated BI tools





# BI Integrator for Business Analytics

- Power BI & wind farm power generation data

Ontario Wind Power Generation

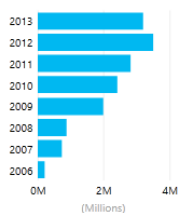
Site

- Amaranth
- Comber
- Greenwich
- Port Alma I
- Port Alma II
- Port Burwell
- Prince
- Undenwood
- Wolfe Island

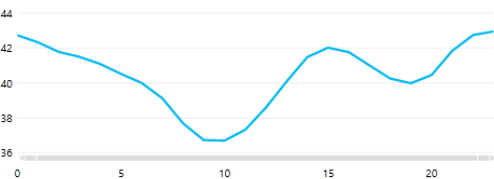
Wind Farm Generation by Month, MWh



Yearly Generation, MWh



Wind Farm Utilization by Hour of Day



Ontario Weather Effects on Generation

Site

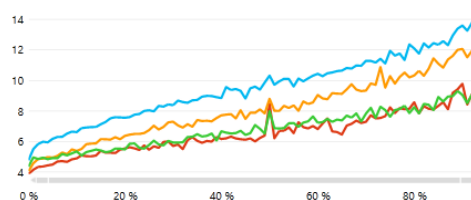
- Amaranth
- Comber
- Greenwich
- Port Alma I
- Port Alma II
- Port Burwell
- Prince
- Undenwood
- Wolfe Island

Wind Farm Utilization vs. Wind Speed and Direction

Wind Direction

- West
- North
- South
- East

Wind Speed, mph

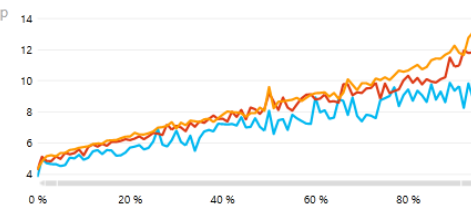


Wind Farm Utilization vs. Wind Speed and Humidity

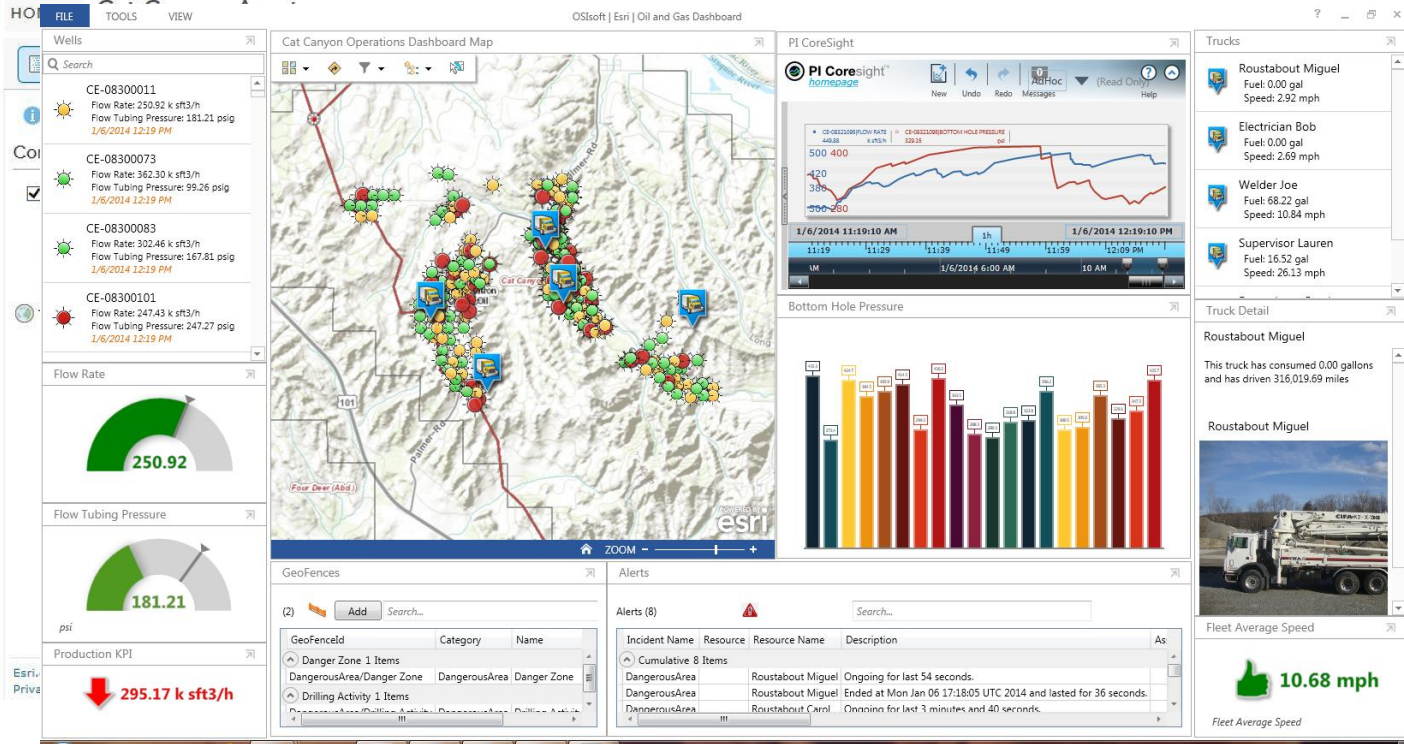
Humidity Group

- 50
- 60
- 80

Wind Speed, mph



# PI Integrator for Esri ArcGIS



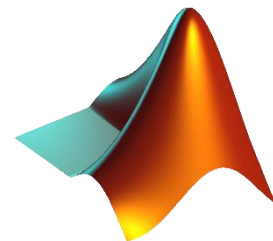
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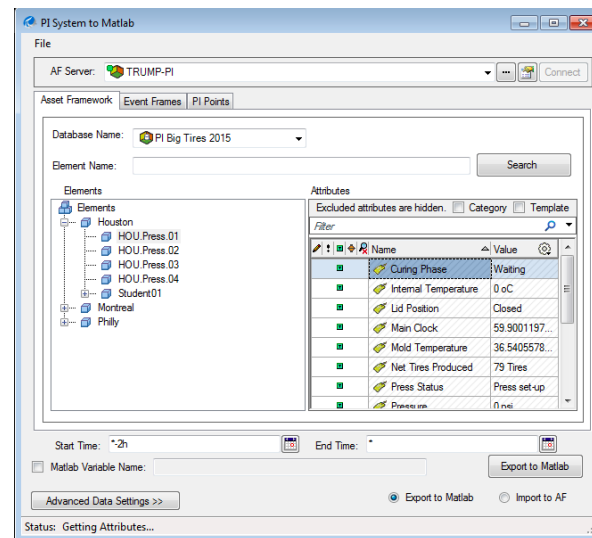
# PI Integration with MATLAB



PI-to-MATLAB  
Utility



PI Developers  
Club White Paper



# PI Integration with R



- R platform central to Data Science curricula
- PI Integrator for Business Analytics
- PI Web API
  - Real-time deployment, ability to write back to PI
  - Example program shared as a learning resource



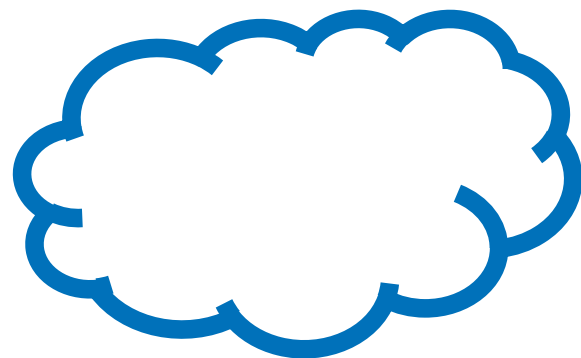


# Data Science Labs



## Our Data Science Labs

- Teaching labs shared at OSIsoft Users Conferences
- Labs guide our customers to apply predictive analytics
  - R Framework
  - Azure Machine Learning
- Cloud-based learning environment
- Fully developed training documents



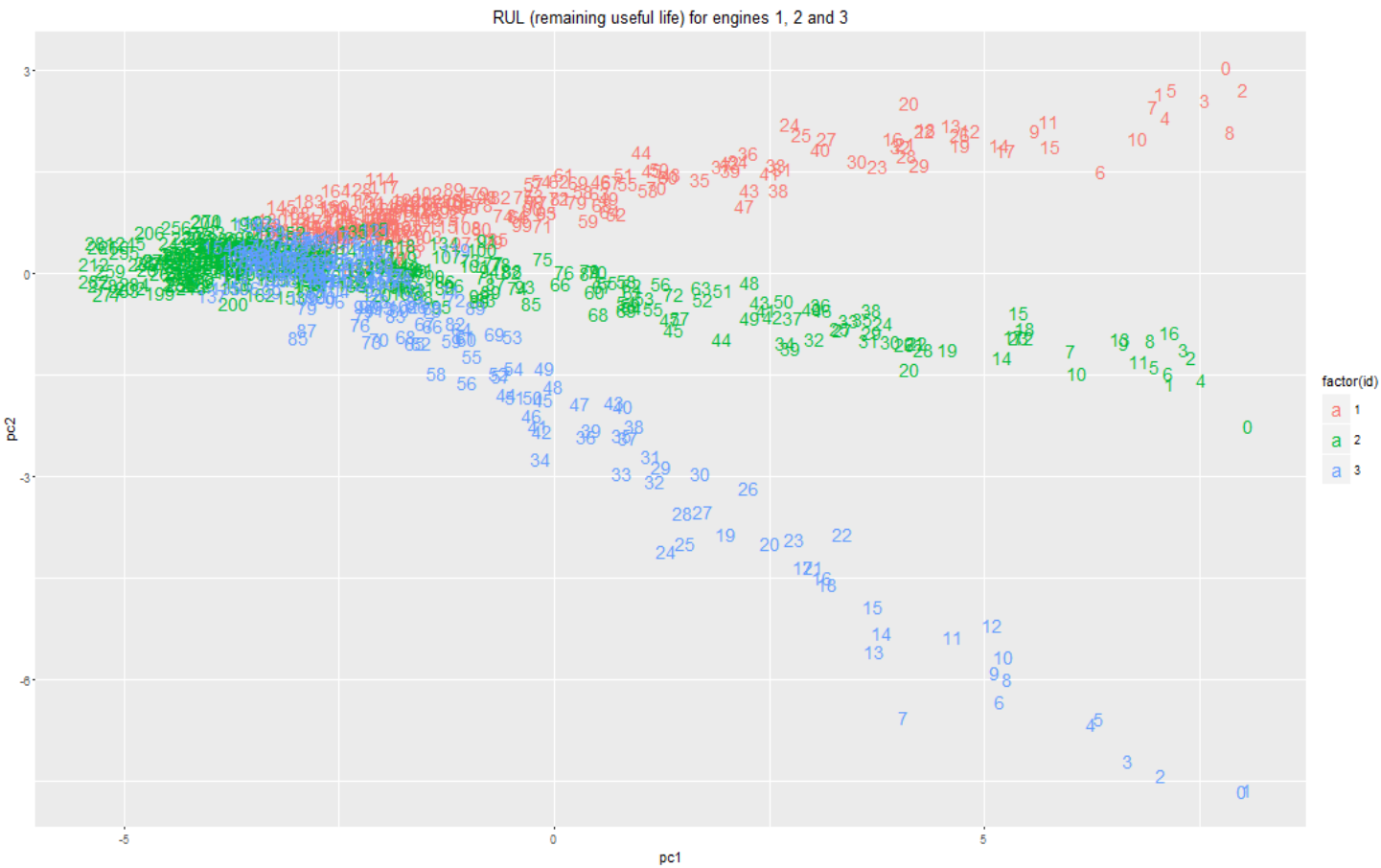
# End-to-End Exercises

- Provide time-series datasets with asset context
- Motivated by industry need
  - Predictive maintenance – equipment failure
  - Predicting hourly energy usage – facility/building
- Well-defined problem with clear objectives
- Defined solutions

# Engine data

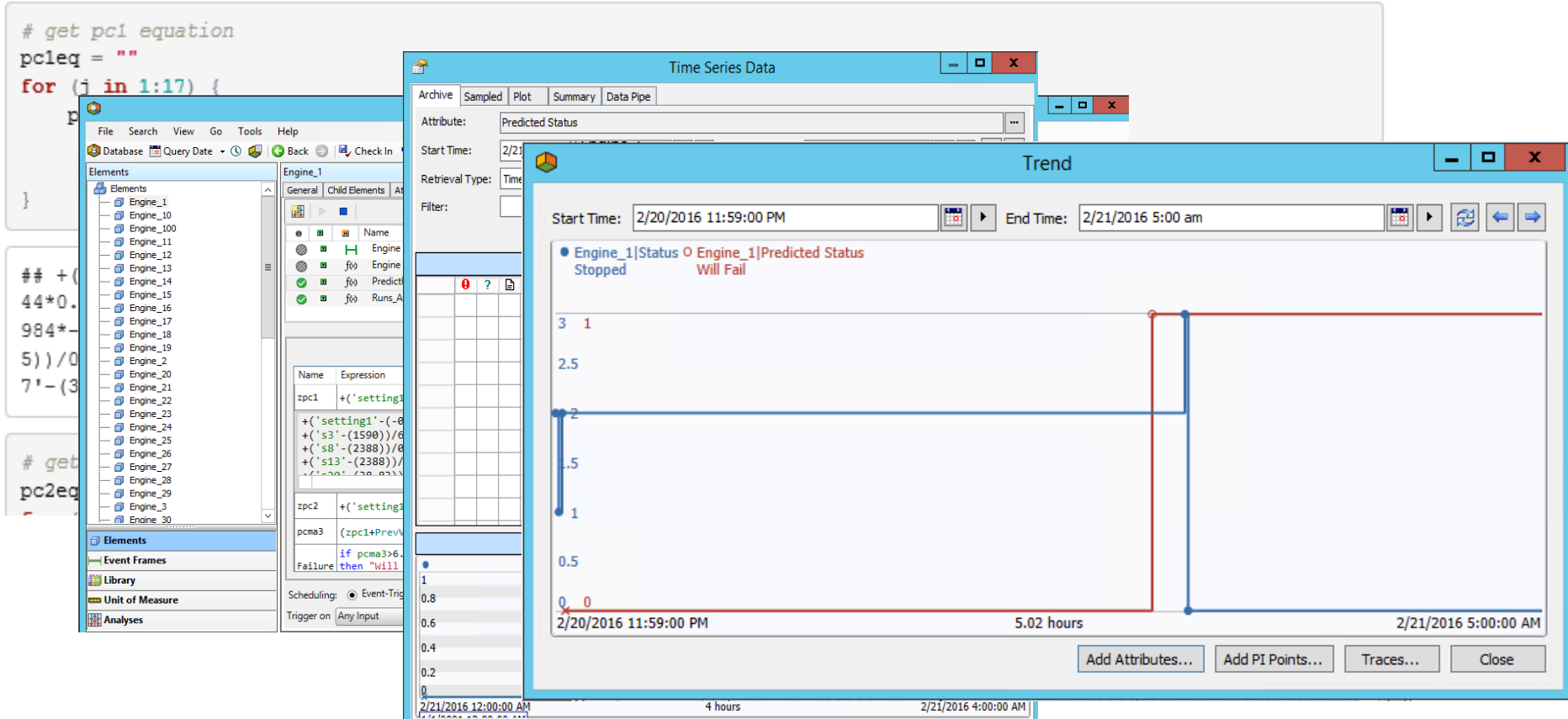
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1	id	cycle	setting1	setting2
2	1	1	-0.0007	-0.0004
3	1	2	0.0019	-0.0003
4	1	3	-0.0043	0.0003
5	1	4	0.0007	0
6	1	5	-0.0019	-0.0002
190	1	189	-0.0006	0.0002
191	1	190	-0.0027	0.0001
192	1	191	0	-0.0004
193	1	192	0.0009	0
194	2	1	-0.0018	0.0006
195	2	2	0.0043	-0.0003
196	2	3	0.0018	0.0003
197	2	4	0.0035	-0.0004
198	2	5	0.0005	0.0004

	A	B	C	D
1	id	cycle	setting1	setting2
2	1	1	-0.0007	-0.0004
3	1	2	0.0019	-0.0003
4	1	3	-0.0043	0.0003
5	1	4	0.0007	0
6	1	5	-0.0019	-0.0002
20625	100	193	-0.0001	0.0001
20626	100	194	-0.0011	0.0001
20627	100	195	-0.0002	-0.0001
20628	100	196	-0.0004	-0.0001
20629	100	197	-0.0016	-0.0001
20630	100	198	0.0004	
20631	100	199	-0.0011	0.0001
20632	100	200	-0.0032	-0.0001
20633	100	201	-0.0001	0.0001

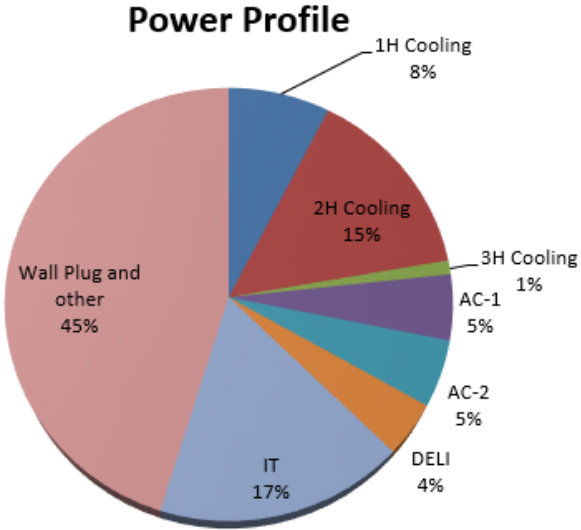
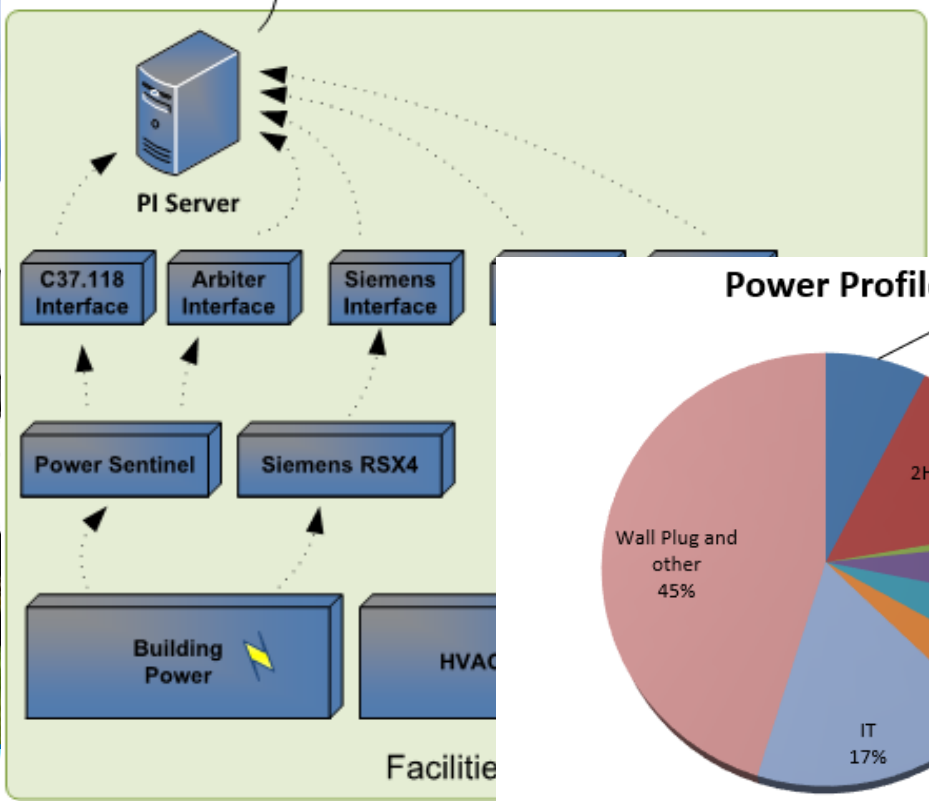
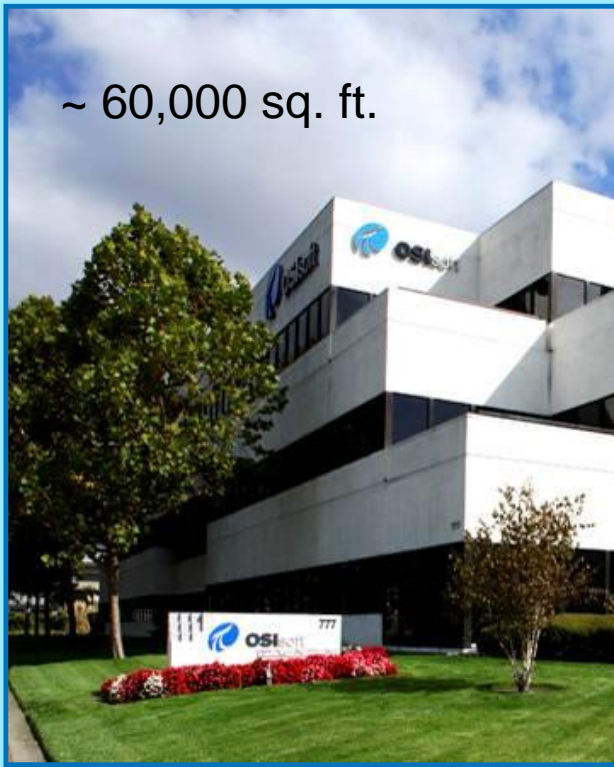




# Engine failure prediction



# Building/facility – HVAC and Power



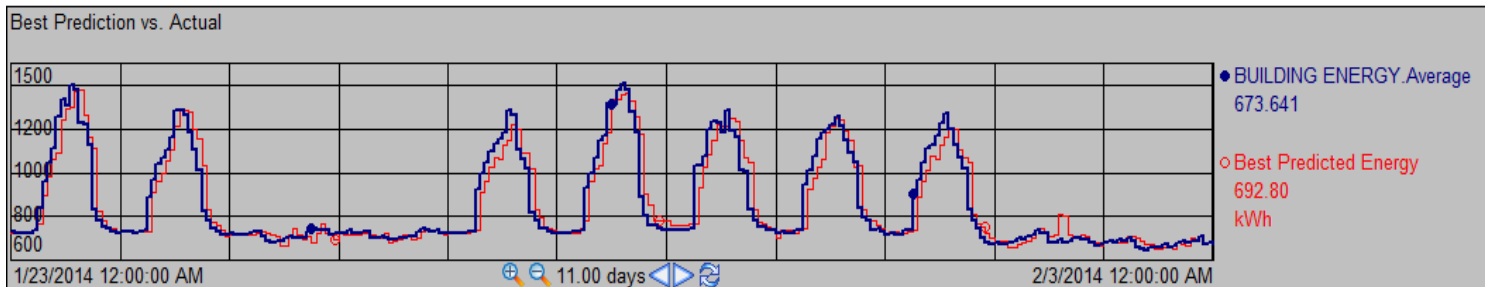
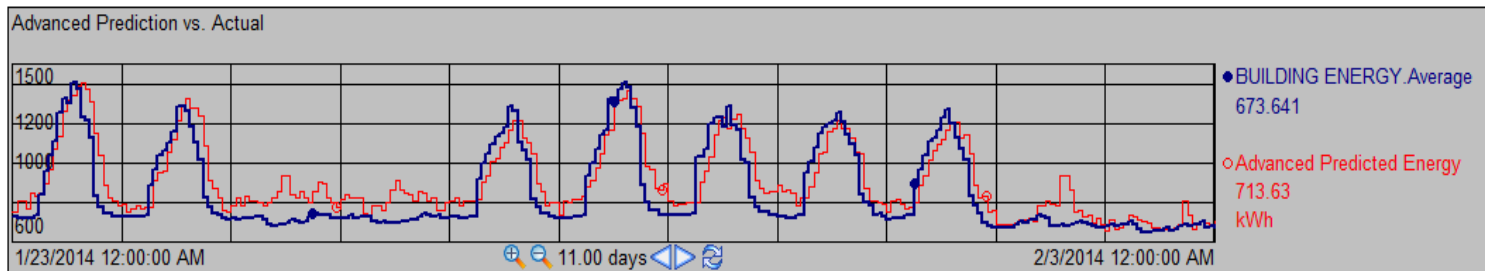
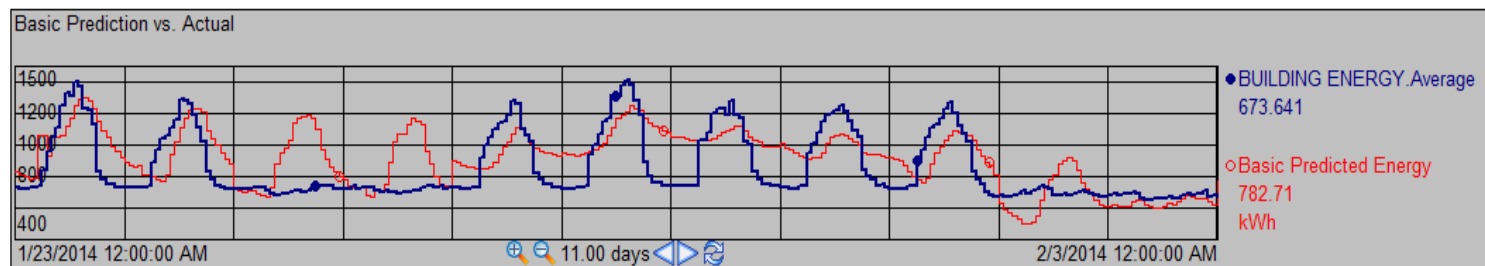
# Building/facility - Predict hourly energy use

## Lab Exercise

-Basic

-Advanced

-Best



## Call to Action + Q&A

- Think about how these tools fit into your curriculum
- To discuss your course syllabus, contact Nicolas Peels

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Instructional Systems Designer

OSIsoft, LLC

감사합니다

谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado



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