“History is a thing way of beating itself, is the history you do not know.”

- Harry S. Truman
Operating Forecast

Wind farm generation prediction based on weather forecast.

Graph showing real-time generation compared to predicted generation.
Electrical Spike Detection

Actual facility demand exceeds statistical significant range of prediction
Emerging Technologies

• Experimentation and Predictive Modelling
  – Microsoft Azure Machine Learning (ML)

• Shaping and Publishing PI System Data
  – Internal Alpha PI Integrator for Azure SQL

• Data Analysis and Assessment
  – Power BI Designer Preview

• Operationalization
  – PI System 2015 Future Data
Scenario: “Predict Building Energy Use”

Develop a model to predict energy use at our Headquarters Building. This model can be used for capacity planning, and abnormal spike detection and notification.

- Actual Energy Use
- Predicted Energy Use
Hypothesis: Variables Affecting Building Energy

Facilities
• Power, kW
• Hour of Day
• Weekday

Weather Station
• Outdoor Temperature

IT Network
• Network MAC Address Count
Predictive Modelling Process

Cloud Services

On Premise Applications

Power BI Designer
PI Integrator for Azure (internal Alpha)
PI System 2015

Facilities
Weather Station
IT Network

Azure SQL Database
Azure ML Studio
PI Integrator for Azure SQL (internal Alpha)

- Currently in OSIsoft development
- Create “PI Views”
- Filtered selection of AF Elements by name, hierarchy, or category
PI Integrator for Azure SQL (internal Alpha)

- Select time range and interval
- Add columns for aggregating PI System data
- Add columns for common time and date functions
- Share “PI Views”
- Publish table to Azure SQL
Power BI Designer Preview

- Provides Power BI Add-in Functionality Independent of Excel
- Free download from Microsoft
Microsoft Azure ML Studio

- Self-service data science
- Experimentation to find “best fit” prediction models
- Publish finalized models as accessible web service
- Pay as you go
“Basic” Energy Prediction Model Experiment

- Read data from Azure SQL table
- Select model input variables
- Split data for training and testing
- Train model using a selected algorithm
- Score (Test) model
- Evaluate model
“Basic” Energy Prediction Model Evaluation Results

- Visual and Statistical Analysis of Model Scoring
- “Coefficient of Determination” a.k.a. R-Squared = 0.63
“Advanced” Energy Prediction Model Experiment

- Copy “Basic” Model
- Add “Boosted Decision Tree Regression” algorithm
- Train both algorithms with Training Dataset
- Score both models with Scoring Dataset
- Evaluate algorithms
“Advanced” Energy Prediction Model Evaluation Results

“Boosted Decision Tree Regression”
R-Squared = 0.83

“Linear Regression”
R-Squared = 0.63
“Best” Energy Prediction Model

- Consider Seasonal Effect on Building Energy Demand
- Added feature, “Week Number” of the Year
- Insert “R” Script to “Week of Year” column
- R-Squared 0.96
Energy Predictions in PI System 2015

R Squared 0.63

R Squared 0.83

R Squared 0.96
“Basic Energy Prediction Model” Web Service

- Create Scoring Experiment
  - Trained Model
  - Configure Web service input and output parameters

- Publish Web Service
  - Sample access code
  - Testing dialog
  - Excel spreadsheet
Operationalization with PI System 2015

• Programmatic
  – Develop application to call the Azure ML web service
  – Example script generated by Azure ML Studio

• PowerShell Scripting
  – Temperature forecast from Weather Underground
  – PI Interface for Universal File and Stream Loading (PI UFL)

• Azure Data Factory
  – Azure orchestration engine
  – PI Interface for Relational Database (RDBMS)
PowerShell Scripting

OutsideTemperature Forecast RestAPI call for a given location
http://api.wunderground.com/api/8b3ebc8ba1df734a/hourly/q/CA/Oakland.json

BldgEnergy_kWh = f(
    OutsideTemperature, HourOfDay, DayOfWeek, WeekNumber
)
Azure Data Factory

Cloud Services

- Azure Data Factory
- Azure SQL Database
- Azure ML Web Service

On Premise Applications

- PI Integrator for Azure (internal Alpha)
- PI System 2015
- PI Interface for Relational Database
Questions

Please wait for the microphone before asking your questions

State your name & company