MATLAB EXPO 2016

Get More From Your Data with Data Analytics

Guangyuan Yang
BuildingIQ Develops Proactive Algorithms for HVAC Energy Optimization in Large-Scale Buildings

Office buildings, hospitals, and other large-scale commercial buildings account for about 30% of the energy consumed worldwide. The heating, ventilation, and air-conditioning (HVAC) systems in these buildings are often inefficient because they do not take into account changing weather patterns, variable energy costs, or the building’s thermal properties.

BuildingIQ has developed Predictive Energy Optimization™ (PEO), a cloud-based software platform that reduces HVAC energy consumption by 10–25% during normal operation. PEO was developed in cooperation with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), HVAC pressure sensors, as well as weather and energy cost data. A single building often produces billions of data points, and the scientists and engineers needed tools for efficiently filtering, processing, and visualizing this data.

To run their optimization algorithms, the scientists and engineers had to create an accurate mathematical model of a building’s thermal and power dynamics. The algorithms would use this calculated model to run constrained optimizations that maintained occupant comfort while minimizing energy costs.

BuildingIQ needed a way to rapidly develop mathematical models, test optimization algorithms, and visualize the results. They chose MATLAB because of its fast, flexible, and comprehensive environment for building such models.
How did we achieve this?
\[ \frac{\partial u}{\partial t} - \alpha \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right) = 0 \]
Challenges to Gain Value from Data

- Access and Explore Data
- Process Data
- Develop Predictive Models
- Integrate Analytics with Systems

More devices
More data
More often

Rapid data exploration
Development of scalable algorithms
Ease of deployment

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Why MATLAB?

1. Analytics increasingly require both business and engineering data.

2. Enable Domain Experts to be Data Scientists.

3. Develop embedded systems with analytics powered functionality.

4. Develop analytics to run on both enterprise and embedded platforms.

DATA
- Engineering, Scientific, and Field
- Business and Transactional

Embedded Systems

Business Systems

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Smarter Embedded Systems

DATA
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Business Systems
Accessing Data
Accessing Data

```
% Connect to data
ds = datastore('phonedata')

% Load in the data, and create feature vectors
trainingData = [];

while hasdata(ds)
    rawdata = read(ds);
    % Summary Statistics
    varMeans = varfun(@mean, rawdata(:,1:6));
    varStdss = varfun(@std, rawdata(:,1:6));
    % Signal Processing
    varRMS = varfun(@rms, rawdata(:,1:6));
    varMeanFreq = varfun(@meanfreq, rawdata(:,1:6));
    % Activity
    activity = rawdata(1,end);
```
Processing Signals and Images

- cheby2
- filter
- rms
- pwelch
- periodogram
- xcov
- findpeaks
- movmean
- movstd
- ...

- rgb2gray
- imfill
- bwmorph
- imfindcircles

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## Processing Data

![MATLAB GUI](image.png)

### Table: Sensor Data

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<th>Setting2</th>
<th>Setting3</th>
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<th>LPCOutletTemp</th>
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Processing Data

```
% Processing Data

% Read sensor data
sensorData = readtable('train_FD001_Unit_1.csv', 'ReadVariableNames', true);

% Select relevant variable names
variableNames = {'Unit' 'Time' 'LPCOutletTemp' 'HPCOutletTemp' ...
                 'LPTOutletTemp' 'TotalHPCOutletPres' 'PhysFanSpeed' ...
                 'PhysCoreSpeed' 'StaticHPCOutletPres' 'FuelFlowRatio' ...
                 'CorrFanSpeed' 'CorrCoreSpeed' 'BypassRatio' ...
                 'BleedEnthalpy' 'HPTCoolantBleed' 'LPTCoolantBleed'};
sensorData = sensorData(:, variableNames);

% Remove noise

% Plot data
>> plot(sensorData.LPCOutletTemp)
>> plot(sensorData.FanInletTemp)
>> sensorData(:, 'FanInletTemp') = [];
```
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3. Smarter Embedded Systems

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Business Systems

Data Scientist
“MATLAB has helped accelerate our R&D and deployment with its robust numerical algorithms, extensive visualization and analytics tools, reliable optimization routines, support for object-oriented programming, and ability to run in the cloud with our production Java applications.”

Borislav Savkovic, BuildingIQ
Apps - Classification Learner app
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MATLAB Differentiators

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