Analytics

Apply robust, statistically-motivated methods to data produced from complex systems to

**understand** what has happened,

**predict** what will happen, and

**suggest** decisions or actions.
Enterprise Integration – Forecasting Model

Forecast electricity demand for US power grids with live data from ISOs and weather stations using Neural Network.

Easy and accurate day-ahead system load forecast.

Requirements:
- Acquire and clean data from multiple sources
- Serve Multiple requests
- Deploy to production environment

http://54.165.201.58:8080/DemandForecastWeb/demandForecast.jsp
Deployment Scenarios

Sharing Reports

Sharing & Integrating Algorithms

Deploying Industrial Analytics

Enterprise scale analytics
Why is Deployment challenging?

- Multiple internal and external consumers of MATLAB algorithms
- Algorithm integration in different IT Applications and Workflows
- Scaling up model for multiple (simultaneous) users and big data

A Developer’s challenge to solve ...
How MATLAB can ease the challenges?

- What about an end to end solution on one single platform!!!

MATLAB: Single Platform

Data Acquisition
- Engineering, Scientific, and Field
- Business and Transactional

Data Analytics
- Data Pre-processing
- Feature Extraction
- Building algorithms, math models
- Making business decisions

Analytics Integration
- Integrate algorithms with IT
- Analytics run on Embedded targets

Business Systems
Smart Connected Systems
Key Takeaways for Today’s Session

1. Distribute applications to MATLAB users with Apps.

2. Distribute applications to non-MATLAB users as standalone applications.

3. Integrate MATLAB functions into existing workflows and development platforms.

4. Deploy MATLAB applications to service simultaneous user requests enterprise-wide.
Let’s solve them one by one…

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http://54.165.201.58:8080/DemandForecastWeb/demandForecast.jsp
Enterprise scale deployment of an Analytic
Deployed Analytics
MATLAB Production Server

Web Application Server
Apache Tomcat
Web Server/Webservice

MATLAB Production Server
MATLAB Production Server
Request Broker

MATLAB Desktop
Train in MATLAB
Predictive Models
Weather Data
Energy Data

MATLAB EXPO 2017
Data is too big to process!
Use MATLAB with Spark on Clusters

- tall array
- or
tall tables

Access data from HDFS

Apache Spark™

Run algorithms on Spark
Run MATLAB scripts on SPARK & HADOOP

MATLAB workers on worker nodes in the cluster
- MDCS workers (working from MATLAB)

Job submitted using Java RDD API

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MATLAB Production Server
Enterprise Class Framework For Running Packaged MATLAB Programs

- Server software
  - Manages packaged MATLAB programs and worker pool

- MATLAB Runtime libraries
  - Single server can use runtimes from different releases

- RESTful JSON interface and lightweight client library (C/C++, .NET, Python, and Java)
Key Takeaways

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Sharing Solar Analysis with Python users

%% Predicting Global Solar Radiation
% This demo creates and tests a temperature- and humidity-based estimate of daily global solar radiation. As the sun's rays penetrate the atmosphere, a portion of the radiation is reflected or absorbed. The amount reaching the Earth's surface, directly or through scattering, is known as global solar radiation. Maximum daily temperature, minimum daily temperature, and humidity are used to estimate the ratio of global solar radiation to extraterrestrial radiation (i.e. the ratio between the amount of solar radiation that hits the surface of the Earth and that which hits the atmosphere).

>> SolarAnalysisScript
Compiling Libraries
Calling MATLAB Compiled Package from Python

```python
>>> import CompiledSolarAnalysisFcn
```
MATLAB library leveraged in Python

```
import CompiledSolarAnalysisFcn

mySolarfunc = CompiledSolarAnalysisFcn.initialize()  # initialize the MCR

# import library for datatype integration between MATLAB and Python
import matlab

# Provide input path to MATLAB script from Python
filepath="C:\Users\pkar\Pallavi\Work\Deployment\Python Deployment\DemoFinal\Data"

type(filepath)

# Evaluate or call the MATLAB function
mySolarfunc.SolarAnalysisFcn(filepath)
```

Retain MATLAB’s capability
Integrate MATLAB-based Components With Your Own Software
# Pass Data to MATLAB from Python

## Python Type to MATLAB Scalar Type Mapping

When you pass Python® data as input arguments to MATLAB® functions, the MATLAB Engine for Python converts the data into equivalent MATLAB data types.

<table>
<thead>
<tr>
<th>Python Input Argument Type — Scalar Values Only</th>
<th>Resulting MATLAB Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>float</td>
<td>double</td>
</tr>
<tr>
<td>complex</td>
<td>Complex double</td>
</tr>
<tr>
<td>int</td>
<td>int64</td>
</tr>
<tr>
<td>long (Python 2.7 only)</td>
<td>int64</td>
</tr>
<tr>
<td>float(nan)</td>
<td>NaN</td>
</tr>
<tr>
<td>float(inf)</td>
<td>Inf</td>
</tr>
<tr>
<td>bool</td>
<td>logical</td>
</tr>
<tr>
<td>str</td>
<td>char</td>
</tr>
<tr>
<td>unicode (Python 2.7 only)</td>
<td>char</td>
</tr>
<tr>
<td>dict</td>
<td>Structure if all keys are strings</td>
</tr>
<tr>
<td></td>
<td>not supported otherwise</td>
</tr>
</tbody>
</table>

## Python Container to MATLAB Array Type Mapping

<table>
<thead>
<tr>
<th>Python Input Argument Type — Container</th>
<th>Resulting MATLAB Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>matlab numeric array object (see MATLAB Arrays as Python Variables)</td>
<td>Numeric array</td>
</tr>
<tr>
<td>bytearray</td>
<td>uint8 array</td>
</tr>
<tr>
<td>bytes (Python 3.x)</td>
<td>uint8 array</td>
</tr>
<tr>
<td>bytes (Python 2.7)</td>
<td>char array</td>
</tr>
<tr>
<td>list</td>
<td>Cell array</td>
</tr>
<tr>
<td>set</td>
<td>Cell array</td>
</tr>
</tbody>
</table>
Consumer otoscope in a mobile device
MATLAB to iPhone and Android Made Easy

Generating readable and portable C code from your MATLAB algorithms for your iPhone, iPad, or Android app

Bill Chou

Resources:


https://www.mathworks.com/matlabcentral/fileexchange/48954-matlab-to-iphone-made-easy-example-files

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function MonitoringDashboard(engNum)
if ~any(engNum==1:100)
    error('Input must be integer value from 1 to 100')
end
adddpath(fullfile(pwd,'helperFunctions'))
%% load trained model
load trainedmodel

%% read-in one file
filename = 'train_FD001_Unit_';
file = fullfile(pwd,'Data',filename num2str(engNum) '.csv');
Data = readtable(file,'ReadVariableNames',true);

%% Select relevant variable names based on visualization
VariableNames = {'Unit' 'Time' 'LPCOutletTemp' 'HPCOutletTemp' ...
                    'LPTOutletTemp' 'TotalHPCOutletPres' 'PhysFanSpeed' ...
                    'PhysCoreSped' 'StaticHPCOutletPres' 'FuelFlowRatio'...
                    'CoreFanSped' 'CorrCoreSped' 'BypassRatio'...
                    'S bleedEnthalpy' 'HPTCoolantBleed' 'LPTCoolantBleed'};
SensorNames = VariableNames(3:end);
filterWindow = 5;
Threshold = [50, 125, 200]; % thresholds
CatNames = {'urgent','short','medium','long'}; % categories
%% Prepare data needed for the prediction
testData = fPreprocess(Data,SensorNames,filterWindow);
Application Deployment
Compiling MATLAB functions
Share Applications Built Completely in MATLAB

1. Application Author
2. MATLAB Compiler
   - Standalone Application
   - Excel Add-in
   - Hadoop
3. MATLAB Runtime

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Can I run multiple analysis through multiple .exes?

- Do they run in parallel or serial?
- What if they need to run for different datasets?

Resource Management??

MATLAB has solutions designed for production environments:

- MATLAB Production Server
- MATLAB Distributed Computing Server
Mondi Implements Statistics-Based Health Monitoring and Predictive Maintenance for Manufacturing Processes with Machine Learning

**Challenge**
Reduce waste and machine downtime in plastics manufacturing plants

**Solution**
Use MATLAB to develop and deploy monitoring and predictive maintenance software that uses machine learning algorithms to predict machine failures

**Results**
- More than 50,000 euros saved per year
- Prototype completed in six months
- Production software run 24/7

Link to user story

**MATLAB EXPO 2017**

“MathWorks Consulting’s support is among the best I’ve seen; the consultants are fast and exceptionally knowledgeable. We’ve already seen a positive return on investment from cost savings, and now we have more budget and time to complete more machine learning projects that will provide similar benefits.”

Dr. Michael Kohlert
Mondi

One of Mondi Gronau’s plastic production machines, which deliver about 18 million tons of plastic and thin film products annually.
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MATLAB Apps to share algorithms with MATLAB users

- MATLAB Apps helps users prototype algorithms faster.
- You can use Apps with parallel.
- Automate or generate code from Apps.

How to package my own app?
Key Takeaways
What have we learnt?

1. Distribute applications to non-MATLAB users royalty-free.

2. Integrate MATLAB functions into existing workflows and development platforms.

3. Deploy MATLAB Analytics for Big Data on Hadoop enabled Spark Clusters.

4. Deploy MATLAB applications to service simultaneous user requests enterprise-wide via web or cloud frameworks.
Write Your Programs Once
Then Share To Different Targets

With MATLAB Users
MATLAB EXPO 2017

With People Who Do Not Have MATLAB

Source Code
MathWorks Services

- **Consulting**
  - Integration
  - Data analysis/visualization
  - Unify workflows, models, data

  [www.mathworks.com/services/consulting/](http://www.mathworks.com/services/consulting/)

- **Training**
  - Classroom, online, on-site
  - Data Processing, Visualization, Deployment, Parallel Computing, Machine Learning

  [www.mathworks.com/services/training/](http://www.mathworks.com/services/training/)
Online Resources

Call to action

• Documentation – MATLAB Production Server

• Technical Newsletter - Data-Driven Insights with MATLAB Analytics: An Energy Load Forecasting Case Study

• Free White Paper – Building a Website with MATLAB Analytics

• Website – Using MATLAB With Other Programming Languages

• Website – MATLAB for Enterprise scale Applications
Your feedback is valued.

Please complete the feedback form provided to you.
THANK YOU