MATLAB EXPO 2017
Integrating MATLAB Analytics into Enterprise Applications

Pallavi Kar
Application Engineer
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!!!
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…

1. Deploy MATLAB applications to service simultaneous user requests enterprise-wide

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

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

4. Distribute applications to MATLAB users with Apps.
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
Enterprise scale deployment of an Analytic
Deployed Analytics

MATLAB Production Server

Web Application Server

MATLAB Production Server

MATLAB Desktop

Train in MATLAB

Predictive Models

Weather Data

Energy Data

Apache Tomcat

Web Server/Webservice

Request Broker

CTF

Deployed Analytics

MATLAB Production Server

MATLAB EXPO 2017
Request Management

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)
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

1. Distribute applications to MATLAB users royalty-free.

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

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

4. Deploy MATLAB applications to service simultaneous user requests enterprise-wide.
Sharing Solar Analysis with Python users

% Predicting Global Solar Radiation
% This demo creates and tests a temperature- and humidity-based estimate of mean daily global solar radiation. As the sun’s energy penetrates 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 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

**Application Author**

1. **MATLAB**
   - Toolboxes

2. **MATLAB Compiler SDK**
   - C/C++
   - .NET
   - Python
   - Java
   - MATLAB Production Server

3. Software Developer

4. **MATLAB Runtime**

**MATLAB EXPO 2017**
## 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 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

Key Takeaways

1. Distribute applications to MATLAB users royalty-free.

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

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

4. Deploy MATLAB applications to service simultaneous user requests enterprise-wide.
function MonitoringDashboard(engNum)

    if ~any(engNum==1:100)
        error('Input must be integer value from 1 to 100')
    end

    addpath(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' 'LPTOutletPres' 'PhysFanSpeed' 'StaticHPCOutletPres' 'FuelFlowRatios' 'CorrFanSpeed' 'CorrCoreSpeed' 'BypassRatio' 'SlewedEnthalpy' 'HPTCoolantBleed' 'LPTCoolantBleed'};
    SensorNames = VariableNames(3:end);
    filterWindow = 5;

    % thresholds
    Threshold = [50, 125, 200];

    % categories
    CatNames = {'urgent', 'short', 'medium', 'long'};

    %% Prepare data needed for the prediction
    testData = fPreprocess(Data, SensorNames, filterWindow);

MATLAB EXPO 2017
Application Deployment
Compiling MATLAB functions
Share Applications Built Completely in MATLAB

MATLAB

Toolboxes

1

MATLAB Application

2

MATLAB Compiler

Standalone Application
Excel Add-in
Hadoop

3

End User

MATLAB Runtime

MATLAB EXPO 2017
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
**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

---

“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

---

Link to user story

MATLAB EXPO 2017
Key Takeaways

1. Distribute applications to MATLAB users royalty-free.

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

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

4. Deploy MATLAB applications to service simultaneous user requests enterprise-wide.
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
With People Who Do Not Have MATLAB

Apps
Files
Custom Toolbox

Source Code

MATLAB

MATLAB Compiler
MATLAB Compiler SDK
MATLAB Coder

Standalone Application
Excel Add-in
Hadoop
C/C++
Java
.NET
Python
MATLAB Production Server

With MATLAB
Users

MATLAB EXPO 2017
# Technology Stack

## Data
- Databases
  - neo4j
  - MongoDB
  - SQL Server
  - Azure Blob
  - S3
- Cloud Storage
  - kafka

## Analytics
- MATLAB Distributed Computing Server
- MATLAB Production Server
- Request Broker

## Business System
- Visualization
  - Qlik
  - Tableau
  - Spotfire
- Web
  - Microsoft IIS
  - WebSphere
  - Apache Tomcat
- Custom App
  - Python
  - R

## Platform
- Public Cloud
  - Microsoft Azure
  - Amazon Web Services
  - Rackspace
  - OpenStack
- Private Cloud
  - VMware

---

MATLAB EXPO 2017
MathWorks Services

- **Consulting**
  - Integration
  - Data analysis/visualization
  - Unify workflows, models, data
  
  www.mathworks.com/services/consulting/

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

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

MATLAB EXPO 2017
Your feedback is valued.
Please complete the feedback form provided to you.
THANK YOU