MATLAB EXPO 2016
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등록 하기 matlabexpo.co.kr
센서 데이터 애플리틱스를 위한 신호처리 및 머신러닝 기법

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Sensor Analytics and Edge Node Development
Key topics

- Signal Processing methods (e.g. digital filtering, spectral analysis)
- Machine Learning algorithms (e.g. classification)
- MATLAB environment “enablers” (e.g. language, visualization, Apps, documentation)
- Flow from predictive algorithms to embedded implementation (e.g. DSP system simulation, automatic code generation)
Sensor Analytics Workflow

**Acquire**
- Data Acquisition Toolbox
- Instrument Control Toolbox
- Hardware Support Packages (XX)
- Database Toolbox
- ThingSpeak

**Analysis**
- Simulink
- Signal Processing Toolbox
- DSP System Toolbox

**Analytics**
- MATLAB
- Stats & Machine Learning TB
- Neural Networks Toolbox

**Deployment**
- MATLAB Coder
- Simulink Coder
- Embedded Coder
- MATLAB Compiler
- MATLAB Production Server
Signal analysis for classification
Application examples

- Mobile sensing
- Structural health monitoring (SHM)
- Fault and event detection
- Automated trading
- Radar post-processing
- Advanced surveillance
- …
Example: Human Activity Analysis and Classification

Dataset courtesy of:
Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra and Jorge L. Reyes-Ortiz.
*Human Activity Recognition on Smartphones using a Multiclass Hardware-Friendly Support Vector Machine.*
Sensor Data Analytics Workflow – the bigger picture

- Domain knowledge
- Open-ended problem
- Long discovery cycles
- Built-in algorithms
- Concise code (54 lines for 66 features!)
- Apps and visualisation accelerate insight
Sensor Data Analytics Workflow – the bigger picture

- Different tools and environments
- Disconnect between hardware and analysis
- Inefficiencies in data sharing

MATLAB Connects to DAQ interfaces and sensors directly. E.g.
- **Android Sensor Support**
- **iPhone and iPad Sensor Support**
Sensor Data Analytics Workflow – the bigger picture

- Signal analysis vs. on-line DSP
- From Machine Learning theory to pre-trained, low-footprint classifiers
- MATLAB vs. C/C++
- Streaming algorithms, data sources and visualization for System modelling and simulation
- Automatic code generation
Leverage Built-in Algorithms, Apps, and Technologies

- **Signal Processing Toolbox™**
  Built-in algorithms and Apps to process and analyse signals

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

\[
|H(j\omega)|^2 = \frac{e^{2}C_2^2(\omega_p/\omega)}{1 + e^{2}C_2^2(\omega/\omega)}
\]

\[
C_2(\omega) = \begin{cases} \csc(N\cos^{-1}(\omega_p/\omega)), & |\omega| \geq \omega_p \\ \frac{1}{\csc(N\cos^{-1}(\omega/\omega))}, & |\omega| < \omega_p \end{cases}
\]

\[
P_{xx}(f) = \frac{1}{2F_s} \left| \sum_{n=0}^{L-1} x[n] \exp(-j2\pi fn/F_s) \right|^2
\]

\[
\hat{f}_k = \frac{kF_s}{N}, \quad k = 0, 1, ..., N-1
\]

\[
v_{xy}(m) = \begin{cases} \sum_{n=0}^{N-1} \left( x[n+m] - \frac{1}{N} \sum_{i=0}^{N-1} x_i \right) \left( y[n+m] - \frac{1}{N} \sum_{i=0}^{N-1} y_i \right), & m > 0 \\ \frac{1}{N} \sum_{i=0}^{N-1} x_i y_i, & m = 0 \\ \sum_{n=-\infty}^{\infty} \left( x[n] - \frac{1}{N} \sum_{i=0}^{N-1} x_i \right) \left( y[n-m] - \frac{1}{N} \sum_{i=0}^{N-1} y_i \right), & m < 0 \end{cases}
\]
Leverage Built-in Algorithms, Apps, and Technologies

- Signal Processing Toolbox™
- Parallel Computing Toolbox™
  Accelerate computationally and data-intensive problems using multicore processors, GPUs and computer clusters
Leverage Built-in Algorithms, Apps, and Technologies

- Signal Processing Toolbox™
- Parallel Computing Toolbox™
- Statistics and Machine Learning Toolbox™

Functions and apps to describe, analyze, and model data. Regression, clustering and classification algorithms to draw inferences from data and build predictive models.
Leverage Built-in Algorithms, Apps, and Technologies

- Signal Processing Toolbox™
- Parallel Computing Toolbox™
- Statistics and Machine Learning Toolbox™
- **Neural Network Toolbox™**
  Functions and apps to design, train, visualize, and simulate neural networks

- `>> nprrtool`
- `patternnet`
Leverage Built-in Algorithms, Apps, and Technologies

- Signal Processing Toolbox™
- Parallel Computing Toolbox™
- Statistics Toolbox™
- Neural Network Toolbox™

• DSP System Toolbox™
  Streaming algorithms, data sources and visualization for system modelling and simulation

- BiquadFilter
- MatFileReader
- Autocorrelator
- SpectrumEstimator
- TimeScope
Leverage Built-in Algorithms, Apps, and Technologies

- Signal Processing Toolbox™
- Parallel Computing Toolbox™
- Statistics Toolbox™
- Neural Network Toolbox™
- DSP System Toolbox™
- MATLAB Coder™

Generate embeddable source C/C++ from MATLAB code

(Learn more: MATLAB to C Made Easy webinar)
Signal Processing and Machine Learning Techniques for Sensor Data Analytics

Summary

- Extensive set of de-facto standard functions for signal processing and machine learning

- Environment accelerates insight and automation: visualisation, apps, language, documentation

- Path to embedded products, from on-line simulation to automatic code generation