MATLAB EXPO 2018

Are you ready for AI?
Is AI ready for you?

Dr. Mischa Kim
Alexa –
Write my Expo keynote for me
Alexa –
Play Mozart 🎼
Artificial Intelligence Is in Early Adoption

Percentage of Respondents

- 14% No interest
- 35% On the radar, no action planned
- 25% In medium- or long-term planning
- 21% In short-term planning/actively experimenting
- 4% Have already invested and deployed

Q: What are your organization’s plans in terms of artificial intelligence?
Base: All answering, n = 3,138
Source: Gartner 2018 CIO Survey

Source: Gartner, *Real Truth of Artificial Intelligence* by Whit Andrews
Presented at Gartner Data & Analytics Summit 2018, March 2018
Artificial Intelligence

The capability of a machine to imitate intelligent human behavior
Artificial Intelligence

The capability of a machine to match or exceed intelligent human behavior
Artificial Intelligence Today

The capability of a machine to *match or exceed* intelligent human behavior

*by training a machine to learn the desired behavior*
There are two ways to get a computer to do what you want

Traditional Programming

Data → COMPUTER → Output

Program → COMPUTER → Output
There are two ways to get a computer to do what you want

Machine Learning

Data → COMPUTER → Program

Output
There are two ways to get a computer to do what you want

Machine Learning

Data → COMPUTER → Model

Output

Artificial Intelligence  Machine Learning
Are you ready for AI?
Are you ready for AI?
Are you ready for AI?

Access Data
Analyze Data

Data
Output
Model
Are you ready for AI?

Access Data
Analyze Data
Develop
Deploy

Data
Output
Model
Are you ready for AI?

Access Data
Analyze Data
Develop
Deploy

Data
Output
Model

EVERYTHING ELSE
## Are you ready for AI?

<table>
<thead>
<tr>
<th>Access Data</th>
<th>Analyze Data</th>
<th>Develop</th>
<th>Deploy</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>AI model</td>
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<td></td>
<td></td>
<td>Algorithm development</td>
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<td></td>
<td>Modeling &amp; simulation</td>
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</tbody>
</table>
Are you ready for AI?

**Access Data**
- Sensors
- Files
- Databases

**Analyze Data**
- Data exploration
- Preprocessing
- Domain-specific algorithms

**Develop**
- AI model
- Algorithm development
- Modeling & simulation

**Deploy**
Are you ready for AI?

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**Develop**
- AI model
  - Algorithm development
  - Modeling & simulation

**Deploy**
- Desktop apps
- Enterprise systems
- Embedded devices
Are you ready for AI?

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- Desktop apps
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Caffe
TensorFlow
Do you need AI?
AI for Predictive Maintenance

- Measure the wear of each robot
- Predict and fix failures before they happen
- AI handles uncertainty and variability
Are you ready for AI if …

You’ve never used machine learning?
What is crispiness?

Crushing Sound + Crushing Force = Crispy Enough

Crispy
Crispy Enough
Soggy
Replicating human perception with machine learning
Technical University of Munich

Machine Learning Workflow

Data ➔ Feature extraction ➔ Classification

- Crispy
- Crispy enough
- Soggy
Replicating human perception with machine learning
Technical University of Munich

Classification Learner
Are you ready for AI if you’ve never used machine learning?

- No experience required
- Use apps to try out all possible models
- Use domain expertise and familiar tools to prepare data
Find out more:

“MATLAB을 이용한 머신 러닝 (기본)”

“복잡한 문제를 단순하게 만드는 MATLAB환경에서의 머신 러닝 (중급)”
Are you ready for AI if …

You can’t identify features in your data?
Use deep learning to identify features automatically

Machine Learning Workflow

Data -> Feature extraction -> Classification

- Crispy
- Crispy enough
- Soggy
Use deep learning to identify features automatically

Machine Learning Workflow

Data → Feature extraction → Classification → Crispy ✓

Crispy

Crispy enough

Soggy

Deep Learning Workflow

Data → Deep neural network → Crispy ✓

Crispy

Crispy enough

Soggy
Traditional Approach
- Geologists assess seven different metrics
- Can take hours to analyze one site
- Critical shortage of geologists

New Approach
- Use deep learning to automatically recognize metrics based on images
- On-site evaluators decide with support from deep learning
Efficient tunnel drilling with deep learning
Obayashi Corporation

Split into sub-images

Label each sub-image

<table>
<thead>
<tr>
<th>Image</th>
<th>Weathering Alteration (1-4)</th>
<th>Fracture Spacing (1-5)</th>
<th>Fracture State (1-5)</th>
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<tbody>
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Efficient tunnel drilling with deep learning
Obayashi Corporation

Transfer learning

AlexNet
PRETRAINED MODEL

Ice cream  Teapot  Goose

Custom Network

Weathering alteration: 4
Fracture spacing: 3
Fracture state: 2
Efficient tunnel drilling with deep learning
Obayashi Corporation

Transfer learning

MATLAB Production Server

Weathering alteration: 4
Fracture spacing: 3
Fracture state: 2

AlexNet
PRETRAINED MODEL
Ice cream
Teapot
Goose

Custom Network
Are you ready for AI if you can’t identify features in your data?

- Deep learning

```matlab
nnet = alexnet;
cam = webcam;
picture = snapshot(cam);
picture = imresize(picture,[227 227]);
label = classify(nnet, picture)
```
Are you ready for AI if you can’t identify features in your data?

- Deep learning
- Transfer learning

Deep learning in 5 lines of code
Are you ready for AI if you can’t identify features in your data?

- Deep learning
- Transfer learning
- Automation and AI to label data
Are you ready for AI if you can’t identify features in your data?

- Deep learning
- Transfer learning
- Automation and AI to label data

Classification

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<tr>
<td>Ground</td>
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Point cloud semantic segmentation
Find out more:
“개발에서 구현까지 MATLAB 환경에서의 딥러닝”
“딥러닝을 활용한 영상 인식 응용프로그램 개발 워크플로우”
“GPU 기반의 임베디드 하드웨어에서의 딥러닝 및 코드 생성”
Are you ready for AI if ...

If you don’t have the right data?
AI for Predictive Maintenance

- Measure the wear of each blade
- Predict and fix failures before they happen
- Can’t rely on failures in the field
Predictive maintenance with synthetic failure data with MATLAB & Simulink

Simulink model
Predictive maintenance with synthetic failure data with MATLAB & Simulink

- Measured data
- Refine model
- Simulink model
- Inject failures
- Failure data
- Failure conditions
Are you ready for AI if you don’t have the right data?

- Generate data with simulations
- Simulation environment for reinforcement learning

**Reinforcement Learning**

- **Learn**
- **Act**
- **Define Reward**

**Goal:** learn to take actions that maximize reward
Find out more:

“고장 진단 및 건전성 관리 기술: 알고리즘 개발에서 사물인터넷 환경 구성까지”

“물리모델 시뮬레이션을 활용한 고장 예측”
Low-carbon homes

- Generate power with fuel cell and solar panels
- Store power in battery
- Buy power when needed; sell when extra
- Record data on environment and energy usage
Low-carbon homes

- Generate power with fuel cell and solar panels
- Store power in battery
- Buy power when needed; sell when extra
- Record data on environment and energy usage

Goals

- Minimize energy cost
- Use EV battery for additional storage
Optimizing home energy management system

Denso

Generated and consumed power

Home Energy Controller

Battery command

Home

Stored energy
Optimizing home energy management system

Denso

Electricity prices

Predicted vehicle use

Generated and consumed power

Battery command

Home Energy Controller

Stored energy

Home

Model predictive control
Mixed integer linear programming

Simscape Power Systems
# Optimizing home energy management system

**Denso**

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<td>Control algorithms</td>
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<td>Optimization</td>
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“The effort would have taken significantly longer if we had used disparate tools.

[MATLAB] enabled our team of domain experts, who lacked formal training in data science, machine learning, and parallel computing, to incorporate all these areas in our design process.”

Akira Ito and Ryu Matsumoto
Exceeding human capabilities with a robotic drumming prosthesis
Georgia Tech Center for Music Technology
Exceeding human capabilities with a robotic drumming prosthesis
Georgia Tech Center for Music Technology

EMG
Microphone

Processing laptop
AI algorithms
PID controller

Host computer
Drummer
Prosthesis

Music
Are you ready for AI if …

You’ve never used machine learning?  Easy programming
                                   Apps
                                   Domain expertise to prepare data
Are you ready for AI if …

You’ve never used machine learning?
- Easy programming
- Apps
- Domain expertise to prepare data

You can’t identify features in your data?
- Deep learning identifies features for you
- Transfer learning works with less data
- Use AI to label data
Are you ready for AI if …

You’ve never used machine learning?  
Easy programming  
Apps  
Domain expertise to prepare data

You can’t identify features in your data?  
Deep learning identifies features for you  
Transfer learning works with less data  
Use AI to label data

You don’t have the right data?  
Generate failure data with simulations  
Simulate environment for reinforcement learning
With MATLAB and Simulink, you ARE ready for AI!