MATLAB EXPO 2018

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

Mike Agostini
Alexa –
Write my Expo keynote for me
Alexa –
Play soothing jazz
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: Allanswering, 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
- Program
- Computer
- Output
There are two ways to get a computer to do what you want

Machine Learning

- Data
- Output
- Program
There are two ways to get a computer to do what you want.
Are you ready for AI?

Data

Output

Model
Are you ready for AI?

- Data
- Output
- Model
Are you ready for AI?

Access Data

Analyze Data

Data

Output

Model
Are you ready for AI?

Access Data

Develop

Analyze Data

Deploy

Data

Output

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

Access Data
- Sensors
- Files
- Databases

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

Develop
- AI model
- Algorithm development
- Modeling & simulation

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

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<td>Data exploration</td>
<td>AI model</td>
<td>Desktop apps</td>
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<td>Files</td>
<td>Preprocessing</td>
<td>Algorithm development</td>
<td>Enterprise systems</td>
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<td>Databases</td>
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<td>Embedded devices</td>
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</table>
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?

Crispy 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
Are you ready for AI if …

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

Machine Learning Workflow

Data → Feature extraction → Classification

- Crispy
- Crispy enough
- Soggy

Deep Learning Workflow

Data → Deep neural network

- Crispy
- Crispy enough
- Soggy
Mikusa Tunnel
Japan
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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
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<td>2</td>
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<td></td>
<td>...</td>
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<td>...</td>
</tr>
</tbody>
</table>
Efficient tunnel drilling with deep learning
Obayashi Corporation

Transfer learning

AlexNet
PRETRAINED MODEL

Custom Network

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

Ice cream  Teapot  Goose
Efficient tunnel drilling with deep learning
Obayashi Corporation

Transfer learning

MATLAB Production Server

AlexNet
PRETRAINED MODEL

Ice cream
Teapot
Goose

Custom Network

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

Classification table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>Red</td>
</tr>
<tr>
<td>Truck</td>
<td>Orange</td>
</tr>
<tr>
<td>Background</td>
<td>Blue</td>
</tr>
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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

- Car
- Truck
- Background
- Ground

Point cloud semantic segmentation
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 → Inject failures → Simulink model → Failure data

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

- Generate data with simulations
- Simulation environment for reinforcement learning

Goal: learn to take actions that maximize reward
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

Home

Stored energy

Model predictive control

Mixed integer linear programming

Simscape Power Systems
# Optimizing home energy management system

## Denso

<table>
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<tr>
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<tr>
<td>![Folder](1000 CSV Files)</td>
<td><img src="Preprocessing" alt="Bar graph" /></td>
<td>![Sound wave](Classification Learner)</td>
<td></td>
</tr>
<tr>
<td>1000 CSV Files</td>
<td>Parallel computing</td>
<td></td>
<td></td>
</tr>
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- **Access Data**: 1000 CSV Files
- **Analyze Data**: Preprocessing, Parallel computing
- **Develop**: Classification Learner
- **Deploy**: None
### Optimizing home energy management system

**Denso**

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<td>Simscape Power Systems</td>
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<tr>
<td></td>
<td></td>
<td>Control algorithms</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Optimization</td>
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</tr>
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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

EMG

Processing laptop

PID controller

Host computer

Prosthesis

Drummer

Music
Exceeding human capabilities with a robotic drumming prosthesis
Georgia Tech Center for Music Technology
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
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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
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You’ve never used machine learning?
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You can’t identify features in your data?
- Deep learning identifies features for you
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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!