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: All Answering, n = 3,138
Source: Gartner 2018 CIO Survey

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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 → COMPUTER → Program

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

Machine Learning

Artificial Intelligence

Output

Data

COMPUTER

Model

Machine Learning
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?

Data

Model

Access Data

Analyze Data

Develop

Deploy
Are you ready for AI?

- **Data**
- **Output**
- **Model**

Access Data
- Analyze Data
- Develop
- Deploy

EVERYTHING ELSE
Are you ready for AI?

<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>
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<tr>
<td></td>
<td></td>
<td>Algorithm development</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Modeling &amp; simulation</td>
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</tbody>
</table>

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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
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Analyze Data
- Data exploration
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- Domain-specific algorithms

Develop
- AI model
- Algorithm development
- Modeling & simulation

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

**Access Data**
- Sensors
- Files
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**Analyze Data**
- Data exploration
- Preprocessing
- Domain-specific algorithms

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

**Deploy**
- Desktop apps
- Enterprise systems
- Embedded devices
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 Sound = Crushing Force

- 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
Fresh 93%
91%
91%
91%
89%
95%

True Class

Soggy

Fresh  Predicted Class  Soggy
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

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

Deep Learning Workflow

Data → Deep neural network → Classification

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>
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</table>
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

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

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

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

Failure conditions
Are you ready for AI if you don’t have the right data?

- Generate data with simulations
- Simulation environment for reinforcement learning
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

Battery command

Home Energy Controller

Stored energy

Home
Optimizing home energy management system
Denso

Electricity prices
Predicted vehicle use

Generated and consumed power
Battery command
Home

Home Energy Controller

Stored energy

Model predictive control
Mixed integer linear programming

Simscape Power Systems
Optimizing home energy management system
Denso

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<tr>
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## Optimizing home energy management system

### Denso

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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

EMG
Processing laptop
Host computer
Prosthesis
Drummer
Music

PID controller
Exceeding human capabilities with a robotic drumming prosthesis
Georgia Tech Center for Music Technology

- EMG
- Microphone
- Processing laptop
- Host computer
- AI algorithms
- PID controller
- 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 …

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<th>Solution</th>
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<td>Generate failure data with simulations&lt;br&gt;Simulate environment for reinforcement learning</td>
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With MATLAB and Simulink, you ARE ready for AI!