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**#MATLABEXPO**



# MATLAB EXPO

## MATLAB with TensorFlow and PyTorch

*David Willingham*



*Yann Debray*



*Sivylla Paraskevopoulou*



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The following presentation is inspired by  
situations and questions from  
current **MATLAB and Python users**



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Questions about **deep learning**  
in situations such as...

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*Our data scientists use TensorFlow & PyTorch*  
*Our engineers use MATLAB*

***How can our teams work together?***

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*The latest models come out in  
TensorFlow & PyTorch first.*

***What support does MATLAB have for the latest models?***

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*Deploying models into embedded systems  
is time-consuming*

***Can MATLAB help us deploy to embedded systems quicker?***

# Our presenters will roleplay a scenario to answer these questions



David  
**The Project Manager**



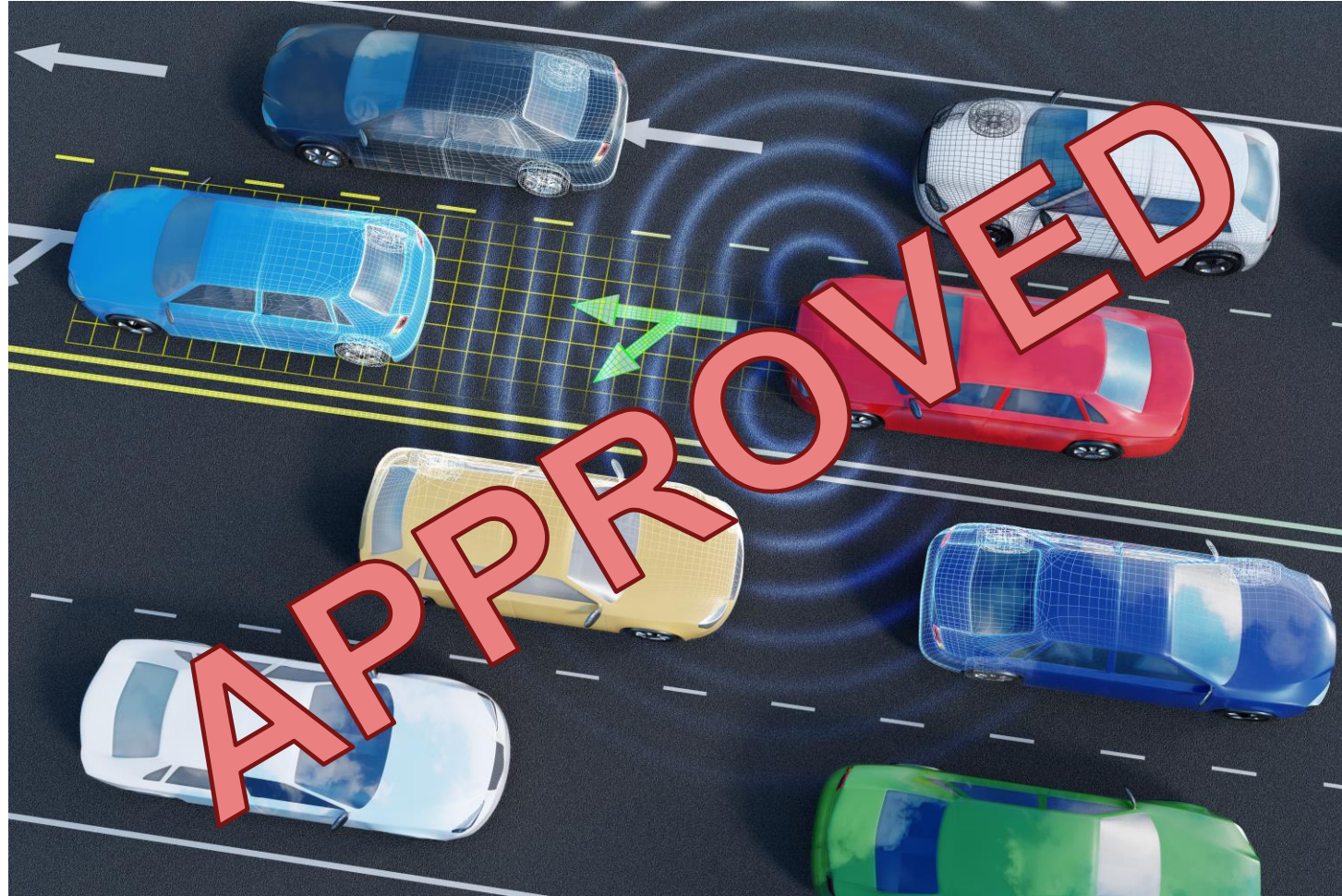
Sivylla  
**The Engineering Team  
Lead**



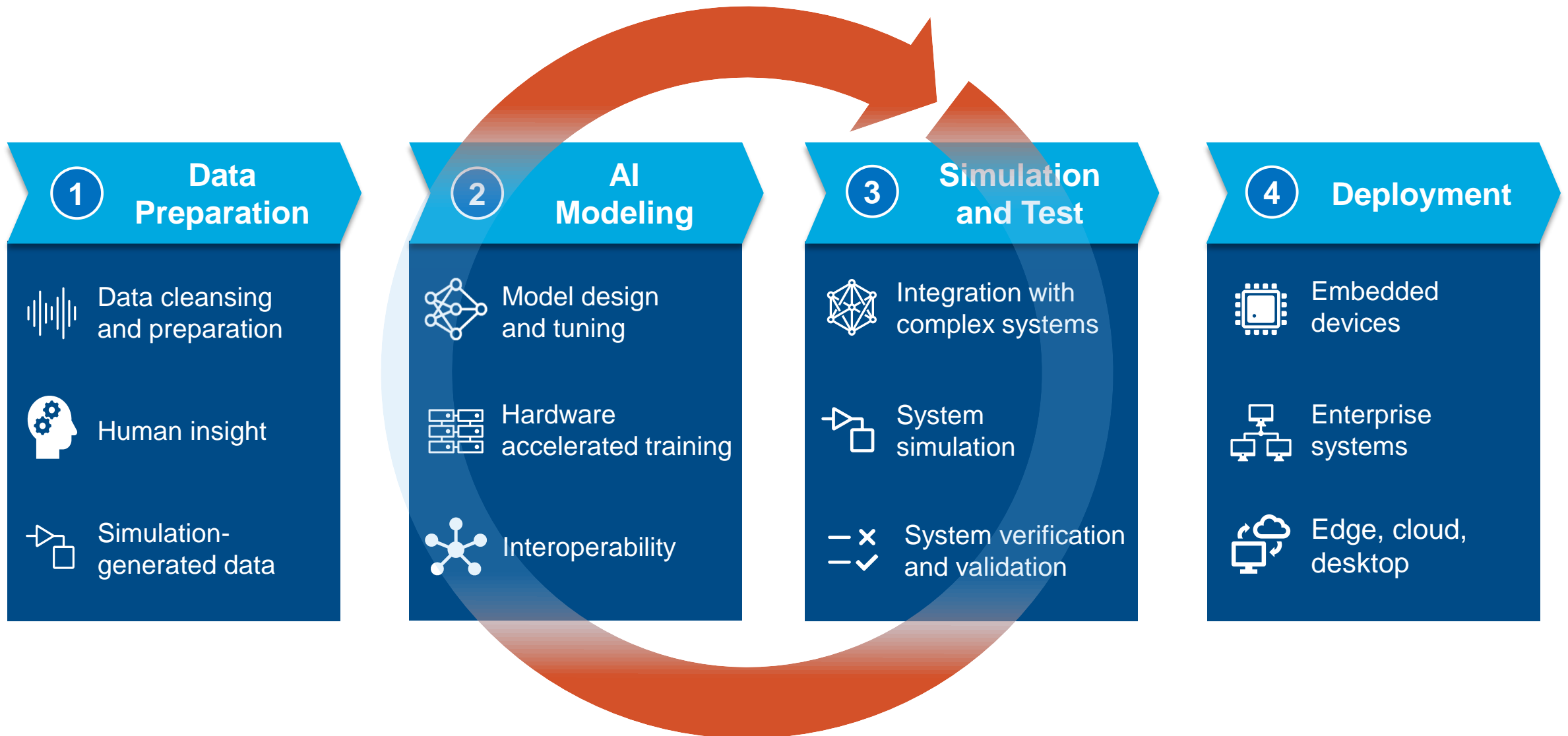
Yann  
**The Data Science Team  
Lead**



The AI enabled car project has been approved!



# Our best results come from following the AI system design workflow



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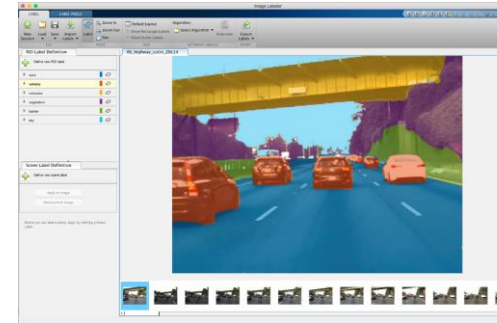
Here are the  
higher-level project requirements

# Data Preparation requirements

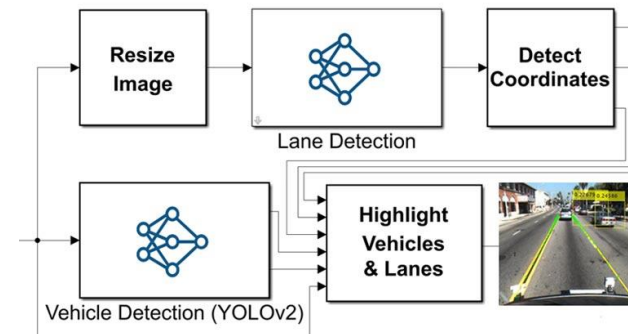
- Add domain knowledge

**1 Data Preparation**

- Data cleansing and preparation
- Human insight
- Simulation-generated data



- Make sure you have enough data
  - Generate synthetic data from system simulations

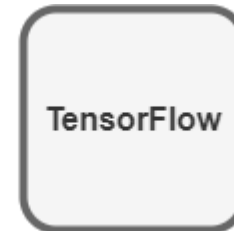


# AI modeling requirements

**2 AI Modeling**

- Model design and tuning
- Hardware accelerated training
- Interoperability

- Find best model(s) for each application
- Don't limit yourself to one tool



# Simulation and Test requirements

3

## Simulation and Test



Integration with complex systems

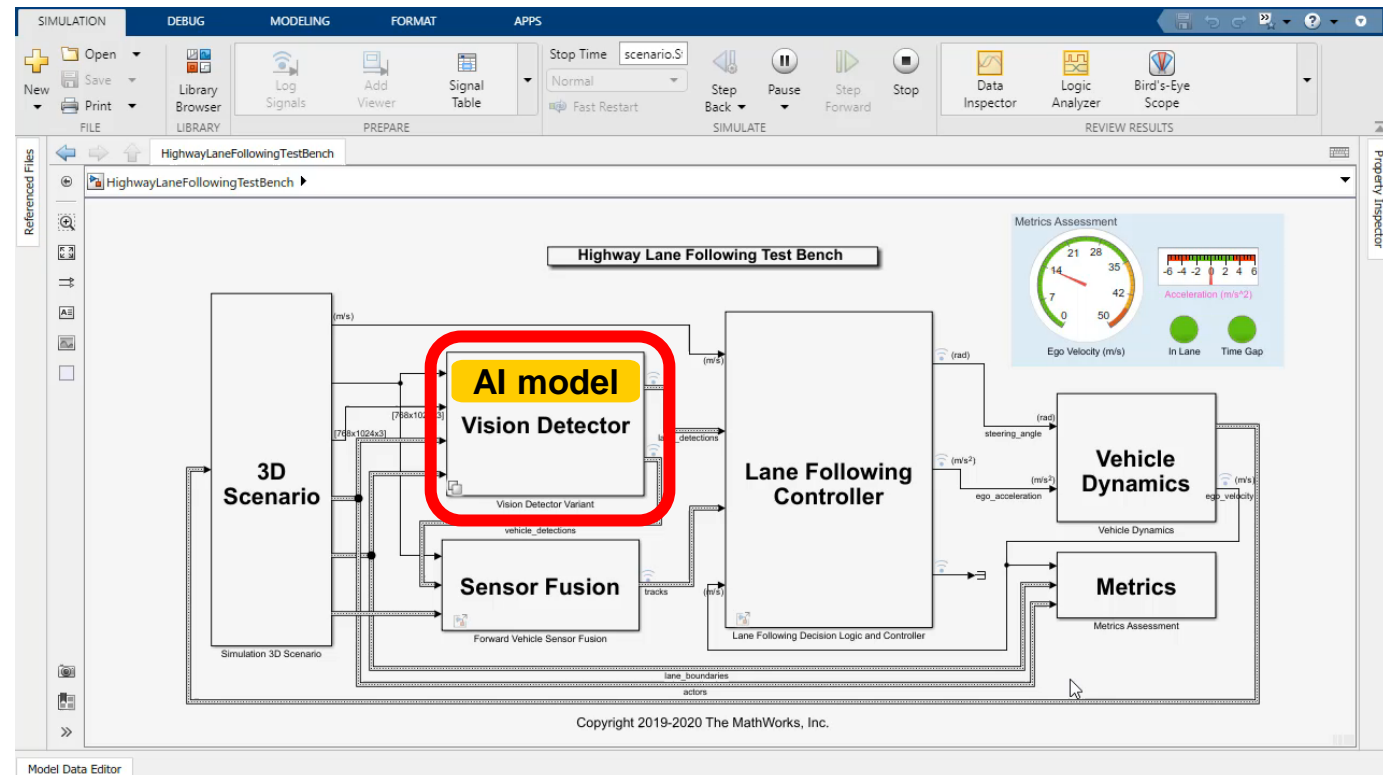


System simulation



System verification and validation

- You must test the model in the overall system
  - Requires integrating with system level simulations



# Deployment requirements

## 4 Deployment



Embedded devices

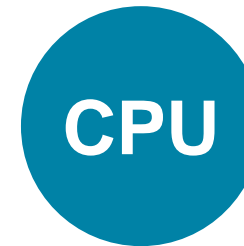


Enterprise systems



Edge, cloud, desktop

- The aim is to target lowest cost, lowest power embedded devices available



One last requirement...

**Find the best way both teams can work together**

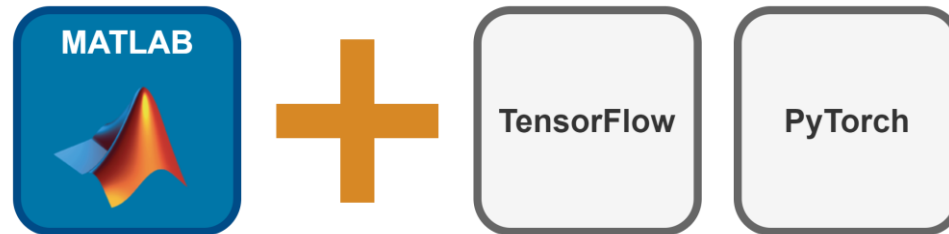




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Which tools should we use?

Why don't we use the tools together?



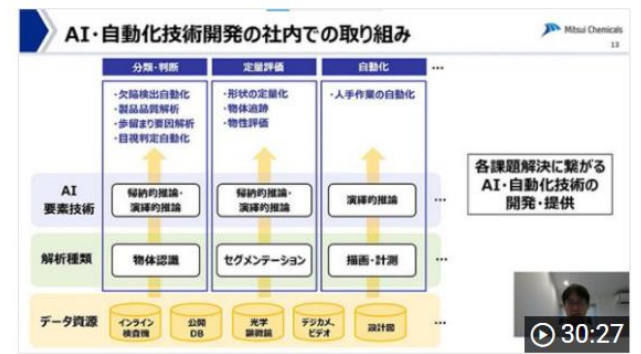
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Sivylla and Yann are having a friendly conversation  
Discussing their options...

## Mitsui Chemicals Deploys AI and Automation Systems with TensorFlow and MATLAB

“MATLAB solved our problems on the field implementation and saved development time. That led to highly accurate development.”

— Shintaro Maekawa, Mitsui Chemicals, Inc.



Watch video (in Japanese)

Mitsui Chemicals develops factory automation solutions by applying AI, mainly machine learning.

At the beginning of development, Mitsui Chemicals used Python+Keras (TensorFlow) for automated visual inspection of sheet-shaped products on the production line. However, ease of use and maintenance were issues in implementing the trained models in the field.

Mitsui Chemicals engineers chose MATLAB® to create applications with easy-to-understand user interfaces. The model was imported using the Deep Learning Toolbox™ Importer for TensorFlow/Keras Models. The

### Key Outcomes

- Reduced visual inspection time by 80%
- Effectively used models trained in other frameworks
- Deployed application with a user interface that anyone can use

### Products Used

- MATLAB
- Deep Learning Toolbox
- MATLAB Compiler

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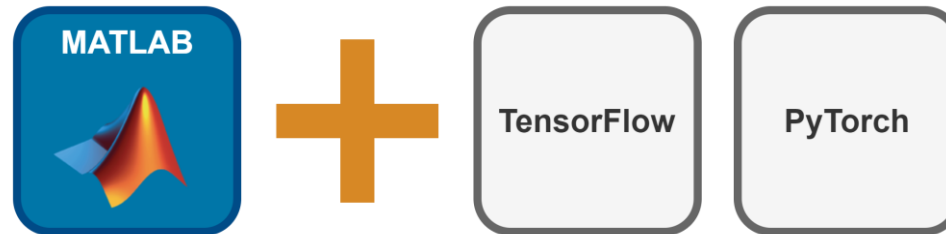
A short time later...

# There are 3 ways MATLAB can work with TensorFlow & PyTorch

#	Option
1	Co-execution with TensorFlow or PyTorch
2	Model converters for TensorFlow & ONNX
3	MATLAB Deep Learning Model Hub

# 1. Co-execution with MATLAB, TensorFlow or PyTorch

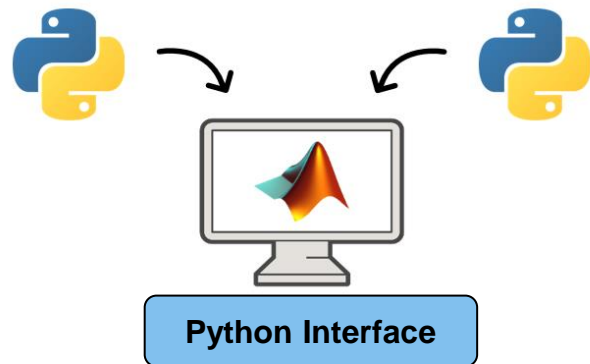
- Requires MATLAB and TensorFlow / PyTorch
- Requires datatype conversion / reformatting
- Performance is impacted by data transfer between frameworks
- Allows testing of any model from TensorFlow / PyTorch in MATLAB



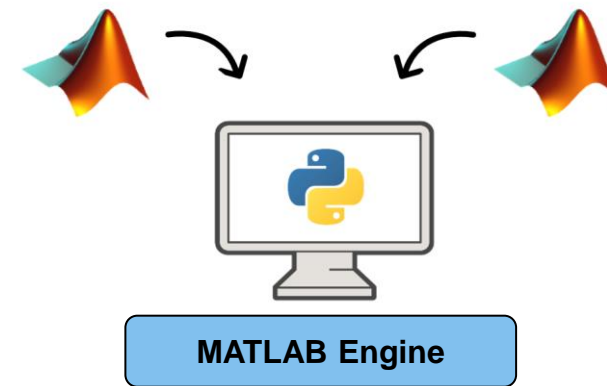
## Co-execution allows:

- Calling Python from MATLAB to access any AI frameworks and networks
- Calling MATLAB from Python to reuse the domain specific processing

Calling Python from MATLAB



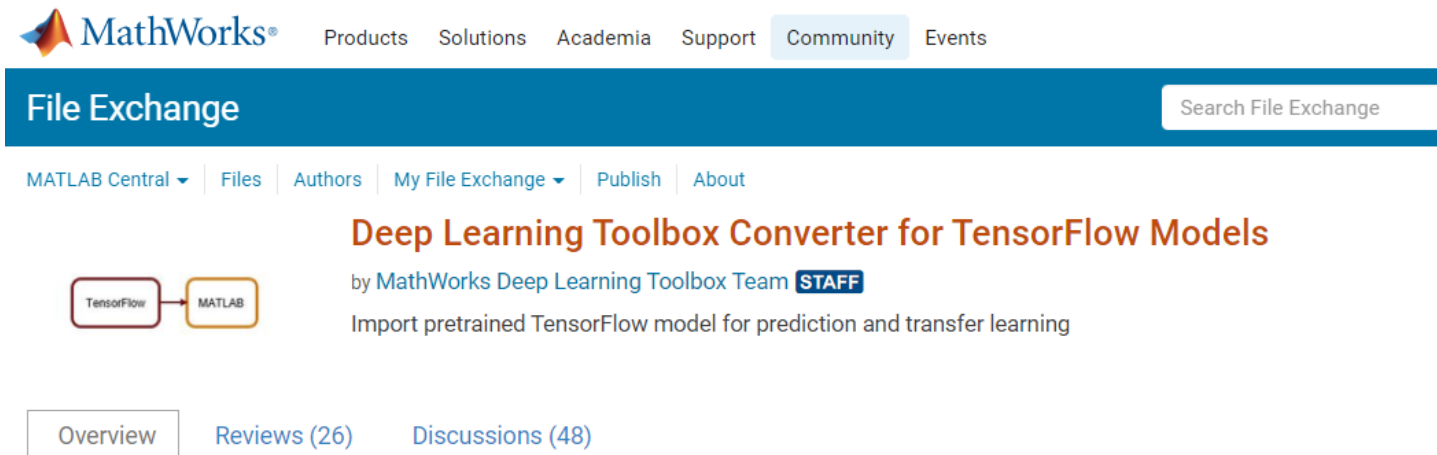
Calling MATLAB from Python





## 2. Model Import via TensorFlow & ONNX Converters

- Requires MATLAB only
- Import TensorFlow directly
- Import PyTorch via ONNX
- New features added each release



The screenshot shows the MathWorks File Exchange interface. At the top, the MathWorks logo is on the left, and navigation links for Products, Solutions, Academia, Support, Community, and Events are on the right. Below this is a blue header bar with 'File Exchange' on the left and a search box on the right. Underneath, there are navigation links for MATLAB Central, Files, Authors, My File Exchange, Publish, and About. The main content area features a title 'Deep Learning Toolbox Converter for TensorFlow Models' in orange, followed by 'by MathWorks Deep Learning Toolbox Team' and a 'STAFF' badge. Below the title is a diagram showing a box labeled 'TensorFlow' with an arrow pointing to a box labeled 'MATLAB'. The description reads: 'Import pretrained TensorFlow model for prediction and transfer learning'. At the bottom of the page, there are tabs for 'Overview', 'Reviews (26)', and 'Discussions (48)'.

The importer for the TensorFlow models would enable you to import a pretrained TensorFlow models and weights. You can then use this model for prediction or transfer learning. Alternatively, you can import layer architecture as a Layer array or a LayerGraph object. You can then train this model.

# 3. MATLAB Deep Learning Model Hub

- Requires MATLAB only
- Over 50 pretrained models
- Similar model collection with TensorFlow and PyTorch repositories

The screenshot shows the GitHub repository for 'matlab-deep-learning / MATLAB-Deep-Learning-Model-Hub'. The repository is public and has 13 watchers, 23 forks, and 1 star. The main content area displays a file tree with the following items:

File Name	Commit Message	Commit Date
Images	initial commit	3 months ago
LICENSE	Initial Commit	3 months ago
MATLABDeepLearningModelHub.mlx	Live script added, MATLABDeepLearningModelHub.mlx, so users have q...	2 months ago
README.md	Live script added, MATLABDeepLearningModelHub.mlx, so users have q...	2 months ago
SECURITY.md	Initial Commit	3 months ago
viewDeepLearningModelHubGitHub.m	Script for launching the Deep Learning Model hub in a browser.	24 days ago

The README.md file content is visible below the file tree:

## MATLAB Deep Learning Model Hub

Discover pretrained models for deep learning in MATLAB.

### Models

#### Computer Vision

- Image Classification
- Object Detection
- Semantic Segmentation
- Instance Segmentation
- Image Translation

On the right side of the repository page, there is an 'About' section with the following information:

- Discover pretrained models for deep learning in MATLAB
- Link: [www.mathworks.com/solutions/deep-lea...](http://www.mathworks.com/solutions/deep-lea...)
- Tags: [deep-learning](#), [matlab](#), [pretrained-models](#)
- Readme
- View license
- 127 stars
- 13 watching
- 23 forks

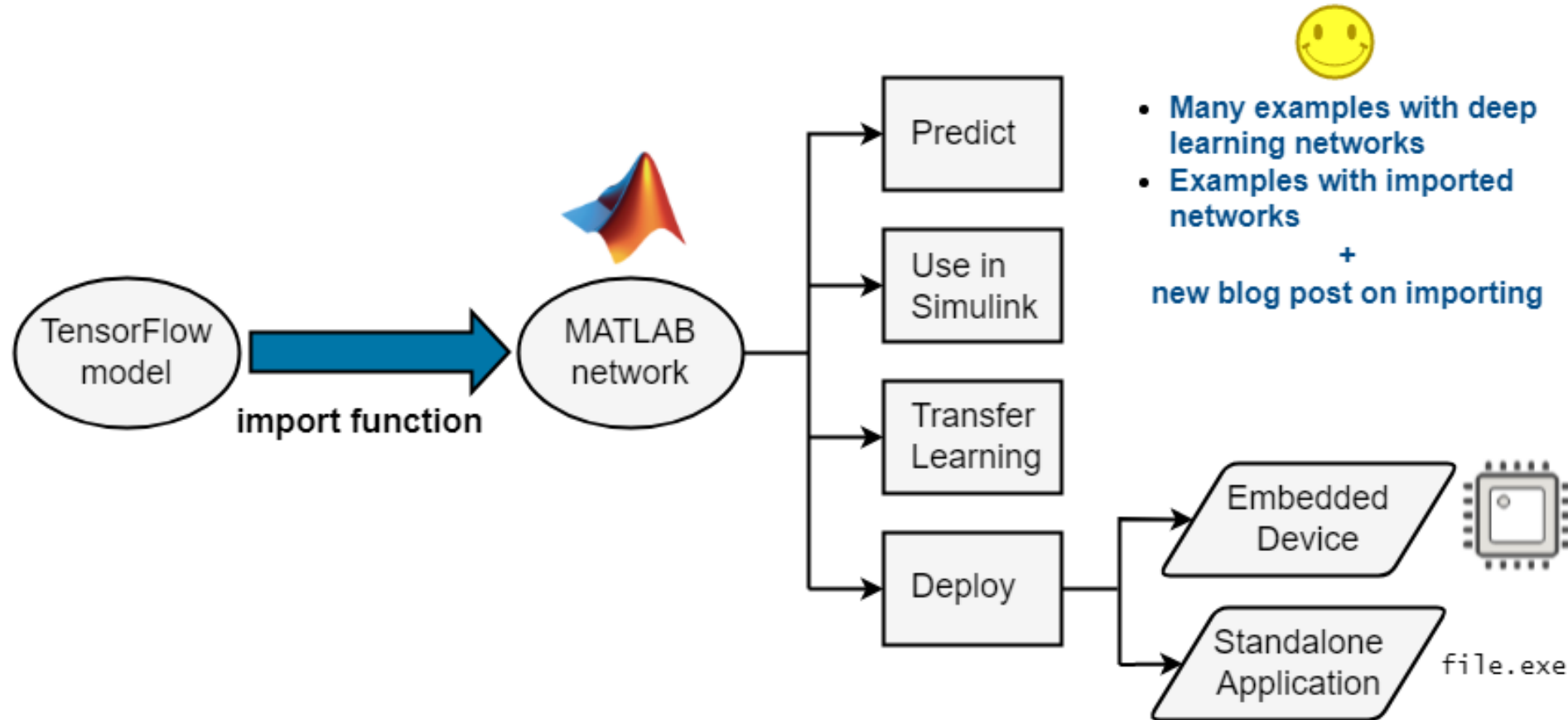
Below the 'About' section, there is a 'Releases' section with one release:

- R2021b (Latest) on Dec 16, 2021

There is also a 'Packages' section with the message: 'No packages published. Publish your first package.'

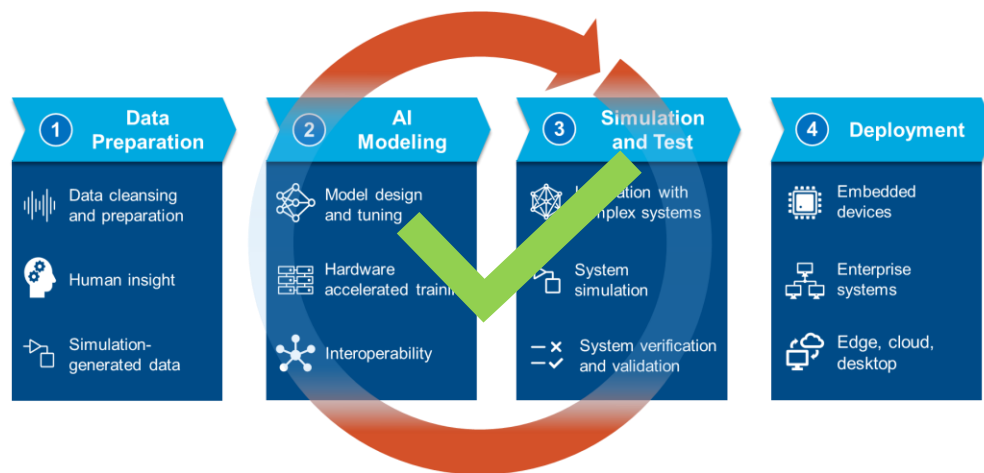
At the bottom right, there is a 'Languages' section with a progress bar showing 100.0% for MATLAB.

# Deep Learning Workflows with MATLAB Networks



# Our key challenges and their solutions

#	Challenge	Approach
1	Find and test the best model	<ul style="list-style-type: none"><li>• Co-execution</li></ul>
2	Deploying to embedded targets	<ul style="list-style-type: none"><li>• Check if the model exists in the MATLAB Deep Learning Model Hub</li><li>• Import into MATLAB using model converters</li></ul>



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Let's get this done!

This now concludes our presentation

**Links from today's talk:**

[Co-execution between MATLAB and TensorFlow](#)

[Importing Models from TensorFlow, PyTorch, and ONNX](#)

[MATLAB Deep Learning Model Hub](#)

[MITSUI Chemicals User Story](#)



# MATLAB EXPO

Thank you



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