Technical Computing Camp 2023

Preparing future engineers for the growing AI workforce

Marco Rossi, PhD
MathWorks Academia Team
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HUMUSOFT

10. ročník letního setkání příznivců technických výpočtů a počítačových simulací:

Technical Computing Camp 2023, 7.-8.9.2023, Brněnská přehrada

Edu EMEA Indirect

Marco Rossi
MathWorks Italy

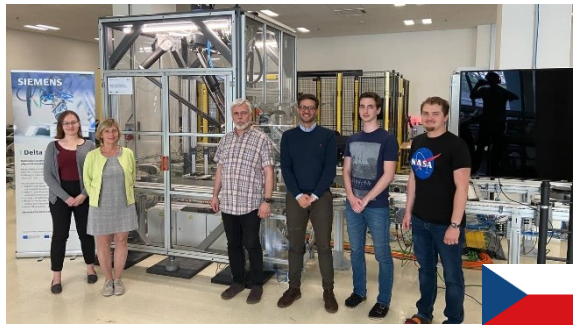
Edu Customer Success Engineer
MathWorks Academia Team

Mission

Support Lecturers and Researchers in the usage of MATLAB and Simulink

Yildiz Teknik Universitesi in Istanbul

Széchenyi István University in Győr



České vysoké učení technické in Prague

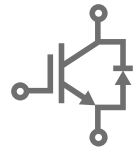
University of Cape Town

Research

Accelerate Discovery

Education

Train the Next Generation



Industry

Product Development


10
Happy
Anniversary!

AI-Based Models for Predicting Electricity Demand

Challenge

- Forecast energy demand across the entire country
- Increase grid stability and maximize power generated

Solution

- Use MATLAB to develop AI algorithms

Results

- Prediction error halved
- Models updated rapidly for pandemic-related changes
- Production tool developed and deployed in 6 months

Demand prediction App

"MATLAB made the project straightforward for us with toolboxes that are easy to learn and use."
- Lead engineer, Administrador del Mercado Mayorista

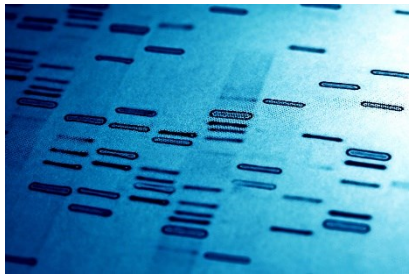
Link to user story

Key Industries

Aerospace and Defense

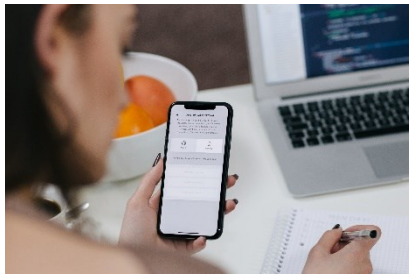
Automotive

Biological Sciences



Biotech and Pharmaceutical

Communications



Electronics

Energy Production

Financial Services

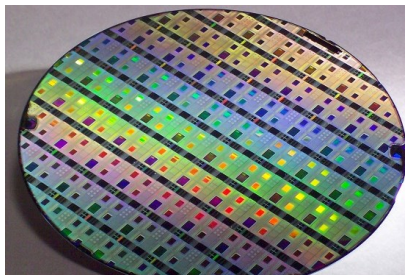
Industrial Machinery

Medical Devices

Metals, Materials, Mining

Neuroscience

Railway Systems



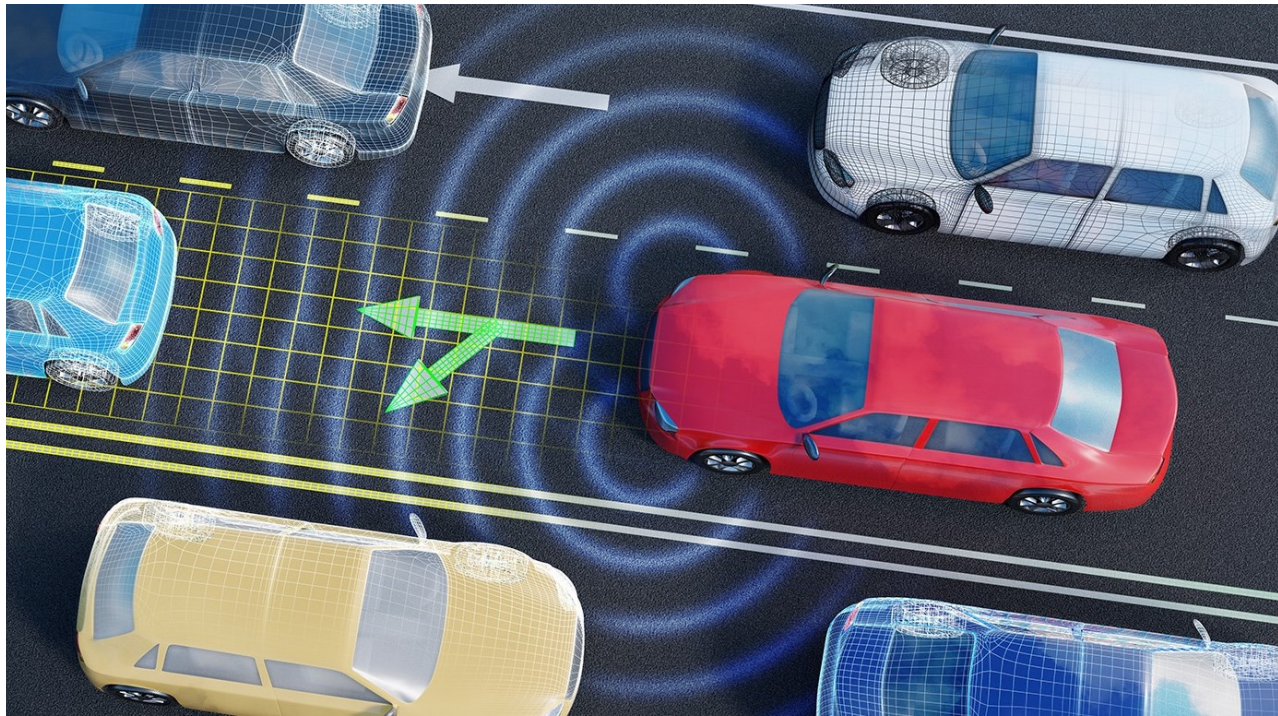
Semiconductors

Software and Internet


amazon


Luke Skywalker
94.5%

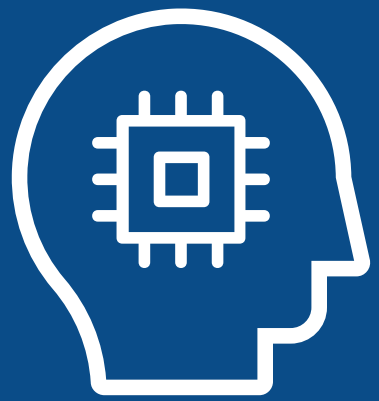

도시로의 접근
ACCESS TO CITY



Artificial Intelligence Megatrend

ARTIFICIAL INTELLIGENCE

Any technique that enables machines to mimic human intelligence

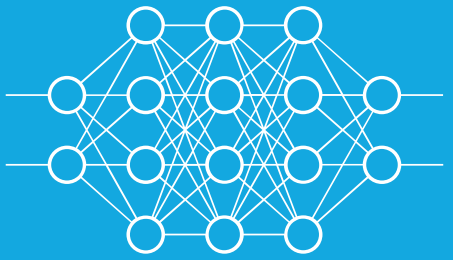


MACHINE LEARNING

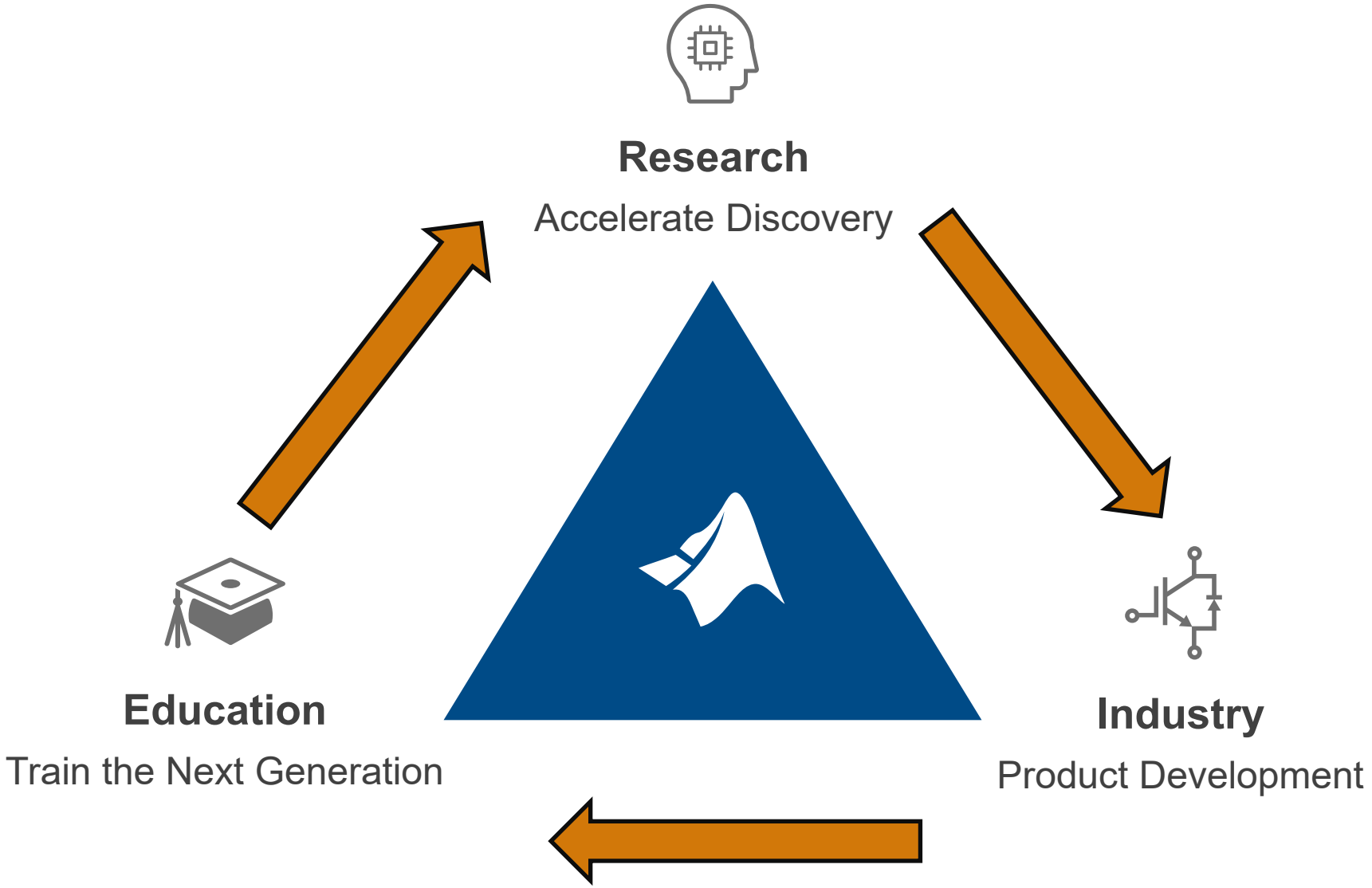
Statistical methods that enable machines to "learn" tasks from data without explicitly programming

DEEP LEARNING

Neural networks with many layers that learn representations and tasks "directly" from data



1950s 1980s 2010s


Research
Accelerate Discovery
Education
Train the Next Generation
Industry
Product Development

Research

Accelerate Discovery

Education

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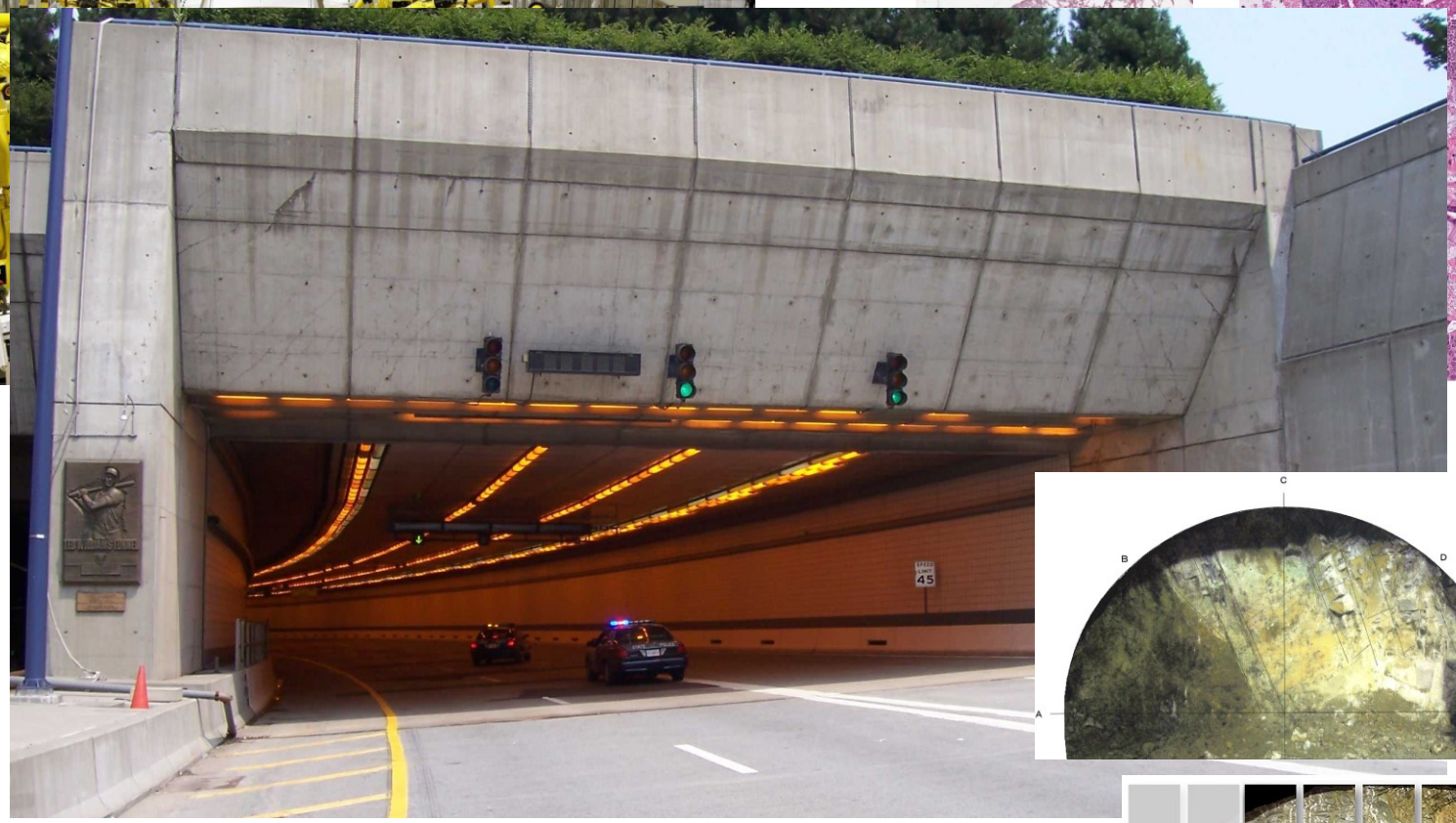
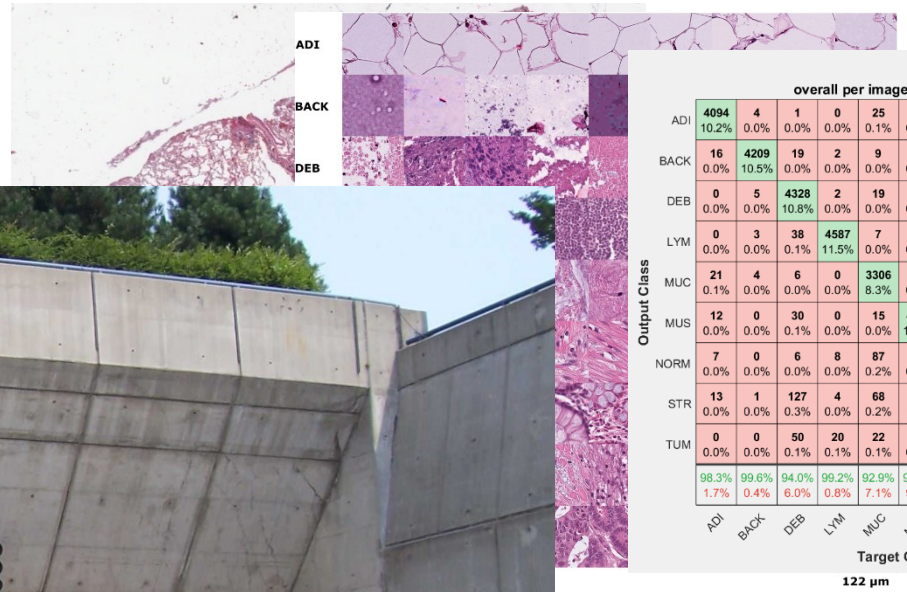
Industry

Product Development

Today, we see AI applications in all fields of engineering





overall per image accuracy 95%

Output Class \ Target Class	ADI	BACK	DEB	LYM	MUC	MUS	NORM	STR	TUM	
ADI	4094 10.2%	4 0.0%	1 0.0%	0 0.0%	25 0.1%	56 0.1%	6 0.0%	4 0.0%	3 0.0%	97.6% 2.4%
BACK	16 0.0%	4209 10.5%	19 0.0%	2 0.0%	9 0.0%	3 0.0%	1 0.0%	0 0.0%	3 0.0%	98.8% 1.2%
DEB	0 0.0%	5 0.0%	4328 10.8%	2 0.0%	19 0.0%	38 0.1%	11 0.0%	67 0.2%	38 0.1%	96.0% 4.0%
LYM	0 0.0%	3 0.0%	38 0.1%	4587 11.5%	7 0.0%	0 0.0%	22 0.1%	0 0.0%	19 0.0%	98.1% 1.9%
MUC	21 0.1%	4 0.0%	6 0.0%	0 0.0%	3306 8.3%	10 0.0%	96 0.2%	24 0.1%	19 0.0%	94.8% 5.2%
MUS	12 0.0%	0 0.0%	30 0.1%	0 0.0%	15 0.0%	4889 12.2%	3 0.0%	118 0.3%	13 0.0%	96.2% 3.8%
NORM	7 0.0%	0 0.0%	6 0.0%	8 0.0%	87 0.2%	7 0.0%	3142 7.9%	18 0.0%	105 0.3%	93.0% 7.0%
STR	13 0.0%	1 0.0%	127 0.3%	4 0.0%	68 0.2%	388 1.0%	20 0.1%	3920 9.8%	42 0.1%	85.5% 14.5%
TUM	0 0.0%	0 0.0%	50 0.1%	20 0.1%	22 0.1%	23 0.1%	204 0.5%	27 0.1%	5485 13.7%	94.1% 5.9%
	98.3% 1.7%	99.6% 0.4%	94.0% 6.0%	99.2% 0.8%	92.9% 7.1%	90.3% 9.7%	89.6% 10.4%	93.8% 6.2%	95.8% 4.2%	94.9% 5.1%

122 µm

AI is more than just a model…

Success with AI requires more than data and training an AI model. You need high-quality data, staff with skills for AI work, and an end-to-end AI workflow. **Start with the workflow.**

1. Data Preparation
2. AI Modeling
3. Simulation and Test
4. Deployment

AI is more than just a model…

1 Data Preparation

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

Access historical load and weather data

2 AI Modeling

- Model design and tuning
- Hardware accelerated training
- Interoperability

Machine Learning and Deep Learning

3 Simulation and Test

- Integration with complex systems
- System simulation
- System verification and validation

Testing with new data before deployment

4 Deployment

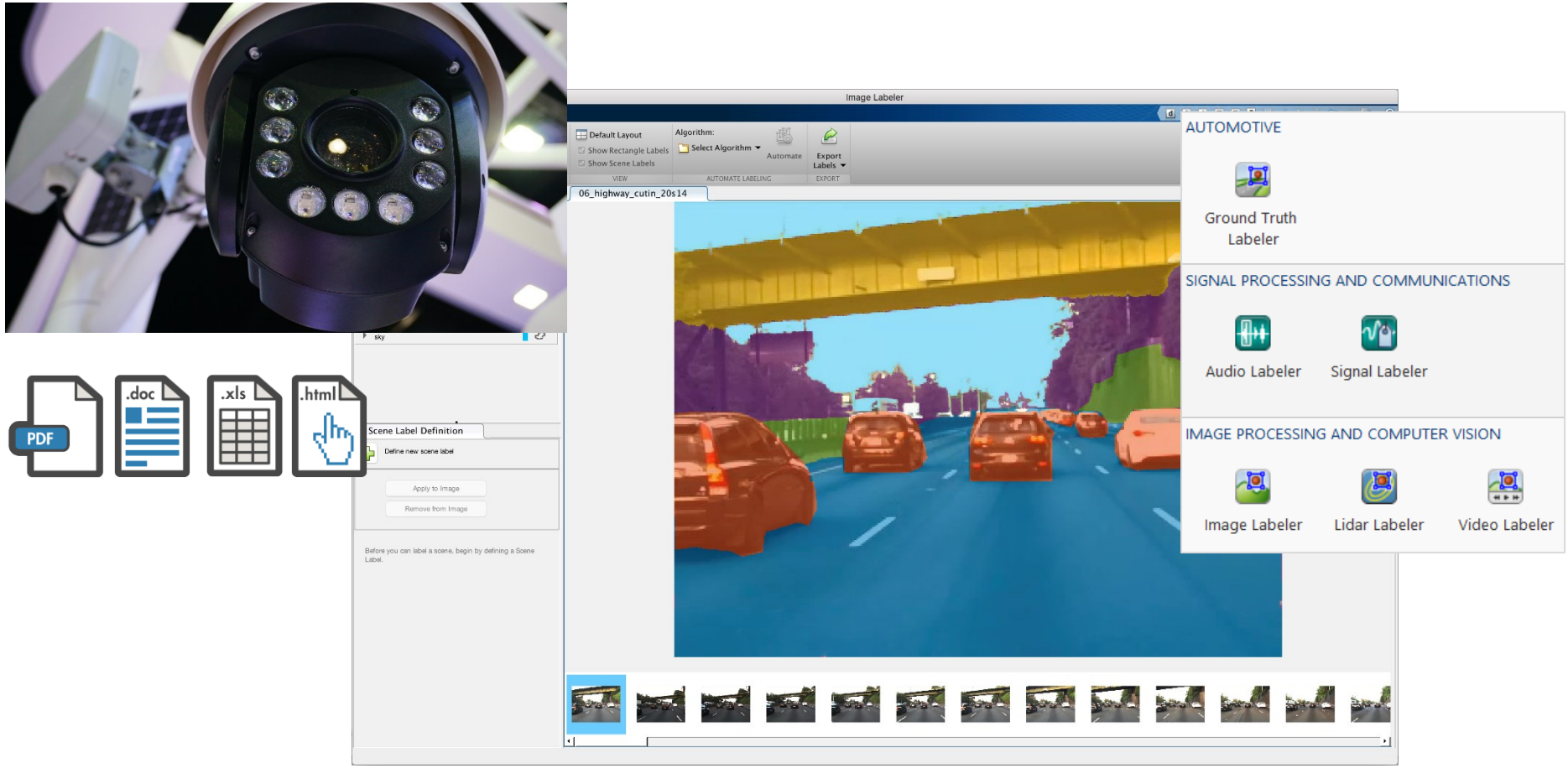
- Embedded devices
- Enterprise systems
- Edge, cloud, desktop

Deployment to enterprise with an app


TuSimple
Autonomous System
SYSTEM ON / OFF
AUTO MODE ON / OFF

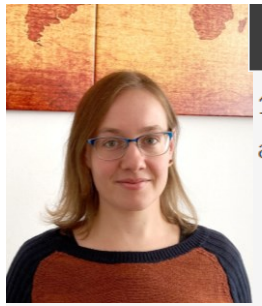
Data preparation is crucial for the success of AI

1. Data Preparation
2. AI Modeling
3. Simulation and test
4. Deployment



Use labeling apps for deep learning workflows like semantic segmentation

Importing data and leveraging interoperability



Thursday 7/9/2023

10:50 a.m

Options for processing and visualizing 3D data in MATLAB

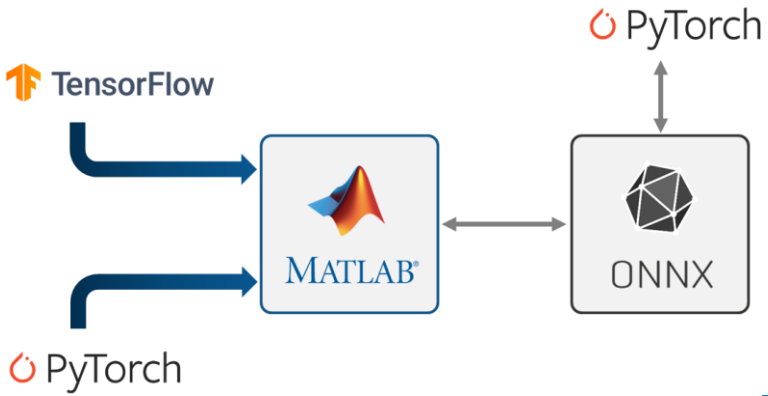
Introducing the possibilities of working with 3D data and their environment visualization in MATLAB - vector and scalar volume data, pointcloud and others.

Anna Tocháčková, Humusoft

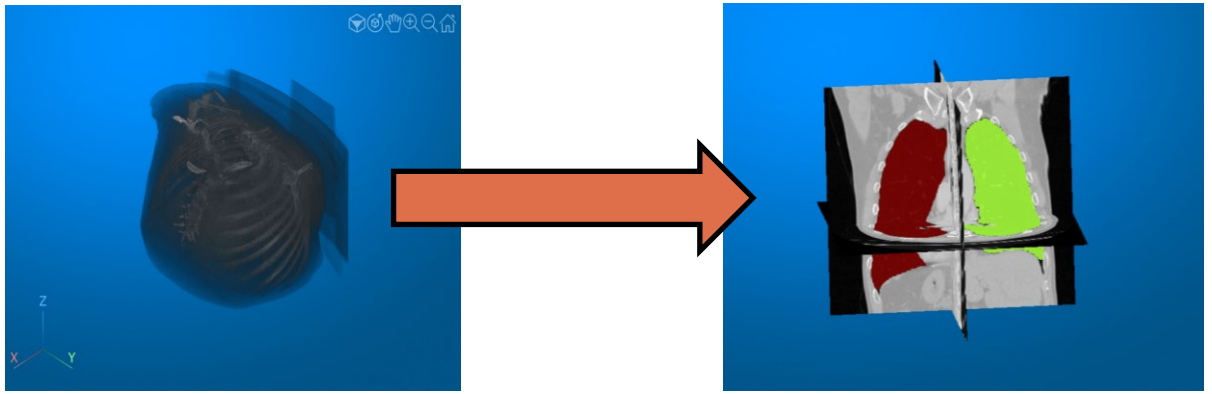
Friday 8/9/2023

10:45 Demo showcase

1. Data Preparation
2. AI Modeling
3. Simulation and test
4. Deployment

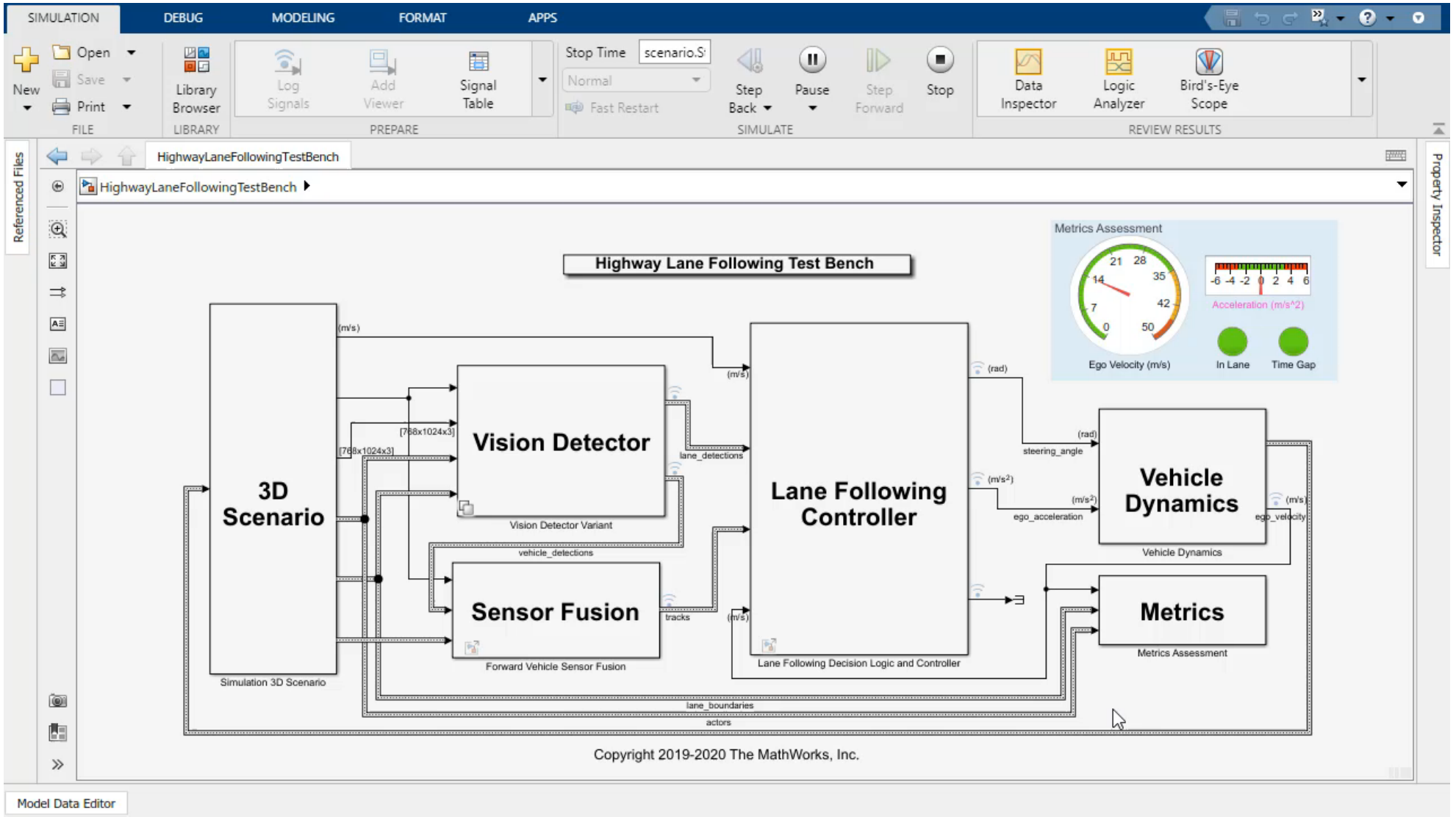


- Semantic segmentation of lungs
- Pretrained ONNX™ 3-D U-Net neural network
- Extract surface of the lungs to create a model for 3D printer



Complex, AI-driven systems require integration and simulation

1. Data Preparation
2. AI Modeling
3. Simulation and Test
4. Deployment



Complex, AI-driven systems require integration and simulation

Friday 8/9/2023

10:45 Demo showcase

- **AI and Model-Based Design**

  A classification model based on AI (deep learning) as part of a wider algorithm created in the Simulink environment. The algorithm is implemented on the Raspberry PI platform using automatic code generation in the C language.

Jaroslav Jirkovský, Humusoft

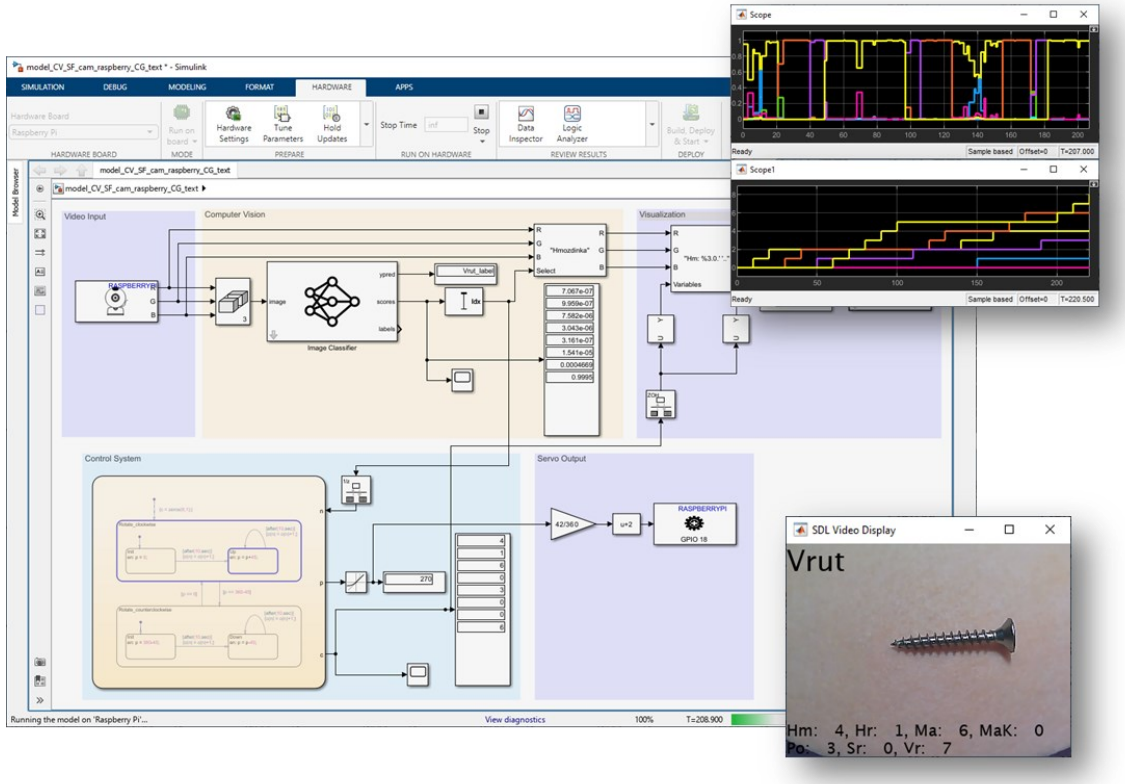
1. Data Preparation
2. AI Modeling
3. Simulation and Test
4. Deployment

Image classification
- Algorithm based on deep learning

Control system
- Model in Simulink and Stateflow

Deployment
- Standalone application
- Leverage C-code generation

Hardware
- Raspberry Pi 4, webcam

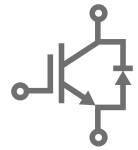


Research

Accelerate Discovery

Education

Train the Next Generation



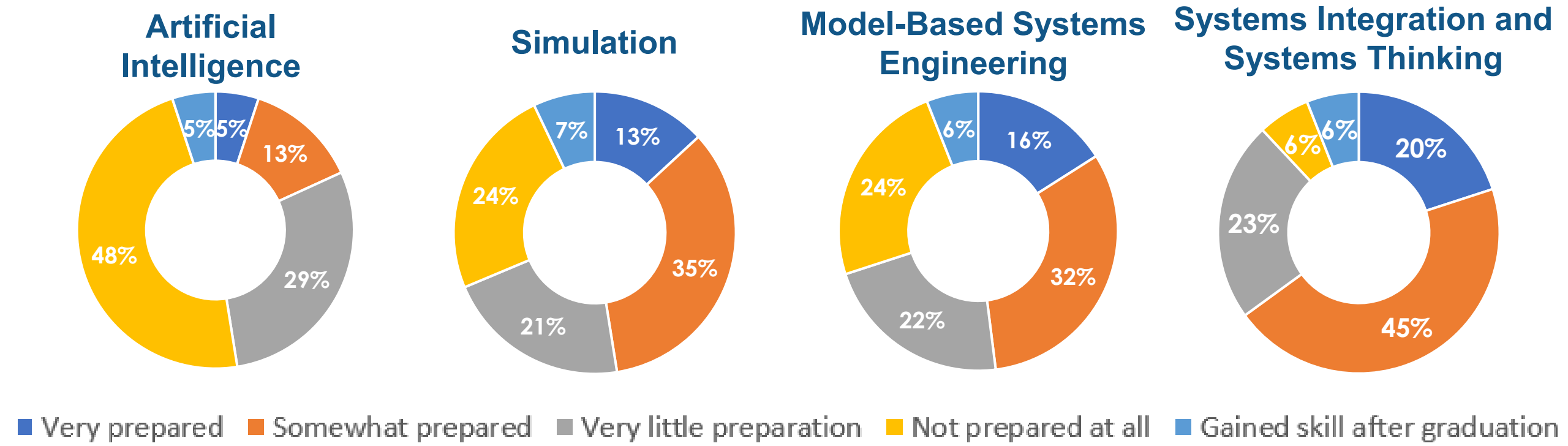
Industry

Product Development

What are the gaps between the skills of new engineers and what the industry requires?

Technical Skills – Existing gaps

Skills Gap Survey in Recent Engineering Graduates (ASEE, 2020):



https://www.asee.org/documents/cmc/2020-SURVEY-FOR-SKILLS-GAPS-IN-RECENT-ENGINEERING-GRADUATES.pdf

Teaching AI + X

- Audio Processing
- Signal Processing
- Image Processing
- Biomedicine
- Robotics
- …

Lecture

- 1 – 2 classes
- Overview on theory
- Domain-specific applications

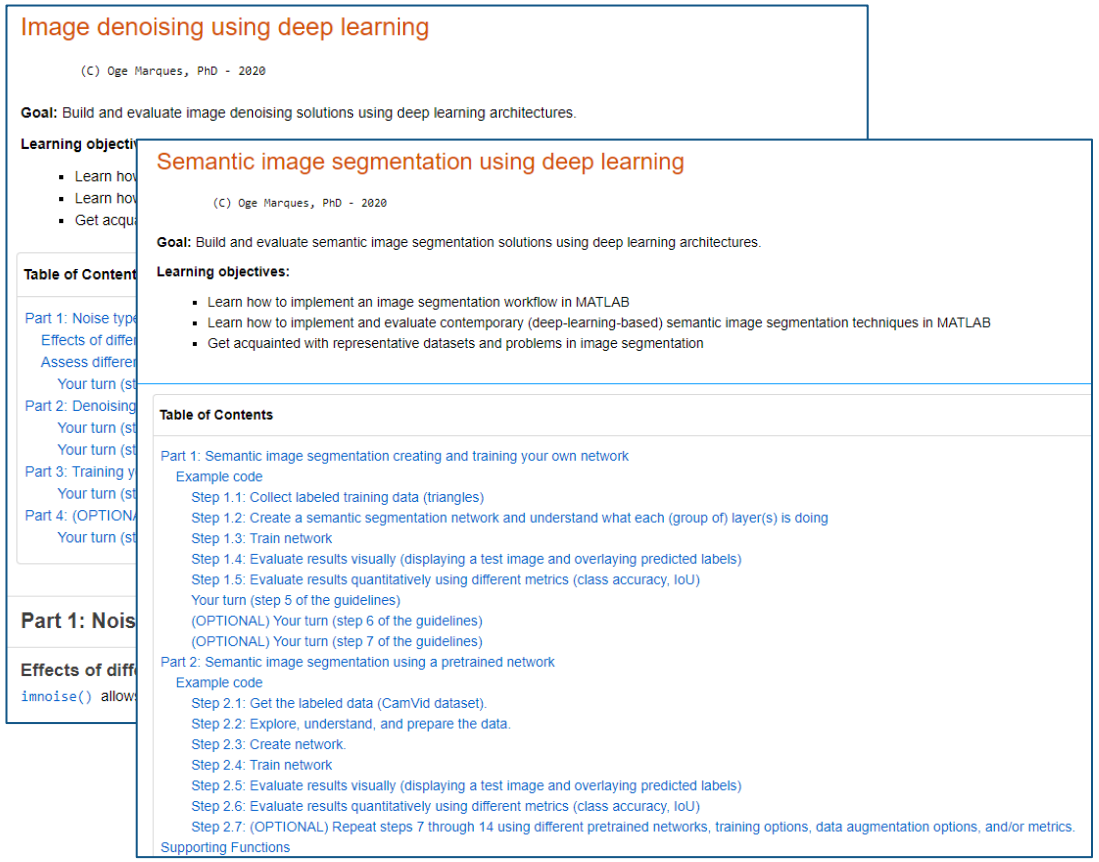
Pre-work

- Readings
- Self-paced courses

Assignment

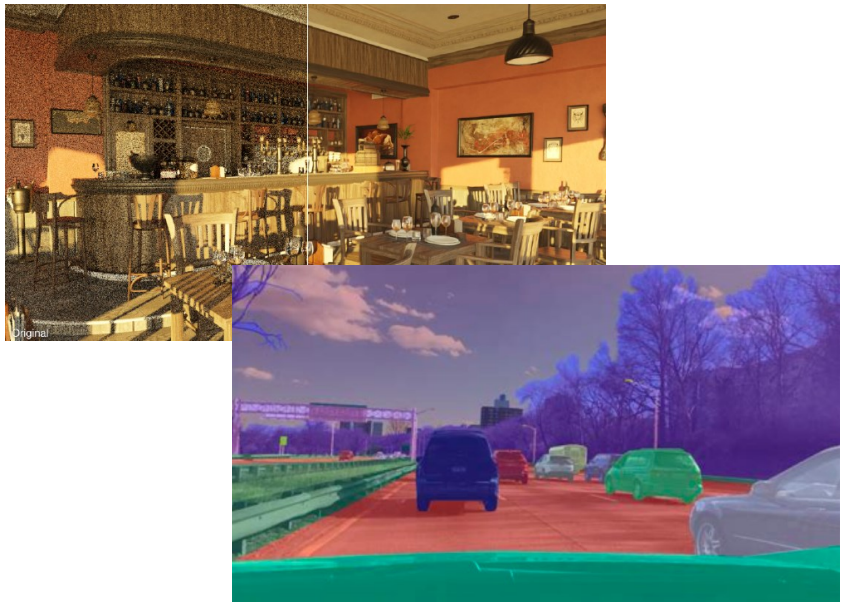
- **[Problem]** Continue problem from class on MATLAB Online
- **[Guided project]** Work on examples of AI problems in the course domain

Deep Learning + Image Processing



Prof. Oge Marques
Florida Atlantic University

Deep Learning Onramp



https://github.com/MathWorks-Teaching-Resources/deep-learning-for-image-processing

Suggested Prework

- MATLAB Onramp – a free two-hour introductory tutorial to learn the essentials of MATLAB.
- Machine Learning for Regression: Part 1

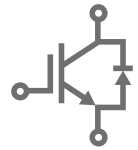
Can you predict future electricity demand?

Research

Accelerate Discovery

Education

Train the Next Generation



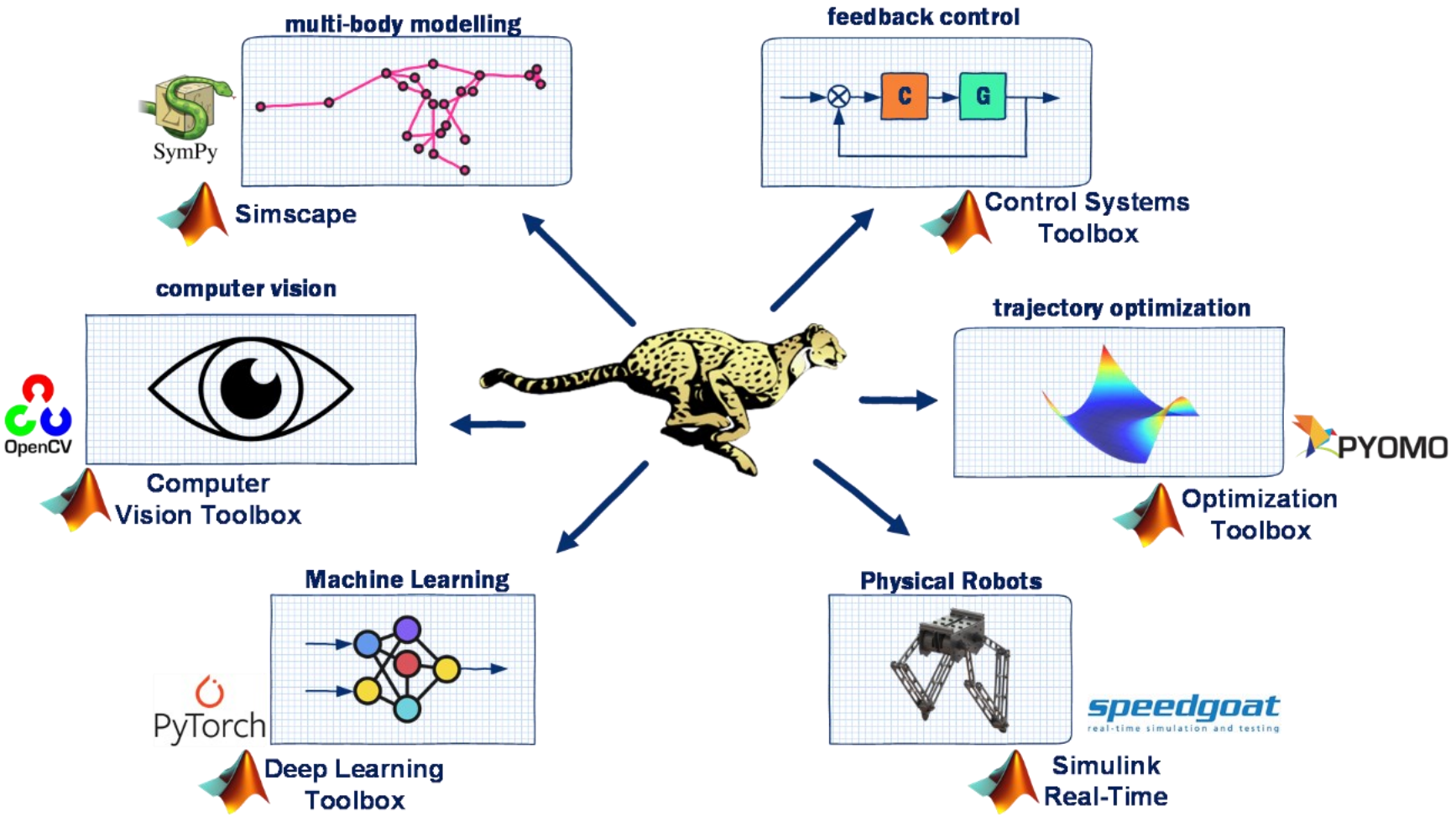
Industry

Product Development

WildMove Decoding Neuromechanics using Big Data

Prof. Amir Patel
University of Cape Town
African Robotics Unit

WildMove Decoding Neuromechanics using Big Data



Prof. Amir Patel
University of Cape Town
African Robotics Unit

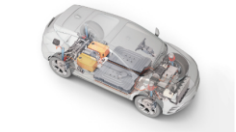
Climate Science and Student Competitions

Sustainability and Renewable Energy Challenge

We are excited to announce the MathWorks Sustainability and Renewable Energy Challenge! We invite you to submit innovative solutions to environmental challenges related to sustainability and renewable energy. Select a project from our list and submit a solution to be eligible to win up to $1,000 (USD). Showcase your creativity and contribute to a more sustainable future!

Contact us with questions

January 5, 2024: Submission deadline



Energy Management for a 2-Motor BEV using Model-Predictive Control

Develop a Model-Predictive Control algorithm to optimally distribute torque in a 2-motor Battery Electric Vehicle (BEV) powertrain.

Impact: Reduce energy consumption while maintaining best motor performance.

Expertise gained: Sustainability and Renewable Energy, Automotive, Control, Electrification, Modeling and Simulation

Carbon Neutrality

Build a CO2 emission model from historical data and create a plan to achieve carbon neutrality in the future.

Impact: Set up a strategy for carbon neutrality and consolidate the international collaboration.

Expertise gained: Computational Finance, Sustainability and Renewable Energy, Modeling and Simulation, Machine Learning

Coastline Prediction using Existing Climate Change Models

Develop an example that predicts and visualizes coastline impact due to rising sea levels.

Impact: Assess and plan for the potential impact of climate change.

Expertise gained: Sustainability and Renewable Energy, Modeling and Simulation

Landslide Susceptibility Mapping using Machine Learning

Develop a tool to identify and visualize geographical areas susceptible to landslides.

Impact: Identify areas that are at risk for landslides to help mitigate devastating impacts on people and infrastructure.

Expertise gained: Sustainability and Renewable Energy, Machine Learning

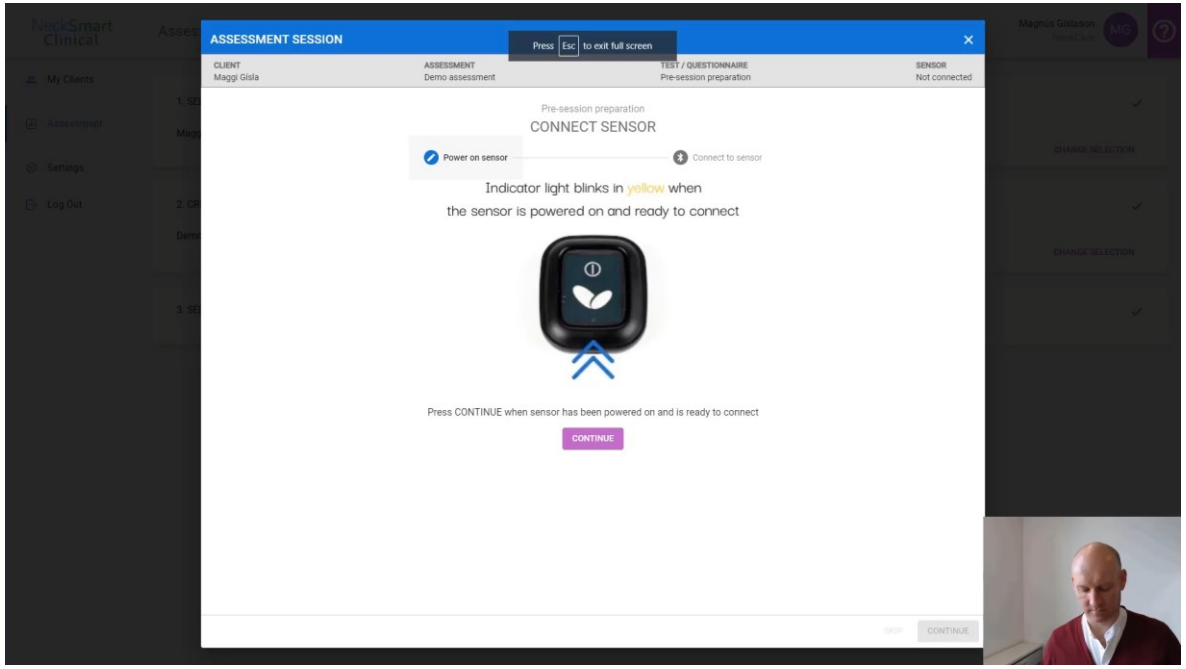
Improving Neck Injury Assessment with Machine Learning

Prof. Magnús Kjartan Gíslason
Associate professor in Biomechanics, Reykjavik University
Director of Data & Analytics, NeckCare

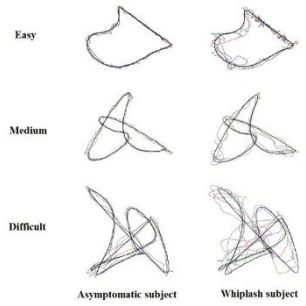
Full access to MathWorks platform

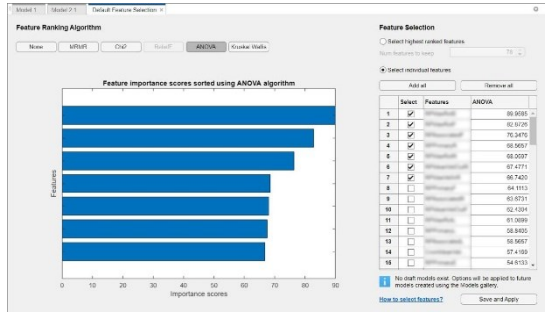
Campus Wide License

Startup Program



- Patient follows pattern on the screen
- IMU headgear measures parameters in different tests
- AI with MATLAB classifies whiplash and concussions





[Link to story on MathWorks website]

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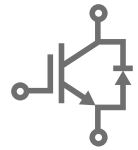


Industry

Product Development

MathWorks as an AI industry partner

Your People

Helping you build an agile workforce today and preparing tomorrow's engineers

The Platform

MATLAB, Simulink, and over 100 add-on products for specialized applications

Our Expertise

From onboarding and implementation to solving advanced engineering challenges

What can I do next?

New to MATLAB or AI?

Take self-paced trainings

Explore tutorials and examples

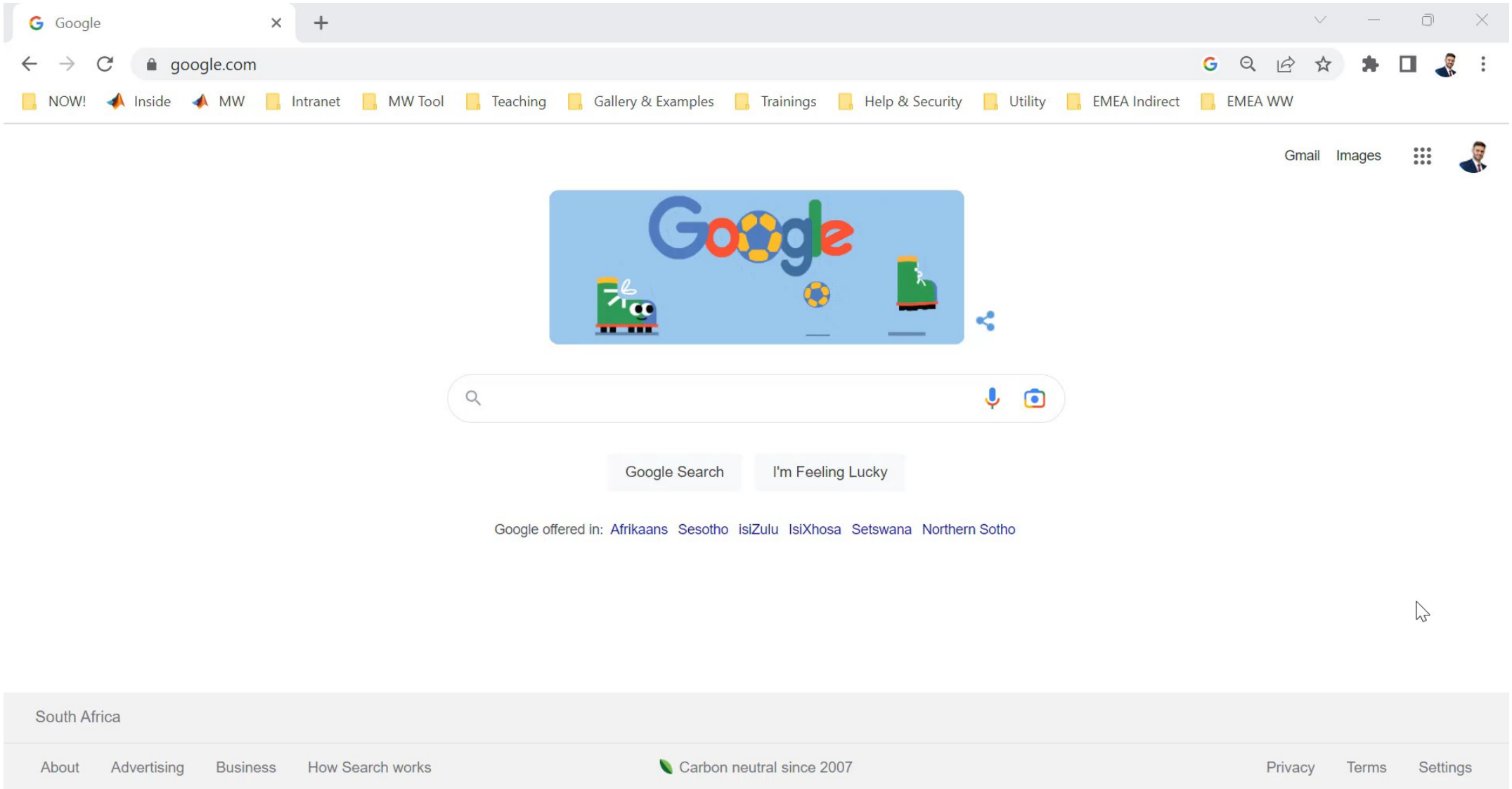
- Machine Learning
- Deep Learning

Ready to take it to the next level?

Explore Courseware & books

Explore more advanced projects

Connect with us!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Intranet
MW Tool
Teaching
Gallery & Examples
Trainings
Help & Security
Utility
EMEA Indirect
EMEA WW
Gmail
Images
Google Search
I'm Feeling Lucky
Google offered in: Afrikaans Sesotho isiZulu IsiXhosa Setswana Northern Sotho
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Terms
Settings

Thank you