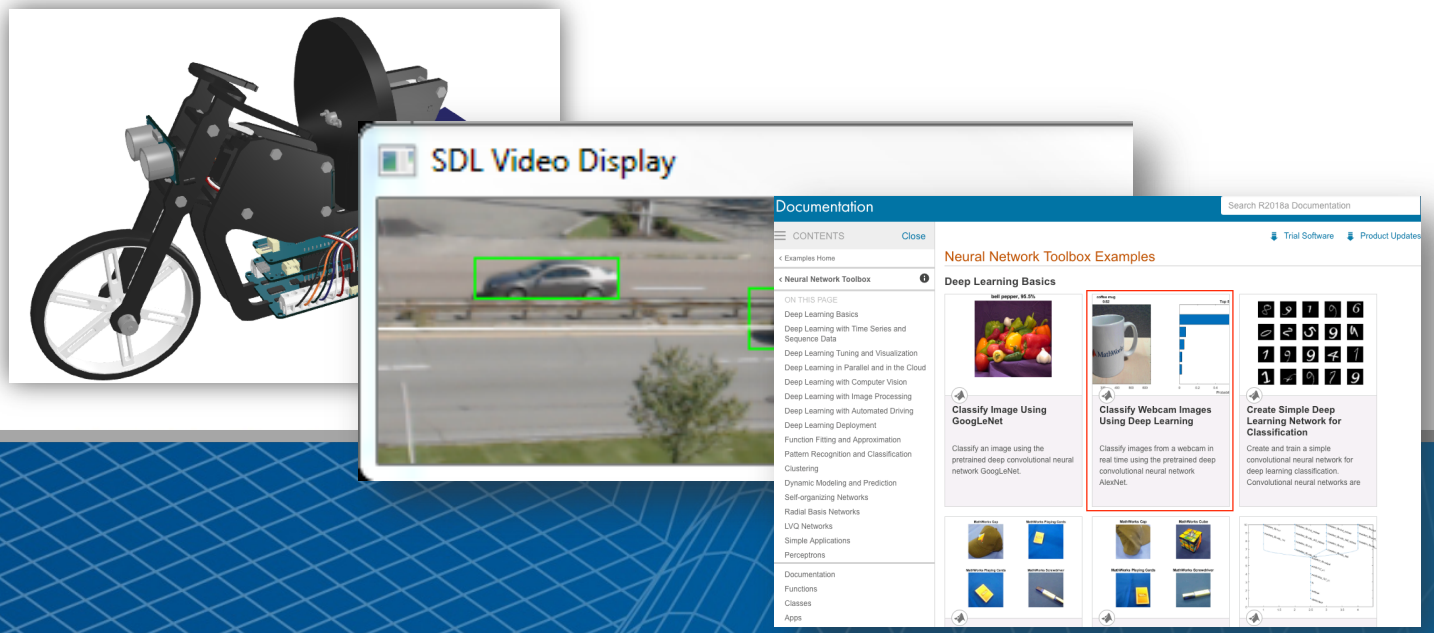
Teaching and Learning with MATLAB & Simulink in the Modern Classroom



Sumit Tandon – Senior Customer Success Manager
Sumit.tandon@mathworks.com

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Airbus

Saved three months of development time on the A380, the world's largest passenger jet

Advanced Driver-Assistance Systems

Critical safety features for everyone

Detects obstacles, applies brakes, adjusts cruise control, and stays in lane

Robotic Prosthetics

Drumsticks controlled by flexing muscles and artificial intelligence

Patient can play faster, more complex rhythms than a typical human drummer

Where are MathWorks' products used…

https://www.mathworks.com/solutions.html

By Capability

- Data Acquisition
- Data Analysis
- Mathematical Modeling
- Algorithm Development
- Parallel Computing
- Desktop and Web Deployment
- Machine Learning
- System Design and Simulation
- Physical Modeling
- Discrete-Event Simulation
- Rapid Prototyping
- Embedded Code Generation
- HDL Code Generation and Verification
- Verification, Validation, and Test

By Application

- Embedded Systems
- Control Systems
- Digital Signal Processing
- Wireless Communications
- Image Processing and Computer Vision
- Internet of Things
- FPGA Design and Codesign
- Mechatronics
- Test and Measurement
- Computational Biology
- Computational Finance
- Robotics
- Data Analytics
- Motor and Power Control
- Deep Learning

By Industry

- Aerospace and Defense
- Automotive
- Biological Sciences
- Biotech and Pharmaceutical
- Communications
- Electronics
- Earth, Ocean, and Atmospheric Sciences
- Energy Production
- Financial Services
- Industrial Automation and Machinery
- Medical Devices
- Metals, Materials, and Mining
- Neuroscience
- Railway Systems
- Semiconductors
- Software and Internet
- See More Industries

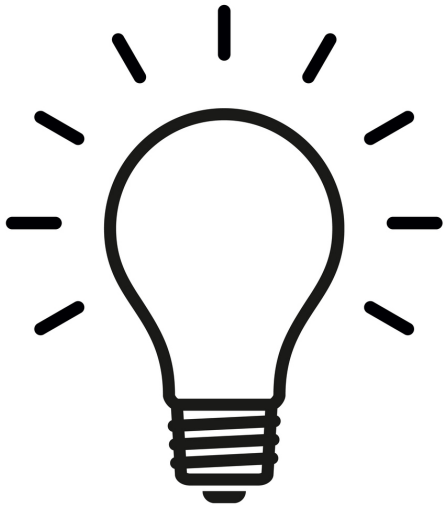
Common Feedback from Education

I want to …

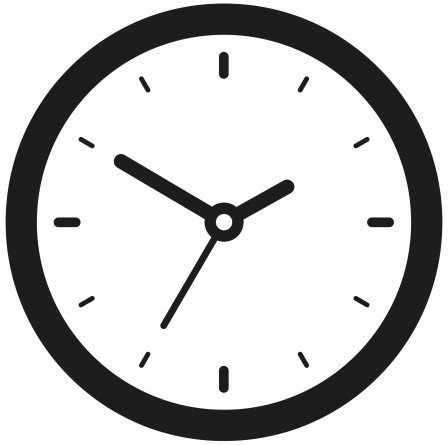
- Prepare (students) for their careers
- Incorporate (use) latest technology into the curriculum
- Motivate students to stay (be) engaged

… but I have limited time and resources.

Benefits of teaching & learning with MATLAB/Simulink



Get ideas



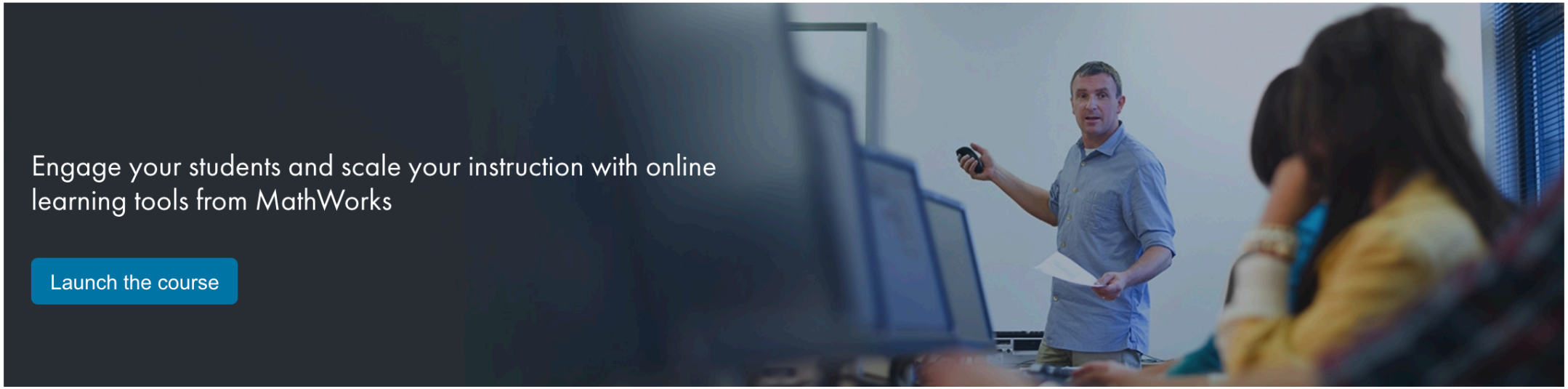
Save time

Engage students

Anytime, anywhere

https://www.mathworks.com/learn/teaching-with-matlab.html

Teaching with MATLAB



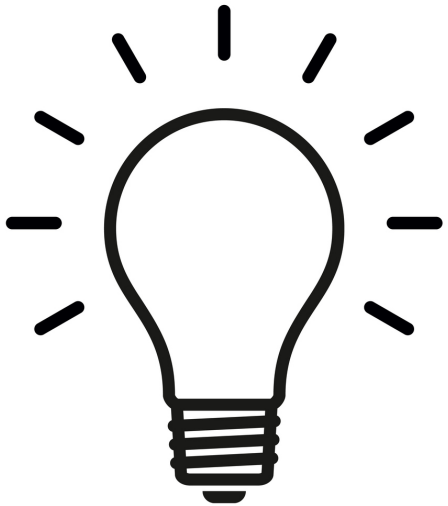
Access to MATLAB through your web browser

MATLAB integrated file sharing

Hands-on exercises with automated assessments and feedback

Ready-to-use resources to enhance your instruction

Benefits of teaching & learning with MATLAB



Get ideas

Save time

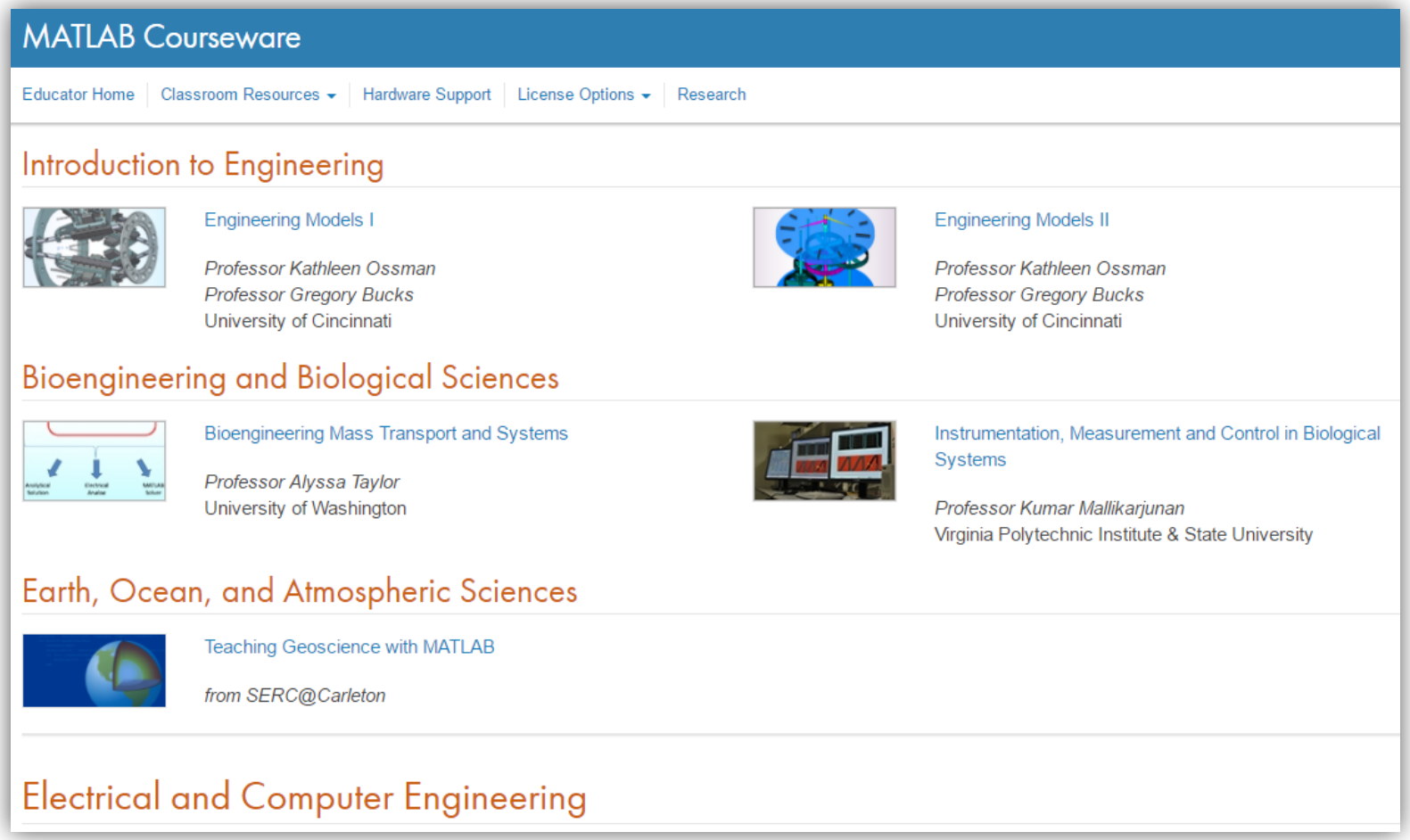
Engage students

Anytime, anywhere

Examples from others teaching with MATLAB

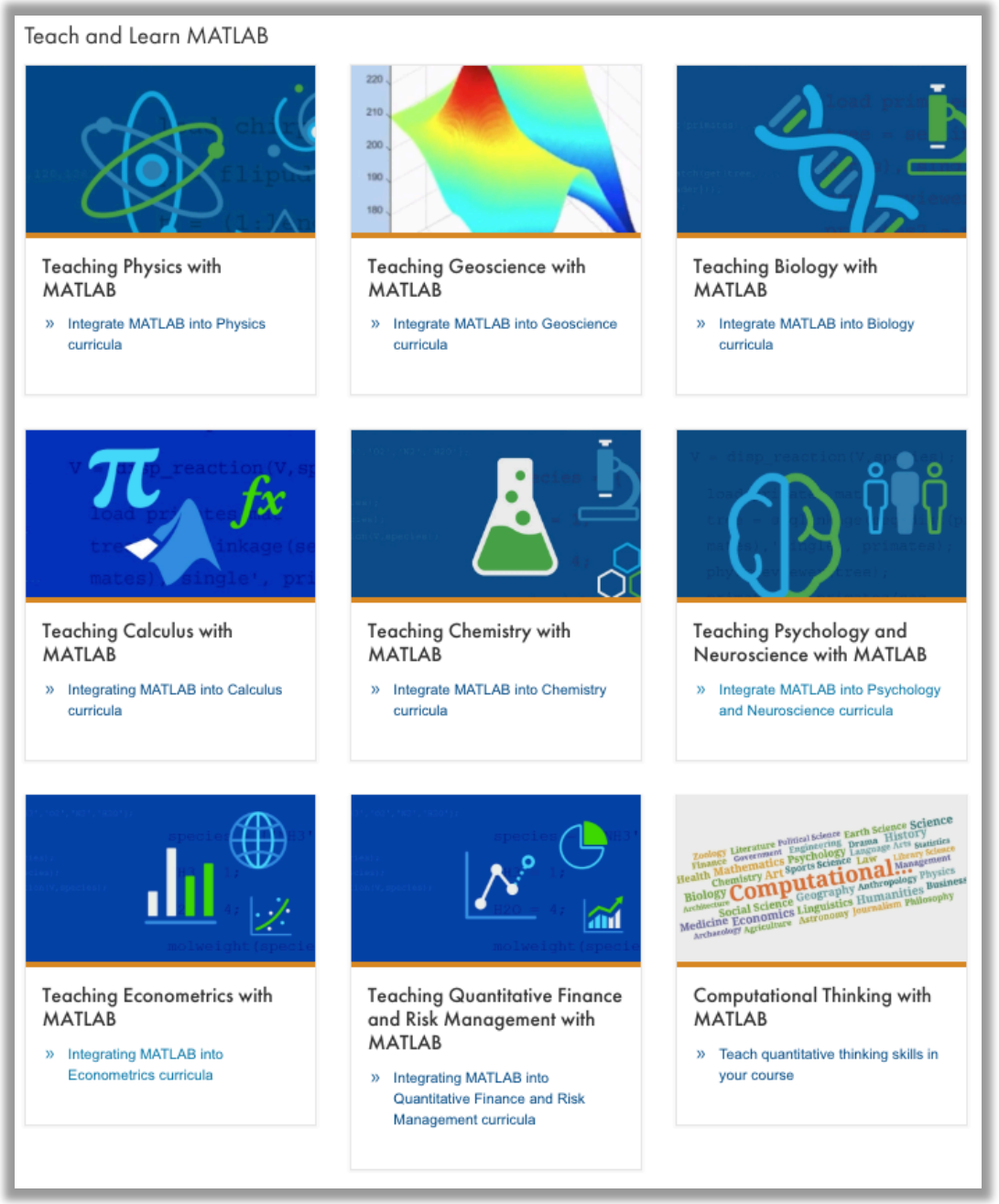
Teaching resources created by your peers:

www.mathworks.com/academia/courseware.html

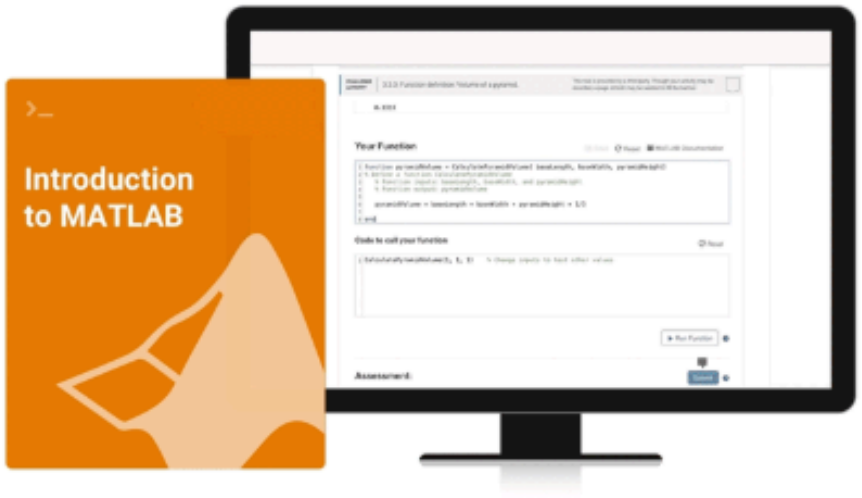


MATLAB for teaching and learning in Sciences

https://www.mathworks.com/academia/courseware/teaching-science-with-matlab.html



Intro to MATLAB zyBook



Introduction to MATLAB - zyBook

Authors: ***Andre Knoesen,*** *University of California, Davis |* ***Rajeevan Amirtharajah,*** *University of California, Davis*
Publisher: zyBooks · ISBN: 978-0-9895902-5-9 · Language: English

Written for undergraduate students, this web-based book presents a comprehensive introduction to MATLAB through interactive questions, animations, and automated MATLAB assessment. Topics include variables, scripts, functions, and strings, with an emphasis on arrays and their

Show more

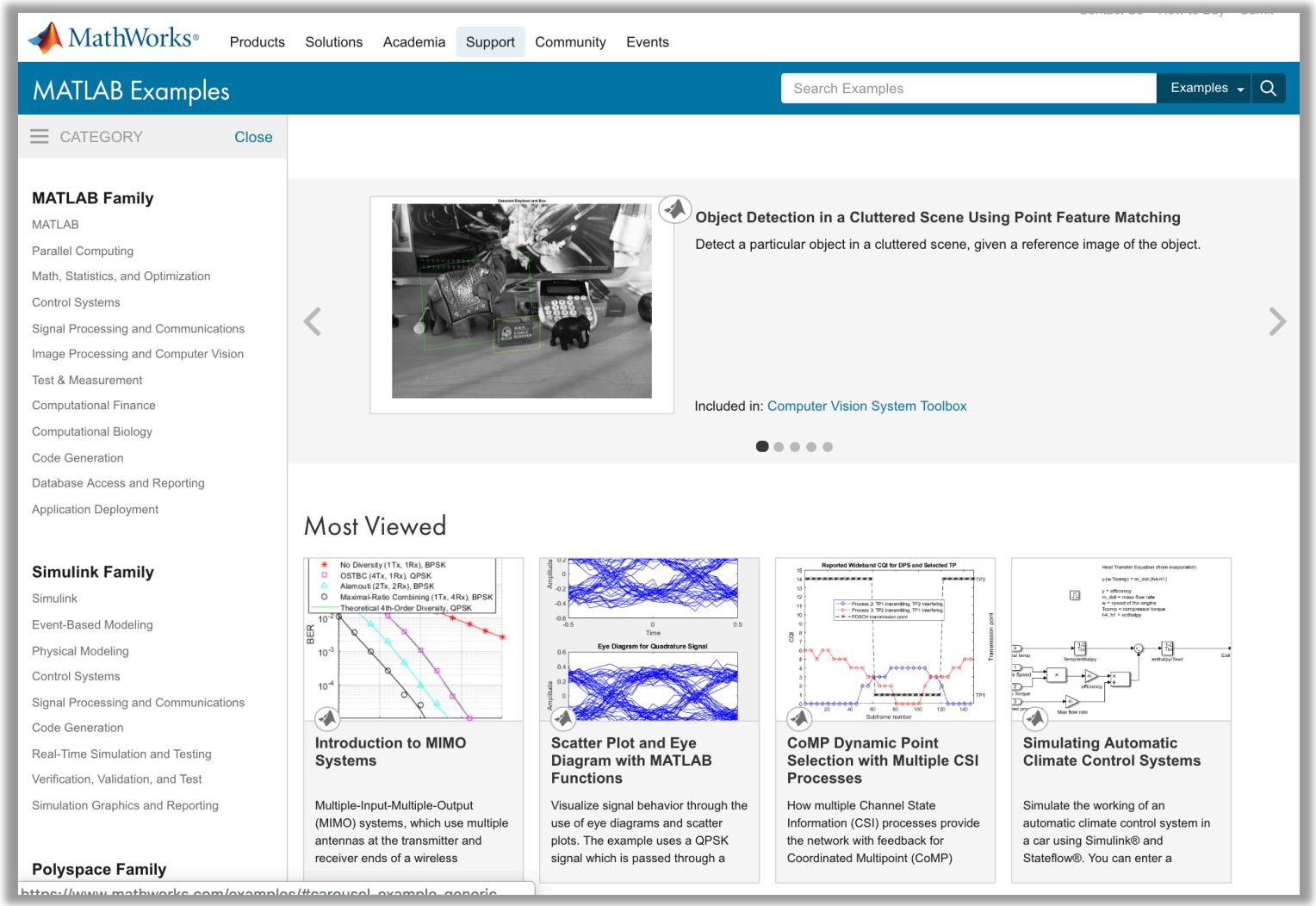
Get an evaluation copy

Ideas from the industry/application/domain: Videos and Webinars

www.mathworks.com/videos

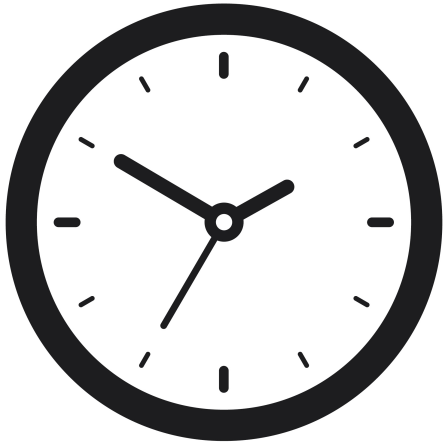
Ideas from the industry: MATLAB Examples

www.mathworks.com/examples/



Benefits of teaching & learning with MATLAB

Get ideas



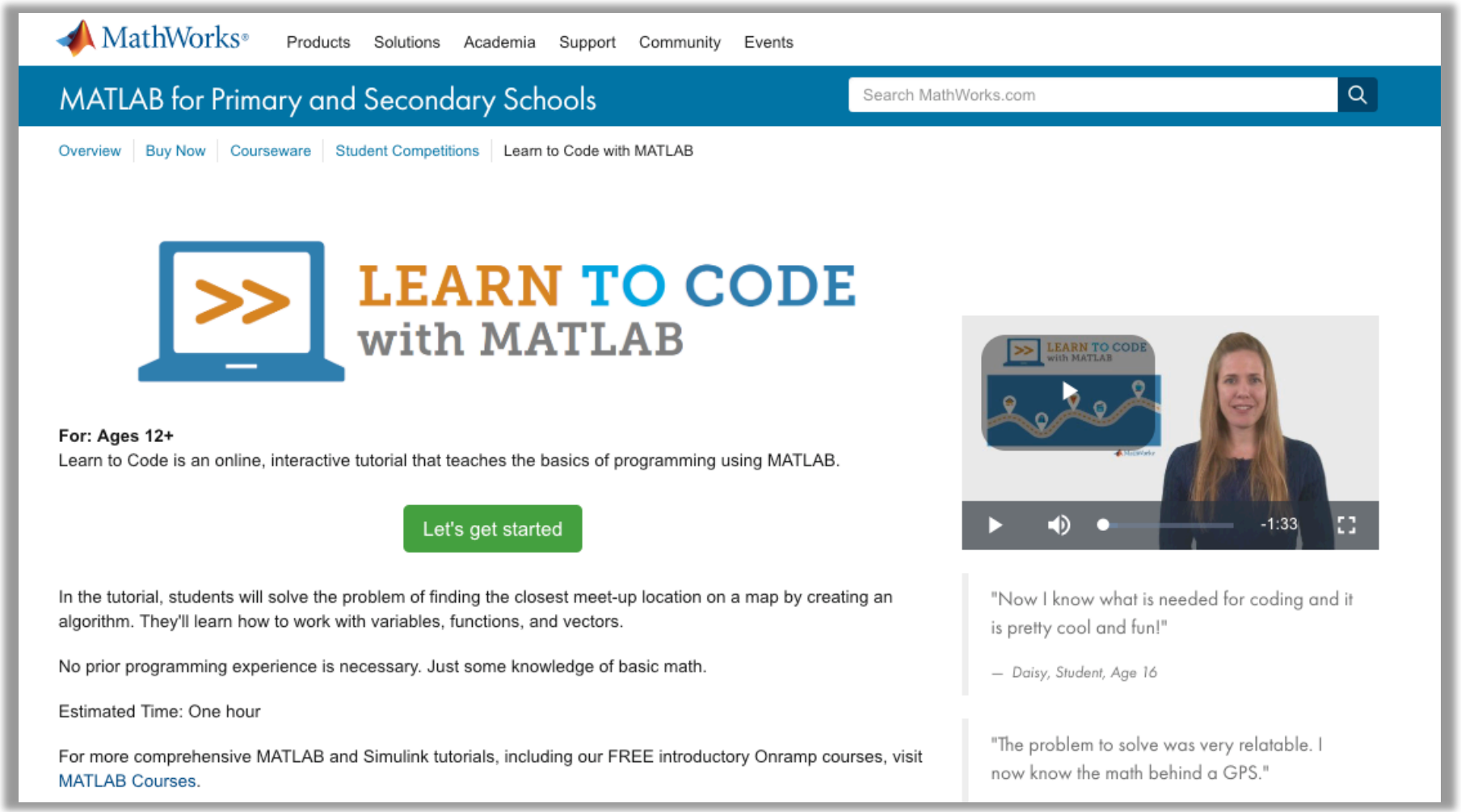
Save time

Engage students

Anytime, anywhere

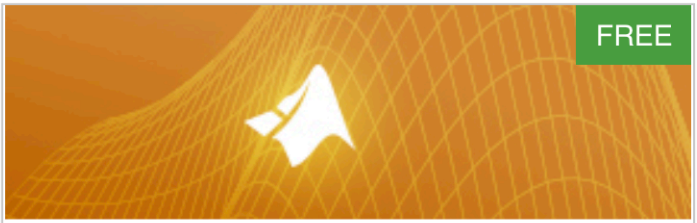
Learn to Code with MATLAB

https://learntocode.mathworks.com/



Self-paced Online Tutorials

Ideal for introductory assignments or a refresher:
https://matlabacademy.mathworks.com/



MATLAB Onramp

Get started quickly with the basics of MATLAB.

Launch | Details

Simulink Onramp

Get started quickly with the basics of Simulink.

Details

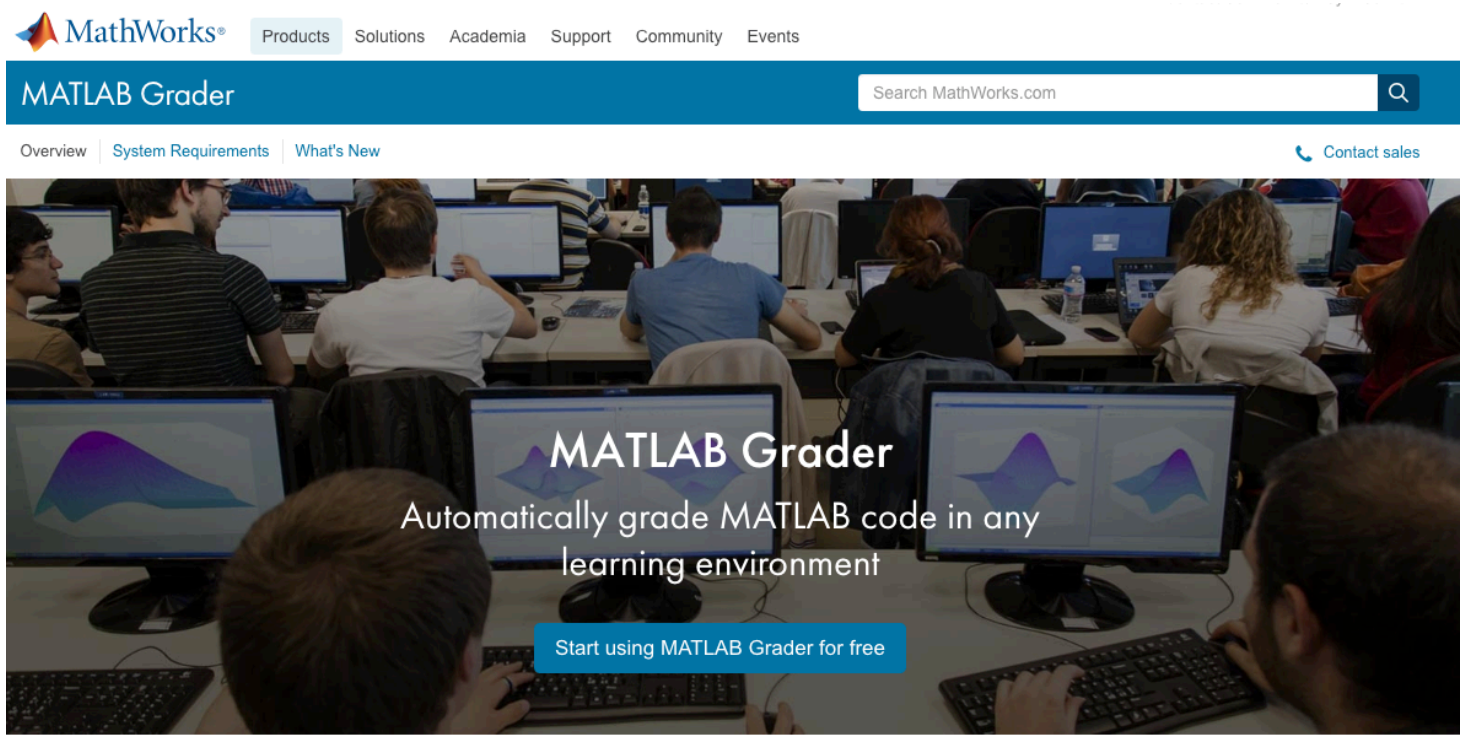
Deep Learning Onramp

Get started quickly using deep learning methods to perform image recognition.

Launch | Details

Automatically grade code (MATLAB Grader)

Instant Feedback and Analytics: https://grader.mathworks.com/



Create interactive course assignments

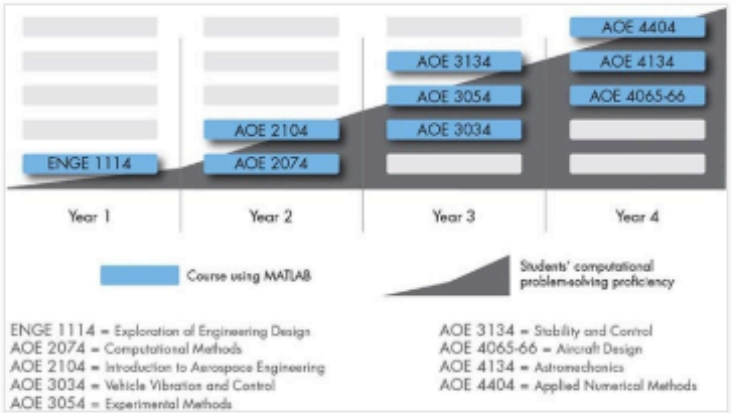
Automatically grade student work and provide feedback

Run your assignments in any learning environment

Educators and Instructors are Teaching with MATLAB Grader

MATLAB Grader automates grading of assignments at Technische Universiteit Eindhoven

» Learn more



MATLAB Grader enhances student learning at Virginia Tech

» Learn more

"The fact that you can get immediate feedback (or confirmation) on a quite complicated piece of code is really neat, and without it, debugging your own code would really be a mess. It also motivated me to get 100% score on all the MATLAB assignments."

— *Juoost P., Virginia Tech Student*

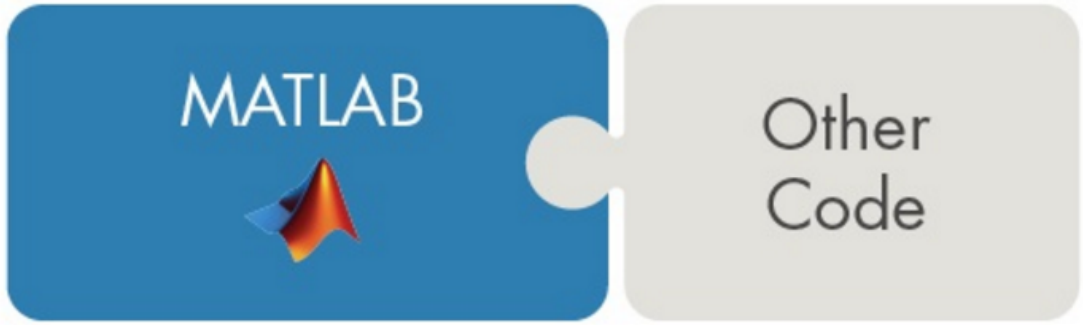
1,000+ instructors

100,000+ students

Over 6 million student submissions

External Interfaces

Calling Libraries Written in Another Language From MATLAB



- Java
- Python R2014b
- C/C++
- Fortran
- COM components and ActiveX® controls
- RESTful, HTTP, and WSDL web services

Calling MATLAB from Another Language

- Java R2016b
- Python R2014b
- C/C++
  - Updated C++ API R2017b
- Fortran
- COM Automation server

Benefits of teaching & learning with MATLAB

Get ideas

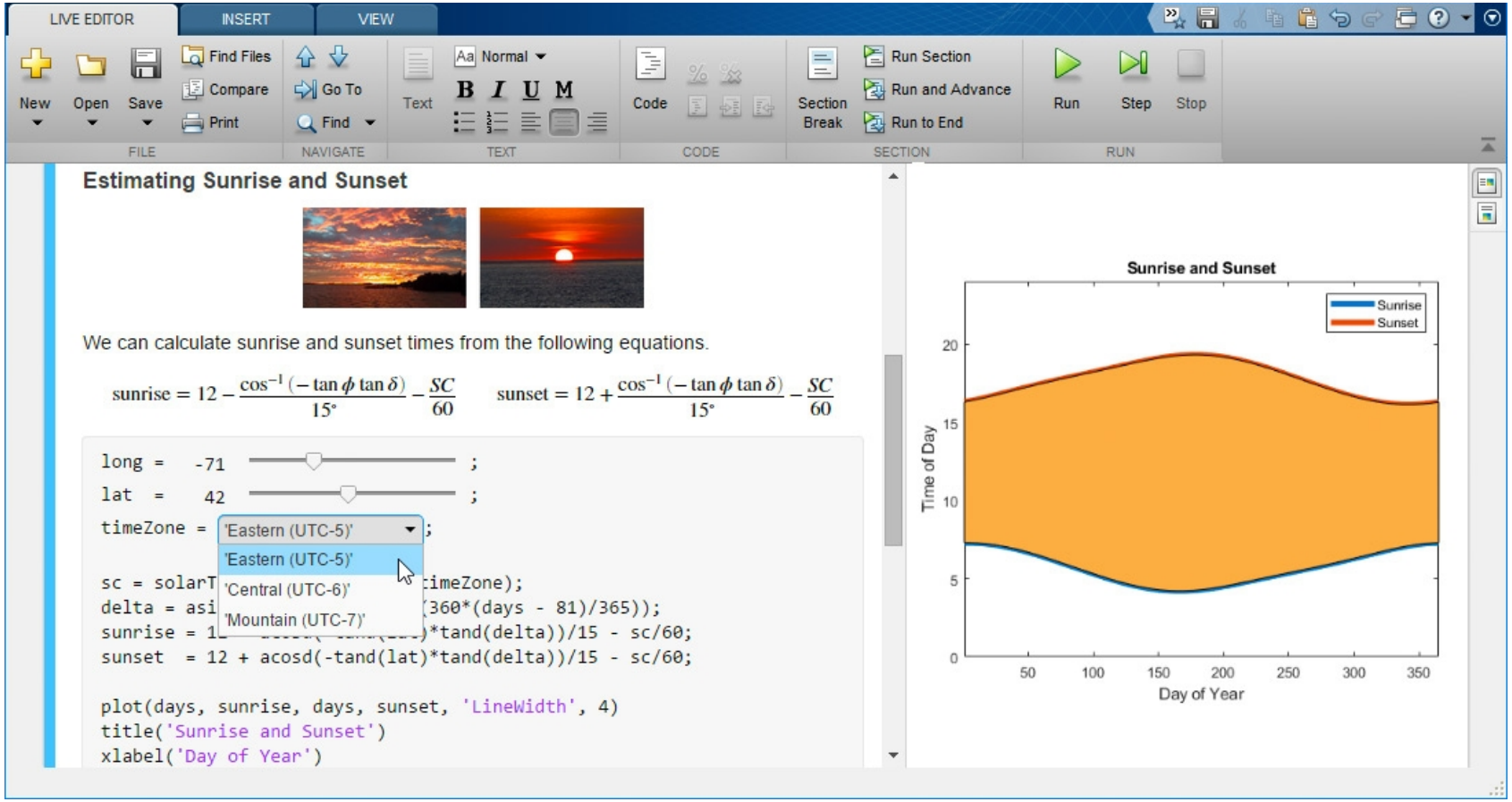
Save time

Engage students

Anytime, anywhere

Interactive MATLAB documents – Live Editor

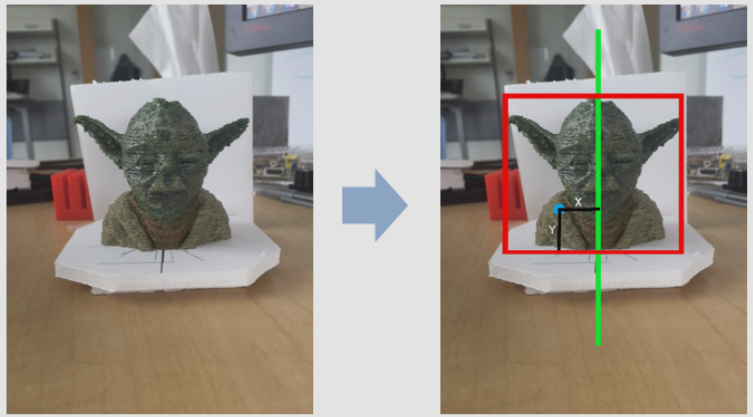
Single environment for content and code:
www.mathworks.com/products/matlab/live-editor.html



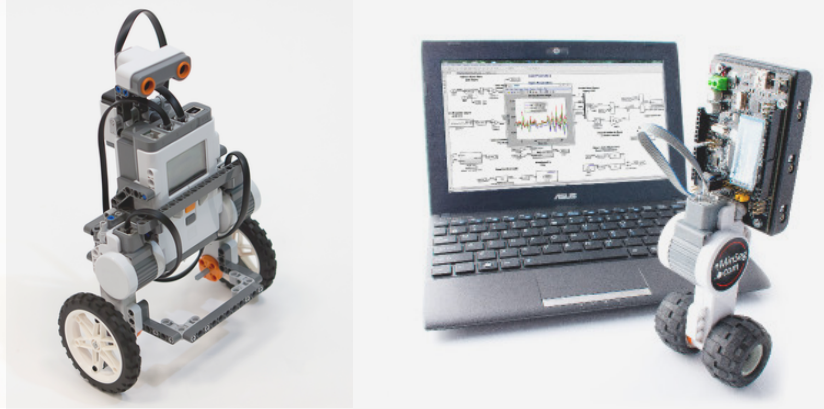
Hands-on with Project-Based Learning

Low-cost Hardware and Mobile Sensors:

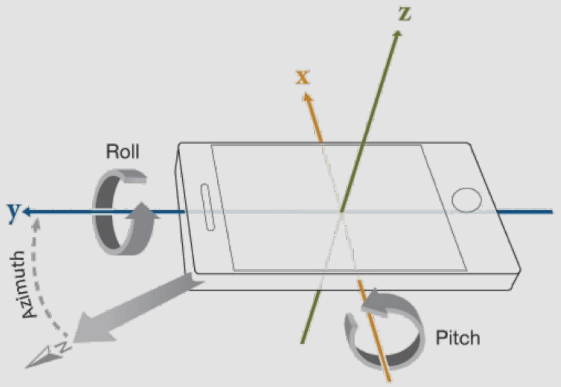
www.mathworks.com/hardware-support



MATLAB based 3D Scanner using
Raspberry Pi



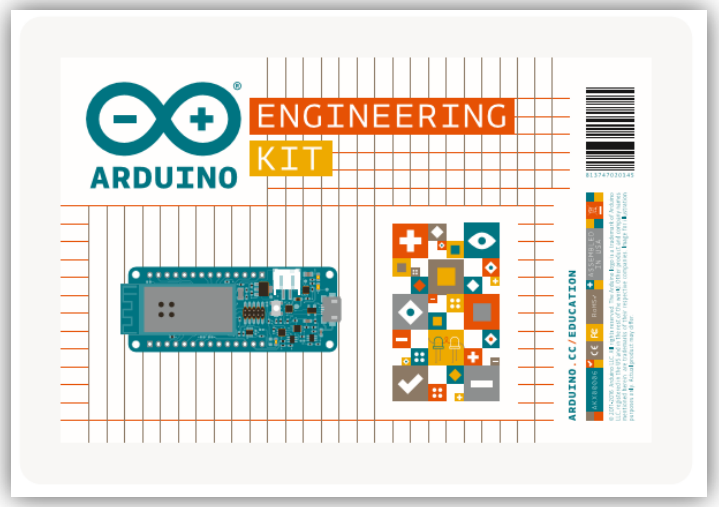
Self-balancing robots using
LEGO and Arduino



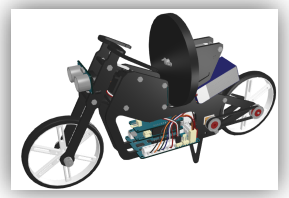
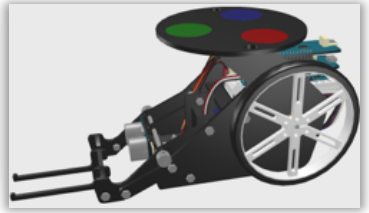
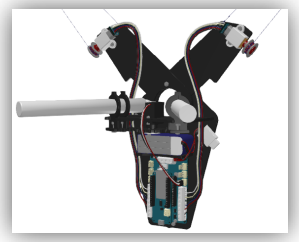
Sensor support for
Android and iOS devices

Search: MATLAB Hardware Catalog

Arduino Engineering Kit - Inside the Box



- Arduino MKR1000 board and all components to create 3 engaging, hands-on projects:

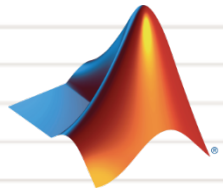
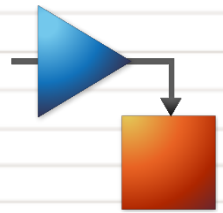




- 1-year individual user license of MATLAB and Simulink products
- Online learning materials that facilitate projects

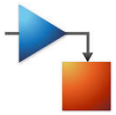
Available through the Arduino Store

THIS KIT CONTAINS:

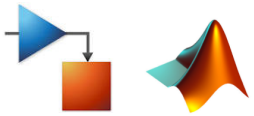
- 1 Arduino MKR1000 Board
- 1 Arduino MKR Motor Shield
- 1 Arduino MKR IMU Shield
- 1 DC Motor
- 2 Geared DC Motors with Encoders
- 1 Standard Micro Servo
- 1 Hall Sensor Module
- 1 Ultrasonic Sensor Module
- 1 Webcam
- 1 LiPo Battery
- 1 Lipo Battery Charger
- 1 Micro USB Cable
- 1 3to4 Pin Module Cable
- 1 3pin Module Cable
- 3 Sets of Assembly Pieces
- 2 Wheels
- 1 Caster Wheel
- 1 Timing Belt
- 2 Timing Pulleys
- 2 DC Motor Mounting Brackets
- 1 Metal Shaft (90 mm)
- 2 Metal D Shafts(50 mm)
- 1 Set of Distance Spacers (17 mm)
- 1 Sets of M2 Bolts (10 mm, 25mm)
- 1 Sets of M3 Bolts (10 mm, 15 mm, 25 mm)
- 1 Set of M3 Locknuts with Nylon Insert
- 3 Shaft Collars
- 1 Propeller Adapter Screw
- 2 Magnets
- 1 Thread
- 2 Whiteboard Pens
- 1 Sticker for Image Recognition

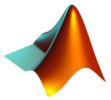
Projects



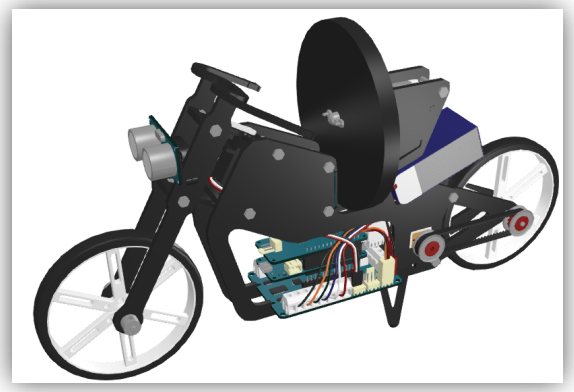
- **Self-balancing motorcycle**
  - Maneuvers itself on varying terrain and remains upright using a flywheel for balance
  - Concepts: Controls, IMU sensing, filter design, system modeling, simulation

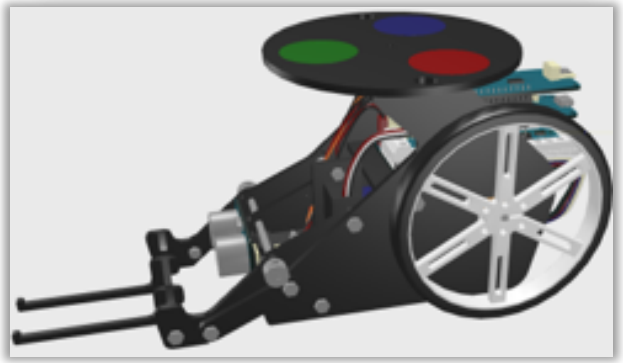


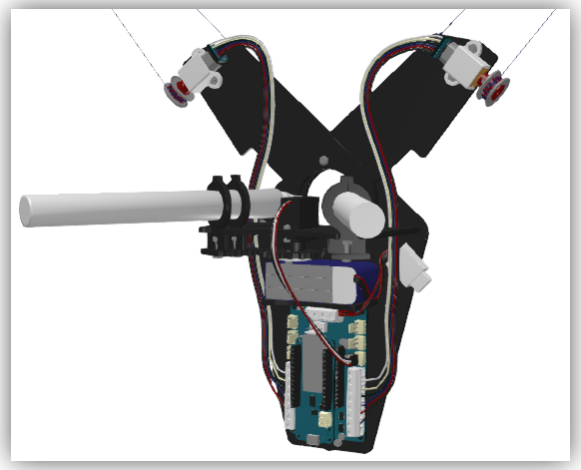
- **Mobile rover**
  - Navigates between reference points, locates and moves objects with a forklift
  - Concepts: Robotics, system modeling, simulation, controls, object tracking, localization



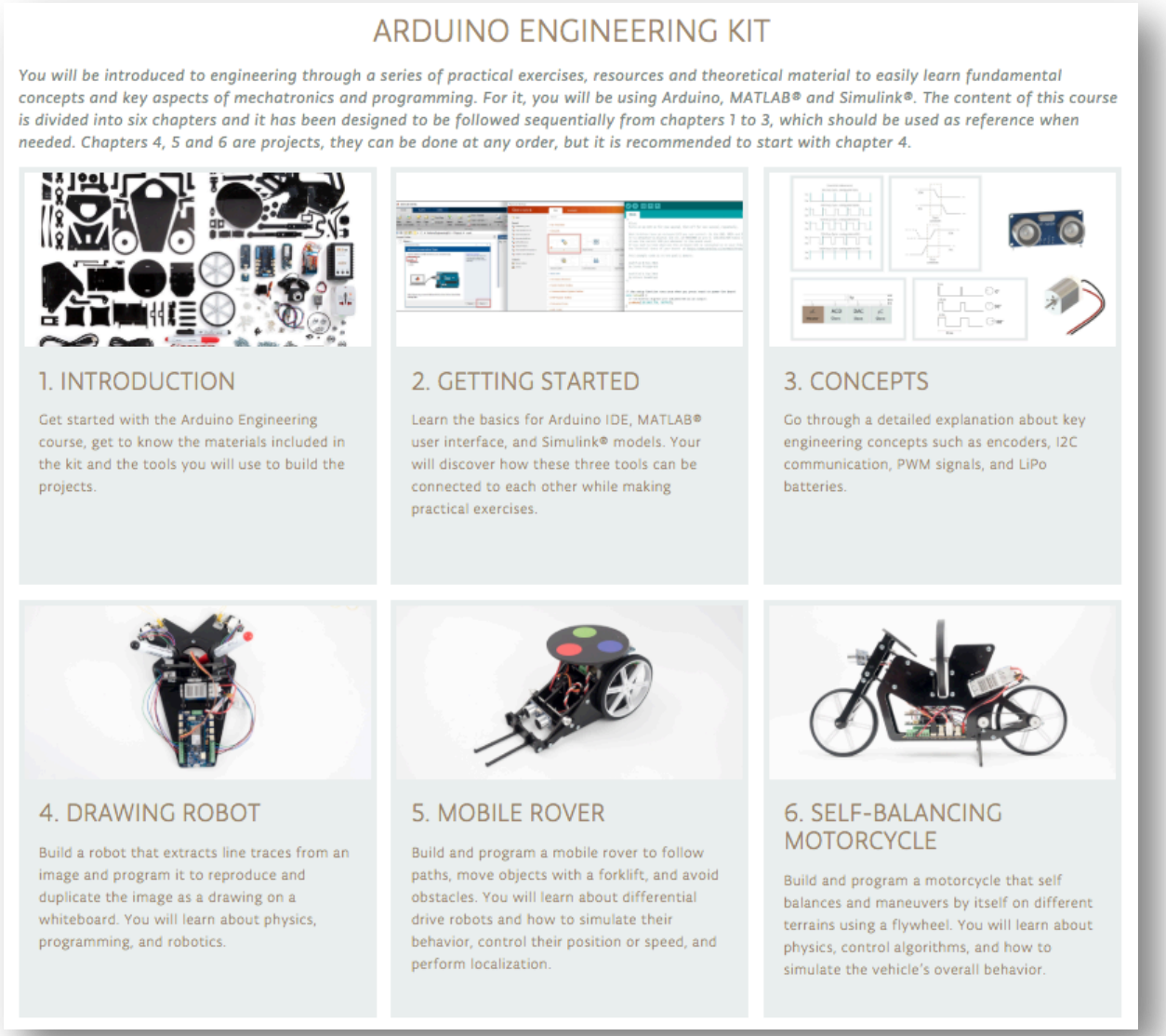
- **Drawing robot**
  - Takes a reference drawing and duplicates it on a whiteboard
  - Concepts: Image acquisition & processing, optimization, kinematics







Learning Guides for Getting Started



ARDUINO ENGINEERING KIT

You will be introduced to engineering through a series of practical exercises, resources and theoretical material to easily learn fundamental concepts and key aspects of mechatronics and programming. For it, you will be using Arduino, MATLAB® and Simulink®. The content of this course is divided into six chapters and it has been designed to be followed sequentially from chapters 1 to 3, which should be used as reference when needed. Chapters 4, 5 and 6 are projects, they can be done at any order, but it is recommended to start with chapter 4.

1. INTRODUCTION

Get started with the Arduino Engineering course, get to know the materials included in the kit and the tools you will use to build the projects.

2. GETTING STARTED

Learn the basics for Arduino IDE, MATLAB® user interface, and Simulink® models. Your will discover how these three tools can be connected to each other while making practical exercises.

3. CONCEPTS

Go through a detailed explanation about key engineering concepts such as encoders, I2C communication, PWM signals, and LiPo batteries.

4. DRAWING ROBOT

Build a robot that extracts line traces from an image and program it to reproduce and duplicate the image as a drawing on a whiteboard. You will learn about physics, programming, and robotics.

5. MOBILE ROVER

Build and program a mobile rover to follow paths, move objects with a forklift, and avoid obstacles. You will learn about differential drive robots and how to simulate their behavior, control their position or speed, and perform localization.

6. SELF-BALANCING MOTORCYCLE

Build and program a motorcycle that self balances and maneuvers by itself on different terrains using a flywheel. You will learn about physics, control algorithms, and how to simulate the vehicle's overall behavior.

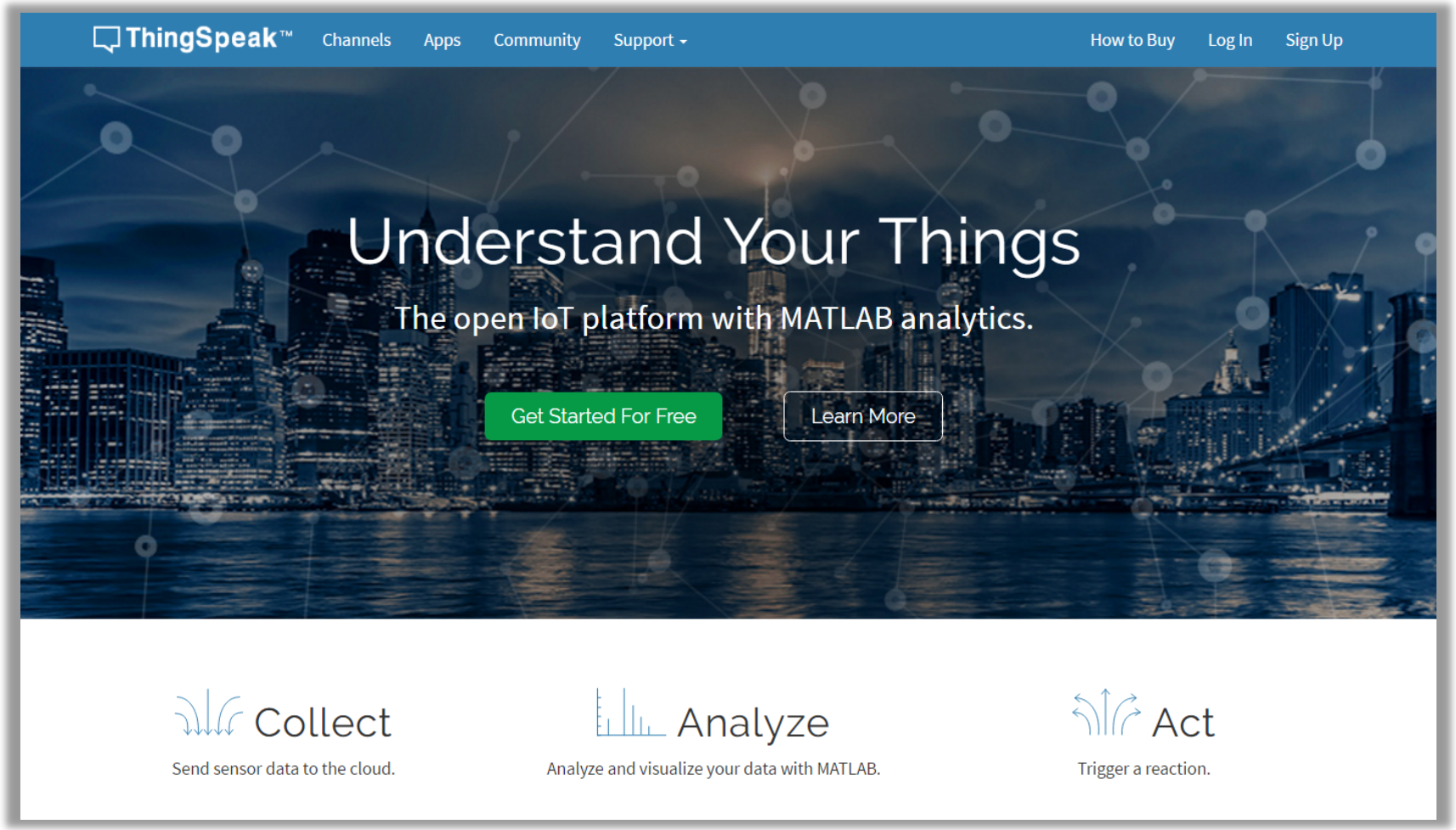
Introduces engineering fundamentals with:

- Kit instructions
- Key theoretical concepts & background
- Practical exercises

https://create.arduino.cc/edu/courses/

Internet of Things (IoT) with ThingSpeak

Cloud-based projects / workflows:
www.mathworks.com/products/thingspeak.html



Benefits of teaching & learning with MATLAB

Get ideas

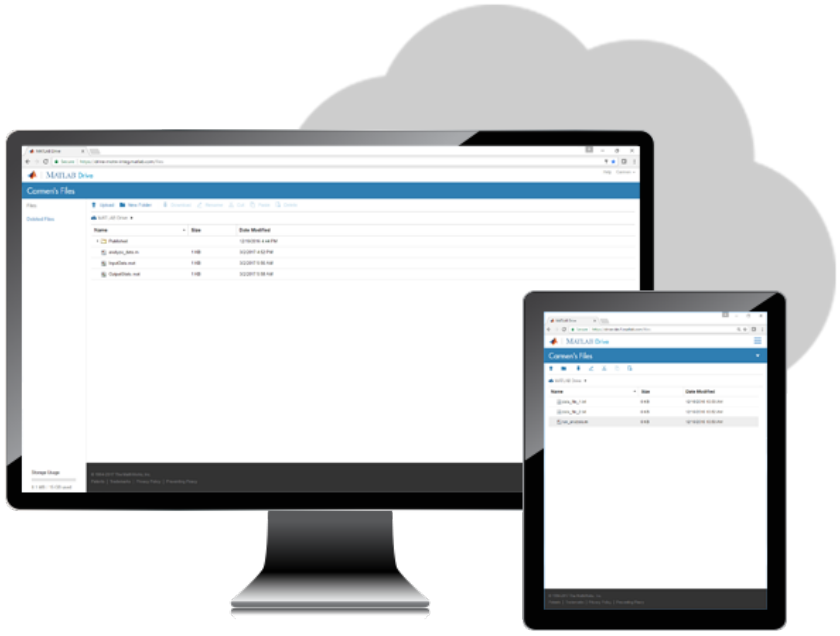
Save time

Engage students

Anytime, anywhere

Convenient, lightweight access directly through the web:
www.mathworks.com/products/matlab-online.html

MATLAB Online

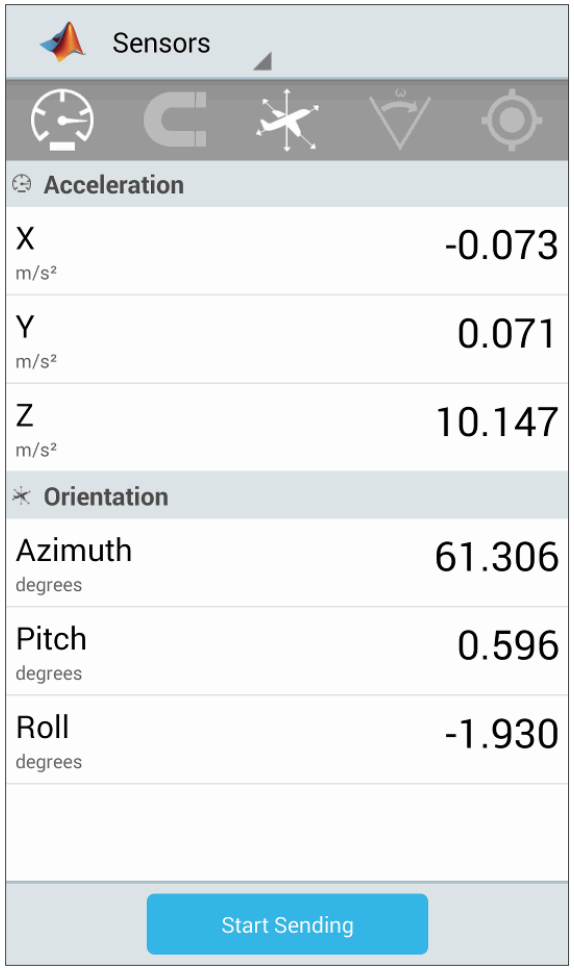


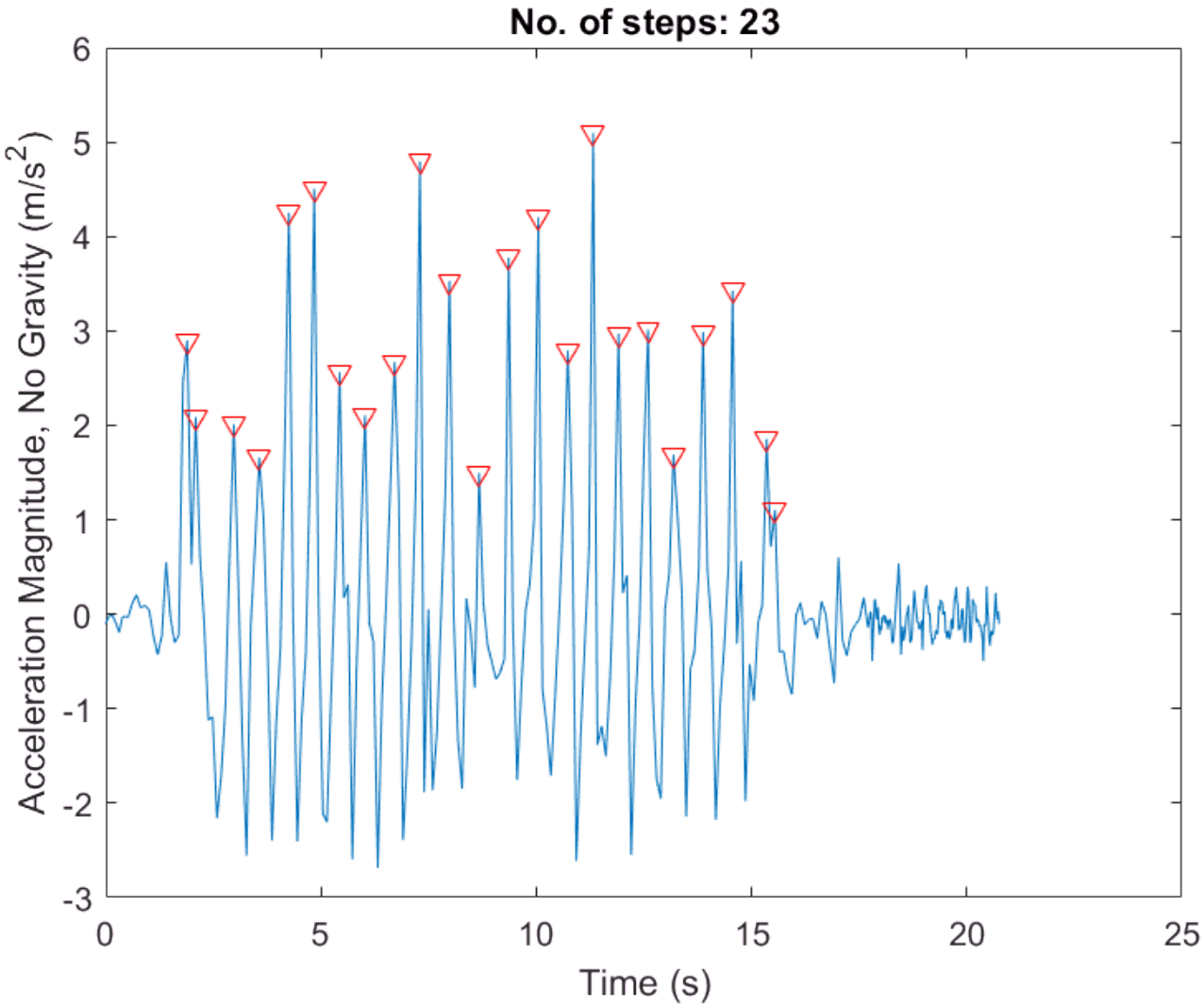
No download or installation required
Always running the latest version

Synchronize across all devices

Everything is mobile now … even MATLAB:

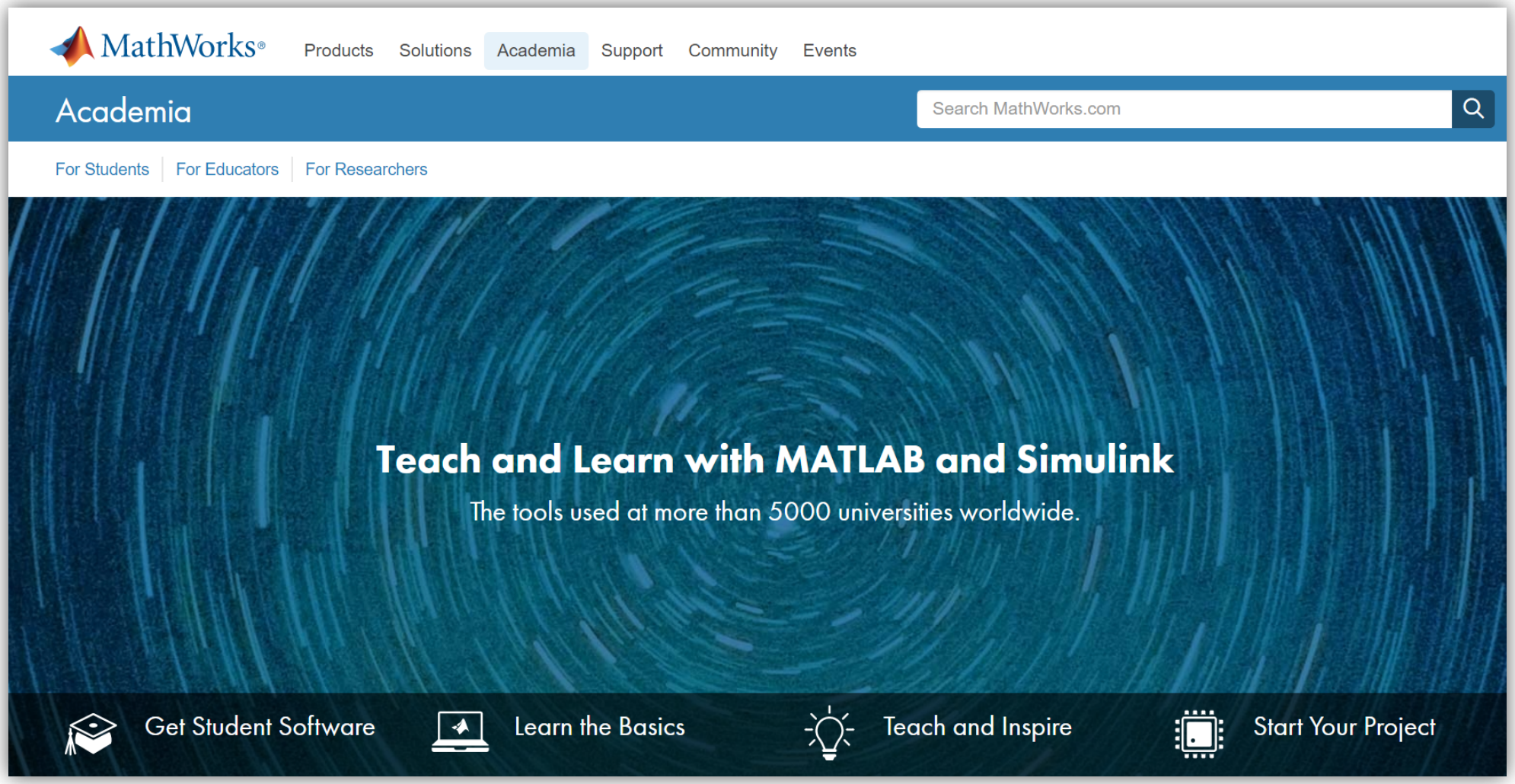
www.mathworks.com/products/matlab-mobile.html





Resources for Educators and Students

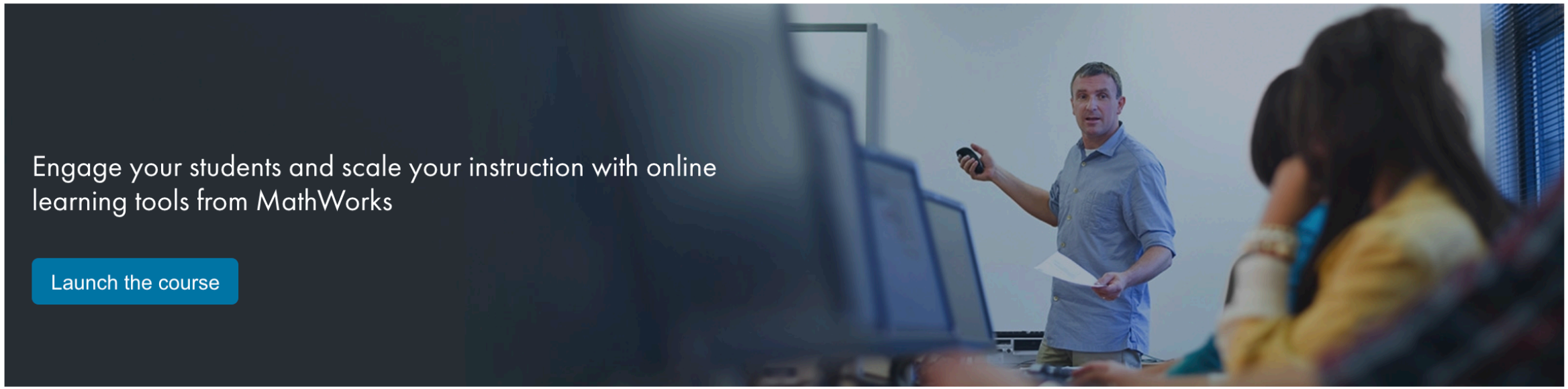
mathworks.com/academia



How do I start using these resources – some ideas:

- Assign Learn to Code / MATLAB Onramp as Homework # 0 for the class
- Open MATLAB scripts in Live Editor – use as a teaching tool / homework template
- Log into matlab.mathworks.com *(MATLAB Online, MATLAB Drive)*
- Download the MATLAB Mobile APP on your smartphone
- Assign webinars and MATLAB Examples as projects/exercise
- Test MATLAB Grader for 1-2 assignments – ***ask a CSE for help***
- Explore MATLAB Courseware and partner with peers for ideas

Teaching with MATLAB



Access to MATLAB through your web browser

MATLAB integrated file sharing

Hands-on exercises with automated assessments and feedback

Ready-to-use resources to enhance your instruction

What if I need help?

- Explore product pages and documentation
- Leverage the MATLAB user community
- Contact
  - Technical Support
  - Customer Success Engineer
  - Account Manager

Q & A