



Online Learning and Virtual Labs with MATLAB and Simulink



Online course example



Definite Integrals in Maxima and Minima

To maximize $F(x) = \int_0^x \sin(ax) \sin(x/a) dx$ for $a \geq 0$, first, define the symbolic variables and assume that $a \geq 0$:

```

syms a x
assume(a >= 0);

```

Then, define the function to maximize:

```

F = int(sin(a*x)*sin(x/a), x, -a, a);

```

Note the special case here for $a = 1$. To make computations easier, use `assume1` to ignore this possibility.

```

assume1(a ~= 1);
F = int(sin(a*x)*sin(x/a), x, -a, a);

```

Create a plot of F to check its shape:

```

fplot(F, [0 28]);

```

Use `diff` to find the derivative of F with respect to x . The zeros of F_x are the local extrema of F .

```

Fa = diff(F,a);
hold on

```

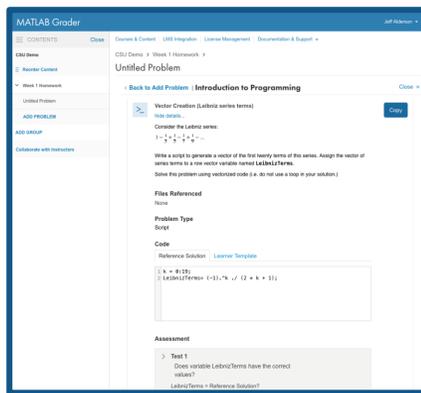
Learn techniques to interpret and solve differential equations



XSeries Program in
18.03x Differential Equations

I'm interested

MATLAB Online



MATLAB Grader

Live Scripts

Learner Testimonials

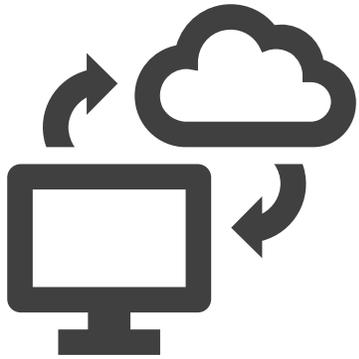
"Wonderful course on differential equations. The teachers provide a nice computational tool to depict the dynamics of solving the equations, which is very useful for students to grasp the key ideas and concepts." - Jiting (completed this course, spending 10 hours a week on it and found the course difficulty to be medium)

"Interesting course. Lectures, homeworks and review exercises of any part are really well setup. One of the best MOOC on topic of differential equations." - Gaetano (completed this course, spending 4 hours a week on it and found the course difficulty to be medium)

"Another excellent course from MIT. The lecture videos are excellent and so are the exercises. This course also has MATLAB based exercises which is wonderful. The problem sets are excellent and so are the staff and the community teaching assistants who are always there to help any time." - Dna47a (completed this course, spending 8 hours a week on it and found the course difficulty to be medium)

Source: <https://www.edx.org/xseries/mitx-18.03x-differential-equations>

Virtual course design



Access



Instruction

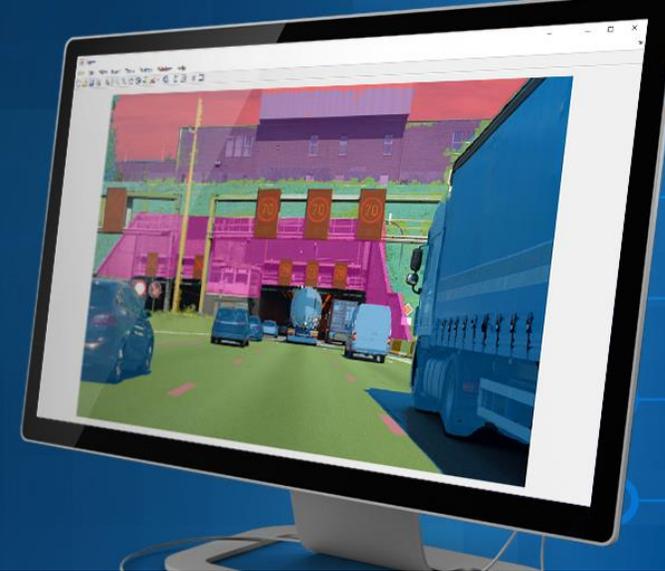


Assessment

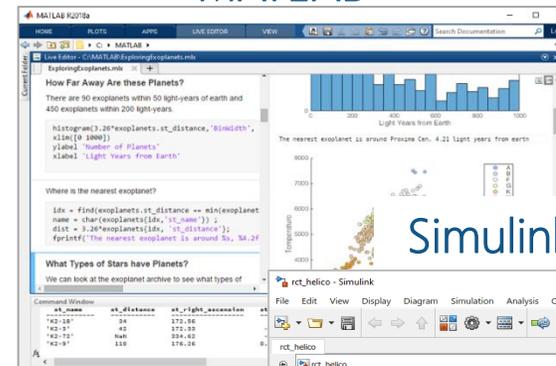


Getting Help

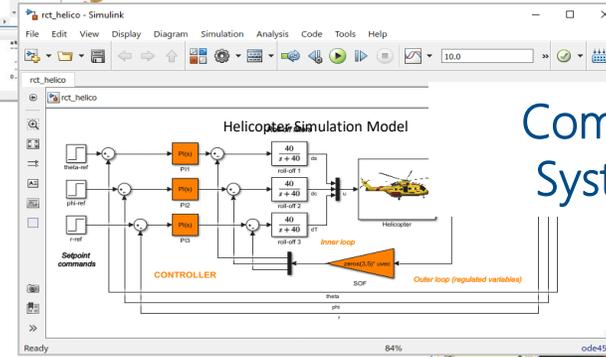
Our Products MATLAB® & SIMULINK®



MATLAB



Simulink



Computer Vision System Toolbox



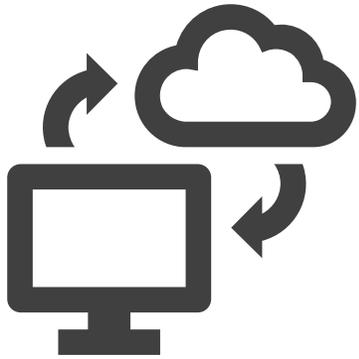
- MATLAB is a programming environment for algorithm development, data analysis, visualization, and numeric computation.
- Simulink is a graphical environment for designing, simulating, and testing systems.
- 100 add-on products for specialized tasks.

ACCESS

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Access



Instruction



Assessment



Getting Help

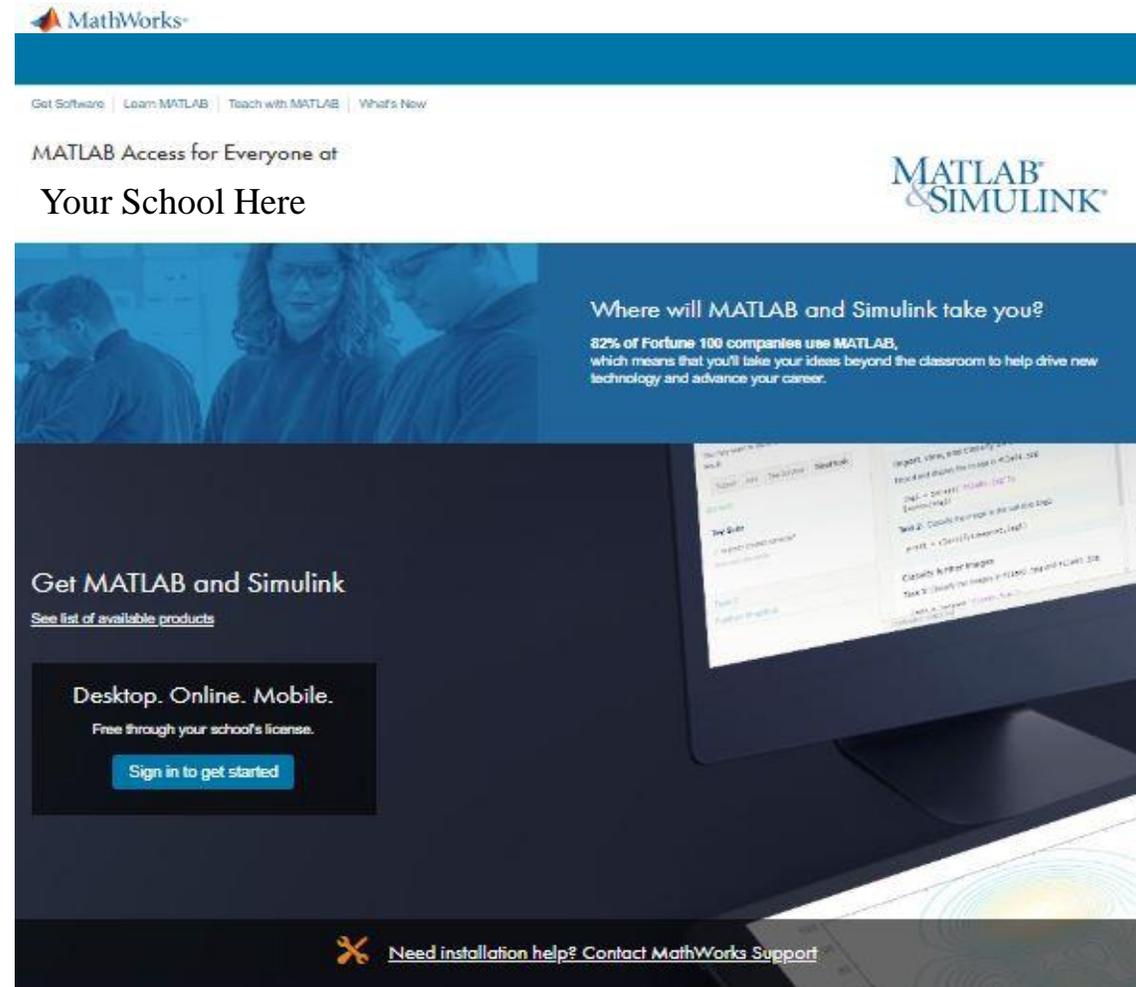
ACCESS

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Campus-wide access



The screenshot shows the MathWorks website page for campus-wide access. At the top, there is a navigation bar with links for 'Get Software', 'Learn MATLAB', 'Teach with MATLAB', and 'What's New'. The main heading reads 'MATLAB Access for Everyone at Your School Here'. To the right is the 'MATLAB & SIMULINK' logo. Below this is a blue banner with the text 'Where will MATLAB and Simulink take you?' and a statistic: '82% of Fortune 100 companies use MATLAB, which means that you'll take your ideas beyond the classroom to help drive new technology and advance your career.' The main content area features the heading 'Get MATLAB and Simulink' with a link to 'See list of available products'. A dark box contains the text 'Desktop. Online. Mobile. Free through your school's license.' and a 'Sign in to get started' button. At the bottom, there is a link for 'Need installation help? Contact MathWorks Support' with a wrench icon.

ACCESS

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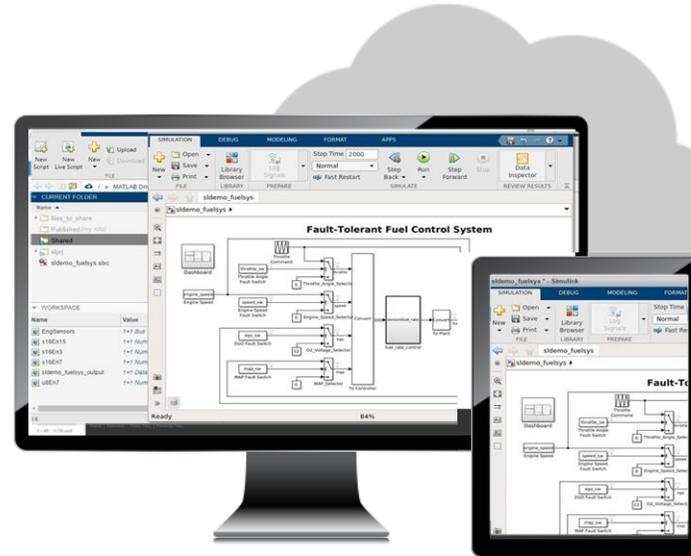
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MATLAB Online



Simulink Online



MATLAB Drive



No download or installation required

Access to the latest version

No minimum device specs other than that for your web browser

ACCESS

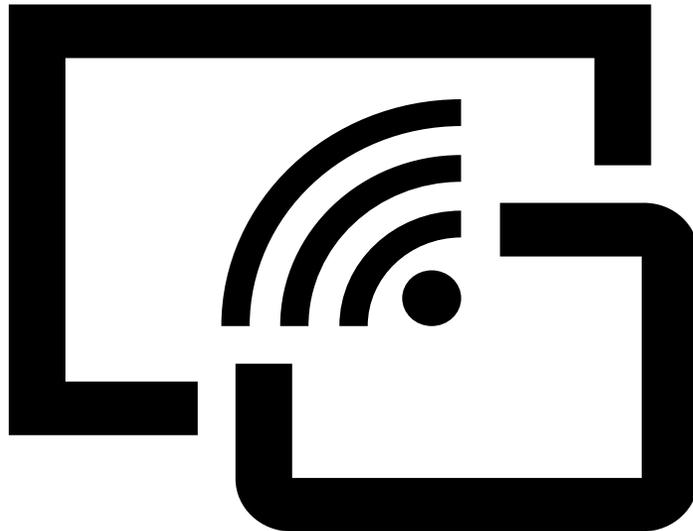
INSTRUCTION

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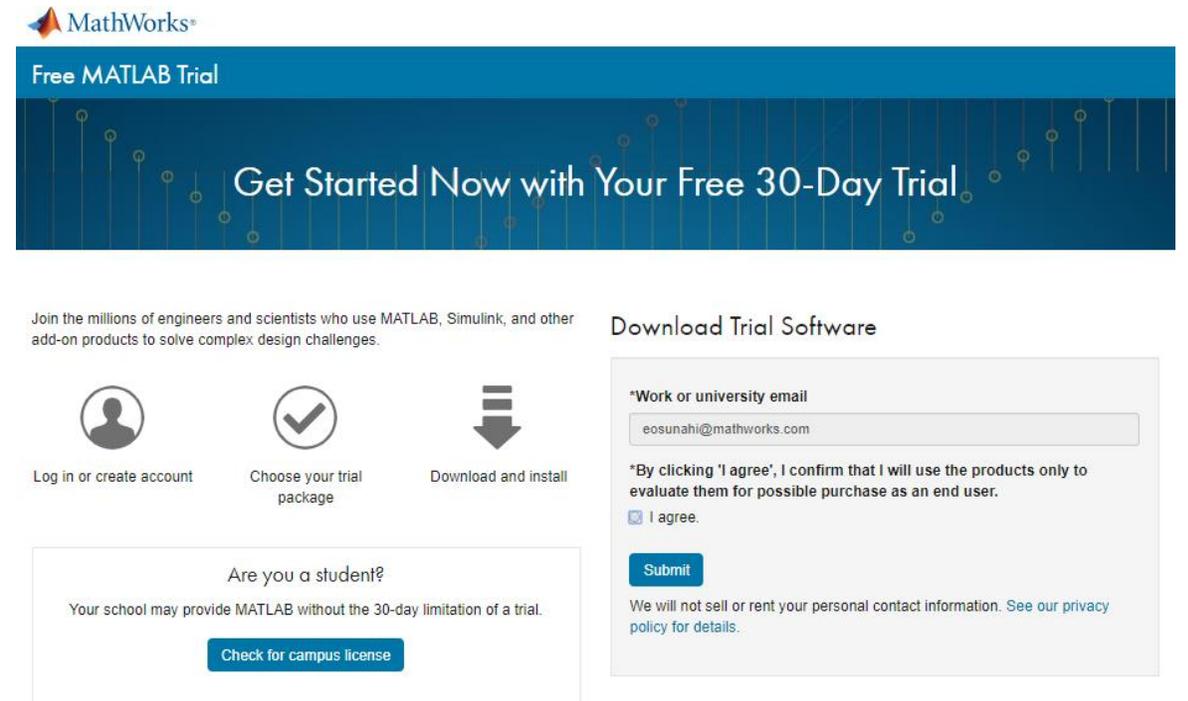
GETTING HELP

Access for universities without campus licenses

If available, access secure connection



For immediate needs, download 30 day trial



MathWorks®

Free MATLAB Trial

Get Started Now with Your Free 30-Day Trial

Join the millions of engineers and scientists who use MATLAB, Simulink, and other add-on products to solve complex design challenges.

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Are you a student?
Your school may provide MATLAB without the 30-day limitation of a trial.
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Access



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Assessment



Getting Help

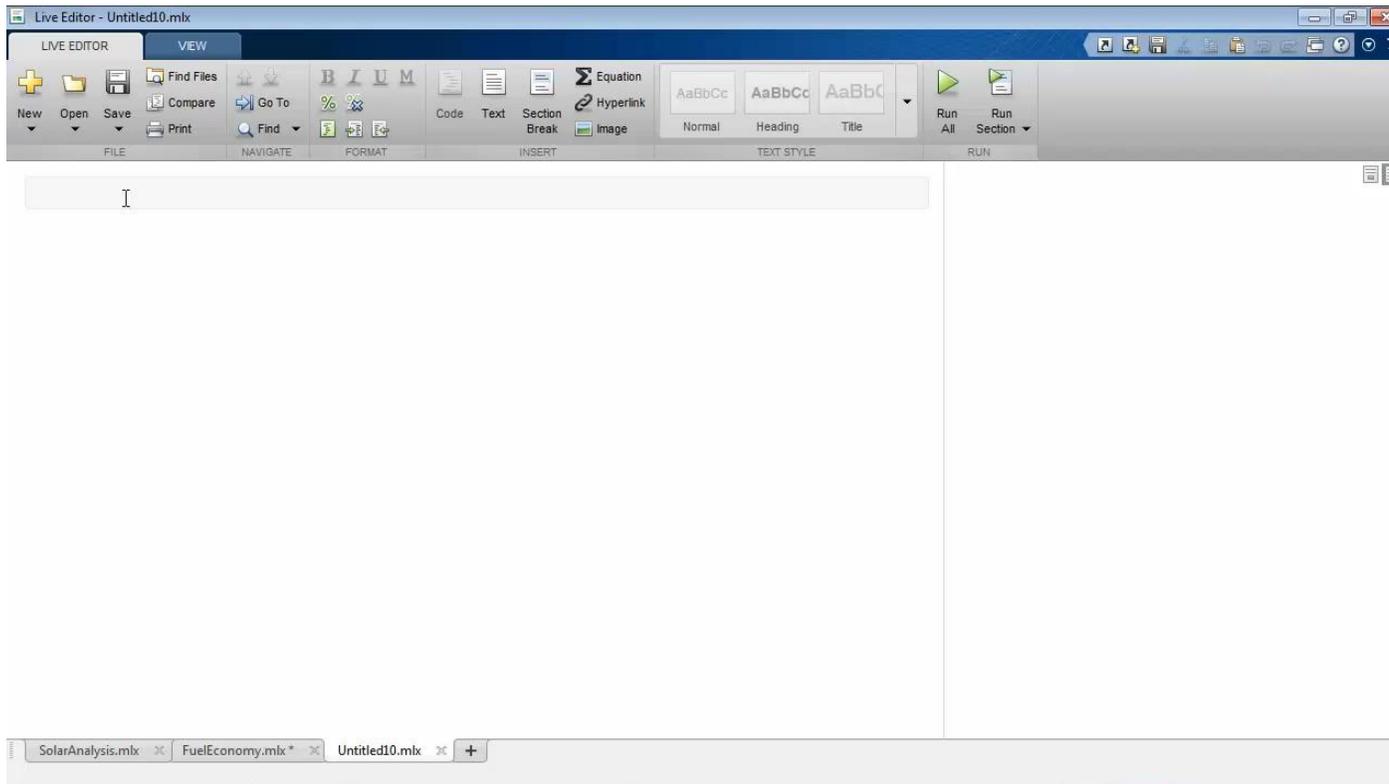
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Interactive programming with Live Editor



Features

- Teach with interactive documents
- Accelerate exploratory programming
- Create an interactive narrative
- Publish consistent reports

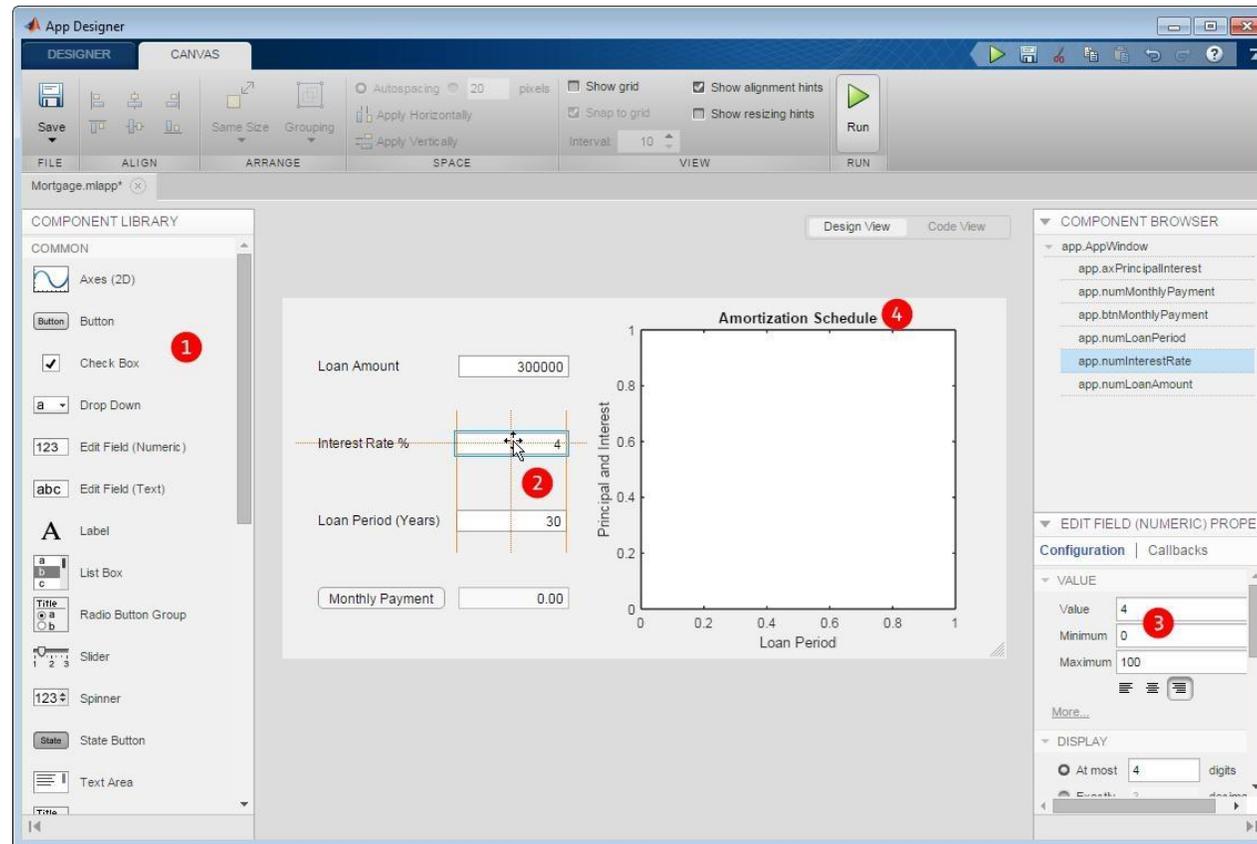
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MATLAB App Designer



ACCESS

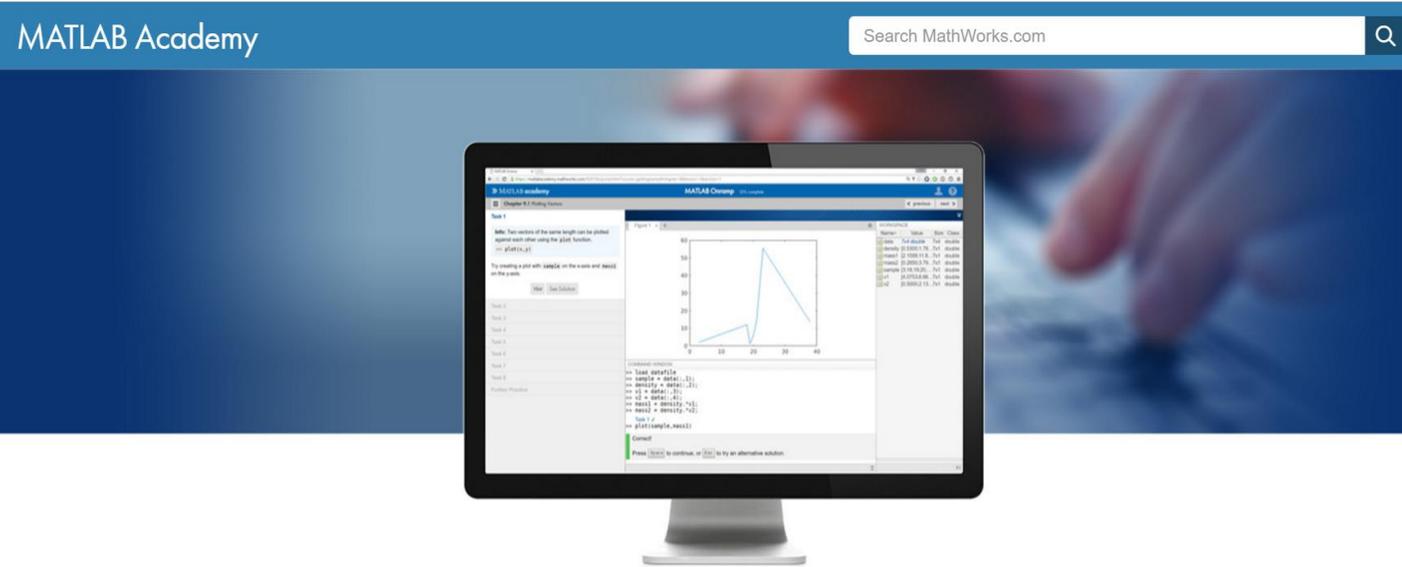
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Self-paced courses

MathWorks® Products Solutions Academia Support Community Events Company



Learn MATLAB for Free

Launch MATLAB Onramp now

“The interactive MATLAB tutorials were perfect for engaging students and getting them up to speed quickly.”

–Dr. Yu-li Wang, Carnegie Mellon University

FREE COURSES (2-3 hours)

- | | |
|-------------------------------------|--------------------------------|
| MATLAB Onramp | Simulink Onramp |
| Stateflow Onramp | Image Processing Onramp |
| Machine Learning Onramp | Deep Learning Onramp |
| Signal Processing Onramp | Optimization Onramp |
| Circuit Simulation Onramp | Simscape Onramp |
| Reinforcement Learning Onramp | Wireless Communications Onramp |
| Control Design Onramp with Simulink | |

FOCUSED COURSES

- | | |
|---|---|
| FOUNDATIONAL COURSES (17-21 hours) | COMPUTATIONAL MATH COURSES (2-3 hours) |
| MATLAB Fundamentals | Introduction to Linear Algebra |
| MATLAB Programming Techniques | Solving Ordinary Differential Equations |
| MATLAB for Financial Applications | Introduction to Statistical Methods |
| MATLAB for Data Processing and Viz | Solving Non-Linear Equations |
| Machine Learning with MATLAB | Introduction to Symbolic Math with MATLAB |
| Deep Learning with MATLAB | |

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Access



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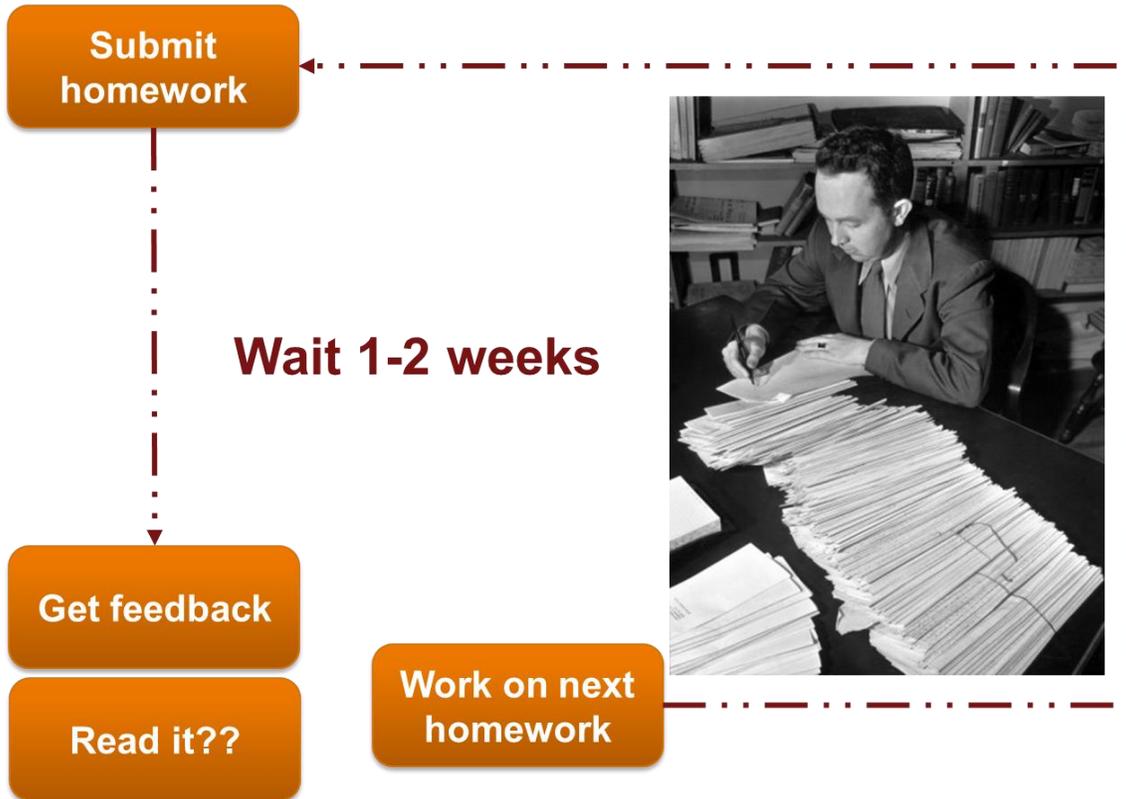
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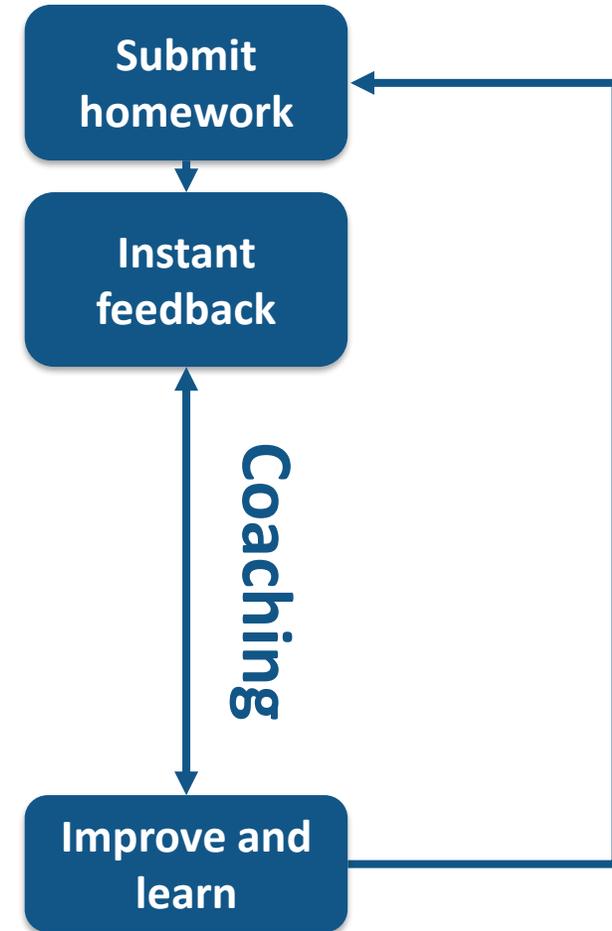
GETTING HELP

Autograde MATLAB Assignments

Traditional Grading



Autograding

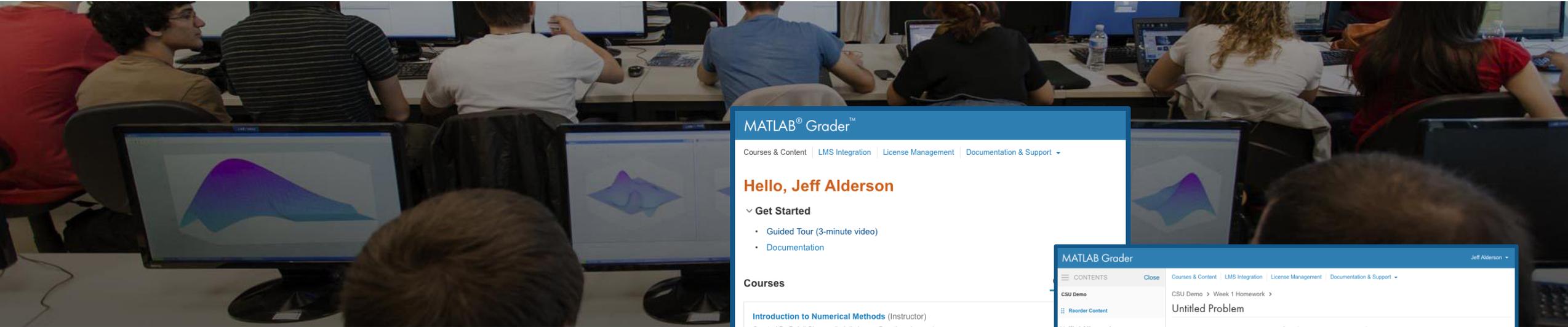


ACCESS

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MATLAB® Grader™

Courses & Content | LMS Integration | License Management | Documentation & Support

Hello, Jeff Alderson

Get Started

- Guided Tour (3-minute video)
- Documentation

Courses

Introduction to Numerical Methods (Instructor)
 Created By Balaji Sharma (balaji.sharma@mathworks.com)
 Duration (EDT): 01 Jan 2018 - 03 Sep 2018
 3 Problems | 3 Students

Copy of Introduction to Programming (Instructor)
 Created By Eric Davishahi (edavishahi@everettcc.edu)
 Duration (PDT): 03 Apr 2018 - 15 Sep 2018
 94 Problems | 0 Students

Example Problems (Instructor)
 Created By Aditya Jain (aditya.jain@mathworks.com)
 Duration (UTC): Not Specified - Not Specified
 11 Problems | 0 Students

ADD COURSE

Content

Create problems outside of a course, storing them in collections. You can later use these problems in courses.

ADD PROBLEM

MATLAB Grader

CSU Demo > Week 1 Homework > Untitled Problem

Back to Add Problem | Introduction to Programming

Vector Creation (Leibniz series terms)

Consider the Leibniz series:
 $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \dots$

Write a script to generate a vector of the first twenty terms of this series. Assign the vector of series terms to a row vector variable named **LeibnizTerms**. Solve this problem using vectorized code (i.e. do not use a loop in your solution.)

Files Referenced: None

Problem Type: Script

Code

```
1 k = 0:19;
2 LeibnizTerms = (-1).^k ./ (2 * k + 1);
```

Assessment

Test 1
 Does variable LeibnizTerms have the correct values?
 LeibnizTerms = Reference Solution?



Create interactive course assignments



Automatically grade student work and provide feedback



Run your assignments in any learning environment

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Student Experience

The screenshot displays the student experience in the MathWorks environment. On the left, a navigation sidebar shows a course structure with 'Topic 1' selected. The main content area is divided into two parts. The top part, titled 'My first course', shows a code editor for a MATLAB script titled 'Navigating a Robot'. The script includes comments and code for calculating a transformation matrix T and applying it to a robot's position. The bottom part, titled 'Assessment: All Tests Passed', shows two questions that have been successfully completed, each with a green checkmark and a 'Submit' button.

```

1 pRobotWorld = randi([-5 5], 1, 2);
2 theta = 2*pi*rand;
3 pObjectWorld = randi([-5 5], 1, 2);
4
5 % Calculate T
6 T = [cos(theta), -sin(theta),
7
8 % Use the inverse of T (or backslash) to get
9 % position in the robot frame
10 pObjectRobot = inv(T)*[pObjectWorld(1:2)];
11
12 % Now take only the first two elements
13 pObjectRobot = pObjectRobot(1:2);
14
15

```

Assessment: All Tests Passed

- ✓ Is the transformation matrix correct?
- ✓ Is the destination position in the robot coordinate frame correct?

"The fact that you can get immediate feedback ... 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."

– Student, Virginia Tech

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Grading and Learning Metrics

The screenshot shows a user report for 'My first course'. The left sidebar contains navigation options: My first course, Participants, Badges, Competencies, Grades (selected), General, Topic 1, Topic 2, Topic 3, Topic 4, Topic 5, and Home. The main content area is titled 'My first course: View: User report' and includes a breadcrumb trail: Home / My courses / My first course / Grades / Grade administration / User report. Below this is a section for 'User report - Sam Student' with tabs for 'Overview report' and 'User report'. A table displays the following data:

Grade item	Calculated weight	Grade	Range	Percentage	Feedback	Contribution to course total
My first course						
Navigating a Robot	100.00 %	100.00	0-100	100.00 %		100.00 %
Σ Course total	-	100.00	0-100	100.00 %		-

“The approach enables students to **learn more quickly** from their mistakes on their own.”

– Dr. Bob Canfield, Virginia Tech

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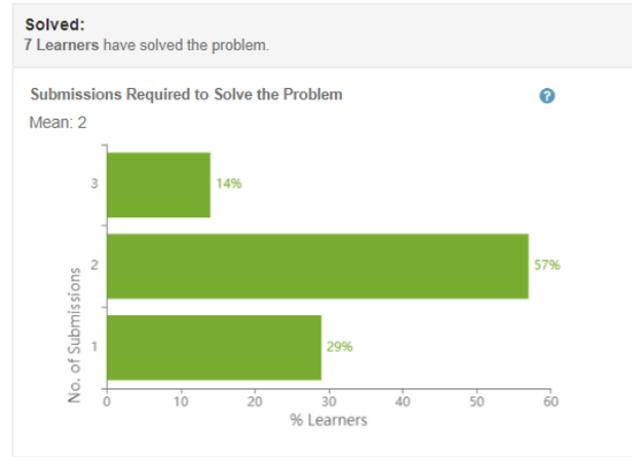
ASSESSMENT

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Grading and Learning Metrics

“With MATLAB Grader, students can learn at their own pace until they are satisfied, and I am noticing deeper understandings from my students.”

- Dr. Masatide Abe
Tohoku University



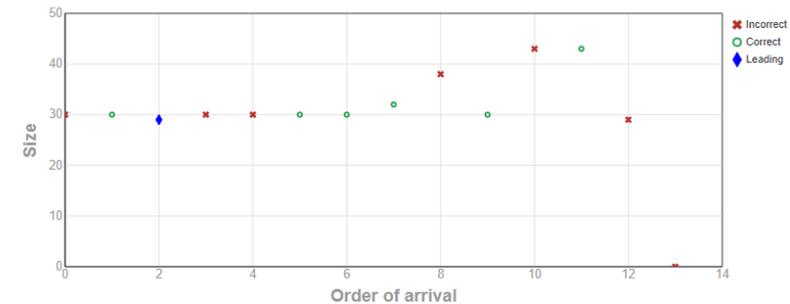
Vector Creation (creating equally spaced vectors)

Learner Analytics

Class Overview | **Learner Solutions**

Map View | List View

Search by last name, code or solution ID



Click on any solution marker in the graph to display solution in this box.

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Access



Instruction



Assessment



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MATLAB Courseware

Teaching resources created by your peers

MATLAB Courseware

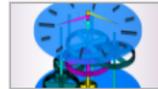
[Educator Home](#) |
 [Classroom Resources](#) |
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Introduction to Engineering



Engineering Models I

Professor Kathleen Ossman
Professor Gregory Bucks
 University of Cincinnati



Engineering Models II

Professor Kathleen Ossman
Professor Gregory Bucks
 University of Cincinnati

Bioengineering and Biological Sciences



Bioengineering Mass Transport and Systems

Professor Alyssa Taylor
 University of Washington



Instrumentation, Measurement and Control in Biological Systems

Professor Kumar Mallikarjunan
 Virginia Polytechnic Institute & State University

Earth, Ocean, and Atmospheric Sciences



Teaching Geoscience with MATLAB

from SERC@Carleton

Teaching Kits for Free

Download content consisting of:

- Lecture Notes
- Project Ideas
- Accompanying Code

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Training for Educators

Engage your students and scale your instruction with online learning tools from MathWorks

Launch the course



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

ACCESS

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MathWorks MOOCs



Four courses (approx. 2 months to complete)

- Exploratory Data Analysis with MATLAB
- Data Processing and Feature Engineering with MATLAB
- Predictive Modeling and Machine Learning with MATLAB
- Data Science Project: MATLAB for the Real World



Free Online MATLAB course is a top MOOC

- Functions
- Linear Algebra
- Loops and Data Types
- File Input/Output

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Online Teaching with MATLAB and Simulink

Whether you are transitioning a classroom course to a hybrid model, developing virtual labs, or launching a fully online program, MathWorks can help you foster active learning no matter where it takes place. Here you will find resources and ideas for providing hands-on experiences with MATLAB and Simulink, plus tools for delivering instruction, engaging students, and assessing outcomes.



Learn how a professor at Chalmers University of Technology successfully engaged students while using a hybrid teaching model that combines online and onsite learning.



Instructional Resources



Virtual Labs and Projects



Online Assessments

Create Engaging, Interactive Course Materials

Make your courses more interactive, promote self-directed learning, and increase student engagement through Live Editor and MATLAB apps.

Use MATLAB on the desktop or MATLAB Online to create live scripts. Share live scripts with students through your university's learning management system or using MATLAB Drive. Learn more about creating and sharing live scripts for applications such as flipped classrooms on the [Instructional Resources page](#).

In addition, you can host and run a collection of MATLAB apps on your own MATLAB Web App Server at your university.

Keep Teaching through Distance Learning

Posted by [Loren Shure](#), March 23, 2020

As many universities are moving quickly to distance learning, it is vital for educators to think carefully about how to adapt their approach to still deliver key learning outcomes for students in an online setting.

[» Read more...](#)

Discussions

[Start a discussion](#)



Welcome to the Distance Learning Community

Latest activity by [jiro](#) on 30 Mar 2020 at 13:17

Tags: [distance_learning](#)

0

replies



Tell us your story

Latest activity by [jiro](#) on 30 Mar 2020 at 13:05

Tags: [distance_learning](#)

0

replies

[» View all discussions](#)

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Next Steps Checklist

- ✓ Complete the [Online Training for Educators](#)
- ✓ Add [MATLAB Onramp and/or Simulink Onramp](#) to courses
- ✓ Convert coding examples to interactive [Live Scripts](#)
- ✓ Tell your LMS administrator to add [MATLAB Grader](#) to your LMS
- ✓ Virtualize your labs with [MATLAB Mobile](#) and [ThingSpeak](#)

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Customer Success Engineers

consult with faculty and researchers to support them with their STEM initiatives, including integrating computational or systems thinking into their curriculum.

info@terasoft.com.tw



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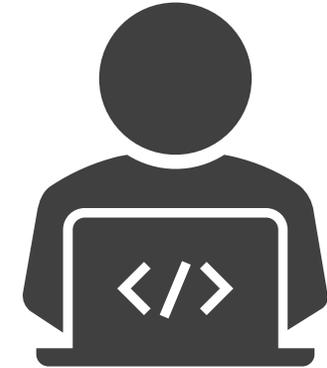
INSTRUCTION

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Learn by doing

... and learn from mistakes



"Mistakes... are the portals of discovery."
—James Joyce



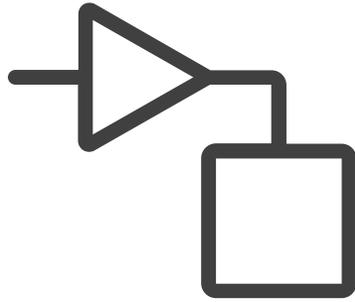
ACCESS

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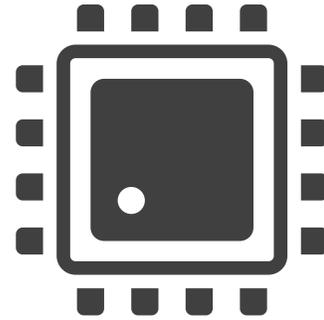
ASSESSMENT

GETTING HELP

Laboratory Models



Virtual



Hardware
at Home



Remote

Complexity

High

Low

High

Interactivity

High

High

Low

Hands-On

Low

High

Low

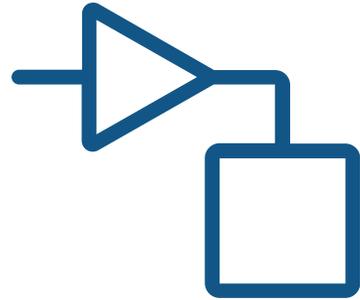
Realism

Low

Low

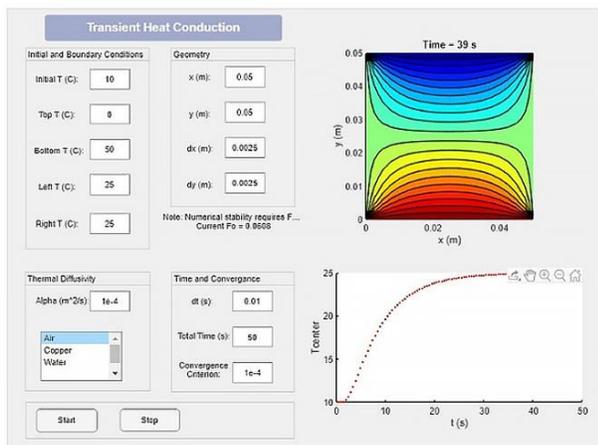
High

Fully-Virtual Labs



↑ Complexity Interactivity

↓ Realism Hands-On



Graphical Interface with Visualization

Mathematical Model of Processes

Equipment or Hardware Simulations

- Challenges:
- Incorporating sufficient visuals
 - Replacing the hands-on component
 - May lose real-world factor

ACCESS

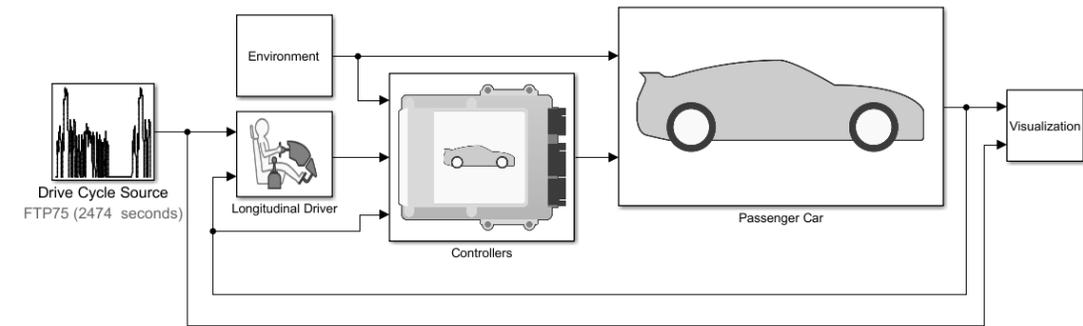
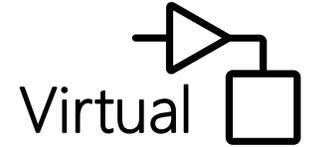
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SIMULINK®

Simulation and Model-Based Design



ACCESS

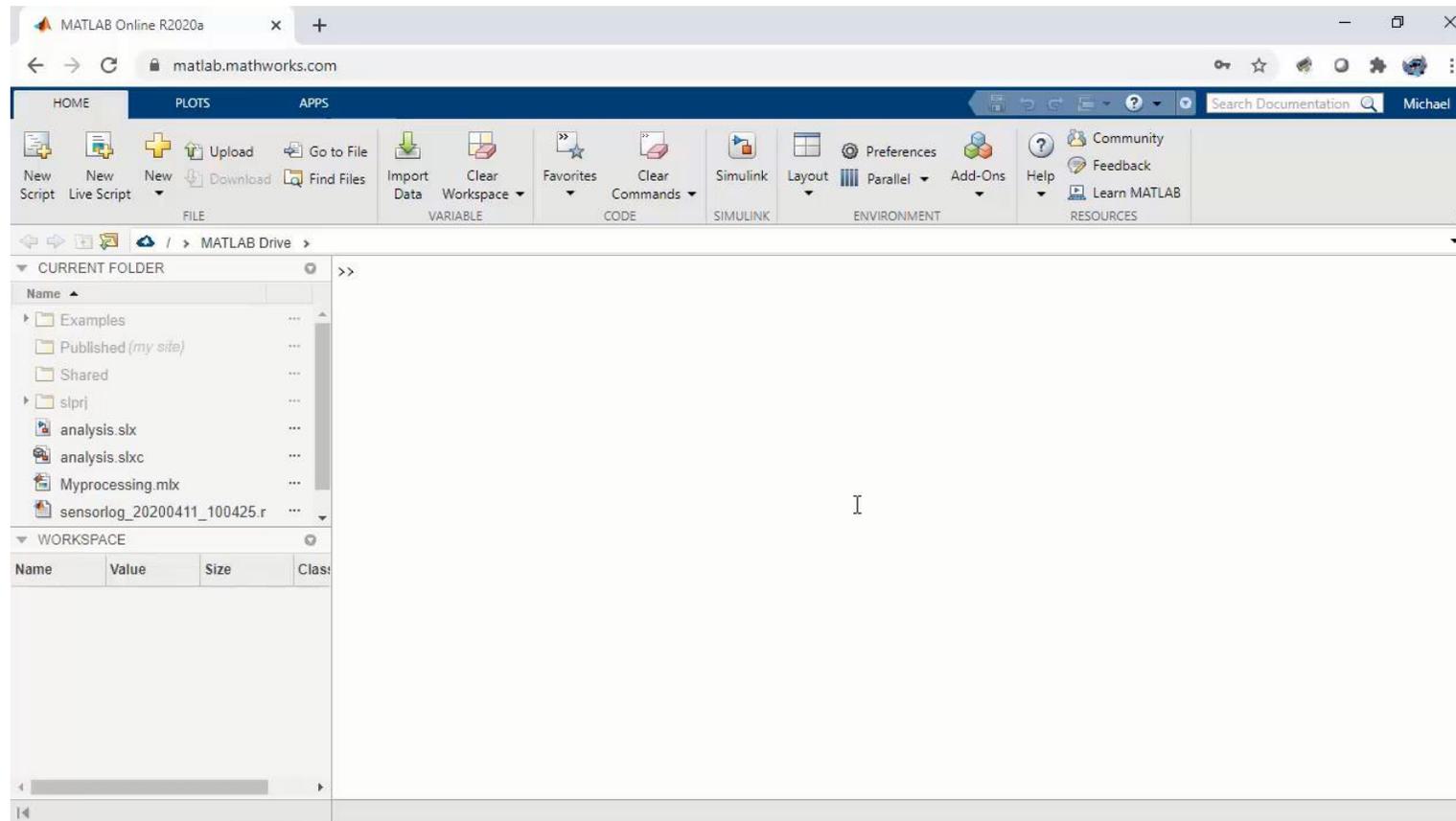
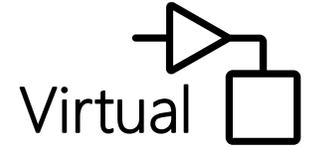
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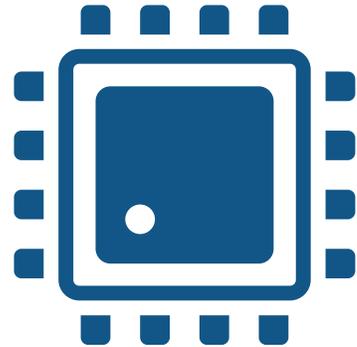
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SIMULINK®

Simulation and Model-Based Design



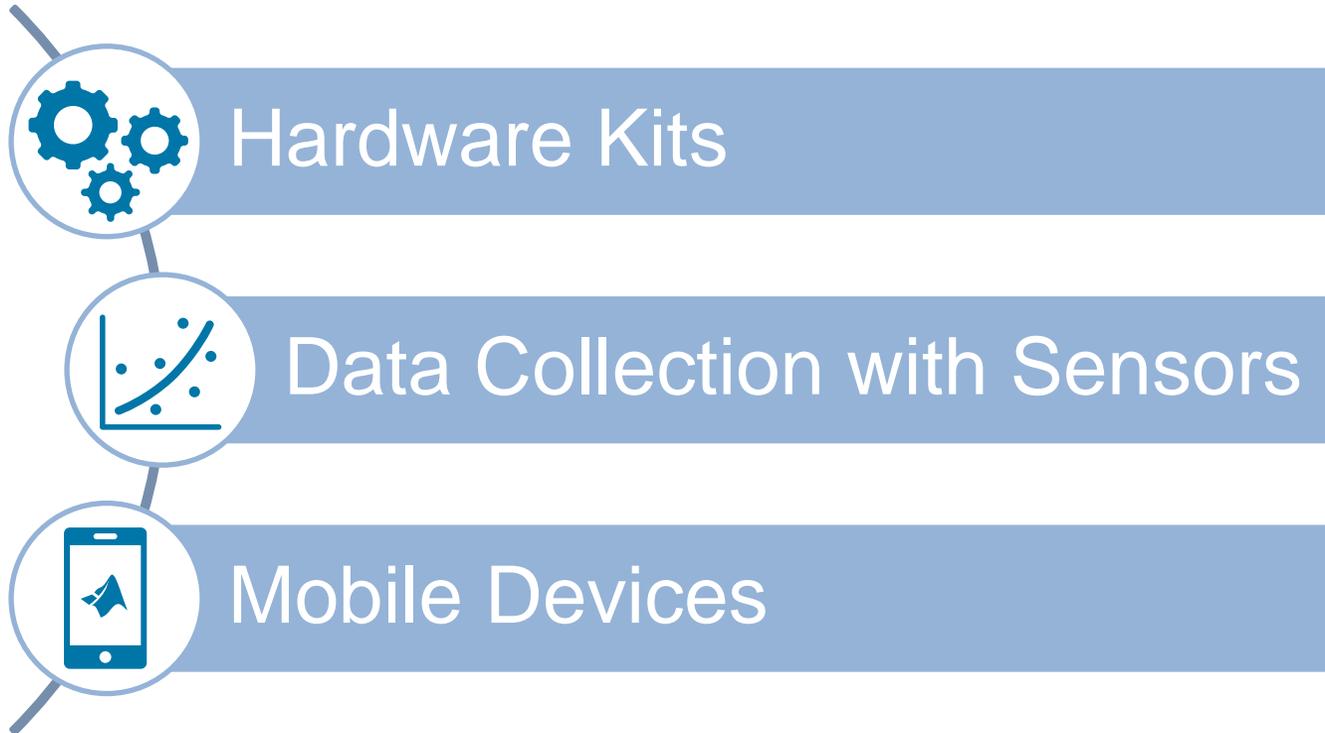
Hardware at Home Labs



↑ Hands-On Interactivity

↓ Realism Complexity

ENGINEERING KIT R2



- Challenges:
- Kit and hardware logistics
 - Too simplistic
 - Safety and oversight of students

ACCESS

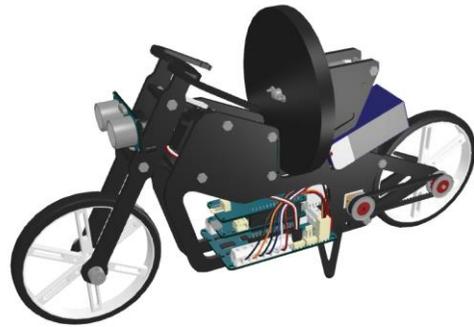
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Project-based learning with low-cost hardware

Hardware



Self-balancing robots using
Arduino



Edge Detection using
Raspberry Pi

"I really enjoyed, 'Edge AI with Raspberry Pi using MATLAB' to deploy face detection and age prediction algorithms on a Raspberry Pi. I have no experience in hardware, but I completed the tutorial and now have a strong curiosity!"

-Katie Amrine, PhD
Decision Scientist, Facebook

ACCESS

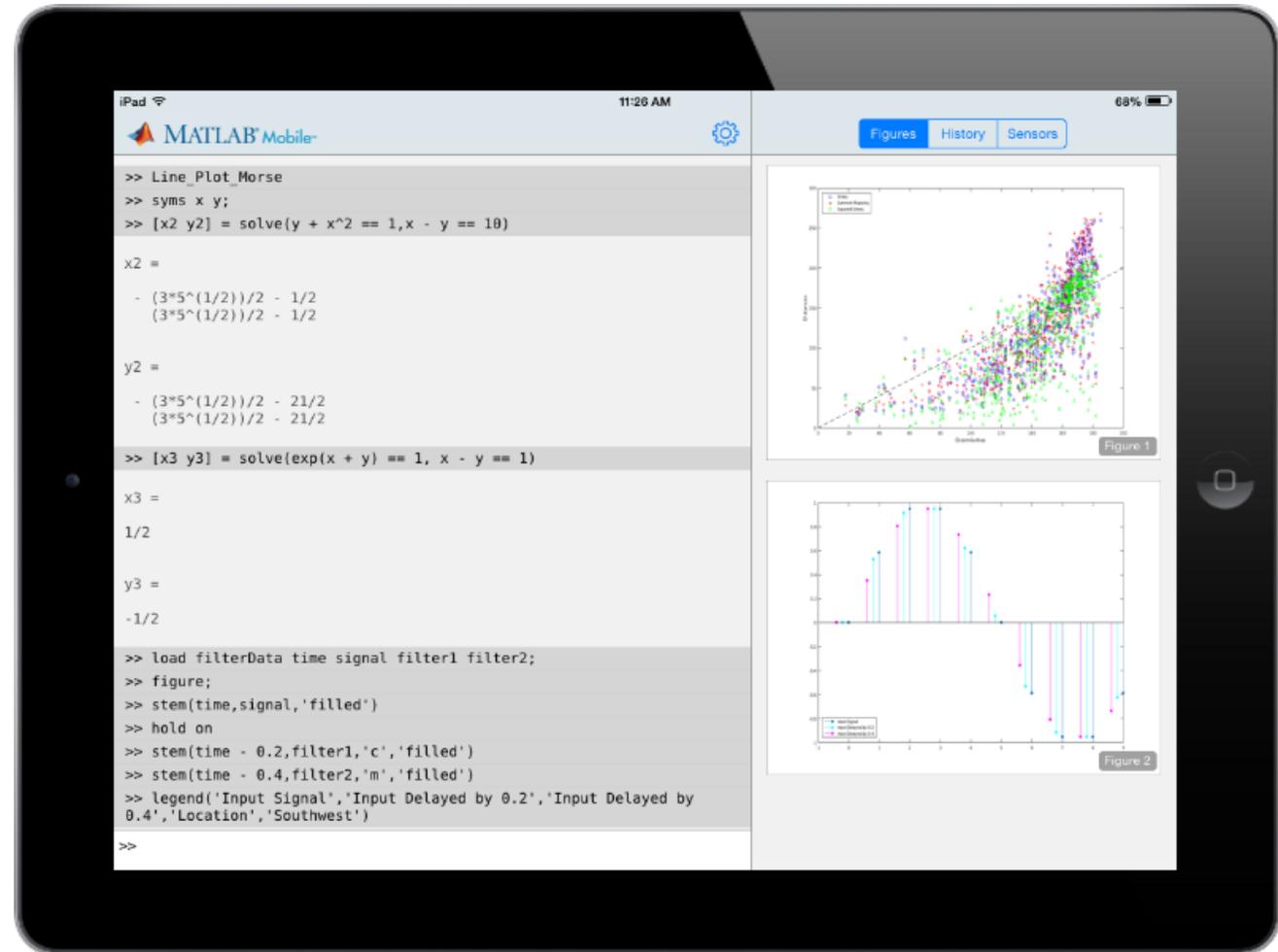
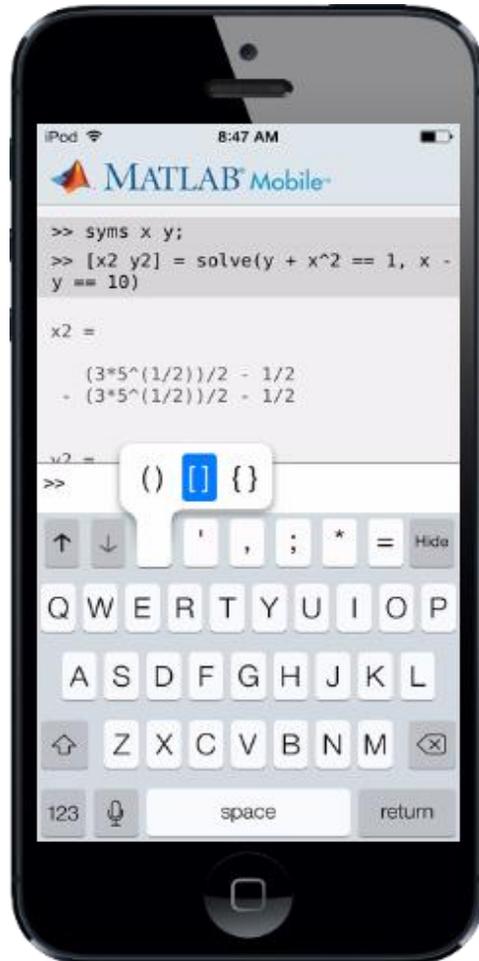
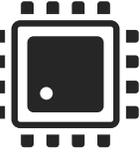
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MATLAB Mobile

Hardware



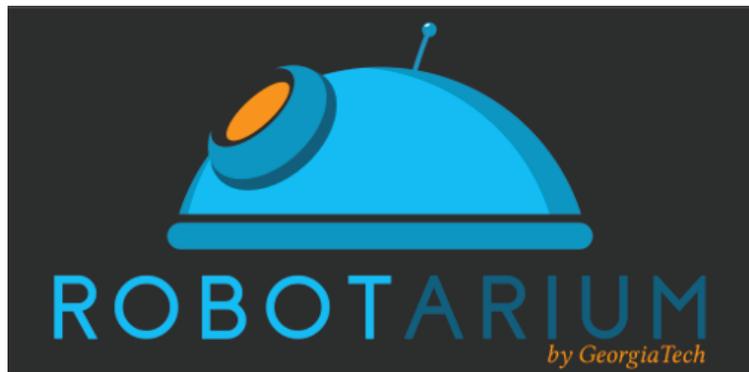
Remote-Access Labs



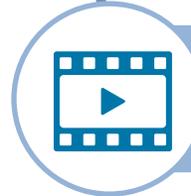
Realism
Complexity



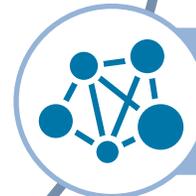
Hands-On
Interactivity



Remote Control of Equipment



Live Stream from University Lab



Internet of Things

Challenges:

- Students need more than watching
- Incorporating sufficient interactivity
- Replacing the hands-on component

ACCESS

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ThingSpeak
IoT analytics platform

Remote 



 Collect

Send sensor data privately to the cloud.

 Analyze

Analyze and visualize your data with MATLAB.

 Act

Trigger a reaction.

ACCESS

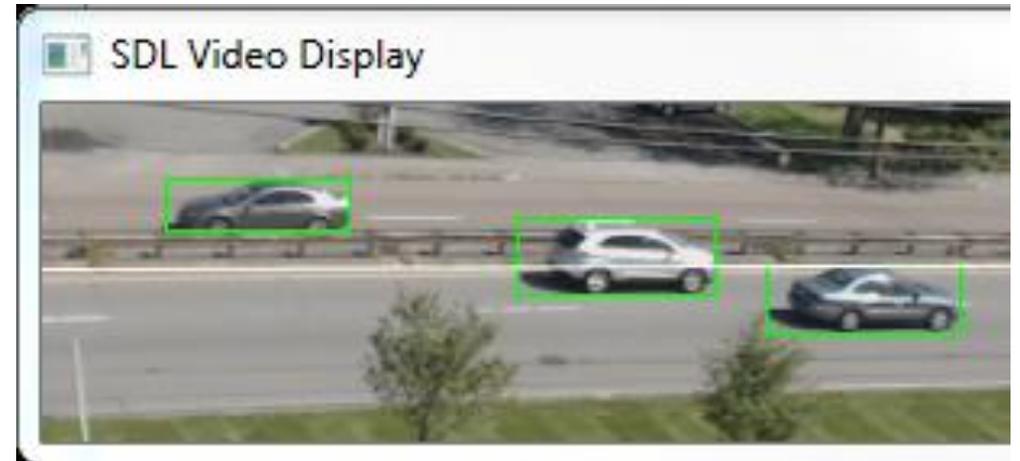
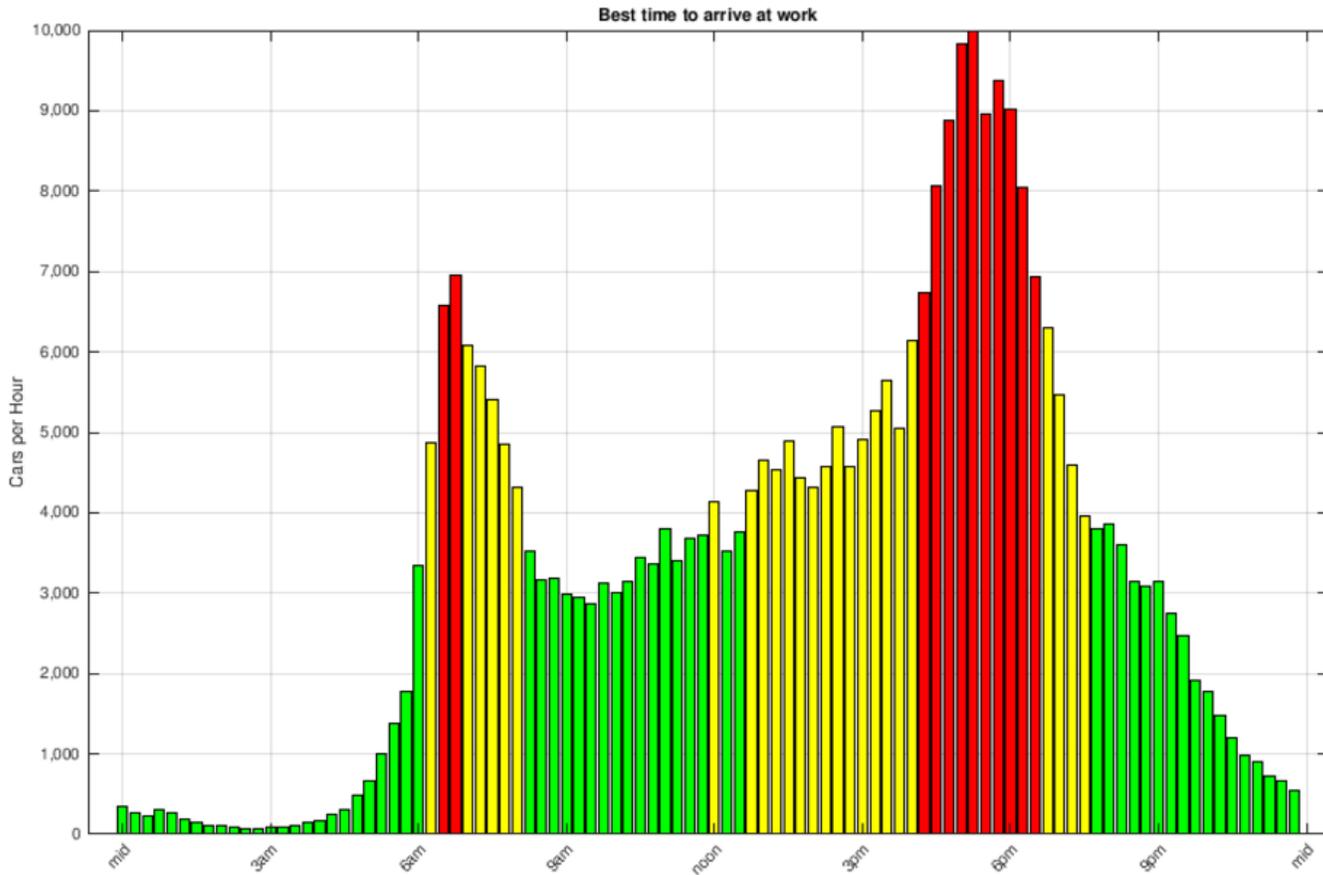
INSTRUCTION

ASSESSMENT

GETTING HELP

Traffic Analysis

Remote



ACCESS

INSTRUCTION

ASSESSMENT

GETTING HELP

Remote Labs

Robotarium at Georgia Tech

