MATLAB EXPO

Electrification, AI and the Future of Engineering Education

Carlos Sanchis
Senior Academic CSE
@carsanbo

Sumit Tandon
Academic CSE Manager
@sumit77tandon

MathWorks

2020 ASEE Survey for Skills Gaps in Recent Engineering Graduates

Systems Thinking (80%)

Model-Based Systems Engineering
Project Management
Critical Thinking
Data Analytics
Robotics
Emotional Intelligence
Artificial Intelligence
Communication
Multidisciplinary Work
Augmented Reality
Hard Science and Engineering Fundamentals
Formulate and Solve Problems
Curiosity
Digital Twin
Cultural Awareness
Self-Drive
IoT
InfoSec
Simulation
Additive Manufacturing
Ethical Standards
Economics and Business Acumen

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

Electrification
of Everything

Autonomous
Systems

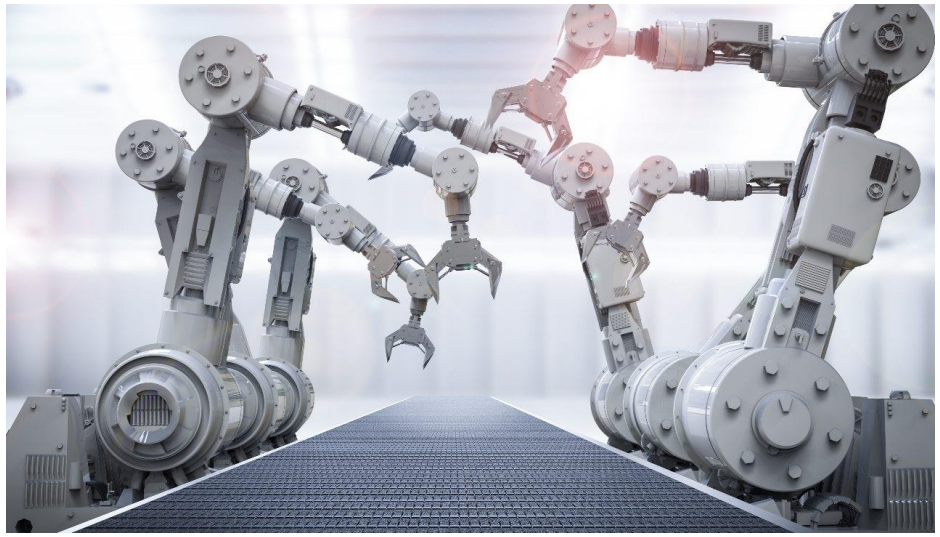
Systems Thinking
in the Classroom

Electrification of Everything

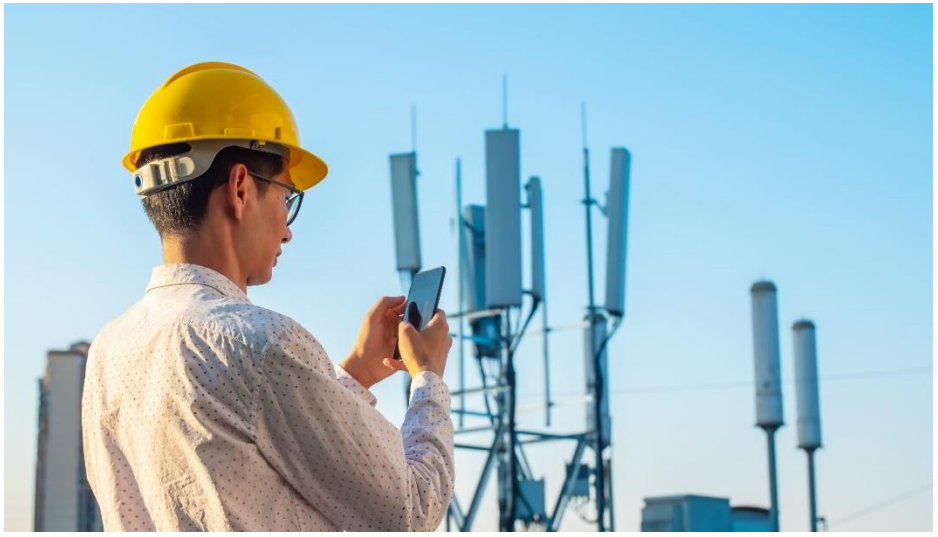
Renewable Energies

Electric Vehicles

Electric Motors



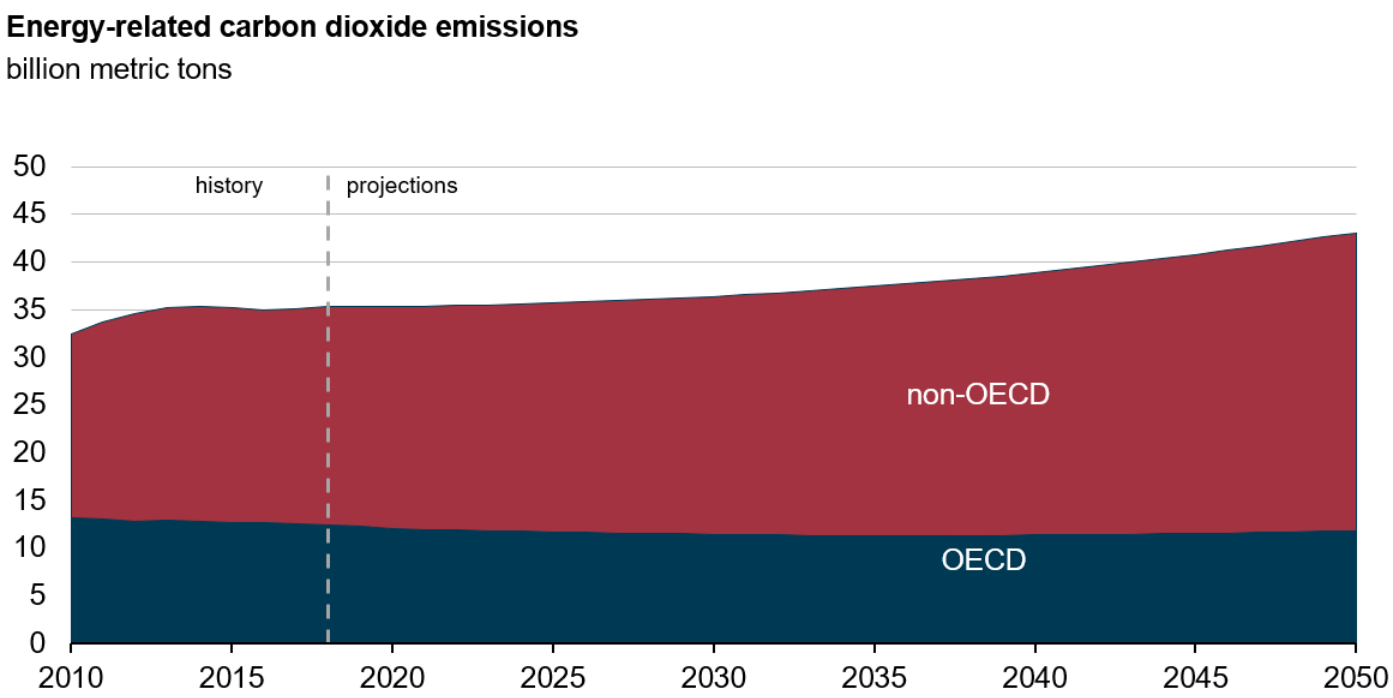
Electronics Everywhere



Electrification of Everything

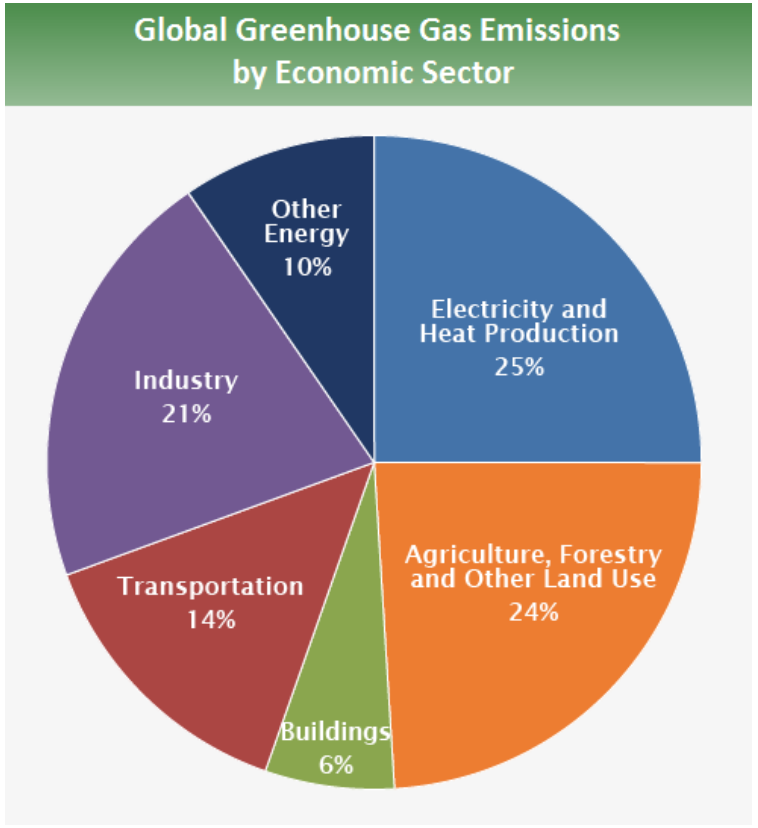
- Why is it happening?
- What challenges is Industry facing?
- How are engineers overcoming them?

Climate Change



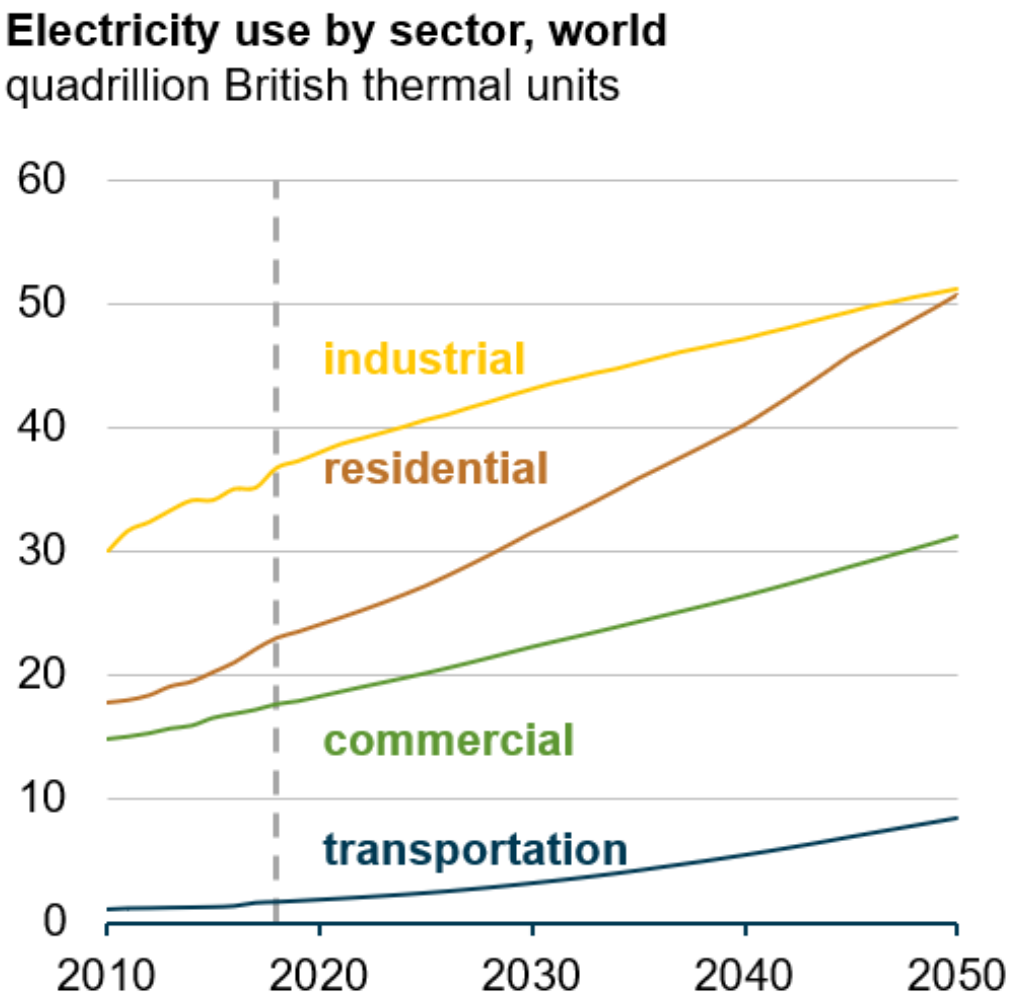
OECD: Organization for Economic Cooperation and Development

International Energy Outlook 2019
https://www.eia.gov/outlooks/ieo/pdf/ieo2019.pdf



United States Environmental Protection Agency
https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data#Sector

Need for Smarter, More Efficient Systems



Electricity use in the **residential** and **commercial** sectors is predicted to grow fastest in China, India, and other countries with growing middle classes.

International Energy Outlook 2019
https://www.eia.gov/outlooks/ieo/pdf/ieo2019.pdf

Electrification of Everything

- Why is it happening?
- What challenges is Industry facing?
- How are engineers overcoming them?

Key Challenges in Electrification

Batteries

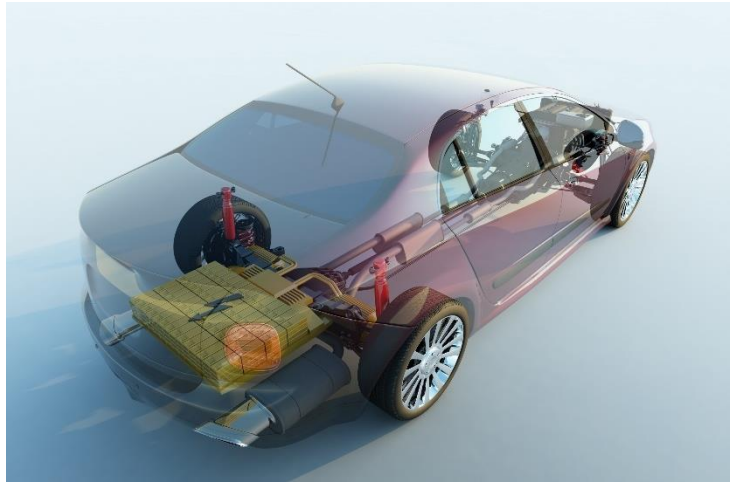
- Battery Modeling
- Safe Operation
- Aging Optimization
- BMS Development

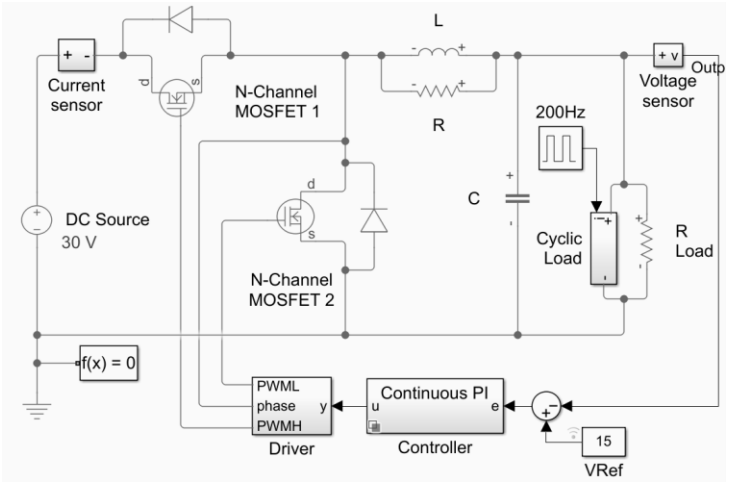
Power Electronics

- Dynamic Simulation
- Digital Control
- Supervisory Logic
- Rapid Prototyping

Motor Control

- Sensor Calibration
- Parameter Estimation
- Efficient Algorithms
- Controller Tuning





Electrification of Everything

- Why is it happening?
- What challenges is Industry facing?
- How are engineers overcoming them?

Lightyear One

World’s First Solar-Powered Car

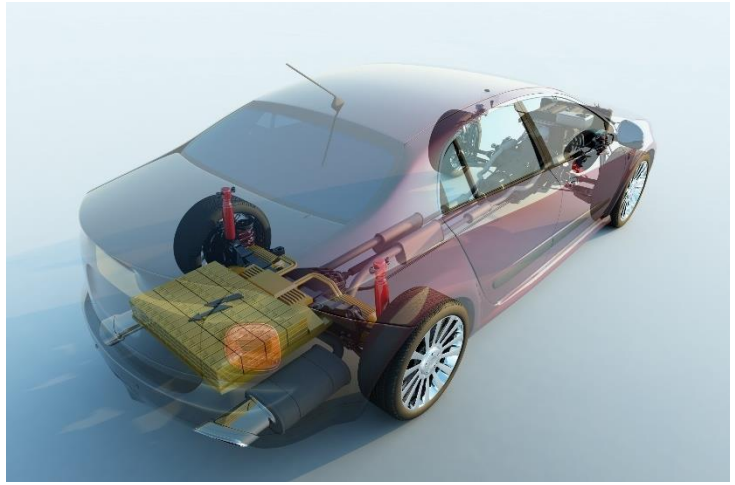
450 Miles on a Single Charge.

From Student Competition to Startup.

Key Challenges in Electrification

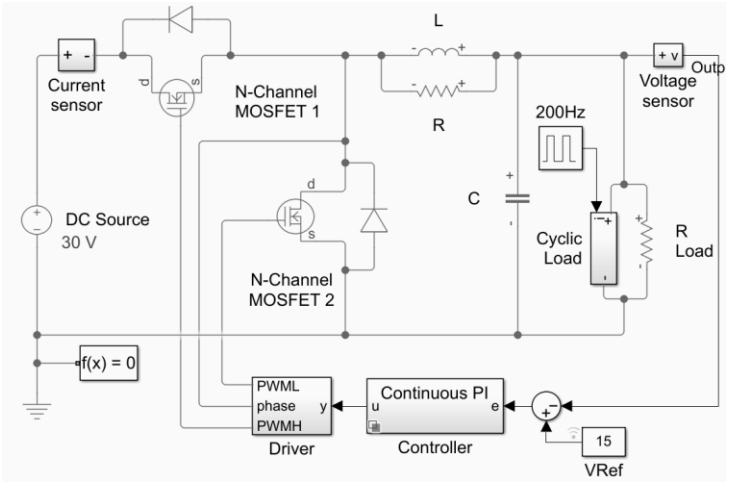
Batteries

- Battery Modeling
- Safe Operation
- Aging Optimization
- BMS Development



Power Electronics

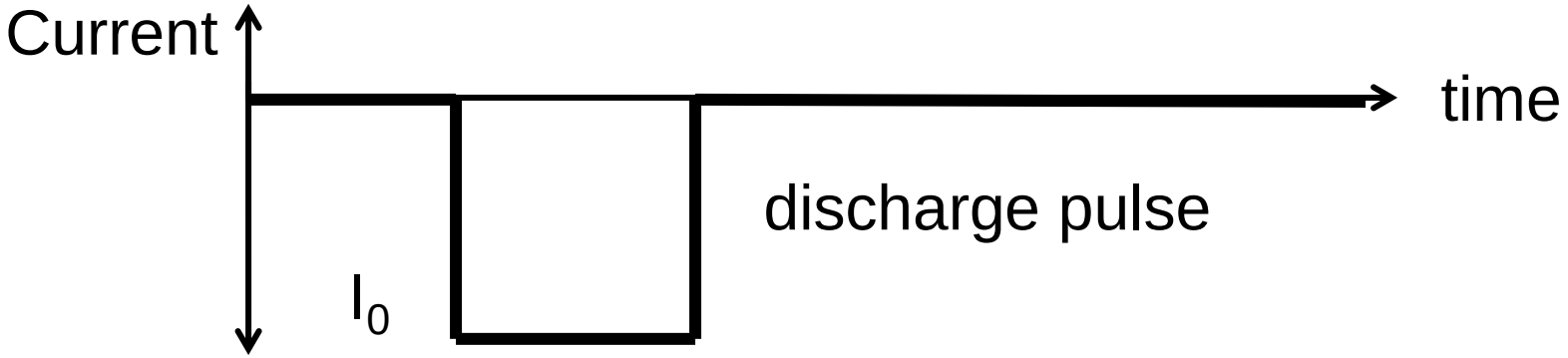
- Dynamic Simulation
- Digital Control
- Supervisory Logic
- Rapid Prototyping

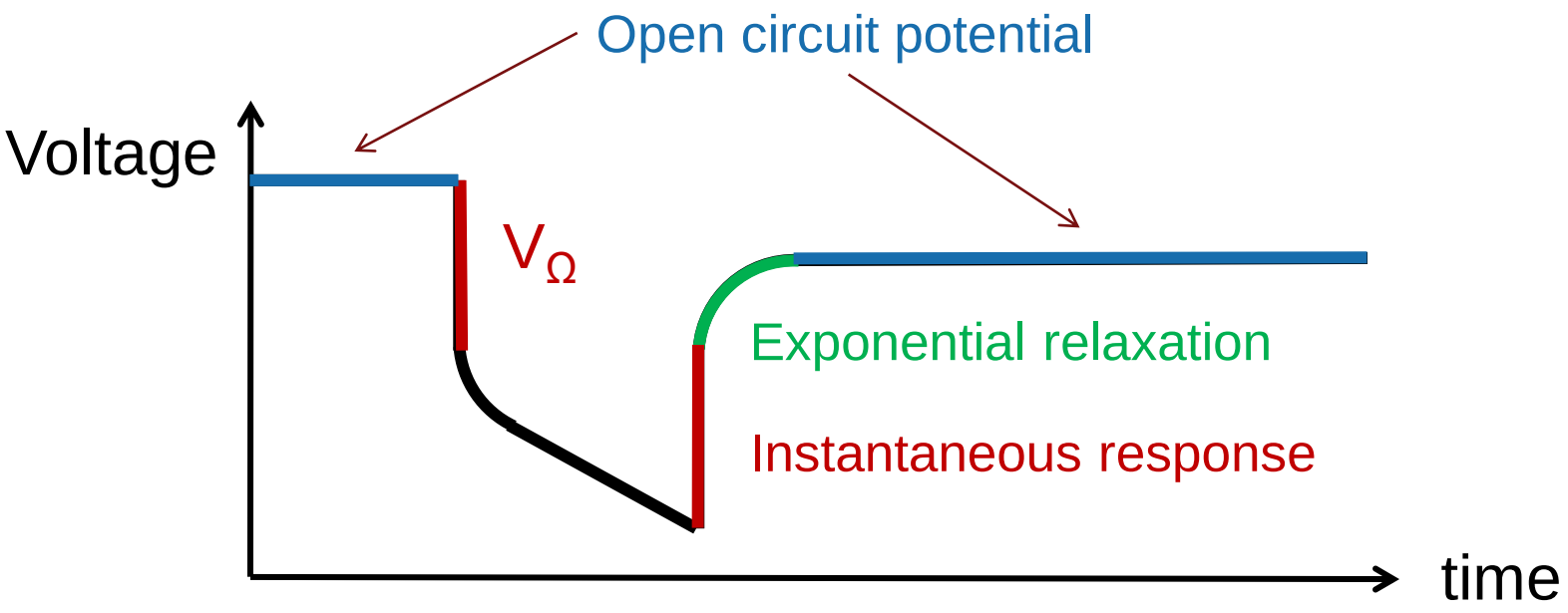


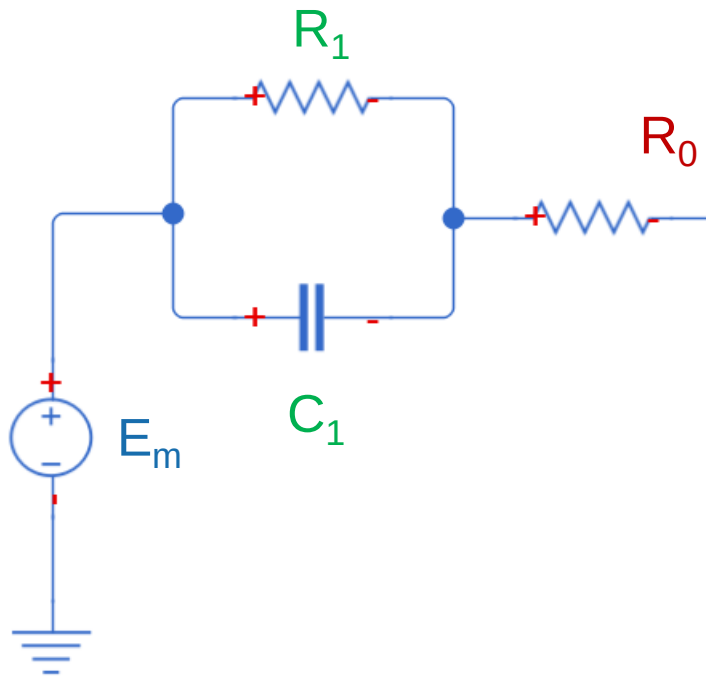
Motor Control

- Sensor Calibration
- Parameter Estimation
- Efficient Algorithms
- Controller Tuning

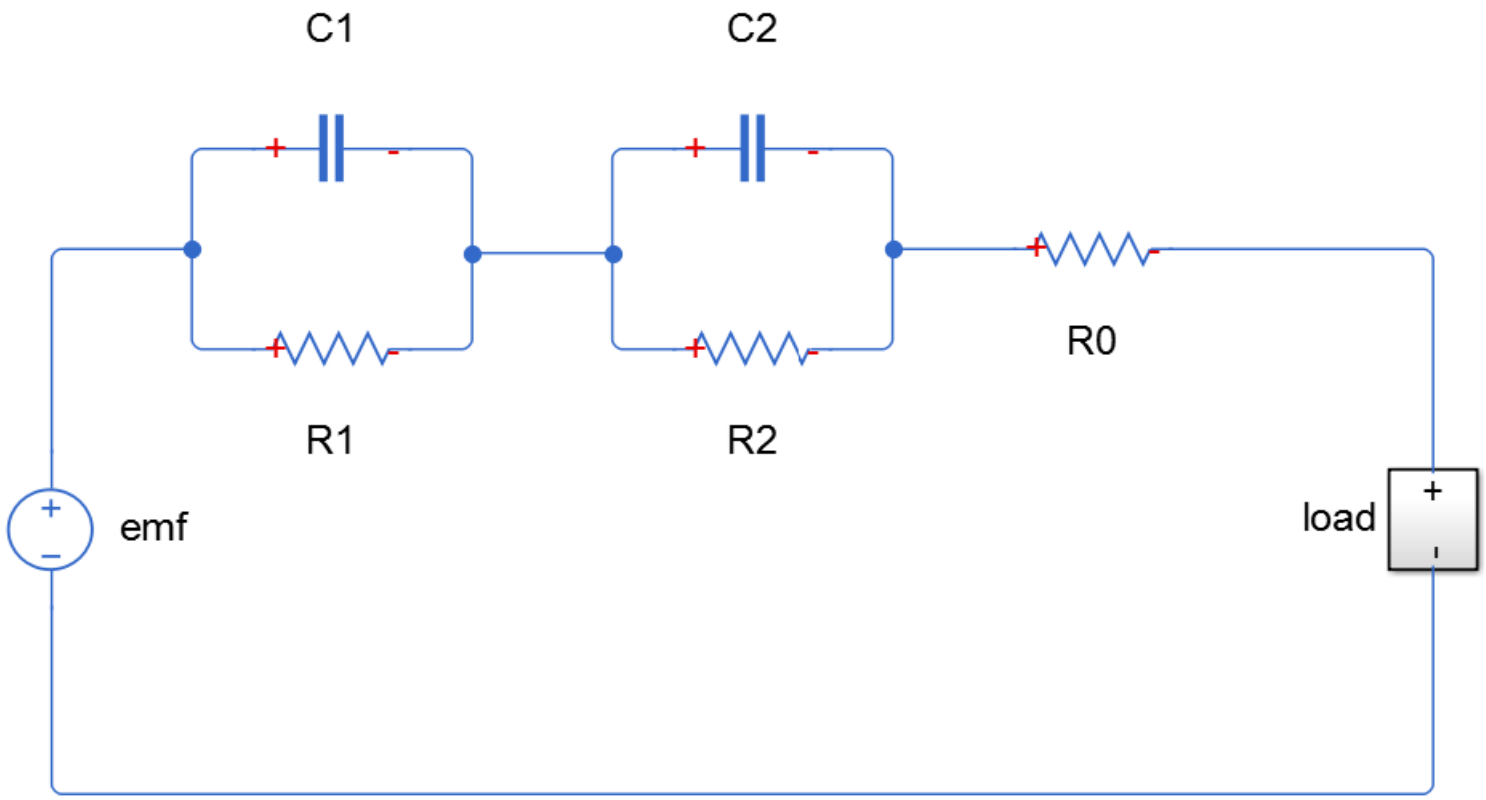
Modeling Li-ion Battery Cells







Equivalent Circuit



BatteryCellEquivalentCircuit - Simulink

SIMULATION DEBUG MODELING FORMAT APPS

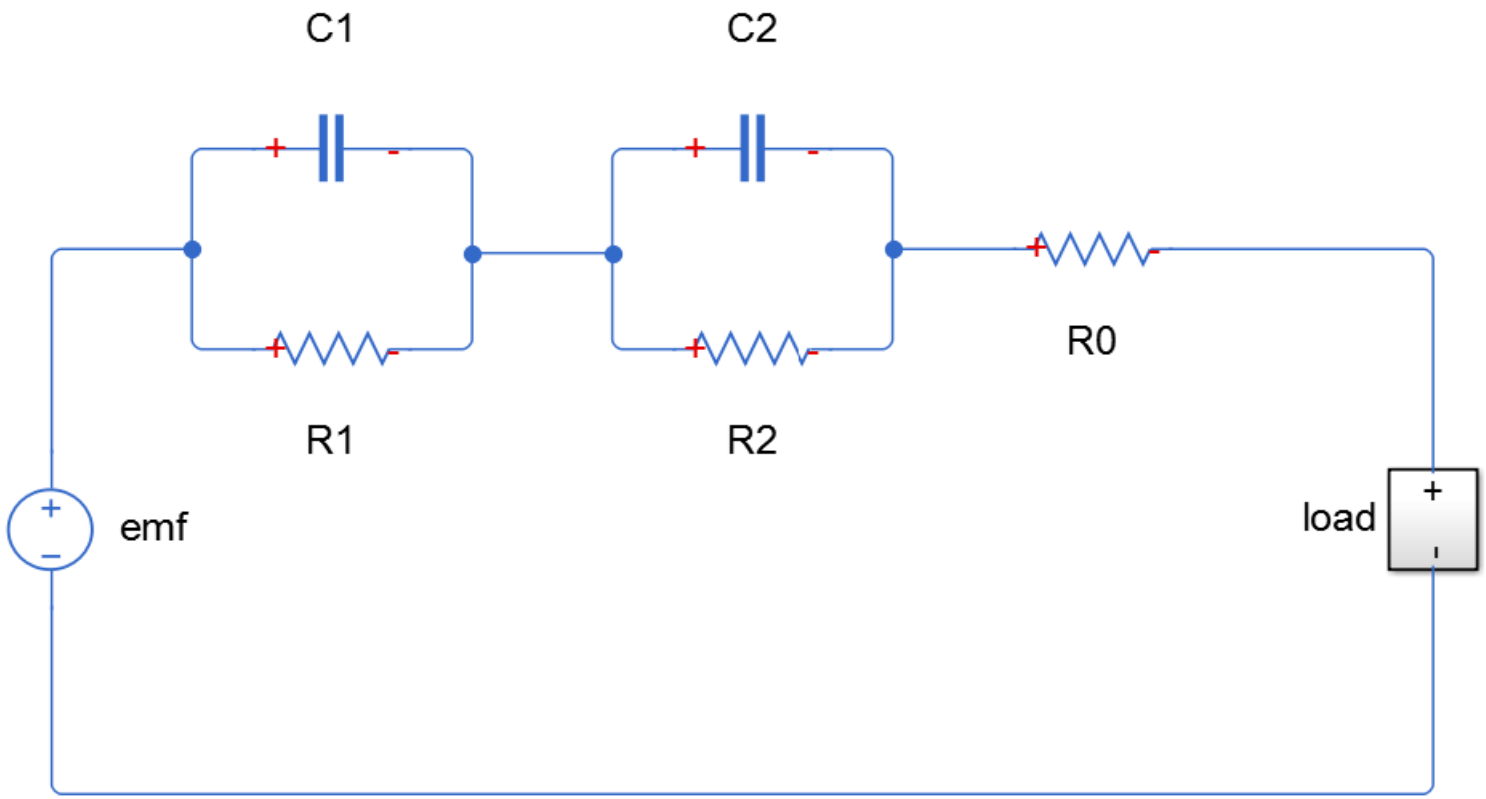
New Open Save Print | Library Browser | Log Signals Add Viewer Signal Table | Stop Time 10.0 Normal Fast Restart | Step Back Run Step Forward Stop | Data Inspector Logic Analyzer Bird's-Eye Scope Simulation Manager

FILE LIBRARY PREPARE SIMULATE REVIEW RESULTS

Model Browser

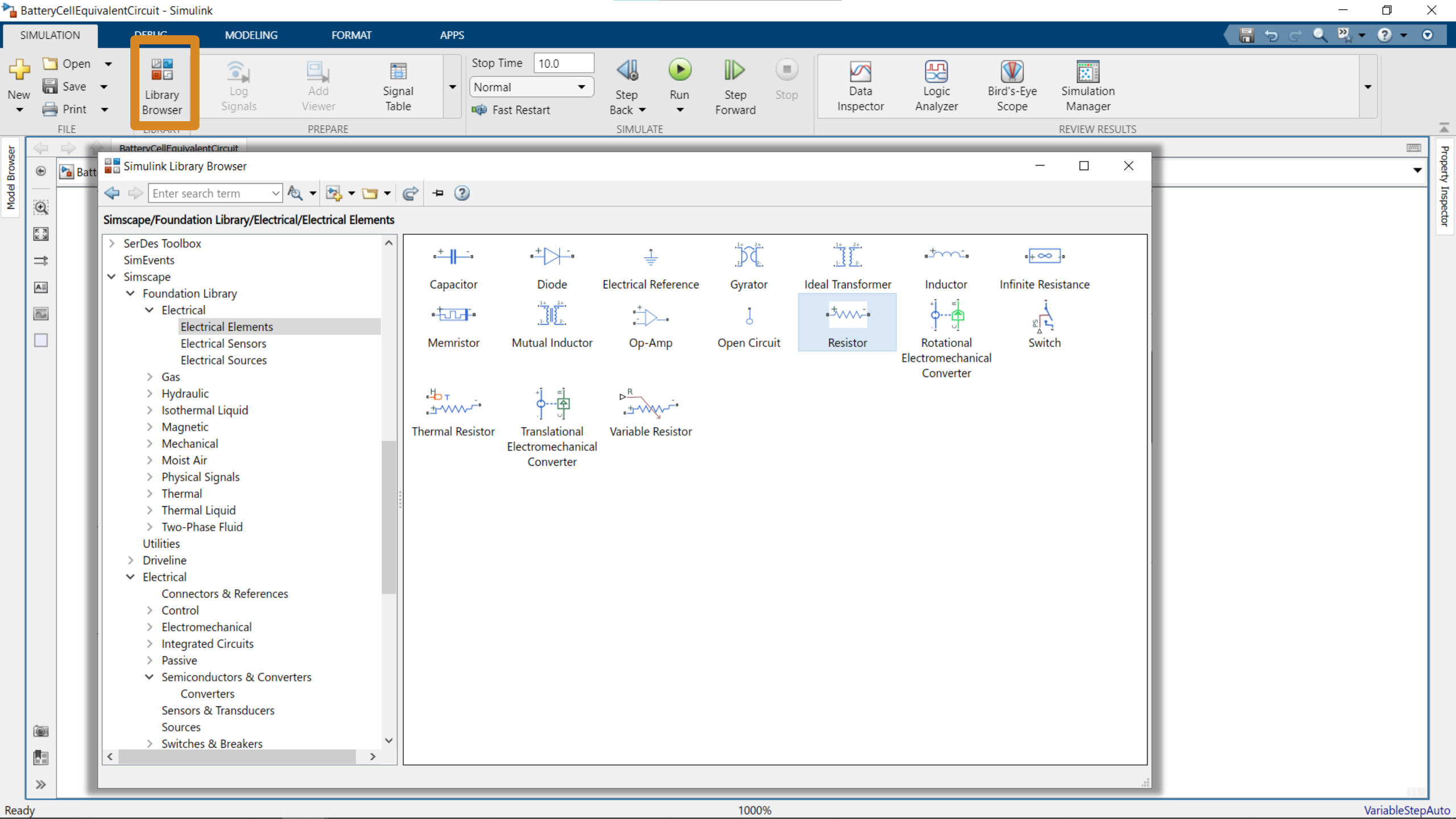
BatteryCellEquivalentCircuit

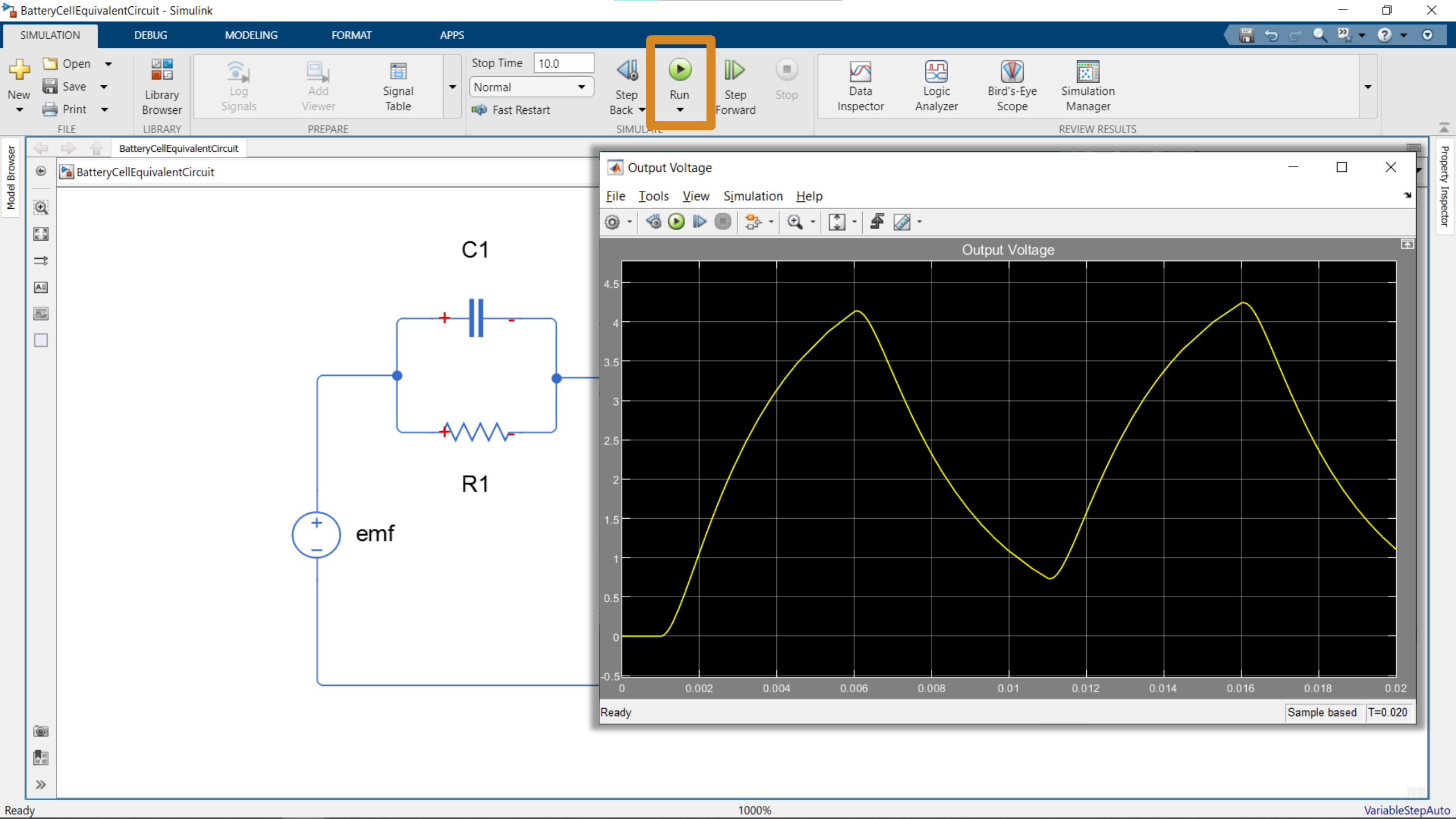
BatteryCellEquivalentCircuit

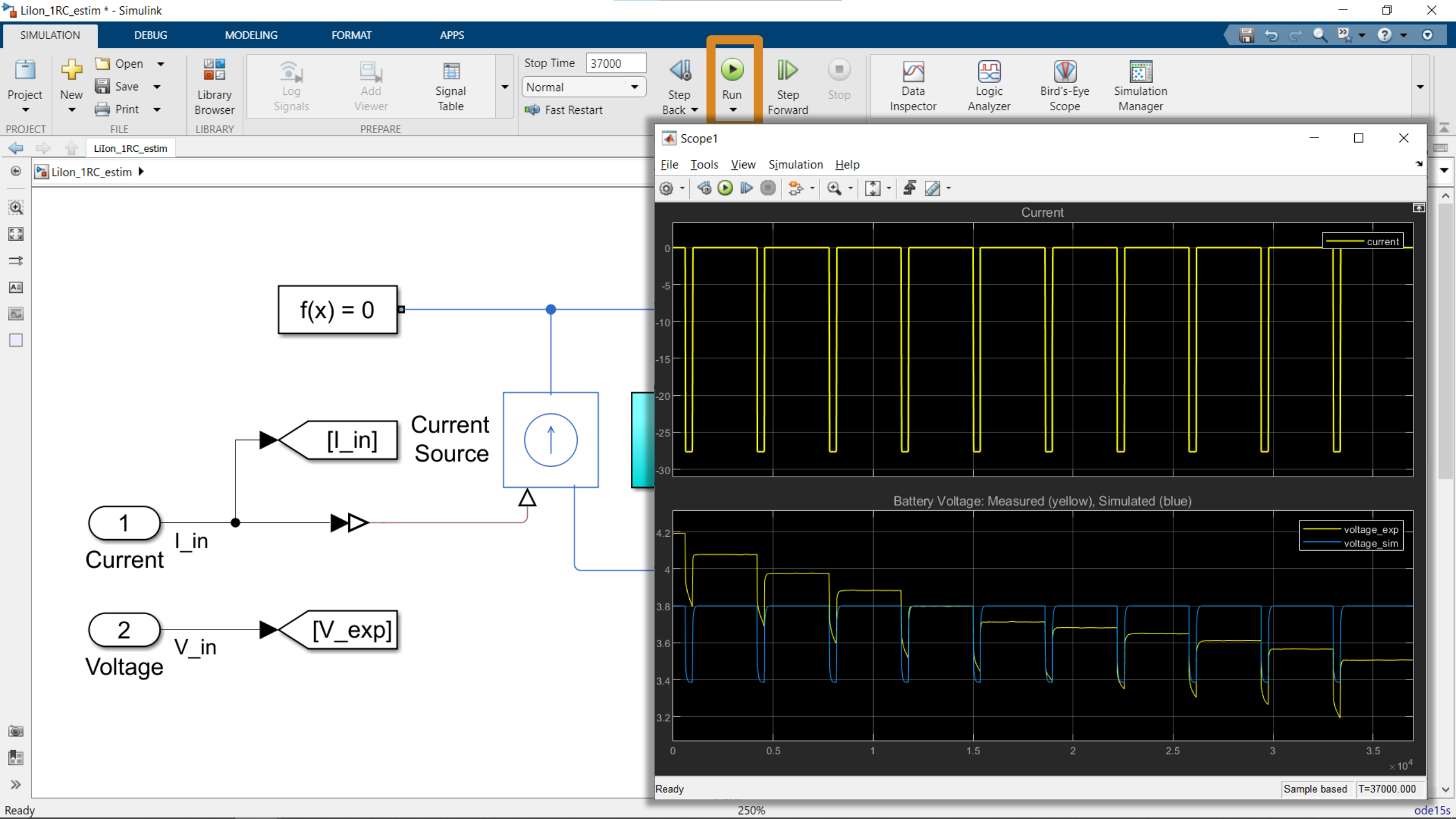


Property Inspector

Ready 1000% VariableStepAuto

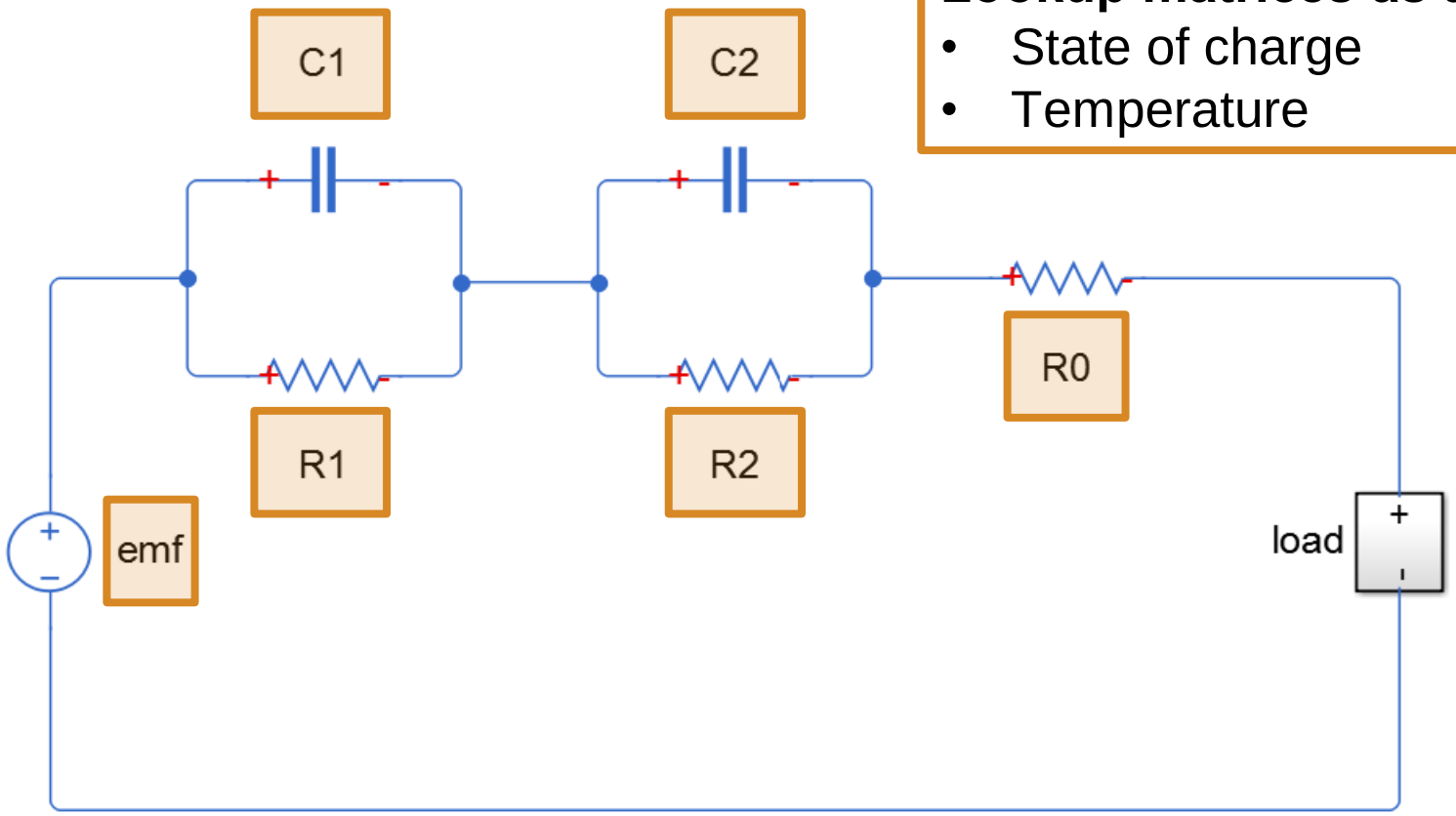

BatteryCellEquivalentCircuit - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
New
Open
Save
Print
FILE
Library Browser
LIBRARY
Log Signals
Add Viewer
Signal Table
PREPARE
Stop Time
10.0
Normal
Fast Restart
Step Back
Run
Step Forward
Stop
SIMULATE
Data Inspector
Logic Analyzer
Bird's-Eye Scope
Simulation Manager
REVIEW RESULTS
Model Browser
Property Inspector
Simulink Library Browser
Enter search term
Simscape/Foundation Library/Electrical/Electrical Elements
SerDes Toolbox
SimEvents
Simscape
Foundation Library
Electrical
Electrical Elements
Electrical Sensors
Electrical Sources
Gas
Hydraulic
Isothermal Liquid
Magnetic
Mechanical
Moist Air
Physical Signals
Thermal
Thermal Liquid
Two-Phase Fluid
Utilities
Driveline
Electrical
Connectors & References
Control
Electromechanical
Integrated Circuits
Passive
Semiconductors & Converters
Converters
Sensors & Transducers
Sources
Switches & Breakers
Capacitor
Diode
Electrical Reference
Gyrator
Ideal Transformer
Inductor
Infinite Resistance
Memristor
Mutual Inductor
Op-Amp
Open Circuit
Resistor
Rotational Electromechanical Converter
Switch
Thermal Resistor
Translational Electromechanical Converter
Variable Resistor
Ready
1000%
VariableStepAuto

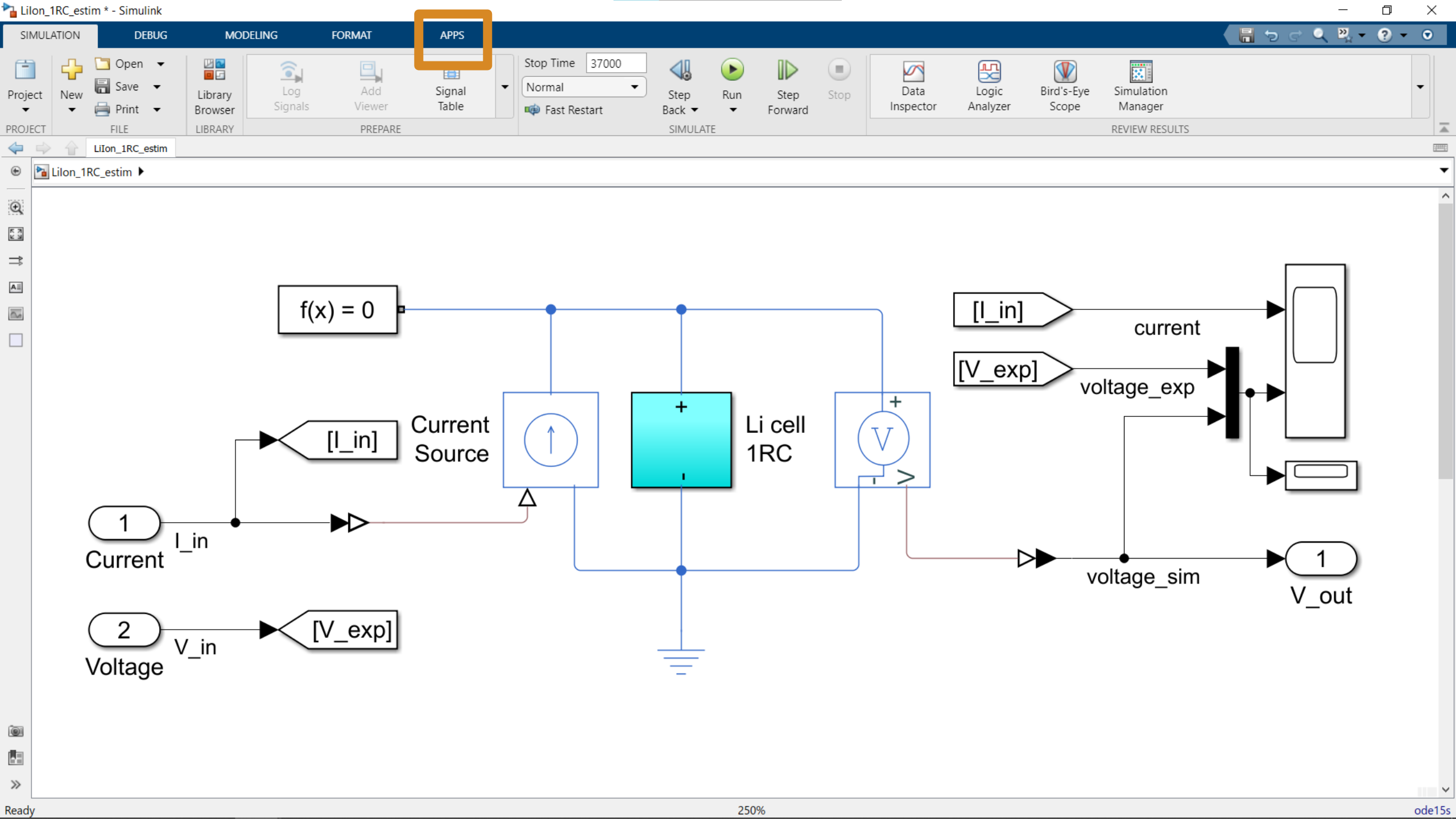

BatteryCellEquivalentCircuit - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
New
Open
Save
Print
FILE
Library Browser
LIBRARY
Log Signals
Add Viewer
Signal Table
PREPARE
Stop Time
10.0
Normal
Fast Restart
Step Back
Run
Step Forward
Stop
SIMULATE
Data Inspector
Logic Analyzer
Bird's-Eye Scope
Simulation Manager
REVIEW RESULTS
Model Browser
BatteryCellEquivalentCircuit
C1
R1
emf
Output Voltage
File
Tools
View
Simulation
Help
Output Voltage
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02
Ready
Sample based
T=0.020
Property Inspector
Ready
1000%
VariableStepAuto

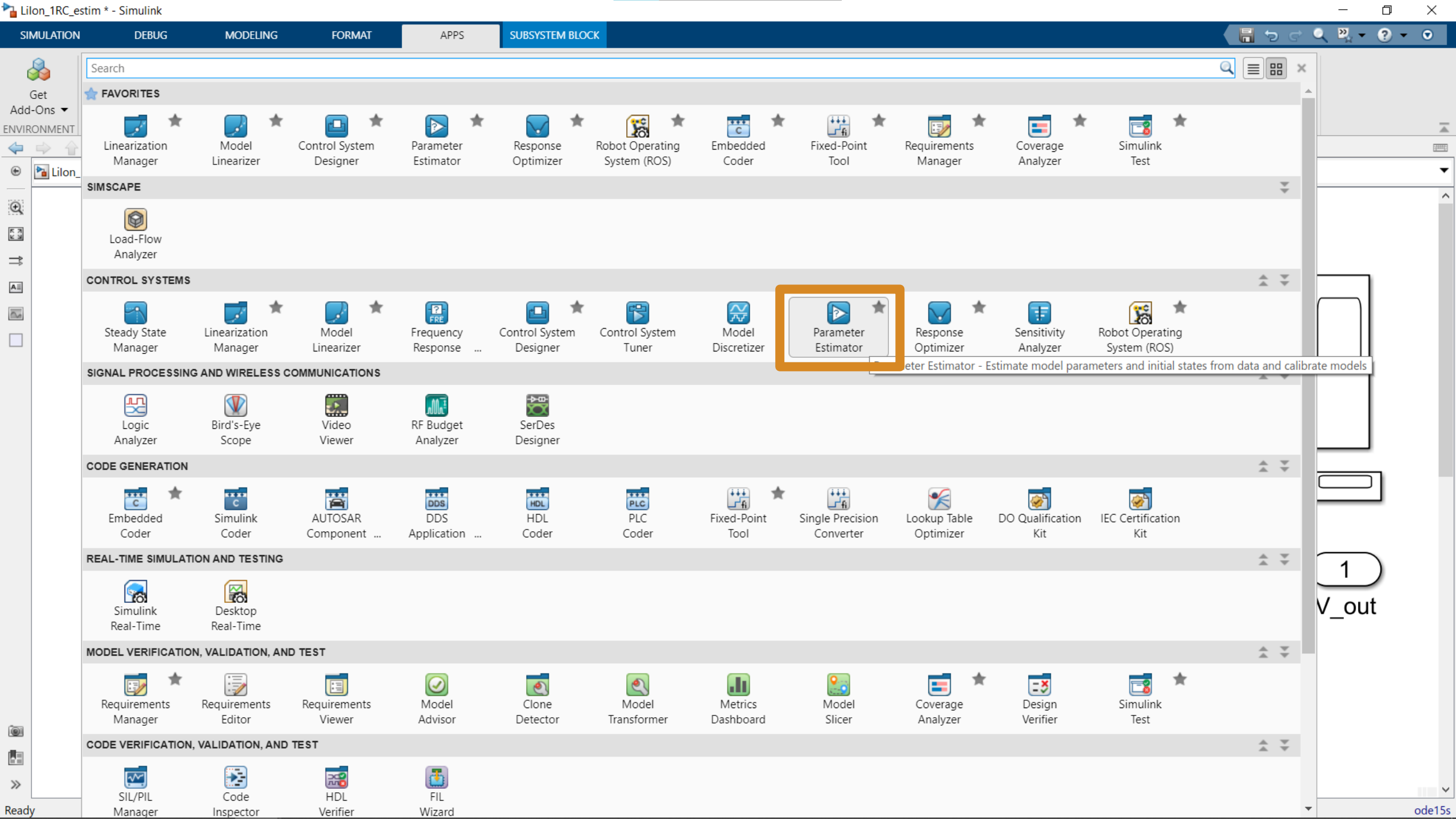

LiIon_1RC_estim * - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
Project
New
Open
Save
Print
Library Browser
Log Signals
Add Viewer
Signal Table
Stop Time
37000
Normal
Fast Restart
Step Back
Run
Step Forward
Stop
Data Inspector
Logic Analyzer
Bird's-Eye Scope
Simulation Manager
LiIon_1RC_estim
f(x) = 0
[I_in]
Current Source
1
Current
I_in
2
Voltage
V_in
[V_exp]
Scope1
File
Tools
View
Simulation
Help
Current
current
Battery Voltage: Measured (yellow), Simulated (blue)
voltage_exp
voltage_sim
Ready
Sample based
T=37000.000
Ready
250%
ode15s

Equivalent Circuit Parameters

Lookup matrices as a function of…
- State of charge
- Temperature




LiIon_1RC_estim * - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
Project
New
Open
Save
Print
Library Browser
Log Signals
Add Viewer
Signal Table
Stop Time
37000
Normal
Fast Restart
Step Back
Run
Step Forward
Stop
Data Inspector
Logic Analyzer
Bird's-Eye Scope
Simulation Manager
PROJECT
FILE
LIBRARY
PREPARE
SIMULATE
REVIEW RESULTS
LiIon_1RC_estim
Lilon_1RC_estim
f(x) = 0
[I_in]
Current Source
Li cell 1RC
1
Current
I_in
2
Voltage
V_in
[V_exp]
[I_in]
current
[V_exp]
voltage_exp
voltage_sim
1
V_out
Ready
250%
ode15s


LiIon_1RC_estim * - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
SUBSYSTEM BLOCK
Get Add-Ons
ENVIRONMENT
Search
FAVORITES
Linearization Manager
Model Linearizer
Control System Designer
Parameter Estimator
Response Optimizer
Robot Operating System (ROS)
Embedded Coder
Fixed-Point Tool
Requirements Manager
Coverage Analyzer
Simulink Test
SIMSCAPE
Load-Flow Analyzer
CONTROL SYSTEMS
Steady State Manager
Linearization Manager
Model Linearizer
Frequency Response ...
Control System Designer
Control System Tuner
Model Discretizer
Parameter Estimator
Response Optimizer
Sensitivity Analyzer
Robot Operating System (ROS)
eter Estimator - Estimate model parameters and initial states from data and calibrate models
SIGNAL PROCESSING AND WIRELESS COMMUNICATIONS
Logic Analyzer
Bird's-Eye Scope
Video Viewer
RF Budget Analyzer
SerDes Designer
CODE GENERATION
Embedded Coder
Simulink Coder
AUTOSAR Component ...
DDS Application ...
HDL Coder
PLC Coder
Fixed-Point Tool
Single Precision Converter
Lookup Table Optimizer
DO Qualification Kit
IEC Certification Kit
REAL-TIME SIMULATION AND TESTING
Simulink Real-Time
Desktop Real-Time
MODEL VERIFICATION, VALIDATION, AND TEST
Requirements Manager
Requirements Editor
Requirements Viewer
Model Advisor
Clone Detector
Model Transformer
Metrics Dashboard
Model Slicer
Coverage Analyzer
Design Verifier
Simulink Test
CODE VERIFICATION, VALIDATION, AND TEST
SIL/PIL Manager
Code Inspector
HDL Verifier
FIL Wizard
1
V_out
Ready
ode15s

Parameter Estimation - Lilon_1RC_T_estim - EstimatedParams

PARAMETER ESTIMATION | VALIDATION | ITERATION PLOT | VIEW

Open Session | Save Session | New Experiment | Select Experiments | Select Parameters | Sensitivity Analysis | Add Plot | Plot Model Response | Cost Function: Sum Squared Error | More Options | Stop Estimation

FILE | EXPERIMENTS | PARAMETERS | PLOTS | OPTIONS | ESTIMATE

Data Browser

Parameters

C1
Em
R0
R1

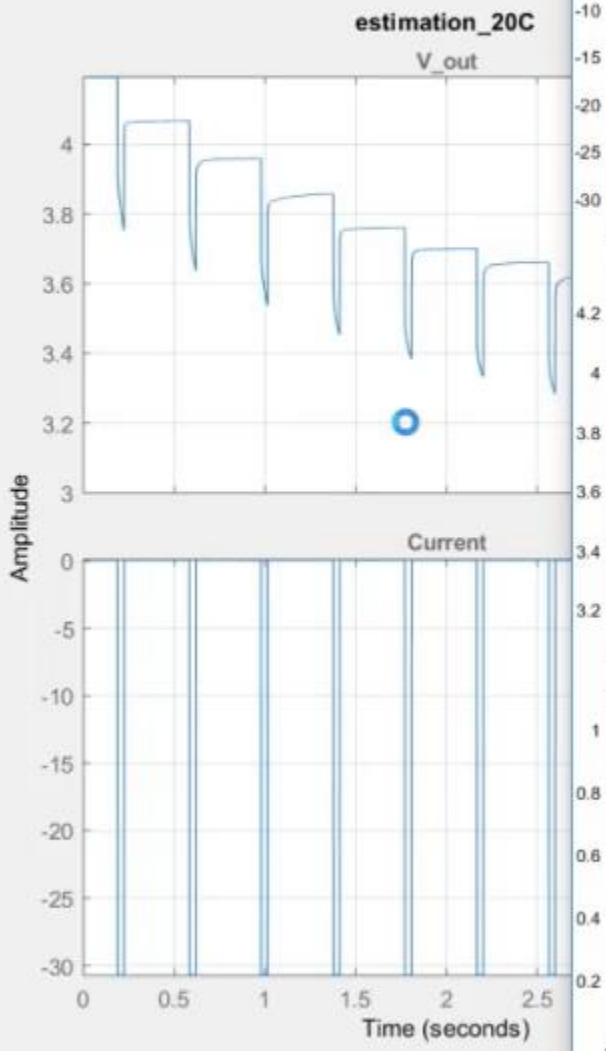
Experiments

estimation_20C
estimation_40C
estimation_5C
validation_20C

Results

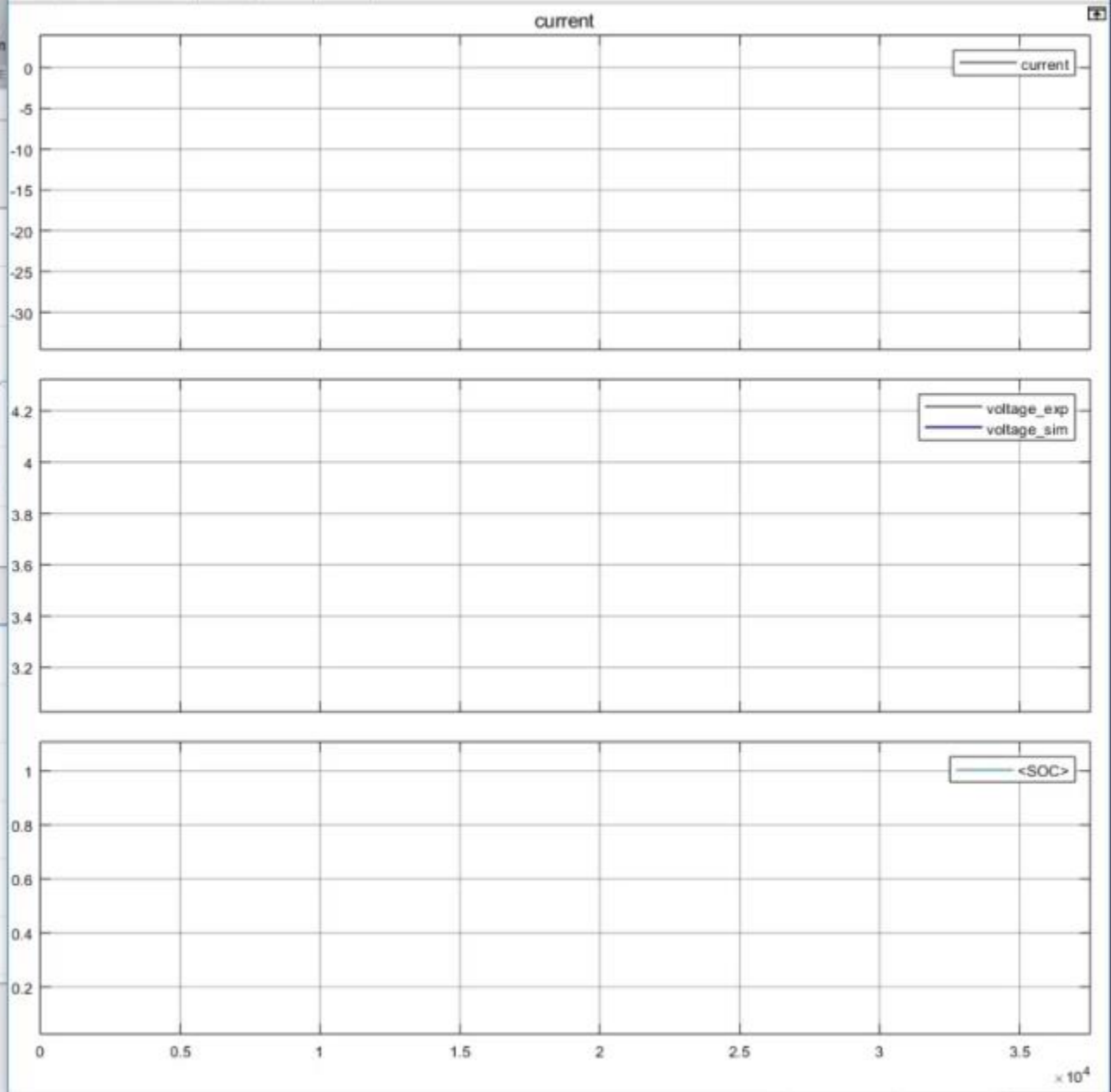
Preview

Experiment plot: estimation_20C



Scope

File Tools View Simulation Help



Running | Sample based | Offset=0 | T=37520.000

Parameter Estimation* - Lilon_1RC_T_estim - EstimatedParams

PARAMETER ESTIMATION | VALIDATION | ITERATION PLOT | VIEW

sandbox B battery C clean

Open Session | Save Session | New Experiment | Select Experiments | Select Parameters | Sensitivity Analysis | Add Plot | Plot Model Response | Cost Function: Sum Squared Error | More Options | Estimate

FILE | EXPERIMENTS | PARAMETERS | PLOTS | OPTIONS | ESTIMATE

Data Browser

Parameters

C1
Em
R0
R1

Experiments

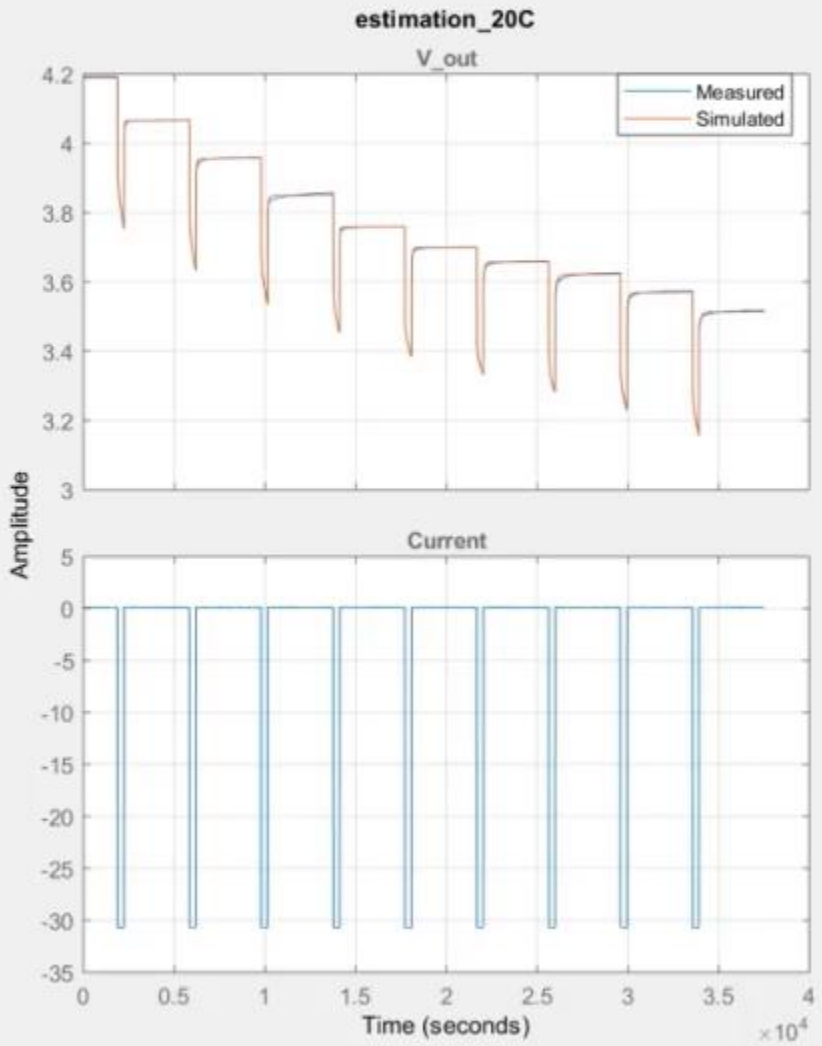
estimation_20C
estimation_40C
estimation_5C
validation_20C

Results

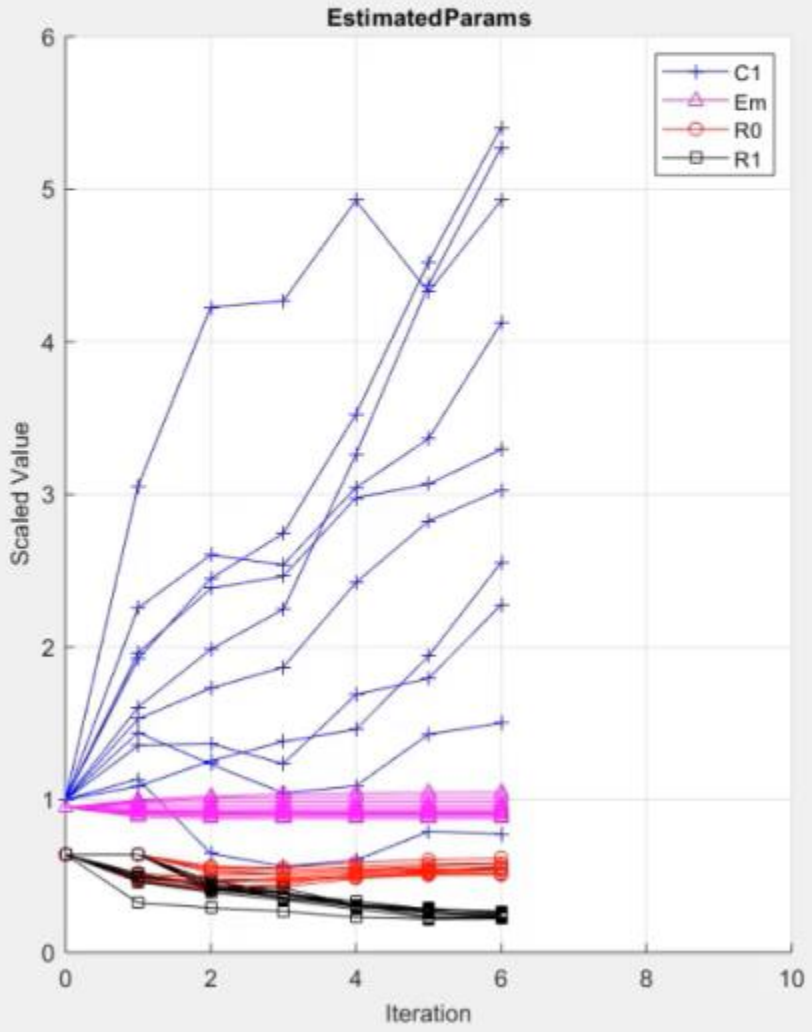
EstimatedParams

Preview

Experiment plot: estimation_20C



EstimatedParams



ssc_battery_charge_balance_3RC/Battery * - Simulink

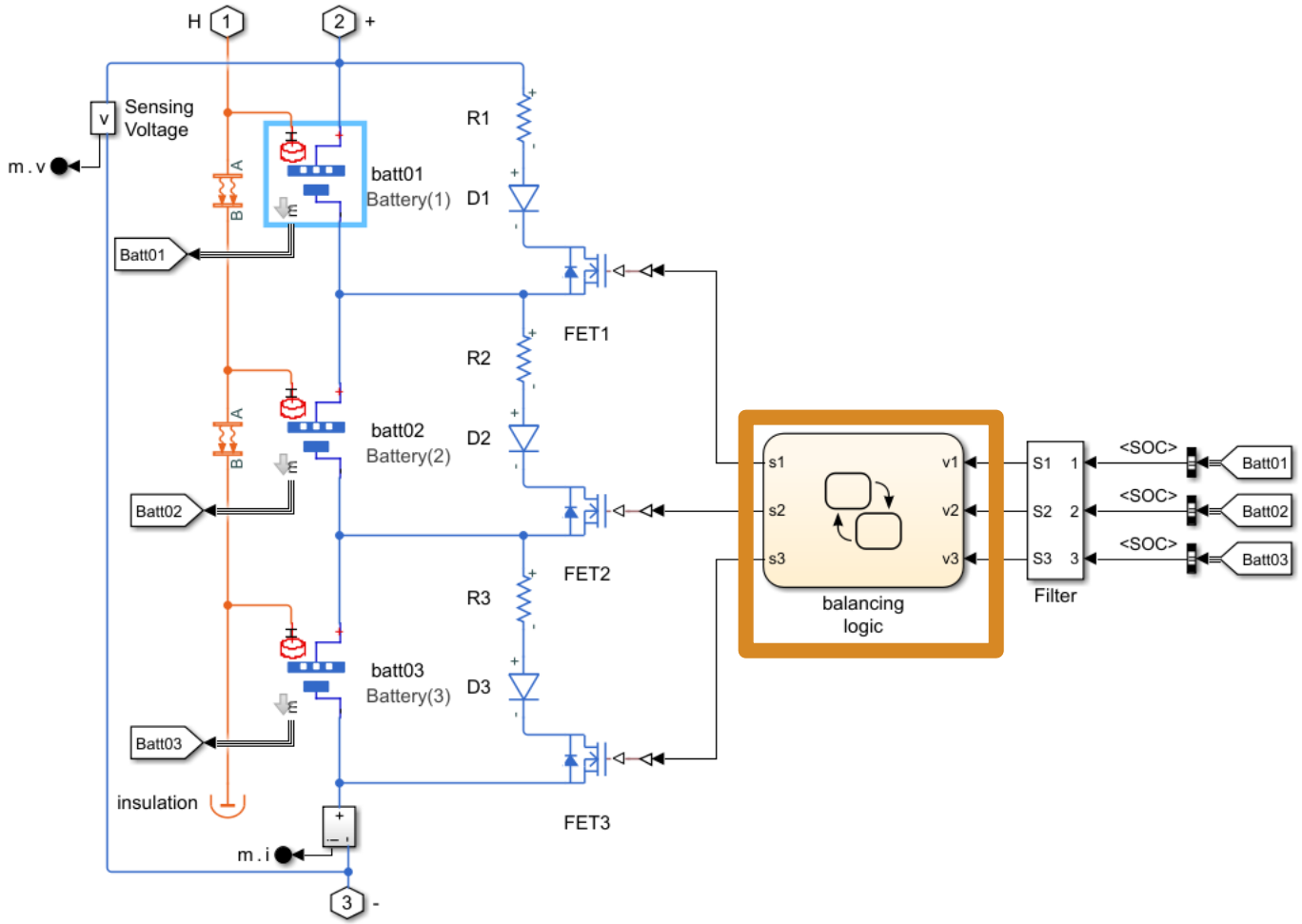
SIMULATION DEBUG MODELING FORMAT APPS BLOCK

Project New Open Save Print Library Browser Log Signals Log Events Add Viewer Stop Time 3600 * 4 Normal Fast Restart Step Back Run Step Forward Stop Data Inspector Sequence Viewer Logic Analyzer Bird's-Eye Scope Simulation Manager Simscape Results ...

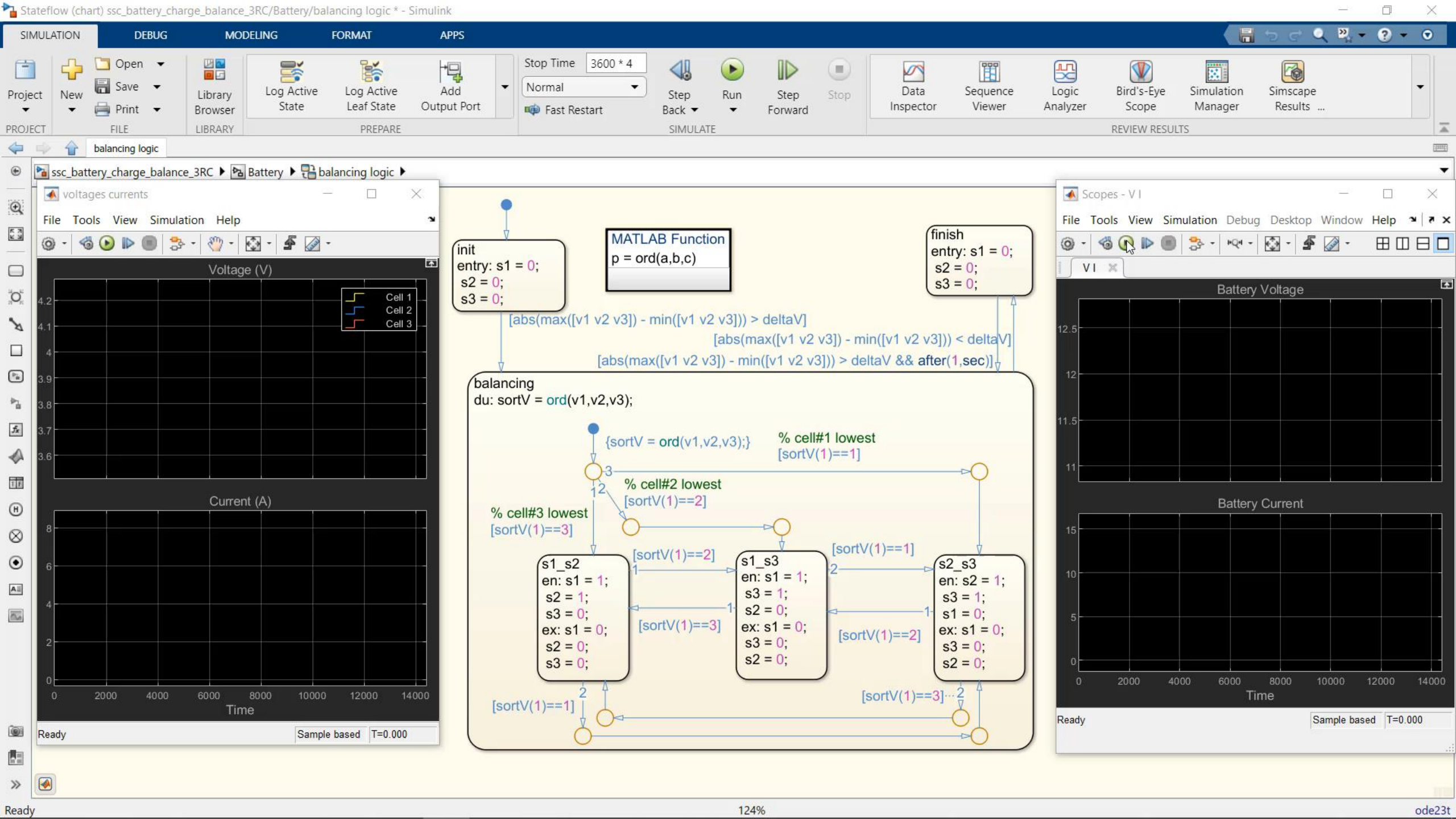
PROJECT FILE LIBRARY PREPARE SIMULATE REVIEW RESULTS

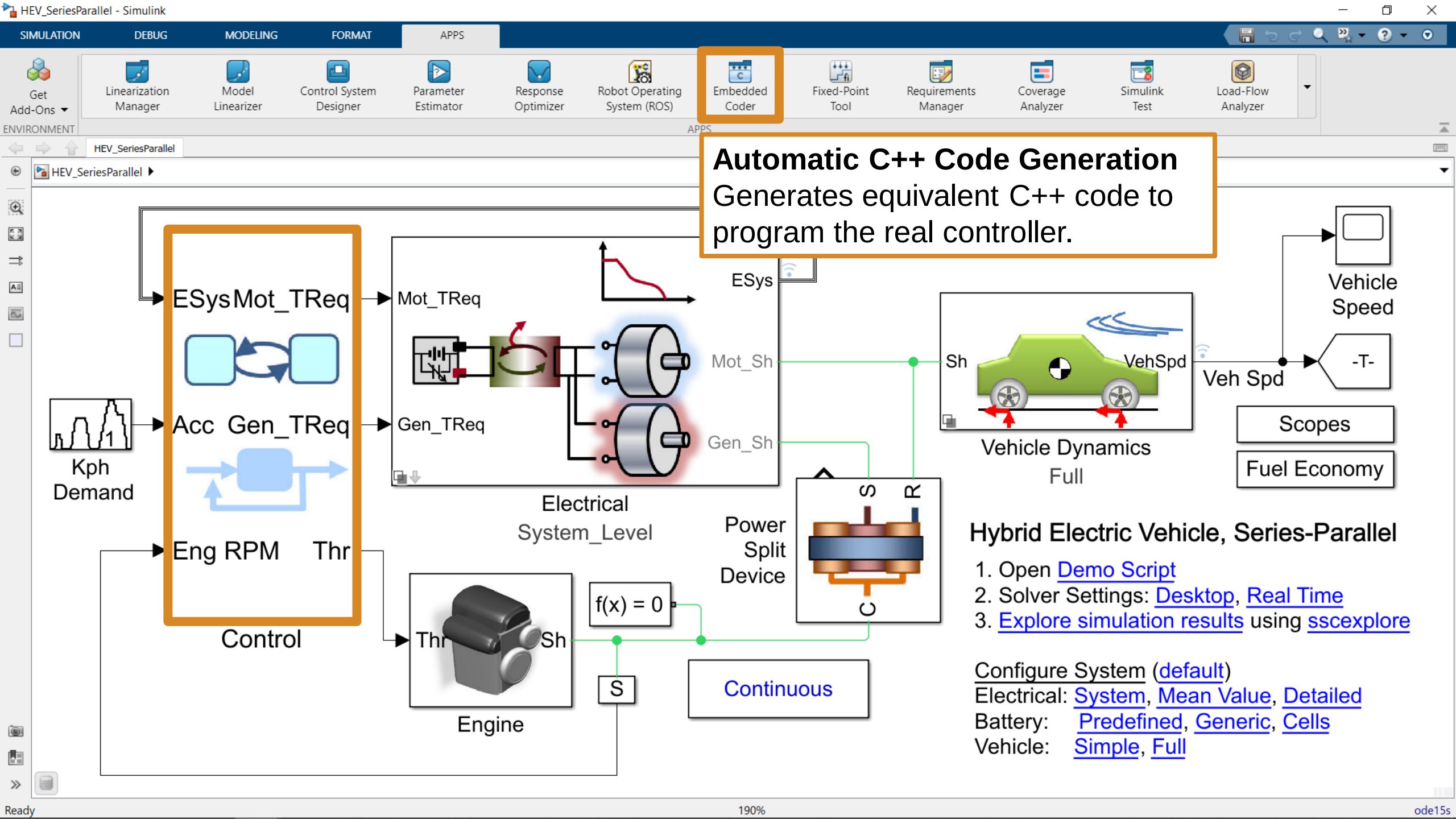
Battery

ssc_battery_charge_balance_3RC ▸ Battery ▸

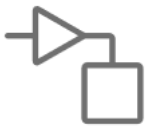


Ready 101% ode23t


Stateflow (chart) ssc_battery_charge_balance_3RC/Battery/balancing logic * - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
Project
New
Open
Save
Print
Library Browser
Log Active State
Log Active Leaf State
Add Output Port
Stop Time
3600 * 4
Normal
Fast Restart
Step Back
Run
Step Forward
Stop
Data Inspector
Sequence Viewer
Logic Analyzer
Bird's-Eye Scope
Simulation Manager
Simscape Results ...
PROJECT
FILE
LIBRARY
PREPARE
SIMULATE
REVIEW RESULTS
balancing logic
ssc_battery_charge_balance_3RC
Battery
balancing logic
voltages currents
File Tools View Simulation Help
Voltage (V)
Cell 1
Cell 2
Cell 3
Current (A)
Time
Ready
Sample based
T=0.000
init
entry: s1 = 0;
s2 = 0;
s3 = 0;
MATLAB Function
p = ord(a,b,c)
finish
entry: s1 = 0;
s2 = 0;
s3 = 0;
[abs(max([v1 v2 v3]) - min([v1 v2 v3])) > deltaV]
[abs(max([v1 v2 v3]) - min([v1 v2 v3])) < deltaV]
[abs(max([v1 v2 v3]) - min([v1 v2 v3])) > deltaV && after(1,sec)]
balancing
du: sortV = ord(v1,v2,v3);
{sortV = ord(v1,v2,v3);}
% cell#1 lowest
[sortV(1)==1]
% cell#2 lowest
[sortV(1)==2]
% cell#3 lowest
[sortV(1)==3]
s1_s2
en: s1 = 1;
s2 = 1;
s3 = 0;
ex: s1 = 0;
s2 = 0;
s3 = 0;
s1_s3
en: s1 = 1;
s3 = 1;
s2 = 0;
ex: s1 = 0;
s3 = 0;
s2 = 0;
s2_s3
en: s2 = 1;
s3 = 1;
s1 = 0;
ex: s1 = 0;
s3 = 0;
s2 = 0;
Scopes - V I
File Tools View Simulation Debug Desktop Window Help
V I
Battery Voltage
Battery Current
Time
Ready
Sample based
T=0.000
Ready
124%
ode23t


HEV_SeriesParallel - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
Get Add-Ons
ENVIRONMENT
Linearization Manager
Model Linearizer
Control System Designer
Parameter Estimator
Response Optimizer
Robot Operating System (ROS)
Embedded Coder
Fixed-Point Tool
Requirements Manager
Coverage Analyzer
Simulink Test
Load-Flow Analyzer
APPS
HEV_SeriesParallel
Automatic C++ Code Generation
Generates equivalent C++ code to program the real controller.
ESys
Mot_TReq
Acc
Gen_TReq
Eng RPM
Thr
Control
Kph Demand
Mot_TReq
Gen_TReq
ESys
Mot_Sh
Gen_Sh
Electrical
System_Level
Power Split Device
S
R
C
Thr
Sh
Engine
f(x) = 0
S
Continuous
Sh
VehSpd
Vehicle Dynamics
Full
Vehicle Speed
Veh Spd
-T-
Scopes
Fuel Economy
Hybrid Electric Vehicle, Series-Parallel
1. Open Demo Script
2. Solver Settings: Desktop, Real Time
3. Explore simulation results using sscexplore
Configure System (default)
Electrical: System, Mean Value, Detailed
Battery: Predefined, Generic, Cells
Vehicle: Simple, Full
Ready
190%
ode15s

Model-Based Design: From Concept to Code

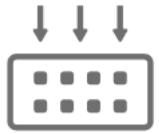


Model and Simulate Your System

Explore a wide design space by modeling the system under test and the physical plant. Your entire team can use one multi-domain environment to simulate how all parts of the system behave.

Test Early and Often

Reduce expensive prototypes by testing your system under conditions that are otherwise too risky or time-consuming to consider. Validate your design with hardware-in-the-loop testing and rapid prototyping. Maintain traceability from requirements to design to code.

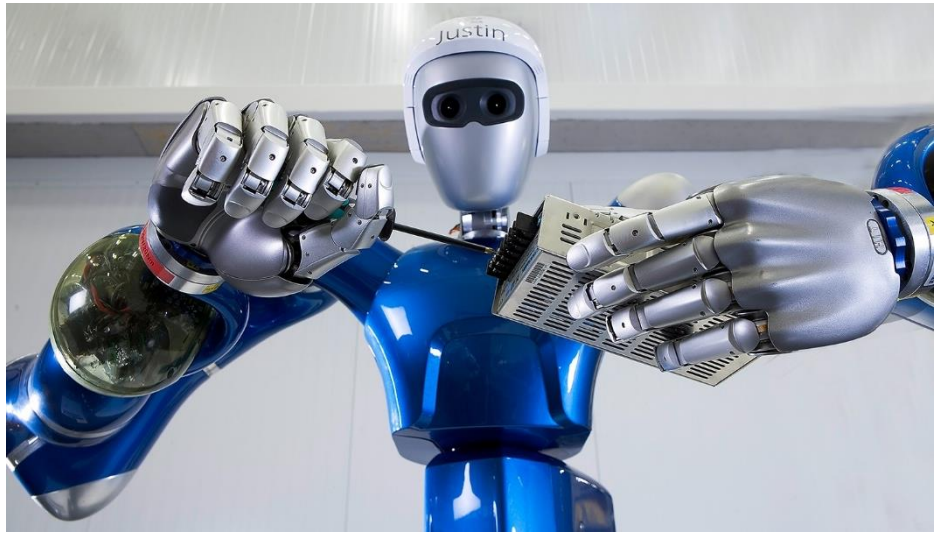


Automatically Generate Code

Instead of writing thousands of lines of code by hand, automatically generate production-quality C and HDL code that behaves the same way as the model you created in Simulink. Then deploy it directly onto your MCU, DSP, or FPGA.

Autonomous Systems

Autonomous Systems



Autonomous Systems

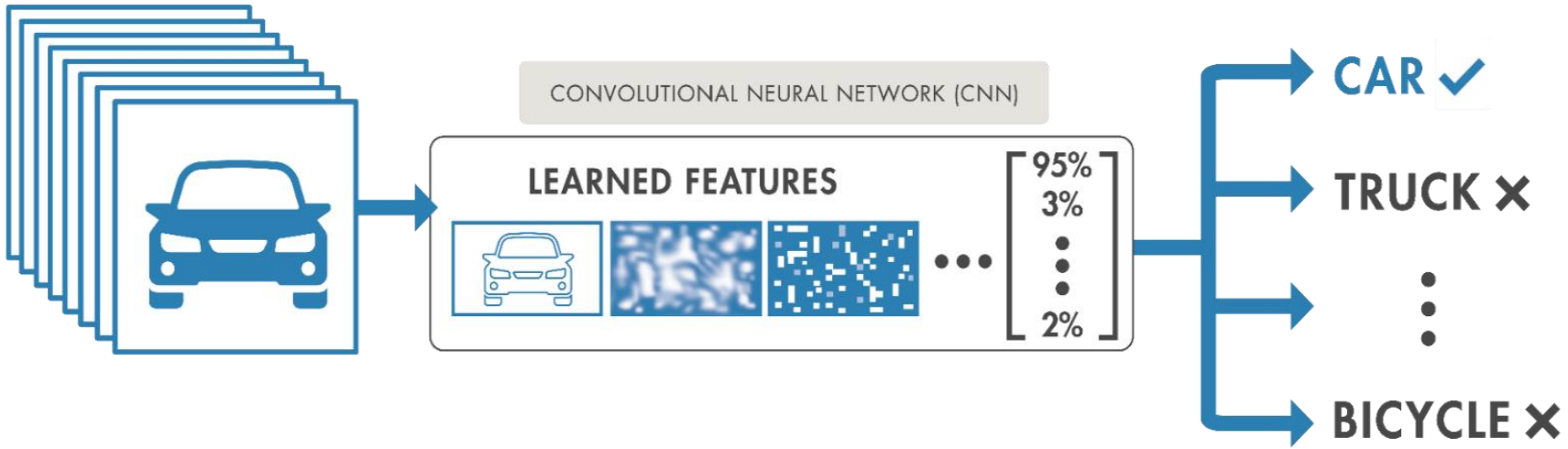
- Why is it happening now?
- What challenges is Industry facing?
- How are engineers overcoming them?

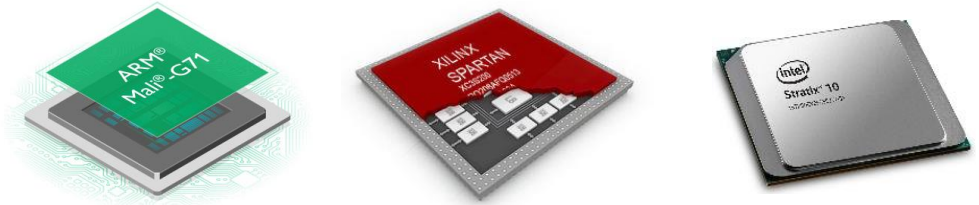
Why Now?

Artificial Intelligence

Machine Learning

Deep Learning





Autonomous Systems

- Why is it happening now?
- What challenges is Industry facing?
- How are engineers overcoming them?

Key Challenges in AI

1 Data Preparation

- Data cleansing and preparation
- Domain expertise
- Simulation-generated data

2 AI Modeling

- Model design and tuning
- Transfer Learning
- Hardware accelerated training

3 Simulation and Test

- System simulation
- System verification and validation

4 Deployment

- Embedded devices
- Cloud/desktop

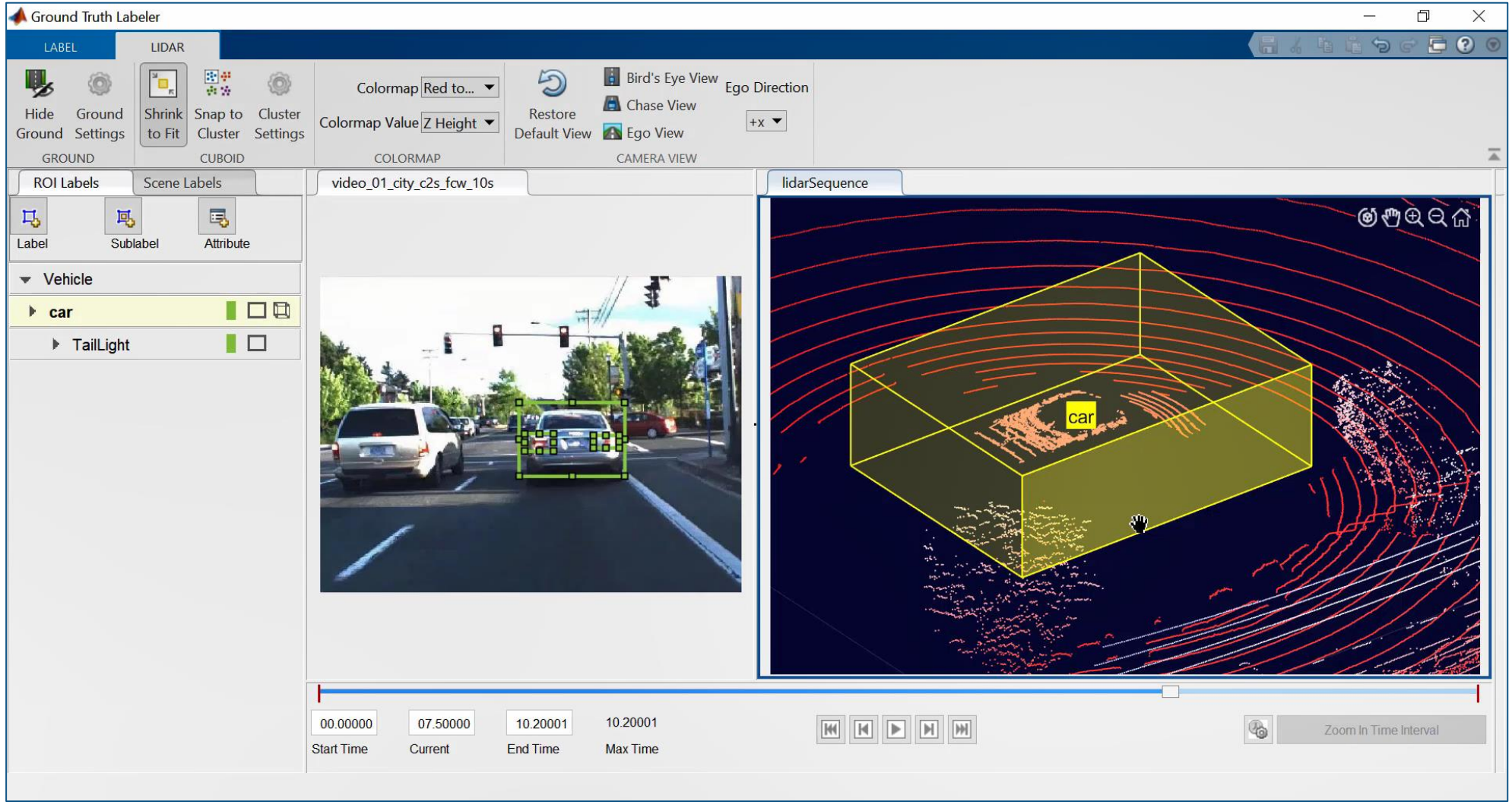
Autonomous Systems

- Why is it happening now?
- What challenges is Industry facing?
- How are engineers overcoming them?


Subaru EyeSight
Detects obstacles, applies brakes, adjusts cruise control, and stays in lane.
FN-0328

Automated Labeling Apps

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



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

Algorithms

Machine learning
Trees, Naïve Bayes, SVM…

Deep learning
CNNs, GANs, LSTM, MIMO…

Reinforcement learning
DQN, A2C, DDPG…

Regression
Linear, nonlinear, trees…

Unsupervised learning
K-means, PCA, GMM…

Predictive maintenance
RUL models, condition indicators…

Bayesian optimization

Pre-built models

Image classification models
AlexNet, GoogLeNet, VGG, SqueezeNet, ShuffleNet, ResNet, DenseNet, Inception…

Reference examples

Object detection
Vehicles, pedestrians, faces…

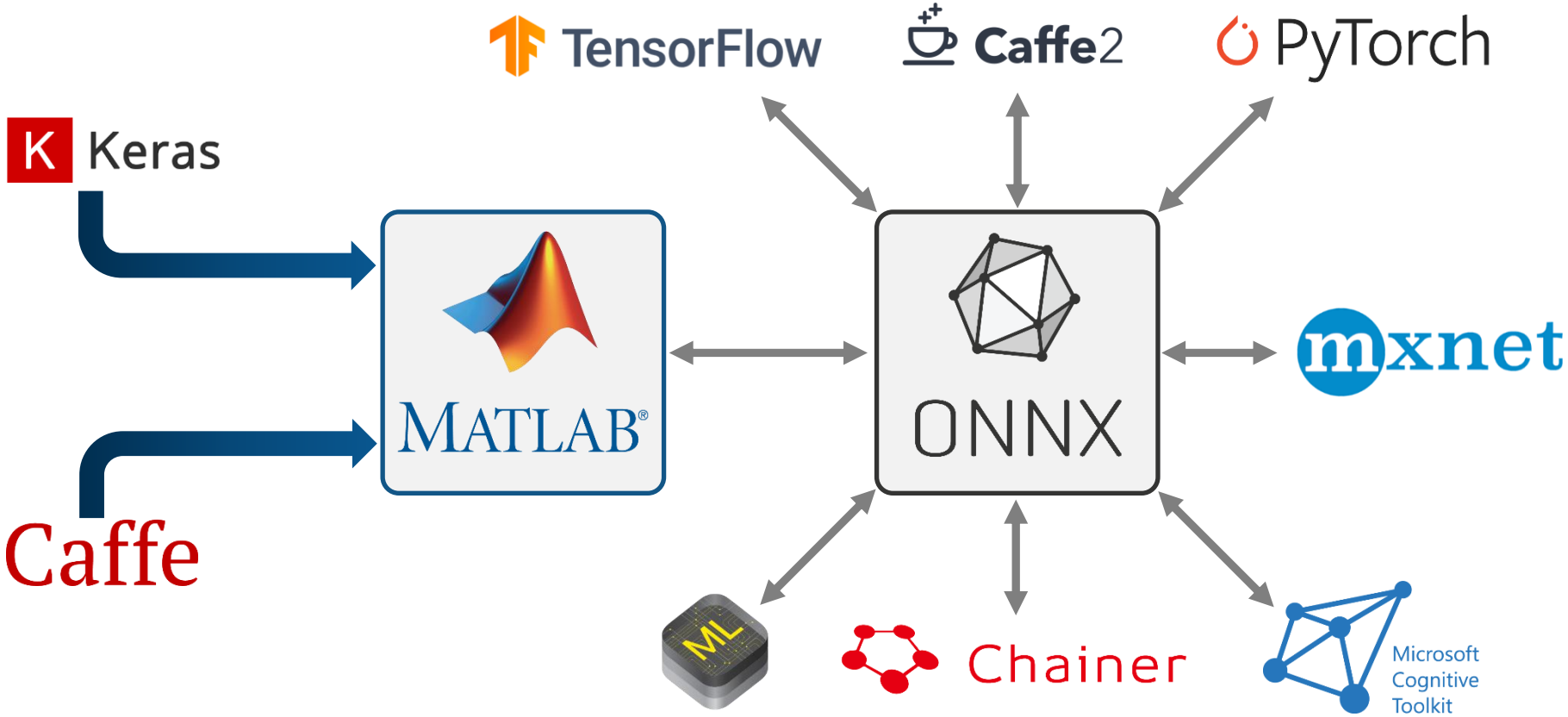
Semantic segmentation
Roadway detection, land cover classification, tumor detection…

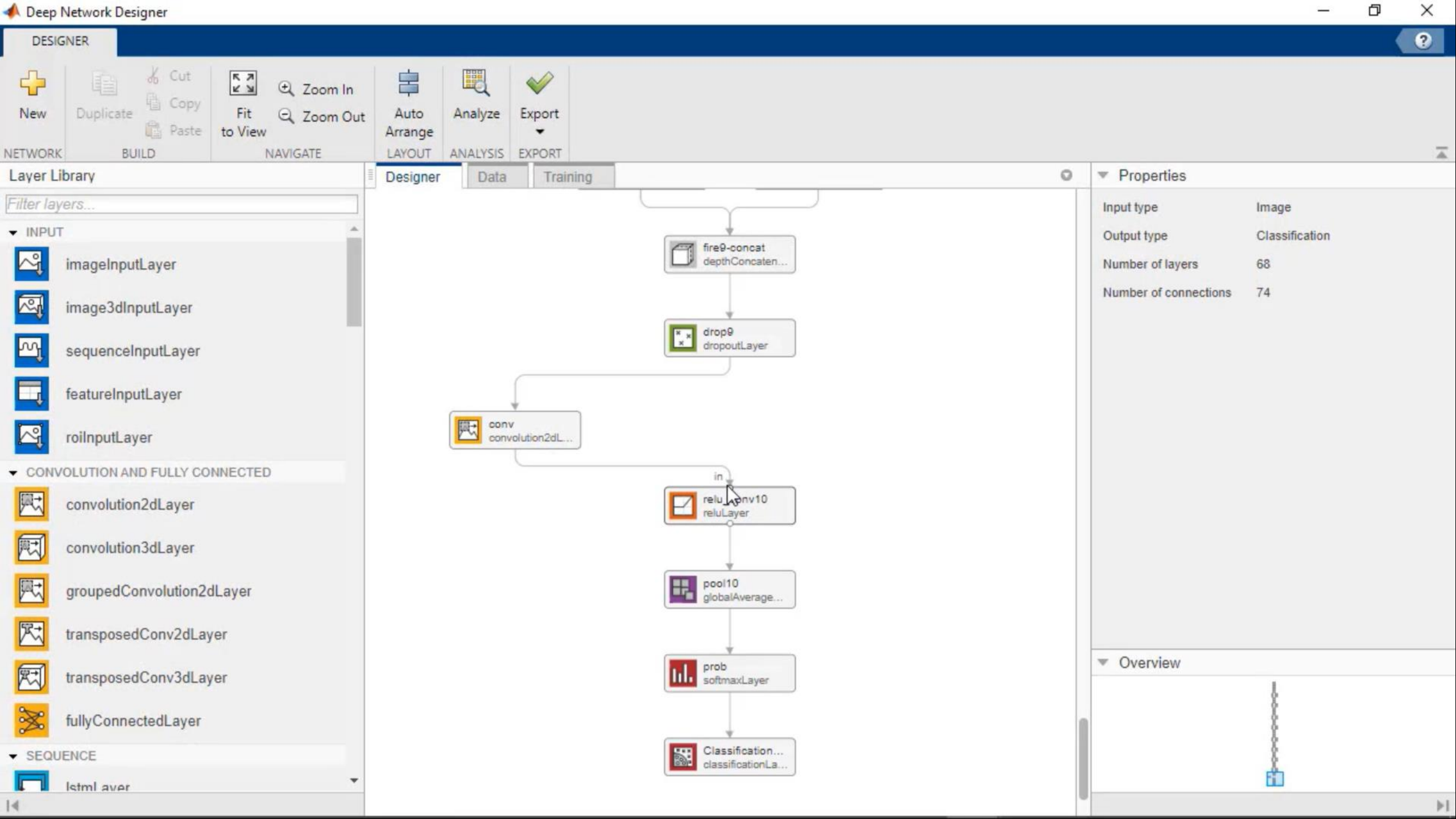
Signal and speech processing
Denoising, music genre recognition, keyword spotting, radar waveform classification…

…and more…

Leveraging the Larger AI Community

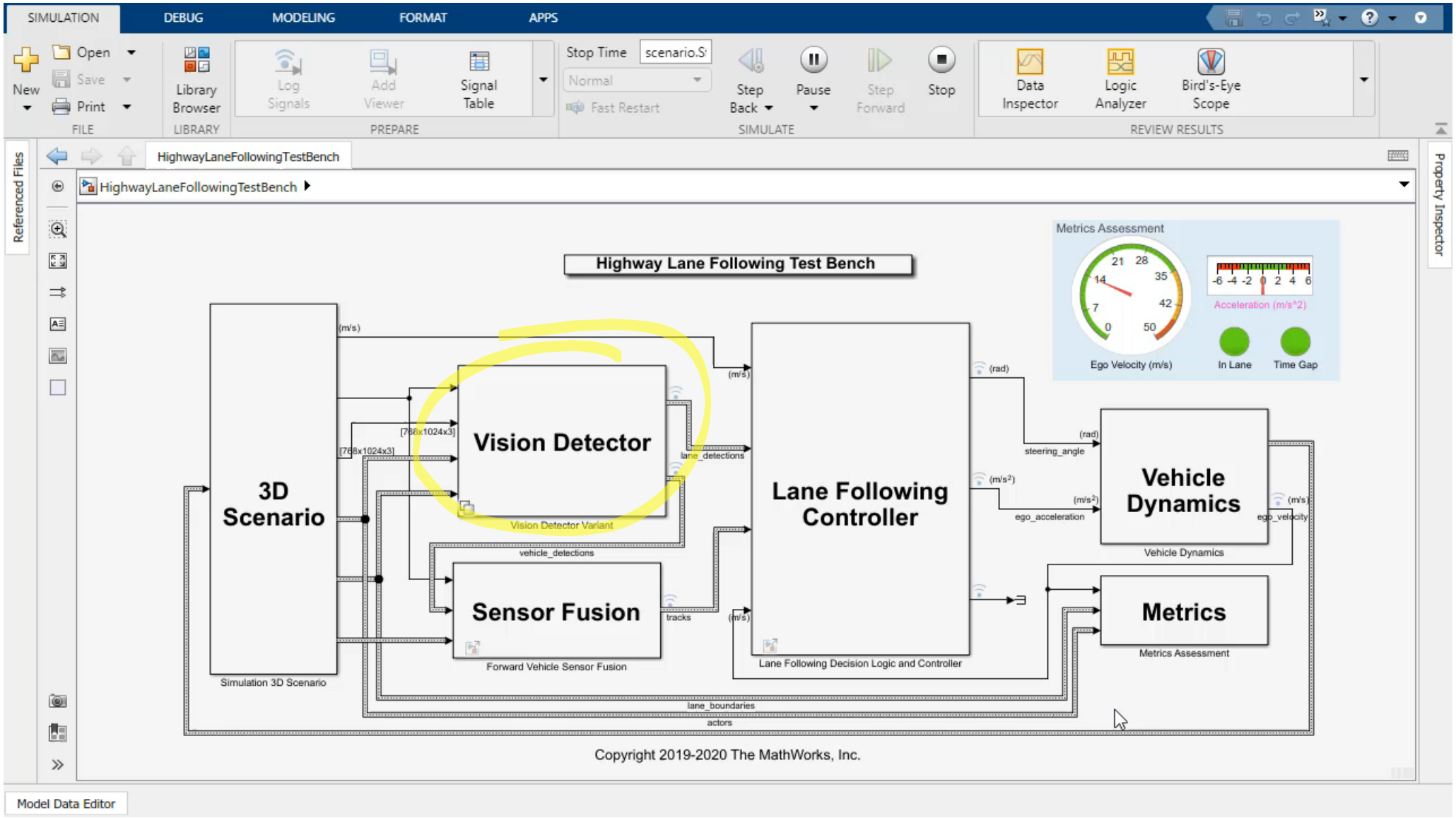
1. Data Preparation
2. AI Modeling
3. Simulation and Test
4. Deployment




Deep Network Designer
DESIGNER
New
Duplicate
Cut
Copy
Paste
Fit to View
Zoom In
Zoom Out
Auto Arrange
Analyze
Export
NETWORK
BUILD
NAVIGATE
LAYOUT
ANALYSIS
EXPORT
Layer Library
Filter layers...
INPUT
imageInputLayer
image3dInputLayer
sequenceInputLayer
featureInputLayer
roiInputLayer
CONVOLUTION AND FULLY CONNECTED
convolution2dLayer
convolution3dLayer
groupedConvolution2dLayer
transposedConv2dLayer
transposedConv3dLayer
fullyConnectedLayer
SEQUENCE
lstmLayer
Designer
Data
Training
fire9-concat
depthConcaten...
drop9
dropoutLayer
conv
convolution2dL...
in
relu_conv10
reluLayer
pool10
globalAverage...
prob
softmaxLayer
Classification...
classificationLa...
Properties
Input type
Image
Output type
Classification
Number of layers
68
Number of connections
74
Overview

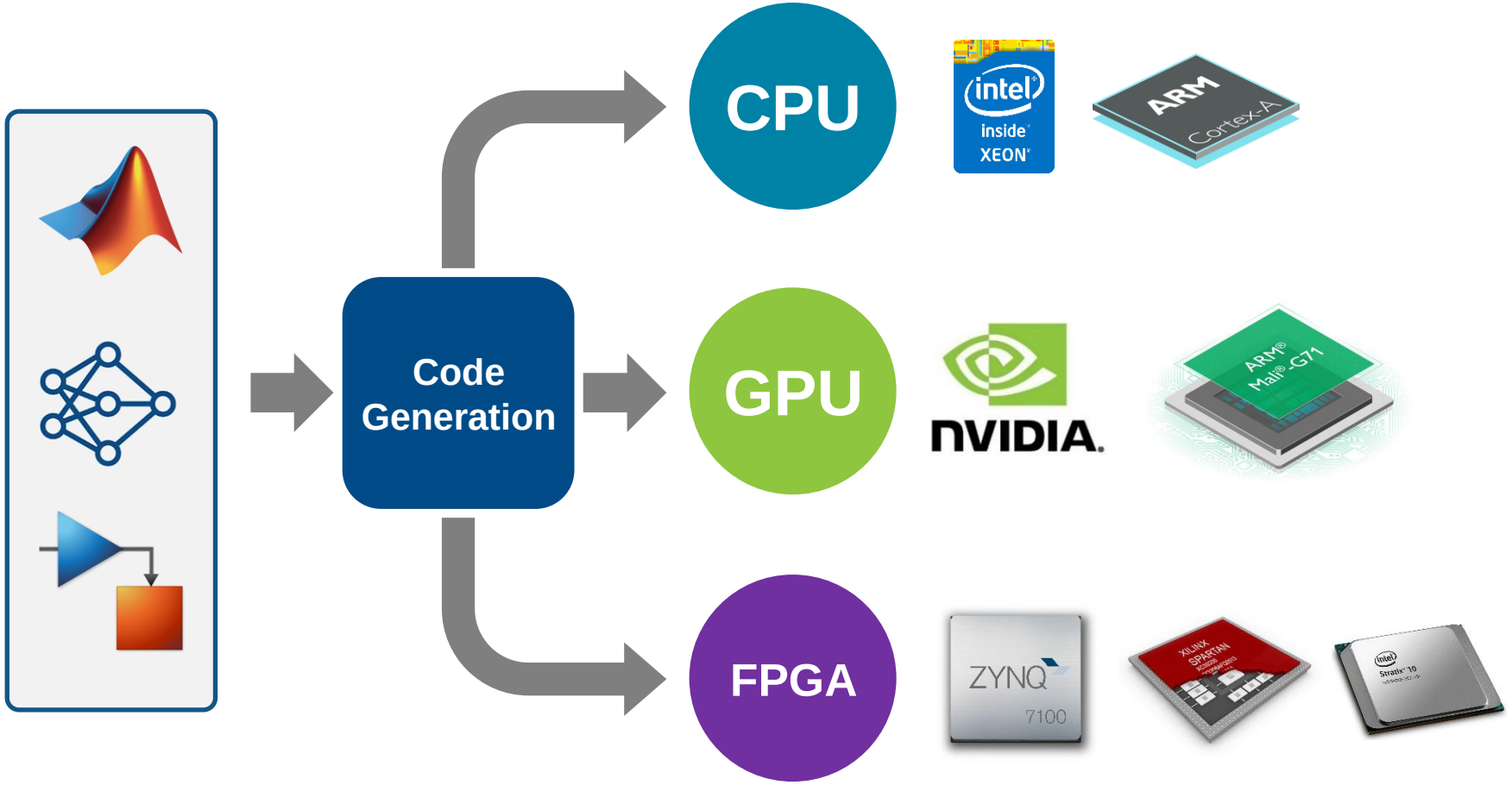
System Simulation

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

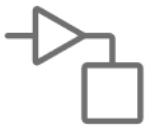


Deploy to Any Device with Zero Coding Errors

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



Model-Based Design: From Concept to Code

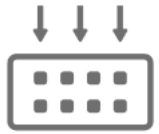


Model and Simulate Your System

Explore a wide design space by modeling the system under test and the physical plant. Your entire team can use one multi-domain environment to simulate how all parts of the system behave.

Test Early and Often

Reduce expensive prototypes by testing your system under conditions that are otherwise too risky or time-consuming to consider. Validate your design with hardware-in-the-loop testing and rapid prototyping. Maintain traceability from requirements to design to code.



Automatically Generate Code

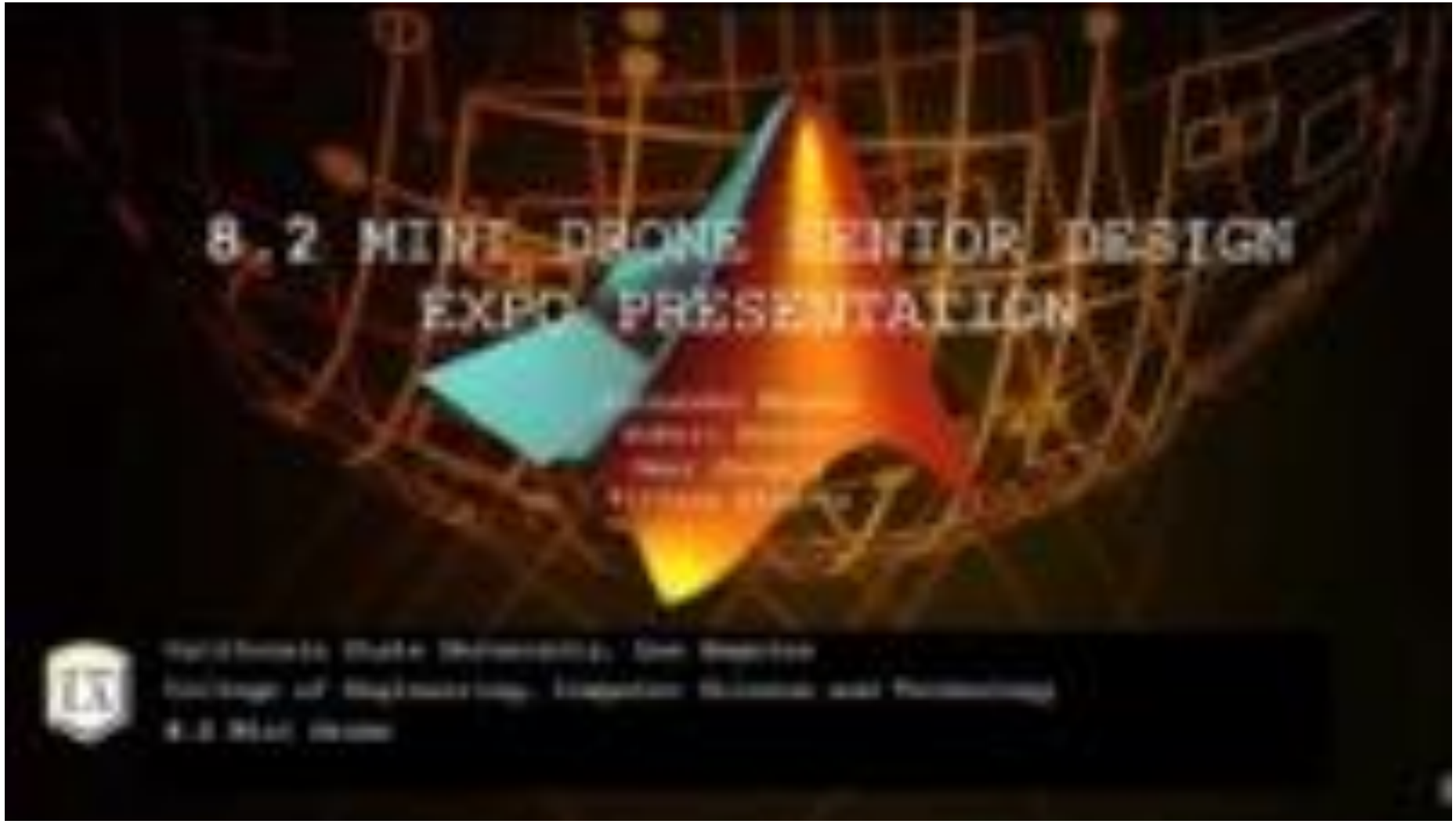
Instead of writing thousands of lines of code by hand, automatically generate production-quality C and HDL code that behaves the same way as the model you created in Simulink. Then deploy it directly onto your MCU, DSP, or FPGA.

Systems Thinking in the Classroom

Systems Thinking in the Classroom

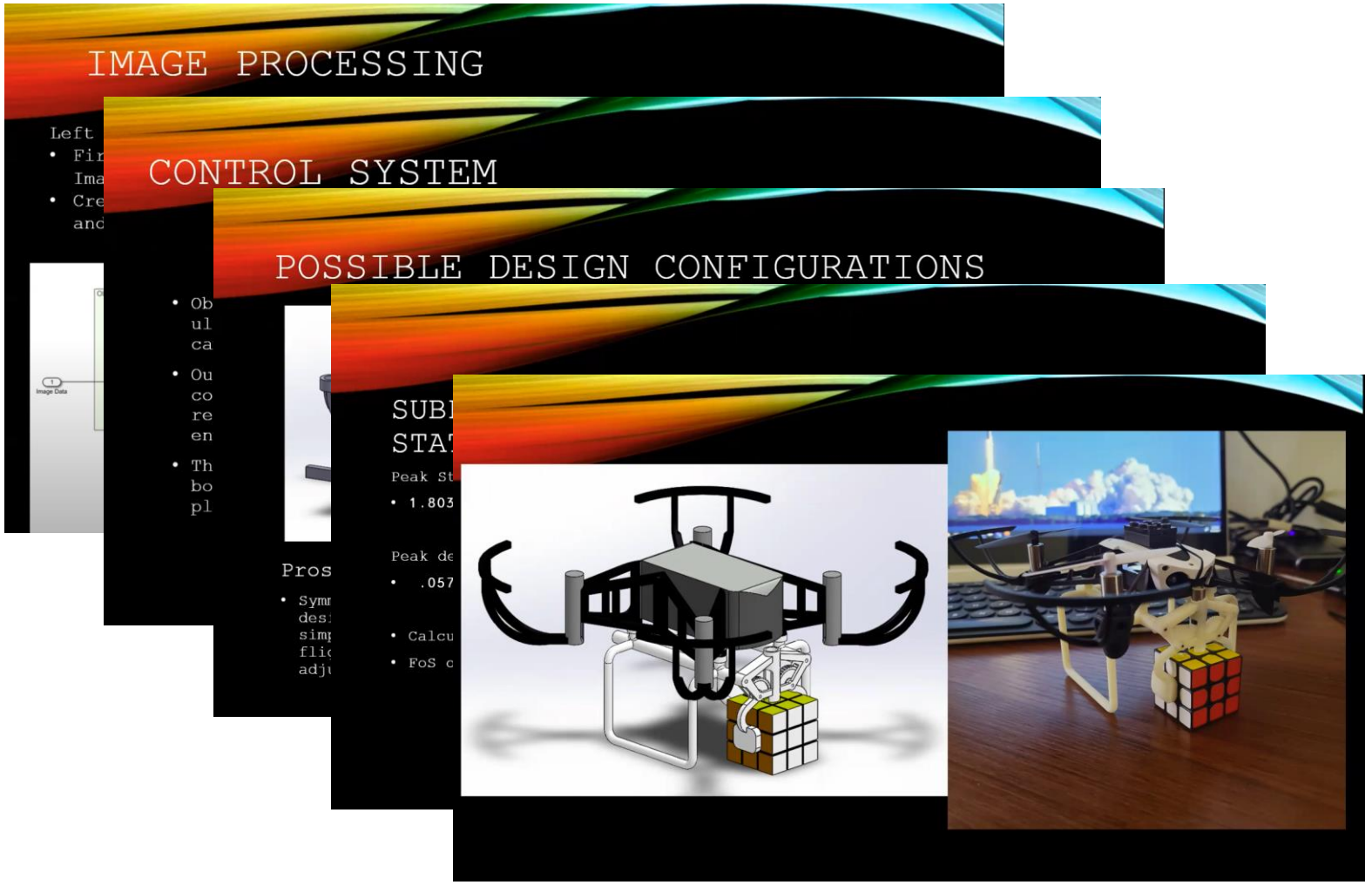
- How can Systems Thinking be incorporated?
- How can Students be prepared?
- What if you have questions?

Cal State Los Angeles – Minidrone Project



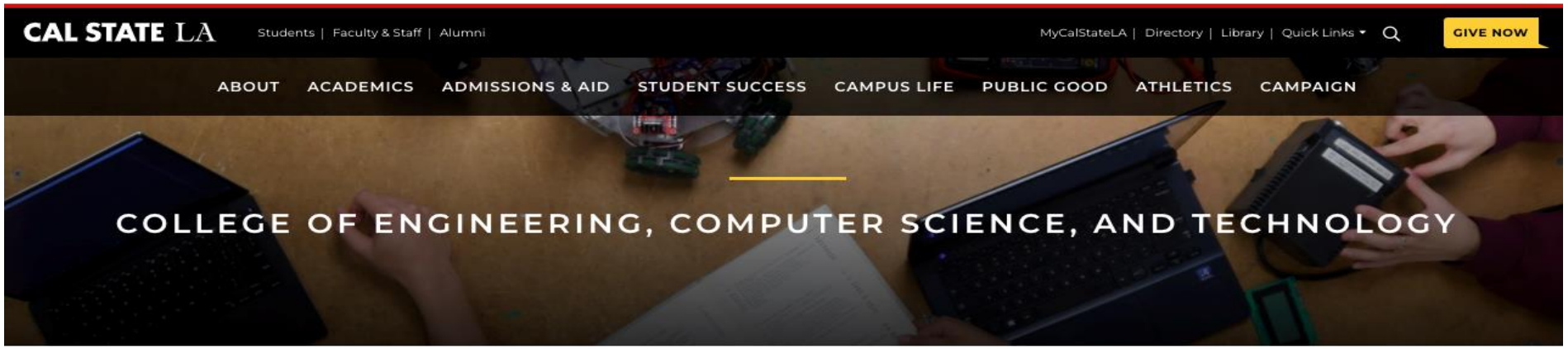
https://tinyurl.com/3ws24bc7

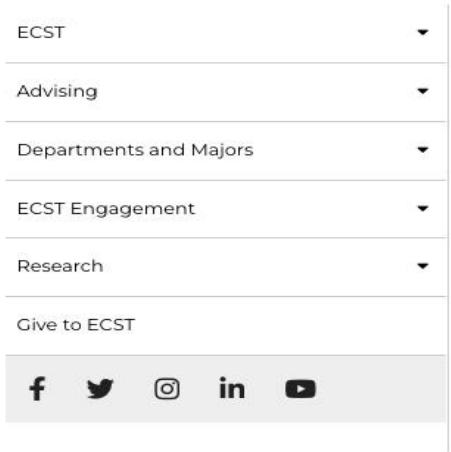
Incorporating Systems Thinking: The technical aspects



Incorporating Systems Thinking: The non-technical aspects

Observations of student, faculty and the university





CAL STATE LA SUPPORTS USING THE TOOLS PROFESSIONALS USE IN ENGINEERING EDUCATION

Photo: Jocylene Arevalo

USING THE TOOLS PROFESSIONALS USE GIVES ECST STUDENTS A LEG UP

https://tinyurl.com/bdfmknb3

Systems Thinking in the Classroom

- How can Systems Thinking be incorporated?
- How can Students be prepared?
- What if you have questions?

Resources to consider:

MathWorks Excellence in Innovation Projects

Contribute to t[illegible]

Are you looking
based on indus
you learn about
technical comp
for your proble

Projects by technology trends

- 5G
- Artificial Intelligence
- Autonomous Vehicles
- Big Data
- Computer Vision
- Drones
- Industry 4.0
- Neuroscience
- Robotics
- Sustainability and Renewable Energy

Flight Controller Design and Hardware Deployment

Build a mini drone and use the PX4 Hardware Support package to design the flight controller using Simulink.

Portable Charging System for Electric Vehicles

Design a portable charger for Electric Vehicles

https://github.com/mathworks/MathWorks-Excellence-in-Innovation

Self-Paced Online Training

MATLAB Onramp

Simulink Onramp

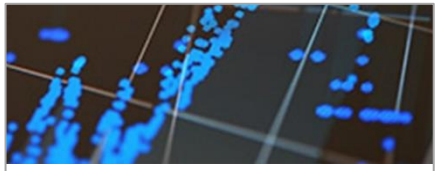
Stateflow Onramp

Control Design Onramp

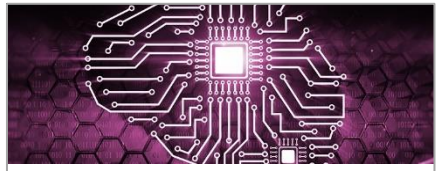
Circuit Simulation Onramp

Machine Learning Onramp

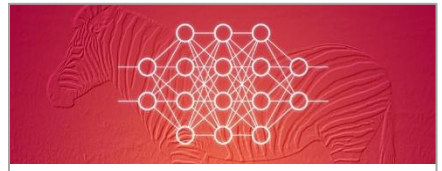
Deep Learning Onramp



MATLAB for Data Processing and Visualization



Machine Learning with MATLAB



Deep Learning with MATLAB

matlabacademy.mathworks.com

Freely Reusable Courseware

Teaching Calculus with MATLAB

» Integrate MATLAB into your Calculus curriculum

Teaching Physics with MATLAB

» Integrate MATLAB into your Physics curriculum

Teaching Chemistry with MATLAB

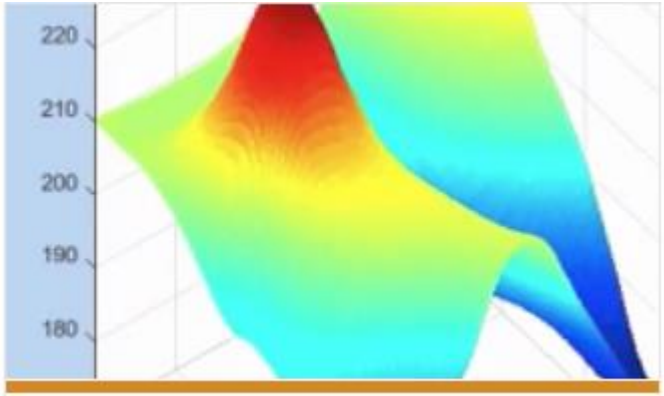
» Integrate MATLAB into your Chemistry curriculum

mathworks.com/academia/**educators**

Freely Reusable Courseware

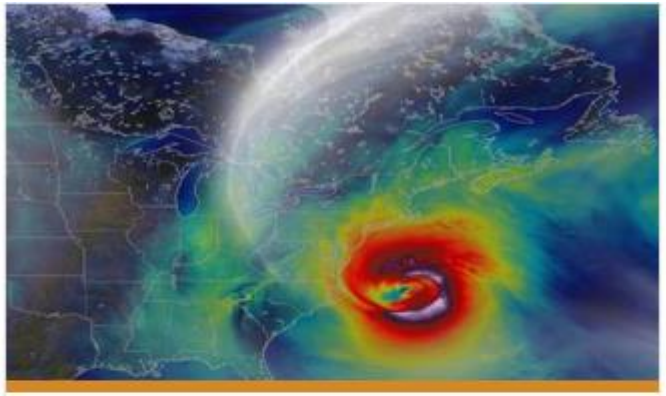
Teaching Biology with MATLAB

» Integrate MATLAB into your Biology curriculum



Teaching Geoscience with MATLAB

» Integrate MATLAB into your Geoscience curriculum



Teaching Computational Science Using MATLAB

» Integrate MATLAB into your robust data analysis, data visualization and exploration curriculum

mathworks.com/academia/**educators**

Freely Reusable Courseware

Teaching Psychology and Neuroscience with MATLAB

» Integrate MATLAB into your Psychology and Neuroscience curriculum

Teaching Econometrics with MATLAB

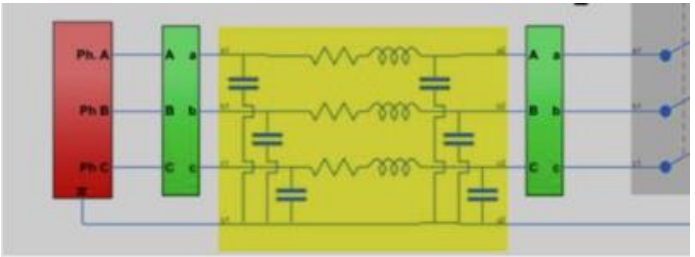
» Integrate MATLAB into your Econometrics curriculum

Teaching Quantitative Finance and Risk Management with MATLAB

» Integrate MATLAB into your Quantitative Finance and Risk Management curriculum

mathworks.com/academia/**educators**

Self-Paced Virtual Labs



ELECTRICAL ENGINEERING

Electric Machine and Power Labs

Douglas Jussaume, University of Tulsa

Eight power labs and assignments that mimic hardware lab operation; the typical lab requires students to connect the power circuit, run and record data, and submit a lab report

Includes: Models, Assignments

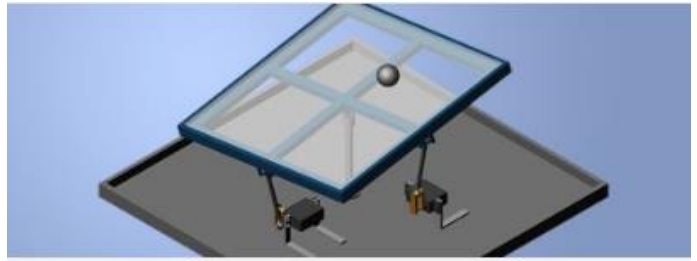
ELECTRICAL ENGINEERING

Digital Communication Laboratory

Lee C. Potter and Yang Yang, The Ohio State University

Laboratory course providing hands-on exploration of physical layer communication

Includes: Code, Assignments



MECHANICAL AND ELECTRICAL ENGINEERING

Virtual Hardware and Labs for Controls

MathWorks

Four introductory labs with virtual models; designed to give an intuitive introduction to basic controls concepts, such as feedback control

Includes: Code, Models, Assignments

mathworks.com/academia/**courseware**

Systems Thinking in the Classroom

- How can Systems Thinking be incorporated?
- How can Students be prepared?
- What if I have questions?

What if I have questions?

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

MATLAB EXPO

Thank you