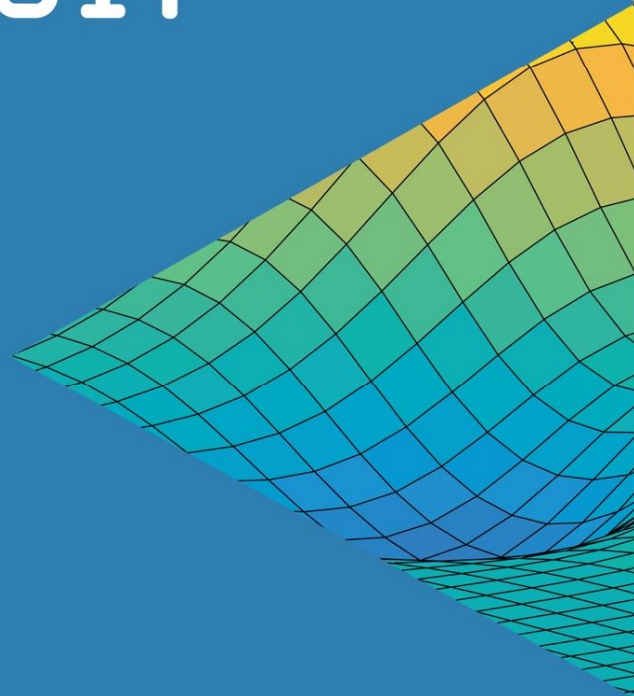


MATLAB EXPO 2017

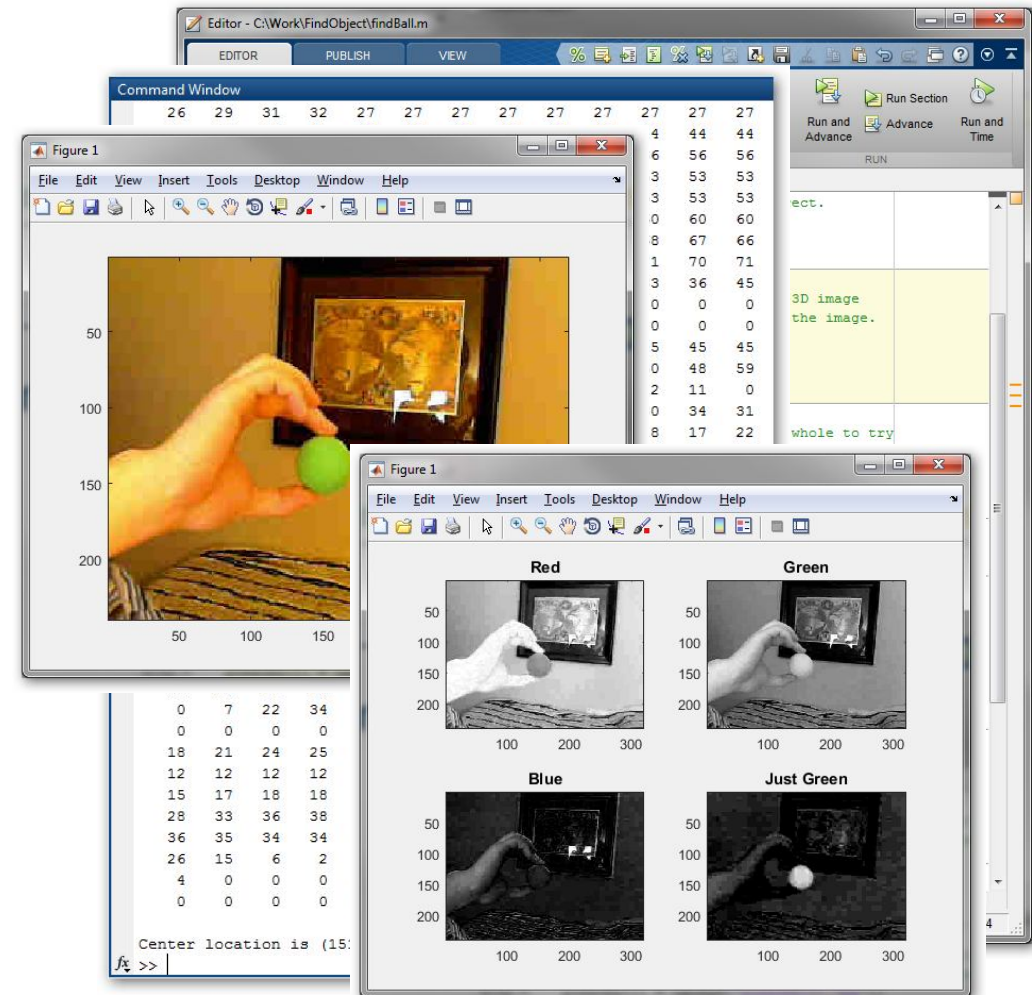
Teaching with the MATLAB Live Editor

Dr. Oliver Kluge



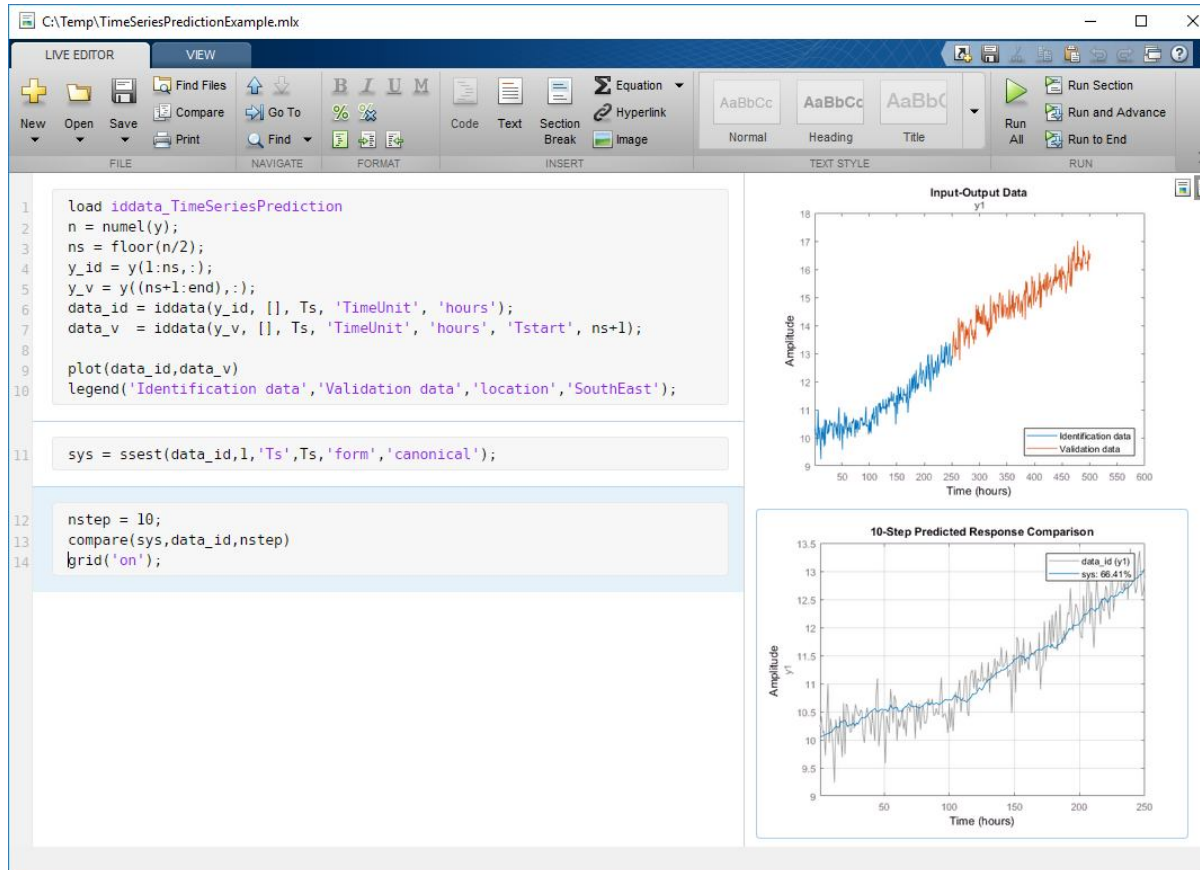
Editing and Running MATLAB Code without the MATLAB Live Editor

- Plain-text editing
- Output goes to Command Window
- Multiple figure windows appear
- Equations, images, and hyperlinks only appear if published



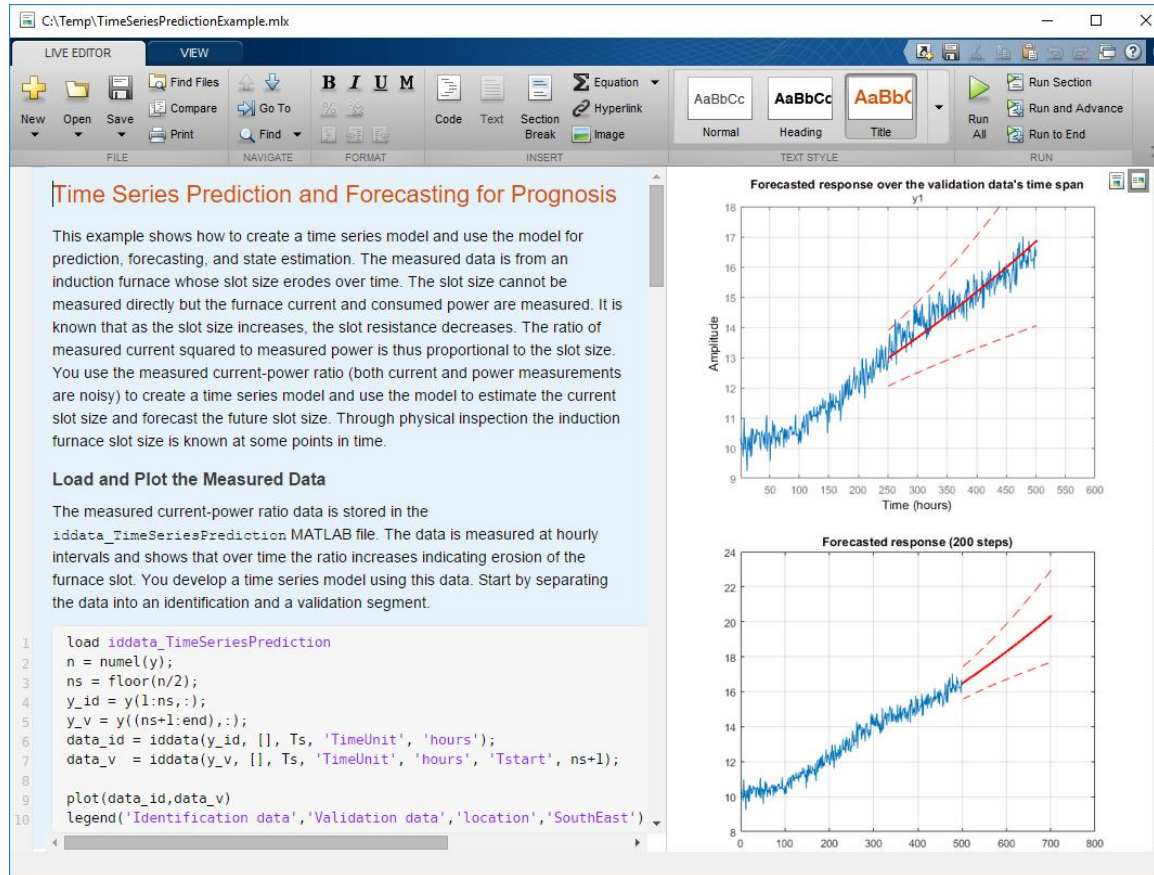
MATLAB Live Editor

The Live Editor provides a new way to create, edit and run MATLAB scripts.



MATLAB Live Editor

Turn script into an Interactive Narrative for Exploratory Learning and for Teaching.



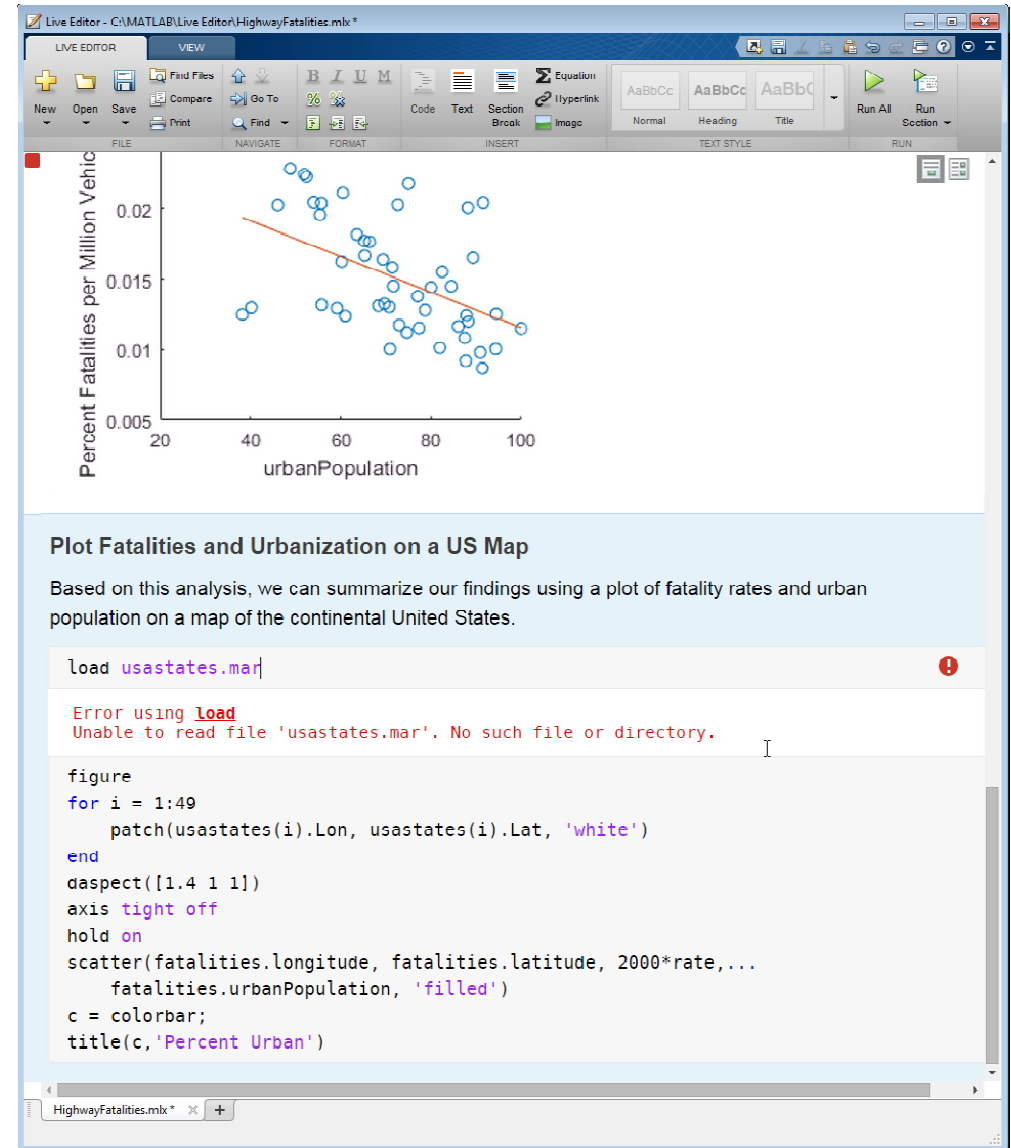
Live Editor – Areas of Application

- Exploratory Programming and Learning
- Create an Interactive Narrative
- Teach with Live Scripts

Live Editor

Exploratory Programming and Learning

- Write, execute, and test code in a single interactive environment
- Generate results and graphics alongside the code that produced them
- Run blocks of code individually or run the whole file
- Find errors at the location in the file where they occur



Live Editor

Create an Interactive Narrative

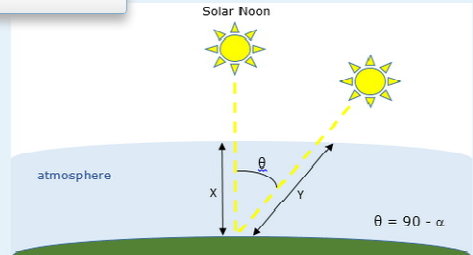
- Add titles, headings, and formatted text
- Include equations
- Add images, and hyperlinks as background material
- Save your narrative with code, results, images, and text in a single file
- Others can use your narrative to validate and extend your results
- Convert interactive documents to HTML or PDF for publication

Live Editor - C:\MATLAB\Live Editor\SolarPower.mlx

Air Mass and Solar Radiation

As light from the sun passes through the earth's atmosphere, some of the solar radiation will be absorbed. The [air mass](https://en.wikipedia.org/wiki/Air_mass) is a function of solar elevation (α). As shown in the diagram below, it is a measure of the length of the path of light through the atmosphere (Y) relative to the shortest possible path (X).

https://en.wikipedia.org/wiki/Air_mass
Ctrl+Click to follow link



The larger the air mass, the less radiation reaches the ground. The air mass can be calculated from the equation

$$AM = \frac{1}{\cos(90 - \alpha) + 0.5057(6.0799 + \alpha)^{-1.6364}}$$

Then the solar radiation (in Kw/m²) reaching the ground can be calculated from the empirical equation

$$sRad = 1.353 * 0.7^{AM^{0.678}}$$

```
AM = 1/(cosd(90-alpha) + 0.50572*(6.07955+alpha)^-1.6354);
sRad = 1.353*0.7^(AM^0.678); % kW/m^2
disp(['Air Mass = ' num2str(AM) ' Solar Radiation = ' num2str(sRad) ' kW/m^2'])
```

Air Mass = 1.0688 Solar Radiation = 0.93164 kW/m²

Solar Radiation on Fixed Panels

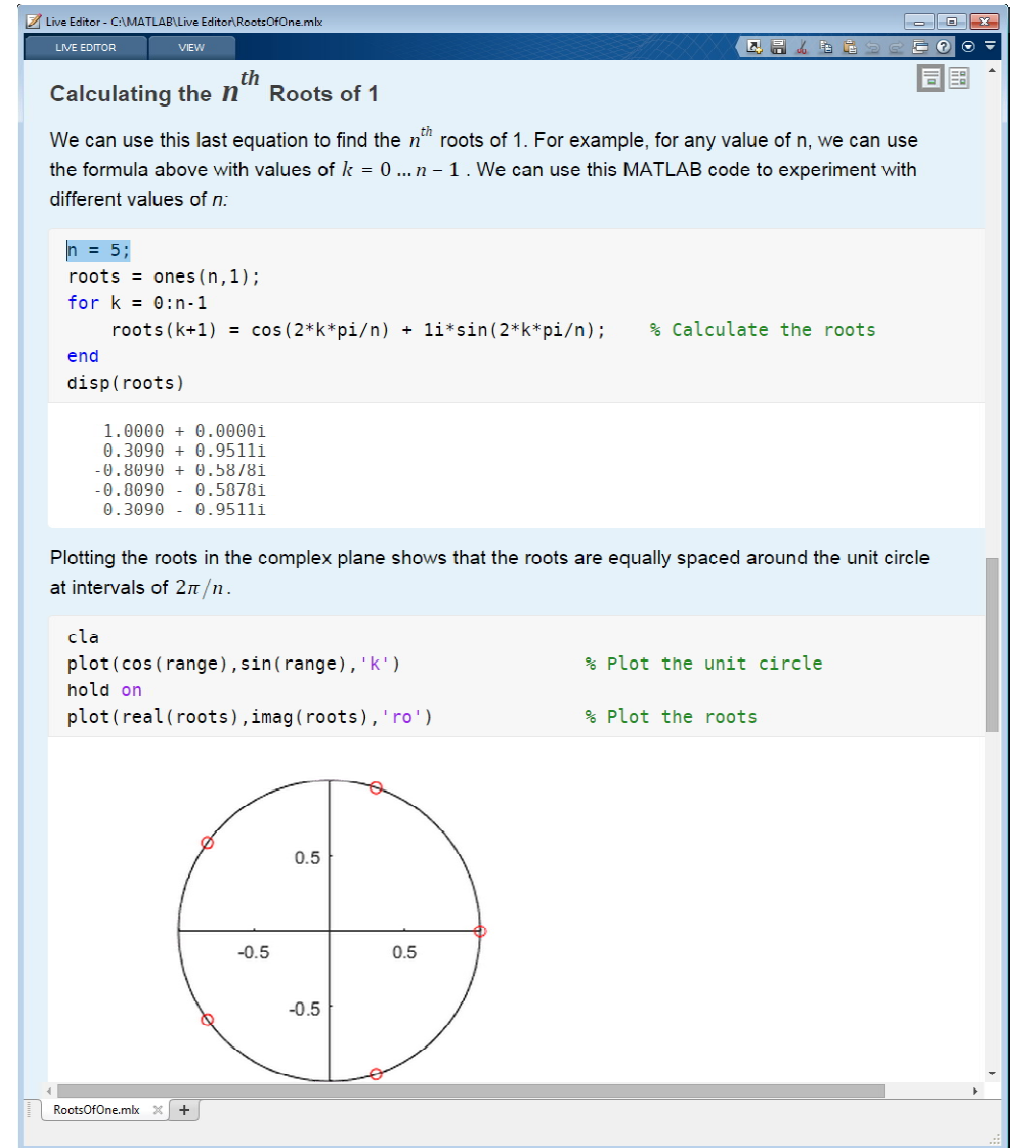
Panels installed with a [solar tracker](#) can move with the sun and receive 100% of the sun's radiation as the sun moves across the sky. However, most [solar cell](#) installations have panels set at a fixed azimuth and tilt. Therefore the actual radiation reaching the panel will also depend on the sun's

SolarPower.mlx

Live Editor

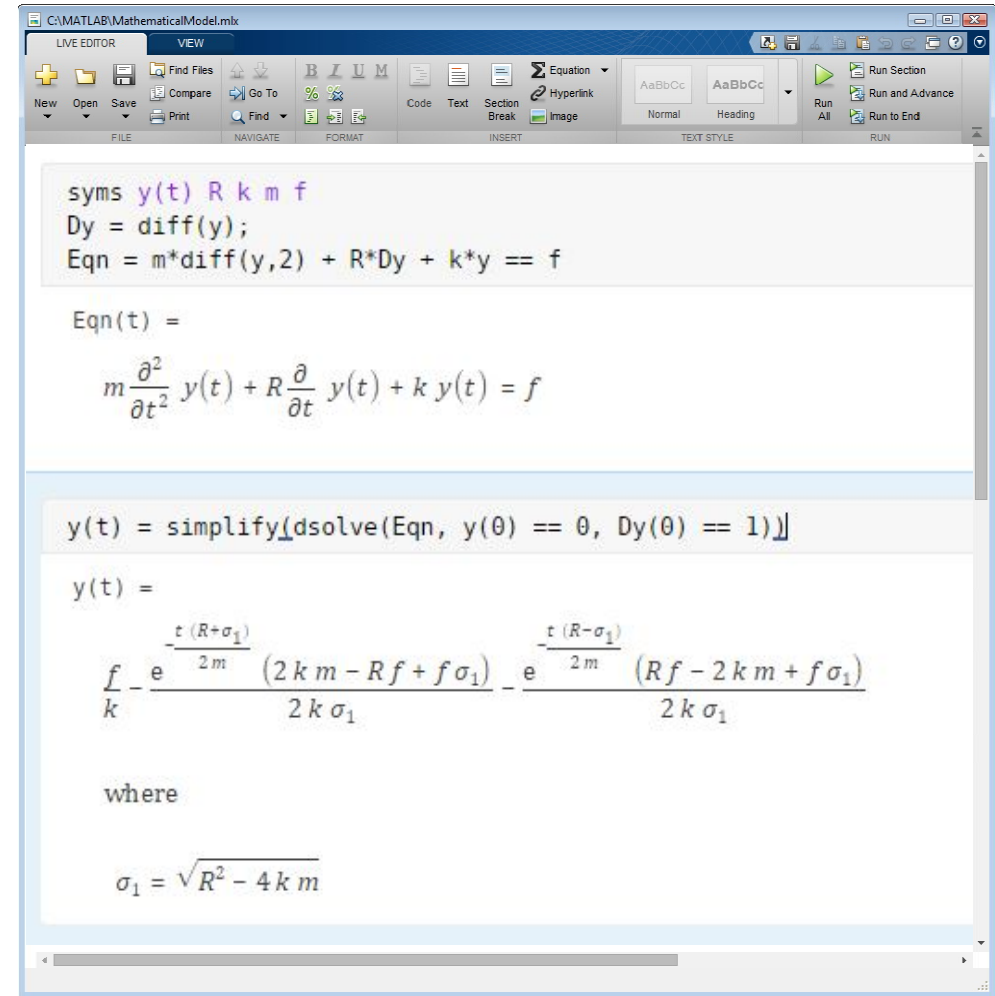
Teach with Live Scripts

- Create training materials that combine code and results with formatted text and mathematical equations
- Include images, and links to supporting materials
- Modify and run code on the fly to answer questions or explore related topics
- Share as interactive documents or in hardcopy format.
- Create partially completed files for individual assignments or team projects



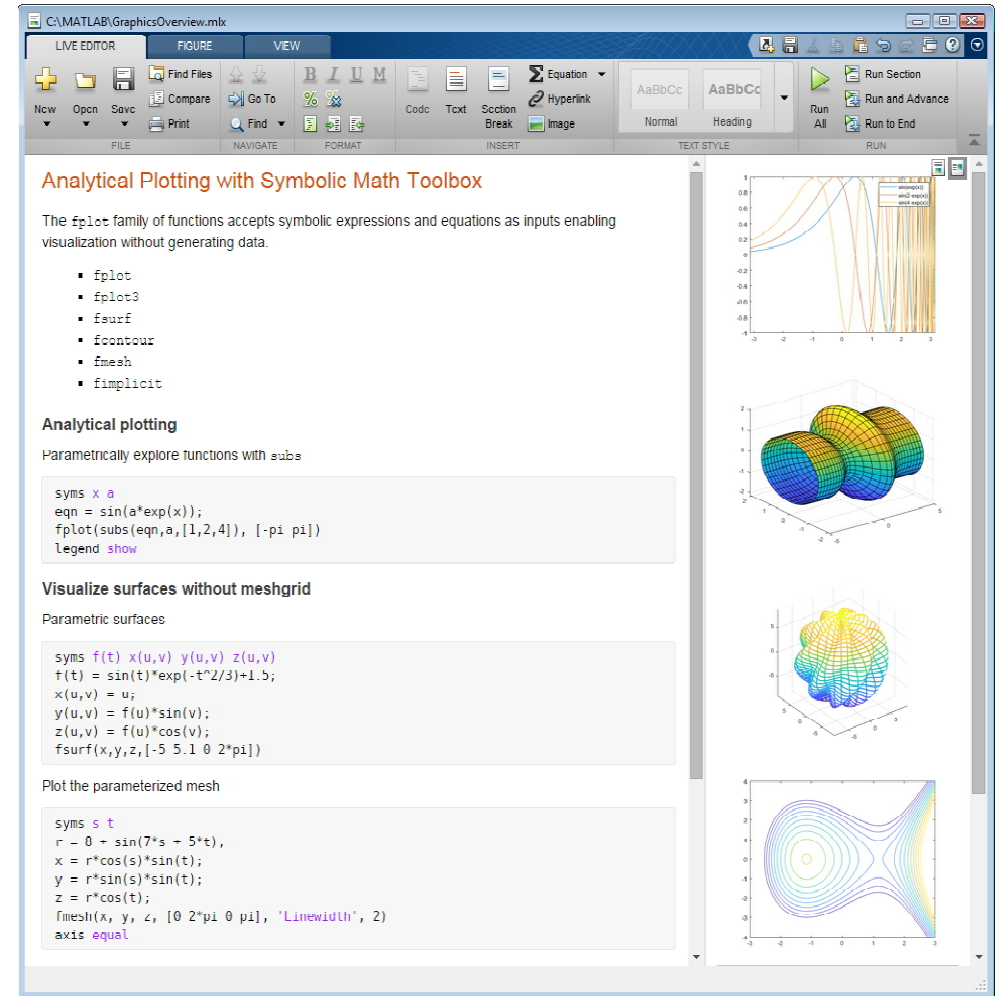
Live Editor – Symbolic Math

- **Math** – Create, manipulate, substitute and solve equations in a familiar mathematical typeset.



Live Editor – Symbolic Math

- **Math** – Create, manipulate, substitute and solve equations in a familiar mathematical typeset.
- **Visualize** – Plot expressions and equations without generating discrete data.



Live Editor – Symbolic Math

- **Math** – Create, manipulate, substitute and solve equations in a familiar mathematical typeset.
- **Visualize** – Plot expressions and equations without generating discrete data.
- **Units** – Work with dimensioned physical quantities.

The screenshot displays the MATLAB Live Editor interface. The main document is titled "Modeling the Velocity of a Paratrooper". It contains an introduction, a diagram of a paratrooper, a governing equation, and two plots showing velocity over time in SI and US units.


Modeling the Velocity of a Paratrooper

Model the deceleration of the velocity of a paratrooper in SI and US units.

Introduction

Imagine that a paratrooper is dropped from an airplane. Assuming the paratrooper falls straight down the forces acting on the paratrooper include the gravitational force and an opposing drag force from the parachute.

The governing equation which describes the balance of forces can be expressed as follows.



mass · acceleration = drag force - gravitational force

$$m \frac{\partial}{\partial t} V(t) = K_1 V(t)^2 - mg$$

where

- m is the paratroopers mass
- g is the acceleration due to gravity
- $V(t)$ is the paratrooper velocity
- K_1 is the drag constant, assumed to be 40

Find the units of the drag constant

The units of Force are Newtons (N) or expressed in SI units are $\left(\frac{\text{kg} \cdot \text{m}}{\text{s}^2}\right)$. Since equivalent they have a unitConversionFactor of 1.

On the right side, the symbolic equations are shown in a typeset format:

```
ans = N
ans = 1
K =
40  $\frac{\text{kg}}{\text{m}}$ 
eq(t) =
 $\left(m \frac{\partial}{\partial t} v(t)\right) \frac{1}{s} + g m = (40 v(t)^2) \frac{\text{kg}}{\text{m}}$ 
velocity =
 $\sqrt{10} \sqrt{g} \sqrt{m} \tanh\left(\frac{2 \sqrt{10} \sqrt{g} t}{\sqrt{m}} \sqrt{\text{kg} \frac{1}{\text{m} \cdot \text{s}}}\right) - 20$ 
vel_SI =
 $\frac{3 \sqrt{763} \tanh\left(\frac{3 \sqrt{763} t}{35}\right)}{70} \frac{\text{m}}{\text{s}}$ 
vel_US(t) =
 $\frac{125 \sqrt{763} \tanh\left(\frac{3 \sqrt{763} t}{35}\right)}{254} \frac{\text{ft}}{\text{s}}$ 
```

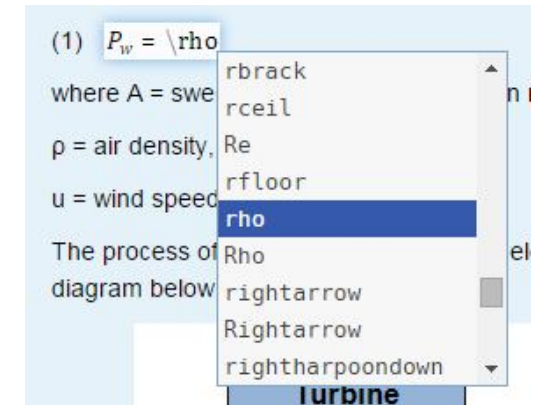
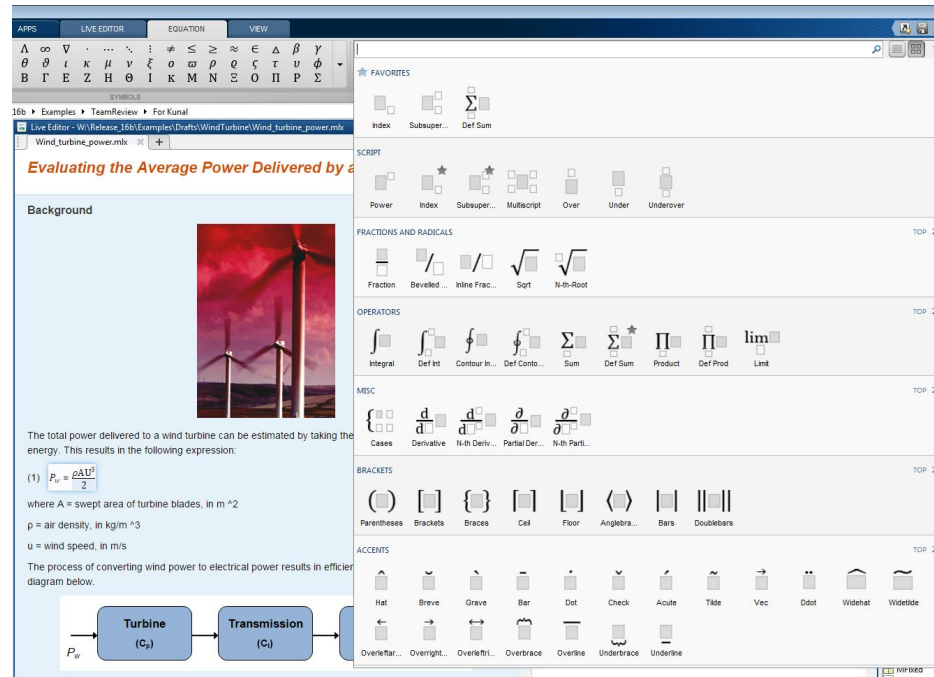
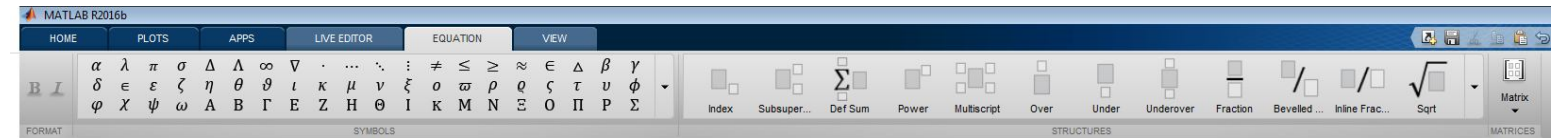
At the bottom right, there are two plots:

- Deceleration in SI Units:** A plot of Velocity in m/s versus Time in s. The velocity starts at 0 and decreases towards -4 m/s.
- Deceleration in US Units:** A plot of Velocity in ft/s versus Time in s. The velocity starts at 0 and decreases towards -10 ft/s.

Live Editor – Equation Editing

Create equations

- Integrated equation editor
- Easy authoring of mathematics.
- Shortkeys
- Copy equation as LaTeX or MathML



Live Editor – Equation Editing

Create equations

- LaTeX input.

Background

The total power delivered to a wind turbine is proportional to the cube of the wind speed. This results in the following expression

$$P_w = \frac{\rho A u^3}{2} \quad (1)$$

- A is the swept area of turbine
- ρ = air density, in kg/m^3
- u = wind speed, in m/s

s kinetic energy.

Enter LaTeX equation code:

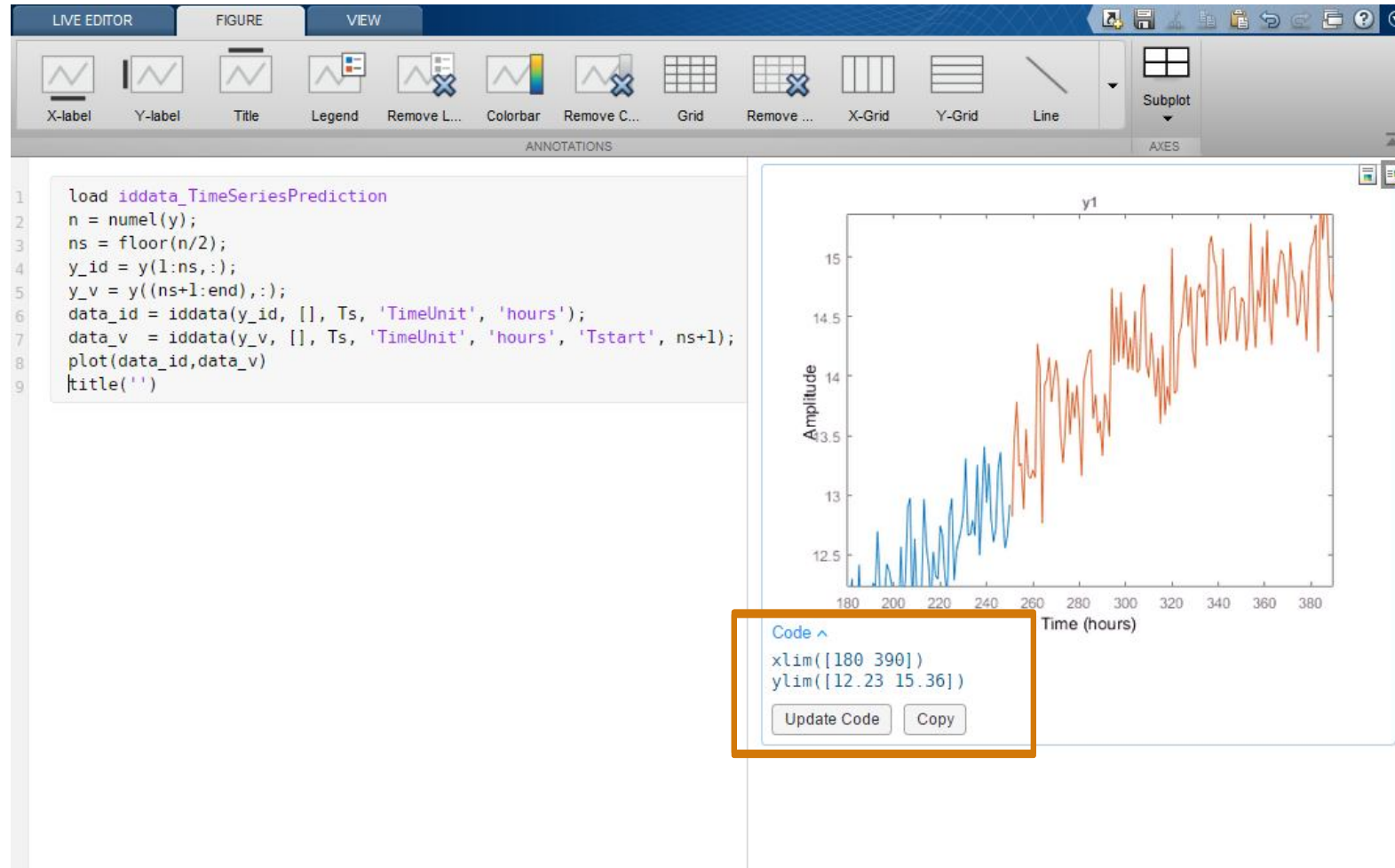
$P_w = \frac{\rho A u^3}{2}$

Preview:

$P_w = \frac{\rho A u^3}{2}$

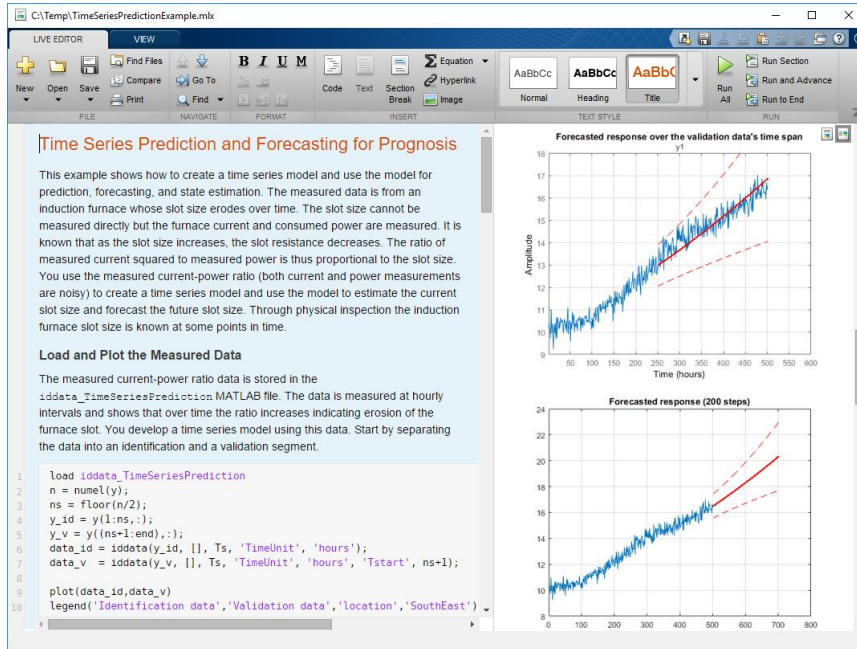
OK Cancel Help

Live Editor – Interactive Figures

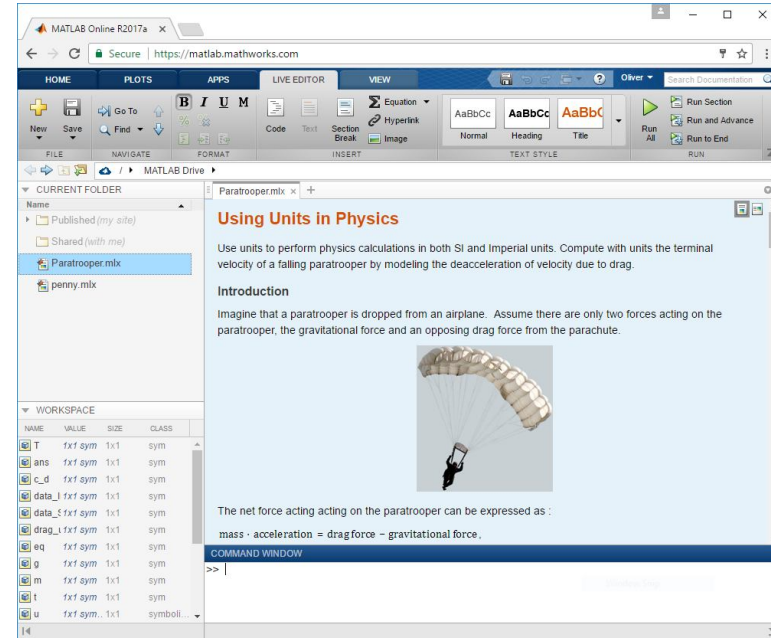


Live Editor – Availability

Desktop MATLAB



MATLAB Online



Live Scripts – Interoperability

Plain Scripts (.m scripts) can be opened as Live Scripts

Live Scripts can be saved as Plain Scripts

```
%% Time Series Prediction and Forecasting for Prognosis
% This example shows how to create a time series model and use the model
% for prediction, forecasting, and state estimation. The measured data is
% from an induction furnace whose slot size erodes over time. The slot size
% cannot be measured directly but the furnace current and consumed power
% are measured. It is known that as the slot size increases, the slot
% resistance decreases. The ratio of measured current squared to measured
% power is thus proportional to the slot size. You use the measured
```

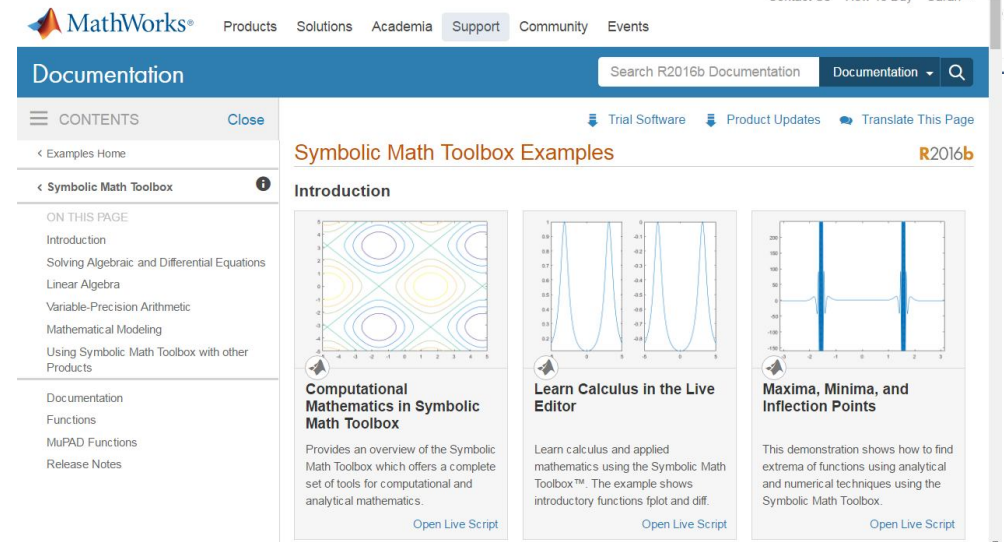
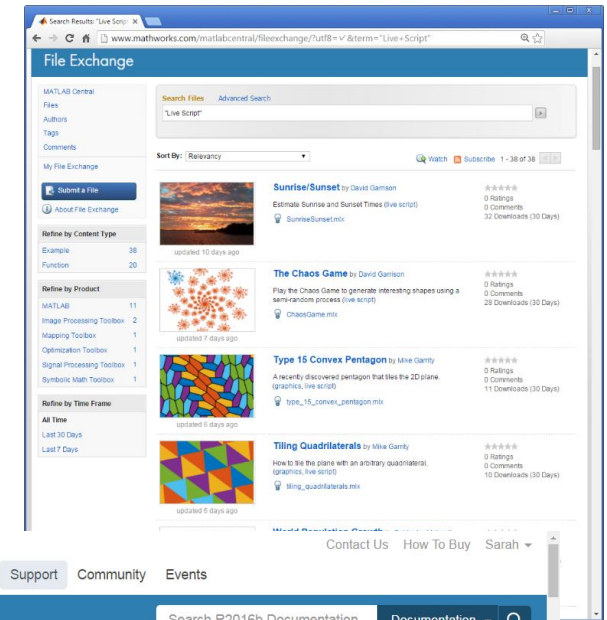


Time Series Prediction and Forecasting for Prognosis

This example shows how to create a time series model and use the model for prediction, forecasting, and state estimation. The measured data is from an induction furnace whose slot size erodes over time. The slot size cannot be measured directly but the furnace current and consumed power are measured. It is known that as the slot size increases, the slot resistance decreases. The ratio of measured current squared to measured power is thus proportional to the slot size. You use the measured current-power ratio (both current and power measurements are noisy) to create a time series model and use the model to estimate the current slot size and forecast the future slot

Learn More

- MATLAB Live Editor website
- Live Editor Webinar
- Documentation Examples
- Live scripts on File Exchange
- Symbolic Math Toolbox website



www.mathworks.com/products/matlab/live-editor

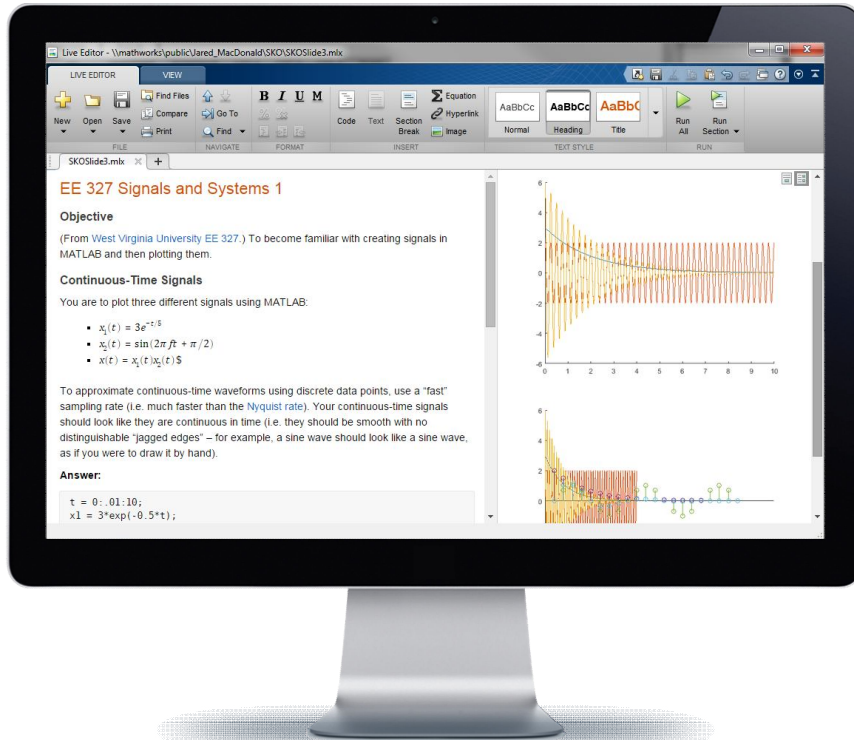
www.mathworks.com/products/symbolic/

Live Editor – Additional Information

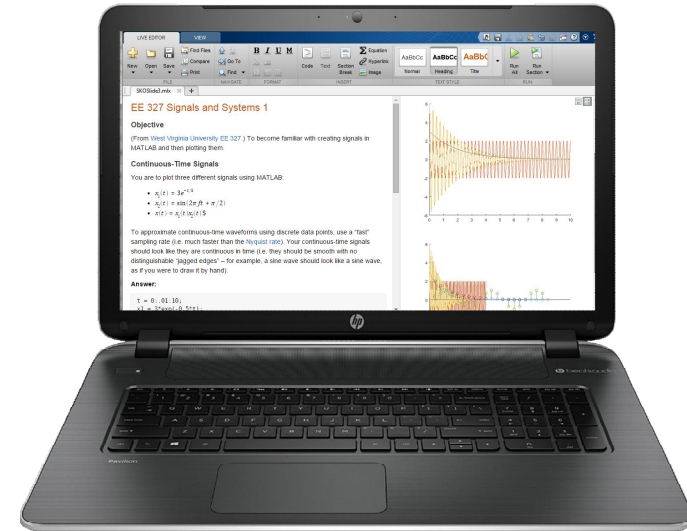
On the following slides additional information can be found:

- Sharing Live Scripts
- Cross-Locale Sharing
- Functions in Scripts

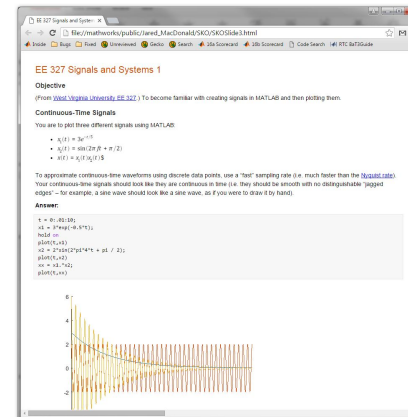
Live Editor – Sharing



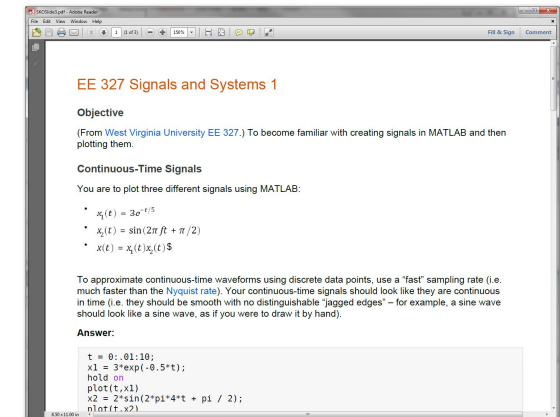
MATLAB EXPO 2017



Colleague with MATLAB



HTML

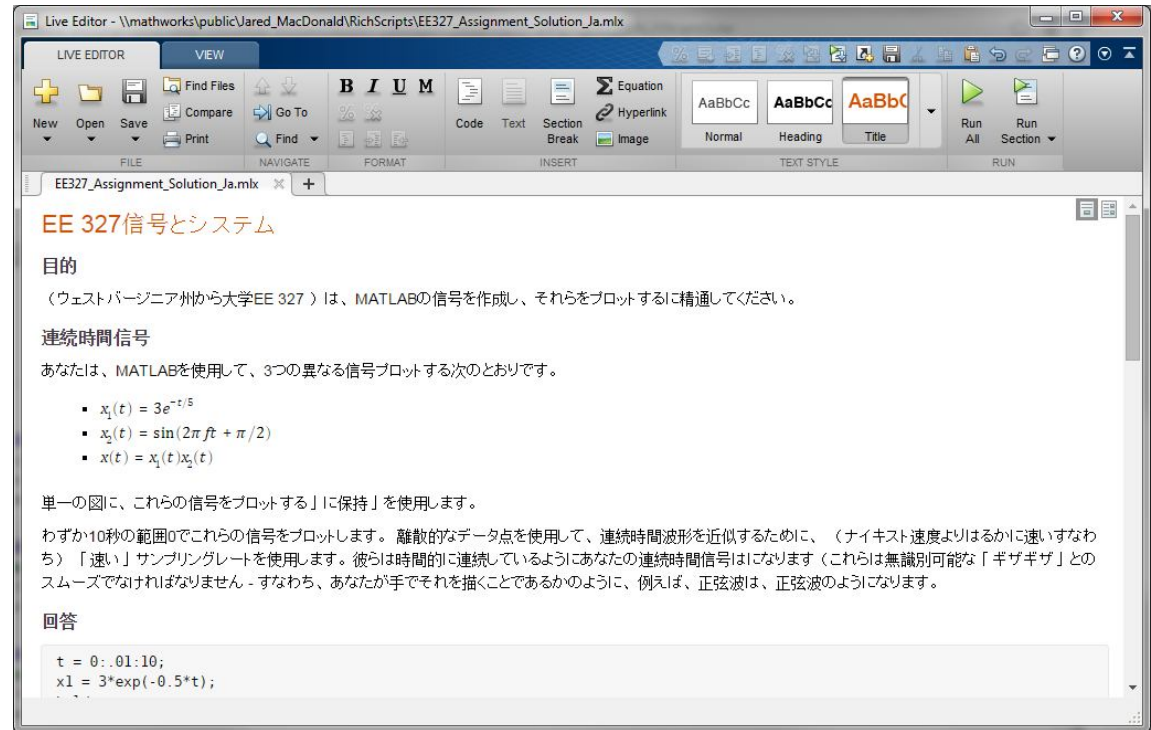


PDF

Live Editor – Cross-Locale Sharing

Characters are correctly preserved across platforms and locales

- Share without loss of data with colleagues around the world
- Include symbols and special characters in your comments



Live Editor – Functions in Scripts

Define and use functions from within a script, without needing to create a separate file

