

MathWorks
FINANCE
CONFERENCE 2024

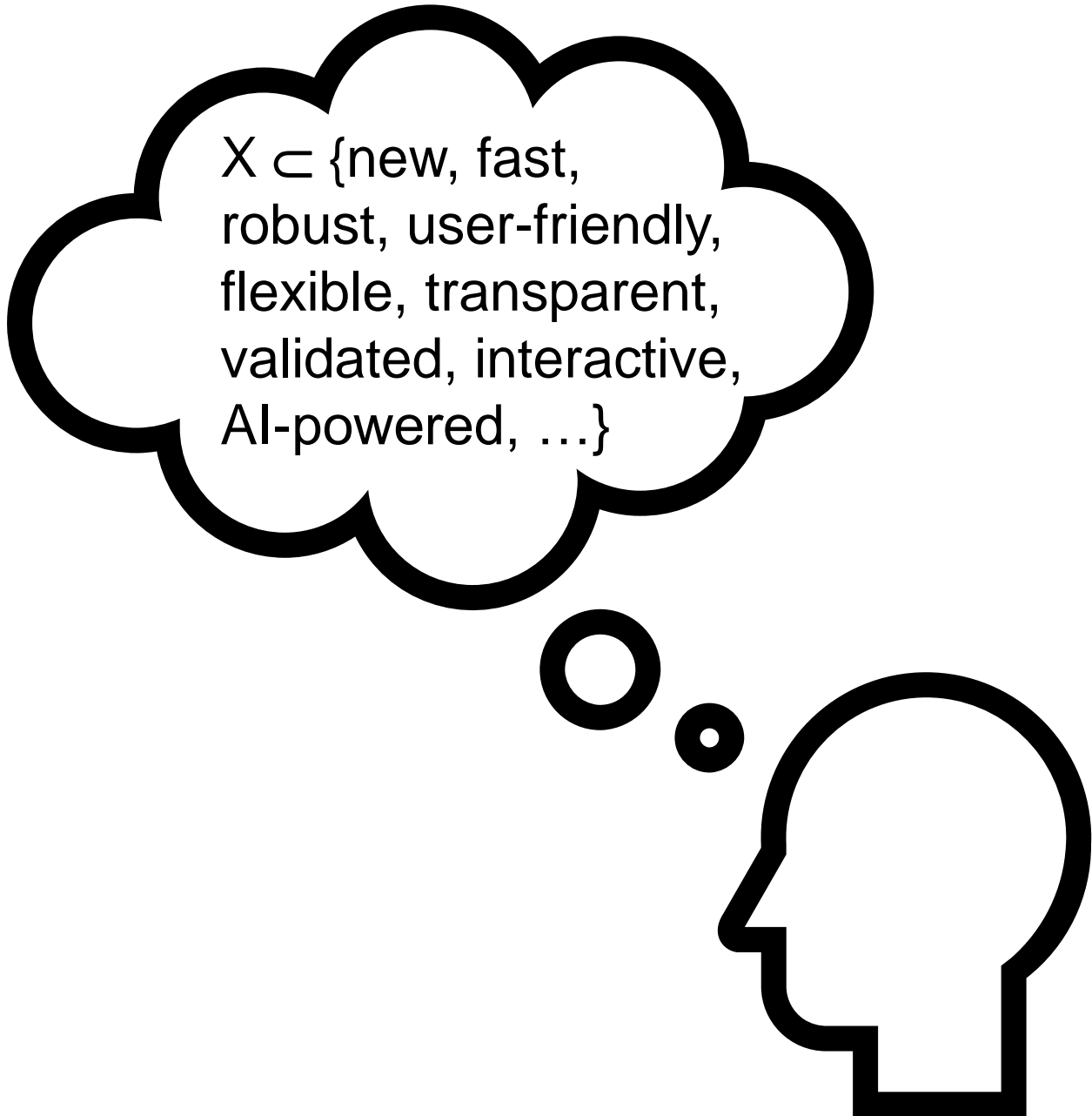
Harnessing Advanced Financial Modeling Technologies with **MATLAB**

Alexander Diethert, MathWorks





```
>> edit my_X_application
```



$X \subset \{\text{new, fast, robust, user-friendly, flexible, transparent, validated, interactive, AI-powered, ...}\}$

The Environmental Multi-Sector DSGE model EMuSe: A technical documentation

Natascha Hinterlang, Anika Martin, Oke Röhe, Nikolai Stähler, Johannes Strobel



The official site for the SDMX community A global initiative to improve Statistical Data and Metadata eXchange



Macroeconomic modeling for all



X-13 Toolbox for Seasonal Filtering

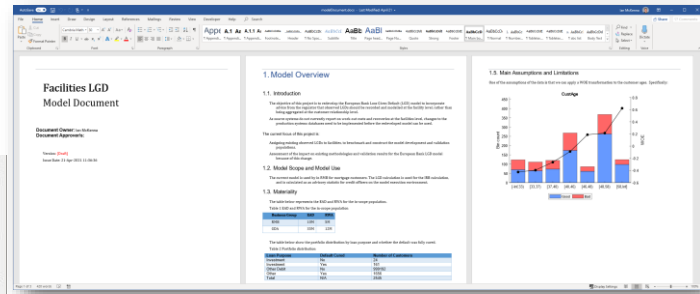
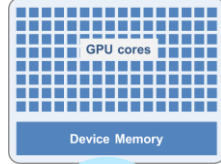
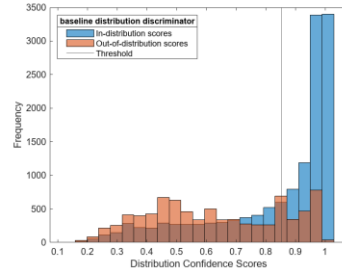
version 1.51.1 (2.22 MB) by Yvan Lengwiler

Matlab toolbox providing access to X-13 seasonal adjustment programs of the US Census Bureau.

Rationality In Switching Environments (RISE) Toolbox

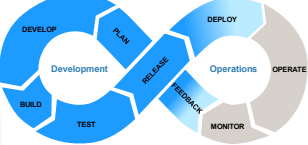
Welcome to RISE!! For any issue, suggestion or bug report, please send an email to junior.math AT gmail.com

RISE is an object-oriented Matlab toolbox for solving and estimating nonlinear Regime-Switching Dynamic Stochastic General Equilibrium (RS-DSGE) models.



MATLAB® Test Report

Timestamp: 08-Oct-2022 22:10:35
Host: ius-adelphi
Platform: win64
MATLAB Version: 9.13.0.2049777 (R2022b)
Number of Tests: 27
Testing Time: 4.1594 seconds
Overall Result: FAILED



Azure Pipelines

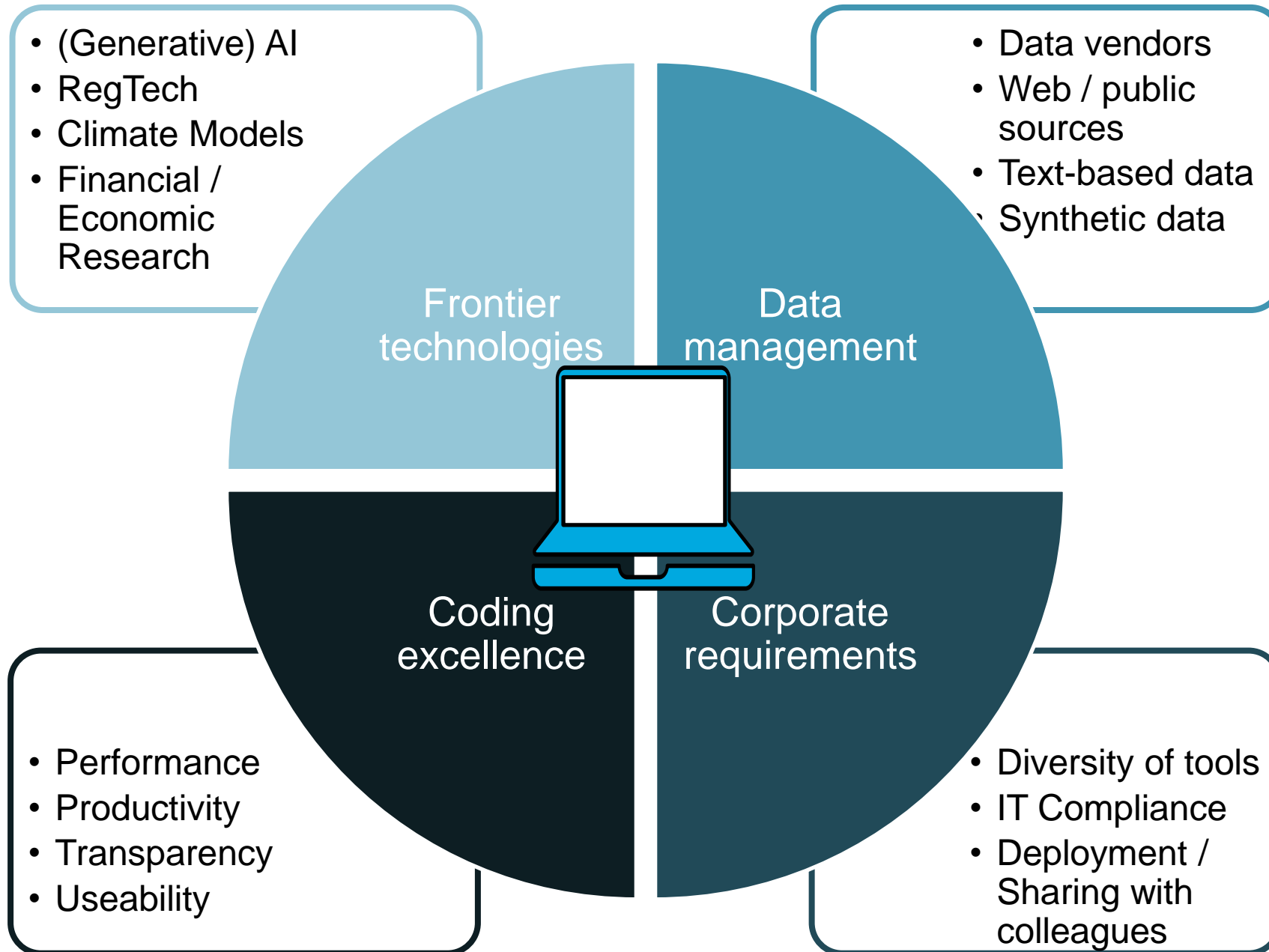


Table with columns: Index, ID, Summary, Instrumental, Verified. It lists model requirements for credit data, support for live data, and various machine learning models.

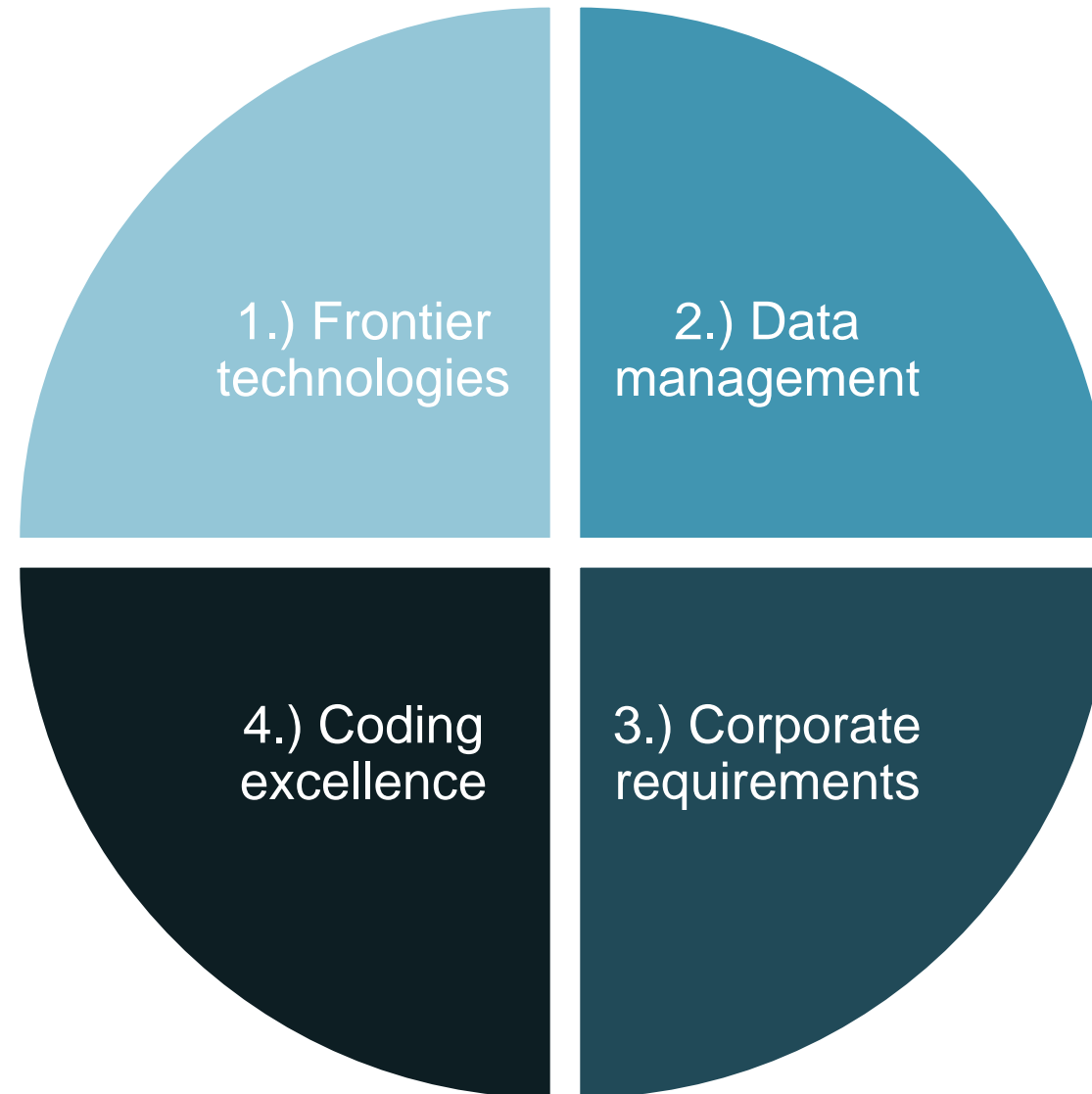
Data Analytics - Load Forecasting Case Study. Includes sections for 'Load messy data', 'Missing data', and 'Clean Missing Data' with various options and visualizations.

Git commit history and file explorer view showing repository structure and commit messages.





Agenda





Frontier technologies

- (Generative) AI
- RegTech
- Climate Models
- Financial / Economic Research

Frontier technologies

- (Generative) AI
- RegTech
- Climate Models
- **Financial / Economic Research**

October 16 October 17

2:30 PM CEST	Welcome
2:35 PM CEST	Keynote: Sustainable Finance with MATLAB Thierry Roncalli, <i>Amundi</i>
3:00 PM CEST	Innovations in the Delivery of AI-Powered Financial Services Paul Peeling, <i>MathWorks</i>
3:30 PM CEST	Break
3:45 PM CEST	Navigating Climate Finance: Software Solutions for Climate Risk Management Elre Oldewage, <i>MathWorks</i>
4:15 PM CEST	Counterparty Risk Assessment with Two Steps: Monte Carlo and Parallel Computing Pablo García Estébanez, <i>Banco Sabadell</i>

Examples of shared MATLAB based tools (today)

2024

2023



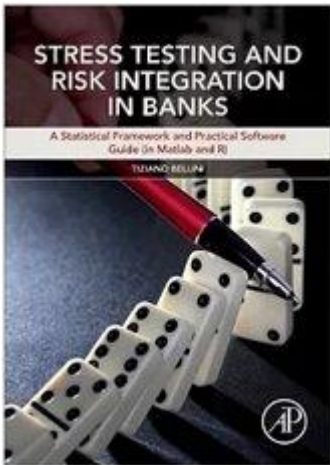
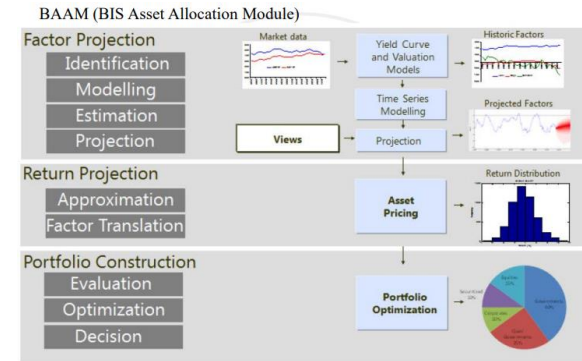
Parallel sequential Monte Carlo for efficient density combination: The DeCo MATLAB toolbox

X-13 Toolbox for Seasonal Filtering

version 1.51.1 (2.22 MB) by Yvan Lengwiler
 Matlab toolbox providing access to X-13 seasonal adjustment programs of the US Census Bureau.

Rationality In Switching Environments (RISE) Toolbox

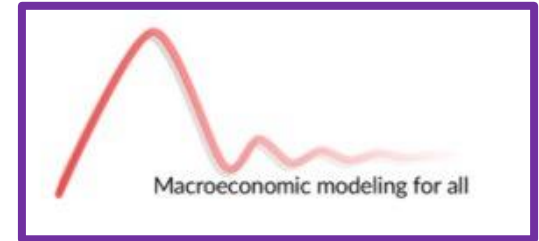
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ARNIE in Action: The 2013 FSAP Stress Tests for the Austrian Banking System



The official site for the SDMX community
 A global initiative to improve Statistical Data and Metadata eXchange



Systemic Risk

version 3.5.0 (8.99 MB) by Tommaso Belluzzo
 A framework for systemic risk valuation and analysis.
<https://github.com/TommasoBelluzzo/SystemicRisk>



YADA

YADA is program for conducting Bayesian estimation and evaluation of Dynamic Stochastic General Equilibrium (DSGE) and Vector AutoRegressive (VAR) models. It is developed by the New Area-Wide Model (NAWM) team at the Forecasting and Policy Modelling Division (formerly at the Monetary Policy Research Division and before that at the Econometric Modelling Division within the Directorate General Research) of the European Central Bank (ECB). Unlike other DSGE estimation applications, such as Dynare, YADA is a GUI-based program.



Board of Governors of the Federal Reserve System

The Federal Reserve, the central bank of the United States, provides the nation with a safe, flexible, and stable monetary and financial system.
 Home > Economic Research
 Estimated Dynamic Optimization (EDO) Model

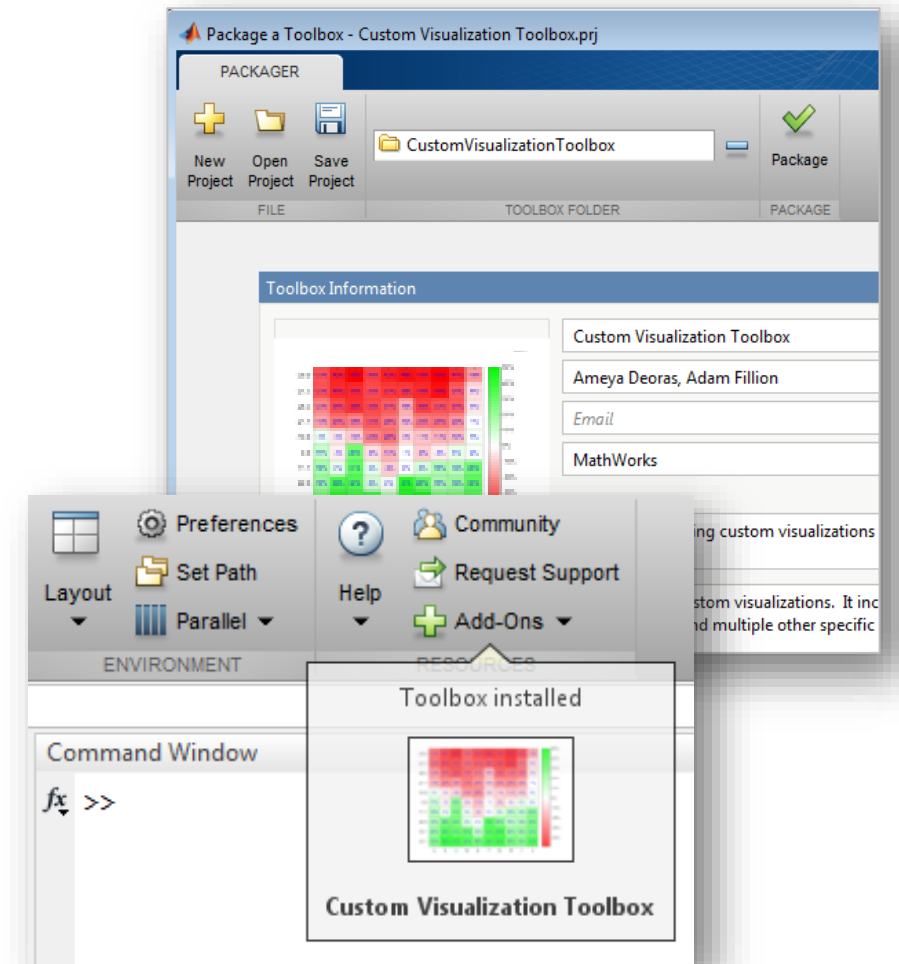


The Environmental Multi-Sector DSGE model EMuSe: A technical documentation

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Custom Toolbox Packaging for Easy Sharing

- Package your toolbox as a single installer file
 - Contains all of the code, data, apps, documentation, and examples
 - Checks for dependent files and automatically includes them
 - Documents required products
- Included folders and files automatically appear on path when installed
- View details and uninstall toolboxes with Manage Custom Toolboxes dialog box



Example: BEAR Toolbox on File Exchange / GitHub

MathWorks®

MATLAB Answers File Exchange Cody AI Chat Playground Discussions Contests Blogs More

Files Authors My File Exchange Publish About

BEAR ★★★★★ (1)

Version 5.2.1 (14.3 MB) by Alistair Dieppe 1.7K Downloads Updated 14 May 2024

The Bayesian Estimation, Analysis and Regression toolbox (BEAR) View License on GitHub

<https://github.com/european-central-bank/BEAR-toolbox>

Follow

Share Open in MATLAB Online Download

Overview Functions Examples Version History Reviews (1) Discussions (3)

Sign in

Notifications Fork 37 Star 96

Public

Code Issues 41 Pull requests 1 Actions Projects Security

master Go to file Code About

ebenetice fixed bear app icon 5a0c54 · 5 months ago

- .github/workflows README changes an... 3 years ago
- images Added png files to p... 3 years ago
- release Fixed app issue with ... 3 years ago
- resources/project Contents.m + impro... 10 months ago
- tbx fixed bear app icon 5 months ago

The Bayesian Estimation, Analysis and Regression toolbox (BEAR) is a comprehensive (Bayesian Panel) VAR toolbox for forecasting and policy analysis.

Readme Activity Custom properties 96 stars

! We just added some major changes into the main functionality of BEAR to improve its usability. To access the previous version of the code use the legacyCode branch

View BEAR 5.2 on File Exchange

GitHub® Actions

MATLAB passing

The BEAR toolbox

Table of Contents

- Introduction
- Installation of the toolbox

MATLAB Actions

Automatically build, test, package, and deploy MATLAB code and Simulink models

Verified

112 followers <https://www.mathworks.com/solution...> @matlab continuous-integration@mathworks.c...

Overview Repositories 6 Projects Packages People 3

README.md

Use MATLAB with GitHub Actions

With GitHub® Actions, you can build and test your MATLAB® project as part of your workflow. For example, you can automatically identify any code issues in your project, run tests and generate test and coverage artifacts, and package your files into a toolbox. The GitHub actions for MATLAB let you run MATLAB code and Simulink® models on self-hosted or GitHub-hosted runners:

- To use a self-hosted runner, you must set up a computer with MATLAB as your self-hosted runner and register the runner with GitHub Actions. The runner uses the topmost MATLAB release on the system path to execute your workflow.
- To use a GitHub-hosted runner, you must include the Setup MATLAB action in your workflow to set up your preferred MATLAB

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

Design App Get More Apps Install App System Identification Signal Analyzer PID Tuner Curve Fitter Optimization Wireless Waveform... BEARApp

Files GettingStarted.mlx

Getting Started with the BEAR toolbox

The Bayesian Estimation, Analysis and Regression toolbox (BEAR) is a comprehensive (Bayesian Panel) VAR toolbox for forecasting and policy analysis. Use of BEAR implies acceptance of the End User Licence Agreement (EULA) for the BEAR toolbox.

BEAR Interface

SPECIFICATION APPLICATIONS SELECT VAR TYPE

Bayesian OLS Panel Stochastic Volatility Time Varying

Bayesian VARs Priors FAVAR Options

Autoregressive coefficient (ar) FAVAR Options

Overall tightness (k1) FAVAR Options

Cross-variable weighting (k2) FAVAR Options

Lag decay (k3) FAVAR Options

Exogenous variable tightness (k4) FAVAR Options

Exogenous variables tightness (k5) FAVAR Options

Block exogeneity shrinkage (k6) FAVAR Options

Sum of coefficient tightness (k7) FAVAR Options

Dummy initial observation tightness (k8) FAVAR Options

Long-run prior tightness (k9) FAVAR Options

Iterations

Total number of iterations: Iterations

Number of burn-in iterations: Iterations

Options

Grid search (on excel) Grid search (on excel)

Block exogeneity (on excel) Block exogeneity (on excel)

Dummy observation extension... Dummy observation extension...

Sum of coefficients Sum of coefficients

Dummy initial observations Dummy initial observations

Long-run priors Long-run priors

Data Frequency: quarterly

Estimation Start Date: 1974q1 Estimation End Date: 2014q4

Enter the list of endogenous variables: YER HICSA STN

Enter the list of exogenous variables:

Lags: 4 Include constant: Off

Output in: Produce: Save Workspaces: [checked]

Select Excel file with: /MATLAB Add-Ons/Toolboxes/BEAR tool

Results file name: results Change

Quick Export to Workspace: Quick Export to Workspace

RUN



Data Management

- Data vendors
- Web / public sources
- Text-based data
- Synthetic data

Connectors to MATLAB available out of the box

As part of Datafeed Toolbox

Examples from the Community

Ice for MATLAB

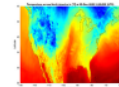
Develop powerful, distributed MATLAB applications using the Ice Framework



SDMX

Version 3.4.0 (263 KB) by Attilio Mattiocco

Provides functions to retrieve data and metadata from providers that disseminate data by means of SDMX web services.
<https://github.com/amattioc/SDMX>



Meteomatics Weather API Connector

Version 4.0.0.1 (3.63 MB) by Martin Fengler

This package contains routines to query meteorological and maritime data from the Meteomatics Weather API.
<https://www.meteomatics.com/en/api/getting-started/>

Climate IAM Explorer

Version 1.3.4 (297 KB) by Edu Benet Cerda **STAFF**

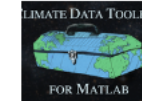
App to explore Integrated Assessment Model results
<https://github.com/mathworks/Climate-IAM-Explorer>



Climate Data Store Toolbox for MATLAB

Version 2.2.6.0 (1.08 MB) by Rob Purser **STAFF**

MATLAB(R) Tools to access the Climate Data Store
[\(https://cds.climate.copernicus.eu/\)](https://cds.climate.copernicus.eu/)
<https://github.com/mathworks/climatedatastore>



Climate Data Toolbox for MATLAB

Version 1.01 (109 MB) by Chad Greene

A set of low-level functions and tutorials for analyzing and displaying Earth science data.
http://www.chadagreene.com/CDT/CDT_Contents.html

Use MATLAB APIs

Command Window

```
>> url =
"https://www.mathworks.com/company/events/conferences/
mathworks-finance-conference/2024.html";
>> text = webread(url);
>> text = extractHTMLText(text);
>> extractBefore(text, "Register")
```

ans =

'October 16-17 | Online

MathWorks
FINANCE CONFERENCE 2024
 October 16-17 | Online
 Register

Data Service Provider	Market Data Type				
	Real Time	Current Market	Intraday Tick / Time Series	Historical / End-of-Day	News / Times Series
Bloomberg Desktop	✓	✓	✓	✓	
Bloomberg Server	✓	✓	✓	✓	
Bloomberg B-PIPE	✓	✓	✓	✓	
Datastream Web Services				✓	
FactSet Data Server	✓	✓			
Federal Reserve Economic Data (FRED)				✓	
Haver Analytics				✓	
IHS Markit		✓		✓	
Money.Net	✓	✓	✓	✓	
Quandl				✓	
Refinitiv Machine Readable News					✓
Refinitiv Tick History			✓	✓	
SIX Financial Information		✓	✓	✓	
Twitter					✓

Example projects using text data

Webscrapping of news and financial sentiment analysis

Presented by Deutsche Bundesbank

Source: https://www.bis.org/ifc/publ/ifcb59_22.pdf

MathWorks PoC: generating identifiers for data accessible through [SDMX](#) using textual queries and a large language model

```
{
  "FREQ": "D",
  "REF_AREA": "L0+L4+L3+L6+L2+L1+L5+L8+L7+H0+U3+U0+K4+K3+K6",
  "ADJUSTMENT": "NA",
  "ICP_ITEM": "NA",
  "STS_INSTITUTION": "NA",
  "ICP_SUFFIX": "NA"
}
```

D.L0+L4+L3+L6+L2+L1+L5+L8+L7+H0+U3+U0+K4+K3+K6...

Creating synthetic data: *synthesizeTabularData*

synthesizeTabularData

Synthesize tabular data
Since R2024b

R2024b

[collapse all in page](#)

Syntax

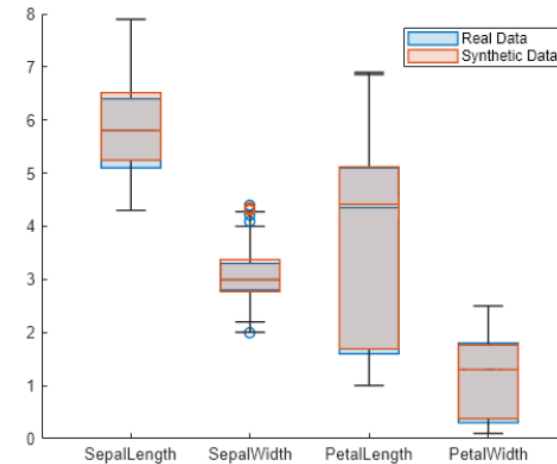
```
syntheticX = synthesizeTabularData(X,n)
syntheticX = synthesizeTabularData(X,n,Name=Value)
```

Description

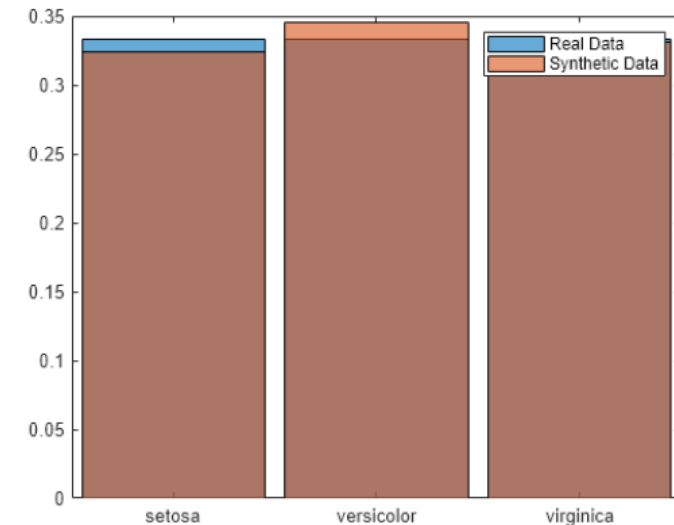
`syntheticX = synthesizeTabularData(X,n)` generates `n` observations of synthetic data using the existing data `X`. The function returns the synthetic data `syntheticX`. example

`syntheticX = synthesizeTabularData(X,n,Name=Value)` example
specifies additional options using one or more name-value arguments. For example, you can specify the bin method, the variables to use, and the options for computing in parallel.

Works with numeric data...



... and with categorical data

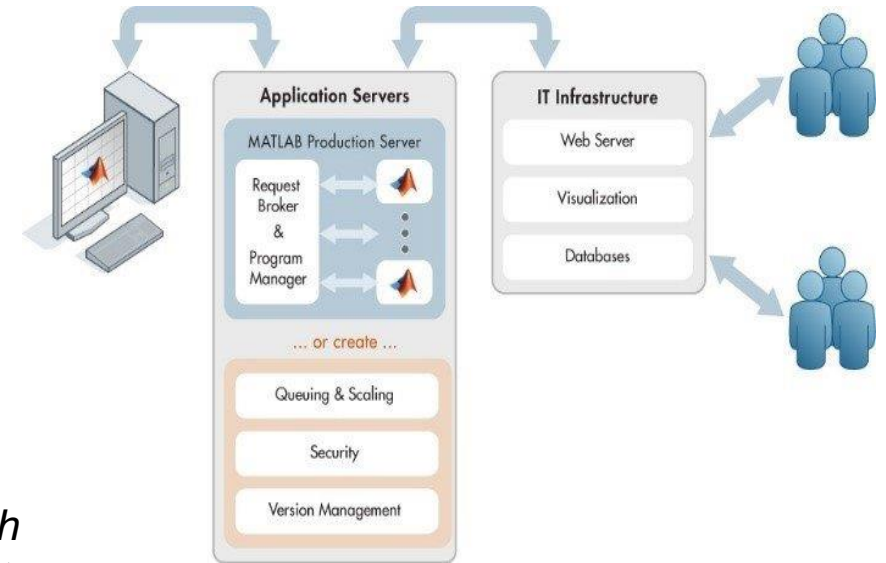




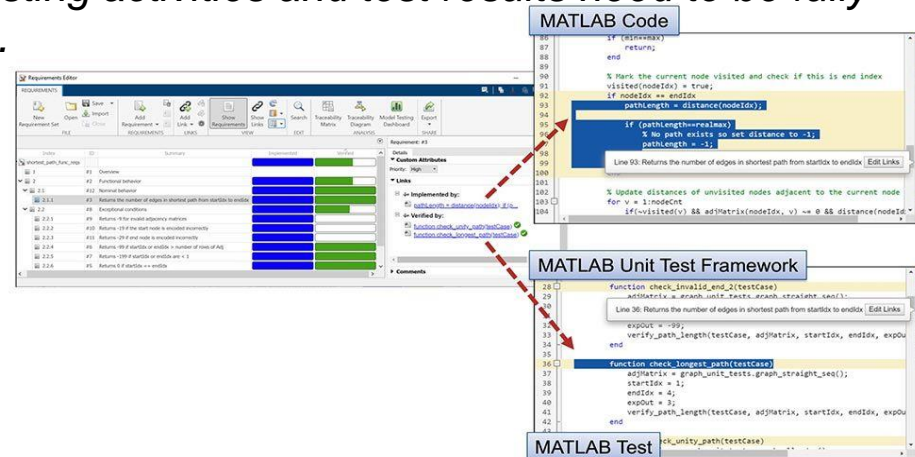
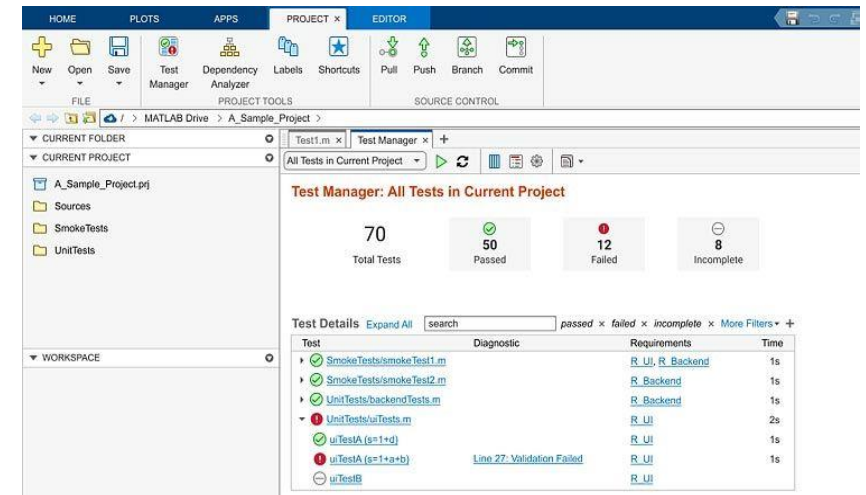
Corporate Requirements

- Diversity of tools
- IT Compliance
- Deployment / Sharing with colleagues

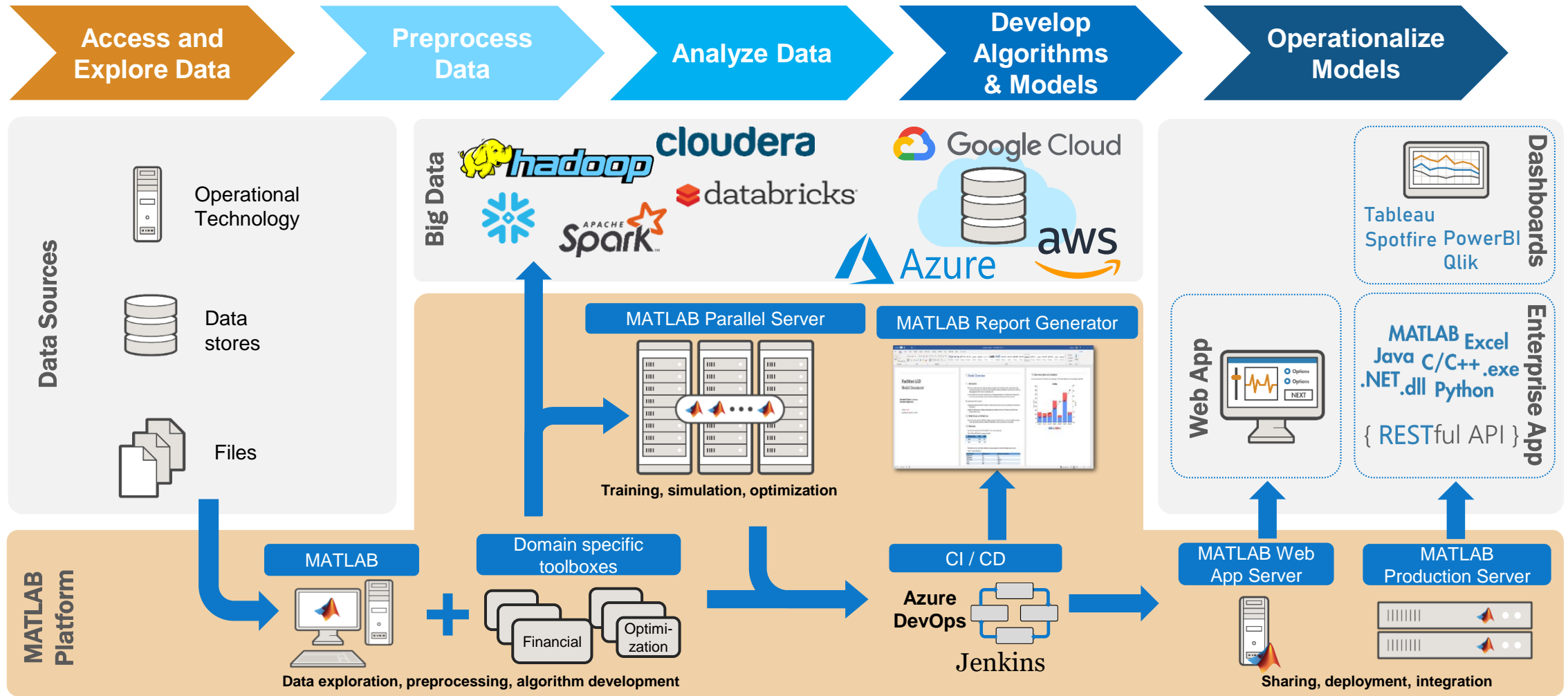
Important aspects of IT Governance



- Environment Segregation:** A strict separation between development, testing and production environment must be ensured.
- Application Encryption and Security:** The programs deployed into production shall be encrypted and not subject to modifications outside the defined IT process.
- User Access Control:** User access rights shall be granted consistently with established roles and policies to enable function separation to avoid conflict of interests.
- Testing:** IT Systems must be fully tested before their deployment into production systems.
- Tests Documentation:** All testing activities and test results need to be fully documented and reported on.



Integration in complex IT environments



Sharing Applications through Apps – Real World Examples

The screenshot displays the Amundi Asset Management software interface. On the left, there is a sidebar with the Amundi logo and an 'Import dataset' section. Below this is a table with columns for ID, Category, Label, and Y/N, listing various solutions and overlays. At the bottom of the sidebar are 'Strategy selections' with 'Clear all' and 'Select all' buttons, and 'Solutions' and 'Overlays' buttons.

The main area is divided into several sections:

- Cumulative Price Index (base = 100) - day:** A line chart showing performance from 2006 to 2022. The legend includes Benchmark, SXST Index + P10D1YREM, SXST Index + P20D1YREM, SXST Index + P10D1YREM, and SXST Index + P55D20D1YREM.
- Drawdown reduction:** Two bar charts showing reduction in bp for different periods. The legend includes SXST Index + P30D1YREM, SXST Index + P20D1YREM, SXST Index + P10D1YREM, and SXST Index + P55D20D1YREM.
- TSO Coverage:** A bar chart showing the number of pricing data points for different periods (27.09.2023, 26.09.2023, 25.09.2023) across various categories.
- RKZ Coverage:** A bar chart showing the number of pricing data points for different periods across 'Data RKZ Lieferantenstufe' categories (N.A., 450, 550, 600, 650, 700, 800, 1000, 1100, 1200, 2000).
- Log Window:** A table showing system logs with columns for STEP_DT, PROCESS_NAME, MSG_TYPE, MSG_TEXT, STEP_LINE, POSITION, LOG_ID, and AUFTRAG_ID.

At the bottom of the interface, there are status indicators for 'State loading' (green dot), 'Bloomberg Connection' (red dot), and 'Selection List' (Show/Hide toggle). A 'Report a bug' button and the 'Helaba Invest' logo are also visible.

STEP_DT	PROCESS_NAME	MSG_TYPE	MSG_TEXT	STEP_LINE	POSITION	LOG_ID	AUFTRAG_ID
2023-09-28 11:42:41.960161	mps_load_overlay_fonds#202309281130007...	Close	connection	234	ProcessLibraries.closeDB	827912	MSA-MPS&P-SRV-MATLAB01#28-Sep-2023 11:30...
2023-09-28 11:42:07.260938	mps_load_overlay_fonds#202309281130007...	mps_LOF	Starte virtuelle Fonds	114	mps_load_overlay_fonds	827911	MSA-MPS&P-SRV-MATLAB01#28-Sep-2023 11:30...
2023-09-28 11:35:40.697007	mps_load_overlay_fonds#202309281130007...	mps_LOF	Starte Fonds mit Durchschau	95	mps_load_overlay_fonds	827910	MSA-MPS&P-SRV-MATLAB01#28-Sep-2023 11:30...
2023-09-28 11:35:40.586882	mps_load_overlay_fonds#202309281130007...	mps_LOF	Starte Fonds ohne Durchschau	80	mps_load_overlay_fonds	827909	MSA-MPS&P-SRV-MATLAB01#28-Sep-2023 11:30...
2023-09-28 11:35:40.475645	mps_load_overlay_fonds#202309281130007...	mps_LOF	Starte mfm_lib.felch	72	mps_load_overlay_fonds	827908	MSA-MPS&P-SRV-MATLAB01#28-Sep-2023 11:30...
2023-09-28 11:35:40.369728	mps_load_overlay_fonds#202309281130007...	mps_LOF	Starte Build Meta	61	mps_load_overlay_fonds	827907	MSA-MPS&P-SRV-MATLAB01#28-Sep-2023 11:30...

Both examples are taken from presentations at the MathWorks Finance Conference 2023.



Corporate Requirements

- Performance
- Productivity
- Transparency
- Useability

Native support for Apple Silicon

- Run MATLAB natively on M series chips
 - Faster startup time
 - Faster linear algebra
 - Reduced battery usage
 - Reduced memory usage

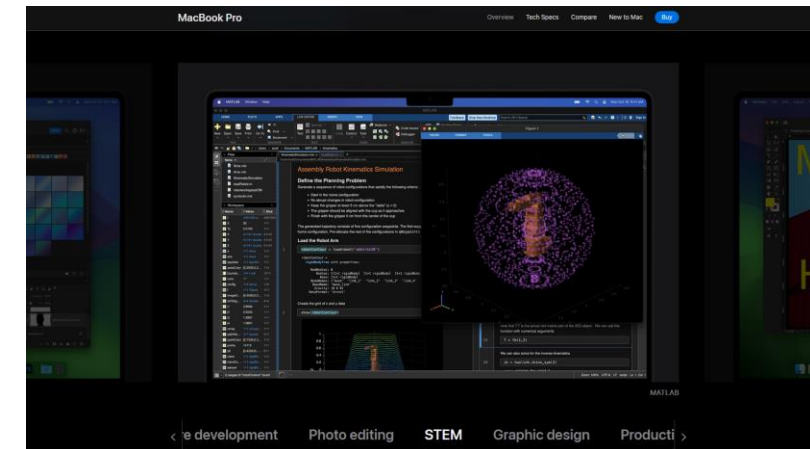
[Apple Release Event](#) – Oct 2023



[MacBook Pro promo video](#)



[MacBook Pro home page](#)



New Desktop for MATLAB is in open beta

R2024b

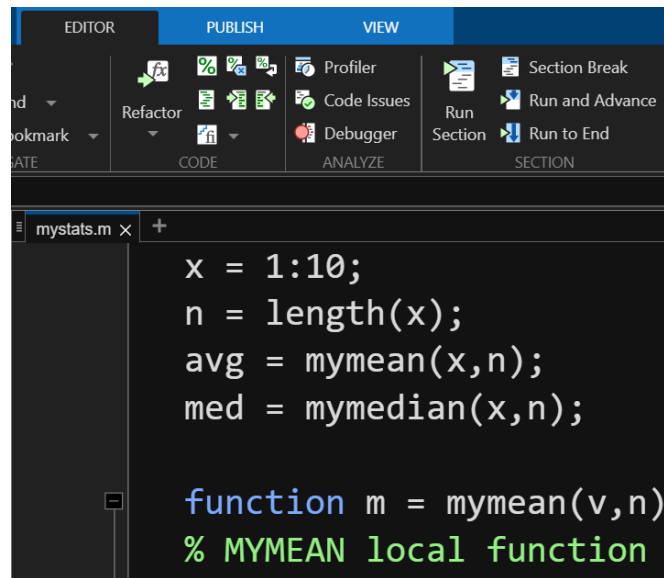
- Find on [File Exchange](#) or Add-Ons menu
- Previews of upcoming features
- Integrated feedback for functionality requests, performance issues, and bugs

The image illustrates the user journey to try the new MATLAB desktop. It starts with a search on the File Exchange website for 'New Desktop for MATLAB (Beta)'. A button labeled 'Try the New Desktop' is shown on the documentation page. Finally, the MATLAB R2024b desktop is shown, featuring a dark theme and a Live Editor window displaying a tutorial on 'Calling Functions'.

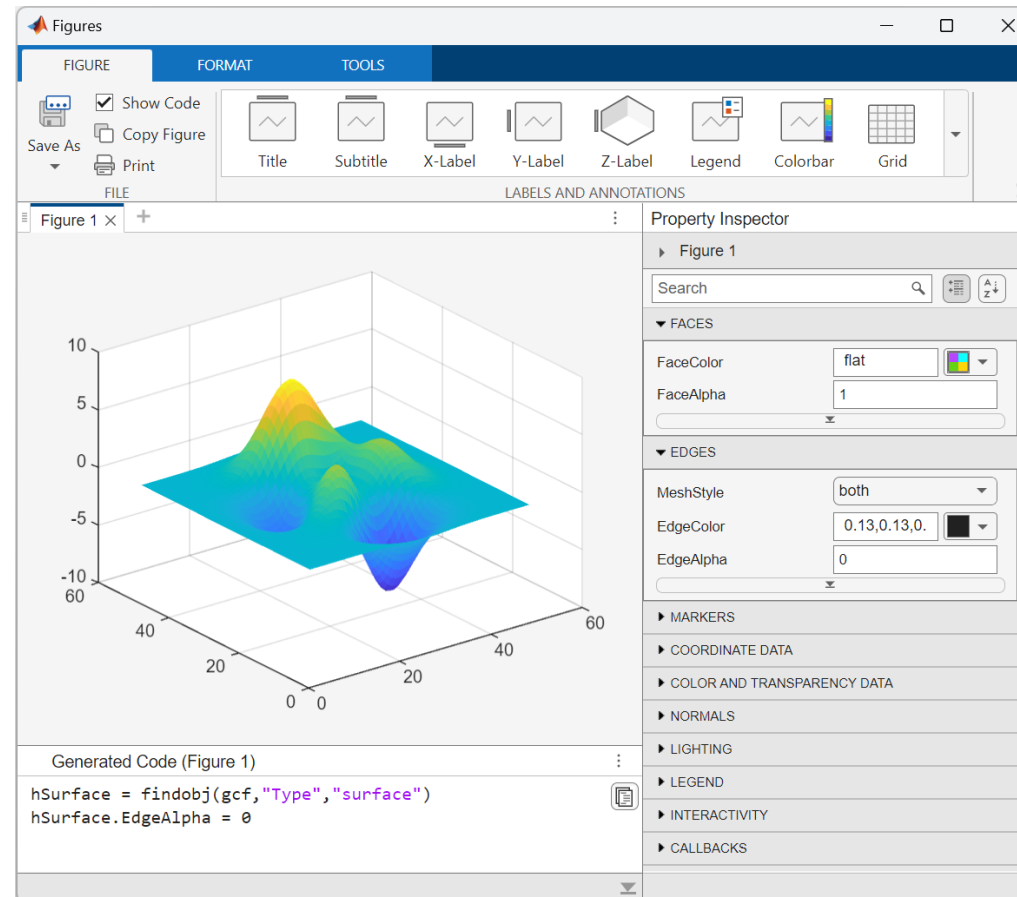
New Desktop unlocks enhanced productivity features

Already available in MATLAB Online

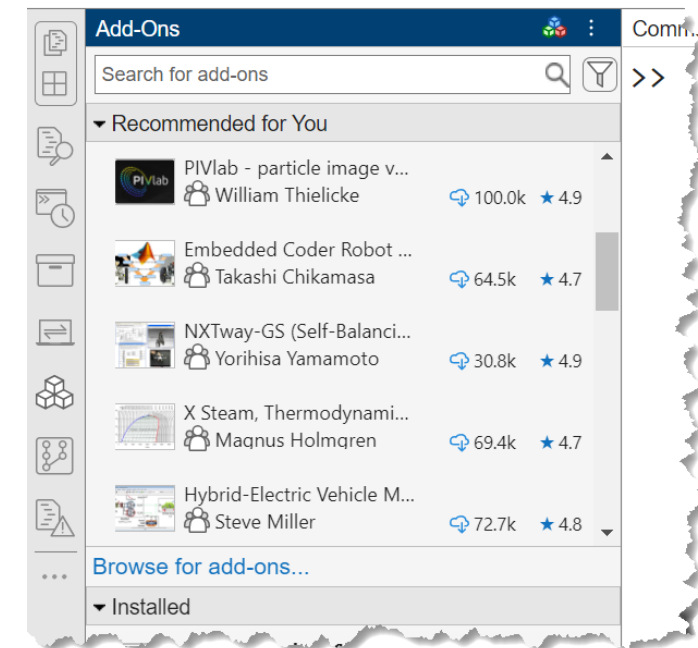
Dark Mode



Enhanced Figure Window



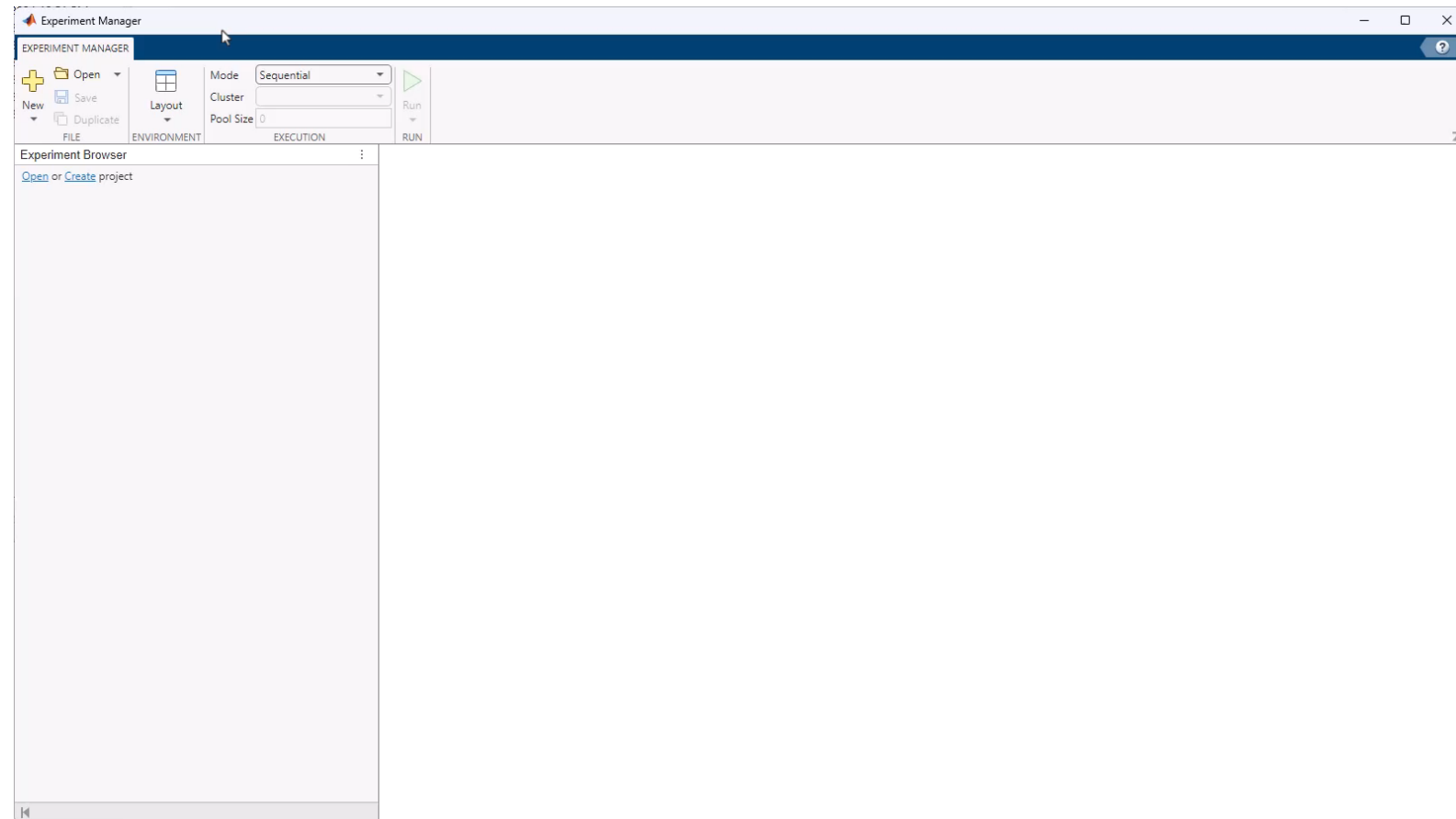
New Side Panels



- Source control
- Debugging
- Add-On management
- Many more...

Use Experiment Manager to perform computational experiments

- Create and manage experiments
- Parameter sweeps and hyperparameter tuning
- Parallel and batch processing
- Pre-built experiments for machine learning and AI



Create interactive, human readable scripts in the Live Editor

- Make scripts readable
 - Richly formatted text
 - Interleave code & output
- Add interactivity
 - Hyperlinks and table of contents
 - Live Controls to adjust parameters
- Share with non-MATLAB users
 - Export as report (pdf, docx, etc.)
 - Share through GitHub and MATLAB Online

SunriseSunset.mlx × +

Estimating Sunrise and Sunset

We can estimate sunrise and sunset times if we know the latitude, longitude, and UTC offset. The [solar declination](#) (δ) is the angle of the sun relative to the earth's equatorial plane. On any given day of the year (d), using the latitude (ϕ), the sun's declination (δ) and the solar time correction (SC) we can calculate sunrise and sunset times.

Solar Declination	Sunrise	Sunset
$\delta = \sin^{-1} \left[\sin(23.45) \sin \left(\frac{360}{365} (d - 81) \right) \right]$	$12 - \frac{\cos^{-1}(-\tan \phi \tan \delta)}{15^\circ} - \frac{SC}{60}$	$12 + \frac{\cos^{-1}(-\tan \phi \tan \delta)}{15^\circ} - \frac{SC}{60}$

Table of Contents

- [Estimating the Sunrise and Sunset Times](#)
- [Plot Yearly Results](#)

Estimating the Sunrise and Sunset Times

Set the latitude, longitude, and UT offset.

```

1 lat = 42  ;
2 lon = -71  ;
3 UTCoff =  ;

```

Estimate the sunrise and sunset times. We use the custom [equationOfTime](#) function to calculate the solar time [correction](#) (SC).

```

4 day = 1:365;
5 timeCorr = equationOfTime(day)

```

```

timeCorr = 1×365
-3.7052 -4.1497 -4.5894 -5.0239 -5.4528 -5.8756 -6.2921 -6.7018 ...

```

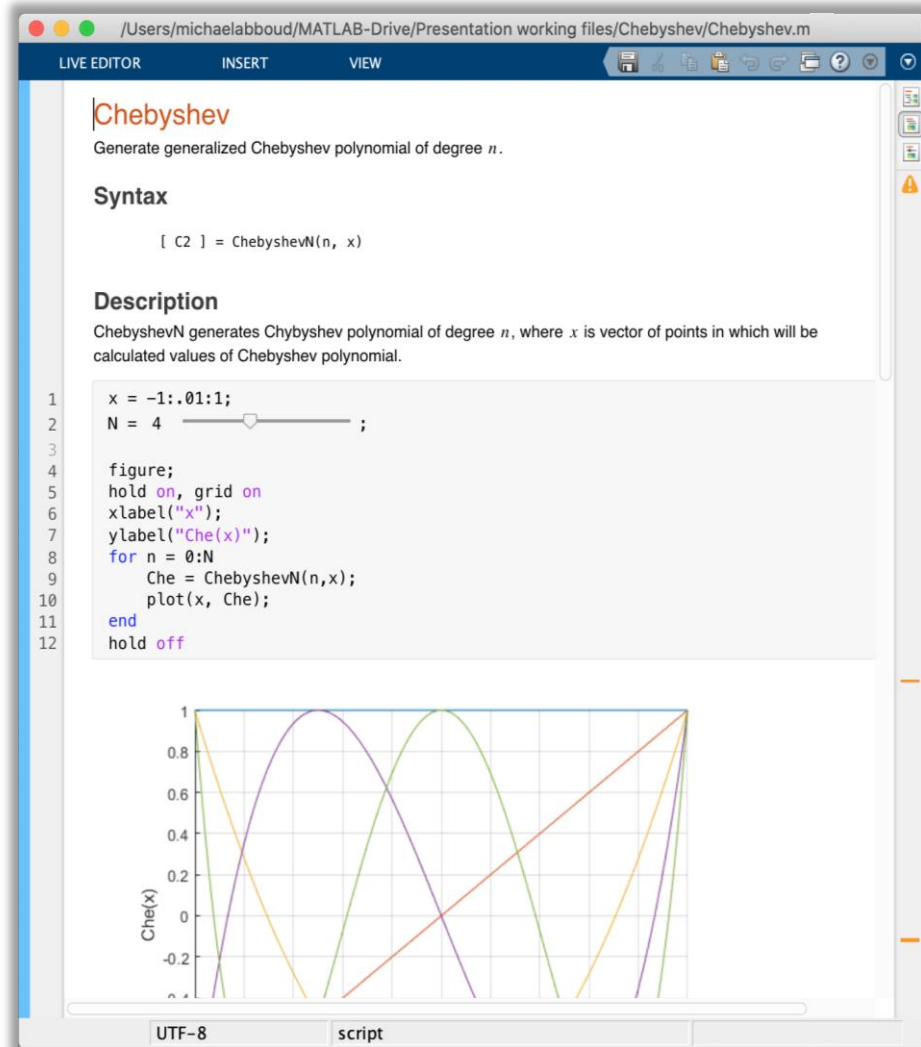
```

6 plotSunriseSunset(lon, UTCoff, timeCorr, day, lat)

```

Sunrise and Sunset

New feature: Save Live Scripts as marked-up text files



Within MATLAB



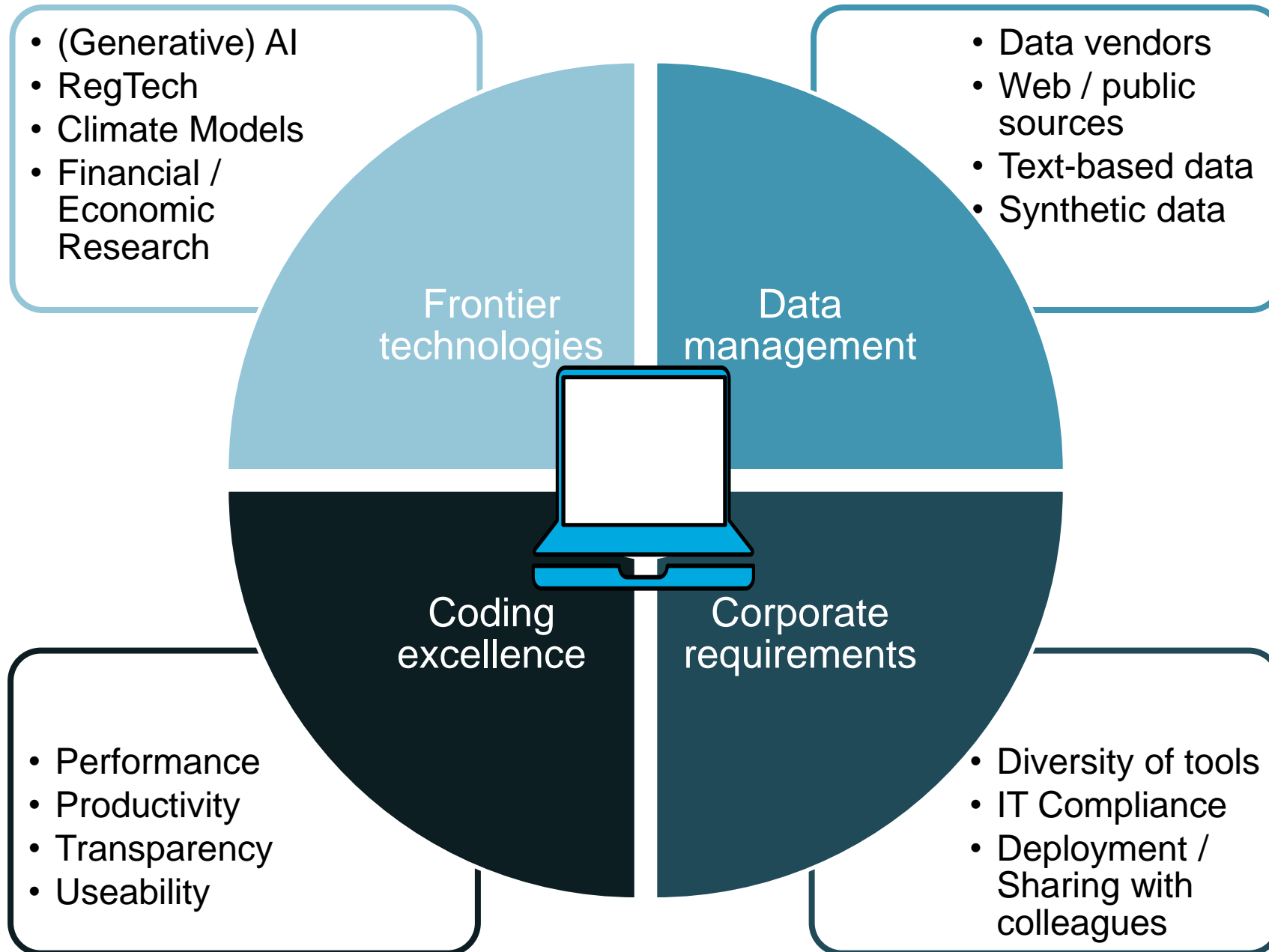
```

1 %%text
2 %{
3 # Chebyshev!
4 Generate generalized Chebyshev polynomial
5
6 #### Syntax
7 -` [ C2 ] = Chebyshev( n, x )`
8
9 #### Description
10 Chebyshev( n, x ) generates Chebyshev polynomial of degree `n`, where `x`
11 vector of points in which will be calculated values of Chebyshev polyno
12 %}
13
14 N = 4; %#control:slider:1 min:1, "max":7, "step":1
15
16 figure; %#output:1
17 hold on, grid on;
18 xlabel("x");
19 ylabel("Che(x)");
20 for n = 1:N
21     Che = ChebyshevN(n,x);
22     plot(x, Che);
23 end
24 hold off;
25
26
27 %%appendix
28 %{
29     "control:slider:1":{
30         "data":{
31             "defaultValue":4,
32             "executionModel":"Section",
33             "executionOn":"ValueChanging"
34         },
35         "release":"R2023a"
36     },
37     "output:1":{
38         "type":"figure",
  
```

View code and diffs in source control!

Edit your code outside of MATLAB!

Outside of MATLAB



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Thank you

