

WHITE PAPER

SS1/23 Compliance with Modelscope

What Is the SS1/23 Regulation?

Supervisory Statement 1/23 (SS1/23), published by the Bank of England, is a set of model risk management principles for financial institutions. It aims at supervising regulated risk management and governance functions regarding the model lifecycle.

The five principles cover:

1. Model identification and model risk classification
2. Governance
3. Model development, implementation and use
4. Independent model validation
5. Model risk mitigants

This white paper covers the major considerations for SS1/23 compliance and how you can use the MathWorks Modelscape solution as an enabler for the structural and cultural shifts in MRM that the PRA is expecting.

“As someone who has worked in finance analytics for many years, it is great to see the publication of the Bank’s SS1/23. This paper, for the first time, sets out in one place what we need to do to create viable, understandable, transparent, and sound modeling practices in banks, covering a broad range of use cases.

MathWorks has worked diligently over the last few years to produce a model lifecycle framework [Modelscape] that firms can use to help them on their journey of model design, development, validation, implementation, monitoring, and governance.

This paper covers all elements of the model lifecycle and addresses the key points from SS1/23. It is a very useful guide to both the regulation and how to adapt to the regulation.

I look forward to discussing this with a wider audience.”

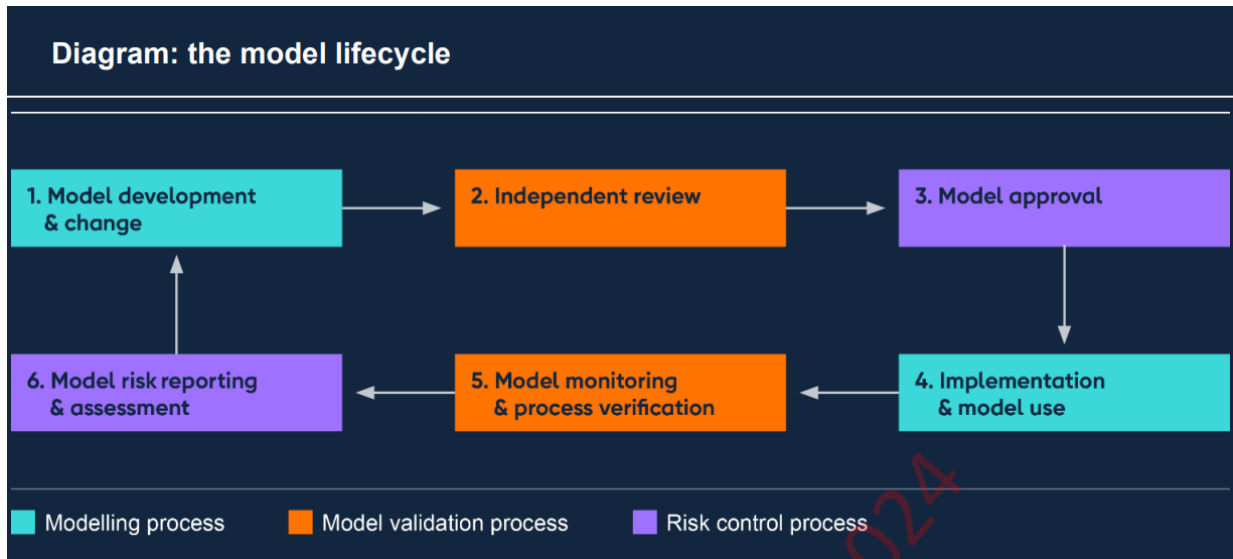
— Ray O’Brien, Consultant and Former Head of Global Analytics at HSBC

Important SS1/23 Considerations

Although SS1/23 sets out clear principles for model risk management, there are some challenges that organizations may have with its implementation:

- **Data quality:** Good model risk management relies on high-quality data. Ensuring that data is accurate, complete, and timely across complex organizational structures is critical.
- **Model complexity:** As financial models become more complex, so does the process of validation and monitoring.
- **Communication and cultural change:** To implement effective model risk management, regulated financial institutions must communicate the importance of model risk management to staff across the organization, which often requires significant cultural change.

- **Model governance:** Regulated financial institutions must ensure that models are governed effectively, with clear roles and responsibilities assigned to individuals or committees. This requires a robust governance framework.
- **Model risk assessment:** Regulated financial institutions must assess and mitigate model risk, but this process requires careful monitoring of model performance and regular validation and stress testing.



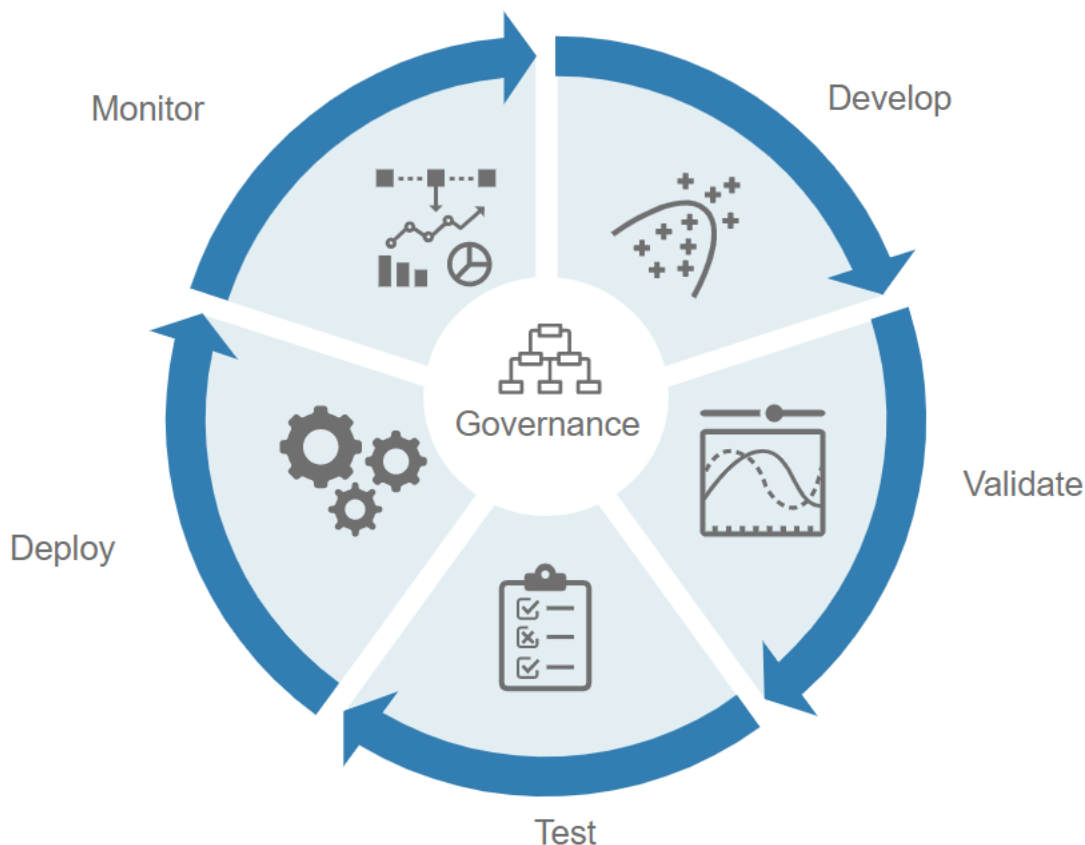
The model lifecycle diagram as described in SS1/23. Image source: Bank of England, SS1/23.

MathWorks Modelscape Solution

MathWorks Modelscape is an MRM solution that provides a holistic view of all models used in a company's operations. Modelscape lets you organize, document, and perform quality control of all models through the entire life cycle.

Modelscape is a comprehensive way to manage model risk and improve efficiency in a financial institution's model workflow. The platform enables users to reduce the cost, redundancy, and inconsistencies that arise from managing multiple models. It does this through centralized production-grade models and automated model documentation. The platform's user-friendly interface enables users to build AI production-level models that satisfy regulatory requirements. With Modelscape, your organization can enhance their model processes and ensure a robust framework for managing the entire model lifecycle.

A typical model lifecycle comprises six stages:



The lifecycle of a model.

These stages are supported by Modelscape components:

- **Modelscape Develop** allows you to explore, document, and backtest models. It helps improve model transparency, reproducibility, and reusability through auto-generated documentation and reports.
- **Modelscape Validate** provides a unified environment for testing and validating models written in multiple languages, using a library of validated algorithms and built-in interfaces for communication and documentation. It auto-generates validation reports.
- **Modelscape Test** provides an environment for continuous integration and testing of model artifacts to ensure ongoing quality assurance, with the ability to manage automated and manual validation tests, execute equivalence and performance testing, and provide traceability to development and reviews.
- **Modelscape Deploy** offers a unified and secure environment for deploying machine learning models, with the ability to execute multiple versions of models in different environments and integrate with existing technology infrastructures, without the need to refactor or recode models.

- **Modelscope Monitor** provides real-time monitoring of model execution results through a configurable web dashboard. You can analyze data segments, model usage, behavior, and health; and automate monitoring alerts and thresholds.
- **Modelscope Governance** lets you manage and centralize modeling projects with a dashboard, providing workflows across the model lifecycle and access to an inventory of all models in one centralized web-based environment.

Compliance with SS1/23

Modelscope can help you comply with the SS1/23 regulation by providing a complete view of all models in use, including ownership and usage history, as well as documentation. Modelscope can help organizations meet the PRA's expectations for establishing a transparent model risk management framework and comply with all five principles of the regulation.

Principle 1: Model Identification and Model Risk Classification

“Firms should have an established definition of a model that sets the scope for MRM, a model inventory, and a risk-based tiering approach to categorize models to help identify and manage model risk.” Source: SS1/23

The screenshot displays the Modelscope dashboard interface. At the top, it shows the breadcrumb 'Models > Model Versions #3429' and a '+ New Model Version' button. Below this, the details for a 'Credit Loss Provisioning Model for Credit Card Portfolio' are shown, including an 'Edit Details' button. The model details are organized into two rows of key-value pairs:

MODEL CLASS	PRODUCTS	MODEL PLATFORM	MODEL MATERIALITY SCORE	MODEL TIER	MODEL RISK SCORE	OWNERS
Provisioning	Credit Cards	Excel	5 (5 blue dots)	Tier 1	3 (3 red dots)	Business @Arpit, Model Development @Edward, Model Validation @David, Model Internal Audit @Rich
BUSINESS GROUP	MODEL TYPE	MODEL STATUS	MODEL COMPLEXITY SCORE	EXPOSURE	MODEL RISK RATING	
Retail Banking	Proprietary	IN DEVELOPMENT	1 (1 blue dot)	High	MEDIUM	

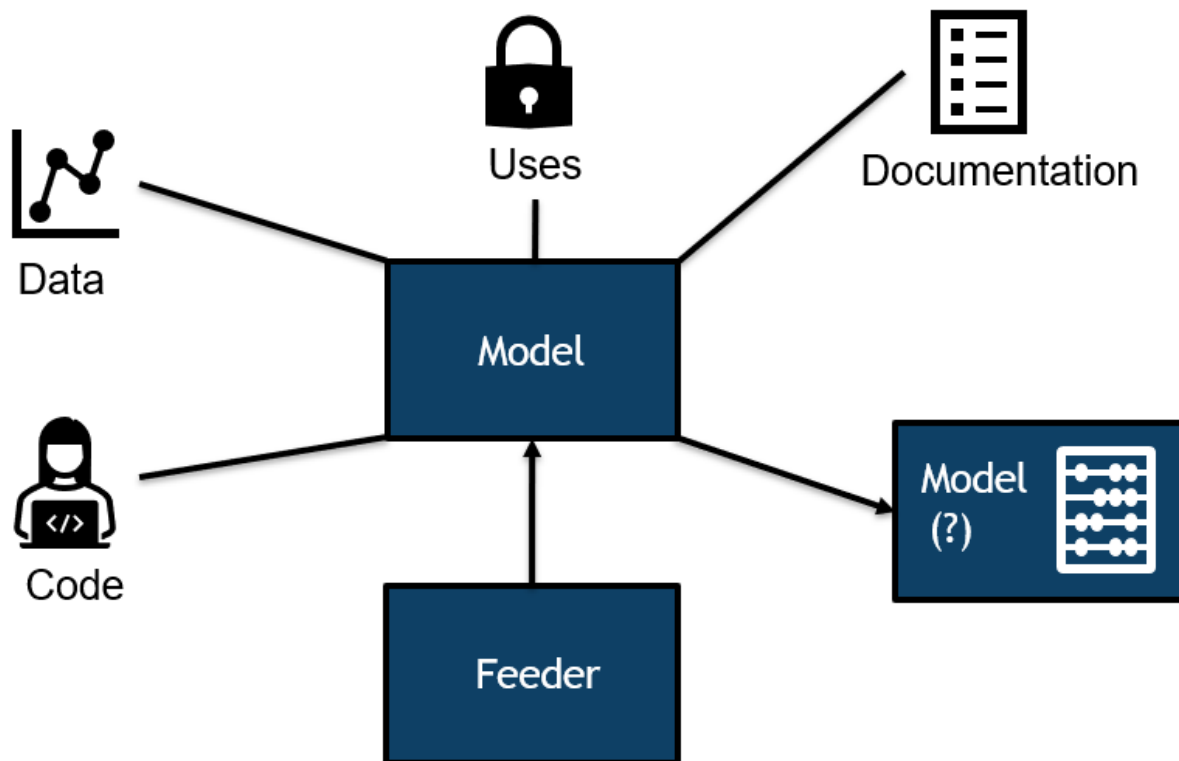
Below the model details, there is a 'Model Versions' section with a table listing various model versions. The table has columns for ACTIONS, NAME, PURPOSE, MODEL CLASS, BUSINESS GROUP, PRODUCTS, MODEL DEV. OWNER, BUSINESS OWNER, MODEL VALIDATION OWNER, and MODEL INTERNAL AUDIT OWNER.

ACTIONS	NAME	PURPOSE	MODEL CLASS	BUSINESS GROUP	PRODUCTS	MODEL DEV. OWNER	BUSINESS OWNER	MODEL VALIDATION OWNER	MODEL INTERNAL AUDIT OWNER
Open Review	Credit Loss Provisioning Model for Credit Card Portfolio	-	Provisioning	Retail Banking	Credit Cards	@Arpit	@Edward	@David	@Rich
Open Review	Credit Loss Provisioning Model for Mortgage Portfolio	-	Provisioning	Retail Banking	Mortgage	@Tash	@Corey	@Mark	@Rich
+ Create Review	Credit Loss Provisioning Model for CRE Portfolio	-	Provisioning	Commercial Banking	CRE Loans	@Phil	@Edward	@David	@Rich
+ Create Review	Credit Loss Provisioning Model for Mortgage Portfolio	-	Provisioning	Retail Banking	Mortgage	@Tash	@Corey	@Mark	@Rich

Modelscope dashboard.

The Modelscope dashboard lets your organization manage model risk and comply with the SS1/23 regulation. Modelscope provides a clear link between models and their underlying code, enabling a more rigorous review process. A risk tiering questionnaire is built into Modelscope to help rate the risk of different models based on their complexity, materiality, and

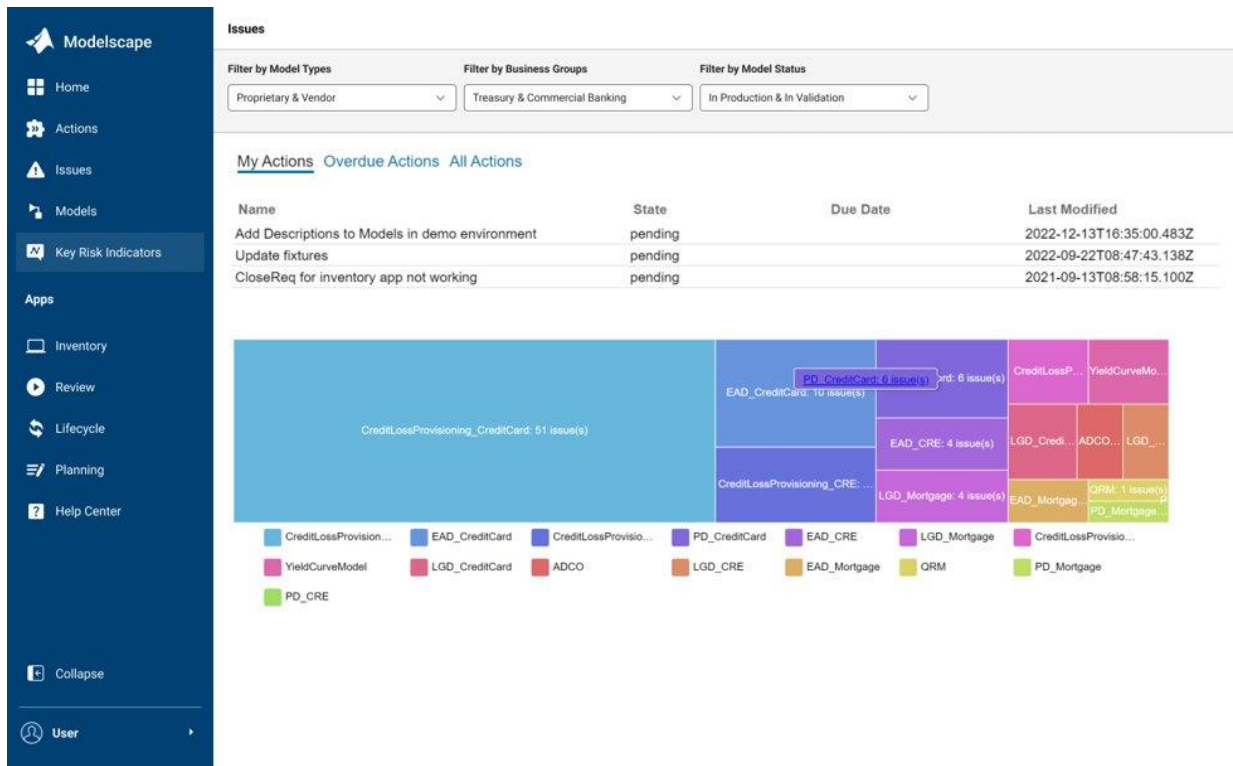
impact. Modelscope also includes a well-documented model definition for every model in the firm-wide model inventory. Models and non-models are also differentiated inside the inventory.



Model elements include model templates, documentation templates, structured executable models, model lineage to manage versions, and secured access.

Principle 2: Governance

“Firms should have strong governance oversight with a board that promotes an MRM culture from the top through setting clear model risk appetite. The board should approve the MRM policy and appoint an accountable individual to assume the responsibility to implement a sound MRM framework that will ensure effective MRM practices.” Source: SS1/23



Modelscape dashboard with centralized access to models, dependencies, metadata, lineage, audit trail, risk scoring, and model risk reporting.

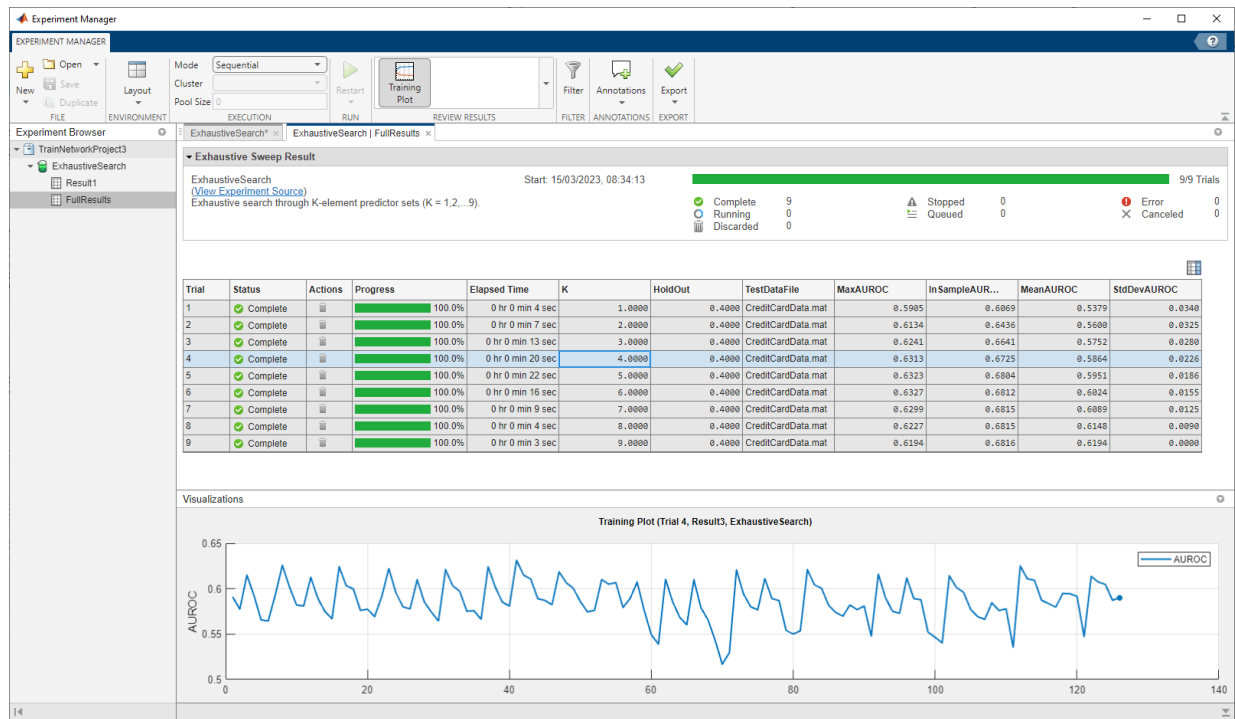
Modelscape supports models through the entire lifecycle, including concept, design, development, validation, deployment, monitoring, and eventual decommissioning. The platform provides tight enterprise integration between the governance framework (model inventory) and the development, validation, deployment, and monitoring platforms, eliminating separate data entry regardless of the implementation platform and modeling language. For each model, all documentation from each part of the lifecycle is available directly from the inventory. Modelscape helps model risk professionals like the MRM Senior Management Function (SMF) to continuously monitor model risk against KPIs.

Index	ID	Summary	Implemented	Verified	Owner	Milestone
irb_validation*						
1	#1	Model Validation Metrics			Model Validation Owner	05-May-2023
1.1	#2	Bayesian Error Rate				N/A
1.2	#3	Brier Score			Example of sub-article ownership	04-May-2023
1.3	#4	Cumulative Accuracy Profile				
1.4	#5	Entropy Measures				
1.5	#6	Hosmer-Lemeshow Test				
1.6	#7	Kendall's tau and Somers' D				
1.7	#8	Mann-Whitney U Test				
1.8	#9	Pietra Index				
1.9	#10	Receiver Operating Characteristic				

Tracking progress of model development and validation against standards.

Principle 3: Model Development, Implementation, and Use

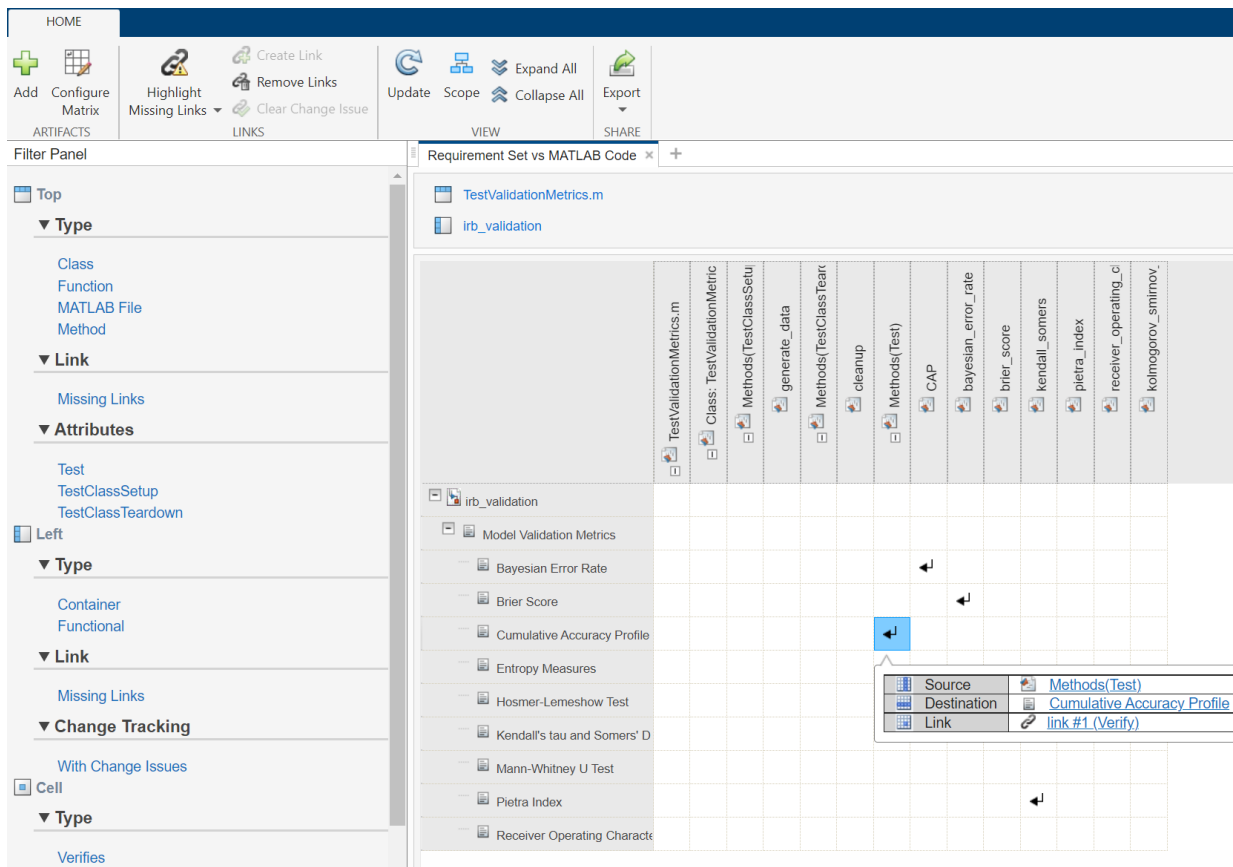
“Firms should have a robust model development process with standards for model design and implementation, model selection, and model performance measurement. Testing of data, model construct, assumptions, and model outcomes should be performed regularly in order to identify, monitor, record, and remediate model limitations and weaknesses.” Source: SS1/23



Experiment Manager dashboard.

Modelscape helps you produce high-quality model documentation beginning at the model concept design stage. Throughout the model development cycle, the process is templated and driven, automatically generating relevant model artifacts and documentation from the development environment. The documentation process ensures a clear traceable linkage between the Model Definition, Statement of Purpose, and Model implementation.

Firms are expected to ensure that appropriate data is selected, documented, and recorded throughout the process, including what data was discarded and why. The data sets recorded are available for model reproducibility. For effective model risk management, it is necessary to validate supporting systems and ensure they are fit for use. The model development testing must demonstrate that the models work as intended within defined boundaries. The Model Monitoring Dashboard displays the state of running models. You can drill down to the real-time performance of individual models and access up-to-date accuracy, sensitivity, and explainability metrics on production data.

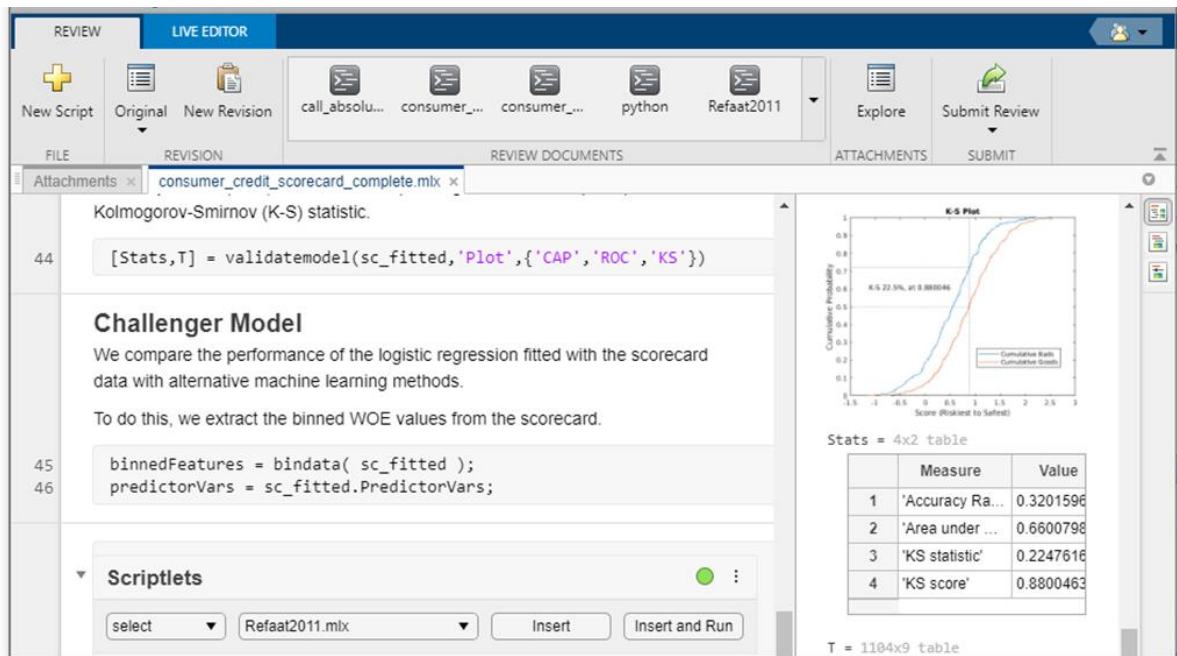


Traceability between requirements, code, and testing.

Setting up performance boundaries and alerts for model deviations is vital for effective model management. Customizable web dashboards provide a holistic view of ongoing model results and a detailed view of model usage. The data helps you analyze key performance measures. You can also pinpoint models ready for retirement, thus simplifying the process of eliminating outdated or ineffective models. With these steps, your organization can more efficiently monitor and manage models and ensure they remain current, beneficial, and compliant with regulatory standards.

Principle 4: Independent Model Validation

“Firms should have a validation process that provides an ongoing, independent, and effective challenge to model development and use. The individual/body within a firm responsible for the approval of a model should ensure that validation recommendations for remediation or redevelopment are actioned so that models are suitable for their intended purpose.” Source: SS1/23



ModelScape Validate.

A key aspect of effective model validation is standardizing the development and validation processes. This results in more efficient validation of all models greater ease in monitoring them. A well-designed independent model validation function should provide an evaluation of conceptual soundness, statistical techniques, and data robustness. Templated validation tasks reduce errors and costs, and validators can access model data, code, documentation, executable artifacts, and reports.

To achieve consistent model validation, it's crucial to have a platform that supports all model types across languages and platforms and tracks the validation processes, findings, and documentation through an inventory. Resource management and workflow enable granular visibility of the validation lifecycle and track remedial actions. The system should also manage exceptions in the validation process and provide easy evidence of validation excellence to regulators. Such a system would ensure consistency, support automated workflow, increase efficiency, and provide a high-quality validation process.

▼ Properties



Type: Functional ▾

Index: 1.1

Custom ID: #2

Summary: Bayesian Error Rate

Description Rationale

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In this section we (first line) provide a detailed rationale for the BER Thresholds.

Keywords:

▼ Revision information:

SID: 2

Revision: 2

Created by: ppeeling

Created on: 20-Apr-2023 13:26:41

Modified by: ppeeling


Modified on: 09-May-2023 12:21:36



▼ Custom Attributes



Milestone: N/A

Owner:

▼ Links

 **Verified by:**

 [738997.852.2 in TestValidationMetrics.m](#) 

 [Detailed justification of BER score](#) 

▼ Comments

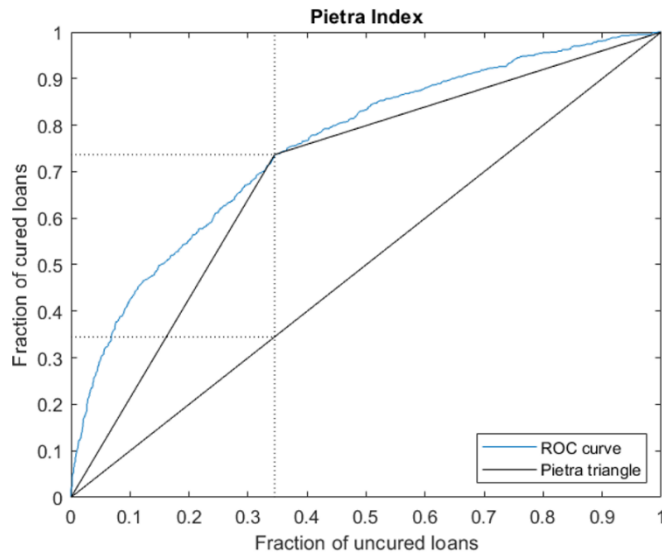
Add Comment

Commented by ppeeling at 09-May-2023 12:21:12 (Rev:2)

Request a justification be provided

Streamline communication across the three lines of defense.





Change Information No change issue detected.

Links

Artifact: [TestValidationMetrics.m](#)

Linked Item	Link Type
function pietra_index(tc)	↔ Verified by

Implementation Status

Total: 1, Implemented: 0, Justified: 0, None: 1

Verification Status

Total: 1, Passed: 1, Justified: 0, Failed: 0, Unexecuted: 0, None: 0

1.9 Receiver Operating Characteristic

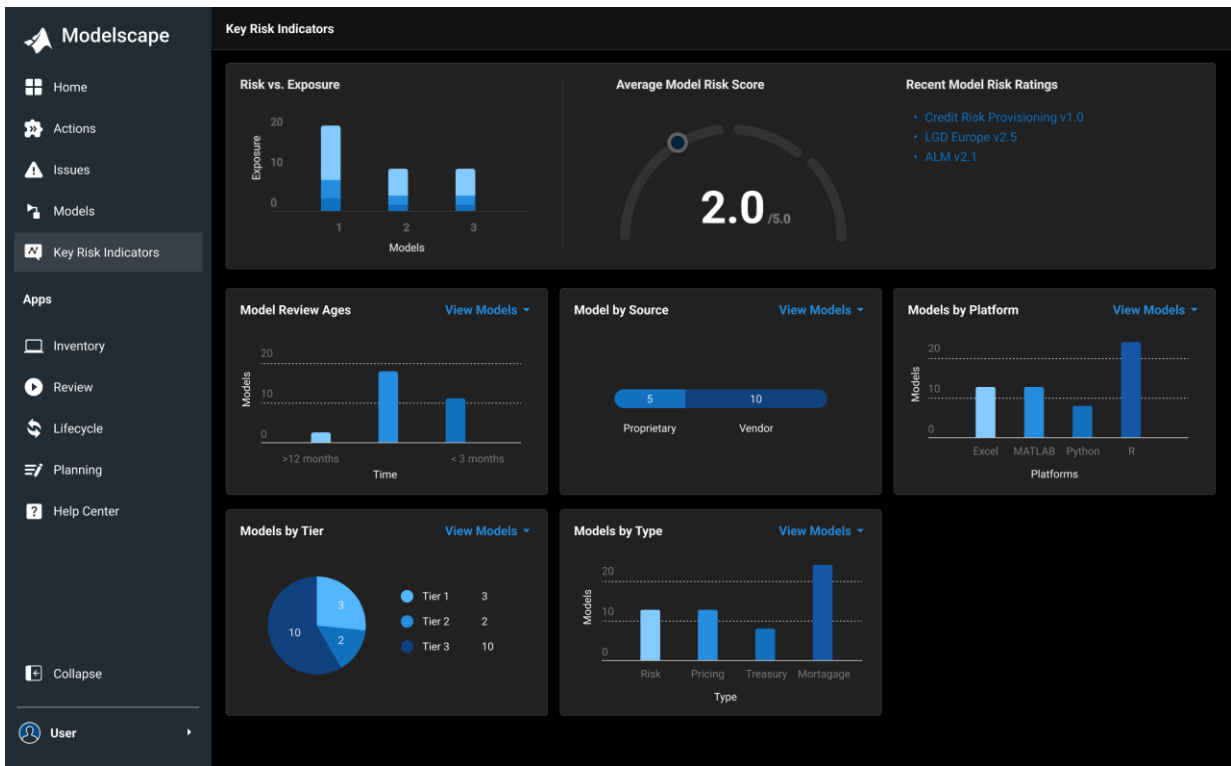
Model validator findings and recommended actions

Good model risk management requires clear communication between model developers, validators, and users. Validators need the tools to thoroughly explore the model’s behavior and challenge the model's assumptions and behavior in a reproducible way. A robust, auditable framework for documenting and communicating findings, issues, and resolutions between the lines of defense is essential.

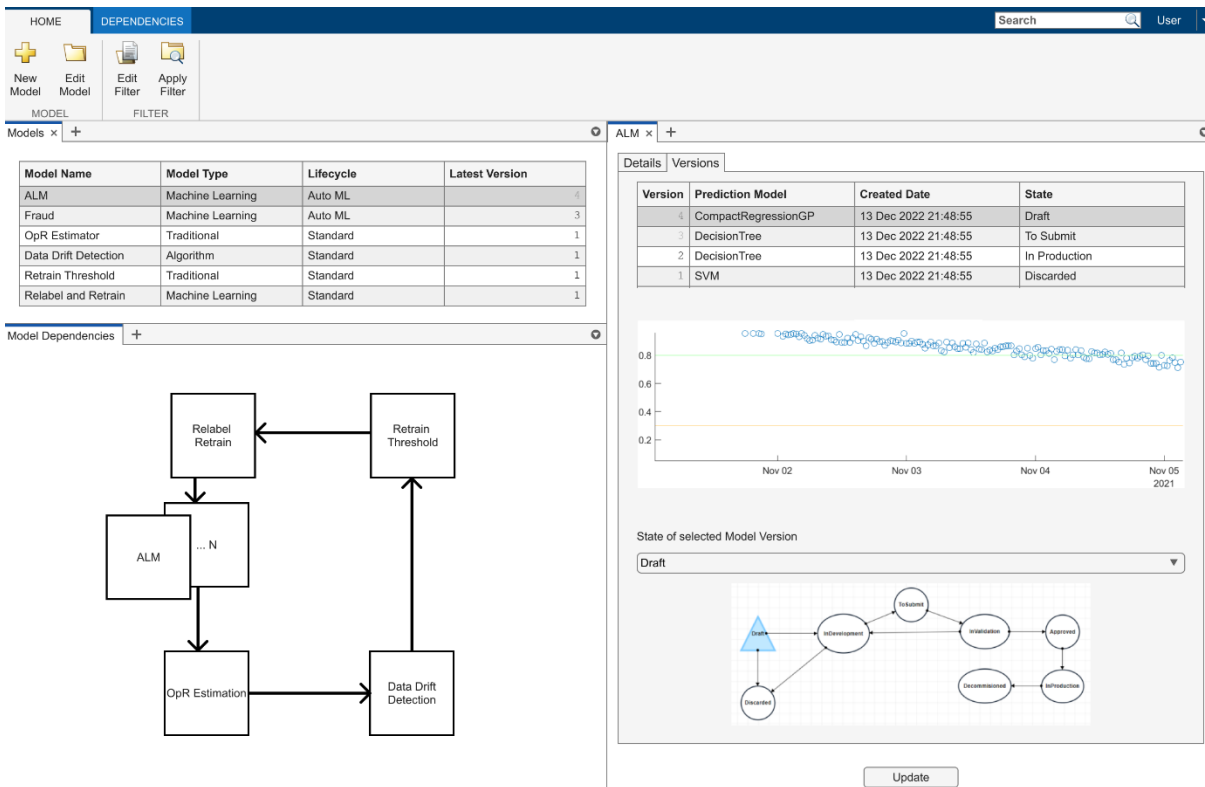
Principle 5: Model Risk Mitigants

“Firms should have established policies and procedures for the use of model risk mitigants when models are underperforming and should have procedures for the independent review of post-model adjustments.” Source: SS1/23





Modelscope home.



Modelscope Monitor.

Post model adjustments (PMAs) in credit risk models are tweaks made to the output of these models to account for their limitations or risks not fully captured. PMAs help refine model results based on expert judgment or additional data. Modelscape supports good governance of PMAs to include proper documentation and transparency. Each adjustment should have a clear rationale and be approved by the appropriate level of management. Regular audits or reviews can be conducted through Modelscape to ensure the continued validity and appropriacy of the adjustments.

Summary

Model risk management (MRM) is a critical component of financial regulation; managing it efficiently and effectively is essential to achieving regulatory compliance. Recognizing the importance of MRM helps financial institutions establish a robust framework to identify, assess, and mitigate model risks and understand their implications. MRM trains people to follow policies and adapt to changing regulatory requirements.

Principles are designed to evolve based on new best practices to improve the effectiveness of the MRM processes. So too is MathWorks Modelscape, which helps firms achieve compliance with the SS1/23 Model Risk Management Framework regulation.

Learn More

[MathWorks Modelscape Model Risk Management Solution](#)