WHITE PAPER

ModelOps with SAS and Microsoft

Contents

Machine learning is more important than ever 1
Machine learning challenges 1
Understanding the analytics life cycle 2
ModelOps to the rescue 2
Conducting ModelOps with SAS® Model Manager and Azure Machine Learning 3
Reimagining ML model deployment, monitoring and governance 3
About SAS® Model Manager 3
About Azure Machine Learning 4
Realizing the benefits of SAS® and Microsoft integration 4
5 best practices for optimizing ModelOps with SAS® Model Manager and Azure Machine Learning 5
Best practice 1: Create models with repeatable machine learning pipelines using SAS® Model Manager 5
Best practice 2: Apply automation to your ModelOps rollout and audit trail 6
Best practice 3: Use Azure Machine Learning to deploy models into the Microsoft Cloud 6
Best practice 4: Use SAS® Model Manager to monitor performance and drift 7
Best practice 5: Use SAS® Model Manager to retrain, score and redeploy models faster 7
Learn more 8

Machine learning is more important than ever

According to the **Global McKinsey Survey on the State of AI in 2021**, the adoption of AI is continuing to grow at an unprecedented rate. Fifty-six percent of all respondents reported AI adoption – including machine learning (ML) – in at least one function, up from 50% in 2020.

Businesses are deploying ML models for everything from data exploration, prediction and learning business logic to more accurate decision making and policymaking. ML is also solving problems that have stumped traditional analytical approaches, such as those involving unstructured data from graphics, sound, video, computer vision and other high-dimensional, machine-generated sources.

More and more, organizations are relying on machine learning (ML) models to turn massive volumes of data into better, faster insights and information.

Machine learning challenges

But as organizations build and scale their use of models, governance challenges increase as well. Most notably, they struggle with:

- **Managing data quality and exploding data volumes.** Most large enterprises host their data in a mix of modern and legacy databases, data warehouses, and ERP and CRM services – both on-premises and in the cloud. Unless organizations have ongoing data management and quality systems supporting them, data scientists may inadvertently use inaccurate data to build models.
- **Collaborating across business and IT departments.** Model building requires multidisciplinary teams of data scientists, IT infrastructure and business experts across the organization working together. This can be a difficult task for many enterprises due to poor workflow management, skill gaps between roles, and unclear divisions of roles and responsibilities among stakeholders.
- **Building models with existing programming skills.** Learning a programming language can take years to perfect, so if data scientists can build models using the skills they already have, the faster they can deploy new models. Modern machine learning services must empower data scientists to build using their language of choice and provide a low-code/no-code user interface that nontechnical employees can use to build models.
- **Scaling models.** Enterprises must have the ability to deploy models anywhere – in applications, in the cloud or on the edge. To ensure the best performance, models need to be deployed as lightweight as possible and have access to a scalable compute engine.
- **Efficiently monitoring models.** Once deployed, ML models will begin to drift and degrade over time due to external real-world factors. Data scientists must be able to monitor models for degradation and quickly retrain and redeploy the models into production to ensure companies are returning maximum productivity.
- **Using repeatable, traceable components.** To minimize the time a given model is out of production during rescoring and training, models must be built using repeatable and traceable components. Without a component library and documented version history, there's no way to understand which components were used to build a model, which means it must be rebuilt from scratch.

Understanding the analytics life cycle

To help you address these challenges, SAS builds its services – and integrations in the Microsoft Cloud – with the analytics life cycle in mind. The analytics life cycle enables businesses to move seamlessly from questions to decisions by connecting DataOps, artificial intelligence and ModelOps (known as MLOps in the wider data science community) in a continuous and deeply interrelated process (see Figure 1). Let's take a closer look at each of these elements:

- **DataOps.** Borrowing from agile software development practices, DataOps provides an agile approach to data access, quality, preparation and governance. It enables greater reliability, adaptability, speed and collaboration in your efforts to operationalize data and analytics workflows.
- **Artificial intelligence.** Data scientists use a combination of techniques to understand the data and build predictive models. They use statistics, machine learning, deep learning, natural language processing, computer vision, forecasting, optimization and other techniques to answer real-world questions.
- **ModelOps.** ModelOps focuses on getting AI models through validation, testing and deployment phases as quickly as possible while ensuring quality results. It also focuses on ongoing monitoring, retraining and governance to ensure peak performance and transparent decisions.

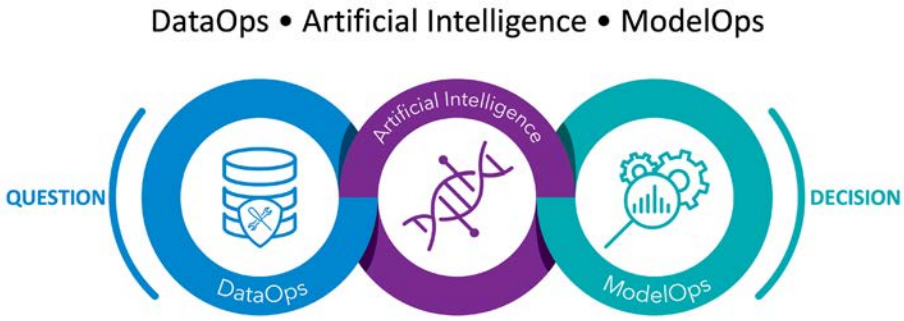


Figure 1. The analytics life cycle.

So how can we apply the analytics life cycle to help us solve the challenges we listed above? To answer that, we'll have to take a closer look at ModelOps.

ModelOps to the rescue

Based on longstanding DevOps principles, SAS® ModelOps is a critical capability for rapidly moving models through the analytics life cycle so they're deployed faster, perform as expected and enable decisioning. ModelOps empowers you to manage and scale models to meet demand and continuously monitor them to spot and fix early signs of degradation.

ModelOps also increases confidence in ML models while reducing risk through an **efficient and highly automated governance** process. This ensures high-quality analytics results and the realization of expected business value. At every step, ModelOps ensures that deployment-ready models are regularly cycled from the data science team to the IT operations team. And, when needed, model retraining occurs promptly based on feedback received during model monitoring.

- **Managing data quality and exploding data volumes.** ModelOps ensures that the data used to train models aligns with the operational data that will be used in production. Managing data in a data warehouse, such as Azure Synapse Analytics, helps you ingest data from multiple sources and perform all ELT/ETL steps so data is ready to explore and model.
- **Collaborating across business and IT departments.** ModelOps empowers data scientists, IT infrastructure and business experts to work in harmony thanks to a mutual understanding of their counterparts and end users.
- **Building models with existing programming skills.** Make it easier for everyone on your team to build models using their preferred programming language – including SAS, Python and R – in addition to visual drag-and-drop components for a faster building experience.
- **Scaling models.** Deploy your models anywhere in the Microsoft Cloud, including applications, services, containers and edge devices.
- **Efficiently monitoring models.** Think of deployment as you build your models. Operationalization should not be an afterthought. Think through how you will put a model into production and what the handoffs are between data scientists, IT and business users – and how that can integrate with established DevOps practices so you can monitor and quickly retrain models as they degrade.
- **Using repeatable, traceable components.** There are no black box models anymore because the business always knows the data it uses to train the model, monitors that model for efficacy, tracks the history of the code used in training the models, and uses automation for deployment and repeatability.

Conducting ModelOps with SAS® Model Manager and Azure Machine Learning

Reimagining ML model deployment, monitoring and governance

SAS and Microsoft make it easier for companies to address the challenges of ML model deployment, monitoring and governance. Specifically, SAS and Microsoft have built integrations between SAS Model Manager and Microsoft Azure Machine Learning. Both are hubs for your ModelOps processes, but they also offer complementary capabilities that, when used together, make it possible to conduct ModelOps with the benefit of streamlined workflow management.

About SAS® Model Manager

SAS Model Manager is an enterprise-ready solution for ModelOps. It provides an industry-leading framework for ModelOps that enables collection, testing, deploying, monitoring, governance and retraining of models, regardless of what language they are written in (such as SAS, Python or R). Once you build a model, you can register it in SAS Model Manager to test, deploy and monitor performance in its production environment.

SAS and Microsoft make it easier for companies to address the challenges of ML model deployment, monitoring and governance by enabling a seamless experience – a single, unified ModelOps toolset that manages operational efficiencies, scalability and performance. And we have delivered on this vision by integrating Azure Machine Learning and SAS Model Manager.

SAS Model Manager adds value to the ModelOps process by providing **a common application interface** that enables both business insight and IT governance, which:

- Simplifies process workflow and automation efforts.
- Improves communication and collaboration between business, IT and data scientists throughout the analytics life cycle.
- Gives business users a more active role in model monitoring and management processes.
- Governs data and assets with transparency and DevOps conformity.
- Integrates with decisioning and streaming technologies.

About Azure Machine Learning

Azure Machine Learning is Microsoft's enterprise-grade service for end-to-end machine learning; empowering data scientists and developers to build, deploy, and manage high-quality models faster and with confidence. You can use Azure Machine Learning to accelerate time to value with industry-leading interoperability with open source tools and frameworks. Azure Machine Learning also empowers ModelOps to bring machine learning models into production in a highly secure and tightly governed production environment. Once deployed, you can also scale models to use anywhere in the Microsoft Azure cloud, any hybrid cloud or on-premises via Azure Arc to easily meet business demands.

Additionally, Azure Machine Learning can access enterprise data and resources organizations have running in Microsoft Azure. For example, you can centrally store and manage your enterprise data in Azure Data Lake and even use Power BI to enrich your dashboards with predictive analytics, Azure Synapse to use these ML models via in-database queries, or Azure Synapse Analytics' Spark runtime so you don't have to pay to transfer data between SAS and Microsoft environments.

Finally, Azure Machine Learning also gives data scientists services to accelerate and automate their day-to-day workflows. For example, application developers gain services for integrating models into applications and platform developers have a robust set of services, backed by Azure Resource Manager APIs, for building advanced ML services. And because all of this is powered by Azure, you can use familiar management and security controls to keep your data secure, manage your costs and more.

Realizing the benefits of SAS® and Microsoft integration

It's important to note that both SAS Model Manager and Azure Machine Learning are hubs for ModelOps processes. But they also complement one another in important ways. As noted previously:

- Azure Machine Learning adds volume and speed through scalable deployment of models to your favorite applications in the Microsoft Cloud.
- At the same time, SAS Model Manager provides an enterprise view of all models in production so that quick action can be taken to administer and replace nonperformant models quickly and efficiently. As a model repository, SAS Model Manager supports collaboration across data science, IT and business users with natural language explanations of outputs and a unique no-code/low-code environment that makes it easier to participate in the ModelOps process.

- Workflow management capabilities in SAS Model Manager empower users to automate and delegate tasks across the model life cycle, including registering the model, running a test or validation, deploying a model, setting alerts for model accuracy declines and retraining models. You can also "push" a model from the building environment (SAS or open source) to SAS Model Manager, where all the files related to the model (score code, metadata, etc.) are automatically created and stored, ready for testing and deployment.

5 best practices for optimizing ModelOps with SAS® Model Manager and Azure Machine Learning

There are different ways you can use these two services to accelerate model building, deployment and monitoring. Figure 2 summarizes best practices for conducting ModelOps using SAS Model Manager and Azure Machine Learning.

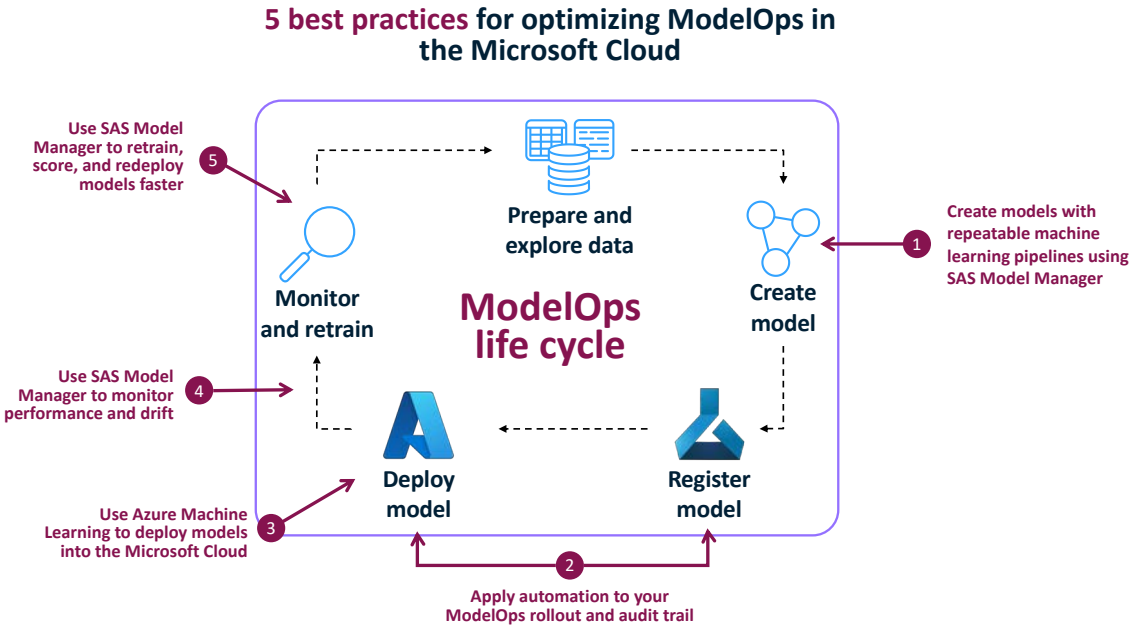


Figure 2. Five best practices to optimize the ModelOps life cycle on the Microsoft Cloud.

Best practice 1: Create models with repeatable machine learning pipelines using SAS® Model Manager

When data scientists create models in SAS® Viya® and register in SAS Model Manager, they can innovate and build faster. Users can build models using the SAS services they already know and love, like SAS Intelligent Decisioning, to construct predictive models in an interpretative context. This makes it easy to collaborate between business users, IT and data scientists to create models that achieve desired business outcomes. SAS Viya not only creates pipelines of reusable ML components but also allows users to easily import reusable components from any language. SAS Viya can also convert score code from one language to another, helping data scientists avoid recoding efforts. For example, SAS Viya can import R or Python packages, or even a Jupyter Notebook, and instantly convert them to run in SAS code (and vice versa).

Central to these SAS capabilities is the modeling metadata repository that SAS uses for drift monitoring and oversight functions. The actual code repository can be in GitHub, Microsoft's library for prebuilt code. Integrated SAS capabilities enable you to store and keep track of repeatable components in GitHub and make it easy for others to find and reuse them. In this way, SAS supports an ecosystem for model building. SAS Model Manager also provides this central modeling metadata repository and simultaneously enhances ModelOps processes.

As you build models, you can test them using SAS Model Manager before putting them into production. Whether you create in Python, R, SAS or a Jupyter Notebook, the software enables you to efficiently validate the model logic using precise methodology that records each test. As a result, you always know models will run seamlessly in your deployed environment.

Best practice 2: Apply automation to your ModelOps rollout and audit trail

SAS Model Manager also facilitates more effective governance by enabling users to:

- Collect all models, projects and pipelines in a searchable, secure and versioned repository.
- Keep track of different versions for each model so you can track model history and ownership changes in a single, readily available user interface.
- Compare models from different languages and libraries side by side (for instance, SAS, TensorFlow, scikit-learn and more).
- Maintain model version control and history tracking in one place.
- Access models and model-score artifacts using REST APIs.

Best practice 3: Use Azure Machine Learning to deploy models into the Microsoft Cloud

Now that you have validated your model, the analytic scoring code will execute correctly, and you can deploy your model anywhere in the Microsoft Cloud. You can call your model from Microsoft Dynamics 365, Azure Synapse Analytics and Microsoft Power Platform, including Power BI, which empowers you to bring your models to more places.

You can also deploy your model to the OCI (Open Container Initiative) compliant Docker containers in the Microsoft Cloud as a lightweight image in SAS Container Runtime (SCR). SCR images provide a modern, reliable, nonproprietary system for transferring and executing runtime code. This greatly simplifies efforts to move code from your testing environment to your production environment. Simply register your SAS containerized model to your favorite Microsoft Azure or docker location and create an app, or use REST APIs to score new data against your published model with SAS Container Runtime.

When you host SAS Viya and your data on Microsoft Azure, you reduce friction and improve performance by running your analytics close to your data.

Best practice 4: Use SAS® Model Manager to monitor performance and drift

Models begin to degrade the moment you put them in production as conditions in the market, customer behavior and data change over time. SAS Model Manager includes performance monitoring to easily track and view performance against the KPIs that have been predetermined with IT and business experts.

SAS Model Manager also supplements the ModelOps process by empowering business experts to take ownership of the monitoring process. For example, SAS Model Manager provides visual analytics and reporting from which you can centrally monitor model performance within Azure Machine Learning and detect model drift. Use it to:

- Generate out-of-the-box performance reports using a wizard.
- Easily access data to build your own reports and KPIs.
- Schedule jobs to detect model drift and automatically retrain models in case of poor performance or bias detection.

Data visualizations make it easy for teammates in the line of business to see data score changes, monitor changes in accuracy over time and see which models are drifting and need retraining.

Best practice 5: Use SAS® Model Manager to retrain, score and redeploy models faster

If model performance degrades, your organization should embark on one of three approaches:

- Retrain the existing model on new data.
- Revise the model with new techniques (such as feature engineering or new data elements).
- Replace the model entirely with a better model.

But regardless of your choice, the critical questions remain the same:

- How do you know when you need to retrain the model?
- Once the model is retrained, how do you determine when to redeploy the model?
- Can you predict how long the model will be relevant?

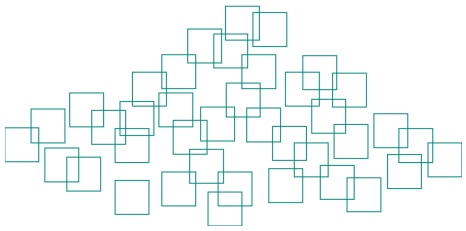
SAS Model Manager helps you answer these questions and take timely action. If it observes model drift, it proactively alerts you with a built-in feedback mechanism and vastly simplifies, optimizes and accelerates model retraining and redeployment. In fact, SAS allows you to revise a model with new techniques (such as feature engineering or new data elements) or replace an entire model with a better one.

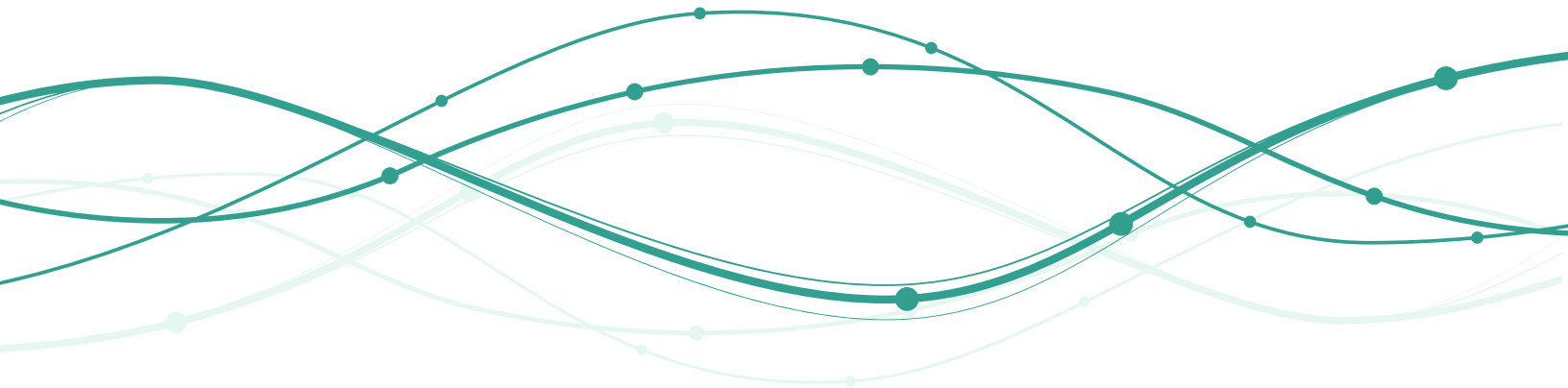
Learn more

There are many advantages to using SAS Model Manager with Azure Machine Learning. Most notably, you gain a no-code/low-code environment in which business users – not just data scientists – can build and deploy SAS and open source models, continuously monitor for performance and drift, and retrain models – all within a single, intuitive SAS user interface. This frees you to establish collaborative, cross-functional teams that ensure models solve real business problems today – and continue to do so in the future. Issues get detected earlier – and retraining and redeployment happen faster – because all models are hosted, collected and tracked in one application. And the efficiencies you gain from automation and real-time monitoring, reporting, testing and more mean you can scale your use of ML models in your Microsoft environment with confidence.

Are you ready to get more from your ML models with less time, effort and risk? Learn more at **sas.com/microsoft**, or check out:

- The **SAS Viya on Azure demo video**.
- Our **ModelOps assessment: Unlock the untapped potential of your data and analytics**.





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