

DECISION
MANAGEMENT
SOLUTIONS

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SAS Decision Manager

A Technical Supplement

SAS Decision Manager combines business rules management with predictive analytic models and analytic model management. These capabilities are combined in a single, decision flow interface that graphically links together all decision elements into a single, traceable and highly agile environment. SAS Decision Manager documents decisions so they can be consistently applied for real-time decision processing.

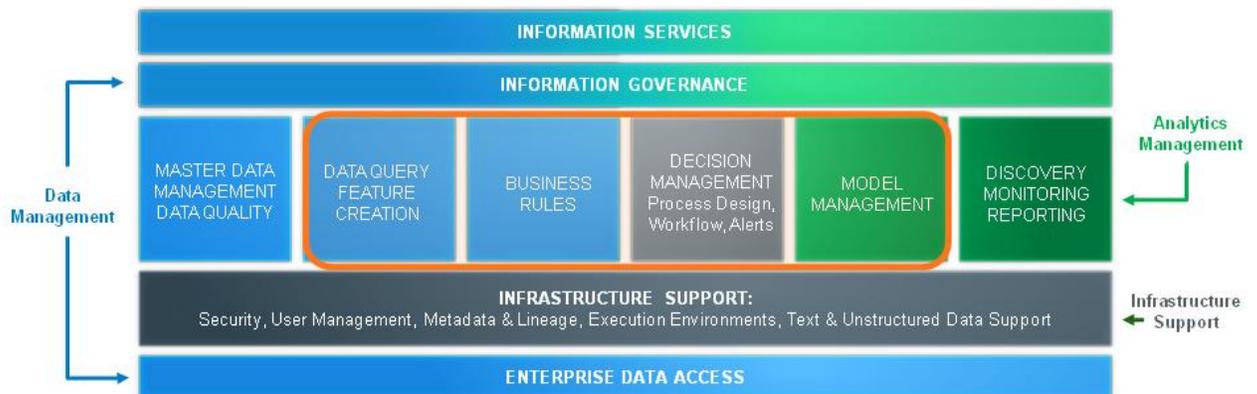
Table I: Key Features

Key Capability	Value Proposition
Decision flow integrates predictive analytic models and business rules into a single environment.	The decision flow at the core of SAS Decision Manager allows business rules and analytic models to be integrated into a single, graphical flow with appropriate tooling for each available in situ.
Multiple deployment options are available for both batch and real-time decision-making.	Decision flows are deployed to both batch and real-time interactive environments. Supported environments include SAS’s data management platform, and web services for integration with virtually any application.
Integrated metadata from data to deployment	SAS Decision Manager is integrated with the SAS Metadata layer (which supports SAS and third party platforms) to facilitate sharing of existing data structures, published models, and rules in order to maximize their reuse in different deployments
Advanced analytic model management capabilities are integrated into the product.	SAS Decision Manager integrates model management so analytical data mining models (from SAS or PMML) are accessible, registered, monitored, managed and evolved.
A single, integrated browser-based environment is provided.	A single graphical environment handles all decision management capabilities—data exploration, business rules and analytic models—as well as features like visualization, meta data interrogation, etc.
Includes business rule definition and management	SAS Decision Manager includes comprehensive business rule authoring and management, allowing the definition and deployment of custom business rules and decision tables.
There is tight integration with SAS’ data mining and predictive analytics capabilities	SAS Decision Manager is integrated with SAS’s rich data mining and analytic capabilities that can extend to 3 rd party model inclusions (like R), tightly integrating predictive analytic models with business rules for rapid deployment.
SAS Decision Manager includes integration with operational data	Execution and deployment of decision flows in low latency federated data environments as well as interrogation of input data tables are supported within the same, consistent environment.

Product Architecture

SAS Decision Manager delivers a number of capabilities from SAS' overall solution matrix. Four particular capabilities are provided—data management, business rules management, model management and decision management.

Figure 1: SAS Decision Manager Capabilities



Source: SAS

- ▶ **Operational Data Integration**
SAS Decision Manager takes full advantage of the SAS metadata layer as well as its lineage and workflow components. This allows users to reuse and update the core information assets defined in their existing SAS infrastructure. Decision Manager includes and is integrated with a visual environment for data preparation in support of rule authoring as well as model retraining and decision flow testing.
- ▶ **Business Rules**
The business rules capability allows users to create decision tables and business rules, collect these up into simple rule flows or sequences, and package these as business rule nodes in a decision flow or as part of a data integration flow.
- ▶ **Analytic Model Management**
The analytic model management capabilities in SAS Decision Manager can integrate SAS and PMML models, accessing models registered with the SAS metadata layer. SAS Decision Manager can monitor the performance of these analytical models and provide reporting and retraining through the core browser interface.
- ▶ **Decision Management**
The core of the decision management capabilities is the decision flow editor. This defines and manages a decision process step by step, bringing business rules, analytic models, other SAS code and external services calls into a single deployable unit. Interactive and batch testing extend the core flow. A wide range of deployment options are available for Decision Management.

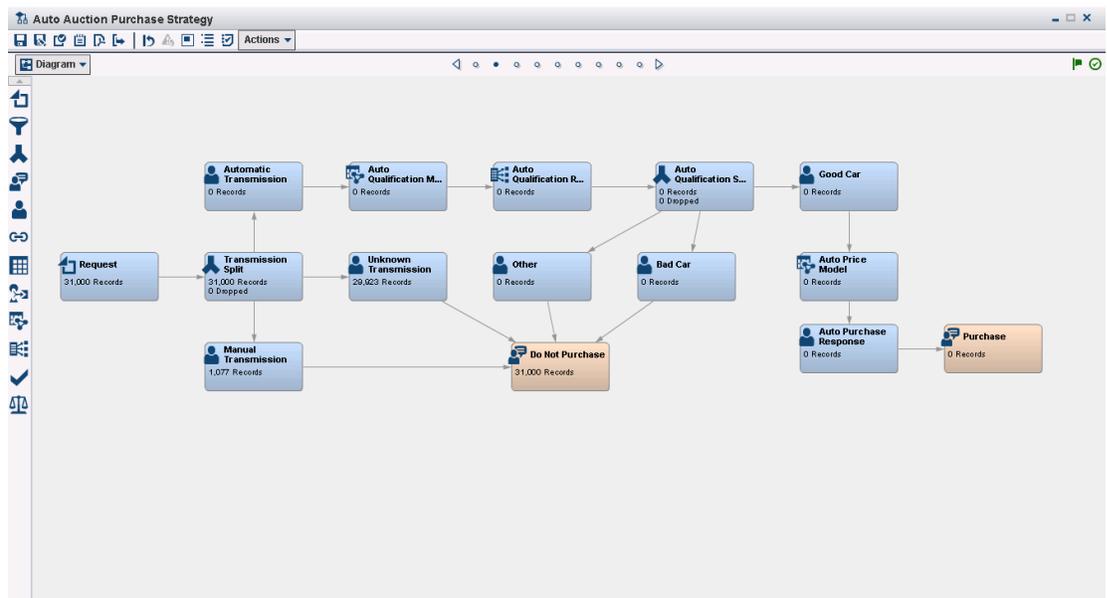
Key Features

SAS Decision Manager is a new platform for developing Decision Management Systems focused on those centered on merging advanced predictive analytic models with business rules. Eight key features underlie this capability:

Decision Flow Integrates Analytics and Business Rules

The decision flow interface shown in Figure 2 is at the heart of SAS Decision Manager. Decision flow allows business rules and predictive analytic models to be integrated for deployment as a decision-making component. Decision flows freely include multiple business rule or predictive analytic model nodes and appropriate tooling is available for each kind of node in situ.

Figure 2: Decision Flow



Source: SAS

The Decision Flow editor allows for the definition and inclusion of sub-diagrams, allowing complex decisions to be broken down, and supports both branches to route transactions appropriately and filters to limit processing to a subset of all records provided. A/B testing can be built into a decision using a pre-defined A/B testing node and this drives allocation of transactions to the various test paths and tracks results for later reporting.

In addition, business rules and analytic models can be reused in multiple flows. The editor identifies and warns about any changes made to reused components, allowing different versions to be packaged up in different flows if necessary.

Test cases can be associated with each Decision flow and these can be run interactively, showing the path of each test case through the flow as well as associated data values.

Decision flow supports the integration of predictive analytic models using SAS Model Manager (these can be SAS, PMML or R models as a result) as well as SAS code and external web service calls.

Multiple Deployment Options Are Available

Once business rules and predictive analytic models have been integrated into a single Decision flow they must be deployed. SAS Decision Manager allows the same business rules and analytic models to be deployed to both batch and interactive environments without additional coding. A wide range of environments are supported for deployment including:

- ▶ SAS data integration can execute business rules nodes as part of an ETL flow (the SAS Data Integration client is bundled with SAS Decision Manager).
- ▶ Web service deployment for batch or interactive use.
- ▶ Additional deployment options to SAS deployment platforms including LASR, Hadoop, SAP/Hana and in-database deployment are forthcoming.

SAS Metadata Capabilities Are Leveraged and Integrated

SAS has a wide range of metadata capabilities. SAS Decision Manager is fully integrated with the SAS metadata layer. This allows existing data structures, defined in the SAS metadata layer, to be used as the basis for a business rules vocabulary. This ensures that business rules are being written against the existing data structures defined and in use for analytic model development, reporting and master data management. By sharing the same view of the data, analytical modelers and rule authors can reduce the time required to develop, test, and deploy decisions.

In addition, any predictive analytic model already registered in the metadata layer can be included in a Decision flow and Decision flow nodes can access any table object defined in the metadata server. The metadata server is included in the product as a foundation capability or SAS Decision Manager can be integrated with an existing SAS metadata server.

Within the single browser-based environment, SAS Decision Manager includes the ability to define new data structures and views on existing data structures in a visual environment as shown in Figure 3, storing the results anywhere in the data infrastructure. These new data structures can then be made available for rules development, for instance.

The sophisticated lineage analysis provided in the SAS metadata layer is available for business rules deployed using SAS data integration capabilities and will soon be

- ▶ Support for SAS, PMML and R models
- ▶ Rich model metadata management
- ▶ Model performance reporting
- ▶ Expanded integration for SASP/Hana and Hadoop deployments

A Single, Integrated, Browser-based Environment

SAS Decision Manager is delivered in SAS' new generation of browser-based capabilities. This means that a single browser-based environment handles all of the new decision management capabilities. This includes writing and managing business rules, managing predictive analytic models, running Decision flow testing, deploying flows into production and more.

In addition this allows users to access other installed SAS products and capabilities from within this same, common environment. This means that features like advanced visualization (SAS Visual Analytics), visual data integration, metadata management and lineage can all be accessed from this common environment. Because multiple windows and tabs can be opened, all of these capabilities can be used at once, giving users a great deal of flexibility when it comes to deciding what to view and how to work on a problem.

Integrated Business Rules Management

SAS Decision Manager includes a comprehensive business rules definition and management capability. This is designed to allow the creation, testing, execution and management of the business rules in a decision.

Business Rules

Rule sets and decision tables are specified using the browser-based editor. Business rules can include group processing as well as business rules for initiation, core processing and wrap-up. Syntax and vocabulary checking are built-in and both interactive and batch testing is supported. The editors support check-in/check-out, versioning and comments. Rule sets and decision tables can be combined into simple sequences, rule flows, and packaged up for use in Decision flows or in data integration flows. Business rules can be published for execution in batch, as a web service using SAS stored process technology, or in database using separately licensed SAS Code Accelerator technology.

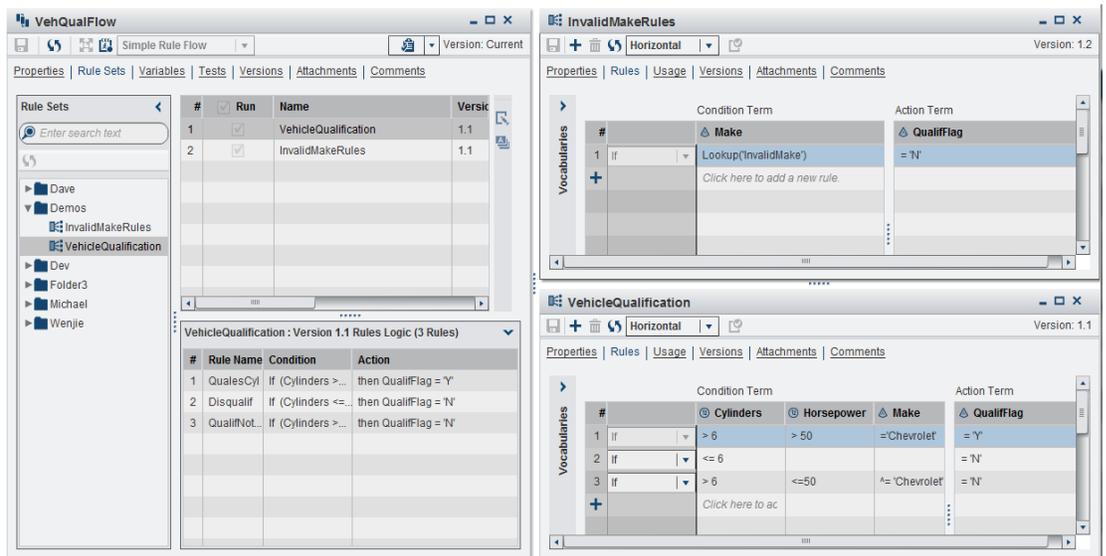
Vocabularies

This business rules capability supports the definition of vocabularies, business rules and decision tables, simple and complex rule flows as well as testing of these elements. Vocabularies can be defined from scratch, through importing definitions in the SAS metadata layer, and automatically generated from data source tables,

allowing immediate access to existing data structures. Business rules are then written against the vocabulary which is mapped to operational data at deployment time, allowing one set of business rules to be re-used with multiple data structures.

To speed development, the technology provides a set of utilities that can be used to import vocabularies, rule sets, and rule flows using a predefined CSV format. This allows users to quickly import these objects in bulk to speed development. These utilities, SAS Macros, also support the export of these objects for editing or manipulation in CSV editor formats.

Figure 6: Business Rules Management

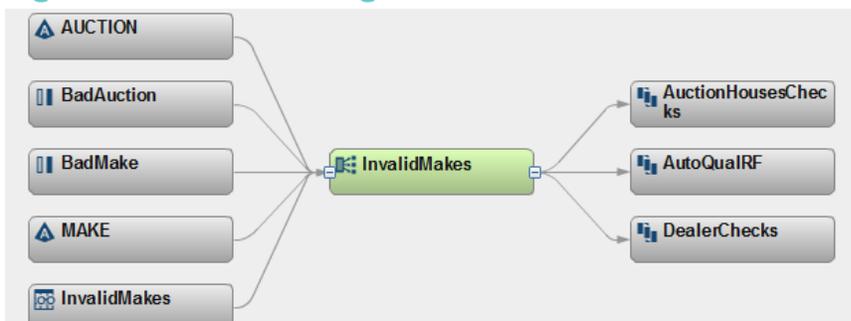


Source: SAS

Rule Lineage

Understanding the downstream impacts to changes to business rules is greatly enhanced with the ability to visually represent the relationships with business rule sets shown in Figure 7. Before making changes, analysts can view the objects used by a rule set and can also understand where the rule set is in use to better understand impact of proposed changes. Impact analysis can assist with test coverage and deployment timing of the affected downstream objects.

Figure 7: Rule Set Lineage



Source: SAS

Advanced Predictive Analysis Integration

One of the core use cases for SAS Decision Manager is to speed the deployment and integration of advanced analytics, especially predictive analytic models, developed using SAS. SAS Decision Manager is integrated both with SAS's data mining and other SAS advanced analytic capabilities.

Model Management

- ▶ Any SAS data mining model developed and registered with the metadata layer is immediately available in SAS Decision Manager using the model management capabilities.
- ▶ Decision flow can include nodes representing these individual models as well as nodes containing custom SAS code representing an analytic model.
- ▶ Models developed using R or developed outside the SAS environment and imported using PMML can be likewise registered in the metadata layer and used in SAS Decision Manager.

In addition the results of decisions are also stored in the repository providing information that can be mined later for additional predictive modeling using data related to the decisions that have been made.

Data-driven Rule Discovery

Many business rules can be derived from the analysis of historical data. The time required to enter such business rules manually is greatly reduced by utilizing advanced analytics to discover and generate business rules. SAS Decision Manager offers data-driven discovery techniques that allow users to discover new business rules without having to leave SAS Decision Manager or manually enter the rules. Analytical techniques including decision trees, market basket, RFM (recency-frequency-monetary), and scorecarding can be used to

Figure 8: Guided Rule Discovery

Rule Name	Operator	Term	Value
Implement Rule 1 in CHIF		C_bourbon	= 1
	THEN	Support	= 22.2222222222222
	AND	Confidence	= 100
	AND	RuleClusterIndex	= 1
	AND	A_peppers	= 1
Implement Rule 2 in CHIF		C_chicken	= 1
	AND	C_peppers	= 1
	THEN	Support	= 22.2222222222222
	AND	Confidence	= 100
	AND	RuleClusterIndex	= 1
	AND	A_comed_b	= 1
Implement Rule 3 in CHIF		C_peppers	= 1
	THEN	Support	= 22.2222222222222
	AND	Confidence	= 66.6666666666666
Implement Rule 1 in CHIF		C_ice_crea	= 1
	THEN	Support	= 22.2222222222222
	AND	Confidence	= 100
	AND	RuleClusterIndex	= 2
	AND	A_sardines	= 1

Source: SAS

derive business rules, providing greater precision and easier business rules creation. As shown in Figure 8, users can experiment with these data-derived rules and can explicitly edit them for maximum user control.

Built-in Data Integration

With the data integration available in SAS Decision Manager, any defined rule flow can easily be deployed as part of a standard data integration routine.

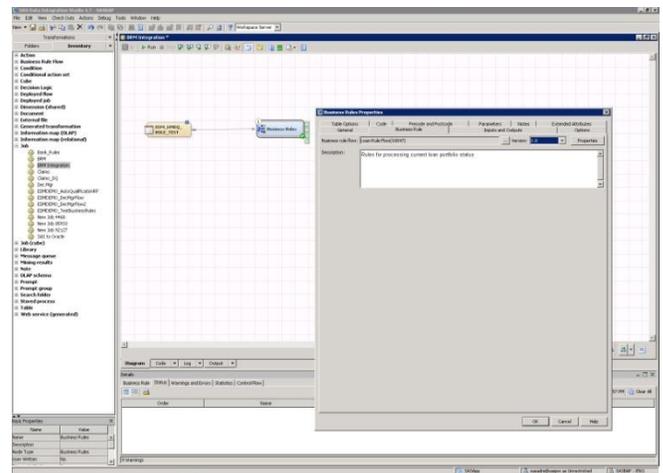
SAS data integration within SAS Decision Manager uses a pre-built transform to depict the business rules in the repository, allow a user to select the appropriate rule sets or rule flows, map data from the flow to the vocabulary used in the business rules and the rules will then execute in the data integration flow. From within the data integration environment, users can see how the business rules fired, what results were achieved etc.

This allows business rules to be easily used in data integration, allowing business-level transformations to be managed using business rules while more technical data transformations are handled by the established data integration tools.

Workflow Automation

In addition to the key features outlined above, SAS Decision Manager has been integrated with the SAS workflow tool to support governance processes. These workflows can either be the standard workflows for review, approval, champion/challenger etc provided as part of SAS Decision Manager or can be custom workflows published from the included SAS Workflow Studio. Once the workflows are attached to business rules or model projects, an inbox displays tasks assigned to the current user (or to their group or that are unassigned). The inbox displays a graphical view of the task in its workflow context as well as its current status, assignments and available actions. The user can then change the status of their tasks as they complete them, moving the project through the workflow. An administrative view provides a more detailed overview.

Figure 9: Data Integration Support



Source: SAS

Availability

SAS Decision Manager V2.2 is built on SAS 9.4 and takes advantage of a number of components released with SAS 9.4 including:

- ▶ SAS Visual Analytics 6.2 (including the Visual Data Builder 6.2)
- ▶ SAS Model Manager 13.1
- ▶ SAS 9.4 Foundation
- ▶ SAS Data Integration Studio, Version 4.9
- ▶ SAS Real-Time Decision Manager 6.3

In this release all the major components of SAS Decision Manager will be updated

- ▶ SAS Decision Manager, Version 2.2
- ▶ SAS Business Rules Manager, Version 2.2
- ▶ SAS Model Manager, Version 13.1

In addition SAS is working to include aspects of SAS Decision Manager in its solution portfolio.

Works Cited

Taylor, J. (2013). *Decision Management Systems Platform Technologies Report*. Palo Alto CA: Decision Management Solutions.

Taylor, J. (2011). *Decision Management Systems: A Practical Guide to Using Business Rules and Predictive Analytics*. New York, NY: IBM Press.

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