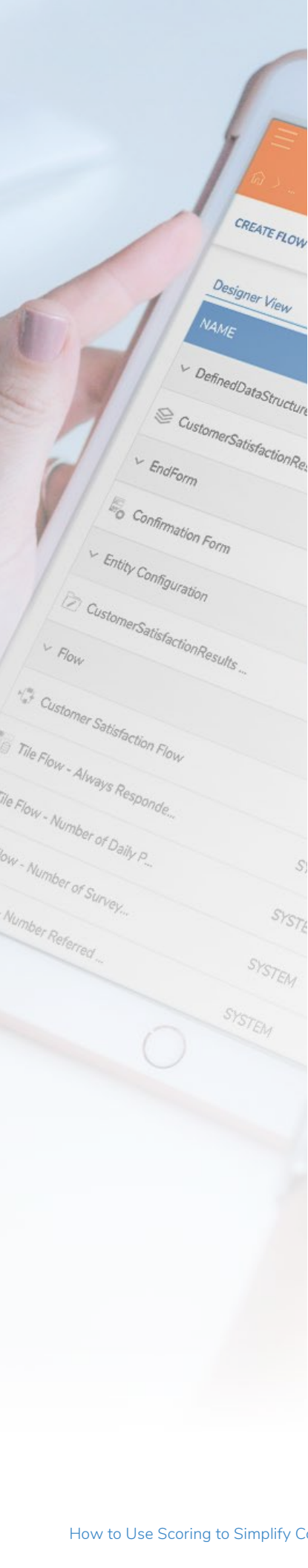**WHITEPAPER**

How to Use Scoring to Simplify Complex Business Rules in Process Automation

Business rules are vital tools for streamlining operations but one particular type of business rule has unique attributes that can help summarize complex data. This is the scoring rule. Much like any business rule, it takes input and produces a decision, but features additional capabilities. The differences between a scoring rule and a normal business rule can be defined as:

- Scoring rules can produce very rich results. With scores, multiple data points and decision points entities can be expressed in a single output.

- By analyzing historical data, scoring rules can also produce scores that quantify the probability of a certain outcome. This could be the probability that a loan is paid back or the likelihood a student is successful at a university.

Scoring Introduction

All organizations use business rules, policies, and processes to operate. Some are simple, but others can be very complex. These complex rules are often a composition of multiple individual decisions that are combined or analyzed to produce a much more nuanced and complicated result.

When a complex scoring decision is made, it often incorporates things like:
- Factors - data inputs that influence the decision

- Calculations - mathematical operations used to manipulate factors

- Elements - individual decisions

These items are combined together to produce a result and each item influences the final result in its own way. Understanding how scoring rules and models work is very important in applying it effectively. Only with the ability to evaluate each element independently can a granular explanation of the result can be surmised.

Let's take a credit score as an example. A credit score is a number that represents how likely a loan is to be paid back. It is based on a number of factors such as current debt level, number of late payments, and duration of current residence. Credit scores are also made up of a number of elements which can be examined in detail to understand what constitutes the score.

APPLYING SCORING RULES

Applying scoring rule sets can be a key process in an organization and are quite complex. But, not all decisions are important or complex enough to require a scoring rule and a simple business rule will suffice. Take the following two decisions as it relates to a university setting:

- Is a student going to be offered admission?
- Is a library fine due?

Both of these questions require rules to answer but only one of them requires a complex set of rules and is core to the mission of the organization.

Who makes up a student body is much more complex and important than the status of a library book. To optimize the process, scoring rules are often used to improve decision making in admissions offices. Based on historical values and experiences, scoring rules can be developed to measure the likelihood a student will be a good addition to the student body. If the score meets a certain standard an offer for admission can be extended. Scoring can also support additional decisions. For example, if the probability is high that the student will make a very positive impact they may be offered a scholarship and if the student is less likely to to make a positive impact than other applicants they might get waitlisted.

The admission decision may consider a wide range of factors including: academic record, which courses have been taken, academic record in relevant courses, ethnicity and gender, financial status, volunteer work, references, geographic location, standardized test scores, and others. While all these factors influence an applicant's score, not all of them are as important in identifying the strongest applicant or most likely to add value to the university. Some factors may be less meaningful while others more important.

Contrast this complexity with a library fine. This one is simple. The rules around library books are not complex because the data 100% predicts the outcome. If the book is late, a fine is due, there is no gray area. The fact that a book is overdue also has very little impact on the central mission of a university. No need for a scoring rule here.

Because scoring rules are applied to such complex and important processes they need to be analyzed and the nuances of each decision has to be clearly understood to ensure the best outcomes.

Basic Scoring Strategies

Scoring rules are a combination of smaller elements that are combined together to produce a final result. Each of the elements in a scoring rule set have some commonalities:

- They all start with the same basic set of data
- They all output data used as inputs into the overall result

Scoring rule sets can also be made up of compositions of other scoring rule sets. For instance, a payment history might be scored to produce a number that is an input for the overall credit score.

Scoring is fundamentally a concept of the coordination of individual decision points - whether simple or complex - and the processing of these values forms the overall result or decision.

COMBINING RULES

The manner in which the resulting scores of individual elements are combined is often as intricate of a process as defining the individual elements themselves. Sometimes the interrelation of two or more elements provide greater meaning. For example a student with good grades who participates in extracurricular activities but may not have the best SAT scores may be a better candidate than a student with top SAT scores.

In more extreme cases one element may be a terminal decision in an overall rule set. For example, one element may dictate that felons are not acceptable, terminating the process for an applicant who has committed a felony, even if their SAT scores are exemplary.

The way scores are combined has a significant impact on the outcome so understanding the implication on how scores come together is important. Some of the simpler ways scores are combined include:

- **Total Score** - Adding up the number of scores
- **Percentage** - The total score divided by the highest possible score
- **Voting** - Total number of 'affirmative' results in the rule set
- **Lowest Score** - Evaluate for any scores that are below the minimum

Using Total Score can be the simplest way to combine scores but an obvious problem arises as new elements are added; the total possible score changes providing less meaning to historical results. Using a percentage can avoid this pitfall and make adding new elements much simpler.

Lowest Score thresholds can also be applied to scoring rules that would automatically disqualify an applicant if a score is below a minimum. For instance, even if high scores are made on the SAT test and all other factors are good, there may be a minimum number of high school credits needed for admission.

A common first step to move past these simple combination patterns is to provide weighting. By increasing or decreasing the weight of each element based on predictability, the overall computation of the score can be tweaked. For example, when calculating a credit score, work history score may be low, but it does significantly impact the likelihood of repayment, consequently it may only account for 5% of the score.

CONNECTING RULES

Often scoring rules can be used to make more than one decision or can be applied in more than one context. To use the university admission scoring example again, there may be different sets of rules for the college of engineering and the college of education. They may share some common elements but thresholds and inputs might be different based on the context. A high score on the math section of the SAT's is going to produce a different score for engineering students compared to education students.

There are two main scenarios when connecting rule sets is practical:

- **Shared rules** - Where there are shared rules between two sets of logic but adjustment to each set may be required. Adjustments may include excluding an element or providing a different comparison value to a rule to identify differences. Adding rules to the terminal nodes to extend the logic might also be a necessary adjustment to the rule.

- **Compared rules** - Where there is a desire to compare scores against a number of different scores to find the best match. For instance, comparing a score on an insurance application against metrics that rate a number of different policies to determine which one is most suitable for the applicant.

Understanding the Rule Logic is Vital

To better understand the elements of a scoring decision the rule set might be thought of as a tree instead of a list. In this analogy, consider elements as branches that come together to form limbs that connect to the trunk of the tree which represents the final score.

If we take our college application scoring example, the score could be made up of 3 primary factors:

- Academic Record
- Standardized Scoring
- Personal Evaluation

Each of these might have different weights; personal evaluation representing 40% of total score, for instance. Each factor might also consist of a number of different elements or even other scores.

To understand how the rule engine arrived at a final score we need to drill into a specific limb of the tree and examine each branch to find out which decisions had the greatest weight and influence on the final output. For example, knowing that a candidate dropped out of boy scouts and quit the football team which resulted in a lower personal evaluation score would provide significant insight into why an applicant's overall score was lower than one might expect.

As rules get more complex, if well constructed, the elements that make up the scoring decision can be identified and the level that they influence the result can be understood. Understanding what factors have the greatest influence on predicting the likelihood of an outcome also informs decision makers and analysts on how models and assumptions can be adjusted to incorporate new data. For example, if a candidate received a marginal admissions score but went on to be

a high performing and valuable student, assumptions can be re-evaluated to see why such a standout student didn't get a score that reflected his or her potential. Understanding what elements dragged down the students' score enables admissions teams to adjust weighting to ensure that high performing students are not overlooked in the future.

It is important that scoring models and the elements that support them be accessible so they can be analyzed and understood. While combining elements, logic based inclusions and exclusions, and custom calculations are important, any scoring tool can compute the individual decisions. What separates a rule engine from a scoring solution is the ability to process the results of decisions and provide filters to identify which, if any, elements of the decision are to be included as an explanation for the result.

Scoring rules can also be built into application code. With this approach, rules are much less accessible and any change needs to be done by a developer and cost and time.

HOW ACCESSIBILITY OF RULE ENGINES CAN HELP SCORING

One of the primary advantages of using a rule engine is that rules and how they are defined and executed, are described in a way that is equally understandable to business and technical staff members. Business rules can also be searched and older versions can be examined to provide a clear history of how rules evolve. Rules can also be tested and can be read and edited by non-technologists. This is useful for simple rules but is critical for complex, multi-part decisions like a scoring decision. If a rule has a number of individual decisions each with information about how a specific decision participates in the overall result, it can get very challenging to manage. Having these elements scattered in different technology or buried in programming language also makes it difficult for the business stakeholders to have visibility beyond how logic is defined, limiting insight into how it actually runs. Keeping rules in a black box limits the flexibility of the rule model.

Mechanics of a Rules Stack

Rules engines do not operate in a vacuum but function in a decisioning stack.
They need to be incorporated into systems that create workflows, integrate data and present an interface for end users.

Rule engines are tuned to make specific decisions and the process of combining various elements is delegated to the calling application. The application logic rolls up individual decisions or runs sets of rules. This can be as simple as a piece of logic that runs through a list of rules and executes them to as complex as a process that selects rules based on conditions, weighs and combines the results to produce a more complex decision.

The result of a scoring decision can be handled with a workflow. A workflow processes information through a series of steps with people interacting at some points and software automating at others. Rules can be used as conditions to inform a workflow on which steps to take based on imputed data. Workflows can also be used to gather additional information by user or system interactions for the purpose of re-running scoring decisions.

While by definition there is a basic set of data that is presented to the scoring system overall, the elements of scoring may need to gather additional information. The scoring system may also need to incorporate logic from external systems to make the decisions needed to produce inputs to the overall scoring rule set. Modern rules engines typically have multiple ways to integrate data from various systems to drive decisions.

If a scoring ruleset is to be useful, it needs to be run in some active context, like a website or an application. Users will rarely interact directly with a scoring rule engine because a rule engine lacks the interfaces and the context to determine how the resulting evaluations are to be used. Applications can leverage a service interface to call the scoring rule set to present the results to users.

Scoring rules can be very powerful tools for managing complex decisions as multiple inputs can be rolled up to a single output. While a score can simplify the complex, the nuance of how the decision is made remains. A simplification of the numerous factors that influence a decision comes with risk. When leveraging scoring strategies, users must have a good understanding of the model behind the score to ensure it is producing the best outcomes.

To learn more about how different ways to build individual business rules that drive scores take a look at our whitepaper on Basic Business rules.

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