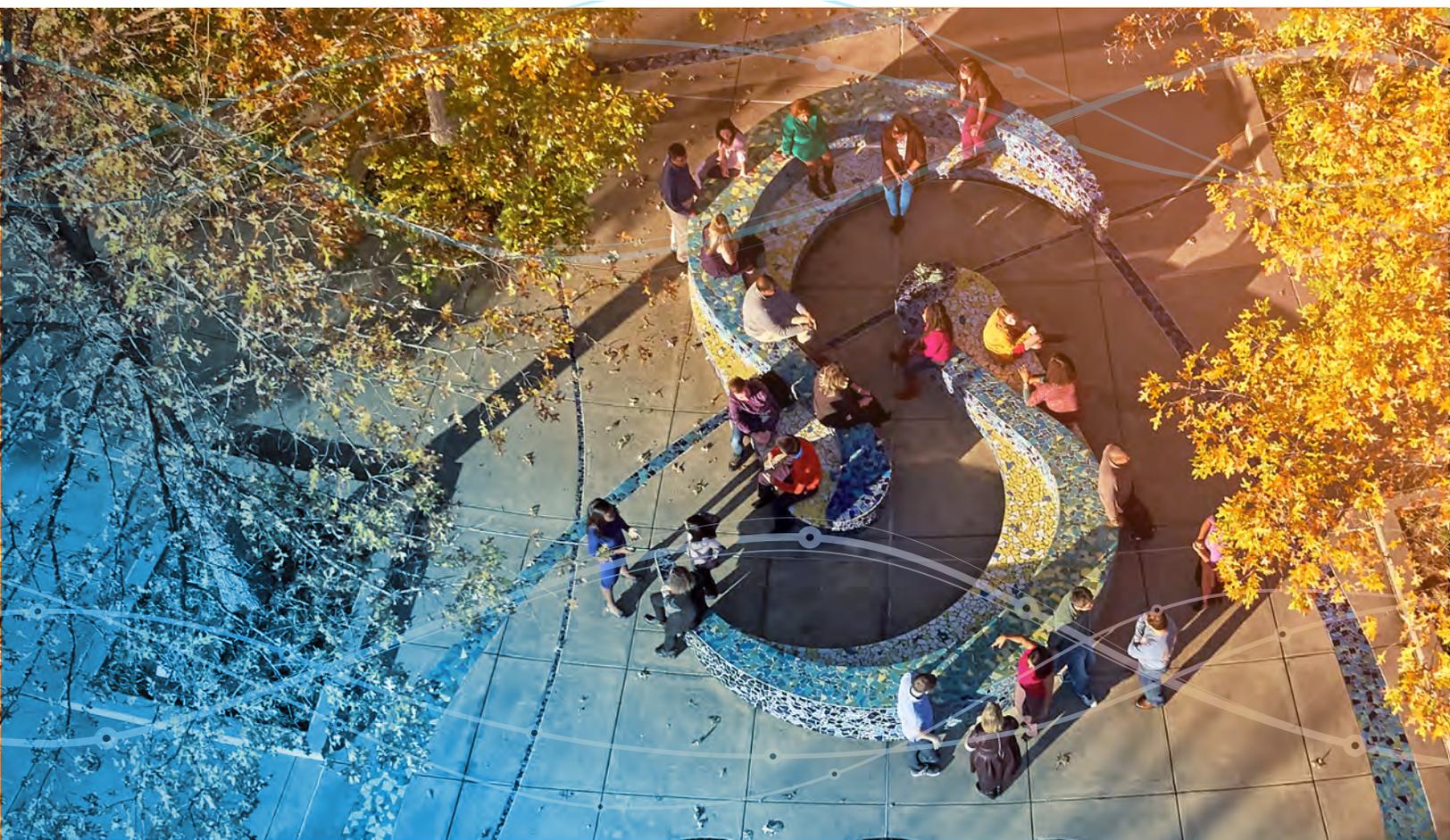# The Quality Imperative:
SAS Institute's Commitment to Quality

A corporate statement of SAS' commitment to product quality, service quality, and customer satisfaction

The Foundation of Quality Development

The Foundation of Quality Development

This section outlines key underpinnings of quality software development at SAS, including external and internal standards, reliability and accuracy in algorithms and artificial intelligence, and project team organization and oversight.

Technical Industry Standards

SAS continuously monitors external technical industry standards and engages with regulatory and governing organizations to inform the evolution of SAS' internal quality processes, including:

- Standards and process organizations such as International Standards Organization (ISO), National Institute of Standards and Technology (NIST), and System and Organization Controls (SOC).
- Government regulations and programs such as the FDA Code of Federal Regulations and the Federal Risk and Authorization Management Program (FedRAMP).
- Security organizations and frameworks such as Open Web Application Security Project (OWASP), National Vulnerability Database (NVD), and Common Vulnerability Scoring System (CVSS).
- Global privacy laws such as General Data Protection Regulation (GDPR) and California Consumer Privacy Act (CCPA).

SAS continuously updates internal policies and standards as technology evolves and customers' needs change, through:

- Continuous monitoring of industry standards, such as ISO, NIST, and FedRAMP, and incorporating applicable processes and controls across SAS where appropriate.
- Maintaining strategic and cooperative relationships with leading hardware and software manufacturers to establish effective integration and performance.
- Contributing to legislation and requirements through active participation in committees and organizations.
- Encouraging and supporting employee membership in professional organizations and committees.

R&D Policies, Standards, and Processes

R&D uses internal policies, standards, and processes to ensure that consistent development methods, architectural components, software engineering processes, and tools produce quality deliverables for customers. Figure 1 illustrates the relationship between policies, standards, and processes and the software development life cycle.
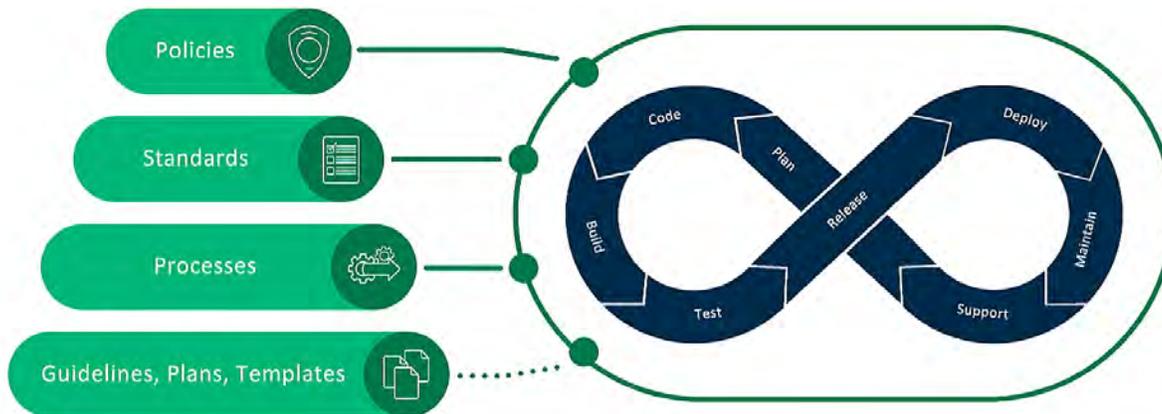
Figure 1: R&D Policies, Standards, and Processes.

R&D policies, standards, and processes are required aspects of software development, and provide foundational consistency for coding practices, software security, accessibility, user interfaces, and other factors. They are formally documented and continually reviewed, refined, expanded, and enhanced. Guidelines, plans, and templates are less formal documents, as indicated by the dotted line in Figure 1. They are specific to the software under development, and they help ensure conformance to required policies, standards, and processes.

Accessibility

SAS is committed to enabling people of all abilities to access the power of analytics. To that end, the internal standard for accessibility of products, documentation, training, and support materials uses the **Web Content Accessibility Guidelines (WCAG) version 2.1** at the A and AA levels of conformance.

R&D staff receive training in accessibility technologies, such as Accessible Rich Internet Applications (ARIA, a specification from the W3C). Internal training on WCAG, keyboard operations, software accessibility, and web accessibility is available. Internal training on effective testing with assistive technologies, such as screen readers and voice input devices, helps testers validate adherence to accessibility standards. Product test suites include an accessibility test plan. Using a standard test case, products are tested to evaluate functional performance with assistive technologies.

There is a central accessibility team within R&D. This team defines product requirements, coordinates training, establishes guidelines and checklists, assists in testing applications for compliance, and works with customers to address accessibility questions.

The SAS Disability Support Center (**https://support.sas.com/accessibility/**) provides direct access to the latest information about the accessibility of SAS products. It includes links to user documentation for accessibility features, webinars, training, and much more. Users with disabilities can also email the central accessibility team directly at **accessibility@sas.com.**

Software Globalization

Software globalization refers to the process of designing and developing applications that function for multiple cultures. This process consists of two core functions: internationalization (i18n) and localization (l10n).

Internationalization entails designing and implementing software so that the English version of the software functions properly and processes data correctly for any locale or region of the world. Internationalization also ensures that the software is designed so that it is ready for the localization process.

Localization, on the other hand, is mostly driven by market demand. It is the process of adapting software for a particular geographical region or locale. Translation of the user interface, system messages, and documentation is a large part (but not all) of the localization process. Most importantly, not all global markets require that the product be localized (translated) into their native language.

At SAS, software globalization teams around the world spearhead efforts to drive quality and best practices in this area in the following ways:

Internationalization:

- Publishing and curating internationalization R&D guidelines and best practices
- Providing software components that handle character data correctly, regardless of the character encoding
- Supporting collation of data according to expected linguistic or cultural guidelines
- Presenting dates, times, and numbers in a format that meets cultural expectations
- Processing character data for one language or many languages equally well
- Supporting the ability for customers to translate a single report into many languages
- Executing formal test plans in English and other locales simultaneously during the development cycle in order to detect cultural or language bias in SAS software as early as possible
- Exercising SAS products using character data from many languages

Localization:

- Localizing software on a schedule that allows for simultaneous delivery with English
- Maximizing reuse of translations to ensure consistency and a higher quality user experience
- Testing localized versions of the software in country to provide higher quality translations

Software Security

To design, deliver, and maintain products that meet customers' security requirements, all R&D product teams are required to comply with internal software security policies, standards, and processes. SAS uses the following publications to help product teams evaluate and remediate security weaknesses and vulnerabilities:

- Open Web Application Security Project (OWASP) Top Ten Project
- SANS Top 25
- Common Weakness Enumeration (CWE™)
- Common Architectural Weakness Enumeration (CAWE)
- Common Attack Pattern Enumeration and Classification (CAPEC™)

For more information, see the papers and links highlighted on the SAS Security Assurance website (**sas.com/security-assurance**). Details on testing for compliance with internal software security policies, standards, and processes are found in this paper's **Software Security Testing** section.

Third-Party Software

The Third-Party Software standard mandates a process for evaluating and managing third-party and open-source software that is used internally for development activities and/or incorporated into production offerings. This process applies to any open source, closed source, and/or freeware that is developed by an entity other than SAS. It plays an important part in protecting SAS and SAS customers by evaluating third-party software against a pre-defined set of legal, business, and technical guidelines.

Terminology

The SAS Terminology Standard specifies that all SAS software and supporting materials must be written in a way that does not contribute to social biases with the use of insensitive language. SAS uses bias-free language guidelines, incorporating style and grammar that reflect the diversity of the wider SAS community, both internally and externally.

User Interfaces

SAS follows a user interface standard that is based on research, usability testing, and other disciplines. This standard is compiled with input and approval from the user experience design, visual design, accessibility, documentation, internationalization, and legal teams. The SAS user interface standard affects the following areas:

- User interaction and visual design
- Accessibility
- Embedded user assistance and terminology
- Internationalization
- Legal notices

Following this standard promotes these results:

- Ensures that SAS products are usable
- Establishes a consistent look-and-feel for SAS products
- Provides a high-quality user experience to all users

Algorithm Choices

SAS staff reviews the relevant literature and evaluates established algorithms for numerical stability, time requirements, and space requirements. Algorithms are chosen that provide the best combinations of these sometimes conflicting requirements. If satisfactory algorithms are not found in the prevailing literature, then SAS staff may perform research to develop better algorithms in-house. All algorithms in SAS software are tested extensively. Furthermore, the analytical and statistical software documentation provides sections that cover computational details and references to source literature.

Numerical Accuracy

SAS' uncompromising pursuit of accuracy has firmly established SAS software as one of the most reliable products on the market today. Extensive use of SAS software in medical and pharmaceutical research, government statistical reporting, and government and academic epidemiological studies attests to customers' confidence in the accuracy of SAS software.

Two of the most critical issues in software development, especially for analytical software, are the accuracy and reliability of results. In this context, accuracy describes the degree of agreement between the reported result and the unique true value, if such exists. Sometimes, rather than a unique solution, any solution from a set of solutions is also acceptable. Reliability is a more subjective measure, considering the degree of confidence in the accuracy of the result.

There are two factors that affect the accuracy of a computed result. The first factor is the hardware's ability to represent real numbers in finite precision. Not all real numbers can be represented in binary finite precision, and that means that representation of real numbers might introduce errors because of binary rounding. Arithmetic operations might also introduce rounding errors.

The second factor is the software itself. Internally, for analytical computations in SAS software, all numeric representations, functions, and operations are calculated by using double-precision, floating-point arithmetic that offers the maximum level of precision provided by the underlying architecture. Although single-precision arithmetic allows only 6 to 7 significant digits, double-precision arithmetic allows 15 to 16 significant digits. Accuracy might be further limited by the algorithms that are selected and by the implementation strategies. Algorithms must be chosen carefully and coded to achieve optimal performance, as measured by speed, efficiency, and precision.

At SAS, developers carefully select and code efficient algorithms for numeric operations to guarantee a reasonable number of correct digits and the maximum domain of evaluation on most machines. When the software cannot guarantee this predetermined level of accuracy, the software is designed to return a missing result rather than a potentially inaccurate result.

In response to industrial concerns about the numerical accuracy of computations from statistical software, the National Institute of Standards and Technology's (NIST) Information Technology Laboratory provided data sets with certified values for a variety of statistical methods (NIST 2007). As one of many approaches to ensure accuracy, SAS integrates NIST data into automated tests and compares SAS results to the results that are supplied by NIST.

Developers take steps to verify that SAS works correctly with operating system datetime functions. In general, developers rely upon operating system datetime values and perform checks to ensure correct functioning for special situations, such as daylight savings time.

SAS procedures have numerous options that alter the nature and extent of output. However, the same output is always produced with the same options, even across hardware and operating systems within standard machine precision limits (typically 1E-12 or smaller). This assumes that the same random number seed is specified for algorithms requiring pseudo-random number generation.

For more information about validating a statistical procedure, see **Appendix 2: Validating an Analytical Component**.

For more information about numerical precision, see the technical paper "Assessing the Numerical Accuracy of SAS Software" (**http://support.sas.com/rnd/app/stat/papers/ statisticalaccuracy.pdf**)

Responsible Artificial Intelligence

Artificial Intelligence (AI) has been an integral part of SAS software for decades, helping customers in every industry capitalize on AI advancements. SAS is committed to the development, implementation, and promotion of responsible AI solutions that help ensure sustainable improvements for our customers, the economy, and society.

In 2019, SAS announced a $1 billion investment in AI over three years. This commitment builds on SAS' already strong foundation in AI that includes:

- Advanced Analytics
- Machine Learning
- Deep Learning
- Natural Language Processing
- Optimization
- Forecasting
- Computer Vision
- Data Lineage
- Model Governance

As SAS continues to drive the future of analytics, SAS' innovative AI capabilities address the imperative towards the responsible development and implementation of AI. With this expertise, SAS engages with worldwide policymakers and regulators to help shape future AI regulation and ensure that SAS and our customers remain in the forefront of these developments.

Organizations should operationalize AI in ways that are fair, transparent, accountable, and carefully managed. SAS has the resources and expertise to help our customers customize and implement our products in ways that help them meet their needs and comply with applicable legal requirements. SAS also supports customers with complete and comprehensive training on responsible use of AI, model management, and interpretation.

Whether AI solutions are built by SAS or in collaboration with our customers, diverse teams are more likely to create solutions that anticipate unfair bias and take steps to avoid or mitigate it. SAS' diversity and inclusion efforts encourage multidimensionality both within SAS and beyond, for example, through SAS' investments in fostering diversity in STEM talent.

Shared Sublibraries and Code Reuse

We have a rich tradition of reuse, and we regularly use our prior work as the building blocks of innovations in applications. SAS software products share the same sublibraries or components. As a result, there is a high incidence of code reuse. Developers are encouraged to reuse routines when possible. Each routine is tested in the development environment and then across supported operating environments. We have several reuse categories of shared components:

- Golang libraries
- MultiVendor Architecture (MVA) and threaded kernel (TK) libraries
- SAS and SAS Component Language (SCL) code
- .NET
- Java libraries
- JavaScript libraries

Low-level, reusable modules are unit tested and then used in developing more complex modules. Shared components are tested on machines with multiple SAS releases and are also tested after installing or uninstalling releases. The benefit of shared sublibraries is that a significant percentage of code has been tested collectively across a wide variety of operating and computing environments. SAS is built with source code and components that are reused from release to release. This adds stability to the software because each successive release of SAS software inherits code that has been tested and used in prior releases.

Supporting R&D Quality Development

At SAS, every executive, manager, and product team member are responsible for quality. By intelligently structuring teams and promoting a culture of quality throughout the company, SAS can support and encourage the innovation and creativity that our customers have come to expect.

Product Teams

Product teams are the heart of software development at SAS. Product teams are cross-functional, typically including development and testing engineers, product and project managers, and other roles determined by product functionality and development phase. A loose matrix organization among diverse product teams enables each team to customize processes in an agile manner, while guided by internal policies, standards, and processes. This flexible relationship encourages high degrees of innovation and facilitates knowledge sharing, while ensuring product consistency and interoperability.

Product teams use retrospectives to improve processes and software quality. During the retrospective process, teams discuss project details and identify opportunities for improvement. Teams then develop a concrete plan of action for implementing the changes and following up on the results. Over the course of the software development cycle, teams may perform retrospectives at any or all of these times:

- Periodically within a release cycle
- On a release boundary
- On an ad hoc basis to immediately address a specific issue

In addition to retrospectives, development teams use other continuous improvement methods to improve software quality and the customer experience. These include a focus on personal and professional development, sharing best practices, conducting both internal and external usability reviews, and acting on customer feedback.

Project Management

SAS R&D project managers play a key role, supporting the product team's agile processes and enabling teams to deliver projects on time, within budget, and according to functional and quality specifications. Each offering is assigned a project manager who works with a project team to scope the work and establish a schedule. The scope of work and planned schedule become the foundation for the ongoing tracking and oversight of the project. On an ongoing basis, they work with project teams to identify project risks and develop mitigation plans to address them. When actual status deviates from the plan, project managers work with team management to determine and implement actions to get the project back on course. Examples of actions can include changes in scope, timelines, resources allocation, and so on. Throughout the project, project managers ensure adequate visibility into the overall health of the project via status reporting, project reviews, and surfacing project data to a company-wide scorecard to ensure that the project is meeting the stated goals and objectives. Status reporting and project reviews occur at both the individual team level, as well as at the executive and enterprise level.

Quality and Compliance Team

The R&D Quality and Compliance team advocates for software quality through compliance, education, and facilitation across the wider SAS community.
Activities include:

- Expanding and supporting quality directives and initiatives throughout SAS.
- Ensuring that R&D policies, standards, and best practices are aligned with corporate vision and are defined, communicated, adopted, and measured.
- Achieving, expanding, and maintaining information security and related industry-supported compliance certifications.
- Providing expertise and audit services on quality measures, standards, internal controls, and external certifications.

Quality Review and Oversight

The R&D Executive Team consists of executive representatives from across the R&D organization. This team provides cross-divisional management and oversight of all R&D product releases. The team meets regularly to evaluate the progress, quality, and readiness of upcoming releases.

The SAS R&D Scorecard, visible to all R&D employees, surfaces key quality and progress metrics from each development project. The R&D Executive Team reviews this scorecard regularly to anticipate areas of concern, and develops targeted mitigation strategies, such as resource-balancing across teams, to better help teams deliver on their schedule, feature, and quality commitments. The R&D Executive Team encourages openness and transparency in progress reporting so that teams can comfortably surface project concerns to the R&D Executive Team, confident that the information will be received and dealt with in a fair and positive manner. The Chief Technology Officer is accountable for the overall quality of SAS software.

Release Information
The version of this paper is January 2022.

Unless otherwise indicated, this document relates only to SAS 9.4, SAS Viya, and the products that are available with SAS 9.4 and SAS Viya. It also relates to services from the date of this paper forward. Quality processes are continually evolving. Therefore, SAS reserves the right to modify the processes described in this document at any time. If you are using SAS 9.4 and SAS Viya and have questions about processes in those releases, send email to **qualitypaper@sas.com.**

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