

[PharmaSUG SDE Japan 2022]

# Role of Visualization in Supporting Efficient Workflows across the Life Cycle of Drug Development

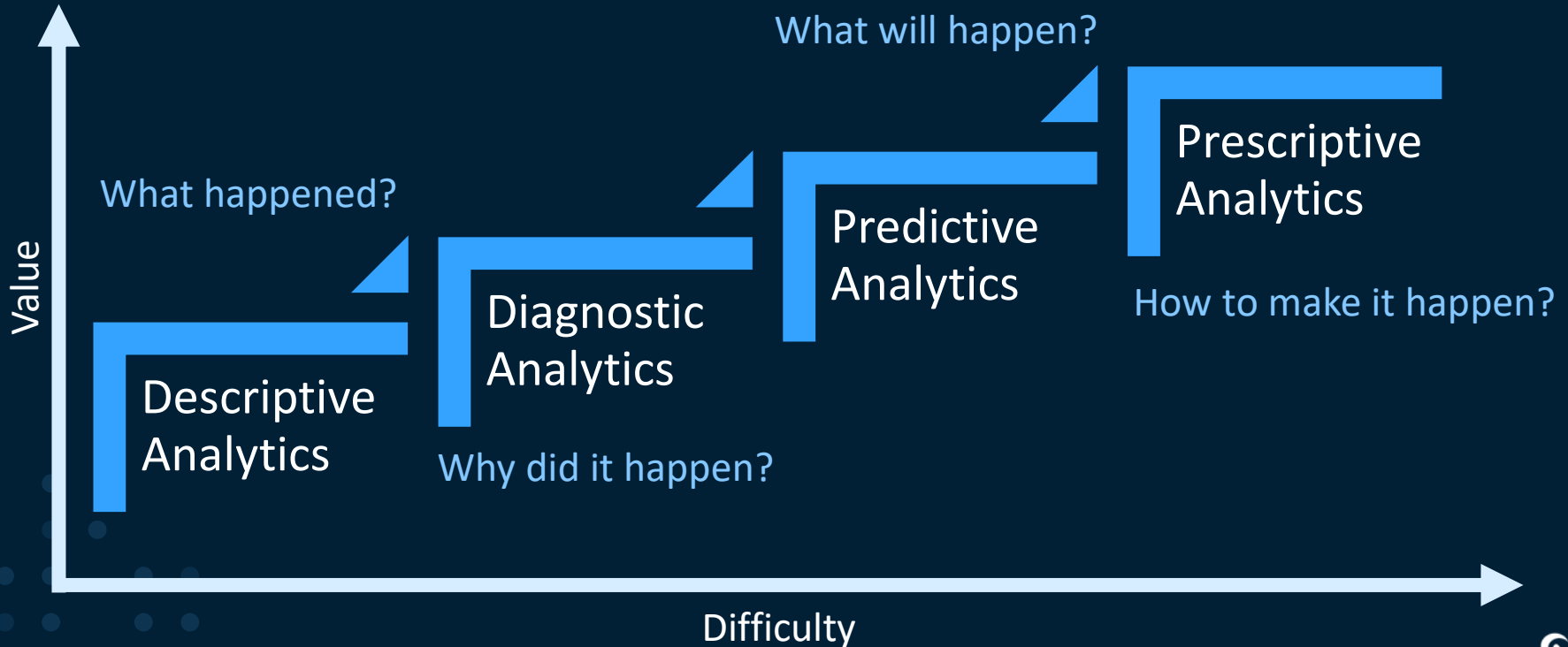
**William Kuan**

Industry Consultant, EMEA & APAC Health and Life Sciences Practice, SAS



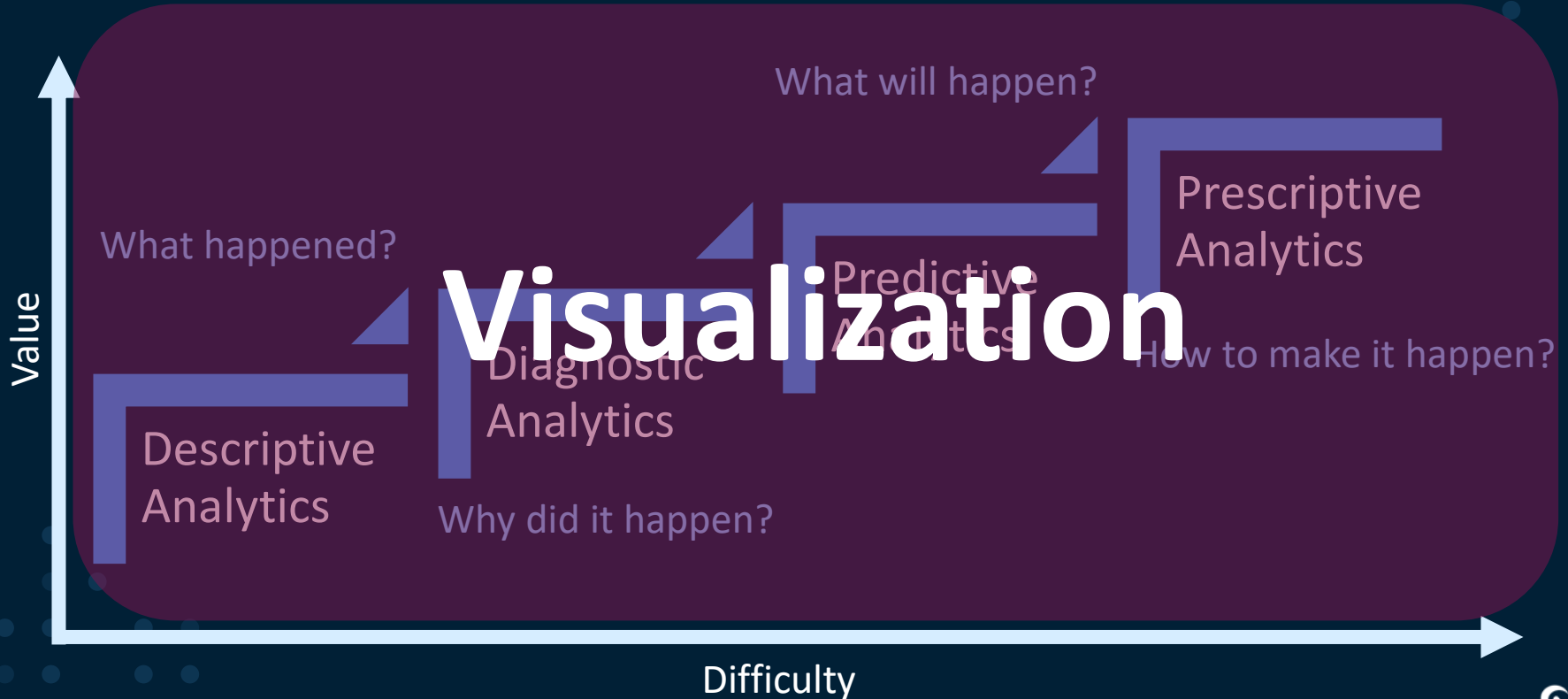
# Introduction

Visualization is not only for Descriptive Analytics

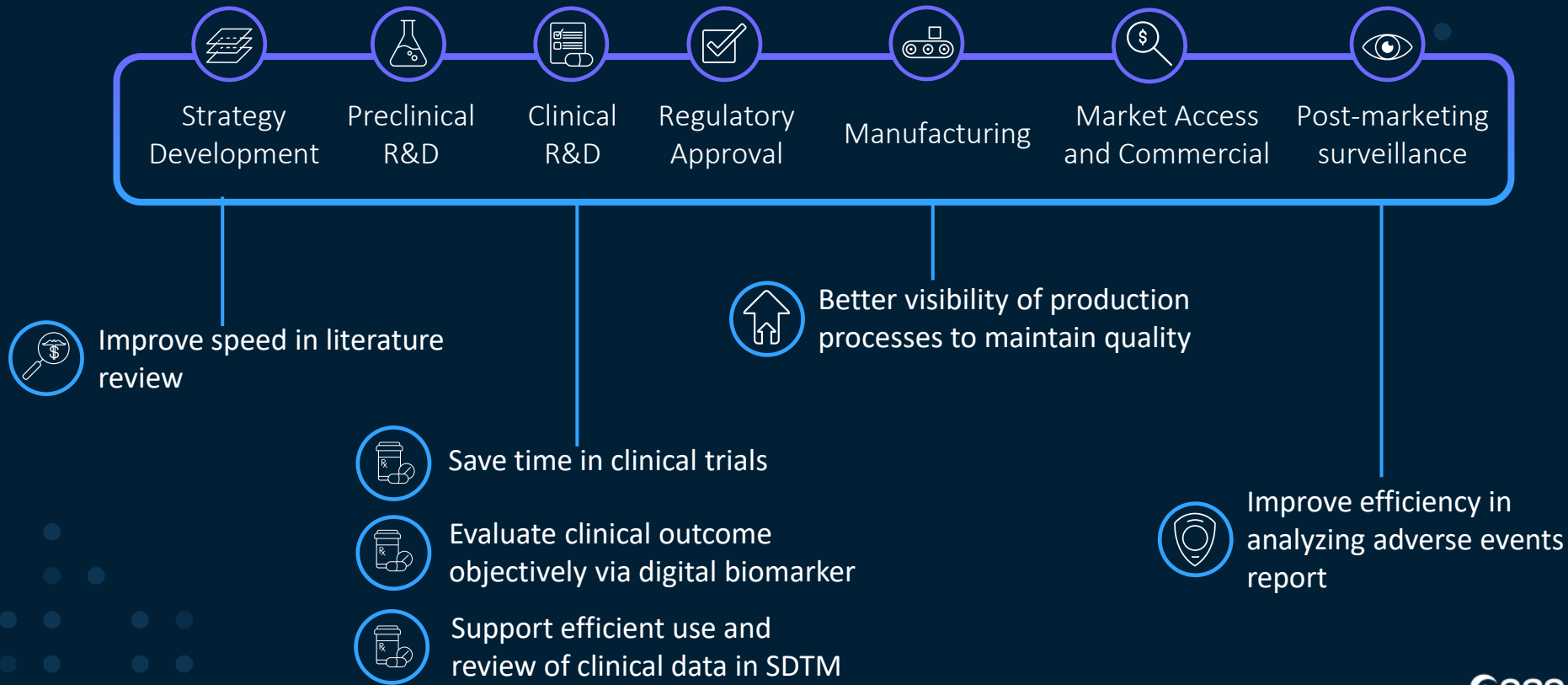


# Introduction

Visualization is not only for Descriptive Analytics

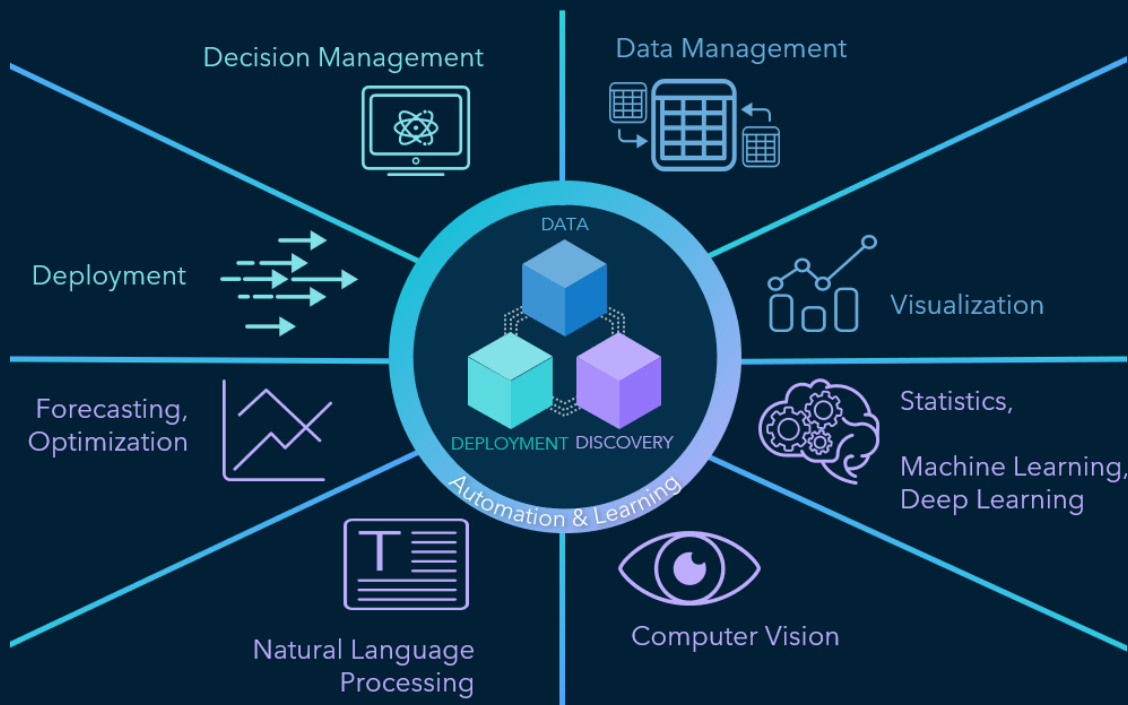


# Visualization Across Life Cycle of Pharmaceutical Product



# SAS Viya – The hero behinds the scenes

SAS Viya is one single platform for all your analytical needs, allowing seamless transition in your analytical lifecycle



- Faster at processing the same workload
- Agile and scalable



# SAS 9 and SAS Viya

## Main Differences

- *SAS Viya products are located centrally and accessed in one user interface (UI)* whereas SAS 9 has multiple UIs to access multiple products
- *SAS Viya is accessed securely through the web*, making it accessible on any device you are using
- The underlying architecture - analytics engine and microservices

# SAS 9 and SAS Viya - User Interface (SAS 9)

## SAS Enterprise Guide

## SAS Display Manager

The screenshot shows the SAS Display Manager interface. The top pane displays system information and notes:

- NOTE: Copyright (c) 2016 by SAS Institute Inc., Cary, NC, USA.
- NOTE: SAS (r) Proprietary Software 9.4 (TS1M5) Licensed to SAS IT, User: P0848195.
- NOTE: This session is executing on the X64\_10990 platform.
- NOTE: Updated analytical products:
  - HW/MTM 14.3
  - HW/LTO 14.3
  - HW/PL 14.3
  - HW/IM 14.3
  - HW/IC 14.3
- NOTE: Additional host information:
  - X64\_10990 WIN 10.0.16299 Workstation
- NOTE: SAS initialization used:
  - real time 2.45 seconds
  - cpu time 1.43 seconds

The bottom pane shows SAS code for a PROC PRINT statement:

```
proc print data=work.data (obs=10);  
run;
```

Additional code includes options like ODS=HTML, ODS=PDF, and ODS=RTN, and a data table definition:

```
data hahaha.revisions;  
  int work.data;  
  drop _all_;  
run;
```

The screenshot shows the SAS Enterprise Guide interface. The top pane displays a project workflow with steps like 'Import Data from SAS9', 'Data Imported from SAS9', 'Chart of ratings', and 'ITM - Chart of ratings'. The bottom pane shows a search results table:

Before Results	Name	Type	Process Flow
<input type="checkbox"/> All	Data Imported from SAS9	Data	Analyze SAS Data
<input type="checkbox"/> Program	Data Imported from SAS9	Data	Analyze SAS Data
<input type="checkbox"/> Data	Data Imported from SAS9	Data	Analyze SAS Data
<input type="checkbox"/> Report	Chart Data	Query	Analyze SAS Data
<input type="checkbox"/> Data	Import Data History	Task	Analyze SAS Data
<input type="checkbox"/> Query	Import Data from SAS9	Task	Analyze SAS Data
<input type="checkbox"/> Saved process	Log	Log	Analyze SAS Data
<input type="checkbox"/> Log	Log	Log	Analyze SAS Data
<input type="checkbox"/> View	Log	Log	Analyze SAS Data

## SAS Enterprise Miner, SAS Text Miner

The screenshot shows the SAS Enterprise Miner interface. The top pane displays a complex workflow diagram with nodes like 'Import Data', 'Data Imported from SAS9', 'Chart of ratings', and 'ITM - Chart of ratings'. The bottom pane shows a search results table:

Before Results	Name	Type	Process Flow
<input type="checkbox"/> All	Data Imported from SAS9	Data	Analyze SAS Data
<input type="checkbox"/> Program	Data Imported from SAS9	Data	Analyze SAS Data
<input type="checkbox"/> Data	Data Imported from SAS9	Data	Analyze SAS Data
<input type="checkbox"/> Report	Chart Data	Query	Analyze SAS Data
<input type="checkbox"/> Data	Import Data History	Task	Analyze SAS Data
<input type="checkbox"/> Query	Import Data from SAS9	Task	Analyze SAS Data
<input type="checkbox"/> Saved process	Log	Log	Analyze SAS Data
<input type="checkbox"/> Log	Log	Log	Analyze SAS Data
<input type="checkbox"/> View	Log	Log	Analyze SAS Data

# SAS 9 and SAS Viya - User Interface (SAS Viya)

## Application Menu

The screenshot shows the SAS Studio application menu. The browser address bar displays `viya4.globalhls.sashq-d.openstack.sas`. The menu is organized into several categories:

- ANALYTICS LIFE CYCLE**
  - Discover Information Assets
  - Manage Data
  - Prepare Data
  - Explore and Visualize
  - Build Models
  - Manage Models
  - Build Decisions
  - Share and Collaborate
  - Develop Code and Flows
- CLINICAL**
  - Simulate Enrollment
- STREAMING ANALYTICS**
  - Design Streaming Projects
  - Manage Streaming Analytics
  - Visualize Event Streams
- ADMINISTRATION**
  - Build Custom Graphs
  - Manage Themes
  - Explore Lineage
  - Manage Environment

## SAS Studio

The screenshot displays the SAS Studio interface with a code editor on the left and a results window on the right. The code editor shows SAS code for training and evaluating a model. The results window displays the AUC (Area Under the Curve) for the ROC curve, along with a plot of the ROC curve.

ROC Curve (using validation data)	
model	Area Under ROC
Train	0.917132
Calibration	0.918842
SM	0.880947
Residual	0.920909

The ROC curve plot shows the True Positive Rate (Y-axis) versus the False Positive Rate (X-axis). The plot includes a diagonal line representing a random classifier and several curves representing different models: SM (green), Calibration (yellow), Train (red), and Residual (blue).

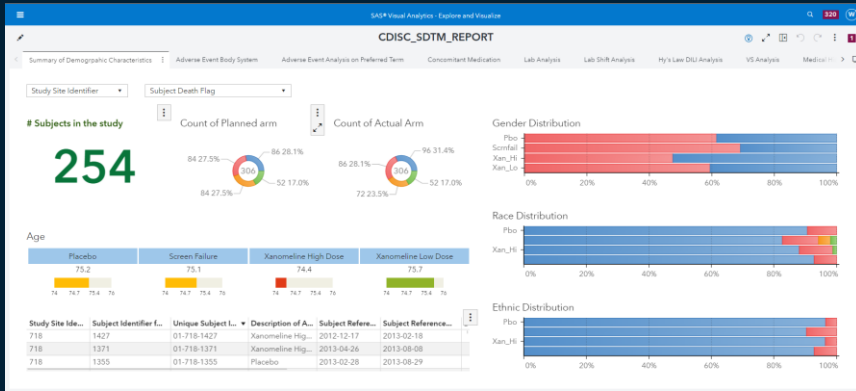
The screenshot displays the SAS Studio interface with a flow diagram on the left and a code editor on the right. The flow diagram shows a sequence of steps: BL-Flick-Image-Book, Import, Manage Columns, clean date of publication, clean place of publication, sort by date of publication, and result. The code editor shows SAS code for cleaning the data.

```
1 import numpy as np
2
3 pub = df['PublicationPlace']
4 london = pub.str.contains('London')
5 oxford = pub.str.contains('Oxford')
6
7 df['PublicationPlace'] = np.where(london, 'London',
8                                 np.where(oxford, 'Oxford',
9                                 pub.str.replace(' ', '')))
10 df['PublicationPlace']
11 SAS._DF2$(df, '_output1')
```

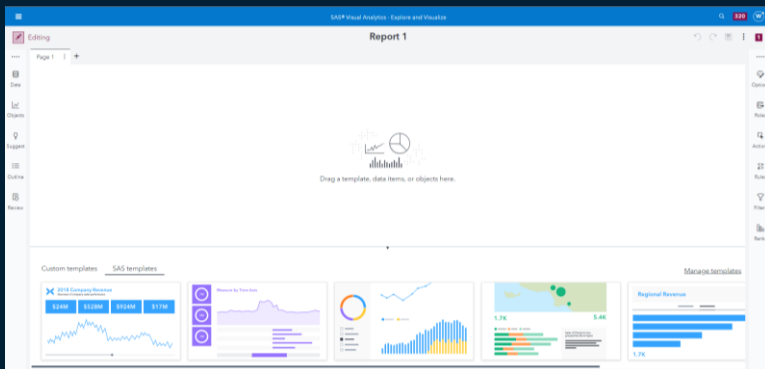


# SAS 9 and SAS Viya - User Interface (SAS Viya)

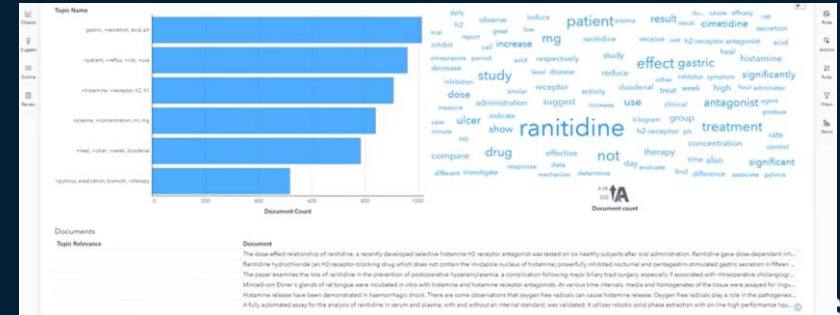
## SAS Visual Analytics



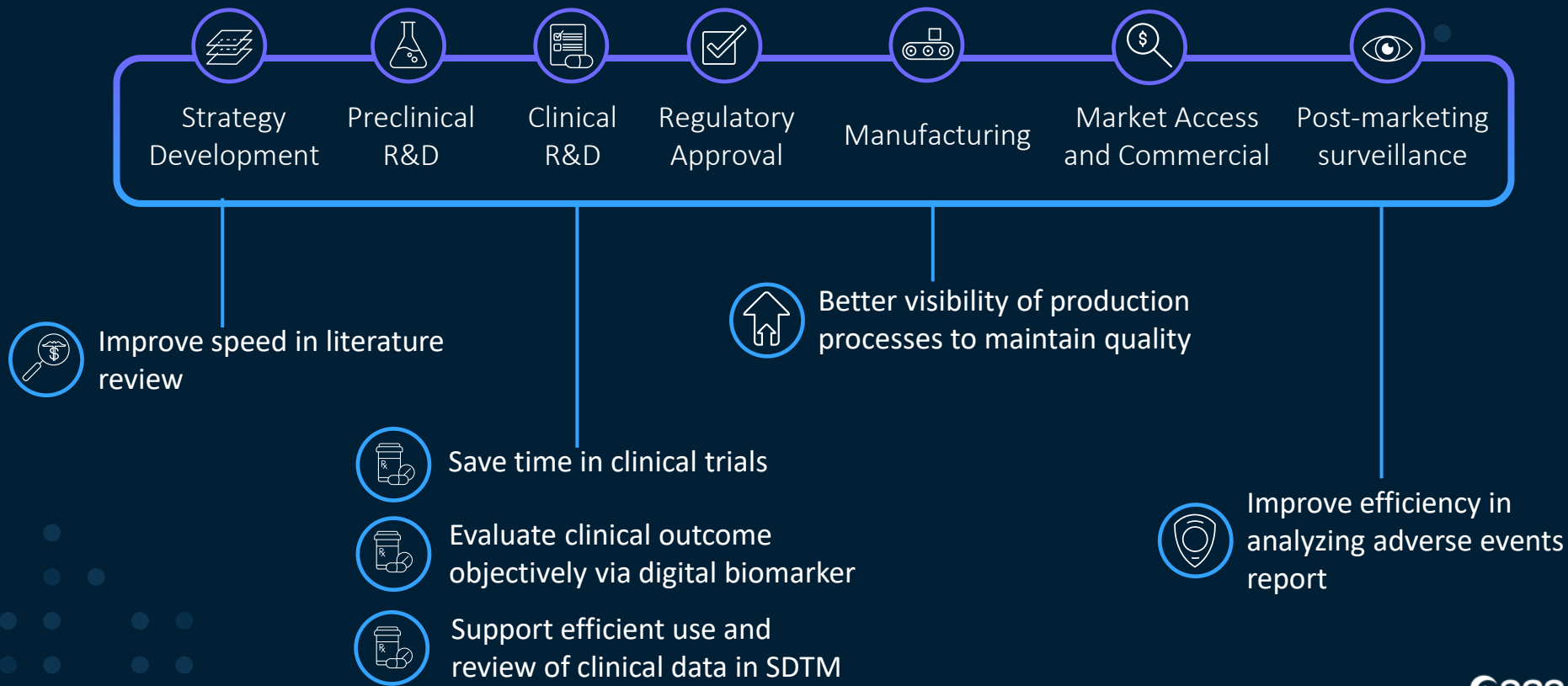
## SAS Visual Data Mining and Machine Learning



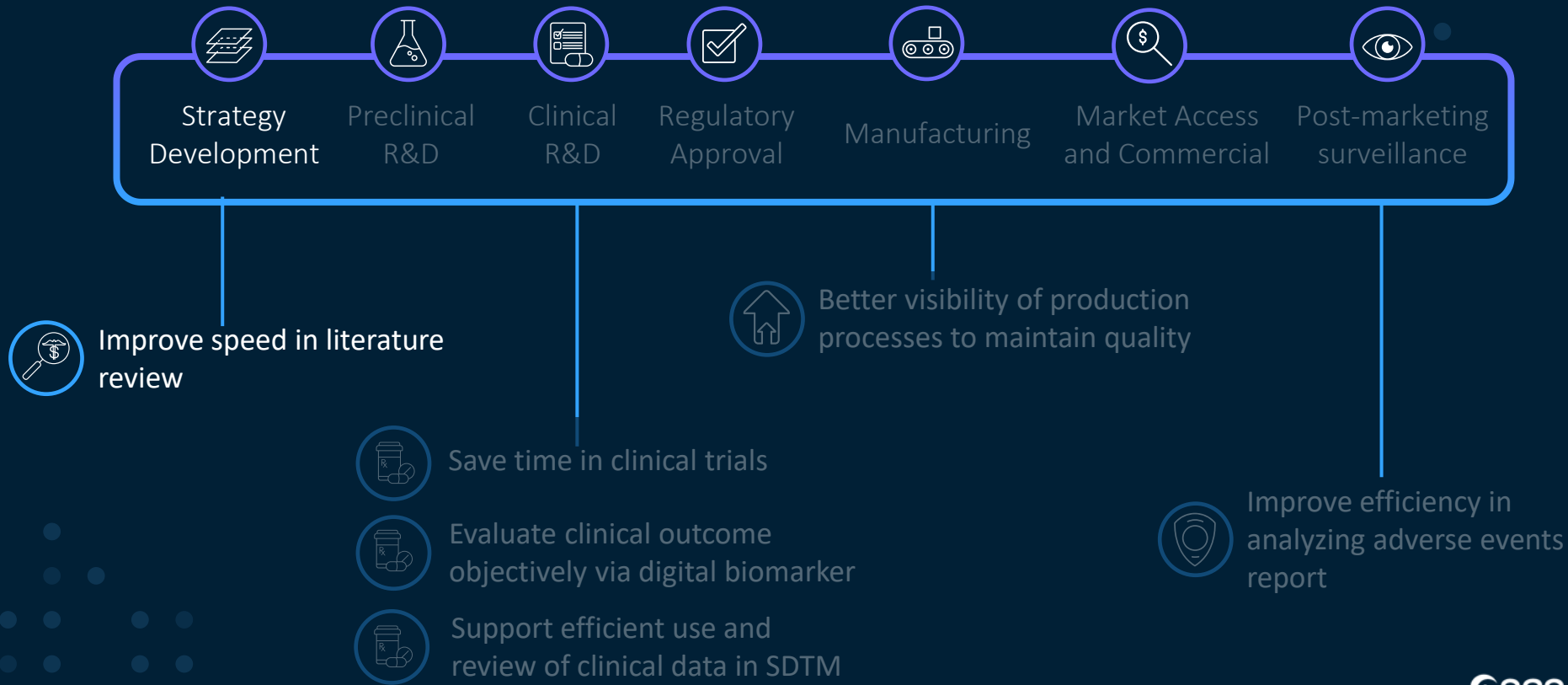
## SAS Visual Text Analytics



# Visualization Across Life Cycle of Pharmaceutical Product



# Visualization Across Life Cycle of Pharmaceutical Product



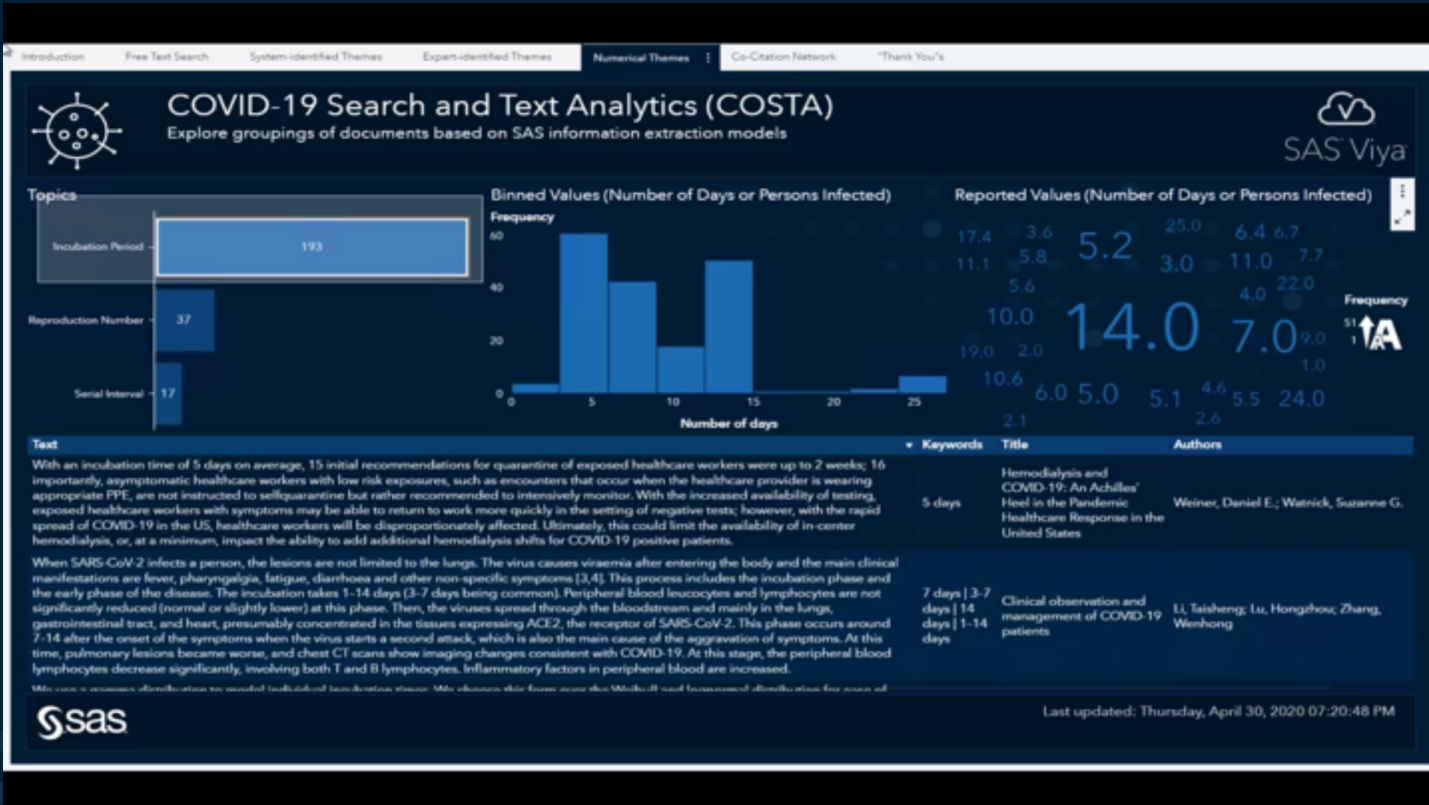
# Improve the Speed in Literature Review

Use visual text analytics to mine COVID-19 research

- More than 50,000 full-text scientific research articles include studies on treatment effectiveness, vaccine development, mitigation efforts, genetic analysis, economic impact and more. It is impractical to analyze it all manually
- Effectively mining unstructured text from scientific literature can effectively categorize and determine relevancy of research findings
- Explore relevant research on coronavirus topics such as incubation period, genetic variations, risk assessment and more.
- Visualize extracted keywords and summarized quantitative data, quickly identify co-citations and the authority of papers using network analysis visualization, and search for key terms in free text

Powered by SAS Visual Text Analytics & SAS Visual Data Mining and Machine Learning in SAS® Viya

# Visualize extracted keywords and summarized quantitative data



# Explore relevant research on different topics

The screenshot displays the SAS Viya Analytics (COSTA) interface. On the left, a 'Topics' sidebar lists various research areas with their respective counts. The main area shows search results for the keyword 'fever', including a word cloud, a table of relevant articles, and a list of authors.

### Topics

- Syndromic Surveillance (5,552)
- Ecology Epidemiology - 470
- General Risk Assessment - 31,404
- Movement Control Strategies - 180
- Population attributes - 779
- PPE - 2,507
- PPE Effectiveness - 1,488
- Risk Assessment: Human Infections - 529
- Risk Assessment: Animal Distribution - 2
- Risk Assessment: Animal Transmissibility - 2,446
- Risk Assessment: Antigenic Relatedness - 680
- Risk Assessment: Antiviral Drugs Treatments - 365
- Risk Assessment: Disease Severity - 173
- Risk Assessment: Genomic Variation - 1,014
- Risk Assessment: Human Transmissibility - 8,040
- Risk Assessment: Population Immunity - 8
- Risk Assessment: Receptor Binding - 6,803
- Social Distancing Efficacy - 849
- Syndromic Surveillance - 5,552
- Transmission Environment - 344
- Viral Hazard - 4,302

### Analytics (COSTA)

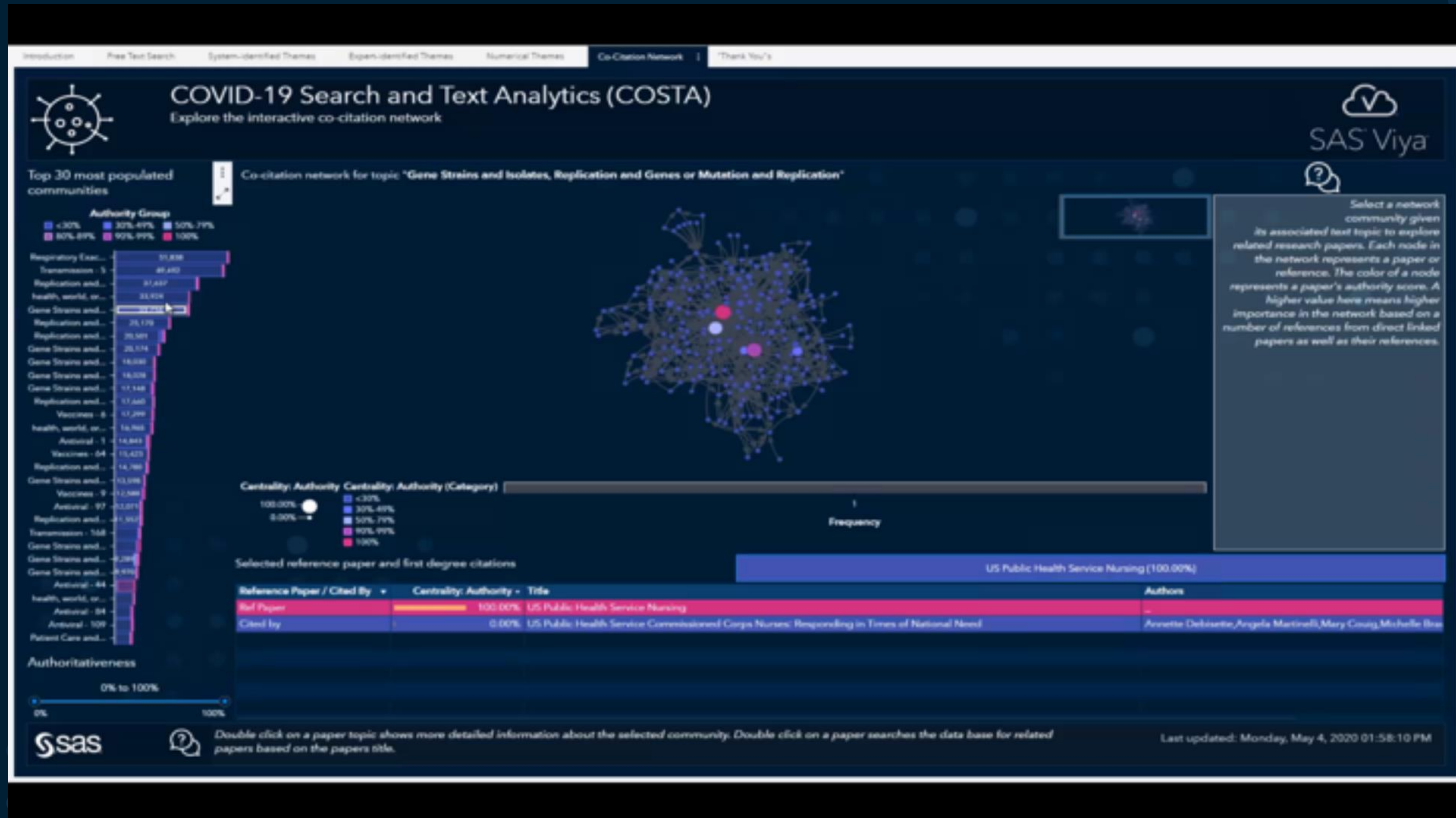
Information extraction models

Keywords: fever, pregnant, pulmonary, cardiac, diabetes, dialysis, wheezing, stress, cardiovascular disease, heart failure

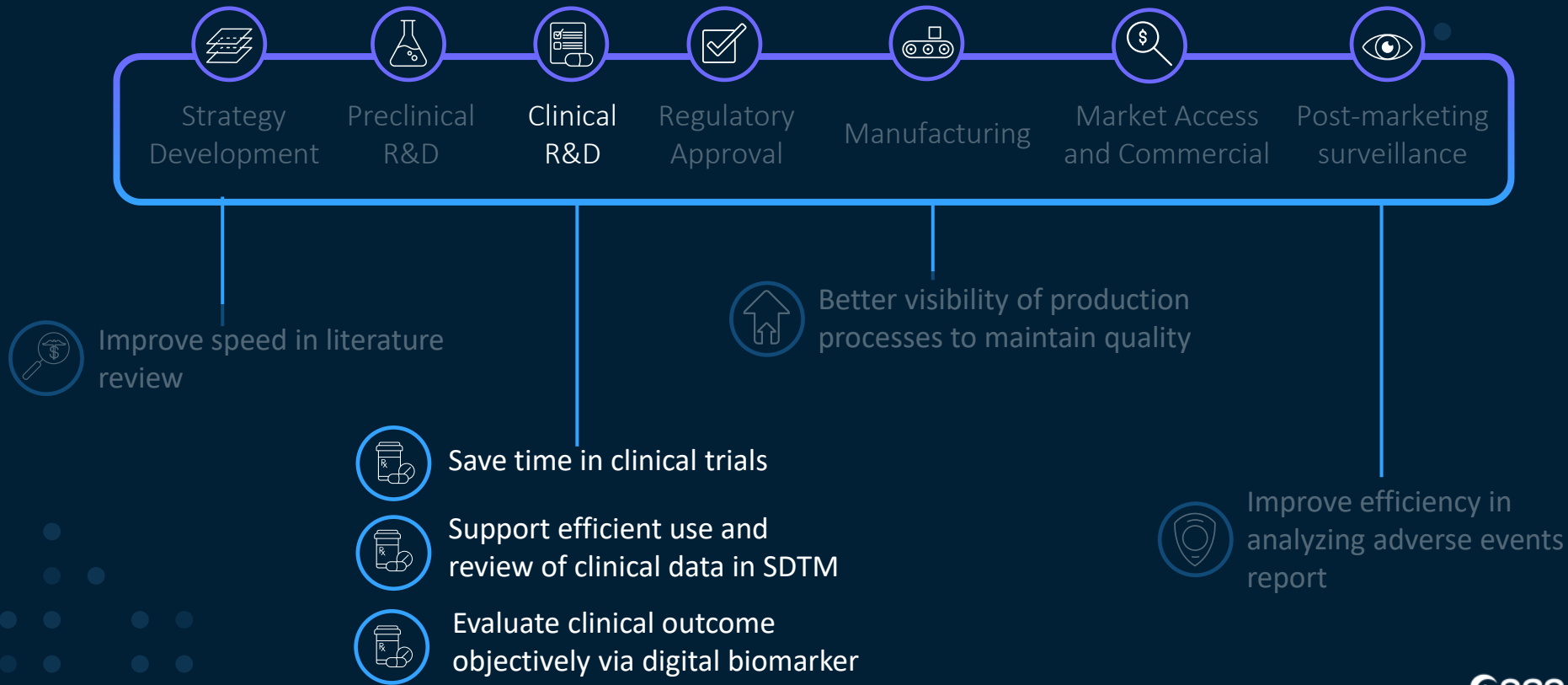
Relevant to the topic: text, titles, authors and of the keywords in the tree	Title	Authors	Pi
Remote Monitoring Devices Used to Support Patient Monitoring During the COVID-19 public health emergency: clinical electronic thermometers, pulse oximetry (SpO <sub>2</sub> ), non-invasive blood pressure (NIBP), respiratory	Heart Failure Collaboratory Statement on Clinical Trials in the Landscape of COVID-19	Abraham, William T.; Fuzat, Mona; Psotka, Mitchell A.; O'Connor, Christopher M.	20
A significant impact on clinical trials for current and future study participants, narsage clinical trials during the COVID-19 pandemic is of particular relevance to risk for COVID-19 related morbidity and mortality. This ecosystem includes payers, and both public and private sponsors of HF clinical trials.	Heart Failure Collaboratory Statement on Clinical Trials in the Landscape of COVID-19	Abraham, William T.; Fuzat, Mona; Psotka, Mitchell A.; O'Connor, Christopher M.	20
Study for SARS-CoV-2 infection (the causative agent of COVID-19), found that half of patients had a fever 15%. Their symptoms were mainly fever 98%, cough 78%, and fatigue 29%. RNAemia 19%, acute cardiac injury 12%, and other secondary symptoms. The death rate was 15% [5].	COVID-19: Zoonotic aspects	Almad, Tauseef; Khan, Muhammad; Haroon, Musir, Taha Hussein; Nasir, Saama; Hui, Jie; Borzillo Aldana, D.Katherine; Rodriguez-Morales, Alfonso J.	20
Some of the CoVs are zoonotic, meaning they can be transmitted from animals to humans. The virus has an incubation period of 2-14 days before symptoms appear, such as cough, fever, and muscle aches. In addition, serious complications related to COVID-19 include acute renal failure, septic shock and ventilator-associated pneumonia. 1, 2 Elderly patients and those with comorbidities are considered to be at higher risk of developing serious	SARS-CoV-2 outbreak: How can pharmacists help?	Al-Quteimat, Osama M.; Amer, Amer Mustafa	20

Last updated: Sunday, May 3, 2020 10:38:11 PM

# Identify co-citations and the authority of papers using network analysis visualization



# Visualization Across Life Cycle of Pharmaceutical Product





# Save Time in Clinical Trials

## Leverage Synthetic Control Arm

- In some circumstances, conducting traditional RCTs study design is unethical, impractical, or infeasible. (E.g., rare diseases)
- Provide researchers an interactive cohort building tool to identify external patient cohorts for comparison.
- Quickly identify appropriate synthetic control arms for the Tx arm in a single-arm trial.
- Reduce operation time or eliminate the need to enroll patients for control arms

Powered by [SAS Health Cohort Builder](#) & [SAS Visual Analytics](#) in [SAS® Viya](#)

# Identify patient cohorts with easy drag-and-drop

The screenshot displays the SAS Health Cohort Builder interface. The top navigation bar includes 'Projects', 'Data Sources', 'Add-ins', and 'Expressions'. The main workspace is titled 'Synthetic\_control\_arm > Tx\_arm' and features a 'Define Cohort' button, 'Add Variables', and 'Build Analysis' buttons. The cohort name is 'Tx\_arm', the data source is '800k\_clinical' with N=711,479, and the cohort count is displayed. A timeline at the top shows dates from May 2007 to Jul 2013. The central 'Index Event' section is titled 'NSCLC' and contains a list of criteria: 'AGE\_AT\_INDEX\_DT' (>= 18), 'NOT ECOG Performance Status\_Poor', 'NOT Renal function\_Poor', 'NOT EGFR-TKI', 'NOT Chemotherapy', 'NOT Neoplasm other than NSCLC', 'NOT Dry eye syndrome', 'NOT HIV', and 'Chronic viral hepatitis'. A 'NDC Drug Codes' button is visible at the bottom of the criteria list. On the right, the 'Attrition' section shows options for 'Attrition', '% of Population', and 'Counts'. The left sidebar shows a tree view of concepts, with 'NDC Drug Codes' expanded under 'Prescriptions'.

# Generate propensity score matched patient cohort with standardized analysis template

SAS Studio - Develop SAS Code

Start Page haf\_addin\_cohortPscoreMatch\_v2 x +

Run Cancel Refresh

Code Log Results Output Data (12)

Code panel Edit Code

Steps

Type to filter list

SAS Steps Shared

- COMPILE\_DATA\_MAPPER
- Demographic Pull\_Count
- haf\_addin\_cohortPscoreMatch\_v2
- haf\_addin\_cohortPscoreMatch\_v2
- haf\_cohortPSMatch\_CASLibrary
- Outlier Filter

Table 1 Number of patients pre- and post-matching

Group	Pre-matching	Post-matching
Treatment group	719	716
Control group	2383	716

Table 2 Standardized differences of baseline characteristics before and after propensity score matching

Covariates	Pre-matching	Post-matching
	Standardized Difference	Standardized Difference
CHAR_RISK_SCORE	0.18048	0.01224
GENDER_CD	-0.03298	0.03442
Logit Prop Score	0.18495	0.00138
Prop Score	0.18820	0.00156
age_at_index_dt	0.00971	-0.04963

Summary of treatment and control groups matching information

Parameter	Parameter value
Distance Metric	Propensity Score

File: /Public/RWE\_UC2/haf\_addin\_cohortPscoreMatch\_v2.step

Recover (7) Submission (0)

# Visualize demographics & clinical characteristics in patient cohorts



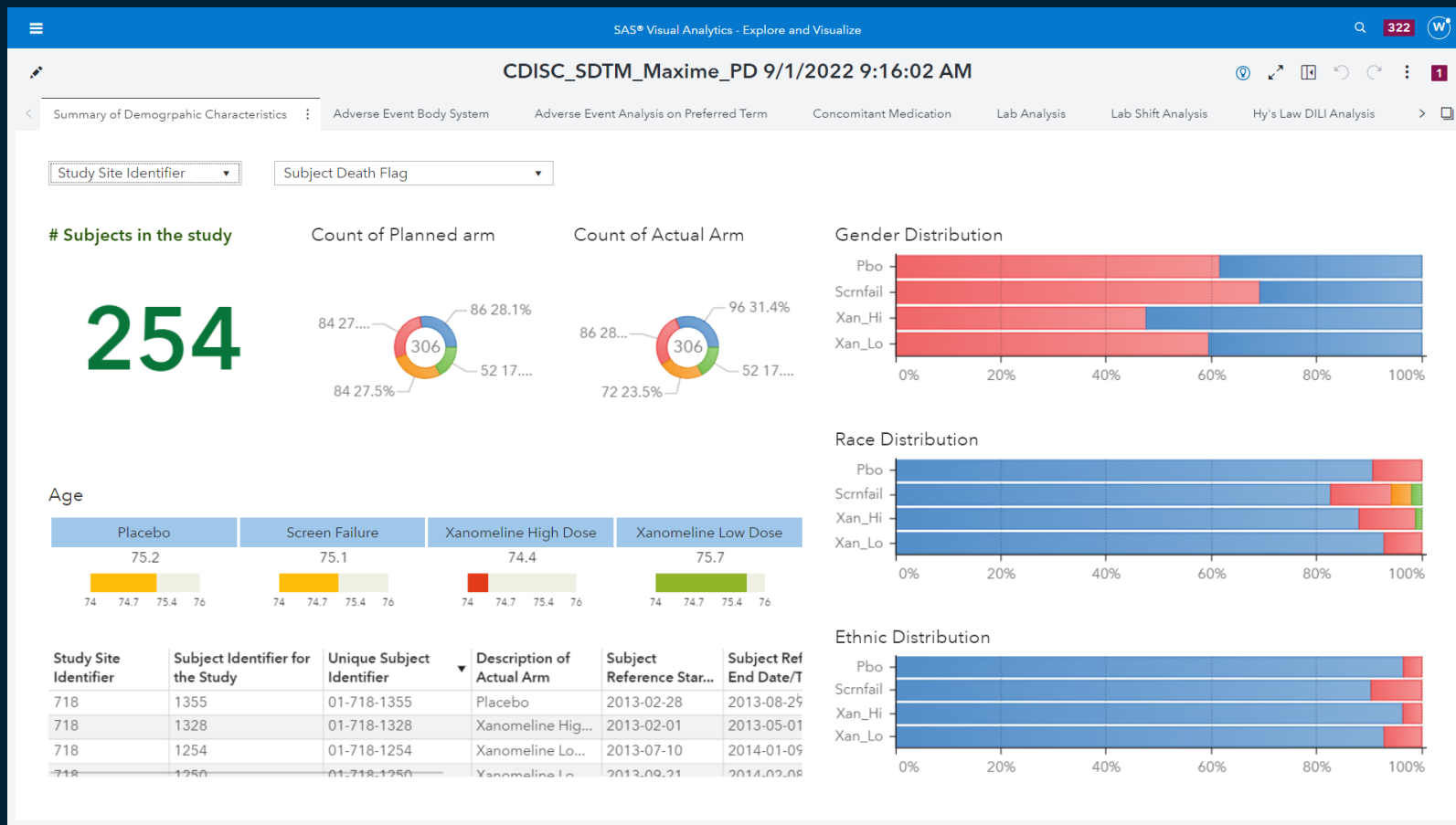
# Support efficient use and review of clinical data in SDTM

## Clinical Data Dynamic Report

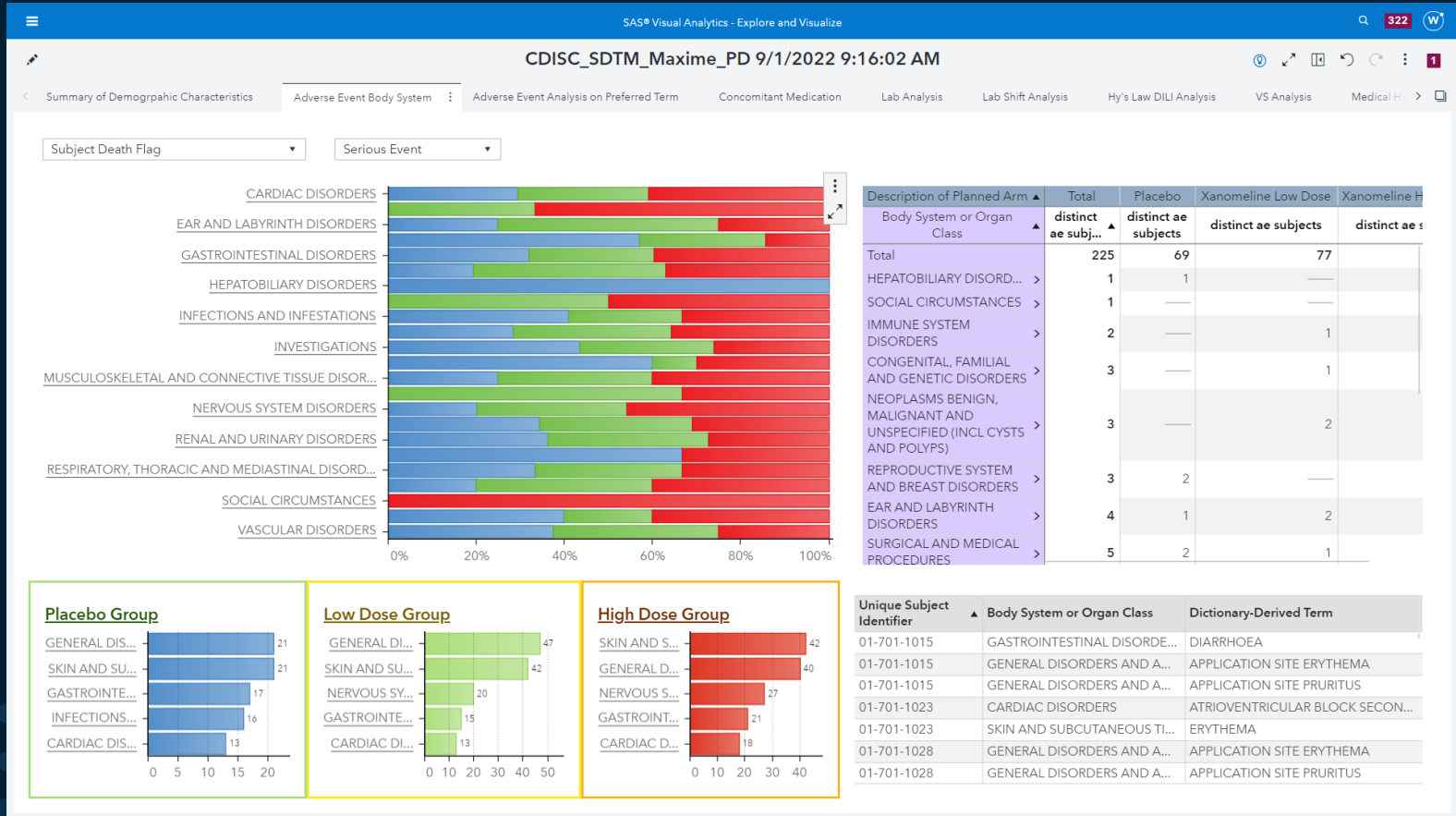
- Clinical data reviewers work with programmers to produce reports for monitoring data quality issues, reviewing safety signal, and identifying trends. However, the back-and-forth communication is often a resources intensive process
- Create an interactive, user-friendly dashboard for clinical data reviewing and monitoring task on an ongoing basis
- Reduce operational costs and save patient lives in time

Powered by SAS Visual Analytics in SAS® Viya

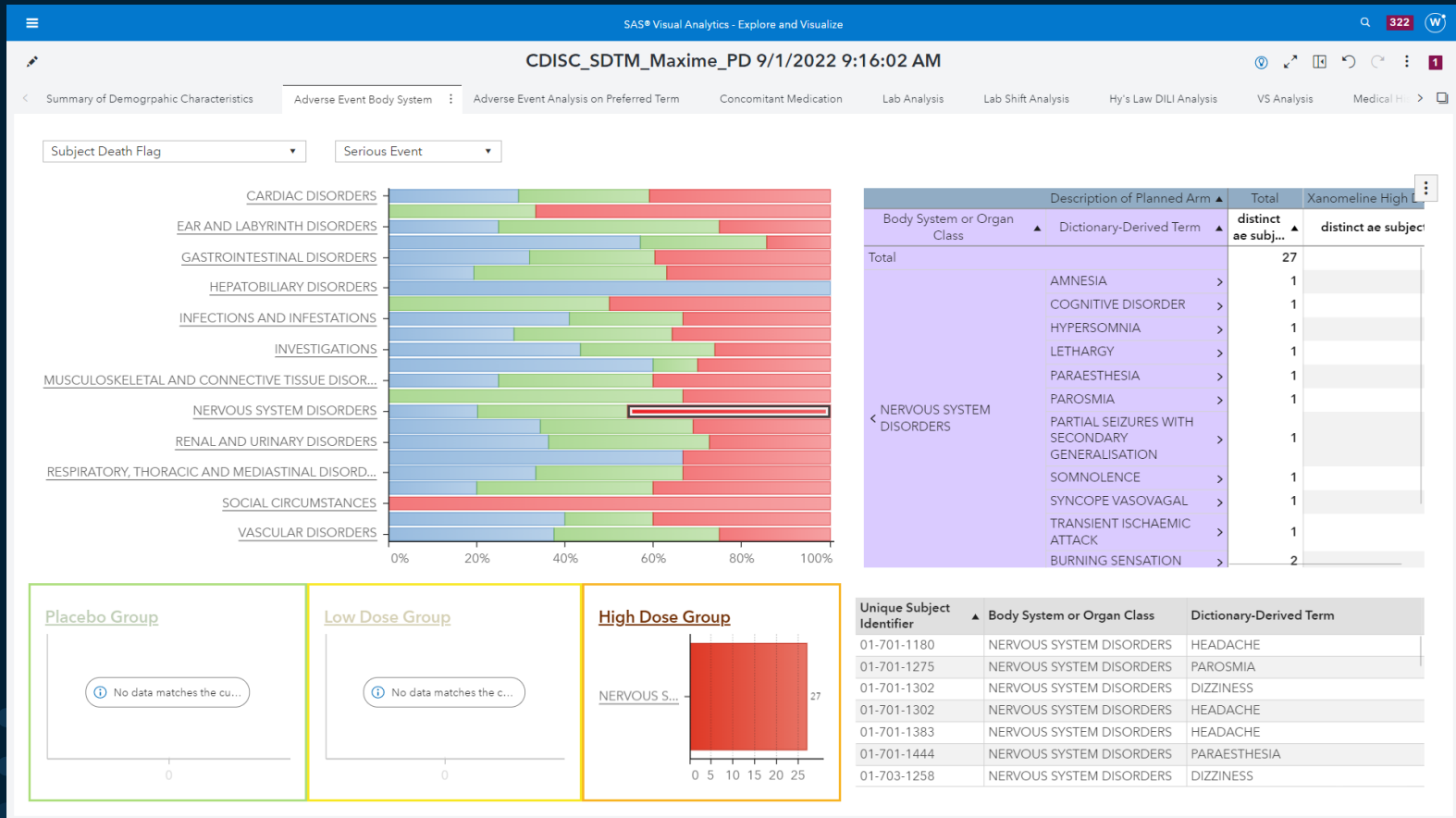
# Visualize SDTM - Summary of Demographic Characteristics



# Visualize SDTM - Adverse Events

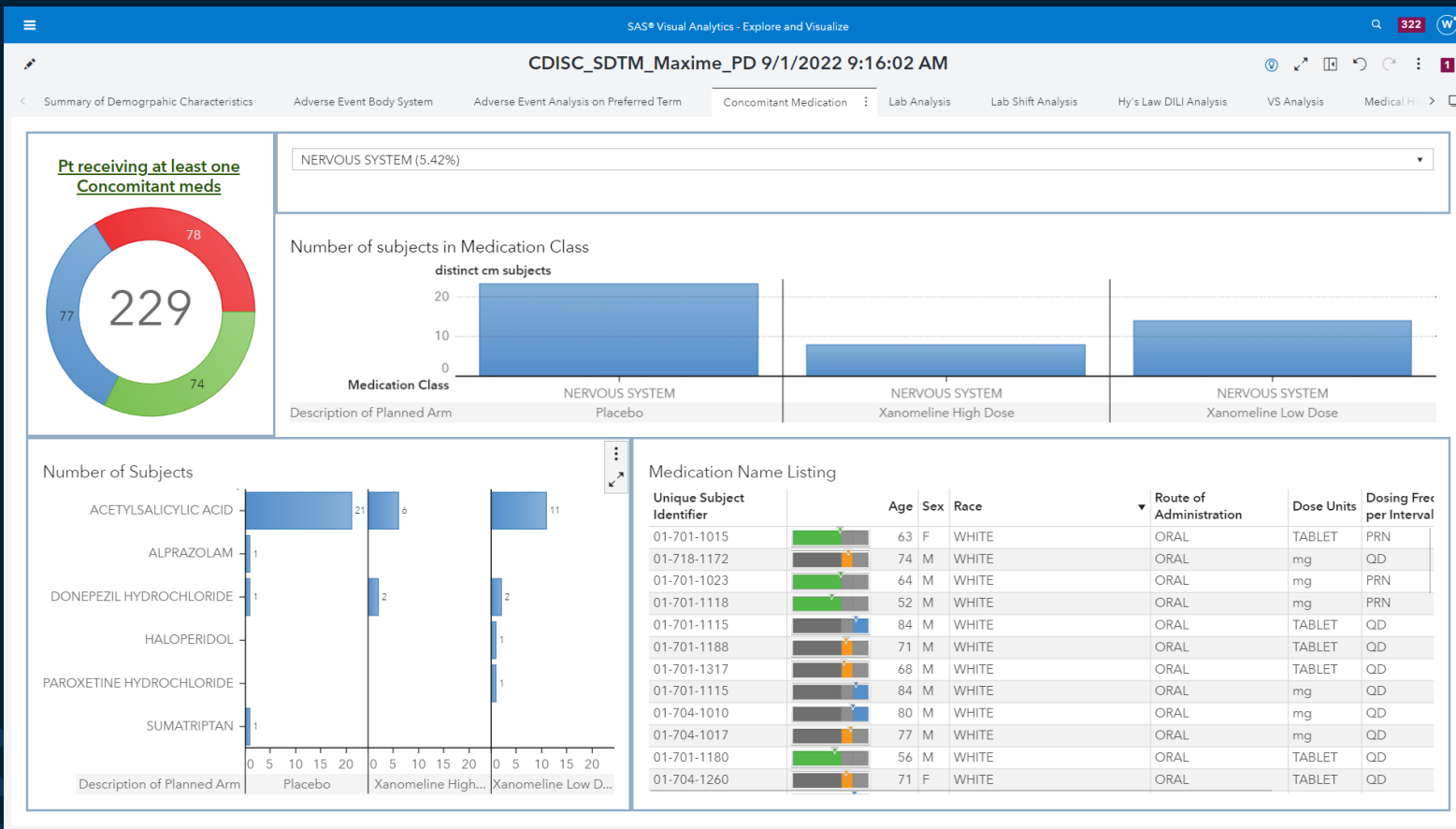


# Visualize SDTM - Adverse Events

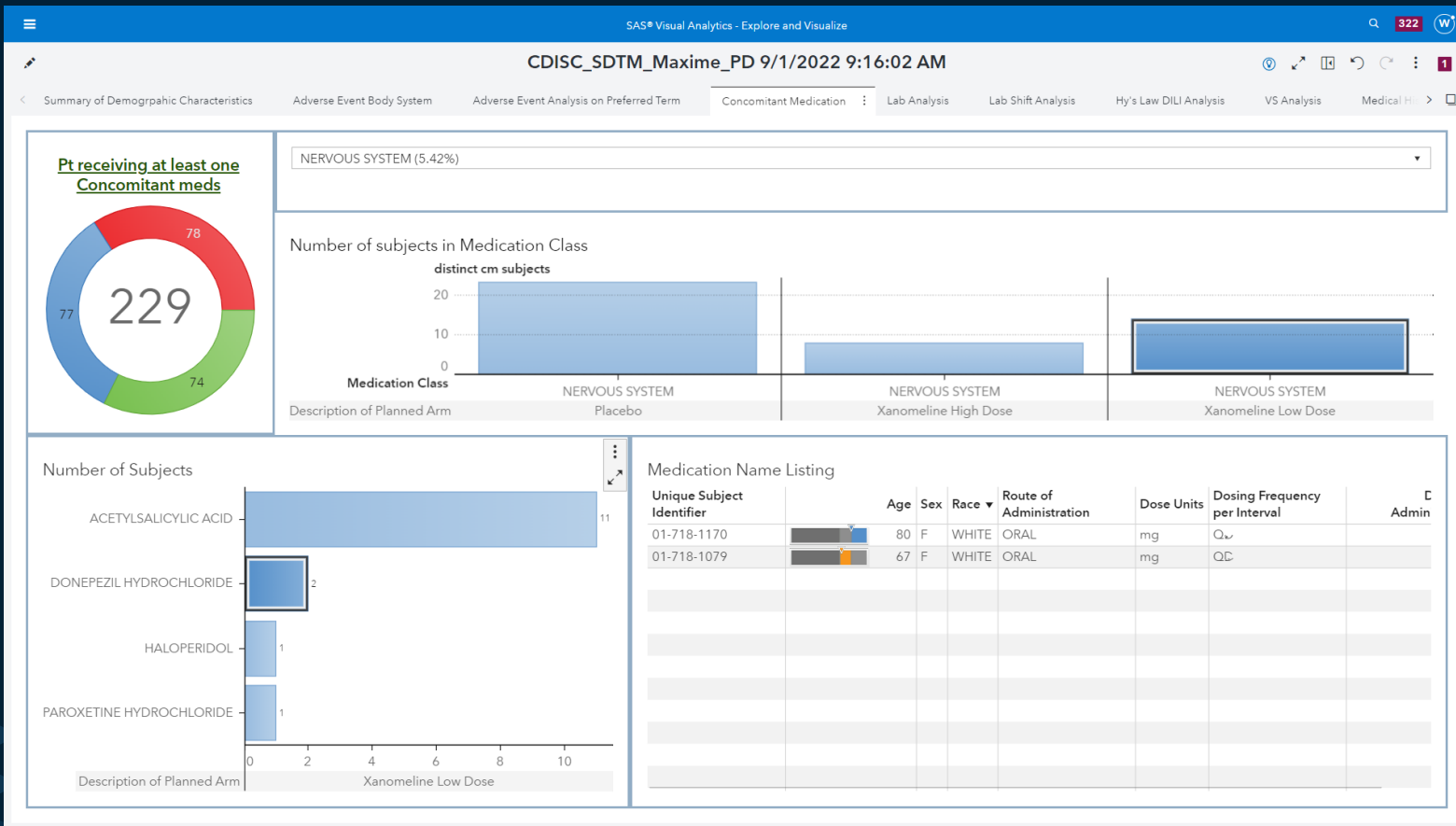




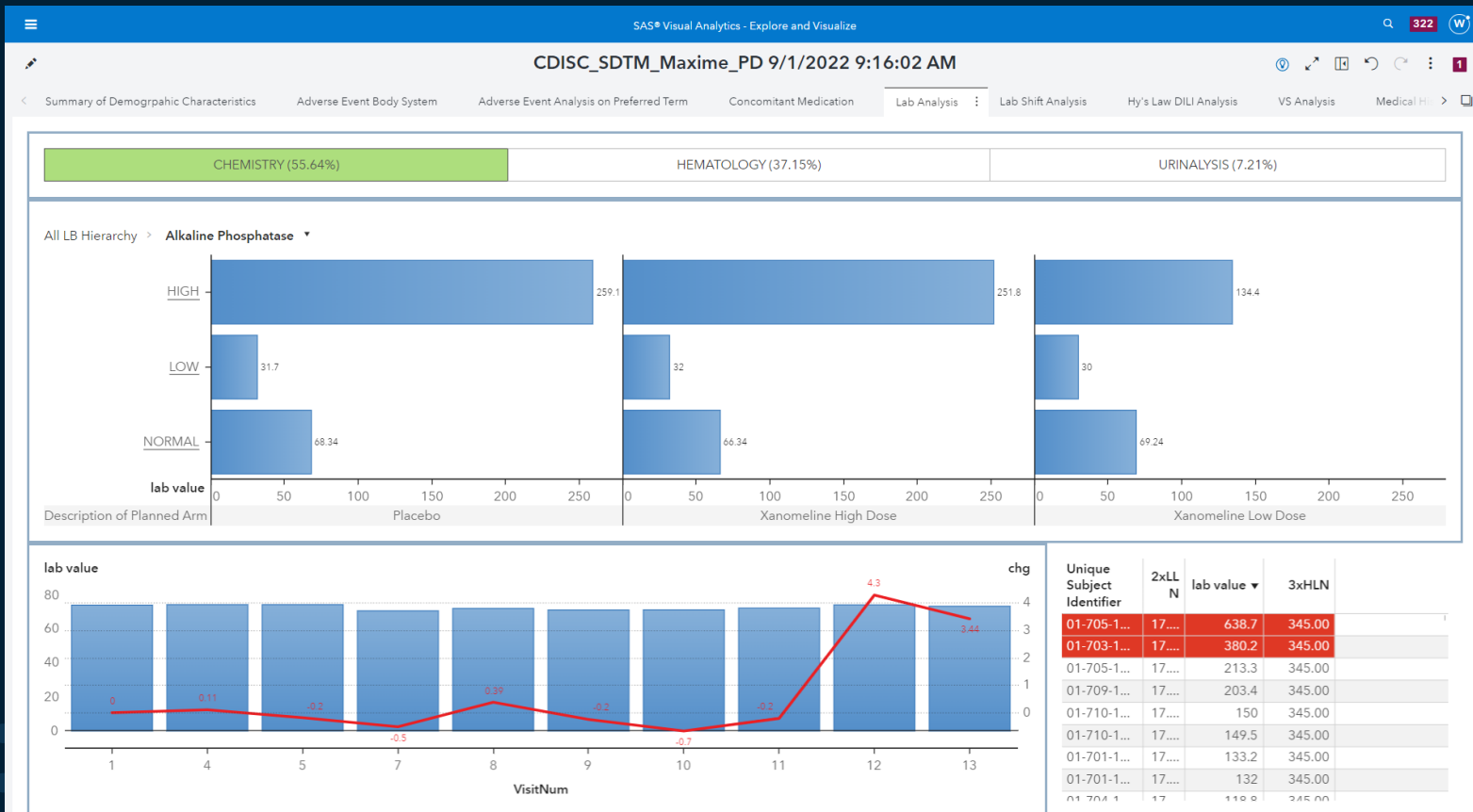
# Visualize SDTM – Concomitant Medication



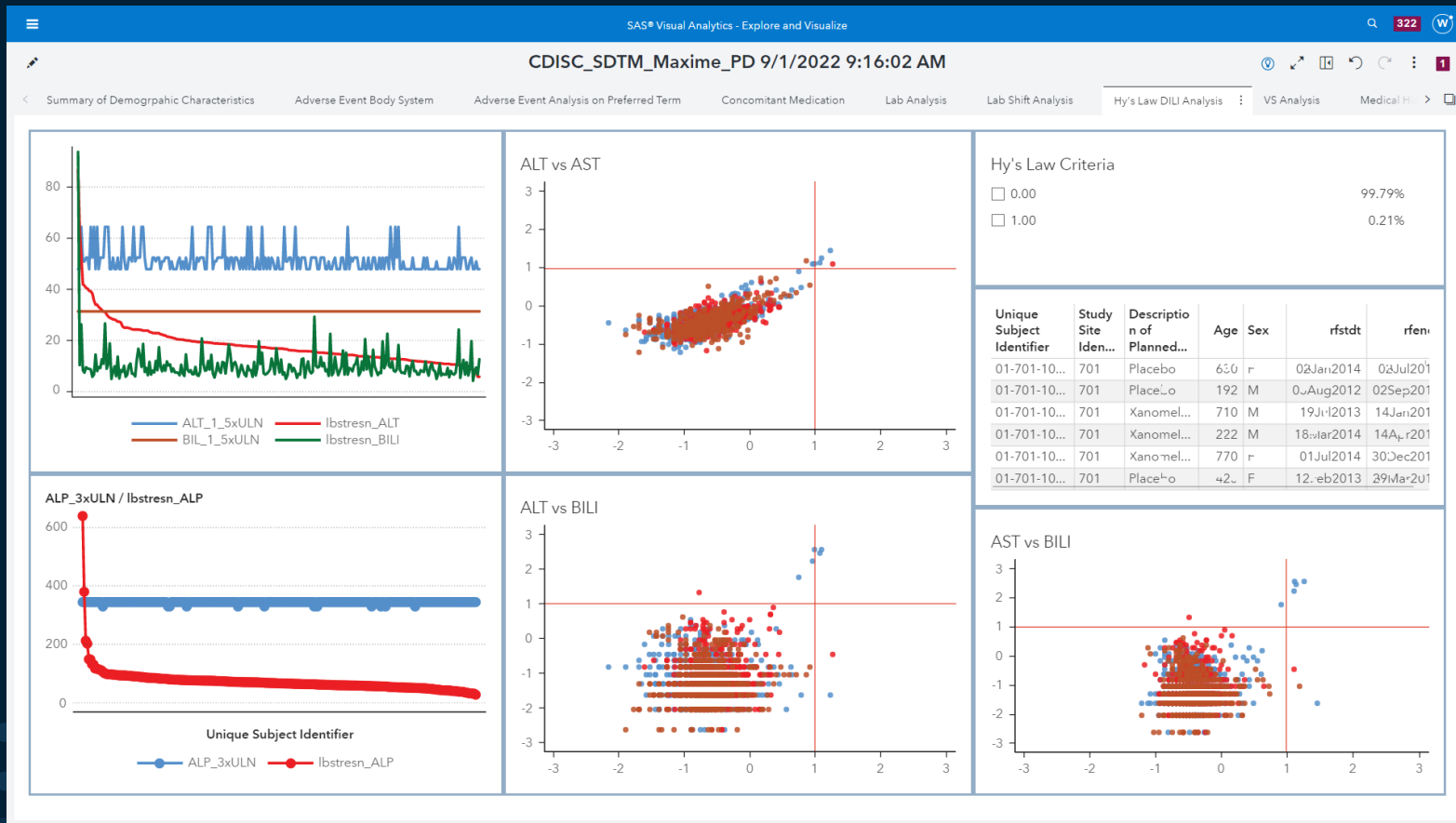
# Visualize SDTM – Concomitant Medication



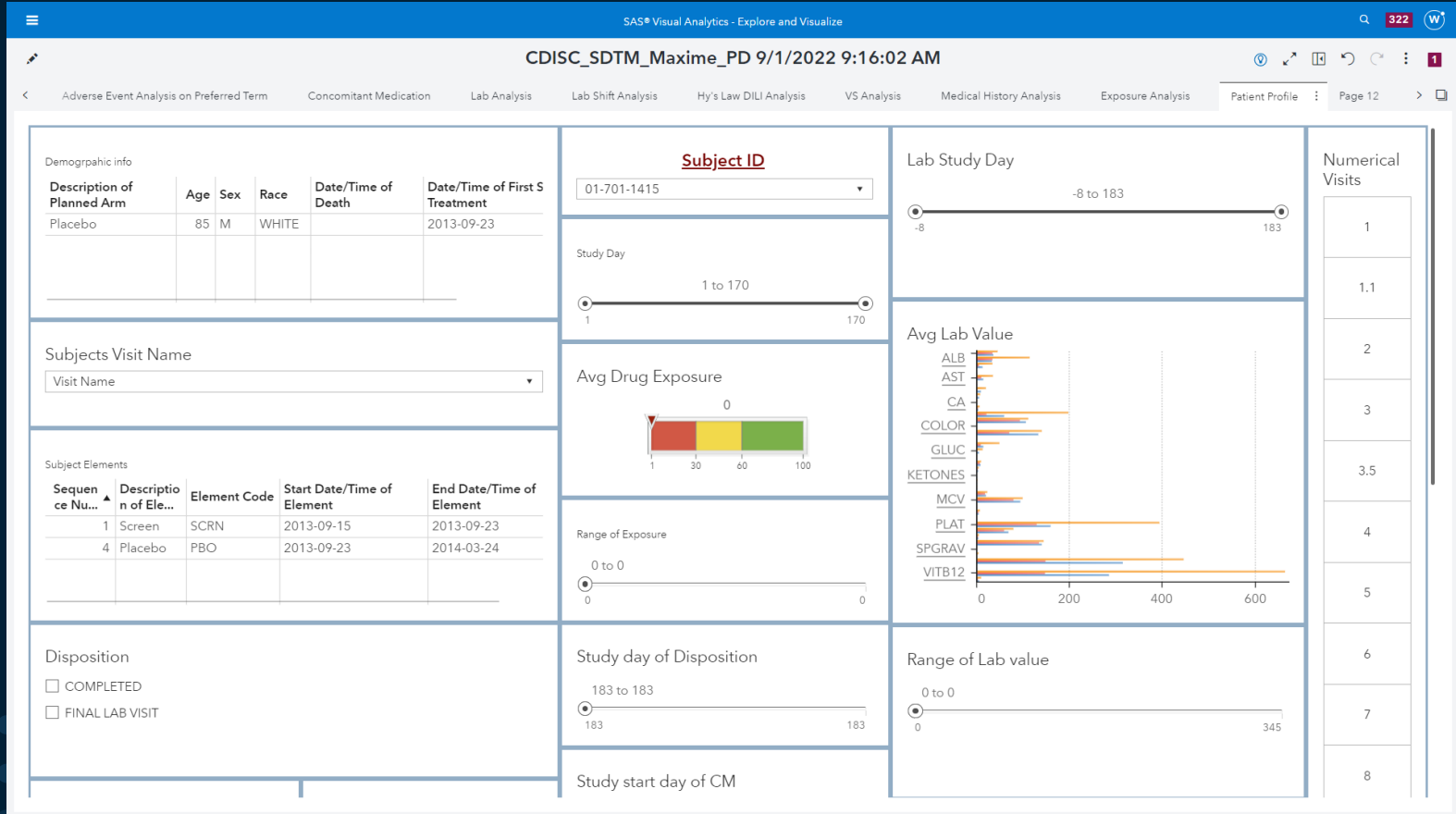
# Visualize SDTM – Lab Analysis



# Visualize SDTM – Hy's Law Analysis



# Visualize SDTM – Patient Profile



# Evaluate clinical outcome objectively via digital biomarker

## Analyze Patient Motion with AI/Machine Learning

- Loss of balance can increase the risk of falling and impact the patient. Berg Balance Scale (BBS) is a paper-based clinical assessment tool to determine a patient's ability to balance. However, it takes clinicians up to 20 minutes to complete the evaluation
- Use cameras and sensors to capture movement data and build machine learning model to determine risk score for falling and assist early determination of progression of injury
- Clinicians can analyze patients' balance ability quickly, accurately and objectively

HACKATHON  
PROVIDES



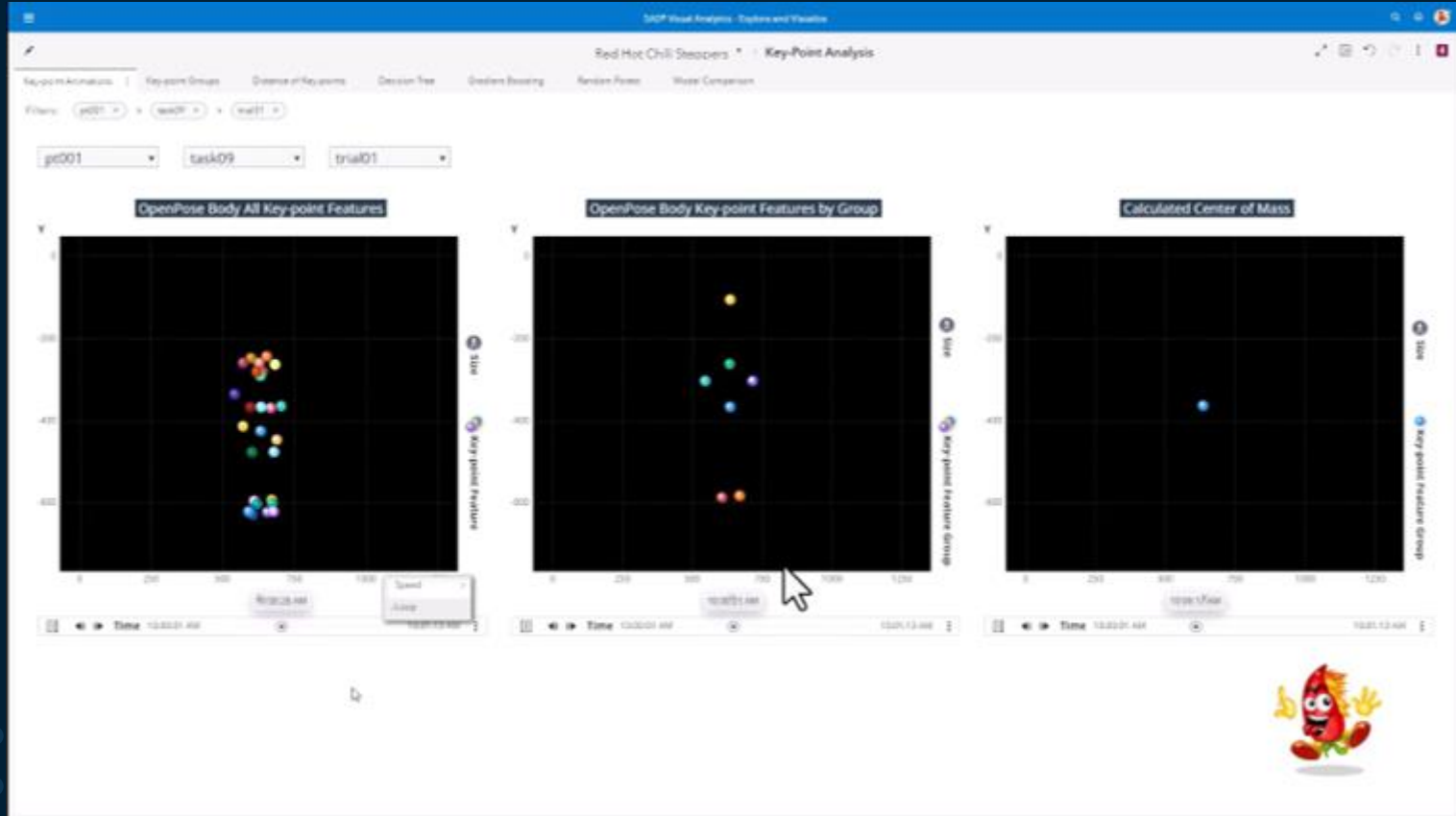
autonomous\_ID

OntarioTech  
UNIVERSITY

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# Collect patient movement data



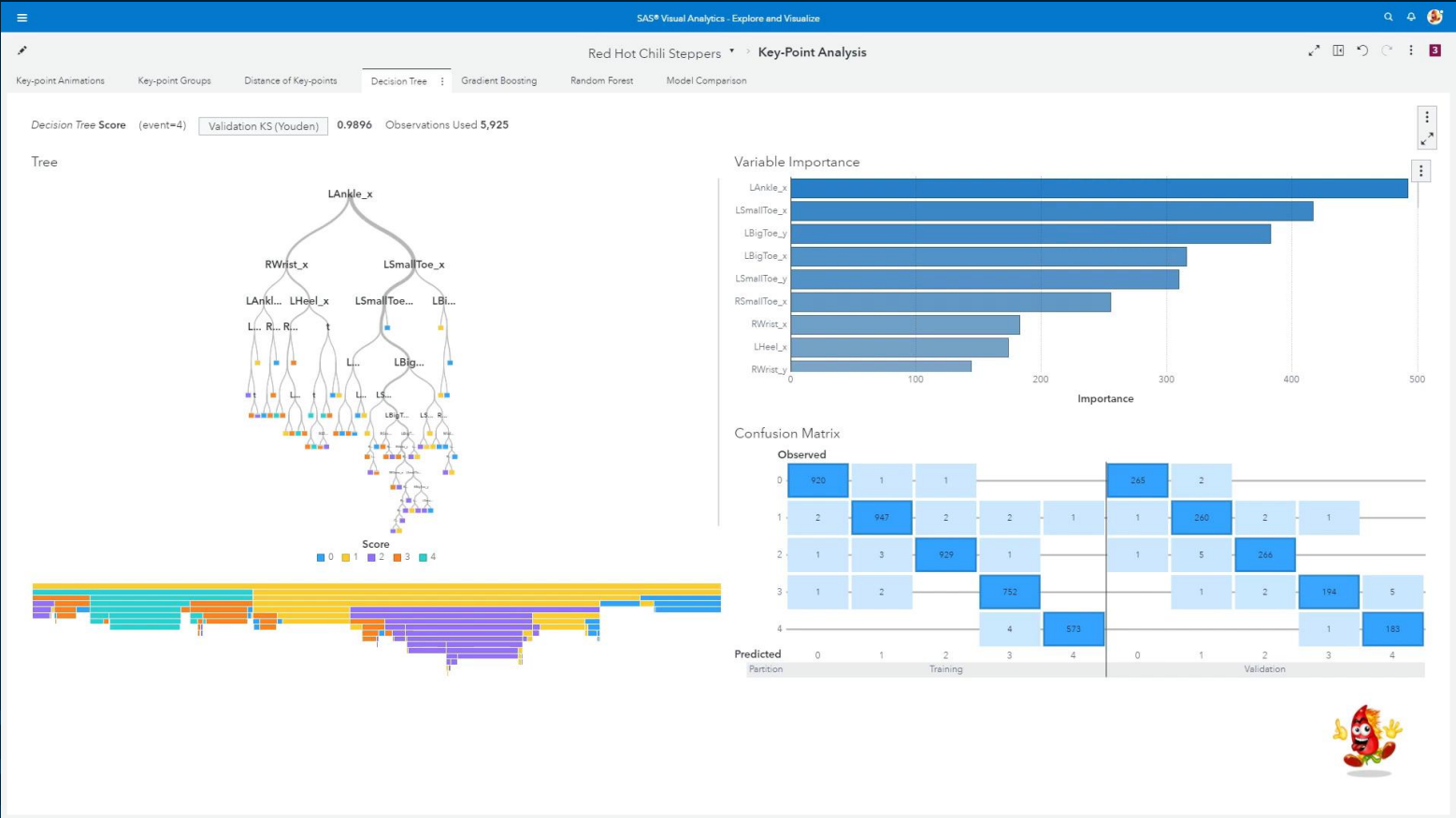
# Determine risk scores in real-time

The screenshot shows a web application interface for "SAS Visual Analytics - Explore and Visualize". The main content area is titled "Red Hot Chili Steppers > Improved > Measurement > Real-Time Scoring". It displays six video frames arranged in a 2x3 grid, each showing a person's skeletal tracking and a risk score for "Reaching for Object".

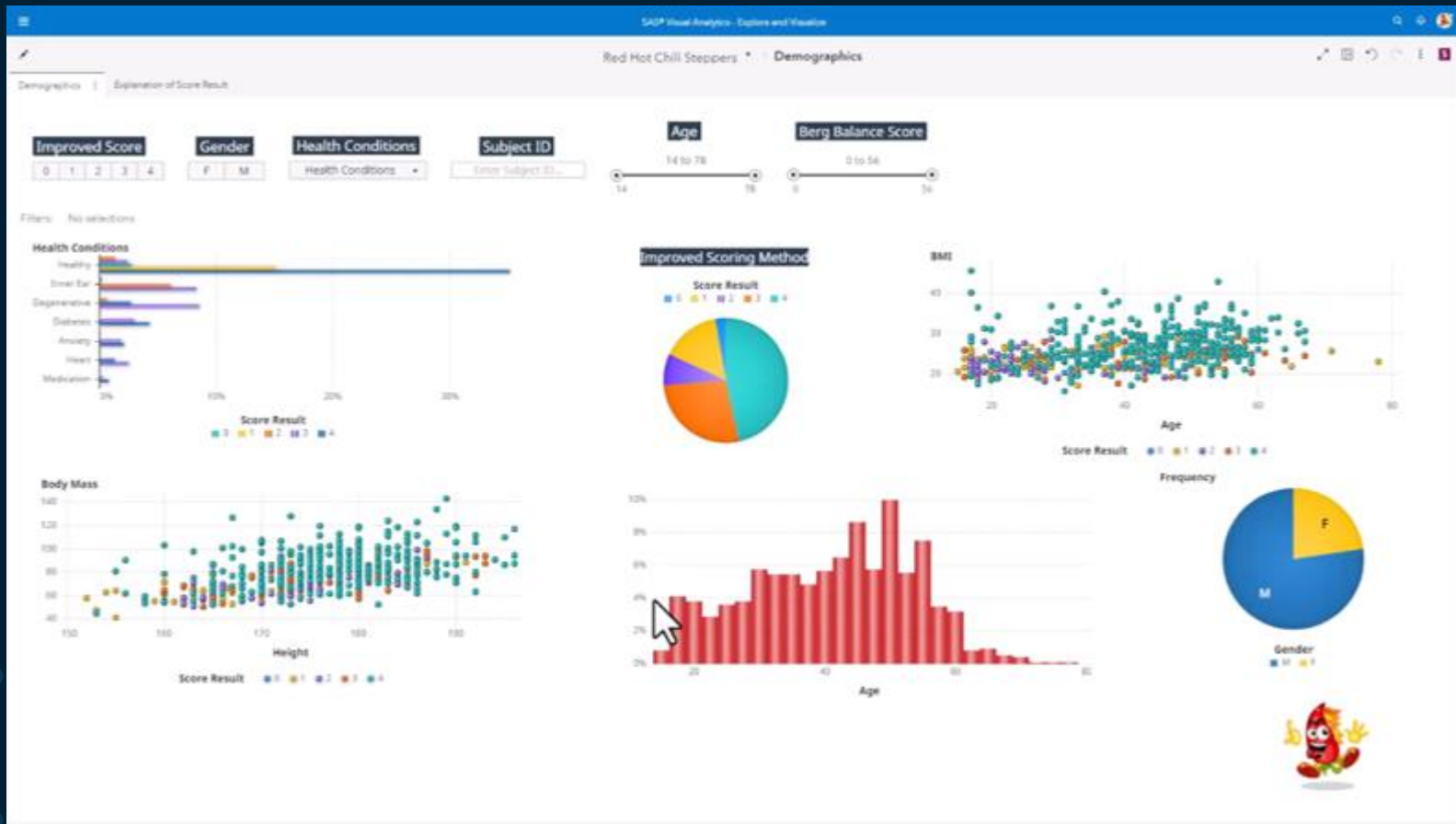
Score	Status	Additional Info
Score 4	87.48% @ Not Trying	Pick up Object from Floor
Score 4	86.79% @ Not Trying	Pick up Object from Floor
Score 3	86.80% @ Not Trying	
Score 2	1.00	
Score 1	0:04 / 0:08	Watch later, Share, 1/1
Score 0	46.96% @ Unstable	



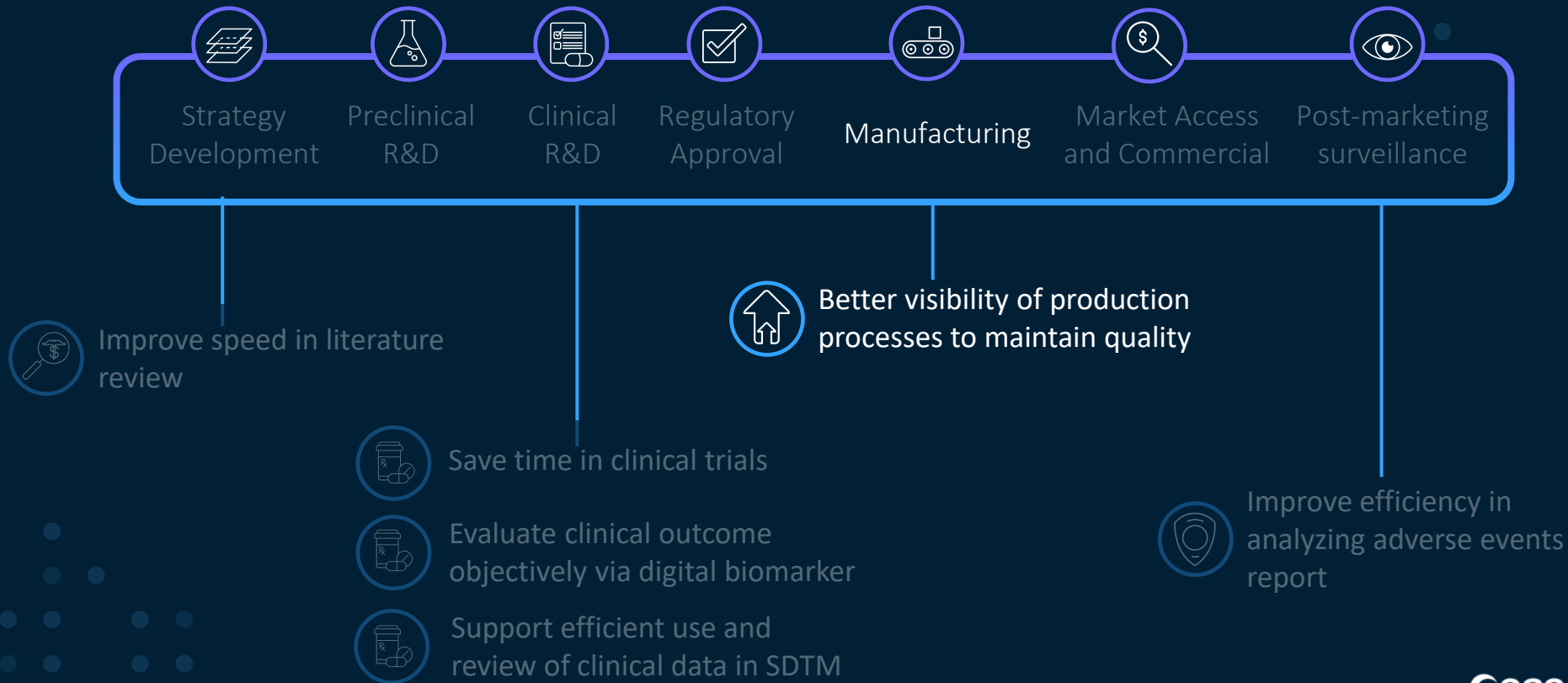
# Build models to quantify variable importance related to risk scores



# Visualize patient profiles by risk group



# Visualization Across Life Cycle of Pharmaceutical Product



# Better visibility of production processes to maintain quality

## Computer Vision on Product Quality

- Quality inspections are a key part of the manufacturing process. Some issues are still best identified via high-resolution images review by the human eye. This process is extremely time-consuming
- Apply computer vision techniques to analyze product images to provide a ranking score for each product image. The product image that differ most from a gold standard image is identified (i.e. likely to be a defective product)
- The system can assess product images within seconds
- Inspectors could prioritize batches for further manual review to save time

Powered by **SAS Visual Data Mining and Machine Learning in SAS® Viya**



# Identify products with suspected defects

Enter Start Device ID

Enter IPC Start ID: 10000

IPC Report

## Suspected Defects

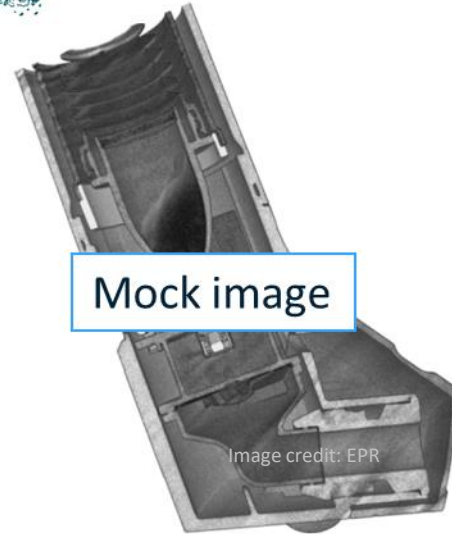
2

Device ID	Part	Image DateTime
8915102	Spigot	March 18, 2019 08:27:57 AM
8915130	Spigot	March 18, 2019 08:40:21 AM

Total Images Processed



System is currently unavailable, please follow other instructions



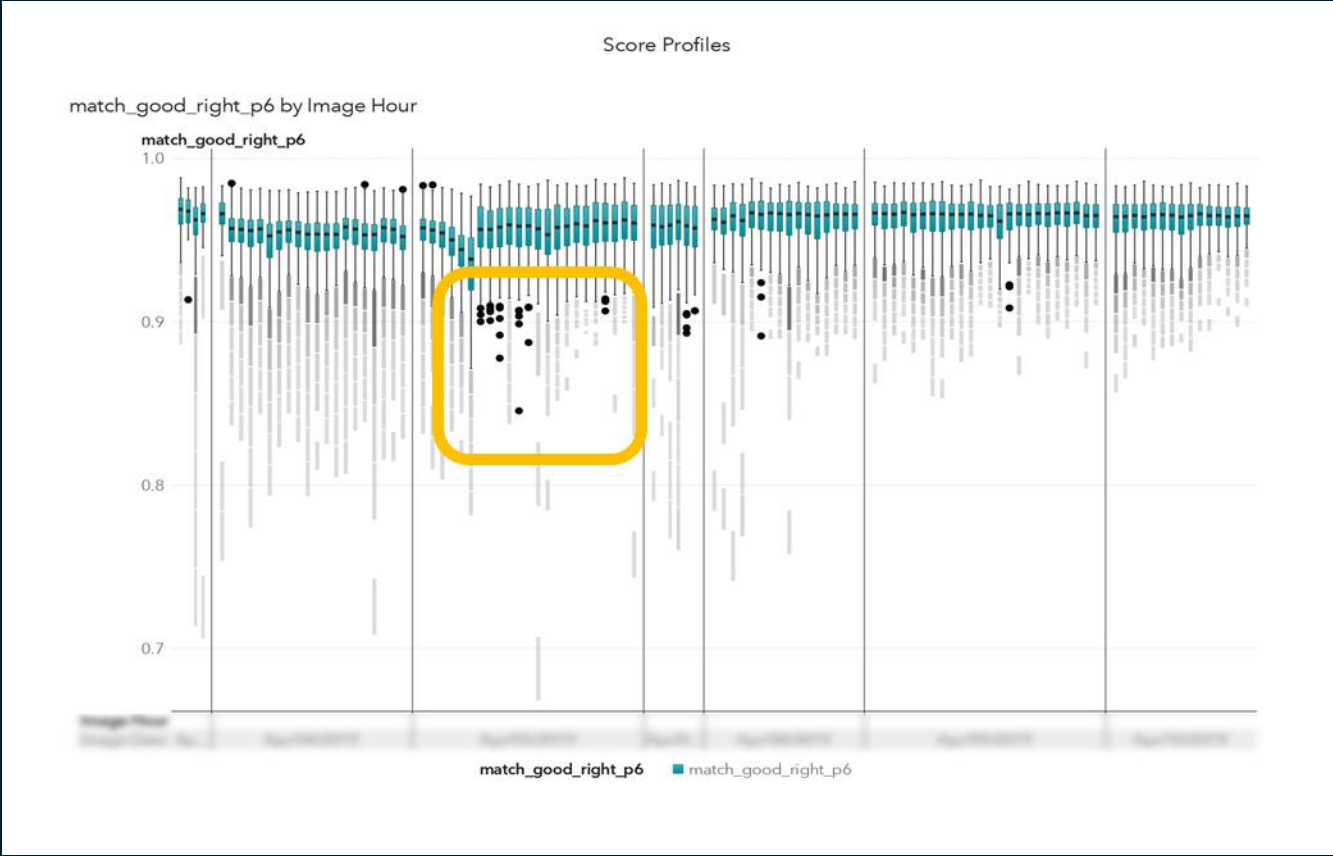
Mock image

Image credit: EPR

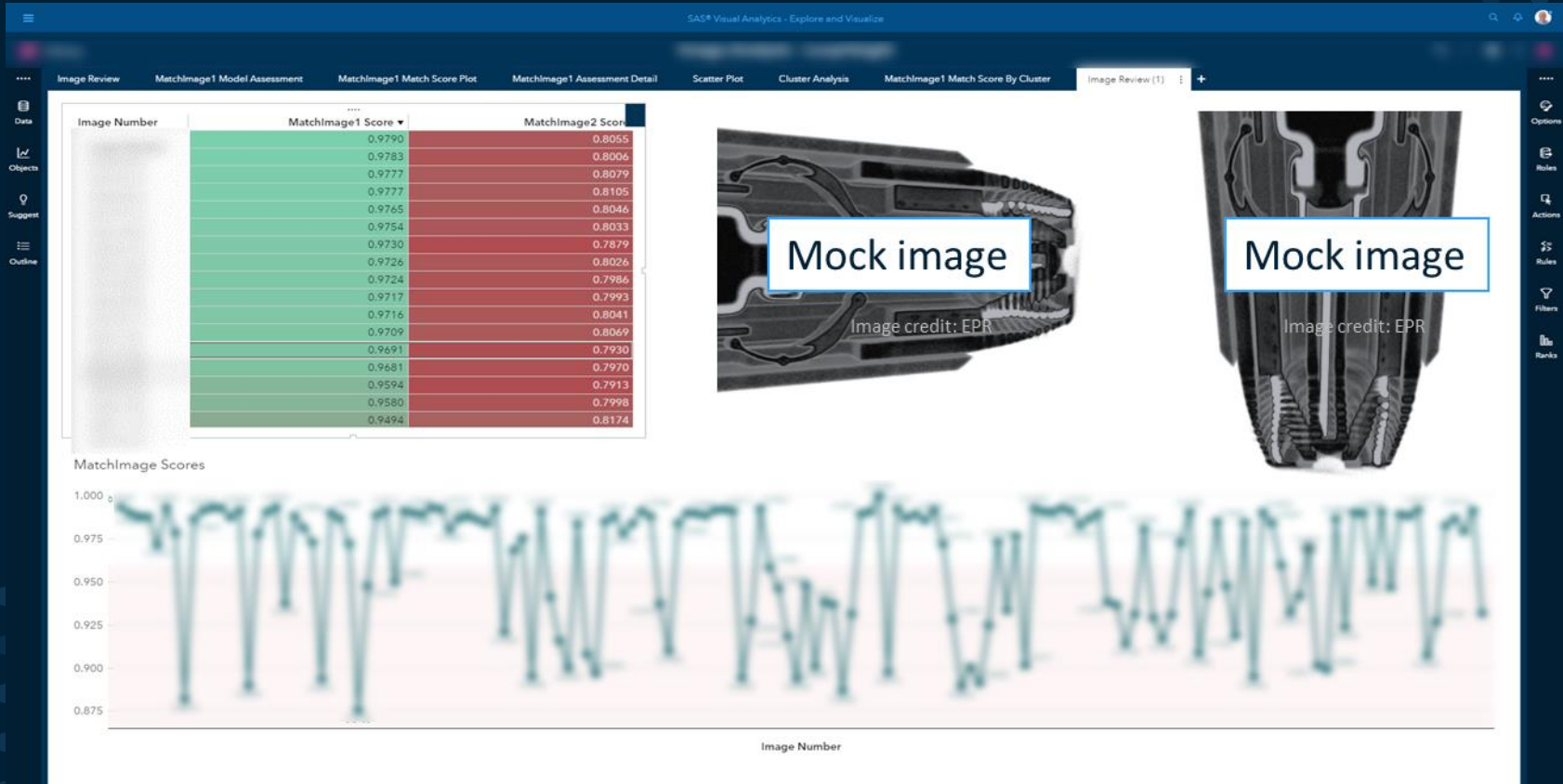
Good Device

Bad Device

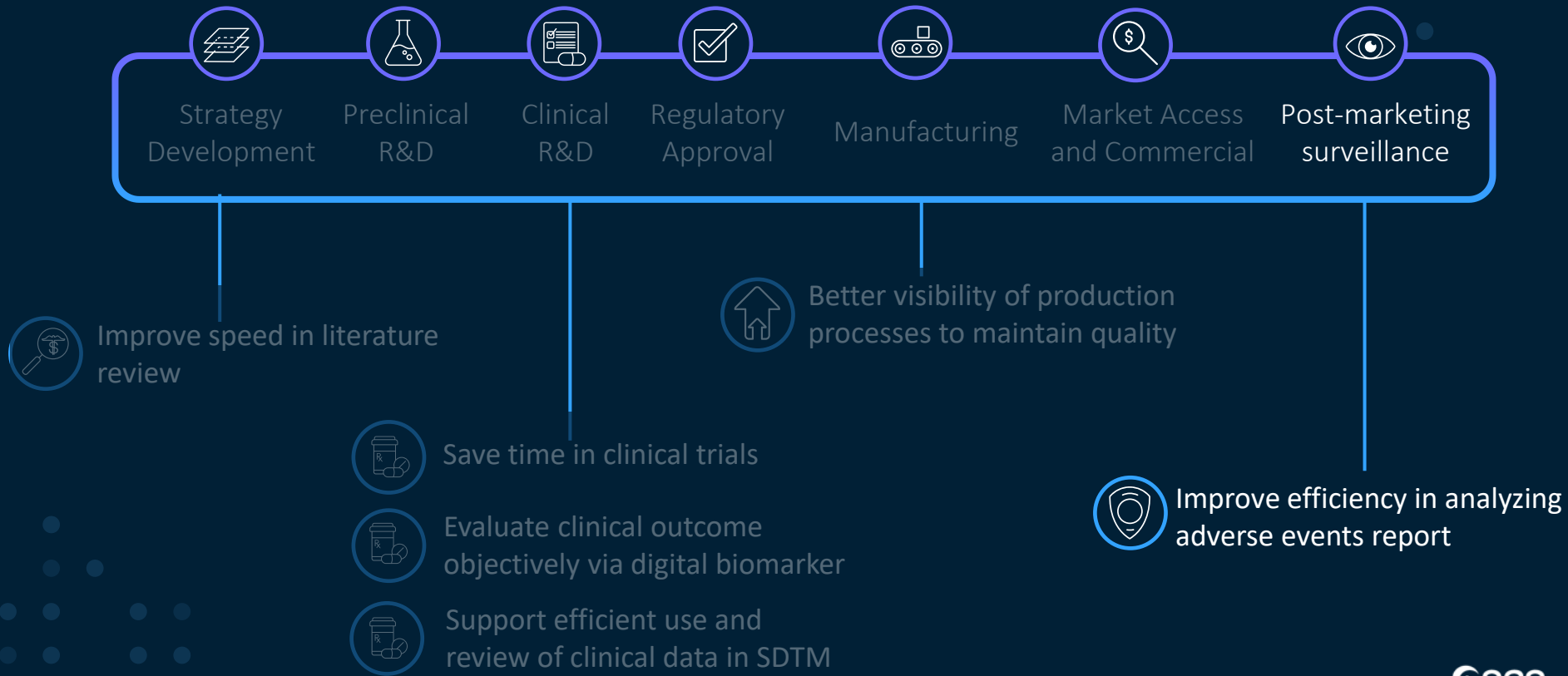
# Visualize the batch with suspected defects



# Compare suspected product images with the gold standard



# Visualization Across Life Cycle of Pharmaceutical Product





# Improve efficiency in analyzing adverse events report

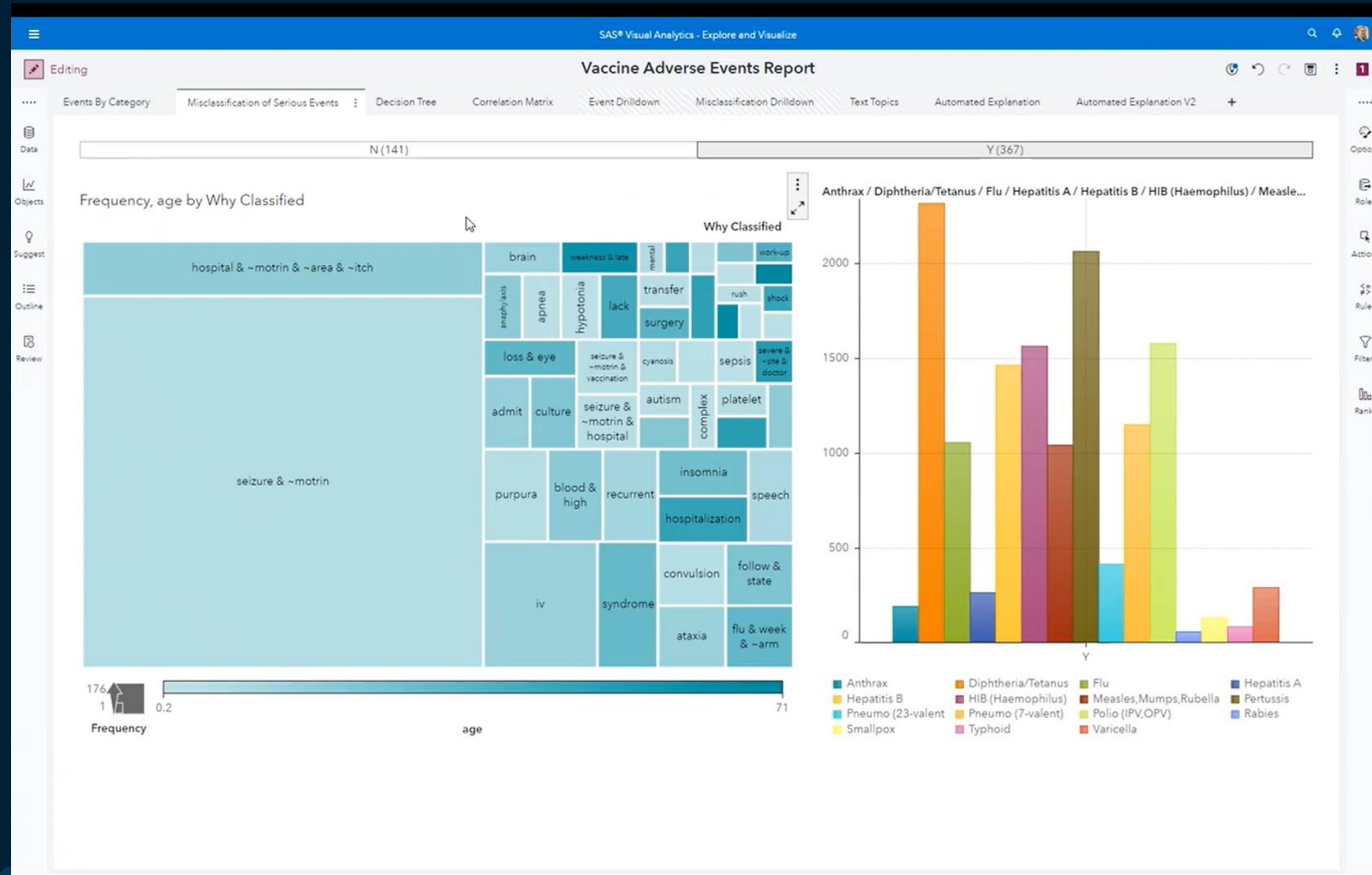
Use text analytics and visualization techniques

- Analyze unstructured data (i.e., symptom text) from vaccine adverse event reports
- An analytic platform that can generate Topics and Terms from text data automatically
- Provide researchers quick insights on serious adverse events from 500+ reports

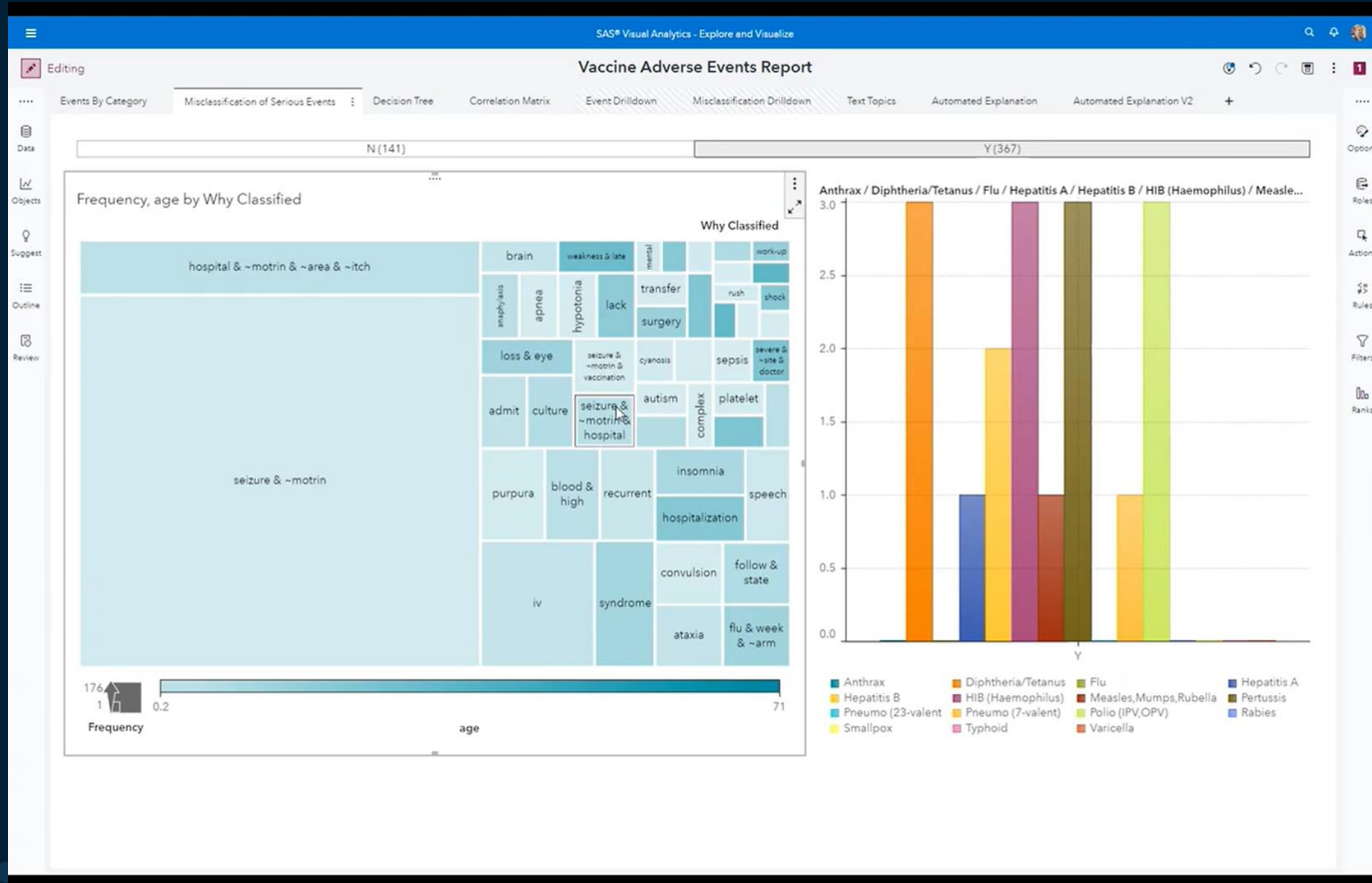
Powered by SAS Visual Text Analytics & SAS Visual Data Mining and Machine Learning in SAS® Viya



# Visualize the relationship between vaccine types and key topics



# Visualize the relationship between vaccine types and key topics



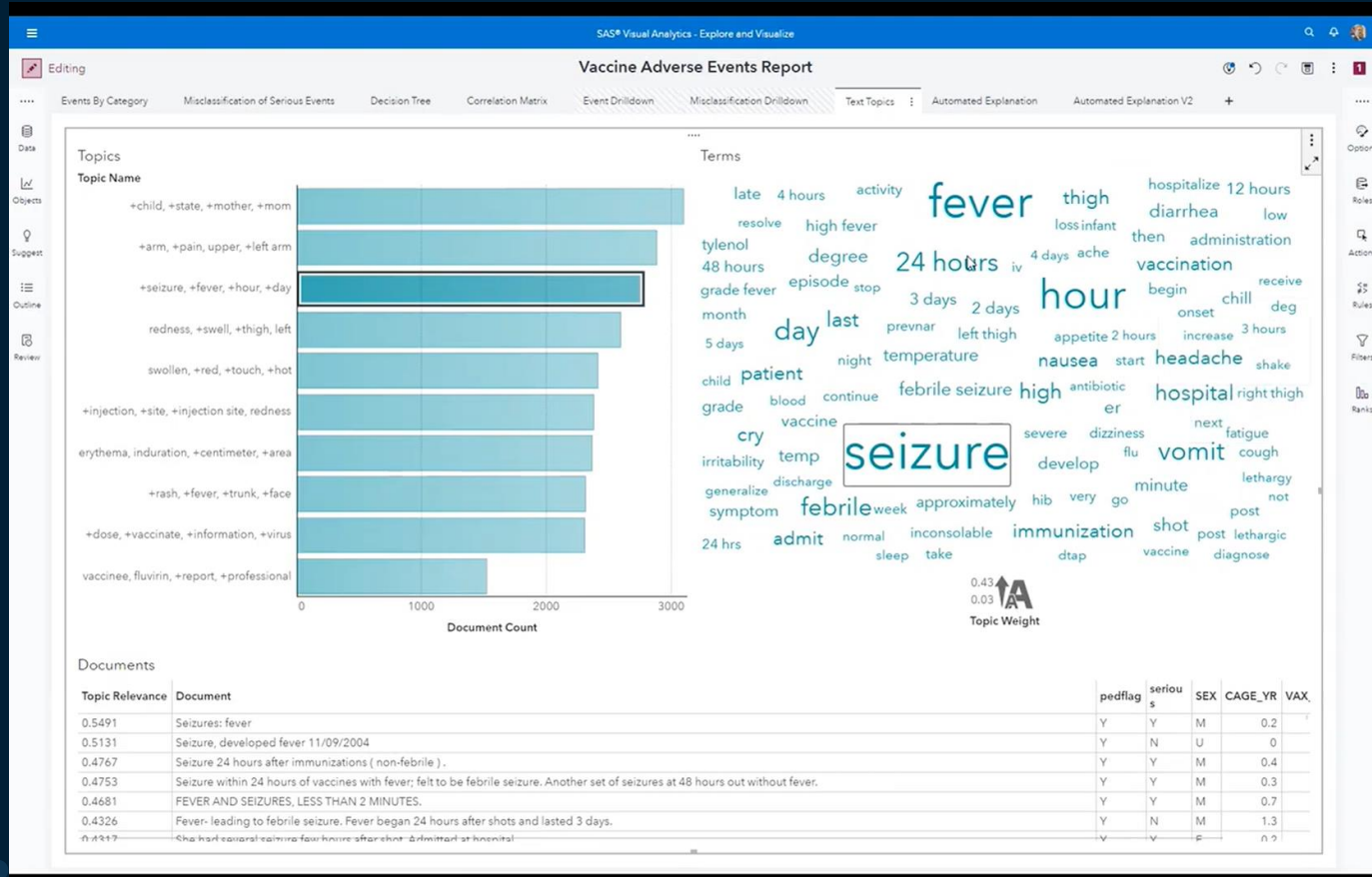
# Drill down to the individual text data

SAS® Visual Analytics - Explore and Visualize

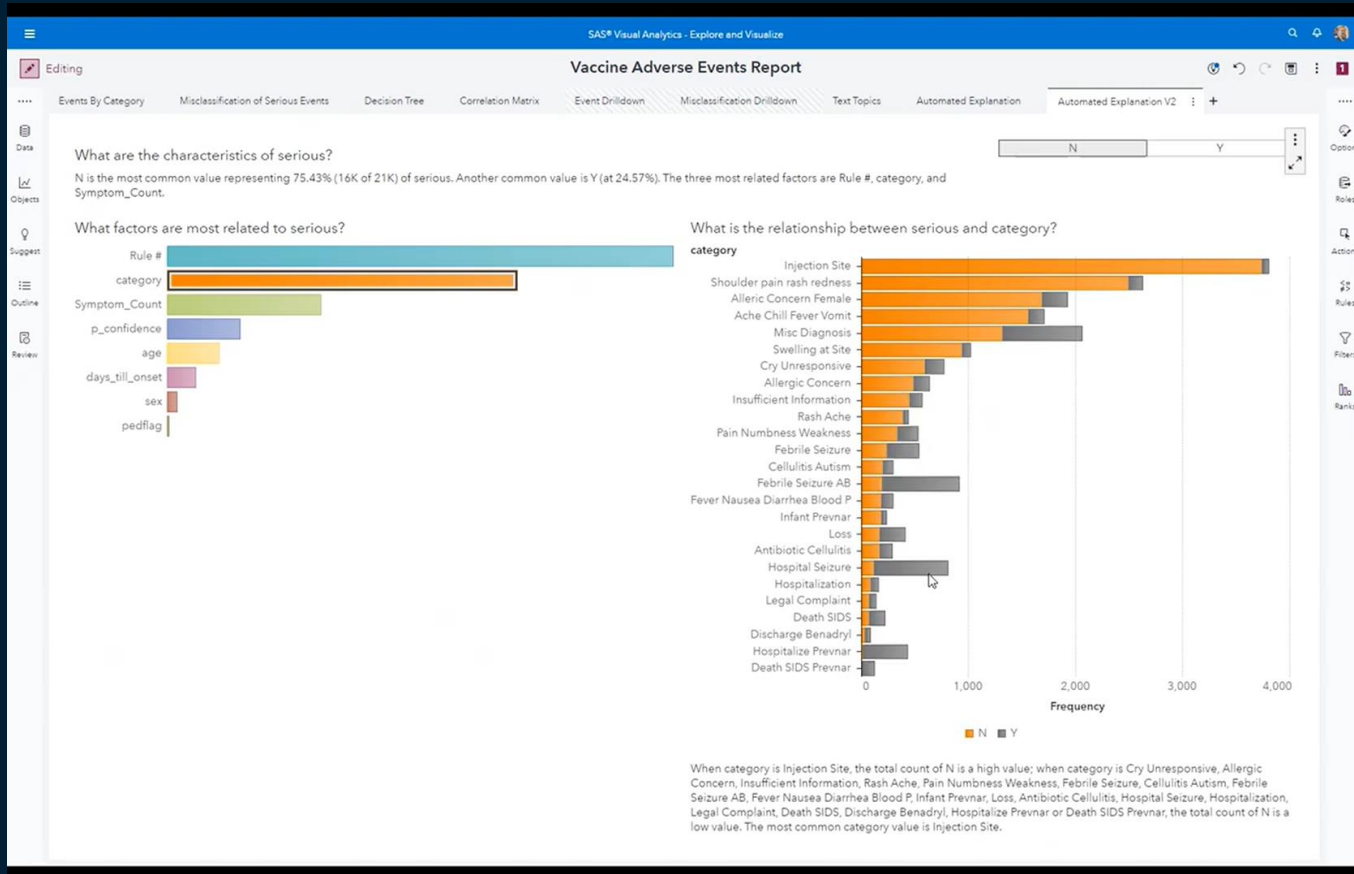
Editing Vaccine Adverse Events Report > Misclassification Drilldown

Predicted Target	serious ▲	age	days_till_onset	category	Why Classified	SYMPTOM_TEXT
Y	N	2.2	0	Febrile Seizure AB	seizure & ~motrin & hospital	The pt had a seizure several hours after the vaccination. The pt went to a hospital ER.
Y	N	1.3	0	Hospital Seizure	seizure & ~motrin & hospital	105 temp, seizure-seen in ER, also diagnosed with stomach flu, 2 weeks later had pneumonia seizure with high fever, seen at hospital
Y	N	0.6	1	Hospital Seizure	seizure & ~motrin & hospital	8 seizure like episodes which began 1 day following vaccinations and lasted 1 day, no episodes since ( currently 3 days post last episode ) sent to hospital and pt referred to neurology.
Y	N	0.4	1	Febrile Seizure AB	seizure & ~motrin & hospital	Felt warm per paramedics, ER at hospital. Seizure Activity 11/25/04 6:00am S2 at home.

# Visualize the key topics and terms from text data



# Visualize the relationship between seriousness and key topics

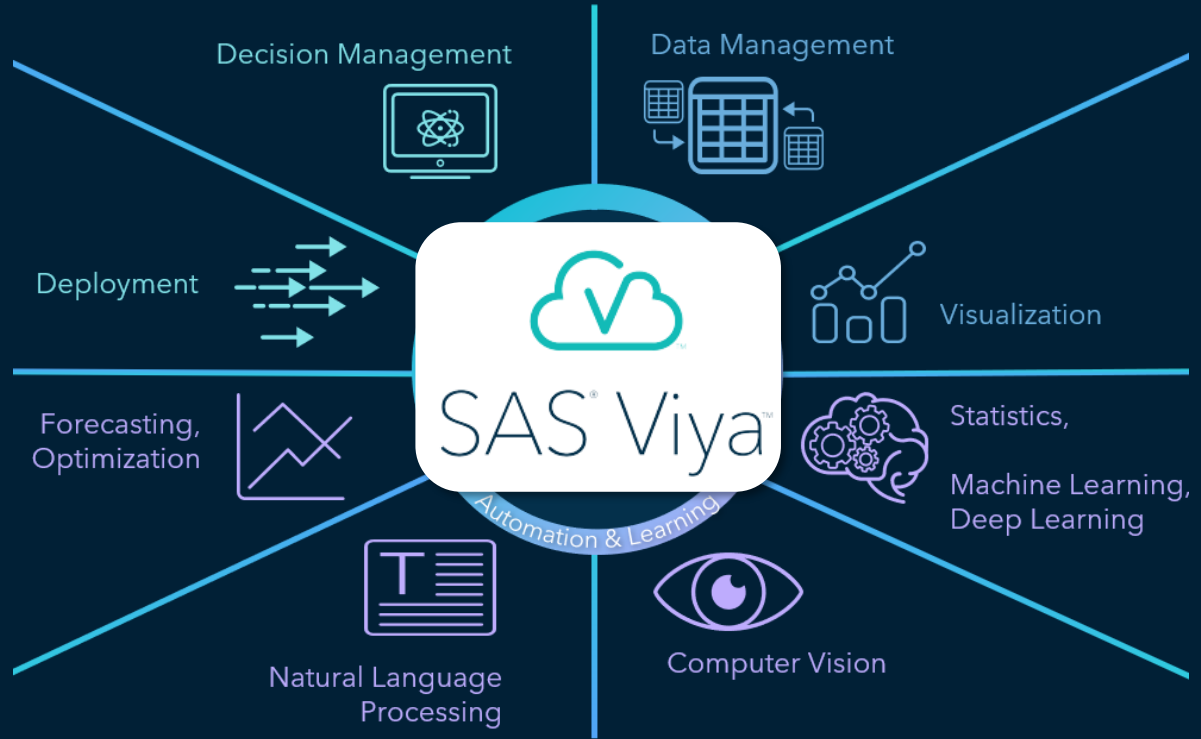


# Takeaway Messages

- In addition to having all the powerful analytical techniques SAS is known for in SAS 9, **SAS Viya** also contains the latest machine learning, deep learning and visualization capabilities with friendly user interface
- SAS 9 and **SAS Viya** are integrated so you can still use what you've built. SAS code and SAS 9 is here to stay, as part of the **SAS Viya** environment
- Visualization helps people interact, understand and even analyze the data, especially for users with different level of analytical skills
- Visualization can support efficient workflows and data-driven decision across the life cycle of drug development
- Modernize the analytics platform can help organizations stay competitive in the market

**Thank you!**  
**Any Question?**

[William.Kuan@sas.com](mailto:William.Kuan@sas.com)



Confident decisions at every moment.

