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

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Introduction

Visualization is not only for Descriptive Analytics



Introduction

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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



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 Display Manager

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SAS Enterprise Guide



SAS Enterprise Miner, SAS Text Miner





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

Application Menu



SAS Studio



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

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COVID-19 Search and Explore groupings of documents based	d Text Analytics (COSTA) I on SAS information extraction models		SAS Viya					
Topics Incubation Reviod - 193 Regroduction Number - 37 Senal Internal - 17	Binned Values (Number of Days or Persons Infected) Prequency	Reported Values (Number 17.4 3.6 5.2 5.6 10.0 1.4 19.0 2.0 10.6 6.0 5.0 2.1	r of Days or Persons Infected) 25.0 6.4 6.7 3.0 11.0 7.7 4.0 22.0 7 0.9.0 5.1 4.6 5.5 24.0 2.6 2.0					
Text		+ Keywords Title	Authors					
With an incubation time of 5 days on average, 15 initial recommendations for importantly, asymptomatic healthcare workers with low risk exposures, such appropriate PPE, are not instructed to selfquarantime but rather ecommend exposed healthcare workers with symptoms may be able to return to work is spread of COVID-19 in the US, healthcare workers will be disproportionately hemodialsysis, or, at a minimum, impact the ability to add additional hemodi	or quarantine of exposed healthcare workers were up to 2 weeks; 16 as encounters that occur when the healthcare provider is wearing field to intensively monitor. With the increased availability of testing, more quickly in the setting of negative tests; however, with the rapid y affected. Ultimately, this could limit the availability of in-center alysis shifts for COVID-19 positive patients.	Hemodialysis and COVID-19: An Achilles' 5 days Heel in the Pandemic Healthcare Response in 1 United States	Weiner, Daniel E.; Watnick, Suzanne G. the					
hemodialysis, or, at a minimum, impact the ability to add additional hemodialysis shifts for CCVID-19 positive patients. When SARS CoV 2 infects a person, the lesions are not limited to the lungs. The virus causes viruemia after entering the body and the main clinical manifestations are forwer, pharyngaligis, latigue, diameter non-specific symptoms [3,4]. This process includes the incubation phase and the early phase of the disease. The incubation takes 1-14 days [3-7 days being common,]. Peripheral blood leucocytes and lymphosytes are not significantly reduced (normal or slightly lower) at this phase. Then, the viruses spread through the bloodstream and mainly in the langs, agatrointestinal trace, and heart, presumably concentrated in the tissues expressing ACE2, the receptor of SARS-CoV-2. This phase occurs around time, pulmonary lesions became wore, and chect T scans show imaging changes consistent with in the peripheral blood are increased.								
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Explore relevant research on different topics

Topics	Numerical Therees Co-Citation Network 'Thank You's							
Syndromic Surveillance (5,552)	Analytics (COSTA)		22					
Ecology Epidemiology - 470	prmation extraction models							
General Risk Assessment - 31,404			SAS VIJ	ya				
Movement Control Strategies - 180	elevant to the topic Keywords							
Population attributes - 779	of the keywords in the tree		tric cool					
PPE - 2,507	cardiac TEVEL and pro		313	incy				
PPE Effectiveness - 1,488	diabetes datyes		the states of the	4				
Risk Assesment: Human Infections - 529		Title	Authors	. P				
Risk Assessment: Animal Distribution - 2	re Remote Monitoring Devices Used to Support Patient Monitoring During the to the following one-invasive remote monitoring devices that measure or detect	Heart Failure Collaboratory	Abraham, William T.;					
Risk Assessment: Animal Transmissibility - 2,446	the CCMD 19 public health emergency: clinical electronic thermometers, a cube cometry (ScO2), non-investive blood consume (MBP), respiratory	Statement on Clinical Trials in the Landscape of	Fiurat, Mona; Piotka, Mitchell A.; O'Connor,	2				
Risk Assessment: Antigenic Relatedness - 680	A free and the second se	COVID-19	Christopher M.					
Risk Assessment: Antiviral Drugs Treatments - 365	Is a significant impact on clinical trials for current and future study participants, nanage clinical trials during the COVID-19 pandemic is of particular relevance to	Heart Failure Collaboratory Statement on Clinical Trials	Abraham, William T.; Fiuzet, Mona; Psotka,					
Risk Assessment: Disease Severity - 173	Isk for COVID-19 related morbidity and mortality. This ecosystem includes a payers, and both public and private sponsors of HF clinical trials.	In the Landscape of COVID-19	Mitchell A.; O'Connor, Christopher M.					
Risk Assessment: Genomic Variation - 1,014			Ahmad, Tauseef; Khan, Muhammad: Herpon, :					
Risk Assessment: Human Transmissibility - 8,040	Tive for SARS CoV 2 infection (the causative agent of COVID 19), found that half of opertunsion 15%. Their symptoms were mainly fever 98%, cough 76%, and fatigue	COVID-19: Zoonotic	Muse, Taha Hussein; Nasir, Saima; Hui, Jin;					
Risk Assessment: Population Immunity - 8	drome 29%, RNAaemia 15%, acute cardiac injury 12%, and other secondary The death rate was 15% [5].	aspects	Bonilla Aldana, D.Katterine:	2				
Risk Assessment: Receptor Binding + 6,803			Rodriguez Morales, Alloese J.					
Social Distancing Efficacy - 849	cold to severe disease. Some of the CoVs are zoonotic, meaning they can be		Weise States					
Syndromic Surveillance + 5,552	e strain of Cov that was named SNIS CoV 2 (standing for severe acute respiratory use. The virus has an incubation partiod of 2-14 days before symptoms appear.	SARS-CoV-2 outbreak						
Transmission Environment - 344	breath and muscle ache. In addition, serious complications related to COVID-19 cute renal failure, septic shock and ventilator associated pre-umonia. 1, 2 Elderly	How can pharmacista help?	Arren, Amer Mustala	21				
	For disease and concell are considered to be at higher risk of developing serious							

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

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Generate propensity score matched patient cohort with standardized analysis template

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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





Visualize SDTM - Summary of Demographic Characteristics

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Visualize SDTM - Adverse Events

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Visualize SDTM - Adverse Events

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Visualize SDTM – Concomitant Medication

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Visualize SDTM – Concomitant Medication

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<i>y</i> *		CDISC_SDTM	1_Maxime_PD 9	/1/2022 9:16:0	2 AM				 x[×] I 	୬୯ : 1
Summary of Demogrpahic Characteristics	Adverse Event Body System	Adverse Event Analysis on Prefer	red Term Concomi	ant Medication : La	b Analysis	La	b Shift Analysis	Hy's Law DILI Anal	ysis VS Analysis	Medical His 🗲 🔲
<u>Pt receiving at least one</u> <u>Concomitant meds</u>	NERVOUS SYSTEM (5.42%)									•
78	Number of subjects in I distir 20 10	Medication Class htt cm subjects								
74	0 Medication Class NERVOUS SYSTEM NERVOUS SYSTEM Description of Planned Arm Placebo Xanomeline High Dose Xanome						NERVOUS SYSTEM Xanomeline Low Dose			
Number of Subjects	-	:	Medication Nam Unique Subject	e Listing	ge Sex	Race 🔻	Route of	Dose Units	Dosing Frequency	С
ACETYLSALICYLIC ACID -		11	1dentifier 01-718-1170		80 F	WHITE	Administration ORAL	mg	Q ₂	Admin
DONEPEZIL HYDROCHLORIDE	2		01-718-1079		67 F	WHITE	ORAL	mg	QC	
HALOPERIDOL -	1									
PAROXETINE HYDROCHLORIDE -	1									
0 Description of Planned Arm	2 4 6 Xanomeline Low	8 10 Dose								

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Visualize SDTM – Lab Analysis



Visualize SDTM – Hy's Law Analysis



Visualize SDTM – Patient Profile

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<i>*</i> CD	ISC_SDTM_Maxime_PD 9/1/2022 9:16:02 AM	
C Adverse Event Analysis on Preferred Term Concomitant Medication Lab Analysis	Lab Shift Analysis Hy's Law DILI Analysis VS Analysis Medical History Analysis Exposure Analysis	Patient Profile : Page 12 > 🗍
Demogrpahic info Description of Planned Arm Age Sex Race Date/Time of Death Date/Time of First S Treatment Placebo 85 M WHITE 2013-09-23	Subject ID Lab Study Day 01-701-1415 -8 to 183 Study Day -8	Numerical Visits 183 1
	1 to 170 1 to 170 1 Availab Value	1.1
Subjects Visit Name Visit Name	Avg Drug Exposure	3
Subject Elements Sequen Descriptio Element Code Start Date/Time of End Date/Time of		3.5
ce Nu n of Ele Element Element 1 Screen SCRN 2013-09-15 2013-09-23 4 Placebo PBO 2013-09-23 2014-03-24	Range of Exposure	4
	O VITB12 0 200 400	600 5
	Study day of Disposition Range of Lab value	6
FINAL LAB VISIT	183 183 0 to 0 0 0 0	345 7
	Study start day of CM	8

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

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



Collect patient movement data



Determine risk scores in real-time



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



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Visualize the batch with suspected defects



Co

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



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Visualize the relationship between vaccine types and key topics



Drill down to the individual text data

=							SAS® Visual Analytics - Explore and Visualize C	a o	
Editing						Vaccine Adve	rse Events Report > Misclassification Drilldown 🖇 😗 🔿 🕫	9 :	0
	Predicted Target	serious 🔺	age	days_till_o	category	Why Classified	SYMPTOM_TEXT	:	 ©
Data	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.		Options
[√ bjects	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		Roles
Ŷ	Y	N	0.	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.		G,
Qest	Υ	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.		Actions
									Rules Pitters Dao Ranis

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Visualize the key topics and terms from text data

	Versing Adverse Franks Demost		
liting	vaccine Adverse Events Report	() •) ()	
Events By Category	Misclassification of Serious Events Decision Tree Correlation Matrix Event Drilldown Misclassification Drilldown 1	Text Topics 🚦 Automated Explanation Automated Explanation V2 +	
Tenies	т		
lopics	lerms		
topic Name +child,	+state, +mother, +mom	activity fever thigh hospitalize 12 hour diarrhea low	
+arm,	+pain, upper, +left arm to be degr	tylenol degree 24 hoters is 4 days ache vaccination	
+seiz	ure, +fever, +hour, +day grade fever episode	stop 3 days 2 days hour begin chill do	
redi	ness, +swell, +thigh, left day las	prevnar left thigh appetite 2 hours increase 3 hours	
swo	llen, +red, +touch, +hot child patient ni	ight temperature nausea start headache shak	
+injection, +site,	+injection site, redness grade blood cont vaccine	er next fatigue	
erythema, indurat	ion, +centimeter, +area	Seizure develop flu vomit cough	
+ra:	ih, +fever, +trunk, +face generalize symptom febr	ileweek approximately hib very go no post	
+dose, +vaccina	te, +information, +virus 24 hrs admit "	normal inconsolable immunization ^{shot} post lethargic sleep take dtap vaccine diagnose	
vaccinee, fluvirin	, +report, +professional	0.43	
	0 1000 2000 3000		
	Document Count	topic morgin	
Documents			
Topic Relevance	Document	pedflag seriou SEX CAGE_YR	
	Seizures: fever	Y Y M 0.2	
0.5491	Seizure, developed fever 11/09/2004	Y N U 0	
0.5491 0.5131			
0.5491 0.5131 0.4767	Seizure 24 hours after immunizations (non-febrile) .	Y Y M 0.4	
0.5491 0.5131 0.4767 0.4753	Seizure 24 hours after immunizations (non-febrile) . Seizure within 24 hours of vaccines with fever; felt to be febrile seizure. Another set of seizures at 48 hours out without fever.	Y Y M 0.4 Y Y M 0.3	
0.5491 0.5131 0.4767 0.4753 0.4681	Seizure 24 hours after immunizations (non-febrile) . Seizure within 24 hours of vaccines with fever; felt to be febrile seizure. Another set of seizures at 48 hours out without fever. FEVER AND SEIZURES, LESS THAN 2 MINUTES.	Y Y M 0.4 Y Y M 0.3 Y Y M 0.7	
0.5491 0.5131 0.4767 0.4753 0.4681 0.4326	Seizure 24 hours after immunizations (non-febrile). Seizure writhin 24 hours of vaccines with fever; felt to be febrile seizure, Another set of seizures at 48 hours out without fever. FEVER AND SEIZURES, LESS THAN 2 MINUTES. Fever- leading to febrile seizure. Fever began 24 hours after shots and lasted 3 days.	Y Y M 0.4 Y Y M 0.3 Y Y M 0.7 Y N M 1.3	

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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





Confident decisions at every moment.

