Refining Testable Cases and Scenarios for Evaluating Level 3 Through Level 5 Automated Driving System Concepts

Project Overview

NHTSA GCAPS SwRI QS-2 VT TRANSPORTATION INSTITUTE VIRGINIA TECH

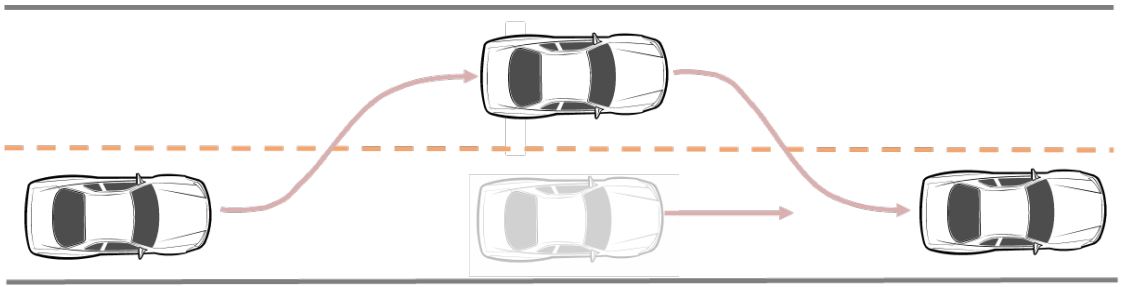
Refining Testable Cases and Scenarios for Evaluating L3 - L5 ADS Concepts

Purpose:

Develop a *method* to guide the design and selection of cases to test the performance of an Automated Driving System (ADS) - using *lane change scenario* data for *piloting purposes*.

Objectives:

- Develop a model-based feature representation of multivariate driving scenario data to further define testable cases.
- Apply previous testable cases framework to identify ADS test cases and quantify the relationship and boundaries between test cases.



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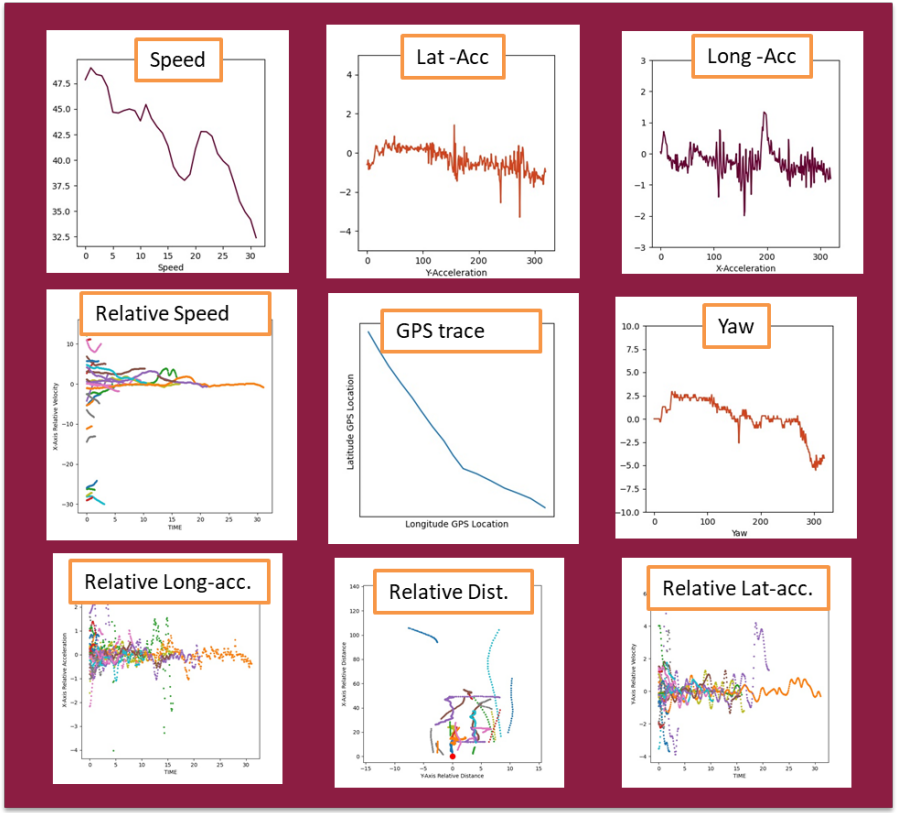
Project Motivation:

- Data Breadth
- Data Scale
- Data Science



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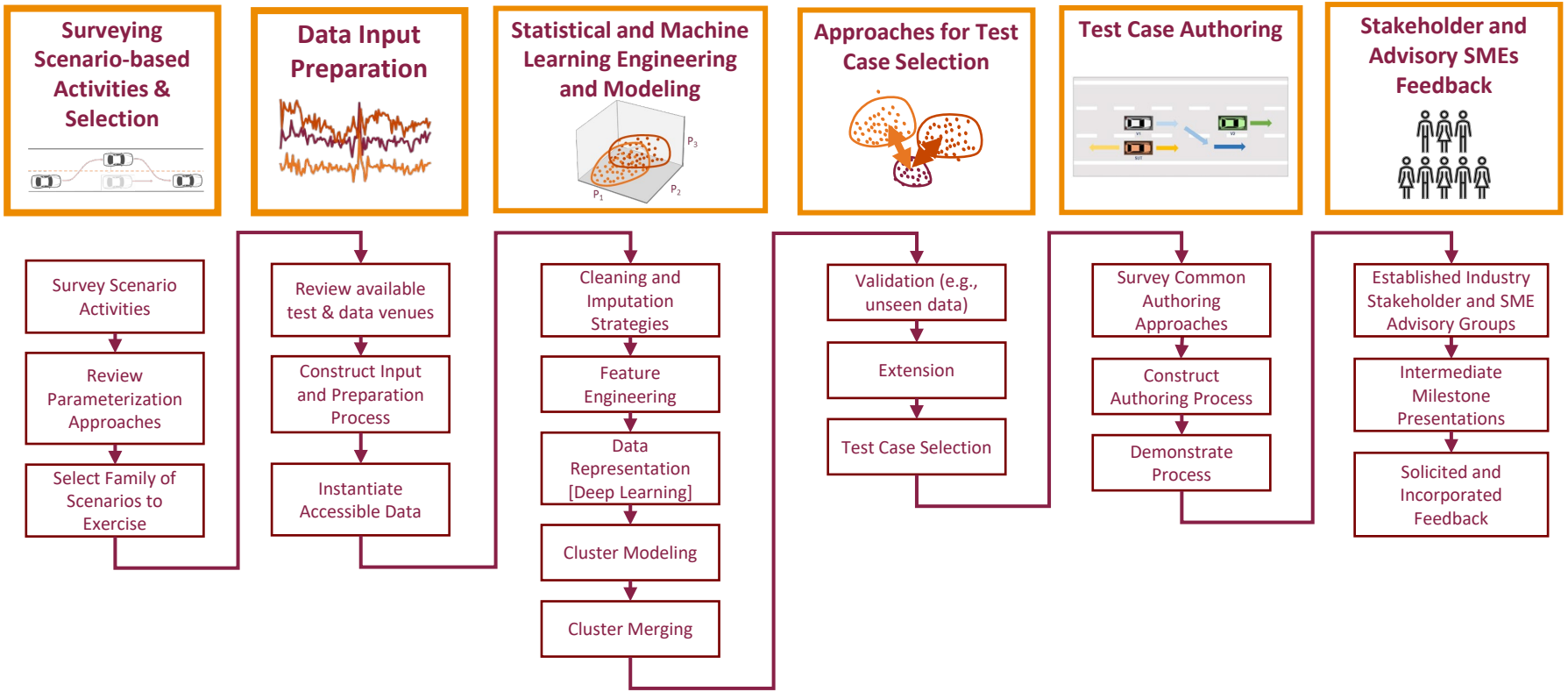
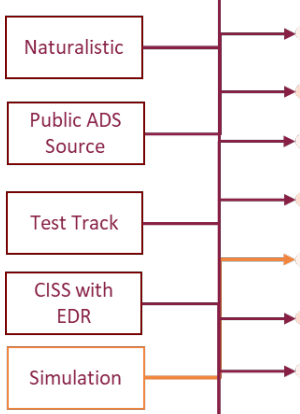


Scenario Sources for Statistical Models

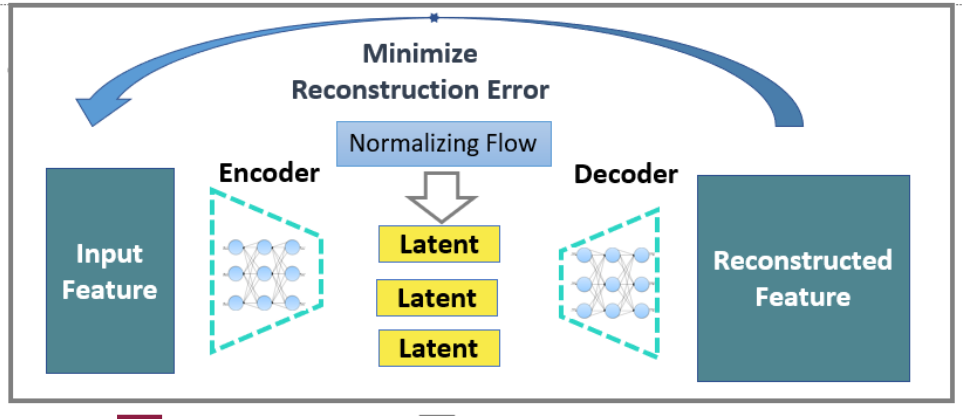


Venue	Approximate Count	Description
NDS	500,665	Routine lane changes greater than 31 mph
NDS	435	Routine lane changes, located in random samples
Public ADS	306	Lane changes in proximity of automated driving system
NDS	5003	Routine merges
Test Track	567	Routine lane changes
NDS	919	Cut-ins
Simulation	10,799	3 core cases X 3600 simulated variations
NDS	1394	Near-crashes
Test Track	5	Event avoidance lane changes
NDS	53	Crashes
CISS	145	CISS EDR cases
	520,291	Total

Nominal Criticality

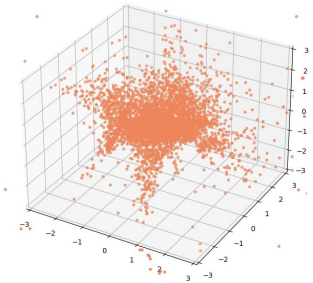
Note: Tables were intentionally populated with more units than would be used (1) to learn more from the import and preparation task and (2) to provide more options for downstream processes.

Cluster Modeling Workflow

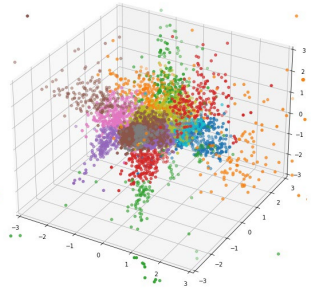


Models Considered

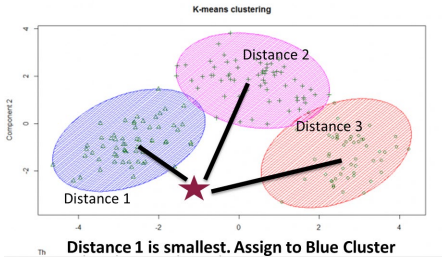
1. Variational Auto Encoder (VAE-NF)
2. Principal Component Analysis (PCA)
3. Fast Independent Component Analysis (Fast-ICA)
4. Kernel-PCA
5. t-distributed stochastic neighbor embedding (tSNE)
6. Truncated Singular Value Decomposition (TSVD)
7. Spectral Embedding (SE)



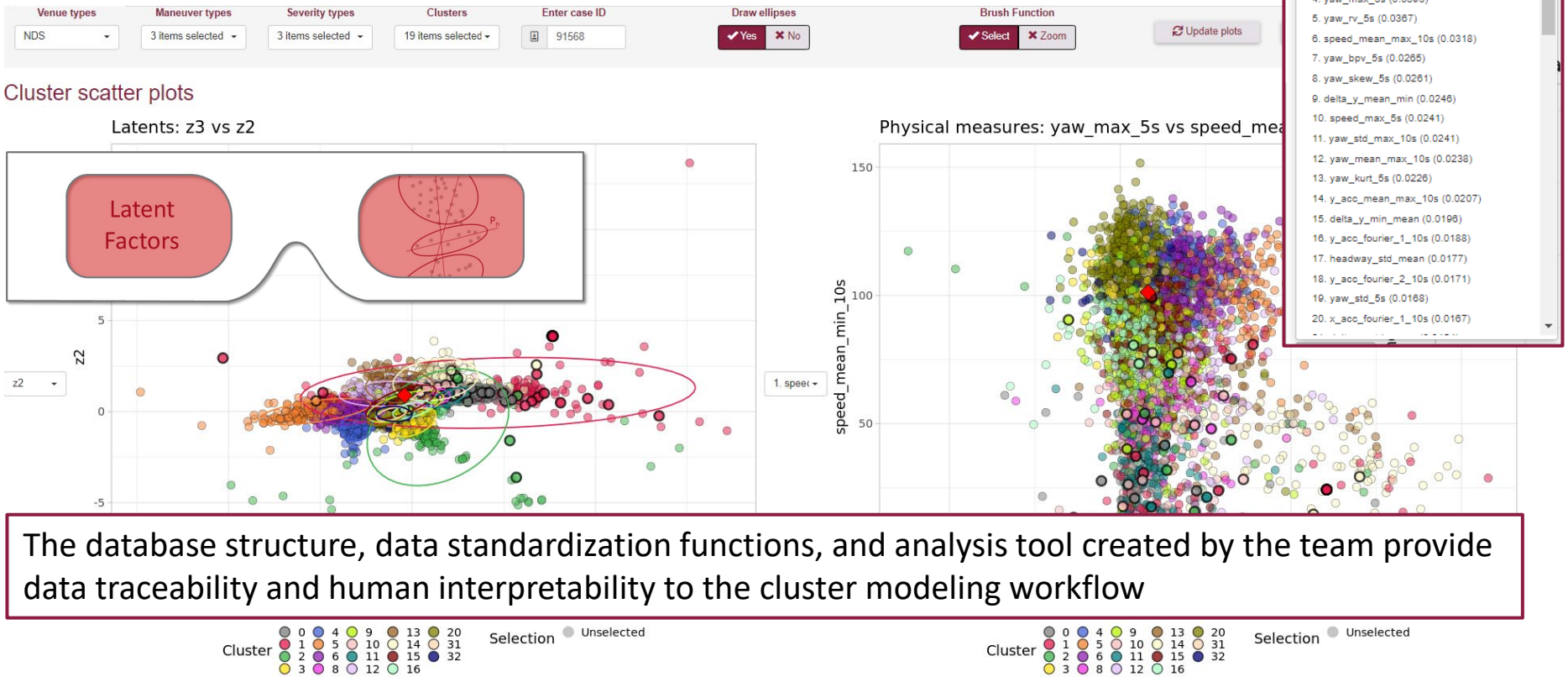
Clustering



Validation and Extension

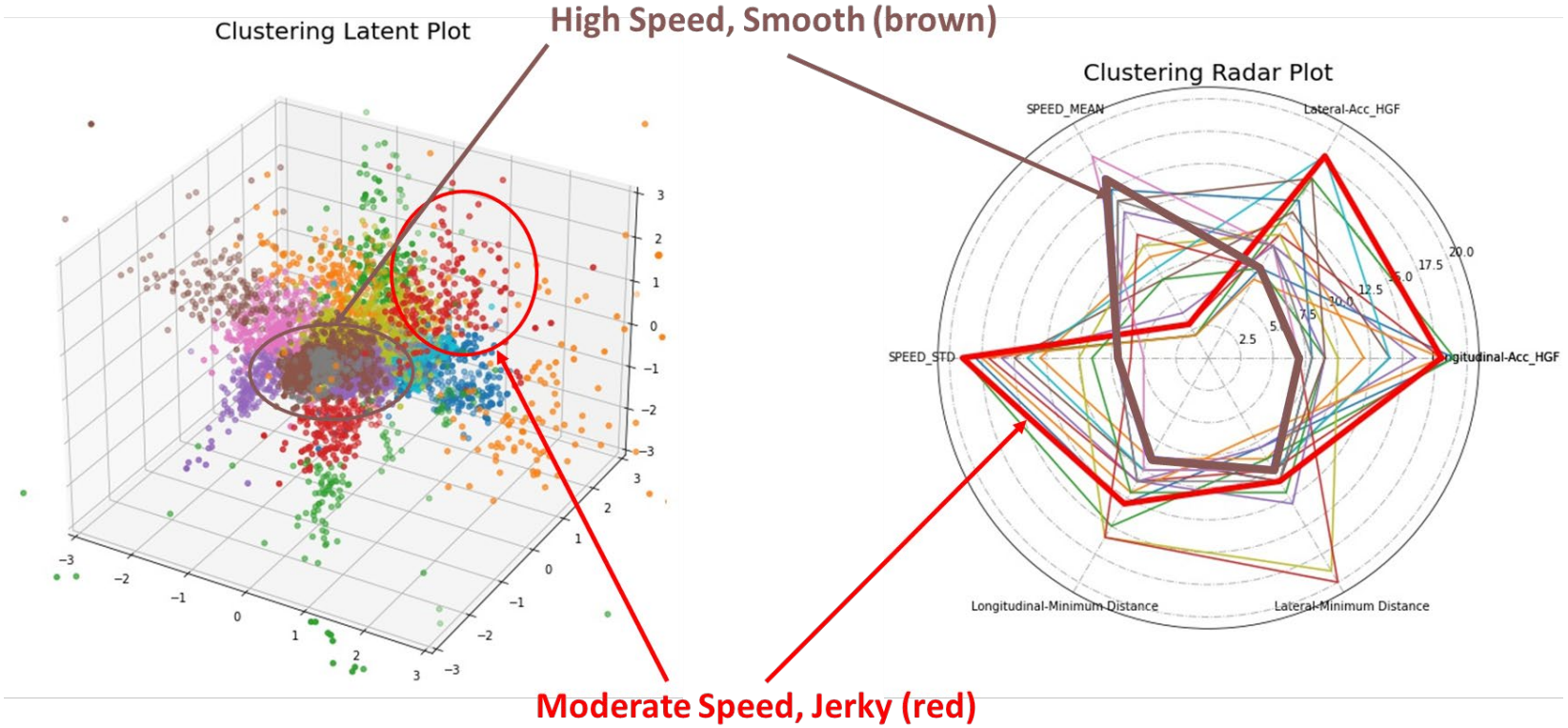


Relating Latent Factors to Engineered Features



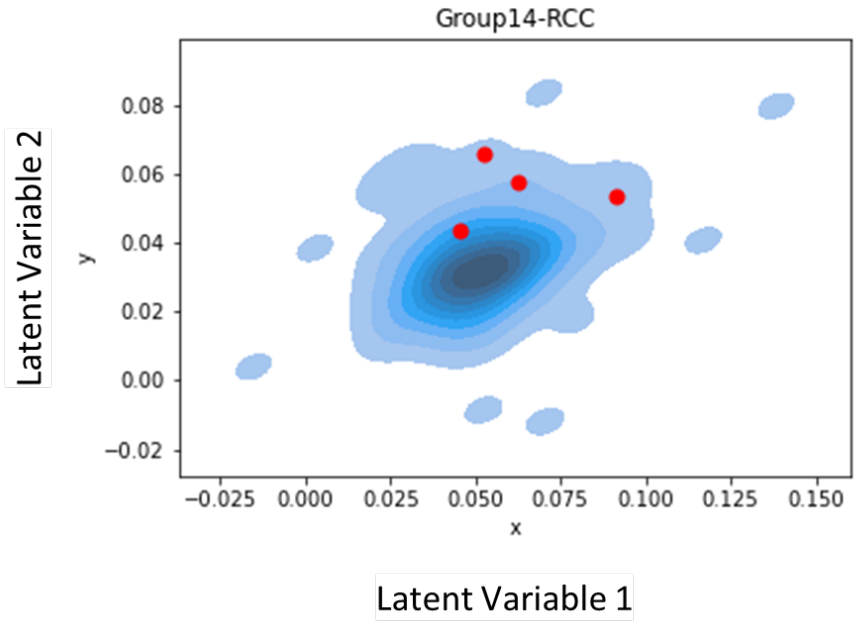
The database structure, data standardization functions, and analysis tool created by the team provide data traceability and human interpretability to the cluster modeling workflow

Clustering to Test Cases



Clustering to Test Cases

Moderate speed, jerky



High density: More likely to happen

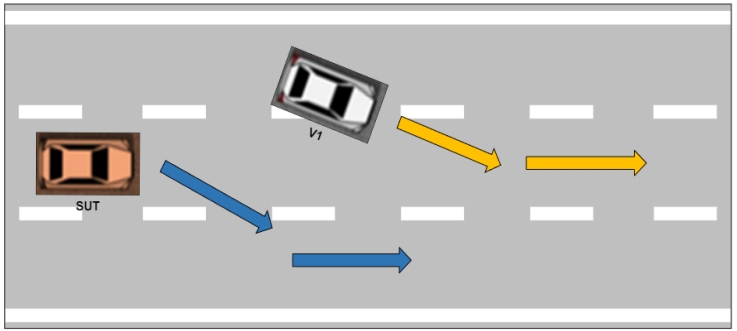
Low density: Less likely to happen

: safety-critical events

- Certain feature combinations occur more frequently than others
- Safety-critical events tend to occur on low-density regions

Test Case Authoring

The SUT is traveling straight on a multi-lane highway with V1 ahead in left adjacent lane. As V1 initiates lane change into SUT's path, SUT responds.



SUT	A (to Right) **Event 1**	B (Straight)
V1	A (to Right) **Event 1**	B (Straight)
Road Type	Three-lane Highway	
Weather	Clear, Afternoon	
Time		

Contact Info

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Thank You!