

# Introduction of Company and Software Solution

April 2024

- **Introduction Company**
- **Overview Software Solution**
-  **Result Data Analysis Capabilities**

# Company SCALE GmbH

- Company is dedicated to **„CAE process and data management“**
- SCALE GmbH established 2012 in Germany by DYNAmore
  - 4 branch offices in Germany
  - Subsidiary in India (development center)
  - Subsidiary in USA
- Staff at SCALE are a mix of
  - experienced CAE engineers
  - professional computer scientists
- Focus on Automotive Industry
  - SDM products developed in cooperation with German automotive industry
  - Large Installations (>1000 Users)

## Offices in Germany



# International Partners for Sales and Support



## Our Portfolio

### SCALE.sdm

Standard software solution for CAE process and data management

Requirements ▶ Modelling ▶ Solving ▶ Evaluation ▶ Monitoring



### SERVICES

Individual software projects on customer order

- Requirement analysis
- Conceptual design, planning
- Specifications
- Implementation and project management
- Focus on IT projects related to simulation methods and processes



### CONSULTING

- CAE processes
- Machine Learning and AI methods in CAE
- Introduction of SDM
- Software design



- Introduction Company
- Overview Software Solution
-  Result Data Analysis Capabilities

**SCALE.sdm** → Software Solution for Simulation Data Management

## Benefits of the system



**Standardization** of data and processes



**Documentation** of all activities



**Quality** improvement with automated model checks



**Collaboration** – Support of teamwork and data sharing



**Time Savings** – Automation of processes / workflows



**Transparency** – Easy interaction of engineers



**Reporting / Assessment** – Standardized and automated



## SCALE.sdm

 Project

 Model

 Result

 Project

Project



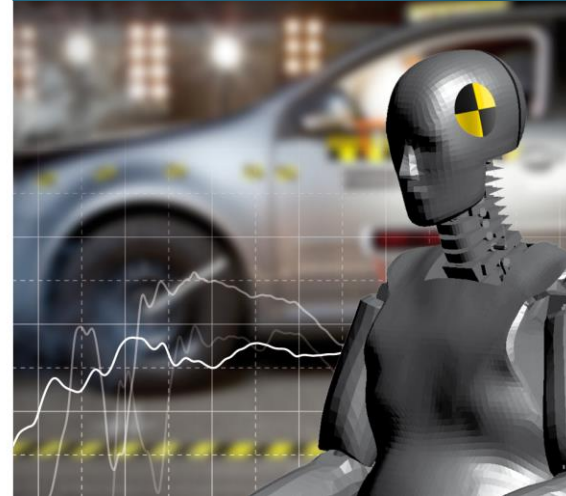
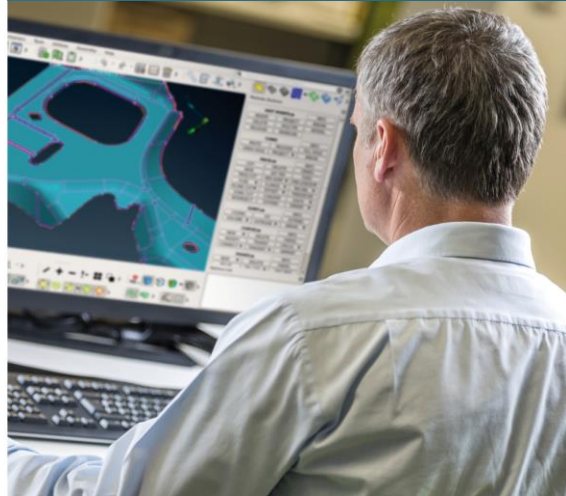
Simulation



Assessment



Targets





## SCALE.sdm



Setup of Project



Define Responsibilities



Specify Milestones



Prescribe Requirements

The screenshot displays the SCALE.sdm software interface. On the left, a sidebar shows a list of projects under 'My Projects' and 'Starred Projects'. The main area is titled 'Requirements' and shows a table of milestones with columns for Group, Name, Description, Threshold, and Status. The table lists various test cases and their corresponding thresholds and status indicators (e.g., green for pass, red for fail). A search and filter panel is visible on the right side of the interface.

Group	Name	Description	Threshold	Status
Projects Test Case	(4)			
	Chest acceleration cumulative (3 ms) (Copy)	S15.3.3 The re...	$4.895 \leq x < 6.118$	6.526 $\leq x < \infty$
	Chest deflection (Copy)	S9.2.1(b) The d...	$-44.00 \leq x < -35.20$	$-35.20 \leq x < \infty$
	Ensure Glass - Lip characteristic compr...		x = YES	x = NO
	Extraction force after 8h of heat aging (Copy)		$40.00 \leq x < \infty$	
Frontal FMVSS 208 4...	(5)			
	Chest acceleration cumulative (3 ms)	S15.3.3 The re...	$4.895 \leq x < 6.118$	$6.118 \leq x < \infty$
	Chest deflection	S15.3.4 Compr...	$-52.00 \leq x < -41.60$	$-41.60 \leq x < \infty$
	Femur force compression (left)	S15.3.5 The for...	$-6.805 \leq x < -5.444$	$-5.444 \leq x < \infty$
	Femur force compression (right)	S15.3.5 The for...	$-6.805 \leq x < -5.444$	$-5.444 \leq x < \infty$
	Head HIC (15 ms)	S15.3.2 Head L...	$560.0 \leq x < 700.0$	$700.0 \leq x < \infty$
Frontal FMVSS 208 3...	(9)			
	Chest acceleration cumulative (3 ms)	S15.3.3 The re...	$4.895 \leq x < 6.118$	$6.118 \leq x < \infty$
	Chest deflection	S15.3.4 Compr...	$-52.00 \leq x < -41.60$	$-41.60 \leq x < \infty$
	Femur force compression (left)	S15.3.5 The for...	$-6.805 \leq x < -5.444$	$-5.444 \leq x < \infty$
	Femur force compression (right)	S15.3.5 The for...	$-6.805 \leq x < -5.444$	$-5.444 \leq x < \infty$
	Head HIC (15 ms)	S15.3.2 Head L...	$560.0 \leq x < 700.0$	$700.0 \leq x < \infty$
	Neck force compression	S15.3.6 Neck L...	$-2.520 \leq x < -2.020$	$-2.020 \leq x < \infty$
	Neck force tension	S15.3.6 Neck L...	$2.100 \leq x < 2.620$	$2.620 \leq x < \infty$

## SCALE.sdm



Import CAD or Meshes



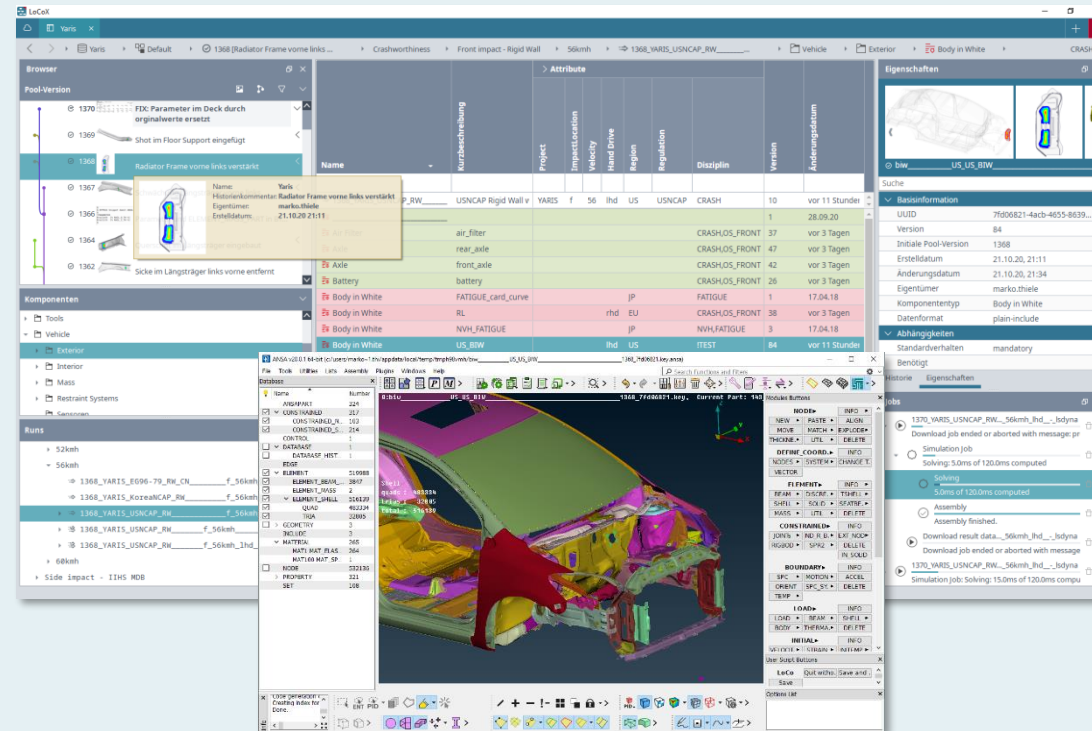
Prepare Models



Define Load Cases



Run Simulations



## SCALE.sdm

Project

Model

Result

Project

Extraction and Evaluation of Results



Management of Post Data



Correlation Test vs. Simulation



Assessment and Reporting

The screenshot displays the CAViT software interface. At the top, the browser address bar shows <https://demo.w3sysse.scale.eu/cavit/dashboard>. The main interface is divided into several sections:

- Projects and Collections:** A sidebar on the left shows a tree view with 'Projects' (LEGO, Yaris) and 'Collections' (No Rows To Show).
- Scenarios:** A section below 'Collections' shows 'Front' (33 ...), 'Side' (0 / ...), and 'Rear' (0 / ...).
- Data Table:** A central table displays simulation results. The table has columns for 'Name', 'OLC ...', 'OLC ...', and 'OLC Tunnel'. The data includes rows for various test scenarios like 'TEST\_YARIS\_USNCAP\_RW\_f\_56kmh\_lhd\_T5677' and '1371\_YARIS\_USNCAP\_RW\_f\_56kmh\_lhd\_lsdyna'.
- Report:** A panel on the right titled 'Report' contains a 'Legend' with a red and green color key, a 'Side' view showing a red car with a yellow mesh overlay, and a video player showing a yellow car. Below the video is a graph titled 'Engine Acceleration' with the subtitle 'Acceleration-X Engine top'. The graph plots acceleration in m/(s²) on the y-axis (ranging from -2000 to 1000) against time on the x-axis.

## SCALE.sdm



Import of Key Results



Monitor Project Status



Analyze Maturity Level



Decision for Approval

SCALE.sdm | Project | Confidential Information

Yaris

- Overview
- Requirements
- Settings
- Project members

### Requirements

Milestones

Quickfilter

Group	Name	Description	Threshold	Value	Status	Asses...	Comment	Access	User
EQ CHINA (6)									
	Chest deflection		$\pm x < -50.00$	+4 45 mm	brown		TEST-public	public	david.jung
	Femur force co...		$\pm x < -7.560$	+4 -4 kN	green		TEST - manual ...	public	gordon.geissle
	Femur force co...		$\pm x < -7.560$	+4 -2.123 kN	green			public	gordon.geissle
	Head a3ms		$\pm x < 7.342$	+4 5.099 G	green		TEST	public	admin
	Head HIC (36m...		$\pm x < 650.0$	+4 450	green		current referen...	public	gordon.geissle
	Neck force ten...		$\pm x < 2.300$	+4 2.2 kN	green		Demo with Pan-I	public	ferenc.leichser
EQ NORTH_AMERICA (14)					red				
	Chest accelera...	S15.3.3 The re...	$\pm x < 4.895$	+2 4.997 G	yellow		TEST 3	public	david.jung
	Chest deflection	S9.2.1(b) The d...	$\pm x < -44.00$	+2 543 mm	red		fvedfv	public	david.jung
	Chest deflection	S15.3.4 Compr...	$\pm x < -52.00$	+2 -50 mm	yellow		Mein erater test	public	david.jung
	Femur force co...	S15.3.5 The for...	$\pm x < -6.805$	+2 -1.11 kN	green		TEST2	public	admin
	Femur force co...	S15.3.5 The for...	$\pm x < -6.805$	+2 0.9 kN	green		TEST green	public	ferenc.leichser
	Firewall intrus...		$\pm x < -450.0$	+4 -321 mm	green			public	gordon.geissle
	Head HIC (15 ...	S15.3.2 Head L...	$\pm x < 560.0$	+2 600	yellow		TEST	public	admin
	Neck force co...	S15.3.6 Neck L...	$\pm x < -2.620$	+2 0.75 kN	green		Demo	public	admin
	Neck force co...		$\pm x < -4.450$	+4 0.4 kN	green			public	david.jung
	Neck force ten...		$\pm x < 3.690$	+4 3.55 kN	green		TEST	public	gordon.geissle
	Neck force ten...	S15.3.6 Neck L...	$\pm x < 2.100$	+2 1.99 kN	green		TEST ABC	public	admin
	Neck Nij		$\pm x < 0.5230$	+4 1	brown		TEST	public	ferenc.leichser
	Neck Nij	S15.3.6 Neck L...	$\pm x < 0.8000$	+2 0.8	yellow		TEST yellow	public	joan.costa
	Pubic symphys...	S9.2.1(c)(2) Th...	$\pm x < 4.800$	+2 3.99 kN	green		TEST	public	gordon.geissle

Status

14 Requirements

- 1 (7.14%)
- 1 (7.14%)
- 4 (28.57%)
- 8 (57.14%)

## On Premise



## Cloud



### SCALE.sdm Desktop

Next generation of desktop applications with desktop integration and local caches



### SCALE.sdm Web Apps

Device independent lightweight applications



## Scalable

Scale your business



## Cloud-native

Runs in cloud –  
available everywhere



## Easy to Customize

Customize to your needs  
with addons



## Data Provision

Fast and easy access  
to process data



Cloud ready

Version Control

Project management

Data Handling

Evaluation

Collaboration

Data compression

Security

Customization

Reports

Usability

## SCALE.sdm

Project

Model

Result

Project

Project



Simulation



Assessment



Targets



# Project | Key Features



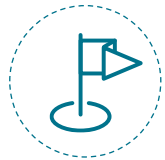
## Project Setup

Project Information and Properties



## Responsibilities

Assign Project Members and Tasks



## Milestones

Visualize Status to Project Milestones



## Requirements

Manage Technical Product Targets



## Monitor

Track Requirements and Maturity Level

Project Name	Progress	SOP
Automobile / European Fuel Cell Van Project	[Progress bar]	2020-12-24
Automobile / LEGO	[Progress bar]	2020-12-24
Automobile / Medium Electrical Car Platform	[Progress bar]	2020-12-24
Modulprojekt / Next Generation Chassis	[Progress bar]	2020-12-24

### Project Overview

**Yaris Automobile**

**Description**  
Toyota Yaris - SCALE.sdm DEMO Showcase

**Documents**

Name	Creator	Uploaded	Delete
1395_YARIS_IHS_MDB_Irdyna_status_CW47.pdf	admin	11/16/20, 9:49 AM	[Delete]
1429_YARIS_USNCAP_RW_Irdyna_status_CW47.pdf	admin	11/16/20, 9:49 AM	[Delete]
1429_YARIS_USNCAP_RW_Irdyna_status_CW47.pdf	admin	11/16/20, 9:49 AM	[Delete]

**Milestones**

Milestone Name	Date
MS1	2020-11-19
MS0	2020-06-30
SOP	2021-02-15

### Project Details

Name	Description	Threshold
Head HPC	Anforderung für 'Hez	$650 \leq x < 1000$ (green)
S2 Dummy Tempe	S11.3 The stabilized t	$293.75 \leq x < 295.35$ (green)
FC_ThrBP	Front Crash - Schwell	$13 \leq x < 15$ (red)
Vehicle Speed	S9.1.2 Except as prov	$8.889 \leq x < 9$ (green)

### Requirements and Status



# SCALE.sdm

 Project

 **Model**

 Result

 Project

Project



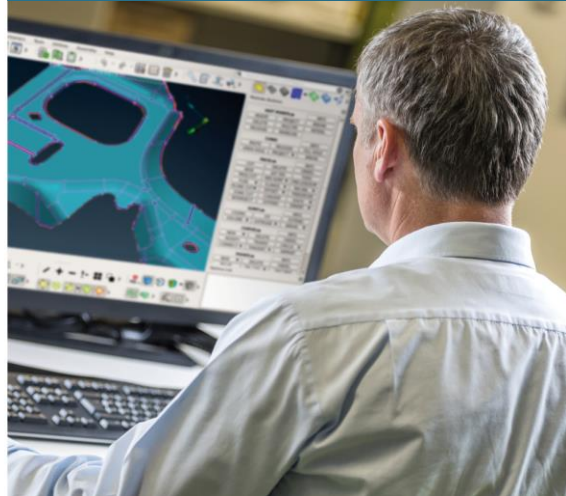
**Simulation**



Assessment



Targets

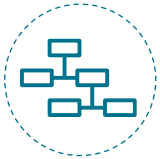


# Model | Key Features



## Integration

Seamless Integration of CAE Tools



## Version Control

Manage and Access All Your Data



## Collaboration

Scale Up Simulation Business



## Variants

Manage Huge Amounts of Load Cases



## Democratization

Simulation Processes as a Service



## Version Control

Load Cases

CAD & Meshing

Documentation

Scripts

## Simulation Data

Processes

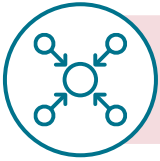
Collaboration

Model Checks



→ <https://youtu.be/eVkax8ley2Q>

# Model | Key Features



## Integration

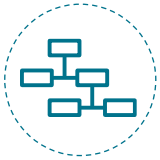
Seamless Integration of CAE tools

### Integration of Arbitrary CAE Disciplines and Solvers

CRASH, NVH, FATIGUE, PEDESTRIAN, HEAD IMPACT, CFD, MISSUSE, ...

### Integration of CAE Tools

ANSA, Animator4, Generator, Primer, HyperMesh, META, .... (scripting interface)



## Version Control

Manage and Access All Your Data



## Collaboration

Scale Up Simulation Business



## Variants

Manage Huge Amounts of Load Cases



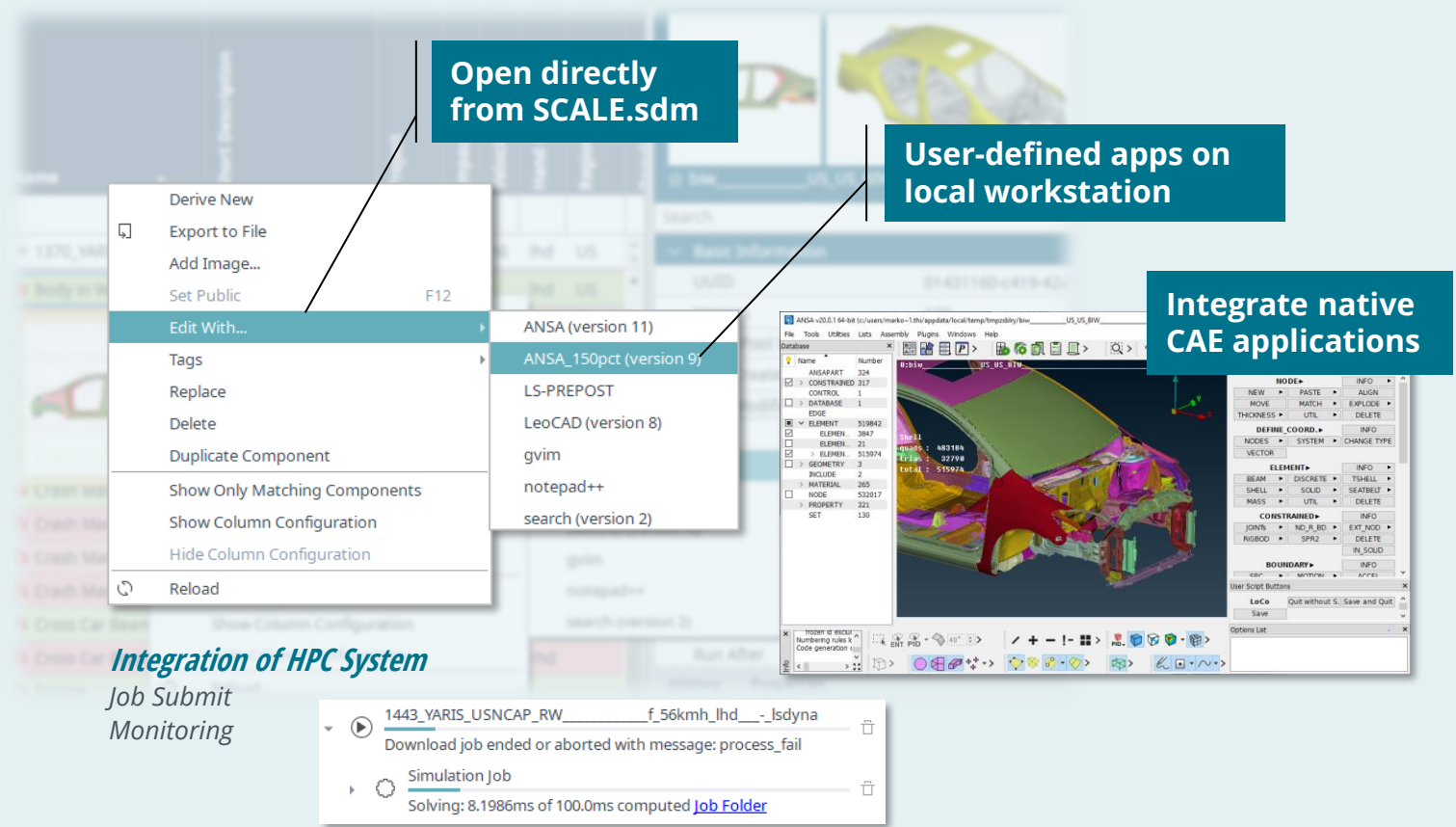
## Democratization

Simulation Processes as a Service

Open directly from SCALE.sdm

User-defined apps on local workstation

Integrate native CAE applications



### Integration of HPC System

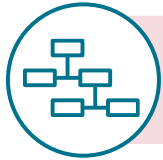
Job Submit  
Monitoring

# Model | Key Features



## Integration

Seamless Integration of CAE Tools



## Version Control

Manage and Access All Your Data



## Collaboration

Scale Up Simulation Business



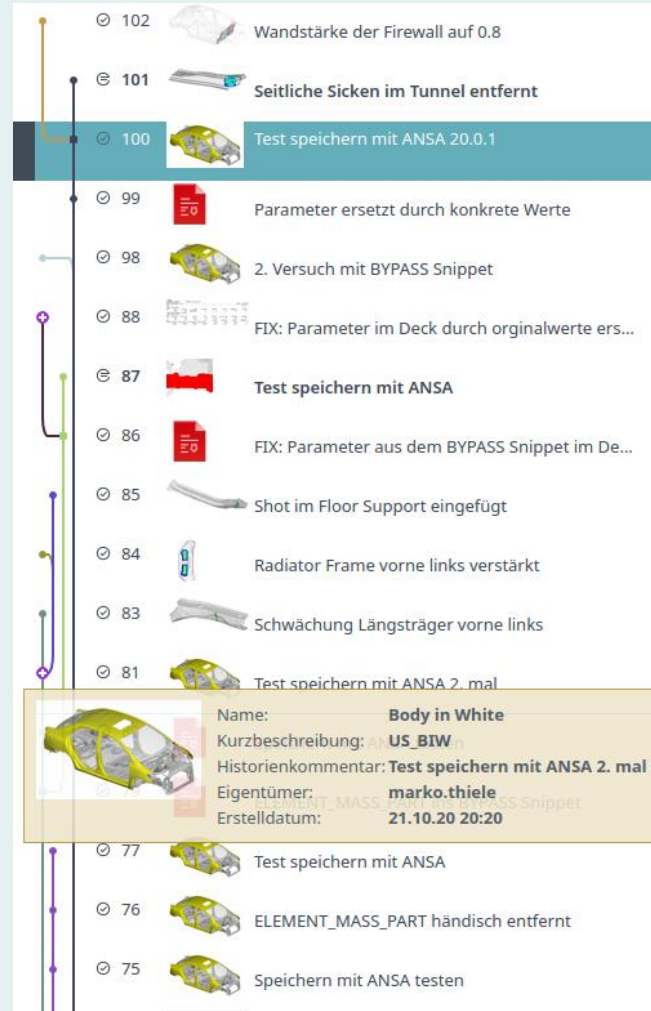
## Variants

Manage huge amounts of load cases

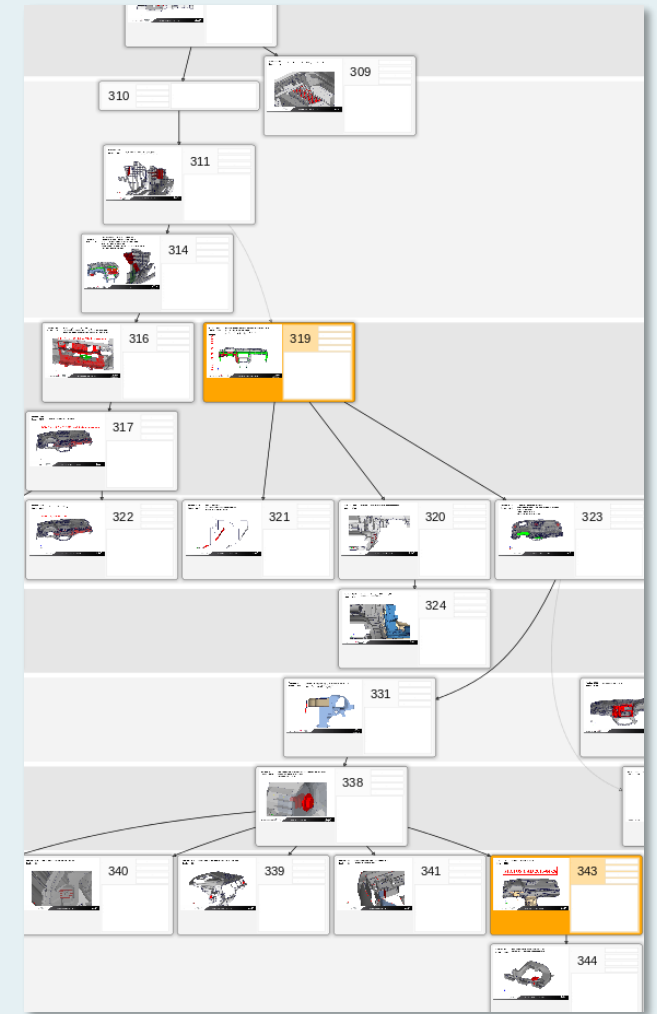


## Democratization

Simulation Processes as a Service

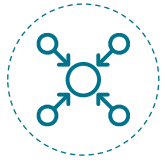


Rail Graph for Fast Navigation of Versions



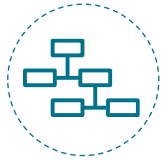
Comprehensive Visualization of Relations Between Versions

# Model | Key Features



## Integration

Seamless Integration of CAE Tools



## Version Control

Manage and Access All Your Data



## Collaboration

Scale Up Simulation Business



## Variants

Manage Huge Amounts of Load Cases



## Democratization

Simulation Processes as a Service

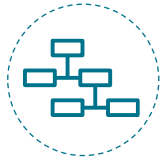


# Model | Key Features



## Integration

Seamless Integration of CAE tools



## Version Control

Manage and Access All Your Data



## Collaboration

Scale Up Simulation Business



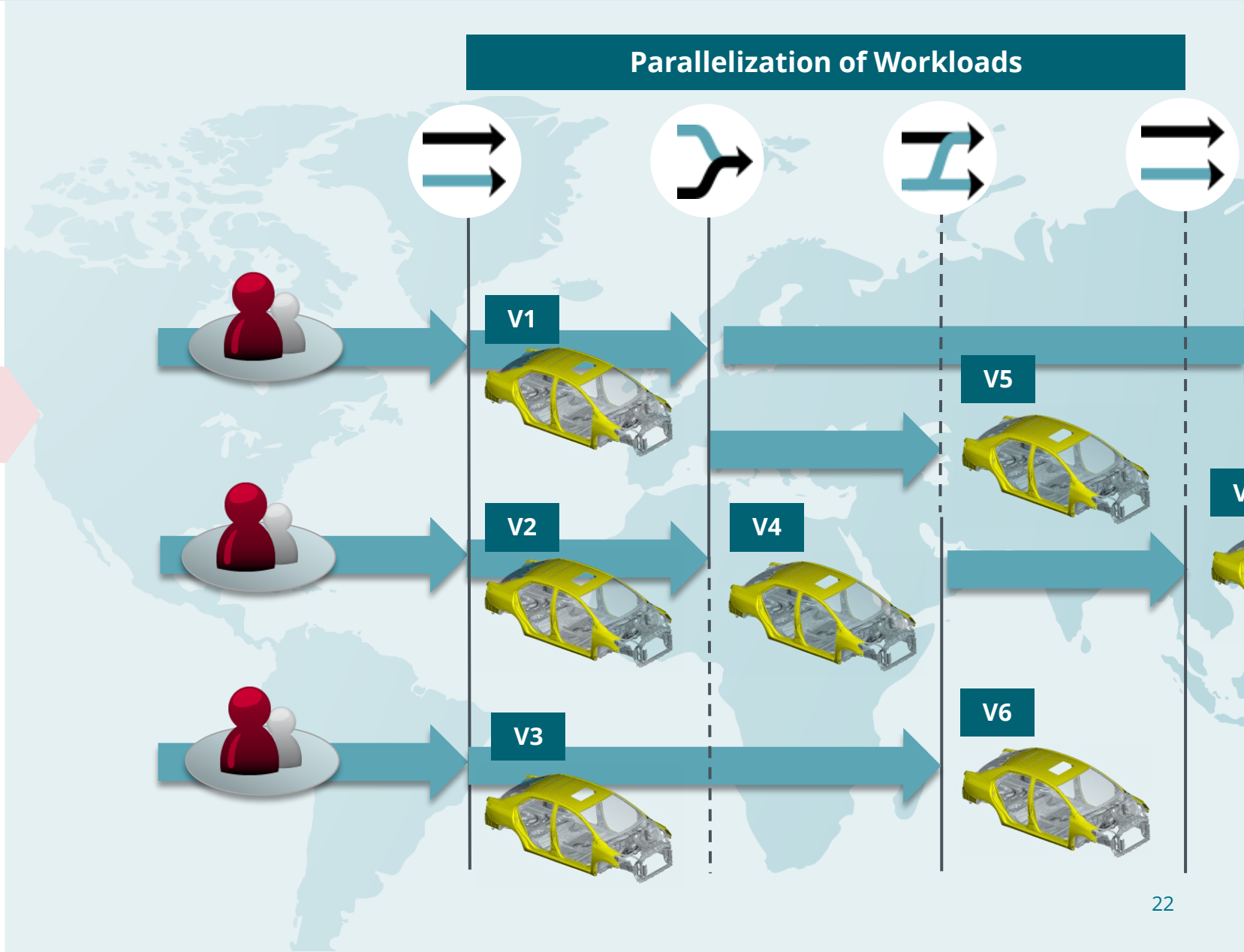
## Variants

Manage Huge Amounts of Load Cases



## Democratization

Simulation Processes as a Service

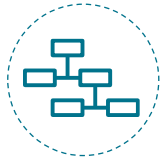


# Model | Key Features



## Integration

Seamless Integration of CAE tools



## Version Control

Manage and Access All Your Data



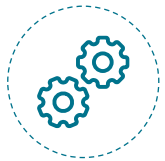
## Collaboration

Scale Up Simulation Business



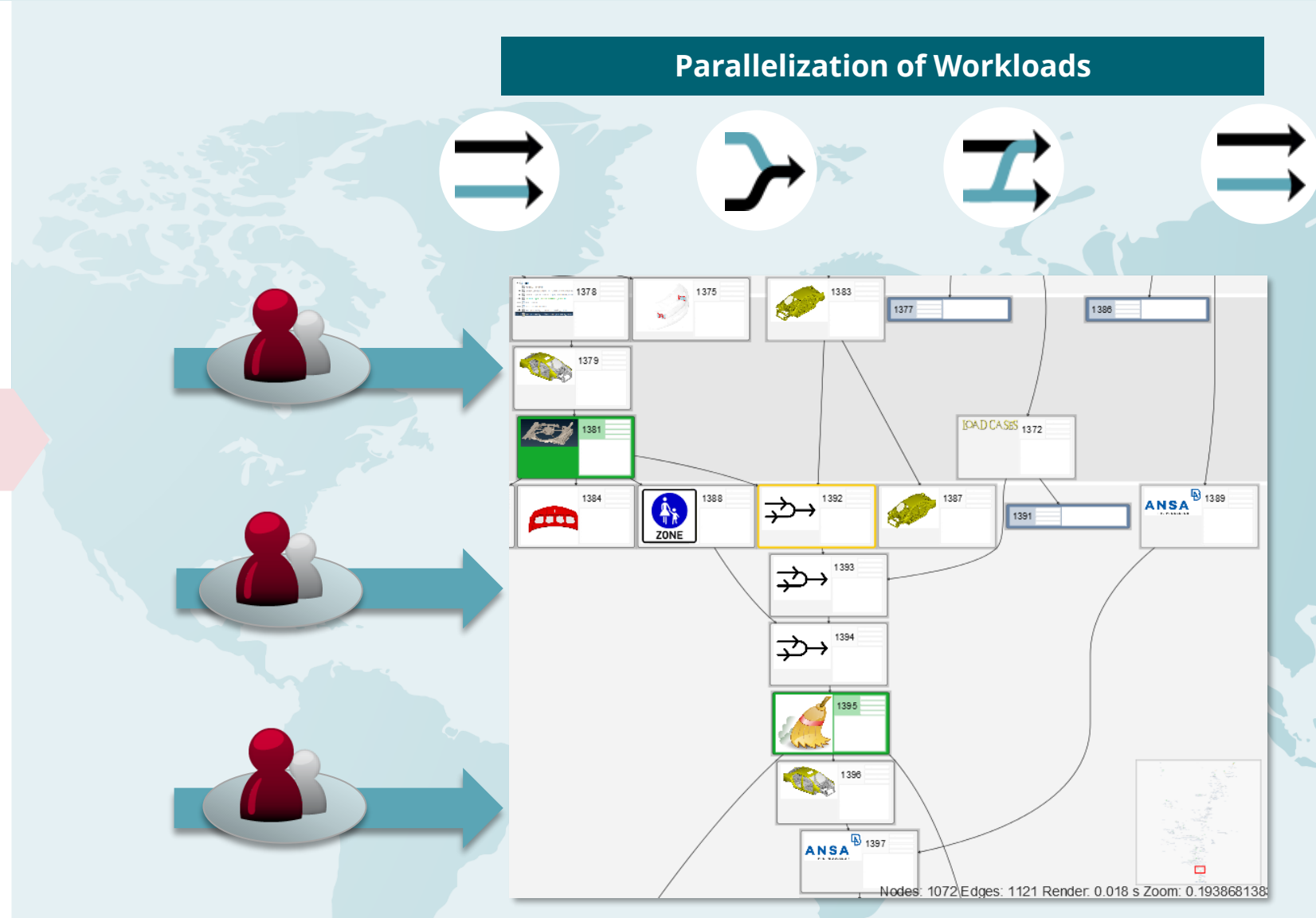
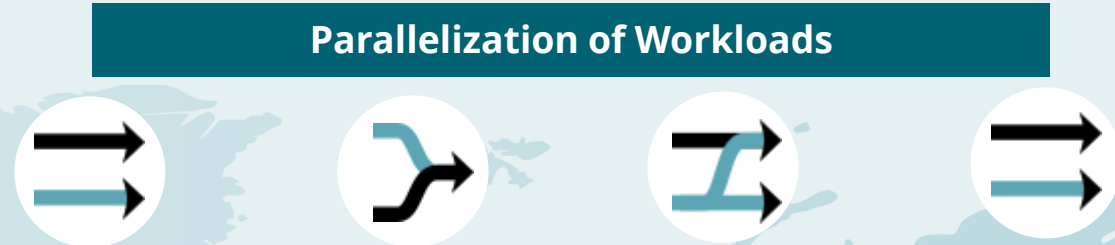
## Variants

Manage Huge Amounts of Load Cases



## Democratization

Simulation Processes as a Service

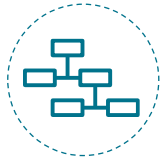


# Model | Key Features



## Integration

Seamless Integration of CAE Tools



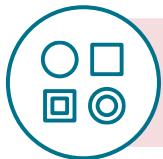
## Version Control

Manage and Access All Your Data



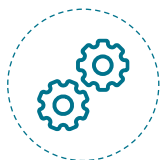
## Collaboration

Scale Up Simulation Business



## Variants

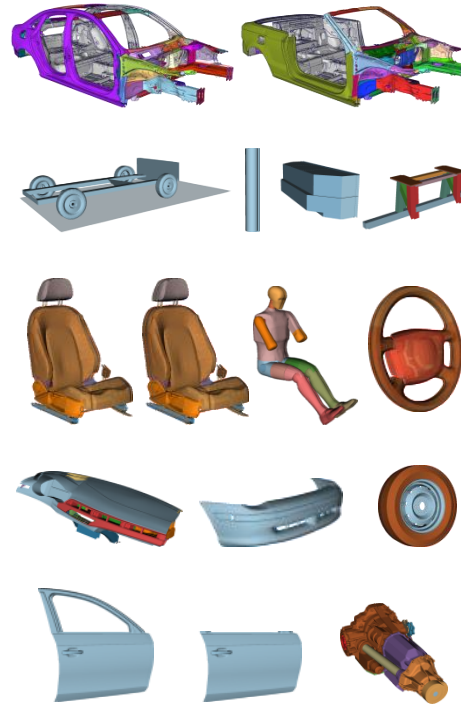
Manage Huge Amounts of Load Cases



## Democratization

Simulation Processes as a Service

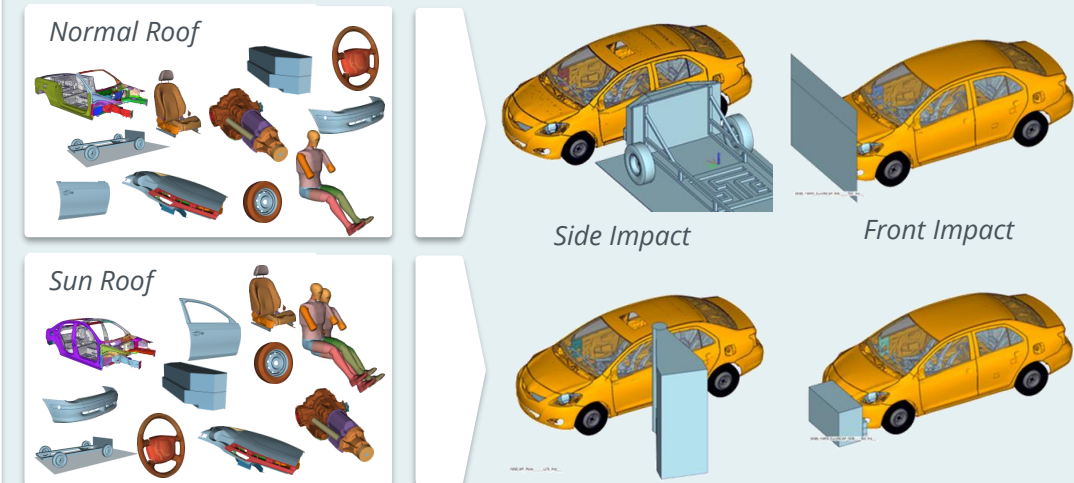
### Component Pool



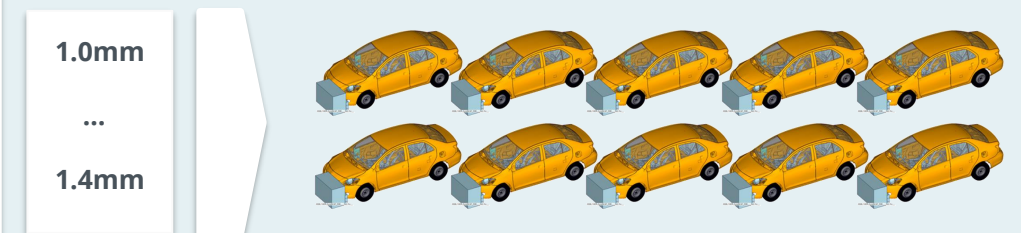
### Component Parameters

- Airbag TTF
- Sheet Thickness [ 1.0 ... 1.4 ]mm
- Calc Time
- Friction

### Assembly of Multiple Load Cases and Derivates



### Setup Robustness and DEOs Studies or Optimization Assembly of Vast Amounts of Simulations



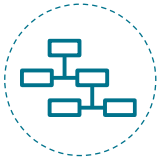


# Model | Key Features



## Integration

Seamless Integration of CAE Tools



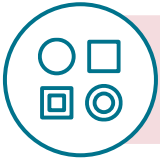
## Version Control

Manage and Access All Your Data



## Collaboration

Scale Up Simulation Business



## Variants

Manage Huge Amounts of Load Cases



## Democratization

Simulation Processes as a Service

### Load Cases (run configurations)

```

    ▶ Pedestrian safety
    ▶ NVH
    ▶ USA
    ▶ Japan
    ▶ Europa
    ▶ FATIGUE
    ▶ Crashworthiness
    ▶ USA
    ▶ USNCAP_RW
    ⇒ 1436_YARIS_USNCAP_RW_____f_60kmh_lhd___-_1sdyna
    ▶ ⇒ 1436_YARIS_USNCAP_RW_____f_56kmh_lhd___-_1sdyna
    ⇒ 1436_YARIS_USNCAP_RW_____f_52kmh_lhd___-_1sdyna
    ▶ USNCAP_Pole
    ▶ IIHS_SOL_Pole_US_right
    ▶ IIHS_SOL_Pole_US_left
    ▶ IIHS_SOL_ODB_US_PS
    ▶ IIHS_SOL_ODB_US_DS
    ▶ IIHS_MDB
    ▶ FMVSS_RW_30D
    ⇒ 1436_YARIS_FMVSS_RW_30D_____f_48kmh_lhd___-_1sdyna
    ⇒ 1436_YARIS_FMVSS_RW_30D_____f_40kmh_lhd___-_1sdyna
    ⇒ 1436_YARIS_FMVSS_RW_30D_____f_32kmh_lhd___-_1sdyna
    ▶ FMVSS_ODB
    ▶ Korea
    ▶ Europa
    ▶ EuroNCAP_RW
    ⇒ 1436_YARIS_EuroNCAP_RW_____f_50kmh_lhd_SR_-_-1sdyna
    ⇒ 1436_YARIS_EuroNCAP_RW_____f_50kmh_lhd_NR_-_-1sdyna
    ▶ EuroNCAP_Pole_right
  
```

Disciplines

Markets

Regulations

### Includes (components)

Check	Name	Kurzbeschreibung
	⇒ 1439_YARIS_USNCAP_RW_...	USNCAP Rigid Wall with
☒	Body in White	CAD-BIW_step
✓	Body in White	KR_BIW
✓	Body in White	SunRoof
✓	Body in White	CN_BIW
☒	Body in White	FATIGUE_card_curve
✓	Body in White	US_BIW
☒	Body in White	CAD-Update_-roof
✓	Body in White	RL
☒	Body in White	LL
✓	Body in White	NormalRoof
✓	Crash Management System	front
✓	Crash Management System	front
✓	Crash Management System	rear
☒	Crash Management System	rear
☒	Crash Management System	rear
☒	Crash Management System	front
✓	Cross Car Beam	cross_car_beam
✓	Cross Car Beam	cross_car_beam
✓	Engine	engine
✓	Fuse Box	fuse_box
✓	Hatch	hatch
✓	Hood	hood
✓	Pedalry	pedalry
✓	Radiator	radiator

Autom. Attribute-based Matching

In Productive Pools Easily up to 300 Different Configurations

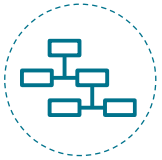
Up to 500 Components in One Pool Version and 200 for Each Run

# Model | Key Features



## Integration

Seamless Integration of CAE Tools



## Version Control

Manage and Access All Your Data



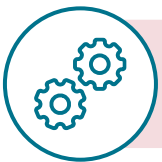
## Collaboration

Scale Up Simulation Business



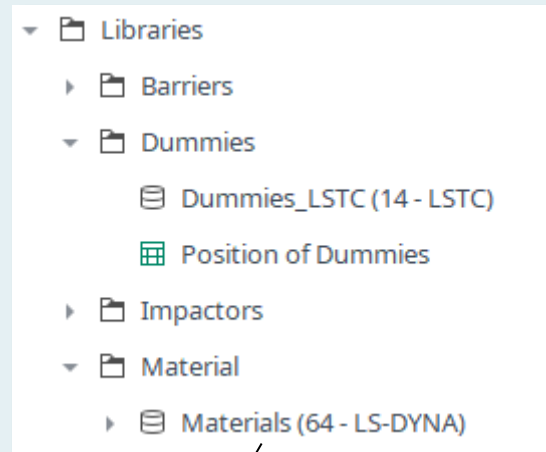
## Variants

Manage Huge Amounts of Load Cases



## Democratization

Simulation Processes as a Service



Libraries



CAE Experts  
Specialists



SCALE.sdm

CAE Users  
Engineers

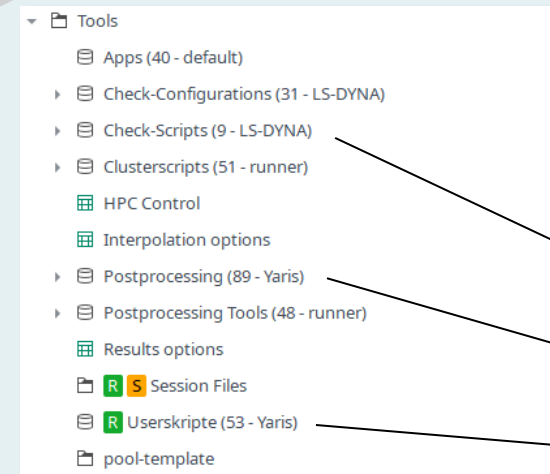


CAE Users  
Engineers



CAE Users  
Engineers

Processes



Checks

Postprocessing

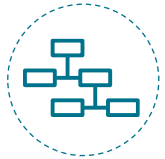
Scripts

# Model | Key Features



## Integration

Seamless Integration of CAE Tools



## Version Control

Manage and Access All Your Data



## Collaboration

Scale Up Simulation Business



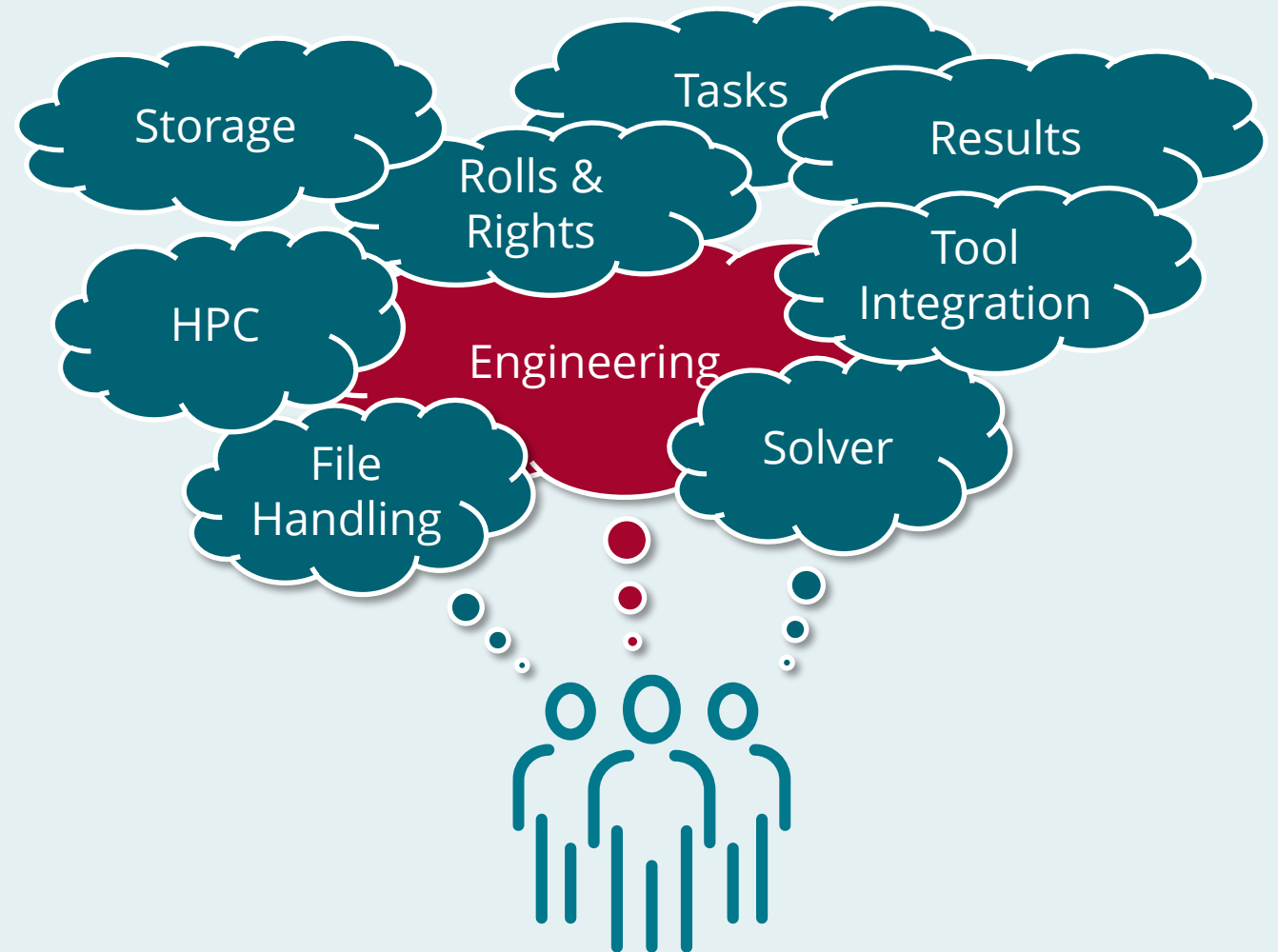
## Variants

Manage Huge Amounts of Load Cases



## Democratization

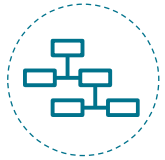
Simulation Processes as a Service





## Integration

Seamless Integration of CAE Tools



## Version Control

Manage and Access All Your Data



## Collaboration

Scale Up Simulation Business



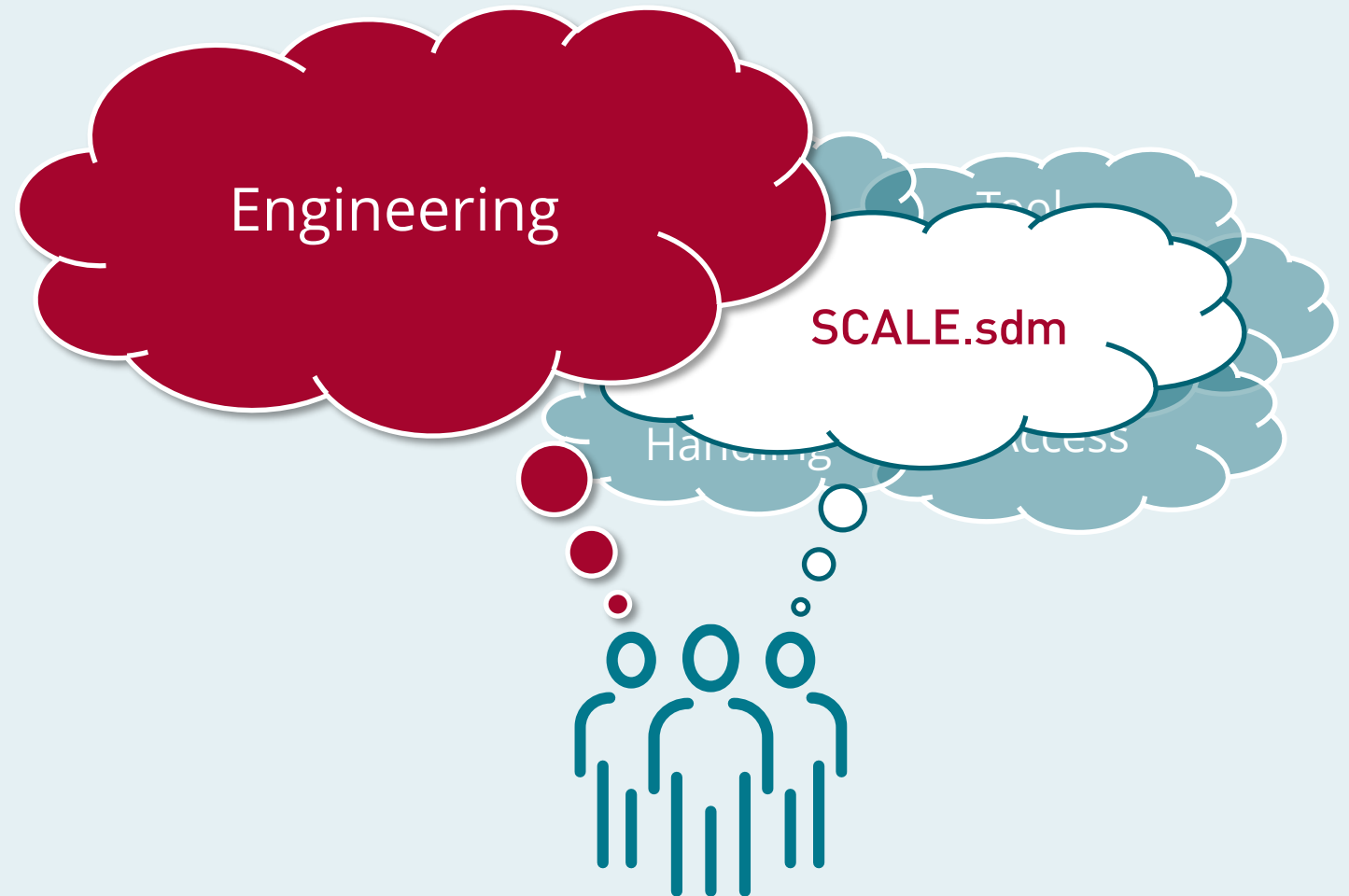
## Variants

Manage Huge Amounts of Load Cases



## Democratization

Simulation Processes as a Service



# SCALE.sdm

 Project

 Model

 **Result**

 Project

Project



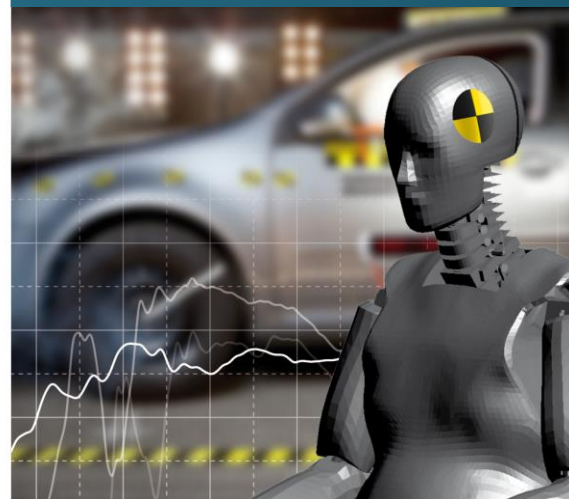
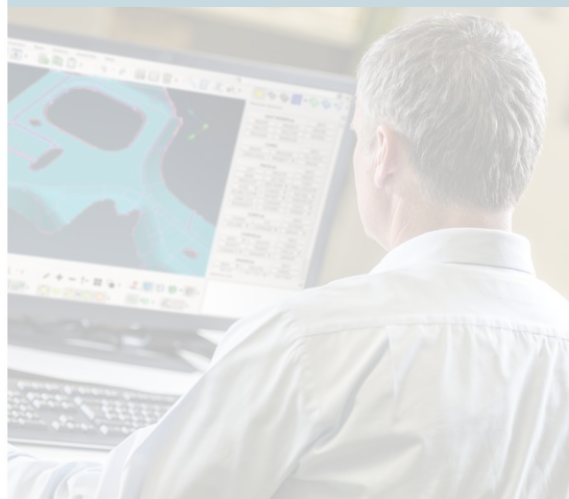
Simulation



**Assessment**



Targets



# Result | Key Features



## CAT & CAE

Compare Simulation and Physical Tests



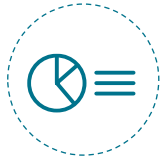
## Evaluation

Visualize and Evaluate All Key Results



## Assess Results

Assess with Respect to Project Targets



## Reporting

Comprehensive and Interactive Reports



## Data Analysis

Machine Learning and Data Mining

The screenshot displays the CAVIT dashboard interface. At the top, there's a browser window with the URL <https://demo.w3sysse.scale.eu/cavit/dashboard>. The main content area is divided into several sections:

- Projects and Collections:** A sidebar on the left shows a tree view of projects like 'Yaris' and collections like 'Screenshot (1)'. Below that, 'Scenarios' are listed with checkboxes for various regions (Japan, Korea, USA, etc.) and their completion status.
- Tabular Overview:** A central table with columns for 'Name', 'History Comment', 'Firewall Intrusion [mm]', 'B-Pillar', and 'Rocker panel'. A blue overlay text reads 'Tabular Overview Filter, Group, Sort, Search'. The table contains multiple rows of simulation data.
- Report Section:** On the right, there's a 'Report' window with a 'Legend' and several video thumbnails. One video is titled 'Crash' and another 'NVH'. Below these, there's a 'Firewall Intrusion' section with a 3D model of a car showing intrusion points and a color-coded scale. An 'Engine Acceleration' section features a line graph titled 'Acceleration-X Engine top' showing acceleration in m/s² over time. The graph has several data points highlighted with callouts.
- Image Grid:** At the bottom, there's a grid of small images showing various test results, including car exteriors, interiors, and crash test dummies.

# Result | Key Features



## CAT & CAE

Compare Simulation and Physical Tests



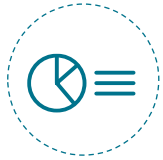
## Evaluation

Visualize and Evaluate All Key Results



## Assess Results

Assess with Respect to Project Targets



## Reporting

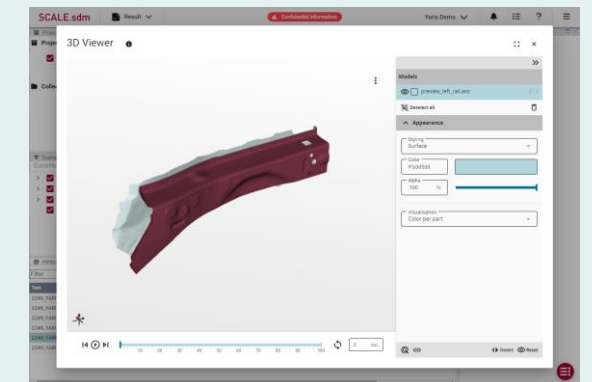
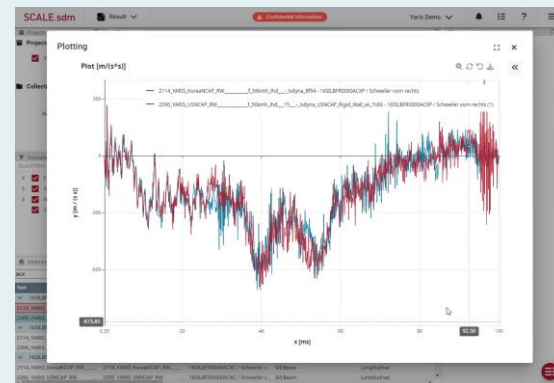
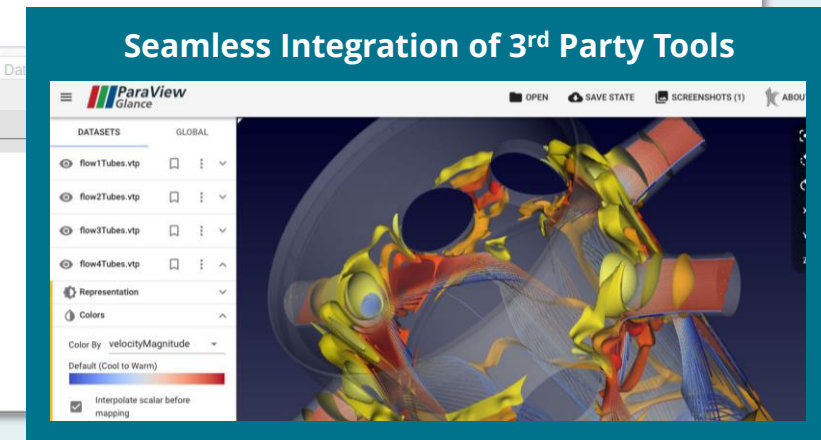
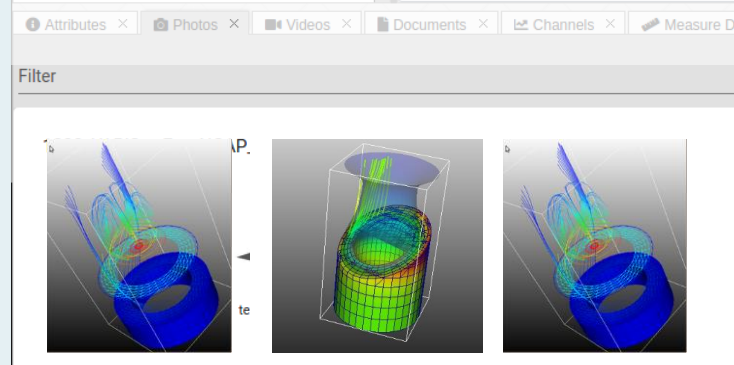
Comprehensive and Interactive Reports



## Data Analysis

Machine Learning and Data Mining

Front	(9 / 9)	1310_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_2_R_____Isdyna_10.2_dp_M...	2020-09-14T20:07:47	Pole
Europe	(1 / 1)	1299_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_3_LFB_ev_t_60_Isdyna_11.1_dp...	2020-09-08T03:06:13	Pole
NAR	(8 / 8)	1288_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_3_LFB_ev_t_40_Isdyna_11.1_dp...	2020-09-05T02:31:27	Pole
Japan	(0 / 0)	1288_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_F_na_n_0_Isdyna_10.2_dp_MPP	2020-08-22T15:46:49	Pole
China	(0 / 0)	1288_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_3_LFB_ev_t_60_Isdyna_10.2_dp...	2020-09-18T13:08:37	Pole
Korea	(0 / 0)			
Sensor	(0 / 0)			
Sonstiges	(0 / 0)			
Side	(8 / 8)			
Europe	(8 / 8)			



Model / Measurements 3D Preview (integrated)

# Result | Key Features



## CAT & CAE

Compare Simulation and Physical Tests



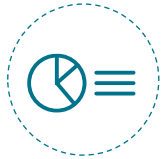
## Evaluation

Visualize and Evaluate All Key Results



## Assess Results

Assess with Respect to Project Targets



## Reporting

Comprehensive and Interactive Reports



## Data Analysis

Machine Learning and Data Mining

The screenshot displays a software interface with a table of test data and a 3D model viewer. The table lists various test configurations, including impact tests and USNCAP tests, with columns for test ID, description, date, and target. The 3D model viewer shows a wireframe model of a car's front end, with a 'Measure Data Demo' window overlaid, displaying 'Surface' representation and 'Scalar visibility' options.

Test ID	Description	Date	Target
1310_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_2_R_____Isdyna_10.2_dp_M...		2020-09-14T20:07:47	Pole
1299_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_3_LFB_ev_t_60_Isdyna_11.1_dp_...		2020-09-08T03:06:13	Pole
1288_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_3_LFB_ev_t_40_Isdyna_11.1_dp_...		2020-09-05T02:31:27	Pole
1288_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_F_na_n_0_Isdyna_10.2_dp_MPP		2020-08-22T15:46:49	Pole
1288_YARIS_r_EuroNCAP_p_s_l_lhd_50kmh_90_3_LFB_ev_t_60_Isdyna_10.2_dp_...		2020-09-18T13:08:37	Pole
Front Impact (1)			
1290_YARIS_EuroNCAP_RW_____f_50kmh_____Isdyna_10.2_sp_MPP		2020-08-31T14:42:37	Rigid Wall
USNCAP (8)			

Viewer for Test Measure Data & Comparison of Multiple Data Sets (integrated)



# Result | Key Features



## CAT & CAE

Compare Simulation and Physical Tests



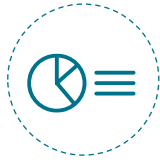
## Evaluation

Visualize and Evaluate All Key Results



## Assess Results

Assess with Respect to Project Targets



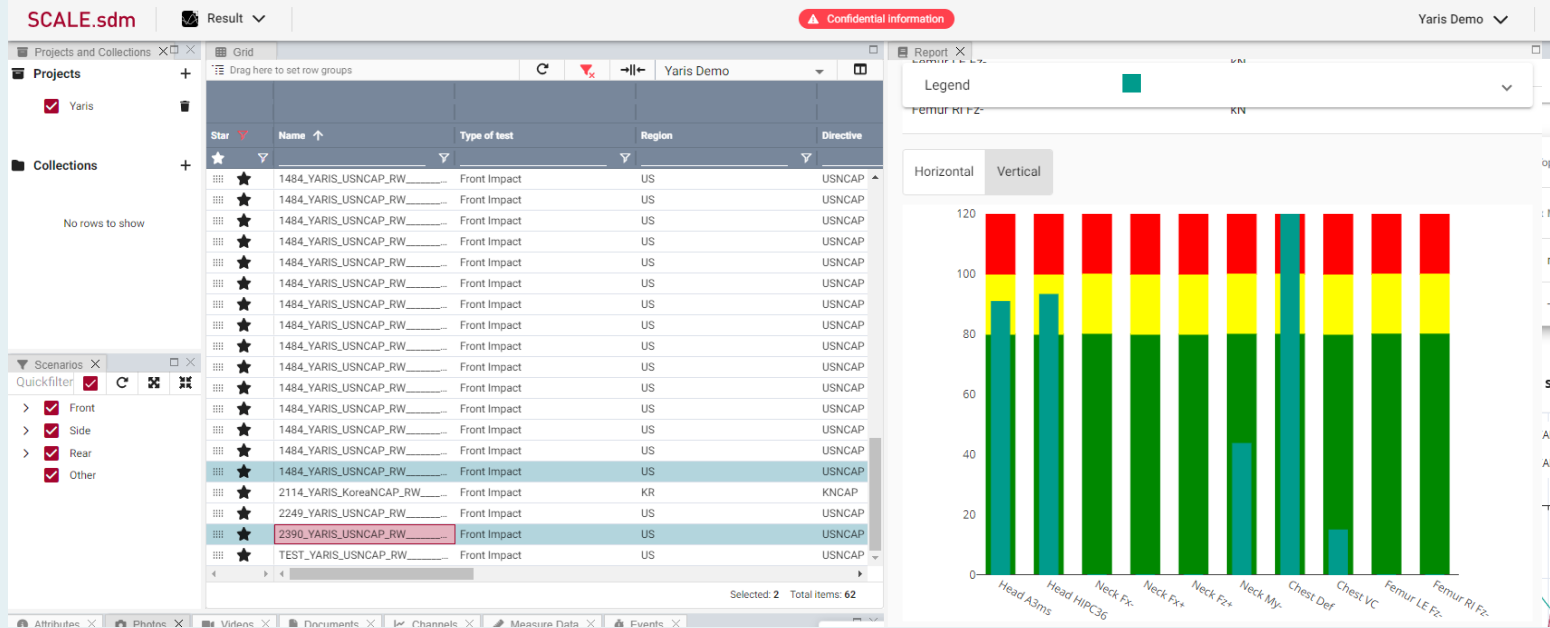
## Reporting

Comprehensive and Interactive Reports

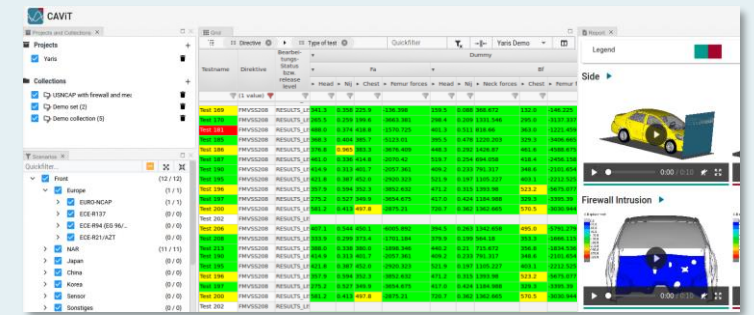


## Data Analysis

Machine Learning and Data Mining



- Test and simulations are pre-assessed
- Key result targets from **Project** are utilized
- User can manually override



Upcoming

# Result | Key Features



## CAT & CAE

Compare Simulation and Physical Tests



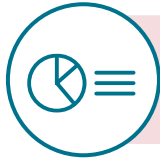
## Evaluation

Visualize and Evaluate All Key Results



## Assess Results

Assess with Respect to Project Targets



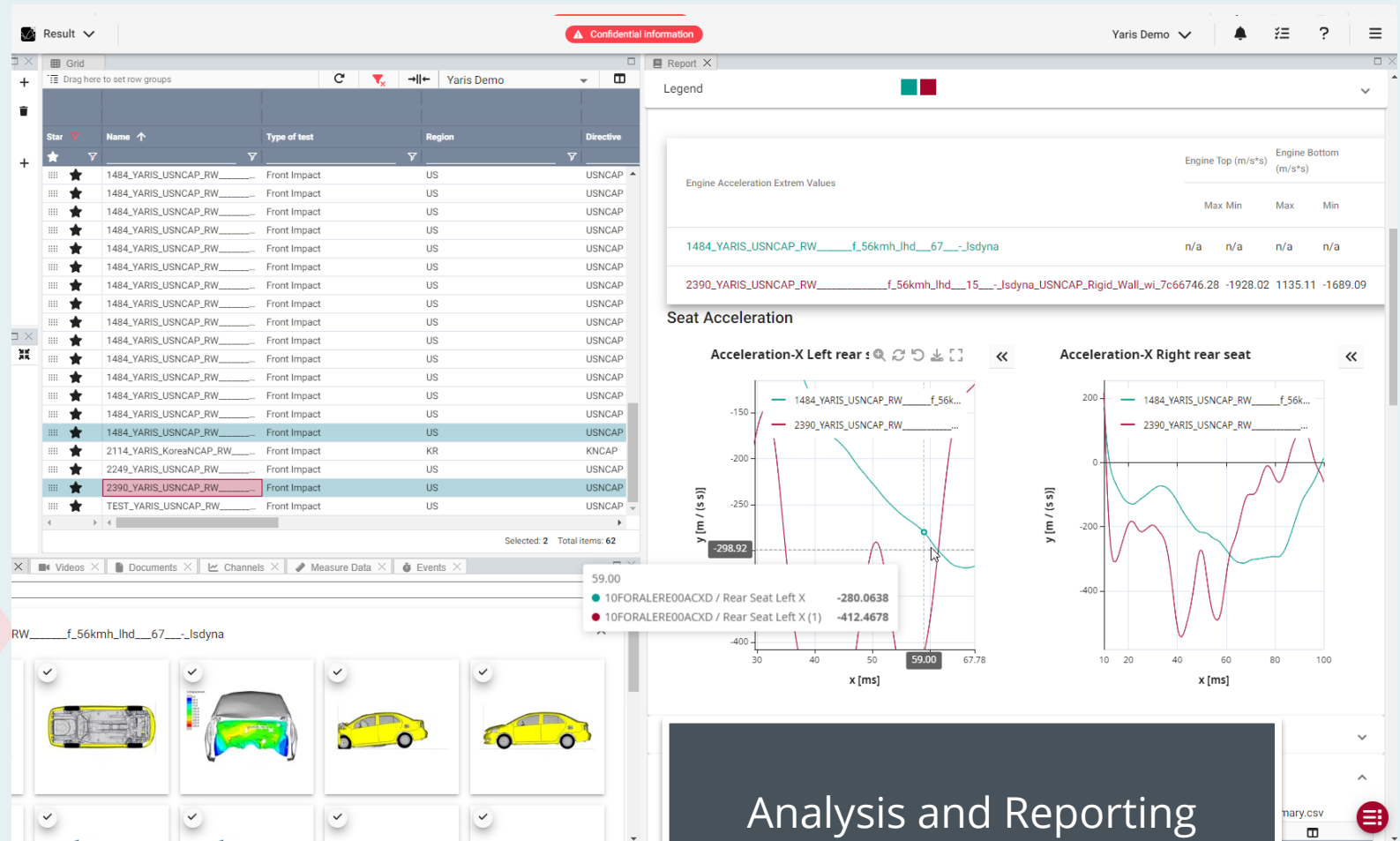
## Reporting

Comprehensive and Interactive Reports



## Data Analysis

Machine Learning and Data Mining



Analysis and Reporting  
Extensible with Add-ons

# Result | Key Features



## CAT & CAE

Compare Simulation and Physical Tests



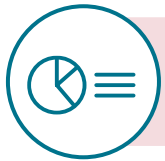
## Evaluation

Visualize and Evaluate All Key Results



## Assess Results

Assess with Respect to Project Targets



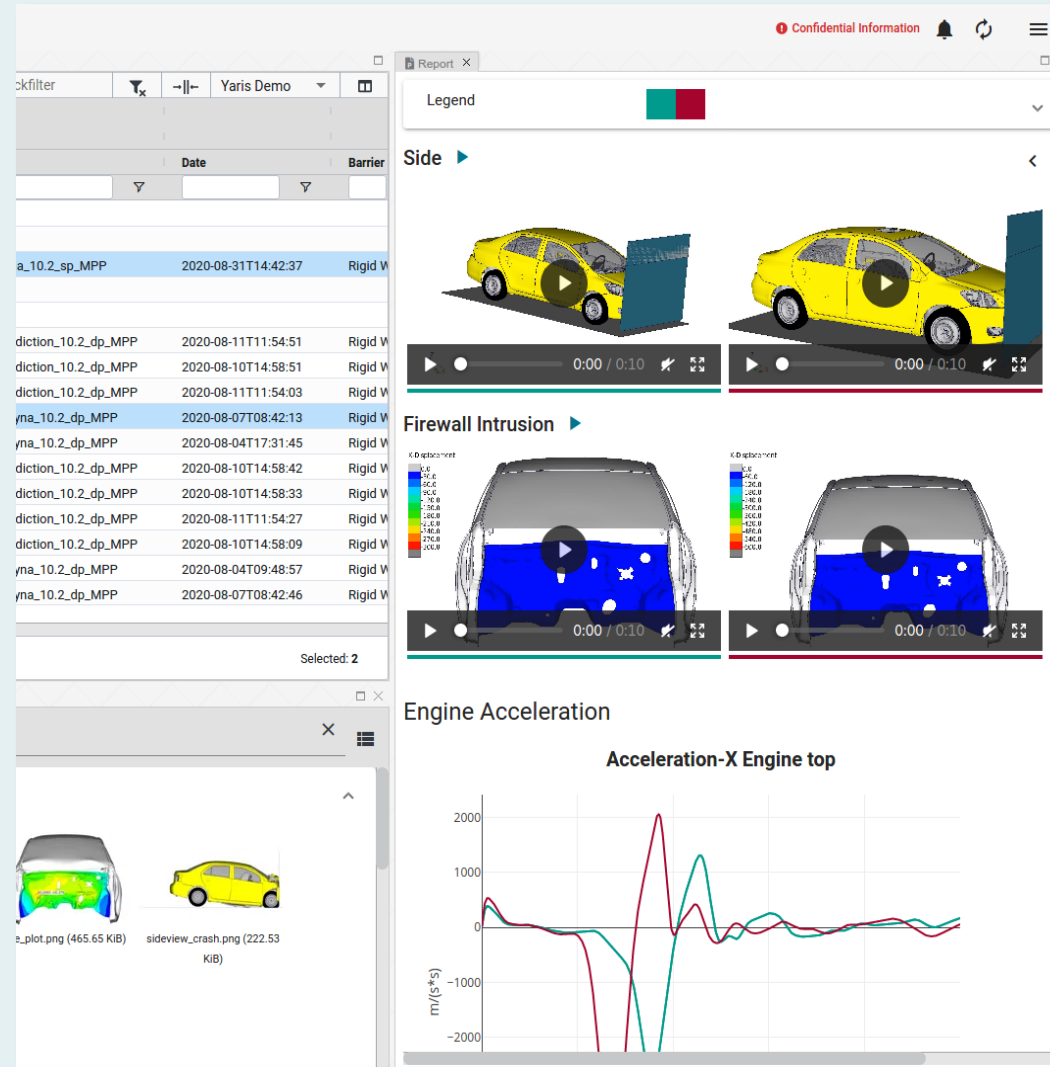
## Reporting

Comprehensive and Interactive Reports



## Data Analysis

Machine Learning and Data Mining



# Result | Key Features



## CAT & CAE

Compare Simulation and Physical Tests



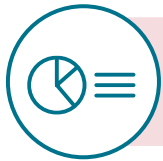
## Evaluation

Visualize and Evaluate All Key Results



## Assess Results

Assess with Respect to Project Targets



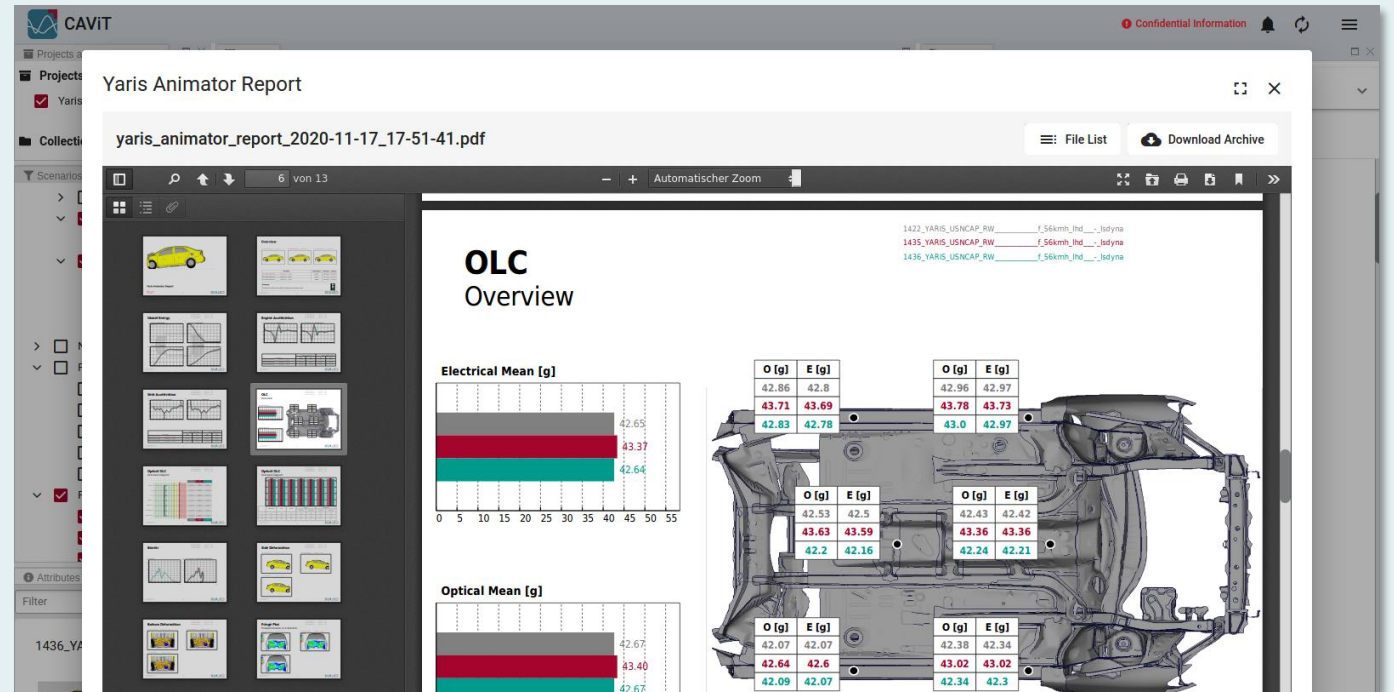
## Reporting

Comprehensive and Interactive Reports

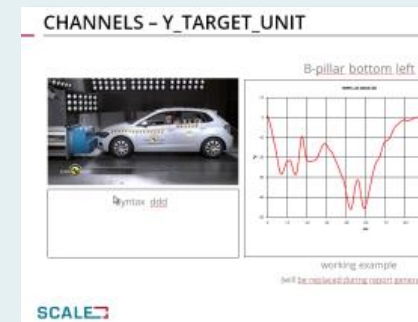


## Data Analysis

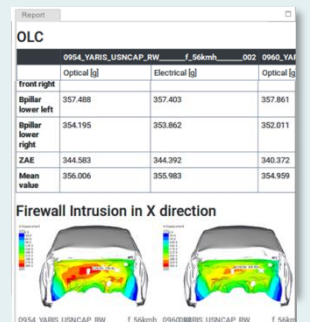
Machine Learning and Data Mining



Text Documents  
Compliance Reports



Slide-based



Interactive

# Result | Key Features



## CAT & CAE

Compare Simulation and Physical Tests



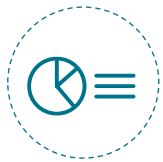
## Evaluation

Visualize and Evaluate All Key Results



## Assess Results

Assess with Respect to Project Targets



## Reporting

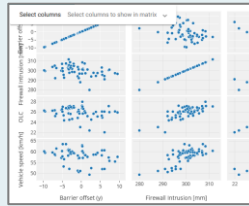
Comprehensive and Interactive Reports



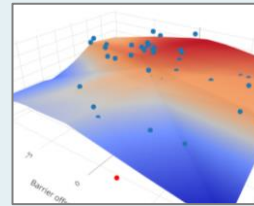
## Data Analysis

Machine Learning and Data Mining

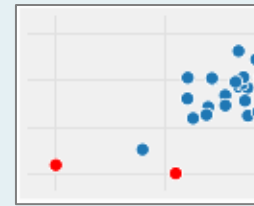
### Available



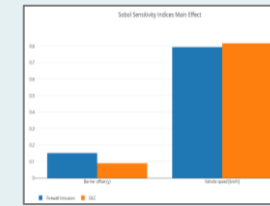
**Correlation**  
Anthill Plots



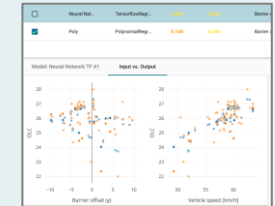
**Visualization**  
Scatter Plots  
w Response Surfaces



**Outlier Detection**  
For Scalars



**Sensitivity Analysis**  
Nonlinear Sobol Indices

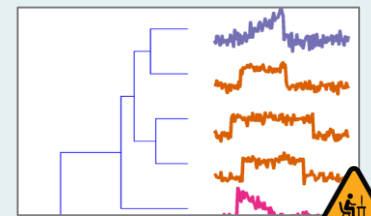


**Meta Modeling**  
NN-based / Polynomial

### In Development / Integration Options



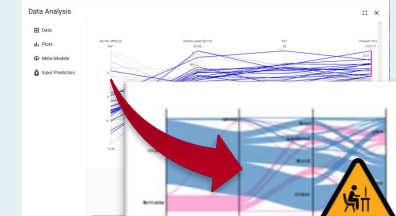
**Amazon QuickSight**  
**Amazon Sagemaker**  
Serverless Analysis Solution  
<https://aws.amazon.com/de/quicksight/>



**Time Series Classification**  
Labeling / Error Detection  
Q3/2021

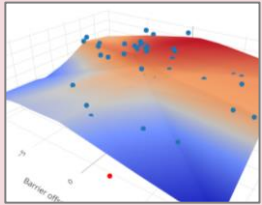


**SIDACT/SCAI**  
**Event Detection**  
Outlier Detection on  
Simulation / Part level



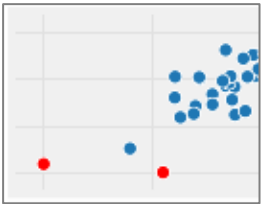
**Permissible Design Ranges**  
Detects Input Ranges Leading  
to Permissible Designs

- Introduction Company
- Overview Software Solution
-  **Result Data Analysis Capabilities**



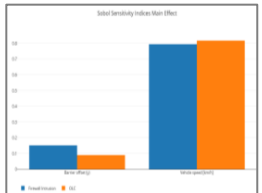
## Visualization

Scatter Plots w  
Response Surfaces



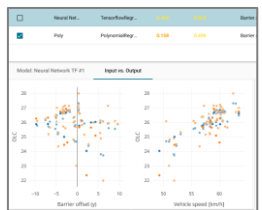
## Outlier Detection

For Scalar Values



## Sensitivity Analysis

Nonlinear Sobol Indices

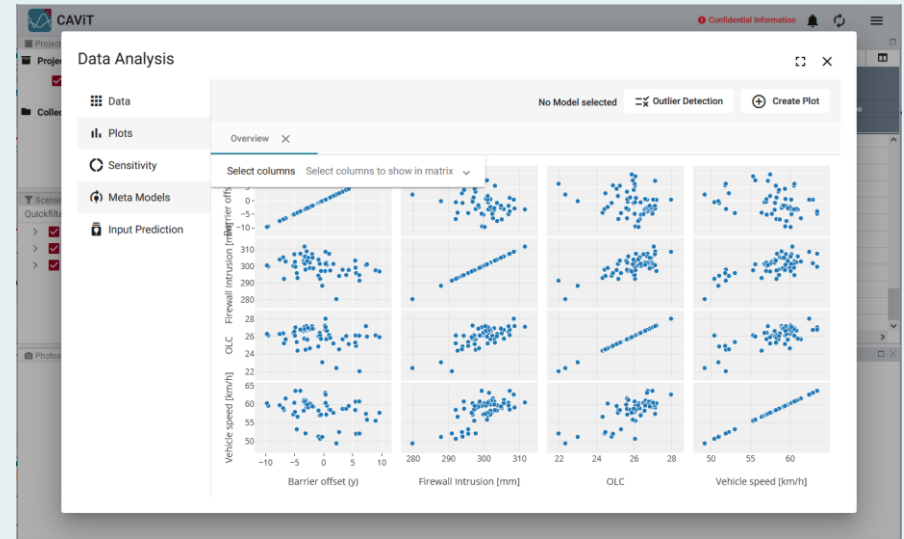


## Meta Modeling

NN-based  
Polynomial

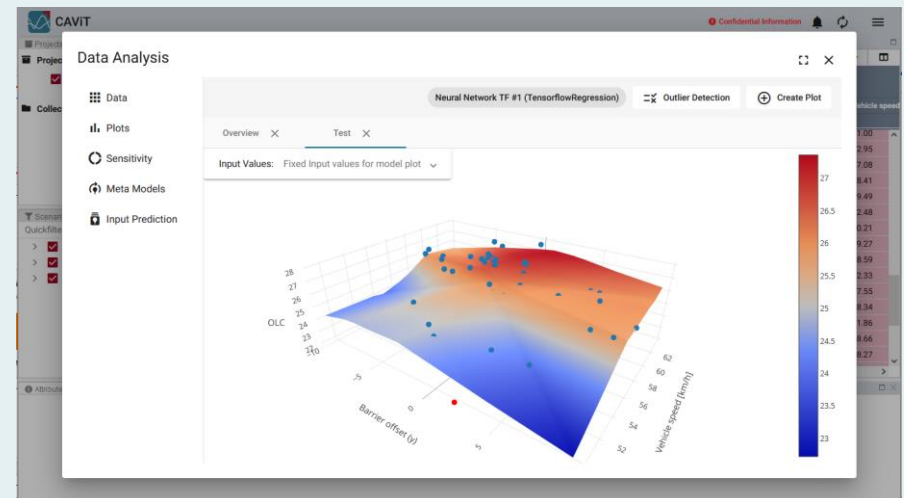
## Anthill / Correlation Plots

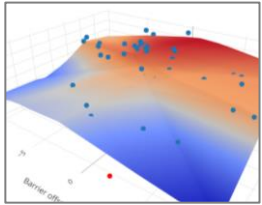
- Dependencies between variables
- Correlations between variables
- Distributions of variable values



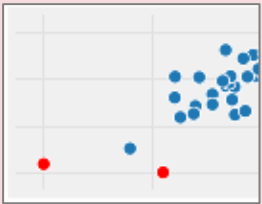
## 2D / 3D Scatterplots

- Visualization of multiple runs
- Display of response surface approximation based on the selected meta model

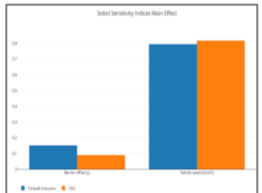




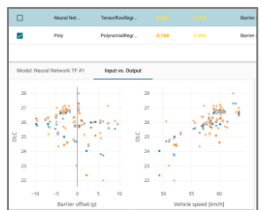
**Visualization**  
Scatter Plots w.  
Response Surfaces



**Outlier Detection**  
For Scalar Values

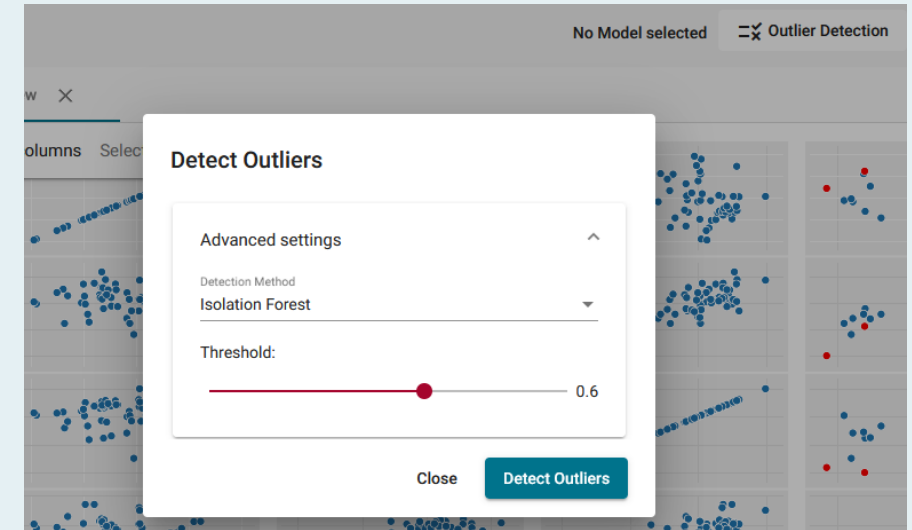


**Sensitivity Analysis**  
Nonlinear Sobol Indices



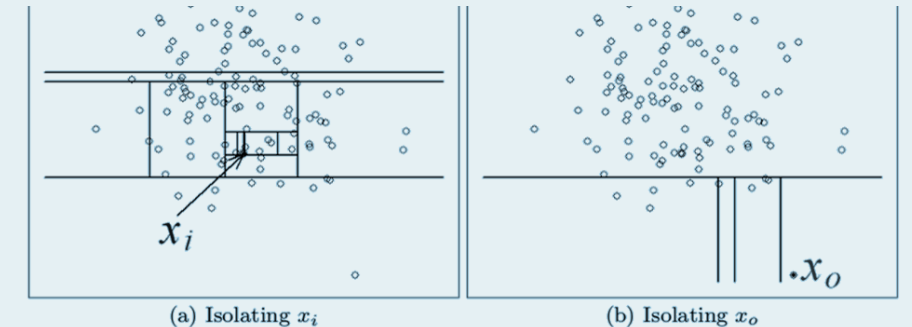
**Meta Modeling**  
NN-based  
Polynomial

- Detect outliers in multi-dimensional data sets
- Exclude outliers from further analysis (optional)
- Visualize outliers in anthill and scatter plots



## Implemented Approaches

- k-Nearest Neighbours,
- DBSCAN
- Isolation Forest



Isolation Forest (Illustration taken from [1]).  $x_i$  is an inlier (hard to separate from the other points), and  $x_o$  is an outlier (easy to separate from the others).

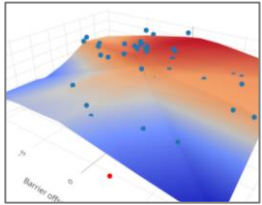
## Further reading

[1] Liu et al., Isolation-Based Anomaly Detection, 2012.  
 [2] <https://en.wikipedia.org/wiki/DBSCAN> (original references are non-free)  
 [3] Charu C. Aggarwal. Outlier Analysis. Springer Publishing Company, Incorporated, 2nd edition, 2016.



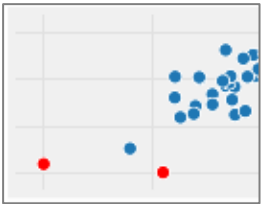


# Data Analysis | Machine Learning and Data Mining



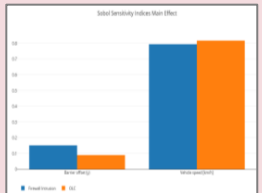
## Visualization

Scatter Plots w  
Response Surfaces



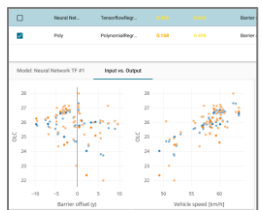
## Outlier Detection

For Scalar Values



## Sensitivity Analysis

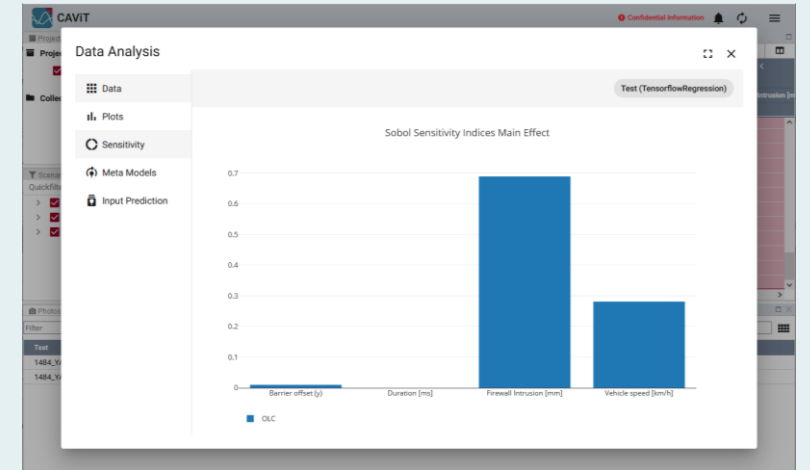
Nonlinear Sobol Indices



## Meta Modeling

NN-based  
Polynomial

- Determine the contribution of input parameters to the result variation
- Classical variance-based approach but works for non-linear dependencies
- Contribution impact is shown as value between 0 ... 1 (main effect or 1<sup>st</sup> order)



## Implemented Approach

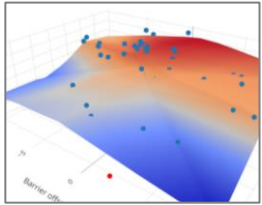
- Variance-based approach based on Sobol's methods
- Quasi-Monte-Carlo Simulation with low discrepancies sampling
- Meta models are utilized for analysis
- Higher Order effects possible but not displayed yet (Total and second order effects)

## Further reading

- [1] Sobol, Global sensitivity indices for nonlinear mathematical models and their Monte Carlo estimates, 2001
- [2] Saltelli et al., Variance based sensitivity analysis of model output. Design and estimator for the total sensitivity index, 2009
- [3] <http://extremelearning.com.au/unreasonable-effectiveness-of-quasirandom-sequences/>

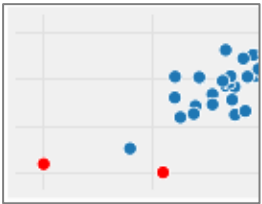


# Data Analysis | Machine Learning and Data Mining



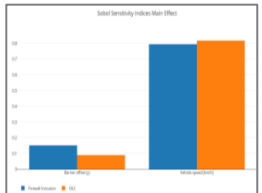
## Visualization

Scatter Plots w  
Response Surfaces



## Outlier Detection

For Scalar Values



## Sensitivity Analysis

Nonlinear Sobol Indices



## Meta Modeling

NN-based  
Polynomial

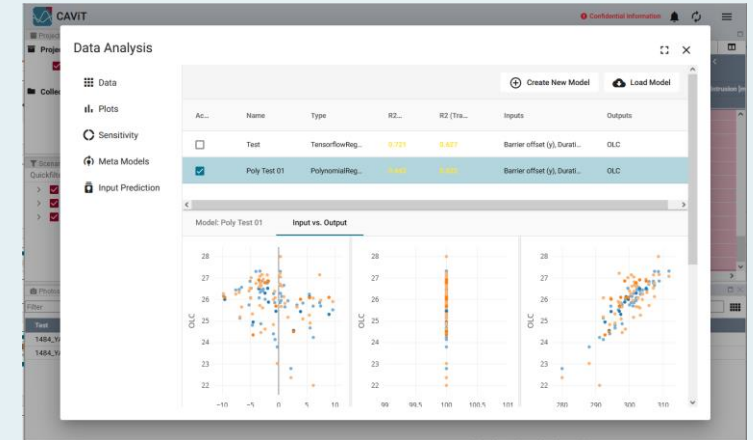
- Meta models are used for visualization, sensitivity analysis, prediction, ...
- Standard meta model is established automatically based on hyper parameter optimization
- Meta models can be trained, evaluated and optimized by users

## Implemented Approaches

- Neural Nets
- Polynomial Regression
- Hyper parameter optimization implemented for automatic model selection

## Further reading

- [1] <https://www.tensorflow.org>
- [2] <https://www.npmjs.com/package/regression-multivariate-polynomial>
- [3] Bergstra, Bengio, Random Search for Hyper-Parameter Optimization, 2012



Use Cross Validation  
k (number of folds)  
5

Keep Random Seed

Tensorflow

Number of (random) trials \*  
4

Number of epochs \*  
50

Number of hidden layers \*  
2

Optimizer \*



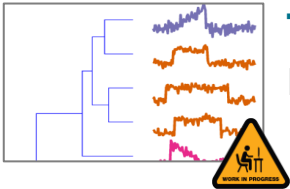
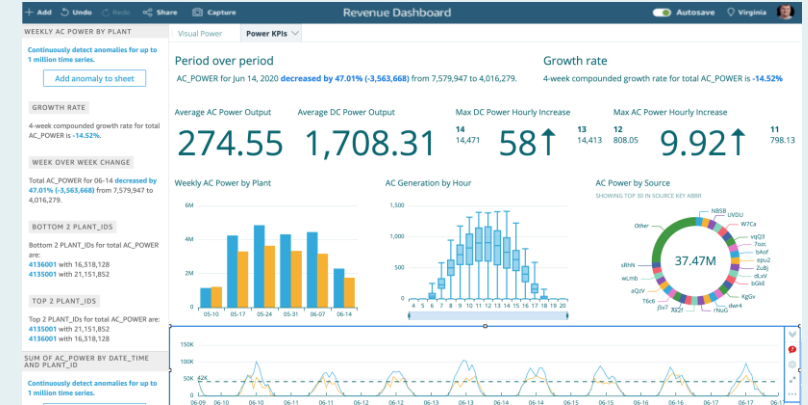
# Data Analysis | Machine Learning and Data Mining



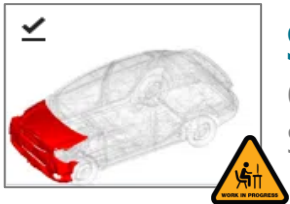
## Amazon QuickSight Serverless Analysis Solution



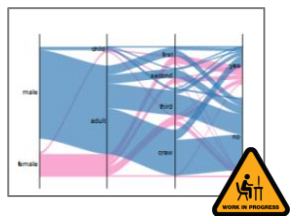
- Scalable, serverless, embeddable, machine learning-powered business intelligence (BI) service from Amazon
- Can be connected to **Result** on request
- Direct access to data in AWS cloud setup (no data needs to be duplicated)



## Time Series Classification Labeling and Error Detection



## SIDACT Event Detection Outlier Detection on Simulation / Part level



## Permissible Design Ranges Detects Input Ranges Leading to Permissible Designs

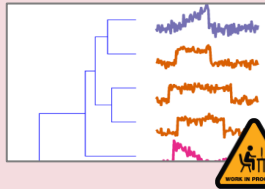
## Implemented Approaches | Further Reading

- Comprehensive set of features, see <https://aws.amazon.com/quicksight/>



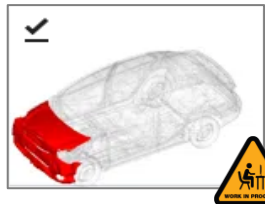
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Serverless Analysis Solution



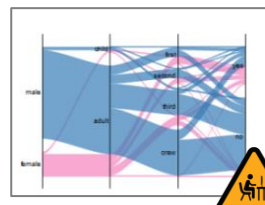
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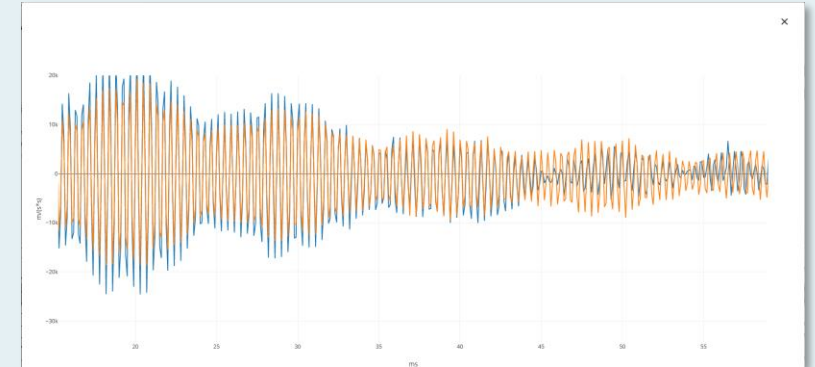
### Classification

Automatic generation of labels like channel codes

### Detections of erroneous time series

Inverted, failure at time  $t$ , extreme noise, ...

Prototype expected in Q3/2021



## Approaches in Focus | Further Reading

[1] Bagnall et al., The Great Time Series Classification Bake Off: ..., 2016  
Algorithms: COTE, Shapelet, Vector, Elastic

[2] Fawaz et al., Deep learning for time series classification: a review, 2019

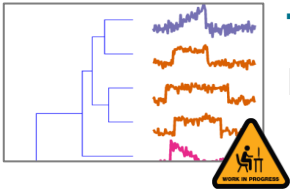
[3] Oates et al., Time Series Classification from Scratch with Deep Neural



# Data Analysis | Machine Learning and Data Mining



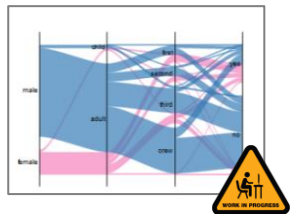
**Amazon QuickSight**  
Serverless Analysis Solution



**Time Series Classification**  
Labeling and Error Detection



**SIDACT Outlier Detection**  
Outlier Detection on  
Simulation / Part level



**Permissible Design Ranges**  
Detects Input Ranges Leading to  
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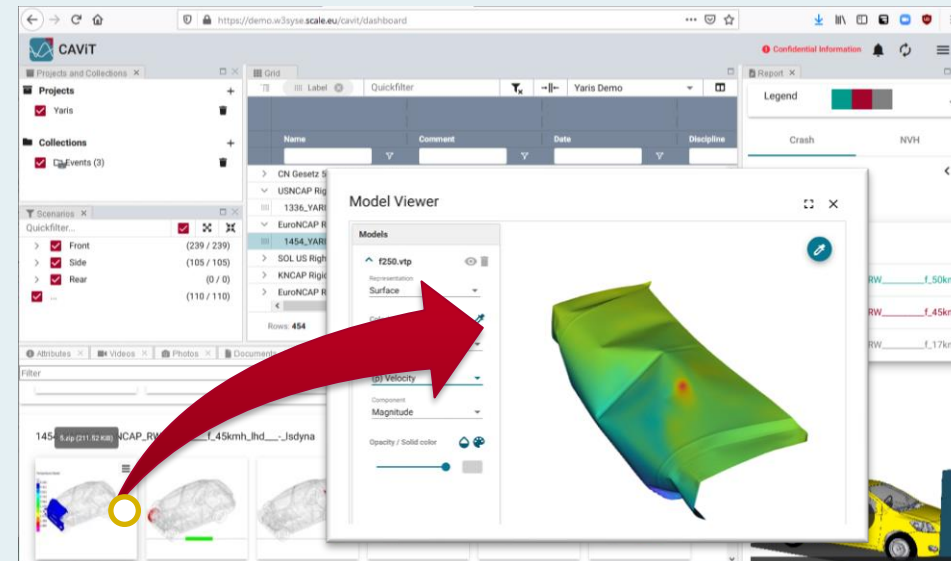
Scan All Incoming  
Simulations



Detect Anomalies  
with SIDACT Tools



Visualize  
in Result



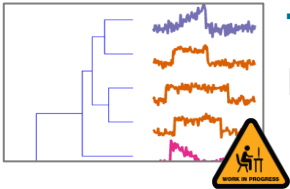
## Implemented Approaches | Further Reading

- Software and algorithms are property of SIDACT (*Partner of SCALE*)
- Available integrated in **Result** on request, requires additional licensing of SIDACT software
- <http://sidact.de>



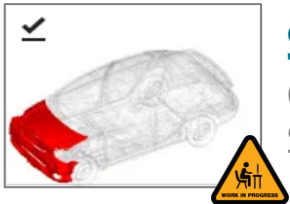
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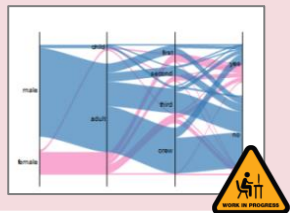
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Labeling and Error Detection



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Outlier Detection on Simulation / Part level

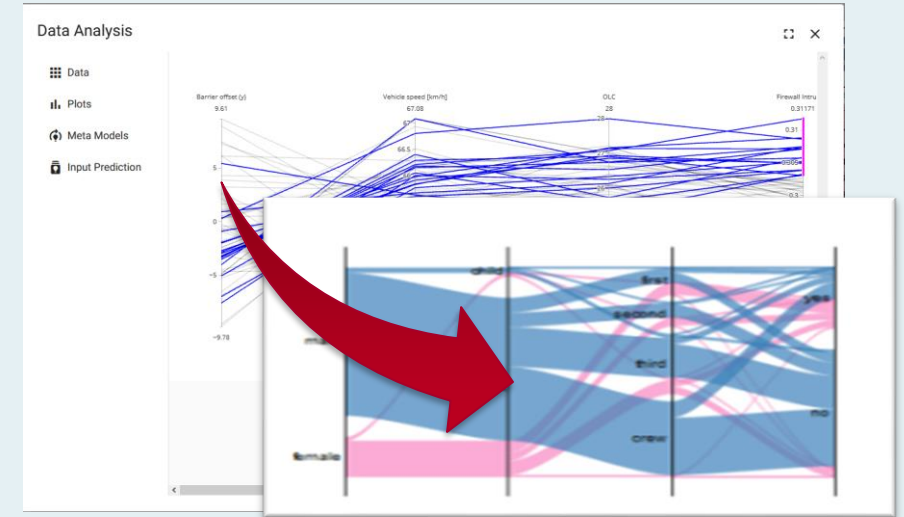


## Permissible Design Ranges

Detects Input Ranges Leading to Permissible Designs

## Permissible Design Ranges

- Limits for output parameters are defined by the user
- Permissible ranges of for design parameters (blue belts) are determined
- Visualization in a parallel coordinate plot



## Approaches in Focus | Further Reading

Exact algorithm exists. Bad message: Problem is NP-hard.

[1] Eckstein, The Maximum Box Problem and its Application to Data Analysis, 2002

Heuristic and specialized algorithms possible are investigated

- Evolutionary Algorithms, Simulated Annealing, ...
- Using general purpose discrete optimization solver, by: Formulation as Mixed Integer Program / Formulation as Constrained Optimization Program