Machine Learning for Truck Aerodynamic Performance Evaluation and Optimization

RICOS Co. Ltd. 21st Jan. 2025

Agenda

- Updates on generative CAE
- Discussion of project status
- Demonstration of Gen-CAE

Updates on generative CAE

- Overview
 - Generative CAE model is updated to satisfy constraints for all the designs created during optimization
- Result of trial optimization on updated model
 - Trial optimization study is performed with the updated model



Optimization study results

| parameter | Trial00 | Trial3783 |
|-----------------------------|---------|-----------|
| "cab_height_displacement" | 0.0 | -171 |
| "window_angle_displacement" | 0.0 | -27 |
| "front_angle_displacement" | 0.0 | -200 |
| "side_fillet_expanding" | 0.0 | 47 |
| "under_cover_ratio" | 1.0 | 0.549 |
| Predicted Cd | 0.4289 | 0.4258 |



Best design Trial3783 (red) and base design Trial00 (gray, semi-transparent)

Discussion of project status

- Summary of 1st step(June-Dec)
 - We approached your problem with both Lightning and Generative CAE using your data
 - Both tools operated properly, and produced expected results
- Next Actions
 - We will open the Gen-CAE access to both of you(or your group members) after today's call, and provide a quick manual(as below)
 - You can freely use that until end-of February

- We want to collect your feedback to refine the system for a potential full introduction
- Feedback & improvements
 - During the test period, please evaluate tool usability, output accuracy, and any other aspects important to you
 - Let us know if you have any specific feature requests or improvements
- Next February discussion
 - \circ $\,$ We will collect your feedback and discuss about next step $\,$

Demonstration of Gen-CAE

- Preparation
 - Login to RICOS Production Suite
 - Cloud based tool. Nothing to install to your PC.
 - Please choose the Scania group from "Workspace"
 - When selecting the group, all of the team members will access the same data

| RICOS Production Suite | ∎ ^{Sc} | |
|--|------------------------|---|
| RICOS Fluid Conversion Pre-process | RICOS Production Suite | |
| TrainPrediction | Workspace • | |
| Data | · mel | |
| File-set List | 😩 Sc | 6 |
| Batch process | | |
| File-set bulk upload | | |

- Go to File-set List and find Generative CAE Template
- You will see "Generative CAE" from "File-set information"

| RIC | OS Product | tion Suite | | | a_okay | ama | | Sc | | • |
|-----|---------------|--------------|---------------------------------|--------------|-----------------------------------|-----|------|---------------|--------------|---|
| | | = | File-set > File-set Information | | | | | | | |
| Sc | LIGHTNI | NG | 20250120_scania_trial.json | | | | C Ed | it 2025/01/20 | 21:34:21 | |
| ፟ | Upload | Ť | | | | | | | | |
| | Conversion | Ð | Generative CAE Share | | | | | | | |
| | Preprocess | | | | | | | | | |
| 15 | Training | ۲ | , | | | | | | · | |
| | Prediction | ం_ిం ∎=≅= | | Drag and dro | op or <u>browse</u> to add files. | | | | | |
| | | | Filename | Туре | Created at | | | Size | \checkmark | |
| | File-set List | | 20250120_scania_trial.json | JSON | 2025/01/20 21:34:22 | | | 1.6KB | \mathbf{F} | |
| C* | Job List | | template.json | JSON | 2025/01/20 21:42:41 | | | 1.6KB | \mathbf{F} | |
| | Bulk Upload | | | | | | | | | |

- Execution
 - Click "Generative CAE" to proceed to modify optimization settings
 - Enter min and max values for each parameter
 - Enter arbitrary "Trial name"
 - Choose Generative CAE "Engine"
 - Click "Run Simulation" to proceed to execute settings
 - Execute settings
 - Computation Time Limit : Up to 86,400 minutes (60 days)

| 0. Cab Height Displacement | max: | 50 | min: | -200 | mm |
|-----------------------------|---------|-----|------|------|----|
| 1. Window Angle Displacemer | nt max: | 200 | min: | -50 | mm |
| 2. Front Angle Displacement | max: | 48 | min: | -200 | mm |
| 3. Side Fillet Expanding | max: | 50 | min: | 0 | mm |
| 4. Under Cover Ratio | max: | 1 | min: | 0 | |

| | Gen. CAE |
|---|---------------------------|
| Į | Trial name |
| | 20250120_scania_trial.jso |
| | Run Simulation |
| | Engine |
| | Generative CAE |

| Sc Sc | | | | | | _ | ¢ | Do |
|---------------------|------|----------|---------------------------|------------------|------------------------|------|----------------------|-----------------------|
| | | | Do you war | nt to execute th | ne job? | - 62 | Gen. CAE | |
| | | | Compute Resource | iv_24x_ 🗸 | 24 CPU/480 GB/0 GPU | 202 | : 50120_scania_tr | frial name ial.jso |
| | | | No. of Nodes | 1 ~ | | | 5 | |
| | | | Computation Time Limit | 1440 | Up to 86400 minutes | Enj | Run Simulation | |
| | | | License | GenCAE 🗸 | | Gen | erative CAE | ~ |
| | _ | | No. of Jobs | 1 | | | | |
| . Cab Height | max: | | Maximum Usage | 約 5760.0 円 | | | | |
| visplacement | min: | | Charge Billing | | | | | |
| . Window Angle | max: | | Information | 株式会: 🗸 | | | | |
| isplacement | min: | | | | | | | |
| . Front Angle | max: | | Execute | C | Cancel | | | |
| isplacement | min: | 200 | | _ | _ | _ | | |
| . Side Fillet | max: | 50 mm | | | | | | |
| xpanding | min: | 0 | | | | | | |
| . Under Cover Ratio | max: | 1 | | | | | | |
| | min: | 0 | | | | | | |

- After running optimization, you will see "Summarize Result" for your File-set
 - This feature enables you to visualize the best designs of your optimization study

| RIC | OS Product | ion Suite | | | a_okayama | | Sc | | • |
|-----|------------------------|--------------|---------------------------------|--------------|----------------------------------|------|----------------|--------------|---|
| | | = | File-set > File-set Information | | | | | | |
| Sc | LIGHTNIN | IG | 20250120_scania_trial.json | | | C Ec | lit 2025/01/20 | 21:52:23 | |
| 畿 | Upload Conversion | (↑ ₽0 | Summarize Result Share | | | | | | |
| | Preprocess | 6 * * | | | | | | | |
| N\$ | Training Prediction | ÷ | (| Drag and dro | p or <u>browse</u> to add files. | | | | |
| | | | Filename | Туре | Created at | | Size | ⊻ | |
| | File-set List | | 20250120_scania_trial.json | JSON | 2025/01/20 21:52:27 | | 1.6KB | \mathbf{F} | |
| C* | Job List | | template.json | JSON | 2025/01/20 21:52:27 | | 1.6KB | $_{\pm}$ | |
| | Bulk Upload | | | | | | | | |

- PostProcess
 - When you click "Summarize Result", you will see the list of optimization jobs

- Choose the optimization job that you want to summarize the result
- Choose GenerativeCAE Summary from "Engine"
- Enter arbitrary "prefix" and "suffix" to identify the postprocess results
- Enter the number of results that you want to visualize
- Click "Batch processing" to start visualization of the result

| ≣ | Sc | | | | Ţ | 2 |
|----------|----------------------------|---------------------|---------------------------------|----------------------------------|---------------------------|-----------|
| Batch | Mode | | | | Batch processing | Desfu |
| | Name | Create time | Туре | ID | 20250120_test1_ | Prefix |
| | | Descending | Generative CAE Optimize Trial 🗢 | | | Suffix |
| ~ | 20250120_scania_trial.json | 2025-01-20 21:52:23 | Generative CAE Optimize Trial | 0cdbd5eb2a944056a6edc91c8f46c4c1 | | |
| | Trial1 | 2024-12-13 17:46:08 | Generative CAE Optimize Trial | b7d78fb39e354825b458ab2204c37bcc | Batch processing | |
| | 20241213_scania.json | 2024-12-13 14:46:21 | Generative CAE Optimize Trial | 325545cfee6b47318090bbe58d8a8ed1 | selecting 1 out of 6 jobs | 5 |
| | 20241205_scania_1212 | 2024-12-12 16:00:09 | Generative CAE Optimize Trial | ac126ad6a8c549ad9936926f97a48ec5 | Engine | |
| | 20241205_scania | 2024-12-11 23:13:29 | Generative CAE Optimize Trial | 5640ec5566304431a696225344432152 | GenerativeCAE Summary | |
| | 20241205_scania | 2024-12-11 12:37:56 | Generative CAE Optimize Trial | 580da635a40d4b4da1e878b872810d38 | Number of S | orresults |

- Once the job is done (you will receive email from the system), you can download the followings:
 - Summary.log
 - Summary of Trial number and Cd value
 - trials.csv
 - Details of trials including result and each parameter
 - result/*.zip
 - Visualized result of the specific trial
 - The number means the order of Cd value (1 means the best)
 - It contains the followings:
 - result/features.txt : cda and cd value
 - result/mesh.vtu : mesh file including pressure and velocity field predicted by RICOS Lightning
 - shape : STL files of the specific trial
 - trials.zip
 - Combined zip file of the results
 - template.json
 - Template file used in the optimization study

| RIC | OS Product | ion Suite | | | | a_okayama | | Sc | | |
|------------|------------------------------------|-----------|--|--|--|-----------|------|---------------|-------------|--|
| _ | | = | File-set > File-set Information | | | | | | | |
| Sc | LIGHTNIN | IG | 20250120_test1_20250120_scania_trial.j | ison | | | ピ Ed | it 2025/01/2 | 20 22:30:11 | |
| ፟ | Upload Conversion Preprocess | £ → | Share | | | | | | | |
| 1 5 | Training Prediction | , ⊕ \$1 | (| Drag and drop or <u>browse</u> to add files. | | | | | | |
| | | | Filename | Туре | Created at | | | Size | ⊻ | |
| O. | File-set List | | 20250120_scania_trial.json | JSON | 2025/01/20 22:30:11 | | | 1.6KB | * | |
| S | Job List | | template.json | JSON | 2025/01/20 22:30:12 | | | 1.6KB | ₹ | |
| | Bulk Upload | | summary.log | Application Log File | 2025/01/20 23:00:28 | | | 6 byte | * | |
| | | | trials.csv | CSV | 2025/01/20 23:00:28 | | | 5 byte | * | |
| | | | trials.zip result/1.zip | | 2025/01/20 23:00:28 2025/01/20 23:00:28 | | | 296MB 59MB | * | |
| | | | result/1.zip | | 2025/01/20 23:00:28 | | | 59MB | ± | |
| | | | result/3.zip | | 2025/01/20 23:00:28 | | | 59MB | ± | |
| | | | result/4.zip | | 2025/01/20 23:00:29 | | | 59MB | * | |
| | | | result/5.zip | | 2025/01/20 23:00:29 | | | 59MB | ₹ | |