# DYNAMIC RISK ASSESSMENT FOR VEHICLES OF HIGHER AUTOMATION LEVELS BY DEEP LEARNING

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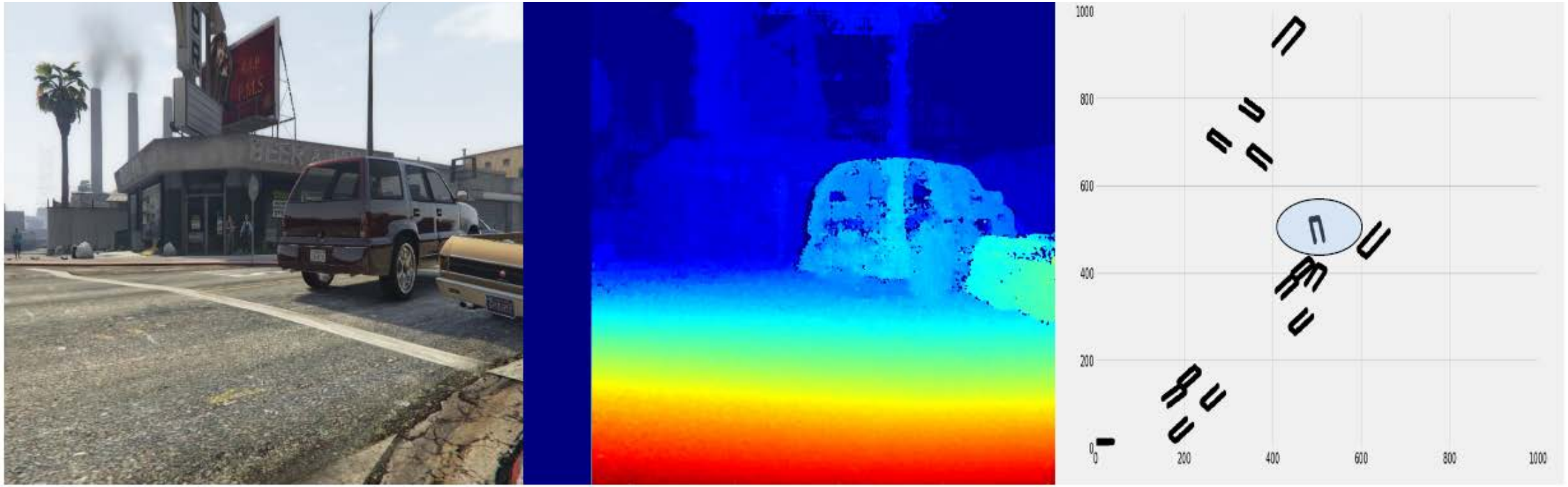


* Author present



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2: German Research Centre for Artificial Intelligence (DFKI)



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# Motivation

- With higher
- From a safety
- Assessment c
  Dynamic Risk
- DRA in autor

riate behavior.

ation levels →

**WEDNESDAY SEPTEMBER 19TH**

| | |
|---|---|
| 08:00 - 08:45 | Registration Desk |
| 08:45 - 09:00 | Welcome Note |
| 09:00 - 10:00 | **Keynote Talk 1**: Robyn Lutz (Session chair: Irfan Sljivo) |
| 10:00 - 10:30 | Coffee Break |
| 10:30 - 12:00 | **Session 1** - Automotive safety standards and cross-domain reuse potential: (Session chair: Ewen Denney)<br>Papers:<br>• Automotive Safety Practices vs. Accepted Principles (Practical Experience Report). *Philip Koopman*<br>• A Generic Method for a Bottom-Up ASIL Decomposition. *Alessandro Frigerio, Bart Vermeulen and Kees Goossens*<br>• Assurance Benefits of ISO 26262 Compliant Microcontrollers for Safety-Critical Avionics. *Andreas Schwierz and Håkan Forsberg* |
| 12:00 - 12:30 | Exposition overview |
| 12:30 - 14:00 | Lunch Break |
| 14:00 - 15:30 | **Session 2** - Autonomous driving and safety analysis: (Session chair: Elena Troubitsyna)<br>Papers:<br>• Structuring Validations Targets of a Machine Learning Function applied in Automated Driving. *Lydia Gauerhof, Peter Munk and Simon Burton*<br>• Multi-Aspect Safety Engineering for Highly Automated Driving - Looking beyond functional safety and established standards and methodologies. *Patrik Feth, Rasmus Adler, Takeshi Fukuda, Tasuku Ishigooka, Satoshi Otsuka, Daniel Schneider, Denis Uecker and Kentaro Yoshimura*<br>• A Model-Based Safety Analysis of Dependencies Across Abstraction Layers. *Christoph Dropmann, Eike Thaden, Mario Trapp, Denis Uecker, Rakshith Amarnath, Leandro Avila Da Silva, Peter Munk, Markus Schweizer, Matthias Jung and Rasmus Adler* |





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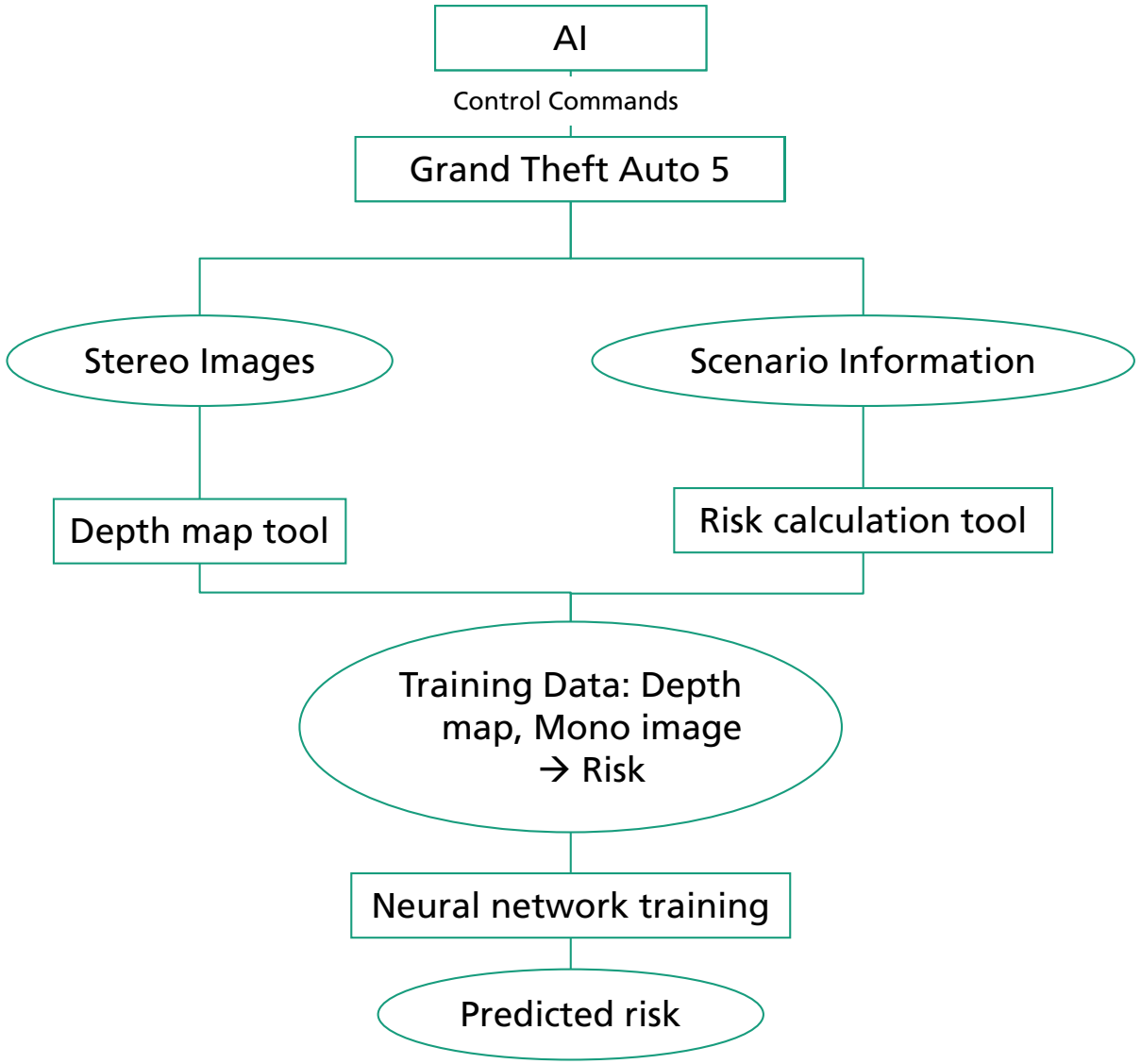
# Motivation

- Risk metrics traditionally calculated based upon sensor data and algorithms
- Here we analyze if the calculation of a risk metric is also possible with a Convolutional Neural Network

# Overview





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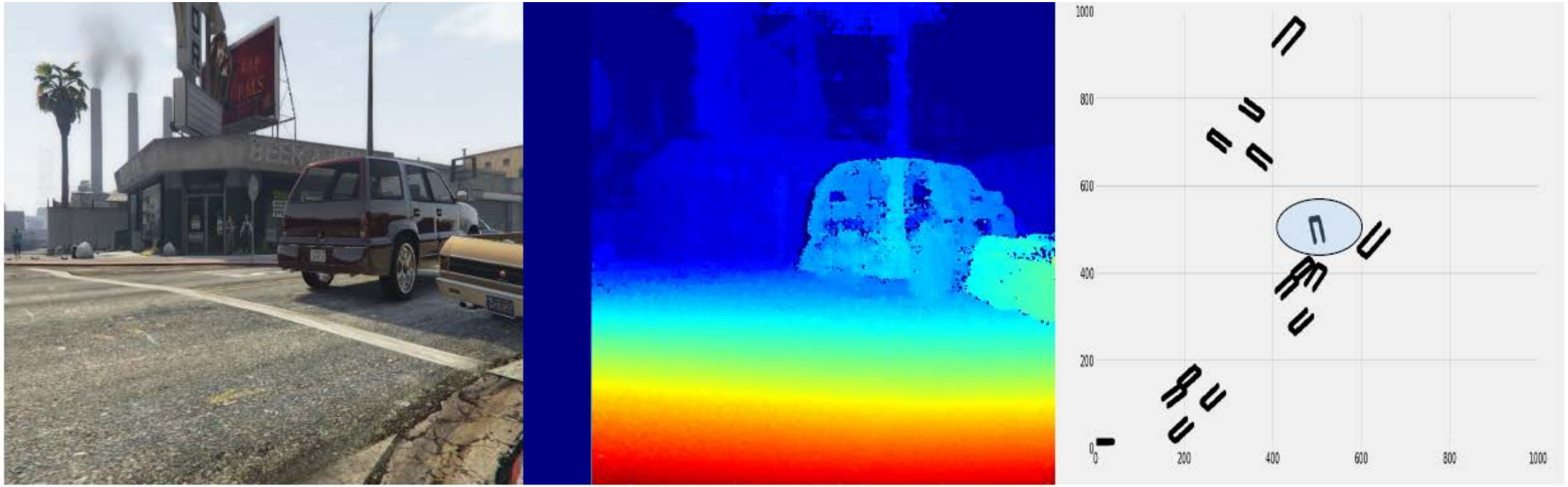
# Brief methodology

- Virtual stereo camera simulation
- Data pre-processing:
  - Quality estimation
  - Disparity estimation
  - True risk estimation
- Training of neural network

# Neural network

- Convolutional neural network
- By Nvidia DAVE-2





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# Confusion matrix of the CNN

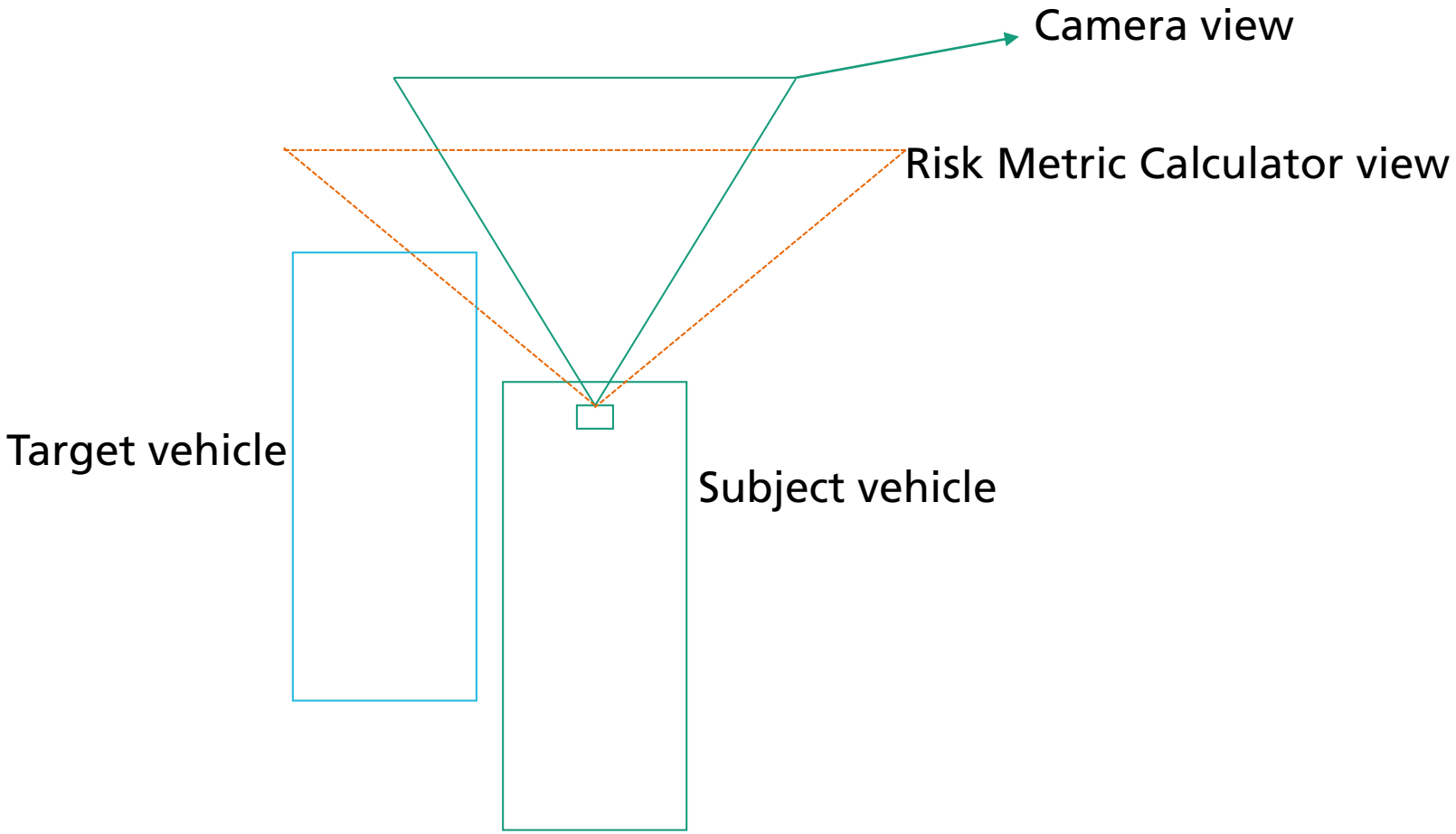
- Accuracy Paradox
- Threshold time headway: 1.5 seconds
- **72.87%**

| | Actual critical situation | Actual uncritical situation |
|---|---|---|
| Predicted critical situation | 67052 (63.16%) | 19069 (17.96%) |
| Predicted uncritical situation | 9737 (9.17%) | 10312 (9.71%) |

**Is this accuracy enough?**

- Depends on application. warning system vs emergency breaking systems.

# Reason for inadequate performance



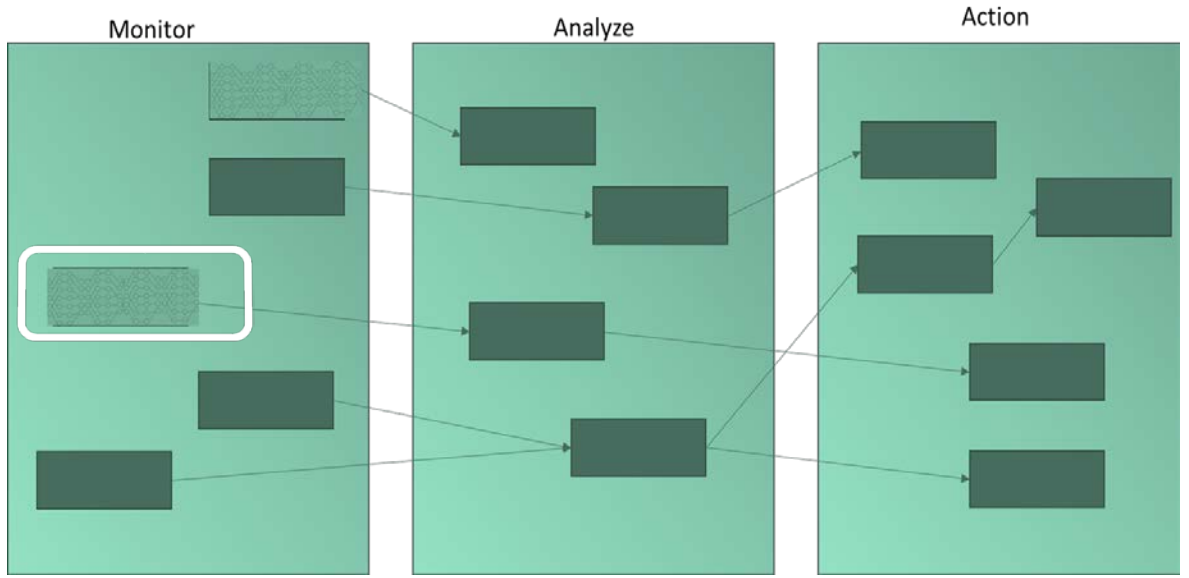
# Reason for inadequate performance (Cont . . . )

Risk from RMC: 0.36, CNN Prediction: 0.38

Risk from RMC: 0.75, CNN Prediction: 0.39

# Conclusion

- Novel approach for the dynamic risk assessment from images
- The trained network achieved an accuracy of **72.87%** on our test set
- Heterogeneous  redundancy



# Future work

- Ground truth data should map the visible area for the CNN
- Using more sophisticated risk metrics
- Using more advanced neural networks, for example LSTM
- Using an open source simulation environment like CARLA

# Thank You

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