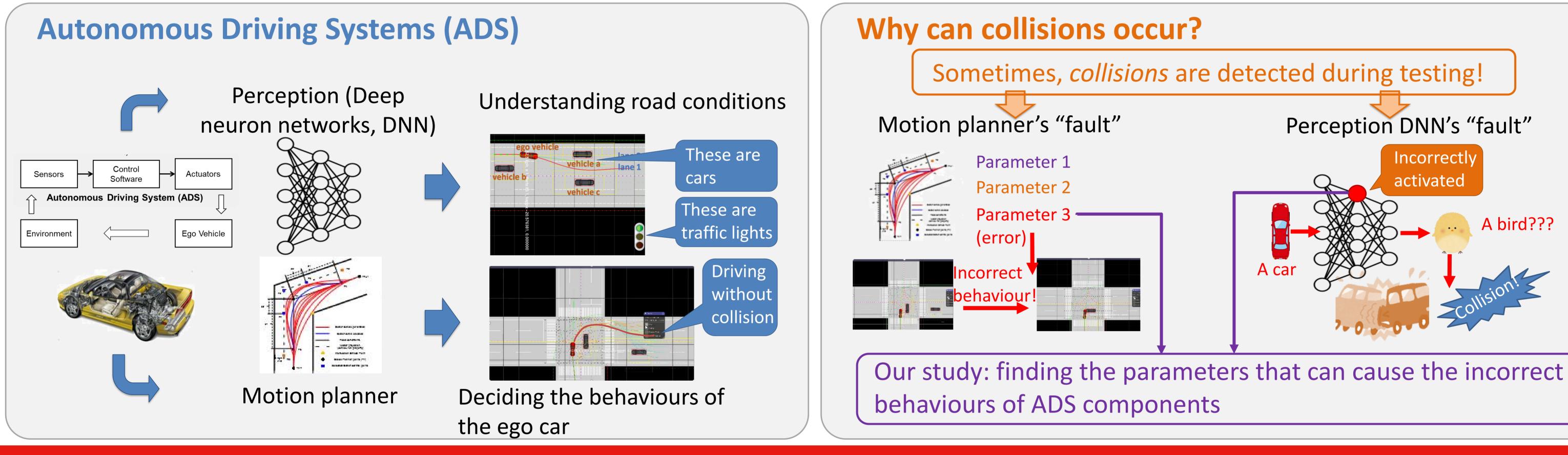
Bug localization for autonomous driving systems Localising System Parameters Leading to Autonomous Driving Collisions Xiao-Yi Zhang, Paolo Arcaini, Fuyuki Ishikawa

Problem

- Several benefits from Autonomous Driving (AD)
- However, collisions during AD can lead to disruptive damages
- Important to explore why these collisions can occur and how to solve them

Our study

- We propose an approach to assess ADS collisions
- We apply spectrum-based techniques (borrowed from software debugging) to analyse the relationship between the incorrect behaviours of ADS components
- Autonomous Driving Systems (ADS) contain various components with various parameters
- Difficult to localise the *suspicious* parameters
- and the parameters of these components
- Our approach shows which parameters can cause AD collisions



Localising *suspicious* path planner parameters

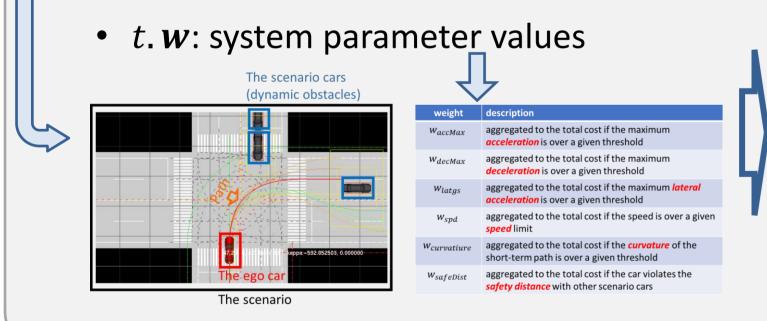
Localising *suspicious* neurons for DNNs

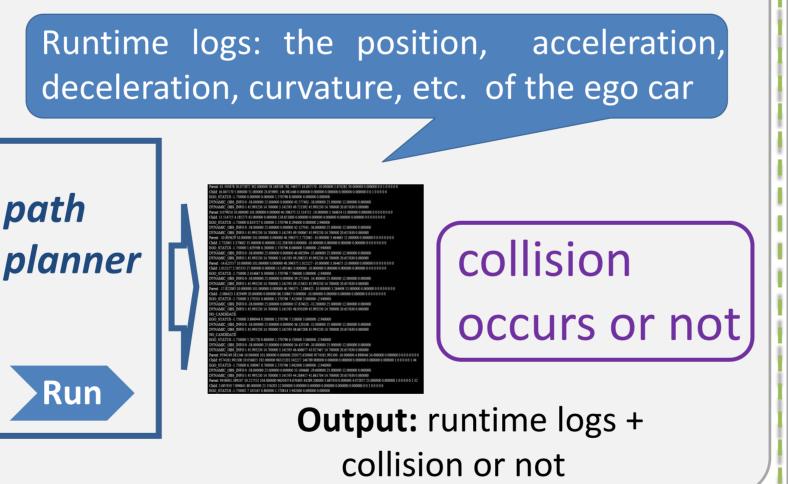
Benchmark: an industrial path planner (PP)

At runtime, automatically generate safe and efficient path for the ego car

Input: $(t = \langle S, w \rangle)$

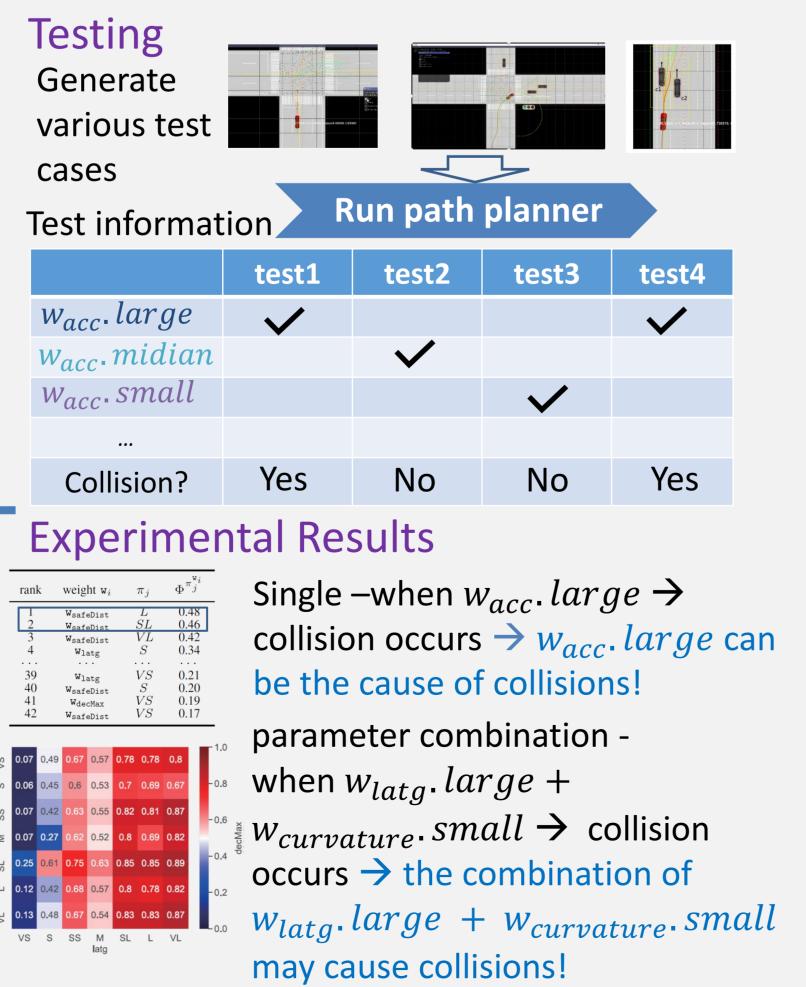
t.S: the traffic scenario



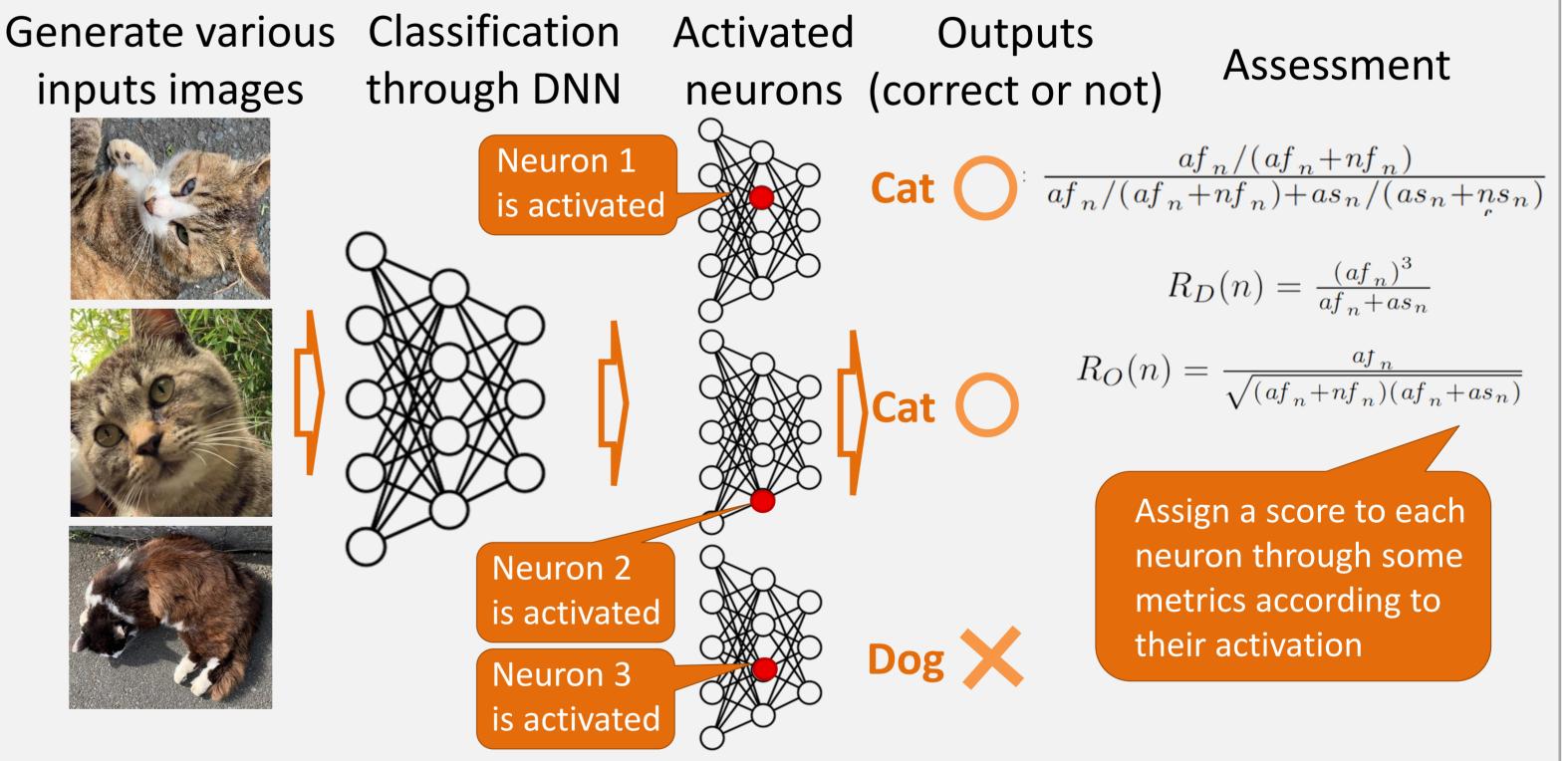


Spectrum-based analysis for PP

fuzzification Fuzzification System Parameters: w_{acc} . large Penalty for w_{acc}.midian acceleration w_{acc} w_{acc}.small w_{dec}.large Penalty for



Spectrum-based analysis for DNN models



Neuron 3 is activated in error cases \rightarrow it has a higher suspiciousness score \rightarrow responsible for the misclassification from a cat to a dog

Experiments

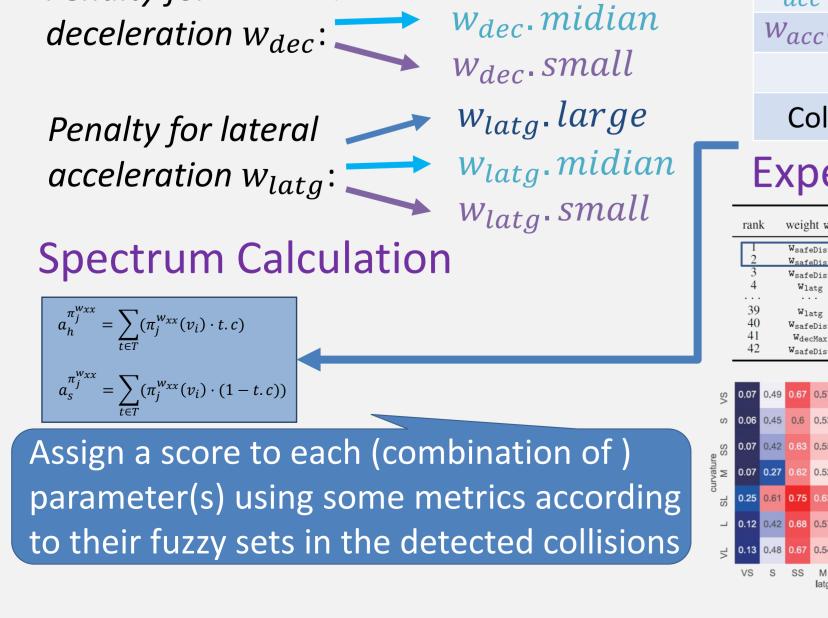
Intersection of the suspicious neurons

among different

misclassifications

Errors synthesised

A bird???



Zhang, Xiao-Yi, Paolo Arcaini, and Fuyuki Ishikawa. "An Incremental Approach for Understanding Collision Avoidance of an Industrial Path Planner." IEEE Transactions on Dependable and Secure Computing (2022).

Dataset – MNIST, CIFAR10 DNN - CNN with

various structures

The intersection sizes are small \rightarrow Different misclassifications are caused by different neurons

by activating the suspicious neurons Wrong labels Synthesising inputs by triggering the

suspicious neurons can indeed produce misclassifications (errors)! Duran, Matias, Xiao-Yi Zhang, Paolo Arcaini, and Fuyuki Ishikawa. "What to Blame? On the Granularity of Fault Localization for Deep Neural Networks." In 2021 IEEE 32nd International Symposium on Software Reliability Engineering (ISSRE), pp. 264-275. IEEE, 2021.

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