SAE level 3 Autonomous driving in urban setting using cognitive architecture

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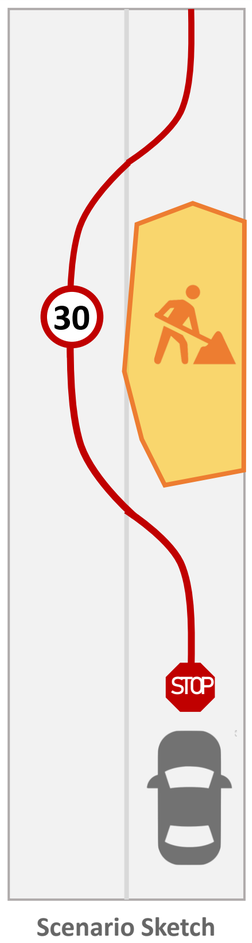
Scenario

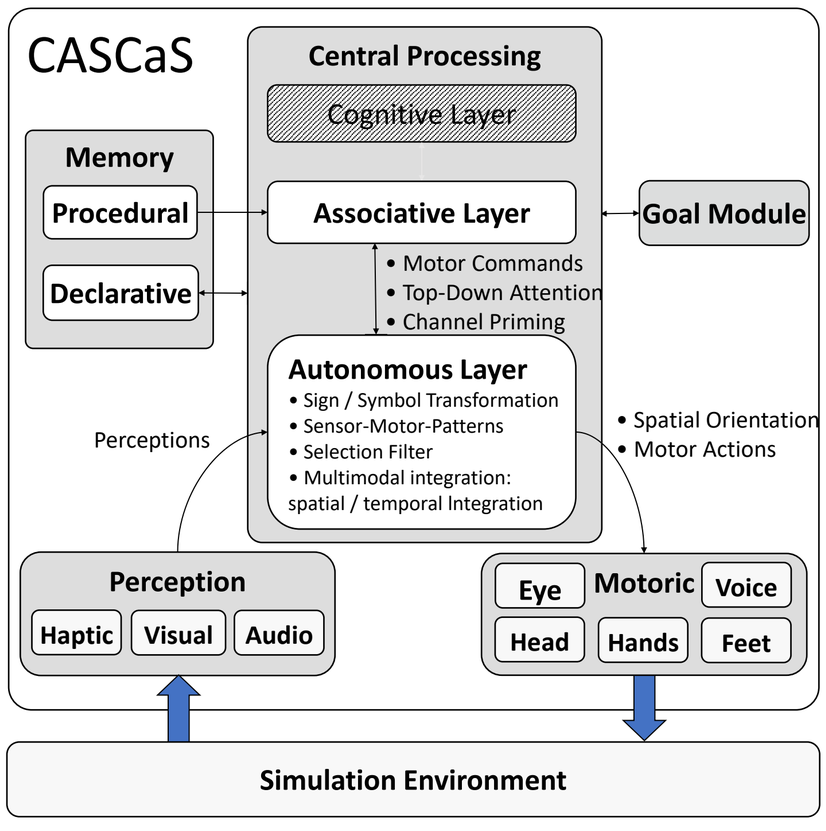
The car drives autonomously until it recognizes an obstacle it can only pass by moving through oncoming traffic. For legal reasons it can only do so when initiated by a human. It sends a prompt to the driver, to press a button at an opportune time and informs of a legal speed limit for autonomous overtaking maneuvers. Combined with slow acceleration this makes it harder to assess required gap sizes in oncoming traffic.



Scenario Sketch

Cognitive Architecture

We use human data to validate and further develop our cognitive architecture, which can be deployed earlier in the developing process, interacting with a digital twin of the HMI design.



Cognitive Architecture for Safety Critical Task Simulation

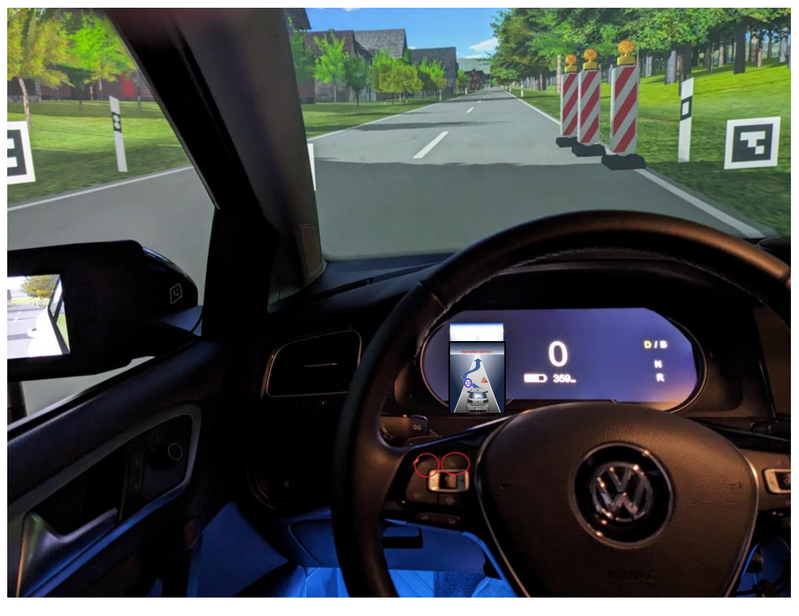
Developed by DLR-SE.

It is similar to ACT-R, but build from the ground up for safety critical tasks like vehicle control.

Unlike trained models cognitive architectures do not need new training data for every new scenario, they are more performant than general models like big LLMs and unlike both they are not a black box. Thus they allow for perfect assessment of Situation Awareness at any given moment.
The downsides are longer development, worse fit and more predictability.

Study

Features 30 situations with 1 out of 5 construction site lengths, combined with 1 out of 6 oncoming traffic spacing variants.

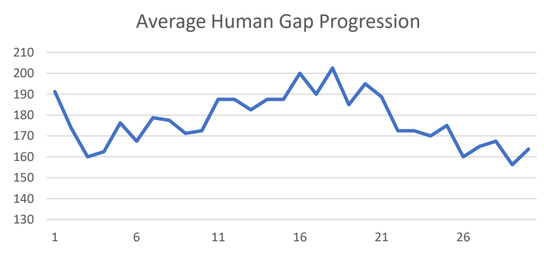


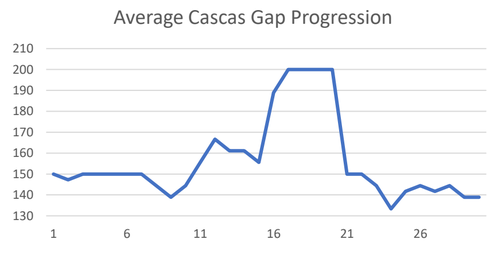
Driving Simulator at DLR-SE. Complete Car mounted on hydraulic platform, surrounded with round screen.
The car has stopped in front of an obstacle and promts the driver via display, to find a gap in traffic and press a button on the wheel.

22 Humans Participants took part in the driving simulator study, wearing an eye-tracker, and answered a questionnaire afterwards.

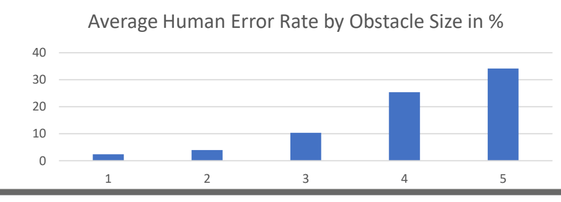
Some Results

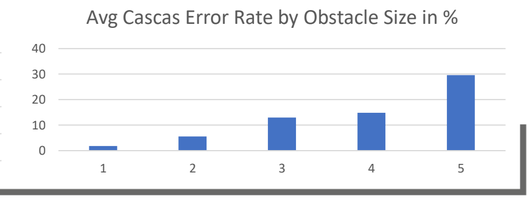
While most participants claimed to keep learning, the data does not support this. Instead decisions are dominated by the gap sizes that present themselves first, which grew towards the middle then shrank again. The Cascas variants follow this trend more harshly and have less variance between them.





A huge driver of error were the obstacle sizes ranging from 11m to 28m. With rising length the error went from close to 0% up to 35%. This could be due to length recognition failure. However Cascas makes the same errors , which arise due to takeover time calculation and difficulty of finding a corresponding large traffic gap.





V&V4NGC
Methoden, Prozesse und Werkzeugketten für die Validierung & Verifikation von Next Generation Car

ACT4D Transformation

DLR