#CAM2019 @LCV_Event

connected automated mobility cenex

Verification of Connected and Autonomous Vehicles: The Safe Deployment of CAVs on Public Roads

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SELF-DRIVING REVOLUTION

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Verification of Connected and Autonomous Vehicles

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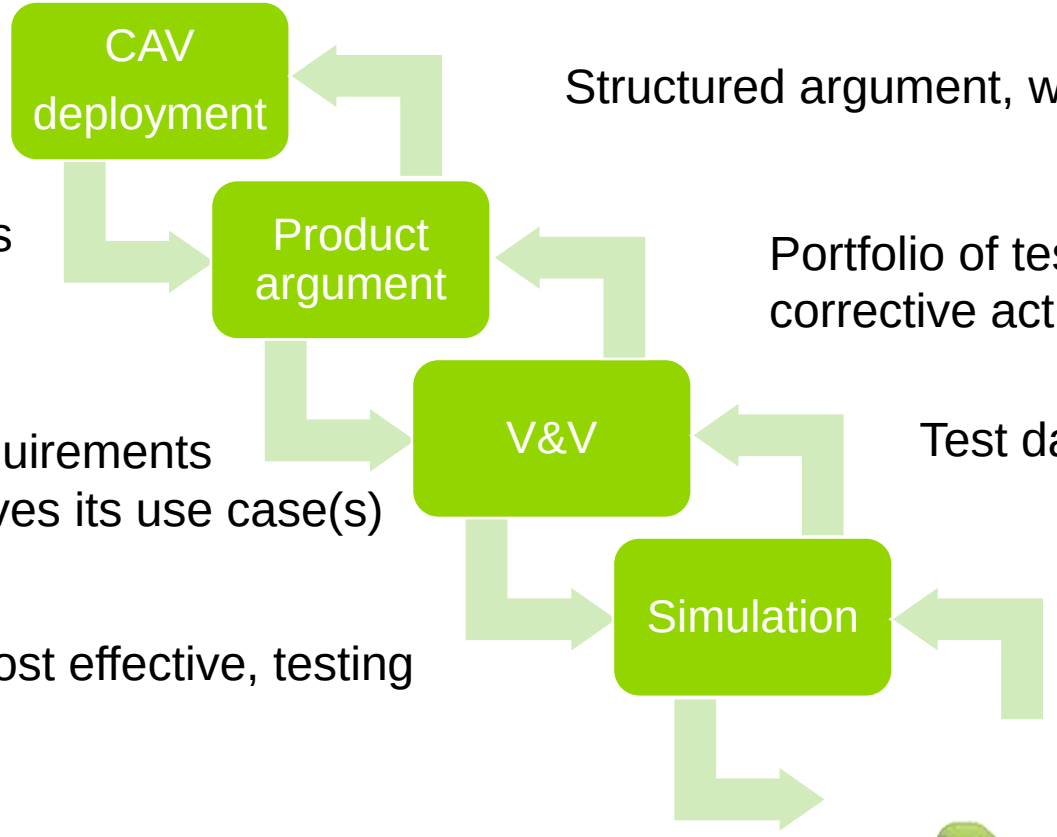
Project context



Structured argument, with robust justification

Prove and demonstrate system is **functional**, **safe** and **robust**

Portfolio of test evidence, corrective actions

Verify the system meets its requirements
Validate that the system achieves its use case(s)

Test data from simulation

Accelerated, cost effective, testing

Consortium members

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A HORIBA COMPANY MIRA

CATAPULT Connected Places

LATENT LOGIC

aimsun.

UNIVERSITY OF LEEDS

VeriCAV is supported by

Centre for Connected & Autonomous Vehicles

Innovate UK

Three key research questions

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What to test?

- Large parameter sets
  - Complex scenarios
  - Real world diversity
- Every CAV is different
  - Performance factors & failure modes
  - One size does not fit all

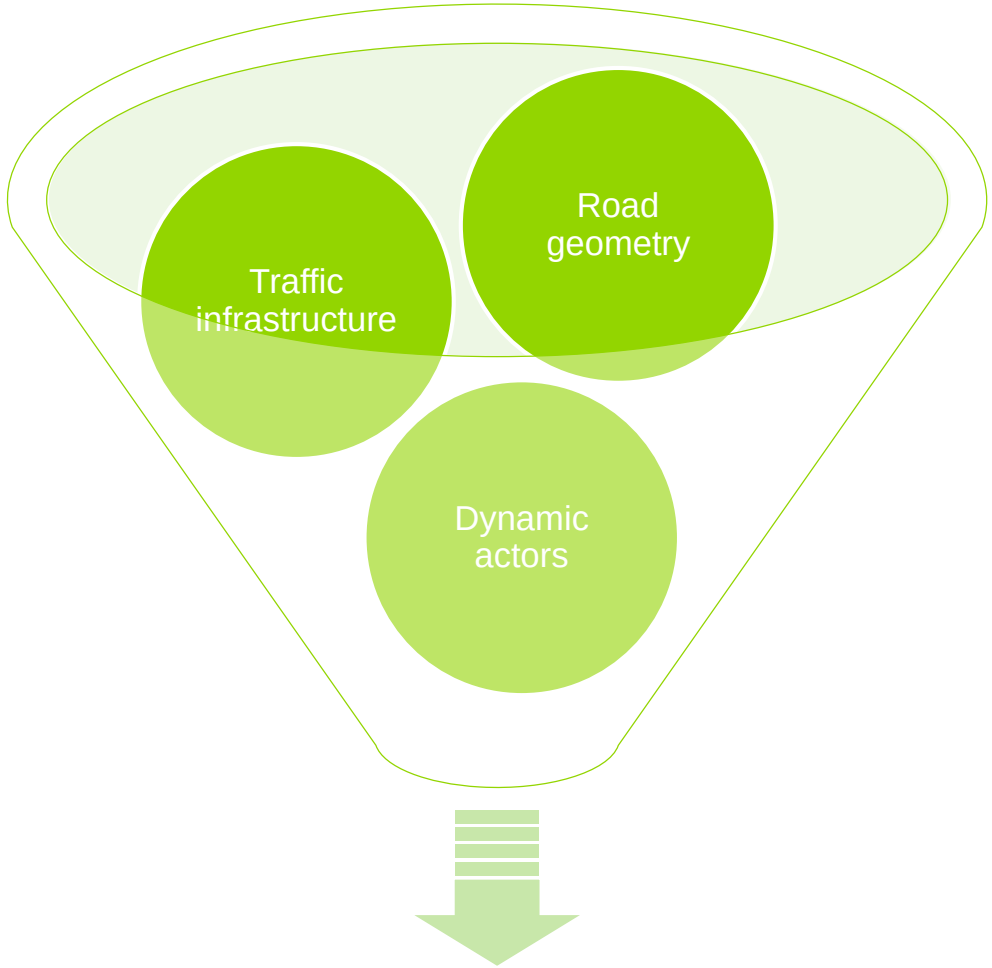
How to test?

- Simulation environment
  - Dynamic road user interactions
  - Fidelity, accuracy and correlation
- Volume of test data
  - Automation required
- Gaps in interface standards

How much to test?

- Acceptable performance depends on scenario context
- Statistical case for coverage
  - Meaningful
  - Achievable
  - Provable

What to test in simulation?



Automated test generation

Scenario attributes

- Attribute database
- Structured descriptions (e.g. PEGASUS layers)
- Logical scenarios:
  - Range, resolution, and probability distribution

Configurable constraints

- Operational Design Domain (ODD)
- Simulation capability and API
- System design and functionality
- Test objectives

Efficient sampling

- Initial randomised distribution
- Search space optimisation

How to test in simulation? Modular architecture

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Attribute database

Test Generator

Simulation Environment

Sensor models

Dynamic models

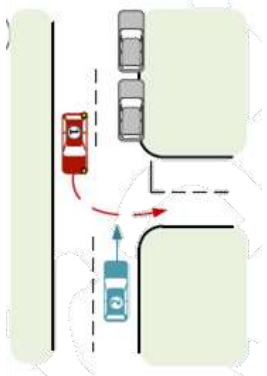
ADS Under Test

Smart Actors

How to test in simulation? Smart Actors

Challenge

- Dynamic interactions
- Non-linear behaviour
- Varied responses

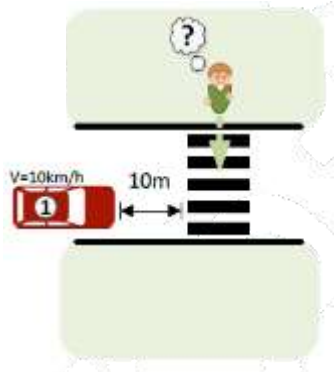


Car crossing traffic

Dual Approach

- Machine learning from real world data (Latent Logic)
- Cognitive models (Leeds University)

Pedestrian crossing road



Scenarios

- Fundamental conflict cases between road users
  - Leverage prior work from InterACT
- Advanced cases inc. complex roundabouts and highway driving

Markkula, G., Romano, R., Madigan, R., Fox, C. W., Giles, O. T., & Merat, N. (2018). Models of Human Decision-Making as Tools for Estimating and Optimizing Impacts of Vehicle Automation. *Transportation Research Record*, 2672(37), 153–163. https://doi.org/10.1177/0361198118792131
Wilbrink et al. (2017). *interACT D1.1 Definition of interACT use cases and scenarios*. https://www.interact-roadautomation.eu/projects-deliverables/

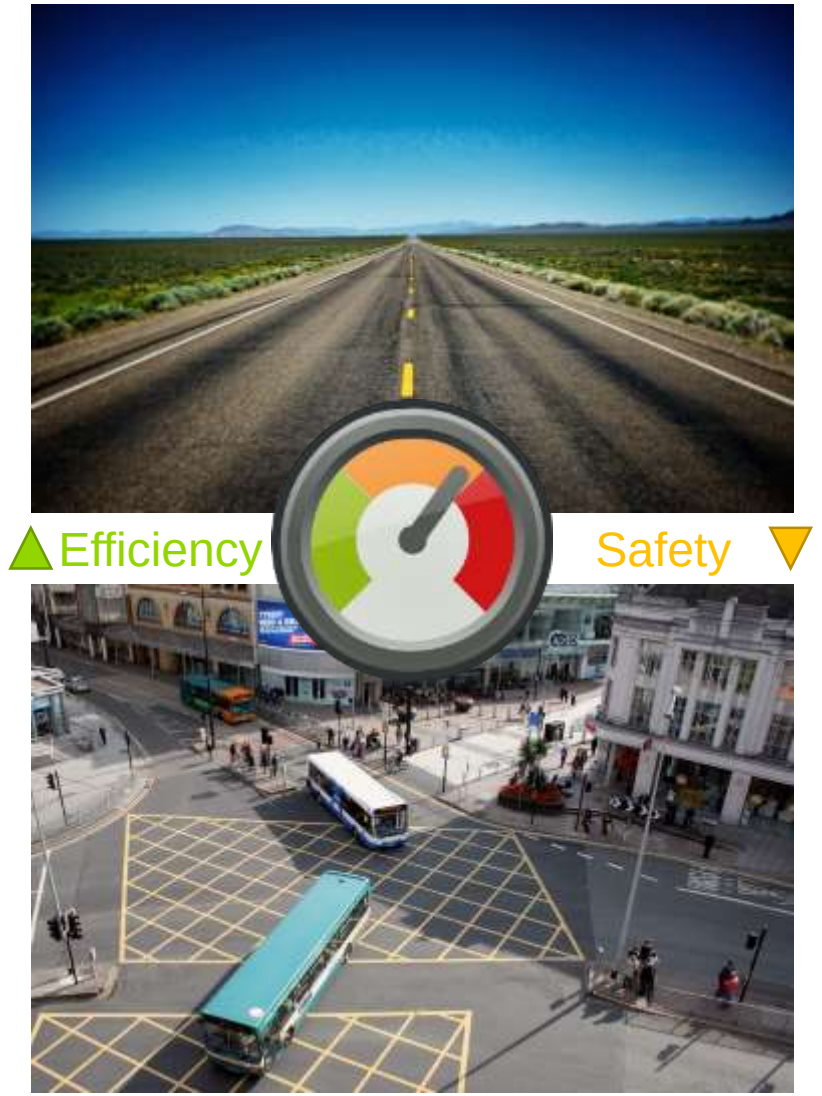
How much to test in simulation? Oracle

Automated acceptance criteria

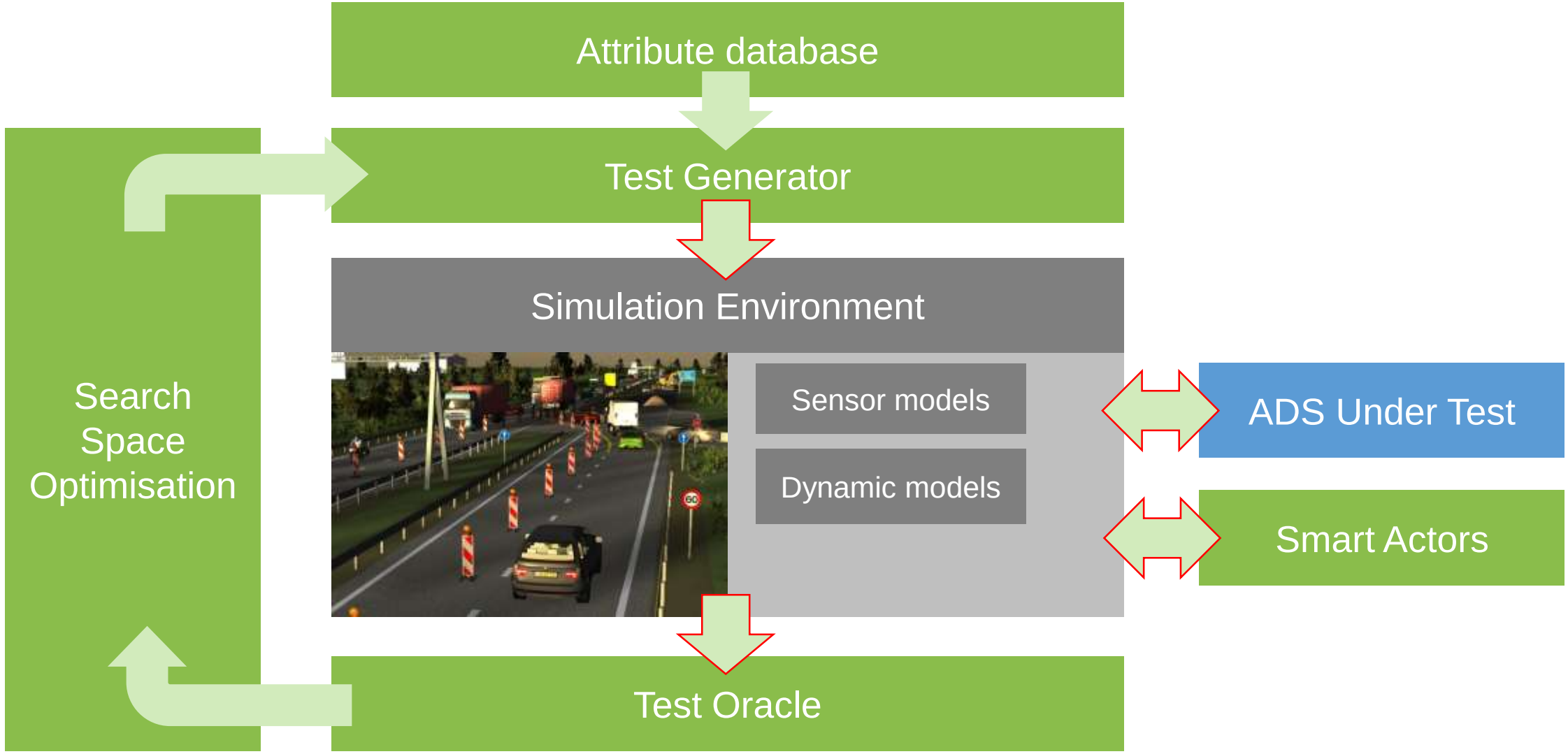
- Generated scenarios, require generated acceptance criteria
- Account for scenario context
- e.g. Pegasus Criticality

Quantified performance metrics

- Not just pass/fail, looking for performance degradation
- Evaluation from multiple perspectives
- e.g. Mobileye Responsibility Sensitive Safety (RSS)



How much to test in simulation?



How much to test in simulation? Search

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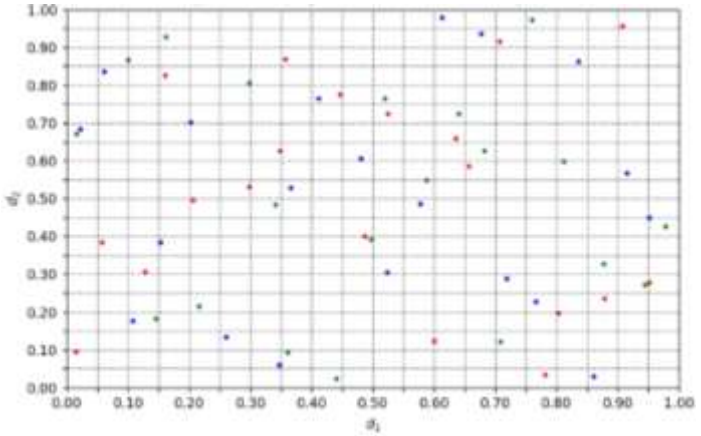
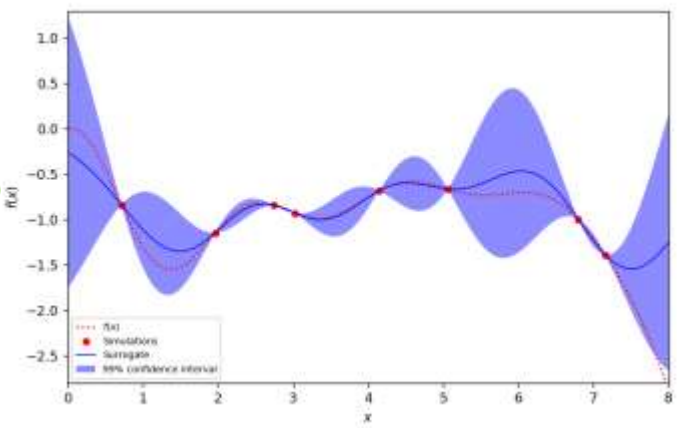
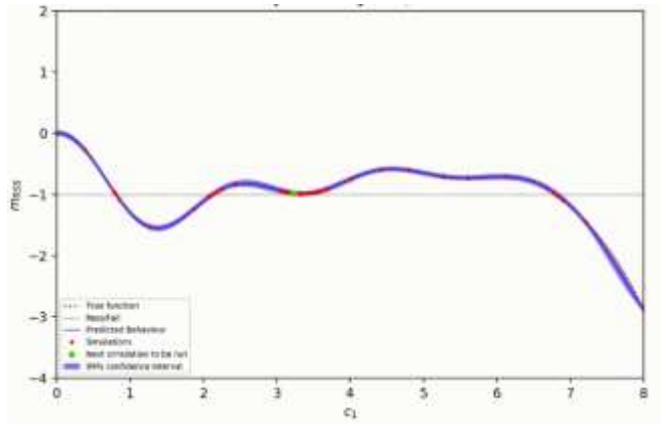
Initial sampling



Characterisation



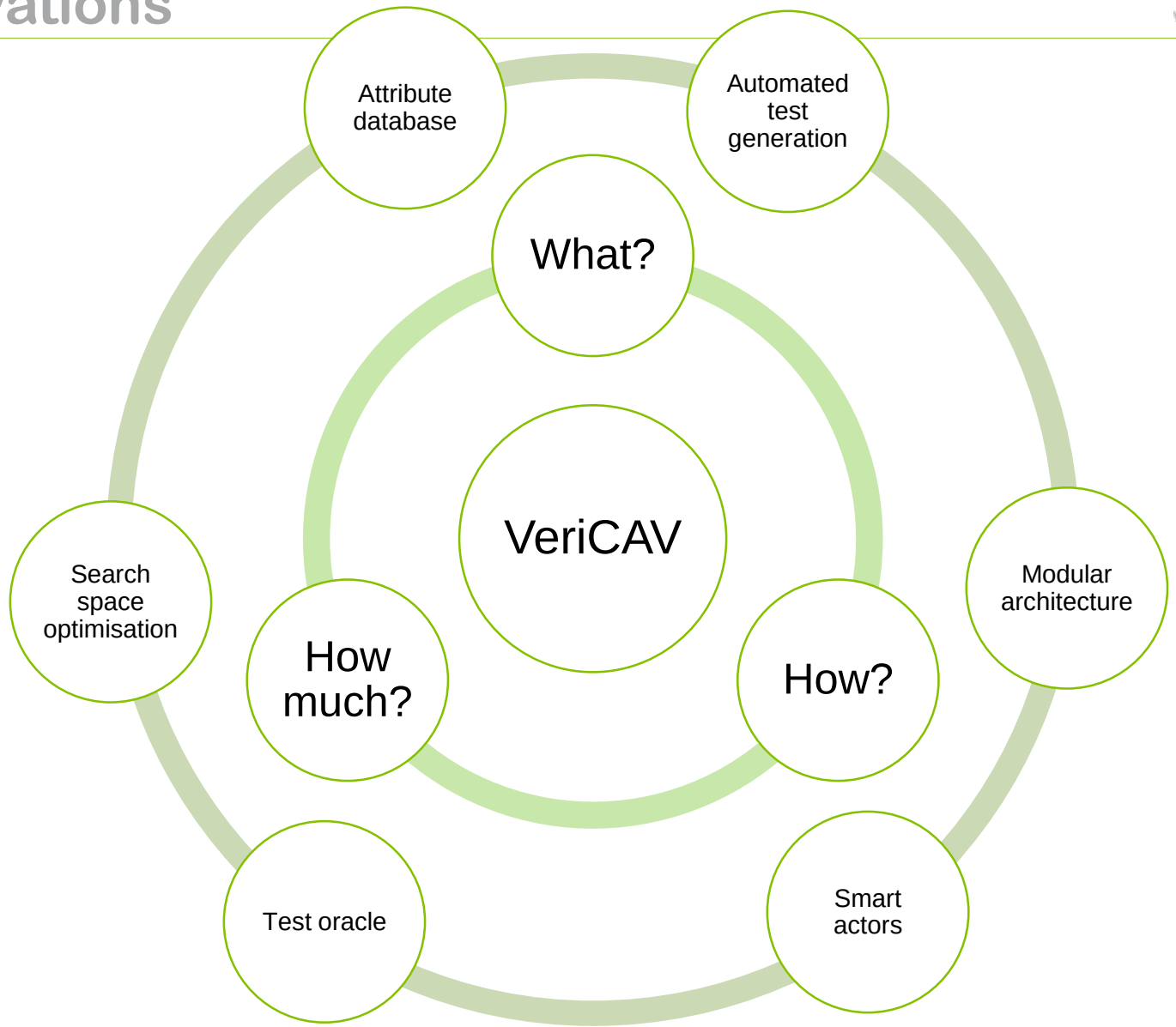
Boundary conditions



Discovery

Exploitation

Key innovations



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Thank you

Any questions?

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