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Verisimilar Percept Sequences Tests for Autonomous Driving Intelligent Agent Assessment

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Safety

- Autonomous cars → improve safety
  - Human driver blamed for (94 ± 2.2)% of motor vehicle crashes in US *
  - Simple logic: remove driver → safer traffic
- What is safety and how to measure safety ?
  - Relative emotional state
  - It is not a measurable quantity !!!

* Singh, S., 2015. Critical reasons for crashes investigated in the national motor vehicle crash causation survey (No. DOT HS 812 115).

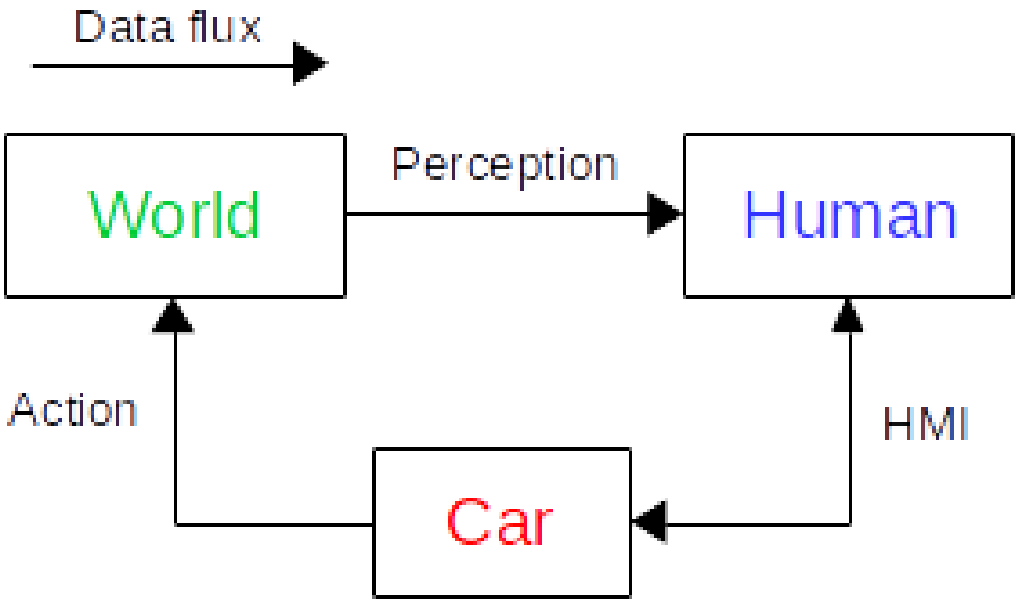
Safety

- March 23, 2018 - Uber self-driving car
  - First pedestrian kill

https://www.theguardian.com/technology/2018/mar/19/uber-self-driving-car-kills-woman-arizona-tempe

The Usual Car

- Human driver
  - perceive environment & controls vehicle



The Usual Car

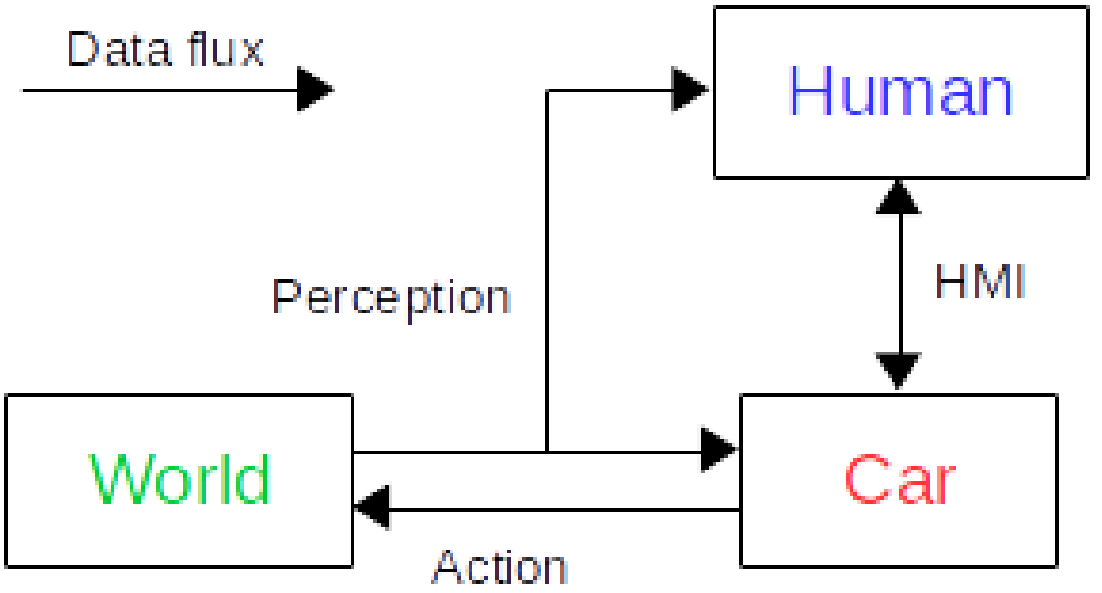
- What the human driver do ?
  - Using the eyes:
    - Identify road
    - Identify obstacles (vehicles, pedestrians, cyclists)
    - Identify traffic signs
    - objects distance
  - Arms and legs:
    - Controls steering wheel, pedals and gearbox
- Drivers must have a perfect vision and body movement.

Driver Evaluation

- Human driver evaluation:
  - Medical exams
  - Theoretical and practical tests
- Driver’s license upon approval
  - No self-driving car license

Autonomous Cars

- Human driver is optional



Car Evaluation

- Autonomous car evaluation:
  - Disengagement rate
    - Number of times of human driver intervention
    - Lower disengagement rate does not mean safer systems
  - There is no standard
    - Perception: datasets
    - System integration: field tests
    - They are not enough

Car Evaluation

- Dataset problems:
  - Cherry-picked:
    - Perfect data (images, LIDAR, radar)
    - Restricted domain representation
- Field tests problem:
  - After action review → number of accidents
    - Time-consuming and dangerous

Verisimilar Percept Sequences

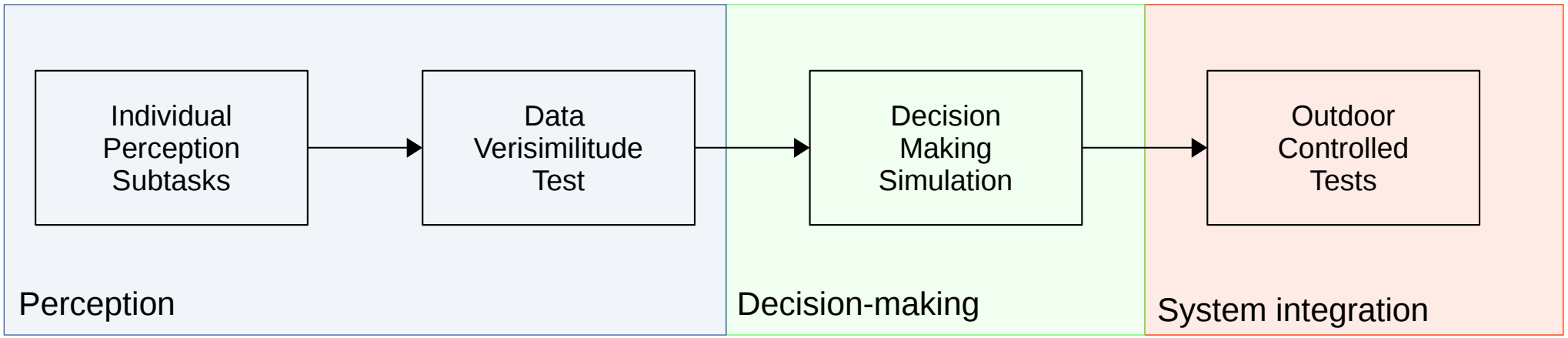
- Our proposal:
  - Intelligent Agent / Rational Agent (RA)
    - perception + decision-making
- RA as a critical system → it must not fail
  - Environment constraints evaluation
- Evaluate the perception with realistic data
  - We describe the problems that arise from realistic situations and data.

Verisimilar Percept Sequences

- Percept Sequences (PS)
  - "*the complete history of everything the agent has ever perceived*" - Russell and Norvig *
  - streams of sensors data with timestamps
  - sequential data → estimate future states
    - Partially or completely occluded objects

* S. J. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd ed. Prentice-Hall, 2009.

Evaluation Pipeline



Evaluation Pipeline

- Individual Perception Subtasks →
- Data Verisimilitude Test
  - Data estimation
  - Data absence
  - Data flux interruption
  - Data corruption
  - Data attacks
- Decision-making Simulation
- Outdoor Controlled Tests

Usual dataset – evaluates performance on perception subtasks (detection / segmentation). Useful to train and compare models.

Evaluation Pipeline

- Individual Perception Subtasks
- Data Verisimilitude Test → Percept sequences with realistic data
  - Data estimation
  - Data absence
  - Data flux interruption
  - Data corruption
  - Data attacks
- Decision-making Simulation
- Outdoor Controlled Tests

Evaluation Pipeline

- Individual Perception Subtasks
- Data Verisimilitude Test
  - Data estimation → Percept sequences with partially and totally occluded obstacles
  - Data absence
  - Data flux interruption
  - Data corruption
  - Data attacks
- Decision-making Simulation
- Outdoor Controlled Tests

Evaluation Pipeline

- Individual Perception Subtasks
- Data Verisimilitude Test
  - Data estimation
  - Data absence → Percept sequences with rare and unusual examples
  - Data flux interruption
  - Data corruption
  - Data attacks
- Decision-making Simulation
- Outdoor Controlled Tests

Evaluation Pipeline

- Individual Perception Subtasks
- Data Verisimilitude Test
  - Data estimation
  - Data absence
  - Data flux interruption → Percept sequences with incomplete data
  - Data corruption
  - Data attacks
- Decision-making Simulation
- Outdoor Controlled Tests

Evaluation Pipeline

- Individual Perception Subtasks
- Data Verisimilitude Test
  - Data estimation
  - Data absence
  - Data flux interruption
  - Data corruption → Percept sequences with noisy data
  - Data attacks
- Decision-making Simulation
- Outdoor Controlled Tests

Evaluation Pipeline

- Individual Perception Subtasks
- Data Verisimilitude Test
  - Data estimation
  - Data absence
  - Data flux interruption
  - Data corruption
  - Data attacks → Percept sequences with simulated data attacks (adversarial examples)
- Decision-making Simulation
- Outdoor Controlled Tests

Evaluation Pipeline

- Individual Perception Subtasks
- Data Verisimilitude Test
  - Data estimation
  - Data absence
  - Data flux interruption
  - Data corruption
  - Data attacks
- Decision-making Simulation → Percept sequences representing task environments
- Outdoor Controlled Tests

Evaluation Pipeline

- Individual Perception Subtasks
- Data Verisimilitude Test
  - Data estimation
  - Data absence
  - Data flux interruption
  - Data corruption
  - Data attacks
- Decision-making Simulation
- Outdoor Controlled Tests → Mock-up field tests to validate system integration.

Conclusion

- Stimulate discussion about the topic
  - Model and list of rational agents problems
  - Autonomous car evaluation → refined over time
- Future work:
  - Percept sequences examples
  - Each step can be created separately

Thanks !

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