Intelligent Driving Agents

The agent approach to tactical driving in autonomous vehicles and traffic simulation

Presentation Master's thesis

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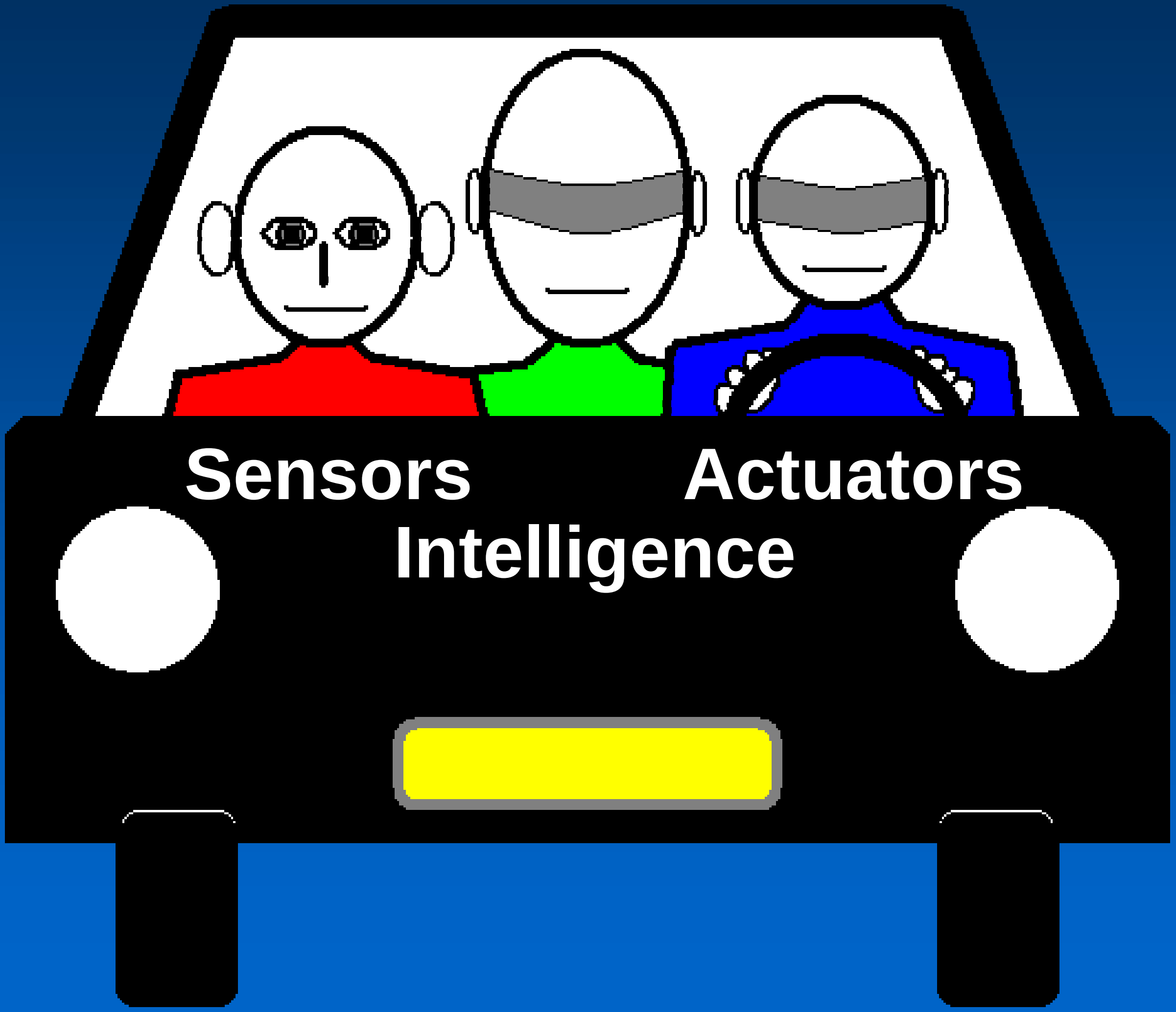
Imagine....



Overview of presentation

- Project and theory
- Design
- Simulation
- Conclusions and recommendations
- Short demonstration

Project

- Study the use of intelligent agents controlling a vehicle in an urban environment

- Two cases:
  1. Real life vehicles
  2. Simulated vehicles

- Focus on **tactical-level** driving

Theory: tactical driving

Driving task separated in three levels:

- **strategic**
  long-term decisions, determine goals
- **tactical**
  short-term decisions, current situation
- **operational**
  actual performed actions

Theory: what are agents?

Definition: autonomous computerized entity capable of sensing its environment and acting intelligently based on its perception.

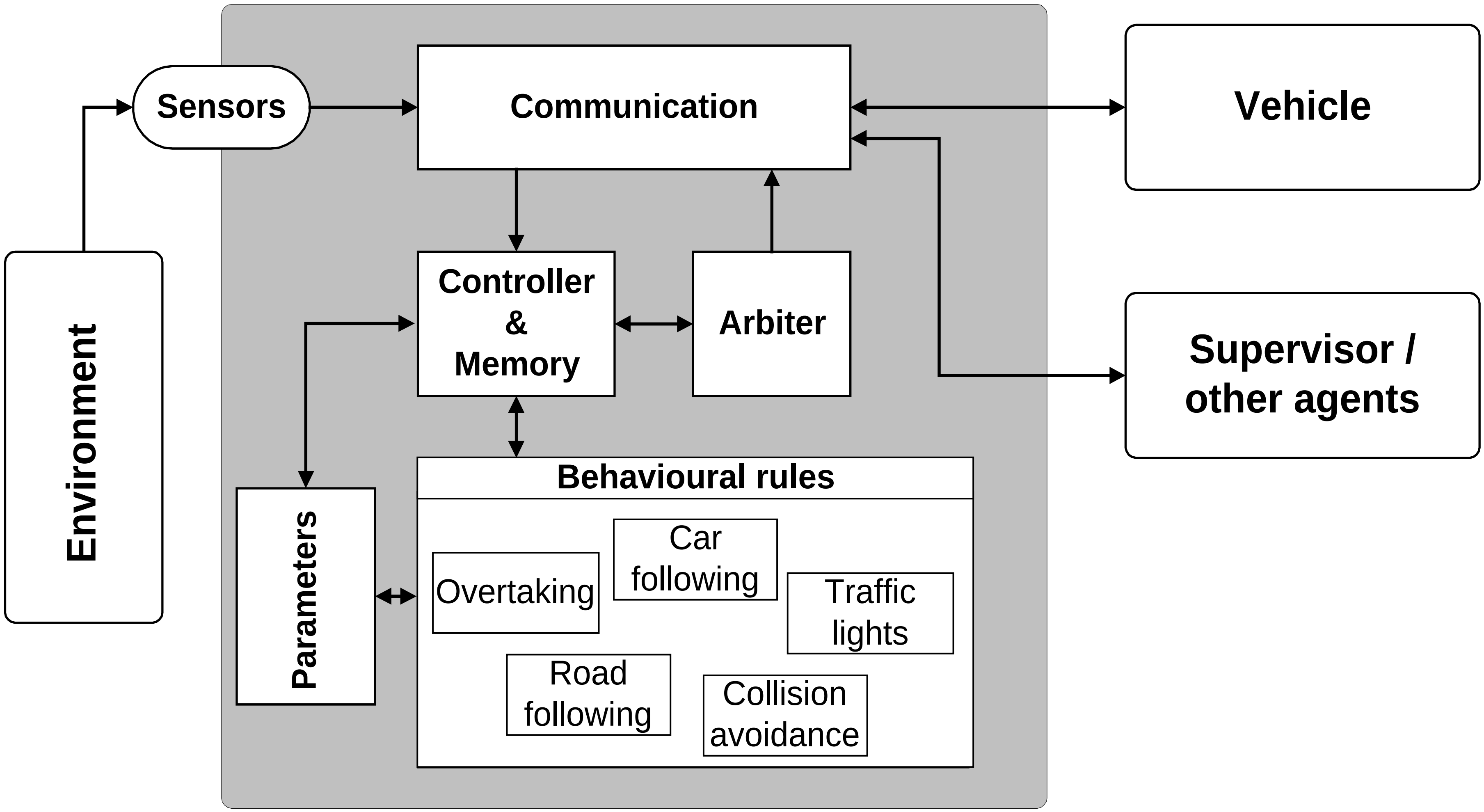
“smart creature inside computer”

- Ability to perform a given task
- Autonomous
- Adaptive / capable of learning

Design: driving agent

- Perform tactical driving
- Real time control
- Safety
- Expandibility

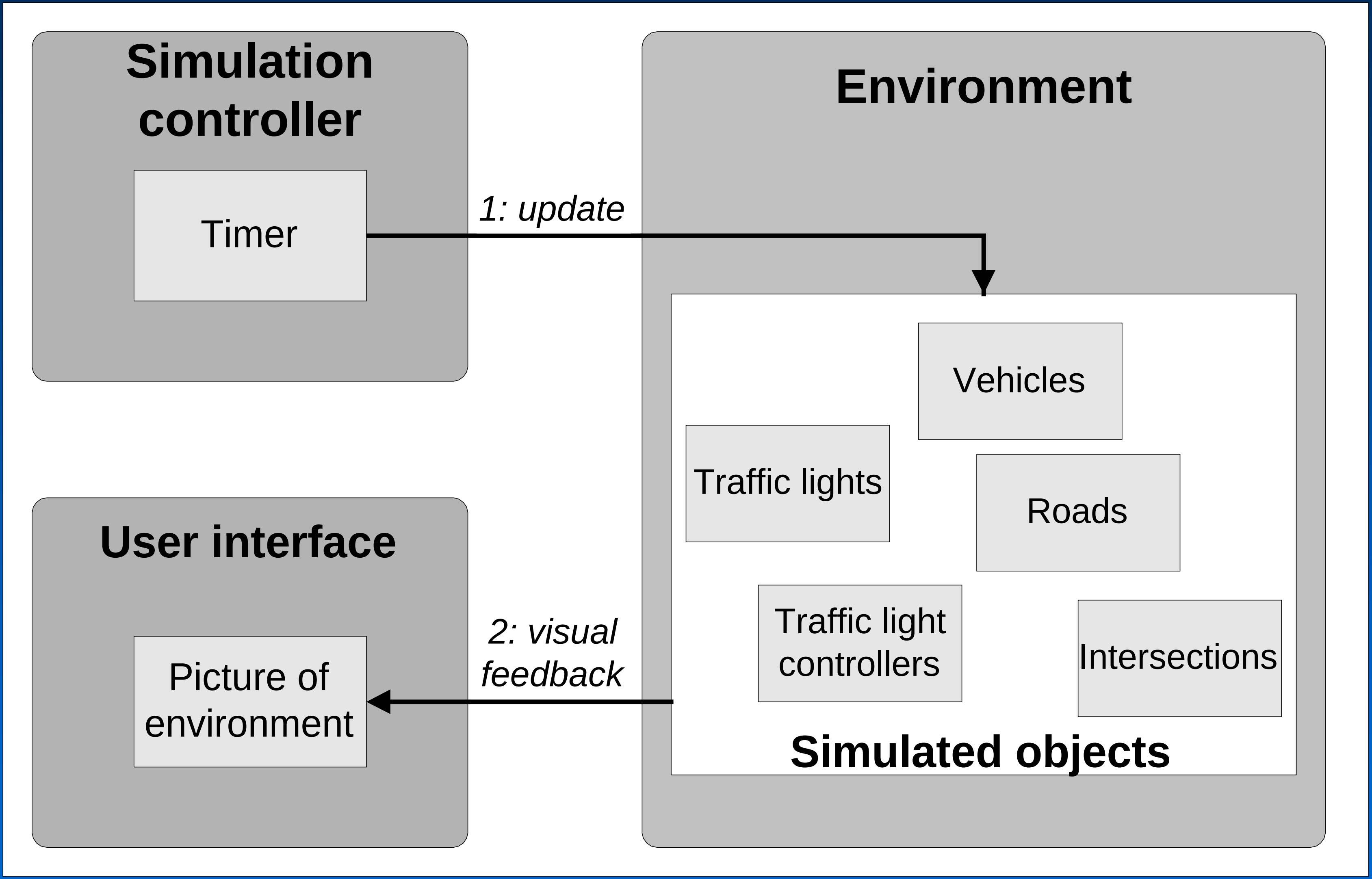
Design: driving agent (continued)



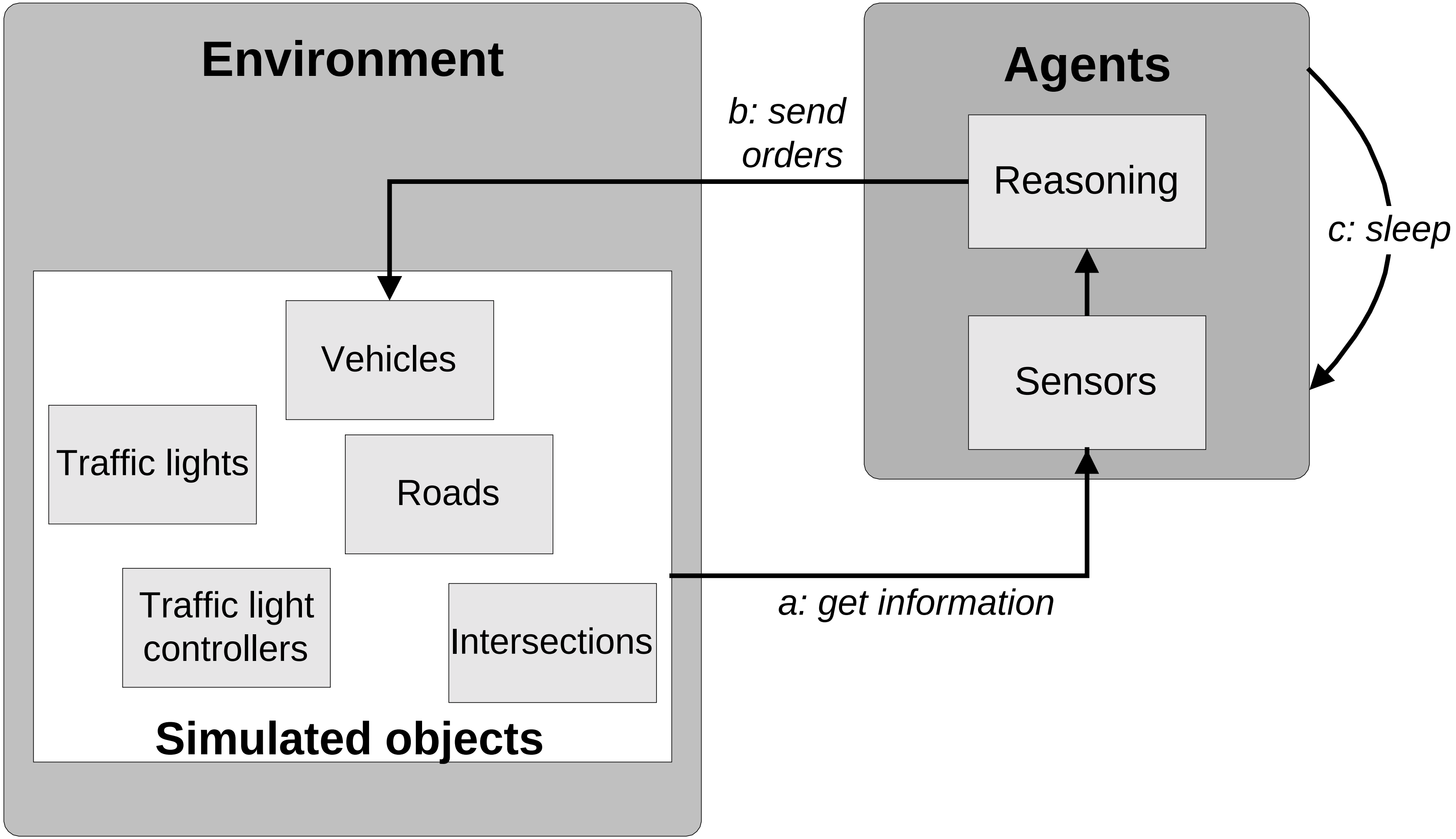
Implementation: simulator

- Decided to create new prototype traffic simulation program
- Used Borland Delphi 5 language
    - Suitable for fast prototyping
    - Experience

Implementation: simulator



Implementation: agent



Environment

Simulated objects

Vehicles

Traffic lights

Roads

Traffic light controllers

Intersections

Agents

Reasoning

Sensors

b: send orders

a: get information

c: sleep

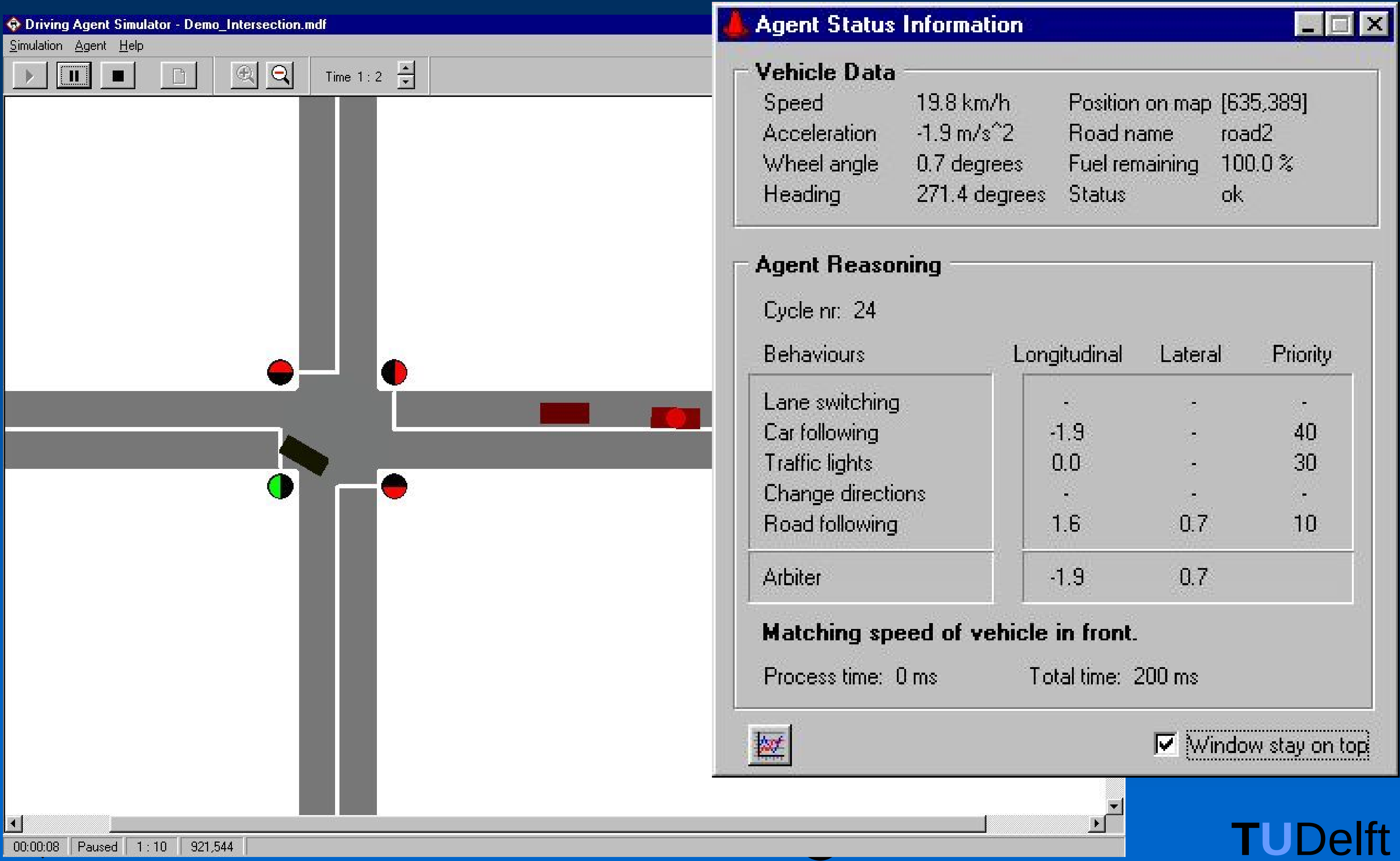
Implementation: rules

- Implemented and tested one-by-one

- Behaviour rules are directly coded into the program

example: **If** (agent speed < preferred speed)
then Accelerate (normal)

Implementation: example



Agent Status Information

Vehicle Data

Speed	19.8 km/h	Position on map	[635,389]
Acceleration	-1.9 m/s^2	Road name	road2
Wheel angle	0.7 degrees	Fuel remaining	100.0 %
Heading	271.4 degrees	Status	ok

Agent Reasoning

Cycle nr: 24

Behaviours	Longitudinal	Lateral	Priority
Lane switching	-	-	-
Car following	-1.9	-	40
Traffic lights	0.0	-	30
Change directions	-	-	-
Road following	1.6	0.7	10
Arbiter	-1.9	0.7	

Matching speed of vehicle in front.

Process time: 0 ms   Total time: 200 ms

☑ Window stay on top

Conclusions

- Designed driving agent can control vehicles
- Advantages agent-based simulation
  - increased realism
  - flexible
  - distributed processing possible
- Disadvantages
  - increase computational load
  - many parameters

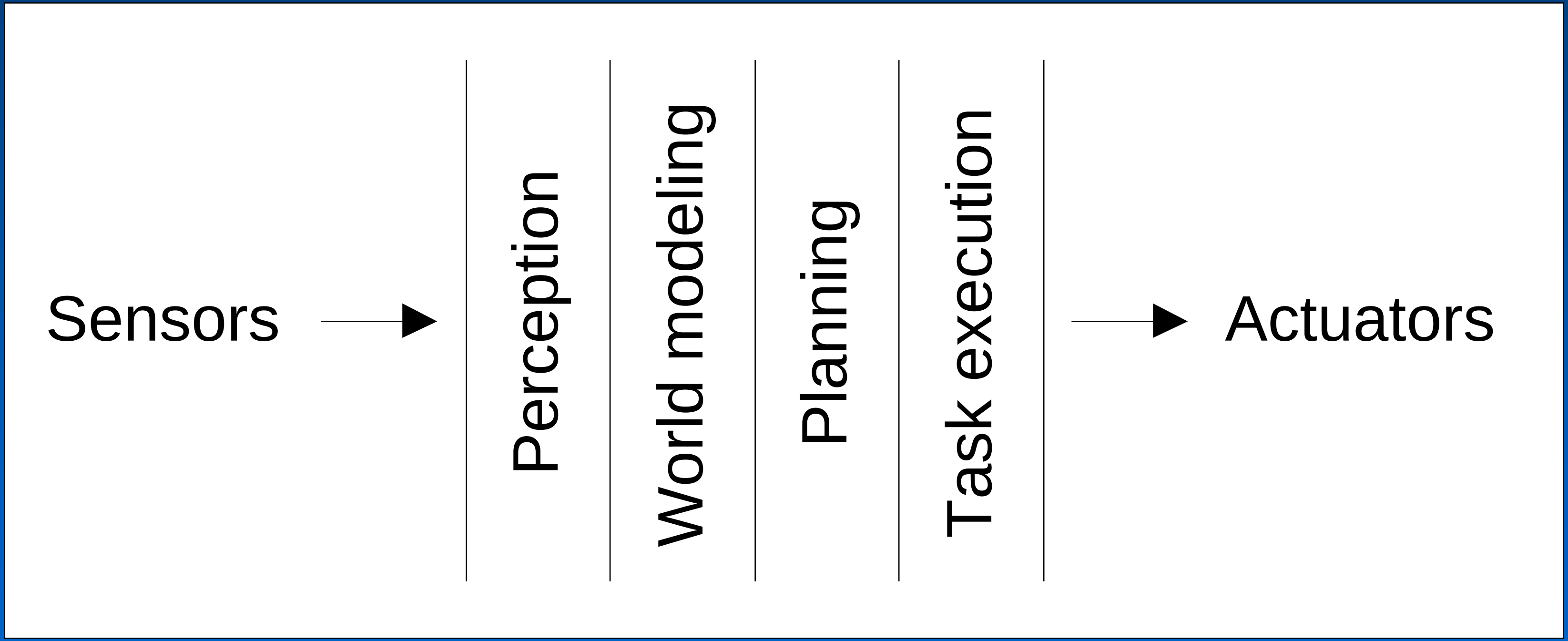
Recommendations / Future work

- Improve simulator and agent
- Use distributed approach
- Use agent to control real vehicles ?

Demonstration

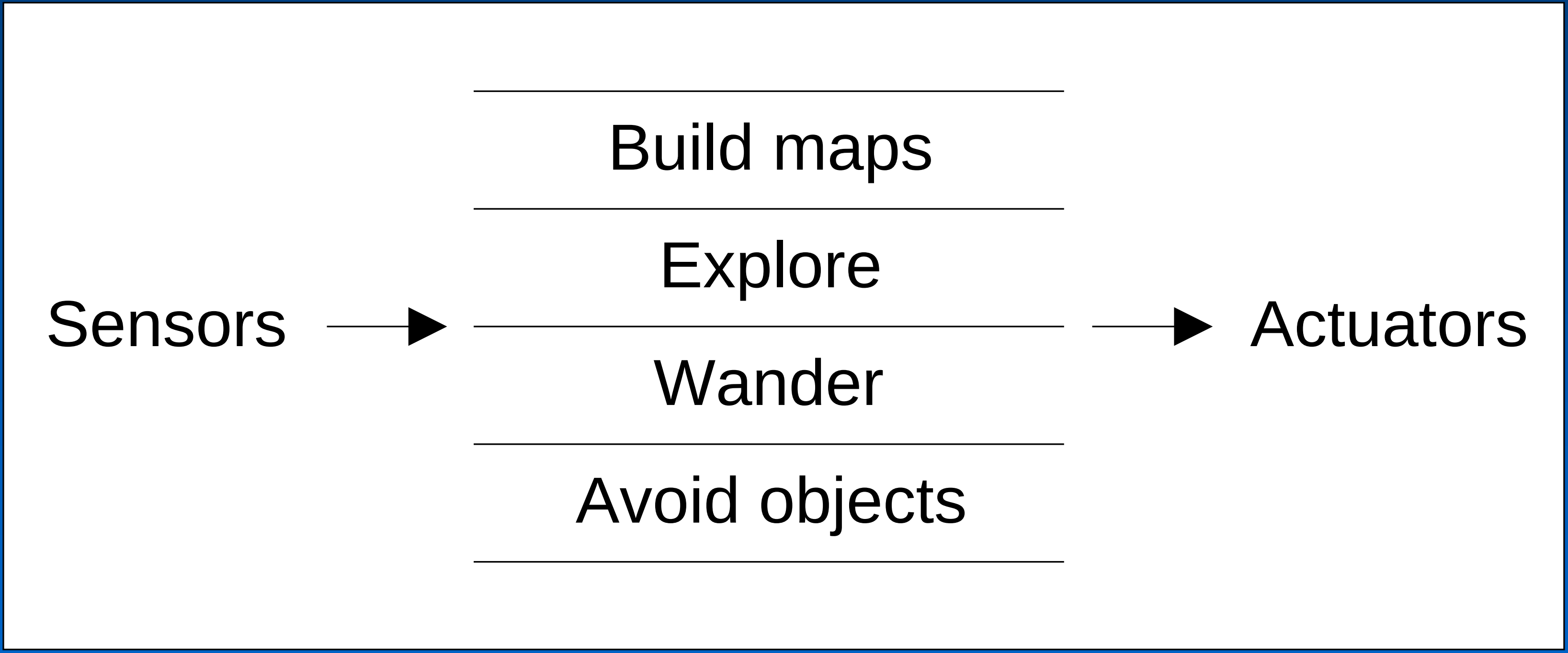
Theory: sense-plan-act

Traditional model, popular in 70's and 80's



Theory: subsumption

Rodney Brooks, MIT 1986



Build maps

Explore

Sensors

Actuators

Wander

Avoid objects

Design: behaviour rules

- Specialised and fast procedures that propose an action
- Any method may be used within constraints
- Use behavioural parameters
  - preferred speed
  - acceleration & deceleration rate
  - gap acceptance
  - reaction time
  - sensor range (visibility)

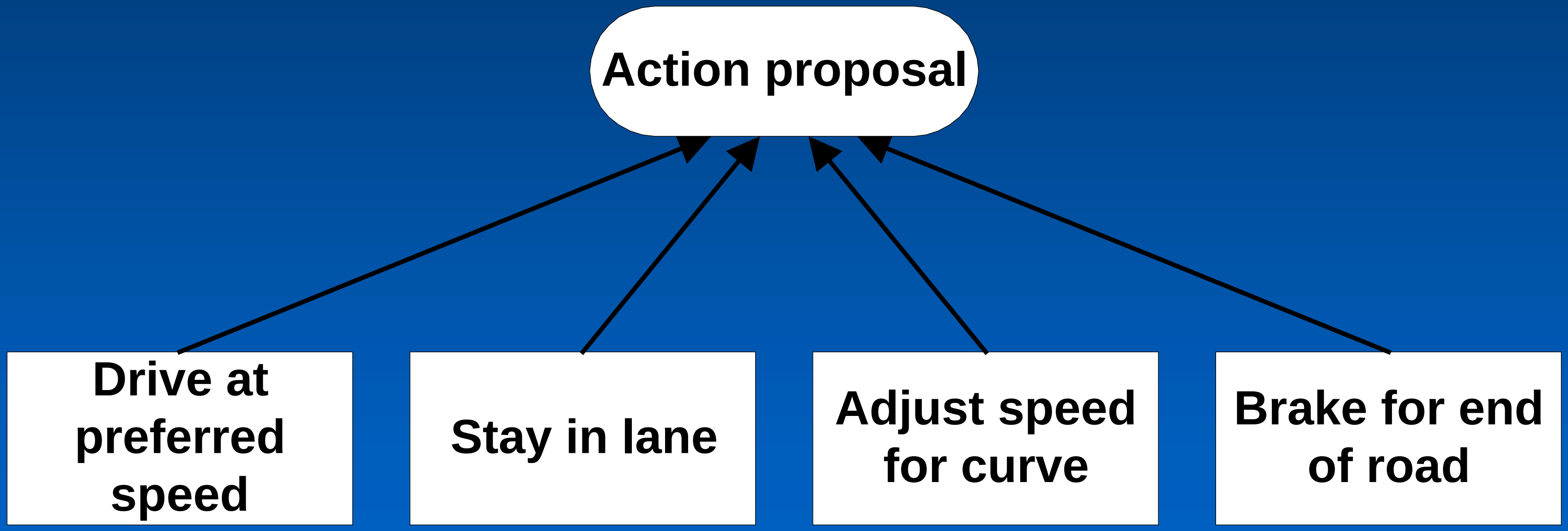
Implementation: agent

- Agent execution loop

    1. Get input from sensors
    2. Send input to memory
    3. Determine action proposals
    4. Arbiter selects best proposal
    5. Send proposal to vehicle
    6. Sleep until next loop

Implementation: rules (continued)

- Example Road Following



Action proposal

Drive at preferred speed

Stay in lane

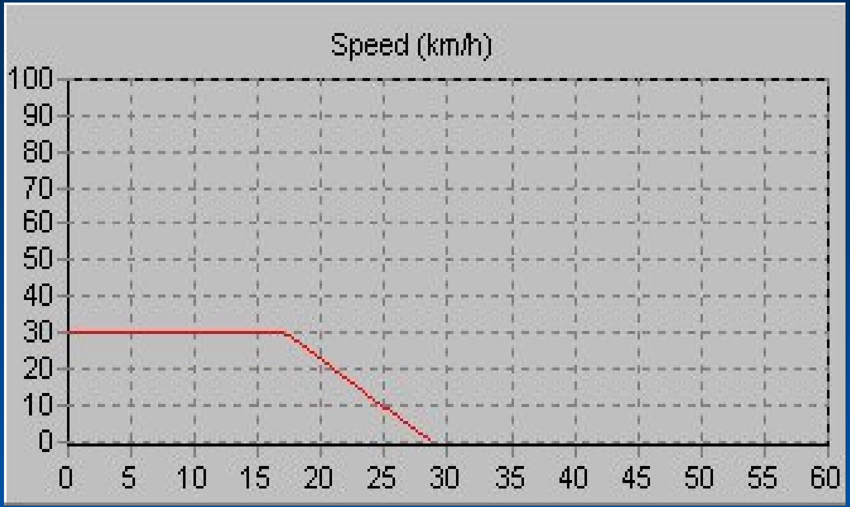
Adjust speed for curve

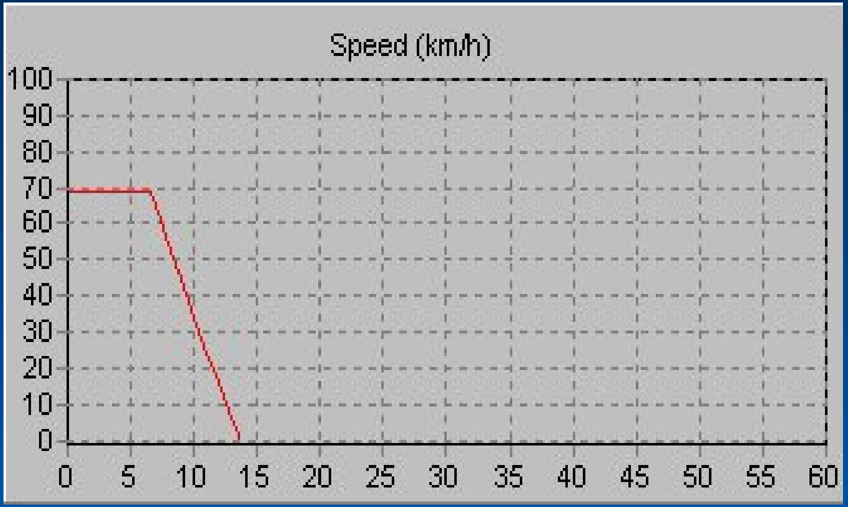
Brake for end of road

Example .MDF file

```
DESCRIPTION="Demo scenario - Intersection"
SCALE=40
MAPWIDTH=300
MAPHEIGHT=300
ROAD (road1, [000,100], [100,100], 350, 350,1,1)
ROAD (road2, [100,100], [300,100], 350, 350,1,1)
ROAD (road3, [100,100], [100,000], 350, 350,1,1)
ROAD (road4, [100,100], [100,300], 350, 350,1,1)
TRAFFICLIGHT (light1, [087,113], road1, 1, right)
TRAFFICLIGHT (light3, [113,087], road2, 1, left)
TRAFFICLIGHT (light4, [087,087], road3, 1, left)
TRAFFICLIGHT (light2, [113,113], road4, 1, left)
LIGHTCONTROLLER (lc1, 5000, light1, light2, light3, light4)
```

Experiments





- Low preferred speed
- Large gap acceptance
- Low deceleration rate

- High preferred speed
- Small gap acceptance
- High deceleration rate

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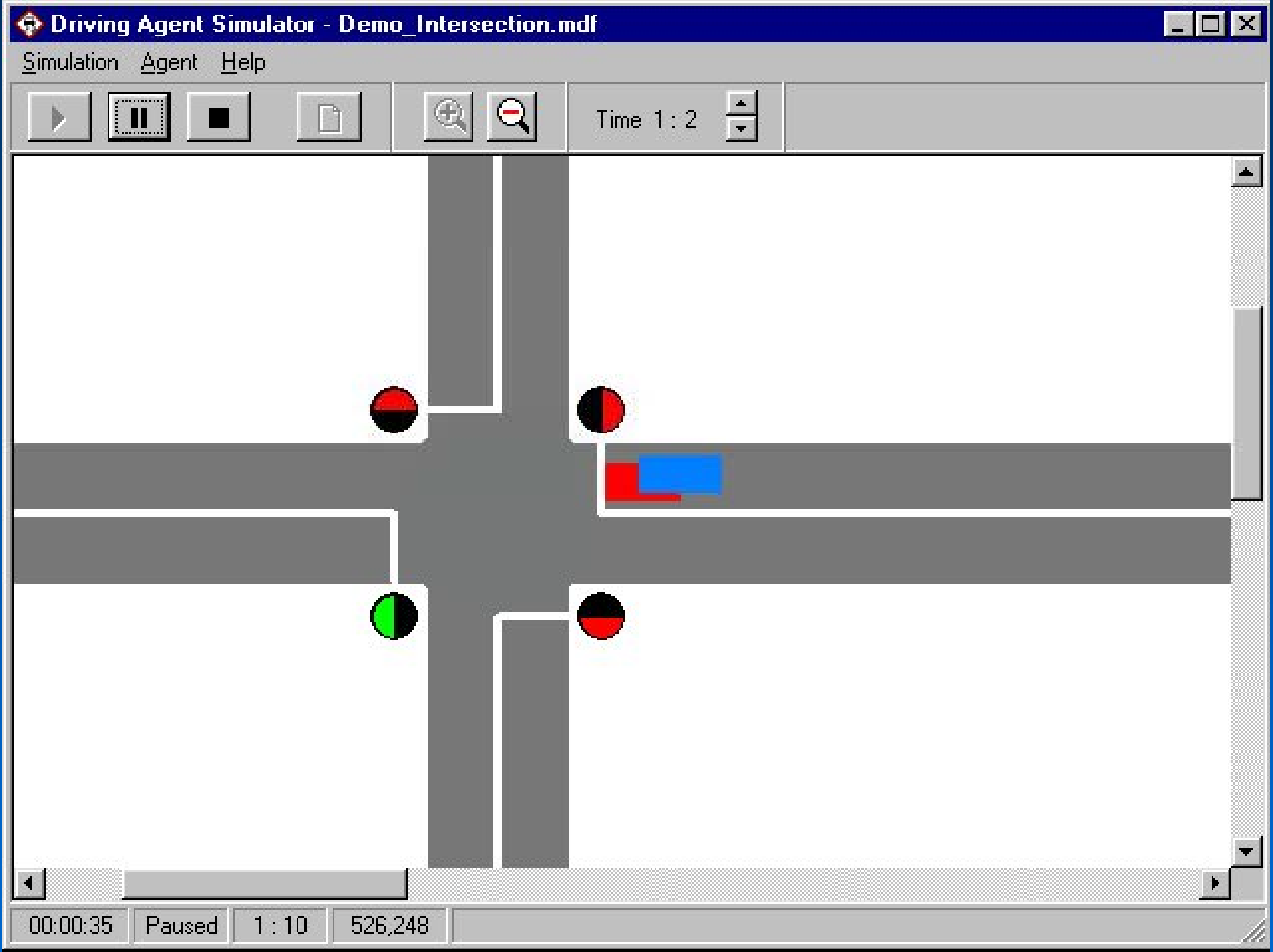
Experiments (continued)



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