AI51
Final Examination F2024

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The evaluation scale is given as an indication (± 1)

1 copy per part

Part 1 (12 points – N. Gaud)

Exercise 1 – AOSE applied to Real-Time Traffic Monitoring and Issue Resolution – EasyTraffic (8 points)

EasyTraffic is an online software application (SaaS) designed for real-time traffic monitoring, revolutionizes how cities manage traffic flow and address congestion. It uses live data collected from various sources like cameras, GPS, and sensors to monitor traffic conditions, detect anomalies, and predict potential issues. These intelligent systems analyze vast amounts of data to identify traffic patterns, congestion hotspots, and accidents. By processing this information in real-time, intelligent agents can make dynamic decisions, such as adjusting traffic signal timings or rerouting vehicles, ensuring smooth and efficient traffic management.

EasyTraffic features:

- **Real-Time Traffic Flow Optimization**: analyze real-time data to dynamically control traffic lights and reroute vehicles, reducing congestion, minimizing delays, enhancing fuel efficiency, and ensuring smoother traffic flow across urban networks.
- **Accident Detection and Response**: Computer vision algorithms monitor traffic camera feeds to detect accidents instantly, identify incident locations, and alert emergency services, enabling faster responses and reducing the impact of traffic disruptions.
- **Traffic Congestion Prediction**: Predictive analytics models use historical and real-time traffic data to forecast congestion, identify potential bottlenecks, and recommend preventive measures, such as rerouting or adjusting traffic signal timings.
- **Smart Parking Systems**: analyze parking availability in real-time, guiding drivers to vacant spots using mobile apps or in-car navigation, reducing unnecessary circling, and improving parking efficiency.
- **Public Transportation Optimization**: monitor demand and real-time conditions to adjust bus and train schedules dynamically, improving frequency, reducing overcrowding, and ensuring efficient and reliable public transportation services.

Modules: Data collection, Analysis, Issue resolution, Traffic Flow Optimization, Scalability.

Question 1 (5 points)
Using the CRIO language, describe the organizational model of a multiagent-based decentralized implementation of the EasyTraffic online application: please provide the different organizations, the roles that make them up and the associated capacities, external resources (e.g. DB, GUI, etc.) if necessary as well as potential links between these organizations (Stereotyped UML Class diagram).

Question 2 (3 points):
Describe an example of instanciation of this EasyTraffic online application presenting the different software agents required, the roles they play within the different groups instantiating the organizations proposed in the previous question (Cheeseboard diagram – Holarchy description). The consistency of your answer with the one you provided to the previous question is an important point.

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Exercise 2 – PEAS (4 points)

Provide the PEAS (Performance, Environment, Actuators, Sensors, Chapter 2 Russel & Norvig) description of the environment of *an autonomous robot for Subsea Oil and Gas Pipeline Inspection for detecting leaks and corrosion (mainly to inspect flange bolts)*, and propose possible architectures to design it.

Description of the operating context: With an increasing number of severe accidents in the global oil and gas industry caused by damaged pipelines, we are developing an autonomous robot to identify potential pipeline leaks and structural failures during subsea inspections. Oil and gas pipelines fail for a variety of reasons including equipment malfunctions, corrosion, weather and other natural causes, or vessel-related accidents which account for most large leaks. Toxic and corrosive fluids leaked from a damaged pipe can lead to devastating environmental pollution.

You must detail the different dimensions of the considered task environment in our analysis, and justify your agent architectures proposals that could be used to design the aforementioned agent.

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Part 2 (4 points – F. Gechter) – Reactive Multiagent Systems

A team of autonomous robots must perform a moving task by transporting items from a house to a truck located outside. Initially, all items are in the house. We want the robots' behaviors to be as simple as possible, functioning only with local perception and without direct communication between the robots.

Question 1 (2 points): Model the problem by defining the agents, the environment, the interactions, and any other elements necessary to solve the problem. Propose an initial solution inspired by what has been covered in class.

Question 2 (2 points): Is it possible to solve this problem using eco-solving? If yes, explain how it can be implemented in this case. Does this change the model proposed in question 1?

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Part 3 (4 points – S. Galland) – Agent-based Simulation.

Question 1 (1 points) :

In agent-based simulation, define the concepts of "environment" and "agent environment". Your definitions must highlight the relationship between these two concepts.

Question 2 (1 points) :

In a multiagent system designed for simulation with an agent environment, cite two different methods for enabling agents to exchanged information between them, whatever the type of information or application.

Question 3 (2 points) :

In the context of agent-based simulation, describe an hybrid method for synchronizing the agents in order to ensure that the agents are perceiving, deciding and acting at the same simulated time.