Site: **Your Learning Platform**

Module: **Intelligent Agents July 2025 A (IA_PCOM7E July 2025 A)**

Glossary: **Module Wiki**

A

Agent Communication Languages (ACLs)

Agent Communication Languages (ACLs) define formal structures for information exchange among intelligent agents. Two widely recognised standards are KQML (Knowledge Query and Manipulation Language) and KIF (Knowledge Interchange Format). These languages use performatives—such as *inform*, *request*, or *query*—to represent communicative intentions (Finin et al., 1994). ACLs ensure interoperability between heterogeneous systems by providing both syntactic and semantic frameworks for dialogue. The semantic grounding of these languages often relies on shared ontologies to reduce ambiguity. By enabling meaningful cooperation, ACLs form the backbone of distributed AI systems, particularly in multi-agent coordination and negotiation.

Reference: Finin, T. et al. (1994) 'KQML as an agent communication language', *CIKM*, 1, pp**. 456–463.**

AI Ethics and Explainability (XAI)

AI ethics concerns the responsible design, deployment, and governance of intelligent systems to ensure fairness, accountability, and transparency (Nasim, Ali and Kulsoom, 2022). As AI becomes increasingly integrated into decision-making, issues such as bias, data privacy, and explainability gain prominence. Explainable AI (XAI) seeks to make machine learning models interpretable, helping stakeholders understand the reasoning behind automated outcomes. Ethical AI frameworks promote trust, mitigate harm, and align technology with human values. Incorporating ethical principles into intelligent agent design ensures socially responsible innovation in domains like finance, healthcare, and industry.

Reference: Nasim, S.F., Ali, M.R. and Kulsoom, U. (2022) 'Artificial Intelligence Incidents & Ethics: A Narrative Review', *IJTIM*, 2(2), pp. 52–64.

Artificial Neural Networks (ANN)

Artificial Neural Networks (ANNs) are computational models inspired by biological neural systems. They consist of interconnected nodes (neurons) organised into input, hidden, and output layers (Aqab and Tariq, 2020). Each connection carries a weight that adjusts through training via backpropagation and gradient descent, allowing the network to learn patterns from data. ANNs are foundational to supervised learning and underpin applications like handwriting recognition, image classification, and predictive analytics. They form the basis of deep learning architectures such as CNNs and RNNs, enabling high-dimensional data processing and adaptive decision-making.

Reference: Aqab, S. and Tariq, M.U. (2020) 'Handwriting recognition using artificial intelligence neural network and image processing', *IJACSA*, 11(7).

Autonomy

Autonomy refers to an agent's ability to operate without continuous human control, making decisions based on its own internal models and objectives (Wooldridge, 2009). It is a defining characteristic of intelligent agents, enabling them to plan, act, and adapt in dynamic environments. In hybrid agent architectures, autonomy is balanced between reactive and deliberative layers to ensure both responsiveness and reasoning (Russell and Norvig, 2021). This feature supports the concept of *delegation in computing*, where tasks are assigned to agents capable of independent execution.

D

Delegation in Computing

Delegation refers to the act of assigning control or decision-making authority to computer systems, allowing them to carry out tasks—sometimes critical—on our behalf.

Example: Autopilot systems in aircraft often override human input in safety-critical sc**enarios.**

G

Global Computing

Global Computing refers to extremely large-scale computing systems composed of thousands (or millions) of interconnected processors. These systems present challenges in software scalability, coordination, and resource management.

Key Insight: This concept arises from combining trends like ubiquity, interconnection, and delegation**.**

H

Human-Orientation

Human-orientation is the trend toward designing systems and interfaces that align with natural human behaviour, rather than expecting users to adapt to machines.

Example: The shift from command-line interfaces to touchscreens and voice assistants**.**

Hybrid Architecture

Hybrid agent architectures integrate *reactive* and *deliberative* models to combine the strengths of both (Wooldridge, 2009). The reactive layer handles immediate responses to environmental stimuli, while the deliberative layer supports higher-level planning and goal management. This integration enables agents to balance flexibility with long-term reasoning (Müller, 1997). Hybrid approaches are particularly useful in complex and dynamic domains such as autonomous vehicles and robotics, where agents must act quickly while considering strategic objectives (Ferguson, 1992).

I

Industry 4.0 and Smart Manufacturing

Industry 4.0 refers to the ongoing digital transformation of manufacturing through the integration of intelligent, connected systems (Wang et al., 2016). It incorporates cyber-physical systems, Internet of Things (IoT), data analytics, and multi-agent systems to create smart factories. Within these environments, autonomous agents monitor, coordinate, and optimise production processes in real time. Digital twins simulate physical systems for predictive maintenance and performance optimisation. By enabling adaptive and self-organising manufacturing, Industry 4.0 improves efficiency, sustainability, and flexibility across supply chains.

Reference: Wang, S. et al. (2016) ‘Towards smart factory for Industry 4.0’, *Computer Networks*, 101, pp. 158–168.

Intelligent Agent

An intelligent agent is an autonomous entity capable of perceiving its environment, reasoning about its state, and acting upon it to achieve specific goals (Wooldridge, 2009). Agents exhibit four fundamental properties: autonomy (operating without direct intervention), reactivity (responding to environmental changes), proactivity (initiating goal-directed behaviour), and social ability (interacting with other agents). Intelligent agents are foundational to artificial intelligence, enabling adaptive and goal-oriented behaviours across domains such as robotics, finance, and smart manufacturing. Their design incorporates sensory input, internal models, and actuators to transform decisions into actions. Modern implementations often combine symbolic reasoning with machine learning to create hybrid systems that can both plan strategically and adapt in real time. These agents form the building blocks of larger distributed systems known as Multi-Agent Systems (MAS).

Reference: Wooldridge, M.J. (2009) *An Introduction to Multiagent Systems.* 2nd edn. Wiley.