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BCA Honours | Semester III | Calicut University

Foundations of Artificial Intelligence

Course Code: BCA3CJ204 • Module 3 Notes

MODULE III: KNOWLEDGE REPRESENTATION AND LOGIC AGENTS

1. Propositional Logic Agents and Resolution Refutation

Knowledge-based agents deduce new knowledge using the resolution principle on Conjunctive Normal Form (CNF) clauses.

2. Illustrative Computational Working: Step-by-Step Numerical Example

Worked Example: Resolution Refutation Proof in Propositional Logic

Problem Statement:

Given Knowledge Base: (1) $PlorQ$, (2) $ eg P lor R, (3) eg Q.$Prove$R$ using Resolution Refutation.

Solution & Step-by-Step Working:

1. Negate the theorem to prove: Add $ eg R$ to the clause set.
2. Clause set: ${P lor Q, \quad eg P lor R, \quad eg Q, \quad eg R}$.
3. Resolve $(PlorQ)$ and $(eg Q)$→ $Resolvent :< strong >$P$.
4. Resolve P and $(eg P lor R)$→ $Resolvent :< strong >$R$.
5. Resolve R and $(eg R)$→ $Resolvent :< strong >$square$ (Empty Clause / Contradiction).

Conclusion: Derivation of the empty clause proves that R is logically entailed.

Advanced Architectural Extensions & Industrial Systems Synthesis

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1. Contemporary Engineering Dilemmas and Architectural Solutions

Engineering teams designing systems centered around Foundations of Artificial Intelligence must systematically navigate fundamental computational trade-offs:

- **Time Complexity Optimization versus Space Consumption:** In high-throughput algorithmic pipelines related to Logical Reasoning and Resolution, pre-computing intermediate lookup tables (memoization, spatial indices, hash tables) achieves near-instantaneous $O(1)$ query latency, but inflates physical memory footprints. Conversely, in-place algorithms minimize RAM utilization at the expense of higher cycle counts. Modern architectures dynamically calibrate memory allocations using memory-mapped I/O and cache-aware data layouts.
- **Concurrency Scalability versus Thread Contention:** While multi-core architectures allow massive horizontal execution, concurrent modifications to shared state structures create severe lock contention, thread synchronization bottlenecks, and cache line invalidation storms. High-performance frameworks

deploy lock-free algorithms, optimistic concurrency control, and atomic compare-and-swap (CAS) primitives.

- **Algorithmic Determinism versus Real-World Heuristic Scalability:** Exact mathematical algorithms frequently encounter NP-hard combinatorial explosions as problem dimensions scale. Contemporary industrial systems bridge this gap by deploying bounded approximation algorithms and meta-heuristics that produce near-optimal solutions within guaranteed execution time windows.

2. Empirical Comparative Framework

A structured comparative assessment clarifies operational distinctions across conventional and modern paradigms in Foundations of Artificial Intelligence:

Evaluation Dimension	Conventional Traditional Approach	Contemporary Integrated Paradigm	Strategic Impact Metric
Architecture Paradigm	Monolithic single-threaded architectures with tightly coupled state.	Distributed microservices with asynchronous event queues and thread-safe data structures.	Linear scalability and resilient fault isolation under peak transactional loads.
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System Telemetry & Auditing	Static text logging with periodic post-incident analysis.	Distributed tracing (OpenTelemetry), structured JSON metrics, and automated root-cause diagnostics.	Mean Time to Detection (MTTD) and Recovery (MTTR) reduced from hours to seconds.

3. Step-by-Step Implementation and Operational Governance Roadmap

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Industrial Risk Governance, Statutory Compliance & Failure Mode Analysis

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