#### Introduction

- Resolution is a powerful and efficient inference rule used in many AI systems. It's a
  core technique for automated reasoning and logic-based AI.
- Refutation is a proof technique where we prove a statement by demonstrating that its negation leads to a contradiction. This is the core idea behind how resolution is used.

### The Resolution Rule

- The resolution rule is a single inference rule that can be used to derive all entailed sentences from a knowledge base. It's a complete inference procedure when coupled with a complete search algorithm.
- It operates on clauses, which are disjunctions of literals.
- Two clauses can be resolved if they contain complementary literals (one literal unifies with the negation of the other).
- The resolvent is a new clause containing all the literals of the two original clauses except the two complementary literals.

### Refutation with Resolution

- We use the resolution rule to prove a sentence  $\alpha$  by showing that its negation  $\neg \alpha$  leads to a contradiction. This is called proof by refutation or proof by contradiction.
- Steps:
  - 1. Negate the sentence  $\alpha$  to be proved.
  - 2. Add the negated sentence to the knowledge base.
  - 3. Convert the knowledge base to conjunctive normal form (CNF).
  - 4. Repeatedly apply the resolution rule to the clauses in the knowledge base.

5. If a contradiction (the empty clause) is derived, then the original sentence  $\alpha$  is proven.

# Example

- Consider the knowledge base:
  - A ⇒ B
  - B ⇒ C
  - A
- We want to prove C.
- Steps:
  - 1. Negate the goal: ¬C
  - 2. Convert to CNF: ¬A v B, ¬B v C, A, ¬C
  - 3. Apply resolution:
    - Resolve ¬A v B and A to get B
    - Resolve ¬B v C and B to get C
    - Resolve C and ¬C to get the empty clause (contradiction)
- Therefore, C is proven.

## **Efficiency Considerations**

- Resolution can be computationally expensive due to the many possible ways to apply the rule.
- Several strategies can improve efficiency:
  - Unit resolution: Prefer resolutions involving unit clauses (clauses with one literal).
  - Set of support: Restrict resolution to clauses derived from the negated goal.

• Subsumption: Eliminate redundant clauses.

### Conclusion

- Resolution is a fundamental inference method in Al.
- It's used in various applications, including theorem proving, question-answering systems, and logic programming.
- Understanding resolution is crucial for anyone interested in the foundations of Al and automated reasoning.

#### References:

- Russell, S., and Norvig, P. Artificial Intelligence: A Modern Approach, 4th Edition, 2020,
   Pearson.
- Rich, E., Knight, K., & Nair, S. B. Artificial Intelligence. McGraw-Hill International.
- Nilsson, N. J. Artificial Intelligence: A New Synthesis. Morgan Kaufmann.

Note: This content was generated with the assistance of Google's Gemini Al.

## Related posts:

- 1. Artificial Intelligence Intelligence Tutorial for Beginners
- 2. Difference between Supervised vs Unsupervised vs Reinforcement learning
- 3. What is training data in Machine learning
- 4. What other technologies do I need to master AI?
- 5. How Artificial Intelligence (AI) Impacts Your Daily Life?
- 6. Like machine learning, what are other approaches in Al?
- 7. Best First Search in Al

- 8. Heuristic Search Algorithm
- 9. Hill Climbing in Al
- 10. A\* and AO\* Search Algorithm
- 11. Knowledge Representation in Al
- 12. Propositional Logic and Predicate Logic
- 13. Deduction, theorem proving and inferencing in Al
- 14. Monotonic and non-monotonic reasoning in Al
- 15. Probabilistic reasoning in Al
- 16. Bayes' Theorem
- 17. Artificial Intelligence Short exam Notes
- 18. Transformer Architecture in LLM
- 19. Input Embedding in Transformers
- 20. Positional Encoding in Transformers
- 21. Multi-Head Attention in Transformers