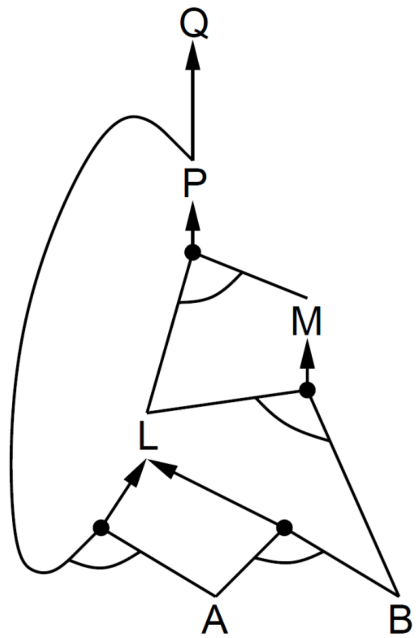
Artificial Intelligence - Logic Test Practice Questions

Example problems for Chapters 7-9.

1. Run forward chaining on the following Knowledge Base:

$$P \Rightarrow Q$$
$$L \wedge M \Rightarrow P$$
$$B \wedge L \Rightarrow M$$
$$A \wedge P \Rightarrow L$$
$$A \wedge B \Rightarrow L$$
$$A$$
$$B$$



Use the following algorithm:

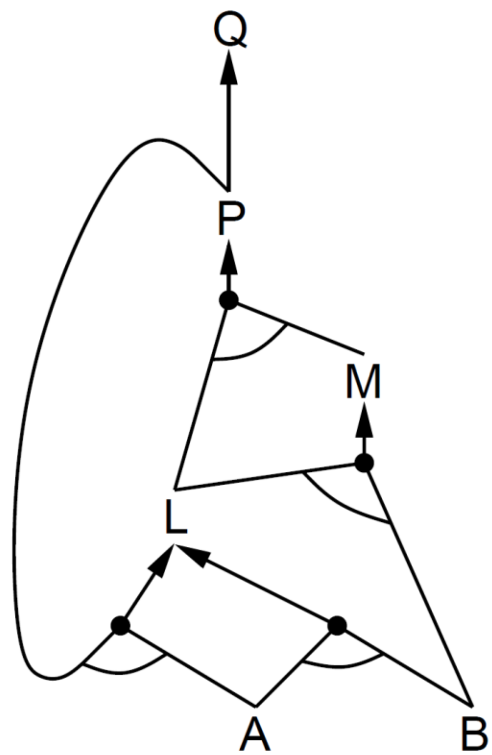
```
function PL-FC-ENTAILS?(KB, q) returns true or false
   inputs: KB, the knowledge base, a set of propositional Horn clauses
           q, the query, a proposition symbol
  local variables: count, a table, indexed by clause, initially the number of premises
                   inferred, a table, indexed by symbol, each entry initially false
                   agenda, a list of symbols, initially the symbols known in KB

   while agenda is not empty do
       p ← POP(agenda)
       unless inferred[p] do
           inferred[p] ← true
           for each Horn clause c in whose premise p appears do
               decrement count[c]
               if count[c] = 0 then do
                   if HEAD[c] = q then return true
                   PUSH(HEAD[c], agenda)
   return false
```

Content sourced from Dr. Debasis Mitra, Artificial Intelligence: A Modern Approach by Russell & Norvig, Dr. Marius Silaghi, and Wikipedia.

2. Run backward chaining on the following Knowledge Base:

$$P \Rightarrow Q$$
$$L \wedge M \Rightarrow P$$
$$B \wedge L \Rightarrow M$$
$$A \wedge P \Rightarrow L$$
$$A \wedge B \Rightarrow L$$
$$A$$
$$B$$



3. Convert the following KB to CNF:

$B_{1,1} \Leftrightarrow (P_{1,2} \vee P_{2,1}) \wedge \neg B_{1,1}$

4. Run the resolution algorithm with the given KB:

$$(\neg P_{2,1} \vee B_{1,1}) \wedge (\neg B_{1,1} \vee P_{1,2} \vee P_{2,1}) \wedge (\neg P_{1,2} \vee B_{1,1}) \wedge (\neg B_{1,1})$$

and

$$\alpha = \neg P_{1,2}$$

Use the following algorithm:

Proof by contradiction, i.e., show $KB \wedge \neg\alpha$ unsatisfiable

```
function PL-RESOLUTION(KB, α) returns true or false
    inputs: KB, the knowledge base, a sentence in propositional logic
            α, the query, a sentence in propositional logic

    clauses ← the set of clauses in the CNF representation of KB ∧ ¬α
    new ← { }
    loop do
        for each C_i, C_j in clauses do
            resolvents ← PL-RESOLVE(C_i, C_j)
            if resolvents contains the empty clause then return true
            new ← new ∪ resolvents
        if new ⊆ clauses then return false
        clauses ← clauses ∪ new
```

5. Run DPLL on the following clause:

$$(A \lor B \lor \neg C) \land (A \lor \neg B \lor C) \land (\neg A \lor B) \land (\neg A \lor \neg B) \land C$$

Use the following algorithm:

```
Algorithm DPLL
    Input: A set of clauses Φ.
    Output: A truth value indicating whether Φ is satisfiable.
```

```
function DPLL(Φ)
    // unit propagation:
    while there is a unit clause {l} in Φ do
        Φ ← unit-propagate(l, Φ);
    // pure literal elimination:
    while there is a literal l that occurs pure in Φ do
        Φ ← pure-literal-assign(l, Φ);
    // stopping conditions:
    if Φ is empty then
        return true;
    if Φ contains an empty clause then
        return false;
    // DPLL procedure:
    l ← choose-literal(Φ);
    return DPLL(Φ ∧ {l}) or DPLL(Φ ∧ {¬l});
```

- "←" denotes assignment. For instance, "*largest* ← *item*" means that the value of *largest* changes to the value of *item*.
- "**return**" terminates the algorithm and outputs the following value.

6. Convert the following sentence to CNF:

$$\forall x\ [\forall y\ Animal(y)\ \Rightarrow Loves(x, y)]\ \Rightarrow [\exists y\ Loves(y, x)]$$

See chapter09.pdf slides 24-39 & slides 43-46 for forward chaining, backward chaining, and resolution in FOL.

Content sourced from Dr. Debasis Mitra, Artificial Intelligence: A Modern Approach by Russell & Norvig, Dr. Marius Silaghi, and Wikipedia.