

ARTIFICIAL INTELLIGENCE

Project-Report

Rakesh Kumar Mahato
RKM190000

Design:

This project is focused on building a Knowledge Base for a supermarket system. The knowledge base is designed in Prover9. This is done in 3 steps:

1. Creating a Knowledge Base by capturing general information about the functioning of a supermarket. This data is captured in plain English.
2. The Knowledge Base is converted to First Order Logic to be implemented in Prover9.
3. The First Order Logic form is implemented in Prover9 to answer questions based on the exercise problems given in problems 12.5 and 12.6.

Designing a Knowledge base for a supermarket is very broad. So, I took examples in class and approached by making a knowledge base based on the questions from problem 12.5 and 12.6. I kept adding data as required to prove our goals one by one.

Knowledge Base:

- Supermarket is a place which owns different items to sell to customers.
- A customer is a person.
- A person can come and purchase items from a supermarket.
- Safeway is one of the supermarkets.
- Safeway is located in North Berkeley.
- There are different kinds of items in a supermarket.
- The items can be food items or personal care items.
- A supermarket can own items either by producing in-house or by purchasing from outside market and dealers.
- Items in Safeway are owned by Safeway Corporation.
- A person can be a child or an adult.
- If a person is not a child, he is adult.
- If a person is a child is not an adult.
- A child can carry maximum 1 quantity of items.
- An adult can carry maximum 5 quantity of items.
- If a person can carry max quantity 1, he cannot carry 2 quantities and can carry 1 quantity.
- If a person can carry max quantity 2, he cannot carry 3 quantities and can carry 2 quantity.
- If a person can carry max quantity 3, he cannot carry 4 quantities and can carry 3 quantity.
- If a person can carry max quantity 4, he cannot carry 5 quantities and can carry 4 quantity.
- If a person can carry max quantity 5, he cannot carry 6 quantities and can carry 5 quantity.
- If a person can carry 6 quantity he can carry 5 quantity.
- If a person can carry 5 quantity he can carry 4 quantity.
- If a person can carry 4 quantity he can carry 3 quantity.
- If a person can carry 3 quantity he can carry 2 quantity.
- If a person can carry 2 quantity he can carry 1 quantity.

- If a person cannot carry 1 quantity he cannot carry 2 quantity.
- If a person cannot carry 2 quantity he cannot carry 3 quantity.
- If a person cannot carry 3 quantity he cannot carry 4 quantity.
- If a person cannot carry 4 quantity he cannot carry 5 quantity.
- If a person cannot carry 5 quantity he cannot carry 6 quantity.
- If a person can carry a quantity, he can carry all quantities less than that.
- If a person cannot carry a quantity, he cannot carry quantity more than that.
- If a person purchases an item, he can carry it.
- If a person purchases an item of some quantity, he has at least that much quantity of the item .
- If a person has at least some quantity of item he has at least a quantity less than that.
- Safeway has at least 20 tomatoes.
- John purchases two quantity of tomatoes.
- Tomato is a veggie.
- John is a person.
- Mary is a person.
- Mary purchases four quantity of tomatoes.
- Meat is a food item.
- Veggie is a food item.
- All food items are items.
- Mary was purchasing at the same time as John.
- If two person are at the same time and buy the same item from Safeway then they see each other.
- Safeway purchases 30 tomato from outside market.
- Safeway purchases 20 deodorant from a dealer.
- Safeway purchases 15 chicken from outside market.
- Safeway purchases 15 ground beef outside market.
- Safeway makes 10 pizza in house.
- Safeway makes 10 cake in house.
- If Safeway makes items in house, then it owns the item and the items are made in the supermarket.
- If supermarket purchases items from outside, then it is not made in house.
- If John buys a food item, he will eat it.
- All items that are owned by a supermarket is sold by the supermarket.
- If a person buys an item he brings either money or a credit card to purchase.
- John has money m1.
- M1 is money.
- CC is credit card.
- If a person has money and purchases an item, he has less money than the previous amount.
- Z is a staff member.
- John shops from Safeway.
- Staff is a person.
- Person B is other people to person A if A is not equal to B.
- For a purchase to happen there are always staff members to facilitate the transaction.
- John buys one quantity of ground beef.

- Ground beef is a type of beef.
- Beef is a type of meat.
- If a person eats meat, he is not vegetarian.
- Items in Safeway are owned by Safeway Corporation.
- Place in the neighborhood is called next door.
- John fills gas in the Shell station.
- Shell station is in the neighborhood of Safeway.
- If a person fills gas from a gas station the gas station has gas.
- Shell station is a gas station.
- if a person buys an item it fits in his car trunk.
- Chicken is a type of meat.
- Pizza is a food item.
- Cake is a food item.
- Similar categories of items are kept in same area.
- For purchase, cash money or credit card is needed.
- John and Mary are customers.
- Safeway makes 20 quantity of bread.
- Safeway makes 10 quantity of muffin.
- Bread is a food item.
- Muffin is a food item.
- If a person has at least 6 quantity, he has at least 5 quantity.
- If a person has at least 5 quantity, he has at least 4 quantity.
- If a person has at least 4 quantity, he has at least 3 quantity.
- If a person has at least 3 quantity, he has at least 2 quantity.
- If a person has at least 2 quantity, he has at least 1 quantity.
- If a person brings a car to supermarket, he parks in the parking lot.
- Supermarket has different aisles to keep different items.
- Safeway keeps cooking items.
- Safeway keeps fruits.
- Perishable items need to be kept in refrigerator.
- Edible items are kept in food section.
- Bulbs and batteries are kept in electronics section.
- If there are many customers, there is a queue.
- If the item quantities are more than 5, need to get a trolley.

Examples of First Order Logic used:

- $\text{all } x \text{ all } y \text{ all } q (\text{MadeInhouse}(x, y, q) \ \& \ \text{SuperMarket}(x) \rightarrow \text{Owns}(x, y, q) \ \& \ \text{MadeIn}(x, y)) .$
- $\text{all } x \text{ all } y \text{ all } q (\text{SuperMarket}(x) \ \& \ \text{Item}(y) \ \& \ \text{Owns}(x, y, q) \rightarrow \text{Sells}(x, y)) .$
- $\text{all } x \text{ all } y \text{ all } q (\text{Purchase}(x, y, q) \ \& \ \text{Item}(y) \rightarrow \text{CanCarry}(x, q)) .$
- $\text{all } x \text{ all } y \text{ all } z (\text{SameTime}(x, y) \ \& \ \text{Buys}(x, z) \ \& \ \text{Buys}(y, z) \rightarrow \text{Sees}(x, y) \ \& \ \text{Sees}(y, x)) .$
- $\text{all } x \text{ all } y \text{ all } q ((\text{Purchase}(x, y, q)) \ \& \ \text{Item}(y) \rightarrow \text{Buys}(x, y) \ \& \ \text{Has}(x, y) \ \& \ \text{Quantity}(x, y, q)) .$
- $\text{all } x \text{ all } y \text{ all } q (\text{Purchase}(x, y, q) \ \& \ \text{FoodItem}(y) \rightarrow \text{Eats}(x, y)) .$
- $\text{all } x \text{ all } y \text{ all } q (\text{Purchase}(x, y, q) \ \& \ \text{HasMoney}(x, m1) \ \& \ \text{Money}(m1) \rightarrow \text{HasMoney}(x, m2) \ \& \ \text{Money}(m2) \ \& \ \text{LessThan}(m2, m1)) .$
- $\text{all } x \text{ all } y (\text{BringsCarToSupermarket}(x, y) \rightarrow \text{ParksInParkingLot}(x, y)) .$
- $\text{all } x \text{ all } y \text{ all } q (\text{Owns}(x, y, q) \ \& \ \text{SuperMarket}(\text{Safeway}) \rightarrow \text{owns}(\text{SafewayCorporation}, y)) .$
- $\text{all } x (\text{Child}(x) \rightarrow \text{CanCarryMaxQty}(x, 1)) .$
- $\text{all } x (\text{Child}(x) \leftrightarrow \neg \text{Adult}(x)) .$
- $\text{all } x (\neg \text{Child}(x) \leftrightarrow \text{Adult}(x)) .$
- $\text{all } x \text{ all } y \text{ all } q (\text{Purchase}(x, y, q) \ \& \ \text{Item}(y) \rightarrow \text{CanCarry}(x, q)) .$

Conclusion:

- With the knowledge base created we could Prover9, could resolve the “goals” in problem set 12.5 and 12.6.
- It was difficult to add arithmetic operators. So, I included multiple statements to accommodate few relations. Example. AtLeast, CanCarryMaxQty, etc.

References

1. Prover9 Manual and Examples
 - <https://www.cs.unm.edu/~mccune/mace4/manual-examples.html>
2. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach. 3rd Edition, Prentice Hall Press, 2009.
3. Christiane Fellbaum. WordNet: An Electronic Lexical Database. Bradford Books, 1998.
4. Kurt Bollacker, Colin Evans, Praveen Paritosh, Tim Sturge, and Jamie Taylor. Freebase: a collaboratively created graph database for structuring human knowledge. In Proceedings of the 2008 ACM SIGMOD international conference on Management of data, pages 1247–1250, 2008.