A Study of First Order Logic's Real Time Applications

Arthi C.I[1], Pawan Ahuja[2], Mohit Lalwani[3], Nitin Motwani[4], Neeraj Nagpal[5]
Assistant Professor and Students from Computer Department and Mumbai University
Vivekanand Education Society's Institute of Technology Chembur, Mumbai, India

Abstract – *Various studies have been done on using first order logic (FOL) is first of its kind. First Order Logic is a type of predicate logic which has a huge collection of many formal systems which are used today in philosophy, mathematics, linguistics, and in computer science. FOL is considered as a symbol of reasoning in which the given statements can be broken in to a subject and a predicate for that particular statement. It investigates the reasoning models in medicine diagnostic anatomical and the third one being causal reasoning. It is also used in policy reasoning, the first order logic represents or supports clear syntax and semantic. Its application also includes representation of clinical practice and to mitigate adverse interactions.*

Keywords – *First Order Logic*

I. INTRODUCTION

First Order Logic better known as first order predicate calculus is a mathematical model discovered by GottlobFrege and Charles Sandres Pierce. It uses variables in quantified form over the non- logical objects and then we may use these sentences that contain the variables rather than using propositions. Such as Kunal is a man we can have it in the expression form "there exists Q such that Q is Kunal and Q is a man" and there exists a quantifier While Q being a variable. This discerns it from the proposition logic which never uses the quantifiers and the relations. Thus in this study of predicting diseases FOL can be considered as the heart of the system and can provide an efficiency rate or percentage which is higher than that of other techniques.There are many systems for first order logic which are resonant and comprehensive, but the logical outcome of it is recursively enumerable, as much of the progress can be done in the automation system. Many techniques are used to uncover the patterns from the data provided to it for detection of the diseases and efficiency of those is not as efficient as FOL.

The language of FOL basically or mainly relies on the logical as well as non logical symbols. Now thinking about what is logical and non logical, then they are defined as the logical symbol are considered to the ones having a fixed meaning in the language whereas the non logical symbols are which are dependent on applications or application dependent. FOL has or supports two syntactic expressions the first being terms (such as constant, functions etc.). And the second one being formulas (predicates, connectivities etc.). And these together are known as sentences. FOL is also considered as collection of these sentences. It is also considered as the language which states the relationships between classes of the object and the individual objects in which each of them is expressed using predicate symbols. This logic has taken a firm position in knowledge representation of sentences. Also this logic is sufficient in expressing the objectives that we set. The first order logic includes constants, predicate symbols, quantifications and function symbols. It also depicts relational model and valuations which include satisfiability notations which help in validating formulas for first order logic.

FOL is considered and used as an significant improver of expressiveness by introducing the predicates which represent relationships and properties in their respective domains. Let us consider another example here A statement which states "P is greater than Q" can or is represented as GREATER(P,Q) it can be defined as Greater(P,Q) = T, if P>Q or =F, otherwise. The first order calculus logic can become first order logic if rules of inference can be added to it. It also supports interpretation logic which is simply an undertaking of truth values to atoms. Interpretation of a formula in FOL includes
- Furnished Domain D
-and allocation of values to each and every constant.
Interpretation in FOL is denoted by I.

According to Martin Michalowski [1] A FOL theory D will be only consistent if there will exist at least one model to work upon also this can be proved by automatic reasoning theorem that will construct a proof for the domain D, but this theorem gives the answers only in binary format. Using FOL in a framework requires four key components first is the vocabulary that will be used to construct FOL theory, second one being a mitigation theory third key is the operators that help in encoding the knowledge which will be needed for identification of address adverse interactions and the fourth one is the mitigation algorithm that will control the applications for the operators. As described by

joseph halpern [2] sorted first order logics can be used with equality on the vocabulary which will express and reason.
Also assuming that the reader here will be familiar with the syntaxes that the first order logic uses including the constants and the predicates. Vocabulary here is considered as different application. According to Peter Lucas [3] in first order logic syntactically each relation can be expressed using predicate symbols and the dependencies in this model is expressed by means of the function models that have terms which can define the objects and the related references .

II. FIRST ORDER LOGIC LANGUAGE

In this Section we are going to describe the Syntax and Semantics of First-Order Predicate Logic.

A. SYNTAX AND SEMANTICS

First Order Logic is basically used to convey knowledge regarding the relation between the Individual Objects and Classes of Object. Syntactically, each relation is expressed by a Predicate Symbol say P, and Objects which are in relation are expressed by the terms ti, which acts as arguments to a predicate symbol thus yielding the atomic formulas or in short we can say atoms, of the form P (t1, t2... tn). A term either denotes a constant or a variables (called as class of Objects). This was all about Syntax.
If we Assign a meaning to a formula in First-Order logic, then its constitutes symbols in a mathematical structures of relations *S.* Now the interpretation of a formula is initiated by determining which of the atoms in formula are true and
which are false in the Structure *S.* Also the truth values obtained are combined by meanings of Logical Connectives. We are mostly interested in formulas in which every variable is bounded by a quantifier. If a sentence is TRUE in the structure *S,* then it is denoted by |=*S.*

B. LOGICAL NOTATIONS

FOL has three new and basic notations in comparison with the propositional logic they are as follows terms, predicates and quantifiers (can be universal or existential).

A. Term- it is nothing but the constant or a variable that represents different individuals.

B. Predicate- it maps the terms to output the result as either true or false.

C. Quantifiers- It uses the variables in terms of conjunction with the quantifier's viz. "For all" and "there exist".

Examples - "jay loves everyone" can be represented as, ∀(x) Love (jay, x).

C. WELL FORMED FORMULA

Atomic formula here can be defined as anwell formed formula where we can consider P as an predicate and t0...tn can be considered as the terms. It is also termed as atom. If □ and □ are considered to be well formed formulae then we can say that ~ (α), (α∧ β), (α∨ β) and then (α↚β.) these are then well formed formulas.

D. INFERENCE IN THE LOGIC

There are two basic rules for inference in FOL the modus ponen rule and the modus tollen rule.

A. Modus ponen - if there are two formulas α, β then Q(c) is defined as the logical sequence where c can be termed as or can be considered as a constant.

B. Modus tollen - if there are two formulas α, β then P(c) is defined as the logical consequence where c can be termed as or can be considered as a constant.

III. COMPARISON WITH OTHER LOGICS.

Here we have a table of comparison with other logics which are fuzzy logic and non-monotonic logic which is as follows.
Result is based on variance.

TABLE: Comparison of FOL with other Logics

Frequency (rate of acceptance)	FOL	Fuzzy logic	Non monotonic
0-9	8	0	8
10-19	9	0	9
20-29	6	0	4
30-39	10	0	9
40-49	14	0	11
50-59	13	1	16
60-69	15	6	10
70-79	9	15	16
80-89	8	25	10

90-100	8	53	7
Total	100	100	100

Result analysis -
Here the FOL and non-monotonic logics have a better result than the fuzzy logic. This depicts that FOL as a slightly high performance than the other two logics. However fuzzy logic is better than the other two logics in the terms of variance implication.

IV. LIMITATIONS OF FOL

This section describes the limitations in first order logic:

A. Real world limitation-
A sacrifice needs to be made in expressing the power in order to reduce the complexity of computation for using a logic which is particular in formalism in the real world scenarios.

Also, expressing the degree of similarity or the degree of relatedness can be a major challenge in implementation. It is also a semi decidable task when it comes to tautology, in this case there is an algorithm so that we can prove if a given formula is tautology or not, however here we cannot prove that the given formula is not a tautology

B. Theoretical limitations-
Let us consider some facts for this limitation
Let's assume the following sentences “jay is a man” ,”jagjit is a man”, “Johnathan is a man”, lets symbolize this as A, B, C respectively, here we can’t come to any conclusions for the similarities between A, B, and C. Also it is very difficult to represent some sentences and then these type of sentences need some quantification to be applied to them. Also here in this logic the quantification is over some simple variables.

V. CONCLUSION
Thus from this paper we see that first order logic is a very expressive logic. It helps in various areas of development such as in clinical practices, in mitigation of adverse interactions, in medical systems , also in policy reasoning, and also in medical reasoning, thus these are various real world applications that are done using the first order logic, it is precisely the best accurate logic that is available for various applications although the implementation of the same is a bit of complicated task but when the same is implemented this becomes a boon for the industry. Thus it helps in development and enhancement of various applications. Also this paper outlines the various applications and limitations of FOL in real world application. This will help in understanding and exploring more of the First order logic.

VI. REFERENCES

[1] Peter Lucas, Department of Computer Science, *The Representation of Medical Reasoning Models in Resolution-based Theorem Provers*, Artificial Intelligence in Medicine, 5(5), 395–414, 1993.
[2] Martin Michalowsk, Xing Tan, Wojtek Michalowski, Szymon Wilk , Daniela Rosu; *Using First-Order Logic to Represent Clinical Practice Guidelines and to Mitigate Adverse Interactions*, Expanding the Boundaries of Health Informatics Using AI: Papers from the 2014 AAAI Fall Symposium.
[3] Joseph Y. Halper, Vicky Weissma; *Using First-Order Logic to Reason about Policies*, Authors supported in part by NSF under grant CTC-0208535, by ONR under grants N00014-00-1-03-41 and N00014-01-10-511, by the DoD Multidisciplinary University Research Initiative (MURI) program administered by the ONR under grant N00014-01-1-0795, and by AFOSR under grant F49620-02-1-0101.