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Relevance of Symbolic Logic to other disciplines

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Abstract:

The newly discovered ocean, symbolic logic, is in its broadest sense, a new science which studies through use of efficient symbols the nature and properties of all non-numerical relations, seeking precise meaning and necessary conclusion. Symbolic logic is in a broadest sense a normative science which studies through signs, use of efficient symbols. As an applied science, it holds immense promise. For example, it may give us an unambiguous language for political, economic, and social fields, which will conveniently reflect the structure of these fields and make discussion and analysis easy. In this present work I would like to give very brief historical sketch of symbolic logic and also would like to focus on relevance of symbolic logic in other disciplines. In the part of departure of this work I would like to argue that science of reasoning can be applied in every field of human affairs.

Key words: *modern development, symbolic logic begins, Augustus*

Introduction

In 1513 the Spanish adventurer Balboa discovered an ocean three times bigger than any other ocean in the world. When he returned to Europe at the end of the year and told the Spaniards, they probably did not fully believe him. Like Balboa, the symbolic logicians have recently discovered a new vast ocean of thought, and like the Europeans of his day, many people are hardly aware of the discovery or its full implications. ….. Edmund C. Berkeley [1]

The subject with which we are concerned has been variously referred to as 'Symbolic Logic', 'Logistic', 'Algebra of Logic', 'Calculus of Logic', and 'Mathematical Logic' and probably by other names.[2] Most common word is symbolic logic. Logic which is basically concerned with uses symbols in certain specific ways – these ways which are exhibited generally in mathematical procedures. According to Charles Peirce, 'Nearly a hundred definitions of it have been given'[3]. But Peirce goes on to write: 'It will, however, generally be conceded that its central problem is the classification of arguments, so that all those who are bad are thrown into one division, and those which are good into another….'

If we have to give some definition of logic, we shall begin with the following definition given by Lewis which presented the main feature of Symbolic logic:

> "Symbolic logic is the development of the most general principles of rational procedure, in ideographic symbols, and in a form which exhibits the connection of those principles one with another."[4]

The history of symbolic logic properly begins with Leibniz.[5] The modern development of symbolic logic begins with Augustus De. Morgan (1809-1878), {Professor of mathematics at University College, London since 1828)}, and George Boole (1815-1864),{ 1849 Professor of mathematics at Queen's College-now University College, in Cork) in the 19th century}. The Journal of Symbolic logic (1936 and 1938), shows that a continuous and uninterrupted development of symbolic logic started only in 1847 with the pressing publication of A. De. Morgan's "*Formal logic*" and George Boole's "*The mathematical analysis of logic*". The common source of earlier attempts in symbolic logic is found in Aristotle's logical works. Contributions of symbolic logic were made by Ploucequent, Lambert, Castillon and other on the continent[6]. Aristotle was one of the first to attempt to formulate laws for logical reasoning and since his time hosts of excellent minds have concerned themselves with the logic which was built upon the structure Aristotle raised and transmitted to the present day as 'formal' or 'Aristotelian' logic with few modernizations.

Characteristics of Symbolic Logic

Symbolic logic, in its broader sense, is a new science that has the following characteristics.

- It studies mainly non-numerical relations.
- It seeks precise meanings and necessary conclusion.
- Its chief instrument is efficient symbols.

It is the general experience of childhood to first associate numbers with concrete object – two apples, two pennies, two shows, are instances in which the duality is a part of the thing itself. Later the more mature child begins to conceive of 'two' separated and abstracted from its associated use with specific objects. Soon, in school, he is introduced to the symbol '2' and learns that it represents the abstract conception of 'two'. On being introduced to Algebra further symbolization, abstraction and generalization is continued. Now any symbol, such as 'x' can represent any definite but unknown quantity of anything. It is probably not until this stage is achieved that the power and utility of reducing facts to symbols and the greater and greater generalization of these facts becomes apparent. Symbolic logic has as its basis the symbolization and generalizing of the laws of reason and logical thinking. It reduces reasoning to a set of symbols and then proceeds to use these same symbols to valid conclusions much as is done in algebra or even in simple calculation.

Difference between Mathematics and Symbolic Logic

Mathematics as an expression of the human mind reflects the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality and individuality

…….Richard Courant

Its closest cousin among the sciences is Mathematics. But symbolic logic differs from mathematics; to make the differences clear, Mathematics and symbolic logic may be compared in a number of respects.

- Mathematics deals with words plus, minus, times, divided by. Symbolic logic deals with more basic words like yes, no, and, or, not, the of , is, same, different, some, all, none.

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- Mathematics deals mainly with numbers and their properties. Symbolic logic deals mainly with statements, classes, and relations.
- Mathematics concentrates on answers to questions like: how much? How far/ How long? Symbolic logic deals with questions like: What does this mean? Does this set of statements have inconsistencies or ambiguity? What is the basis of this proof?

For example of rule in mathematics is, “the reciprocal of the reciprocal of a number is the number itself.” An example of a rule in a symbolic logic is, “the denial of the denial of a statement is the statement itself.”

Subject matter of logic (Branches of Symbolic Logic)

It was not until many years later when scholars and original thinkers conceived of a practical way to convert the material used in logic into symbols that any distinct advance was made in Symbolic logic. They not only did symbolization of the cumbersome components of Aristotelian logic make for much greater ease and facility in dealing with logical structures but it made the interrelationships of parts more readily ascertainable at a glance. Moreover, it revealed extensions into fields of thought both general and mathematical which would not even have been suspected as existing without the convenience and power which lies in the ability to reduce a problem to a few, concise symbols. For example, the study of the fundamental laws of logic would furnish invaluable tolls for simplifying electrical circuits or formulating insurance policies or feeding data to digital computers.

Historically, symbolic logic is the result of applying the powerful technique of mathematical symbolism to the subject matter of logic.

There are four or five recognized branches of symbolic logic.

1. Boolean algebra: the algebra of and, or, not and statements (or classes). For example, a rule from Boolean algebra is that “neither A, nor B is the same as not A, and not B.” ~(pvq) = (~p . ~q)

   Here A and B are statements or classes, but not numbers. As a result of work by Claude Shannon, Boolean algebra has proved to be useful in designing and checking electrical paths using communicates or electronic tubes. This application of symbolic logic is important in the design and construction of automatic computers.

2. (Another branch of symbolic logic)

   It deals with the foundations of mathematics. It has studies such questions as

   What is a number?

   What is a variable?

   What is a mathematical function?

   It has answered these questions to a large extent. *Principia Mathematica*, by Bertrand Russell and A.N. Whitehead (Published 1910-1913), which aim to furnish a logical foundation for all of mathematics.

3. (A third branch of Symbolic Logic)

   It is called the algebra of relations. (Logic of relations) This deals with such concepts as symmetric relations, transitive relations, connected relations, series, etc.

4. Fourth branch deals with what is called the decision procedure, i.e., the procedure for deciding that a statement is true or false. Symbolic or formal logicians have investigated the problem of proving statements in any mathematical system. These studies have produced some remarkable results. For example, it can be shown that there are statements in arithmetic, and in other mathematical systems, that can never be decided as true or false. Nevertheless, mechanical brains can be applied to deciding statements that can be decided, in problems that would take years of human labour to decide.

Relevance of Symbolic Logic in other Disciples

1. Symbolic Logic and Psychology:

No one denies that there is some relation between psychology and logic. After all, logical reasoning takes place within the mind. The question is whether mathematical logic is a very special kind of mental process, or whether, on the other hand, it is closely connected with everyday thought processes. And, beginnings around a century ago, both logicians and psychologists have overwhelmingly voted for the former answer.

The almost complete dissociation of logic and psychology which one finds today may be partly understood as a reaction against the nineteenth-century doctrines of psychologism and logism. Both of these doctrines represent extreme views: logism states that psychology is a subset of logic; and psychologism states that logic is a subset of psychology.

Boole's attitude was explicitly logistic -- he optimistically suggested that the algebraic equations of his logic corresponded to the structure of human thought. Leibniz, who anticipated many of Boole's discoveries by approximately two centuries, was ambitious beyond the point of logism as I have defined it here: he felt that elementary symbolic logic would ultimately explain not only the mind but the physical world. And logism was also not unknown among psychologists -- it was common, for example, among members of the early Wurzburg school of Denkpsychologie. These theorists felt that human judgments generally followed the forms of rudimentary mathematical logic.

But although logism played a significant part in history, the role of psychologism was by far the greater. Perhaps the most extreme psychologism was that of John Stuart Mill (1843), who in his *System of Logic* argued that

Logic is not a Science distinct from, and coordinates with, Psychology. So far as it is a Science at all, it is a part or branch of Psychology.... Its theoretic grounds are wholly borrowed from Psychology....

Mill understood the axioms of logic as "generalizations from experience." For instance, he gave the following psychological "demonstration" of the Law of Excluded Middle (which states that for any p, either p or not-p is always true):

The law on Excluded Middle, then, is simply a generalization of the universal experience that some mental states are destructive of other states. It formulates a certain absolutely constant law, that the appearance of any positive mode of consciousness cannot occur without excluding a correlative negative mode; and that the negative mode cannot occur without excluding the correlative positive mode.... Hence it follows that if consciousness is not in one of the two modes it much be in the other (bk. 2, chap.,7, sec.5)

Even if one accepted psychologism as a general principle, it is hard to see how one could take "demonstrations" of this nature seriously. Of course each "mode of consciousness" or state of mind excludes certain others, but there is no intuitively experienced exact opposite to each state of mind. The concept of logical negation is not a "generalization" of but rather a specialization and falsification of the common psychic experience which Mill describes. The leap from exclusion to exact opposition is far from obvious and was a major step in the development of mathematical logic.

Nietzsche (1888/1968) also attempted to trace the rules of logic to their psychological roots. But Nietzsche took a totally different approach: he viewed logic as a special system devised by man for certain purposes, rather than as something wholly deducible from inherent properties of mind.

1. Symbolic Logic and Law:

Law is profession which the public relies upon to be expert in the art of communication; lawyers have a responsibility to be familiar with the full kit of tools that is available to us to communicate clearly and precisely. To the extent that symbolic logic is such a tool, a certain obvious conclusion seems necessary. Few lawyers would deny that as professional communicators we ought to struggle to keep side by side of the developments in communication technology that will enable us to perform communication tasks more effectively. Symbolic logic can be useful to lawyers in the exercise of such fundamental skills as reading and writing. In the phase of law practice it is important that reading or writing be careful and precise; most layers can probably profit from some training in Symbolic logic.

Practicing law might find logic of some practical application, especially that the mastery of a few of the formulas of modern logic could sharpen his insight into legal concepts and provide reliable tests of the validity of arguments.

At the outset, at least two types of vagueness in written or spoken statements should be distinguished. A lawyer may be vague or ambiguous in what he writes because he intends to be vague or ambiguous, or such imprecision may creep into his statements inadvertently. It is with this latter kind of imprecision- the not deliberate ambiguities – that the use of symbolic logic is recommended as an effective aid to help notice and control. However, it should be noted that the same techniques also can be used more wisely to cover some of the intentional ambiguities that a draftsman may wish to put into a statement.

“Or” in ordinary discourse is sometimes ambiguous. In A door must be open or shut” both alternatives cannot be true. This is the term employed in its exclusive sense. In “Do you have two nickels or a dime?” outside of a Skid Row setting, the context does not imply that the one questioned may not have both. This is the inclusive sense of “or”.

Logic recognizes this ambiguity. The law insists that the word is univocal in its exclusive sense. Persistence in this semantic aberration has caused many an unwanted case to bloom where none grew before; and created one of the most clumsy-read; illogical-means in the dark secret of legal functions.

Having ruled that "or" could not be used to say – "A or B, or A and B" courts interpreting texts in which the word was so used have held that what the writer really meant to say was "A and B". people were careless in the use of "or" and "and", the one for the other – a "carelessness" to be found in the courts own opinions, which are studded with as many inclusive "or's" as lay language.

Much space is given in modern logic to the transformations that can be made in formulas composed of symbols. Long and complicated sentences can be reduced to relatively, simple formulas. Obviously, the manipulation of such formulas can be performed with more facility than that of the sentences themselves. Once the juggling has achieved its ends, the results can be translated back into ordinary language.

If reasoning the ability to look at an idea in its various aspects is highly important. A better attack can be made on a question after setting it out in different ways. Using a variety of expressions to repeat the same conclusion can give it much additional force in a brief. An opponent may have made a statement without realizing that it is equivalent to an admission awkward to his side. In argument equivalence can have all the importance of a valid inference. No discipline compares with symbolic logic for making one immediately aware of all of the possible inferences and equivalences a statement carries with it. p ɔ q' = ~p v q.

Very easily we can get fallacies or error occurred in an argument. Like reasoning rule according to modus ponens a conclusion follows only when P is affirmed; this affirmation is the keynote of the whole argument – a far remove from irrelevancy and ineffectiveness. That so many reviewers of rank should have failed to notice the error, one of the most obvious fallacies pointed out by logic, demonstrates the low estate of this discipline in the profession. But at the same tile it poses the question how much of a handicap are those attorneys imposing upon themselves who insist in playing-it-by-ear?

Symbolic logic is by far the simplest kind of logic—it is a great time-saver in argumentation. Additionally, it helps prevent logical confusion when dealing with complex arguments.

Symbolic Logic and Shorthand Technique and coding system:

There is a very close relation between shorthand techniques and symbolic logic[7]. Symbolic logic is very helpful for development of shorthand and coding systems. If we see the techniques used in shorthand it is very much similar to symbols of logic like relational symbols, set symbols and other symbols.

Symbolic logic explaining the symbols used, can be presented only in terms of its shorthand, without a single word of any common language. For example, instead of saying 'at least one of the two propositions p and q is true', they write 'p v q', ' p o q' means 'proposition p ɔ q' (B. Russell and Whitehead's notation); then 'g ɔ p v q' means 'g implies that at least either p or q is true' and' p o q = - ~ (pq)'. (Lew's notation) means the statement that p and q are consistent is equivalent to the statement it is not true

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that it is impossible that p and q both be true etc.[8]

Strictly speaking, the ideographic symbols or peculiar shorthand used by Symbolic logic is a device only for a special and better kind of presentation and fixation, and not of explanation, of our cognitive activities. Indeed, like all symbols, they do not say anything beyond, the actual phenomena for which they stand. They represent certain logical units, do not introduce anything more than the units express, and have no meaning or significance beyond the meanings of the corresponding logical units. But one the other hand, when we applied consistently and vigorously, the ideographic method of representation brings in quite new possibilities for a much more comprehensive and inclusive correlation and reconstruction of logical units; and in this way it becomes more than a mere device of representation and grows into a new and extremely powerful, precise and effective method of organizing our reasoning; in other words, it becomes a new method of Logic.[9]

So it is quite clear that Symbolic logic is very close to other disciplines which much related to human and social life. There are many more Possible areas of application of Symbolic Logic: in business- corporate area, life insurance—beneficiary sections, sets of rules and their codification, accounting, record keeping, indexing information etc., classifications for libraries, development of shorthand and coding systems. In applied science like economics, psychology, construction of theories, languages, measurement, Construction of dialogues, exposition, explanation, etc, diagrams, models, analogies, charts etc., controversies, games, puzzles etc.

In a republican nation, whose citizens are to be led by reason and persuasion and not by force, the art of reasoning becomes of the first importance.[10]
…… Thomas Jefferson

I would like to conclude with saying that Reason can be applied in every sphere of human affairs. The study of logic supports that application, helping us to distinguish good arguments from bad ones, advancing the quest of knowledge and understanding whatever the field of our interests may be. A common complaint about college courses is that they are 'not relevant' to the pressing affairs of everyday life. That complaint cannot be fairly brought against the study of logic, which can strengthen intellectual skills having very wide and effective uses. Logic is relevant to every enterprise in which reliable judgments are sought. In the personal life of the student, a heightened (Sharp/Sensitive) ability to express ideas clearly and concisely, an increased skill in defining one's terms, and an enlarged capacity to formulate arguments rigorously and to analyze them critically are only some of the early benefits of the study of logic. In the life of society uses of logic are equally apparent. Democratic institutions require that citizens think for themselves, discuss problems freely with one another, and ultimately choose their leaders and decide issues on the basis of deliberation and the rational considering of argument and evidence. Because democracy encourages a respect for reason, the study of principles that underlie good reasoning reinforces and makes more secure the values we mainly honor.

Notes:

Shorthand Notation for Logical Operators

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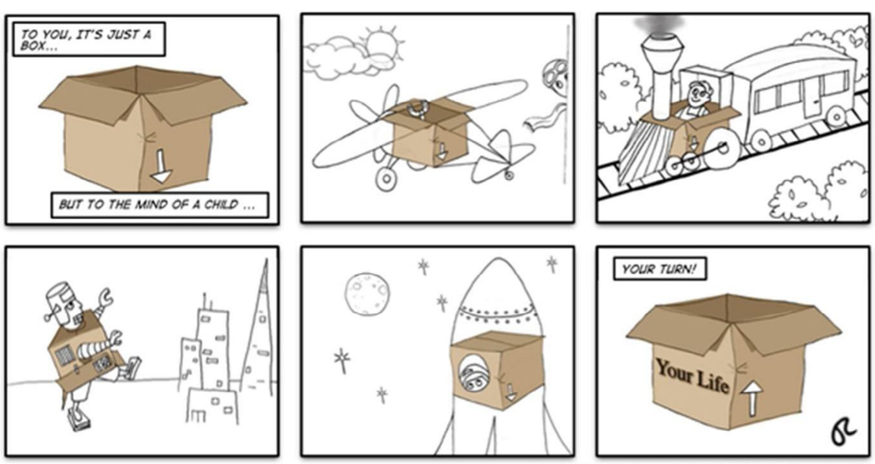
- e is shorthand notation for "not".ea means "not a".
- ^ is shorthand for "and". a ^ b is shorthand for "statement a and statement b" and it is true if and only if both a and b are true.
- _ is shorthand for "or". a _ b is shorthand for "statement a or statement b" and it is true if and only if one of a or b is true.
- =) is shorthand for "implies". a) b is shorthand for "statement a implies statement b"; or "if a then b". Sometimes it is easier to prove that a) b by contraposition, i.e. by proving that "if b is not true, then a is not true"
- () is shorthand for "is equivalent to". a () b is shorthand for "statement a is equivalent to statement b". You can prove equivalence by proving that a) b and b) a.
- e(a g b) , (ea) f (eb) 7. e(a f b) , (ea) g (eb)
- **Set Notation**
- [is the mathematical symbol for union. A [B = fx : x 2 A or x 2 Bg
- \ is the mathematical symbol for intersection A \ B = fx : x 2 A and x 2 Bg
- is the mathematical symbol for subset. A B : x 2 A) x 2 B:
- The di§erence of sets is denoted either by AnB or A B = fx : x 2 A and x =2 Bg
- You can prove that the sets A and B are equal by proving A B and B A:
- The set Ac = fx : x =2 Ag is called the complement of A:

Application of Logic:



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[3] Logic, in Dictionary of Philosophy and Psychology, James Mark Badwin, ed., Macmillan Publishing, Cp., Inc., New York, 1925.

[4] Ibid, p. 1.

[5] Ibid, p. 3.

[6] Ibid

[7] See note at the end of this paper I have mentioned symbols which are used in shorthand techniques.

[8] The Technique of Controversy: Principles of Dynamic, by Boris B. Bogoslovsky, first Published in 1928, Kegan Paul, Trench, Trubner and Co.Ltd, now published in 2014, Routledge, USA.

[9] Ibid p. 239.

[10] Copi, I.M. and Carl Cohen, (2000), *Introduction to Logic*, 9th[th] Edition, Macmillan, New York, p. v.