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Chapter 1 : Mathematical notation | Revolvy

An Actuarial Notation Based on Symbolic Logic by G. C. Taylor (Australia) Research Paper No. 50 published by the Macquarie University in April 8.

Hindu-Arabic numeral system Despite their name, Arabic numerals actually started in India. His book On the Calculation with Hindu Numerals, written about , along with the work of Al-Kindi , [note 4] were instrumental in spreading Indian mathematics and Indian numerals to the West. Al-Khwarizmi did not claim the numerals as Arabic, but over several Latin translations, the fact that the numerals were Indian in origin was lost. Islamic mathematics developed and greatly expanded the mathematics of the ancient Near Eastern , Indian and Central Asian [18] civilizations. Woepcke, [24] praised Al-Karaji for being "the first who introduced the theory of algebraic calculus. Ibn al-Haytham would develop analytic geometry. Al-Haytham derived the formula for the sum of the fourth powers, using a method that is readily generalizable for determining the general formula for the sum of any integral powers. Al-Haytham performed an integration in order to find the volume of a paraboloid , and was able to generalize his result for the integrals of polynomials up to the fourth degree. Nasir al-Din Tusi Nasireddin made advances in spherical trigonometry. Muslim mathematicians during this period include the addition of the decimal point notation to the Arabic numerals. Many Greek and Arabic texts on mathematics were then translated into Latin , which led to further development of mathematics in medieval Europe. Liber Abaci is better known for the mathematical problem Fibonacci wrote in it about a population of rabbits. The growth of the population ended up being a Fibonacci sequence , where a term is the sum of the two preceding terms. Symbolic stage Main articles: Kashi also had an algorithm for calculating nth roots. The plus sign was first used by Nicole Oresme in Algorismus proportionum , possibly an abbreviation for "et", which is "and" in Latin in much the same way the ampersand began as "et". The minus sign was first used by Johannes Widmann in Mercantile Arithmetic. Widmann used the minus symbol with the plus symbol, to indicate deficit and surplus, respectively. Calculus notation See also: History of calculus Calculus had two main systems of notation, each created by one of the creators: In modern usage, this notation generally denotes derivatives of physical quantities with respect to time, and is used frequently in the science of mechanics. Leibniz, on the other hand, used the letter d as a prefix to indicate differentiation, and introduced the notation representing derivatives as if they were a special type of fraction. This notation makes explicit the variable with respect to which the derivative of the function is taken. The symbol is an elongated S , representing the Latin word Summa, meaning "sum". When finding areas under curves, integration is often illustrated by dividing the area into tall, thin rectangles. Infintesimally thin rectangles, when added, yield the area. The process of add up the infintesmal areas in integration, hence the S for sum.

Chapter 2 : Symbolic Logic Problems and Solutions | The Rational

G. C. Taylor: An actuarial notation based on symbolic logic, research paper no. 50 of the School of Economic and Financial Studies, Macquarie University, Sydney, April

Many challenging questions do not involve numerical or geometrical considerations but call for deductive inferences based chiefly on logical relationships. Such puzzles are not to be confounded with riddles, which frequently rely upon deliberately misleading or ambiguous statements, a play onâ€¦ Scope and basic concepts An inference is a rule-governed step from one or more propositions , called premises , to a new proposition, usually called the conclusion. A rule of inference is said to be truth-preserving if the conclusion derived from the application of the rule is true whenever the premises are true. Inferences based on truth-preserving rules are called deductive , and the study of such inferences is known as deductive logic. An inference rule is said to be valid, or deductively valid, if it is necessarily truth-preserving. That is, in any conceivable case in which the premises are true, the conclusion yielded by the inference rule will also be true. Inferences based on valid inference rules are also said to be valid. Logic in a narrow sense is equivalent to deductive logic. By definition , such reasoning cannot produce any information in the form of a conclusion that is not already contained in the premises. In a wider sense, which is close to ordinary usage, logic also includes the study of inferences that may produce conclusions that contain genuinely new information. Such inferences are called ampliative or inductive , and their formal study is known as inductive logic. They are illustrated by the inferences drawn by clever detectives, such as the fictional Sherlock Holmes. The contrast between deductive and ampliative inferences may be illustrated in the following examples. However, when a forensic scientist infers from certain properties of a set of human bones the approximate age, height, and sundry other characteristics of the deceased person, the reasoning used is ampliative, because it is at least conceivable that the conclusions yielded by it are mistaken. The most important logical constants are quantifiers , propositional connectives, and identity. Logical form can also be thought of as the result of replacing all of the nonlogical concepts in a proposition by logical constants or by general logical symbols known as variables. The study of the relations between such uninterpreted formulas is called formal logic. It should be noted that logical constants have the same meaning in logical formulas, such as 3 and 4 , as they do in propositions that also contain nonlogical concepts, such as 1 and 2. Valid logical inferences are made possible by the fact that the logical constants, in combination with nonlogical concepts, enable a proposition to represent reality. Indeed, this representational function may be considered their most fundamental feature. A proposition G, for example, can be validly inferred from another proposition F when all of the scenarios represented by Fâ€"the scenarios in which F is trueâ€"are also scenarios represented by Gâ€"the scenarios in which G is true. In this sense, 2 can be validly inferred from 1 because all of the scenarios in which it is true that someone envies everybody are also scenarios in which it is true that everybody is envied by at least one person. Not all philosophers accept these explanations of logical validity, however. For some of them, logical truths are simply the most general truths about the actual world. For others, they are truths about a certain imperceptible part of the actual world, one that contains abstract entities like logical forms. In addition to deductive logic, there are other branches of logic that study inferences based on notions such as knowing that epistemic logic , believing that doxastic logic , time tense logic , and moral obligation deontic logic , among others. These fields are sometimes known collectively as philosophical logic or applied logic. Some mathematicians and philosophers consider set theory , which studies membership relations between sets, to be another branch of logic. Logical notation The way in which logical concepts and their interpretations are expressed in natural languages is often very complicated. In order to reach an overview of logical truths and valid inferences, logicians have developed various streamlined notations. Such notations can be thought of as artificial languages when their nonlogical concepts are interpreted; in this respect they are comparable to computer languages, to some of which they are in fact closely related. The propositions 1 â€" 4 illustrate one such notation. Logical languages differ from natural ones in several ways. The task of translating between the two, known as logic translation, is thus not a trivial one. The reasons for this difficulty are similar to the reasons why it is difficult to program a computer to interpret or express sentences in a natural language. Consider, for example, the sentence 5 If Peter owns a donkey, he beats it. Thus 6 can be read: Yet theoretical linguists have found it extraordinarily difficult to formulate general translation rules that would yield a logical formula such as 6 from an English sentence such as 5. Contemporary forms of logical notation are significantly different from those used before the 19th century. Until then, most logical inferences were expressed by means of natural language supplemented with a smattering of variables and, in some cases, by traditional mathematical concepts. One can in fact formulate rules for logical inferences in natural languages, but this task is made much easier by the use of a formal notation. Hence, from the 19th century on most serious research in logic has been conducted in what is known as symbolic, or formal, logic. The most commonly used type of formal logical language was invented by the German mathematician Gottlob Frege â€” and further developed by the British philosopher Bertrand Russell â€” and his collaborator Alfred North Whitehead â€” and the German mathematician David Hilbert â€” and his associates. In the logical language, each of these senses is expressed in a different way. It could be that it has a single sense that is differently interpreted, or used to convey different information, depending on the context in which the containing sentence is produced. Indeed, before Frege and Russell, no logician had ever claimed that natural-language verbs of being are ambiguous. But quantifiers may also range over other entities, such as sets, predicates , relations, and functions. For example, there are languages in which all the entities referred to are functions. Depending upon whether one emphasizes inference and logical form on the one hand or logic translation on the other, one can conceive of the overarching aim of logic as either the study of different logical forms for the purpose of systematizing the study of inference patterns logic as a calculus or as the creation of a universal interpreted language for the representation of all logical forms logic as language. Logical systems Logic is often studied by constructing what are commonly called logical systems. A logical system is essentially a way of mechanically listing all the logical truths of some part of logic by means of the application of recursive rulesâ€"i. This is done by identifying by purely formal criteria certain axioms and certain purely formal rules of inference from which theorems can be derived from axioms together with earlier theorems. All of the axioms must be logical truths, and the rules of inference must preserve logical truth. If these requirements are satisfied, it follows that all the theorems in the system are logically true. The systematic study of formal derivations of logical truths from the axioms of a formal system is known as proof theory. It is one of the main areas of systematic logical theory. Not all parts of logic are completely axiomatizable. Second-order logic, for example, is not axiomatizable on its most natural interpretation. Likewise, independence-friendly first-order logic is not completely axiomatizable. Hence the study of logic cannot be restricted to the axiomatization of different logical systems. Logical systems that are incomplete in the sense of not being axiomatizable can nevertheless be formulated and studied in ways other than by mechanically listing all their logical truths. The notions of logical truth and validity can be defined model-theoretically i. Such studies belong to model theory , which is another main branch of contemporary logic. Model theory involves a notion of completeness and incompleteness that differs from axiomatizability. A system that is incomplete in the latter sense can nevertheless be complete in the sense that all the relevant logical truths are valid model-theoretical consequences of the system. This kind of completeness, known as descriptive completeness, is also sometimes confusingly called axiomatizability, despite the more common use of this term to refer to the mechanical generation of theorems from axioms and rules of inference. Definitory and strategic inference rules There is a further reason why the formulation of systems of rules of inference does not exhaust the science of logic. Rule-governed, goal-directed activities are often best understood by means of concepts borrowed from the study of games. For example, one of the most fundamental ideas of game theory is the distinction between the definitory rules of a game and its strategic rules. Definitory rules define what is and what is not admissible in a gameâ€"for example, how chessmen may be moved on a board, what counts as checking and mating, and so on. But knowledge of the definitory rules of a game does not constitute knowledge of how to play the game. For that purpose, one must also have some grasp of the strategic rules, which tell one how to play the game wellâ€”for example, which moves are likely to be better or worse than their alternatives. They are merely permissive. That is, given a set of premises, the rules of inference indicate which conclusions one is permitted to draw, but they do not indicate which of the permitted conclusions one should or should not draw. Hence, any exhaustive study of logicâ€"indeed, any useful study of logicâ€"should include a discussion of strategic principles of inference. Unfortunately, few, if any, textbooks deal with this aspect of logic. In most nontrivial cases, however, the strategic rules cannot be mechanically recursively applied. The rules that license such inferences need not be truth-preserving, but many will be ampliative, in the sense that they lead or are likely to lead eventually to new or useful information. There are many kinds of ampliative reasoning. Inductive logic offers familiar examples. Thus a rule of inductive logic might tell one what inferences may be drawn from observed relative frequencies concerning the next observed individual. In some cases, the truth of the premises will make the conclusion probable, though not necessarily true. In other cases, although there is no guarantee that the conclusion is probable, application of the rule will lead to true conclusions in the long run if it is applied in accordance with a good reasoning strategy. It can be shown that there is in fact a close connection between optimal strategies of ampliative reasoning and optimal strategies of deductive reasoning. For example, the choice of the best question to ask in a given situation is closely related to the choice of the best deductive inference to draw in that situation. This connection throws important light on the nature of logic. At first sight, it might seem odd to include the study of ampliative reasoning in the theory of logic. Such reasoning might seem to be part of the subject of epistemology rather than of logic. In so far as definitory rules are concerned, ampliative reasoning does in fact differ radically from deductive reasoning. But since the study of the strategies of ampliative reasoning overlaps with the study of the strategies of deductive reasoning, there is a good reason to include both in the theory of logic in a wide sense. Some recently developed logical theories can be thought of as attempts to make the definitory rules of a logical system imitate the strategic rules of ampliative inference. Cases in point include paraconsistent logics, nonmonotonic logics, default reasoning, and reasoning by circumscription, among other examples. Most of these logics have been used in computer science , especially in studies of artificial intelligence. Further research will be needed to determine whether they have much application in general logical theory or epistemology. The distinction between definitory and strategic rules can be extended from deductive logic to logic in the wide sense. Often it is not clear whether the rules governing certain types of inference in the wide sense should be construed as definitory rules for step-by-step inferences or as strategic rules for longer sequences of inferences. Furthermore, since both strategic rules and definitory rules can in principle be explicitly formulated for both deductive and ampliative inference, it is possible to compare strategic rules of deduction with different types of ampliative inference.

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Predicate Logic and Quanti ers CSE Universe of Discourse Consider the previous example. Does it make sense to assign to x the value \ blue "? Intuitively, the universe of discourse is the set of all things we.

Five was an X between two horizontal lines; it looked almost exactly the same as the Roman numeral for ten. In the history of the Chinese, there were those who were familiar with the sciences of arithmetic, geometry, mechanics, optics, navigation, and astronomy. Mathematics in China emerged independently by the 11th century BC. Chinese of that time had made attempts to classify or extend the rules of arithmetic or geometry which they knew, and to explain the causes of the phenomena with which they were acquainted beforehand. The Chinese independently developed very large and negative numbers , decimals , a place value decimal system, a binary system , algebra , geometry , and trigonometry. Counting rod numerals Chinese mathematics made early contributions, including a place value system. In arithmetic their knowledge seems to have been confined to the art of calculation by means of the swan-pan , and the power of expressing the results in writing. Our knowledge of the early attainments of the Chinese, slight though it is, is more complete than in the case of most of their contemporaries. It is thus instructive, and serves to illustrate the fact, that it can be known a nation may possess considerable skill in the applied arts with but our knowledge of the later mathematics on which those arts are founded can be scarce. Knowledge of Chinese mathematics before BC is somewhat fragmentary, and even after this date the manuscript traditions are obscure. Dates centuries before the classical period are generally considered conjectural by Chinese scholars unless accompanied by verified archaeological evidence. As in other early societies the focus was on astronomy in order to perfect the agricultural calendar , and other practical tasks, and not on establishing formal systems. The Chinese Board of Mathematics duties were confined to the annual preparation of an almanac, the dates and predictions in which it regulated. Ancient Chinese mathematicians did not develop an axiomatic approach, but made advances in algorithm development and algebra. The achievement of Chinese algebra reached its zenith in the 13th century, when Zhu Shijie invented method of four unknowns. As a result of obvious linguistic and geographic barriers, as well as content, Chinese mathematics and that of the mathematics of the ancient Mediterranean world are presumed to have developed more or less independently up to the time when The Nine Chapters on the Mathematical Art reached its final form, while the Writings on Reckoning and Huainanzi are roughly contemporary with classical Greek mathematics. Some exchange of ideas across Asia through known cultural exchanges from at least Roman times is likely. Frequently, elements of the mathematics of early societies correspond to rudimentary results found later in branches of modern mathematics such as geometry or number theory. The Pythagorean theorem for example, has been attested to the time of the Duke of Zhou. The state of trigonometry in China slowly began to change and advance during the Song Dynasty â€" , where Chinese mathematicians began to express greater emphasis for the need of spherical trigonometry in calendarical science and astronomical calculations. Gauchet and Joseph Needham state, Guo Shoujing used spherical trigonometry in his calculations to improve the calendar system and Chinese astronomy. Indian mathematical notation[edit] Although the origin of our present system of numerical notation is ancient, there is no doubt that it was in use among the Hindus over two thousand years ago. The algebraic notation of the Indian mathematician , Brahmagupta , was syncopated. Addition was indicated by placing the numbers side by side, subtraction by placing a dot over the subtrahend the number to be subtracted , and division by placing the divisor below the dividend, similar to our notation but without the bar. Multiplication, evolution, and unknown quantities were represented by abbreviations of appropriate terms. His book On the Calculation with Hindu Numerals, written about , along with the work of Al-Kindi , [note 13] were instrumental in spreading Indian mathematics and Indian numerals to the West. Al-Khwarizmi did not claim the numerals as Arabic, but over several Latin translations, the fact that the numerals were Indian in origin was lost. Islamic mathematics developed and expanded the mathematics known to Central Asian civilizations. Woepcke, [47] praised

Al-Karaji for being "the first who introduced the theory of algebraic calculus. Ibn al-Haytham would develop analytic geometry. Al-Haytham derived the formula for the sum of the fourth powers, using a method that is readily generalizable for determining the general formula for the sum of any integral powers. Al-Haytham performed an integration in order to find the volume of a paraboloid , and was able to generalize his result for the integrals of polynomials up to the fourth degree. Nasir al-Din Tusi Nasireddin made advances in spherical trigonometry. Muslim mathematicians during this period include the addition of the decimal point notation to the Arabic numerals. Many Greek and Arabic texts on mathematics were then translated into Latin , which led to further development of mathematics in medieval Europe. Liber Abaci is better known for the mathematical problem Fibonacci wrote in it about a population of rabbits. The growth of the population ended up being a Fibonacci sequence , where a term is the sum of the two preceding terms.

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Chapter 4 : History of mathematical notation - Wikipedia

The existing international actuarial notation was founded on the ' Key to the Notation' given in the Institute of Actuaries Text-Book, Part II, Life Con- tingencies, by George King, and is embodied in an explanatory statement.

Mathematical notation Save Mathematical notation is a system of symbolic representations of mathematical objects and ideas. Mathematical notations are used in mathematics , the physical sciences , engineering , and economics. Definition A mathematical notation is a writing system used for recording concepts in mathematics. The notation uses symbols or symbolic expressions which are intended to have a precise semantic meaning. In the history of mathematics , these symbols have denoted numbers, shapes, patterns, and change. The notation can also include symbols for parts of the conventional discourse between mathematicians, when viewing mathematics as a language. The media used for writing are recounted below, but common materials currently include paper and pencil, board and chalk or dry-erase marker , and electronic media. Systematic adherence to mathematical concepts is a fundamental concept of mathematical notation. See also some related concepts: Logical argument , Mathematical logic , and Model theory. Expressions A mathematical expression is a sequence of symbols which can be evaluated. For example, if the symbols represent numbers, the expressions are evaluated according to a conventional order of operations which provides for calculation, if possible, of any expressions within parentheses, followed by any exponents and roots, then multiplications and divisions and finally any additions or subtractions, all done from left to right. In a computer language , these rules are implemented by the compilers. For more on expression evaluation, see the computer science topics: Precise semantic meaning Modern mathematics needs to be precise, because ambiguous notations do not allow formal proofs. Suppose that we have statements , denoted by some formal sequence of symbols, about some objects for example, numbers, shapes, patterns. Until the statements can be shown to be valid, their meaning is not yet resolved. While reasoning, we might let the symbols refer to those denoted objects, perhaps in a model. The semantics of that object has a heuristic side and a deductive side. In either case, we might want to know the properties of that object, which we might then list in an intensional definition. Those properties might then be expressed by some well-known and agreed-upon symbols from a table of mathematical symbols. This mathematical notation might include annotation such as "All x", "No x", "There is an x" or its equivalent, "Some x" , "A set", "A function" "A mapping from the real numbers to the complex numbers" In different contexts, the same symbol or notation can be used to represent different concepts. Therefore, to fully understand a piece of mathematical writing, it is important to first check the definitions that an author gives for the notations that are being used. This may be problematic if the author assumes the reader is already familiar with the notation in use. History Counting It is believed that a mathematical notation to represent counting was first developed at least 50, years ago[1] â€” early mathematical ideas such as finger counting [2] have also been represented by collections of rocks, sticks, bone, clay, stone, wood carvings, and knotted ropes. The tally stick is a way of counting dating back to the Upper Paleolithic. Perhaps the oldest known mathematical texts are those of ancient Sumer. The Census Quipu of the Andes and the Ishango Bone from Africa both used the tally mark method of accounting for numerical concepts. The development of zero as a number is one of the most important developments in early mathematics. It was used as a placeholder by the Babylonians and Greek Egyptians , and then as an integer by the Mayans , Indians and Arabs. See The history of zero for more information. Geometry becomes analytic The earliest mathematical viewpoints in geometry did not lend themselves well to counting. The natural numbers , their relationship to fractions , and the identification of continuous quantities actually took millennia to take form, and even longer to allow for the development of notation. Modern notation The 18th and 19th centuries saw the creation and standardization of mathematical notation as used today. Euler was responsible for many of the notations in use today: Many fields of mathematics bear the imprint of their creators for notation: Computerized notation Mathematically oriented markup languages such as TeX , LaTeX and, more recently, MathML are powerful enough to express a wide variety of mathematical notations. Theorem-proving software naturally comes with its own notations for mathematics; the OMDoc project seeks to provide an open commons for such notations; and the MMT language provides a basis for interoperability between other notations. Non-Latin-based mathematical notation Modern Arabic mathematical notation is based mostly on the Arabic alphabet and is used widely in the Arab world , especially in pre- tertiary education. Western notation uses Arabic numerals , but the Arabic notation also replaces Latin letters and related symbols with Arabic script. Some mathematical notations are mostly diagrammatic, and so are almost entirely script independent. Examples are Penrose graphical notation and Coxeterâ€"Dynkin diagrams.

Chapter 5 : Mathematical notation - Wikipedia

REFORM OF ACTUARIAL NOTATION by Mr. Taylor's approach was based on symbolic logic and, now would require some 44 symbols in symbolic logic.