THE LOGIC OF TYPED FEATURE STRUCTURES pdf

1: LOGIC OF TYPED FEATURE STRUCTURES, THE - WITH APPLICATIONS TO UNIFICATION GRAMM

This book develops the theory of typed feature structures, a new form of data structure that generalizes both the first-order terms of logic programs and feature-structures of unification-based grammars to include inheritance, typing, inequality, cycles and intensionality.

That is, the logical validity of deductive arguments depends neither on the meanings of the name and predicate and relation terms, nor on the truth-values of sentences containing them. It merely supposes that these non-logical terms are meaningful, and that sentences containing them have truth-values. Deductive logic then tells us that the logical structures of some sentencesâ€"i. This is the notion of logical inconsistency. The notion of logical entailment is inter-definable with it. A collection of premise sentences logically entails a conclusion sentence just when the negation of the conclusion is logically inconsistent with those premises. An inductive logic must, it seems, deviate from the paradigm provided by deductive logic in several significant ways. For one thing, logical entailment is an absolute, all-or-nothing relationship between sentences, whereas inductive support comes in degrees-of-strength. For another, although the notion of inductive support is analogous to the deductive notion of logical entailment, and is arguably an extension of it, there seems to be no inductive logic extension of the notion of logical inconsistencyâ€"at least none that is inter-definable with inductive support in the way that logical inconsistency is inter-definable with logical entailment. Another notable difference is that when B logically entails A, adding a premise C cannot undermine the logical entailmentâ€"i. This property of logical entailment is called monotonicity. But inductive support is nonmonotonic. In a formal treatment of probabilistic inductive logic, inductive support is represented by conditional probability functions defined on sentences of a formal language L. These conditional probability functions are constrained by certain rules or axioms that are sensitive to the meanings of the logical terms i. The axioms apply without regard for what the other terms of the language may mean. Although each support function satisfies these same axioms, the further issue of which among them provides an appropriate measure of inductive support is not settled by the axioms alone. That may depend on additional factors, such as the meanings of the non-logical terms i. A good way to specify the axioms of the logic of inductive support functions is as follows. These axioms are apparently weaker than the usual axioms for conditional probabilities. For instance, the usual axioms assume that conditional probability values are restricted to real numbers between 0 and 1. The following axioms do not assume this, but only that support functions assign some real numbers as values for support strengths. However, it turns out that the following axioms suffice to derive all the usual axioms for conditional probabilities including the usual restriction to values between 0 and 1. We draw on these weaker axioms only to forestall some concerns about whether the support function axioms may assume too much, or may be overly restrictive. This axiomatization takes conditional probability as basic, as seems appropriate for evidential support functions. Notice that conditional probability functions apply only to pairs of sentences, a conclusion sentence and a premise sentence. So, in probabilistic inductive logic we represent finite collections of premises by conjoining them into a single sentence. For instance, they do not say that logically equivalent sentences are supported by all other sentences to the same degree; rather, that result is derivable from these axioms see result 6 below. Nor do these axioms say that logically equivalent sentences support all other sentences to the same degree; rather, that result is also derivable see result 8 below. Indeed, from these axioms all of the usual theorems of probability theory may be derived. The following results are particularly useful in probabilistic logic. Their derivations from these axioms are provided in note 2. It turns out that the all support values must lie between 0 and 1, but this follows from the axioms, rather than being assumed by them. The scaling of inductive support via the real numbers is surely a reasonable way to go. Axiom 1 is a non-triviality requirement. It says that the support values cannot be the same for all sentence pairs. This axiom merely rules out the trivial support function that assigns the same amount of support to each sentence by every sentence. One might replace this axiom with the following rule: Axiom 2 asserts that when B logically entail A, the support of A by B is as strong as support can possibly be. This comports with the idea that an inductive support function is a generalization of the deductive entailment relation, where the premises of deductive entailments provide the strongest possible support for their conclusions. This is an especially weak axiom. But taken together with the other axioms, it suffices to entail that logically equivalent sentences support all sentences to precisely the same degree. Axiom 4 says that inductive support adds up in a plausible way. When C logically entails the incompatibility of A and B, i. The only exception is in those cases where C acts like a logical contradiction and supports all sentences to the maximum possible degree in deductive logic a logical contradiction logically entails every sentence. Read this way, axiom 5 then says the following. Suppose B is true in proportion q of all the states of affairs where C is true, and suppose A is true in fraction r of those states where B and C are true together. Then A and B should be true together in what proportion of all the states where C is true? The degree to which a sentence B supports a sentence A may well depend on what these sentences mean. In particular it will usually depend on the meanings we associate with the non-logical terms those terms other than the logical terms not, and, or, etc. However, evidential support functions should not presuppose meaning assignments in the sense of so-called secondary intensionsâ€"e. Thus, the meanings of terms we associate with a support function should only be their primary intensions, not their secondary intensions. In the context of inductive logic it makes good sense to supplement the above axioms with two additional axioms. Here is the first of them: The idea behind axiom 6 is that inductive logic is about evidential support for contingent claims. Nothing can count as empirical evidence for or against non-contingent truths. In particular, analytic truths should be maximally supported by all premises C. One important respect in which inductive logic should follow the deductive paradigm is that the logic should not presuppose the truth of contingent statements. If a statement C is contingent, then some other statements should be able to count as evidence against C. This is no way for an inductive logic to behave. The whole idea of inductive logic is to provide a measure of the extent to which premise statements indicate the likely truth-values of contingent conclusion statements. Such probability assignments would make the inductive logic enthymematic by hiding significant premises in inductive support relationships. It would be analogous to permitting deductive arguments to count as valid in cases where the explicitly stated premises are insufficient to logically entail the conclusion, but where the validity of the argument is permitted to depend on additional unstated premises. This is not how a rigorous approach to deductive logic should work, and it should not be a common practice in a rigorous approach to inductive logic. Nevertheless, it is common practice for probabilistic logicians to sweep provisionally accepted contingent claims under the rug by assigning them probability 1 regardless of the fact that no explicit evidence for them is provided. Although this convention is useful, such probability functions should be considered mere abbreviations for proper, logically explicit, non-enthymematic, inductive support relations. Some Bayesian logicists have proposed that an inductive logic might be made to depend solely on the logical form of sentences, as is the case for deductive logic. The idea is, effectively, to supplement axioms 1â€"7 with additional axioms that depend only on the logical structures of sentences, and to introduce enough such axioms to reduce the number of possible support functions to a single uniquely best support function. It is now widely agreed that this project cannot be carried out in a plausible way. Perhaps support functions should obey some rules in addition to axioms 1â€"7. But it is doubtful that any plausible collection of additional rules can suffice to determine a single, uniquely qualified support function. Later, in Section 3 , we will briefly return to this issue, after we develop a more detailed account of how inductive probabilities capture the relationship between hypotheses and evidence. The issue of which of the possible truth-value assignments to a language represents the actual truth or falsehood of its sentences depends on more than this. It depends on the meanings of the non-logical terms and on the state of the actual world. Similarly, the degree to which some sentences actually support others in a fully meaningful language must rely on something more than the mere satisfaction of the axioms for support functions. It must, at least, rely on what the sentences of the language mean, and perhaps on much more besides. Perhaps a better understanding of what inductive probability is may provide some help by filling out our conception of what inductive support is about. There will not generally be a single privileged way to define such a measure on possible states of affairs. This idea needs more fleshing out, of course. The next section will provide some indication of how that might go. Subjectivist Bayesians offer an alternative reading of the support functions. First, they usually take unconditional probability as basic, and take conditional probabilities as defined in terms of unconditional probabilities: Subjectivist Bayesians usually tie such belief strengths to how much money or how many units of utility the agent would be willing to bet on A turning out to be true. Roughly, the idea is this. These relationships between belief-strengths and the desirability of outcomes e. Subjectivist Bayesians usually take inductive probability to just be this notion of probabilistic belief-strength. Undoubtedly real agents do believe some claims more strongly than others. And, arguably, the belief strengths of real agents can be measured on a probabilistic scale between 0 and 1, at least approximately. In any case, some account of what support functions are supposed to represent is clearly needed. The belief function account and the logicist account in terms of measures on possible states of affairs are two attempts to provide this account. But let us put this interpretative issue aside for now. One may be able to get a better handle on what inductive support functions really are after one sees how the inductive logic that draws on them is supposed to work. The Application of Inductive Probabilities to the Evaluation of Scientific Hypotheses One of the most important applications of an inductive logic is its treatment of the evidential evaluation of scientific hypotheses. The logic should capture the structure of evidential support for all sorts of scientific hypotheses, ranging from simple diagnostic claims e. This section will show how evidential support functions a. Bayesian confirmation functions represent the evidential evaluation of scientific hypotheses and theories. This logic is essentially comparative. The evaluation of a hypothesis depends on how strongly evidence supports it over alternative hypotheses. The collection of alternatives may be very simple, e. Whenever two variants of a hypothesis or theory differ in empirical import, they count as distinct hypotheses.

THE LOGIC OF TYPED FEATURE STRUCTURES pdf

2: Logic - Wikipedia

The Logic of Typed Feature Structures is the first monograph that brings all the main theoretical ideas into one place where they can be related and compared in a unified setting.

The added notations may include transcriptions of all sorts from pho While there are several ongoing efforts to provide formats and tools for such annotations and to publish annotated linguistic databases, the lack of widely accepted standards is becoming a critical problem. Proposed standards, to the extent they exist, have focused on file formats. This paper focuses instead on the logical structure of linguistic annotations. We survey a wide variety of existing annotation formats and demonstrate a common conceptual core, the annotation graph. This provides a formal framework for constructing, mai Show Context Citation Context These AVMs could contain references to other parts of the annotation, and multiple AVMs could contain shared substructures. Substructures could be disjoined to represent th We explain why this is a desirable goal, and we present some conservative extensions to current practice in computational linguistics and in non-linear phonology wh We explain why this is a desirable goal, and we present some conservative extensions to current practice in computational linguistics and in non-linear phonology which we believe are necessary and sufficient for achieving this goal. We begin by exploring the application of typed feature logic to phonology and propose a system of prosodic types. Next, taking HPSG as an exemplar of the grammar frameworks we have in mind, we show how the phonology attribute can be enriched, so that it can encode multi-tiered, hierarchical phonological representations. Finally, we exemplify the approach in some detail for the nonconcatenative morphology of Sierra Miwok and for schwa alternation in French. The approach taken in this paper lends itself particularly well to capturing phonological generalisations in terms of high-level prosodic constraints. Phonology in Constraint-Based Grammar Classical generative phonology is couched within the same set of assumptions that dominated standard transformational grammar. While this work has an increasingly declarative flavour, most versions retain procedural devices for repairing representations that fail to meet certain constraints, or for constraints to override each other. This view is in marked contrast to the interpretation A partial ordering over the types gives rise to an inheritance hierarchy of constraints. Ontologies allow the abstract conceptualisation of domains, but a given domain can be conceptualised through many different ontologies, which can be problematic when ontologies are used to support knowledge sharing. We present a formal account of ontologies that is intended to support knowledg We present a formal account of ontologies that is intended to support knowledge sharing through precise characterisations of relationships such as compatibility and refinement. We take an algebraic approach, in which ontologies are presented as logical theories. This allows us to characterise relations between ontologies as relations between their classes of models. A major result is cocompleteness of specifications, which supports merging of ontologies across shared sub-ontologies. Various feature descriptions are being employed in logic programming languages and constrained-based grammar formalisms. The common notational primitive of these descriptions are functional attributes called features. The descriptions considered in this paper are the possibly quantified first-order The descriptions considered in this paper are the possibly quantified first-order formulae obtained from a signature of binary and unary predicates called features and sorts, respectively. We establish a first-order theory FT by means of three axiom schemes, show its completeness, and construct three elementarily equivalent models. One of the models consists of so-called feature graphs, a data structure common in computational linguistics. The other two models consist of so-called feature trees, a record-like data structure generalizing the trees corresponding to first-order terms. Our completeness proof exhibits a terminating simplification system deciding validity and satisfiability of possibly quantified feature descriptions. Section 3 defines the theory FT by means of three axiom schemes. Section 4 establishes the o CFT is a recent constraint system providing records as a logical data structure for logic programming and for natural language processing. It combines the rational tree system as defined for logic programming with the feature tree system as used in natural language processing. The formulae considered in this paper are all first-order-logic formulae over a signature of binary and unary predicates called features and arities, respectively. We establish the theory CFT by means of seven axiom schemes and show its completeness. Our completeness proof exhibits a terminating simplification system deciding validity and satisfiability of possibly quantified record descriptions. Order-sorted feature OSF terms provide an adequate representation for objects as flexible records. They are sorted, attributed, possibly nested, structures, ordered thanks to a subsort ordering. Sort definitions offer the functionality of classes imposing structural constraints on objects. These constraints involve variable sorting and equations among feature paths, including self-reference. Formally, sort definitions may be seen as axioms forming an OSF theory. OSF theory unification is the process of normalizing an OSF term, using sort-unfolding to enforce structural constraints imposed on sorts by their definitions. It allows objects to inherit, and thus abide by, constraints from their classes. A formal system is thus obtained that logically models record objects with recursive class definitions accommodating multiple inheritance. We show that OSF theory unification is undecidable in general. However, we propose a set of confluent normalization rules which is complete for detecti Unsupervised learning of morphology without morphemes by Sylvain Neuvel, Sean A. LEARN , " The first morphological learner based upon the theory of Whole Word Morphology Ford et al. The program, Whole Word Morphologizer, takes a POS-tagged lexicon as input, induces morphological relationships without attempting to disc The program, Whole Word Morphologizer, takes a POS-tagged lexicon as input, induces morphological relationships without attempting to discover or identify morphemes, and is then able to generate new words beyond the learning sample. Some of these systems e. ConTroll is a grammar development system which supports the implementation of current constraint-based theories. It uses strongly typed feature structures as its principal data structure and offers definite relations, universal constraints, and lexical rules to express grammar constraints. The aspects of ConTroll of relevance to the development of large grammars are discussed in detail. The system is fully implemented and has been used as workbench to develop and test a large HPSG grammar. The practical effect of this is that Troll implements an exhaustive typing strategy which provides the stronger kind of inferencing over descriptions Gerdemann and King, , required by st Feature trees generalize first-order trees whereby argument positions become keywords "features" from an infinite symbol set F. Constructor symbols can occur with any argument positions, in any finite number. Feature trees are used to model flexible records; the assumption on the inf Feature trees are used to model flexible records; the assumption on the infiniteness of F accounts for dynamic record field updates. They form the semantics of record calculi like [AK86], which are used in symbolic programming languages [AKP91b] and in computational linguistics cf. In the logical framework for record structures of [BS92], they constitute the interpretation of a completely axiomatizable, and hence decidable, first-order theory. We introduce a constraint system called FT. This system offers a theoretical and practical alternative to the usual Herbrand system of constraints over constructor trees. Like Herbrand, FT provides a universal data structure based on trees. However, the trees of FT called feature trees are more g However, the trees of FT called feature trees are more general than the constructor trees of Herbrand, and the constraints of FT are of finer grain and of different expressiveness. The feature tree structure determines an algebraic semantics for FT. We establish a logical semantics thanks to three axiom schemes presenting the first-order theory FT. We propose using FT as a constraint system for logic programming. We provide a test for constraint unsatisfiability, and a test for constraint entailment. The former corresponds to unification

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3: Six Logical Writing Structures | www.enganchecubano.com

The outcome was the adoption of typed feature structures [Carpenter,], which offer the advantage to encode precisely each type of information and, when necessary, to structure it into a.

This kind of logical relation is called an entailment. An entailment is a logical relation between or among propositions such that the truth of one proposition is determined by the truth of another proposition or other propositions, and this determination is a function solely of the meaning and syntax of the propositions concerned. Another way to remember the difference between an inference and an entailment is to note that people infer something, and propositions entail something. The argument structure is the sum and substance of logic. All that remain in this course is to sketch out a bit of what this means. We have spoken earlier of the relation between or among propositions. What is a proposition or statement we will use these words interchangeably? Hence logic is just concerned with those statements that have truth-values. There is very much of life that is irrelevant to logic. Consider the confusion that would result if we considered the following sentences as statements: Then, if ever, come perfect days Thus, phatic communication, greetings, commands, requests, and poetry, among other uses of language, are not mean to be taken as statements. Which of the following sentences are statements? There is iron ore on the other side of Pluto. Tomorrow, it will rain. Open the door, please. You should vote in all important elections. More distinctions with regard to statements are worth suggesting. Consider whether there are two statements in the box: A Republican is President of the U. Aside from the ambiguity of when the statements are uttered, of which President is being spoken, and so on, we would say that there is one statement and two sentences in the box. Sometimes logicians make a distinction between a sentence token the ink, chalk marks, or pixels and a sentence type the meaning of the marks. Every statement comes with an implicit time, place, and reference. Summary of the distinction between a sentence and a statement assumes that adequate synonymy of expression and translation between languages is possible. One statement can be expressed by two different sentences. A sentence can express different statements at different times. A statement is independent of the language in which it is asserted, but a sentence is specific to the language in which it is expressed. A sentence can express an argument composed of several statements. Normally, the sentence would be considered as being composed of two premises and a conclusion. Thus, this sentence would be composed of three statements.

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4: Structure (mathematical logic) - Wikipedia

This book develops the theory of typed feature structures and provides a logical foundation for logic programming and constraint-based reasoning systems.

Modal logic In languages, modality deals with the phenomenon that sub-parts of a sentence may have their semantics modified by special verbs or modal particles. For example, "We go to the games" can be modified to give "We should go to the games", and "We can go to the games" and perhaps "We will go to the games". More abstractly, we might say that modality affects the circumstances in which we take an assertion to be satisfied. Confusing modality is known as the modal fallacy. His work unleashed a torrent of new work on the topic, expanding the kinds of modality treated to include deontic logic and epistemic logic. The seminal work of Arthur Prior applied the same formal language to treat temporal logic and paved the way for the marriage of the two subjects. Saul Kripke discovered contemporaneously with rivals his theory of frame semantics , which revolutionized the formal technology available to modal logicians and gave a new graph-theoretic way of looking at modality that has driven many applications in computational linguistics and computer science , such as dynamic logic. Informal reasoning and dialectic[edit] Main articles: Informal logic and Logic and dialectic The motivation for the study of logic in ancient times was clear: This ancient motivation is still alive, although it no longer takes centre stage in the picture of logic; typically dialectical logic forms the heart of a course in critical thinking , a compulsory course at many universities. Dialectic has been linked to logic since ancient times, but it has not been until recent decades that European and American logicians have attempted to provide mathematical foundations for logic and dialectic by formalising dialectical logic. Dialectical logic is also the name given to the special treatment of dialectic in Hegelian and Marxist thought. There have been pre-formal treatises on argument and dialectic, from authors such as Stephen Toulmin The Uses of Argument , Nicholas Rescher Dialectics , [32] [33] [34] and van Eemeren and Grootendorst Pragma-dialectics. Theories of defeasible reasoning can provide a foundation for the formalisation of dialectical logic and dialectic itself can be formalised as moves in a game, where an advocate for the truth of a proposition and an opponent argue. Such games can provide a formal game semantics for many logics. Argumentation theory is the study and research of informal logic, fallacies, and critical questions as they relate to every day and practical situations. Specific types of dialogue can be analyzed and questioned to reveal premises, conclusions, and fallacies. Argumentation theory is now applied in artificial intelligence and law. Mathematical logic Mathematical logic comprises two distinct areas of research: Mathematical theories were supposed to be logical tautologies , and the programme was to show this by means of a reduction of mathematics to logic. If proof theory and model theory have been the foundation of mathematical logic, they have been but two of the four pillars of the subject. Recursion theory captures the idea of computation in logical and arithmetic terms; its most classical achievements are the undecidability of the Entscheidungsproblem by Alan Turing , and his presentation of the Churchâ€"Turing thesis. Most philosophers assume that the bulk of everyday reasoning can be captured in logic if a method or methods to translate ordinary language into that logic can be found. Philosophical logic is essentially a continuation of the traditional discipline called "logic" before the invention of mathematical logic. Philosophical logic has a much greater concern with the connection between natural language and logic. As a result, philosophical logicians have contributed a great deal to the development of non-standard logics e. Logic and the philosophy of language are closely related. Philosophy of language has to do with the study of how our language engages and interacts with our thinking. Logic has an immediate impact on other areas of study. Studying logic and the relationship between logic and ordinary speech can help a person better structure his own arguments and critique the arguments of others. Many popular arguments are filled with errors because so many people are untrained in logic and unaware of how to formulate an argument correctly. Computational logic and Logic in computer science A simple toggling circuit is expressed using a logic gate and a synchronous register. Logic cut to the heart of computer science as it emerged as a discipline: The notion of the general purpose computer that came from this work was of fundamental importance to the designers of the computer machinery in the s. In the s and s, researchers predicted that when human knowledge could be expressed using logic with mathematical notation , it would be possible to create a machine that reasons, or artificial intelligence. This was more difficult than expected because of the complexity of human reasoning. In logic programming , a program consists of a set of axioms and rules. Logic programming systems such as Prolog compute the consequences of the axioms and rules in order to answer a query. Today, logic is extensively applied in the fields of artificial intelligence and computer science , and these fields provide a rich source of problems in formal and informal logic. Argumentation theory is one good example of how logic is being applied to artificial intelligence. Boolean logic as fundamental to computer hardware:

5: Aristotle's Logic (Stanford Encyclopedia of Philosophy)

The Logic of Typed Feature Structures by Robert L. Carpenter, , available at Book Depository with free delivery worldwide.

Think of structure as the skeleton of a piece of writing. It is the bare bones of the piece, all connected to form a solid, uniform foundation upon which you, the writer and the creator, will build something unique. Humans, for example, all have nearly identical basic skeletons. Remember being assigned five-paragraph essays on your first day back to grade school every fall? This general format is the root of the six common writing structures that can be used for both formal and informal written communication. In a categorical structure, a series of equally important topics are addressed. A political speech, like a campaign speech or even The State of the Union Address, is a good example of categorical writing. You might use a similar structure in a cover letter for a job application, in which you describe all of your traits that would make you an ideal candidate for the position. In an evaluative structure, a problem is introduced, and then pros and cons are weighed. You might employ an evaluative structure when writing an e-mail to ask a close friend for advice. When your focus is more the actual telling of the story than the end result, employ a chronological structure. Think of joke telling. Similarly, most short stories and novels are written chronologically. This structure is similar to evaluative, but it is used when there are more layers to the situation at hand that is being weighed. This structure is similar to Chronological, but is normally employed with a how-to voice when a step-by-step process is being described. If you were going to write about how to make your famous chocolate layer cake, or how to get to a great bed-and-breakfast you discovered out in the country, you would write sequentially, using words like, "First," "Next," "Then," and "Finally" to clarify your instructions. This structure might at first glance seem similar to Comparative structures, but it differs in that it does not involve weighing options against one another. Instead, it discusses the causes and then the effects regarding a particular topic or issue in that order. You might use this structure if you were writing an article on how something has come about, such as the contributing factors to air pollution. Or you might employ this technique in a letter explaining why you have decided to resign from your job. Now that you know about the different kinds of structures, start paying attention to the skeletons of all the pieces of writing around you. You might also like:

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6: www.enganchecubano.com | The Logic of Typed Feature Structures, Robert L. Carpenter | | Boeken

Feature Structures and Path Congruences. The discussion of abstract feature structures raises a historical difficulty. While I do not dispute that the full theoretical investigation of feature structures modulo renaming is correctly attributed to Moshier, the idea of representing renaming classes by.

No deduction has two negative premises No deduction has two particular premises A deduction with an affirmative conclusion must have two affirmative premises A deduction with a negative conclusion must have one negative premise. A deduction with a universal conclusion must have two universal premises He also proves the following metatheorem: All deductions can be reduced to the two universal deductions in the first figure. His proof of this is elegant. First, he shows that the two particular deductions of the first figure can be reduced, by proof through impossibility, to the universal deductions in the second figure: This proof is strikingly similar both in structure and in subject to modern proofs of the redundancy of axioms in a system. Many more metatheoretical results, some of them quite sophisticated, are proved in Prior Analytics I. In contrast to the syllogistic itself or, as commentators like to call it, the assertoric syllogistic , this modal syllogistic appears to be much less satisfactory and is certainly far more difficult to interpret. Aristotle gives these same equivalences in On Interpretation. However, in Prior Analytics, he makes a distinction between two notions of possibility. He then acknowledges an alternative definition of possibility according to the modern equivalence, but this plays only a secondary role in his system. Most often, then, the questions he explores have the form: A premise can have one of three modalities: Aristotle works through the combinations of these in order: Two necessary premises One necessary and one assertoric premise Two possible premises One assertoric and one possible premise One necessary and one possible premise Though he generally considers only premise combinations which syllogize in their assertoric forms, he does sometimes extend this; similarly, he sometimes considers conclusions in addition to those which would follow from purely assertoric premises. Since this is his procedure, it is convenient to describe modal syllogisms in terms of the corresponding non-modal syllogism plus a triplet of letters indicating the modalities of premises and conclusion: The conversion rules for necessary premises are exactly analogous to those for assertoric premises: Aristotle generalizes this to the case of categorical sentences as follows: This leads to a further complication. Such propositions do occur in his system, but only in exactly this way, i. Such propositions appear only as premises, never as conclusions. He does not treat this as a trivial consequence but instead offers proofs; in all but two cases, these are parallel to those offered for the assertoric case. The exceptions are Baroco and Bocardo, which he proved in the assertoric case through impossibility: A very wide range of reconstructions has been proposed: Malink , however, offers a reconstruction that reproduces everything Aristotle says, although the resulting model introduces a high degree of complexity. This subject quickly becomes too complex for summarizing in this brief article. From a modern perspective, we might think that this subject moves outside of logic to epistemology. However, readers should not be misled by the use of that word. We have scientific knowledge, according to Aristotle, when we know: The remainder of Posterior Analytics I is largely concerned with two tasks: Aristotle first tells us that a demonstration is a deduction in which the premises are: Aristotle clearly thinks that science is knowledge of causes and that in a demonstration, knowledge of the premises is what brings about knowledge of the conclusion. The fourth condition shows that the knower of a demonstration must be in some better epistemic condition towards them, and so modern interpreters often suppose that Aristotle has defined a kind of epistemic justification here. However, as noted above, Aristotle is defining a special variety of knowledge. Comparisons with discussions of justification in modern epistemology may therefore be misleading. In Posterior Analytics I. Whatever is scientifically known must be demonstrated. The premises of a demonstration must be scientifically known. They then argued that demonstration is impossible with the following dilemma: If the premises of a demonstration are scientifically known, then they must be demonstrated. The premises from which each premise are demonstrated must be scientifically known. Either this process continues forever, creating an infinite regress of premises, or it comes to a stop at some point. If it continues forever, then there are no first premises from which the subsequent ones are demonstrated, and so nothing is demonstrated. On the other hand, if it comes to a stop at some point, then the premises at which it comes to a stop are undemonstrated and therefore not scientifically known; consequently, neither are any of the others deduced from them. Therefore, nothing can be demonstrated. Aristotle does not give us much information about how circular demonstration was supposed to work, but the most plausible interpretation would be supposing that at least for some set of fundamental principles, each principle could be deduced from the others. Some modern interpreters have compared this position to a coherence theory of knowledge. However, he thinks both the agnostics and the circular demonstrators are wrong in maintaining that scientific knowledge is only possible by demonstration from premises scientifically known: To solve this problem, Aristotle needs to do something quite specific. It will not be enough for him to establish that we can have knowledge of some propositions without demonstrating them: Moreover and obviously , it is no solution to this problem for Aristotle simply to assert that we have knowledge without demonstration of some appropriate starting points. He does indeed say that it is his position that we have such knowledge An. There is wide disagreement among commentators about the interpretation of his account of how this state is reached; I will offer one possible interpretation. What he is presenting, then, is not a method of discovery but a process of becoming wise. The kind of knowledge in question turns out to be a capacity or power dunamis which Aristotle compares to the capacity for sense-perception: Likewise, Aristotle holds, our minds have by nature the capacity to recognize the starting points of the sciences. In the case of sensation, the capacity for perception in the sense organ is actualized by the operation on it of the perceptible object. Similarly, Aristotle holds that coming to know first premises is a matter of a potentiality in the mind being actualized by experience of its proper objects: So, although we cannot come to know the first premises without the necessary experience, just as we cannot see colors without the presence of colored objects, our minds are already so constituted as to be able to recognize the right objects, just as our eyes are already so constituted as to be able to perceive the colors that exist. It is considerably less clear what these objects are and how it is that experience actualizes the relevant potentialities in the soul. Aristotle describes a series of stages of cognition. First is what is common to all animals: Next is memory, which he regards as a retention of a sensation: Even fewer have the next capacity, the capacity to form a single experience empeiria from many repetitions of the same memory. Finally, many experiences repeated give rise to knowledge of a single universal katholou. This last capacity is present only in humans. Definitions The definition horos, horismos was an important matter for Plato and for the Early Academy. External sources sometimes the satirical remarks of comedians also reflect this Academic concern with definitions. Aristotle himself traces the quest for definitions back to Socrates. What has an essence, then? In general, however, it is not individuals but rather species eidos: A species is defined by giving its genus genos and its differentia diaphora: As an example, human might be defined as animal the genus having the capacity to reason the differentia. However, not everything essentially predicated is a definition. Such a predicate non-essential but counterpredicating is a peculiar property or proprium idion. Aristotle sometimes treats genus, peculiar property, definition, and accident as including all possible predications e. Later commentators listed these four and the differentia as the five predicables, and as such they were of great importance to late ancient and to medieval philosophy e. Just what that doctrine was, and indeed just what a category is, are considerably more vexing questions. They also quickly take us outside his logic and into his metaphysics. Here are two passages containing such lists: These are ten in number: An accident, a genus, a peculiar property and a definition will always be in one of these categories. To give a rough idea, examples of substance are man, horse; of quantity: Categories 4, 1b25â€”2a4, tr. Ackrill, slightly modified These two passages give ten-item lists, identical except for their first members. Here are three ways they might be interpreted: First, the categories may be kinds of predicate: On this interpretation, the categories arise out of considering the most general types of question that can be asked about something: Thus, the categories may rule out certain kinds of question as ill-formed or confused. Second, the categories may be seen as classifications of predications, that is, kinds of relation that may hold between the predicate and the subject of a predication. For Aristotle, the relation of predicate to subject in these two sentences is quite different in this respect he differs both from Plato and from modern logicians. The categories may be interpreted as ten different ways in which a predicate may be related to its subject. Third, the categories may be seen as kinds of entity, as highest genera or kinds of thing that are. A given thing can be classified under a series of progressively wider genera: Socrates is a human, a mammal, an animal, a living being. The categories are the highest such genera. Each falls under no other genus, and each is completely separate from the others. Which of these interpretations fits best with the two passages above? The answer appears to be different in the two cases.

7: The Structure of Arguments

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8: Inductive Logic (Stanford Encyclopedia of Philosophy)

The Logic of Typed Feature Structures with Applications to Unification Grammars, Logic Programs and Constraint Resolution.

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