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The Logic Manual

Peter Millican, Hertford College, Oxford. These notes are also designed to be read in advance, without. However the theory is intended to follow what *The Logic Manual* laid down. I am very grateful to Volker Halbach for his willingness to check my text for accuracy, so that users.

My section numbers broadly follow those of the *Logic Manual* except that I generally divide the sections *The Logic Manual* into sub-sections. These points can cause confusion, both for novices *The Logic Manual* also for those who are used to different formal treatments; hence I have given additional space to them. Put crudely, a set is simply a collection of items, each of which is called a member or an element of that set. Sets are extensional which means that sets containing the same items i .

So the set of colours in the French flag which contains the three colours red, white and blue, is the same as the set of colours in the British flag — these are two different ways of referring to the very same set. A set may be specified extensionally by listing all of its elements, or intensionally by giving a rule.

All of the following are alternative ways of specifying the very same set — a to d are extensional specifications, and e to f intensional. Note that: We conventionally use capital letters to denote sets and lower case letters to denote their elements or members. *The Logic Manual* cardinality of a set *The Logic Manual*.

Set A is called a subset of set B if there is no element of A which is not also an element of B . Notice this implies that every set is a subset of itself; A is called a *The Logic Manual* subset of B if it is a subset of B but not identical to B . A is a proper subset of B . The set of aardvarks enrolled at Oxford University and the set of numbers greater than 3 and less than 1 both have no members whatever.

Since their membership is the same, they are therefore one and the same set. This unique set, the set which has no elements, is called the null set. Note that the null set is a subset of every set, because whichever set A you choose, there are no elements in the null set that are not also in A . Note also that any set containing n elements will have 2^n *The Logic Manual*, e.

Given any property, the extension *The Logic Manual* the property will be the set of objects to which it applies. We think of these as different properties, but they have the same extension. It seems, then, that having the same extension is not enough to guarantee sameness of property. Properties, as we usually understand them, are therefore intensional rather than extensional.

However properties can also be interpreted extensionally *The Logic Manual* i . On this understanding of the notion, the property of being an *The Logic Manual* number between 3 and 8 inclusive is exactly the same property as the property of being a prime number between 3 and 8 inclusive. Likewise — and perhaps seemingly paradoxically — on this understanding the property of being a man weighing over a tonne is exactly the same property as the property of being a man weighing less than a kilogram.

To repeat, however, as far as we are concerned here, properties *The Logic Manual* intensional also that it is possible to have two different properties with the same extension. So the extension of a binary relation is a set of ordered pairs in this case. In the same way, the extension of a ternary relation will be a set of ordered triples, and so on. On the extensional understanding of relations, these two relations are one and the same: as far as this *The Logic Manual* is concerned, knowing someone is loving them!

This no doubt seems counter-intuitive, but don't let it worry you at all. Just think of it as a formal convenience, which enables us to do our work without worrying about the metaphysical nature of relations: all we're interested in when we handle them in logic is which pairs of objects or triples etc.

From *The Logic Manual* on, we shall treat binary relations extensionally, and therefore as equivalent to sets of ordered pairs and, correspondingly, ternary relations as sets of ordered triples, and so on.

Consistently with this, we shall treat unary relations extensionally also — so they will not be equivalent to properties which we are interpreting intensionally. A set is a binary relation if and only if it contains only ordered pairs. Hence we *The Logic Manual* also call *The Logic Manual* null set the null relation.

Here are some examples of non-null binary relations. In each case a description is given to explain how the choice of pairs has been made. But notice that as we are understanding them, a relation is a set of ordered pairs, and the description is quite inessential to it: any other description that captured the *The Logic Manual* set would do just as well.

As we shall understand relations, they are simply sets of n -tuples. Relation i . Set of Ordered *The Logic Manual*. So as we are understanding relations here — as simple sets of ordered pairs — a relation will never be said to be reflexive absolutely, but only reflexive on a set and a different *The Logic Manual* might give a different result.

Note that irreflexive is not defined in the *Logic Manual* and not required for the course. The null set contains no elements at all, hence trivially it follows that all of its elements are even numbers, all of its elements are pink elephants, etc.

It can be easier to understand this negatively: to say that all elements of a set are pink elephants is to say that there is no element of the set that is not a pink elephant. Then it is clear that this will automatically be true if S is the null set. Note The Logic Manual intransitive and non-transitive are not defined in the Logic Manual and not required for the course.

We have now seen that symmetry, asymmetry, antisymmetry The Logic Manual, and transitivity unlike reflexivity can all be understood in a form that is not relative to any particular set.

Here is what the corresponding unrelativised definition would be like, as given by Halbach in The Logic Manual text following Definition 1. A binary relation R is. However some logicians prefer to define these concepts like reflexivity as relativised to a set. Then the unrelativised notions are defined in terms of the relativised notions, as follows:

If a relation is reflexive on set S , symmetric on S and transitive on S then it is called an equivalence relation on set S . Note that an equivalence relation is reflexive; hence it is not possible to have an unrelativised notion of an equivalence relation. A binary relation R is an equivalence relation on S iff R is reflexive on S . Take the case of d above, for example: Binary relations can often be represented using an arrow diagram in which:

Using arrow diagrams to represent binary relations can help to make clear the significance of the various properties defined above. Note that with the properties other than reflexivity, the notions can be understood as relativised to set S by restricting attention to arrows that both start and end at objects within set S .

The diagram can include other objects as well. Clearly any relation that The Logic Manual an infinite number of pairs cannot be represented by an arrow diagram! That is, there are no two-step journeys which lack a short cut.

Some of these properties are related in surprising ways. So there are no two-step journeys at all and hence none which either lack, or have, a direct short cut. It is indeed worth remembering the strange properties of the null relation, which is reflexive on the null set but not on any other set, symmetric The Logic Manual, asymmetric, antisymmetric, transitive and intransitive. The Logic Manual says, in effect, that in the arrow diagram of a function, you can never have two distinct arrows.

We can do this only because each of these is well-defined: a number has one, and only one, cube root or square for example. It just means that there are some numbers for which The Logic Manual function is not defined, or. Functions are of particular interest in mathematics, because they can take. This is a well-defined function, because nobody has more than one biological mother.

And here we can distinguish between the domain of the function f . R is a function into the set M The Logic Manual and only if all elements of the range of the function are in M . The Logic Manual following definition exploits this feature of functions.

If d is in the domain of a function R one writes $R(d)$ for the unique object e . Binary relations, as we have seen, consist of sets of ordered pairs.

In the same way, ternary 3-place relations consist of ordered triples, and so on. So a binary relation has arity 2, a ternary relation has arity 3, and so on. An The Logic Manual way of dealing with this sort of situation would be to say that someone whose eldest children are born simultaneously has The Logic Manual eldest child. The logical notion of an argument is, of course, quite different from the conversational notion of a row, or heated dispute, or disagreement.

So here is an example of an argument in this sense: John is studying Physics at Oxford University. So John cannot be a mature student. We could therefore represent the argument above in The Logic Manual following simplified form. Everyone studying at Oxford University either has A-levels or is a mature student. This suggests a provisional definition of what an argument is, but we shall soon go on to refine it: An argument consists of a set of premisses, together with a. We need to refine this by getting a bit clearer on what exactly a premiss and conclusion are.

Are they The Logic Manual — and if so, what are they? Or are they sentences? We shall in fact The Logic Manual opting for a subset of the latter, namely declarative sentences but it might be helpful first to explain why.

Propositions, Declarative Sentences, and Logical Form. In the previous section, the word proposition was used for the The Logic Manual of an argument. This is. On this understanding, we say that a proposition is expressed by a. The following sentences, for example, seem to state that some determinate state of affairs.

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The deal is subject to regulatory approval; Cogeco expects it to close by February The Logic. The Globe and Mail. Login with The Logic Manual.

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