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And AND *or*: MEET AND/OR JOIN?
A PROBLEM IN THE SEMANTICS OF (NON-)PROPOSITIONAL CONNECTIVES*

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1. THE PROBLEM

In their role as propositional connectives, the English particles *and* and *or* and their counterparts in other languages[1] are traditionally and successfully modeled by meet (infimum) and join (supremum) operations[2], respectively, on the constituent propositions. If the latter are modeled by sets, for instance sets of possible worlds, the relevant ordering is set inclusion and therefore meet amounts to intersection and join to union. The same particles, however, in English and in quite a few other languages serve also as connectives of referring expressions, and as such, they seem to need a different treatment: *John and Mary* can only denote the join of John and Mary (or a pair set, the union of their singletons), since their meet (or the intersection of their singletons) is empty (provided they are not Siamese twins).[3]

And even if the meet is not empty, as with *Americans and Germans*, the conjoined construction doesn't denote the set of individuals that happen to have both nationalities, the intersection of the corresponding sets, but their union. So one part of the problem is: Why does non-propositional *and* denote what propositional *or* denotes, namely join (union)? One could resolve this by simply stipulating that *and* is homophonous. But this is not a very attractive solution for linguists, since there is no indication that the two readings share shape by accident, and above all, it does not resolve the other part of the problem: If *John and Mary* denotes the join of John and Mary, what does *John or Mary* denote? The homophony assumption for *and* would not only entail that *or* is homophonous as well, but also that propositional *or* is the dual of propositional *and*, whereas non-propositional *or* is not only different from the dual of non-propositional *and*, but bears to it a rather mysterious relation. So the chief criterion of adequacy for an acceptable solution is that in *a and b* the connective denotes basically the same operation, whatever the denotation of *a* and *b*, and similarly for *a or b*.[4]

2. OUTLINE OF A SOLUTION

The way out of the problem proposed and discussed in this paper is to have the cake and to eat it too, treating both propositional and non-propositional *and* uniformly as denoting union as well as intersection, and keeping the role of dual counterpart for all kinds of *or*. The price that has to be paid is that two different levels of representation are needed. The more basic level of representation is a powerset algebra of sets of urelements where individuals are modeled by sets: singular individuals by singletons, and plural individuals by non-singletons.

The second level of representation is a powpowerset algebra, namely the powerset of the powerset used on the first level. Here, individuals are modeled by sets of sets of urelements, namely for each first-level individual by the set of its supersets, also called the principal filter generated by it.[5] Intuitively, this corresponds to the set of individuals the given individual is a constituent of. The difference between singular and plural individuals is reflected on this level by the difference between principal ultrafilters and other principal filters. Accordingly, *John and Mary* denotes the principal filter that is the intersection of the principal ultrafilters generated by the singletons of John and of Mary; it coincides with the principal filter generated by the pair set of John and Mary.

If we represent propositions analogously, namely each proposition by the set of propositions that contain or entail it, the first problem is solved and the unity of propositional and non-propositional *and* is saved. But the second problem is solved as well, provided we let *John or Mary* denote the union of the denotations of its constituents, i.e., of the principal ultrafilters generated by the singletons of John and of Mary. This union is not a principal filter anymore, since it has two minimal elements. If we decide to let sets with several minimal elements represent indeterminate objects, this is exactly what we want: *John or Mary* denotes an indeterminate object that may be specified either as John or as Mary.

3. AN ELABORATION AND FURTHER PROBLEMS

3.1. Propositions and their truth

The ontology presupposed here for the elaboration of the basic idea is a rather simple one. It consists of a very broadly conceived set of entities, called cases, with a proper subset, called concepts, and a relation between the cases and the concepts called 'instantiation'; its converse is called 'characterization'. (This motivates the terminological choice: If some x instantiates some concept y, or conversely y characterizes x, we also say: x is a case of y. Intuitively, cases are everything that can be characterized, individuals, events, propositions, etc.) Cases that can only be characterized but cannot characterize themselves are called proper cases. So the concepts are just the improper cases or the possible characterizers. Cases are partially ordered by constituency. If a case contains another case as a constituent, we call the former a supercase of the latter and the latter a subcase of the former. Since stronger concepts are constituted by weaker ones, their superconcepts, this means that if x is a superconcept of y, or, equivalently, if y is a subconcept of x, then x is a subcase of y, or, equivalently, y is a supercase of x. So the concept *hemlock* is a supercase of the concept *tree* since it contains this concept (one of its superconcepts) as a notional constituent.

This basic ontology is modeled on the first level of representation by sets, with set inclusion modeling constituency. Note that the setup is strongly intensional in that concepts are not modeled by sets of cases and therefore the instantiation relation cannot be modeled by set membership. So we have to postulate that *ins*, our first level instantiation relation, is right downward monotonous since if some case x instantiates some concept y, it is an analytical truth that it instantiates all superconcepts or subcases of y as well.

On the second level of representation, cases are modeled by sets of first-level cases, hence by sets of sets; consequently, subcases are modeled by supersets, and subconcepts by subsets. Whereas on the first level there are only determinate cases and determinate concepts, on the second level indeterminate cases and indeterminate concepts are allowed for, and therefore we must say something about how to lift the instantiation relation to the second level. A necessary condition for this relation *Ins* seems to be that at least one minimal element of the case first-level instantiates at least one minimal element of the concept.

But now we have to think about possible uses of the third Boolean operation, complementation, and here contrastive negation like *not Máry*, meaning *somebody else but not Mary*, seems a plausible candidate. If we define |*not A*| as |*A*|'-{Ø}, |*nobody*| as {Ø}, |*somebody*| as |*not nobody*|, |*only A*| as the set of minimal elements of |*A*|, and |*somebody else than A*| as |*not ónly A*|, then we get the desired equivalence of |*Not Máry came*| and |*Somebody else but not Mary came*|.

If we now compare |*John*| and |*John and not Mary*|, we see that the truth conditions are different, so the maximal elements have to enter the definition of *Ins* as well. It therefore reads as follows: A proposition *x Ins y* is true iff there are x' and y' such that (i) x' is a minimal element of x, (ii) y' is a minimal element of y, and (iii) x' *ins*tantiates y', and there are no x'' and y'' such that (i) x'' is a proper superset of a maximal element of x, (ii) y'' is a proper superset of a maximal element of y, and (iii) x'' *ins*tantiates y''. In other words, second level cases instantiate second level concepts iff at least a minimal element and at most a maximal element of the case instantiates at least a minimal element and at most a maximal element of the concept.

3.2. The problem of lost structure

Consider the following sentences:

(1) John or John and Mary will be able to do the job.
(2) John will be able to do the job.

Sentence (1) does not have the same truth conditions as (2), since if the job turns out to require two people, (1) may still be true, but (2) is clearly false. Our Boolean approach, however, by the so-called principle of absorption, cannot distinguish between the denotations of the noun phrases in (1) and in (2). The solution advocated here is in the spirit of Grice. It states that if a literal reading of what people say is obviously redundant, then what they mean is probably some other reading. So in one reading, (3) below is equivalent with (4), but what people mean is most often something like (5), and similarly, so I claim, for (1), (2), and (6).

(3) It's raining and raining and raining.
(4) It's raining.
(5) It's raining on and on.
(6) John will be able to do the job or John and Mary will.

On the narrow scope reading of *or*, (1) exhibits redundancy compared to (2), so what is meant by an utterance of (1) is probably a wide scope reading with a zero cataphora of the verb phrase after the first word, a reading paraphrased by (6). And there is no unnecessary reduncancy in (6), since its second conjunct does not entail the first one. The reason is that *be able to do the job* is not inherently distributive.[6]

3.3. The problems of plurality

Keenan and Faltz (cf. fn. 4) do not treat plurals, but they would have problems with properties like *gather*, which apply only to plural objects. By contrast, in the present approach non-distributivity is taken care of automatically: *John and Mary met* does not entail *John met and Mary met.* On the other hand, what we have a problem with is inherent distributivity. A plausible solution seems to require for inherently distributive concepts that they can only characterize singular cases, thus *John and Mary sneezed* can only be true with wide scope *and* and consequently entails *John sneezed and Mary sneezed.* In order to interpret a proposition where a concept is used to characterize a non-fitting case one has to break up the latter into its subcases until they fit. This is similar to the strategy required for interpreting seemingly inconsistent characterizations.

3.4. The problem of inconsistent characterizations

Incompatible concepts are mutually exclusive: If x is a husband, x is not a wife, if y is a boy, y is not a girl, if this is black, it is not white. Therefore, the conjunction of incompatible concepts should yield inconsistent characterizations, truthfully applicable only to the empty case as in (7), but we are nonetheless used to interpreting (8)-(10) also as contingent and not as contradictory sentences:

(7) Nothing is black and white.

(8) This is black and white.
(9) They are five boys and girls.
(10) John and Mary are husband and wife.
The least transparent case is (8), which shows no grammatical hints at an internal structure of the case to be characterized. The situation is less opaque with propositions like (9), where the internal structure of the case is indicated by the plural. The key to a solution of the seeming paradox is most conspicuous in cases like (10), where the internal structure not only of the concept but also of the case is clearly visible. In order to truthfully characterize non-empty cases by inconsistent concepts, one has to reanalyze the latter as consistent ones that are somehow related to the structure of their instantiations. We can do this by interpreting them as resulting not from concept but from case conjunction via concept abstraction.

Let us stipulate that for any propositon p open in x, $[x \mid p]$ is a concept that characterizes exactly those cases that satisfy p. Then the consistent readings of (8) and (9) are (8') and (9'):

(8') $|This|\ Ins\ [x \mid \exists y \exists z\ [x = y \cap z\ \&\ y\ Ins\ |black|\ \&\ z\ Ins\ |white|]]$

(9') $|They|\ Ins\ |five| \cap [x \mid \exists y \exists z\ [x = y \cap z\ \&\ y\ Ins\ |boy|\ \&\ z\ Ins\ |girl|]]$

These can be paraphrased as *This is partially black and partially white* and *They are five and part of them are boys and part of them are girls*, respectively.

4. CONCLUSION

The aim of this paper was to support the view that it is both possible and adequate to model the rather unrestricted applicablility of natural language connectives like *and* and *or* with the corresponding Boolean operators even where plurals, which seem to require a join interpretation of *and*, and other phenomena not discussed in (Keenan/Faltz 1985) enter the stage. For lack of space, however, the details will have to be spelled out elsewhere.

5. NOTES

* I am indebted to Godehard Link for helpful comments and criticism.

[1] For a discussion of the question of the universality of *and* see (Gil 1991).

[2] The meet or infimum of some given elements of an ordered set is the highest element on the ordering which is below all the given elements (their highest common subordinate); dually, the join or supremum of some elements of an ordered set is the lowest element on the ordering which is above all the given elements (their lowest common superordinate). Cf. Davey/Priestley 1990.

[3] Cf. Link's (1991) plural semantics with joins modeling plural individuals.

[4] This desideratum and the spirit of the approach is shared with (Keenan/Faltz 1985); the solution, however, differs in that it treats plurals and that it shares with Situation Semantics the strongly intensional setup.

[5] The same idea can be found in (Barwise/Cooper 1981:166); the difference is that they don't treat plural individuals and therefore model individuals only with principal ultrafilters.

[6] Even with an inherently distributive predicate such as *catch the flue*, a sentence like *John or John and Mary will catch the flue* may be non-equivalent with *John will catch the flue*, namely where ... *and nobody else* is understood, as in complete answers to constituent questions.

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