

SCALAR IMPLICATURE OF LOGICAL CONNECTIVES

Bogdan Babych

Ukrainian National Academy of Sciences

Ukrainian Lingua-Information Fund

E-mail: Babych@ffd.univ.kiev.ua

bvb2@cornell.edu

The analysis presented in this paper is based on the assumption that we need the theory of implicature which not only explains facts about language meanings but also allows to predict and calculate possible contextual meanings. Such goal certainly was not achieved in this paper but we hope that some steps in the right direction were made.

1. Truth-conditions , use, and implicature of “if”

The use of “if in ordinary language is not completely predicted by the truth-value table for logical implication.

A	if _(implic.)	B	
T	T	T	L1
T	T	F	L2
F	F	T	L3
F	T	F	L4

table1.

The objections are about the line L2 in the truth table when from the false antecedent follows the true consequent, and the whole expression should be true.

(1) I will give a book to you if I find it

cannot be true in case I not find a book but manage to give it to you somehow.

(2) You will receive a reward if you work hard

cannot mean that you will receive a reward anyway: the implicature of the connective “if” here brings the “equivalence meaning” to it: “if and only if”. It can be shown that this implicature is cancelable, suspendable and reinforcable, so it is a real conversational implicature. One can note that such implicature appears in cases when the elements joined by the connective is extralinguistically related between each other. It is the same situation when the connective “or” is used as “exclusive or” and the connective “and” -- as “consequential and” (meaning ‘and then’). Such new meanings of the connectives are due to implicature, so new truth-conditions are implicated, but not implied by the speaker. But generally, as a result of such implicature “and” and “or” loose their property to be transitive, and “if” becomes transitive instead (though it is controversial about the transitivity of “if and only if” in everyday speech: somehow the two following utterances appear to mean different things:

- “I will give you some pie if [and only if] you will find your mittens” *and*
- “You will find your mittens if [and only if] I will give you some pie”

In our paper we do not concentrate on the problem of inheriting transitivity and the role of the implicature in this process, but the possible explanation could be an overlapping of some “secondary implicature” on the new truth-values which were formed by another implicature previously.

But where does it come from? How these meanings can be predicted by the theory? This paper is supposed to explore this question, though as it will be shown the answer can not be easily found.

Still we can think about the context in which the use of “if” will satisfy the truth conditions on the table as they appear on the table 1.

Suppose, in the moment when George Byron’s noble relative has just died, George did not know about it (and, consequently, he could not imagine that he himself became an English Lord). Suppose that in such time he went to have dinner in a tavern, did not like soup which was served, and said:

(3) I am an English Lord if it is soup.

According to the truth conditions on table 1, at that moment George Byron was really an English Lord, so (3) could be true in any case: if the soup is either good or bad (L1 and L2): (3) should not tell us anything about the quality of the soup. But this is not what Byron really wanted to say. In our situation Byron and a waiter shared the belief that Byron could not be an English Lord under any circumstances: the truth value of A on table 1 was fixed to FALSE and only lines L3 and L4 could be employed here. So Byron uses “if” truth-conditionally.

But imagine that a minute ago the waiter received a note for George where he read: “Pour X just died. So pity. You became English Lord. Congratulations.” Is the waiter after hearing (3) in the position to say (4)?

(4) Oh, you see, read here. You are really English Lord. So pay for the soup, please, your Excellence.

Truth-conditionally -- no, though such response will seem natural for somebody. The beauty of implicature of the connective “if” is that in such situation truth-conditionally nothing is depended on the truth value of the antecedent in case the consequent is constantly true. In the particular situation the truth of Byron’s utterance does not depend on the quality of the soup. Implicating “if and only if” meaning from the connective “if” the speaker still is in the position to use the original truth-values of “if” strictly, so Byron may not pay reasonably: only the implicature requires from L2 to be different in the truth table, but not the content of “if”. So, we come to Principle 1:

(Pr1) “if” can be used both as “if_{implicative}” and “if_{equivalent}”, but the entailed truth-values of this connective still remain the same: only implicated truth-values are changed. The same situation can be found with other logical connectives -- “and” and “or”, as we will show further. Implicated truth values appear in contexts where two connected elements are related extralinguistically, but not only logically. The character of extralinguistic relation between these elements (e.g. temporal sequence, etc.) determines the nature of the implicated meanings. The implicated meanings of logical connectives, even if they change truth conditional table of the *used* item are always cancelable, suspendable and reinforcable.

(5) You will know who is phoning if you pick up the receiver.
 -- Implies only that it is impossible to you not to come to know who is phoning in case you pick up the receiver, but implicates that you do not have any other possible ways to know who is phoning: e.g. you do not have a special device on your phone by looking at which you could see the phone number from which the call comes. So implicature of “if” adds the additional requirement: this way and only this way. But it is possible, that there could be another way: e.g. there is such indicator on a phone, in this case the speaker can cancel, suspend or reinforce its implicature:

($\mathcal{S}_{\text{canceled}}$) ... but in fact, you may look on the indicator.

($\mathcal{S}_{\text{suspended}}$)... I am not sure if it is any other way to know it.

($\mathcal{S}_{\text{reinforced}}$)... and there is no other way to know it.

Further we argue that implicatures of the shown type are *scalar* implicatures. We explore the question how the direction on such scales can be predicted and, therefore, what are the conditions and restrictions to produce implicatures according to the position of the element on the scale.

2. The Shared Domains of logical connectives.

In the truth tables of logical connectives certain lines correspond to each other. This means that in case when the truth value of one of the elements will have the constant truth value, two or more connectives could have the same “reduced” truth tables, where they will have the same contents, so they “mean” the same and can be used interchangeably (to some extent). Such space of corresponding lines on the truth table we call the Shared Domain of logical connectives. Further on table 2 Shared Domains of every two of three connectives are shown as mutually directed arrows between the corresponding lines on the truth table:

A	if	B		A	and	B		A	or	B
(11)T	T	T	↔	T	T	T	↔	T	T	T
(12)T	T	F		T	F	F		T	T	F
(13)F	F	T	↔	F	F	T		F	T	T
(14)F	T	T		F	F	F	↔	F	F	F

table 2

The concept of the Shared Domain is based on fixing the truth values of certain elements in some contexts. Further we introduce the notion of the Shared Domain more formally.

The Shared Domain (SD) of several logical connectives a, b, \dots, n is a set to truth values which is formed by intersection of the individual sets $T_a \cap T_b \cap \dots T_n$.

$$SD_{a,b,\dots,n} = T_a \cap T_b \cap \dots T_n$$

The Shared domain of two connectives can equal to the individual sets of the truth values: in case “but” and “and” $SD_{but, and} = [11,12,13,14]$ (conventional implicature is formed in this case). Shared Domain of equivalence and exclusive or is empty: $SD_{or(excl), iff} = []$. But the domains interesting for us in now are tree:

$$SD_{and, or} = [11,14];$$

$$SD_{if, and} = [11,13];$$

$$SD_{if, or} = [11,12];$$

$SD_{if, and, or} = [11]$ can be analyzed as combination of more simple cases discussed in this paper.

In each Shared Domain we explore 2 cases: the case when connected elements are not extralinguistically related and the case when they are.

The scales in SD are formed according to the following principle:

Principle 2:

(P2) Two or more logical connectives form the scale only in their Shared Domain. The direction on a scale determines the implicature of connectives and can be predicted: more “strong” element is more “effort consuming” in some world. If it is world of logical relations (if the 2 elements can not be related extralinguistically, the only relation between them is logical), more “strong” statement would be that statement which has more chances to be true *outside* the Shared Domain. The extralinguistically related elements usually have the direction of the scale which is opposite to “truth-conditional”, “unrelated” direction. Such switch of the direction of the scale produces implicatures (predicted by new order of the elements) which can result into the change meaning, reflexivity, and/or truth-conditions of use of both connectives in the similar contexts.

The principle 2 predicts that in the Shared Domain of “or” and “and”, in case they connect 2 unrelated elements ($SD_{or, and}$) the more “stronger” statement is formed by “or”, because more “effort consuming” for the speaker is to be committed to allowing the bigger chance for the statement to be true: speakers should feel oneself more responsible for saying A or B: the speaker is allowing his statement to be true in case if only one of elements is true. “And” requires less logical “responsibility”. In such way (P2) can be interpreted in “cognitive” terminology, but formally “or” is “stronger” because outside $SD_{and, or}$ “or” is always true, “and” is always false. “Unrelated” use of these connectives forms the scale $Sc_{and, or}$. (In the notation of scales ($Sc_{x,y}$) the order of (x,y) is important; in notation $SD_{x,y}$ the order of (x,y) is not important). But when joined elements are “related” the direction of the scale changes, which causes “or” to add new implicature to its truth values: namely “not and” (in the shared domain). Such additional meaning turns inclusive “or” into exclusive “or”. Principle 2 makes some other predictions discussed further.

3. $SD_{and, or} = [I1, I4]$ ¹

Distinction between inclusive and exclusive interpretations of disjunction according to Grice’s theory is derived from implicature which the word “or” has on the scale of “weaker” and “stronger” statements. That means that weaker (truth-conditional, inclusive) sense of “or” is less informative than stronger (not truth-conditional, exclusive) sense of “or”. Saying inclusive “or” we can implicate that we are not in the position to use exclusive sense of “or”. So, according to [Grice, 1989, p. 46] “or” has two senses, the strong excluding sense is derived from the weak inclusive sense.

Such theory still has problems because the existence of two senses of “or” contradicts Grice’s Modified Occam Razor principle (p.47). Further we propose an explanation which is based on Grice’s theory and which allows us to say that “or” has only one conventional sense, but can be used both exclusively and inclusively.

We stipulated that: /1/ The *sense* of “or” is always inclusive (weak); from /1/ we will show that exclusive (strong) use of “or” appears when the inclusive sense is intersecting with implicature of “or” in calculable class of contexts.

/2/ “Or” is always bound with “and” on the scale of implicature. From /2/ we will show that implicatures of both conjunction and disjunction can be explained by changing the direction of “strength” on the scale by certain classes of contexts. This explanation correctly predicts that contexts which change the use of “or” simultaneously change the use of “and” in the same way.

Changing the direction of “strength” on the scale of implicature takes place in cases like 1)². The particular direction on the scale in each case can be

¹ The following Chapter 3 reproduces the essay for the exam in “Implicature and Pragmatic theory 492.53” with some minor corrections and changes. If you have read the essay, you may want to skip Chapter 3 or read it briefly and go to the Chapter 4.

predicted in a way that more “strong”, “effort consuming” statement always can be implicated when the “weaker” statement is uttered.

1) a. He was in Washington for 5 days (impicat.: not more), but in fact he was there 6 days.

b. He can run 100 meters in 10 seconds (implic.: not less), but in fact he can run it in 9.8 seconds.

The same process we see in 2). 2.a.) appears in “middle class” context, where to have more cars or money requires more effort. Bigger number of cars means stronger statement.

2) a. John has three cars/ \$1000 (implic.: not more). But in fact he has 4 cars / \$1200.

2.b.) can appear in “*very rich*” or “*snobbish*” context, where for John to contradict the group opinion of social prestige requires more effort. But 2.b.) always presupposed that John is one of “us” -- rich people.

b. John has three cars/ \$1000 (implic.: not less). But in fact he has two cars (one car is out of fashion or broken)/ \$800 (even less).

So some contexts can switch the direction on the scale of implicature, namely those where previously weaker statements become more “effort consuming”. But the same objects remain on scale and only the character of implication and implicature is changed.

Conjunctions and disjunction have different domains of use if one and only one element which is joined by them is false. But they work in the same domain when both elements are true or both elements are false. According to our postulation (2) conjunction and disjunction always form the scale of implicature. What is changed – is only the direction of “strength” on this scale. This direction can be predicted by the character of joined elements.

Between the use of conjunctions and disjunction exists an interesting correlation: [A] In the same kind of contexts, namely in the case when two joined elements have some asymmetric sequential or causative relation we can have only the exclusive “or” and we can have only “and” meaning ‘and then’:

3) a. I will show you three people and you will tell me whom have you seen before.

b. - You will go to Congo as an ambassador...

- But...

- ...Or you will go to Siberia.

[B] On the contrary, when the relation of elements is symmetric (no logical consequence or time sequence), we have inclusive “or” and “and” used as its synonym.

4) - Have you been to Belgrade or to Zagreb?

- Yes, I have been to both.

² Since this chapter was written before as an essay, the numeration of examples in it is local and differs from the numeration in the paper by having only one closing bracket on the right of the number of an example.

It is also interesting that in the case [A] we can try to substitute “and” by “or”, but we will need to insert negation; it is also possible than to transform this sentence into “asymmetric” implicative statement (A if and only if B), preserving the meaning of the sentence:

- 5) a. You will hurry up and you will catch your train.
 b. You will tell me the truth and I will do something for you.
- 6) a. You will hurry up or you will not catch your train
 b. You will tell me the truth or I will not do anything for you.
- 7) a. If and only if you hurry up, will you catch your train.
 b. If and only if you tell me the truth will I do something for you.

In case [B] such replacements cannot be made.

3.1 Sc_{and, or} -- connecting unrelated elements

The explanation is that if in [B] we have two symmetrically related events, the disjunction (inclusive) is more effort consuming, the speaker is committed to more “responsible truth conditions, allowing the whole statement to be true if only one of elements is true. So in case [B] Conjunction and disjunction form the following scale:



In such case saying OR automatically implies (not implicates) that AND is also true. “And” is synonym to “or” (more precisely –hyponym to “or”). Response like (4) is based on the implication, not on the implicature.

But if we use “and” in such context we are committed to the implicature that we mean “not or”. Such implicature can be canceled.

- 8) I will be wrong when I say that you and me had a good time. (implicat.:
 I am not in the position to say that at least one of us had a good time) But
 in fact I had a good time.

We see, how implicature is made along the scale oriented by symmetrically related events.

3.2 Sc_{and, or} -- connecting related elements

But in case [A] we have two asymmetrically related events. In such conditions conjunction turns to be more strong (effort consuming) statement. It requires to be true from both elements, but inclusive “or” does not require it. Such ordering turns the direction of “strength on the scale of implicature:



The content of “or” is still inclusive here, but the use of “or” is exclusive due to overlapping of the implicature, derived from such direction of “strength” on the scale. Saying “or” I am not in the position to say “and”, so “or” also implicates “not and” in the domain discussed. This implicature can also be canceled. consider such explanation for the foreigner how works the Coke machine:

- 10) You will drop a coin into a Coke machine or you will stay without
 Coke. (implicat.: it is very improbable that you will drop a coin and still stay

without Coke). But in fact, sometimes you can drop a coin and still stay without Coke.

And finally, we will show that it is possible to make a statement with “and” on such scale. Our explanation predicts that in the context [A] (asymmetric relation) such use will imply the truth of “or”. But what “or” – exclusive or inclusive?. We will show, that in order to get rid of the exclusive use of “or” in asymmetric contexts we need to isolate it by truth conditional frames. Otherwise we need to insert negation.

11) This machine is out of order: you will drop a coin into it and you will stay without Coke.

This Implies (not implicates!):

It will be always true: or you will drop a coin, or you will stay without Coke.

Inclusive content of “Or” is isolated from asymmetric disjuncts by the truth-conditional frame.

So we see, that not the meaning, but the use of disjunction can only be exclusive.

Such explanation accounts for the reason why sentences (5-7) are synonyms. In (6) “or” is used exclusively, (there is no truth-conditional frame). Here appear “strange” negation which is explainable if “or” is exclusive and “if” means “asymmetrical equivalence” (if and only if relation):

F1: $(B \text{ iff } A) \Leftrightarrow (B \vee_{\text{excl}} \neg A) \Leftrightarrow (\neg B \vee_{\text{excl}} A) \Leftrightarrow (\neg(B \vee_{\text{excl}} A))$,

some of such transformations can seem odd in ordinary language, but all have the equivalent truth values and all are possible in principle.

4. SD_{if, and} = [11,13]

4.1 Sc_{and, if} -- connecting unrelated elements

According to (P2) in contexts without any extralinguistic relation between elements “if” should be “stronger”, since it has more chances to be true outside the SD_{if, and} = [11,13]. The direction of the scale and the implicatures produced in SD_{if, and} = [11,13] is very much the same as in SD_{and, or} = [11,14] in the similar context.

If the truth value of the antecedent and the element which comes second in the disjunction is constantly true, the value of the statement can be true or false depending on the truth value of the consequent (the first element in disjunction). So, the truth of values of (6) and (7) are equivalent if the speaker is John Major in 1995.

(6) It is good soup if I am a Prime Minister

(7) It is good soup and I am a Prime Minister

and this entails the a the soup which Major is having is good (if he does not try to deceive us). The implicature on this scale works in the direction from “and” to “if”: saying (7) the speaker feels him/herself not in the position to say (6), postulating “stronger” logical relation between the facts: the implicature of (7) can be “the relation between these facts is not very important”.

4.2 Sc_{if, and} -- connecting related elements

Saying (8):

(8) I will give you \$5 if you mow the lawn

implicates that I am not in the position to say that

(9) I will give you \$5 and_(then) you will mow the lawn,

which means “I want to get the work done first, no prepayments!”. But from the scale it can be predicted that the utterance (9) entails (8).

In this case the use of “if” has implicature “not and”, which overlaps its truth values and the connective gets meaning “if and only if”, as it was discussed in Chapter 1. Such mechanism explains the waiter’s problem: when Byron uttered the sentence (3) the floating of Quality switched the direction on the scale of implicature from the direction Sc_{and, if} into the direction Sc_{if, and}, and the conjunction “if” is pretended to join somehow “related in the outside world” elements, so “if” in that context is used as “iff”. But when the facts turned around and fixed truth values changed, the utterance (3) remained with its original (implicative) truth values, not with “equivalent” truth values, and suddenly appeared that *really* it is no connection between the 2 facts, antecedent and consequent: the original sentence could be true anyway in case the antecedent was false (in that situation -- in case the soup was bad). It happened because “if” is no longer on the scale with “and”. The logical relation to which Byron was committed by entailment was not as strong as scalar implicature of that expression, and he still may not pay, even after he became an English Lord.

The discussion of this example shows that the way in which every connective is used in the utterance is completely predictable from the character of joined elements and the domain which the particular connective can share with the other connectives (and form the scale of implicature), considering the truth values of joined elements which can be fixed in the particular world. The implicature added to the truth values of the logical expressions (exclusive “or”; equivalential “if”) never really becomes entailment and the speaker can never be committed by entailment to these new values. But s/he can always cancel, suspend or reinforce such “additions” meanings.

In [Heim, 1983] it was shown that the truth values of the basic logical connectives can be predicted too; it seems to be some inner relation between Heim’s attempt and our analysis of possibilities to predict the scalar implicature of the connectives. This implicature sometimes can influence the truth values of how the connective is used in ordinary language, so there is some deeper relation between the nature of implicated and truth-conditional meanings in language.

5 Connectives “if” and “or”. (SD_{if, or} = [I1, I2])

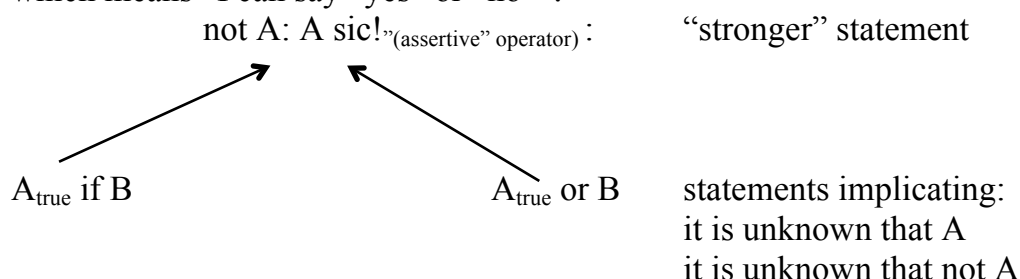
If and or can not form any scales: (P2) predicts that in if nay scale existed between them, there should be some way to determine the direction on that

scale. But outside their $SD_{if, or}$ have equal chances to be true, so none of them can be considered “stronger” than the other. If these elements are used to join the related elements they behave strictly in accordance with their truth values. Two facts are interesting about these connectives: $SD_{iff, or(excl)} = []$: there can be no intersection in truth values (see F1 in Chapter 3.2); But still within the $SD_{if, or}$ the connectives seem to be somehow “opposite” to each other, not “cooperative”, like any of them with “and”, but still they are “cooperative” in some different sense. Consider such strange answer:

- (10) -- Will it rain tomorrow?
 -- The Earth is round_(constantly true fact) if it rains.
 or:
 ...
 -- The Earth is round or it will rain.

Both answers implicate “I know nothing about the rain tomorrow”: That is : I am not in the position to say: “Yes, tomorrow will rain”, I am not in the position to say: “No, tomorrow will not rain”, I am not in the position neither assert or deny that fact.

We can represent this as scalar implicature of both elements; each of them is independently bound on the scale with the special assertive/negative operator, which means “I can say “yes” or “no””:



But this is exactly the clausal implicature or logical connectives “if” and “or”, discussed in [Gazdar, 1979]. It means that the clausal implicature has a scalar explanation within the proposed framework.

6. Conclusions

The basic truth-values of logical connectives determine their possibilities to form implicature scales. Scales are formed in the domains with equivalent truth-value subsets of truth-tables of 2 or more connectives. Implicatures are generated according to the direction of statement “strength” on the scale.

The methodology predicts scalar implicatures which connectives have in everyday use and also clausal implicatures, as a particular case of scalar implicatures. The use of connectives is predicted by the nature of joined elements and the ability of these elements to fix their truth values in real situations. The pragmatic meanings of connectives can influence their truth values, but still remain cancelable in the conversation.

7. References:

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