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► **To cite this version:**

Karl Schlechta. A pre-semantics for counterfactual conditionals and similar logics. 2017. hal-01408541v2

HAL Id: hal-01408541

<https://hal.science/hal-01408541v2>

Submitted on 25 Feb 2017 (v2), last revised 4 Apr 2017 (v3)

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A pre-semantics for counterfactual conditionals and similar logics

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February 25, 2017

Abstract

The elegant Stalnaker/Lewis semantics for counterfactual conditionals works with distances between models. But human beings certainly have no tables of models and distances in their head.

We begin here an investigation using a more realistic picture, based on findings in neuroscience. We call it a pre-semantics, as its meaning is not a description of the world, but of the brain, whose structure is (partly) determined by the world it reasons about.

In the final section, we reconsider the components, and postulate that there are no atomic pictures, we can always look inside.

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1 Introduction

The idea is in its initial stages, and much work needs to be done to flesh it out. We are not even sure if we found the right level of abstraction, time and experience will tell. Still, we think the basic idea is promising, and would like to present it for discussion.

We have three types of objects:

- (1) areas,
- (2) connections,
- (3) attention.

Areas will be connected areas of the brain, corresponding to some information, areas may connect to other areas with different types of connectors, which may be positive (attractions) or negative (repulsions). Finally, attention focusses on areas or parts of areas, and their connections, or part thereof.

Areas do not necessarily correspond to nodes of graphs, as they are not atomic, and they can combine to new areas. Attention may hide contradictions (repulsions), so the whole picture may be contradiction tolerant.

This idea is elaborated in the last section, where we postulate that areas or pictures are not atomic, and can always be decomposed - this seems a reasonable assumption in our context -, and that there is no clear distinction between areas (pictures) on the one hand, and connections (or paths) on the other hand.

The brain usually is strongly redundant, democracy of areas and connections will provide robustness.

2 Components

2.1 Areas

We use the word “area” to designate

- on the physiological level a (perhaps only momentarily) strongly connected area of the brain,
- on the meaning level a picture, scene (in the sense of conscious scene), a prototype (without all the connotations the word “prototype” might have), any fragment of information. It need not be complete with all important properties, birds which fly, etc., it might be a robin sitting on a branch in sunshine, just any bit of information, abstract, concrete, mixture of both, whatever.

Thus, we are deliberately vague.

In particular, an area will not necessarily be atomic, we leave the possibility of looking inside, splitting an area into several areas, open. Areas need not be pre-determined, they may be formed and dissolved dynamically. (This will not be discussed here.)

2.2 Connections between areas

Areas can connect to each other. We simplify, as we separate surface from interior of areas. The picture we have in mind is that of a cell or a virus, which present “docking possibilities” on their surface. But, again, real areas need not have a surface, separate from the interior, through which all outside contacts have to pass.

We simplify, the “docking parts” will have two parts, a quality, and a value. Quality may, for instance, be colour, species, etc. Value may then be black, raven, car, etc. For simplicity, qualities will correspond to expressions in a suitable language. This makes manipulation easier. We suppose that only connectors of the same quality can connect to each other. Colour can connect to colour, but not colour to species. (A black raven is an area, black and raven may be connected inside the area. It is a simplification!) In analogy to nerves, we suppose that connections have a direction. If we have connections in both directions, we can always work with a (coupled) pair.

A connection between two connectors can be variously strong. For instance, the connection between $\langle \text{colour}, \text{black} \rangle$ and $\langle \text{colour}, \text{grey} \rangle$ will be stronger than that between $\langle \text{colour}, \text{black} \rangle$ and $\langle \text{colour}, \text{red} \rangle$. If the values differ too much, then it is rather a repulsion, than a poor attraction. Obviously, having no connection of a certain type is different from having a repulsion of this type.

Two (or more) areas may connect via more than one connector, e.g. the area “raven” and the area “blackbird” may connect via “bird” and via “colour”. Connected areas may sometimes be seen as one area, which can connect to new areas or other composite areas. This process is not necessarily commutative, etc., see below. Two areas may have several connections for the same quality. The overall strength will then be (somehow) calculated, adding (and perhaps subtracting) the individual strengths.

2.3 Attention

A third ingredient is “attention”. We picture attention as a light which shines on some areas, perhaps only on parts of those areas, and their connections, or only parts of the connections.

Attention allows, among other things, to construct a coherent picture by focussing only on parts of the picture, which are coherent. In particular, we might focus our attention on coherences, e.g., when we want consolidate a theory, or incoherences, when we want to attack a theory. Focussing on coherences might hide serious flaws in a theory, or our thinking in general. In context A , we might focus on α , in context B , on β , etc.

As we leave attention deliberately unregulated, changes in attention may have very “wild” consequences.

2.4 Composing areas

Areas can be composed.

We may compose “black movement in the sky” via “black”, “flies” with “raven” to the picture “black raven flies overhead” or so.

Not all connectible areas need to be composed. Either they (or their connections) are not in the focus of attention, or the connections are considered (presently!) too weak for composition (perhaps in competition with other possible connections). The coherence of the composed area is the strength of the connections (for simplicity: of the inter-area connections), minus the repulsions.

The robustness is measured under varying attention. We may focus on repulsions, or just different connectors.

Suppose we try to compose area A with areas of type β and γ . When choosing area B of type β , we might choose by the strength of the connections between A and B . Choosing now C of type γ , we may choose by the strength of the connections between composed area $A + B$ and C . Of course, the order may matter. Choosing first area C' of type γ to compose with A , and then B' to compose with $A + C'$ need not result in $B = B'$ and $C = C'$. Choosing simultaneously B'' and C'' to give the best overall result $A + B'' + C''$ might give still different B'' and C'' .

2.5 Majority rule

It was Edelman's insight, see e.g. [Ede89], [Ede04], to see the parallels between the brain and the immune system, both working with selection from many possibilities. We imitate this principle. When areas are combined, we evaluate the results by its coherence, the strengths of the connections between the elements. We assume that we have many candidates of the same type, so we have a population from which to chose. We chose the best (by coherence), and consider this set for the properties of those combined areas. This is a weighed democracy, and offers some robustness.

3 Comparisons and properties

As we left the attention deliberately unregulated, it seems very difficult to obtain any non-trivial properties under changing attention.

But even with fixed attention, it seems difficult to obtain the usual logical properties like AND, OR, CUM, etc.

3.1 Pre-semantics and semantics

There is a conceptual difference between "real" semantics, and our pre-semantics.

Real semantics interpret language and logic in (an abstraction of) the world. Pre-semantics is an abstraction of (the functioning of) the brain. Of course, the brain is "somehow" connected to the world, but this would then be a semantics of (the functioning of) the brain. Thus, this pre-semantics is an intermediate step between language and the world.

3.2 Areas and models or model sets

Areas do NOT necessarily correspond to models or model sets, be they partial or not. For instance, the area "bird" need not be connected or strongly connected to all birds, species of birds, etc., which we know. The connection might be too weak, rarely considered, or not in the focus of our attention. In classical logic, there is no cost involved for going from model sets to subsets, or individual models, and back. Depending on attention and strength of connections, the cost might here be considerable.

Thus, a semantics for counterfactual conditionals based on this idea of areas will be different from the usual semantics for counterfactual conditionals, which is monotone in the first argument. (The more general the present situation is, the more "closest" situations will be considered.)

3.3 Inferential distance

In a composed area, we have an "inferential distance", say from subarea a to subarea c via subarea b , perhaps over various connections. This is then a "natural" inferential distance and not one determined by an "artificial" proof schema. Likewise, we can complete a definition, say of a certain animal, when necessary, using more "far fetched" properties.

3.4 The Stalnaker/Lewis semantics for counterfactual conditionals

To see what happens with counterfactual conditionals, we consider the following example: "If it were to rain, I would take an umbrella, despite the strong wind."

First, we have the present situation. Then, we have the picture of an umbrella protecting against the rain. We also have the picture of an umbrella which is blown inside out in a strong wind. Then we have pictures of situations where we would not take an umbrella, wind or not, e.g., we have to use both hands to carry our Christmas presents, and no way to carry an (open) umbrella. Then, we have situations where an umbrella is useful even in strong wind, e.g., we just come from an expensive hairdresser, and protecting our hairdo is all we need, and we have both hands free.

To construct a picture corresponding to the situation and its implications, we need to consider pictures of rain and umbrella, wind and umbrella, reasons why we use an umbrella, reasons why we might even use an umbrella in strong wind, etc. There is no ready picture available, but we have to combine several pictures, and make them fit with the original situation.

The minimal change idea of the Stalnaker/Lewis semantics, see e.g. [Sta68], [Lew73], is replaced here by coherence. The more things we have to modify, the less good coherence will be.

We have to separate looking for pictures, and combining them. Language helps in both tasks, addressing and combining areas liberally.

Note that the case of update is somewhat different. In update, the question is how the actual world changes, and not how we believe the world (and we) behave, as is the case here.

3.5 Preferences and the hierarchy in [GS16]

It is natural to combine the ideas of the hierarchy in [GS16], chapter 11 there, with our present ideas. Exceptional classes, like penguins, are only loosely bound to regular classes, like birds; surprise cases even more loosely.

3.6 Defeasible inheritance diagrams

Inheritance diagrams give in general different results for upward and downward chaining. In this sense, they are similar to our approach (first combine a with b , then with c , or first with c , then with b). Length of path approaches are somewhat “global”, as determining the quality of a composed area by a global assessment here, is. Thus, we find some similar considerations in the theory of defeasible inheritance networks.

For an overview of defeasible inheritance, see e.g. [Sch97-2].

3.7 Reactive arrows

As we can have several connections of the same quality, there is a similarity to Gabbay’s reactive arrows, see e.g. [Gab04], [GS08e]: We can cancel one connection by another one, which has opposite polarity and is stronger.

This way, there could be a negative connection from “penguin” to the positive connection from “bird” to “fly”.

4 Shortcomings

In our examples, we only mentioned static pictures, but there is no restriction - we can also work with dynamic pictures, birds, which do not fly at the moment, but are able to fly, etc.

We can combine areas, but our ability to look inside areas is limited. The only way to do this in our outline is by focussing our attention. In a further development, one might want to break up existing areas, or, conversely, make internal connections stronger.

One might also like to have an automatic degradation of connections which were not used recently.

In this first draft, we treat the areas we find basically as atoms, though we know that they are not. It is a simplification. In addition, in the “real life of the brain” there is not necessarily a surface vs. an interior of the areas, all this is dynamical. The best definition might be coherence of areas by number and strength of the interior connections vs. those of the exterior of the area. For instance, it might be interesting to separate acoustical from visual properties.

Negation can be introduced by an inversion of values, $\langle colour, black \rangle$ has then to pass through $\langle colour, not - black \rangle$. We do not know if this is realistic.

5 Details - a theory of constructions

5.1 Introduction

Human reasoning seems to work with scenarios, prototypes, pictures, etc., which are connected by association, reasoning, developments, etc.

We imagine these scenarios etc. to be realised on the neural level by neurons or clusters of neurons, and the connections also by neurons, or bundles of neurons.

For simplicity, we call the scenarios pictures, and the connections paths.

This leads to consider the basic entities of pictures and paths.

Traversing a path has a certain cost, say a positive real value. We will describe certain qualitative laws about this cost.

Attention is related to our aims (find food, avoid dangers, etc.) and allows to focus on certain pictures (or parts of pictures) and paths. We will describe how this might be related to above cost.

5.2 Basic entities

(1) Pictures

On the

- meaning level, they correspond to thoughts, scenarios, pictures, etc.
- neural level, they correspond to neurons, clusters of connected neurons, etc.

For our purposes, there are no atomic pictures from which other pictures will be composed, but which cannot be analysed any more. What should such atomic pictures correspond to? Single neurons? Do they have meaning? If they cannot be analysed further, will this always correspond to a single neuron, or sometimes a cluster of neurons, perhaps spanning over several areas of the brain?

It seems more reasonable to postulate (for our purposes) that we can always “look inside” such pictures.

(2) Paths

On the

- meaning level, they correspond to associations, deductions, developments, etc.
- neural level, they correspond to neurons, bundles of more or less parallel neurons, connecting clusters of neurons, etc.

Again, it seems reasonable, but perhaps less necessary, to assume that there are no atomic paths. But we leave this open.

(3) The distinction between pictures and paths is artificial, there is no fundamental difference between them.

- A picture can be a path.

Consider the following pictures:

Yesterday evening, I had too much beer, this morning, I have a headache. We can see this as a path connecting (too much) beer to headache.

A shard of glass focussing the sunlight, and creating a bright spot on the wall. This can be seen as a path leading from sunlight and glass to a (perhaps dangerously) bright spot.

- A path can be a picture.

We can see the beer drinking episode first as a path leading from beer to headache, and later see it as the whole picture.

(4) Paths can be between pictures, or internal to pictures.

We can see the development from beer drinking to headache as a path between the pictures “drinking beer” and “headache”, or as an internal path of the whole picture.

To summarize:

- (1) neither pictures nor paths have an atomic structure, inside pictures are again pictures, etc., conversely, pictures can be composed to bigger pictures, etc.
- (2) pictures can be seen as paths, and vice versa,
- (3) paths can be between pictures, or internal to pictures.

5.3 The cost of (traversing) paths and attention

5.3.1 The cost of paths

The cost of traversing a path need not be a symmetrical distance (and single neuron connections work only in one direction anyway).

It is more costly to traverse a longer path, than a shorter one (e.g. a subpath of the longer path).

It is cheaper to traverse parallel paths than single ones.

A good analogy seems to consider the flow of a liquid through pipes.

The cost decreases with recent use. This is the positive side of (good) habits, and the negative side of prejudice and rigidity.

Using a (composite) picture lowers the cost of the internal paths, it makes the picture more coherent, as well as the cost of the paths leading to the picture.

Remarks:

- (1) Even a classical inference has a certain cost (of traversing this path), thus, e.g., elements of subsets might be more difficult to access than other elements of the superset.
 In particular, all logics based on relations such as preferential logics, distance based logics (theory revision, update, counterfactuals) use comparisons between elements of subsets and supersets “without cost”, and their laws cannot be expected to hold here. (Consider e.g. the fundamental law of preferential reasoning: $X \subseteq Y \Rightarrow \mu(Y) \cap X \subseteq \mu(X)$.)
- (2) Using an argument makes it more accessible for use again, contrary to properties of basic linear logic.

5.3.2 Attention

We see attention as activation through (soft) associative memory. “Soft” means that not all aspects need to be present to establish the connection. E.g., when we are hungry, the smell of food, a picture of a steak, and the word “steak” are activated.

Activation means that the cost of the paths leading to the picture goes down, as well as the costs of internal paths of the picture.

Thus, whereas memory (recent use) automatically decreases cost, attention is an active process.

Conversely, pictures which are easily accessible (low cost of paths going there), are more in the focus of our attention. E.g., we are hungry, think of a steak (associative memory), and focus our attention on the fridge where the steak is.

Attention and cost influence each other.

Attention originates in the “I” and its aims and desires. Likewise, “accessibility” is relative to the “I” - whatever that means. (This is probably a very simplistic picture, but suffices here.)

5.4 Manipulation of pictures

Suppose that a certain picture is in the focus of our attention. We may see that only part of the picture is important. E.g., we remember the steak in the wrapping as we bought it in the supermarket, but we focus on

the “steak part” of the composite picture. When we begin to prepare the steak, we focus on the wrapping, and to open it.

Thus, we decompose a complex picture. (We need the recursive sub-pictures here.)

In neural language, we strengthen parts of the internal paths, and the paths leading there.

Conversely, if a single accessible picture is not enough, we can compose several pictures (or parts, after prior decomposition). This is, e.g., important for complex planning.

In neural language, we lower the cost of paths between the two pictures, so they are seen as one.

(The author conjectures that these operations have much in common with the work of the immune system, digestion, etc., on the molecular level.)

5.4.1 Further details

We suppose that pictures are sometimes first selected for manipulation, inspected, and perhaps rejected, as they do not “fit” well enough, so we look for other pictures, etc.

Combined pictures may be inconsistent, as the attention might neglect the inconsistencies - recall that classical deduction is just some path with a cost, too.

There might be multi-level handling, construction on one level, judging the result on another level, etc.

5.5 Application to counterfactuals, a toy example

Consider the sentence:

If I were to fell that tree, I would hammer a pole into the ground, and tie a rope between tree and pole, so the tree cannot fall on the house.

We have

- the present picture (situation) where the tree stands close to the house, there are neither rope nor pole, and we do not want to fell the tree.
- the picture of a pole being hammered into the ground - for instance, we remember this from camping holidays
- the picture of a rope tied to a tree and its effect - for instance, we once fastened a hammock between two young trees and saw the effect, bending the trees over
- the picture of someone pulling with a rope on a big tree - it did not move

Thus, the last picture is useless, the force would be too small.

The hammock picture has to be modified, we focus on rope and one tree.

The pole picture has to be modified, too, no tent.

The present situation picture has to be modified, we want to fell the tree, etc.

Finally, we compose the different fragments.

5.5.1 A remark on flexibility

Traditional counterfactual semantics is not only unrealistic, but also rather rigid: there is only one choice involved.

Composing (partial) pictures in several ways has more flexibility, we can begin with picture 1, then continue with picture 2, or conversely, etc.

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