

# Articulating gradability, dimension selection, and homogeneity in color adjectives

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**Context-sensitivity and homogeneity.** Color adjectives are a textbook case of two phenomena: (i) *context-sensitivity* (Travis, 1985; 1994; Szabó, 2001; Rothschild & Segal, 2009; Kennedy & McNally, 2010; a.o) and (ii) *homogeneity in summative predication* (Löbner, 2000; Chatain, 2021; Paillé, 2022; a.o.). One of the ways in which color adjectives are sensitive to context concerns what parts of an object they apply to. A first description of the interaction between this component and homogeneity is due to Löbner (see also Chatain, 2021), who points to a cognitive process of dimension selection: “[...] colour predicates apply either to the surface or the body mass of three-dimensional objects. For instance, a yellow peach might both be a peach with a yellow skin and a peach with yellow flesh, but need not be both. Once the dimension is chosen, the totality condition holds.” (Löbner, 2001)

**Goals of the present work.** The two strands of literature mentioned above have not interacted much. Here I want to articulate (i) and (ii): on the one hand I show that a process akin to what Löbner calls dimension selection is a grammatical process for which there is linguistic evidence in certain syntactic environments. On the other hand, even when dimension selection is filtered out, homogeneous behavior obtains over a sub-set of the parts of the relevant objects, i.e. those that satisfy certain definedness of the relevant predicate – in the case of color predicates, relevance to color perception.

**Part I: context-sensitivity.** Italian pre-nominal adjectives have only a subset of the interpretations of adjectives in the unmarked post-nominal position (Cinque, 2010, 2014). Cinque (2010) (p. 93) briefly notes that this general pattern extends to color adjectives. In what follows, we’ll be interested in the following facts which, to our knowledge, has not been observed. Like English ‘red pen’, Italian ‘penna rossa’ (‘red pen’, post-nominal) can be a pen red on its surface, or a red-inked pen. Instead, pre-nominal ‘rossa’ (‘rossa penna’) can only describe a pen with a red outer surface. Note that pre-nominal color adjectives do not simply imply that the outer surface of an object is e.g. red, but rather that its perceivable part is. In English we can describe a whole, uncut watermelon with green rind and red flesh as a ‘red watermelon’, as pointed out by Rothschild & Segal (2010). In Italian, the same is true for post-nominal ‘rossa’, but not for pre-nominal ‘rossa’. Importantly, however, if the flesh is visible both expressions can be used. See (9)-(10), page 4. These judgments were all confirmed with 7 Italian native speakers who are not linguists, and are not aware of our account. While the expression is slightly marked in terms of (higher) register, judgments are very systematic. This provides evidence that Löbner’s dimensions are in fact grammaticalized, and in certain syntactic configurations only some dimensions are possible; we will be concerned with capturing this.

**Provisional analysis 1: the analogy between ‘red’ and ‘skillful’.** Szabó (2001) views ‘red’ as specifying which points on an object it applies to via a free variable, in analogy with context-sensitive adjectives such as ‘skillful’. ‘Skillful’ is held to be context-sensitive since, in the right context, a lawyer who is good at cooking can be called a ‘skillful lawyer’, i.e. a skillful(*as-a-cook*) lawyer (cf. von Fintel & Heim, 1999). In the spirit of Szabó, we propose that ‘red’ has an implicit argument. In our view, this is a property argument  $P$ ; ‘red’ returns the degree of qualitative redness of the sum of all subatomic parts of  $x$  that have property  $P$ . ‘Red’ comes with a measure function, like other gradable adjectives, and is a function from individuals to degrees; its standard is then provided by the positive morpheme (Kennedy, 1999; Kennedy & McNally, 2010). The measure function  $\mu_{\text{red}}$  is only concerned with the degree of qualitative redness that an object would display in the event of perception, and thus for instance only with the visible surface of solid objects.

$$(1) \quad \text{a. } \llbracket \text{red} \rrbracket = \lambda P. \lambda x. \mu_{\text{red}}(\bigoplus \{y : y \leq x \wedge P(y)\}) \quad \text{b. } \llbracket \text{pos} \rrbracket = \lambda \mathbf{G}_{e,d}. \lambda x. \mathbf{G}(x) \geq \mathbf{s}$$

What saturates the property argument of ‘red’? To answer this question, consider the following facts

about modification with ‘skillful’ in Italian. ‘Avvocato bravo’, (‘skillful lawyer’, post-nominal) is context-sensitive, i.e. has the range of readings of English mentioned above. Its pre-nominal counterpart ‘bravo avvocato’ can instead only refer to someone skillful as a lawyer (Cinque, 2010). This almost parallel behavior provides a novel argument for the analogy between ‘skillful’ and ‘red’. As argued by Cinque, the behavior of ‘bravo’ is best explained by assuming that the implicit argument providing the activity targeted by the adjective can in general take its value from the context, but is forced to take its value from the noun in pre-nominal modification (see Cinque, 2014, p. 25; cf. also Martin, 2022; Guerrini, 2024). Extending this analysis to color adjectives, we predict that in ‘rossa penna’ (‘red pen’, pre-nominal), ‘rossa’ can take the value of its input property only from the NP it composes with – thus something like  $\lambda x.pen(x)$ . We therefore get a reading where the whole pen is perceived as red, via its visible surface. In post-nominal position, instead,  $P$  can be provided by any contextually salient property, and can therefore be something like  $\lambda x.ink(x)$ . We therefore attribute to the sum of all subparts of the pen that have the property of being ink a degree of perceptual redness higher than  $s$ .

- (2)  $\llbracket\text{rossa penna}\rrbracket = \llbracket\text{pos}\rrbracket(\llbracket\text{rossa}\rrbracket(C)) \cap \llbracket\text{penna}\rrbracket$  pre-nominal, so necessarily  $C = \lambda x.pen(x)$   
 $= \lambda x.\mu_{\text{red}}(\bigoplus\{y : y \leq x \wedge pen(y)\}) \geq s \wedge pen(x)$
- (3)  $\llbracket\text{penna rossa}\rrbracket = \llbracket\text{penna}\rrbracket \cap \llbracket\text{pos}\rrbracket(\llbracket\text{rossa}\rrbracket(C))$  post-nominal, so  $C$  can be e.g.  $\lambda x.ink(x)$   
 $= \lambda x.pen(x) \wedge \mu_{\text{red}}(\bigoplus\{y : y \leq x \wedge ink(y)\}) \geq s$

The same analysis can be straightforwardly applied to the watermelon case. Moreover, notice ‘red’ is sensitive to ‘with respect to’ phrases, just like ‘skillful’: just like we can describe someone as ‘skillful in every respect’ (cf. Sassoon, 2013), we can describe a pen that has red ink, red surface, and so on as ‘red in every respect’, a novel observation that constitutes a further argument for the analogy. For reasons of space I cannot motivate further the analogy, but only mention that ‘red’ and ‘skillful’ fall in the same class of adjectives according to recent classifications of adjectives that analyze the mode of composition of adjectives rather than their emergent entailment pattern, such as Guerrini (2024, pp. 32-34).

**Part II: homogeneity and non-maximality.** The analysis above is silent about what it means for a sum of subparts to be  $s$ -red, and about the patterns of homogeneity, non-maximality, and their removal displayed by ‘red’. I am not concerned, here in the abstract, with distinguishing between competing theories of predicate homogeneity, and do not have space to compare them; I will work in a Križ-style trivalent framework. In a potential talk I may present a way to capture the articulation between gradability, dimension selection, and homogeneity facts in a Paillé-style framework, which requires a number of assumptions and allows for novel points of comparison with Križ’s framework.

**Provisional analysis 2: homogeneity over subparts that have the property provided by the implicit argument.** We want to range over subparts that are part of some object that has the input property: for instance, for the case of a red-fleshed watermelon, we want the subparts of which we predicate redness to be part of something that is (watermelon) flesh. In other words, in this reading we want ‘red watermelon’ to be equivalent to ‘watermelon whose every subpart of flesh is red’.

- (4) a.  $\llbracket\text{red}\rrbracket = \lambda P.\lambda d.\lambda x.\mu_{\text{red}}(x) \geq d \wedge \exists y(P(y) \wedge x \leq y)$   
b.  $\llbracket\text{red } C\rrbracket = \lambda d.\lambda x.\mu_{\text{red}}(x) \geq d \wedge \exists y(\text{flesh}(y) \wedge x \leq y)$  (with  $C = \lambda x.flesh(x)$ )

In words, ‘red’ denotes the set of subparts of anything that has the property of being flesh that are at least (qualitatively)  $d$ -red. Once the implicit property argument is saturated, ‘red’ combines with a positive morpheme setting the standard for what counts as enough qualitative redness (and modifiers like ‘somewhat’, ‘extremely’, and ‘perfectly’ can replace  $pos_{\text{quality}}$  in the structure).

- (5)  $\llbracket\text{pos}_{\text{quality}}\rrbracket = \lambda \mathbf{G}_{\langle d, \langle e, t \rangle \rangle}.\lambda d.\lambda x.\exists d.\mathbf{G}(d)(x) \wedge d = \mathbf{s}$

This analysis is illustrated in the structure in (11) (page 4) with an example in which the implicit property argument of ‘red’ is ‘flesh’, and the *adjective + implicit argument* complex composes via Predicate Modification with the noun.

**Definitive analysis.** Notice at this point that this entry for ‘red’, while yielding correct predictions for a case like ‘red(-fleshed) watermelon’, it predicts too strong a meaning for cases in which ‘red’ takes as its input a property denoting complex solid objects like  $\lambda x.chair(x)$ . Consider for instance a case like ‘rossa sedia’ (red chair, pre-nominal). We have seen earlier that in this syntactic configuration, the implicit argument of the adjective must obligatorily be saturated by the property denoted by the noun. The meaning we predict then is one where ‘rossa sedia’, as predicated of  $x$  is true if  $x$  is a chair and all of its subparts are at least s-red; false either if  $x$  is not a chair or if all of its subparts are not at least s-red; and undefined if  $x$  is a chair and some but not all of its subparts are at least s-red. This is intuitively too strong, as when we call something a red chair or in Italian a ‘rossa sedia’, we require its *perceivable* subparts to be red, but not its inner subparts. One may think that this is non-maximality, but only the outer subparts are targeted even when homogeneity and non-maximality are removed: we can call something an ‘entirely red chair’ if all of its surface is red but not its interior. Different predicates have different constraints: a red apple is red on the outside, a sweet apple is sweet throughout. In what follows, I propose to encode such constraints as presuppositions of the relevant predicates: ‘red’ is only defined for subparts relevant to color perception – thus the external ones. ‘Sweet’ is defined for all subparts relevant for taste perception: hence internal ones as well. For color perception, we can introduce a condition requiring a subpart to be relevant to the perception of some object having the covert input property. We do this via (6), which requires the relevant subparts to both have the implicit argument property and be relevant to perception:

$$(6) \text{RP}(P)(y) = \{y : \exists z.P(z) \wedge y \text{ is relevant to the perception of the color of } z\}$$

We will here leave implicit what it means for a subpart to be relevant to the (visual) perception of another subpart. What is crucial at this point is which covert property input will be the argument of ‘red’: take for instance the case where it is ‘chair’. We only keep subparts that are on the outer, perceivable surface of chairs. Not any subpart of a chair is a chair, and consequently many subparts of chairs, i.e. internal subparts, will be left out from the denotation of (7). In a case like ‘ink’, for any object that has the property of being ink, we want to include the subparts relevant for its perception. This is why, intuitively, a portion of red ink is red throughout (although not necessarily at the lowest physical level; ink electrons may not be red, naïvely speaking). I propose that ‘red’ is only defined if its argument is relevant to the perception of some object having the implicit input property. I further propose that DIST only quantifies over subparts that satisfy the definedness conditions of their input property – a sort of domain restriction. We thus end up with a structure as in (12) (page 5).

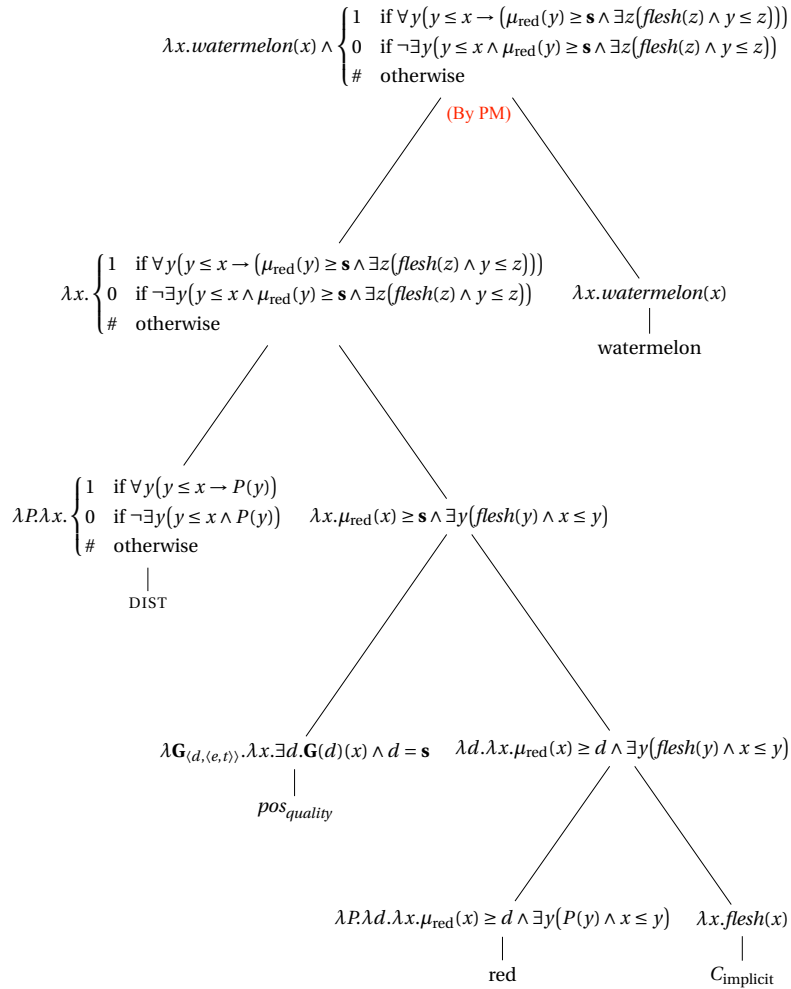
$$(7) \llbracket \text{red} \rrbracket = \lambda P.\lambda d.\lambda x. \begin{cases} 1 & \text{if } \mu_{\text{red}}(x) \geq d \\ 0 & \text{if } \mu_{\text{red}}(x) < d \\ \# & \text{if } \neg \text{RP}(P)(x) \end{cases} \quad (8) \llbracket \text{DIST} \rrbracket = \lambda P.\lambda x. \begin{cases} 1 & \text{if } \forall y \left( (y \leq x \wedge P(y) \neq \#) \rightarrow P(y) = 1 \right) \\ 0 & \text{if } \forall y \left( (y \leq x \wedge P(y) \neq \#) \rightarrow \neg P(y) = 1 \right) \\ \# & \text{otherwise} \end{cases}$$

**Homogeneity removal.** How does homogeneity removal happen? Homogeneity removers cannot replace DIST, or else we end up with wrong structures and predictions for a case like ‘completely red and sweet (apple)’. In (13) (p.6) homogeneity removal happens above the conjunction of the two predicates, and replaces DIST. It yields wrong truth conditions, only requiring the external parts of the apple to be sweet; while we want the apple to be red on the outside and sweet throughout. The right structure is in (14) (p.7), where distributivity is local, and homogeneity removers apply above it. We get the correct truth conditions: all of the apple is such that its subparts relevant to the perception of color (external) are red and its subparts relevant to the perception of taste (external and internal) are sweet.

### Additional pages for references, figures and glossed examples

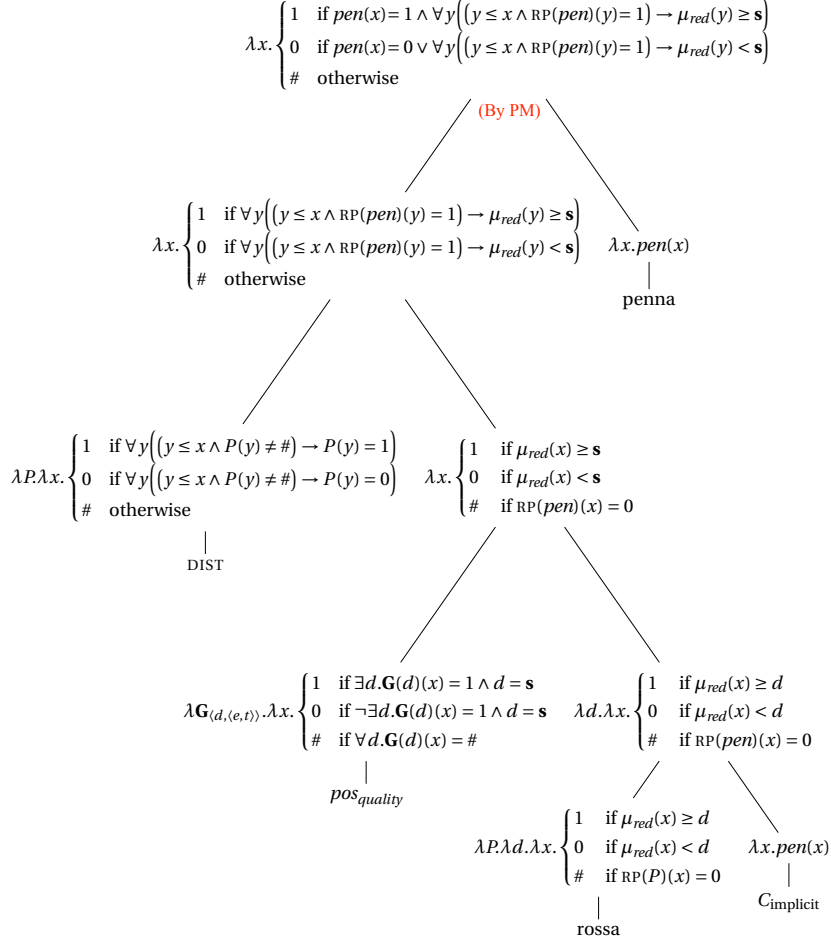
- (9) a. **Context C1**: Luca is looking at whole, uncut watermelons, whose flesh is thus not visible.  
 b. **Context C2**: Luca is looking at cut watermelons, whose flesh is therefore visible.
- (10) Luca notò {un'anguria rossa<sup>{C1<sup>✓</sup>, C2<sup>✓</sup>}</sup> / una rossa anguria<sup>{C1\*, C2\*}</sup>} sul banco.  
 Luca noticed {a **watermelon red**/ a **red watermelon**} on the stall.  
 'Luca noticed a red watermelon on the fruit stall.'

- (11) Structure for  $\llbracket [\text{DIST } [\text{pos}_{\text{quality}}[\text{red } C]]] \text{ watermelon} \rrbracket$ , with  $C = \lambda x.flesh(x)$ :

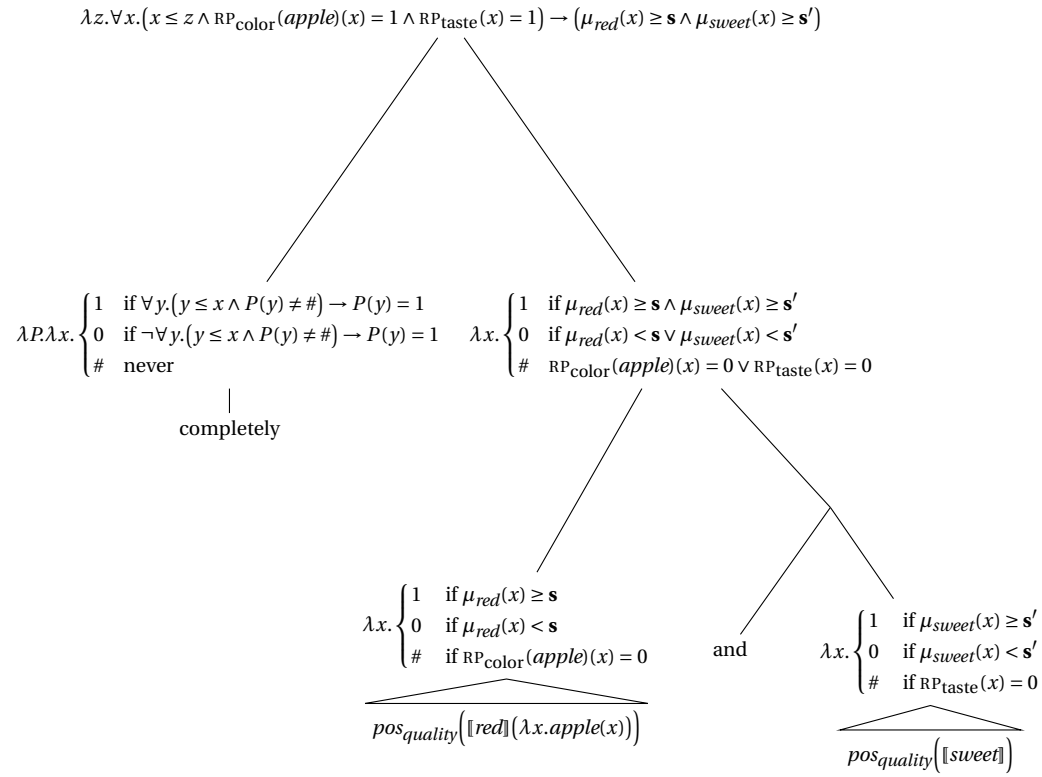


(12) Structure for  $\llbracket [\text{DIST } [\text{pos}_{\text{quality}}[\text{rossa } C]]] \text{ penna} \rrbracket$ .

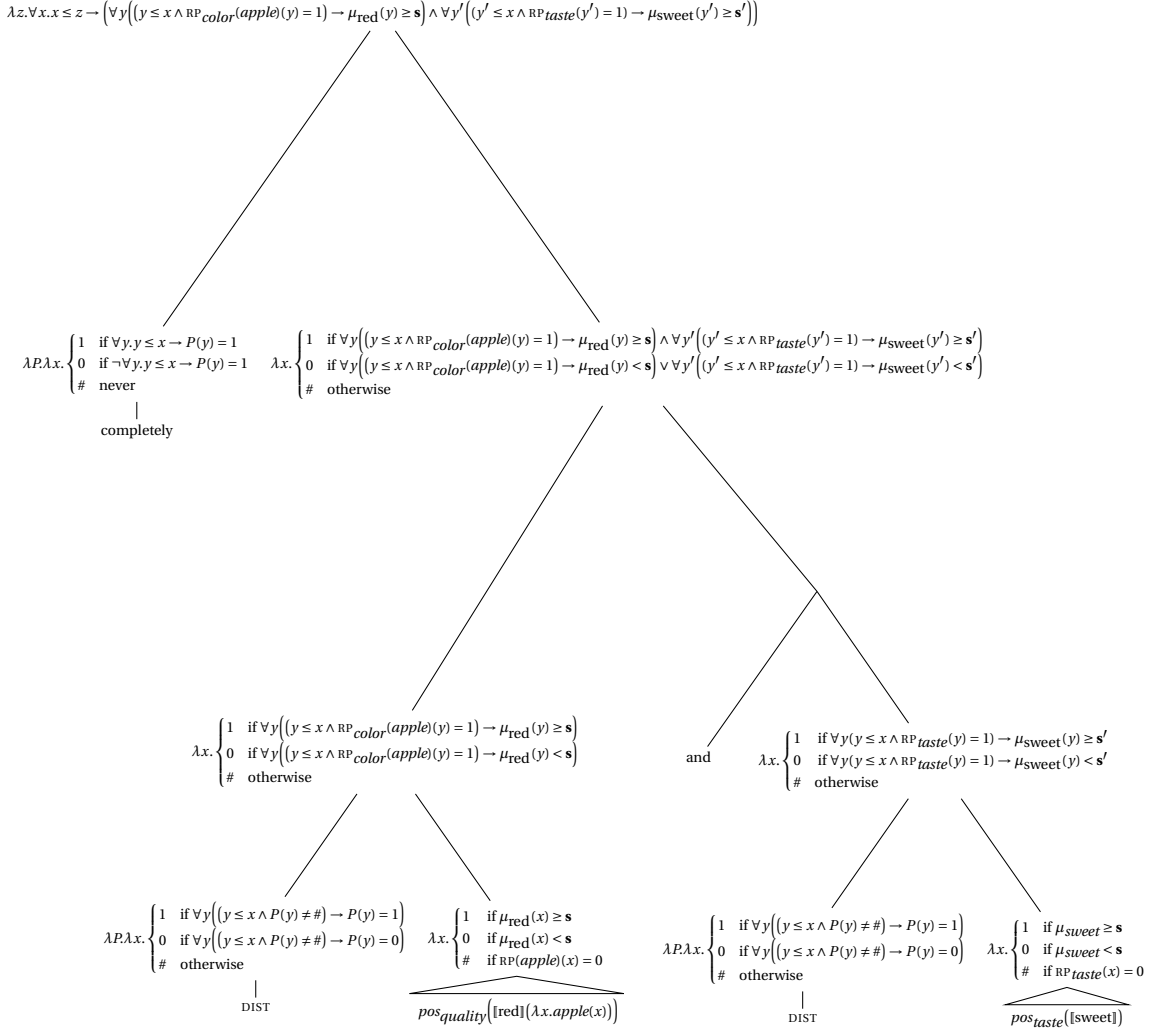
(pre-nominal, so necessarily  $C = \llbracket \text{penna} \rrbracket$ )



(13) Structure for ‘completely red and sweet’ if ‘completely’ replaces DIST (wrong):



(14) Structure for ‘completely red and sweet’ if ‘completely’ occurs above DIST (correct):



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