Uniqueness Effects in Donkey Sentences and Correlatives

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1 The Phenomena: Anaphora to Dependencies in Donkey Sentences and Correlatives

The goal of this presentation[1]: to provide a unified account of (the variability of) the uniqueness implications associated with cross-clausal anaphora in **donkey sentences** and **correlatives**.

Donkey sentences – so called because of the paradigm example of such anaphora, given in (1) below (based on an example in Geach 1962):

1. Every^{u} farmer who owns a$^{u'}$ donkey beats it$_{u'}$.

- superscripts – on antecedents; subscripts – on anaphors;
- indices: discourse referents (dref's) introduced / retrieved by particular lexical items;
- determiners and not whole DP's introduce new dref's because all the non-determiner elements in a DP can also be part of definite DP's, which do not (necessarily) introduce new dref's.

Correlatives – "biclausal topic-comment structures […] [in which] the dependent clause introduces one or more topical referents to be commented on by the matrix clause, where each topical referent must be picked up by — correlated with — an anaphoric proform." (Bittner 2001: 4). See also Dayal (1995, 1996), Bhatt (2003) and references therein.

- the Hindi examples in (2) and (3) (a single wh-topic correlative and a multiple wh-topic correlative respectively) are from Dayal (1996) [2].

2. jo^{u} laRkii lambii hai, vo$_{u}$ khaRii hai.
   which girl tall be.prs, she standing be.prs
   The one girl that is tall is standing.

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[2] Example (2) is a slight variant of example (1a) in Dayal (1996): 152 and (3) is example (16) in Dayal (1996): 197.

3. jis^{u} laRkii-ne jis$^{u'}$ laRke-ke saath khel-aa, us$_{u}$-ne us$_{u'}$-ko haraa-yaa.
which girl-Erg which boy-with together play-pfv, she-Erg he-Acc defeat-pfv
Every girl that played against a boy is such that she played against exactly one boy and she defeated the one boy she played against.

- and here are two examples of Romanian correlatives; note the definite vs. universal contrast in interpretation between the Hindi and the Romanian examples[3]:

4. Care^{u} fată e înaltă, (aceea$_{u}$) stă în picioare.
which girl is tall, (that one) stands on legs
Every girl that is tall is standing (or: stands up).

5. Care^{u} fată împotriva cărui$^{u'}$ băiat a jucat, l$_{u'}$ =a bătut.
which girl against which.Gen boy HAVE played, HIM=HAVE defeated.
Every girl that played against a boy defeated every boy she played against.

Why are donkey sentences and correlatives interesting? (Part 1)

From a syntax/semantics interface perspective:

- **semantically – quantifier binding**: (1) is interpreted as: every farmer who owns a donkey beats **every** donkey s/he owns; that is, the pronoun *it*$_{u'}$ is not used referentially – at least not referentially in the sense of cross-sentential anaphora of the kind instantiated in (6) below;

6. Linus bought a$^{u'}$ donkey. It$_{u'}$ hadn't been vaccinated.

It might very well be that, in example (6), the use of the indefinite *a*$^{u'}$ *donkey* pragmatically brings to salience a particular donkey (the one Linus bought on a particular occasion) and the pronoun *it*$_{u'}$ is interpreted referentially, i.e. as referring to the pragmatically salient donkey. But there is no particular salient donkey that (1) refers to.

- **syntactically – no c-command** [4]; in general, we need c-command for quantifier binding, as shown by (7) below, which constrasts with the minimally different example in (8).

7. #Every^{u} boy who read every$^{u'}$ *Harry Potter* book recommended it$_{u'}$ to his$_{u}$ friends.

8. Every^{u} boy who read a$^{u'}$ *Harry Potter* book recommended it$_{u'}$ to his$_{u}$ friends.

- correlatives pose a similar problem for a compositional syntax/semantics mapping because "the relative clause in these sentences is often analyzed as adjoined to the main clause […] [and] a direct linking [i.e. quantifier binding] between the wh NP

[3] Hindi and Romanian also differ with respect to the position of the wh-phrases: fronting is optional in Hindi correlatives (see Dayal 1996: 188, (2) and the related discussion), while multiple wh-fronting is obligatory in Romanian correlatives (just as it is in questions) – as shown by the infelicitous sentence in (i) below, which is like (5) above modulo the fact that the wh-PP *împotriva cărui*$^{u'}$ *băiat* (against which^{u} boy) is left *in situ*.

(i) *Care^{u} fată a jucat împotriva cărui$^{u'}$ băiat, l$_{u}$=a bătut.

[4] C-command / o-command / outranking etc. – whichever syntactic formalism the reader favors.

and the main clause NP is ruled out since they are not in a c-command relation" (Dayal 1995: 179-180).

- the basic syntactic structure of Hindi and (for all intents and purposes) Romanian correlatives is provided in (9) below (see (3) in Dayal 1995: 179 [5])

9. $[_{IP}\ [_{CP}$ which^{u} girl is standing$]$ $[_{IP}$ she$_{u}$ is tall $]$ $]$

Why are donkey sentences and correlatives interesting? (Part 2)

From a semantics/pragmatics interface perspective:

- they display **variable uniqueness effects**, i.e. a **universal vs. definite** variation in interpretation, both within a particular language and across languages;

- consider the wh-phrase *jo^{u} laRkii* / *jis^{u} laRkii-ne* (which girl) in the Hindi examples above: *jo^{u} laRkii* receives a definite / unique interpretation in (2) and a universal / non-unique interpretation in (3);

- similarly, the wh-phrase *care fată* (which girl) can receive either a universal or a definite interpretation; the universal reading is salient in the single wh-topic Romanian correlative in (4) (with or without the demonstrative anaphor) if we take (4) to be an answer to a question like *How can one identify tall girls on a very small airplane?* – every girl that is tall has to stand up because she doesn't have enough leg room;

- in contrast, *care fată* (which girl) in the correlative in (10) below receives a definite interpretation: (10) is intuitively felicitous only in situations in which only one girl lost her coat;

10. Care fată şi =a pierdut haina, o găseşte la secretariat.
Which girl HER.f.sg.Dat =HAVE lost coat.f.sg.the, IT.f.sg find.prs.3.sg at secretary off.
The girl that lost her coat can find it in the secretary's office.

- the variation in interpretation between the universal correlative in (4) and the definite correlative in (10) is a pragmatic matter: we deal with regularities, law-like phenomena in (4) and accidental, sporadic events in (10) – and it is world knowledge that enables us to make this distinction;

- in particular, the difference in interpretation between (4) and (10) is not a consequence of the temporal-aspectual structure of the topic / comment clauses, because we can get a universal interpretation with an episodic *passé compose*, as shown by the Romanian single wh-topic correlative in (11) below:

[5] For a recent discussion and a different take on the syntax of Hindi correlatives, see Bhatt (2003).

11. Care fată a vorbit cu colega de bancă în timpul examenului,
Which girl HAVE talked with mate.f.sg.THE of desk in time.THE exam.THE.Gen,
a fost dată afară din sală.
HAVE been removed out of room.
Every girl that talked to her desk mate during the exam was removed from the room.

- the Hindi correlative in (2) contrast with the Romanian correlative in (4) in that the former is not felicitous as an answer to the question, i.e. *How can one identify tall girls in a small airplane?*, which is compatible only with a universal / non-unique reading;

- one way to generate a suitable universal reading for the Hindi correlative in (2) is to switch from episodic to habitual morphology, as first observed in Dayal (1995)[6]; the habitual counterpart of the episodic correlative in (2) is provided in (12) below:

12. jo$_u$ laRkii lambii **ho-tii** hai, vo$_u$ khaRii **ho-tii** hai.
which girl tall be-hab.f be.prs, she standing be-hab.f be.prs
Always, the girl who is tall stands up (i.e., every case / situation / instance [7] that features a unique tall girl is a situation in which the tall girl stands up).

- we see a similar contrast between Hindi multiple-topic correlatives and their Romanian counterparts;

- the multiple wh-topic Romanian correlative in (5) contrasts with its Hindi counterpart in (3) with respect to the interpretation of the non-main wh-topic (i.e. the non-initial wh-topic): the Romanian example has an across-the-board universal reading;

- in the Hindi example, however, only the main (initial) wh-topic is universal, while the other one – or the other ones, as shown by the triple wh-topic correlative in (13) below – receive an across-the-board definite reading;

13. jis laRke-ne jis laRkii-ko jo tohfaa diyaa
which boy-Erg which girl-Dat which gift.m give.pfv.m.sg
us-ne us-se vo vaapas maang-aa
he-Erg her-from that back demand-pfv.m.sg
Every goy gave exactly one gift to exactly one girl and every boy asked the corresponding girl to give him back the gift he gave her.

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[6] See Dayal (1995): 180, (4) and Dayal (1995): 188, (15b) and the related discussion.

[7] The "case" paraphrase is due to Lewis (1975). The "(minimal) situation" paraphrase is due to Heim (1990). The "instance" paraphrase is due to Kadmon (1990).

[8] Rajesh Bhatt reports that, intuitively, this kind of sentences generalize over situations where there is a unique girl who is tall and, of each such situation, we predicate that the girl in that situation stands up (p.c.).

- the Romanian counterpart of the Hindi triple wh-topic correlative is provided in (14) below:

14. ?Care băiat cărei fete ce cadou i = a dat de Crăciun,
which boy which.Dat girl what gift.m her.Dat=HAVE given for Christmas
i l =a cerut înapoi ziua urmatoare. [9]
her.Dat it.m=HAVE asked back day next.
Every boy that gave a gift to a girl for Christmas asked her to give it back to him the following day (i.e. every boy asked every girl he gave a gift to to give him back every gift he gave her).

- finally, donkey sentences exhibit the same kind of universal / definite variation in interpretation: the donkey anaphora in (1) above receives a universal interpretation (every donkey owning farmer beats **every** donkey s/he owns), while the donkey anaphora in (15) below (see Parsons 1978: 19, (4), where the example is attributed to Barbare Partee) receives a definite interpretation:

15. Every^{u} man who has a$^{u'}$ son wills him$_{u'}$ all his money.

- "What does this sentence say about men who have more than one son? It somehow seems inappropriate to apply the sentence to them […]" (Parson 1978: 19). Intuitively, this sentence is interpreted either as: (*i*) every man (in a given, contextually salient set) who has a son has a unique son and wills his unique son all his money or as (*ii*) every man who has a unique son wills his unique son all his money;

- thus, sentence (15) exihibits a form of relativized uniqueness (the *u'*-son is unique relative to each *u*-man), just as the *u'*-boy is unique relative to each *u*-girl in the Hindi correlative in (3) above;

- other examples in which the donkey anaphora receives a non-unique interpretation are provided in (16), (17) and (18) below (see Heim 1990: 162, (49), Rooth 1987: 256, (48) and Heim 1982: 89, (12) respectively).

16. Most^{u} people that owned a$^{u'}$ slave also owned his$_{u'}$ offspring.

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[9] Triple wh-topic correlatives are degraded in Romanian, just as triple wh-questions with the same initial sequence of wh-phrases is degraded, e.g. *?Care băiat cărei fete ce cadou i-a dat de Crăciun?* (Which boy gave what gift to which girl for Christmas?) This seems to be a performance issue, so I will idealize and take such examples to be acceptable as far as the semantic competence is concerned. We obtain an example that is perfectly acceptable if we replace one wh-topic, e.g. *ce cadou* (what gift) with a donkey indefinite, e.g. *un cadou* (*a gift*), as a shown in (i) below.

(i) Care băiat cărei fete i-a dat un cadou, i l-a cerut înapoi.
Every boy that gave a gift to a girl asked her to give it back to him, i.e. asked every girl that got at least one gift from him to give him back every gift he gave her.

17. No^{u} parent with a$^{u'}$ son still in high school has ever lent him$_{u'}$ the car on a weeknight.

18. Everybody^{u} who bought a$^{u'}$ sage plant here bought eight$^{u''}$ others along with it$_{u'}$.

Summary:

Donkey sentences and correlatives pose the following challenges:

- **syntax/semantics interface**: quantifier binding without c-command;

- **semantics**: we need to capture anaphora to *dependencies* between objects, not only anaphora to objects; the most striking example is the Romanian triple wh-topic correlative in (14) above, where we are looking at three sets: (*i*) the set of all boys that gave a gift to some girls, (*ii*) the set of all gifts that were given by a boy to some girl and (*iii*) the set of all girls that were given a gift by some boy; the comment part of the correlative elaborates on the "giving" relation between these three sets and not only on the sets themselves: each boy asked each of the girls he gave a gift to – and not some other girl – to give him back the gift/s he gave her – and not some other gift/s;

- **syntax/semantics interface**: compositionality, i.e. we need to capture this cross-clausal quantifier binding – or, to be more precise: anaphora to quantificational dependencies – in a compositional way, i.e. the semantic values of the items in the topic part of a correlative and in the restrictor of a donkey sentence should be fine-grained enough to enable us to pass on the information about quantificational dependencies across clausal boundaries – without the elements that introduce these dependencies (indefinites and wh-phrases respectively) syntactically scoping out of their clause (the topic clause and the restrictor relative clause respectively)

- **semantics/pragmatics**: the *same* semantic values need to be able to express *both* the universal / non-unique and the definite / unique readings associated with donkey anaphora and correlatives while leaving the choice up to pragmatics: it is world knowledge about wills that makes the unique reading more salient in (15) above (cf. *Every man who has a son shares with him all his money / shows him all his money*) and it is world knowledge that makes the universal reading more salient in the regularity-based Romanian correlative in (4) above (or the rule-based correlative in (11)) and the definite reading more salient in the Romanian correlative in (10).

2 THE BASIC PROPOSAL

The variable nature of the uniqueness effects emerges as a result of the interaction of three distinct components:

- **singular number morphology** on the anaphors, which requires a form of context-relative uniqueness;

- **the meaning of (wh-)indefinites**, which update the context by introducing maximal witness sets[10], i.e. by introducing all the individuals that satisfy their restrictor and nuclear scope;

- **the pragmatically specified granularity level for the 'main' quantificational structure**, i.e. for the structure that has the (wh-)indefinite in its first clause and the anaphor in its second clause;

- the quantification can be **coarse-grained**: we quantify over the individuals that satisfy the restrictor (in the case of donkey sentences) or the topic clause (in the case of correlatives), i.e. the nuclear scope (in the case of donkey sentences) or the comment clause (in the case of correlatives) has to hold with respect to the individuals characterized by the restrictor / topic clause; this yields **definite / unique readings**;

- the quantification can be **fine-grained**: we quantify over the cases / minimal situations that satisfy the restrictor (in the case of donkey sentences) or the topic clause (in the case of correlatives), i.e. the nuclear scope (in the case of donkey sentences) or the comment clause (in the case of correlatives) has to hold with respect to the cases / minimal situations characterized by the restrictor / topic clause; this yields **universal / non-unique** readings.

For example:

- the donkey sentence in (1) above (*Every^{u} farmer who owns a$^{u'}$ donkey beats it$_{u'}$*), in which the donkey anaphora receives a universal reading, is analyzed as follows:

19. for each donkey-owning farmer *u*:
    introduce and store in *u'* all the donkeys that the *u*-farmer owns (this is the **maximal witness** set introduced by the indefinite);
    then, check that the nuclear scope holds relative to each case / minimal situation characterized by the restrictor, i.e. containing the *u*-individual under discussion and one of the corresponding *u'*-individuals (this is **fine grained quantification**);
    that is, check that the set of *u'*-individuals under discussion is a singleton (this is the **context-relative uniqueness** contributed by the singular anaphor, trivially satisfied in each particular case / minimal situation) and that the *u*-individual under discussion beats the *u'*-individual under discussion.

- the donkey sentence in (15) above (*Every^{u} man who has a$^{u'}$ son wills him$_{u'}$ all his money*), in which the donkey anaphora receives a definite reading, is analyzed as follows:

[10] A witness set for a static quantifier **DET**(*A*) (where **DET** is a static determiner and *A* is a set of individuals) is any set of individuals *B* such that $B \subseteq A$ and **DET**(*A*)(*B*). See Barwise & Cooper (1981): 103 (page references to Portner & Partee 2002).

20. for each man *u* that has a son:
    introduce and store in *u'* all the sons that the *u*-man has (this is the **maximal witness** set introduced by the indefinite);
    then, check that the nuclear scope holds relative to each *u*-individual characterized by the restrictor (this is **coarse grained quantification**);
    that is, check that the set of *u'*-individuals under discussion is a singleton (this is the **context-relative uniqueness** contributed by the singular anaphor, requiring the maximal witness set introduced by the indefinite to be a singleton) and that the *u*-individual under discussion beats the *u'*-individual under discussion.

- the Romanian single-topic correlative in (4) above, which has a universal reading (*Every girl that is tall is standing*), is analyzed in parallel to the donkey sentence in (1):

21. topic clause: introduce and store in *u* all the girls that are tall (this is the **maximal witness** set introduced by the wh-indefinite);
    then, check the comment clause relative to each case / minimal situation characterized by the topic clause, i.e. containing one of the *u*-individuals under discussion (this is **fine grained quantification**);
    that is, check that the set of *u*-individuals under discussion is a singleton (this is the **context-relative uniqueness** contributed by the singular anaphor, trivially satisfied in each particular case / minimal situation) and that the *u*-individual under discussion is standing.

- the Romanian single-topic correlative in (10) above, which has a definite reading (*The girl that lost her coat can find it in the secretary's office*), is analyzed in parallel to the donkey sentence in (15):

22. topic clause: introduce and store in *u* all the girls that lost their coats (this is the **maximal witness** set introduced by the wh-indefinite);
    then, check the comment clause relative to each each *u*-individual characterized by the topic clause (this is **coarse grained quantification**);
    that is, check that the set of *u*-individuals under discussion is a singleton (this is the **context-relative uniqueness** contributed by the singular anaphor, requiring the maximal witness set introduced by the wh-indefinite to be a singleton) and that the *u*-individual under discussion can find her coat in the secretary's office.

- in Hindi correlatives, the granularity level of the topic-comment structure is not left for pragmatics to decide: correlatives with episodic morphology like (2) above are coarse-grained (hence uniqueness), while correlatives with overt habitual morphology like (12) above are fine-grained (hence non-uniqueness).

- multiple-topic correlatives in both Hindi and Romanian have to have a universal reading (across-the-board in Romanian and restricted to the main topic in Hindi) – that is, the granularity level of multiple-topic correlatives cannot be coarse-grained, i.e. individual-based; why is that?

- suggestion: topic-comment structures have to be about **only one topic**;

- when correlatives have a single wh-indefinite, the topic can be either the individual introduced by the wh-indefinite (coarse-grainedness) or any case / situation featuring such an individual (fine-grainedness);

- when correlatives have multiple wh-indefinites, i.e. multiple DP's are morphologically marked as topical, the topic can only be a case / situation featuring such individuals;

- hence: we get across-the-board universal readings for Romanian correlatives;

- hence: we get a main-topic universal reading in Hindi, i.e. an **intermediate level of quantificational granularity**; we do not get an across-the-board universal reading because this has to be morphologically realized as habitual morphology.

Unifying Dynamic Semantics and Situation-based E-type Approaches to Donkey Anaphora:

- the vacuous satisfaction of uniqueness when the quantification is fine-grained – which enables us to capture the universal / non-unique readings of donkey sentences and correlatives is very much like the vacuous satisfaction of the uniqueness presupposition associated with E-type pronouns in situation-based E-type approaches (see Heim 1990 among others);

- more generally, the dynamic system couched in classical type logic introduced in the following section can be taken to effectively unify dynamic and situation-based E-type approaches to donkey anaphora[11].

3 OUTLINE OF THE ACCOUNT: PLURAL INFO STATES AND ANAPHORA TO DEPENDENCIES

- the first, **syntax/semantics** desideratum (see the summary at the end of section **1** above) is to get quantifier binding without c-command, i.e. we need a way to record information about how variable assignments are manipulated by donkey indefinites, e.g. $a^{u'}$ *donkey* in (1) above, and wh-topics, e.g. *care*^{u} *fată* (which girl) in (4) above, and pass this information across clausal / sentential boundaries;

- the general strategy that I will pursue here: leave the syntax untouched and change the semantics by making semantic values dynamic (i.e. finer-grained) – see Kamp (1981), Heim (1982), Groenendijk & Stokhof (1991); hence, the meaning of natural language expressions (*i*) will be dependent on the discourse context (as in static semantics) and, in addition, (*ii*) will change / update this context;

[11] See chapter 5 in Brasoveanu (2007) for a more detailed discussion.

- thus: sentences are not interpreted as sets of contexts, but as relations over contexts, i.e. sets of pairs of contexts of the form <Input Context, Output Context>; I use context here in the sense of (discourse) information states

- the second, **semantic** desideratum above is to capture anaphora to dependencies between objects, not only anaphora to objects – I will thefore take information states to be sets of variables assignments (van den Berg 1994, 1996, building on ideas in Barwise 1987 and Rooth 1987; see also Krifka 1996 and Nouwen 2003 among others) and not single assignments (as classical dynamic semantics would have it);

- a set of variable assignments can be represented as a matrix with variable assignments / sequences as rows, as shown in (23) below:

23. Info State I

	…	u		u'		…
i_1	…	x_1	(i.e. ui_1)	y_1	(i.e. $u'i_1$)	…
i_2	…	x_2	(i.e. ui_2)	y_2	(i.e. $u'i_2$)	…
i_3	…	x_3	(i.e. ui_3)	y_3	(i.e. $u'i_3$)	…
…	…	…		…		…

Values – sets of objects (e.g. individuals): $\{x_1, x_2, x_3, \ldots\}$, $\{y_1, y_2, y_3, \ldots\}$ etc.

Structure (plural discourse reference) – *n*-ary relations between objects: $\{\langle x_1, y_1\rangle, \langle x_2, y_2\rangle, \langle x_3, y_3\rangle, \ldots\}$ etc.

- a matrix, i.e. a plural info state, is two-dimensional and encodes two kinds of discourse information: values and structure;

- the values are the sets of objects that are stored in the columns of the matrix, e.g. a dref u stores a set of individuals relative to a plural info state, since u is assigned an individual by each assignment (i.e. row).

- the structure, i.e. the quantificational dependencies, is *distributively* encoded in the rows of the matrix: for each assignment / row in the plural info state, the individual assigned to a dref u by that assignment is structurally correlated with the individual assigned to some other dref u' by the same assignment;

- the third, **syntax/semantics** desideratum is compositionality at sub-clausal / sub-sentential level; this is achieved by couching the plural info state-based dynamic system in classical type logic: I will extended Compositional DRT (CDRT, see Muskens 1996) with plural info states and dub the resulting system Plural CDRT (PCDRT);

- our type logic is basically Gallin's Ty2; we have three basic types: type t (truth-values); type e (individuals); type s (modeling variable assignments as they are used in Groenendijk & Stokhof's DPL);

- constants of type e: *dobby*, *megan* etc.; variables of type e: x, x' etc.;

- variables of type s: i, j etc.

- a dref for individuals u is a function of type se from assignments i_s to individuals x_e (subscripts on terms indicate their type);

- intuitively, the individual $u_{se}i_s$ is the individual that the assignment i assigns to the dref u;

- dynamic info states I, J etc. are plural: they are sets of variable assignments, i.e. they are terms of type st;

- as shown in matrix (23) above, an individual dref u stores a set of individuals with respect to a plural info state I, abbreviated as $uI := \{u_{se}i_s: i_s \in I_{st}\}$, i.e. uI is the image of the set of assignments I under the function u;

- thus, dref's are modeled like individual concepts in Montague semantics: an individual concept is a function from indices of evaluation to individuals, while a dref is a discourse-relative invidual concept, modeled as a function from discourse salience states to individuals (in PCDRT, a discourse salience state is just a Tarskian, total variable assignment);

- a sentence is interpreted as a Discourse Representation Structure (DRS), i.e. as a relation of type $(st)((st)t)$ between an input info state I_{st} and an output info state J_{st}: J differs from the input info state I at most with respect to the **new dref's** and J satisfies all the **conditions**;

24. [**new dref's** | **conditions**] := $\lambda I_{st}.\lambda J_{st}.\ I$[**new dref's**]$J \wedge$ **conditions**J

25. [u, u' | $girl\{u\}$, $boy\{u'\}$, $play\_against\{u, u'\}$] :=
$\lambda I_{st}.\lambda J_{st}.\ I[u, u']J \wedge girl\{u\}J \wedge boy\{u'\}J \wedge play\_against\{u, u'\}J$

26. tests (DRS's that do not introduce new dref's):
[**conditions**] := $\lambda I_{st}.\lambda J_{st}.\ I{=}J \wedge$ **conditions**J

27. [$defeat\{u, u'\}$] := $\lambda I_{st}.\lambda J_{st}.\ I{=}J \wedge defeat\{u, u'\}J$

- conditions, e.g. lexical relations like $play\_against\{u, u'\}$, are sets of plural info states, i.e. they are terms of type $(st)t$;

- lexical relations are *unselectively distributive* with respect to the plural info states they accept (where "unselective" is used in the sense of Lewis 1975); that is, lexical relations universally quantify over variable assignments / cases: a lexical relation accepts a plural info state I iff it accepts, in a pointwise manner, every single assignment i in the info state I, as shown in (28) below;

28. **Lexical relations in PCDRT**:
$R\{u_1, \ldots, u_n\} := \lambda I_{st}.\ I{\neq}\emptyset \wedge \forall i_s \in I(R(u_1 i, \ldots, u_n i))$,
for any non-logical constant R of type $e^n t$ [12].

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[12] Where, following Muskens (1996), $e^n t$ is defined as the smallest set of types such that: (*i*) $e^0 t := t$ and (*ii*) $e^{m+1}t := e(e^m t)$.

29. Info state I	…	u_1	…	u_n	…
i	…	x_1 (=u_1i)	…	x_n (=u_ni)	…
		$R(u_1i, \ldots, u_ni)$, i.e. $R(x_1, \ldots, x_n)$			
i'	…	x_1' (=u_1i')	…	x_n' (=u_ni')	…
i''	…	x_1'' (=u_1i'')	…	x_n'' (=u_ni'')	…
…	…	…	…	…	…

- **Truth.** A DRS D of type $(st)((st)t)$ is *true* with respect to an input info state I_{st} iff $\exists J_{st}(DIJ)$.

- given the underlying type logic, compositionality at sub-clausal level follows automatically: in a Fregean / Montagovian framework, the compositional aspect of interpretation is largely determined by the types for the 'saturated' expressions, i.e. names and sentences; let's abbreviate them as **e** and **t**;

- an extensional static logic is the simplest: **e** is e (individuals) and **t** is t (truth-values); the denotation of the noun `book` is of type **et**, i.e. et: `book` $\rightsquigarrow \lambda x_e.\ book_{et}(x)$. The generalized determiner `every` is of type (**et**)((**et**)**t**), i.e. $(et)((et)t)$: `every` $\rightsquigarrow \lambda S_{et}.\lambda S'_{et}.\ \forall x_e(S(x) \rightarrow S'(x))$

- we go dynamic by making the 'meta-types' **e** and **t** finer-grained: **e** will be the type of discourse referents for individuals, i.e. se, and **t** will be the type of DRS's, i.e. $(st)((st)t)$;

- the denotation of the noun `book` is still of type **et**, as shown in (30) below:

30. `book` $\rightsquigarrow \lambda v_{\mathbf{e}}.\ [book\{v\}]$, i.e. `book` $\rightsquigarrow \lambda v_{\mathbf{e}}.\lambda I_{st}.\lambda J_{st}.\ I{=}J \wedge book\{v\}J$

- let us turn now to the last, **semantics/pragmatics** desideratum listed above, namely: being able to semantically express both the universal / non-unique and the definite / unique readings associated with donkey anaphora and correlatives while leaving the choice between the two of them up to pragmatics;

- the three crucial ingredients of the account are: (*i*) the interpretation of singular anaphors, (*ii*) the interpretation of (wh-)indefinites and (*iii*) the interpretation of generalized determiners and topic-comment structures;

- a pronoun that is anaphoric to a dref u is interpreted as the Montagovian quantifier-lift of the dref u (of type **e**), i.e. its type is (**et**)**t**;

- singular number morphology on pronouns contributes a context-relative uniqueness requirement, defined in (31) below: the dref u stores the same individual throughout

the plural info state I; for simplicity, I take the **unique**$\{u\}$ condition to be asserted and not presupposed[13];

31. **unique**$\{u\} := \lambda I_{st}.\ I{\neq}\emptyset \wedge \forall i_s{\in} I \forall i'_s{\in} I(ui{=}ui')$

32. he_u / vo_u / us_u / $aceea_u \rightsquigarrow \lambda P_{\mathbf{et}}.\ [\mathbf{unique}\{u\}];\ P(u)$

- determiners and indefinite articles have denotations of the expected type, i.e. (**et**)((**et**)**t**): they take two dynamic properties $P_{\mathbf{et}}$ (the restrictor property) and $P'_{\mathbf{et}}$ (the nuclear scope property) as arguments and return a DRS (i.e. a term of type **t**) as value;

- (wh-)indefinites introduce maximal witness sets, as shown in (33) below; the restrictor DRS $P(u)$ and the nuclear scope DRS $P'(u)$ are dynamically conjoined and dynamic conjunction ';' is defined in (34) below as relation composition;

33. a^u / jo^u / $care^u \rightsquigarrow \lambda P_{\mathbf{et}}.\lambda P'_{\mathbf{et}}.\ \mathbf{max}^u(\mathbf{dist}(P(u);\ P'(u)))$

34. $D;\ D' := \lambda I_{st}.\lambda J_{st}.\ \exists H_{st}(DIH \wedge D'HJ)$, where D and D' are DRS's (type **t**)

- informally, the update $\mathbf{max}^u(\mathbf{dist}(P(u);\ P'(u)))$ in (33) can be paraphrased as: introduce the dref u and store in it the maximal set of individuals (this is the $\mathbf{max}^u$ part) such that,
  when we take each variable assignment in the resulting plural info state one at a time, hence each u-individual one at a time (this is the **dist** part),
  the u-individual satisfies the restrictor property P and the dynamic property P'.

- the two relevant operators are: (*i*) selective discourse-level maximization $\mathbf{max}^u$, "selective" because it targets a particular dref, namely u, and "discourse-level" because it maximizes over plural info states, and (*ii*) unselective discourse-level distributivity **dist**, "unselective" (in the sense of Lewis 1975) because it targets variable assignments in general, not particular drefs, and (*ii*) "discourse-level" because it distributes over plural info states;

35. $\mathbf{max}^u(D) := \lambda I_{st}.\lambda J_{st}.\ ([u];\ D)IJ \wedge \forall K_{st}(([u];\ D)IK \rightarrow uK{\subseteq}uJ)$,
  where D is a DRS (type **t**).

36. $\mathbf{dist}(D) := \lambda I_{st}.\lambda J_{st}.\ \exists R_{s((st)t)}{\neq}\emptyset(I{=}\mathbf{Dom}(R) \wedge J{=}\cup\mathbf{Ran}(R) \wedge \forall{<}k_s,L_{st}{>}{\in}R(D\{k\}L))$,
  where D is a DRS (type **t**).[14]

- analyzing the wh-elements as basically indefinites is independently motivated by languages in which they are morphologically identical, e.g. in Yucatec Mayan, or morphologically related, e.g. in Romanian;

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[13] See Sauerland (2003) (among others) for a very similar proposal in a static system and for more discussion of the semantics of number morphology.

[14] Where $\mathbf{Dom}(R) := \{k_s: \exists L_{st}(RkL)\}$ and $\mathbf{Ran}(R) := \{L_{st}: \exists k_s(RkL)\}$.

- wh-indefinites are always strong – this is independently justified by their interpretation in exhaustive-answer questions;

Interpreting single-topic correlatives in Hindi and Romanian:

- the topic and the comment clause in correlatives are dynamically conjoined in a way that respects their surface order, i.e. the topic clause is the first conjunct;

- we set the granularity level for the topic-comment structure: pragmatically in Romanian and semantically, i.e. the episodic vs. habitual morphology, in Hindi;

- **coarse-grained quantification** is modeled by the lack of a distributivity operator **dist** with scope over the comment clause; for example, the Hindi single-topic correlative in (2) that receives a definite reading is represented as shown in (37); the PCDRT representation is obtained compositionally based on the meanings of the individual lexical items (the Romanian single-topic correlative in (10) that receives a definite reading is represented in a similar way);

37. single-topic correlatives – definite / unique readings:
TOPIC: $\mathbf{max}^{u}(\mathbf{dist}([girl\{u\}, tall\{u\}]))$; COMMENT: $[\mathbf{unique}\{u\}]; [standing\{u\}]$

- the uniqueness effect, i.e. the definite reading, associated with the correlative in (2) arises as a consequence of the interaction between the $\mathbf{max}^{u}$ operator contributed by the wh-indefinite and the $\mathbf{unique}\{u\}$ condition contributed by the singular anaphor (crucially, the condition is outside the scope of the $\mathbf{max}^{u}$ and **dist** operators)

- informally, the update in (37) can be paraphrased as: (topic part) consider the set of all the tall girls and store it in the dref u; (comment part) the set of u-individuals is a singleton and the only individual that is a member of this set is standing;

- **fine-grained quantification** is modeled by the presence of a distributivity operator **dist** with scope over the comment clause, contributed by habitual morphology in the Hindi correlative in (12) and pragmatically introduced in the Romanian correlative in (4)[15]; the Hindi correlative in (12) receives a universal reading as a consequence of nuclear scope **dist** operator, as shown in (38) below;

38. single-topic correlatives – universal / non-unique readings:
TOPIC: $\mathbf{max}^{u}(\mathbf{dist}([girl\{u\}, tall\{u\}]))$; COMMENT: $\mathbf{dist}([\mathbf{unique}\{u\}]; [standing\{u\}])$

- the **unique** condition is vacuously satisfied in the immediate scope of a **dist** operator because the **dist** operator instructs as to examine one variable assignment at a time

[15] A full treatment of the Quantificational Variability Effects exhibited by Hindi and Romanian correlatives will probably involve an approach like the one in de Swart (1993), where habitual morphology and overt adverbs of quantification are interpreted as generalized quantifiers over eventualities.

(and not the entire plural info state) – and the dref u is obviously assigned a unique value in any particular variable assignment

- the generalized determiner `every` is represented in PCDRT as shown in (39) and (40) below[16];

39. coarse-grained (individual-based) quantification:
$\texttt{every}^{u} \rightsquigarrow \lambda P_{\mathbf{et}}.\lambda P'_{\mathbf{et}}.\ \mathbf{max}^{u}(\mathbf{dist}_{u}(P(u)));\ \mathbf{dist}_{u}(P'(u))$

40. fine-grained (case-based / situation-based) quantification:
$\texttt{every}^{u} \rightsquigarrow \lambda P_{\mathbf{et}}.\lambda P'_{\mathbf{et}}.\ \mathbf{max}^{u}(\mathbf{dist}_{u}(P(u)));\ \mathbf{dist}(P'(u))$

41. $\mathbf{dist}_{u}(D) := \lambda I_{st}.\lambda J_{st}.\ I{\neq}\emptyset \wedge uI{=}uJ \wedge \forall x_{e}{\in}uI(DI_{u=x}J_{u=x})$,
where $I_{u=x} := \{i_{s}{\in}I\colon ui{=}x\}$

- the two translations differ only with respect to the kind of distributivity operator that scopes over the nuclear scope update $P'(u)$: (*i*) a selective distributivity operator $\mathbf{dist}_{u}$, "selective" because it targets only the dref u over which `every` quantifies, defined in (41) below[17], and (*ii*) the unselective discourse-level distributivity operator **dist**;

- $\mathbf{dist}_{u}$ yields the coarse-grained, individual-based interpretation of the quantificational structure, while **dist** yields the fine-grained, situation-based interpretation;

- as already indicated, I take the distributivity operators scoping over the nuclear scope $P'(u)$ to be specified pragmatically; therefore, (39) and (40) are the PCDRT translations for `every` after they are fully specified pragmatically; semantically, we have only one translation that leaves the exact nature of the distributivity operator underspecified;

- in the PCDRT translations of $\texttt{every}^{u}$ in (39) and (40), we need the selective $\mathbf{dist}_{u}$ operator over the restrictor update $P(u)$ to capture the fact that the generalized determiner $\texttt{every}^{u}$ selectively quantifies over the dref u;

- the first update in (39) and (40) is $\mathbf{max}^{u}(\mathbf{dist}_{u}(P(u)))$, which instructs us to store in u the set of all individuals (this part is due to $\mathbf{max}^{u}$) such that, when taken one individual at a time (this part is due to $\mathbf{dist}_{u}$), they satisfy the restrictor property P;

- that is, we store in u all the individuals that distributively satisfy P and we want to check that they also satisfy the nuclear scope property P' – as (39) and (40) above show, we can check this one u-individual at a time (hence coarse-grained quantification) or one case / minimal situation at a time (hence fine-grained quantification);

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[16] The two translations for `every` are simplified versions of the PCDRT definition of dynamic generalized quantification – see Brasoveanu (2007) for the definition and more discussion

[17] This definition is based on van den Berg (1994, 1996) and Nouwen (2003).

- note that, in the representation for $\texttt{every}^{u}$, we maximize only over the restrictor update $P(u)$, while in the representation of (wh-)indefinites, we maximize over both the restrictor update $P(u)$ and the nuclear scope update $P'(u)$;

Interpreting donkey sentences:

- the PCDRT representations for the universal-reading donkey sentence in (1) above and the definite-reading donkey sentence in (15) above are provided in (42) and (43) below (redundant distributivity operators are omitted); these representations capture the intuitively correct truth-conditions;

42. donkey anaphora – non-uniqueness:
$\mathbf{max}^{u}(\mathbf{dist}_{u}([farmer\{u\}]; \mathbf{max}^{u'}([donkey\{u'\}, own\{u, u'\}])));$
$\mathbf{dist}([\mathbf{unique}\{u'\}]; [beat\{u, u'\}])$

43. donkey anaphora – relativized uniqueness:
$\mathbf{max}^{u}(\mathbf{dist}_{u}([man\{u\}]; \mathbf{max}^{u'}([son\{u'\}, have\{u, u'\}])));$
$\mathbf{dist}_{u}([\mathbf{unique}\{u'\}]; [will\_all\_money\{u, u'\}])$

Interpreting multiple-topic correlatives in Hindi and Romanian:

- finally, it is precisely the selective discourse-level distributive operator $\mathbf{dist}_{u}$ that gives us the intermediate level of quantificational granularity that we need for the Hindi multiple-topic correlatives;

- $\mathbf{dist}_{u}$ enables us to assign a universal interpretation to the main wh-topic of the correlative, while assigning definite interpretations to the other wh-topics; this is due to the fact that $\mathbf{dist}_{u}$ enables us to examine each of the sub-states of the input info state I that assign the same individual x to to the dref u, i.e. we examine each substate $I_{u=x}$, for all $x \in uI$;

- we do not examine the individual that is introduced as a topic (which we get when there is no distributivity operator scoping over the comment) or the cases / minimal situations that are introduced as a topic (which we get when there is a **dist** operator scoping over the comment);

- we examine an intermediate kind of topics, namely sets of cases / minimal situations that are identified in terms of the u- individuals;

- the representation for the Hindi multiple-topic correlative in (3) above is provided in (44) below (redundant distributivity operators are removed); this representation derives the intuitively correct truth-conditions: the main reason is that the $\mathbf{dist}_{u}$ operator over the comment update ensures the vacuous satisfaction of the $\mathbf{unique}\{u\}$ condition (the one associated with the main wh-indefinite), but not of the $\mathbf{unique}\{u'\}$ condition.

44. TOPIC: $\mathbf{max}^{u}(\mathbf{dist}([girl\{u\}]; \mathbf{max}^{u'}([boy\{u'\}, play\_against\{u, u'\}])))$;
COMMENT: $\mathbf{dist}_{u}([\mathbf{unique}\{u\}]; [\mathbf{unique}\{u'\}]; [defeat\{u, u'\}])$

- Romanian multiple correlatives have an unselective **dist** operator scoping over the comment, which derives the across-the-board universal reading because the unselective **dist** ensures the vacuous satisfaction of any **unique** condition in the comment update.

Future research:

- pursue the hypothesis that our semantic competence is domain neutral (see Partee 1973, 1984, Stone 1997, 1999, Bittner 2001, Schlenker 2005 among others) by investigating the anaphoric and quantificational parallels between individual-level correlatives and degree-based correlatives, i.e. comparative and equative correlatives (in Hindi, Romanian and English), e.g. *The more intelligent the students are, the better the grades are*.

Gloss abbreviations:

hab := habitual; m := masculine; f := feminine; sg := singular; pl := plural; Erg := Ergative; Dat := Dative; Gen := Genitive; pfv := perfective; impfv := imperfective; prs := present

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