INTRODUCTION

JERUSALEM LECTURES

In 1992, I was a Lady Davis Fellow in the English Department at the Hebrew University of Jerusalem. In the context of this, Edit Doron asked me to present a series of weekly evening lectures.

The idea was that I would be talking about my own current research on plurality in an event based theory, without the restraints that a normal seminar format would impose: i.e. the idea was that I would actually get to the part where I would talk about my own work.

At the same time, Edit added, it would be nice if, rather than just presupposing or presenting a neo-Davidsonian framework to develop my analysis of plurality, I could provide a more general setting of the problems by discussing in some depth the architecture of event arguments and thematic roles. In particular, Terry Parsons' book, Parsons 1990, had appeared relatively recently, and there was real interest among the audience in discussing Parsons' arguments for events and roles.

I have no recollection of how I arrived at the lunatic idea of interpreting the expression 'my own current research' as 'the research to be done in this year'. But this is by and large what happened. I arrived in January with only a very initial version of most of the material which is now in section 4 of lecture Five and the first three sections of lecture Six. At the end of the year, a complete first version of this book had come into existence in the form of extended lecture notes which I handed out during the talks. It was great, but not to be repeated or recommended.

Of course, since after this I spent six years reworking the material, the relations between the original lectures and the present book are complex and diverse - as they should be, because it is a book, and not an historic record (though I hope that some of the spirit and fun of the lectures shines through).

There is a more pedestrian reason for the lecture structure of this book. If you do not have the enviable temperament for writing a Book - a Coherent and Comprehensive Account of a Certain Topic, and you find yourself writing a book instead, you have to find a way of tricking yourself into actually getting it done. This is because the Book is always hovering over the horizon: you are swimming in an ocean of topics that cannot possibly be left out, and literature which obviously needs to be not just mentioned but analyzed and discussed thoroughly, and it's just impossible. And while the book takes shape, these problems actually increase, and with them the threat of paralysis.

Since I liked the structure and content of the original lectures well enough, I used them to structure the content of the book, and in this way to get it done. This means that if your favorite topic or analysis is not in the book, you can be pretty sure that I am

sorry too that it isn't. At the same time, we can console ourselves with the thought that the reason that it isn't in here is, in a way, merely an historic accident.

ROAD MAP

The ten lectures divide in three parts. The first three lectures are on Events; lectures Four and Five are on Plurality; and lectures Six through Ten are on Events and Plurality.

I have tried to make sure that certain parts of the book can be read relatively independently from the rest. For instance, the first three lectures can be read as a relatively selfcontained part on Davidsonian event theories (I twice taught a seminar on just those three lectures). Similarly, if you want to get to the plurality right away, you can safely start in lecture Four, but I would advise backtracking a bit along the road: section 3.3. contains discussion that is relevant to section 5.4., and lecture Six builds on section 2.2. I have myself used a smaller selection, namely sections 1.1, 1.2., 2.2., and 3.2. as a two-week topic in my advanced semantics class (which is the class that in the old days we used to call Montague Grammar), discussing how to add events and adverbials to a semantically interpreted (type shifting) grammar.

TOUR GUIDE

Lectures One to Three discuss the Davidsonian and the neo-Davidsonian event theories and the Unique Role Requirement. The Davidsonian theory here is the assumption that verbs have an (implicit) event argument, and that adverbs are interpreted as predicates of, or relations to, this event argument. The neo-Davidsonian theory is the assumption that noun phrase arguments relate to the verb interpretation through thematic roles, which are relations between the event argument of the verbs and the noun phrase interpretations. The Unique Role Requirement is the assumption that thematic roles are partial functions: a thematic role specifies per event at most one bearer of that role.

Lecture One discusses arguments for the Davidsonian theory. The most important, and convincing, of these is Parsons' modifier argument: the Davidsonian theory provides an account of adverbial modification which captures the semantic parallels between adverbial expressions and adjectives. I argue that the other arguments that Parsons discusses do not have the same convincing power. I discuss arguments concerning explicit reference to events, and show that they are either spurious, or reduce to the modifier argument, or are really arguments for the Unique Role Requirement. In the discussion of Parsons' argument from perception verbs, I argue that the facts about perception verbs are more complex than Parsons assumes, and that, as a consequence, perception verbs do not provide a clear argument for the Davidsonian theory either. This means that, at the end of this lecture, we find on the Davidsonian side of the scales, the modifier argument and some reason to be interested in the Unique Role Requirement.

In the first section of lecture Two I discuss finegrainedness of events. I argue, with Parsons, that arguments from adverbial modification (including, for the purpose of this discussion, the neo-Davidsonian analysis of nominal arguments through thematic roles) show that the events that fill the event arguments of verbs need to be considerably finegrained in order to prevent arguments and adverbs from swapping incorrectly from one verb to another. While the main arguments here are in Parsons, I go through some effort trying to close some loopholes by discussing some options that coarsegrained event theories might consider in order to deal with these problems. I use this discussion to introduce the Unique Role Requirement as the main constraint through which the neo-Davidsonian theory prevents argument and adverb swap.

In the second section of lecture Two, I introduce the first formal theory. I present the syntax and semantics of a neo-Davidsonian Language of Events, which is a type logical language, enriched with Davidsonian apparatus, and I present a (type shifting) grammar. This grammar analyzes verbs as n-place event types, functions from n arguments into sets of events. The grammar deals with verbs and singular noun phrase arguments, scope, and adverbials.

Lecture Three deals with three neo-Davidsonian themes. The first is the analysis of passive-sensitive adverbs (a topic that Parsons 1990 does not deal with) and passivization.

I present and discuss a Davidsonian analysis of these adverbs and argue that the Unique Role Requirement allows for an analysis of passivization which improves upon classical accounts of passive. The second theme is the analysis of collective readings of plural noun phrases. Without the Unique Role Requirement, we could assume that collectivity means that more than one individual fills a (relational) role of an event. I argue against this account of collectivity, and for the alternative, which, in agreement with the Unique Role Requirement, assumes that collectivity implies that a single object, a collection, fills a role. At this point, we have added to the modifier argument on the Davidsonian side of the scales the Unique Role Requirement. The final theme of this lecture is the question whether there is an alternative. I argue that there is. I discuss McConnell-Ginet 1982's argument-extension approach to adverbial modification and argue that we can formulate a version of this which deals adequately with all the problems. This theory does not assume that verbs denote functions into sets of events, but functions into sets of sets of role-argument pairs. I argue that this theory is almost-neo-Davidsonian: while it doesn't contain events, verbs do have an implicit argument, the theory does have thematic roles, and the theory incorporates the Unique Role Requirement. I argue that while this theory can be made to cover the facts, it is, for me, unsatisfactory as a framework for linguistic theory. The reason is that it explicitly does not try to capture the parallels between adjectives and adverbs by assuming that in essence the same semantic operations apply to both.

For me, this is a serious methodological reason to prefer the Davidsonian theory, since the reason that I got interested in the Davidsonian theory in the first place is pre-

cisely the belief that there are deep parallels between what goes on in the nominal domain and the verbal domain, and the desire to have a framework in which these parallels can be explored. This sets the stage for the discussion of plurality in the remainder of the book: I argue that semantic plurality provides another case where we want to argue that the very same notions of singularity and plurality and the same operation of pluralization apply both in the nominal domain and the verbal domain. And I argue that the Davidsonian theory is a natural framework to capture these parallels.

In lecture Four, after introducing the plurality ontology that I will use in these lectures, I present and discuss Scha 1981's theory of plurality. This involves an extensive presentation of Scha's Language of Plurality and his grammar. The lecture centers around four topics: plurality, collectivity, distributivity, and cumulativity. I argue that Scha's account of plurality is inferior to Link's account, which is presented in the next lecture. In Scha's analysis of collectivity, I find much to sympathize with (excepting his analysis of so-called cover readings). I argue that Scha's account of distributivity is inadequate. Scha's paper provides the first formal account of cumulativity. However, cumulativity is dealt with through a special complex grammatical mechanism of binary quantification. This mechanism includes rules for forming binary determiners out of determiners of noun phrases that do not form a constituent. This mechanism is problematic, and it will be the main topic of this book to provide a motivated alternative account of cumulativity.

In lecture Five, I introduce a Language of Plurality and discuss the theories of plurality of Link 1983, 1984 and Landman 1989a,b. Link introduced an operation of semantic pluralization for nominal predicates, and an operation of group formation. With Link, my analysis assumed that plural noun phrases can have a plural interpretation, or they can shift to a singular interpretation, a group interpretation. I briefly discuss some of the arguments. The difference between my analysis and Link's lies in the verbal predicates. I argued that the same operation of pluralization that we find in the nominal domain is also available in the verbal domain. This allowed me to reduce distributivity to plurality: if we apply a pluralized verbal predicate to a semantically plural interpretation of a noun phrase, we get a distributive interpretation. In this theory, collective interpretations are singular interpretations: groups are singular objects, and collective predication is applying a semantically singular predicate to a singular, collective noun phrase interpretation.

In this lecture, I argue that this theory correctly predicts that verbs have the same lexical thematic implications when they apply to collections as when they apply to singular objects. And I propose to turn this observation into a collectivity criterion: the presence of thematic implications concerning the plural argument of a verb indicates that we are dealing with a collective interpretation, and the absence of such implications indicates that the interpretation is not collective. I show that the collectivity criterion entails that distributive interpretations cannot be reduced to collective ones. And I show

that, contrary to what I assumed in Landman 1989a, the collectivity criterion entails that also cumulative readings cannot be reduced to collective readings.

This means that Scha was right in his assumption that the grammar needs to account for cumulativity. However, against Scha, I argue that the close similarity between distributivity and cumulativity indicates that, rather than providing a special mechanism to deal with cumulative readings, we need a unified theory which reduces both distributivity and cumulativity to plurality. Such a theory is developed in the next three lectures.

In lecture Six I merge the Language of Events from lecture Two and the Language of Plurality from lecture Five into a Language of Events and Plurality: this is a type logical neo-Davidsonian language which incorporates the theory of plurality of lecture Five by assuming, in strict analogy to pluralization in the nominal domain, that plural events are sums of singular events and that, in agreement with the Unique Role Requirement and the Collectivity Criterion, their roles are plural roles, where the value of a plural role for a sum of events is the sum of the values of the singular roles of the singular events which make up that sum of events.

In this theory we indeed get collectivity if a singular, group, interpretation of a plural noun phrase fills a (singular or plural) role of the verb; we get distributivity if a plural noun phrase interpretation fills a plural role of the verb; and we get cumulativity if two or more plural noun phrase interpretations simultaneously fill plural roles of the verb. Thus, indeed, both distributivity and cumulativity are reduced to plurality. This means that we can do without Scha's special mechanism of binary quantification to deal with cumulativity. The observation that in a neo-Davidsonian theory of plurality we get, for simple cases, cumulativity for free, I call Schein's observation. What Schein 1986 observed was that, in a neo-Davidsonian theory, plurality operations on the roles in an event type are scopally independent of each other, and this creates the cumulativity effect.

I present a grammar which extends the grammar of lecture Two to plurality. The grammar generates (if there are no lexical restrictions) two readings for one-place verbs with plural noun phrase arguments: a collective and a distributive reading. For two-place verbs with plural noun phrase arguments, we generate four scopeless readings: a double collective reading, a collective-plural reading and a plural-collective reading, and a double plural reading: the cumulative reading.

I then discuss matters of scope. I argue that there is strong evidence that, for two-place verbs with plural arguments, the grammar needs to generate at least one more reading, a reading where both noun phrases are plural, but with the object scopallly dependent upon the subject. For this, we need to add a scope mechanism. In the present theory, a scope mechanism is a mechanism for building derived plural predicates, and, given the two parameters collective/plural and scopal/non-scopal, it adds four scopal readings. I compare this theory with earlier theories of scope and plurality.

Finally, I discuss cover readings. Cover readings are, like cumulative readings, scopeless plural readings, but in cover readings the plural roles are not filled by the

LECTURE ONE

ARGUMENTS FOR THE DAVIDSONIAN THEORY

1.1. THE DAVIDSONIAN THEORY

In this lecture, I will introduce the (neo)-Davidsonian theory of event arguments, and discuss several of the arguments that Terry Parsons gives in Parsons 1990 in favor of this theory. I will discuss some details of Parsons' own proposal in the next lecture. There too, I will present a particular version of the neo-Davidsonian theory, that I will build on in later lectures on plurality.

The Davidsonian theory is a cluster of theories of relations, their arguments and their modifiers. Look at the sentences in (1):

(1) a. Jones buttered the toast.
b. Jones buttered the toast slowly in the bathroom with a knife.

Ignoring verb phrase modification, the classical theory of relations and arguments (as found in e.g. Montague 1973, Thomason and Stalnaker 1973) tells us that the verb *butter* in sentence (1a) expresses a two-place relation between the two nominal arguments, and that the adverbials in (1b) are verb modifiers: functions from verbs to verbs; in other words, the verb and the modifiers in (1b) form a complex two-place relation (as in 2b):

(2) a. BUTTER(j,t)
b. ([WITH(k)(IN(b)(SLOWLY(BUTTER)))]) (j,t)

Davidson 1967 proposes that the verb in an action-sentence (i.e., a non-stative verb), like (1a), expresses a three-place relation between the nominal arguments and an implicit event argument, which is existentially quantified over; and he proposes that the modifiers in (1b) are added conjunctively as predicates of the event argument. This leads to representations like (3a) and (3b):

(3) a. $\exists e[$ BUTTER(e,j,t) $]$
b. $\exists e[$ BUTTER(e,j,t) $\wedge$ SLOWLY(e) $\wedge$ IN(e,b) $\wedge$ WITH(e,k)$]$

What is called the neo-Davidsonian theory, which is explored in, among others, Higginbotham 1983 and Parsons 1990, radicalizes this idea by assuming that all verbs, non-statives and statives alike, have such an implicit argument - verbs are not relations,

but one-place predicates of events (or states); and it assumes that both modifiers and arguments are added conjunctively, the latter through thematic roles. This gives representations like (4a) and (4b):

(4) a. $\exists e[$ BUTTER(e) $\wedge$ AGENT(e)=j $\wedge$ THEME(e)=t $]$
b. $\exists e[$ BUTTER(e) $\wedge$ AGENT(e)=j $\wedge$ THEME(e)=t $\wedge$
SLOWLY(e) $\wedge$ LOCATION(e)=b $\wedge$ INSTRUMENT(e)=k $]$

We see three salient features that the Davidsonian and neo-Davidsonian theory share:

1. Besides the arguments that are explicit in the sentence, verbs have an extra, implicit argument: an event (or state) argument.
2. Modifiers modify this event argument.
3. In the sentence, this event argument is existentially quantified over.

In Parsons 1990, three kinds of arguments are presented in favor of the (neo)-Davidsonian theory: the modifier argument, the argument from explicit event reference, and the argument from perception reports.

In this lecture, I will discuss these arguments. I will extensively discuss the modifier argument, and argue that it is indeed a very powerful argument. I will discuss some putative alternatives in this lecture, but postpone the comparison with what I think is its most serious competitor to lecture Three. I will further argue that the modifier argument applies to stative verbs as well, though the arguments that Parsons' himself gives are not conclusive.

I will argue that Parsons' argument from explicit event reference isn't as powerful as it looks at first sight. I will argue that, in the end, what plausibility it has derives from the modifier argument, and hence this isn't an independent argument. Concerning the argument from perception verbs, I will argue that the facts here are more complicated than Parsons' assumes, and that, in the final account, they are compatible with the Davidsonian theory, but do not support it. Thus, while some of the glamor of the Davidsonian theory will be eroded in this lecture, the theory will still survive as a powerful approach to adverbial modification.

1.2. THE MODIFIER ARGUMENT

I will present Parsons' modifier argument by looking at adjectives first. Look at sentence (5a):

(5) a. John is a blue-eyed, blond, forty year old American with a beard, in his midlife crisis, dressed in a suit.

Kamp 1975 presents and discusses the classical semantic theory of prenominal adjectives. This theory assumes that such adjectives are nominal modifiers, semantically, functions that take a noun (type <e,t>) and turn it into a complex noun (also type <e,t>). This means that semantically, (5a) is analyzed as (5b):

(5) b. DRESSED IN A SUIT(IN HIS MIDLIFE CRISIS (WITH A BEARD(BLUE-EYED(BLOND(FORTY YEAR OLD (AMERICAN)))))) (j)

where each of the modifiers has type <<e,t>,<e,t>> (or rather the corresponding intensional type).

There are two problems with the classical analysis:

1. **Permutation**: Disregarding syntactic distribution constraints (concerning which modifiers are prenominal and postnominal), it seems to be the case that **permuting** the modifiers in (5a) does not change the truth value of (5a), i.e. (5a) is equivalent to (5c):

(5) c. John is a forty year old, blond, blue-eyed American, dressed in a suit, with a beard, in his midlife crisis.

2. **Drop**: We can drop any number of adjectival modifiers anywhere in (5a), and (5a) entails the resulting sentence, i.e. (5a) entails (5d):

(5) d. John is a blue-eyed, forty year old American, in his midlife crisis.

There are two kinds of exceptions to these observations, one real and one not real. In the first place, intensional adjectives like *former* and *potential* do not obey Permutation and Drop, as can be seen by the fact that (6a) and (6b) are not equivalent, and that (6c) does not entail (6d):

(6) a. John is a former world-class ballet dancer.
b. John is a world-class former ballet dancer.
c. This is a potential problem.
d. This is a problem.

Such intensional adjectives only occur as prenominal adjectives, not as predicative adjectives, and I will assume that they form a special class that I will not be concerned with here.

The second kind of exceptions are scalar adjectives.

It would seem at first sight that Permutation and Drop do not hold for the large class of scalar adjectives either, cf. (7a)-(7c):

(7) a. Jumbo is a small pink elephant.
b. Jumbo is a pink small elephant.
c. Jumbo is a small elephant.

It is not clear that (7a) and (7b) have the same truth conditions, and if pink elephants are extraordinarily large, (7a) does not intuitively entail (7c).

However, Kamp 1975 argues that scalar adjectives require for their interpretation an implicit comparison class, and he argues that the nature of this comparison class is determined in discourse. Typically, out of the blue this comparison class is determined by the noun that the scalar adjective applies to (i.e. *pink elephant* in (7a), but *elephant* in (7b)), but, as Kamp and Partee 1994 neatly show, this is not always the case, cf. (8):

(8) a. My three-year-old built a really huge snowman.
b. The college team built a really huge snowman.

Out of the blue, *huge* in (8a) means: huge in comparison to snowmen built by three-year-olds. With appropriate stress on *snowman*, it can even mean: huge in comparison to things typically built by three-year-olds, in which case the noun *snowman* doesn't play any role at all in the comparison class.

Given this, it is no longer clear that scalar adjectives don't obey the principles of Permutation and Drop. The reason is that the principles of Permutation and Drop obviously have nothing to say about inferences where in the premise and the conclusion the adjectives do not have the same interpretation. Since Kamp analyzes scalar adjectives as predicates, he assumes that principles like Permutation and Drop constrain these adjectives as much as they do other adjectives, and that the putative counterexamples in (7) aren't counterexamples: on the problematic interpretation (which is their natural interpretation), they do not challenge Permutation and Drop, because the comparison class is not kept the same.

The claim that Permutation and Drop hold for scalar adjectives is the claim that (9a) and (9b) are equivalent, and that (9a) entails (9c), assuming that the comparison classes are as given, and this claim seems unproblematic.

(9) a. Jumbo is a small[for a pink elephant] pink elephant.
b. Jumbo is a pink small[for a pink elephant] elephant.
c. Jumbo is a small[for a pink elephant] elephant.

We can assume, then, that, except for the intensional adjectives, the principles of Permutation and Drop hold generally for prenominal adjectives.

The problem then is to account for this.

Theoretically, we have the following problem. We have the following structure:

(10) a. A(B(C(N)))(x)

(10a) entails any permutation of the modifiers in (10b):

(10) b. 1. A(C(B(N)))(x)
2. B(A(C(N)))(x)
3. B(C(A(N)))(x)
4. C(A(B(N)))(x)
5. C(B(A(N))(x)

And (10a) entails any case with adjectives dropped in (10c), plus their permutations:

(10) c. 1. B(C(N))(x) 2. C(B(N))(x)
3. A(C(N))(x) 4. C(A(N))(x)
5. A(B(N))(x) 6. B(A(N))(x)
7. A(N)(x)
8. B(N)(x)
9. C(N)(x)
10. N(x)

The standard way to try to ensure this is by means of meaning postulates. One principle that will give us some of these entailments is the so-called meaning postulate of *subsectivity*:

Subsectivity
For any (relevant) modifier A and simple or complex noun N: A(N)(x) entails N(x)

Now (7a) entails (7d), and (7d) entails (7e), and hence (7a) entails (7e):

(7) a. Jumbo is a small pink elephant.
d. Jumbo is a pink elephant.
e. Jumbo is an elephant.

However, such a meaning postulate is not enough, because it cannot give us the entailment from (5e) to (5f):

(5) e. John is a blond, forty year old American.
f. John is a forty year old, blond American.

Nor can it allow us to drop an adjective in the middle, i.e. give the entailment from (5g) to (5h):

(5) g. John is a blond, blue eyed, forty year old American.
h. John is a blond, forty year old American.

To get the latter, we would have to add a principle of *monotonicity*:

Monotonicity
If A(N)(x) and N entails M then A(M)(x)

So let N be the complex noun in (5i), M be the complex noun in (5j), and let A be *blond*. Since (5i) entails (5j), it follows with monotonicity that (5k) entails (5l):

(5) i. Blue-eyed forty year old American
j. Forty year old American
k. Blond blue-eyed forty year old American
l. Blond forty year old American

However, it seems that to get the full permutation facts, a meaning postulate constraining the meaning of a single modifier cannot suffice. More precisely, what is not

LECTURE TWO

THE NEO-DAVISONIAN THEORY, THE UNIQUE ROLE REQUIREMENT AND THE LANGUAGE OF EVENTS

2.1. FINEGRAINEDNESS AND THE UNIQUE ROLE REQUIREMENT

Let us look at the following arguments.

(1) a. John bought Ulysses from Bill.
b. Bill sold Ulysses to John.
c. Only one transaction took place.
d. Hence, John sold Ulysses to himself.

(2) a. I hit Brutus.
b. I revenged myself.
c. My hitting Brutus was my revenge.
d. Hence, I hit myself.

(3) a. I dined tonight.
b. I ate falafel tonight.
c. The falafel was my dinner.
d. Hence, I dined falafel tonight.

These inference patterns are somewhat problematic for the neo-Davidsonian theory. Here is why. A natural representation of the inference in (1) in the neo-Davidsonian theory would be as in (4a-d):

(4) a. $\exists e$[BUY(e) $\wedge$ AGENT(e)=j $\wedge$ THEME(e)=u $\wedge$ SOURCE(e)=b]
b. $\exists e$[SELL(e) $\wedge$ AGENT(e)=b $\wedge$ THEME(e)=u $\wedge$ GOAL(e)=j]
c. The event in (a) is the same as the event in (b).
d. $\exists e$[SELL(e) $\wedge$ AGENT(e)=j $\wedge$ THEME(e)=u $\wedge$ GOAL(e)=j]

The problem is that the inference from (4a)-(4c) to (4d) is valid. (4a)-(4c) together entail (4e) which entails (4d):

(4) e. $\exists e$[BUY(e) $\wedge$ AGENT(e)=j $\wedge$ THEME(e)=u $\wedge$
SOURCE(e)=b $\wedge$ SELL(e) $\wedge$ AGENT(e)=b $\wedge$ THEME(e)=u $\wedge$ GOAL(e)=j]

The argument in (2) is similarly valid. If I am the agent of *hit* and the theme of *revenge* (if theme is what it is), and these events are the same, then I am the agent of an

event which is a hitting and which has me as agent and theme. (3) shows a different problem with a similar origin.

If my dining and my eating falafel are the same event, and the falafel is the theme of *eat*, then there is an event of dining with the falafel as theme. But *dine* is intransitive and shouldn't be able to take a theme.

The problem for the neo-Davidsonian theory is the following: in the neo-Davidsonian theory, modifiers and arguments - from now on **roles** - are added conjunctively to the verbal predication as co-predicates on the event variable. This means that roles are tied to the particular verb only indirectly, through the event variable. If we allow one event to be characterised by two different verbal predicates (as stipulated in each of the above arguments in premise c), we see that we no longer know which verbal predicate which role belongs to, and we can swap them around.

The particular examples in (1)-(3) concern arguments of the verbs, and are problems for the neo-Davidsonian theory because of its assumption that arguments, like modifiers, are added conjunctively to the event argument. Since Davidson's original proposal doesn't make this assumption for arguments, the particular examples in (1)-(3) as such are not a problem for the Davidsonian theory. But the general problem is exactly the same, because the very same arguments can be made with full blooded modifiers as well: the inference in (5) is equally invalid:

(5) a. John bought Ulysses from Bill **with a credit card**.
b. Bill sold Ulysses to John.
c. Only one transaction took place.
d. So, Bill sold Ulysses to John **with a credit card**.

While I will focus here on the neo-Davidsonian theory, it should be kept in mind that the discussion applies equally well to modifier roles in the Davidsonian theory (more discussion below).

The above problems are obviously not problems for theories where argument or modifier roles are not added conjunctively to the verbal predicate (but then, as we saw in lecture One, such theories have problems with the modifier argument). Let us look at what, within the neo-Davidsonian theory, can be done about these arguments.

Parsons 1990 discusses two strategies which can be used to deal with these problems:

- we can make our events more finegrained.
- we can make our roles more finegrained.

Let's discuss the latter strategy first. Instead of assuming a general set of roles: AGENT, INSTRUMENT, etc., we can assume that these roles are **indexed**, in particular, that the grammar indexes them for the verb that they are modifying.

This would give representations (6a) and (6b) for (1a) and (1b) respectively:

(6) a. $\exists e[\text{BUY}(e) \wedge \text{AGENT}_{\text{buy}}(e)=j \wedge \text{THEME}_{\text{buy}}(e)=u \wedge \text{SOURCE}_{\text{buy}}(e)=b]$
b. $\exists e[\text{SELL}(e) \wedge \text{AGENT}_{\text{sell}}(e)=b \wedge \text{THEME}_{\text{sell}}(e)=u \wedge \text{GOAL}_{\text{sell}}(e)=j]$

With premise (4c) we can now derive (6c):

(6) c. $\exists e[SELL(e) \wedge AGENT_{buy}(e)=j \wedge THEME_{sell}(e)=u \wedge GOAL_{sell}(e)=j]$

But (6c) is not the representation of (1d) in this version of the neo-Davidsonian theory; (1d) is represented as (6d):

(6) d. $\exists e[SELL(e) \wedge AGENT_{sell}(e)=j \wedge THEME_{sell}(e)=u \wedge GOAL_{sell}(e)=b]$

And we cannot derive (6d), so the inference is indeed invalid. Since (6c) is not the interpretation of any natural language sentence, the fact that we can derive (6c) is unproblematic, since there is no native speaker's intuition that it conflicts with.

While Parsons discusses some arguments against this approach, he regards them as inconclusive, and he concludes that the finegrained role approach has to be admitted as an alternative to his own approach. I think that a better argument against it can be given.

The finegrained role approach comes into problems with cases where **the same verb** occurs with different modifiers that shouldn't swap, but, like in the cases in (1)-(4), we feel that at some level the events involved are just the same. Here is an example.

Suppose Bill Clinton and James Levine meet at a promotional event. They shake hands. In some intuitive sense, again, sentences (7a) and (7b) describe the same event: one handshake took place.

(7) a. Bill shook hands with James.
b. James shook hands with Bill.

However, for promotional reasons, Clinton is wearing a baseball glove, while, to commemorate the days of the grand Maistros, Levine is wearing white conductor's gloves (and indeed a towel, but not on his hands). Now the following inference is not valid:

(8) a. With a baseball glove, Bill shook hands with James.
b. With a conductor's glove, James shook hands with Bill.
c. One handshake took place.
d. With a baseball glove, James shook hands with Bill.

On the finegrained role analysis, (8a,b) would be represented as (9a,b):

(9) a. $\exists e[SHAKE(e) \wedge AGENT_{shake}(e)=b \wedge THEME_{shake}(e)=j \wedge WITH_{shake}(e)=BG]$
b. $\exists e[SHAKE(e) \wedge AGENT_{shake}(e)=j \wedge THEME_{shake}(e)=b \wedge WITH_{shake}(e)=CG]$

The identifying condition in (8c) allows us to conclude (9c) from (9a) and (9b), which entails (9d), the representation of (8d). Hence, the argument comes out as valid:

(9) c. $\exists e[SHAKE(e) \wedge AGENT_{shake}(e)=b \wedge THEME_{shake}(e)=j \wedge$
$WITH_{shake}(e)=BG \wedge AGENT_{shake}(e)=j \wedge THEME_{shake}(e)=b \wedge$
$WITH_{shake}(e)=CG]$
d. $\exists e[SHAKE(e) \wedge AGENT_{shake}(e)=j \wedge THEME_{shake}(e)=b \wedge WITH_{shake}(e)=BG]$

This suggests that the finegrained role analysis is not adequate, because the roles are not finegrained enough. Of course, we can make the roles more finegrained, say, by distinguishing, through indexing, role $AGENT_{shake,1}$ in a representation for (8a) from role $AGENT_{shake,2}$ in a representation for (8b); i.e. we would associate with different instances of verbs different instances of the roles for that verb. But that is nothing but an encoding of finegrained events as indices, and the finegrained role approach would reduce to the finegrained event approach.

There is yet another alternative that needs some discussion at this point. I have argued in lecture One that modifier phrases like *with a baseball glove* in (8a) cannot be analyzed as predicates of the subject *Bill* in (8a). We have assumed instead that such modifiers are predicates of the implicit argument of the verb. But clearly they seem to have something to say about the subject: it's Bill who has a baseball glove on his hand. We have assumed that verbs, which are explicitly predicates of individuals, have an implicit event argument. We might want to argue that while the Davidsonian theory treats a preposition like *with* in *with a baseball glove* in (8a) as a two-place relation between an event and an object (the glove), we really ought to treat it as a **three-place** relation between an event, an object, **and an individual**, namely the subject of the sentence. This would give for (8a), (8b), and (8d) neo-Davidsonian representations like (9e)-(9g):

(9) e. $\exists e[SHAKE(e) \wedge AGENT(e)=b \wedge THEME(e)=j \wedge WITH(e,b)=BG]$
f. $\exists e[SHAKE(e) \wedge AGENT(e)=j \wedge THEME(e)=b \wedge WITH(e,j)=CG]$
g. $\exists e[SHAKE(e) \wedge AGENT(e)=j \wedge THEME(e)=b \wedge WITH(e,j)=BG]$

And this analysis in fact avoids the problems, because representation (9g) doesn't follow from (9e) and (9f) even if we assume only one event. If this analysis is feasible, then the arguments that we have been discussing in this section show nothing about finegrainedness at all: to avoid argument swap, we can assume the Davidsonian, rather than the neo-Davidsonian theory, and for modifiers, we can assume that they have more than one implicit argument, i.e. also a subject argument.

However, I think that this analysis is not feasible. Like many modifier phrases, *with a baseball glove* is **agent oriented** in that, as a property of the event, it also expresses a property of the agent of the event. But that by itself is not enough to solve the problem, precisely because if there is only one event, it has two agents, Clinton and Levine, and the modifier phrase should be able to orient towards either, and it doesn't. So we crucially have to assume that *with a baseball glove* is subject oriented, rather than agent oriented.

The problem with this analysis is that subject oriented adverbs actually do exist. I will discuss them in lecture Three. But subject oriented adverbs are passive sensitive: in active sentences they orient towards the subject, but in passive sentences they are ambiguous: they can orient either towards the surface subject of the passive verb, or towards the deep subject in the *by*-phrase. Agent oriented adverbs do not show this ambiguity: they orient in active and passive sentences towards the agent. This means that in

active sentences they orient to the subject, but in passive sentences, they orient to the agent in the *by*-phrase. Now look at (8a) and (8e):

(8) a. With a baseball glove, Bill shook hands with James.
e. With a baseball glove, James was shaken hands with by Bill.

Both in (8a) and in (8e), *with a baseball glove* unambiguously orients towards Bill, the agent. This shows that these modifiers are **not** subject oriented, and hence, the preposition *with* should **not** be analyzed as having an argument slot for the subject, because that would make the wrong predictions for passives.

I conclude that trying to solve the finegrainedness problems by making the roles more finegrained, or by adding implicit arguments to the roles, isn't going to work.

The alternative is to make our events more finegrained. This is the road that Parsons follows. In the three inferences in (1)-(3), the third premise suggests that we make the two events in the first two premises identical. Parsons argues that we do not have to read the third premise as claiming this, and hence the inference doesn't go through.

Let me make some ontological suggestions for interpreting this argument. Let us assume, with Parsons, that events are the building blocks of our ontology, and that events are finegrained events: when a buying and a selling are going on, the buying and the selling are distinct events. Yet in some sense, they are not distinct. In what sense? Let us change perspectives briefly. Let us now think of the world as consisting of situations. If situations are our primitives, then what are events? One way to think about them is as aspects of situations, say, some structure that is recognized in or imposed upon situations (this perspective is developed in Bartsch 1981 and goes back to Whitehead 1919). As such, events can be reconstructed as **properties of situations**. But such properties are **intensional**: we may well conceptually distinguish different aspects of situations without being able to differentiate those aspects in terms of situations. This is exactly the kind of finegrainedness that led Gennaro Chierchia to give up reconstructing properties in terms of possible worlds (e.g. Chierchia 1984).

Angelika Kratzer (in Kratzer 1989) uses a situation semantics to define a relation of **lumping** between propositions, which we can here reinterpret as a relation between events: two events **lump** each other if they are aspects of exactly the same situations, i.e. if they are situationally indiscernable.

Alternatively, we can start out with finegrained events and the lumping relation as primitives and **define** situations as groups of events that lump each other.

A particular instance of lumping would be the relation between related buyings and sellings: let us assume that these are events that lump each other. What follows is that, even though we distinguish the particular buying and selling of Ulysses as distinct aspects of certain situations (i.e. finegrained events), there are no situations that contain the one, but not the other, because they are lumped together.

Let us next assume that the 'event-identity' statement in (1c) - only one transaction took place - is a statement not about (finegrained) events, but about situations: we assume that (1c) does not mean (10a), but (10b):

LECTURE THREE

THE NEO-DAVIDSONIAN THEORY AND ITS RIVALS

In this lecture, I will discuss three topics. First, I will discuss (in Section 3.1.) the semantics of passive sensitive adverbs. This topic will lead us to a discussion of the semantics of passivization (in Section 3.2.), and we will see an important application of the Unique Role Requirement when we study the interaction between passive sensitive adverbs and passivization.

Second, in Section 3.3, I will have some initial discussion of the semantics of plurality: two approaches to collective readings of plural noun phrases are discussed. One approach adopts the Unique Role Requirement and assumes that in a collective reading of a plural sentence, a collection fills a single role of a single event. The other approach rejects the Unique Role Requirement and assumes that in a collective reading, singular objects fill multiple roles of a single event. I will defend the first approach here. The topic will be developed further in lecture Five.

Third, I will discuss, in Section 3.4., the argument extension alternative to the Davidsonian theory. Here I will conclude that, while a coherent alternative theory can indeed be worked out, it will in most of its essential respects be so much like the neo-Davidsonian theory, that empirical criteria are unlikely to be able to decide between them. This means that heuristic arguments will have to make that decision. I will use the neo-Davidsonian theory because of the scopelessness phenomena that form the topic of the remainder of these lectures: the analysis of plurality and scope that I will develop in the bulk of these lectures is just much easier to formulate in a neo-Davidsonian theory than in its argument extension competitor.

3.1. PASSIVE SENSITIVE ADVERBIALS

Here are some of the facts about passive sensitive adverbs (discussed in Thomason and Stalnaker 1973, McConnell-Ginet 1982, Wyner 1989a, Wyner 1994).

1. Adverbials like *reluctantly* are subject oriented in active sentences and can be interpreted as both subject or *by*-phrase oriented in passive sentences.

(1) a. Reluctantly, Joan instructed Mary.
b. Reluctantly, Mary was instructed by Joan.

(1a) can only mean that Joan was reluctant, not that Mary was reluctant; (1b) is ambiguous, it means either that Mary was reluctant or that Joan was reluctant. (McConnell-Ginet 1982 discusses which readings these adverbials can have in which positions.) These observations extend to indirect object passives:

(2) a. Reluctantly, Caesar sold Crassus the slave.
b. Reluctantly, the slave was sold by Caesar to Crassus.
c. Reluctantly, Crassus was sold the slave by Caesar.

(2a) means that Caesar was reluctant, not that the slave was reluctant, nor that Crassus was reluctant. (2b) means either that the slave was reluctant, or that Caesar was reluctant, but not that Crassus was reluctant. (2c) means either that Crassus was reluctant, or that Caesar was reluctant, but not that the slave was reluctant.

2. Adverbials like *reluctantly* are intensional. (3a) and (3b) can differ in truth value, even if the queen is the head of the state council:

(3) a. Reluctantly, Joan insulted the queen.
b. Reluctantly, Joan insulted the head of the state council.

3. But adverbials like *reluctantly* are factive: (3a) entails (3c):

(3) a. Reluctantly, Joan insulted the queen.
c. Joan insulted the queen.

4. Adverbials like *reluctantly* are extensional with respect to the argument they are sensitive to. This can be seen by considering the following examples:

(4) a. Reluctantly, the queen insulted Mary.
b. Reluctantly, the head of the state council insulted Mary.

(5) a. Reluctantly, the author of Ulysses was insulted by the author of To The Lighthouse.
b. Reluctantly, the author of Chamber Music was insulted by the author of The Waves.

(6) a. Reluctantly, Mary instructed every student.
b. Reluctantly, every student instructed Mary.

If we compare (3a,b) with (4a,b), we observe that substitution is unproblematic in (4) in the subject argument that *reluctantly* orients to. The same is shown with the different readings of (6). The difference between (6a) and (6b) is instructive: (6a) can mean that Mary was reluctant about the fact that she had to instruct all the students. But (24b) only allows an interpretation where *reluctantly* takes narrow scope with respect to *every student*.

Parsons 1990 suggests that passive sensitive adverbs like *reluctantly* are probably best analyzed as sentence-level adverbs. The reason for making this assumption seems to be the intensionality: the category of sentence level adverbials is where we typically find the intensional adverbials. Parsons assumes further that other postulates will guarantee the appropriate factivity and extensionality.

With Wyner 1989a, I think that this is very stipulative and problematic. The factivity and extensionality of the associated argument are, I think, strong indicators that in fact these adverbs are VP adverbials: treating them as VP adverbials predicts both the required factivity and extensionality automatically. The problem with assuming that they are VP adverbials is that it is not clear how you can predict the intensionality.

Let us ignore the intensionality for the moment and concentrate on the subject orientedness of these adverbials. Let us make the following two assumptions:

1. Passive sensitive adverbials like *reluctantly* are VP adverbials.

2. Passive sensitive adverbials like *reluctantly* are subject oriented.

The first assumption means that, like other adverbials, *reluctantly* can modify transitive and intransitive VPs.

The second assumption means that, whereas an adverbial like *slowly* adds conjunctively a property of the event argument, *reluctantly* adds conjunctively a relation between the event argument and the subject argument of the VP, which is the argument added last, i.e. the innermost individual variable in the lambda-prefix. This leads to the following:

Transitive verb phrase modification:

reluctantly $\rightarrow$
$\lambda V \lambda y \lambda x.\{e \in V(x,y)$: RELUCTANT$(x,e)\}$

Intransitive verb phrase modification:

reluctantly $\rightarrow$
$\lambda V \lambda x.\{e \in V(x)$: RELUCTANT$(x,e)\}$

This analysis is of course not correct, since it doesn't deal with intensionality. Since *reluctantly* is treated like a normal VP adverb, the phenomenon called factivity follows automatically, since it is nothing but the principle of modifier drop: when *reluctantly* modifies *insulted the queen* in (3a), its meaning is added conjunctively. Clearly after the subject *Joan* is added, we get a conjunction of (3c), *Joan insulted the queen*, and something about reluctance. So certainly (3c) will follow from that.

I will give the analysis of passives later, but the following considerations should convince you that, **given assumption 2**, any standard analysis of passives can very easily predict the passive sensitivity facts I mentioned.

We only have to assume that we can apply the modifier to the verb phrase either **before** passivisation, or **after** passivisation to get all these facts.

In the active sentence, the subject is the innermost argument in the λ-prefix at every stage of the derivation, hence modification with *reluctantly* will always orient *reluctantly* towards the subject. In the passive sentences, before passivisation the innermost variable in the λ-prefix is the one corresponding to the subject that will end up in the *by*-phrase. Applying reluctantly at this stage, will produce a reading where *reluctantly* is oriented towards the *by*-phrase subject.

Passivisation makes the direct object or the indirect object the passive subject. This means that it makes the variable corresponding to either the direct object or the indirect object (depending on which will be the passive subject) the innermost variable in the λ-prefix. If we first do passivisation, and then apply *reluctantly*, *reluctantly* will be oriented towards what is at that stage the innermost variable, hence it will be oriented towards the passive subject, which is the object in (2a) and (2b), and the indirect object in (2c). At no stage of the derivation of (2b) is the variable corresponding to the indirect object the innermost variable in the λ-prefix, hence we do not get a reading for (2b) where *reluctantly* is oriented towards the indirect object. For the same reason, we do not get a reading in (2c) where *reluctantly* is oriented towards the direct object.

Let me point out that this is not a new analysis (what will be new is the treatment of passives and some of the remarks concerning intensionality, discussed later). Several proposals in the literature, in particular Thomason and Stalnaker 1973, McConnell-Ginet 1982, and Wyner 1989a treat passive sensitive adverbials as VP adverbials and give an analysis of passive sensitivity which relies by and large on the same idea: *reluctantly* can apply to the 'deep subject' or to the 'surface subject' in passive sentences.

Some of the differences with McConnell-Ginet's theory have to do with the fact that her account is more ambitious. McConnell-Ginet tries to account for the different readings that *reluctantly* can have in its different surface positions in a passive sentence. The proposal that I have made here has (by lack of a syntax) nothing to say about that.

Other differences are fundamental. I have assumed here that the orientation of passive sensitive adverbials is (at least partly) **grammatical, rather than lexical** in nature. This means the following: I am assuming, with everybody else, that there are semantic constraints on the orientation of adverbials like *reluctantly*. It is highly likely that there are certain thematic roles towards which *reluctantly* cannot orient (for instance, roles that cannot be filled by sentient beings). These, I assume are **lexical** constraints on the meaning of *reluctantly*. However, the above analysis assumes that we cannot describe constraints on the orientation of *reluctantly* purely in lexical semantic terms: we need to rely on the **grammatical notion of subject**.

This is not what McConnell-Ginet assumes. She assumes a lexical semantic account of the orientation of *reluctantly*: *reluctantly* orients towards an agentive role. She further assumes that the passive introduces a higher predicate of which the subject is

agentive (enough for *reluctantly* to orient towards it). The two readings in the passive case are then derived structurally: since there are two verbs available - the VP and the higher passive verb phrase, *reluctantly* can attach at two places, hence the two readings.

In the neo-Davidsonian approach, with the Unique Role Requirement, this forces a two-event approach to passives: since there are two agents involved, each must be agent of a different event (or state). Thus, we would have to give the analyses in (8a) and (8b) to the active and passive in (7a) and (7b) respectively:

(7) a. Mary kisses John.
b. John was kissed by Mary.

(8) a. There is an event of kissing with Mary as agent and John as theme.
b. There is a state of John (possibly agentively) having the property of there being an event of kissing with Mary as agent and John as theme.

The problem with this is not that interpretation (8b) is implausible for (7b). It **is** certainly semantically coherent. However, as we have seen before with 'property-interpretations', these interpretations tend to abound. In particular, one would say, that in certain contexts (8b) would be an adequate interpretation for (7a) as well. On McConnell-Ginet's analysis that would be no good, of course, but we would like **independent** evidence for assigning the interpretation in (8b) to (7b) and disallowing this interpretation for (7a). And independent evidence for a two- event analysis of (7b) is hard to come by.

Wyner 1989a, 1994 also presents a lexical semantic theory of orientation. Unlike McConnell-Ginet, Wyner doesn't assume that the passive introduces a higher predicate. Wyner assumes that there is a thematic role **Volitional participant** (VOL), which in a normal lexical predicate is aligned with the Agent role (which means that normally both these roles are assigned to the subject). On Wyner's account, passivisation optionally assigns the Volitional Participant role to its surface subject.

In the active case, the Volitional Participant role is optionally assigned. When it is assigned, it is aligned with the agent role. *Reluctantly* orients towards the volitional participant role, hence in the active case, it requires this role to be assigned, and as a consequence of the role alignment, *reluctantly* will orient towards the subject.

In the passive case, the Volitional Participant role can be assigned lexically; since Wyner assumes that it can be assigned only once, it cannot then be assigned again by the operation of passivisation: when *reluctantly* is added, it will orient towards the *by*-phrase deep subject. Alternatively, the Volitional Participant role can be lexically unassigned; then passivization can assign it to the surface subject; this gives the reading where *reluctantly* orients towards the surface subject.

It is essential for Wyner's approach that *reluctantly* orients towards a Volitional Participant Role, of which there can be only one per event. Clearly more than one participant of an event can be volitional, but also clearly, *reluctantly* cannot orient

LECTURE FOUR

SCHA'S THEORY OF PLURALITY

4.1. PLURALITY STRUCTURES

In this lecture and the next, I will discuss some approaches to plurality, in particular, the approaches by Remko Scha, Godehard Link, and myself. (Other proposals, like Craige Roberts', will be discussed in later lectures.) For reasons of comparison (and simplicity), I will reformulate the set theoretic proposals of Scha and myself in terms of lattice structures. I will start, then, by defining the plurality structures that I will use in formulating these proposals. I will be rather succinct here. Extensive exposition of these structures can be found in Landman 1991.

We will be interested in structures that can form the interpretation domain for singular and plural NPs. We will assume that such a domain is a domain of singular and plural individuals, which is **ordered** by an operation of **sum**, in such a way that plural individuals are sums of singular individuals; and which is ordered by a relation of **part of** (defined in terms of sum). The plural individual **john and bill** is the sum of singular individuals **john** and **bill**, and both **john** and **bill** are part of that plural individual. The difference between singular individuals and plural individuals is that singular individuals have only themselves as part; they are what is called **atoms** with respect to the relation of **part of**.

First, I introduce the notion of an **i-join semilattice**.

An **i-join semilattice** is a structure:

D = <D, $\sqcup$> where:

1. D is a non-empty set.
2. $\sqcup$ is a function that assigns to every non-empty subset X of D an element of D: $\sqcup$X, the sum of X.
3. We define the relation $\sqsubseteq$ by: a $\sqsubseteq$ b iff $\sqcup\{a,b\}=b$. We require $\sqsubseteq$ to be a partial order on D (reflexive, transitive, and anti-symmetric).
4. For every non-empty $X \subseteq D$: $\sqcup$ X is the **join** of X under $\sqsubseteq$, where join is defined as follows:

Let X be a non-empty subset of D:

the **join of** X **under** $\sqsubseteq$ is the unique element $\sqcup X \in D$

(if there is such a unique element) such that:

1. $\forall x \in X: x \sqsubseteq \sqcup X$
2. $\forall d \in D$: if $\forall x \in X: x \sqsubseteq d$ then $\sqcup X \sqsubseteq d$.

So the join of X is the smallest element that is bigger than (or equal to) every element in X. So, in an i-join semilattice, every non-empty subset of D has a join in D.

We write $(a \sqcup b)$ for $\sqcup \{a,b\}$.

As explained in Landman 1989a,b, 1991, not every i-join semilattice can function as a plurality domain (or any other semantic domain). Semantic domains of sums and parts are **part-of structures**.

First some notions:

Let $<D,\sqcup>$ be an i-join semilattice:

a is the **minimum** (or zero) in $<D, \sqcup>$ iff $\forall d \in D: a \sqsubseteq d$

So the minimum, if there is one, is smaller than or equal to everything. If there is a minimum, there is a unique one; we write it as 0.

a is a **minimal element** in $<D,\sqcup>$ iff $\neg\exists d \in D: d \sqsubseteq a$ and $d \neq a$

So a minimal element has nothing smaller than it.

a is an **atom** in $<D,\sqcup>$ iff a is a minimal element in $<D-\{0\}, \sqcup>$

$<D,\sqcup>$ is **atomic** iff $\forall d \in D$: if $d \neq 0$ then there is an atom $a \in D: a \sqsubseteq d$

So D is atomic iff every non-zero element has an atom below it.

In the definitions of atom and atomic, we assume that D has more than one element. For the borderline case, $<\{0\},\sqcup>$, we stipulate that 0 is an atom and $<\{0\},\sqcup>$ is atomic.

a **overlaps** b, a 0 b, iff $\exists c \in D: c \sqsubseteq a$ and $c \sqsubseteq b$

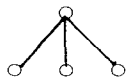
a overlaps b iff they have a common part. I write $a \oslash b$ for: a does not overlap b.

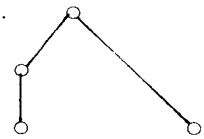
A **part-of structure** is an i-join semilattice $<D,\sqcup>$ *satisfying*:

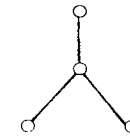
1. if D has a minimum 0 then $D = \{0\}$.
2. **distributivity**: if $a \sqsubseteq b \sqcup c$ then: either $a \sqsubseteq b$ or $a \sqsubseteq c$
   or $\exists b' \sqsubseteq b\ \exists c' \sqsubseteq c: a = b' \sqcup c'$
3. **witness**: if $a \sqsubseteq b$ and $a \neq b$ then $\exists c \sqsubseteq b: a \oslash c$

Examples of i-join semilattices that are not part-of structures:

Non-distributive: non witnessed:

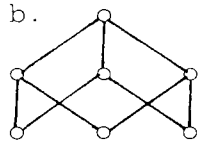
a. 

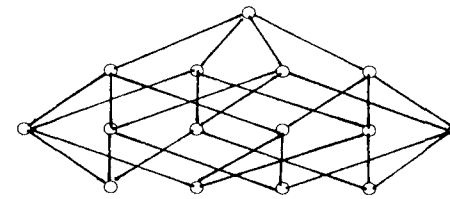
b. 

c. 

Examples of part-of structures:

a. 

b. 

c. 

Theorem:
The part-of structures are up to isomorphism exactly the complete Boolean algebras with 0 deleted and the operations restricted to (generalized) $\sqcup$.

In terms of the notion of a part-of structure, we define the notion of a **domain of singular and plural entities**.

A **domain of singular and plural individuals** is a structure **D** = <D,$\sqcup$,AT>
where: <D,$\sqcup$> is an **atomic** part-of structure with set of atoms AT.

It follows from the above theorem that the domains of plural and singular individuals are precisely the complete atomic boolean algebras with 0 cut out and operations restricted to (generalized) $\sqcup$. From this another theorem follows:

Theorem:
The domains of singular and plural individuals are up to isomorphism exactly the structures: <pow(D)-{$\varnothing$},$\cup$>, where D is any set.

Some more definitions.
Let <D,$\sqcup$> be an atomic i-join semilattice with set of atoms AT.
D is **atomistic** iff every element of D is the sum of atoms
(i.e. for every d $\in$ D there is an X $\subseteq$ AT: d = $\sqcup$ X)

If $d \in D$ then $AT(d) = \{a \in AT: a \sqsubseteq d\}$
AT(d) is the set of atoms below d.

If $X \subseteq D$ then $AT(X) = X \cap AT$
AT(X) is the set of atoms in X

If $d \in D$ then $|d| = |\{a \in AT: a \sqsubseteq d\}|$
$|d|$, the cardinality of d, is the number of atoms below d.

For our purposes the following facts about part-of structures motivate our restriction to these structures:

Let $\langle D, \sqcup, AT \rangle$ be an atomic part of structure.

Theorem:
D is **atomistic**, more precisely: for every $d \in D$: $d = \sqcup AT(d)$

Theorem:
D satisfies **distinctness**: if $X,Y \subseteq AT$ and $X \neq Y$ then $\sqcup X \neq \sqcup Y$

One more definition:

Let $\langle D, \sqcup \rangle$ be an i-join semilattice and $X \subseteq D$ (X non-empty), then:
[X], the i-join semilattice **generated** by X, is the closure of X under $\sqcup$
(i.e. $[X] = \{y \in D: \exists Y \subseteq X: y = \sqcup Y\}$)

Theorem:
[X] is a **sub**-i-join semilattice of D, in fact, the smallest sub-i-join semilattice of D containing X.
(note: we let $[\varnothing] = \varnothing$ and call it the i-join semilattice generated by $\varnothing$, though this is a misuse of terminology, because $\varnothing$ is not an i-join semilattice.)

With this notion we can generalize the above theorem about distinctness to part-of structures in general:

Theorem:
Let $\langle D, \sqcup \rangle$ be a part-of structure and X a set of mutually non-overlapping elements of D. Then [X] is itself an atomic part of structure with X as set of atoms.

As discussed in Landman 1991, these distinctness properties are essential for any semantic domain of sums and parts, because they reflect the identity conditions for objects and their parts: They guarantee that if THE BOYS, THE GIRLS, and THE LINGUISTS are plural individuals that have no parts in common, then THE BOYS $\sqcup$ THE GIRLS and THE BOYS $\sqcup$ THE LINGUISTS and THE GIRLS $\sqcup$ THE LINGUISTS are three distinct plural individuals.

Similarly in other semantic domains: if I have three buckets of water, then the stuff that I get when I put the first two together is different from the stuff that I get when I put the first and the third together, yet different from what I get when I put the second and third together.

On this approach, the difference between the count (plurality) domain and the mass domain is that the count domain is atomic, while the mass domain is atomless.

We turn a domain of singular and plural individuals into a domain of singular and plural individuals **with groups** in the following way:
- We **sort** the set of atoms into two sorts: individual atoms and group atoms.
- We add an operation of **group formation** from sums of individual atoms into atoms, which maps each non-atomic sum of individuals onto a group atom, and which maps each individual atom onto itself. Group formation turns THE BOYS, as the sum of the individual boys, into THE BOYS, AS A GROUP, a collective entity in its own right, which is no longer strictly determined by its part-of structure.
-We add an operation of **membership specification** from atoms into sums of individual atoms, which maps a group atom onto the sum of its members, and an individual atom onto itself.

Formally:

A **domain of singular and plural individuals with groups** is a structure:
D = <D, $\sqcup$, AT,IND,GROUP,$\uparrow$,$\downarrow$> where:

1. <D, $\sqcup$, AT> is a domain of singular and plural individuals.
2. AT = IND $\cup$ GROUP and IND $\cap$ GROUP =$\varnothing$

Let SUM = [IND]

3. $\uparrow$ is a **one-one** function from SUM into ATOM such that:
   1. $\forall$d $\in$ SUM-IND: $\uparrow$(d) $\in$ GROUP
   2. $\forall$d $\in$ IND: $\uparrow$(d)=d
4. $\downarrow$ is a function from ATOM onto SUM such that:
   1. $\forall$d $\in$ SUM: $\downarrow(\uparrow(d)) = d$
   2. $\forall$d $\in$ IND: $\downarrow(d) = d$

SUM is the set of sums of **individuals**. SUMOFGROUP is the set of sums of groups. Note that IND $\subseteq$ SUM; if we want to refer to the domain of non-singular sums, this domain is SUM-IND.

These structures differ a bit from the structures I introduced in Landman 1989a. The notion of group formation is not iterative (I don't have groups of groups here) and group formation is identity for individual atoms. Both of these changes are motivated by the work of Roger Schwarzschild (Schwarzschild 1991, 1992). I will discuss their rationale later.

LECTURE FIVE

DISTRIBUTIVITY, COLLECTIVITY AND CUMULATIVITY

5.1. THE LANGUAGE OF PLURALITY

In the language of plurality introduced in this lecture, we will not yet incorporate a full treatment of verbs. So the language (and the analysis of plurality, in this respect) is poorer than Scha's. For the moment, we won't have functional abstraction, and we will have only one-place verbs, which -again for the moment - we will treat in the same way as nouns: as sets. We do have some plurality operators that Scha doesn't have. In the next lecture, we will combine the present language of plurality with the language of events from lecture Two, to give a full treatment of verbs.

5.1.1. SYNTAX OF THE LANGUAGE OF PLURALITY

TYPES:
TYPE is the set {d, pow(d), t}
-d is the type of individuals
-pow(d) is the type of sets of individuals
-t is the type of truth values

EXPRESSIONS:
-We have constants and variables of type d.
-We have constants of type pow(d), nominal constants and verbal constants.
-We have the following special constants of type pow(d):
IND, GROUP, ATOM, SUM, SUMOFGROUP, D
These will get their obvious interpretation.

We define EXPa, the expressions of type a:
Constants and variables:
-CONa $\cup$ VARa $\subseteq$ EXPa

Connectives and identity:
-if $\phi,\psi \in$ t then $\neg\phi$, $(\phi \wedge \psi)$, $(\phi \vee \psi) \in$ t

-if $\alpha,ß \in d$ then $(\alpha=ß) \in t$

Quantification:

-if $x \in$ VARd, $P \in pow(d)$ and $\phi \in t$
then $\forall x \in P:\phi$, $\exists x \in P:\phi \in t$

Set formation:

-if $x \in$ VARd, $P \in pow(d)$ and $\phi \in t$
then $\{x \in P:\phi\} \in pow(d)$

Set application:

-if $\alpha \in d$ and $P \in pow(d)$ then $(\alpha \in P) \in t$

Plurality:

-If $\alpha,ß \in d$ then $(\alpha \sqsubseteq ß) \in t$
-if $\alpha,ß \in d$ then $(\alpha \sqcup ß) \in d$
-If $P \in pow(d)$ then $\sigma(P) \in d$
-If $P \in pow(d)$ then $\sqcup (P) \in d$
-if $\alpha \in d$ then $\uparrow\alpha,\downarrow\alpha \in d$
-If $\alpha \in d$ then $AT(\alpha) \in pow(d)$
-if $P \in pow(d)$ then $AT(P)$, $^{*}P$, $^{D}P \in pow(d)$

5.1.2. SEMANTICS FOR THE LANGUAGE OF PLURALITY

MODELS:

A **model for the language of plurality** is a tuple

$M = \langle \boldsymbol{D}, \perp, i \rangle$ where:

1. $\boldsymbol{D}$ is a domain of singular and plural individuals with groups.
2. $\perp$, the undefined object, is not in D.
3. i is the interpretation function for the constants:

Our domains are:

-$Dd = D \cup \{\perp\}$
-$Dpow(d) = pow(d)$
-$Dt = \{0,1\}$

The interpretation function i assigns to every constant of type a an interpretation in domain Da; i assigns all special constants their obvious interpretation.

Assignment functions are functions from VARd into Dd.

SEMANTICS:

We define $[\![\alpha]\!]M,g$, the interpretation of α in M relative to g:

Constants and variables:

-if $c \in$ CONd then $[\![c]\!]M,g = i(c)$
-if $x \in$ VARd then $[\![x]\!]M,g = g(x)$

Connectives and identity:

-$[\![\neg\phi]\!]M,g = 1$ iff $[\![\phi]\!]M,g = 0$; 0 otherwise.

-$[\![(\phi \wedge \psi)]\!]M,g = 1$ iff $[\![\phi]\!]M,g=1$ and $[\![\psi]\!]M,g = 1$; 0 otherwise.

-$[\![(\phi \vee \psi)]\!]M,g = 1$ iff $[\![\phi]\!]M,g = 1$ or $[\![\psi]\!]M,g = 1$; 0 otherwise.

-$[\![(\alpha=ß)]\!]M,g = 1$ iff $[\![\alpha]\!]M,g = [\![ß]\!]M,g$ and $[\![\alpha]\!]M,g$, $[\![ß]\!]M,g \neq \perp$; 0 otherwise.

Quantification:

-$[\![\forall x \in P:\phi]\!]M, g = 1$ iff for all $d \in [\![P]\!]M,g$: $[\![\phi]\!]M,g[x:d] = 1$; 0 otherwise.

-$[\![\exists x \in P:\phi]\!]M,g = 1$ iff for some $d \in [\![P]\!]M,g$: $[\![\phi]\!]M,g[x:d] = 1$; 0 otherwise.

Sets:

-$[\![\{x \in P:\phi\}]\!]M,g = \{d \in [\![P]\!]M,g: [\![\phi]\!]M,g[x:d] = 1\}$

-$[\![(\alpha \in P)]\!]M,g = 1$ iff $[\![\alpha]\!]M,g \in [\![P]\!]M,g$; 0 otherwise.

Plurality:

-$[\![\alpha \sqsubseteq ß]\!]M,g = 1$ iff $[\![\alpha]\!]M,g \sqsubseteq [\![ß]\!]M,g$; 0 otherwise.

-$[\![\alpha \sqcup ß]\!]M,g = [\![\alpha]\!]M, g\ [\![ß]\!]M, g$ if $[\![\alpha]\!]M, g \neq \perp$, $[\![ß]\!]M,g \neq \perp$; $\perp$ otherwise

-$[\![\sigma(P)]\!]M,g = \sqcup\ ([\![P]\!]M,g)$ if $\sqcup([\![P]\!]M,g) \in [\![P]\!]M,g$; $\perp$ otherwise

Note that σ does not have the same interpretation as it did in Scha's theory. σ is no longer the iota-operator, but Link's σ operator. Note: $\sigma(P)$ is written $\sigma x.P(x)$ in Link's papers and my earlier papers.

-$[\![\sqcup(P)]\!]M,g = \sqcup([\![P]\!]M,g)$ if $[\![P]\!]M,g \neq \varnothing$; $\perp$ otherwise

-$[\![\uparrow\alpha]\!]M,g = \uparrow([\![\alpha]\!]M,g)$ if $[\![\alpha]\!]M,g \in$ SUM; $\perp$ otherwise

-$[\![\downarrow\alpha]\!]M,g = \downarrow([\![\alpha]\!]M,g)$ if $[\![\alpha]\!]M,g \in$ ATOM; $\perp$ otherwise

Let $\alpha \in d$:

-$[\![AT(\alpha)]\!]M,g = AT([\![\alpha]\!]M,g)$ if $[\![\alpha]\!]M,g \neq \perp$; $\varnothing$ otherwise.

$AT(\alpha)$ can be defined as: $\{x \in AT: x \sqsubseteq \alpha\}$

-$[\![AT(P)]\!]M,g = AT([\![P]\!]M,g)$

$AT(P)$ can be defined as: $\{x \in AT: x \in P\}$

-$[\![^{*}P]\!]M,g = [[\![P]\!]M,g]$

$^{*}P$ denotes the i-join semilattice generated by $[\![P]\!]M,g$: the **closure of** P under sum.

$[\![^{D}P]\!]M,g = \{d \in D: \forall a \in AT(d): a \in [\![P]\!]M,g\}$

^{D}P can be defined as: $\{x \in D: \forall y \in ATOM: y \sqsubseteq x \rightarrow y \in P\}$

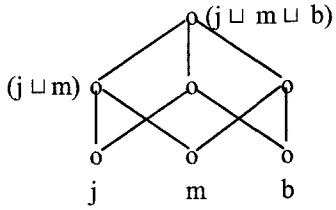
5.2. LINK'S THEORY OF PLURALITY

5.2.1. NOUN PHRASE CONJUNCTION AND DEFINITES

Link's theory incorporates noun phrase conjunction of the form: *John and Mary*, *The boys and the girls*. In Link's theory, *and* is interpreted as the **sum** operation, so:

John and Mary $\rightarrow$ (j $\sqcup$ m)

In a picture:



Unlike Scha, Link does not assume that the singular *boy* and the plural *boys* have the same interpretation.

The singular *boy* denotes a set of atomic individuals:

boy $\rightarrow$ BOY where BOY $\subseteq$ ATOM

Pluralization corresponds to the *-operation:

boys $\rightarrow$ *BOY

*BOY is the closure of the singular predicate BOY under sum, i.e. it adds to the denotation of BOY all sums that you can form with elements of the denotation BOY.

Hence, for example:

If BOY = {j,b}, then *BOY = {j,b,j $\sqcup$ b}
If BOY = {j,b,h}, then *BOY = {j,b,h,j $\sqcup$ b, j $\sqcup$ h, b $\sqcup$ h, j $\sqcup$ b $\sqcup$ h}

Note that BOY $\subseteq$ *BOY. Hoeksema 1983 defines the plural *boys* as: *BOY-AT(BOY). Hence, in Hoeksema's analysis the plural predicate *boys* does not take atomic individuals in its extension. This would give a semantic account of why (1) is not wellformed:

(1) ?John are boys.

I will be following Link rather than Hoeksema here, for three reasons. In the first place, even if we think that Hoeksema's approach is better, it is much easier to develop the theory with Link's operation and afterwards change it to Hoeksema's. Thus, when we compare Link's approach and Hoeksema's, this difference is not a very big deal. Second, in the theory that I will develop later, the inclusion of the atoms **does** play a crucial role. As will become clear, trying to develop a Hoeksema-style variant of that theory, will be more than just cumbersome. Thirdly, as Lasersohn 1988 and Schwarzschild 1991 have pointed out, Hoeksema would have to have the determiner *no* reintroduce the atoms in the interpretation of a sentence like (2):

(2) No boys carried the piano upstairs.

On Hoeksema's account, the interpretation of (2) would be: no sum of two or more boys carried the piano upstairs. On Link's theory, it would be: no sum of boys carried the piano upstairs. Thus, on Link's theory, the quantifier *no boys* ranges over individuals and their sums, rather than non-individual sums, and this seems correct.

By giving the singular and the plural predicate a different interpretation, Link is able to assign the definite article *the* a single meaning, which can apply both to the singular noun and to the plural noun. *The* is interpreted as the σ operator:

the boy $\rightarrow \sigma(\text{BOY})$
the boys $\rightarrow \sigma(^*\text{BOY})$

(Essentially the same analysis of *the* was developed in Sharvy 1980.) Moreover, Link can assume that - apart from a presuppositional factor which is particular to the definite - the definite article *the* is a generalization of NP conjunction *and*: just as *and* takes John and Bill together to form the plural entity $j \sqcup b$, *the* takes the boys, $b_1,...,b_n,...$ together and form the plural entity: $b_1 \sqcup ... \sqcup b_n ...$, which is the sum of all the boys.

But *the* differs presuppositionally from *and*. We capture this by interpreting *the* as σ rather than as ι.

If P is a predicate, $\sigma(P)$ is interpreted as the sum of all the entities in P **if that sum is itself an entity in P**, otherwise it is undefined.

The boys is interpreted as $\sigma(^*\text{BOY})$. $\sigma(^*\text{BOY})$ is undefined if $^*\text{BOY}$, and hence BOY, is empty, so the use of the plural NP *the boys* presupposes that there are boys. If $\text{BOY} \neq \varnothing$, then $^*\text{BOY}$ is the closure of BOY under sum. This means that $\sqcup(\text{BOY}) \in {}^*\text{BOY}$, and hence if $\text{BOY} \neq \varnothing$, $\sigma(^*\text{BOY}) = \sqcup(\text{BOY})$, the sum of all the boys.

The boy is interpreted as $\sigma(\text{BOY})$, where $\text{BOY} \subseteq \text{ATOM}$. If $\text{BOY} = \varnothing$, then similarly $\sigma(\text{BOY})$ is undefined. So the use of the singular NP *the boy* similarly presupposes that there are boys. However, if BOY has more than one element, then $\sqcup(\text{BOY}) \notin \text{BOY}$, since the sum of a non-singleton set of atoms is not itself an atom.