Approaches to Parts and Wholes in Semantics

Advanced course

ESSLLI 2025 Summer School

Friederike Moltmann

Handout 1

Ontological and Semantic Issues concerning Part-Whole Structure

1. Evidence for part-whole structure

Unproblematic facts

Entities generally have parts.

Entities may come with a structure organizing the parts and thus form a unified whole.

.

But what sort of evidence do we have for what counts as a part and for what part-whole structures are? One way of approaching the topic:

Look closely about how we talk about parts and wholes.

Linguistic expression generally focused on *part of*

Part of denotes spatial inclusion?

Examples with *part of* from Varzi (*Mereology* SEP 2016):

(1) a. The handle is part of the mug.

b. The remote control is part of the stereo system.

c. The left half is your part of the cake.

d. The cutlery is part of the tableware.

e. The contents of this bag is only part of what I bought.

f. The outermost points are part of the perimeter.

g. The first act was the best part of the play.

(1a): functional part (replaceable)

(1b) spatially discontinuous part

(1c): material part, or indeterminate part; compare

(1c): attention: there is also an intensional use of *half*:

(1) c'. Half of the cake is yours.

c''. ?? Half of the cake is part of the cake. (any half)

(1d) part of a collection, spatially independent

(1e) *part of* applies unspecified type of material (or unspecific) entity

(1f) parts of abstract object

(1g) part of an event.

---

2. Standard, but not unproblematic, conditions on parthood

(2) a. Everything is part of itself. (reflexivity)

b. P*xx*

(3) a. Any part of any part of a thing is itself part of that thing. (transitivity).

b. (P*xy* ∧ P*yz*) → P*xz*

(4) a. Two distinct things cannot be part of each other. (antisymmetry)

b. (P*xy* ∧ P*yx*) → *x* = y

Some definitions

(5) Proper parthood : PP*xy* $=_{df}$ P*xy* ∧ ¬*x*=*y*

(6) Proper extension: PE*xy* $=_{df}$ P*yx* ∧ ¬*x*=y.

(7) Overlap : O*xy* $=_{df}$ ∃*z*(P*zx* ∧ P*zy*)

(8) Disjointness : D*xy* $=_{df}$ ¬O*xy*

Some issues with the standard conditions:

Reflexivity

Counterintuitive? Not so for the expression *part of*:

(9) a. John owns part of the house, maybe even all of it.

b. John read part of the book, and in fact all of the book.

Quantification over parts:

(10) All of the students were praised. → The students as a whole as well?

Transitivity

Well-known problem cases

Examples from Moltmann (1997)

Invalid inferences:

(11) John is part of the class

John's leg is part of John.

John's leg is part of the class.

(12) The page is part of the book

The book is part of the library.

The page is part of the library.

Does the integrity of the intermediary item block transitivity?

No: it depends on the nature of the whole:

(13) The (nonempty) page is part of the book.

The book is part of Kant's written work.

The page is part of Kant's written work.

But no transitivity with 'the empty pages of the book', 'the margins of the page', etc.

Another example with individuals and functional parts

(14) The arm is part of the body.

The hand is part of the arm.

The hand is part of the body.

Other cases of failure of transitivity:

Furniture: not all parts of a piece of furniture are furniture again.

Luggage: a handle of a suitcase is not luggage.

Ways of dismissing problems for transitivity

1) do not count functional parts as the only parts

Issue: what is the intuitive basis for the part relation, if not the applicability of *part of*?

2) distinguish different part relations, for different ontological levels:

Part relation for individuals, part relation for pluralities, part relation for stuff

Issue: transitivity problems arise within the level of individuals as well (14).

A different perspective: the priority of the whole

Functional and form-related parts depend on the nature of the whole.

For certain entities what the parts are depends on the nature of the whole, its structure, functional organization etc.

Extensionality

Additional principle:

(15) Strong supplementation

$\neg Pyx \rightarrow \exists z(Pzy \wedge \neg Ozx)$

From (2-4) and (15) we can derive Extensionality:

(16) Extensionality:

Composite objects with the same proper parts are identical:

$(\exists z PPzx \vee \exists z PPzy) \rightarrow (x = y \leftrightarrow \forall z(PPzx \leftrightarrow PPzy))$.

Unproblematic:

(17) $x = y \rightarrow \forall z(PPzx \leftrightarrow PPzy)$

(17) is an instance of the indiscernability of identicals:

(18) $x = y \rightarrow (\varphi x \leftrightarrow \varphi y)$

More problematic:

(19) $\forall z(PPzx \leftrightarrow PPzy) \rightarrow x = y$

Problem cases for extensionality

Diachronic example: chair rebuilt as a table

Synchronic examples:

two committees with the same members, but different functions, musical quartet and a sports team, collection of dots, heart drawn with dots, piece of furniture and work of art,

Constitution

A sculpture and the wood that constitutes it: have different temporal and modal profiles and differ in other properties.

Diagnosis of the issues

Extensionality should not hold if the whole is also individuated by structure and (practical, aesthetic) function.

Atomicity

(20) a. Atom: $Ax =_{df} \neg \exists y PPyx$

b. Atomicity: $\exists y(Ay \wedge Pyx)$

c. No being an atom: $\exists y PPyx$

The notion of an atom in natural language semantics

Individuals with respect to the plural-specific part-relation (discussion tomorrow!)

---

3. Different uses of *part* / different nouns *part*

The mass-count distinction for *part*

Part of vs. *a part of* (e.g., Moltmann 1998)

(21) a. John and Mary are part of the class.

b. ?? John and Mary are a part of the class.

(22) a. Sugar is part of lemonade

b. ??? Sugar is a part of the lemonade.

(23) a. Joe ate part of the apple.

b. ?? Joe ate a part of the apple.

The light noun *part* (Ardisson et al. 2025)

Full noun *part*

(24) a. Parts of the ceremony took place yesterday.

b. What John did was a part of the ceremony.

(25) a. John and Mary took part in the ceremony.

b. The priest was part of the ceremony.

c. ??? The priest was a part of the ceremony.

Predicates of participation and the occurrence of the light noun *part*:

Take part in, *part-icipate*, German *teil-nehmen*, French *faire partie*, Italian *avere parte*

Is the occurrence of *part* accidental?

If not, what does this mean for the part structure of events?

---

4. What is the basis for deciding about the ontology of part-whole structure

1) Intuitions about entities and their part-whole structure

What sorts of evidence do we really have about our intuitions regarding reality?

Intuitions need to be uncovered; they are not generally straightforward.

One way of uncovering them is through linguistic data: acceptability judgments.

2) What do the linguistic data consist in?

Standard practice in natural language semantics appeals to:

1. Uses of *part of*
2. More indirect apparent linguistic involvement of part-whole structure: semantics of plurals and mass nouns, part-whole structure of situations used in situation-based semantics (truthmaker semantics)

1) and 2) are not generally taken to coincide

A common view among formal semanticists: compositional semantics requires a particular notion of part, which need not coincide with the notion of conveyed by explicit linguistic expressions such as *part*. Semantics of plurals and mass nouns requires extensional mereology, even if that is not reflected in uses of *part.*

A different approach

Take into consideration the whole range of part-whole-related expression in natural language
Different nouns *part, whole, individual, complete, partial, is missing*, …

---

5. Three views of part-whole structure

Extensional mereology (e.g., Link 1983)

Part-whole structure consists in a part relation that is transitive, extensional and closed under sum formation

Mereotopology and hylomorphism (e.g., Moltmann 1997)

Part-whole structure also consists in conditions of form, structure, connectedness, boundedness

The priority of the whole (new – and very old)

The whole is prior to its parts: it depends on the whole what its parts are and how the parts are to be understood, in terms of function or form.

The views may apply to different sorts of objects and to the semantics of different expressions in natural language.

---

6. Part-whole structure in linguistics

6.1. Explicit expressions of part-whole-related expressions

Part of, a part of

Other partitive constructions: *all of, most of, none of, much/many of*

Do all partitive quantifiers pick out the same sorts of parts as *part of*?

Completion-related expressions

Partial(ly), complete(ly)

Nominal modifiers

(23) a. partial copy of the paper

b. a complete copy of the paper

(24) a. partial realization of the plan

b. complete realization of the plan

(25) a. partial reconstruction of the church

b. complete reconstruction of the church

(26) partial truth, complete truth

Adverbial use

(27) a. John partly forgot the poem.

b. John completely forgot the poem.

Issue

Reference to concrete object (original)

Reference to abstract object (event)

Completion of a whole and absence of a part

Complete vs. *is missing* NP

(28) a. The collection is complete.

b. The collection is missing a piece.

(29) a. The quotation is complete.

b. The quotation is missing a few words.

(30) a. The house is complete.

b. The house is only missing the windows.

Other expressions of completeness

Whole:

(31) a. The whole collection is expensive. (every part of the collection as a whole)

b. The whole thing is incomprehensible. (every part and overall)

c. the whole plan was misguided (every part and overall)

d. the whole time (every part)

German has two words for 'complete': *voellig* and *vollstaendig*

(32) a. die vollstaendige Uebersetzung

'the complete translation'

b. ??? die voellige Uebersetzung

(33) a. die voellige Dunkelheit

'the complete darkness'

b. ??? die vollstaendige Dunkelheit

Vollstaendig involves a reference object with discrete parts, but not so *voellig*, wich relates to a homogenous part structure.

Conclusion

Natural language displays a range of expressions involving not just a part of-relation, but also reference to concrete or abstract wholes and the structure of a whole.

6.2. Plurals and mass nouns

Parallels between singular count, plural, and mass NPs.

Predicates

Singular count, plural, and mass NPs can be arguments of the same predicates.

Determiners

(34) a. the / some woman (singular count)

b. the / some women (plural)

c. the / some personnel (mass)

Conjunction

(35) a. The man and the women met.

b. The men and the women met

c. The sugar and the cinnamon were mixed.

Partitive construction

(36) a. part / some / all / most of the apple

b. part / some / all / most of the apples

c. part / some / all / most of the sugar.

Connections to event semantics

Parallel effect of singular count, plural and mass NPs on the applicability/understanding of *in*-adverbials and *for*-adverbials:

(37) a. John ate the apple in two minutes.

b. John ate the peas in two minutes.

c. John ate the soup in two minutes

(38) a. ??? John ate the apple for an hour

b. ??? John ate the apples for an hour.

c. ??? John ate the sugar for an hour.

Standard view about the semantics of plural and mass nouns

Extensional mereology

Three domains with their own part relations:

1. The domain of individuals with a part relation among individuals

2. The domain of pluralities, the set of sums of individuals, with a part relation that is closed under sum formation

Individuals as atoms with respect to the plural-specific part relation

3. The domain of quantities with its part relation that is closed under sum formation, no atoms

Definite plurals refer to sums of individuals

(39) [*the children*] = sum([*child*])

Definite mass NPs refer to sums of quantities

(40) [*the water in the glass*] = sum ([*water in the glass*])

Two diverging semantic requirements

1) Analogy between singular count, plural, mass semantics

2) Counterintuitive consequences of a singularist semantics of plural and mass NPs:

Pluralities treated as single entities.

Quantities treated as single entities.

But:

(41) a. John and Mary are two.

b. The children are ten.

(42) a. ??? The men and the women are two.

b. ??? The water and the wine are two.

Generalization

Pluralities and quantities never count as single entities, but the formal semantics treats them as such.

Remedy in the case of plurals

Plural reference: definite plural NPs refer to several individuals at once, rather than referring to a single collective thing (Oliver and Smiley 2013, Yi 2005/6, McKay 2006, …)

Remedy in the case of mass NPs:

Sui generis mass reference? (McKay 2016)

Issue

How is plural reference (sui generis mass reference) compatible with the semantic analogy of singular count, plural and mass NPs?

Some references

Cotnoir, A. and A. Varzi (2021): *Mereology*. Oxford UP, New York.

Varzi, A. (2016): 'Mereology', *The Stanford Encyclopedia of Philosoph,* Edward N. Zalta (ed.), URL = https://plato.stanford.edu/archives/spr2019/entries/mereology/

Moltmann, F. (1997): *Parts and Wholes in Semantics*, Oxford UP, New York.

Online version