Approaches to Parts and Wholes in Semantics
Advanced Course
ESSLLI 2025 Summer School
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Handout 3

The Notion of an Integrated Whole and Mereotopology

1. The notion of integrated whole

1.1. The traditional notion of an integrated whole

The notion of an integrated whole - intuitive description:
Having a form, structure, boundary, being maximally self-connected
Being unified, being a single thing by being unified

The importance of the notion of form in ontology
Two entities are identical not just if they are constituted by the same matter, but also share the same essential form.
Two forms of identification
Identity throughout times (endurance)
Identity across different situations or worlds

Historically
Aristotle's hylomorphism: entities consist in parts and a form
Contemporary hylomorphism: Johnston (2006), Fine (2010), Koslicki (2008)

A major philosophical puzzle
What constitutes the unity of matter and form?
What makes something constituted by matter and a form a single thing?

Different views of the ontological status of fom
Form as another part of an object: Koslicki 2008

Form as the unifying force combining the parts: Johnston 2006

Form as structure-building operations for wholes: Fine 2010

The notion of an integrated whole in natural language semantics

Cognitive semantics

Langacker (1987): notion of boundedness, having a boundary

Formal semantics

Moltmann (1997, 1998, 2005): introduction of the general notion of an integrated whole to natural language semantics and of the notion of a maximally self-connected whole in particular (mereotopology)

Mereotopology

studies integrated wholes in space or time, in particular the notion of an entity that is maximally self-connected in space or in time (R-integrated whole, for R being spatial or temporal contiguity)

Recent uses of meretopology by other linguists (Grimm, Filip, Sutton, Henderson, …).

The notion of an R-integrated whole (maximal self-connectedness)

R_{trans}: the transitive closure of R.

(1) Definition

For a nonlogical, symmetric relation R, x is an *(R-)integrated whole* ((R)-INT-WH(x)) iff

for every y and z such that $y < x$ and $z < x$, $R_{trans}(y, z)$, and for every y such that $y < x$, for no w, $\neg w < x$, $R_{trans}(y, w)$.

Special case

FF-integrated whole: an R-integrated whole for the relation FF defined as follows

(2) For a property F, FF(x, y) iff F(x) and F(y).

Examples

(4) a. the blue things

F = being blue.

b. The children in the garden

F = child in the garden

Some linguistic applications

The readings of part-related predicates *compare* and *distinguish* (Moltmann 1997)

FF-integrated wholes:

(5) a. John cannot distinguish the boys and the girls

b. Mary compared the blue and green balls.

R-integrated wholes:

(6) The students that share a dorm room will get the same key

R: share a dorm room with

(7) a. Mary compared the furniture.

b. Mary compared the furniture in the two rooms.

R: be in the same room as

The meaning of *times*

(8) a. John fell several times today.

b. John slept several times today.

c. John was awake a number of times (when I looked into his room, which I did throughout the night).

8a: counting events that are inherent integrated wholes

8b: counting maximally continuous processes in time

8c: counting states at given occasions.

General questions

Are integrated wholes always objects?

Perhaps not:

Pluralities and subpluralities can be integrated wholes.

Quantities and subquantities can be integrated wholes.

Issues

Is the notion of an integrated whole restricted to objects?

Does it always pertain to essential properties of objects?

Essential properties

1. properties an object needs to have in order to exist
2. properties an object needs to have in order to be what it is

1.2. Three types of integrated wholes

1. Essential integrated wholes

Examples:

A heap of sand, a house, a tree, a statue, a ship, a person

Essential integrated wholes may allow for the replacement of parts or constituting material:

Famous example: the ship of Theseus

But not all essential integrated wholes allow for the replacement of parts:

A word as an abstract object

the couple of John and Mary

the group of the students

Kit Fine's (1999) notions:

Essential integrated wholes that allow for replacement of parts: *variable embodiments*

Essential integrated wholes that do not allow for replacement of parts: *rigid embodiments*

2. Accidental integrated wholes

The sand when taking the form of a heap

The clay when taking the form of a statue

The wood when having the form of a tree

3. Conceived integrated wholes

An object may be merely conceived or perceived as an integrated whole:

A notion used in cognitive semantics (Langacker 1987, Jackendoff)

Two uses of conceived integrated wholes in the literature:

Boundedness with a subjective center (Langacker 1987)

Merely conceived integrated whole in Moltmann (1998):

(9) a. the amount of sand (as opposed to 'the sand')

b. the collection of things over there

(10) a. the students together

b. the students as a whole

The claims:
Accidental and conceived integrated wholes are linguistically important:
Langacker (1987) (and Moltmann 1998):
Subjective boundedness plays a role for the mass-count distinction.

Another application in Moltmann (1997, 1998):
Modifiers such as *as a whole, as a team,* and *together* specify an entity as a merely conceived integrated whole, influencing the availability of distributivity and part-related predicates.
Pluralities and quantities as accidental integrated wholes influence the application of part-related expressions

(11) a. John gave the class as a whole an A.
b. John and Mary together / as a team will be able to solve the problem.

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2. The importance of the notion of integrated whole for formal part-whole relations

2.1. Extensional mereology

Posits transitivity, unrestricted sum formation, unique sums (extensionality) for the part-relation
Consequence:
Needs to distinguish different part relations for individuals, pluralities and quantities

Mass-count distinction defined in terms of atomicity and cumulativity
Individual: an atom with respect to the plural-specific part relation:
Quantity: not an atom or not necessarily an atom with respect to the quantity-specific part relation
Domains of pluralities and quantities are cumulative, but not the domain of individuals.

Problems for the division into different part structures
Conceptual problem
Circularity:

Formulating the content of the mass-count distinction involves essential reference to domain-specific part relations, but those part relations strictly depend on the use of mass nouns, singular count nouns, plural nouns themselves

→ No language-independent way of conceiving of the content of the mass-count distinction available within extensional mereology.

Empirical problems

(12) a. John ate part of/all of/some of what was on the table (the apple/the nuts/the bread).

b. John did not eat part of what was on the table.

(13) a. part of the apples and the milk

b. part of the apple and the milk

c. John ate part of what was on the table and what was in the fridge.

Define a new generic part relation $<_{gen}$ for mixed domains on the basis of individual-, plurality- and quantity specific part relation?

But this gives rise to problems of transitivity:

(14) a. John painted part of the paintings.

b. John painted part of one of the paintings.

(14b) does not entail (14a).

2.2. Conditions on part structures and integrated wholes

Transitivity:

(15) The page is part of the book.

The book is art of the library.

The page part of the library.

(16) The page is part of Goethe's written work.

The book is part of Goethe's written work

The page part of Goethe's written work.

Moltmann (1997, 1998):

(17) Condition on transitivity in the domains of individuals and quantities (nonessential integrated wholes only):

If for pluralities, x, y, z, if $x < y$, $y < z$, then $x < z$ only if y is not an integrated whole.

Condition on the integrity of the intermediary item does not suffice.
For essential integrated wholes, it depends on the whole what its parts are (and thus whether the part relation is transitive with respect to the parts pertaining to that whole)

Addendum to Moltmann (1998):
For quantities it depends on what quantities are made of whether the part relation is transitive (*water, laundry, furniture, stuff*).

Integrates wholes and sum formation

(18) Restriction on sum formation

For a non-empty set X, sum(X) exists only if sum(X) would be an integrated whole.

Important:
The integrated whole permitting sum formation may be a merely accidental or conceived integrated whole:

(19) a. The sum that is 'the children': accidental integrated whole

b. A sum that is 'five children together': conceived integrated whole.

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3. The mass-count distinction based on the notion of an integrated whole

3.1. Langacker (1987)

Singular count nouns describe bounded entity, but not so mass nouns

Boundedness in only one dimension: lines, fences
Boundedness with subjective center: flash of light, collection of stuff over there

Mass-count distinction
Singular count nouns denote bounded 'regions' (entities)

Mass nouns denote unbounded regions (entities).

Boundedness may pertain only in one dimension:

'New' solution to the problem of sequence-type nouns: sequences are bounded in one dimension, hence *sequence* is count.

3.2. Moltmann (1998)

(20) a. For a singular count noun N and a reference situation s, if N(x, s), then x is an integrated whole in s.

b. For a mass noun N and a reference situation s, if N(x, s), then x is not an integrated whole in x.

Important: there are different ways to be an integrated whole

An entity x is an integrated whole in a reference situation s if 1, 2, 3, or 4:

1. x is an *essential* integrated whole (in s)
2. x is an *accidental* integrated whole in s: x has properties defining it as an integrated whole perhaps only in the temporally restricted situation s or the circumstances of s.
3. x is *conceived* as an integrated whole relative to s (s being dependent on the mind of the speaker).
4. x is an integrated whole due to the particular *partial information* contained in s.

Accidental integrated wholes

(21) ??? The line of people/The (loose) collection of papers on my desk/The group of people in the room does not exist anymore.

Conceived integrated wholes

(22) a. This patch of snow is a new patch of snow.

b. ?? This patch of snow is new snow.

(23) a. This snow is new snow.

b.??This snow is a new patch of snow.

Integrated wholes due to partial information

(24) a. the blue things and the white things

b. the big things and the small things

Semantic mass-count agreement conditions:

Implicit integrity conditions with *thing* (Moltmann 1998)

(25) a. This thing is an apple. (pointing at an apple)

b. ??? This thing is apple. (pointing at an apple or a piece of apple)

c. This stuff / The content of the bowl is apple. (pointing at small pieces of apples)

Implicit integrity conditions with *part*

(26) a. This wood is part/ ??? a part of the chair. (pointing at a piece or at pieces of wood)

b. The leg is a part of the chair.

c. The leg and the back are parts of / ??? a part of the chair.

3.3. Integrated wholes and semantic selection

The linguistic relevance of accidental integrated wholes:

(27) a. John compared the people / ?? the line of people.

b. John cannot distinguish the papers on my desk / ?? the loose collection of papers on my desk.

c. John counted the people in the room / ?? the group of people in the room.

(28) The Accessibility Requirement

A predicate or reading of a predicate that makes reference to the parts of an argument, but not the whole, can apply to an object x in a reference situation s only if x is not an integrated whole in s.

(29) a. John restructured the schedule.

b. John reorganized the team.

(30) a. Hans zahlte die Klasse durch.

'John counted the class through'

b. Hans zaehlte ?? die Klasse / ?? die Studenten.

'John counted ?? the class / ok the students.'

The semantic effect of part-structure modifiers

(31) a. John and Mary as a team can solve the problem.

b. The stamps as a collection cost 100 dollar.

c. The boxes together are too heavy.

The function of *whole*

(31) a. The whole collection is expensive.

b. The collection as a whole is expensive.

Two readings of (31a), only one reading of (31b).

What does *whole* in (31a) do?

1. maps an integrated whole and a reference situation s to a mere collection of parts in a minimally different reference situation s'.
2. maps an integrated whole and a reference situation s to the collection of the parts *and* the form in a minimally different reference situation s'. (Moltmann 2005)

A different perspective: plural reference

The accessibility requirement as a requirement on a plural argument position.

Predicates making reference to the parts, but not the whole require pluralities as many.

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