# Objects, events, qualities

## An introduction to formal ontological distinctions (in DOLCE)

## Lecture 5 – Constitution, Levels, and Events

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# Outline

- Parthood vs. constitution.
- Grounding and ontological levels.

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- Why events?
- The ontological nature of events:
  - Davidson, Kim, Bennett, Lombard.
- Events vs. objects in DOLCE and DOLCE-CORE.

# 1 Classical extensional mereology

**a1** $\mathsf{P}xx$ *(reflexivity)*

**a2** $\mathsf{P}xy \wedge \mathsf{P}yx \rightarrow x = y$ *(antisymmetry)*

**a3** $\mathsf{P}xy \wedge \mathsf{P}yz \rightarrow \mathsf{P}xz$ *(transitivity)*

**a4** $\neg\mathsf{P}xy \rightarrow \exists z(\mathsf{P}zx \wedge \neg\mathsf{O}zy)$ *(strong supplementation)*

**a5** $\exists s(s\mathsf{SUM}xy)$ *(existence of sums)*

**a6** $\mathsf{O}xy \rightarrow \exists p(p\mathsf{PRO}xy)$ *(existence of products)*

**d1** $\mathsf{O}xy \triangleq \exists z(\mathsf{P}zx \wedge \mathsf{P}zy)$

**d2** $s\mathsf{SUM}xy \triangleq \forall z(\mathsf{O}zs \leftrightarrow (\mathsf{O}zx \vee \mathsf{O}zy))$

**d3** $s\mathsf{PRO}xy \triangleq \forall z(\mathsf{O}zs \leftrightarrow (\mathsf{O}zx \wedge \mathsf{O}zy))$

**t1** $\forall z(\mathsf{P}zx \leftrightarrow \mathsf{P}zy) \rightarrow x = y$ *(extensionality)*

the proof relies on strong supplementation and antisymmetry

# 2 A lively discussion

- About
  - *transitivity*
    e.g. finger, person, orchestra; handle, door, house;
  - *strong supplementation and extensionality*
    e.g. heap of bricks vs. castle, body vs. person;
  - *existence of sum*
    e.g. my nose + the moon.

- Disagreements are often motivated by different intuitions behind (interpretations of) the term '*part*'.
  - e.g. by interpreting parthood as spatial inclusion, extensionality rules out the possibility to have spatially coincident objects.

# 3 Back to Lesniewski

- Lesniewski 1927-1931, On the Foundations of Mathematics. Alternative to Set Theory for escaping Russells paradox.
  - No null individual (no empty set).
  - No distinction between *urelements* ($\in$) and *sets* ($\subseteq$): a single relation of parthood.
  - (applicable to all kinds of entities including *abstracts objects* (e.g. numbers, ideas) that do not have a spatial location, or *immaterial objects* (e.g. holes, ghosts, shadows) that do not 'occupy' space)
- *Main focus*: how entities can be summed up without any commitment on their nature.

⋆ In this *formal* perspective, not to be confused with the common usage of term 'part', classical ext. mereology is perfectly acceptable.

# 4 ... similarly for temporary parthood

- Can *temporary parthood* be reduced to *parthood simpliciter*?

  **d4** $\mathsf{tP}xyt \triangleq \exists zw(\mathsf{TP}zxt \wedge \mathsf{TP}wyt \wedge \mathsf{P}zw)$
  temporal slices need to be assumed

  - a less committed option exists [Masolo, 2009].

- Does *constant coincidence* imply identity?

  **a7** $\forall t(\mathsf{EX}xt \rightarrow \mathsf{tP}xyt) \wedge \forall t(\mathsf{EX}yt \rightarrow \mathsf{tP}yxt) \rightarrow x = y$
  e.g. a statue made of the same clay during its whole life + the clay and the statue are created and destroyed at the same times

  - 'the rotating of sphere $s$' vs. 'the heating up of sphere $s$'; statue and its clay created and destroyed at the same times.

# 5 Modeling strategies?

**1** The castle and the sum of bricks have the same parts (the bricks) but they are different.

**But** this parthood relation is not the one of Lesniewski, it is a *non-extensional mereology*.

- Different mereologies need to be considered.

**2** The bricks are not (mereological) parts of the castle. Extensional mereology can be used at the price of introducing a new relation between the bricks and the castle (e.g. *constitution*).

- The difference is more terminological than conceptual.
- ⋆ **but** the second strategy allows to avoid the discussion of what exactly are the axioms that characterize THE parthood relation.

# 6 Parthood in DOLCE

- DOLCE distinguishes parthood simpliciter (defined on *abstracts* and *perdurants*) from temporary parthood (defined on *endurants*).
  - Temporary parthood cannot be reduced to parthood simpliciter because, in general, endurants do not have temporal parts (therefore (d4) cannot be used).
  - Parthood simpliciter cannot be reduced to temporary parthood because (a7) is not assumed (see the debatable axiom (AP=) in DOLCE).

- Actually, this choice reflects the idea that a temporally qualied parthood is required for endurants but not for perdurants.

# 7 Parthood in DOLCE-CORE

- DOLCE-CORE has a more formal attitude towards parthood.
- Temporary parthood is considered as 'more informative' than parthood simpliciter when temporal slices are not necessary assumed.
- Temporary parthood is defined on all entities, (a7) is accepted, and parthood simpliciter can be defined in terms of parthood simpliciter as *constant* parthood:

  $\mathsf{P}(x, y) \triangleq \forall t(\mathsf{EX}(x, t) \rightarrow \mathsf{tP}(x, y, t))$

# 8 Coincidence in DOLCE

- Bricks are not part (in the sense of P or tP) of the castle, but they *constitute* and are co-located with the castle:
  - K$(x, y, t)$ stands for "$x$ constitutes $y$ at $t$";
  - asymmetric and transitive;
  - implies spatial co-location.

- 'the rotating of sphere $s$' and 'the heating up of sphere $s$' are two different spatio-temporally co-located events that are not one part of the other:
  - the identity of the participants in an event does not imply any parthood (in the sense of P or tP) relation between them.

# 9 ... and qua-entities

- *Counting problem* and *Conflict properties paradox*:
  passenger vs. person.

- Luc-qua-passenger *inheres in*, but he is different from, Luc.
- Is inherence similar to constitution?
  - During its whole existence, a qua-entity inheres in the same *host* (the player of the role passenger in the example).

    while the statue is not necessarily constituted by the same clay during its whole life.

- Is it possible to find a general framework that allows to manage *constitution* and *inherence* in a *uniform* way?

# 10 Entity stacking

- Multiplicative approach based on *existential dependence*:
  - Goliath depends on Lumpl,
  - Luc-qua-passenger depends on Luc,
  - my heart depends on the on cells,

  but the opposite holds for none of the previous examples.

- This dependence can be generalized to kinds.
  - E.g. statues, to exist, require amounts of matter but amounts of matter can exist without any statue.

- I adopt an existential dependence that, following Correia, I call *grounding*.

# 11 Grounding

- Existential dependence is often defined as $\Box(\mathsf{EX}x \rightarrow \mathsf{EX}y)$. (very close to the *specific constant dependence* in DOLCE)
- Existential dependence of $x$ on $y$ "amounts to the necessary truth of a material conditional whose antecedent is about $x$ only and whose consequent is about $y$ only; and given that any such material conditional fails to express any 'real' relation between the two objects, it is hard to see how prefixing it with a necessary operator could change anything in this connection" (Correia 2002, p58).
- Grounding: an object $x$ is grounded on a (different) object $y$ at $t$ if the existence of $y$ at $t$ makes possible the existence of $x$ at $t$, i.e., $x$ owes its existence at $t$ to $y$'s existence at $t$.
- Grounding introduces a *factual relation* among objects.

# 12 The notion of ontological level (1/2)

- Grounding can stack more that one object:
  - a pebble can be grounded on an amount of matter and it can ground a paperweight;
  - cells ground organs that ground bodies that ground persons that ground organizations, etc.
- Grounding is a 'vertical' relation between objects. To group objects in levels an 'horizontal' relation is necessary: *being at the same level*.
- General relation compatible with different views on levels:
  - levels depend only on laws of nature;
  - levels are the result of a conceptualization;
  - levels correspond to (natural) kinds of objects.

# 13 The notion of ontological level (2/2)

- Level hierarchies are assumed as non-linear by some authors.
  - Some comparisons do not make sense: are robots on a higher level than sea slugs? (Baker 2007))
  - Levels account for conceptual points of view on reality, the same object can be seen in different ways.

# OBJECTS AND EVENTS

# 14 Events

- Anything that happens, takes place, or occurs.
- Examples: births, marriages, fallings, football games, etc.
- Common-sense: we perceive, plan, speak and discuss about events, therefore there are events just as there are objects.
- Philosophy:
  - are events just *façon de parler* or do they have an ontological status?
  - are events reducible to objects, properties, change, etc. or are they a genuine ontological category?
- Terminological clarification. According to Simons, *occurrents* include events, processes and states. Here I use *event* in a similar way.

# 15 Events vs. facts/states of affairs

- 'Caesars death' vs. 'that Caesar died',
  'my standing here' vs. 'that I am standing here'
- Events are *concrete* (located in space-time), facts and states of affairs are *abstract*.
- Events *occur* once, propositions and states of affairs can repeatedly *be the case/obtain*.
- 'Caesars death' = 'Caesars violent death',
  'Caesar died' $\neq$ 'that Caesar died violently'.

# 16 Introducing events (1/6)

- How the following sentences involving a verb (to butter) with a variable number of arguments can be represented in FOL?
  - Jones slowly buttered a piece of toast with a knife in the bathroom at midnight.
  - Jones buttered a piece of toast in the bathroom at midnight.
  - Jones buttered a piece of toast in the bathroom.
  - Jones buttered a piece of toast at midnight.
  - Jones slowly buttered a piece of toast.
  - Jones buttered a piece of toast.
  - Jones buttered something with a knife.
  - Jones did something with a knife in the bathroom at midnight.

- By using a plurality of predicates Butter with different arity or different kinds of arguments:
  - Jones buttered a piece of toast in the bathroom at midnight.
    $\mathsf{Butter}_1(Jones, toast, bathroom, midnight)$
  - Jones buttered a piece of toast in the bathroom.
    $\mathsf{Butter}_2(Jones, toast, bathroom)$
  - Jones buttered a piece of toast at midnight.
    $\mathsf{Butter}_3(Jones, toast, midnight)$
  - Jones slowly buttered a piece of toast.
    $\mathsf{Butter}_4(Jones, slowly, toast)$
  - Jones buttered something with a knife.
    $\exists x(\mathsf{Butter}_5(Jones, x, knife))$

# 18 Introducing events (3/6)

- How is it possible to link the different $\mathsf{Butter}_n$ predicates?
- Additional axioms with existential conditions are necessary , e.g.:
  - $\mathsf{Butter}_2(Jones, toast, bathroom)$
  - $\mathsf{Butter}_3(Jones, toast, midnight)$
  - $\mathsf{Butter}_4(Jones, slowly, toast)$
  - $\mathsf{Butter}_2(x, y, z) \rightarrow \exists w(\mathsf{Butter}_3(x, y, w))$
  - $\mathsf{Butter}_3(x, y, z) \rightarrow \exists w(\mathsf{Butter}_2(x, y, w))$
  - $\mathsf{Butter}_3(x, y, z) \rightarrow \exists w(\mathsf{Butter}_4(x, z, y))$
  - ...

# 19 Introducing events (4/6)

- Note that, by assuming a fixed reference to 'Jones' and 'midnight' (of a specific day), one can convert the sentence [Quine]
  - Jones slowly buttered a piece of toast with a knife in the bathroom at midnight.

  into a *conjunction* of four sentences
  - Jones buttered slowly at midnight **and**
    Jones buttered a piece of toast at midnight **and**
    Jones buttered with a knife at midnight **and**
    Jones buttered in the bathroom at midnight.
- However, to split 'buttered slowly' one needs to find an additional fixed reference.

# 20 Introducing events (5/6)

- In his seminal paper [Davidson, 1967] Davidson refers to events and all the parameters are represented by relations with events:
  - Jones slowly buttered a piece of toast with a knife in the bathroom at midnight.
    $\mathsf{Butter}(e) \wedge \mathsf{Slow}(e) \wedge \mathsf{Agent}(e, John) \wedge \mathsf{Patient}(e, toast) \wedge$
    $\mathsf{Time}(e, midnight) \wedge \mathsf{Place}(e, bathroom) \wedge \mathsf{Instrument}(e, knife)$
  - Jones buttered a piece of toast in the bathroom at midnight.
    $\mathsf{Butter}(e) \wedge \mathsf{Agent}(e, John) \wedge \mathsf{Patient}(e, toast) \wedge$
    $\mathsf{Time}(e, midnight) \wedge \mathsf{Place}(e, bathroom)$

- Only one Butter predicate.
- The first formula implies the second one.

# 21 Introducing events (6/6)

- Using events it is also possible to represent the last sentence in a direct way.
  - Jones did something with a knife in the bathroom at midnight.
    $\exists e(\mathsf{Event}(e) \wedge \mathsf{Agent}(e, \mathit{John}) \wedge$
    $\mathsf{Time}(e, \mathit{midnight}) \wedge \mathsf{Place}(e, \mathit{bathroom}))$

# 22 Further advantages

- Event anaphora: "it happened at midnight".
- Event nominalization: "the buttering was slow".
- Quantication: "in every burning, oxygen is consumed and Ann burned the wood, therefore Oxygen was consumed".
- Predication over events: "I enjoyed reading the book", "I saw you enter", "I heard the explosion".
- Using events, tenses can be more systematically accounted for, assuming these have a complex structure (preparatory process, culmination event, conseq. state) [Moens and Steedman, 1988]
- Events play the truthmaking role for some sentences: what makes true the sentence 'John kissed Mary' is any event which is a (past) kissing of Mary by John (semantics of truth requires truthmakers).

# 23 The nature of events

- Events are no widely accepted in ontology.
- Even though events are accepted in the domain of quantification, one needs to clarify their ontological nature.
- In particular, are events a basic kind or are they derivable or constructible in terms of other more basic kinds?

- Again, one can endorse a general approach that reifies events and $(a)$ characterize them, $(b)$ show the link with other entities, and $(c)$ study under which conditions they can be reduced to other entities.

# 24 Events, space and time

- Are events in space in the same way that objects are?
- Are events in time in the way objects are in space?
- Are objects in time in the same way that events are?
- *Hacker*: events occur while objects exist.
- *Davidson*: "Occupying the same portion of space-time, event and object differ. One is an object which remains the same object through changes, the other a change in an object or objects. Spatiotemporal areas do not distinguish them, but our predicates, our basic grammar, our ways of sorting do. Given my interest in the metaphysics implicit in our language, this is a distinction I do not want to give up." [Reply to Quine on Events, p.176]

# 25 Identity criteria for events

- A particularly difficult aspect of the ontological characterization of events is the establishment of identity criteria for them:
  - *"No entity without identity"*

# 26 How many events?

- The spinning of the ball
  The warming up of the ball
- John's answering my question
  John's shouting
- Brutus's stabbing Caesar
  Brutus's killing Caesar
  Caesar's death
- My alerting the burglar
  My illuminating the room
  My turning on the light
  My pushing on the button
  My moving my finger...

# 27 Eventists' views

- *Quine*: events and objects are both 4d entities (perdurants).
- *Lewis*: events are properties of spatio-temporal regions, i.e. classes of individuals collected from various worlds.
- *Kim*: events are exemplifications of properties by substances at a given time (gerundive nominalization of '$s$ has $P$ at $t$').
- *Bennett*: events are tropes, i.e. instances of (some specific) properties located at spatio-temporal regions.
- *Cleland*: events are couples of exemplifications of the same general property.
- *Lombard*: similar to Kim, but events involve change, a 'movement' by an object through some portion of a quality space during a time.

# 28 Identity criteria

- *Quine*: same spatio-temporal location (excludes the rotating and heating sphere example).
- *Davidson*: same place in the causal network, same causes/same effects (circularity in the axiom, all ineffectual events are identical, pulling the trigger vs. killing (events p.xxiii))
- *Kim*: same constituents.

- All these proposals have problems.

# 29 Jaegwon Kim

- **Definition**:
  *an event is the exemplification by an object (several objects) of a property (relation) at a time*.

- Noted by $[x, P, t]$ where $x$ is the constitutive object, $P$ is the constitutive property $x$ exemplifies and $t$ is a time.
- In "John shouts", $x =$ John, $P = \textit{shouting}$, $t$ is the time of shout;
- In "the collision of the Titanic with the iceberg", $x_1 =$ Titanic, $x_2 =$ the iceberg, $R = \textit{colliding with}$.

# 30 Kim: existential condition

- **Existential condition**:
  - $[x, P, t]$ exists *iff* $x$ has $P$ at $t$.
- An event $[x, P, t]$ is not just a triple (that exists when its components exist) but it *supervenes* its essential constituents.
- The notion of supervenience is quite complex.

# 31 Kim: identity condition

- **Identity condition**:
  - $[x, P, t] = [y, Q, t']$ *iff* $x = y$ and $P = Q$ and $t = t'$
- It follows that:
  - Goliath $\neq$ Lumpl $\Rightarrow$ *Goliath's rotating* $\neq$ *Lumpl's rotating*.
  - 'waking' $\neq$ 'waking abruptly' $\Rightarrow$ *John's waking* $\neq$ *John's abrupt waking* (the second property is a specialization of the first one);
- Kim answer: *John's abrupt waking* is *John's waking* with the property of 'being abrupt'.

# 32 Kim vs. Davidson (1/2)

- "Jones slowly buttered a piece of toast with a knife at midnight."
  - **Davidson**:
    $\mathsf{Butter}(e) \wedge \mathsf{Slow}(e) \wedge \mathsf{Agent}(e, John) \wedge \mathsf{Patient}(e, toast) \wedge$
    $\mathsf{Time}(e, midnight) \wedge \mathsf{Instrument}(e, knife)$
  - **Kim** (option 1):
    $[\langle John, toast\rangle, \mathsf{Butter}, midnight] \neq$
    $[\langle John, toast\rangle, \mathsf{SlowButter}, midnight] \neq$
    $[\langle John, toast\rangle, \mathsf{WithKnifeButter}, midnight]$
  - 'Slowly' and 'with a knife' do not modify the constitutive property, therefore one has a duplication of events.
  - To count events is similar to count objects: believing in the calculus of individuals, included in a table there are indefinitely many tables each of which is a proper part of this table.

# 33 Kim vs. Davidson (2/2)

- "Jones slowly buttered a piece of toast with a knife at midnight."
  - **Davidson**:
    $\mathsf{Butter}(e) \wedge \mathsf{Slow}(e) \wedge \mathsf{Agent}(e, John) \wedge \mathsf{Patient}(e, toast) \wedge$
    $\mathsf{Time}(e, midnight) \wedge \mathsf{Instrument}(e, knife)$
  - **Kim** (option 2):
    $\mathsf{Slow}([\langle John, toast\rangle, \mathsf{Butter}, midnight]) \wedge$
    $\mathsf{WithKnife}([\langle John, toast\rangle, \mathsf{Butter}, midnight])$
  - 'Slowly' and 'with a knife' do not modify the constitutive property Butter, instead they are properties of the generic events that exemplify the property Butter.
  - WithKnife and WithStick are different properties, therefore one looses the fact that both knifes and sticks are instruments.

- **Definition**:
  *an event is the instantiation of a property by (something in) a zone (or a thing at a time).*

- Events are similar to *tropes* but differently from tropes they *supervene* on (and are at a different level of) substances and properties (in Trope Theory properties are just abstractions from tropes).
- Zones include 4d regions, planes, lines, and points.

# 35 Bennett: co-located events

- The same zone can instantiate different properties, therefore spatiotemporally coinciding events can exist.
- According to the structure of the property that "individuates" the event, it is possible to fuse or fission the event itself (obtaining zonally coinciding events).
- Fission allows for *abstraction* while fusion for *concreteness*.
  (link to determinable vs. determinate properties)
- *Quine*: only (maximally) concrete events exist (corresponding to the conjunction of all the properties a zone instantiates)

# 36 Lombard: quality space

- A set $S$ of simple (non-compound) static properties $\{P_1, \ldots, P_n\}$ is a *quality space* iff:

($a$) if at any time $t$ an object $x$ has $P_i \in S$ then, at $t$, for any $j \neq i$, it is not the case that $x$ has $P_j \in S$.

($b$) if an object $x$ has $P_i \in S$ at time $t$ and $x$ exists at $t'$ but it fails to have $P_i$ at $t'$, then $x$ changes in $S$, that is, for some $j \neq i$, at $t'$, $x$ $P_j \in S$.

i.e.

- quality spaces consist of mutually exclusive static properties;
- if an object changes loosing a property in a quality space, it must come to have another property of the same kind.
- Close to quality spaces and qualities in DOLCE.

# 37 Lombard: event

- *Events* are "exemplifyings" of *dynamic* properties, i.e. properties that items have by virtue of an alteration in what *static* properties it has (therefore events cannot be instantaneous).
- An event is a 'movement' by an object from the having of one to the having of another property in the same quality space where those properties are such that the object's successive having of them implies that the object changes non-relationally.
- If an *object* changes from having $P_i$ to having $P_j$ at time $t$, then an event is (spatially) located wherever the object is located at $t$. (problems of minimality, [Lombard 1986, p.121-123])
- Objects are the *subjects* of events, objects but not even change.

# 38 Five positions [from Simons 2003]

- *Pure perdurantism*: only events.
- *Pure endurantism*: only objects.
- *Priority endurantism*: both objects and event exist but objects have ontological priority.
- *Priority perdurantism*: both objects and event exist but events have ontological priority.
- *Duality of equals*: both objects and event exist and neither reduces to or is prior to the other.

# 39 Events and objects in DOLCE(-CORE)

- Again DOLCE takes a non reductionist approach that can be restricted when needed: *duality of equals*.
- Having events in the domain of quantification, one can
  - quantify over (complex) actions;
  - directly represent causation;
  - ...
- In DOLCE-CORE the distinction between objects and events is not collapsed to the one between endurants and perdurants.
- This choice is in line with the one of considering a theory of objects that does not commit neither to perdurantism nor to endurantism.

# 40 Events vs. objects in DOLCE(-CORE) (1/2)

- There is no agreement on the ontological nature of events. Events are often characterized in a complex, but not satisfactory way.
- Some of the previous approaches can be (partially) characterized in DOLCE by using qualities and quality spaces. However, to avoid a specific commitment, DOLCE assumes a more general approach.
- In DOLCE-CORE, following [Hacker 1982], events are distinguished from objects on the basis of their connection to time and space:
  - events are *primarily* in time and *indirectly* in space;
  - objects are *primarily* in space and *indirectly* in time.

# 41 Events vs. objects in DOLCE(-CORE) (2/2)

- This subdivision is based on a series of observations.
- The properties (and qualities) that apply to material objects are different from those that apply to events.
  - Material objects have *weight*, *size*, *shape*, *texture* etc. and are related by spatial relationships like *congruence*.
  - Events can be *sudden*, *brief* or *prolonged*, *fast* or *slow*, etc. and can occur *before*, *after*, *simultaneously* to other events.
- Space plays a role in the *identification* of material objects and in their *unity criteria*, time in that of events.
  - Material objects that are simultaneously located at different places are different.
  - Events that have different temporal locations are different.

# 42 Participation

- Even though events are primarily in time and (physical) objects primarily in space, they are strongly interrelated.
- The most general option is to consider both events and objects as forming two primary and related categories:
  - events need participants (objects) and
  - objects need lives (events).
- *Participation* links objects and events:
  - an object $x$ exists at time $t$ "if and because" its life exists at $t$
    (the life of $x$ is the truth-maker for proposition '$x$ exists at $t$').
  - an event $e$ exists in space $s$ "if and because" one of its participants exist in $s$
    (participants in $e$ are the truth-makers for '$e$ exists in $s$').

# 43 A very general notion of participation

- $\mathsf{PC}(x, y, t)$: "the object $x$ participates in the event $y$ at $t$".
- Mutual existence:
  - $Event(x) \wedge \mathsf{EX}(x, t) \rightarrow \exists y(\mathsf{PC}(y, x, t))$
  - $Object(x) \wedge \mathsf{EX}(x, t) \rightarrow \exists y(\mathsf{PC}(x, y, t)$
- Participation relies on unity criteria neither for objects nor for events, i.e. an object does not participate to an event as a whole (its parts participate to it as well) and an event does not individuate its participants by the virtue of some special unity property (any larger event has those participants also):
  - $\mathsf{PC}(x, y, t) \wedge \mathsf{tP}(x', x, t) \wedge Object(x') \rightarrow \mathsf{PC}(x', y, t)$
  - $\mathsf{PC}(x, y, t) \wedge \mathsf{tP}(y, y', t) \wedge Event(y') \rightarrow \mathsf{PC}(x, y', t)$
- PC can be used to define more specific kinds of participations.

# 44 Direct and indirect qualities

- A quality kind directly connected to events cannot be also directly related to objects and vice versa:
  - $\mathsf{i}(x, y) \wedge Q_i(x) \wedge Event(y) \wedge \mathsf{i}(z, v) \wedge Q_j(z) \wedge Object(v) \rightarrow \neg Q_j(x) \wedge \neg Q_i(z)$

  the exact list of quality kinds that apply to objects and events are not fixed, they depend on the modeling interests of the user.
- *Direct qualities* are properties that can be predicated of $x$ because it has a corresponding individual quality.
- *Indirect qualities* are properties of $x$ that are inherited from the properties of other entities that are related to $x$ (in a weak or strong way).

# 45 Spatial coincidence

- The spatial location of events is an indirect property of events defined via the location of their participants.
- The life of an object is the minimal event in which it (maximally) participates.
- One obtains that an object spatio-temporally coincides with its life.
- However, the distinction between *participation* and *parthood* ensures that these two entities, although spatio-temporally coincident, are not identified.

# 46 at the end... only slogans

- Formal ontological analysis provides a rigorous methodology to obtain subtle, robust, and coherent theories.
- A deep interdisciplinary approach is essential.

⋆ Is this hard? *Of course yes! Why should it be easy?*
  - Are computers simple?
  - Are nuclear plants simple?
  - Are bank contracts simple?

⋆ ...**but** using an ontology is easier than building it
...maybe, in the future: *ontology engineering by the masses!*