

Objects, events, qualities

An introduction to formal ontological distinctions (in DOLCE)

Lecture 5 – Events

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Outline

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

1 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* as the more general term.

2 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'.

3 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.

4 Introducing events

(2/6)

- 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.
 $\text{Butter}_1(\text{Jones}, \text{toast}, \text{bathroom}, \text{midnight})$
 - ▶ Jones buttered a piece of toast in the bathroom.
 $\text{Butter}_2(\text{Jones}, \text{toast}, \text{bathroom})$
 - ▶ Jones buttered a piece of toast at midnight.
 $\text{Butter}_3(\text{Jones}, \text{toast}, \text{midnight})$
 - ▶ Jones slowly buttered a piece of toast.
 $\text{Butter}_4(\text{Jones}, \text{slowly}, \text{toast})$
 - ▶ Jones buttered something with a knife.
 $\exists x(\text{Butter}_5(\text{Jones}, x, \text{knife}))$

5 Introducing events

(3/6)

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

6 Introducing events

(4/6)

- Note that, by assuming a fixed reference to 'Jones' and 'midnight' (of a specific day), one can convert the sentence (see 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.

7 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.
 $\text{Butter}(e) \wedge \text{Slow}(e) \wedge \text{Agent}(e, \text{John}) \wedge \text{Patient}(e, \text{toast}) \wedge \text{Time}(e, \text{midnight}) \wedge \text{Place}(e, \text{bathroom}) \wedge \text{Instrument}(e, \text{knife})$
 - ▶ Jones buttered a piece of toast in the bathroom at midnight.
 $\text{Butter}(e) \wedge \text{Agent}(e, \text{John}) \wedge \text{Patient}(e, \text{toast}) \wedge \text{Time}(e, \text{midnight}) \wedge \text{Place}(e, \text{bathroom})$
- Only one Butter predicate.
- The first formula implies the second one.

8 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.

$\exists e(\text{Event}(e) \wedge \text{Agent}(e, \text{John}) \wedge$
 $\text{Time}(e, \text{midnight}) \wedge \text{Place}(e, \text{bathroom}))$

9 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).

10 The nature of events

- Events are not widely accepted in ontology.
- In addition, 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.

11 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]

12 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*”

13 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...

14 Events' identity

****CHIEDERE A LAURE CHE IO NON SO****

- Identity criteria
 - ▶ Co-localization, but strong four-dimentionalism
 - ▶ Causal equivalence, but temporal shifts
 - ▶ Logical equivalence, but slingshot argument
 - ▶ Many different properties: exemplification of proper ties at a time
- A general semantic problem? (cf. definite descriptions)
- Multiplicationism, again...

15 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.

16 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.

- 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”, $x = \text{John}$, $P = \text{shouting}$, t is the time of shout;
- In “the collision of the Titanic with the iceberg”, $x_1 = \text{Titanic}$, $x_2 = \text{the iceberg}$, $R = \text{colliding with}$.

- Events can be seen as complex entities (in the domain of quantification) with three unique constituents individuated by the primitives:
 - ▶ is the constitutive object of,
 - ▶ is the constitutive property of, and
 - ▶ is the time of the occurrence of.
- The theory is not reductive with respect to events, they cannot be reduced to object, properties, and times. The theory just relates the nature of events to the one of objects, properties and times.
- Two basic principles: *existential* and *identity* conditions.

19 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.

20 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'.

21 Kim: properties

- What notion of property does Kim assume? Both Universalism and Trope Theory do not fit very well Kim's definition.
- What identity criteria for properties? Extensional, intensional, ...
- Which kind of properties can *constitute* an event?
 - ▶ Abstract properties that apply to all thing at all time;
 - ▶ self-identity and tautologies;
 - ▶ negation or conjunction/disjunction of properties;
 - ▶ extrinsic properties, 'becoming a widow' (Cambridge events).
- States included in events.

22 Kim vs. Davidson

(1/3)

- “Jones buttered a piece of toast at midnight.”
 - ▶ Davidson (where Butter is here a unary property):
 $\text{Butter}(e) \wedge \text{Agent}(e, \text{John}) \wedge \text{Patient}(e, \text{toast}) \wedge \text{Time}(e, \text{midnight})$.
 - ▶ Kim (where Butter is here a binary property):
 $[\langle \text{John}, \text{toast} \rangle, \text{Butter}, \text{midnight}]$.

23 Kim vs. Davidson

(2/3)

- “Jones slowly buttered a piece of toast with a knife at midnight.”

- ▶ **Davidson:**

$\text{Butter}(e) \wedge \text{Slow}(e) \wedge \text{Agent}(e, \text{John}) \wedge \text{Patient}(e, \text{toast}) \wedge$
 $\text{Time}(e, \text{midnight}) \wedge \text{Instrument}(e, \text{knife})$

- ▶ **Kim** (option 1):

$[\langle \text{John}, \text{toast} \rangle, \text{Butter}, \text{midnight}] \neq$

$[\langle \text{John}, \text{toast} \rangle, \text{SlowButter}, \text{midnight}] \neq$

$[\langle \text{John}, \text{toast} \rangle, \text{WithKnifeButter}, \text{midnight}]$

- ‘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.

- “Jones slowly buttered a piece of toast with a knife at midnight.”
 - ▶ **Davidson:**
 $\text{Butter}(e) \wedge \text{Slow}(e) \wedge \text{Agent}(e, \text{John}) \wedge \text{Patient}(e, \text{toast}) \wedge \text{Time}(e, \text{midnight}) \wedge \text{Instrument}(e, \text{knife})$
 - ▶ **Kim** (option 2):
 $\text{Slow}([\langle \text{John}, \text{toast} \rangle, \text{Butter}, \text{midnight}]) \wedge \text{WithKnife}([\langle \text{John}, \text{toast} \rangle, \text{Butter}, \text{midnight}])$
 - ‘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 loses the fact that both knives 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.

- “[W]herever a space-occupying thing x has property P at time t , that is because at a deeper metaphysical level the zone defined by x at t has a corresponding property P^* .” [Bennett, 1988], p.88:
 1. To be an object in a given region of space is for that region to be *thus* rather than *so*, i.e., in 4d, the notion of object is analyzed in terms of attributes of zones.
 2. Criteria to collect zones of one object are based on causality: the greater causal contribution comes from the thing itself.

27 Bennett vs. Quine vs. Kim

- *Quine*: an event is the (material) content of a zone.
- “One could say that Quine’s events are also property instances, the property (...) being the conjunction, so to speak, of all the properties that are instantiated at the zone.”
“Since a Quinean event is constituted by all the properties that are instantiated at the zone, it is uniquely determined by the zone, with no need to mention properties at all.” [Bennett, 1988], p.104
- “Kim maps events onto zone-property pairs, while Quine maps them onto zones.” [Bennett, 1988], p.104
- Kim does not explicitly refer to *zones*, he talks of *substances* or *constitutive objects*.

28 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)

29 Bennett: tropes vs. events

- Differently from tropes, Bennett's events can have a structure that reflects the one of the properties that 'generate' them.
- No strict Universalism:
 - ▶ the conjunction of two properties is still a property that generate a *complex* event.
- No strict Trope Theory:
 - ▶ tropes have a structure and are not maximally specified (fully determinate);
 - ▶ events can be dynamic while tropes cannot change (if change is reduced to trope substitution).

30 Perdurantism: objects vs. events

- If Perdurantism coincides with commitment to temporal slices, then both concrete and abstract events are perdurants.
- Differently from Quine, Bennett accepts abstract events, that differ from concrete events (that Quine identifies with objects).
- Differently from Quine (following Quinton), Bennett accepts that two events can, while two physical objects cannot, fully occupy a zone.
- In addition, for Bennett, only some zones identify an object and the unity criteria of objects are different from the ones of events.
- Problem: object vs. its history/life.

31 Carol Cleland

- She accepts:
 - ▶ *states*: (fully) determinate properties;
 - ▶ *phases*: determinable properties;
 - ▶ *concrete phases*: instances of phases
particularized properties or tropes the individuality of which is *primitive*, they are basic individuals that cannot be individuated in terms of properties-zones-physical objects.
(+ no reduction of objects to (classes of) concrete phases)
- A concrete phase that is an instance of a property P survive the going in and out of existence of instances of *states* that are specializations of P .
- Similarly to Bennett, non-fully determinate tropes are accepted.

32 Cleland: concrete changes and events

- A *concrete change* R is a pair $\langle x, y \rangle$ such that x is the exemplification of a state s by a concrete phase CP at a time t and y is the exemplification of a state s' by CP at a time t' , where (i) t precedes t' and (ii) $s \neq s'$.
- An *event* is a concrete change, i.e. formally, $\langle [CP, s, t], [CP, s', t'] \rangle$. where '[' denotes the exemplification.
- The identity condition for events is very similar to the one introduced by Kim.

33 Cleland vs. Kim vs. Lombard vs. Bennett

- Events do not depend on physical objects but on concrete phases (which may or may not involve physical objects).
- Different phases can be spatiotemporally co-located, co-localization of events is possible.
- W.r.t. Bennett, it is possible to account for events that involve non-physical objects: concrete changes are possible even in absence of spatial locations.

34 Cleland: dynamical system theory

- *Dynamical systems* are represented as vector fields defined on state spaces.
- A *one dimensional state space* (e.g. temperature) corresponds to a phase P and each state in the space corresponds to a determinate property that comes under P .
- An axis (dimension) in a *multi dimensional state space* (e.g. color) corresponds to a phase and the states correspond to a n -tuples (one for each phase) of determinate properties.
- In a state space, changes are represented as *trajectories* (time-ordered curves) connecting different states.

35 Lombard: quality space

- A set S of simple (non-compound) static properties $\{P_1, \dots, P_n\}$ 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 losing 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.

36 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.

37 Different kinds of Events

- On the basis of some characteristics (e.g. *homeomericity*, *cumilativity*, etc.) it is possible to distinguish different kinds of events, e.g.
 - ▶ activities,
 - ▶ accomplishments,
 - ▶ achievements,
 - ▶ states.
- I don't have time to enter into this topic.

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

- 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;
 - ▶ ...
- However, 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

(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.
- Following [Hacker 1982], DOLCE distinguishes events 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

(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

- $PC(x, y, t)$: “the object x participates in the event y at t ”.
- Mutual existence:
 - ▶ $Ev(x) \wedge EX(x, t) \rightarrow \exists y(PC(y, x, t))$
 - ▶ $Ob(x) \wedge EX(x, t) \rightarrow \exists y(PC(x, y, t))$
- 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):
 - ▶ $PC(x, y, t) \wedge tP(x', x, t) \wedge Ob(x') \rightarrow PC(x', y, t)$
 - ▶ $PC(x, y, t) \wedge tP(y, y', t) \wedge Ev(y') \rightarrow PC(x, y', t)$
- 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:

$$\blacktriangleright i(x, y) \wedge Q_i(x) \wedge Ev(y) \wedge i(z, v) \wedge Q_j(z) \wedge Ob(v) \rightarrow \neg Q_j(x) \wedge \neg Q_i(z)$$

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 ??–Events, process modeling, and plans

- **dire magari due parole con i linguaggi di modellazione di processi come ad es. BPMN, che questi in effetti non definiscono eventi ma al massimo tipologie di eventi, che in realta' introducono un insieme di vincoli strutturali su eventi**
- **link con i piani, anche questi sono simili a descrizioni di processi, forse ancora piu' dettagliati in alcuni casi in quanto sono sequenze di azioni, ma a differenza degli eventi, lo stesso piano puo' essere ri-eseguito, mentre lo stesso evento non puo' ri-succedere**

47 Conclusive slogans

- Formal ontological analysis provides a rigorous methodology to obtain subtle, robust, and coherent theories.
- A humble 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?
- Building an ontology vs. using an ontology.
- Ontology engineering by the masses?