Objects, events, qualities

An introduction to formal ontological distinctions (in DOLCE)

Lecture 4 – Change and persistence

Claudio Masolo
Laboratory for Applied Ontology, ISTC-CNR
masolo@loa-cnr.it

Esslli 2010 – Copenhagen, August 16-20

Outline

- Change and puzzles about change.
- Theories of persistence.
- Perdurantism vs. endurantism: formal aspects.
- Theories of persistence and theories of properties.
- DOLCE and DOLCE-CORE about persistence and properties.

1 What is change?

- In order to an object to change there must be a sense in which it remains the *same* (it *persists*, otherwise it simply ceases to exist) and a sense in which it becomes different (it *changes*).
- Most philosophers analyze change as involving (in the simplest case) four components:
  - the substratum or object changing,
  - the property (or state) the object has before the change,
  - the property (or state) the object has afterwards,
  - the time of change.
- This viewpoint is not shared by all philosophers, in addition it is still too general.

2 Time

- To analyze change, I consider a very weak theory of time:
  - unstructured set of indexes called *times* (indicated with t, t', t_i);
  - *identity* is the only relation btw times (in DOLCE we have P).
- No commitment to the nature of times (punctual or extended entities, primitive or builded entities, e.g. sets of simultaneous events) or to the structure of time (linear or branching, etc.).
- $\mathsf{EX}(x, t)$ (shortly, $\mathsf{EX}_t x$ or $\mathsf{EX}xt$) stands for "x exists at time t".
  - Here is a primitive, while in DOLCE is defined in a complex way.
- *Persistence* through time can be minimally characterized by:
  - $\exists t, t'(\mathsf{EX}(x, t) \wedge \mathsf{EX}(x, t') \wedge t \neq t')$

3 Puzzles about change through time

- According to Sally Haslanger these puzzles rely on general conditions that, when integrally accepted, generate a contradiction.

  1 Objects persist through change.

  2 The properties involved in a change are incompatible.

  3 Nothing can have incompatible properties.

  4 The object before the change is one and the same object after the change.

  5 The object undergoing the change is itself the proper subject of the properties involved in the change.

4 . . . for example

- A rose r persists through a change from 'red' to 'brown'.
- The acceptance of all the conditions 1-5 yields a contradiction because r happens to be both 'red' and 'brown' (assuming that 'red' and 'brown' are incompatible properties).
- Three main solutions exist in the literature.
  - *Perdurantism* (four-dimensionalism) rejects condition 5.
  - *Endurantism* (three-dimensionalism) rejects condition 2.
  - *Stage Theory* rejects condition 1.
- We will see how these solutions 'interact' with the underlying theories of properties.

THEORIES OF PERSISTENCE

5 Endurantism

- Objects undergoing the change *endure*, i.e. they are *wholly present* at any time at which they exist, they maintain their identity through change and they are the subjects of properties, but these properties need to be *temporally qualified*.
- Usually endurantists also accept perduring objects, *events*, as opposed to *objects* (next lecture).
- At any time objects are *wholly present* but 'being red' and 'being brown' need to be *temporally qualified* and they are incompatible only if stated at the same time (about the same object).
- The fact that r is red at t and it is brown at t' does not lead to any contradiction.

6 Perdurantism

- All the objects persist by *perduring*, i.e. objects are extended in time as they do in space: by having different *(temporal) parts* (also called *temporal slices*) at different times.
- At each time, only a part of a persisting object is present, i.e. at a given time persisting objects are only *partially present*.
- If r exists at two different times t and t' then its temporal slices r-at-t ($r@t$) and r-at-t' ($r@t'$) exist and are different.
- r is red at t because its *temporal part* at t, $r@t$, is red.
- The fact that $r@t$ is red and $r@t'$ is brown is not contradictory because $r@t \neq r@t'$.

7 Stage Theory

- Stage Theory denies persistent objects: *stages*, i.e. instantaneous entities, are the only true ontological entities.
- Common-sense persisting objects are the result of a conceptual construction that collects together similar stages (*unity criteria*).
- Perdurantism accepts persistent objects while Stage Theory does not, however both theories rely on the fact that the proper subjects of properties can be instantaneous entities.
  (perdurantists accept properties of persisting objects)
- ⋆ Some stagists assume stages as *static*, but not necessarily instantaneous, entities, i.e. as 'frozen' entities that can persists through time but not through change.

8 Counterpart Theory

- Theory introduced by David Lewis.
- (Time) world bounded entities are linked by the ontological relation of *counterpart*:
  - r exists only at t and it is red, r' exists only at t' and it is brown but they are one the *counterpart* of the other one.
- Counterpart Theory is often seen as a version of Perdurantism, the difference is principally due to the nature of the counterpart relation.

9 Stage Theory vs. Perdurantism

- In what follows I want to talk about persisting entities.
- For stagists these entities have a conceptual nature, while for perdurantists they are true ontological entities.
- Putting aside this difference, the two theories treat change in a very similar way and associate persisting entities with sequels of instantaneous entities.

⋆ For the previous reasons, in the following, I will consider only Endurantism and Perdurantism.

10 *Digression*: a practical usage for Perdurantism

- "Sam Palmisano was named chief executive officer of the IBM Corporation effective March 1, 2002." [Welty & Fikes, 2006]
- The most common way to represent this situation is by means of a ternary predicate: $\mathsf{CEO}^3(\mathsf{sam}, \mathsf{ibm}, \bar{\mathsf{t}})$ where $\bar{\mathsf{t}}$ is March 1, 2002.
- But ternary predicates cannot be represented in OWL.
- An alternative that commits to perdurantism is possible:

  $\mathsf{CEO}^2(\mathsf{sam}@\bar{\mathsf{t}}, \mathsf{ibm}@\bar{\mathsf{t}}) \wedge \mathsf{EX}(\mathsf{sam}@\bar{\mathsf{t}}, \bar{\mathsf{t}}) \wedge \mathsf{EX}(\mathsf{ibm}@\bar{\mathsf{t}}, \bar{\mathsf{t}}) \wedge$
  $\mathsf{P}(\mathsf{sam}@\bar{\mathsf{t}}, \mathsf{sam}) \wedge \mathsf{P}(\mathsf{ibm}@\bar{\mathsf{t}}, \mathsf{ibm})$.
- This alternative uses only binary predicates (however, note that '@' does not indicate a function, but $\mathsf{sam}@\bar{\mathsf{t}}$ and $\mathsf{ibm}@\bar{\mathsf{t}}$ are just the names of two new individuals in the domain).

11 *Digression*: a practical usage for Trope Theory

- "Sam Palmisano was named chief executive officer of the IBM Corporation effective March 1, 2002."
- In addition to standard tropes, let us assume the existence individualizations of relations (called *relational tropes* or *relators*), e.g. "the Sam and IBM being in the chief executive officer relation".
- This trope (indicated with $\mathsf{ceo}_{\mathsf{sam,ibm}}$) inheres in both Sam and IBM and it exists at $\bar{\mathsf{t}}$, then instead of $\mathsf{CEO}^3(\mathsf{sam}, \mathsf{ibm}, \bar{\mathsf{t}})$:

  $\mathsf{CEO}(\mathsf{ceo}_{\mathsf{sam,ibm}}) \wedge \mathsf{I}(\mathsf{ceo}_{\mathsf{sam,ibm}}, \mathsf{sam}) \wedge \mathsf{I}(\mathsf{ceo}_{\mathsf{sam,ibm}}, \mathsf{ibm}) \wedge$
  $\mathsf{EX}(\mathsf{ceo}_{\mathsf{sam,ibm}}, \bar{\mathsf{t}})$.
- Only unary and binary predicates; generalizable to n-ary relations.
- To order the entities in which relators inhere according to the arguments of the relation a more complex framework is needed.

PERDURANTISM VS. ENDURANTISM: SOME FORMAL ASPECTS

12 Perdurantism vs. Endurantism

- The distinction between perdurantism and endurantism is informally stated in terms of the notions of being *partially* or *wholly* present.
- Being partially present has been quite precisely characterized while being wholly present is still quite obscure (some attempt exists).
- Therefore, the formal distinction between perdurantism and endurantism often reduces to different positions on *parthood*:
  - perdurantists assume an atemporal parthood (*parthood simpliciter*, or simply *parthood*) and they define "x is part of y at t" as "$x@t$ is part of $y@t$";
  - while endurantists, rejecting the existence of temporal slices at least for some kinds of individuals, claim that a primitive temporally qualified parthood (*temporary parthood*) is required.

13 Perdurantism stated

- Theodore Sider introduced a formal characterization of Perdurantism that, unusually (for perdurantists), assumes the primitives of
  - *temporary parthood* and *existence in time* instead that
  - *parthood* and *existence in time*.

- *Perdurantists* can read "x is part of y at t" in terms of parthood as "$x@t$ is part of $y@t$";
- *Endurantists* can better grasp Perdurantism because it is expressed in terms of a primitive they understand.

14 A bit of history of mereology

- **Mereology**: from the greek *meros*, 'the theory of parthood'.
- 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.
- Tarski 1935. Link with algebra.
- Leonard and Goodman 1940. The calculus of individuals, nominalism.
- Contemporary studies: Peter Simons (1986), Achille Varzi (1996).

$\star$ No one single mereology, but a plurality of different mereologies.

15 Parthood simpliciter vs. temporary parthood

Parthood simpliciter
$\mathsf{EX}xt$ "x exists at t";
$\mathsf{P}xy$ "x is part of y".

Temporary Parthood
$\mathsf{EX}xt$ "x exists at t";
$\mathsf{tP}xyt$ "x is part of y at t".

Definitions on the basis of P:

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

d2 $\mathsf{TP}xyt \triangleq \mathsf{EX}xt \wedge \mathsf{EX}yt \wedge \neg\exists t'(\mathsf{EX}xt' \wedge t' \neq t) \wedge \mathsf{P}xy \wedge \forall z(\mathsf{P}zy \wedge \mathsf{EX}zt \rightarrow \mathsf{O}zx)$

d3 $\mathsf{tP}xyt \triangleq \exists zw(\mathsf{TP}zxt \wedge \mathsf{TP}wyt \wedge \mathsf{P}zw)$

Definitions on the basis of tP:

d4 $\mathsf{tO}xyt \triangleq \exists z(\mathsf{tP}zxt \wedge \mathsf{tP}zyt)$

d5 $\mathsf{tTP}xyt \triangleq \neg\exists t'(\mathsf{EX}xt' \wedge t' \neq t) \wedge \mathsf{tP}xyt \wedge \forall z(\mathsf{tP}zyt \rightarrow \mathsf{tO}zxt)$

d6 $\mathsf{P}xy \triangleq \forall t(\mathsf{EX}xt \rightarrow \mathsf{tP}xyt)$

16 The theories $\mathcal{T}_{\mathsf{tP}}$ and $\mathcal{T}_{\mathsf{P}}$

$\mathcal{T}_{\mathsf{tP}}$: **temporary parthood** (Sider)

a1 $\exists t(\mathsf{EX}xt)$

a2 $\mathsf{tP}xyt \rightarrow \mathsf{EX}xt \wedge \mathsf{EX}yt$

a3 $\mathsf{EX}xt \rightarrow \mathsf{tP}xxt$

a4 $\mathsf{tP}xyt \wedge \mathsf{tP}yzt \rightarrow \mathsf{tP}xzt$

a5 $\mathsf{EX}xt \wedge \mathsf{EX}yt \wedge \neg\mathsf{tP}xyt \rightarrow \exists z(\mathsf{tP}zxt \wedge \neg\mathsf{tO}zyt)$

pd $\mathsf{EX}xt \rightarrow \exists y(\mathsf{tTP}yxt)$

$\mathcal{T}_{\mathsf{P}}$: **parthood simpliciter**

(a1) $\exists t(\mathsf{EX}xt)$

a6 $\mathsf{P}xx$

a7 $\mathsf{P}xy \wedge \mathsf{P}yx \rightarrow x = y$

a8 $\mathsf{P}xy \wedge \mathsf{P}yz \rightarrow \mathsf{P}xz$

a9 $\neg\mathsf{P}xy \rightarrow \exists z(\mathsf{P}zx \wedge \neg\mathsf{O}zy)$

a10 $\mathsf{P}xy \wedge \mathsf{EX}xt \rightarrow \mathsf{EX}yt$

pdn $\mathsf{EX}xt \rightarrow \exists y(\mathsf{TP}yxt)$

- $\mathcal{T}_{\mathsf{P}}$ is strictly stronger than $\mathcal{T}_{\mathsf{tP}}$.
- $\mathcal{T}_{\mathsf{P}} \setminus \{(\mathsf{a7})\}$ eqiv. $\mathcal{T}_{\mathsf{tP}}$ & $\mathcal{T}_{\mathsf{P}}$ eqiv. $\mathcal{T}_{\mathsf{tP}} \cup \{(\mathsf{a11})\}$ (via (d3) and (d6)):

  a11 $\forall t(\mathsf{EX}xt \rightarrow \mathsf{tP}xyt) \wedge \forall t(\mathsf{EX}yt \rightarrow \mathsf{tP}yxt) \rightarrow x = y$

17 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 (d3) cannot be used).
  - Parthood simpliciter cannot be reduced to temporary parthood because (a11) 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.

18 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, (a11) is accepted, and parthood simpliciter is defined by (d6).
- Entities can coincide only at some times:

  $\mathsf{CC}(x, y, t) \triangleq \mathsf{tP}(x, y, t) \wedge \mathsf{tP}(y, x, t)$

  but when they coincide they are indistinguishable, i.e. all the properties that x has at t are also properties of y at t and vice versa.
- In this purely formal perspective, that must not be confused with the common usage of the term 'part', extensionality (and closure with respect the sum) is no more a problem.

19 Endurantism vs. Perdurantism

- In the analysis provided by Sider, the distinction between Endurantism and Perdurantism is reduced to the rejection or acceptance of temporal parts, then
  - either Endurantism is less constrained than Perdurantism,
  - or Endurantism still lacks a clear formal characterization.

⋆ By assuming a temporary parthood without committing to temporal slices, DOLCE-CORE is quite neutral with respect Endurantism vs. Perdurantism.

- Tomorrow, we will see that the distinction between 'objects' and 'events' do not necessarily coincides with the one between endurants and perdurants (this also motivate the terminological change from DOLCE to DOLCE-CORE).

THEORIES OF PERSISTENCE AND THEORIES OF PROPERTIES

20 a has P at t

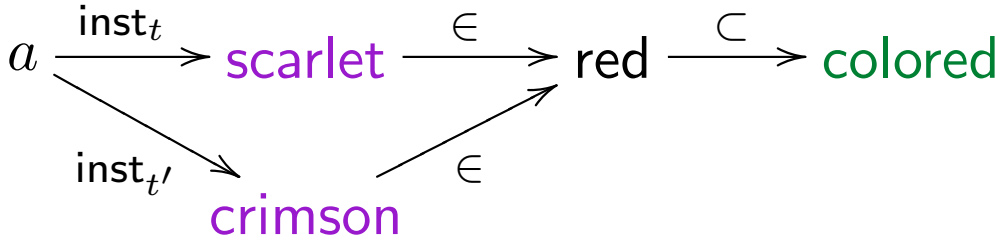
- Let us start from considering the following reading of the FOL formula

  $P(x,t) \wedge Q(x,t')$:

  "x exists at both t and t', it has the property P when t is (was, will be) present and the property Q when t' is (was, will be) present".

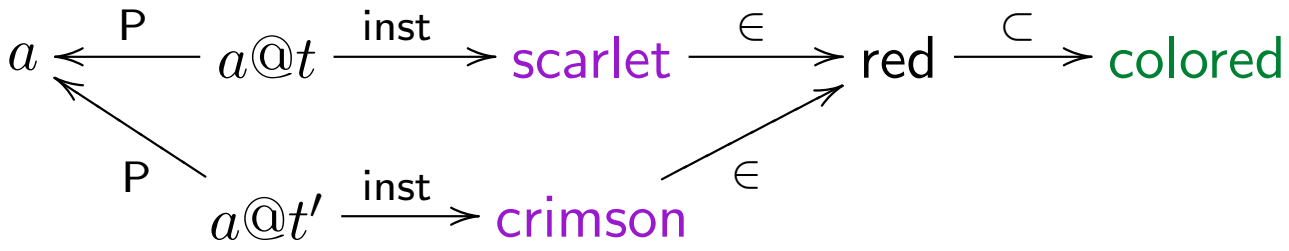
- Let us analyze how $P(x,t)$ can be reduced to more basic relations according to the theories of persistence and properties considered.

21 Universalism and change (1/2)



- Different universals are wholly present in the same object at different times.
- Two ways to represent property change in FOL:
  1. adding a temporal parameter to instantiation:
     $P(x,t) \wedge Q(x,t') \leftrightarrow \mathsf{inst}(x,\mathsf{p},t) \wedge \mathsf{inst}(x,\mathsf{q},t')$;
  2. applying temporal modal operators to binary instantiation:
     $P(x,t) \wedge Q(x,t) \leftrightarrow \Box_t \mathsf{inst}(x,\mathsf{p}) \wedge \Box_{t'} \mathsf{inst}(x,\mathsf{q})$.
- Solutions 1-2 are neutral wrt the existence of temporal slices.

22 Universalism and change (2/2)



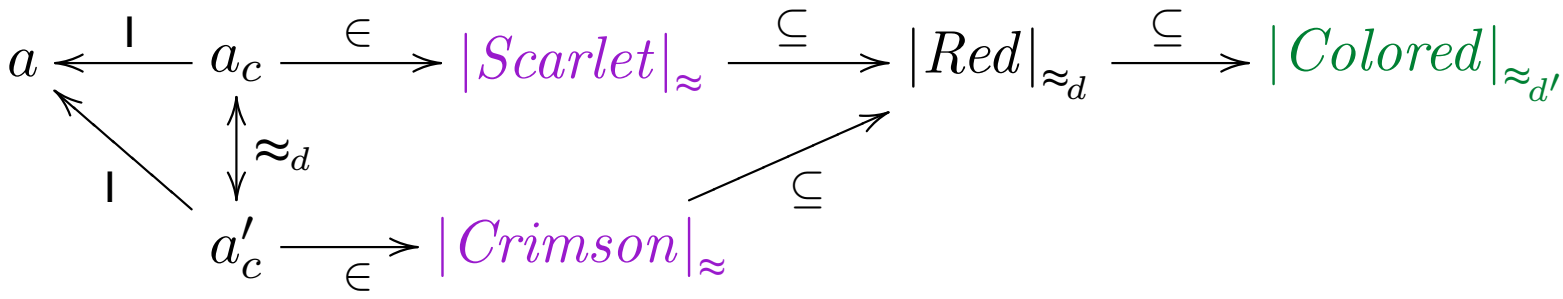
- *Committing to perdurantism*: different universals are wholly present in different temporal slices of an object.

  3 $P(x,t) \wedge Q(x,t) \leftrightarrow \mathsf{inst}(x@t, \mathsf{p}) \wedge \mathsf{inst}(x@t', \mathsf{q})$.

- Solution 3 can be seen as a specialization of solution 1 where $\mathsf{inst}(x, \mathsf{p}, t)$ is reduced to $\mathsf{inst}(x@t, \mathsf{p})$.

- The introduction of temporal modal operators, e.g. $\Box_t \mathsf{inst}(x@t, \mathsf{p})$, does not make so much sense because $a@t$ exists only at t.

23 Trope Theory and change



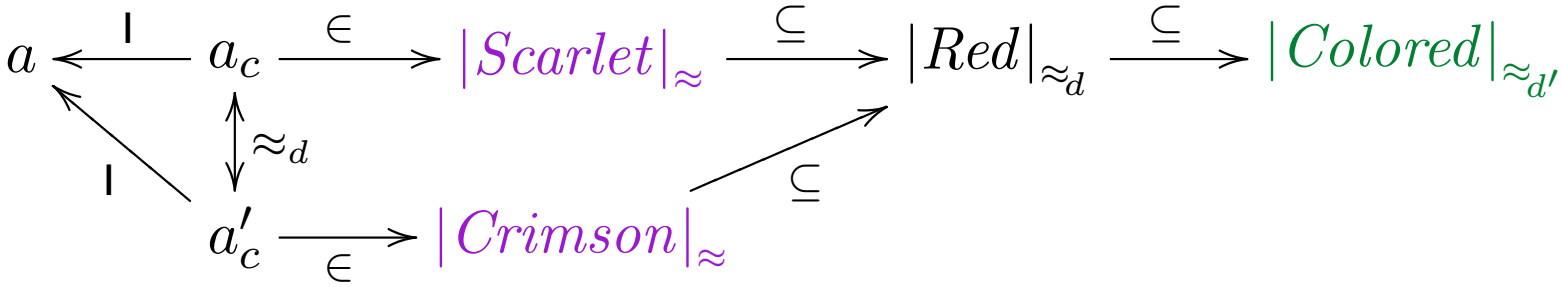
- Similarly to stages, tropes do not change, they do not persist through *change* (but they can 'statically' persist through time).
- Change is reduced to *trope substitution*: an object changes along a dimension, say color, because its color-trope is *substituted* by another non-exactly resembling (but comparable) color-trope.

$$P(x,t) \wedge Q(x,t') \leftrightarrow \exists x_p x_q(\mathsf{I}(x_p,x) \wedge \mathsf{I}(x_q,x) \wedge x_p \in \mathsf{p} \wedge x_q \in \mathsf{q} \wedge \mathsf{EX}(x_p,t) \wedge \mathsf{EX}(x_q,t'))$$

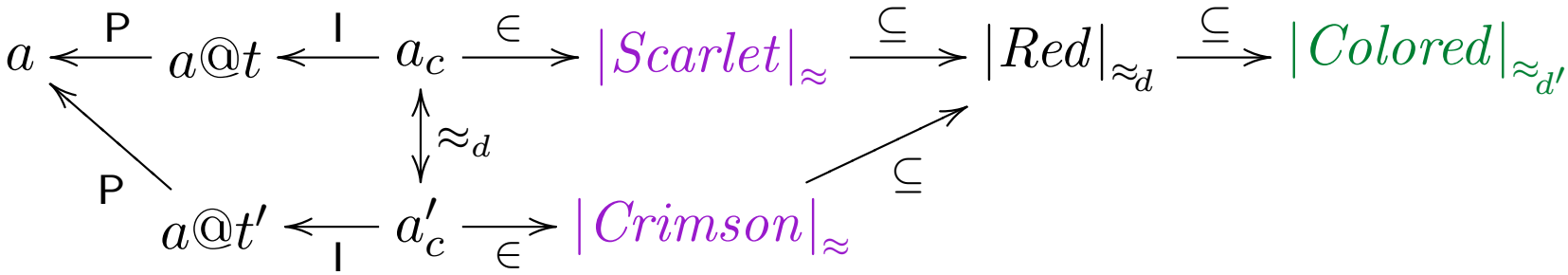
(I use $\in$ to indicate that p and q stands for sets of tropes).

24 Trope Theory and persistence

- Trope Theory assumes a sort of Stage Theory for *tropes*, but it is neutral wrt the way objects in which tropes inhere persist.
- *Tropes and endurants*:



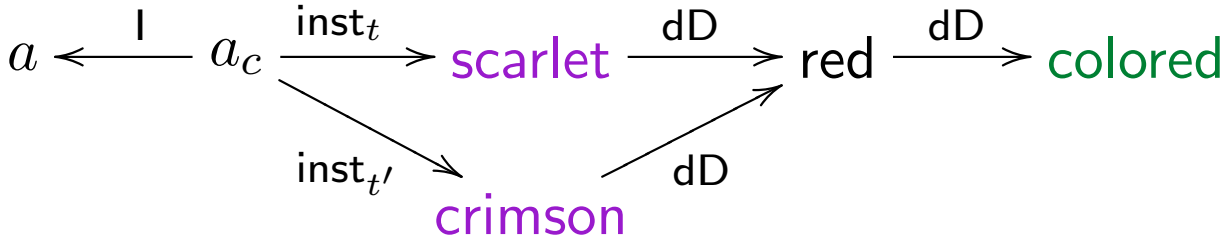
- *Tropes and perdurants* ($a_c \neq a'_c$ even though a does not change because they inhere in different temporal slices):



25 *Digression*: intrinsic properties' change

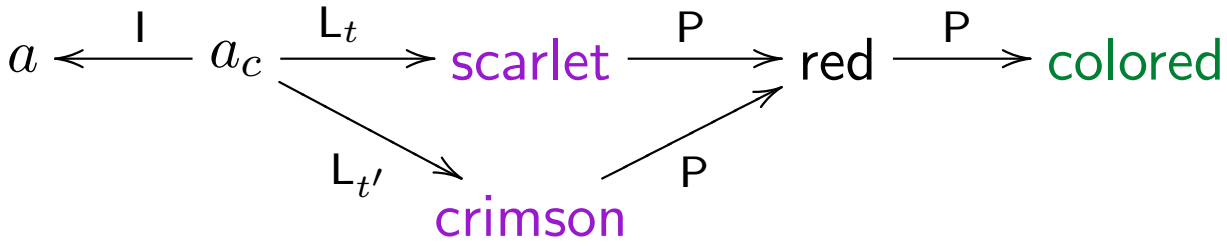
- Let us suppose that P and Q are intrinsic properties.
- (Strong) Perdurantism ontologically explains change of intrinsic properties: x changes because it has temporal parts with different properties, $P(x@t) \wedge Q(x@t')$.
- Endurantists write $P(x,t) \wedge Q(x,t')$ (or use a temporal logic) without explaining what happened to x to change from P to Q.
- David Lewis noticed: either endurantists assume that P and Q are relational properties or an alternative explanation is required.
- Conceiving change as *trope* substitution is an alternative ontological explanation compatible with endurantism.

26 Tropes vs. individual qualities



- Color-qualities persist through the change in color of the objects they inheres in, thus they can change location in the color-space(s).
- Individual qualities can be seen as the mereological sums of tropes of a given dimension that inhere in the same object, i.e. the Trope Theory can be seen as a perdurantist specialization of the theory based on individual qualities.
  - $P(x,t) \wedge Q(x,t) \leftrightarrow \exists x_p x_q(\mathsf{I}(x_p,x) \wedge \mathsf{I}(x_q,x) \wedge \mathsf{inst}(x_p,\mathsf{p},t) \wedge \mathsf{inst}(x_q,\mathsf{q},t'))$
- No commitment on the way objects and individual qualities persist.

27 Individual qualities in DOLCE-CORE (DOLCE)



- Instead of instantiation, DOLCE-CORE considers *location* that needs to be extended with a temporal argument.
- dD is represented by means of parthood simpliciter (spaces and regions are static entities).
  - $P(x,t) \wedge Q(x,t) \leftrightarrow \exists x_p x_q(\mathsf{I}(x_p,x) \wedge \mathsf{I}(x_q,x) \wedge \mathsf{L}(x_p,\mathsf{p},t) \wedge \mathsf{L}(x_q,\mathsf{q},t')).$
- DOLCE is basically the same, it is enough to substitute I with qt and L with ql.

28 Individual qualities without universals

- Can properties been associated to sets of *exactly resembling* individual qualities (as happens in Trope Theory with tropes)?
- Differently from tropes, individual qualities can change, therefore:
  - a *resemblance simpliciter* can just collect all the individual qualities relative to a given dimension, i.e. only general determinables, but not their determinates, can be builded on the basis of it;
  - a *diachronic resemblance*, $x \approx_{tt'} y$ stands for "the individual quality x, as it is at t, exactly resembles to the individual quality y, as it is at t'" does not solve the problem:

    to which full determinate a, individual color-quality that is crimson at t and scarlet at t' belongs?
- The introduction of stages of ind. qualities leads to Trope Theory.

29 Properties in DOLCE-CORE

- **Predicates**. Adequate to model the *basic elements* of the user's conceptualization and the categories/primitive relations of DOLCE. The formalization of properties as extensional predicates is straightforward and requires no special formalism.
- **Concepts**. Concepts are properties *reified* in the domain of quantification to consider the intensional, contextual, or dynamic aspects (roles). A sort of instantiation relation (classification) needs to be introduced in the theory.
- **Qualities and quality spaces**. In addition to the intensional, contextual, and dynamic aspects of concepts, properties are *structured* (possibility of talking of the relations btw properties) in spaces according to specific points of view, instruments, etc.