

# Towards a Unified Theory of **Endurants** and **Perdurants**: UFO-AB

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JOWO  
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# **Endurants**

## **(UFO-A)**

# Endurants

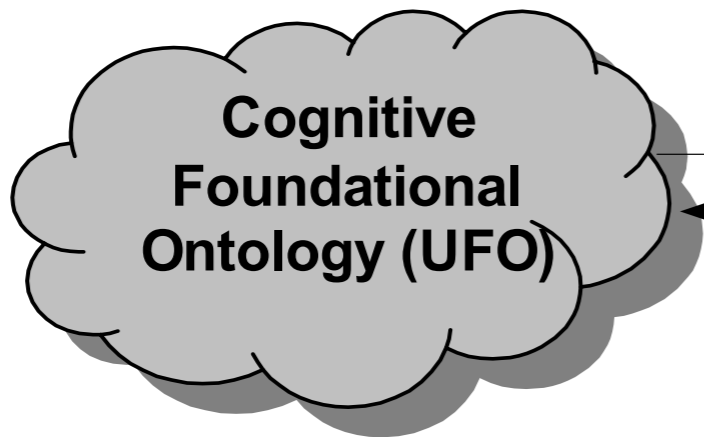
- Whenever they are present, they are wholly present with all their parts
- Have Essential and Accidental Properties
- Can qualitatively change while maintaining their **IDENTITY**
- Can (or could) have been different from how they are
- All these informed by a **KIND** providing a principle of individuation, identity and persistence

# UFO-A

- UFO-A is an ontology of endurants (e.g., substantials, qualities, modes and relators)
- Since endurants are (the natural) bearers of modal properties, there are many modal properties that characterize some categories in this ontology
- The current treatment of modality is restricted to alethic modality (QS5)

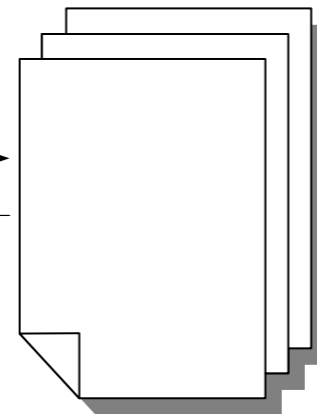


**U**nified  
**F**oundational  
**O**ntology

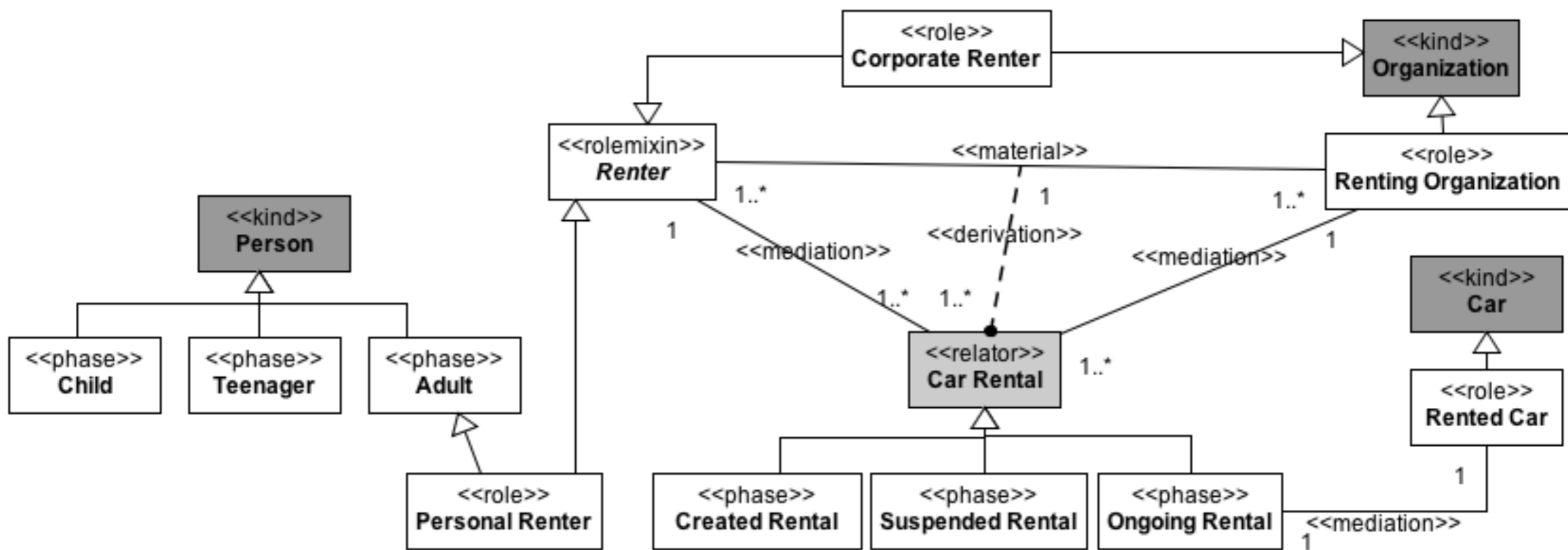


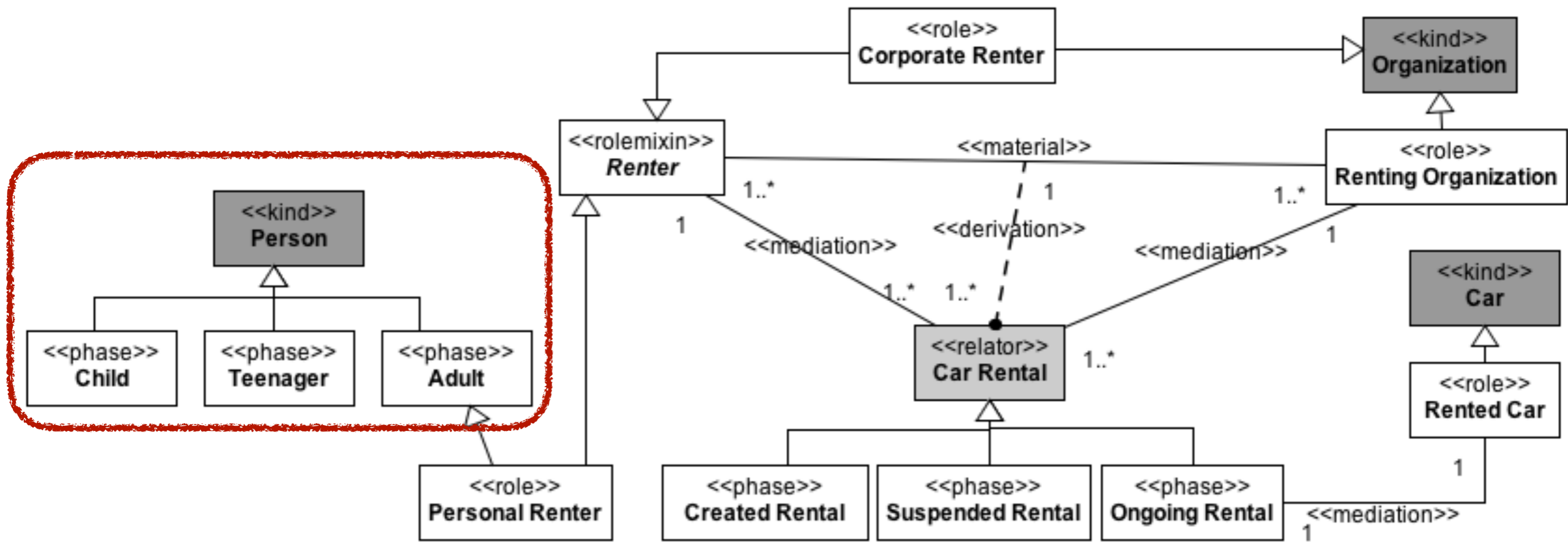
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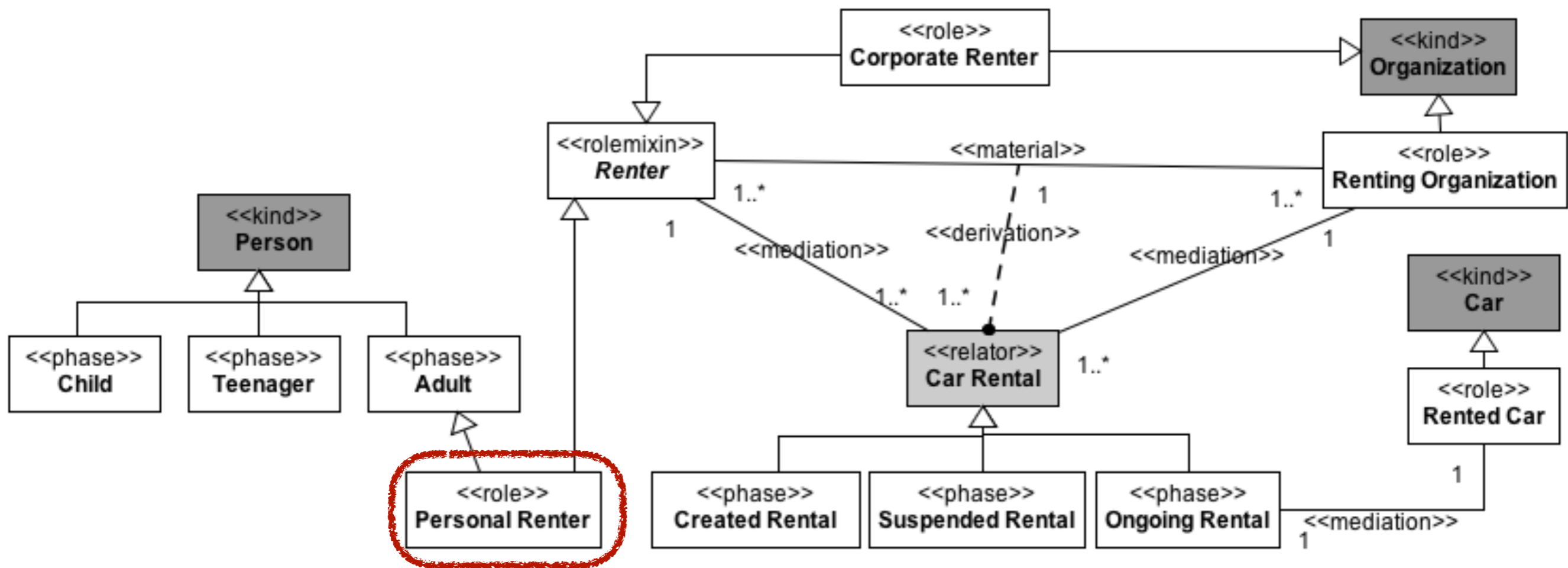
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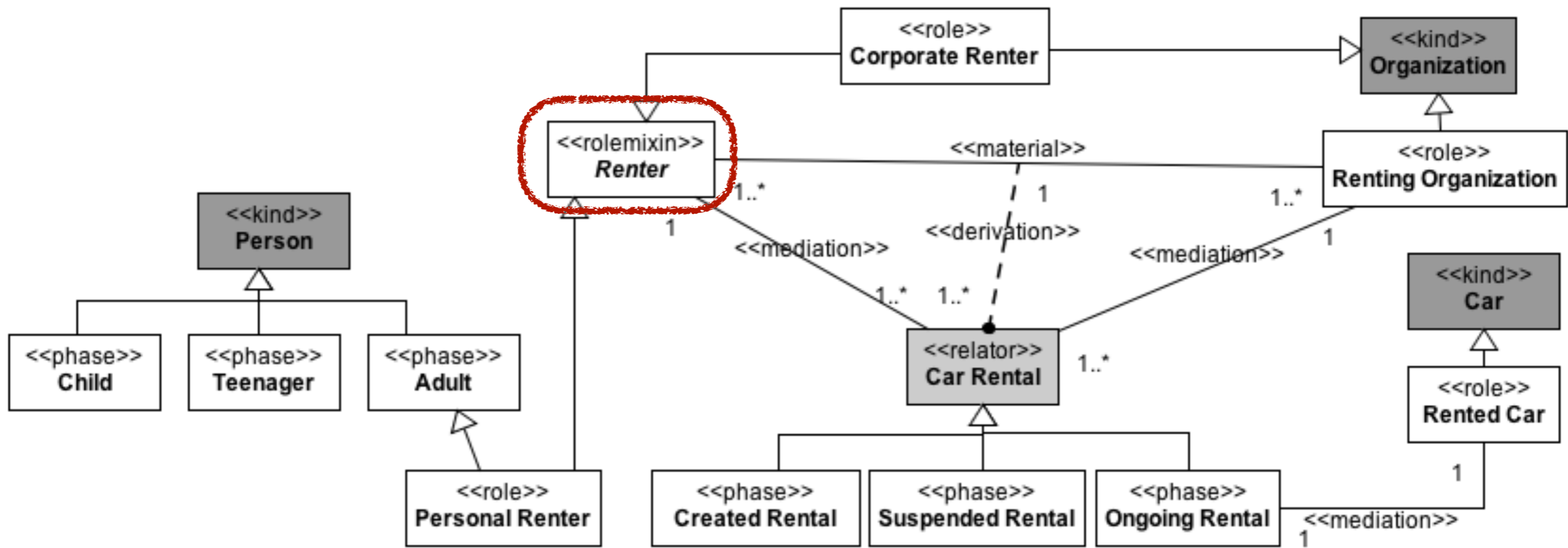
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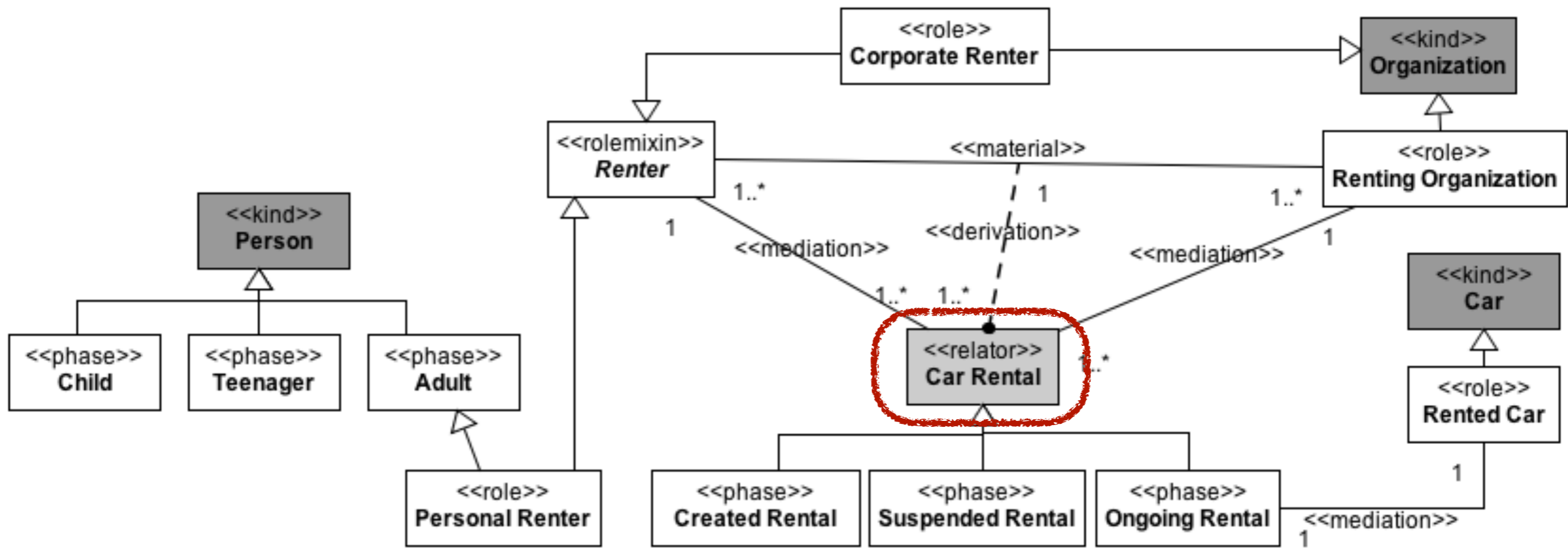


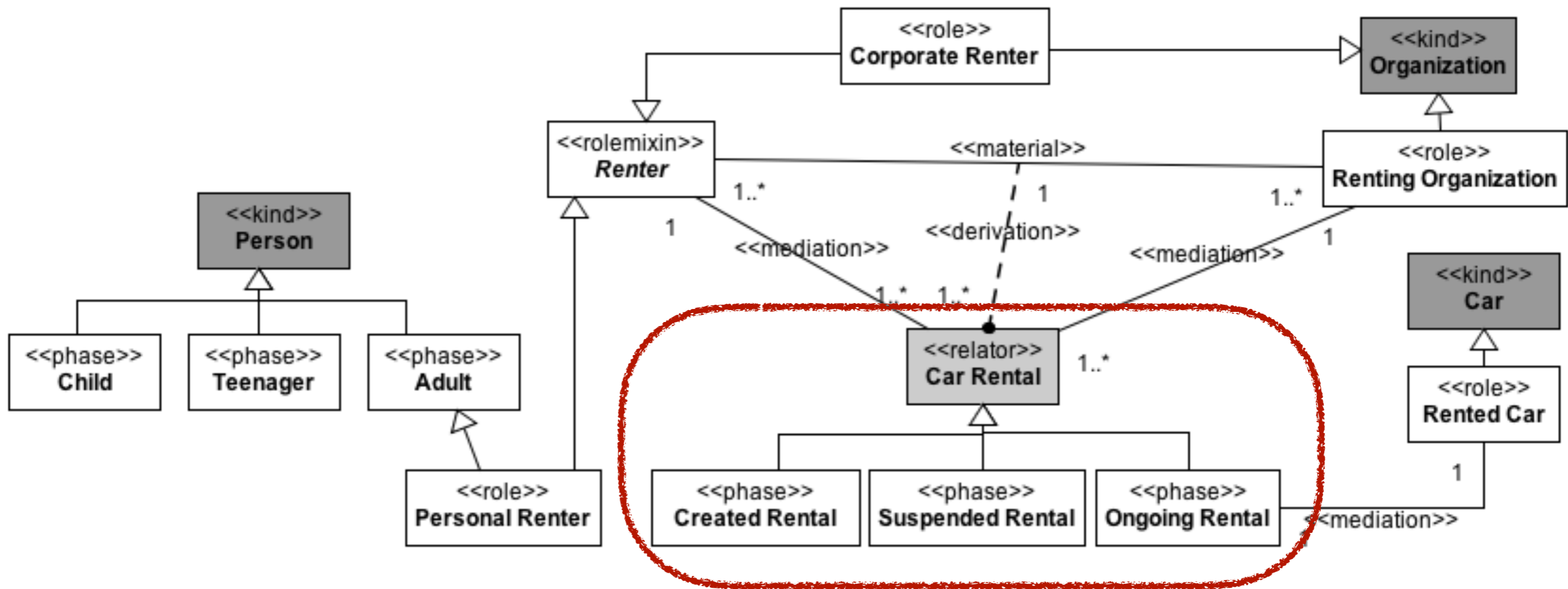












# Events (UFO-B)

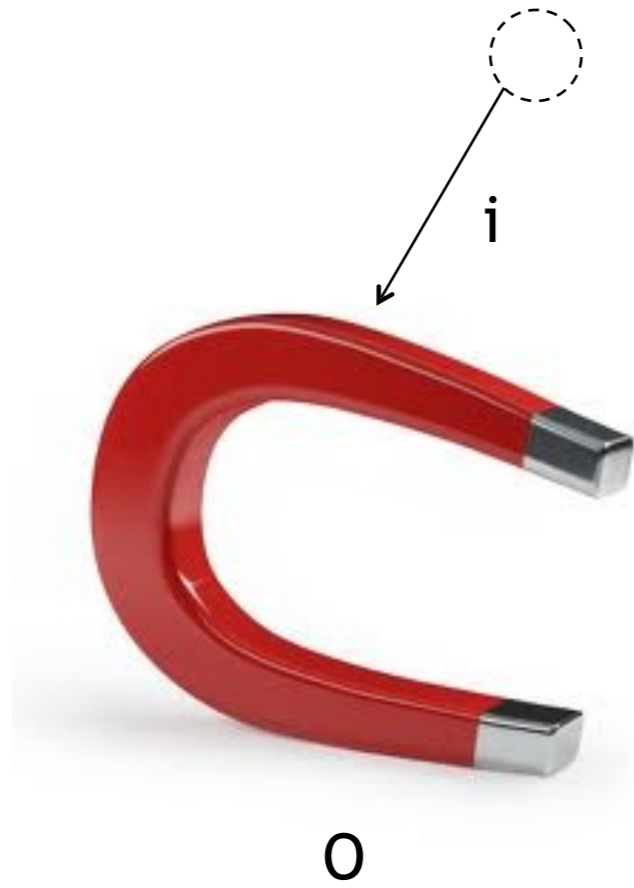
# Events (**UFO-B**)

- Events are **changes** in *states of affairs* in the world by mapping pre-situations to post-situations
- Events have a **mereological structure** (extensional mereology)
- Events unfold in time and, hence, bear **temporal relations** to each other (*Allen Relations*)

# Events (**UFO-B**)

- Events are existentially dependent entities; they are manifestations of intrinsic aspects of endurants. In particular, they are manifestations of **dispositions**

O's disposition to  
attract mettalic material





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# Events (**UFO-B**)

- Events are existentially dependent entities; they are manifestations of intrinsic aspects of endurants. In particular, they are manifestations of **dispositions**
- This has a strong connection to the **roles** endurants play while participating in these events
- It also has a strong connection with **causation**

# Events (**UFO-B**)

- Events can be the bearer of qualities and, hence, event types can form taxonomic structures
- However, they **cannot** qualitatively **change**, i.e., **all their qualities are immutable**, i.e., they cannot be different from what they are (i.e., they locked into a particular history)



# UFO-B

- We have successfully employed UFO-B to analyze, to provide real-world semantics, to propose changes and to semantically interoperate to several standards and reference models in Enterprise Modeling (e.g., **Archimate, RM-ODP, BPMN, UML Activity Diagrams**, etc...) and **Discrete Event Simulation** Frameworks dealing with notions such as **Services, Organizational Structures, Social Roles, Capabilities, Communities, Processes**, etc.

**Relating the two views...**

1

**Events** are first-class citizens in  
**Process Models**

2

**Endurants** are first-class citizens in  
**(Structural) Conceptual Models**

1

**Process Modeling** became interested in **Endurants** (e.g., Data-Centric BPM)

2

Traditional **Conceptual Modeling** became interested in the modeling of **Events** (Event Reification)



# Modeling **Events as Entities** in Object-Oriented Conceptual Modeling Languages (DKE, Olivé & Raventós, 2005)

*“Event entities are instance of **event types**. An event type is a concept whose instances, at a given time, are **identifiable** events that occur at that time. Like any other entity, event entities may **participate in relationships**... [they] may be **specialized** and/or generalized. This will allow us to build a **taxonomy of event types**, where common elements are defined only once.”*

# The Ontological Treatment of the "Event"

## **Construct:** Implications for System Analysis and Design

(Allen & March, 2000)

“Two divergent ontological definitions of event have emerged in the philosophy literature resulting in two divergent information system conceptualizations. One asserts that an **event is a substantive ontological category having identity (existence) and properties** (Davidson 1980). The other asserts that an **event is the change in state of a thing and has neither identity nor properties** (Bunge 1977)”

# The Effects of State-Based and **Event-Based Data Representation** on User Performance in Query Formulation Tasks

(MISQ, Allen & March, 2006)

- **Artifact-based** approach was significantly better in terms of time required for understanding the semantics and in query formulation.
- Improvement curve was faster for the **Event-based approach**
- The Event-Based approach was better in terms of better supporting **casual users** in accurately recognizing when queries were correct

# Relating the two viewpoints...

- Anti-Rigid Types and their associated generalization sets are connection points between the structural and behavioral viewpoints. It is for these structures that we have to associate lifecycle models (state-machines)
- Existential Dependence Relations in the structural model imply lifecycle dependencies in the behavioral model. This is particularly interesting in the presence of parthood structures
- The events that appear in these state-machines are the manifestation of dispositions (functions) that appear in the structural models

# Semantic Shift

- Typically a Structural Conceptual Model is such that the instances of types are OIDs (Object IDs) that behave like individual concepts, proper names, or haecceities
- These OIDs point to different states (snapshot entities) in different worlds
- So, the standard semantics of these models assume a presentist view for OIDs and a stage view for their states
- Introducing events in these models shifts the semantics of the models to view that assumes a growing block view w.r.t. to OIDs

**UFO-AB**

# UFO-AB

- In order to deal with models that represent both endurants and perdurants, these ontologies should be brought together forming an integral whole
- In order to do that, we here propose an interpretation of the modalities in UFO-A in terms of the **temporal structure** of UFO-B
- We must be able to differentiate these two types of contingency, i.e., differentiate between temporal permanence and rigidity
  - (a) within a history (e.g., being a student)
  - (b) across histories (e.g., being Brazilian born)
- In order to do that (i.e., dealing with counterfactuals, in general), we have to use a branching time version of the theory of events that we term **UFO-B\***

# Time

- We define a **precedence** relation that is a partial order over time points
- Worlds are taken as time points and precedence is accessibility
- A **history** is a maximal path of time points w.r.t. the accessibility relation
- **Causal chains do not bifurcate**, i.e., they belong to a single history



# Branching

- A branching after a time point must be justified: **there must be a genuine difference** between the set of things that are presentAt  $t-1$  and the ones presentAt  $t-2$ 
  - *a situations that **obtains** in one but not in the other;*
  - *an event that **begins in** one but not in other;*
  - *and events that **ends in** but not in other*

# Situations

- Situations must obtain in a time point
- Situations do not re-obtain over a history
- We take here that reality at a time  $t$  is partitioned into atomic situations

# Situations

- An Event **bringsAbout** exactly one Situation, which holds in **all end points** of the Event
- An Event is **triggered by** exactly one Situation, which holds in **all beginPoints** of the Event
- Except for time points with no preceding ones, if a situation obtains in  $t$  it has been brought about by an event whose end point is  $t$

# Endurants

- We assume a distinction between existence and presence in a world (possibilism + a **presentAt** predicate)
- Endurants must be present at (at least) one time point
- Hence, modal distinctions among types in UFO-A can be interpreted in these terms:

$$\mathit{AntiRigid}(p) \triangleq x::p \rightarrow \diamond(\neg(x::p))$$

$$\mathit{Rigid}(p) \triangleq x::p \rightarrow \square(\mathit{presentAt}(x) \rightarrow x::p)$$

# Event

- In addition to the **extensional mereology** we had in the original theory, we here add that:
  - A part of an event must occur in all histories in which the whole occurs
  - The ordering of event parts must be the same in all histories

# Event

- Like Lombard, we share the view that events can have inter-world identity, i.e., an event can occur in more than one history
- Lombard, however, does that by considering that events have essential and accidental parts. We, on the other hand, consider that events have no (alethic) modal properties, i.e., **an event could not have been different from what it was**
- However, events can have “temporal branchings” occurring over incomparable time points, provided that the reason for branching is external to the event, i.e., **the event happens in the exact same way in different histories**

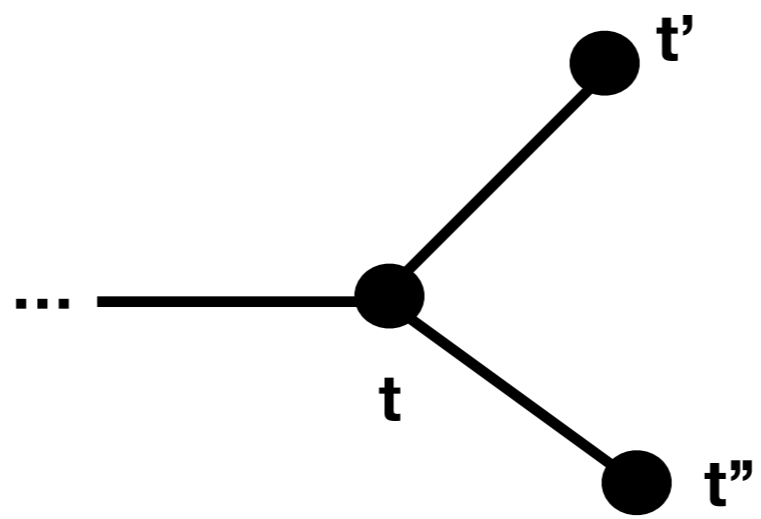
# Event

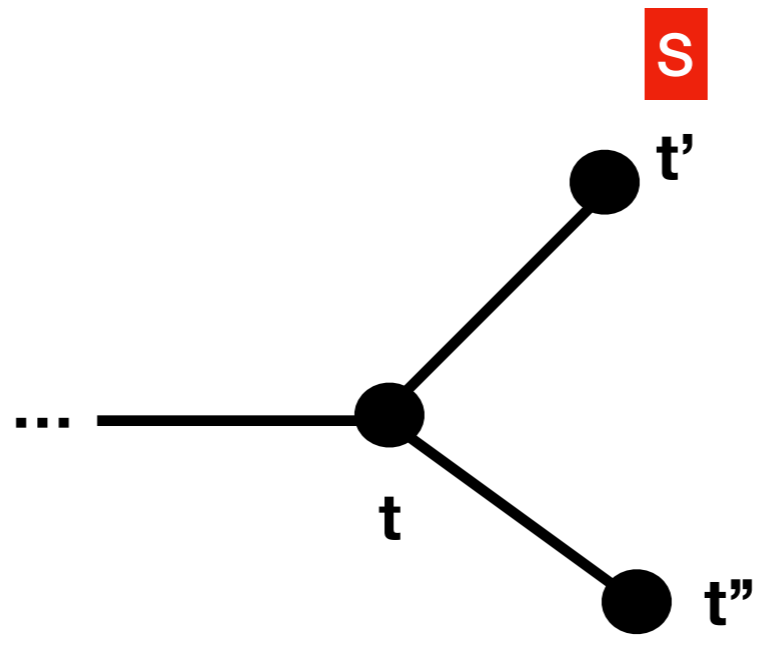
- As a consequence, events can have more than one begin point and more than one end point
- For Lombard, events cannot recur. We take a stronger position here that events have one single begin point (in a history), i.e., they are not intermittent
- Events must end in the histories they begin and they must begin in the histories that they end
- Agreeing with Lombard, if an event occurs over two histories, these occurrences have the same length (but we reject **essentialism**)

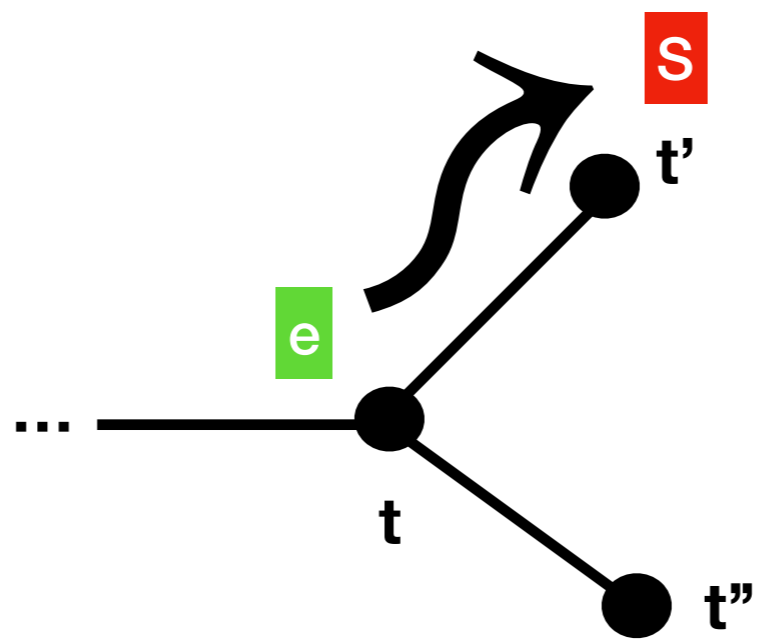
# Time again

- From the following constraints:
  - Branching must be justified
  - Situations that are brought about by events obtain in all end points of that event
  - All manifestations of events in different histories have the same length
  - Events bring about exactly one situation
- It follows that **Time is a set of independent lines**









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