Ontological Analyses of Roles

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Abstract—**This paper discusses roles from ontological point of views. We first propose a most general type including roles and role-like entities in a new way. Then, we discuss ongoing property of roles to in-depth understand temporal aspects of roles. We identify two kinds of roles: original roles and derived roles. Our new findings in this research include all original roles are ongoing and all the derived occurrent-dependent roles are either retrospective or prospective. Finally, we propose a temporal model of derived roles.**

I. INTRODUCTION

Real world entities are heavily mutually dependent, makes ontology building harder. There are many kinds of dependency such as intrinsic dependence of the whole on its parts, existential dependence of quality on the objects, constitutional dependence of physical objects on its babies' dependence on their mother, water's dependence on its glass, etc. Some are philosophical but some are practical. So, how to deal with "dependency" is one of the key technologies in ontology building. Among them roles such customer, president, pedestrians, etc. are dependent on other entities. A company can be a customer of another company while being a supplier to others. Proper treatment of roles is crucial to building a good ontology. This is why the topic of roles has been investigated extensively to date[1]-[7].

Although there exist multiple theories of roles, there is no standard theory yet. In fact, when we try to deal with existing role candidates, we easily have a difficulty by encountering borderline examples. For example, *speaker* and *listener* are roles which make sense to each other, then how about *runner*? "Run" is an intransitive verb, so it has nothing to do with others. So, if we take a theory that defines roles as something meaningful to others, *runner* would not be a role. But, if we take another that accepts *actor* role, then all the three would be roles. Then, we have a problem. How about a *breather*? It is also a special type of *actor* role. For *speaker, listener* and *runner*, while he/she needs not to be so and he/she can start and stop doing, he/she must be a breather throughout his/her life. Being a breather is essential to being an animal which contradicts being a role in some theories.

(Biological) Mother[1] seems to be a role but no woman can stop being a mother once she has started to play it, so it partially violates the dynamicity condition of roles in a theory[7]. However, we still want to consider *mother* is a role. How can we do it? While *patient* is a role, *the sick* is not. Why? A theory says *patient* is externally founded but *the sick* is not. It is true, but except that characteristic both are very similar to each other. Essentially, both are emerging entities played by a person depending on a situation. How can we deal with *the sick* as a role-like entity? Is *murderer* a role? Some answer no. A reason would be because one cannot stop being a murderer once he/she has started to play it. Another would be "it is odd to say "he plays a murderer" if not in a drama". Although these reasons are reasonable to some extent, we need a convincing explanation of what *murderer* is ontologically.

In this paper, after summarizing our role theory [3], we investigate ontological issues underlying those cases concerning roles. Note that our goal here is not to identify a unique definition of roles which everyone agrees on but to provide kinds of role-like dependent entities with clearly distinguished characteristics, which one can select a kind(s) of them for his/hers own use of the notion of role. In spite of this strategy, we do not avoid defining a key concept on which we base our theory. In fact, we define a most general type of all role-like entities in an innovative way. All the existing theories including ours try to define role concept first, and then explain what role holder (or qua-entity) is in terms of role concept and player. We suspect the way would have a difficulty in uncovering what is a role. On the contrary, we first define role holder to explicitly capture its essential characteristic as being *a new entity which emerges context-dependently* which is common to all the existing role and role-like entities.

We next propose a new view of roles to distinguish **derived roles** from **original roles**. Murderer role seems to be a kind of retrospective role in the sense that it is defined in the past event. As we see it below, however, we consider it a derived role derived from the original role of *murderer* by which we mean a person who has just completed a murdering event. On the basis of the new view of roles, we

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[1] The English terms like *mother, teacher, etc.* have two meanings such as "role concept" and "role holder". Readers should not be too sensitive to which meaning they mean in the explanation using examples. We carefully distinguish between the two when discussing technical definitions of them.

can claim all the original roles are ongoing including **continuous** and **instantaneous** roles as variants. We will discuss this view in detail with its taxonomic hierarchy.

We then ontologically analyze temporal issues of roles in the context of enumeration of kinds of roles. We have realized that although most of the roles like *walker* and *president* are *ongoing* and *continuous,* a few are *ongoing* but *instantaneous,* and that most of the derived roles are either retrospective or prospective. We discuss such a temporal issue of roles. Finally, we present concluding remarks together with future work.

II. OVERVIEW OF OUR ROLE THEORY

The fundamental scheme of our roles at the instance level is the following (see the lower diagram in Figure 1.):

"*In Osaka high school, John plays teacher role-1 and thereby becomes teacher-1*"

This can be generalized to the class level (see the upper diagram in Figure 1):

"*In schools, there are **persons** who play **teacher roles** and thereby become **teachers**.*"

By **play**, we mean that something "acts as", that is, it contingently acts as according to the role (role concept). By "**teacher**", we mean a class of dependent entities which roughly correspond to a person who is playing teacher role and which is often called a *qua individual* [2] or *relational tropes* [6]. Our theory introduces a couple of important concepts to enable finer distinctions among role-related concepts: *role concept*, *role holder*, *potential player* and *role-playing thing*.

By **context**, we mean a class of things that should be considered as a whole. Unitary entities and relations can be a context of its parts and participants, respectively. **Role concept** is defined as a concept which is played by some

Figure. 1. Fundamental scheme of a role concept and a role holder.

other entity within a context. So, it essentially depends on the context. By **potential player**, we mean a class of entities which are able to play an instance of a role concept. In many

cases, **potential players** are basic concepts (natural types). When an instance of potential player is playing an instance of a role concept, we call the instance a **role-playing thing**. In this example, we say a person can play an instance of a teacher role. In particular, John is actually playing a specific teacher role, *teacher role-1*. By doing so, he is associated with the instance *teacher-1*, an individual teacher **role holder.** A role-holder class is a class whose instances include, say, teacher-1. As such, it is neither a specialization of a potential player class (e.g., person) nor that of a role concept class (e.g., teacher role), but an abstraction of a composition of a role-playing thing and an instance of role concept, as is shown in Figure 1, which is the heart of our role model.

All the concepts introduced here are core of our role model and contain rich implications which are elaborated in [3]. The above shows that we divide the conventional notion of role into two kinds: role concept and role holder in our model. A role concept can exist at the instance level without being played, since its existence depends only on its context and not on its player. The decomposition explicates the significant difference between a role instantiation and role playing, that is, to claim a role holder (John as a teacher) is not an instance of role concept (teacher role). We now believe this separation is well-understood in the role community. So, in this paper, although the term "role concept" is important, we use "role" to denote" role concept" for notational simplicity.

III. WHAT IS A ROLE?

A. Separation between role-assignment and role playing

According to BFO, a role is a realizable entity. To interpret this idea we need to introduce two kinds of "play": play_1 and play_2. By the former, we mean a role is assigned to a player and the latter the assigned role is literally played by a player. In the most cases of the process-dependent roles such as *runner, singer, etc.* play_1 and play_2 happen at the same time. So, BFO does not consider them as roles. In the case of BFO's roles, while a role is being played_1, the player can appropriately **realize** the assigned role by playing_2 when necessary. Note that BFO calls "play_1" and "play_2" "has" and "play or realize", respectively. The key idea of BFO's role is that a role is a realizable and optional property of a player.

Definition of play_1 and play_2 are as follows:
play_1: =def *a role is assigned to a player. (He/she plays_1 it during the time when assignment is valid in which the assignment can be either explicit or implicit)*
play_2: =def *an assigned role is realized by a player. (Then we say he/she plays_2 the role)*
"**Play**" subsumes *play_1* and *play_2*.
Role holder is defined in terms of *"Play"*

Imagine a teacher role in a school. When John is hired by the school as a teacher, that is, he is assigned a teacher role, we say he plays_1 a teacher role even when he is sleeping in his home, and say he plays_2 the teacher role only when he
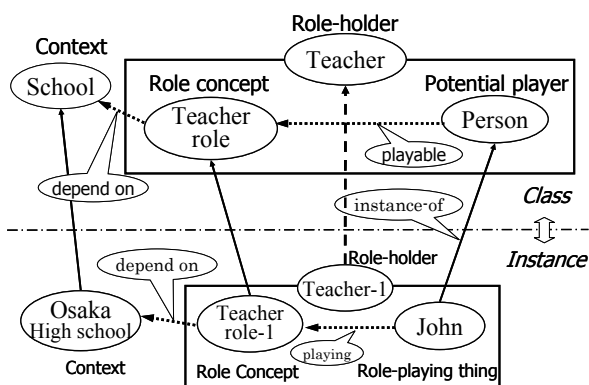
teaches students and/or does some jobs in the school as a teacher. While John runs, he plays_1 a runner role. When he temporarily stops running and drinks some water with intention of continuation of his running, he keeps playing_1 while drinking water. While he is playing_1 the runner role, he is playing_2 the runner role (he is physically running) except such intermissions.

B. Role and two subtypes of Role

We introduce a new type (of role) named **Role** which subsumes two kinds of roles: one is a conventional role which is equivalent to an English word "role" which is literally played in the sense of English, which we call **role-a,** and what we call **role-b** which includes "role-like" entities. By a *Role holder*, which will be defined later, we roughly mean an entity that comes into being context-dependently depending on another entity.

People believe that the following three conditions are key properties of roles:

⑴ **Anti-rigidity**
⑵ **Externally foundedness**
⑶ **Dynamicity**

If *role-a* nicely captured all role individuals existing in the real world, there would be no problem. However, once we try to deal with real world role individuals, we come across quite a few counter examples and/or exceptions. See Table 1 which shows evaluations of typical roles including problematic ones in terms of several factors.

In the examples of "role-like dependent entities" in this table, only the "teacher role" in a school, "invited speaker role" at a conference and "patient role" satisfy all those conditions above. The "invited speaker role" at a conference is different from the "speaker role" which is played when a person who are speaking to other person and thus "play_1" and "play_2"

happen at the same time. The "runner role" has the same characteristic as speaker role. In addition, "run" is intransitive, so, one might say it is not externally-founded. As discussed in Introduction, the "breather role" is neither anti-rigid nor dynamic. The (biological) mother is partially dynamic. The (biological) child is totally non dynamic (has dynamicity neither on staring to play the role nor on stopping), because just after a person has been born the person is always playing a "(biological) child role" until the end of life. These two roles refer to the past event (giving birth or birthing) as we will discuss the temporal characteristics in section V in detail. The "murderer role" also seems to refer to the past killing event because its common meaning is "a person who had killed a person". These examples will be discussed in detail later.

Considering all of the examples seem to share something significant to be a role, the above discussion suggests us we would need a loser/weaker definition of roles to obtain a more usable definition which can cover more role candidates without losing the essential characteristics of roles. Note, however, that we are not proposing "the" definition of roles. As stated in the introduction, one of our goals is to present a most general type which subsumes hopefully all existing types of roles including role-like entities to position them in a common framework. Now, contrary to the traditional way of role definition, we define *Role holder* first and then define *Role by* referring to *Role holder*:

Def. 1 Role holder =def an (emerging) entity that exists context-dependently with the help of another (base) entity which shares the same spatiotemporal region with it. In addition, the identity of the emerging entity depends mainly on the base entity and on the newly acquired properties as well.

TABLE I.
SOME EXAMPLES OF ROLE AND ROLE-LIKE ENTITY

Roles and role-like entities	Context	Anti-rigid (non-essential)	Externally founded	Dynamic		Explicit assignment	Temporal
				Start to play role	Stop to play role		
Teacher	School	Yes	Yes	Yes	Yes	Yes	Ongoing
Speaker	Dialog process	Yes	Yes (transitive)	Yes	Yes	No	Ongoing
Invited speaker	Conference (event)	Yes	Yes	Yes	Yes	Yes	Ongoing
Patient	Medical care process	Yes	Yes (passive. transitive)	Yes	Yes	Yes	Ongoing
Runner	Running process	Yes	No? (intransitive)	Yes	Yes	No	Ongoing
Breather	Breathing process	No	Yes (intransitive)	No	No	No	Ongoing
(Biological) mother	Birth giving event	Yes	Yes (transitive)	Yes	No	No	Past
(Biological) Child	Birth event	No	Yes (passive. transitive)	No	No	No	Past
Murderer	Killing event	Yes	Yes (transitive)	Yes	No	No	Past
The sick	Health condition	Yes	No	Yes	Yes	No	Ongoing

Context includes any objects, occurrents and relations
   with which base entities are associated.

By context-dependence, we mean *that any emerging entity
specifically depends on its context, that is, the emerging
entity can exist (1) only while the individual context is
present or (2) only if the corresponding event as its context
exists before or after the playing time.*

By **emerge**, *we mean an entity comes into being.*

Def. 2 Role =def *a dependent entity which provides a base
   entity with some properties defined in a context to let a
   Role holder to emerge context-dependently. We say a
   basic entity Plays a Role, and thereby becomes a Role
   holder.*

Although *Role holder* does not guarantee any of the above
three conditions, majority of the *Role holders* satisfy all of
them.

(a) Because of the context-dependency, the main
properties of the emerging entity cannot be essential
to the base entity, so ***anti-rigidity*** should hold.

(b) Similarly, because any context usually exists outside
of the emerging entity, it is **externally-founded** in
most cases.

(c) Context-dependency usually implies optional
and suggests whether the emerging entity is in
or out of the context can change from time to
time, so it is usually **dynamic**.

We know, of course, the above claims are very informal.
We have no intention to make them official claims. Rather,
we try to support that the notion of *Role* is not far from the
conventional notion of role discussed in the literature.

We define ***role-a holder*** and ***role-a*** as follows:

Def. 3 role-a holder =def *a specialization of Role holder
   where an explicit role-assignment is done and the
   assigned role is optional to its player. Neither the
   starting time nor the ending time of the duration of
   player's being context-dependent should necessarily
   coincide with those of the life time of the player
   individual, respectively. (Runner in a competition is a
   role-a holder thanks to its temporary and explicit role
   assignment)*

Def. 4 role-a =def *a specialization of Role which provides a
   base entity with some properties defined in a context to
   let a role-a holder to emerge context-dependently. We say
   a basic entity plays_1 a role-a, and thereby becomes a
   role-a holder.*

"role-a holder" satisfies the above three conditions for roles:

(a) If it is not anti-rigid, then some *role-a* individuals do
not need an explicit role-assignment for its existence,
which violates the definition, so it is anti-rigid.

(b) The condition of an explicit role-assignment excludes
context-dependency on internal affairs of the player
because internal dependency cannot be assigned by others
explicitly, so it is externally founded.

(c) The playing time is a proper part of the player's life
time, so it is dynamic.

We define *role-b* as:

  role-b   =def a specialization of *Role* excluding *role-a*
with *additional property of implicit role assignment.* This
addition is valid because *Role* is independent of the way of
role-assignment.

*C. How are role-a holder and role-b holder different from
each other?*

   Some say, *role-a holder*, such as *teacher* is a teacher even
when he is sleeping (not teaching) but *role-b holder*, say,
runner is not a runner when he is not running. This
difference comes from the fact that a teacher is explicitly
assigned to the player, and hence he/she has the role, but a
runner role is not and is truly contingent so that it cannot
have the role. Although such a claim seems right at first
glance, it is not the case. It is right that a runner role is not
explicitly assigned to the player. Note, however, the
following facts: A runner can stop running (playing_2) while
he is running (playing_1) and drink some water. He is a
runner while drinking (playing_1 as far as he still intends to
run). Another example is a driver who is driving his own car.
While he rushes into the toilet after parking his car
somewhere, he is still a driver. A police would detect his car
being illegally parked and ask you "where is the driver of
this car?", then you would answer "the driver is in the toilet".
This is explained by the fact that happens actions are
understood in terms of BDI (Belief, Desire and Intention)
model. That is, an action continues while actor's intention is
still there, and hence termination of an action must be
understood by considering not only observable motion but
also actor's intention. So, within the continuation of the
action the role is being played_1 including the duration
when it is not being played_2.

   We thus believe there is no ontologically significant result
is derived from the difference between *role-a holder* and
role-b holder with respect to the way of role-assignment.
Assignment of *role-a* is explicit and that of *role-b* is implicit.
This is the reason why the expression of "He is playing a
driver role" sounds odd when he is driving his own car.
However, it is not an issue in the context where we are
discussing *Role.* Note, once again, that we have to be careful
for not relying on linguistic expression too much in
investigating what roles are. The fact that either one exist as
an emerging entity context-dependently is the more
important property than the issue of explicitness of role
assignment.

D. Implications of Role holder include

(0) The base entity already exists mostly before the
emerging one comes into being or it comes into being
simultaneously with the emerging entity.

(1) The base entity continues to exist after the emerging one
has come into being in all cases but *victim Role* who dies
by being killed so that he/she cannot play the *Role.*

(2) The base entity continues to exist after the emerging one
has terminated its existence in all cases but a few cases
such as *breather Role.*

(3) Entities constituted of another entity such as a vase constituted of an amount of clay are not *Role holders*, since the identity of such a constituted entity does not come from the constituting entity, e.g., the identity of a vase does not come from the amount of clay.

(4) Artifacts are not *Role holders* because identity of an artifact comes not from its parts but from its properties newly acquired by the design/manufacturing when it has come into being.

(5) The meaning of "playing a role" should be defined in the case of *Role* independently of English word meaning and it should be "a base entity *Plays* a *Role* in a context" and thereby becomes an emerging entity (a *Role holder)*.

(6) *"role-a holder"* is defined as a specialization of *Role holder* by adding an explicit assignment to the base entity when it starts to *play_1* the *Role* and an additional constraint which imposes the duration in which the individual role holder exist is a proper part of the duration of the whole life of the basic entity. E.g., a school teacher comes into being when the assignment contract with John has been made. Since then, John starts to *play_1* the teacher *role-a* and he continues to be a teacher even when he is sleeping. The context of the teacher *role-a* is not the contract but the school. The contract works only for validating the playing_1 status of John. Dissolution of the contract happens when John has been fired or when John has quit the job, which only means to stop to play_1 the role and the teacher *role-a* continues to exist without being played_1 by any person in the school. The school is the context in which the teacher *role-a* is defined. The teacher *role-a*, and hence the teacher entity specifically depends on the school.

(7) *"role-b holder"* can be defined by specializing *Role holder* by adding an implicit assignment to a base entity when it starts to *Play* a *Role*. When John starts to run, he starts to *Play* (to play_1 and play_2 simultaneously) a runner *role-b* and then a runner comes into being as an emerging entity.

(8) When *Role holders* start/terminate its existence is not an issue as far as they do so within the duration where their associated contexts exist, since the context-dependency only imposes specific (existential) dependence on the contexts on them. That is, the duration could coincide with that of the player.

In the rest of this paper, we use the term "role" to denote *"Role"*. The latter will be used only when we need to distinguish the two.

IV. ORIGINAL AND DERIVED *ROLES*

A. Classification of Role

The issue here is the fact that there are many kinds of roles other than what we usually see in the literature on roles such as *teacher, president, wife, patient, etc*. According to the types of the context on which roles are dependent, we can identify two kinds of roles such as those dependent on continuant and those on occurrent. Many of the popular roles including those mentioned above belong to the former. On the other hand, there are quite a few roles depending on

processes or events. They include actor roles such as *driver* and *runner,* task roles such as *symptoms* and *fault hypothesis* played by states in the context of diagnostic tasks, functional roles such as *level-control valve* and *steering wheel of a bike*, artifact role such as *table role* which a box plays, etc. All these roles mentioned thus far are **ongoing**, by which we mean the context the role depends on is present when the role is being played. Surprisingly, at first glance, there seem to be quite a few roles whose contexts are not present when they are played. Typical examples include *murderer, culprit, witness[2], victim, product, residue, etc*. However, as we see it below, those roles are not **original roles** but **derived roles** derived from the corresponding original roles. We have to be very careful not to be caught by language expression-based justification/understanding of roles. Roles should be understood as the original definition defined directly in the context. Original and derived role holders are defined as follows:

Def. 5 Original role holder =def *role holder defined as a participant of its depending occurrent or relation as its context or role holder defined as a part of an object as its context.*

Def. 6 Derived role holder =def *non-original role holder derived from an original role holder.*

A typical example is *murderer* which means "a person who had killed a person" in English and it seems to be a role holder with a historical property. Considering the role model discussed in section II, however, we can find an original *murderer* role holder which means "a person who has just completed a killing action". Then, we can consider "a person who had killed a person" as a derived role holder derived from the original role holder.

Linguistically, *examinee* means a person/student who works/studies hard to pass an (entrance) exam, so it seems to be a prospective role holder. However, it should be a derived role holder because it has no direct context of the taking exam as a process. Its original role holder should be "a person/student who is taking an (entrance) exam" defined in the context of an exam-taking process. The former role holder which has a prospective property should be understood as a derived one from the original one

Another example suggesting a danger of relying on linguistic justification would be *(biological) child* in which people would ignore the difference between the instantaneous event of being born and its persisting existence after it. It would sound odd that the player (John) is born simultaneously the new entity as a *(biological) child* (role holder) of his parents is born. Concerning the above difference, however, *(biological) child* and *murderer* share the same characteristic, and hence *(biological) child* should be understood as a role holder defined at the very time of having been born. Both *Child* and *murderer* carry the property after their appearance events.

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[2] This is not a person who testifies what his/her saw in the court but a person who saw the event.

We know the above explanation is rather informal. Leaving in-depth discussion on this topic later in subsection *B*, let us here summarize the above observation as follows: All original roles are ongoing. Roles which seem to be retrospective and/or prospective roles are derived roles derived from original roles. These are represented in the taxonomy of roles shown below in which clear distinction between original and derived roles is made at the top-level. This topic will be discussed in subsection *B* in detail.

> *Role*
> > **Original role (ongoing)**
> > > non-participatory role (continuous)
> > > > *wife, patient, teacher, Hamlet, friend, etc.*
> > > occurrent-dependent role
> > > > process-dependent role (continuous)
> > > > > dynamic
> > > > > > *speaker/listener, runner, breather, symptom, level-control vale, table role, witness, examinee*
> > > > > static
> > > > > > *baby/infant/adult, the sick*
> > > > event-dependent role (instantaneous)
> > > > > *murderer, victim, residue, conclusion, mother, (biological) child, departing passenger*
> > **Derived role (non-ongoing)**
> > > retrospective
> > > > *murderer as a person who had killed a person*
> > > prospective
> > > > *examinee as a person who studies hard to pass an exam*

B. Ongoing and non-ongoing roles

Although it is implicitly mentioned in the definition of *Role*, we define for roles being ongoing as follows:

Def. 7 Being ongoing $=_{def}$ *when a role is being played, its context is present.*
The condition "when a role is being played" is equivalent to "when a role holder is present". Therefore, the first condition ("when" clause) of this definition can be replaced with: *"when a role holder is present"*

In our role theory, objects and occurrents can serve as a context to its parts and participants to be defined as a role holder, respectively. Following the policy of role definition of this paper, we discuss ongoing property of role holders. Role holders defined in the context of an object is defined as its parts. Parts can exist only when the whole exist. Therefore, when such a role holder exists, its whole exists. This is why all object-dependent roles are ongoing.

Occurrent-dependent roles are classified into process-dependent and event-dependent roles because of the intrinsic difference between processes and events [8]. *Walker* and *singer* role holders are defined as a participant of walking and singing processes, and seem ongoing. Then, what about an event-dependent role? *Murderer* seems non-ongoing. In the case of a murderer who had performed a killing action, the killing event is not alive anymore when he/she plays the murderer role, which suggests we need to divide *murderer* role into original role and derived role. We discuss this topic in detail below.

C. Process-dependent roles are ongoing

As we have discussed it in [8], any process is progressive (ongoing) and any event is not. Events must be dealt with as a temporal whole in any case. The intrinsic difference between processes and events contributes to the ongoing property of occurrent-dependent roles. Let us here examine process-dependent roles. Typical example of this kind is *actor role holder* of such processes which includes *singer of a simple singing process, walker of a simple walking process, etc.* Those role holders are defined as participants of the related processes. The singing process exists when a singer is singing, since he/she is participating in the singing process and the same applies to *walker*. This claim is enhanced by the ongoing property of processes. Therefore, when an individual role holder defined in the context of a process exists, the process is also present and hence such a role is ongoing.

We here discuss *problematic* roles such as *invited speaker, conference chair, (conference) participant*. At first glance, they seem to be event-dependent roles and their context is a conference as an event as shown in Figure 1. However, the player has been explicitly assigned to it long before the conference time and it is valid until the end of the conference. So, like teacher role, it has a clear separation of play_1 and play_2 which corresponds to delivering process of the invited talk. Any *invited speaker* cannot be ongoing before the conference, since the definition of being ongoing requires existence of the context, the conference in this case. We could think of a possibility of these roles of being special kinds of event-dependent roles which are ongoing. But, we have no idea about how to cope with such an explicit assignment and event-dependency?

Although a conference (an event) and a school (an object) are very different ontologically, they can be a context for defining roles in a very similar manner. It suggests necessity of an innovative view to interpret conference as an object-like context to define such roles. This is why we said *invited speaker, program chair, etc.* are problematic roles.

In fact, we can turn "a conference" to an object in the context of role definition. The key idea comes from "explicit role-assignment". Any explicit role-assignment does need the existence of an agent who does it, otherwise the assignment cannot be explicit. In fact, those roles are officially assigned by the organizing committee. Once we notice the existence of the organizing committee with respect to a conference, we realize the fact that those are roles defined in the context of a conference organizing committee as a social object which corresponds to a school which is a social object supposed to perform educational processes. A conference organizing committee is an object which is expected to organize all the necessary activities to run a conference as well as roles to perform them just like a school is. Therefore, in the exactly same way as that teacher roles are defined in the context of a school, these roles such

as *invited speaker, program chair* and *participant* are defined in the context of a conference organizing committee. In summary, on the contrary to initial expectation, those conference-related roles are continuant-dependent roles.

D. Event-dependent role

Contrary to a process, an event has a property of completion and must be dealt with as a whole in any case. A killing event becomes a complete event only when it has been completed. Before completion, it is not a killing event. A *murderer,* a person who had killed a person, cannot have a killing process as its context because it is not yet completed. Only killing event can be the context of *murderer* because of its completion property. Note, however, that the above discussion is based on the conventional meaning of *murderer* and that we need to define original role holder first rather than derived role holder. Considering the model of roles described in section II, the ontological meaning of *murderer* as a role holder should be "a person who has just completed a killing action". At the very moment of the completion, the person can play the *murderer* role and becomes a *murderer.* We believe this is the original role holder of *murderer* and "a person who had killed a person" should be explained as a derived role holder which is discussed in detail in section V.

The above observation implicitly relies on the nature of the action of *murder* which is of the achievement type. A murdering event is an event made of an action of achievement type. There are other kinds of events made of other type of actions like *walk, sing, etc.* John's walking event in a morning which is constituted of walking process cannot define or generate a meaningful role holder like "walking event completer" because it is essentially a walking process. Detailed discussion on this topic is discussed in section V. Thus, a salient feature of completion roles is that its role holder instance is created at the very end of the event and the player can play it only at the very time of completion.

E. Original roles are ongoing

On the basis of the above discussion, we can claim that all the original roles are ongoing, though it includes two sub-kinds: one is continuous and the other is instantaneous. By a continuous role, we mean a role which is played within a non-zero interval and it includes most of the roles. By an instantaneous role, we mean a role which is played at an instant time at the end or start of an event such as *murderer* or *departing passenger roles,* which is consistent with the case of (1) in Def. 1. All the derived roles are either prospective or retrospective. How those derived roles are related to the original roles and how we can deal with them systematically are the main topic in the next section.

V. ONTOLOGICAL ANALYSIS OF A TEMPORAL ASPECT OF DERIVED ROLES

We built an ontological model of the temporal aspect of derived role holders as shown in Figure 2 to examine them in detail. In terms of the temporal model of derived role holders, it seems we can introduce a two-class classification into role holders, in which we call **prospective derived role holder** such as *examinee* as a person who studies hard to pass an exam and *departing passenger* and **retrospective derived role holder** such as *murderer* as a person who had killed a person, *victim* and *(biological) mother*. As will be discussed below, when we consider role holders derived from an occurrent-dependent role holder, any original role holder has three variants associated with it. In the following, in order to represent them systematically, we introduce three names: *derived role holder1* to *derived role holder3* as follows:

Derived role holders

Derived role holder1: Retrospective or prospective reference to the player of a event-dependent role holder

Derived role holder2: Retrospective or prospective reference to the player of an process-dependent role holder

Derived role holder3: Aggregation of derived role holders from an occurrent-dependent role holder

Although all the three kinds of role holders are possible in theory for each original role, how much they make sense depends on the nature of the original process/action constituting a context on which the original role holder depends. We discusses characteristics of their historical properties are discussed in [9] while this paper summarizes them.

A. Retrospective derived role holder

By retrospective derived role holders, we mean role holders which are derived from an original role holder defined dependently on past processes/events. By past, we mean before the playing time. For example, a *murderer1* as a person who had killed a person is derived from an original role holder, *murderer,* dependent on a past killing event in which its player participated. To consider how retrospective derived role holders are dependent on past processes/events, we define the above three kinds of derived role holders for each original occurrent-dependent role holder. For simplicity, we take up the case of actor role. In the case of *murderer, murderer1* is used for referring to the *murderer* after the murder event. We call it "**content-oriented reference**". For example, when people say "He is a murderer", they do not mean *murderer*, which is realized at only the very end of the murder event, but a person who had committed a murder event. *Murderer1* is a "name" to specify the referent in a content-oriented way. When we refer to an entity through *derived role holder1*, it is not necessary that a player of the referent role is present in reality at the time of reference, since the reference to the player of *the original role holder* which the *derived role holder1* specifies is always successful independently of the existence of the player who must have existed when the *original role* was played. Even in the case of *victim* who is not present any more because he/she was killed by a murderer, he/she had been present at the time the killing event.

We find another kind of *murderer* role which is expected to be played by the player of *murderer*. In order to represent this kind of role, we introduce *derived role holder3*. *Murderer3* is defined as an aggregation of "*being chased by police*"-role or "*being punished by justice*"-role, etc. Those
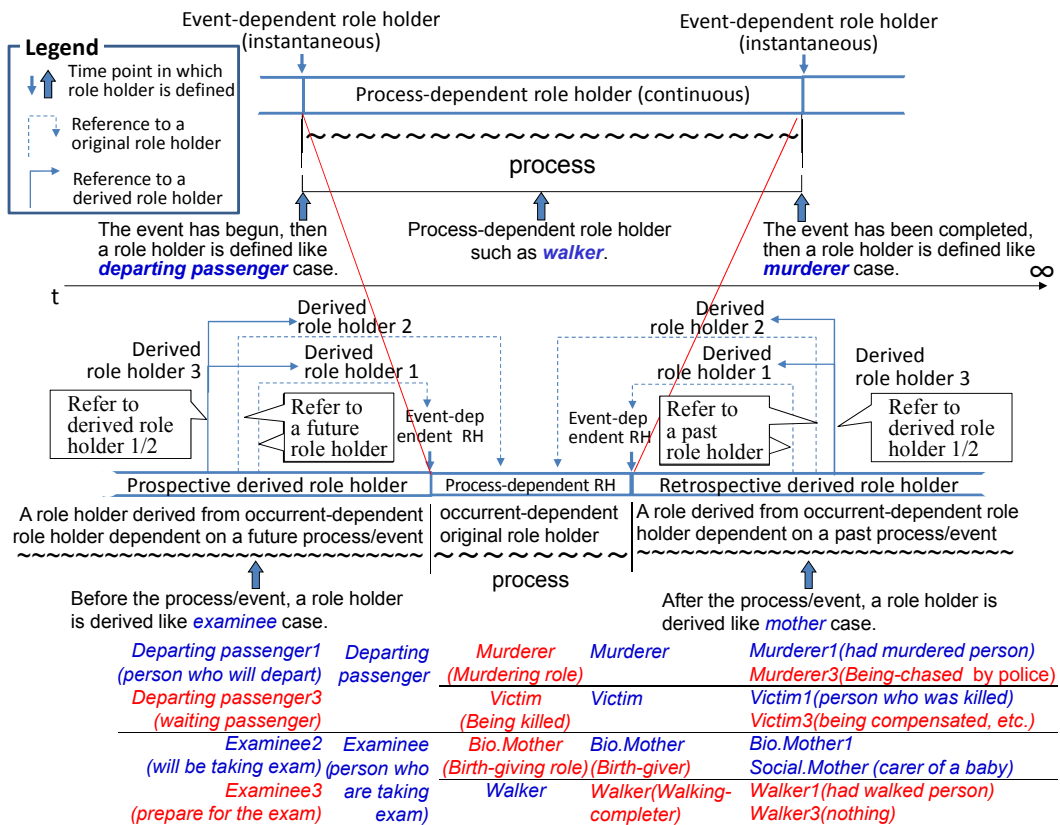
Figure 2. An ontological model of occurrent-dependent roles

roles are derived from the *murderer* and are expected to be played by the person who plays *murderer role*. Therefore, these roles are not only "*being chased by police"-role* or "*being punished by justice"-role* but also "*being chased as a murderer by police"-role* or "*being punished as a murderer by justice"-role*. *Murderer2* which means a person who was murdering does not make sense because "murder" is essentially an accomplishment action. In general, *derived role holder2* is minor in the retrospective case, since such a role holder is realized by using the original *role holder* in the past tense.

B. Prospective derived role holder

Basically, there is the symmetry between retrospective and prospective derived roles. A unique feature of prospective case is that *derived role holder2* is not minor. Examples include *examinee2* and *candidate2*. They just represent what people mean by corresponding words. *Examinee3* is an aggregate of hard worker role, etc. Although space limitation does not allow us to discuss this topic in more detail, the model shown in Figure 2 should be informative so that readers can capture the underlying structure of derived roles.

VI. CONCLUDING REMARKS

In this paper, we proposed a new definition of *Role* holder as a context-dependently emerging entity rather than roles to cover role-like entities as well as conventional roles. Then we introduced a distinction between original and derived roles. We also defined *role-a* which covers only

"less-controversial" roles in English sense. Introduction of play_1 and play_2 clarified the difference between "genuine" roles and role-like entities. Although a few significant problems of roles have been solved, the authors are aware of the fact that there remain a lot of interesting topics. Examples include what we precisely mean by "explicit role assignment", how to deal with derived roles derived from non-participatory roles like *x-wife*, what is a vacant role, etc. All are in the list of our future work.

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