The Ontology of Roles in GOL

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Contents

- Introduction to Onto-Med and GOL
- Context-centered Approach to Roles
- Social Roles in Detail
- "Social Roles and their Descriptions"
- Open Problems



Research Group Ontologies in Medicine

- establishment
 - November 2002 at the University of Leipzig
- objectives
 - basic research in formal ontology (GFO)
 - formal tools for building ontologies (GOL)
 - domain specific ontologies (e.g. clinical trials)
 - software applications
- contact
 - Barbara Heller, Heinrich Herre, Markus Löffler
 - http://www.onto-med.de



Cooperation Partners

- computer science
 - Univ. of Erlangen (Theoretical Informatics)
 - Univ. of Caen (GREYC)
 - Univ. of Twente (CTIT)
 - Univ. of Cottbus
- medical informatics
 - Univ. of Giessen (Inst. for Med. Informatics)
 - Univ. of Heidelberg (Inst. for Med. Informatics)
- medicine
 - Competence Network Malignant Lymphoma
- philosophy
 - Mitteleuropa-Foundation, Bolzano



Research of Onto-Med

- formal ontology and axiomatization
- language design and methodology
- ontologies in medical domains



Overview: Theories

- General Formal Ontology (GFO)
 - system of top-level ontologies
 - axiomatization of basic ontological categories, use of the axiomatic method
 - lattice approach
 - metalogical analysis (e.g. consistency)
 - theoretical foundation of the General Ontological Language (GOL)



Overview: Theories

- meta-ontological framework
 - comparison of leading top-level ontologies
 - general framework for their assessment
- new semantics for modeling languages
 - substitute for standard model theoretic semantics
 - similarities to situation semantics
 - described by GFO-provided terms



Overview: Concepts

- General Ontological Language (GOL)
 - specification language for domain ontologies
 - based on the GFO
 - formal syntax and semantics
 - restricted version for inference support
- methodologies and principles for building ontologies
- application area: construction of a medical domain ontology in the field of oncology

– evaluation and enhancement of GOL



Overview: Concepts

- ontological foundations of conceptual modeling
 - formal semantics for conceptual modeling languages by reduction to GOL
 - evaluation and refinement of conceptual modeling languages
 - focus: foundation and extensions of UML e.g.,
 - foundation of different relations (association, part-of, kind-of, ...)
 - typology of classes
 - treatment of processes



Overview: Applications

- software applications in the medical domain:
 - Onco-Workstation

therapy planning tool

– SOP-Creator

management tool for standard operating procedures (SOPs)

– Onto-Builder

tool for developing domain specific ontologies (\rightarrow data dictionary)

• main objective: quality assurance in medicine





GFO Basic Relations



What is New?

- 1. solution of the endurant-perdurant problem including a new interpretation of endurants
- 2. novel approach to persistence
- 3. new classification of abstracta and its axiomatization
- 4. theory of space and time with boundaries
- 5. a new formal language which is based on classes and categories of finite type



What is New?

- 6. a more elaborated version of relations and (relational) roles
- 7. (a more elaborated situation theory)
- 8. (inclusion of levels of reality)

Some results in

B. Heller, H. Herre (2004) Ontological Categories in GOL. *Axiomathes* 14(1):p.57-76



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Motivation of Roles

- general examples
 - patient, student, food, ... as contrasted with
 - human, apple

ontological distinction

| | Human | Student | |
|------------|----------------------|---------------------------------|--|
| N. Guarino | rigid, independent | anti-rigid, dependent | |
| J.F. Sowa | essence of an entity | ccidental relationship involved | |
| | Natural Kind | Role | |
| | | imico 👊 | |

Motivation of Roles

- technical questions
 - multiple inheritance / multiple instantiation
 - dynamic classification
 - change of properties
- OO requirements (F. Steimann)
 - objects can play (even the same) roles multiply
 - roles have own properties and behavior
 - objects of unrelated types can play the same role
 - identity of an object and its roles (qua-individuals)



"An Analysis of Roles"

- examinations of roles in
 - computer science (DL, Guarino, Sowa, UML, OPM, ...)
 - stimulations from philosophy, linguistics, psychology
- elaboration of a role approach
 - notions: filler and context, (natural kind)
 - 3 types: relational, processual, and social roles
- comparisons (function, state, quality, view)
- critiques
- applications (facts, case study)



Context-centered Approach to Roles

• *filler* and *context:*



John fills the role of a student in the context of some university.

- literature: focus on filler-role-relation
- classification by context
 - relational roles
 - processual roles
 - social roles



Illustrating Role Types

• relational role "The pen is to the left of the case."



material relator material relational roles material objects / persist.

processual role



"John moves the pen."

process processual roles persistants

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Illustrating Role Types

• social role

"John is the student of the University of Leipzig with the registration number #5041."



| John | student | university (society) |
|-----------------|-------------|----------------------|
| material object | social role | social structure |

- problem:
 - student-of can be abstracted to a relationship
 - student can be interpreted as the one who is studying, i.e. as a processual role



Roles in General

- roles and parts
 - role-of similar to part-whole
 - subcategory of part (?)
- role-individuals and -universals
- roles have exactly one player (at a time)
- roles have a context, which is not a role *
- multiple contexts of the same role are related by part-of

* exception: some processual roles?



Social Roles in Detail

- foundations
 - Steimann's criteria (properties and behaviour)
 - Johansson's level theory, to be refined with Poli's
 - three strata: material mental social
 - several sub-layers in various "arrangements"



- Searle's "X counts as Y in context C"



Social Roles in Detail

- features
 - social structures exhibiting properties
 - exactly one filler
 - are atomic parts of "societies"
 - fillers are material or social structures
 - location derives from material fillers





Social Roles and Levels

- level-independent roles
 - relational roles \rightarrow concrete entities
 - processual roles \rightarrow processes
- simple, mixing levels
 - social roles \rightarrow presentials, next to material structures
- with level account
 - four types of entity:
 - all levels
 - one level
 - social role
 - quality



Social Roles and Levels

- discreteness of social processes
 - cf. an examination



Social Roles in Detail

- Delineation from other categories
 - not functions (heart f., f. of a switch), because
 - social roles < individuals
 - functions < processual role / process universals
 - not states (child adult), because
 - states < processes or states < configurations
 - not qualities (weight), because
 - qualities are not parts of something
 - role transfer contradicts non-migration principle for qualities
 - no account of ontological levels
 - possibly a kind of view and interface (implementation)



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Social Roles and their Descriptions

• Loebe: everything as logical individuals



• Masolo, Vieu et al.: roles as reified predicates

| player | instantiation > | role | described-by > | context |
|--------|-----------------|------|----------------|---------|
| ED | | NASO | | NASO |

- why NASO instead of ASO or Agent?
- what would "the student John" be: APO or ASO?

Social Roles and their Descriptions

- double-instantiation problem:
 - President(B) AND President(B)
 - solved by T₁-President(B) AND T₂-President(B)
 - BUT: overlapping qualities are problematic:



connection lost

- a solution (?): introduce subqualities
- advantage of qua-individuals: time built-in

Social Roles and their Descriptions

- role-playing roles: reposed by individual roles
 - role requirement
 - employee satisfies job only if acting as project leader?
- saturated roles (role universals):
 - passenger vs. passenger of flight #AZ120 on Jan 1st
 - BUT: combinations with other information possible (on a different or the same level)
 - passenger of flight #AZ120 on Jan 1st on the left half of the plane

imise

• first-class passenger of flight #AZ230



Open Issues

- missing characterisation of "societies"
 - collections of roles insufficient
 - descriptions cannot cover complexity
- limitation to presentials:
 cf. material and social processes → ontol. levels
- find other criteria to distinguish roles
 - context category not sufficiently sensitive
 - intuitively: (relational, processual) vs. (social)



Open Issues

- role-playing roles
- relation between level transition and representation
- for modeling languages: "smooth" transitions between role types



Issues of Relational Roles

- define relations in terms of relational roles
- advantages
 - adequate: symmetry of relations
 - simplified: anadic relations
- problems
 - infinite regress \rightarrow solution: ignorance

