



## 8 - Further comments on DOLCE and Conclusions

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*Thanks to all LOA people!*

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# Qualities

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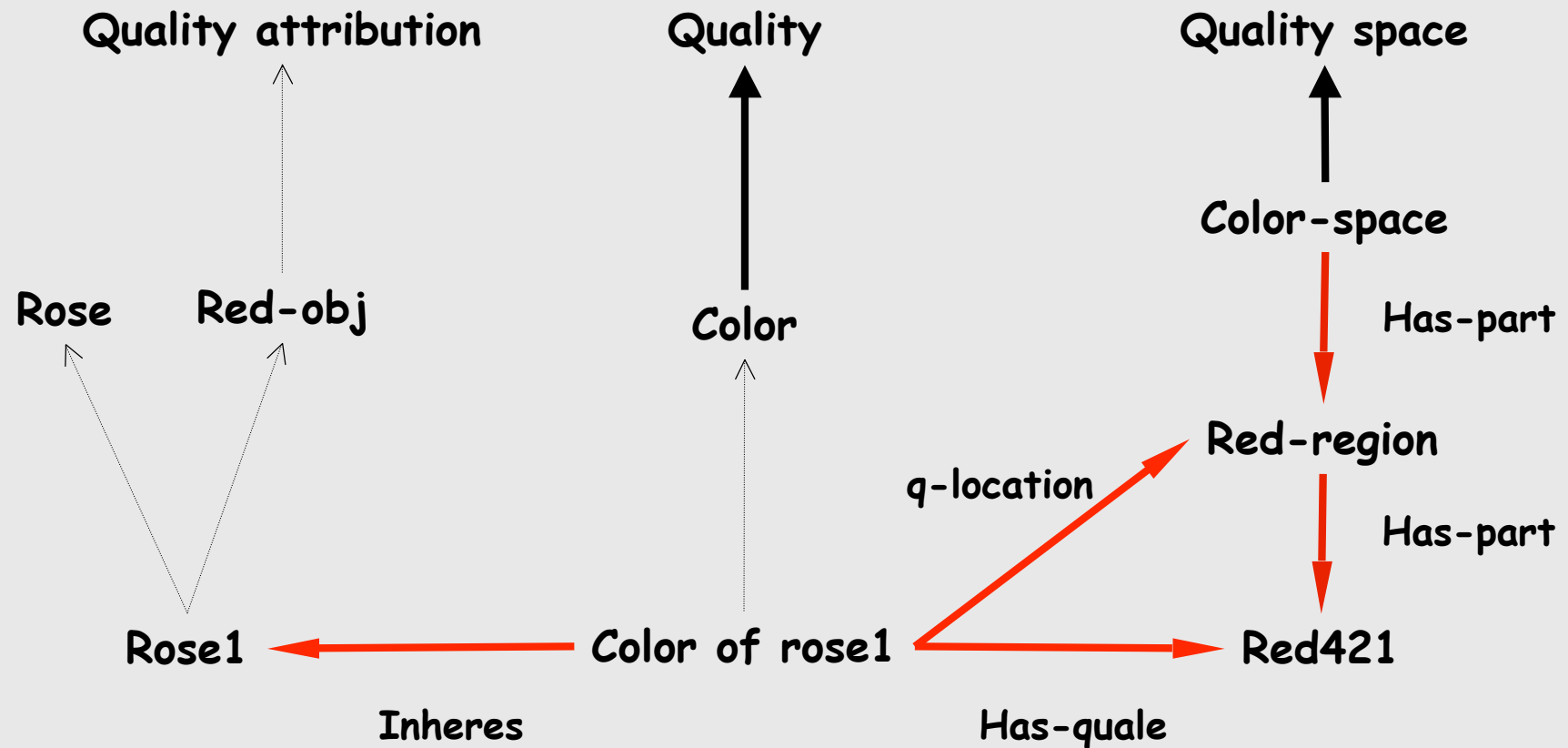


The rose and the chair have *the same color*:

- different color qualities inhere to the two objects
- they are located in the same quality region

Therefore, the same color attribute (red) is ascribed to the two objects

# Qualities



# Qualities and features: a fine-grained approach



# Abstract vs. Concrete Entities

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- Concrete:
  - located (at least) in time
- Abstract - two meanings:
  - Result of an abstraction process (something common to multiple exemplifications)
  - ☞ ***Not located in space-time*** (no inherent spatial or temporal location)
- Examples: ***propositions, sets, symbols, regions***, etc.
  - ***Quality regions*** and ***quality spaces*** are abstract entities
  - Mereological sums (of concrete entities) are concrete, the corresponding sets are abstract...



# Physical vs. Non-physical Endurants

- Physical endurants
  - Inherent spatial localization
  - Not necessarily dependent on other objects



- Non-physical endurants
  - No inherent spatial localization
  - Dependent on agents
    - mental (depending on singular agents)
    - social (depending on communities of agents)
  - Agentive: a company, an institution
  - Non-agentive: a law, the Divine Comedy, a linguistic system...
    - Descriptions, an extension of DOLCE

*FIAT Co.*

# Formalizing DOLCE

# Basic Relations

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- Parthood
  - Between quality regions (immediate)
  - Between arbitrary objects (temporary)
- Dependence
  - Specific/generic constant dependence
- Constitution
- Inherence (between a quality and its host)
- Quale
  - Between a quality and its region (immediate, for unchanging entities)
  - Between a quality and its region (temporary, for changing entities)
- Participation





# Axiomatizing basic relations

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- Domain restrictions:
  - Intra-categorical vs. inter-categorical relations
- Ground axioms (mainly algebraic)
- Links to other relations
- Existential assumptions (dependence)
- Dependence on time



# Kinds of dependence

- (D1)  $SD(x, y) =_{df} o(\exists t(PR(x, t)) \wedge \forall t(PR(x, t) \rightarrow PR(y, t)))$  (Specific Const. Dep.)
- (D2)  $SD(\phi, \psi) =_{df} DJ(\phi, \psi) \wedge o\forall x(\phi(x) \rightarrow \exists y(\psi(y) \wedge SD(x, y)))$  (Specific Const. Dep.)
- (D3)  $GD(\phi, \psi) =_{df} DJ(\phi, \psi) \wedge o(\forall x(\phi(x) \rightarrow \exists t(PR(x, t)) \wedge \forall x, t((\phi(x) \wedge At(t) \wedge PR(x, t)) \rightarrow \exists y(\psi(y) \wedge PR(y, t))))$  (Generic Const. Dep.)
- (D4)  $D(\phi, \psi) =_{df} SD(\phi, \psi) \vee GD(\phi, \psi)$  (Constant Dependence)
- (D5)  $OD(\phi, \psi) =_{df} D(\phi, \psi) \wedge \neg D(\psi, \phi)$  (One-sided Constant Dependence)
- (D6)  $OSD(\phi, \psi) =_{df} SD(\phi, \psi) \wedge \neg D(\psi, \phi)$  (One-sided Specific Constant Dependence)
- (D7)  $OGD(\phi, \psi) =_{df} GD(\phi, \psi) \wedge \neg D(\psi, \phi)$  (One-sided Generic Constant Dependence)
- (D8)  $MSD(\phi, \psi) =_{df} SD(\phi, \psi) \wedge SD(\psi, \phi)$  (Mutual Specific Constant Dependence)
- (D9)  $MGD(\phi, \psi) =_{df} GD(\phi, \psi) \wedge GD(\psi, \phi)$  (Mutual Generic Constant Dependence)

# **DOLCE Extensions and Applications**

# Main DOLCE Extensions

(Thanks to Aldo Gangemi @LOA-RM)

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- Allen-based ontology of time
- Ontology of common-sense locations
- Descriptions and reified concepts (D&S ontology)
- Ontology of functional participation (*thematic roles*)
- Ontology of social entities and organizations
- Ontology of plans and tasks
- Ontology of information objects
- Ontology of knowledge content objects (multimedia descriptions )
- Ontology of (Web) services (with UKA, VUA)
- Ontology of semantic middleware (extending DAML-S beyond Web services - by Daniel Oberle at UKA)
- Core legal ontology (with ITTIG-CNR)



# Mapping with lexicons: the OntoWordNet project

(Aldo Gangemi, Alessandro Oltramari, Massimiliano Ciaramita)

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- 809 synsets from WordNet1.6 directly subsumed by a DOLCE+ class
  - Whole WordNet linked to DOLCE+
  - Lower WordNet levels still need revision
- Glosses being transformed into DOLCE+ axioms
  - Machine learning applied jointly with foundational ontology
- WordNet “domains” being used to create a modular, general purpose domain ontology
- Ongoing work on ontological analysis of specific WordNet domains (cognition, emotion, psychological feature)
- Ongoing cooperation with Princeton University.



## **Kinds of binary relations**

# Binary relations

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- Structuring relations
  - Is-a
  - Instance-of
  - Attribute (including part)
- Non-structuring relations:
  - everything else



# What is an attribute

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- Woods' "What's in a link" :

JOHN

HEIGHT: 6 FEET

HIT: MARY

- "no longer do the link names stand for attributes of a node, but rather arbitrary relations between the node and other nodes"
- different notations should be used





# KL-ONE “roles”

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- The roles represent the *various kinds of attributes, parts, etc*, that things in the world are considered to “have”. These include, for example, such things as parts (e.g., fingers of a hand), inherent attributes of objects and substances (e.g. color), arguments of functions (e.g. multiplier and multiplicand of a multiplication), and “cases” of verbs in sentences (e.g. “agent”). Any *generalized attribute* of this sort has two important pieces (1) the particular entity that becomes the value for the attribute in an instance of the Concept, and (2) the *functional role which that entity fills in the conceptual complex*. A Role is a formal entity that captures both of these aspects in a structured way, by packaging up information about both the role filler and the functional role itself.

[Brachman, On the epistemological status of semantic networks, 1979]

- (...) the Role is the *primary component* of a Concept. A Role acts like a generalized attribute description, representing potential relationships between individuals of the type denoted by the Concept and other individuals. In other words, Roles are the KL-ONE *equivalent of two-place predicates*.

[Brachman & Schmolze, An overview of the KL-One knowledge representation system, 1985]



# Sowa's roles vs. KL-ONE roles

- Subtypes of ENTITY are of two kinds: *natural types*, which have no required set of linguistic associations; and *role types*, which are subtypes of natural types in some particular pattern of relationships. PERSON, for example, is a natural type, and TEACHER is a subtype of PERSON in the role of teaching.  
[Sowa, 88]
- What's the relationships between Sowa's roles and KL-ONE (and DL) roles?
  - Has-teacher is a *relational interpretation* of Teacher
  - Such relational interpretation needs to be suitably constrained. A first constraint is *Woods' linguistic test*:

Y is a value of the attribute A of X if we can say that

*Y is a A of X (or the A of X)*



# An algorithm for checking attributes

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1. **Check** whether A and X satisfy *Woods' linguistic test*: "something is the/an A of (some) X". This test ensures that A is a concept, and that it may be actually related with X.
2. **If** Woods' test succeeds **then**
  - if** the property denoted by A *depends* on X **then**
    - return true** (A is a relational attribute).
  - else if** A is the name of a part of X **then**
    - return true** (A is a non-relational attribute)
  - else**
    - return false.**

[Concepts, Attributes, and Arbitrary Relations - Some Linguistic and Ontological Criteria for Structuring Knowledge Bases. *Data and Knowledge Engineering*, 1992]



# Attributes and roles: the whole picture

[Guarino 92]

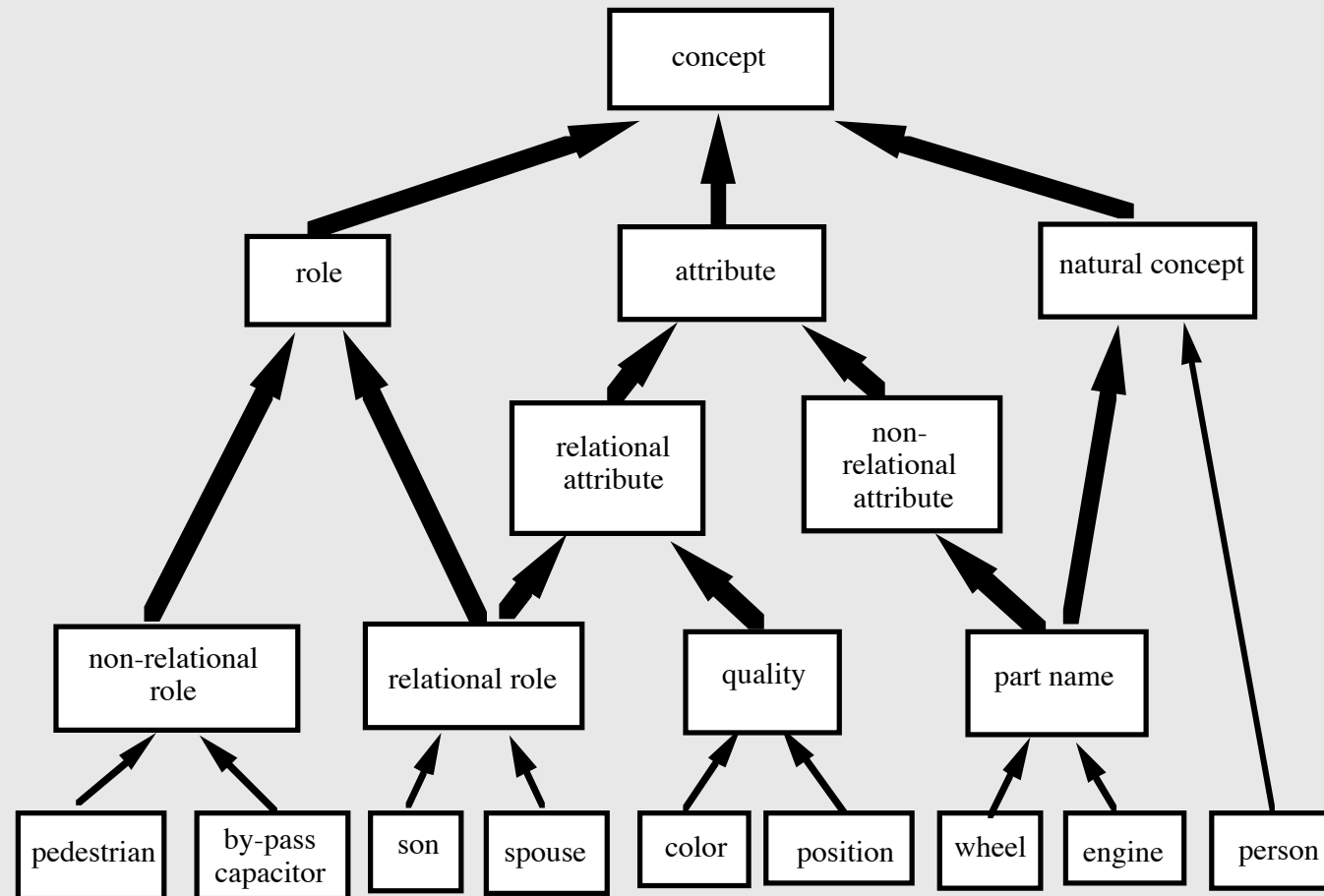


Figure 1. A basic ontology of attributes, showing their relationships with roles and natural concepts. Thick arrows represent inclusion relationships, while thin arrows represent membership relationships.

## Further discussion points:

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- Inheritance: the circle/ellipse dilemma
- Specializing binary relations: different kinds of parts
  - Component/Integral-object
  - Member/Collection
  - Portion/Mass
  - Stuff/Object
  - Phase/Activity
  - Place/Area



# Verso una metodologia

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- Analisi linguistica:
  - semplificare i **termini composti**
    - *haComuneLavoro, haComuneNascita...*
    - *haStatoVerificaContribuzioneDovuta...*
  - Analisi delle dipendenze:
    - termini relazionali/non relazionali
- **Associare i dati alle entita' che li hanno generati** (e gli attributi alle entita' da cui dipendono)
  - *haNome*
  - *haSesso*
  - *haDataNascita*
  - *haDataCessazione*
- **Esplicitare le entita' temporali:** *eventi, storie, situazioni...*
  - ...e i loro *partecipanti*
  - Es.: *rapporto di lavoro* (con le sue *parti*)
- Analizzare gli effetti di possibili cambiamenti
  - *Indirizzo/luogo geografico...*



# Verso una metodologia - 2

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- Primi passi di una *formalizzazione*
  1. Scelta del *dominio del discorso*
    - entita' del “mondo”
    - nostra conoscenza sul “mondo”
  2. Scelta dei concetti e delle relazioni *rilevanti* per tale dominio
  3. Scelta dei concetti e delle relazioni *primitive* (*figlio* vs. *parente* o *antenato*)
- Allineamento rispetto ad una *ontologia di riferimento* (DOLCE?)
  - Oggetti
  - Eventi
  - Qualita'
  - Fatti
  - Descrizioni
  - ...
- Analisi ontologica sistematica in termini di proprieta' e relazioni *formali*...



# The Ontology of Social Reality

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Searle's thesis:

claims and obligations and deontic powers\* are brought into existence by the performance of speech acts  
(*acts of promising, marrying, accusing ...* )

*The Construction of Social Reality* (1989)

\* rights, relations of authority, debts, property-relations, permissions, ...





## Austin/Searle Speech Act Theory

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1. We tell people how things are (*assertives*)
2. We try to get them to do things (*directives*)
3. We commit ourselves to doing things (*commissives*)
4. We express our feelings and attitudes (*expressives*)
5. We bring about changes in the world through utterances (*declarations*) (“I name this ship ...”)



# The role of documents in the ontology of social reality

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– a claim, obligation, right, power, name, office, organization –  
...which survives for an extended period of time

What is the physical basis for this extended existence?

- In small societies: the memories of those involved
- In large societies: documents

**Writing** creates and sustains permanent, *re-usable* **meaning** and permanent *re-usable* **deontic powers**



# Depending on documents

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- Different kinds of dependence relations:
  - Between documents and physical entities
    - Documents are often *about* a physical entity (a person, a house, an event...)
  - Between documents and documents
    - Some documents are *about* documents
  - Between *social entities* and documents
    - Some documents *create* new entities



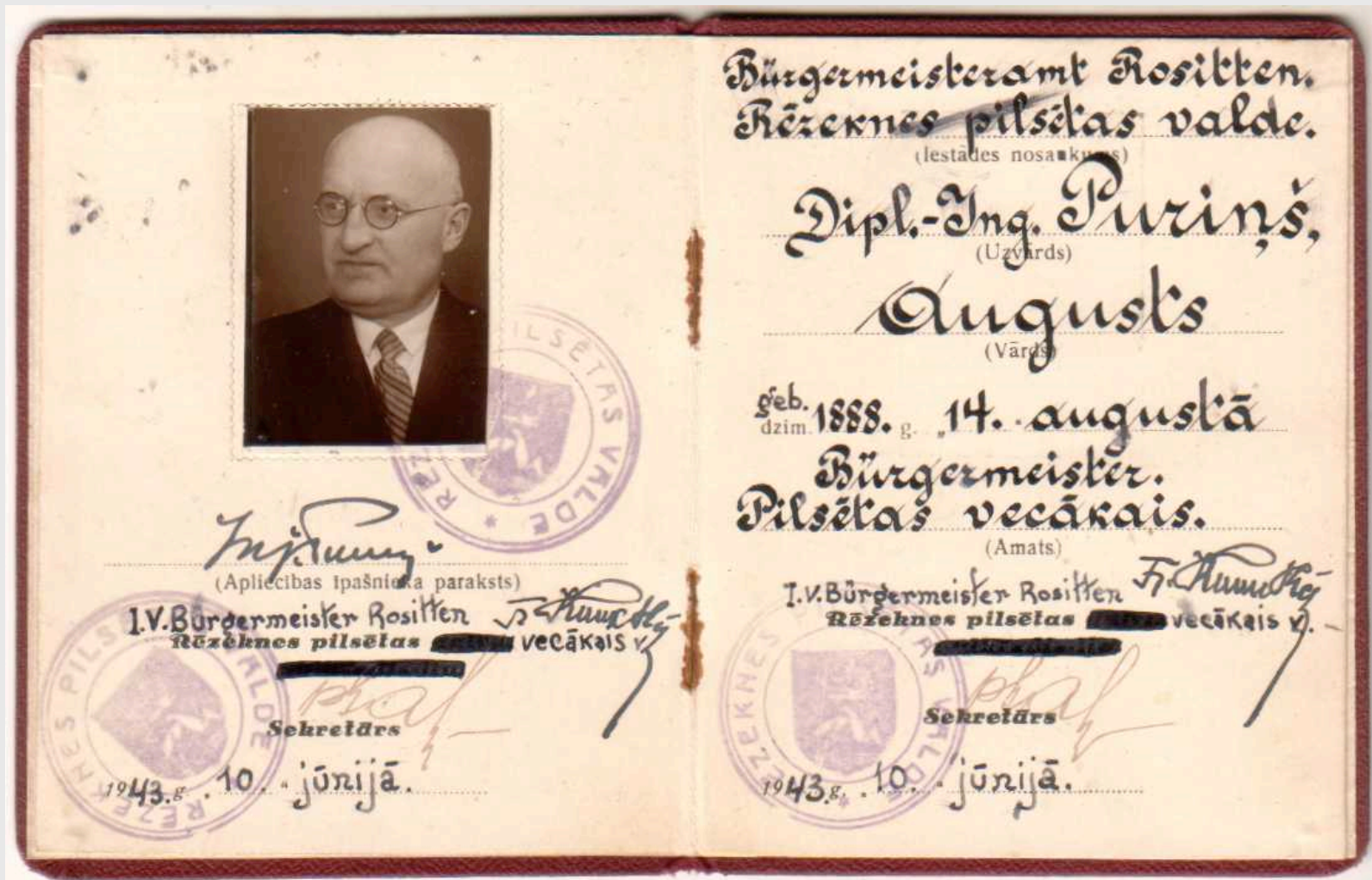
## Differences between document acts and speech acts

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- speech acts are normally self-validating (they wear their provenance on their face)
- documents need technological devices (official stamps, special watermarks, signatures, countersignatures, seals, ...)



## anchoring documents to reality



## The de Soto thesis:

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documents and document systems are mechanisms for creating the institutional orders of modern societies



Hernando de Soto, *The Mystery of Capital*,  
New York: Basic Books, 2000



# The creative powers of documents

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stock and share certificates *create* capital

examination documents *create* PhDs

title deed/cadastral map *creates* real estate parcels

marriage licenses *create* bonds of matrimony

bankruptcy certificates *create* bankrupts

statutes of incorporation *create* companies

title deeds *create* property rights and property owners



# What is missing from existing document-based (and eGov services!) ontologies:

- The various entities documents and services are about: events, people, locations, organizations, goods...
- the social and institutional (deontic, quasi-legal) entities created by documents
- the social interactions in which documents play an essential role (how documents bind people together)
- the sorts of things which we can *do* with documents
- the different types of institutional systems to which documents belong
- the *provenance* of documents (on what distinguishes original, authentic documents from copies, forgeries ...)
- We need clear distinctions between
  - documents (as entities which endure, can be stored, etc.)
  - those acts of recording information which create documents
  - acts of ordering or requesting or signing documents
  - the information recorded in documents
  - the activities described in documents

***No real integration without this rich ontology!***





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