

Business and Enterprise Ontologies

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What is Ontology?

Ontology is a branch of philosophy that researches the nature and structure of things.¹

- ▶ It is a *science*.
- ▶ It goes back to Aristotle.
- ▶ It is independent of reality.
 - ▶ Hence, it makes as much sense to study the Ontology of unicorns as that of horses.
 - ▶ As for both horses and unicorns, both their nature and structure² can be described in terms of general categories and relations.
- ▶ It is typically written with a capital "O".
- ▶ It is an uncountable noun.

¹Nicola Guarino, Daniel Oberle, and Steffen Staab. "What is an ontology?" In: *Handbook on ontologies*. Springer, 2009, pp. 1–17.

²Mereology studies part-whole relationships, Classification studies super- and sub-types, Categorisation studies super- and sub-sets, etc.

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What is an ontology?

- ▶ It is an *artefact*.³
- ▶ The discipline originates in computer science
- ▶ It has been defined as:
 - ▶ An **explicit** specification of a conceptualisation⁴
 - ▶ A **formal** specification of a **shared** conceptualisation⁵
 - ▶ A formal, explicit specification of a shared conceptualisation⁶
- ▶ It is typically written with a lowercase "o".
- ▶ It is a countable noun.
- ▶ The science of designing ontologies⁷ is called **ontology engineering**.

³Guarino, Oberle, and Staab, "What is an ontology?"

⁴T Gruber. "A translation approach to portable ontologies". In: *Knowledge Acquisition* 5.2 (1993), pp. 199–220.

⁵P. Borst. "Constructing of engineering ontologies for knowledge sharing and reuse". PhD thesis. University of Twente, 1997.

⁶Rudi Studer, V Richard Benjamins, and Dieter Fensel. "Knowledge engineering: principles and methods". In: *Data & knowledge engineering* 25.1-2 (1998), pp. 161–197.

⁷Oscar Corcho, Mariano Fernández-López, and Asunción Gómez-Pérez. "Methodologies, tools and languages for building ontologies. Where is their meeting point?" In: *Data & knowledge engineering* 46.1 (2003), pp. 41–64.

What is a conceptualisation?

What is an ontology⁹?

- ▶ It describes a part of the world (i.e. a **domain**)
 - ▶ It does not aim at describing the entire world.
- ▶ It defines a universe of discourse through a set of **universals**⁸
- ▶ The **universe of discourse** constrains the possible states of the world that can be described.
 - ▶ It is independent of the (state of the) world.
 - ▶ It is a pattern that can be observed.

⁸Think of universals as tacit words you are given to describe your mental model of the world (i.e. concepts, relations).

⁹Guarino, Oberle, and Staab, "What is an ontology?"

What is a specification?

What is an ontology¹¹?

A *specification* is a logical theory that distinguished between intended and unintended models representing a conceptualisation.

- ▶ A specification is **explicit**¹⁰
 - ▶ not tacit like a conceptualisation
- ▶ A specification can be extensional
 - ▶ i.e. an exhaustive list of all possible states of the world
- ▶ A specification can be **intensional**
 - ▶ with a set of suitable **axioms**

¹⁰This relates to the field of semiotics. Charles Kay Ogden and Ivor Armstrong Richards. "The meaning of meaning: A study of the influence of thought and of the science of symbolism". In: (1923); Giancarlo Guizzardi. "On ontology, ontologies, conceptualizations, modeling languages, and (meta) models". In: *Frontiers in artificial intelligence and applications* 155 (2007), p. 18

¹¹Guarino, Oberle, and Staab, "What is an ontology?"

What is a formal specification?

What is an ontology¹⁴?

A *formal specification* is a specification in a formal language.

- ▶ A specification can be given in an **informal** language
 - ▶ e.g. in natural language
 - ▶ e.g. glossaires, thesaurus¹²
- ▶ A specification can be given in a **formal** language
 - ▶ e.g. first order logic, RDF, OWL, programming languages
 - ▶ e.g. OntoUML¹³, which also has its own methodology and tools.

¹²Ora Lassila and Deborah McGuinness. "The role of frame-based representation on the semantic web". In: *Linköping Electronic Articles in Computer and Information Science* 6.5 (2001), p. 2001.

¹³<https://ontouml.org>

¹⁴Guarino, Oberle, and Staab, "What is an ontology?"

Are ontologies inherently shared?

What is an ontology?

- ▶ Conceptualisations are tacit and personal
 - ▶ They can't be shared
 - ▶ So ontologies aren't inherently shared
- ▶ Ontologies can help define a "lingua franca" between people each having their own conceptualisation.
 - ▶ This presupposes a shared ontological commitment¹⁵
 - ▶ Such a shared ontological commitment is at best partial¹⁶,
 - ▶ which might lead to ambiguity (e.g. Konnyaku Mondô¹⁷)

¹⁵Ontological commitment represents the interpretation of in a specification, mapping it to a conceptualisation.

¹⁶Guarino, Oberle, and Staab, "What is an ontology?"

¹⁷Mamoru Kaneko and J Jude Kline. "Two dialogues on epistemic logics and inductive game theory". In: *Advances in Mathematics Research* 12 (2010), pp. 199–238.

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Are ontologies useful?

The literature¹⁸ suggests that ontologies are useful in

- ▶ Formal Specifications for Computer-Computer Interaction
 - ▶ system interoperability (e.g. Semantic Web¹⁹, Core vocabularies²⁰)
- ▶ Formal Specifications for Human-Computer Interaction
 - ▶ information retrieval
 - ▶ knowledge representation
- ▶ Informal (and Formal) Specifications for Human-Human Interaction
 - ▶ conceptual modeling
 - ▶ domain understanding

Other claims about the usefulness of ontology (e.g. for establishing a shared understanding²¹) require more scientific evidence.

¹⁸Henry N Roa, Shazia Sadiq, and Marta Indulska. "Ontology Usefulness in Human Tasks: Seeking Evidence". In: ACIS. 2014.

¹⁹<https://www.w3.org/standards/semanticweb/>

²⁰https://ec.europa.eu/isa2/solutions/core-vocabularies_en, <https://schema.org>

²¹Kurt Cagle. *Why 'Ontology' Will Be A Big Word In Your Company's Future*. online.

<https://www.forbes.com/sites/cognitiveworld/2018/07/20/why-ontology-will-be-a-big-word-in-your-companys-future/>. 2018.

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What are Business & Enterprise Ontologies?

- ▶ Business & enterprise ontologies are ontologies pertaining business and enterprises.
- ▶ To the best of my knowledge, there is no academic consensus about the distinction between business and enterprise ontologies.
- ▶ Personally, I consider
 - ▶ ontologies formalising the act of doing business²² *business ontologies*
 - ▶ ontologies formalising the organisation of a project or company *enterprise ontologies*
- ▶ Hence, enterprise ontologies focus on a single organisation at once
- ▶ business ontologies focus on the value network²³ or business ecosystem²⁴ in which these organisations are embedded.

²²e.g. collaboration & competition

²³Verna Allee. "Value network analysis and value conversion of tangible and intangible assets". In: *Journal of intellectual capital* 9.1 (2008), pp. 5–24.

²⁴James F. Moore. *The death of competition: leadership and strategy in the age of business ecosystems*. HarperBusiness New York, 1996; James F. Moore. "The rise of a new corporate form". In: *Washington Quarterly* 21.1 (1998), pp. 167–181.

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Osterwalder's Business Model Ontology

A non-exhaustive list of Business & Enterprise Ontologies

- ▶ PhD thesis²⁵ of Alexander Osterwalder, supervised by Yves Pigneur.
- ▶ Is the origin of the business model canvas among other spinoffs²⁶.
- ▶ The business model canvas:

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
	Key Resources		Channels	
Cost Structure		Revenue Streams		

²⁵Alexander Osterwalder. "The business model ontology a proposition in a design science approach". PhD thesis. Université de Lausanne, Faculté des hautes études commerciales, 2004.

²⁶<https://www.strategyzer.com/books>

The Financial Industry Business Ontology

A non-exhaustive list of Business & Enterprise Ontologies

- ▶ FIBO²⁷ is managed by the EDMCouncil²⁸
- ▶ FIBO is an OMG²⁹ standard³⁰, and
- ▶ FIBO is formalised in the OWL web-standard supported by W3C³¹
- ▶ It is used for:
 - ▶ Data Harmonisation
 - ▶ Standardising Data Integration
 - ▶ Flexible Analysis,
 - ▶ Machine Learning
 - ▶ Blockchain

²⁷Financial Industry Business Ontology

²⁸<https://edmcouncil.org/page/aboutfiboreview>

²⁹Object Management Group

³⁰<https://www.omg.org/hot-topics/finance.htm>

³¹<https://www.w3.org/community/fibo/>

The iStar (i*) ontology

A non-exhaustive list of Business & Enterprise Ontologies

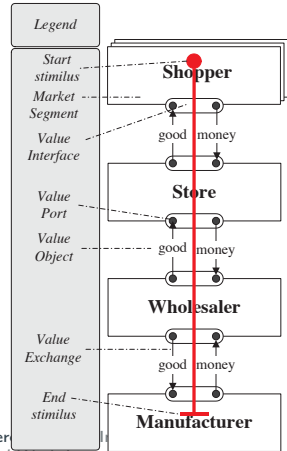
- ▶ The i* ontology was developed for modelling strategic relationships³² by Eric Yu, as part of his PhD dissertation, which was supervised by John Mylopoulos.
- ▶ It is mainly used for requirements engineering
- ▶ Its core concepts are:
 - ▶ Actor
 - ▶ Goal & Soft-Goal
 - ▶ Task
 - ▶ Resource
 - ▶ Means-End link [Task-Goal]
 - ▶ Contribution to (+ or -) [Task-Soft Goal]

³²Eric Yu. "Modelling strategic relationships for process reengineering". In: *Social Modeling for Requirements Engineering* 11 (2011), p. 2011.

The e3value ontology

A non-exhaustive list of Business & Enterprise Ontologies

- ▶ The e3value ontology^a was developed for exploring innovative business ideas by Jaap Gordijn and his PhD supervisor Hans Akkermans
- ▶ It led to a number of spin-off methods: e3value family
 - ▶ e3value: for exploring innovative e-business ideas
 - ▶ e3boardroom: a kick-off executive workshop for new business ideas
 - ▶ e3service: aims at finding techniques and software tools for designing online services. Research problems include matching of customer needs for services, with available online services in the market, and, reasoning about potential service bundles.



^aJaap Gordijn and JM Akkermans. "Value-based requirements engineering: exploring innovative e-commerce Requirements engineering 8.2 (2003), pp. 114–134; Jaap Gordijn. "E³-value in a Nutshell". In: *International Workshop on e-business modeling*, HEC Business School. Citeseer. 2002.

Dietz' Enterprise Ontology

A non-exhaustive list of Business & Enterprise Ontologies

- ▶ Dietz's enterprise ontology³³ is based on speech-act theory.
- ▶ It is the foundation for the DEMO³⁴ framework.
- ▶ DEMO is an acronym for Demo Engineering Methodology for Organisations.
- ▶ Dietz's enterprise ontology contains concepts like:
 - ▶ Initiator & Executor
 - ▶ Order & Result
 - ▶ Request & Promise
 - ▶ Decline & Reject
 - ▶ Quit & Accept

³³Jan LG Dietz. "The atoms, molecules and fibers of organizations". In: *Data & Knowledge Engineering* 47.3 (2003), pp. 301–325.

³⁴<http://www.ee-institute.org/en>

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- ▶ The REA ontology was originally developed as a data-model to create a shared data environment that supports multiple different views³⁵ on the same data.³⁶
- ▶ It was positioned as an ontology by Guido Geerts³⁷
- ▶ It has been used in many domains other than accounting³⁸
- ▶ REA is the acronym for its three core concepts:
 - ▶ Resource
 - ▶ Event
 - ▶ Agent

³⁵i.e. the views of accountants and non-accountants

³⁶William E. McCarthy. "The REA Accounting Model: A Generalized Framework for Accounting Systems in a Shared Data Environment". In: *The Accounting Review* July (1982), pp. 554–578.

³⁷Guido L. Geerts and William E. McCarthy. "The ontological foundation of REA enterprise information systems". In: *Annual Meeting of the American Accounting Association, Philadelphia, PA*. vol. 362. 2000, pp. 127–150.

³⁸Guido L. Geerts. "A design science research methodology and its application to accounting information systems research". In: *International Journal of Accounting Information Systems* 12.2 (2011). Special Issue on Methodologies in AIS Research, pp. 142–151. ISSN: 1467-0895. DOI: <https://doi.org/10.1016/j.accinf.2011.02.004>. URL: <http://www.sciencedirect.com/science/article/pii/S1467089511000200>.

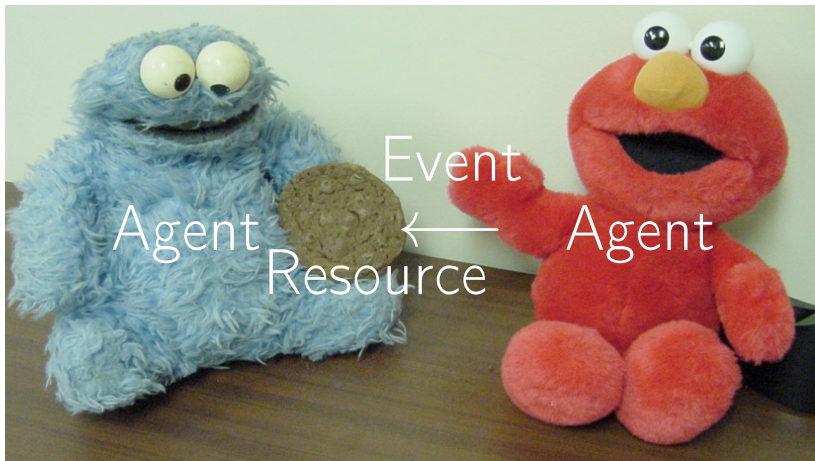
The REA scenario: Initial state



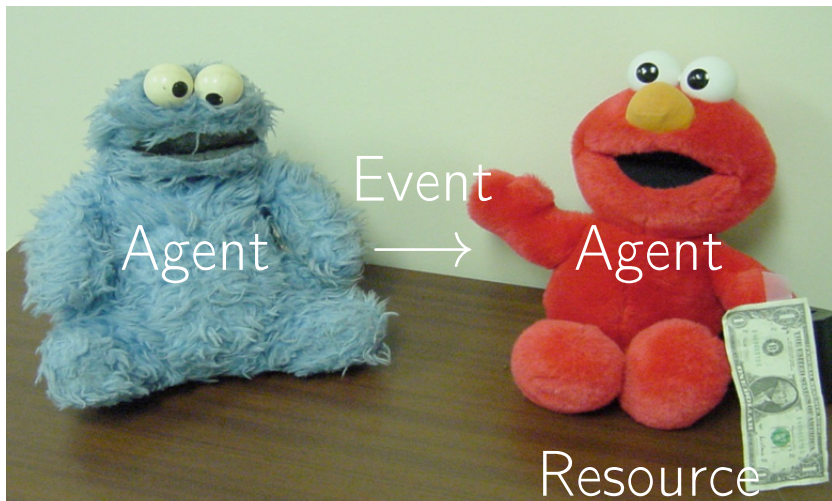
adapted from: Transparents ACC 821, 2008, Michigan State University

©W.E. McCarthy 2008

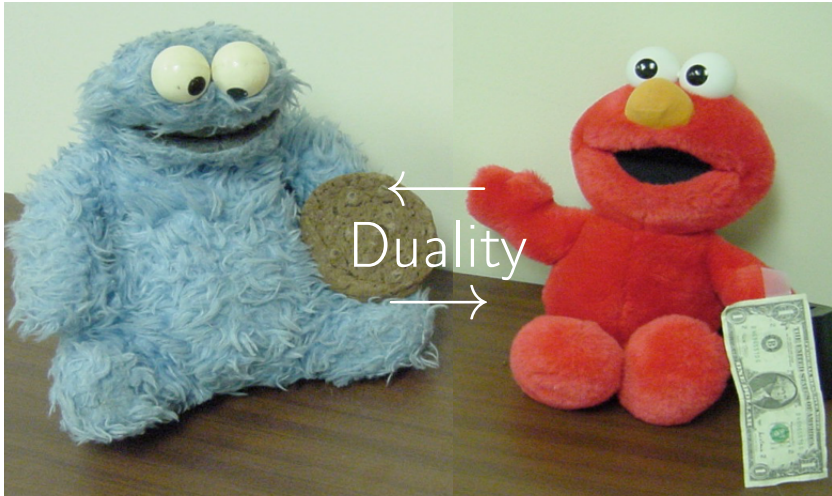
The REA scenario: Cookie transfer



The REA scenario: Cash transfer



REA Duality $\approx$ Fairness³⁹



adapted from: Transparents ACC 821, 2008, Michigan State University

©W.E. McCarthy 2008

³⁹Sarah F Brosnan and Frans BM de Waal. "Evolution of responses to (un) fairness". In: *Science* 346:6207 (2014), p. 1251776. 

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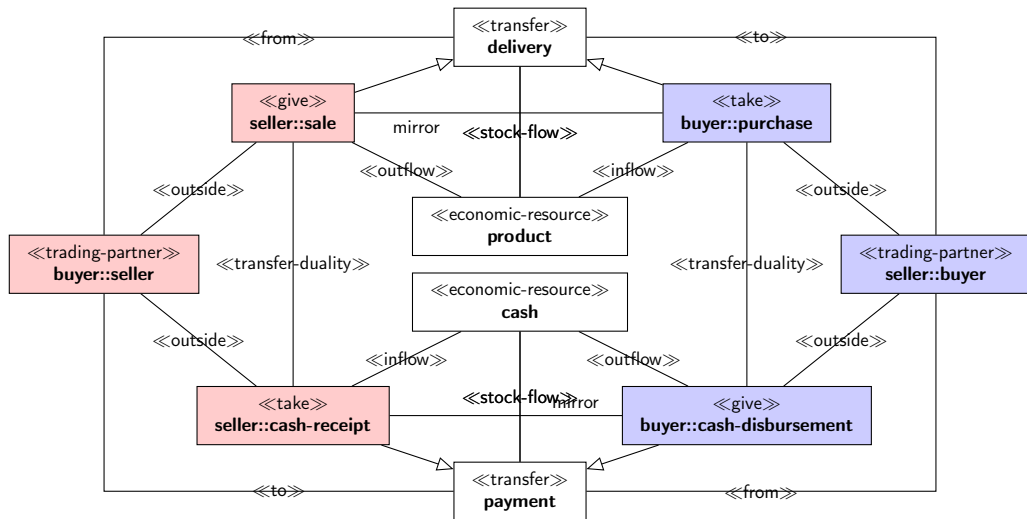
REA²: 3 perspectives

- ▶ The original version of the REA ontology⁴⁰, portrays the perspective of a trading-partner (i.e. either a buyer or a seller) taking part in an exchange.
- ▶ This original version was later baptised the trading-partner or dependent view.
- ▶ The REA ontology later received a clone that portrays the perspective of anybody not taking part in the exchange (i.e. a third party).
- ▶ This clone was called the independent or helicopter view.
- ▶ In 2007, the REA ontology's independent or helicopter view was the foundation for the ISO standard ISO/IEC 15944-4:2007 with got an update in 2015: ISO/IEC 15944-4:2015
- ▶ REA² formalised the semantic relationships between the seller, buyer and third party view in REA⁴¹.

⁴⁰McCarthy, "The REA Accounting Model: A Generalized Framework for Accounting Systems in a Shared Data Environment".

⁴¹Wim Laurier, Jesper Kiehn, and Simon Polovina. "REA2: A unified formalisation of the Resource-Event-Agent ontology". In: *Applied Ontology* 13.3 (2018), pp. 201–224. DOI: 10.3233/ao-180198.

REA²: 3 perspectives



REA²: 3 perspectives

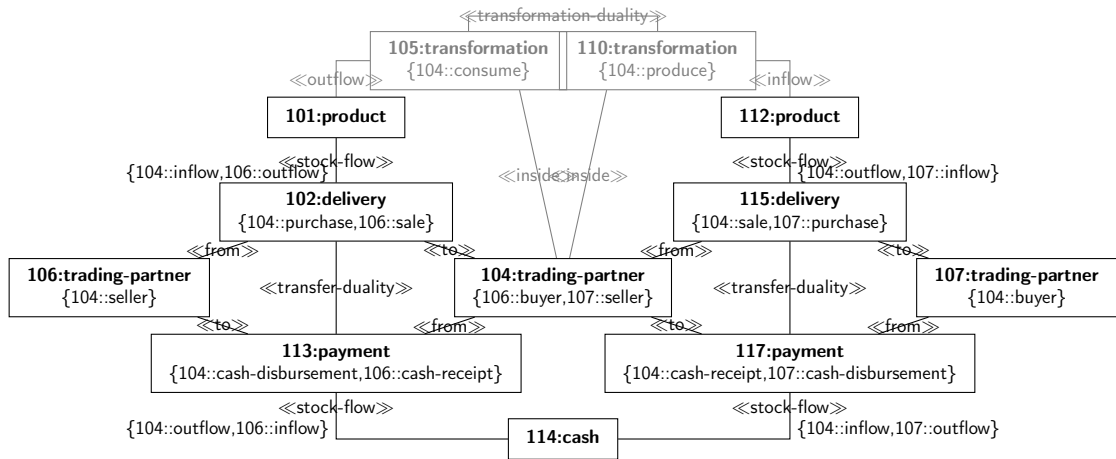


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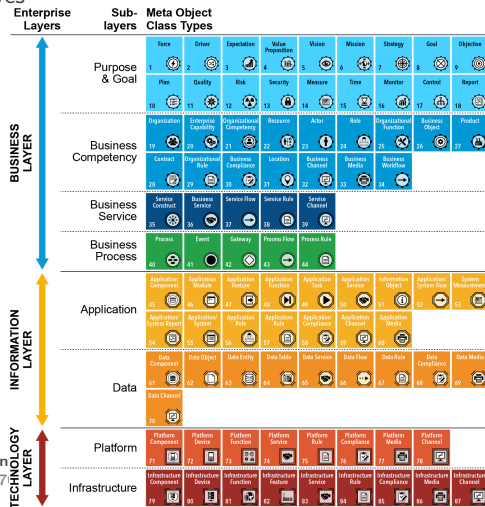
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Global University Alliance Ontology

Multiple perspectives

- ▶ Was primarily developed by Mark von Rosing and Henrik von Scheel^a
- ▶ Contains 87 concepts found in different types of business & enterprise ontologies and management tools
- ▶ Uses the semantic relationships between these 87 concepts to link establish semantic coherence between the different views in different management tools
- ▶ These views are subsets of shared semantics



^aMark von Rosing and Henrik von Scheel. "Using the business ontology to develop en
Journal of Conceptual Structures and Smart Applications (IJCSSA) 4.1 (2016), pp. 48–7

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- ▶ Ontologies can be used to create a shared data environment
- ▶ Ontologies can be used to reach agreement on terminology
- ▶ Ontologies can improve domain understanding
- ▶ Many ontologies either take
 - ▶ The perspective a single person that is part of the universe of discourse
 - ▶ The perspective of an independent observer
- ▶ Some ontologies allow for views
 - ▶ Often these views are subsets of shared semantics
 - ▶ Sometimes these views oppose, and disagreement about terminology is indispensable
 - ▶ Creating a shared data environment with opposing views is a challenge.

Thank you for your attention!

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