

IEEE RAS

Standards Strategy Meeting

September 30, 2018

Madrid, Spain

(in conjunction with IROS 2018)



Meeting Goal

- To review and refine an overall robotics standards landscape to determine areas in which the IEEE Robotics and Automation Society (RAS) should focus on robotics standards development and determine areas in which IEEE RAS should partner with other standard development organizations.

Introductions

Please state your name, organization, and your role in
robot standards

Agenda

Start Time	End Time	Topic	Speaker
9:00	9:20	Welcome/Overview/Introductions	Craig Schlenoff
9:20	9:30	IEEE WG Presentation - IEEE 1872 - CORA	Craig Schlenoff
9:30	9:40	IEEE WG Presentation - IEEE P1872.1 Robot Task Representation	Stephen Balakirsky
9:40	9:50	IEEE WG Presentation - IEEE P1872.2 - Autonomous Robotics	Veera Ragavan
9:50	10:00	IEEE WG Presentation - IEEE P2751 - 3D Map Data Representation	Francesco Amigoni
10:00	10:20	IEEE Ethics Efforts	Ali Hessami
10:20	10:30	IEEE Ethics Efforts (7000 series)	Sandro Fiorini (remote)
10:30	10:40	IEEE WG Presentation - IEEE P2730 - Classification and Terminology of Medical Robots	Tamas Haidegger
10:40	11:00	BREAK	
11:00	11:30	ISO and RIA Efforts in Robot Standards	Roberta Nelson Shea
11:30	12:00	ASME Efforts in Robot Standards	Angel Guzman Rodriguez
12:00	13:00	LUNCH	

Agenda

Start Time	End Time	Topic	Speaker
13:00	13:20	Thoughts of Personal Care Robot Safety, Medical Robot Safety, and Modularity of Service Robots	Gurvinder Virk
13:20	13:40	Thoughts on Autonomous Vehicle Robot Standards	Chris Debrunner
13:40	14:00	Thoughts on Industrial Robot Standards	Henrik Christensen
14:00	14:20	Discussion of Standards Landscape	Craig Schlenoff
14:20	14:40	BREAK	
14:40	16:40	Open Discussion - Gaps/Opportunities/IEEE Priority Areas/Collaboration Opportunities	All
16:40	17:00	Wrap Up / Action Items / Future Work	Craig Schlenoff
21:00		Dinner (El Telegrafo) C/ Padre Damián, 44. 28036 Madrid Tel: 91 359 70 83 https://eltelegrafomarisqueria.com/	

Existing IEEE RAS Standards

- 1872-2015 IEEE Standard Ontologies for Robotics and Automation
 - <https://standards.ieee.org/standard/1872-2015.html>
 - A core **ontology** that specifies the main, most general concepts, relations, and axioms of robotics and automation (R&A) is defined in this standard, which is intended as a reference for knowledge representation and reasoning in robots, as well as a formal reference vocabulary for communicating knowledge about R&A between robots and humans. This standard is composed of a core ontology about R&A, called CORA, together with other **ontologies** that give support to CORA.
- 1873-2015 IEEE Standard for Robot Map Data Representation for Navigation
 - <https://standards.ieee.org/standard/1873-2015.html>
 - A map data representation of environments of a mobile robot performing a navigation task is specified in this standard. It provides data models and data formats for two-dimensional (2D) metric and topological maps.

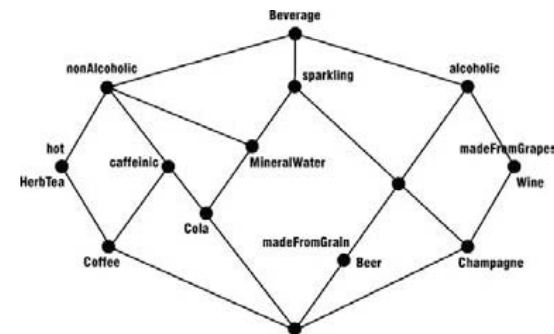
IEEE ORA Working Group Goal

- To develop a standard ontology and associated methodology for knowledge representation and reasoning in robotics and automation, together with the representation of concepts in an initial set of application domains.



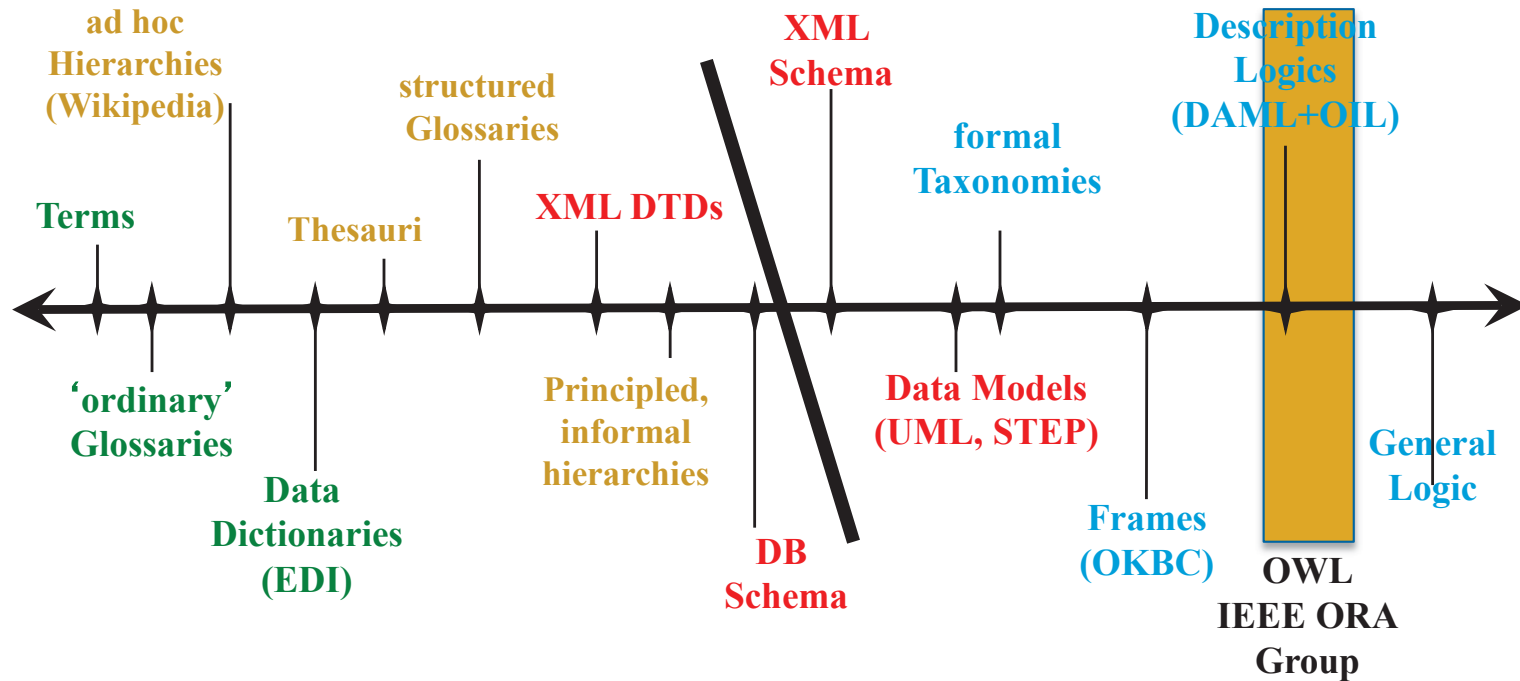
What is an Ontology?

- “a specification of a conceptualization”*
- Ontologies *explicitly* represent key concepts, their properties, their relationships, and their rules and constraints.
- Ontologies often focus more heavily on the *meaning* of concepts as opposed to terms that are used to represent them
- Vocabulary + Structure = Taxonomy
- Taxonomy + (Relationships and Constraints) = Ontology



*Tom Gruber, Stanford Univ.

Formalities of Knowledge Representations



**Glossaries
& Data
Dictionaries**

**Thesauri,
Taxonomi
es**

**MetaData,
XML
Schemas,
& Data
Models**

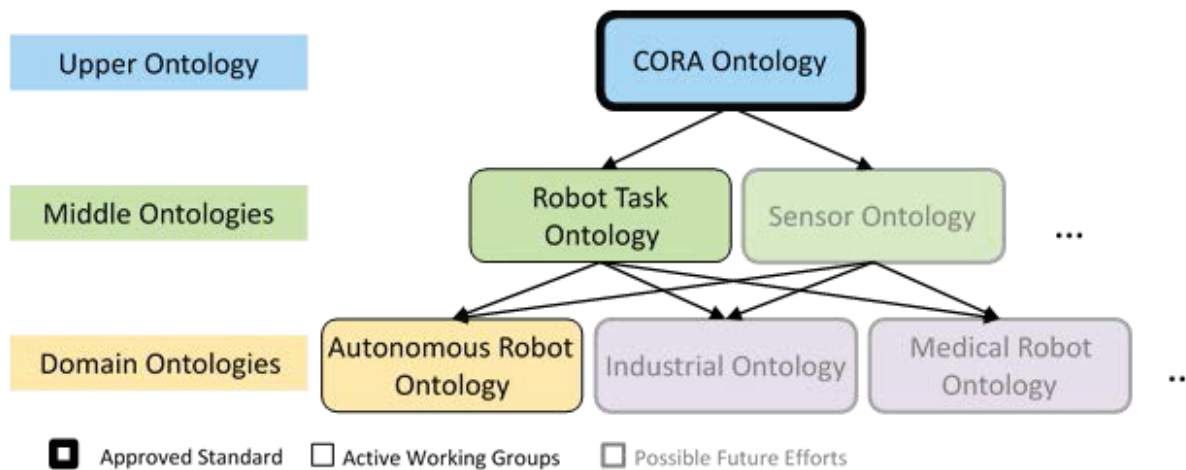
**Formal
Ontologies
& Inference**

Ontologies for Robotics and Automation

Approach

- Top down
 - Upper Ontology / Methodology - Edson Prestes (Brazil)
 - Develop/identify an upper ontology to serve as the overarching structure that information can “hang from”
 - Develop a methodology to add new information to the ontology
- Bottom Up
 - Develop detailed ontologies for a small set of domains
 - Service Robots - Paulo Goncalves (Portugal)
 - Autonomous Robots - Howard Li (Canada)
 - Industrial Robots – Stephen Balakirsky (USA)
 - Domains are intentionally broad to allow for overlapping concepts
- Tying it all together
 - Incorporate the domain ontologies into the upper ontology using the defined methodology
 - Reconcile any discrepancies that exist among concepts

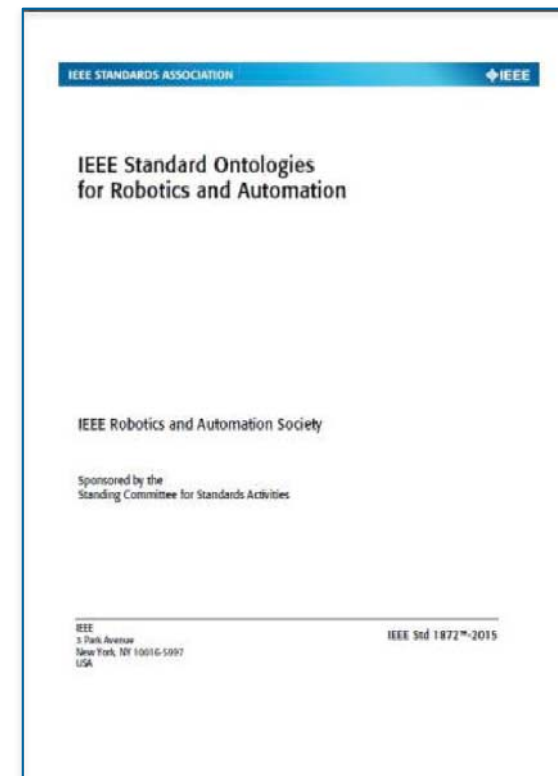
Structure of the IEEE Robotics and Automation Ontologies



- Upper Ontology: Specifies the meaning of high-level, general terms that are applicable across all of the robotics domain.
- Middle Ontology: Specifies the meaning of ubiquitous terms are applicable to many robotics domains. Specializes concepts in the upper ontology.
- Domain Ontology: Specifies the meaning of terms that are primarily relevant to a specific domain. Specializes concepts in the middle ontologies.

Core Ontologies for Robotics and Automation Standard

- IEEE 1872 -Core Ontology for Robotics and Automation (CORA)
 - "... allows for the representation of, reasoning about, and communication of knowledge in the robotics and automation domain."
 - <http://standards.ieee.org/findstds/standard/1872-2015.html>
 - First ontology-based IEEE RAS standard
- IEEE Ontologies for Robotics and Automation Standards Working Group
 - November 2011 – Became a working group
 - July 2014 – Initial standard applied to robots at NIST and Georgia Tech
 - April 2015 – CORA Becomes a Standard (unanimous approval from ballot group)
 - 175 members representing 23 countries
 - ~50% educational institutions, ~25% industry, ~25% government
 - ~50% US, ~50% non-US



C. I. Schlenoff, "Let's Talk, Robots" Scientific Computing Magazine, Scientific Computing, 100 Enterprise Dr. Suite 600, Rockaway, NJ, 07866, United States, (21-Nov-2016)



CORA Recognition and Use

- Won the IEEE-SA Emerging Technology Award (2015) - given once a year to a working group which “advanced, initiated, or progressed a new technology within the IEEE-SA open consensus process.”
 - *“These standards and software modules will allow increased competition in the industrial robot marketplace as well as provide openings to small- and mid-sized companies that have previously been reticent to adopt robot technologies.” Erik Nieves (Yaskawa Motoman -> PlusOne)*
- Prominently featured in two journal special issues
 - Robotic and Computer Integrated Manufacturing Journal entitled “Knowledge Driven Robotics”
 - Industrial Robots journal entitled “Industrial Robot Agility”
- Featured in articles in Engadget and Scientific Computing Magazines
- Mentioned in former President Obama’s “The National Artificial Intelligence Research and Development Strategic Plan”
- Applied to research efforts in numerous institutions such as Georgia Tech and Lund University
- As of June 2018, it has been purchased/downloaded over 1700 times.
 - Undoubtedly applied by many people that we are not aware of

Robot Agility Big Picture (CORA Ontology)

