But, first, let us make it clear how â€¢ human intelligence, â€¢ AI, â€¢ computer intelligence, â€¢ web intelligence, â€¢ agent intelligence, and our subject, â€¢ robotic intelligence, relate to each other: Human intelligence includes all mental activities underl ying human lives. Peer -review under responsibility of the Conference Program Chairs
There isâ€”or was, mostly, in the 1980sâ€”the whole mass of research and trade literature on the much misrepresented Turing test that would ostensibly show whether my unknown in terlocutor is human or a machine, and it was all about intelligence.

Artificial intelligence (AI) emulates parts and aspects of human intelligence in computer applications, where the machine attempts to fulfill a human intellectual task. BDI studies focused on hybrid teamsâ€™ joint intentions
5,6,7, shared plans8,9,10, and some other aspects of intelligent agents 
architecture and implementation11,12,13. The OST ontology equips the CHARMS robots with a sense, heavily bolstered and additionally anchored with its physicality of its:
 Essentially, it is not a text-clustering or data-mining application, where a considerable level of inaccuracy is tolerated, but rather one, in which immediate and precise 
understanding of every command, report, or directive is of essence. Contrary to hybrid human-robot-age nt-collaboration, inter-human collaboration has been studied intensely from several disciplinary and interdisci plinary perspectives: those of sociology, management, industrial engineering/ergonomics, human factors, rhetoric/usability, but it is not easily adjustable to the machine- language algorithmic environment because, inevitably, wh ether explicitly or implicitly, those studies depend on human perception and intelligence. To facilitate robot-human communication, a radically differe nt approach has been attempted, the one similar to the natural development of Pidgin English in the 19th cen tury to mitigate English-Chinese communication in the ports of sea trade, or to the invention of Esperanto, a naive attempt to develop the â€•easiestâ€• natural language that combines the features of the â€•most efficient languagesâ€• so that it could be adopted as the international language. Procedia Computer Science 56 ( 2015 ) 508 â€“ 513
 As the field was growing olderâ€”I donâ€™t want to say, maturingâ€”it became clear that the computer may employ other than human-like methods to achieve some plausible-looking results. Their focus has been on emulating dialog participation by the computer with a single human, and valuable insights have been ach ieved but not concerning real-life robotic agents nor dealing directly with their native systems of communicationâ€”and not with fully semantic methods. 4. The Ontological Semantic Technology (OST) component of CHARMS Throughout this time, our computational semantics, or meaning- and rule-based NLP, has been addressing applications where the very nature of the task calls fo r comprehensive and direct meaning access, and we proceed on the premise that the hybrid communication does not have toâ€”nor will or should itâ€”generate multimillion-word corpora that lend themselves to the statistical methods. While the machines and sensors must be mechanically, optically, etc., improved to the best of the state of the arts, the humans, agents, and robots should contribut e their intelligence, and for us, in robotic intelligence and communication, it means forever maximizing and optimizi ng the autonomy, intelligence, and productivity of the robots. But even thoseâ€”or certainly efforts of the COIN clique--do not reach the level of formality (meaning no human intelligence involve d), sophistication and upward scalability that CHARMS must allow for. The differences between human intelligence and artificia l/computer/robotic intelligences are seriously masked by our increasing abilities to emulate human behavior in th e computer. In fact, if asked to think of a human mental functionality that a robot or any computer is not capable of, an educated mature thinker will mention language, culture, humor , and on all of those counts, the situation is not clear. 1. OST Architecture
It was when Julia Taylor and I, triggered by our pa rticipation in Eric Matsonâ€™s First Summer School on Humanoid Robotics at Purdue in 2011, realized that our ontology was non-language-specific much more strongly: it underlay formal languages and robotic systems just as it did all natural languages, databases, images and other forms of information. Nor should it be read as an attempt to proj ect human collaboration into CHARMSâ€”rather, it is a claim that both should be based on a solid computational semantic foundation. Mihalcea R, Liu H, Lieberman H. NLP (Natural Language Processing) fo r NLP (Natural Language Programming), 7th International Conference on Computational Linguistics and Intelligent Text Processing , LNCS, Mexico City, 2006. In simple terms, ontology-equipped robot â€œunderstandsâ€• the meaning of sensor in exactly the same way as its human partner understand the English wordâ€”or, for that matter, its counterpart in any other language: namely, they relate it to its ontological concept. While there has apparently been no prior work on porting the Na tural Language Processing (NLP) technology, let alone Computational Semantic or any meaning processing t echnology, into supporting the robot/agent communication without limiting it to specific commands or menus, there ha ve, however, been somewhat pertinent efforts in NLP involving intelligent agents, for instance
25,26. 

â€¢ place in the world, â€¢ partners, â€¢ physical parameters, â€¢ position, â€¢ movements, â€¢ repertoire of functions, and many other elements of knowledge that robot designers and users may not be aware of.

Somewhat less pertinently perhaps but not without some relevance to us, there have been some reverberations
18 of the 1980s much misguided philosophical discourse about ways to separate human intelligence from machine intelligence (without knowing much about eith er at the time), in which the Turing Test
19 was loosely metaphorized, if not actually parodied
20,21,22,23 . This paper will explore robotic intelligence as a particular kind of AI (Section 2), argue for the use of natural language, with understanding capabilities by non-humans in CHARMS (Section 3), and briefly mention Ontological Semantic Technology as a mature implementation of this a pproach (Section 4). Since then, our notion of in telligence has changed radically with regard to artificial intelligence while our understanding of our own minds, una dvanced significantly either by the revolutionary progress with mapping the human genome or by mapping out the human brain, has not progressed that much. As we have shown in previous publications, there are several parameters defining the space where CHARMS is; â€¢ Organization:
â—‹ human and other control,
â—‹ division of labor,
â—‹ specialization, optimization, and duplication avoidance, â€¢ Communication:
â—‹ reporting and understanding,
â—‹ interlanguage translation. Natural Language Programming of Agents and Robotic Devices: Publishing for Agents and Humans in English , London, 2008. More pertinent to this research, some of aspects of inter-human collaboration were subsequently extended to intelligent agents, and dominant among those are the belief-desire-intention (BDI) studies of intelligent agents
1,2; rooted in influential scholarship3 on plans and intentionsâ€"see also Wooldridge4. Tambe, M. Towards flexible teamwork, Journal of Artificial Intelligence Research 7, 1997, p. 83-124. 15. Journal of Artificial Intelligence Research 16, 2002, p. 389- Another reason may be that the problem of the communication system among humans, robots, and agents lacks the main premises a nd constituents, such as large corpora of related texts, for the successful applications of currently dominant non-representative, non-rule-based, non-semantic methods. A semantically innocent roboticist, especially one brainwashed by machine-learning-only education should understand that this paper is based on two non-machine-learning principles: it is rule-b ased rather than statistical and it is meaning-based rather than bag-of-words-based. The somewhat simplistic view in early AI, with its largely exaggerated expectations and false hopes, was that if such an application is reasonably successful, we would then understand how human intelligence does it because we would, of course, have designed the computer algorithm ourselves. Part of the reason for that paucity of robot-human communication research would be that active collaboration between agent and NLP research groups, outside of CHARMS, has yet to take off, and, hopefully, this effort may lead to more such interdisciplinary efforts. ROILA
27, a spoken language for talking to robots makes both of these claims: it is billed as simple, easy, and exception-freeâ€"and it is foreign to both sides, human and r obotic, and has to be learned from scratch. In an interesting recent work
35, the mechanical industrial robot was declared to have reached self-awareness because it was programmed to self-check certain elements of itself. And our robot s code for that sensor is just another such word in yet another language. Third, it insists on the semantic approach so that all the HARMS agents "understand" (or even understand) what is going on--along with what is not. Dunin-Keplicz B, Verbrugge R. Collective commitments, International Conference on Multi-agent Systems , 1996, p. 56-63. The computer can barely do anything with unde rstanding, even though it can output tons of text, for instance, answer my command to print out any text, includi ng creating new ones, e.g., the list of all human diseases. Introduction Human-computer interaction has been happening since th e first command was introduced into the computer. Actually, this describes human-human communication as well, does not it? A natu ral language Model for Enabling Human, Agent, Robot and Machine Interaction. Going back to Section 1, CHARMS is designed to make the task of differentiating between manifestations of human and artif icial intelligence even harder than presented there. Keywords: robotic intelligence; robotic communication, ontological semantic technology
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The fascinating difference that robotic intelligence adds is the cyberphysicality of the robots: they do exist in the physical space, which means ha ving dimensions, being subject to time restrictions and abilities to move, etc. It keeps the entire inventory of General Motors automobile parts, in the same number brackets, in its memory, and I, an experienced driver of those cars, can probably list about 30. Probably the closest NLP has ever come to handling problems that are similar to the ones we deal with in this proposal is in the never-dying dream to program in natura l language, a dream that recurs with almost every new approach to NLPâ€"for the latest efforts in this direction, see, for instance
28,29. It is a mature technology that was developed in the 1990s

31, with high-risk NSA grants and developed by Raskin and Taylor with help from Kiki Hempelmann, Max Petrenko and ot her former and current Ph.D. students at Purdue University
32,33,34. Other than serving as research-clique markers, co mputer intelligence and web intelligence cover much overlapping generic territory and are marginal for us here. Both intelligent agents and robots are full-fledged participants of the HARMS hybrid teams, and the whole thrust of the CHARMS system is to maximize the autonomy and, hence, intelligence of the computational components. Unlike many industrial and government ontologies that rarely have many more properties that pure subsumptionâ€"like the Linnean zoology: cat is felineâ€"th e OST ontology is property-rich. Theory, methodology, and implementation of robotic intelligence and communication

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Abstract

This paper makes several uncommon claims. The syntax-, statistics-, and machine-learning-based appr oaches have dominated NLP for several decades and have made very significant inroads into classifying and clustering texts without understandi ng them and without spending efforts on acquiring such resources as machine-tractable repositories of meanings. The computer may easily know all the 37,000 or so human diseases, of which I, a hereditary hypochondriac, may barely think of a hundred. Behavioral and Brain Sciences 3, 1980, 417-424. These efforts are also not satisfactory in NLP applica tions because even their souped-up precision rate of 80% (really, around 60%) is significantly lowe r than the human userâ€™s 95+% expectation of accuracy (make it a maximum 5% error tolerance). Behavioral and Brain Sciences 3, 1980, 429-430. On an automatic acqui sition toolbox for ontologies and lexicons in ontological semantic s. International Conference on Artificial Intelligence , Las Vegas, NE, 2010, p. 863-869. It should be noted that language underdetermines reality, and there are many things that we can perceive only visually, such as, say, the map of Albania or a picture of a human face. Related research in work communication The discrepancy between what CHARMS needs with re spect to organizing and optimizing actual communication among the HARMS partners and what NLP has made availabl e outside of our group is much starker. It is this effort that we refer to24 when talking about the ideal of indistiguishability of communication between a human and a r obot. IBM Watson can defeat human Jeopardy champions, and yet, only the New York Times Tuesday Science section and its multiple trusting readers can believe that the machine is intelligent. It is different than the last two bullets above, which are both firmly in CHARMS land. Web Iintelligence Conference, Lyon, France, 2011.