Natural language processing (NLP) in Artificial Intelligence (AI): a functional linguistic perspective

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This chapter encapsulates the multi-disciplinary nature that facilitates NLP in AI. It identifies work of a linguistically orientated conversational software agent (CSA) (Panesar, 2017) framework sensitive to natural language processing (NLP) concepts, language and the agent environment. A long-standing issue within NLP CSA systems is refining the accuracy of interpretation to provide realistic dialogue to support the human-to-computer communication. Motivated by this, we present novel computational approach of using Role and Reference Grammar (RRG) – a strong, mature, functional linguistic theory as the linguistic engine of a perceiving utterances (via speech act performatives), for further integration, cognitive manipulation and planning to create a grammatical correct RRG based response.

Historically, the CSA's links to the question 'can machines think' (Turing, 1950) making use of dialogue testing to assert intelligence. This question inspired much research and competitions with the yearly Loebner competition to demonstrate human-like conversation ("loebner.net", 2015) with a three times winner Chatbot Mitzuki (Worswick, 2017). We make a distinction between an applied Chatbot and CSA, in that the CSA has a deep strategic role to hold a conversation and enable the mechanisms to focus the conversation on achieving a goal, via NL dialogue (O'Shea et al., 2010).

There is a need to plan, and to decide what do next, and manage the conversation - this is the work of the dialogue manager (DM) (Treumuth, 2011). The CSA's role is that of a linguistic aware knowledge aware process simulating an empowered human to take part in the conversation and ask questions. So how is this goal achieved? This is 'intentionality', in that the agent displays beliefs, desires and intentions (BDI) concerning objects, events and states of affairs in the real world (Searle, 1983). Further, taking the viewpoint of language as action, we view utterances that change the state of the world, and hence speakers and hearer's mental state change as a result of these utterances (Cohen and Levesque, 1988). To achieve this communication and interaction the plan based method of DM using the BDI model architecture is deployed, and is very flexible and supports a greater complexity of conversation (Kluwer, 2011). This CSA investigates the integration, intersection and interface of the language, knowledge, and speech act constructions (SAC) based on a grammatical object (Nolan, 2014a), and the sub-model of BDI (Rao and Georgeff, 1995) and DM for NLP. After deep requirements analysis and considering the works of (Nolan, 2014a, Nolan, 2014b) in regards to DM, a conceptual architecture of the CSA framework is devised, We present an investigation into the intersection and interface between our linguistic and knowledge (belief base) models for both dialogue management and planning.

The architectural approach constitutes three phase models: (1) a linguistic model based on RRG; (2) Agent Cognitive Model (ACM) with two inner models: (a) knowledge representation model employing conceptual graphs (CGs) serialised to Resource Description Framework (RDF) (Chein et al., 2013); (b) a planning model underpinned by BDI concepts (Wooldridge, 2013) and intentionality (Searle, 1983) and rational interaction (Cohen and Levesque, 1990); and (3) a dialogue model employing common ground (Stalnaker, 2002). The CSA framework is mapped to an operational framework, and implemented as a Java prototype, developed in Eclipse IDE, predominantly as POJO (plain old java objects) with some API support, based on a food and cooking domain (ontology) due to its rich and representative (ranging lexical entries) nature.

The validation and verification (VV) approach deployed is based on the phase models and thus is a multi-approach. It is driven by: (1) grammatical testing (English language utterances) and NLP pipeline tasks; (2) software engineering (UML modelling, architecture centric, data structures and algorithms); knowledge representation logics (first order logics and graph theory) and agent practice (message passing, and planning cognitive responses).

The author deems that RRG is as a successful linguistic engine for the CSA, but identify the complexity of the semantic gap of internal representations with subsequent details of a conceptual bridging solution.

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Short biographical note

Dr Kulvinder Panesar is a Senior Lecturer of Computer Science at the School of Art, Design and Computer Science at York St Johns University. Her research work focuses on NLP (Natural Language Processing) in AI (Artificial Intelligence), and meaning and knowledge representation in conversational software agents. Teaching commitments include both undergraduate and postgraduate courses, specifically software engineering design and development; management information systems and strategy; enterprise computing solutions – databases, networks and security; and data science. Additional roles include: course directorship for BSc (Hons) in Software Engineering; placement co-coordinator; 'study abroad' academic advisor and STEM (Science, Technology, Engineering and Mathematics) ambassadorship.

List of similar titles

- A linguistically centred conversational software agent
- Motivating a linguistically centred conversational software agent
- A functional linguistic approach applied to a conversational software agent
- Intersecting, interfacing and intersecting between language and knowledge models of a conversational software agent