

Common Sense Knowledge graph generation for information-gap requests in dialogue systems

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In this study, we propose a methodology to represent Common Sense Knowledge and its application for conversational purposes. Common Sense is defined as “[...] a tremendous amount and variety of knowledge of default assumptions about the world, which is shared by (possibly a group of) people and seems so fundamental and obvious that it usually does not explicitly appear in people’s communications” [Zang et al., 2013, p. 690]. Three aspects of this definition appear to be important for our purposes: i) sharedness, ii) implicitness, iii) communication. These aspects are important in this work as they will guide our conversational agent capable to inferring implicit shared information to process and generate appropriate clarification requests in an incomplete dialogue state, i.e., when relevant arguments of an utterance (mandatory slots) are not filled. This way, the system will be able to pose an appropriate question, such as “Who directed this movie?”, by conversely avoiding *obvious* questions like “Did someone directed this movie?”.

To represent Common Sense, many scholars adopted a graph-based methodology [Zhang et al., 2019, Ilievski et al., 2021, Chang et al., 2021]. In this work, we propose a formal computational procedure to extract this knowledge from graphs databases. We start from the assumption that the accumulation and systematic use of information in our mentalised knowledge allows us to create what we call Common Sense. Similarly, considering a generic knowledge graph, we can extract more basic systematic informative structures forming a sub-graph that represents the Common Sense. For our purpose, we implemented a methodology for Common Sense relationship extractions using the Neo4J framework [Webber, 2012]. Through the use of the Cypher Query language [Francis et al., 2018], we implemented a domain-independent query (Listing 1) to gather information from the JASON movie database [Origlia et al., 2022]. This preliminary query extracts the most systematic relationships between specific types of nodes, starting from their frequency. This can be applied to any kind of domain-specific graph to understand the Common Sense basic concepts.

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MATCH (j:JASONSUBSET)-[r]->(j2:JASONSUBSET)
WITH j2, labels(j) as label, labels(j2) as labels2, apoc.coll.sort(collect(distinct type(r))
) as relations
RETURN apoc.coll.subtract(label, ["CCG", "JASONSUBSET"]) as labels, relations, apoc.coll.
subtract(labels2, [j2.primaryName, "CCG", "JASONSUBSET"]) as labels2, count(relations) as
relationCount
ORDER BY relationCountDESC
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Listing 1: Common Sense Exatraction from a Knowledge Base

Results show that the ontological relationship PART_OF is the most frequent one, connecting 51894 nodes of PERSON and MOVIE types (Table 1). Its domain-specific translations, in order of specificity, are KNOWN_FOR, WORKED_IN, WROTE, and DIRECTED. This information represents the implicit knowledge leading the communicative interaction between the system and the user.

As far as the linguistic realisation of Common Sense knowledge is concerned, a useful approach is provided in cognitive linguistics, i.e., Frame semantics [Fillmore et al., 1976] and FrameNet [Baker et al., 1998]. For instance, the frame **Behind_the_scene** describes the work (i.e., film, play, or similar) produced by an artist. An example of a sentence evoking this type of frame can be labelled as follows:

Node A	Relationship	Node B	Freq
[PERSON]	[DIRECTED,KNOWN_FOR,PART_OF,WORKED_IN,WROTE]	[MOVIE]	51894
[AWARDINSTANCE]	[AWARDED_FOR]	[MOVIE]	3267
[AWARDINSTANCE]	[AWARDED_TO]	[PERSON]	3058
[MOVIE]	[HAS_GENRE,PART_OF]	[GENRE]	2214
[PERSON]	[KNOWN_FOR,PART_OF,WORKED_IN]	[MOVIE]	1269
[AWARDINSTANCE]	[IS_A]	[AWARD]	1112
[PERSON]	[DIRECTED,PART_OF,WORKED_IN,WROTE]	[MOVIE]	871
[PERSON]	[PART_OF,WORKED_IN]	[MOVIE]	326
[PERSON]	[DIRECTED,KNOWN_FOR,PART_OF,REVIEWED,WORKED_IN,WROTE]	[MOVIE]	112

Table 1: Most frequent Common Sense relationships extracted; occurrences less than 100 were left out.

Scorsese^{Artist} **is DIRECTING**^{LU} *The Goodfellas*^{Production}

Whereas the specific knowledge entailed in this sentence, namely the fact that Scorsese directed The Goodfellas, represents a piece of information which is grounded or eligible to be part of the Common Ground [Clark, 1996], the type of relation between the uttered concepts and the type of concepts themselves represent what is defined as Common Sense [Cambria et al., 2009]. The application of FrameNet and graph databases will be integrated in our dialogue system to compensate for information gaps emerging in conversation among users and a conversational agent and the consequent generation of appropriate questions. The advantage of such a linguistic application of Common Sense, can lead to a deeper understanding of Common Sense Knowledge to manage innovative conversational agents.

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