

A Survey of Commonsense Knowledge Organization, Structuring and Categorization

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An example of commonsense knowledge (CK)

"Jenny walked through the rain into the library across the street"
→ Jenny got wet
→ Easy for humans to understand
→ Machines have to be told that explicitly



Research Question Background and Motivation

→ Our understanding of CK is very ambiguous, and CK research has been rising since the 90's
→ Reviewing how existing literature comprehends CK in AI opens up room for further research
→ Surveying how CK could be organized, structured, and categorized provides insights into the current state of CK research
→ Focus on the example resources for representative public commonsense sources found within the CSKG (Figure 1)



Categorization

→ Reviews how existing work builds up a taxonomy of CK
→ Each knowledge source has a different set of criteria/relations on which it is categorized
→ The way a KG is categorized can determine its use, strengths, and weaknesses
→ There are 13 dimensions in which CK is categorized, which shows the coverage of each knowledge source (Table 1)
→ 5 general principals to consolidate sources into the CSKG
→ 3 main techniques to categorizing commonsense reasoning (Figure 5)
→ KG research itself is categorized in 4 ways (Figure 6)

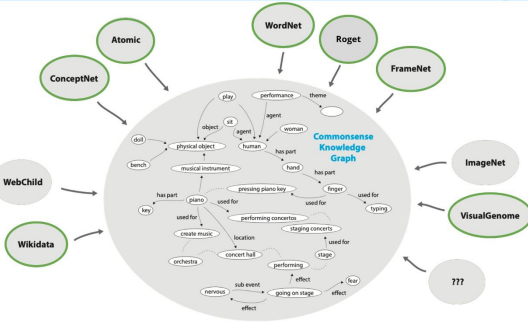


Figure 1: Overview of CSKG [1]

Source	Category	Dimensions	Format
ConceptNet	Commonsense 1-10, 12, KGs	1-10, 12, 13	Triples
WebChild	Commonsense 2, 4-6, 8, KGs	2, 4-6, 8, 10-13	Triples
ATOMIC	Commonsense 9, 10, 12, KGs	9, 10, 12	Triples
WikiData	Common 1-8, 10, 12, 13	1-8, 10, 12, 13	Linked statements
WikiData CS	Commonsense 1-8, 10, 12, 13 *	1-8, 10, 12, 13 *	Tabular
WordNet	Lexical resources	1-5	Linked synsets
Roget	Lexical resources	2, 3	Thesaurus
VerbNet	Lexical resources		Tabular
FrameNet	Lexical resources	1-4, 8, 10, 12, 13	Frame elements
Visual Genome	Visual sources		Scene graphs
ImageNet	Visual sources		Linked synsets

Table 1: Overview of commonsense knowledge sources, the format in which they are stored and their corresponding relations [2]

Structuring

→ Refers to the format in which CK can be stored
→ Depending on this structure, a KG can be transformed, created, enhanced, or analyzed in different ways
→ Table 1 shows the different formats of the representative public CK sources
→ The most used format for knowledge graphs (KGs) is the triple (Figure 3).
→ When consolidating different knowledge sources the Knowledge Graph Toolkit (KGTK) format is used (Figure 4)
→ The KGTK format represents KGs as hypergraphs

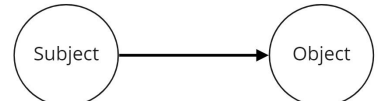


Figure 3: Triples, such as SPO (Subject, Predicate, Object) For example: (losing weight, UsedFor, being healthier)

The integrated Commonsense Knowledge Graph (CSKG) consists of

- 7 key sources
- 2.3M nodes
- 6M edges

Organization

→ Refers to the design schema/ontology of CK
→ The way CK is organized can give a direction for the schema a KG uses
→ A Winograd schema (WS) is a pair of sentences that differ only in one or two words (Figure 2)
→ The Semantic Web is an extension of the World Wide Web, aiming to make the internet more machine-readable
→ Other usages such as
• automatically identifying and managing implicit requirements
• organizing opinions and sentiments extracted from the web
• aiding in emotive reasoning and building topic-specific ontologies for CK topics.

The fish ate the worm. It was hungry.
The fish ate the worm. It was tasty.

Figure 2: A pair of questions in WS challenge that only differ by the final word, which changes the context [4]

Conclusion & Future Work

→ CK is also used in enterprise applications such as e-commerce or financial decision-making
→ Consolidating sources of CK has many challenges & shortcomings on CK reasoning tasks and knowledge base coverage
→ Even then there is great utility in CSKGs with CK finding applications in AI and the CK field still being researched

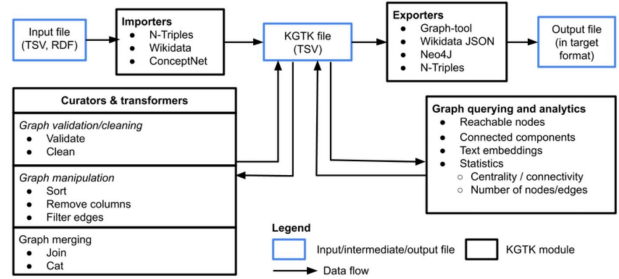


Figure 4: Overview of the different capabilities of KGTK [5]

13 dimensions (numbers corresponds to those in Table 1)

1. lexical
2. similarity
3. distinctness
4. taxonomic
5. part-whole
6. spatial
7. creation
8. utility
9. desire/goal
10. quality
11. comparative
12. temporal
13. relational-other

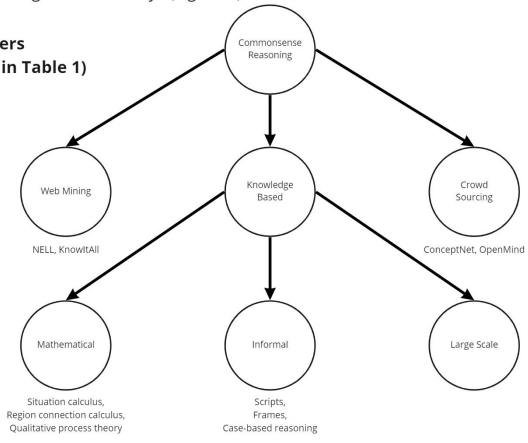


Figure 5: Taxonomy of approaches to commonsense reasoning [3]

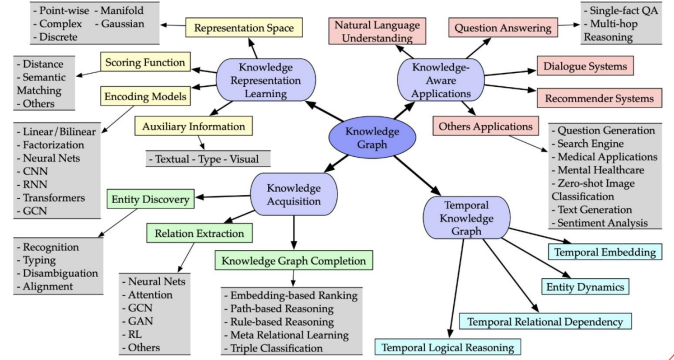


Figure 6: Categorization of KG research [6]

1. Iliievski, F., Szekely, P., & Zhang, B. (2021, June). Cdkg: The commonsense knowledge graph. In European Semantic Web Conference (pp. 689-696). Springer, Cham.
2. Iliievski, F., Oltzarni, A., Ma, X., Zhang, B., McGuinness, D. L., & Szekely, P. (2021). Dimensions of Commonsense Knowledge. arXiv preprint arXiv:2101.04560.
3. Davis, E., & Marcus, G. (2015). Commonsense reasoning and commonsense knowledge in artificial intelligence. Communications of the ACM, 58(9), 92-103.
4. Zhang, H., Zhao, X., & Song, Y. (2020). WinOWhy: A deep diagnosis of essential commonsense knowledge for answering Winograd schema challenge. arXiv preprint arXiv:2005.05763.
5. Iliievski, F., Ganjo, D., Chaloujsky, H., Divvala, N. T., Yao, Y., Rogers, C., ... & Szekely, P. (2020, November). KGTK: a toolkit for large knowledge graph manipulation and analysis. In International Semantic Web Conference (pp. 278-293). Springer, Cham.
6. Ji, S., Pan, S., Cambria, E., Martinen, P., & Philip, S. Y. (2021). A survey on knowledge graphs: Representation, acquisition, and applications. IEEE Transactions on Neural Networks and Learning Systems, 33(2), 494-514.