A Survey of AMR Applications

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Abstract

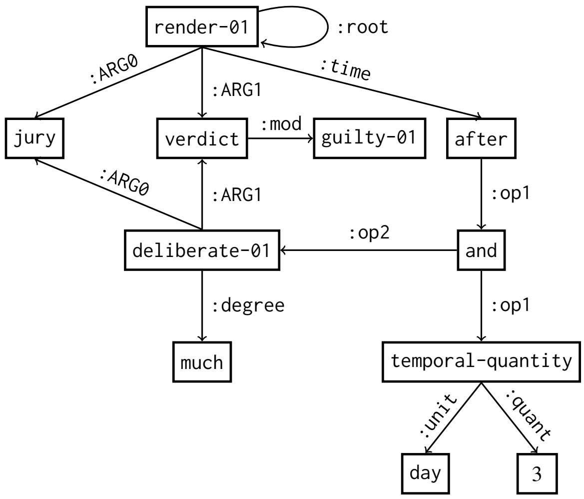
In the ten years since the development of the Abstract Meaning Representation (AMR) formalism, substantial progress has been made on AMR-related tasks such as parsing and alignment. Still, the engineering applications of AMR are not fully understood. In this survey, we categorize and characterize more than 100 papers which use AMR for downstream tasks—the first survey of this kind for AMR. Specifically, we highlight (1) the range of applications for which AMR has been harnessed, and (2) the techniques for incorporating AMR into those applications. We also detect broader AMR engineering patterns and outline areas of future work that seem ripe for AMR incorporation. We hope that this survey will be useful to those interested in using AMR and that it sparks discussion on the role of symbolic representations in the age of neural-focused NLP research.

1 Introduction

Abstract Meaning Representation (AMR; Banarescu et al., 2013) is a semantic representation that takes the form of a rooted, directed graph. Since the release of AMR in 2013, a full AMR-ecosystem has emerged, with substantial research activity on AMR annotation, text-to-AMR parsing, AMR-to-text generation, and domain- and language-based extensions of AMR.[1] In particular, the progress on text-to-AMR parsing and AMR-to-text generation has propelled work using AMR for various NLP applications. To date, downstream applications of AMR have been spread across numerous tasks and have found varying degrees of success.

Thus, given the recent advancements for and with AMR, this survey addresses the pressing question: how can AMR be used for engineering purposes and downstream applications? Our main goals of this investigation include (1) providing an overview of the many *application areas and tasks* where AMR has been applied, (2) examining *what techniques* have been used to leverage AMR for NLP systems, and (3) detecting *new avenues* for future applications of AMR in NLP research.

Our investigation is also motivated by the prevalence of large language models (LLMs) that seem to be able to generalize across a large suite of NLP tasks, prompting consideration of how semantic representations can remain useful. We hope that




```
(r / render-01
    :ARG0 (j / jury)
    :time (a / after
        :op1 (a2 / and
            :op1 (t / temporal-quantity
                :unit (d / day)
                :quant 3)
            :op2 (d2 / deliberate-01
                :degree (m / much)
                :ARG0 j
                :ARG1 v)))
    :ARG1 (v / verdict
        :mod (g / guilty-01)))
```

Figure 1: The AMR for the sentence "After 3 days and much deliberation, the jury rendered a guilty verdict," as a graph (top) and as a string in PENMAN notation (bottom).

[1] Currently, the AMR Bibliography contains more than 450 papers: https://nert-nlp.github.io/AMR-Bibliography/.

our survey will serve both as a useful starting point and a source of inspiration to those interested in working with AMR.

2 Abstract Meaning Representation

2.1 AMR Formalism

Semantic representations such as AMR aim to convey the meaning of a text and can be designed to focus on specific aspects of meaning. AMR is specifically designed to reflect "who does what to whom" as the schema centers on predicate-argument relations. By abstracting away from the surface form, two sentences with equivalent meaning and content words should be represented by the same AMR graph. Among semantic representations, AMR is particularly popular and well-resourced (Sadeddine et al., 2024).

AMRs are rooted and directed, and can be represented in graph form or in the text-based PENMAN notation (Kasper, 1989) (an example AMR in both forms is shown in Figure 1); text-based AMRs are also called *linearized*, and often appear condensed onto one line for ease of neural encoding. Concepts correspond to nodes in the graph, and edges denote relationships between those concepts. These concepts can occupy core argument roles (i.e. `:argN`) or non-core roles (e.g. `:time` and `:domain`). AMR makes use of PropBank frame files (Palmer et al., 2005) to indicate the sense of each concept in the graph, as well as to specify the arguments associated with each concept. AMR annotation is unanchored, so individual tokens do not necessarily align with specific concepts in the graph. Coreferent concepts are reflected in AMR graphs as re-entrant graph nodes.

AMR also notably does not represent morphology or tense, meaning that annotation is fairly lightweight. Inter-annotator agreement is typically measured quantitatively using Smatch (Cai and Knight, 2013), which calculates graph overlap via hill climbing. Embedding-based metrics which measure AMR graph overlap include monolingual S2match (Opitz et al., 2020) and multilingual XS2match (Wein and Schneider, 2022).

AMR was originally designed for English and was not intended to serve as an interlingua (Banarescu et al., 2013), but the schema has since been considered for or adapted to numerous other languages: Czech (Urešová et al., 2014), Chinese (Xue et al., 2014; Li et al., 2016), Spanish (Migueles-Abraira et al., 2018; Wein et al., 2022), Vietnamese (Linh and Nguyen, 2019), Korean (Choe et al., 2020), Portuguese (Sobrevilla Cabezudo and Pardo, 2019; Anchiêta and Pardo, 2018; Inácio et al., 2022; Baptista et al., 2024), Turkish (Azin and Eryiğit, 2019; Oral et al., 2022), Persian (Takhshid et al., 2022), and German (Otto et al., 2024).

Multilingual adaptations of AMR which are not specific to one individual language include Uniform Meaning Representation (UMR; Van Gysel et al., 2021) and BabelNet (Martínez Lorenzo et al., 2022). Some extensions of the AMR schema incorporate tense and aspect (Donatelli et al., 2018; Bakal, 2021), while others move beyond the sentence level (O'Gorman et al., 2018; Moreda et al., 2018; Naseem et al., 2022). Many engineering applications of AMR have focused on English, likely due to English AMR tools currently being the most widely available and accurate.

2.2 AMR Parsing and Text Generation

Two crucial AMR-intrinsic tasks are text-to-AMR **parsing** and AMR-to-text **generation**. Both tasks are actively researched, monolingually and multilingually. Substantial efforts towards highly accurate parsing and generation contribute further to the interest in using AMR for downstream applications.

Parsing and generation models now tend to leverage pre-trained Transformers that are fine-tuned on linearized AMR graphs (Bevilacqua et al., 2021). Current models can parse and generate quite accurately, reporting Smatch scores upwards of 86% for parsing (Lee et al., 2022b; Vasylenko et al., 2023) and more than 50 BLEU (Papineni et al., 2002) points for generation (Cheng et al., 2022).

Thus, while AMR parsing and generation are not yet solved (Opitz and Frank, 2022a; Groschwitz et al., 2023), model performance is quite high, and success towards semantically consistent parsing and generation (Kachwala et al., 2024) has led to a spike in the downstream utility of AMR.

3 Applications of AMR

In this section, we will discuss the broad categories of downstream uses of AMR in natural language processing. We present more than 20 individual areas of application, and discuss how each work incorporated AMR.

3.1 AMR for Meaning-Focused Tasks

Intuitively, the tasks which have most often seen AMR incorporated are *tasks which focus on elu-*

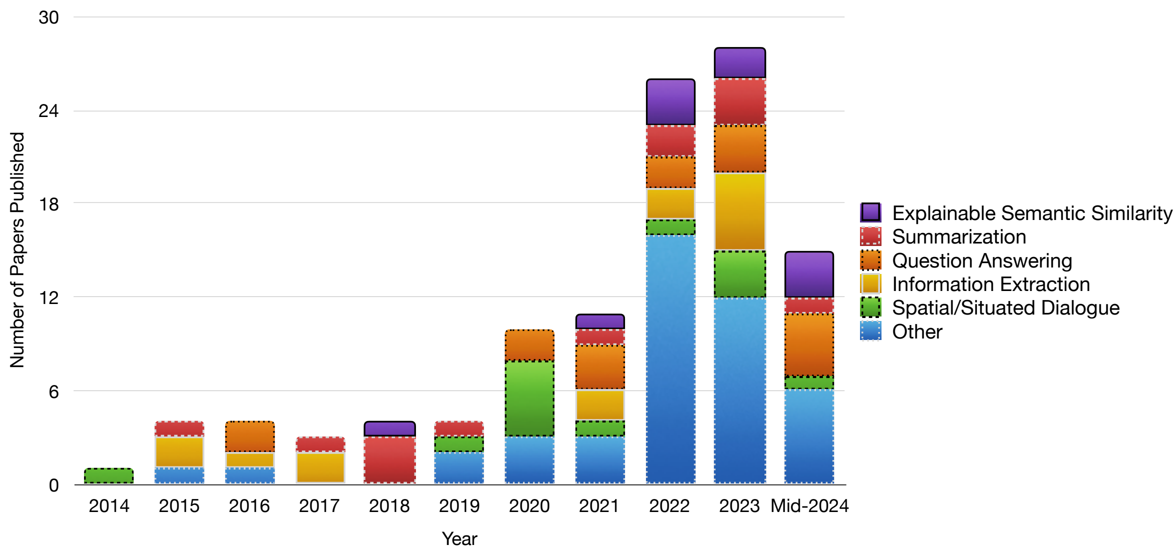


Figure 2: Bar chart of the number of papers using AMR in downstream applications per year, from 2014 to 2024 (year to date). The 5 most common application areas are individually shown, with all other areas grouped into the "Other" category.

cidating the core elements of meaning. Broadly, the meaning-focused tasks which have seen AMR leveraged fall under information extraction, question answering, and summarization; these areas overlap, particularly information retrieval and question answering, as the former can be an important step for the latter.

Information Retrieval/Extraction. Early AMR investigations for information retrieval/extraction focused on the **biomedical domain**. Biomolecular interactions elicited via AMR have been used in classifiers to outperform state-of-the-art interaction models (Garg et al., 2016; Wang et al., 2017). Notably, Rao et al. (2017) showed that biomedical events are subgraphs of full AMR graphs and developed an LSTM model (Hochreiter and Schmidhuber, 1997) to identify those event subgraphs. Zhang et al. (2021) performed biomedical information extraction by creating an AMR graph enhanced with information from an external knowledge base. These enhanced AMR graphs were then encoded into a graph attention network, leading to an improvement over state-of-the-art methods.

Models for **event extraction** have also incorporated AMR, occasionally outperforming state-of-the-art models. First, Li et al. (2015) added AMR features in the form of node-relation unigrams and bigrams to an event detection model. More recently, Xu et al. (2023) created new event extraction labels by using an existing event extraction model and an AMR parser to compute a compatibility score between the event and an argument. Yang et al. (2023) performed event structure extraction by identifying whether there is an edge connecting the event and the argument, parsing an AMR and then using a Graph Neural Network (GNN) to predict whether there is an edge. Again outperforming state-of-the-art event extraction models, Hsu et al. (2023) produced a linearized AMR, encoded it with a neural network, and prepended the encoding to the neural text embedding.

More specifically than general event extraction, Zhang and Ji (2021) performed **entity and relation extraction** by training an AMR encoder and using AMR parses in order to determine the order of decoded events. This work outperformed prior state-of-the-art models on information extraction by multiple F1 points. Gururaja et al. (2023) compared the utility of different sorts of linguistic graphs for Transformer-based models for relation extraction, finding that AMRs were most useful in few-shot settings. Pan et al. (2015); Steinmetz (2023) performed entity linking by mapping named entities onto concepts in AMR graphs.

At the **document level**, Xu et al. (2022) performed event extraction using text embeddings combined with document-level and sentence-level AMR graphs, outperforming prior state-of-the-art systems, and Zhao et al. (2023) encoded document-level AMR graphs in a GNN for relation extraction.

Finally, Müller and Kuwertz (2022) extracted relevant information from remote sensing database management systems, using AMR graph overlap metrics to measure semantic relevance.

Question Answering and Knowledge Graphs. When incorporating AMRs into question answering models, prior approaches have combined AMR graphs with a formal reasoning layer (Mitra and Baral, 2016) and sentence embeddings (Park et al., 2024). On the other hand, Bonial et al. (2020b) used AMR graphs directly, parsing medical questions (about COVID-19) into AMRs and comparing them against AMR graphs of possible answers. The answers were then ranked by similarity and the most similar response AMR was returned as the answer.

Regan et al. (2024) created multilingual AMR graphs of questions and developed a joint AMR-SPARQL parsing model for **hallucination detection** in knowledge base question answering (KBQA). For direct use in **KBQA**, AMR graphs have been converted into SPARQL queries (Bornea et al., 2021; Kapanipathi et al., 2021; Shivashankar et al., 2022). Similarly, AMRs have been used to produce Resource Description Framework (RDF) knowledge graphs (Burns et al., 2016; Meloni et al., 2017; Gangemi et al., 2023), and to semantic roles for a climate-focused knowledge base (Islam et al., 2022).

For **multi-hop question answering** (questions which require multiple steps to reach the answer), Xu et al. (2021) parsed AMR graphs of the hypothesis and the relevant facts and merged them, while Deng et al. (2022) segmented AMR parses of the question into subgraphs, and generated subquestions via AMR-to-text generation of the subgraphs. Similarly, for **open domain question answering** (ODQA), Wang et al. (2023) integrated AMR graphs of the relevant facts from a text by appending a single token embedding of each concept or relation in the AMR graph to the text embedding. Shi et al. (2024) performed ODQA via retrieval augmented generation (RAG), using an AMR-based algorithm to compress textual information into individual concepts. Pham et al. (2024) conditioned QA systems on AMR graphs, finding the approach works best with small models, which then outperformed very large LLMs such as ChatGPT.

The task of **machine comprehension**, which involves systems producing answers about a text, has also benefited from comparison between text and AMR graphs (Galitsky, 2020), with Sachan and Xing (2016) framing machine comprehension as a graph entailment problem. Towards question answer **dataset creation**, Rakshit and Flanigan (2021) parsed AMRs of sentences to generate question-answer pairs.

Summarization. AMR use in summarization has taken various approaches, often by parsing and joining AMR graphs of the sentences determined to be the most important. For instance, Dohare et al. (2017); Liao et al. (2018) picked the most important sentences from a text and created a single AMR graph from those sentences, then generated a short summary from key subgraphs.

Rather than parsing only the most important sentences, Liu et al. (2015) parsed individual AMR graphs of a text, combining them into one "summarization" graph by collapsing multiple concepts into single nodes with new concept labels, and then generating text from the summarized AMR. Variations of this approach have been proposed by Hardy and Vlachos (2018); Kouris et al. (2022).

Numerous approaches to **genre-specific summarization**, such as opinion summarization (Inácio and Pardo, 2021), TV transcript summarization (Hua et al., 2022), timeline generation (Mansouri et al., 2023), long dialogue summarization (Hua et al., 2023), and abstractive summarization of biomedical documents (Frisoni et al., 2023) have all seen the incorporation of AMR. Some of these works have leveraged AMRs by parsing AMRs of the text and then incorporating them into an LLM via an attention mechanism (Hua et al., 2022, 2023; Frisoni et al., 2023). In a non-English setting, Severina and Khodra (2019) used AMR for Indonesian multi-document summarization.

As a **post-hoc refinement step** for text summarization, Ming et al. (2018) used AMR and WordNet (Miller, 1995; Fellbaum, 1998) to filter out redundant information.

3.2 AMR to Abstract Away from the Surface

Following the logic that AMR "abstracts" away from the surface form, recent work has exploited AMR to produce new text with the same meaning as the original text. This work often uses AMR as an intermediate representation, i.e., parses an AMR from a text and then generates new text from the parsed AMR.

Style Transfer. Jangra et al. (2022) leveraged AMR as an intermediate representation to generate a paraphrase in a different style, using a fine-tuned

Transformer-based AMR parser (encoder) and multiple Transformer-based text generators (decoders) for various text styles. Shi et al. (2023) also used AMR as an intermediary, parsing an AMR graph from the text and performing concept-level style rewriting on the AMR graph (modifying the words to a different genre), achieving state-of-the-art results.

Paraphrase Generation. Prior work has utilized AMR for paraphrase generation by producing paraphrases directly from AMR graphs (Huang et al., 2023; Bao et al., 2023), occasionally altered with additional information (Lee et al., 2022a; Tu et al., 2024), or by injecting an embedding of an AMR into a Transformer model (Huang et al., 2022).

As AMR inherently preserves semantic similarity, Huang et al. (2023) used AMR directly as an intermediary to generate syntactically diverse paraphrase sets. They changed the root of the parsed AMR in order to be able to produce multiple AMRs,[2] and thus multiple sentences via AMR-to-text generation. Similarly, Shou et al. (2022); Ghosh et al. (2024) tackled data augmentation by parsing AMR graphs of the text, then editing them and generating new text.

Grammatical Error Correction. Cao and Zhao (2023) constructed denoised AMR graphs of sentences with grammatical errors and incorporated them into a sequence-to-sequence model as additional knowledge, achieving significantly higher precision and recall than the text-only baseline.

Machine Translation. Multiple approaches to neural machine translation have seen performance improvements when incorporating AMR as additional knowledge (Song et al., 2019; Nguyen et al., 2021). Li and Flanigan (2022) in particular observed performance gains when integrating AMR graphs into both the encoder and decoder of a Transformer model. Jin et al. (2024) on the other hand found that feeding an AMR in a zero-shot prompting setting with LLMs did not improve—or even hurt—performance.

AMR can also be used as an intermediary for a translation post-processing step in order to reduce the presence of translation artifacts (*translationese*, Wein and Schneider (2024b)).

[2]In AMR, the root indicates the linguistic *focus* of a sentence. Thus, changing the root of the AMR of the sentence "the cat drinks water" from *drink* to *water*, will yield a paraphrase such as "it is water that the cat drinks."

3.3 AMR for Domain-Specific Adaptations

Given that some syntactic content is not included in AMR graphs, the AMR schema has been adapted as necessary for specific domains.

Math. Two recent works addressed how formulas conveyed in text should be accommodated within AMR graphs. Iordan (2021) developed an AMR parser with an added coreference detection feature to parse AMR graphs from descriptions of geometry problems, and Mansouri et al. (2022) incorporated embeddings of altered AMRs into an LLM for extracting formulas.

Legal Reasoning. As is the case for math, domain-specific language in legal documents necessitates alteration of the AMR formalism. Vu and Nguyen (2019) evaluated the (generally poor) performance of AMR parsers on legal documents; further, Schrack et al. (2022) showed that neuro-symbolic methods which include linearized AMR graphs do not outperform text-only methods on multiple choice question answering for legal reasoning, but do offer a complementary signal. To address these challenges, Vu et al. (2022) introduced a human-annotated dataset of AMRs in the legal domain.

Spatial/Situated Dialogue. A fruitful line of AMR application research has focused on spatial/situated dialogue, in particular on **human-robot interaction**.[3] Numerous datasets of AMR graphs of human-robot interactions have been created (Bastianelli et al., 2014; Shichman et al., 2023). An altered AMR schema called "Dialogue-AMR" (containing information on tense, aspect, and speech acts) supports the representation of human-robot interactions (Bonial et al., 2019; Abrams et al., 2020; Bonial et al., 2020a, 2021, 2023). Ultimately, this has enabled grounded natural language understanding for human-robot interactions.

Other work in spatial and situated AMR (unrelated to human-robot interaction) has also accounted for the necessity of altering AMR to include **grounding language**. Datasets of AMR graphs for multimodal dialogue have incorporated gestures (Donatelli et al., 2022; Lai et al., 2024) and spatial information (Bonn et al., 2020; Dan et al., 2020) into the AMR schema. Martin et al.

[3]While AMR-based dialogue understanding work has been primarily focused on human-robot dialogue, Bai et al. (2022) achieved state-of-the-art performance on general dialogue understanding by using AMR to continuously pre-train a Transformer encoder.

(2020) crowdsourced AMR annotations of text containing spatial information and Tam et al. (2023) investigated action annotation in AMR.

System Requirements. Lamercerie and Foret (2021) altered AMR graphs of system requirements by grouping subgraphs of individual desired properties of the system.

Recipe Instructions. Similarly to the work done on system requirements, Stein et al. (2023) modified AMR graphs for recipes, breaking down sentence-level AMR graphs into graphs of individual actions in the recipe.

3.4 AMR for Image and Speech

As a semantic representation, AMR has been converted into other types of text-based formalisms (such as SPARQL in §3.1 and UMR (Post et al., 2024)), as well as leveraged in support of non-text-based forms of media such as images and speech.

Images. Recent work has investigated the use of AMR for **scene graph parsing**, which is the production of a graph-based representation of object boundaries in images. Choi et al. (2022a,b) converted AMR graphs into scene graphs, while Abdelsalam et al. (2022) explored the use of AMR *as an alternative* to scene graphs (via image-to-AMR parsing).

Image captioning has employed AMR in order to focus on specific aspects of meaning or task-specific difficulties. Neto et al. (2020) used AMR to produce descriptions of specific regions of an image, and Kim et al. (2024) used the relationship between the sentence and object (via AMR) for caption debiasing. Finally, Bhattacharyya et al. (2024) and Chen et al. (2024) leveraged semantic relations from AMR and the image to guide caption generation.

Speech. Little work has investigated the utility of AMR for speech systems, though Addlesee and Damonte (2023) addressed nonstandard speech as an accessibility issue for voice assistants by producing a corpus of AMR graphs of disrupted speech, and training models on this data.

3.5 AMR for NLG Evaluation

AMR's nature as an interpretable semantic representation lends itself to evaluation-based tasks.

Dialogue Evaluation. Ghazarian et al. (2022) developed a robust dialogue coherence measure by training on negative text examples that are generated from AMRs which were manipulated in controlled ways, e.g., introducing contradictions by changing node labels to antonyms. The resulting model achieves significantly better correlation to humans than other text- and graph-based baselines. On the same task, Yang et al. (2024) showed that performance improvements can also be achieved by fusing text and AMR in a model using a dual-encoder, thus more directly using the AMR.

Summary Evaluation. Ribeiro et al. (2022) trained a model that leverages AMR as auxiliary information in a dual encoder, outperforming strong QA-based and NLI-based **summary factuality** models. Addressing the same task, Qiu et al. (2024) produced training examples with manipulated AMRs, resulting in a state-of-the-art factuality prediction model. Tackling the second pillar of summary quality, being **summary relevance**, Nawrath et al. (2024) split AMR graphs of summaries into subgraphs with the aim to generate Summary Content Units (clauses that identify sub-sentential content in summaries (Nenkova and Passonneau, 2004)). In this case, the results were more mixed and the authors noted that development of advanced splitting methods is necessary for improved results. As a general **summary interpretability** method, Landes and Di Eugenio (2024) developed an AMR-alignment tool for the inspection of summaries, aligning parts of the summary with the evidence in the source document.

General Evaluation and Diagnostics. Opitz and Frank (2021) used AMR metrics to compare AMR graphs of candidates and references, enabling measurement of fine-grained text quality aspects like polarity or coreference faithfulness. Using AMR metrics to evaluate NLG quality is limited by current parsing inaccuracies (Manning and Schneider, 2021).

3.6 AMR for Language Studies

AMR is a linguistic tool which has been utilized for language-focused research and teaching.

Linguistic Research. Sawai et al. (2015) used AMR to build a model that answers statistical research questions about the semantic structure of noun phrases.

Teaching. The investigation of the meaning of a text emerges as an intriguing and interesting classroom exercise. In particular, given its linguistic specificity and interpretability, AMR can help students learn about linguistic structures, as exemplified in the lesson and exercise on AMR in Eisenstein (2021).

3.7 AMR for Explainable Semantic Similarity

AMR-based metrics are of wider interest in measuring semantic similarity and relatedness, beyond NLG evaluation (c.f. §3.5). Intuitively, we can parse two input texts and calculate AMR similarity, providing an additional layer of interpretability and explainability via AMR.

AMR metrics have been used for detecting paraphrases (Issa et al., 2018), evaluating the answers provided by language learners on reading comprehension questions (Dellert, 2020), judging argument and text similarity (Opitz et al., 2021b), and matching local knowledge graphs (Kachwala et al., 2024). Furthermore, assessing structural graph isomorphism in the AMRs of multilingual texts achieves finer-grained semantic equivalence judgments than neural methods (Wein et al., 2023). Incorporating AMR graphs and AMR metrics into neural models for **natural language inference** has also been of value (Opitz et al., 2023; Feng and Hunter, 2024; Bao et al., 2023).

Neural text embedding models such as SBERT (Reimers and Gurevych, 2019) and SimCSE (Gao et al., 2021) have been retro-fitted by encoding AMR graphs (Cai et al., 2022). Alternatively, semantic **embedding interpretability** has been induced by binding parts of embeddings to semantic features such as negation, semantic roles, or named entities, that can be measured with AMR metrics (Opitz and Frank, 2022b). In the same direction, Fodor et al. (2024) found that state-of-the-art transformers "poorly capture the pattern of human semantic similarity judgments", and AMR can be used to build simple methods that combine semantic compontents into an improved hybrid model.

3.8 Miscellanea

Finally, we discuss miscellanea, which are either applications where the impetus behind the use of AMR may be less obvious, or applications that escape a categorization into the above classes. Firstly, AMRs have been employed for **commonsense reasoning**, using different strategies: tracing reasoning paths through AMRs (Lim et al., 2020), enriching AMRs with relations from a Commonsense Knowledge Graph (Oh et al., 2022), and within a neuro-symbolic approach where AMR is converted into first-order logic (Chanin and Hunter, 2023). AMR has also been used for **sentiment analysis** (Ma et al., 2023) and to generate feedback for **reinforcement learning** in text-based games (Chaudhury et al., 2023). Elbasani and Kim (2022) parsed AMRs of the text and then used that as input to a convolutional neural network for **toxic content detection**. For a similar task–**fake news detection**–Gupta et al. (2023) used text-based features in conjunction with AMR graphs to classify whether a tweet is fake news. Finally, AMR has been used to perform general **text classification** (Ogawa and Saga, 2023).

4 Engineering with AMR

In the prior section, we categorized AMR applications by task in order to provide an overview of the AMR application landscape, showcasing AMR as a general-purpose representation. In this section, we describe and provide a functional guide to the techniques and patterns which have allowed AMR to be leveraged for the aforementioned engineering purposes.

4.1 AMR Preparation

As an initial step in working with AMR, many applications conduct operations on the AMR graph. We observe frequent use of the following three types of operations: pre-processing, splitting/merging, and encoding.

AMR pre-processing can range from simple string changes to more elaborate graph transformations. Examples of simple string changes include lower-casing or truncating the concept labels. **Graph transformations** that preserve the equivalency of AMRs can include *reification* (Opitz et al., 2021a; Shou and Lin, 2023), where, with the help of a dictionary, we 'generalize' binary edge labels to n-ary structures. Alternatively conversion to a *Levi Graph* (Beck et al., 2018; Lim et al., 2020) which is a bipartite graph without edge labels, alleviates the need to handle edge labels in some specific way other than node labels (see Appendix A for examples of these transformations).

AMR splitting and merging can also come in handy. For example, AMRs are split to find the largest common sub-structures in question answer pairs (Deng et al., 2022), or to extract subgraphs that elicit specific aspects of meaning such as polarity or semantic roles (Opitz and Frank, 2022b; Opitz, 2023). Merging can be applied by first matching concepts or named entities from two graphs, and then connecting or fusing nodes that represent the same entities (Liu et al., 2015; Lee et al., 2021), possibly leveraging advanced coreference resolution within AMR (Fu et al., 2021). In the simplest case, merging is conducted by connecting multiple graphs at their roots (Kouris et al., 2022; Bai et al., 2022).

Bai et al. (2022) also exemplifies the possibility of **AMR enrichment** with task-specific information (here: edges labeled with the speaker in a dialogue). Other examples of additional information used to enrich AMR graphs include VerbNet event structure (Tu et al., 2024) and links from knowledge graphs (Zhang et al., 2021).

These line of work on AMR merging and enrichment may profit from the ongoing research into the 'AMR-intrinsic' tasks of AMR coreference resolution (Fu et al., 2021; Li et al., 2022) and AMR-to-text alignment (Blodgett and Schneider, 2021; Martínez Lorenzo et al., 2023).

Many approaches have required that AMR somehow be encoded into an external model. Synergizing well with the strong NLU inductive bias of text language models, one successful paradigm for **AMR encoding** is to simply feed the linearized graph as a string, where string pre-processing tricks (such as those described) can increase performance (Ribeiro et al., 2021b,a).

AMR encoding can also involve constructing feature vectors (/embeddings) of the full AMR graphs (Wang et al., 2017) or targeted semantic parts (Fodor et al., 2024).

Prior work on AMR-to-text generation has found success encoding AMRs using Graph RNNs (Song et al., 2018) and Graph Transformers (Song et al., 2020; Yao et al., 2020), and the same or similar encoding mechanisms are also found when encoding AMRs for downstream applications (Song et al., 2019).

4.2 Two Processing Paradigms

We observe two major processing paradigms in AMR applications: the neuro-symbolic model, and the use of AMR as an intermediate representation. The first approach has been consistently popular; the second approach has grown in popularity more recently.

Fusing Text and AMR: the Neuro-symbolic Model. The abundant recent interest in neuro-symbolic approaches for NLP (Besold et al., 2021; Hamilton et al., 2022; Yu et al., 2023) has bled into AMR applications.

A common way of leveraging AMR information is merging information from the AMR modality with information from the text modality, typically with an auxiliary motive (e.g., AMR is used to help refine the extracted information from the text to improve a model accuracy by some points). To accomplish this, a prominent strategy has been to construct an AMR parse from the text and then feed both this parse and text into one neural model.

Sometimes, a joint encoder is employed, where AMR and text are simply concatenated and fused at the lowest processing layers (Huang et al., 2022; Hsu et al., 2023). The two modalities (text and AMR) can also be first processed separately, using two individual encoders, to create disjoint higher-level representations that are then fused later such as by adding or concatenating. This fusing can happen in intermediate layers (Dai et al., 2022; Ma et al., 2023), or at the final decision layer (Cai et al., 2022; Opitz et al., 2023).

AMR as an Intermediate Representation. Using AMR as an intermediate representation means typically operating on and with the AMR X as follows: **parse** $\rightarrow X \rightarrow$ **generate**, interlinking parsing and generation models.

One appealing aspect of this technique is the increased interpretility and linguistic control, as to **induce controlled changes in meaning**. For example, the AMR graph can be transformed to generate (1) paraphrases (e.g., by swapping the root (Huang et al., 2023), or swapping out a concept with a synonym, and then generating text (Shi et al., 2023)), or to generate (2) contradictions (e.g., by inserting a targeted negation to a predicate and then generating text from the manipulated structure (Ghazarian et al., 2022)).

On the other hand, the AMR graph can instead remain unaltered while the input text, parsing method, or generation method are varied, such as in the cases of Jangra et al. (2022) for style transfer and Wein and Schneider (2024b) for translationese reduction. As another example, Dohare et al. (2017) compile a summary AMR, by finding AMR nodes focused on important entities, and selecting the subtree hanging from that verb as the summary AMR. Text is then generated from the specified subtree. This highlights that the splitting and merging techniques highlighted in §4.1 can be part of working with AMR as intermediate representation.

5 Areas for Future Work

Surveying the vast number of tasks and techniques utilized throughout the last decade, we observe three notable areas for future work on AMR applications.

First, a technique which has shown great promise for incorporating AMR into neural or non-neural downstream applications is as an **intermediate representation**. This intuitively leverages both AMR's design as a graph-based semantic representation as well as the progress on text-to-AMR parsing and AMR-to-text generation.[4] Using AMR as an intermediary provides us linguistic control and interpretability, which are increasingly desirable in the age of "black box" neural models. Numerous recent studies have successfully exploited AMR as an intermediary (§4.2), indicating that this may be a promising path forward, particularly in low-resource settings or for data augmentation.

Second, recent work has shown the benefits of incorporating AMR in **few-shot or low-resource settings** (Nguyen et al., 2021; Gururaja et al., 2023; Hua et al., 2023; Ghosh et al., 2024). This indicates that, regardless of the technique of incorporation, AMR is positioned to be especially well suited for engineering gains in these settings.

Finally, an area which has been largely understudied (§3.6) but directly follows from the design of AMR as semantic representation, is the use of AMR for **linguistic analysis** and text statistics. Potential applications include language learning or studying predicate-argument patterns in L1 or L2 texts. Additional uses of AMR for linguistic analysis include linguistically-focused evaluations and finer statistics of NLG systems (prior work in this direction discussed in §3.5).[5]

6 Related Work on Applications of Other Meaning Representations

Other surveys have considered the engineering utility of semantic representations. Regarding specific tasks, Verrev (2023) tested out the benefits of various meaning representations for knowledge-base question answering (KBQA), and Prange et al. (2022) for next-word prediction in conjunction with neural models.

Related work has also compared the designs and features of semantic representations (Abend and Rappoport, 2017), with Pavlova et al. (2023) specifically addressing how the features of the semantic representations may play a role in their utility.

[4]This approach also hearkens back to one of the classic approaches towards a fundamental NLP problem, being machine translation: interlingual machine translation (Dorr, 1993).

[5]For mining large unstructured text data, AMR offers semantic triplets that await to be sensibly aggregated, e.g., to craft an automatic knowledge graph.

7 Conclusion

In this survey, we provided a thorough overview of the tasks where Abstract Meaning Representation graphs have been used and the techniques involved in using AMR for engineering purposes. Given the availability of strong parsing systems and the increased interest in AMR, we expect that we are on the precipice of exciting progress employing AMR in downstream applications. As our synthesis of AMR engineering patterns indicates, there are numerous methods, techniques and possible applications that await further exploration and continued improvement.

Limitations

In this survey, we direct our attention exclusively towards the AMR formalism given the recent abundance of work incorporating AMR, and the fact that there are still few surveys addressing AMR. While other semantic representations have been considered as engineering tools (§6), AMR is currently unique in the breadth with which it has been used and studied.

As discussed in §2.1, applications of AMR have been primarily focused on English; recent work (discussed throughout this survey) has demonstrated the cross-lingual and non-English utility of AMR (Wein and Schneider, 2024a), which continues to increase given advancements in multilingual AMR parsing and generation.

We have incorporated the full breadth of existing AMR application work to the best of our knowledge; the bar chart in §3 serves as a lower bound as there may be papers that were missed.

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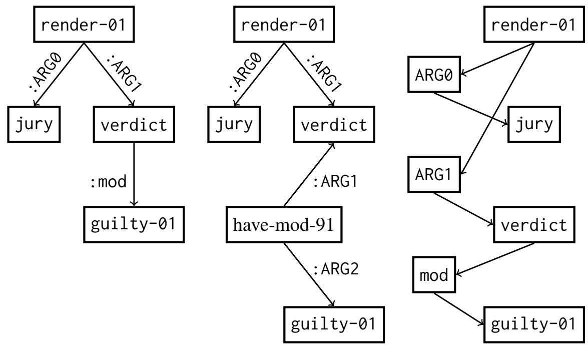
A Reification and Levi Graph




```
(r / render-01
    :ARG0 (j / jury)
    :ARG1 (v / verdict
        :mod (g / guilty-01)))
```

```
(r / render-01
    :ARG0 (j / jury)
    :ARG1 (v / verdict
        :ARG1-of (h / have-mod-91
            :ARG2 (g / guilty-01))))
```

```
(r / render-01
    (a1 / ARG0
        (j / jury))
    (a2 / ARG1
        (v / verdict
            (m / mod
                (g / guilty)))))
```

Figure 3: Three equivalency-preserving AMR transformations for "The jury rendered a guilty verdict." Left/-Top: Standard AMR. Middle/Middle: Reification with AMR rules. Right/Bottom: Bipartite Levi Graph with unlabeled edges. While Levi Graphs are not AMR-specific, reification is. Per the AMR guidelines (Banarescu et al., 2019), any labeled edge not in a standardized set (`:opN`, `:argN`, etc.) is generalized to a new structure, where the old edge assumes the position of a node linked with `:opN`/`:argN` to the original structure (in the example, `:mod` triggers the node `have-mod-91` with arguments `:ARG1` and `:ARG2`).