Semantic Representation of Adverbs in the Lexicalized Meaning Representation (LMR) Framework

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Abstract

Semantic parsing serves as a crucial interface between natural language and formal meaning representations, enabling computational systems to capture the underlying semantic structure of linguistic expressions. This paper addresses a relatively understudied area in both linguistic theory and natural language processing: the semantic representation of *adverbs*. We conduct a comparative analysis of annotation guidelines and practices across two semantic representation frameworks: Lexicalized Meaning Representation (LMR), applied to the European Portuguese edition of the novella "*O Principezinho*" by Antoine de Saint-Exupéry (1943); and Abstract Meaning Representation (AMR), applied to the Brazilian Portuguese edition, "*O Pequeno Príncipe*". The study reveals significant limitations in AMR's handling of adverbial constructions, particularly when assessed against contemporary syntactic-semantic advances in linguistic theory. Furthermore, it highlights the theoretical and practical challenges that LMR continues to face in this domain.

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1 Introduction

Within symbolic approaches to language, semantic parsing acts as a crucial interface between natural language (NLPT) and formal meaning representations, enabling computational systems to capture the underlying semantic structures of linguistic expressions. Among the various linguistic categories, adverbs remain relatively underrepresented in both linguistic theory and natural language processing. This study offers a comparative analysis of annotation guidelines and practices across two semantic representation frameworks as applied to a comparable text corpus in both European (PT-PT) and Brazilian Portuguese (PT-BR).

On the one hand, Abstract Meaning Representation (AMR), a popular framework for semantic parsing [9, 10], was applied to the Brazilian Portuguese edition of Antoine de Saint-Exupéry's novella *O Pequeno Príncipe* [4]. On the other hand, Lexicalized Meaning


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Representation (LMR) [16, 15], an AMR-inspired semantic annotation framework, specifically designed to address challenges particular to European Portuguese and to overcome certain limitations observed in the practical use of AMR for semantic parsing, has been applied to the European Portuguese edition, *O Principezinho* (1943).

The analysis reveals significant limitations in AMR's treatment of adverbial constructions, especially when evaluated against recent developments in syntactic-semantic theory. At the same time, it underscores the ongoing theoretical and practical challenges faced by LMR in this domain.

Given that adverbs and adverbial constructions in general constitute a substantial portion of content words in texts – and fulfill various functions *within* sentences (as determiners, modifiers, and quantifiers) as well as *across* sentences of a discourse (as conjunctive, evaluative, or enunciative elements) – their accurate semantic representation is essential for understanding both the informational content of texts and the organizational structure of meaning in discourse. This paper aims to bring these issues to the forefront and to encourage a discussion that goes beyond mere formalism differences between distinct frameworks, advocating for more robust and descriptively adequate solutions in the semantic representation of adverbs.

The paper is structured as follows: Section 2 provides a succinct literature review on AMR and LMR, including existing lexical resources that support semantic annotation, main applications, and tools associated with semantically annotated corpora, with a focus on current efforts in Portuguese. Section 3 presents, in some detail, the two semantically annotated versions of Saint-Exupéry's novella *The Little Prince / Le Petit Prince*, along with the NLP processing applied to both versions to facilitate information retrieval from the corpora. Sections 4 and 5 summarize the key features of each annotation framework particularly with regard to the semantic parsing of adverbs. Next, Section 6 discusses the main solutions adopted and the challenges encountered in the AMR representation of *O Pequeno Príncipe* [4], and compares these with the strategies proposed by LMR [16] for identical or similar cases. The paper concludes with a summary of the findings and suggestions for future research.

2 Literature review

Since its introduction by Banarescu *et al.* [9], Abstract Meaning Representation (AMR) has emerged as a widely adopted graph-based framework for semantic representation. In AMR, the meaning of a sentence is encoded as a directed, acyclic, single-rooted graph, where nodes correspond to concepts and edges denote semantic relations. Beyond the foundational proposal, supplementary resources – most notably the tutorial by Schneider *et al.* [52] – have played a pivotal role in facilitating the adoption of the formalism. These materials have been essential for training annotators and for standardizing the use of PENMAN notation in the representation of AMR graphs.

The initial motivation behind the AMR formalism was to address the scarcity of corpora with suitable semantic annotations for core natural language processing tasks such as named entity recognition, semantic role labeling, word sense disambiguation, and co-reference resolution [9]. The framework also sought to streamline the annotation process by abstracting away from morphosyntactic details and word order, while simultaneously drawing on existing linguistic resources [43].

Abstract Meaning Representation (AMR) has emerged as a widely adopted semantic representation framework across a broad range of Natural Language Processing (NLP) tasks. Its increasing relevance is supported by recent advances in semantic graph-based text analysis and generation. The following paragraphs highlight key application areas documented in the literature.

AMR has been incorporated into multi-step pipelines involving syntactic parsing, semantic content extraction, and summary generation. [27] propose a three-stage approach: converting narrative text into AMR graphs, extracting summary subgraphs, and generating corresponding sentences. Similarly, AMR2Text [57, 60] addresses the challenge of generating fluent natural language from semantic graphs.

AMR-enhanced Transformer architectures [38] integrate AMR representations into both the encoder and decoder, demonstrating performance improvements in high- and low-resource settings. These models also help mitigate issues such as unwanted repetition and hallucination.

Techniques such as AMR-Data Augmentation [55] generate semantically equivalent paraphrases by transforming AMR graphs and re-generating text, thus enhancing models for textual similarity and classification. The ABEX model[1] [30] further exploits AMR-based abstract descriptions for few-shot semantic understanding tasks. AMR representations, often combined with textual embeddings, have been applied to diverse classification tasks, including sentiment analysis (APARN[2]; [41]), paraphrase detection, AI-generated text detection (DART; [48]), fake news identification (FakEDAMR; [31]), and toxic content detection (AMR-CNN; [28]).

AMR also provides a structured framework for identifying events, relations, and arguments. [39] and [62] demonstrate its effectiveness in event detection and classification. In the biomedical domain, AMR-based approaches have also proven useful for extracting specialized events and relations [8, 51].

AMR has been applied to both Question Answering and Knowledge(-based) Graph Construction tasks, enabling SPARQL query generation[3], decomposition of complex questions into sub-questions (QDAMR [26]), and semantic graph-based answer validation.

Due to its abstract and modular nature, AMR can be customized for specialized contexts such as legal reasoning [53], human–robot interaction (e.g., Dialogue-AMR [19] and Gesture-AMR [37]), and the representation of technical instructions.

AMR has been employed in tasks such as scene graph analysis and image captioning (SGRAM[23]), as well as in speech modeling for interrupted discourse, with implications for the development of accessible voice assistants [1].

AMR-based semantic metrics have been proposed for evaluating coherence in dialogue systems (DEAM; [38]) and factual consistency in summarization (AMRFact; [50]), showing improved correlation with human judgments.

These applications underscore the versatility of AMR as an interpretable and robust semantic representation framework, suitable for a wide range of NLP tasks, including low-resource and multimodal scenarios.

With an initial focus on the English language, AMR-annotated corpora were developed across several domains, including news articles, online forums, and blogs, although only a limited number of these resources are publicly available. Among the accessible corpora are the AMR version of *The Little Prince* and the Bio AMR corpus [6]. The availability of such resources has spurred the development of a variety of AMR parsers, encompassing graph-based approaches [29], dependency-based methods [58, 59], transition systems [25], and deep learning architectures, including sequence-to-sequence models with BiLSTM [40, 49] and transformer-based models [17, 21].

[1] `https://github.com/Sreyan88/ABEX`
[2] `https://github.com/THU-BPM/APARN`
[3] SPARQL is the standard query language and protocol for querying Resource Description Framework (RDF) data, as defined by the World Wide Web Consortium (W3C).

Recognizing the scarcity of AMR resources in languages other than English, several studies have explored adaptation strategies. [18] and [24] applied transfer learning techniques to train multilingual AMR parsers for languages such as Italian, Spanish, German, and Chinese [61, 63].

For Portuguese, parallel developments have taken place for both Brazilian Portuguese (PT-BR) and, later, European Portuguese (PT-PT). In the PT-BR context, the first AMR corpus was created by [2] based on *O Pequeno Príncipe*, the Brazilian translation of the Saint-Exupéry novel, based on the French edition (1943). This initiative was followed by the construction of corpora from the journalistic domain and from the opinion domain (OpiSums-PT-AMR) [20]. In parallel, various parsing approaches were investigated, including a rule-based system [5], adaptations of English parsers – such as NeuralAMR [36], augmented with Portuguese embeddings – and interlingual strategies like XPTA [54], which achieved a Smatch score [22] of 66%.

For European Portuguese (PT-PT), [16] proposed the Lexicalized Meaning Representation (LMR), an adaptation of the AMR framework designed to account for grammatical specificities of PT-PT and to address several issues in the original AMR annotation guidelines. LMR introduces both structural and methodological modifications aimed at preserving the grammatical category and lexical identity of tokens, avoiding abstraction through verb lemmas, and maintaining a direct (one-to-one) link between content words of the surface text and their semantic representation. Unlike AMR, which typically omits auxiliaries, copulas, and prepositions, LMR explicitly represents these elements, encoding corresponding semantic relations such as `:VAUX` and `:VSUP`, in the case of auxiliary verbs, or the semantic nexus conveyed by prepositions, for example `:place`. Annotation in LMR is guided by a catalogue of lexical senses, drawing on resources such as the *Dicionário Gramatical de Verbos do Português* [13] and lexicon-grammar of predicative nouns [14], which provide extensive coverage of verbal and nominal predicates, respectively. Furthermore, the semantic predicates of both these resources are mapped onto their respective adjectivalizations.

In a second study, [15], 50 sentences from the *O Principezinho* were analysed across four language versions (EN, ES, PT-BR, and PT-PT), comparing LMR with traditional AMR. The analysis highlighted inconsistencies in existing annotations and showed that LMR enables greater alignment between syntactic structure and semantic representation, particularly in the treatment of null subjects, sentential adverbials, and auxiliary verb constructions. The proposal is accompanied by a set of public annotation guidelines [11] and aims at greater linguistic adequacy and computational formalization.

Parser evaluation is traditionally based on the SMATCH metric [22], which measures the overlap between generated and gold-standard graphs. However, alternative metrics such as SEMA [7] have emerged, which are more sensitive to structural properties.

Concerning future work on AMR-related issues, [7] propose expanding Brazilian Portuguese AMR corpora, employing techniques such as ensemble learning and back-translation, and explicitly handling linguistic phenomena such as the so-called *null subjects*, multiword expressions (MWE; e.g *pessoas crescidas* "grown-ups"), and synthetic diminutive suffixes (e.g. the suffix -(*z*)*inho* in *Principezinho* "The little Prince").

According to the LMR guidelines [11], certain linguistic phenomena are addressed with specific strategies to streamline the annotation process. Notably, the resolution of zero pronouns – or more broadly, any omitted arguments within a sentence – is deferred to a post-processing phase, unless the antecedent is present within the same sentence. This approach aims to reduce the cognitive load on annotators and enhance consistency across annotations. Conversely, multiword expressions (MWEs) are identified during a pre-processing stage, as

they function as semantic units and should be treated as indivisible entities prior to annotation. This methodology ensures that annotators can focus on delineating semantic relations within sentences. Similarly, the identification, delimitation, and potential normalization of named entities, including temporal expressions [33], are managed through automated processes, thereby relieving annotators of these tasks [16]. Regarding diminutive suffixes – a complex aspect in Portuguese due to their nuanced semantic implications, and, apparently, without any English or French equivalent – the LMR framework currently does not yet prescribe a specific annotation strategy, acknowledging the need for further research in this area.

To sum up, since its introduction [9], Abstract Meaning Representation (AMR) has evolved [10], from a theoretical framework with initial annotations in English to the development of specialized parsers [25, 29] and, more recently, to multisentential [47] and multilingual adaptations [61]. In the context of Portuguese, both Brazilian Portuguese and European Portuguese have witnessed significant advancements. For PT-BR, initiatives include the creation of annotated corpora such as AMRNews and OpiSums-PT-AMR, which address domain-specific challenges in journalistic and opinion texts, respectively [35]. Additionally, strategies like back-translation have been explored to mitigate the scarcity of annotated data for natural language generation tasks [56]. In the case of PT-PT, adaptations have focused on aligning AMR with the linguistic characteristics of European Portuguese, leading to the development of resources like the Lexicalized Meaning Representation (LMR) framework [16]. These collective efforts underscore the commitment to tailoring AMR or AMR-inspired frameworks to the specific features of Portuguese.

3 Methods

This study is based on two parallel corpora derived from different Portuguese translations of *The Little Prince/Le Petit Prince*, de Antoine de Saint-Exupéry (1943): the Brazilian Portuguese version, *O Pequeno Príncipe*, annotated according to the Abstract Meaning Representation (AMR) [9] framework, and the European Portuguese version *O Principezinho*, annotated within the Lexicalized Meaning Representation (LMR) framework [16]. Our analysis pays particular attention to the representation of adverbs, both single-word (e.g. *muito* "very", *atentamente* "attentively") and multiword expressions (e.g. *de vez em quando* "from time to time", *pouco a pouco* "little by little").

The Brazilian AMR corpus follows the AMR annotation guidelines [9] and was developed by aligning it with the English version of *The Little Prince*, and the corresponding AMR annotations [2, p. 975]. Following the methodology adopted in similar AMR projects in other languages, the English AMR structures were imported and then adapted to accommodate the Brazilian Portuguese version. The novel, organized into twenty-seven chapters, contains 1,562 sentences in English and 1,527 in Brazilian Portuguese.

To support the analysis of both the AMR corpus, we processed the Brazilian Portuguese version of the novel through the STRING system [42]. This Natural Language Processing (NLP) system, specifically developed integrates a comprehensive lexicon of Portuguese adverbs, both single-word (e.g. *apenas* "only", *lentamente* "slowly") and multiword expressions (*no entanto* "however", *de preferência* "preferably"), including the Brazilian Portuguese multiword adverb lexicon, currently in development [46]. The corpus was automatically tagged for parts of speech and syntactic dependencies, providing detailed structural information to cross-reference with AMR annotations. The STRING system's output was then used to help retrieve (most of) the instances of adverbs and adverbial structures in the Brazilian text that eventually had been represented in the AMR annotation. In our analysis of *O*

Pequeno Príncipe (PT-BR), we identified 90 distinct single-word adverbs, which appeared 1,023 times throughout the text. Among these, 42 unique adverbs ending in *-mente* were observed, occurring 76 times. Additionally, we found 159 different compound adverbs, with a combined total of 241 occurrences. It is important to note that temporal named entities, despite functioning adverbially, were excluded from this count.

In the analysis of *O Principezinho* (PT-PT), we identified 1,107 adverbs in 1,503 sentences. Of these, 739 were single-word adverbs, corresponding to 51 distinct forms; 297 were compound adverbs, with 174 unique forms; and 71 were *-mente* adverbs, of which 42 were different.

These data establish a solid empirical foundation for the contrastive analysis that follows, enabling a systematic evaluation of how the two semantic annotation frameworks represent adverbs in the context of equivalent translations. The following sections present the core principles and strategies of each of the frameworks under analysis.

4 AMR Guidelines

This section focuses specifically on the relevant components of the AMR guidelines that govern the annotation of adverbial content words. These can be summarized as follows.

Adverbs ending in *-mente* suffix (ing., *-ly*) are for the most part **manner** adverbs. The AMR guidelines stipulate[4] that, for representation purposes, adverbs ending in *-ly* are typically stemmed from their base adjectival form and are introduced by the dependency relation `:manner`.

For example, the adverb *quickly* would be represented as *quick*, so that the lemma form can be easily mapped across related constructions; for example:

(1) *The army moved quickly* vs. *The army moved in a quick way/manner*
→ `(m / move :arg0 (a / army) :manner (q / quick)).`

Naturally, in the case an adverb ending in *-ly* conveys a different sense other than **manner**, it is annotated as it is in the text and it is not stemmed. This is the case of some quantifying adverbs. They involve intensifiers (*very*, *extremely*) and downtoners (*somewhat*, *relatively*), which are annotated with `:degree`[5]. For example, in (2) the quantitative sense of the adverb implies a different representation and the word is not stemmed:

(2) *I hardly know her.*
→ `(k / know-01 :ARG0 (i / i) :ARG1 (s / she) :degree (h / hardly))`

The *frequency* role is used to annotate "how often an action or event occurs"[6]. Analytical frequency temporal expressions, which are usually parsed as temporal named entities, and involve the noun *times* are simply parsed as in:

(3) *We met three times.*
→ `(m / meet-03 :frequency 3 :ARG0 (w / we))`

while, for those that involve several variables, the AMR resources to the special frame `rate-entity-91`, an abstract construct rendering the representation much more complex. For example:

[4] https://github.com/amrisi/amr-guidelines/blob/master/amr.md#adverbs-with--ly
[5] https://github.com/amrisi/amr-guidelines/blob/master/amr.md#degree
[6] https://github.com/amrisi/amr-guidelines/blob/master/amr.md#frequency

(4) *We play bridge every Wednesday afternoon.*
→ `(p / play-01 :frequency (r / rate-entity-91 :ARG4 (d / date-entity :weekday (w2 / wednesday) :dayperiod (a / afternoon))))`.

Still, one can arguably consider that this category also covers simple adverbs such as *often*, or *sometimes*.

In a similar way, **duration**[7] adverbs are annotated with the `:duration` relation, plus the abstract construct `:temporal-quantity`, which takes two arguments, a `:quant` and the `:unit`:

(5) *He worked for two hours.*
→ `(w / work-01 :duration (t / temporal-quantity :quant 2 :unit (h2 / hour)))`

As a final note on the AMR guidelines, note that in this framework, the PENMAN graph has no explicit `root` node; instead, the topmost semantic predicate serves this role. As a consequence, adverbial sentence-external modifiers [44] are inadequately represented when they are forced to depend on the main verb of the sentence, as though they were merely internal verbal modifiers, thereby obscuring their true scope and semantic independence. This is particularly obvious with conjunctive adverbs (*therefore*, *nevertheless*, *however*) evaluative adverbs (*unfortunately*, *hopefully*), and enunciation-oriented adverbs (*sincerely*, *honestly*).

5 LMR Guidelines

In this section, we present the contributions of LMR [16] to the annotation of the various aspects of AMR discussed previously. Our focus is on highlighting a number of fundamental differences between the two frameworks, rather than providing an exhaustive comparison.

The main distinction between LMR and AMR lies in the fact that LMR annotates the text *directly*, constructing the sentence graph on the actual textual elements. In contrast, AMR generates a separate graph that is then *appended* to the sentence as a whole. Secondly, LMR operates directly on the textual elements, without lemmatizing them beforehand; lemmatization, as well as word-sense disambiguation, are considered postprocessing steps.

LMR also avoids introducing abstract constructs to represent meaning. Any abstraction or semantic generalization, such as translating the actual meaning of words into more abstract representations – if should it prove to be necessary, is deferred to a later stage. This choice reflects the understanding that abstract constructs are often difficult for human annotators to manipulate consistently.

Furthermore, LMR does not replace meaningful lexical items, such as conjunctions (e.g., *porque* "because"), with abstract semantic relations like `:cause`. Instead, it retains the original textual elements and repurposes the dependency relation `:op2` to link these so-called grammatical words to their respective arguments.

Finally, the reconstitution of zeroed anaphoric elements is handled in LMR similarly to AMR, provided that the antecedent is present within the same sentence. Anaphora resolution is considered a postprocessing task, so as not to overburden the human annotation process. For this reason, omitted arguments – such as the subject, which is typically zeroed in null-subject languages like Portuguese – are not reconstituted during the annotation phase.

[7] `https://github.com/amrisi/amrguidelines/blob/master/amr.md#duration`

However, LMR does allow for the reconstitution of lexical elements that have been omitted due to contextual redundancy. This corresponds to what [34] referred to as *appropriate reduction*, in which an omitted element can be safely restored because its zeroing results from being the most likely (often the sole) candidate in the given context, and is therefore considered redundant. For example, in:

(6) *O Pedro gosta de* (*ler*) *romances policiais* "Pedro likes (to read) detective novels"
→ `(g / gosta :arg0 (r / Rui) :arg1 (l / ler :arg0 r :arg1 (rp / romances policiais)))`

one can safely reconstitute *ler* (and its repeated zeroed subject, correferent to the main subject) as this representation more adequately describes the meaning of the sentence. By reintroducing such elements, the overt semantic structure of the sentence is fully recovered.

We now turn to the specific features of LMR concerning the representation of adverbs and adverbial constructions. With regard to adverbs ending in *-mente* (and their English equivalents with the *-ly* suffix), LMR adopts an approach distinct from that of standard AMR. Instead of replacing the adverb with its morphologically related adjective (e.g., *quickly* → *quick*), LMR retains the adverb in its textual form as a node in the graph, applying the `:manner` relation directly to the adverb and linking it to the predicate it modifies. Similarly, in the case of analytical phrases (e.g., *in a quick way* / *in a quick manner*), LMR preserves the manner operator-noun (*way*, *manner*) and represents the surface adjective in its original form, while maintaining the relevant syntactic and semantic relations. Hence, for the examples in (1), renumbered below as (7), LMR produces two distinct but semantically equivalent representations: one for the synthetic form of the adverb with the suffix, and another for the analytical construction with the manner operator-nouns:

(7) *The army moved quickly* vs. *The army moved in a quick way/manner*
→ `(m / move :arg0 (a / army) :manner (q / quickly))`
vs. → `(m1 / move :arg0 (a / army) :manner (i / in :op2 (m2 / manner :mod (q / quick)))`.

In addition, *subject-oriented manner adverbs* ([44], class MS), such as *cuidadosamente* "carefully", which are also annotated with `:manner`, an added `:arg0` dependency that links the adverb to the subject, reflecting its dual scope (8):

(8) *O Pedro trabalhava* cuidadosamente cp. *O Pedro era* cuidadoso
"Pedro worked carefully cp. Pedro was careful"
→ `(root :main (t / trabalhava :arg0 (p / Pedro) :manner (c / cuidadosamente :arg0 p)))`

The `:manner` relation is also used in prepositional expressions, such as *com sabedoria* lit.: "with wisdom" "wisely", where the preposition *com* "with" is linked to the upper predicate via `:manner` and to the predicative noun by `:op2`:

(9) <id=222>*Mas, logo a seguir, observou* com sabedoria ... "But, shortly afterwards, he observed wisely."
→ `(o / observou :manner (c / com :op2 (s / sabedoria)))`

The `:degree` relation, used to link adverbial expressions of intensity or degree to the predicative elements they modify, is used in the same way as in AMR:

(10) <id=43> ... *fui despertado por uma vozinha* muito *curiosa* "I was awakened by a very curious little voice."
→ `(v / vozinha :arg0-of (c / curiosa :degree (m2 / muito)))`

This dependency is also to be related to comparative constructions such as *mais* "more" or *menos difícil* "less difficult". This involving a (compound) comparative subordinate conjunction, *do que* "than". In this case, the conjunction is linked by `:compared-to` to the first term of comparison, and the `:op2` relation is linked to the comparative term:

(11) <id=578> *É muito mais difícil julgar-se a si mesmo* do que *julgar os outros.*
"It is much more difficult to judge oneself than to judge others."

```
→ (root :main (d / difícil :vaux (e / é)
:degree (m / mais :degree (mt / muito))
:arg0 (j1 / julgar :arg1 (si / si :mod (msm / mesmo)))
:compared-to (dq / do_que :op2 (j2 / julgar :arg1 (o /
outros)))))
```

Frequency, **duration**, and other **time**-denoting adverbs are represented in LMR in much the same way as in AMR, using the operators `:frequency`, `:duration`, and `:time`, respectively. However, LMR does not distinguish between simple adverbs (e.g., *anteontem* "the day before yesterday") and their multiword equivalents (e.g., *antes de ontem* "idem"). It also does not treat differently any temporal expressions that are typically parsed as *named entities* (e.g., *na passada sexta-feira* "last Friday") [33, 32]. The identification, delimitation, and normalization of these named entities' expressions are expected to take place during the parsing stage, thereby reducing the cognitive load on the human annotator. This allows the annotator to focus primarily on distinguishing among the three major temporal categories.

The `:focus` relation is used in LMR to represent **focus** adverbs whose function is to highlight a constituent or a word within the sentence, following the definiton of [44] (class MF). These include simple forms such as *só* and *apenas* "only, just", *justamente* "just/precisely", and compound expressions such as *em especial* "especially" or *acima de tudo* "above all".

(12) <id=170> *Só então acham que o conhecem.* "Only then do they think they know him."
→ `(a / acham :time (e / então :focus (s / só))`

The specific syntactic-semantic properties of **focus** adverbs are detailed below, in Section 6, but suffice to say, for now, that they show strong resistance to clefting when this operation separates it from the element or constituent they focus on, but they can undergo clefting along with that element or constituent:

(13) a. **É* só *que então acham que o conhecem.*
b. **É* então *que só acham que o conhecem.*
c. **É* só então *que acham que o conhecem.*

In addition to adverbs like *só* "only", the cleft construction *ser... que* "is...that" is also treated as a focusing device. Focus adverbs are thus distinct from other adverbial types. Nevertheless, they exhibit diverse and complex syntactic behavior, as well as different specific meanings, and their scope, whether over the entire sentence or a specific constituent can sometimes be difficult to determine [45].

In the case of **polarity**-denoting adverbs, such as *não* "not", *nunca* "never", and *jamais* "never", these are explicitly encoded in the graph and linked to the element they modify using the `:neg` relation. The negative value conveyed by the subordinating conjunction *sem* "without" is not marked, however, as it is assumed to be incorporated into its lexical entry.

LMR also introduces certain semantic relations not present in AMR. For instance, **conformative** or **proportional** adverbials – such as those introduced by *conforme* "as, according to" or *à medida que* "as, while" – are represented using the relation `:conformative`.

Finally, leveraging the fact that all LMR graphs have a `root` node, sentence-modifying adverbs can be linked to this node to signal their scope on the whole sentence. This is the case of *então* "then", which is a connective discursive device, that is, a conjunctive adverb [44] (class PC) and is to be interpreted as an adverbial modifier on the entire sentence (either as a **time** or a **consequence**), as shown in (14):

(14) <id=15> *Então, desenhei* ... "Then, [I] draw ..."
→ `(root :mod (e / então) :main (d / desenhei ...`

Notice, however, that the AMR guidelines make no reference to sentence-external adverbial modifiers. Most of the time, as we will see below, these elements are either made to depend on the main predicate – which is arguably inadequate – or are omitted altogether from the graph, a rather unsatisfactory solution.

6 Corpora analysis

In this section, we present key findings from our analysis of the AMR corpus of *O Pequeno Príncipe* in Brazilian Portuguese (PT-BR) [3]. Where appropriate, we contrast the annotation solutions observed in this corpus with those found in the LMR annotation of *O Principezinho* in European Portuguese (PT-PT) [12] taking into account the differences between the two language varieties.

In many cases, adverbs ending in *-mente* "-ly", which were supposedly to be represented by the *lemma* of their adjectival base (e.g., *quickly* represented as *quick*, see (1)), appear to have been annotated inconsistently, and were retained in their derived form, i.e. with the suffix *-mente*. Of 76 instances of adverbs ending in *-mente*, 60 have not been stemmed. For example, in (15), we found the derived forms of two adverbs (*lentamente* "slowly", *regularmente* "regularly"), ending in -mente and not the corresponding base forms (*lento* "slow" and *regular* "regular"):

(15) <id=440> ... *os vulcões queimam* lentamente, regularmente*, sem erupções.*
"the volcanoes burn slowly, regularly, without eruptions."
→ `c / queimar :manner (v / lentamente) :manner (v / regularmente)`
`:manner ((e / erupção :polarity -))`

The AMR representation of the corresponding English sentence, although structurally very similar, differs significantly:

(16) <id=440> *If they are well cleaned out , volcanoes burn slowly and steadily , without any eruptions .*
→ `(b / burn-01 :ARG1 (v / volcano :ARG1-of (e2 / erupt-01`
`:polarity -)) :manner (s3 / steady) :ARG1-of (s / slow-05))`

Apparently, the prepositional phrase *without any eruptions* was parsed as a modifier (`:arg1-of`) of the noun *volcanoes*, while the stemmed adverb *steadily* is correctly parsed as a `:manner` of the main verb *burn*. However, despite being coordinated with the latter, the adverb *slowly* – also stemmed to *slow* – was parsed as an `:arg1-of` of the verb, which is likely an annotation error.

The LMR solution to the corresponding sentence in PT-PT addresses all these issues, even if a manner operator-noun *forma* "way/manner" is involved:

(17) <id=440> *Quando são bem limpos, os vulcões ardem de forma lenta e regular, sem erupções.* "When they are well cleaned, the volcanoes burn slowly and regularly, without eruptions."
→
```
(root :main (a / ardem :arg0 (v / vulcões)
:manner (d / de :op2 (f / forma :mod (e / e
:coord1 (l / lenta) :coord2 (r / regular))))
:manner (s / sem :op2 (e / erupções))
```

Still, the (assumed) asyndetic coordination between the **manner** adverbial formed with the operator-noun *forma* and the adverbial introduced by the preposition *sem* is not represented in the graph.

On the other hand, and according to AMR guidelines, *subject-oriented manner* adverbs are parsed in the same way as other, more generic manner adverbs – typically verb- or object-oriented – by using the `:manner` relation.

(18) *Olhou atentamente, e disse: – Não!* "He looked attentively and said, 'No!' "
→ `(o / olhar-01 :ARG0 (e1 / ele) :manner (a / atentamente))`

While this solution is consistent with the AMR guidelines, it fails to capture the dual scope of such adverbs, which modify both the verb and the subject. In this respect, LMR proposes to represent this secondary scope explicitly, by introducing an additional `:arg0` relation linking the adverb to the subject of the sentence.

(19) *Ele analisou com toda a atenção e disse: – Não!* "He examined it very carefully and said: "No!' "
→
```
(root :main (e / e :coord1 (a / analisou :arg0 (e / ele)
:manner (c / com :op2 (a / atenção :arg0 e :quant (t / toda))))
:coord2 (d / disse :arg0 e :arg1 (n / não :mode-exclamative))))
```

In the English AMR-annotated text, 21 instances of the `:duration` relation were identified, most of which make use of the `temporal-quantity` construct, as previously described. However, several examples – some arguably partially idiomatic – are annotated using only `:duration`, without further specification. These include expressions such as *for a time* (id=1559), *for a moment* (id=598), and *for an instant* (id=1522):

(20) <id=1522> *He remained motionless for an instant.*
`(r / remain-01 :duration (i / instant)`

Simple-word **duration** adverbs have been inconsistently represented in *The Little Prince* AMR corpus. Although relatively few in number, these cases provide insightful examples that help highlight inconsistencies in annotation practices. For example, the adverb *forever* appears only three times and is annotated differently in each instance: as `:duration` (id=1040), as `:mod` (id=20), and, in one case, as `:extent` (id=1179) – as in the sentence *You become*

responsible, forever*, for what you have tamed.* This latter annotation corresponds precisely to the recommendation provided in the official AMR guidelines[8], where the example given is *The road goes on* forever. On the other hand, the adverb *never* is systematically represented as *ever*, introduced by the `:time` relation and accompanied by the `polarity -` qualifier on the main verb (e.g., id=20). This is observed in 33 instances). This uniform treatment of *never* as a **temporal** locative rather than a **duration** adverb may be debatable. However, the distinction between these categories is not always clear-cut. In certain cases, the adverb is entirely omitted from the representation (e.g., id=302, 438, 748, 1144). Other uses of `:duration` seem more "creative" and are sometimes difficult to interpret (see, for instance, id=797, 905, or 1119).

We have seen in Section4 the proposed representation for **frequency** adverbials. In practice, AMR annotation of *The Little Prince* for frequency adverbs varies, especially for simple-word adverbs. For *sometimes* we find the adverb directly attached by `:frequency` to the main predicate:

(21) <id=509> *" Then I - - I order you* sometimes *to yawn and sometimes to - - "*
→ `(y2 / yawn-01 :frequency (s / sometimes))`

Other times, the (generic?) `:time` relation is used:

(22) <id=1459> *And you will sometimes open your window ...*
→ `(o / open-01 :time (s / sometimes)`

As for the adverb *often*, besides the `:time` relation, one also finds the abstract construct `have-degree-91` takes the adverb as an argument `:ARG2` and an inverted relation `:frequency-of` operating on the main verb:

(23) <id=1069> *" It is an act too often neglected , " said the fox .*
→ `(n / neglect-01 :ARG1 (a / act-02) ARG1-of (h / have-degree-91 :ARG2 (o / often :frequency-of n)))`

The number of **frequency** adverbials explicitly marked as such in the AMR representation of the PT-BR corpus is smaller (16 instances) than in the English text. Still, the Brazilian annotators did not strictly follow the AMR guidelines. In most cases, instead of using the *temporal-quantity* construct – which appears only three times:

(24) <id=972> ... *ele dá uma volta por minuto ...* "it makes one turn per minute"
→ `(d / dar-03 :ARG0 (p / planeta) :ARG1 (v / volta) :frequency (t2 / temporal-quantity :quant 1 :unit (m1 / minuto)))`

they opted for alternative representations, namely, the annotators just used the `:frequency` relation and omitted the time-denoting noun *vez(es)* "time(s)":

(25) <id=673> ... *só fui incomodado três vezes.* "[I] was only disturbed three times."
→ `(i / incomodar-01 :ARG0 (e / eu) :frequency 3)`

or just added the `:unit` for the *modulo* element:

(26) <id=939> ... *trabalhavam duas vezes por ano.* "[they] worked twice a year"
→ `(t / trabalhar :frequency 2 :unit (a / ano))`

[8] https://github.com/amrisi/amr-guidelines/blob/master/amr.md#extent

For *algumas vezes* "a few times" (id=1168) the determiner is used directly under `:frequency`, like the numbers in (25).

The most salient aspect is the representation of several multiword frequency adverbs in much the same way as proposed by LMR, with the graph nodes formed by hyphenating the individual elements of the multiword expression. Thus, we find compound adverbs such as: *de vez em quando* "once in a while" (id=587), represented as `de-vez-em-quando`; *cada vez* "every time" (id=589), as `cada-vez`; *às vezes* "sometimes" (id=683), as `às-vezes`; *todos os dias* "every day" (id=747), as `todo-dia`; *toda semana* "every week" (id=748), as `toda-semana`. Finally, the multiword expression *de ano em ano* "from year to year" (id=790) is represented simply by *ano*, which is likely an annotation oversight.

The concept of **focus** exists in the AMR directives but deals with a completely different phenomenon and refers to what the sentence is primarily about.[9] In this paper, by the concept of **focus** as applied to determinative adverbs, we consider the use of adverbs as defined in [44] (class MF), namely, an element that is a focus-modifier on a constituent or on another phrase element, including the main verb. We can see examples of these focusing adverbs in the case of *only* in (27) focusing on a quantifier (*one*), *exactly* in (28) focusing on the prepositional phrase *under the star*, or *just* in (29), focusing on the main verb:

(27) <id=370> *They had only one ring of petals* ...

→ `(r / ring :quant 1 :mod (o / only)`

(28) <id=1559> *Wait for a time ,* exactly *under the star.*

→ `(w / wait-01 :mode imperative :location (u / under :op1 (s / star) :manner (e / exact)))`

(29) <id=1395> *I was* just *coming to tell him* ...

→ `(c / come-01 :mod (j / just)`

In nominal and prepositional phrases, focus adverbs resist to be isolated from the constituent they focus on by the clefting operation, for example, (30)-(31) and (33)-(34); but can undergo that operation together with that constituent, as in (32) and (35):

(30) **It was only that they had one ring*

(31) ?/?**It was one ring that they had only*

(32) *It was only one ring that they had*

(33) *He waited exactly under the star*

(34) **It was exactly that he waited under the star*

(35) ?/?**It was under the star that he waited exactly*

While a specific representation of this phenomenon is apparently absent from the AMR directives, in most cases, the focus adverb is captured by a generic `:mod` relation. Notice, however, that *exactly* in (28) is parsed as a `:manner`.

To conclude this section, we offer a brief commentary on *sentence-external adverbial modifiers*, as defined by [44]. These adverbs modify the sentence as a whole and, thus, can be fronted to the beginning of the sentence, even in negative constructions, as they fall

[9] `https://github.com/amrisi/amr-guidelines/blob/master/amr.md#focus`

outside the scope of the negation adverb – an internal sentence modifier (36). Moreover, they do not undergo clefting, since this syntactic operation applies only to sentence-internal constituents (37):

(36) *Portanto, ele (não) fez perguntas.* "So, he (did_not) made some questions."

(37) **Foi portanto que ele (não) fez perguntas.* "It was so that he (did_not) made questions."

Most of these sentence-external adverbs are conjunctive adverbs, whose function is to connect the sentence in which they appear to the preceding sentence (or to another sentence within the same discourse). Therefore, such adverbs cannot occur at the absolute beginning of a discourse.

Since in LMR there is a `root` node for every sentence, it is possible to link sentence-external adverbial modifiers to this *root* node. The lexically-defined, specific semantic nexus conveyed by the adverb can then be used, in a postprocessing stage, to semantically connect different utterances within the same discourse.

For the most part, sentence-external adverbs are omitted from the PT-BR corpus representations. Consider, for instance, *portanto* "so/then/thus/therefore". It appear 5 times in the corpus, and is never represented in the graphs. The multiword *no entanto* "however" appears nine times in *O Pequeno Príncipe* (id=714, 759, 760, 819, 1236, 1255, 1310, 1344, and 1369), and none of these occurrences is represented in the corresponding graphs.

Things become more complex when an adverb can present two or more senses, and thus may correspond to different syntactic-semantic constructions. The adverb *assim* "so" can function either as a sentence-internal **manner** adverb with an anaphoric value (e.g. *Ele fez isto assim = dessa maneira* "He did that in that way"); in that construction, it can also be an anaphor for an adjective or another predicate in a post-copula sentence:

(38) <id=157> *As pessoas grandes são assim.* "Grown-ups are like_that"

or it can function as a sentence-external modifier:

(39) <id=107> *Assim, ... perguntou-me bruscamente ...* "Then/Thus, [he] asked me abruptly"

This adverb appears 25 times in the corpus but is omitted from the graphs in most cases (e.g., in sentences with IDs 18, 22, 25, 174, 211, 264, 286, 397, 417, 466, ...). It is generally retained in the graph only when it occurs in a post-copular, predicative position, functioning anaphorically to replace a previously expressed adjective or predicate, as illustrated in (38). In such cases, it is parsed as an adjectival predicate, and that occurs seven times. There is only one instance where it functions as a **manner** anaphor, as in (id=1257): *E, caminhando assim, eu descobri o poço.* "And, walking like_that, I discovered the well." Finally, we observe the concessive multiword expression *mesmo assim* "even so", where its representation as a **manner** adjunct is clearly inadequate:

(40) <id=630> *Admira-me mesmo assim!* "Admire me, even so!"
→ `(a / admirar :manner (a / assim :mod (m / mesmo)))`

Such examples could be multiplied *ad libitum*.

7 Conclusion

This paper examined the semantic representation of adverbs through a comparative analysis of Abstract Meaning Representation (AMR), as applied to the Brazilian Portuguese edition of *O Pequeno Príncipe* [2], and the corresponding treatment proposed within the Lexicalized Meaning Representation (LMR) framework [16, 11], focusing on its application to the European Portuguese edition of the same novel, *O Principezinho* [12]. As a reference for the original AMR framework, we also considered the English AMR-annotated version of *The Little Prince* [9], in conjunction with the official AMR guidelines [10].

The study has revealed the challenges involved in capturing the semantic contributions of adverbial constructions across both frameworks.

The analysis highlights the underrepresentation and sometimes inadequate semantic parsing of adverbs in AMR, particularly with regard to syntactic-semantic alignment and their interaction with other sentence constituents. Conversely, LMR offers a more linguistically-informed approach grounded in syntactic theory, enabling a richer and more fine-grained encoding of adverbial meaning. However, the paper also notes that LMR faces its own set of theoretical and practical challenges, such as the need for consistent annotation practices and comprehensive guidelines to account for the semantic variety and syntactic flexibility of adverbs.

Overall, the findings suggest that adverbs – despite their frequency and functional importance in natural language – remain a relatively neglected category in semantic parsing. The paper advocates for a more robust theoretical and computational treatment of adverbs in semantic representation frameworks. Future work should aim to extend and refine the annotation guidelines for LMR, improve tool support for automatic parsing, and explore the integration of such enhancements in multilingual and cross-framework scenarios.

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