Abstract Meaning Representation (AMR)

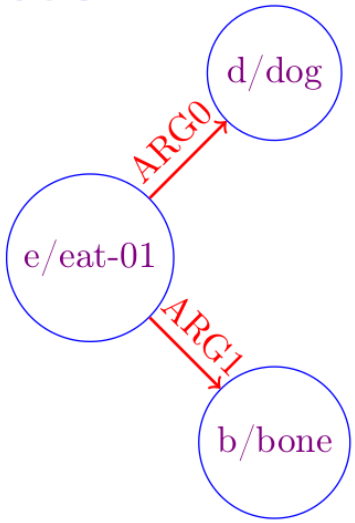
- Very roughly it is supposed to represent ‘who is doing what to whom, where, when and how’ in a sentenceS.
- It is a graph based semantic representation with nodes containing variables labelled with ‘concepts’ and edges between nodes labelled with standard numbered semantic roles drawn from Propbank. It also has within sentence co-reference, named entities and types, modality, negation, quantities etc.
- An AMR is a rooted, directed acyclic graph.
- It is constructed for a sentence.
- It can be linearized textually using the PENMAN notation.
- Each word in the sentence occurs as a node exactly once at the leaf.

References

1. L Bonarescu et al, Absetract Meaning Representation for Sembanking, https://amr.isi.edu/a.pdf.
2. AMR 1.1 specification, http://www.isi.edu/ ulf/amr/help/amr-guidelines.pdf
3. Martha Palmer et al, The Proposition Bank: An Annotated Corpus of Semantic Roles, Comp. Linguistics, 31(1), 1-36, (2005).

Example

The dog is eating a bone.



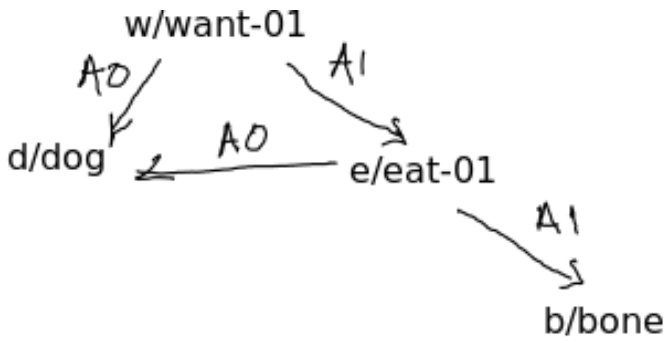
Each node is labelled by a concept and has a variable. For example: b/bone≡ b is an instance of bone.

The linearized PENMAN notation:

```
(e/eat-01
      :A0 (d/dog)
      :A1 (b/bone)
)
```

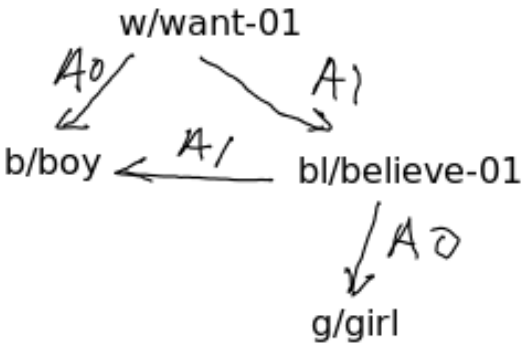
Re-entrancy

```
The dog wants to eat a bone.
(w/want-01
     :A0 (d/dog)
     :A1 (e/eat-01
              :A0 d
              :A1 (b/bone)
         )
)
```



Note how d is repeated - this is called re-entrancy. In the graph the node d/dog occurs only once.

Sentence to AMR is many-to-one



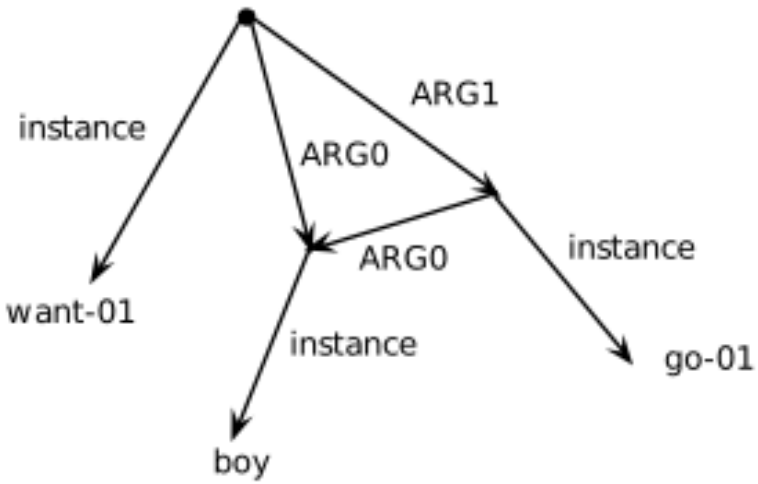
The graph corresponds to all the following sentences:

```
The boy wants the girl to believe him.
The boy wants to be believed by the girl.
The boy has a desire to be believed by the girl.
The boys desire is for the girl to believe him.
The boy is desirous of the girl believing him.
```

amongst others.

The full graph representation

The boy wants to go.



AMR basis

- AMR concepts are words (e.g. boy, bone, dog), Propbank framesets (e.g. want-01) or special keywords that include entity types (e.g. date-entity), quantities (e.g. distance-quantity, monetary quantity), logical conjunctions (e.g. and).
- AMR uses approx. 100 relations
  - Frame arguments using Propbank conventions. :arg0 to :arg5 (or :a0 to :a5). These come from Propbank framesets. Propbank creates a frame for verbs with arguments labelled from :arg0 to :arg5. :arg0 is typically the agent, :arg1 is the patient. Other arguments do not have standard definitions and may vary with the verb being annotated.
  - General semantic relations: :accompanier, :age, :beneficiary, :cause, :compared-to, :concession, :condition, :consist-of, :degree, :destination, :direction, :domain, :duration, :employed-by, :example, :extent, :frequency, :instrument, :location, :manner, :medium, :mod, :mode, :name, :part, :path, :polarity, :poss, :purpose, :source, :subevent, :subset, :time, :topic, :value.

The meanings of the relations are best illustrated through examples (see later).

- Relations for quantities. :quant, :unit, :scale.
- Relations for date-entities: :day, :month, etc.
- Relations for lists :op1 to :op10.
- It includes the inverses of all these relations - :arg0-of.

Propbank role sets - examples

Frameset accept.01 ‘take willingly’
Arg0: Acceptor
Arg1: Thing accepted
Arg2: Accepted-from
Arg3: Attribute
Ex:[Arg0 He] [ArgM-MOD would][ArgM-NEG nt] accept [Arg1 anything of value] [Arg2 from those he was writing about].
(wsj-0186)

Frameset kick.01 ‘drive or impel with the foot’
Arg0: Kicker
Arg1: Thing kicked
Arg2: Instrument (defaults to foot)
Ex1: [ArgM-DIS But] [Arg0 two big New York banks i] seem [Arg0 *trace* i] to have kicked [Arg1 those chances] [ArgM-DIR away], [ArgM-TMP for the moment], [Arg2 with the embarrassing failure of Citicorp and Chase Manhattan Corp. to deliver $7.2 billion in bank financing for a leveraged buy-out of United Airlines parent UAL Corp]. (wsj-1619)
Ex2: [Arg0 John i] tried [Arg0 *trace* i] to kick [Arg1 the football], but Mary pulled it away at the last moment.

Frameset edge.01 ‘move slightly’
Arg0: causer of motion
Arg1: thing in motion
Arg2: distance moved
Arg3: start point
Arg4: end point
Arg5: direction
Ex: [Arg0 Revenue] edged [Arg5 up] [Arg2-EXT 3.4%] [Arg4 to $904 million] [Arg3 from $874 million] [ArgM-TMP in last years third quarter]. (wsj-1210)

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Role of Mr. Dinkins?

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ArgA: Agent of induced action

. . . [ArgA Mr. Dinkins] . . . .

ArgM and modifier tags

In addition to the roles Arg0 to Arg5 verbs can have modifier tags marked by *ArgM* together with a modifier tag from the list below. LOC: location, EXT: extent, DIS: discourse connectives, ADV: general purpose, NEG: negation marker, MOD: modal verb, CAU: cause, TMP: time, PNC: purpose, MNR: manner, DIR: direction

EXT (extent - numerical) and PRD tags.
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PRD is used when the verb signals a predicative relation between some of its roles.

Ex1: [Arg0 Salma] called [Arg1 Hari] [Arg2PRD an idiot].
Predicative versus non-predicative:
Ex2: Salma called Hari a doctor. Ex3: Salma called Hari a doctor.
In Ex2: called: labelled In Ex3: called summoned

Polysemous verbs

Polysemous verbs have multiple frames.

```
Frameset cut.01 'reduce'
Arg0: cutter
Arg1: thing cut
Arg2: medium, source
Arg3: instrument
Ex: [ Arg0 Longer production runs] [ ArgM-MOD would] cut [ Arg1 inefficiencies
from adjusting machinery between production cycles]. (wsj-0317)

Frameset cut.04 cut off = slice
Arg0: cutter
Arg1: thing cut (off)
Arg2: medium, source
Arg3: instrument
Ex: [ Arg0 The seed companies] cut off [ Arg1 the tassels of each plant].
(wsj-0209)
```

AMR other relations

Other relations:

The soldier hummed to the girl as she walked to town.

```
(s / hum-02
    :arg0 (s2 / soldier)
    :beneficiary (g / girl)
    :time (w / walk-01
        :arg0 g
        :destination (t / town)
    )
)
```

AMR - inverse relations

The boy from the college sang.

```
(s / sing-01
    :arg0 (b / boy
        :source (c / college)
    )
)
```

the college boy who sang ...

```
(b / boy
    :arg0-of (s / sing-01)
    :source (c / college)
)
```

The number of pandas increased.

```
(i / increase-01
    :arg1 (n / number
        :quant-of (p / panda)
    )
)
```

Modals, negation

The boy did not go.

```
(g / go-01
    :arg0 (b / boy)
    :polarity -
)
```

The boy cannot go.

```
(p / possible
    :domain (g / go-01
        :arg0 (b / boy)
    )
    :polarity -
)
```

Its possible for the boy not to go.

```
(p / possible
    :domain (g / go-01
        :arg0 (b / boy)
        :polarity -
    ))
```

The boy doesnt have to go.

The boy isnt obligated to go.

The boy need not go.

```
(p / obligate-01
    :arg2 (g / go-01
        :arg0 (b / boy)
    )
    :polarity -
)
```

The boy must not go

```
(p / obligate-01
    :arg2 (g / go-01
        :arg0 (b / boy)
        :polarity -)
)
```

Questions

'amr-unknown' to indicate wh-questions.

What did the girl find?

```
(f / find-01
    :arg0 (g / girl)
    :arg1 (a / amr-unknown))
```

Where did the girl find the boy?

```
(f / find-01
    :arg0 (g / girl)
    :arg1 (b / boy)
    :location (a / amr-unknown))
```

Nouns

Some nouns are represented via AMRs.

```
(d / destroy-01
    :arg0 (b / boy)
    :arg1 (r / room))
```

the destruction of the room by the boy...
the boys destruction of the room ...
The boy destroyed the room.

Named entities

AMR allows any concept to be named via a named relation. It also includes standard forms for approx. 80 types like person, country, etc.

Hari Kumar

```
(p / person
    :name (n / name
        :op1 "Hari"
        :op2 "Kumar"))
```

AMR limitations

- AMR does not represent - inflectional morphology e.g. for tense, number
  - articles - quantifiers - between real and hypothetical events

Other semantic representations

- GMB (Groningen Meaning Bank) - manual
- UCCA (Universal Conceptual Cognitive Annoatation) - manual
- ST (Semantic tree bank)
- Prague Dependency Treebank - manual
- UNL (Universal Networking Language)
- AMR - manual and automatic (CAMR, JAMR, neural parsers are available)