Introduction to the Abstract Meaning Representation (AMR)

http://tiny.cc/amrtutorial

If you are here early, go to the **AMR Editor** and try to log in:

http://tiny.cc/amreditor

Why does AMR matter now?

- AMR is a semantic representation aimed at **large-scale human annotation** in order to **build a giant semantics bank.**
- We do a practical, replicable amount of abstraction (**limited canonicalization**).
- Capture many aspects of meaning in **a single simple data structure.**

Hasn’t this been done before?

- Linguistics/CL have formalized semantics for a long time.
- A form of AMR has been around for a long time too (Langkilde and Knight 1998).
- It changed a lot since 1998 (add PropBank, etc.) and **we actually built a corpus of AMRs.**

Contemporary AMR

- **Banarescu et al. (2013)** laid out the fundamentals of the annotation scheme we'll describe today.

Roadmap for Part I

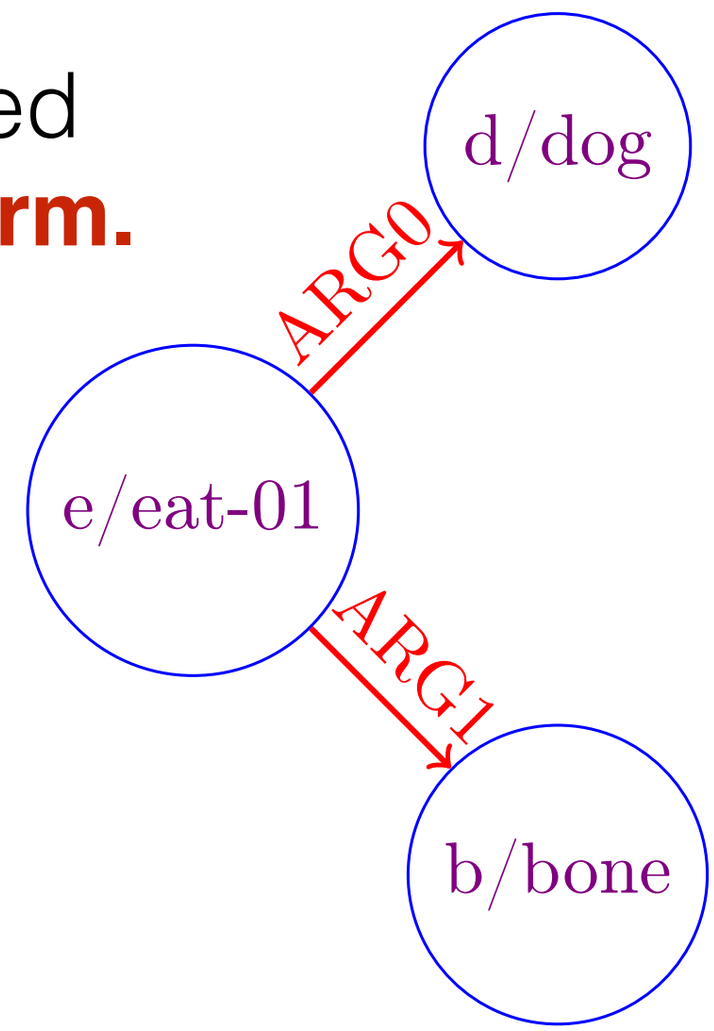
- Fundamentals of the AMR representation
- Hands-on practice I: Representing basic examples
- Advanced topics and linguistic phenomena
- Comparison to other representations
- Hands-on practice II: Doing real, complex text

PENMAN notation

- We use PENMAN notation (Bateman 1990).
- A way of representing a directed graph in a **simple, tree-like form.**

"*The dog is eating a bone*"

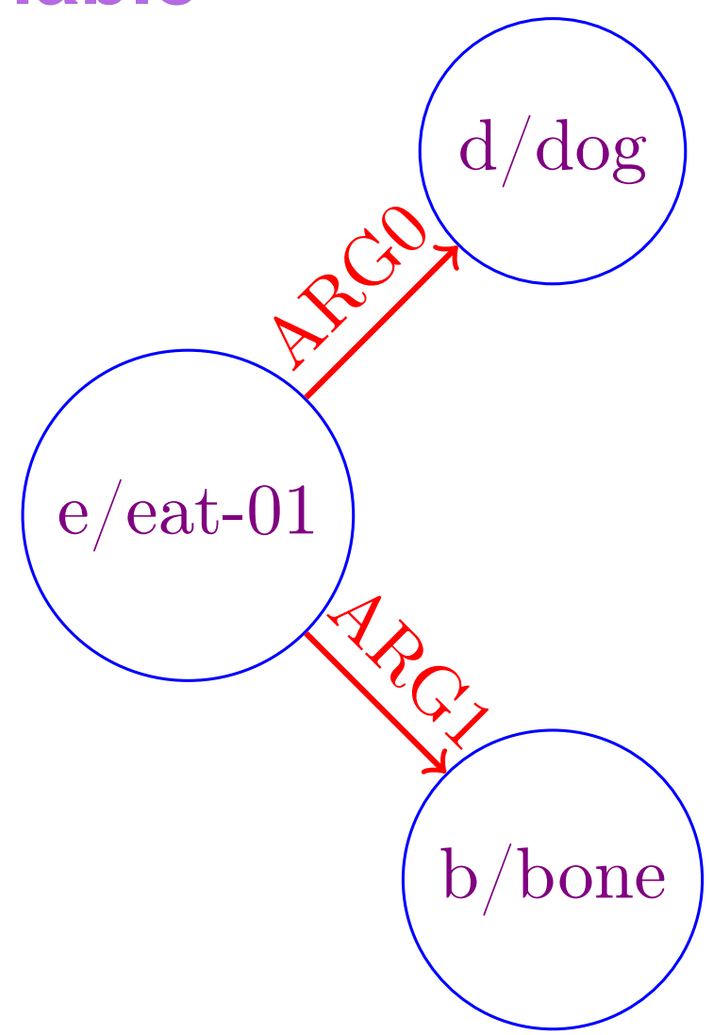
(e / eat-01
:ARG0 (d / dog)
:ARG1 (b / bone))



PENMAN notation

- The edges (ARG0 and ARG1) are **relations**
- Each node in the graph has a **variable**
- They are labeled with **concepts**
- **d** / **dog** means "**d** is an instance of **dog**"

"The dog is eating a bone"
(**e** / **eat-01**
:**ARG0** (**d** / **dog**)
:**ARG1** (**b** / **bone**))

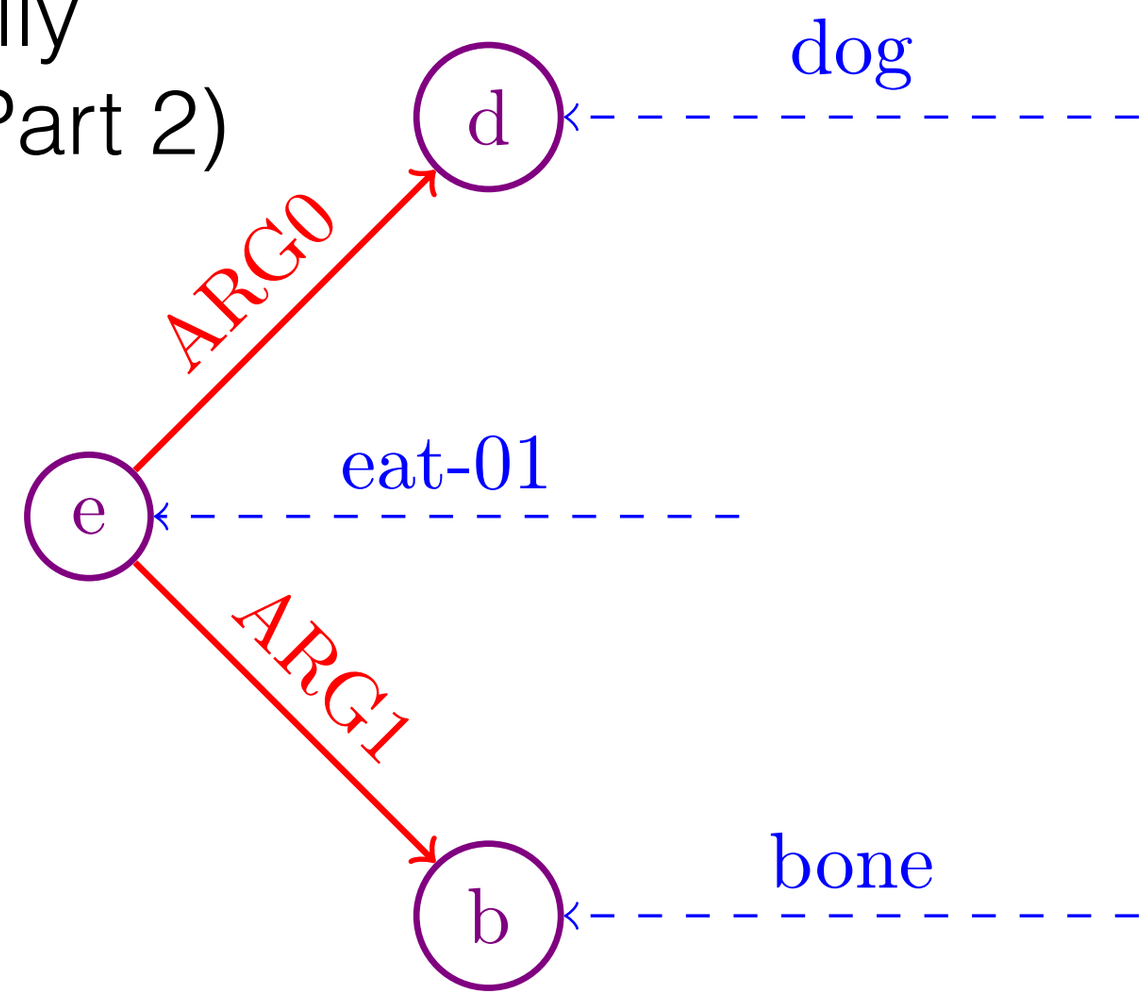


PENMAN notation

- **Concepts** are technically **edges** (this matters in Part 2)

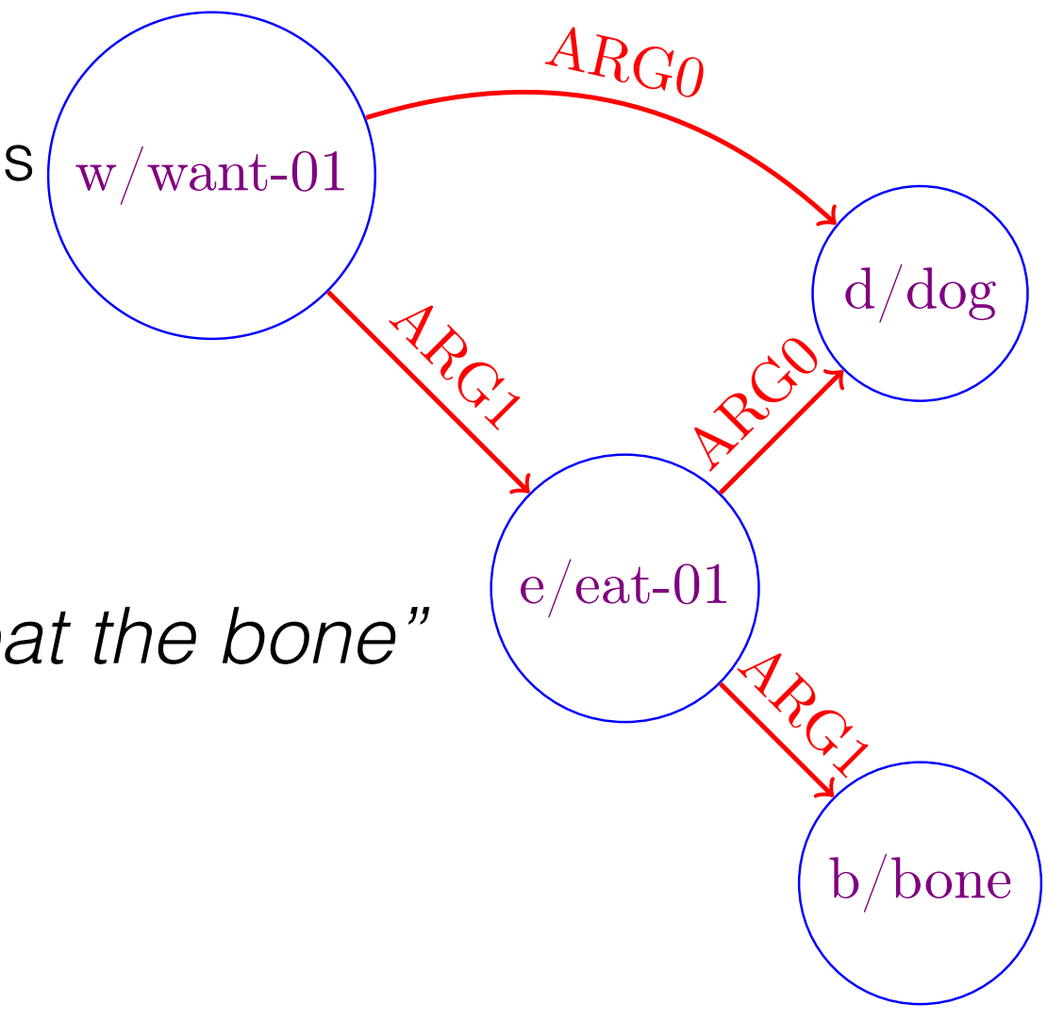
"The dog is eating a bone"

(**e** / **eat-01**
  :**ARG0** (**d** / **dog**)
  :**ARG1** (**b** / **bone**))



Reentrancy

- What if something is referenced multiple times?
- Notice how **dog** has two incoming roles now.
- To do this in PENMAN format, repeat the variable. We call this a **reentrancy**.



*"The dog **wants to** eat the bone"*

(want-01
:ARG0 (**d** / **dog**)
:ARG1 (e / eat-01
:ARG0 **d**
:ARG1 (b / bone)))

Reentrancy

- It **does not matter** where the concept label goes.

  "*The dog wants to eat the bone*"

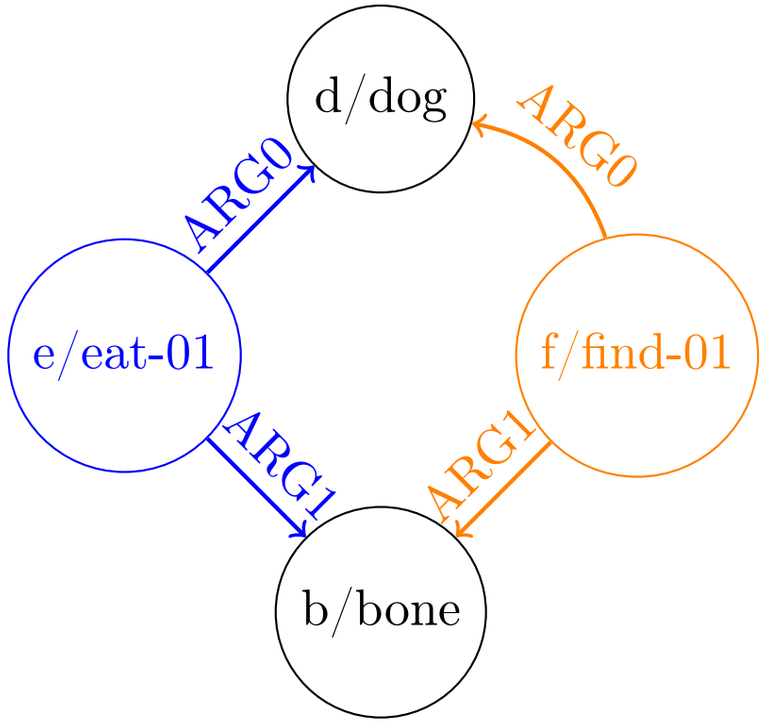
```
(want-01
    :ARG0 (d / dog)
    :ARG1 (e /eat-01
        :ARG0 d
        :ARG1 (b / bone)))
```

=

```
(want-01
    :ARG0 d
    :ARG1 (e /eat-01
        :ARG0 (d / dog)
        :ARG1 (b / bone)))
```

Inverse Relations and Focus

- What about “The dog ate **the bone that he found**”?



- How do we know **what goes on top**?

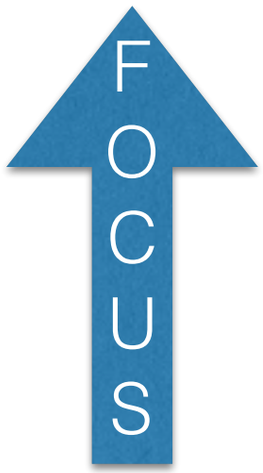
- How do we get these **into the AMR format**?

Inverse Relations and Focus

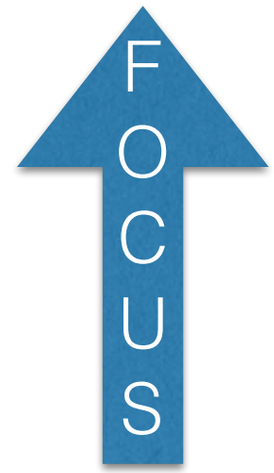
- We call “what goes on top” the **focus**.
- Conceptually, **the main assertion**.
- Linguistically, **often the head**.
  - For a sentence, **usually the main verb**.

Inverse Relations and Focus

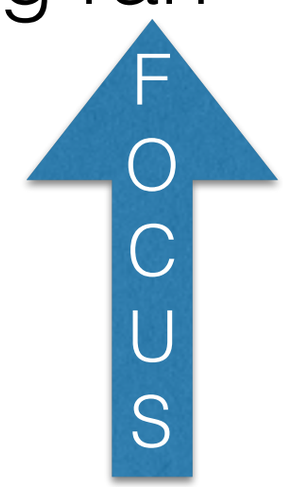
The man at the hotel



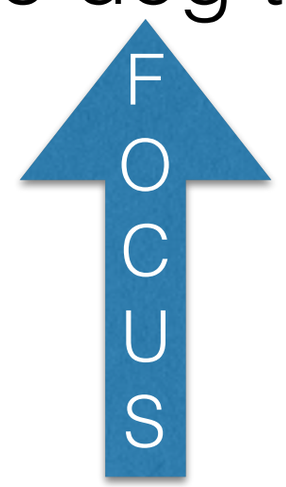
The hotel the man is at



The dog ran

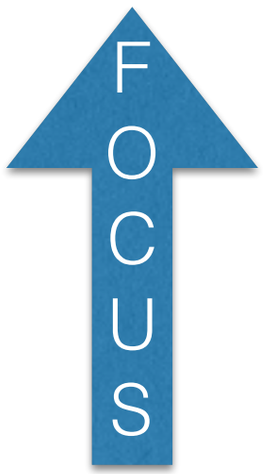


The dog that ran



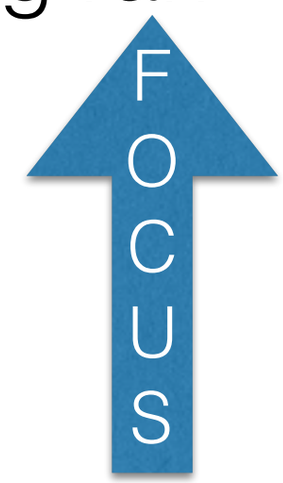
Inverse Relations and Focus

The man at the hotel



(m / man
:**location** (h / hotel))

The dog ran

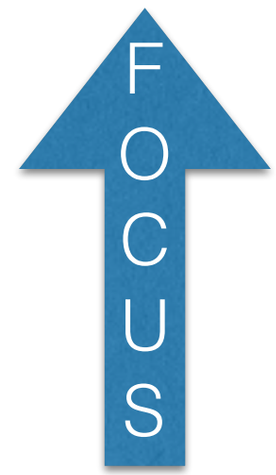


(r / ran-01
:**ARG0** (d / dog))

Inverse Relations and Focus

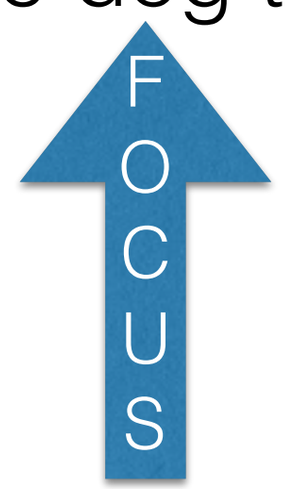
The hotel the man is at

(h / hotel
    :??? (m / man))



The dog that ran

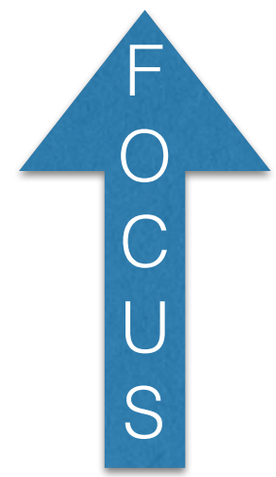
(d / dog
    :???? (r / ran-01))



Inverse Relations and Focus

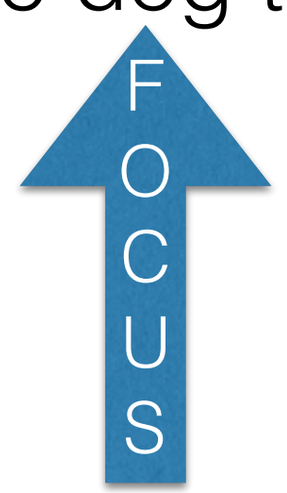
The hotel the man is at

(h / hotel
    :location-of (m / man))



The dog that ran

(d / dog
    :ARG0-of (r / ran-01))

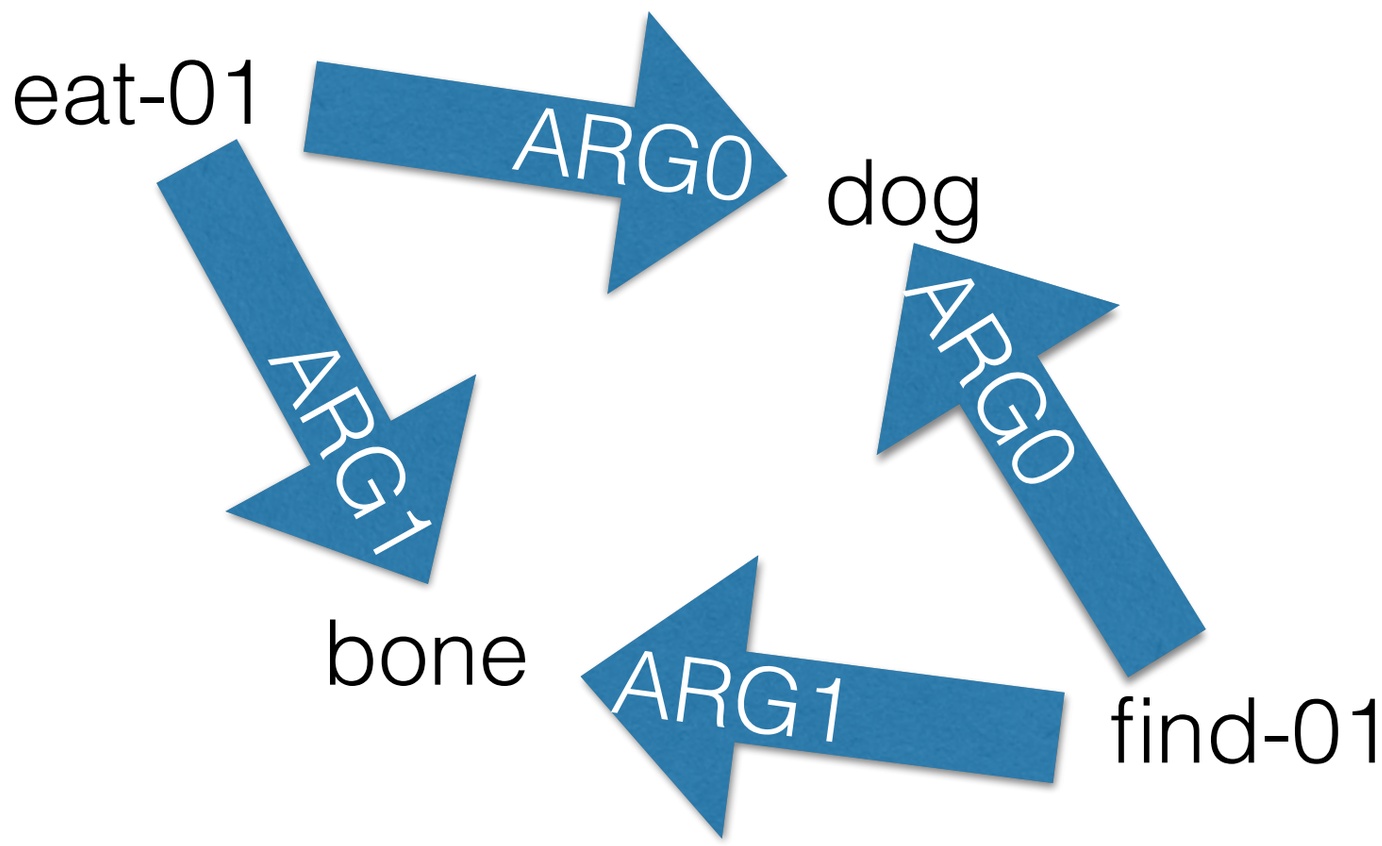


Inverse Relations and Focus

- This is a notational trick: **X ARG0-of Y = Y ARG0 X**
- Often used for relative clauses.
- *These are equivalent for SMATCH scoring purposes too.*

Reviewing the Format

- Imagine a graph for "***The dog ate the bone that he found***"

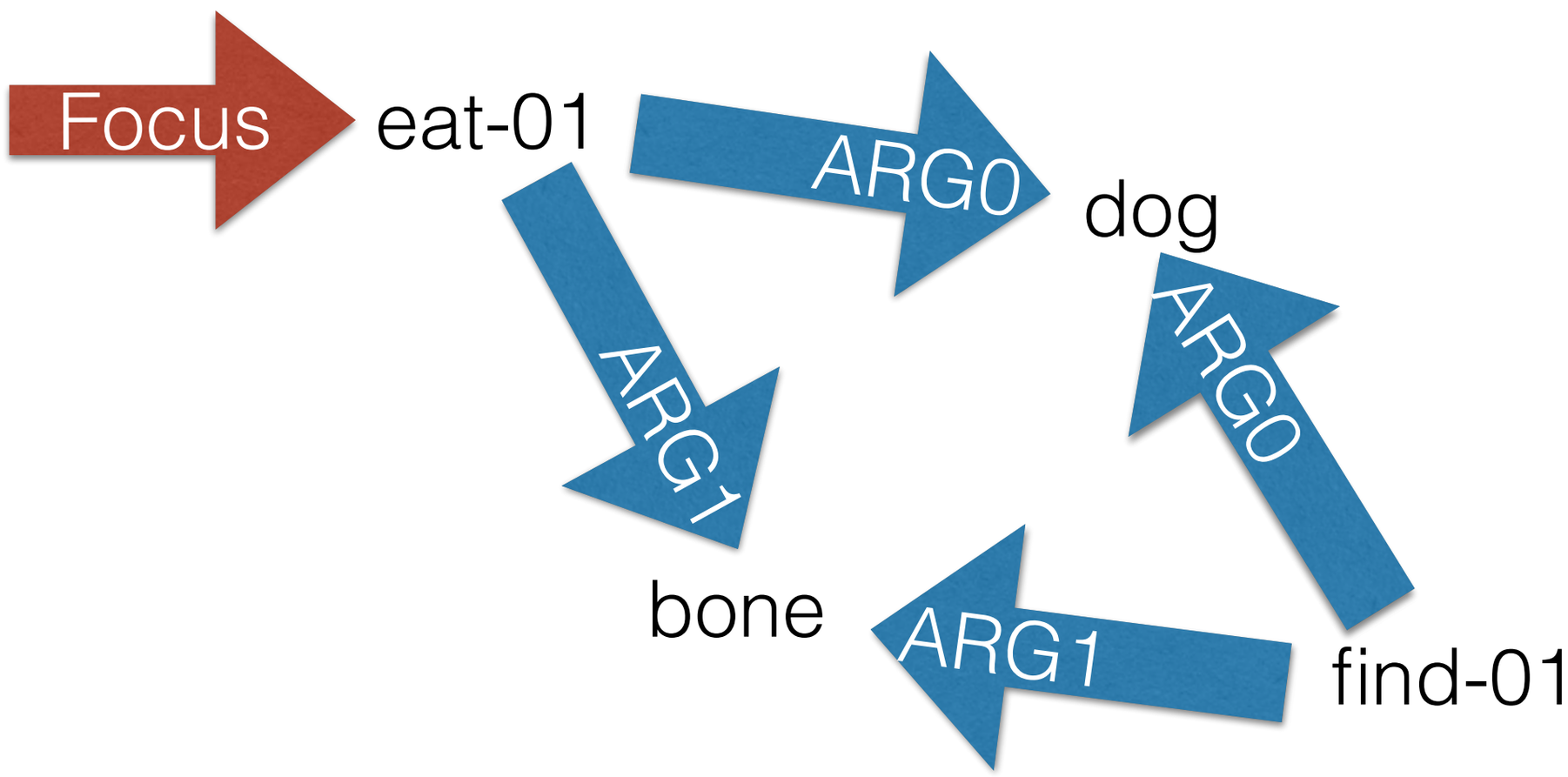


- "***The dog ate the bone that he found***"

Reviewing the Format

(e / eat-01 …)

- Find the focus

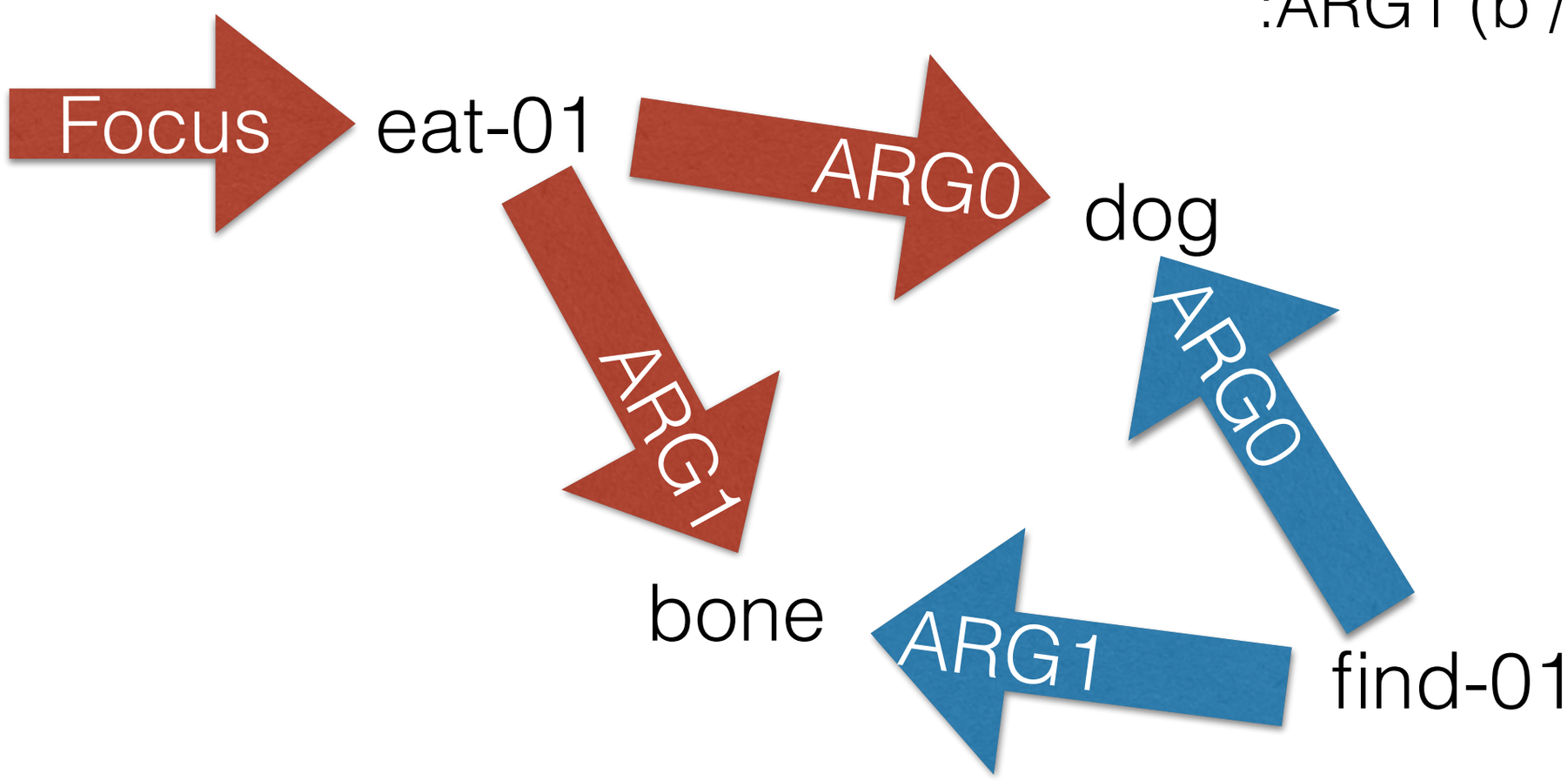


- "***The dog ate the bone that he found***"

Reviewing the Format

- Add entities

```
(e / eat-01
    :ARG0 (d / dog)
    :ARG1 (b / bone))
```

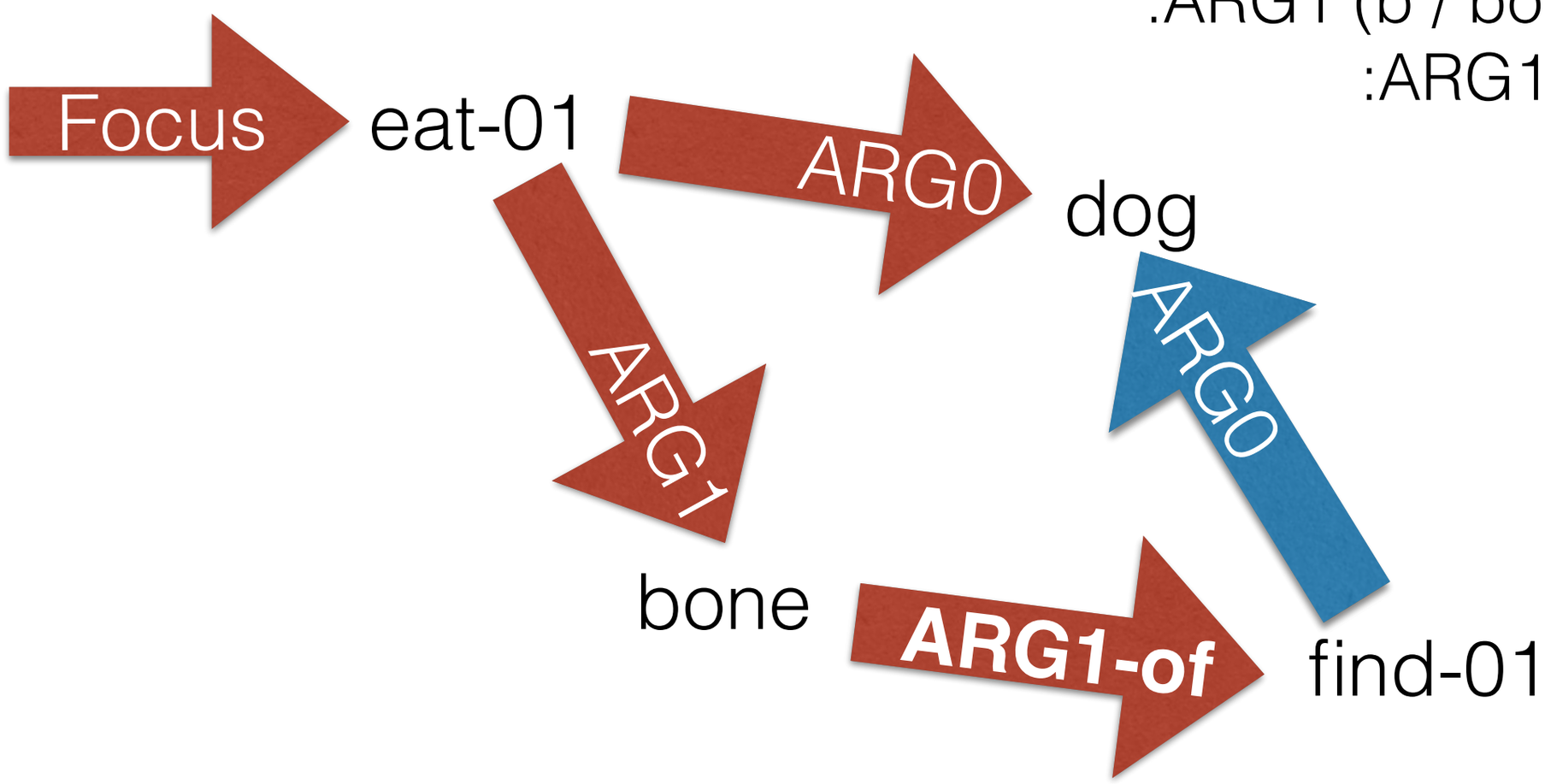


- "***The dog ate the bone that he found***"

Reviewing the Format

- Invert a relation if needed

```
(e / eat-01
    :ARG0 (d / dog)
    :ARG1 (b / bone
            :ARG1-of (f / find-01)))
```

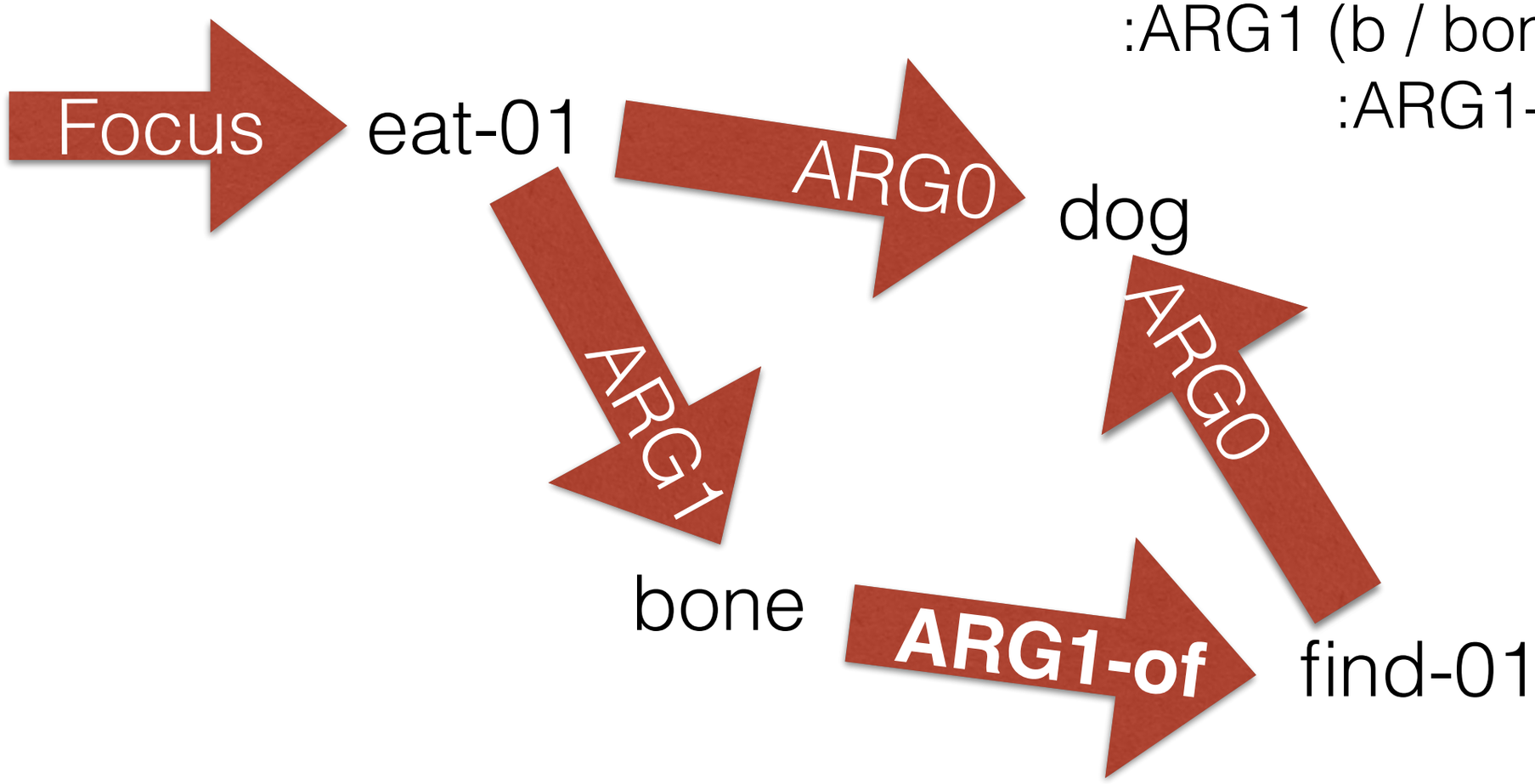


- "***The dog ate the bone that he found***"

Reviewing the Format

- Add reentrancies

```
(e / eat-01
    :ARG0 (d / dog)
    :ARG1 (b / bone)
            :ARG1-of (f / find-01
                        :ARG0 d)))
```



- "***The dog ate the bone that he found***"

Constant

- Some relations, called **constants**, get no **variable**.
- The editor does this **automatically** for certain contexts.
- This happens for **negation**.

*"The dog **did not** eat the bone"*

(e /eat-01 **:polarity -**
:ARG0 (d / dog)
:ARG1 (b / bone))

Constant

- Some relations, called **constants**, get no **variable**.
- The editor does this **automatically** for certain contexts.
- This happens for **numbers**.

*"The dog ate **four** bones"*

(e /eat-01
:ARG0 (d / dog)
:ARG1 (b / bone **:quant 4**))

(to create a concept starting with a nonalphabetic character, type "!" before the concept)

Constant

- Some relations, called **constants**, get no **variable**.
- The editor does this **automatically** for certain contexts.
- This happens for **names**

*"**Fido** the dog"*

(d / dog
    :name (n / name :op1 **"Fido"**))

Concepts vs. Constants

- A **concept** is a type. For every concept node there will be ≥1 instance variable/node.
  - An instance can be mentioned multiple times.
  - Multiple instances of the same concept can be mentioned.
- **Constants** are singleton nodes: no variable, just a value. Specific non-core roles allow constant values.

- That's AMR notation! Let's review before discussing **how we annotate AMRs**.

variable **concept** **constant**

(**e** / **eat-01**
:ARG0 (d / dog)
:ARG1 (b / bone **:quant 4**
:**ARG1-of** (f / find-01
:ARG0 **d**)))

inverse relation **reentrancy**

PropBank Lexicon

- Predicates use the ***PropBank*** *inventory.*
- Each frame presents annotators with a list of senses.
- Each sense has its own definitions for its numbered (core) arguments

run-01 - "operate, proceed, operate or proceed"

- ARG0: operator
- ARG1: machine, operation, procedure
- ARG2: employer
- ARG3: coworker
- ARG4: instrumental

Aliases: run (v), run (n), running (n)
more

---

run-02 - "walk quickly, a course or contest, run/jog, run for office"

- ARG0: runner theme
- ARG1: course, race, distance location
- ARG2: opponent

Aliases: run (v), run (n), running (n)
more

---

run-03 - "cost"

- ARG1: commodity
- ARG2: price
- ARG3: buyer

Aliases: run (v), running (n)

PropBank Lexicon

- We generalize across **parts of speech** and **etymologically related words**:

My fear of snakes	fear-01
I am fearful of snakes	fear-01
I fear snakes	fear-01
I'm afraid of snakes	fear-01

- But we **don't** generalize over synonyms:

My fear of snakes	fear-01
I'm terrified of snakes	terrify-01
Snakes creep me out	creep_out-03

Stemming Concepts

- Non-predicates don't have PropBank frames. They are simply stemmed.

- All concepts drop **plurality**, **articles**, and **tense**.

A cat	eating
The cat	eats
cats	ate
the cats	will eat
(c / cat)	(e / eat-01)

Why drop articles?

- All mentions of a term go to **the same variable**, including **pronouns** and **later nominal mentions**.

I saw ***a nice dog*** *and noticed* ***he*** *was eating a bone*

(d / dog
:mod nice)

Is "d" indefinite or definite?

- We do capture **demonstratives**:

This house

(h / house
:mod (t / this))

Stemming Concepts

- Pronouns that do not have a coreferent nominal mention are **made nominative** and **used as normal concepts.**

The man saved himself	**He** saved himself	He saved **me**
(s / save-01 :ARG0 (m / man) :ARG1 m)	(s / save-01 :ARG0 (**h / he**) :ARG1 h)	(s / save-01 :ARG0 (h / he) :ARG1 (**i / i**))

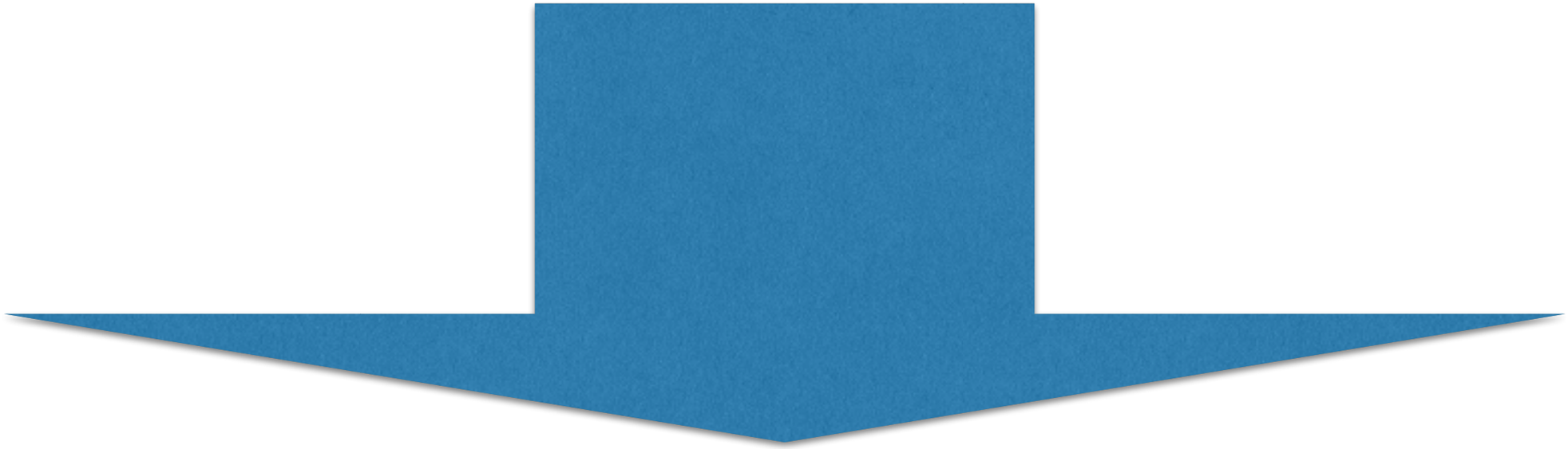
Why drop tense?

- English verbal tense **doesn't generalize well cross-linguistically**; not available for nominal predicates.

- Richer time representation might have required looking beyond a sentence.

- Keep a simple representation.

The man described the mission as a disaster.
The man's description of the mission: disaster.
As the man described it, the mission was a disaster.
The man described the mission as disastrous.



```
(d / describe-01
      :ARG0 (m / man)
      :ARG1 (m2 / mission)
      :ARG2 (d / disaster))
```

Non-core Role Inventory

- If a semantic role is not in the **core roles** for a roleset, AMR provides an inventory of **non-core roles**

- These express things like **:time, :manner, :part, :location, :frequency**

- Inventory on handout, or in editor (the **[roles]** button)

run-01 - "operate, proceed, operate or proceed"

- ARG0: operator
- ARG1: machine, operation, procedure
- ARG2: employer
- ARG3: coworker
- ARG4: instrumental

- **General semantic roles (incl. shortcuts):** :accompanier ex :age e
  :compared-to ex :concession ex :condition ex :consist-of ex :cos
  :direction ex :domain ex :duration ex :employed-by ex :exampl
  :instrument ex :li ex :location ex :manner ex :meaning ex :med
  :name ex :ord ex :part ex :path ex :polarity ex :polite ex :poss
  :source ex :subevent ex :subset ex :superset ex :time ex :topic
- **In quantities:** :quant ex :unit ex :scale ex examples quantity ty
- **In date-entity:** :day :month :year :weekday :time :timezone
  :year2 :decade :century :calendar ex :era ex :mod date-entity
- **Ops:** :op1 :op2 :op3 :op4 :op5 :op6 :op7 :op8 :op9 :op1
- **In multi-sentence:** :snt1 :snt2 :snt3 :snt4 :snt5 :snt6 :snt7

Non-core Role Inventory

- We use **:mod** for attribution, and **:domain** is the inverse of mod (**:domain** = **:mod-of**)

The yummy food
There is yummy food

(f / food
:mod (y / yummy))

The yumminess of the food
The food is yummy

(y / yummy
:domain (f / food))

seeing the yummy food
seeing the food that is yummy

(s / see-01
:ARG1 (f / food
:mod (y / yummy)))

*seeing **that** the food is yummy*

(s / see-01
:ARG1 (y / yummy
:domain (f / food)))

Non-core Role Inventory

- This is also used for attribute/predicative demonstratives and nominals

This house

(h / house
    :mod (t / this))

A monster truck

(t / truck
    :mod (m / monster))

the truck is a monster

(m / monster
    :domain (t / truck))

Non-core Roles: **:op#**

- Some relations need to have an ordered list of arguments, but **don't have specific meanings** for each entry.

- We use **:op1**, **:op2**, **:op3**, … for these

:op# for coordination

- We use this for coordination:
- *Apples and bananas*

```
(a / and
    :op1 (a2 / apple)
    :op2 (b / banana))
```

:op# for names

- *Barack Obama*

```
(p / person
    :name (n / name
        :op1 "Barack"
        :op2 "Obama"))
```

- *Obama*

```
(p / person
    :name (n / name
        :op1 "Obama"))
```

Named Entities

- *Barack Obama*

```
(p / person
    :name (n / name
        :op1 "Barack"
        :op2 "Obama"))
```

- Entities with names get special treatment!
- We assign a **named entity type** from our ontology.
- 70+ categories like ***person, criminal-organization, newspaper, city, food-dish, conference***
- See your handout, or the **[NE types]** button in the editor

Named Entities

- *Barack Obama*

```
(p / person
    :name (n / name
        :op1 "Barack"
        :op2 "Obama"))
```

- Entities with names get special treatment!
- Each gets a **:name** relation to a **name node**
- That node gets :op# relations to the strings of their name ***as used in the sentence***.

Named Entities

- If there is a more specific descriptor present in the sentence, we use that **instead of the NE inventory.**

- *a Kleenex*

```
(p / product
    :name (n / name
        :op1 "Kleenex"))
```

- *a Kleenex tissue*

```
(t / tissue
    :name (n / name
        :op1 "Kleenex"))
```

Wikification

- In a second pass of annotation, we add **:wiki** relations.

- *Barack Obama*

```
(p / person
    :name (n / name
        :op1 "Barack"
        :op2 "Obama")
    :wiki Barack_Obama)
```

- http://en.wikipedia.org/wiki/**Barack_Obama**

Measurable Entities

- We also have special entity types we use for **normalizable entities**.

"Tuesday the 19th"

(**d / date-entity**
:weekday (t / tuesday)
:day 19)

"five bucks"

(**m / monetary-quantity**
:unit dollar
:quant 5)

Measurable Entities

- We also have special entity types we use for **normalizable entities**.

"$3 / gallon"

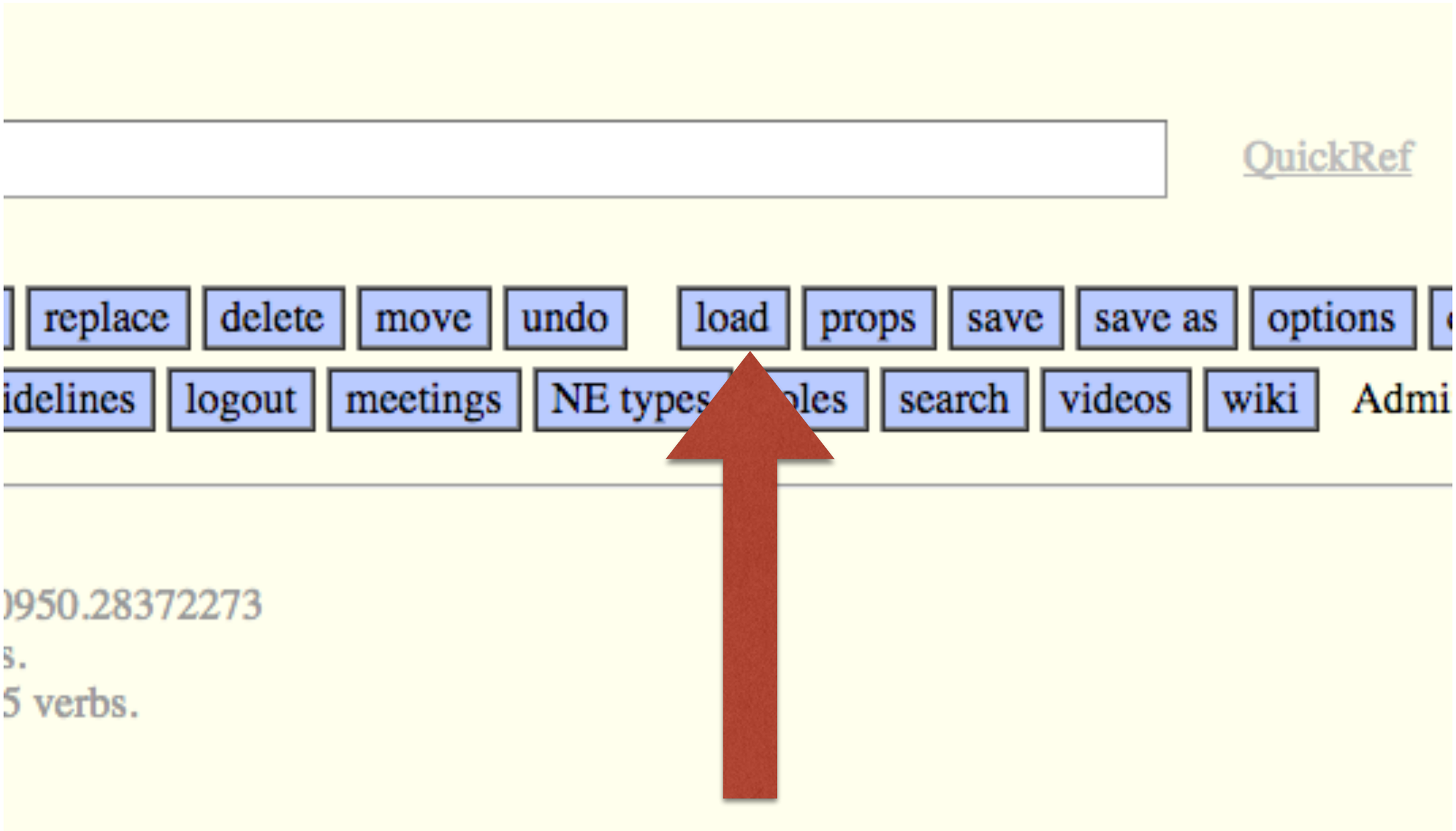
```
(r / rate-entity-91
    :ARG1 (m / monetary-quantity
        :unit dollar
        :quant 3)
    :ARG2 (v / volume-quantity
        :unit gallon
        :quant 1))
```

Hands-on Annotation!

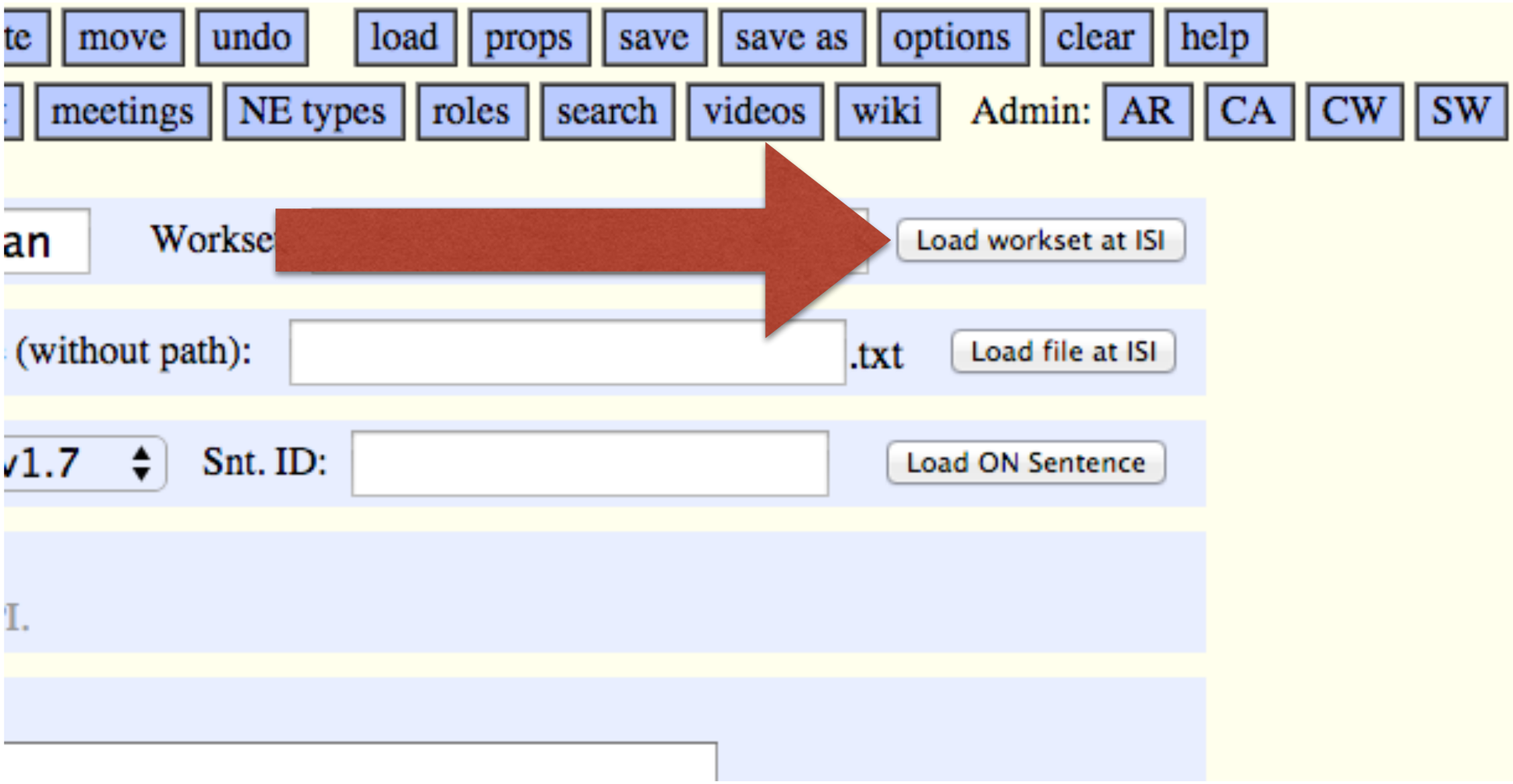
Go to the **AMR Editor**:

http://tiny.cc/amreditor

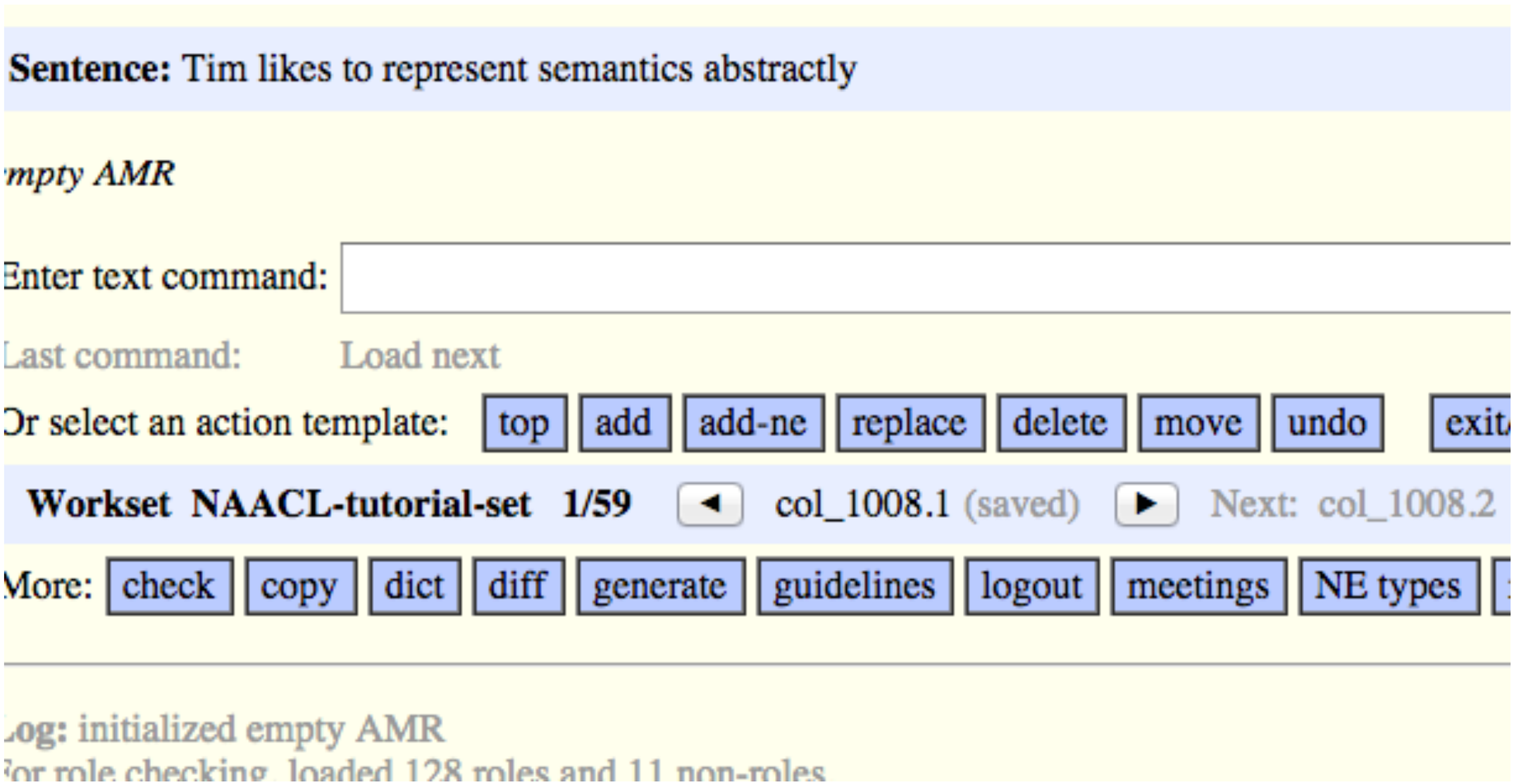
Load the Tutorial Sentences



Select “NAACL Tutorial”

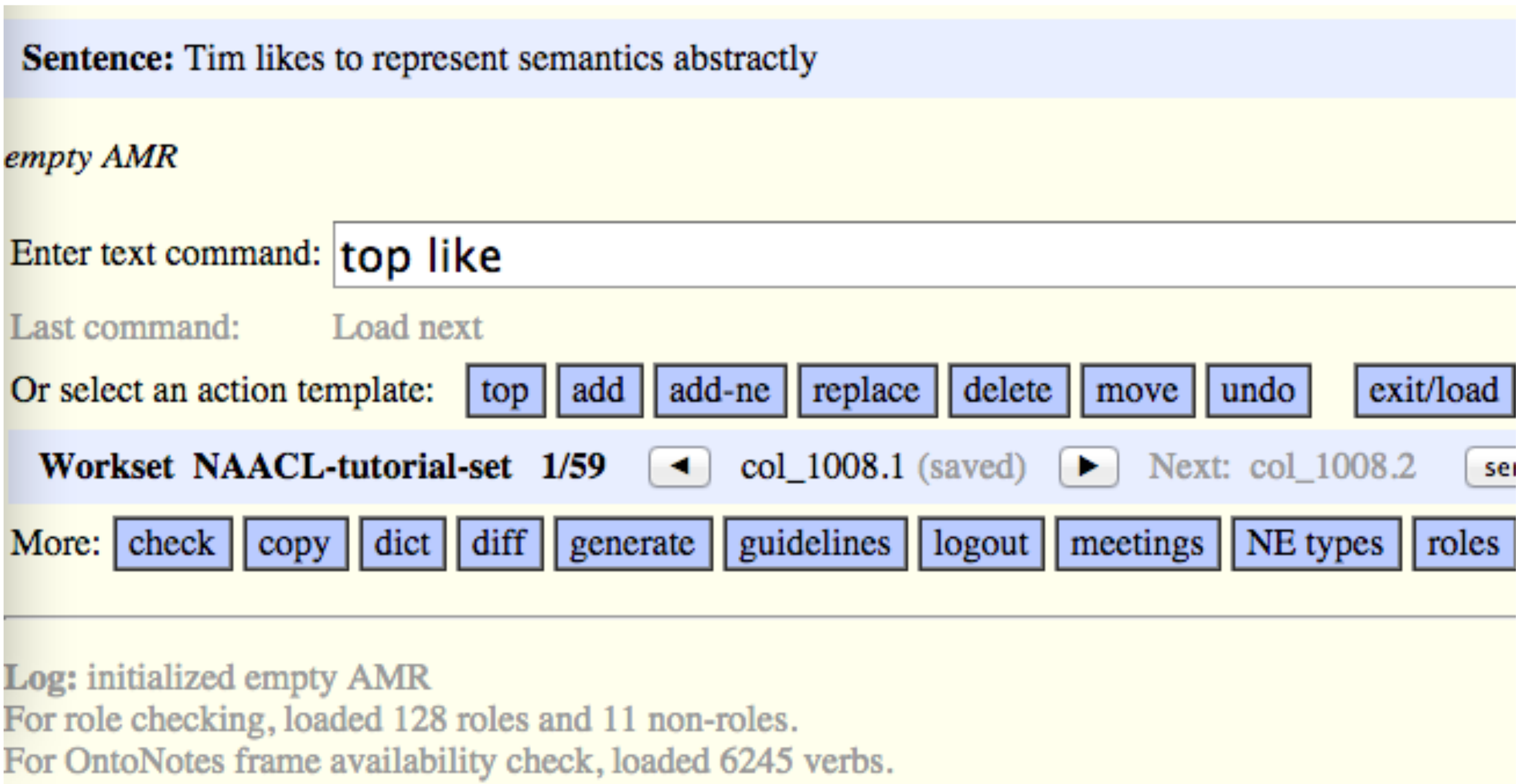


It should look like this



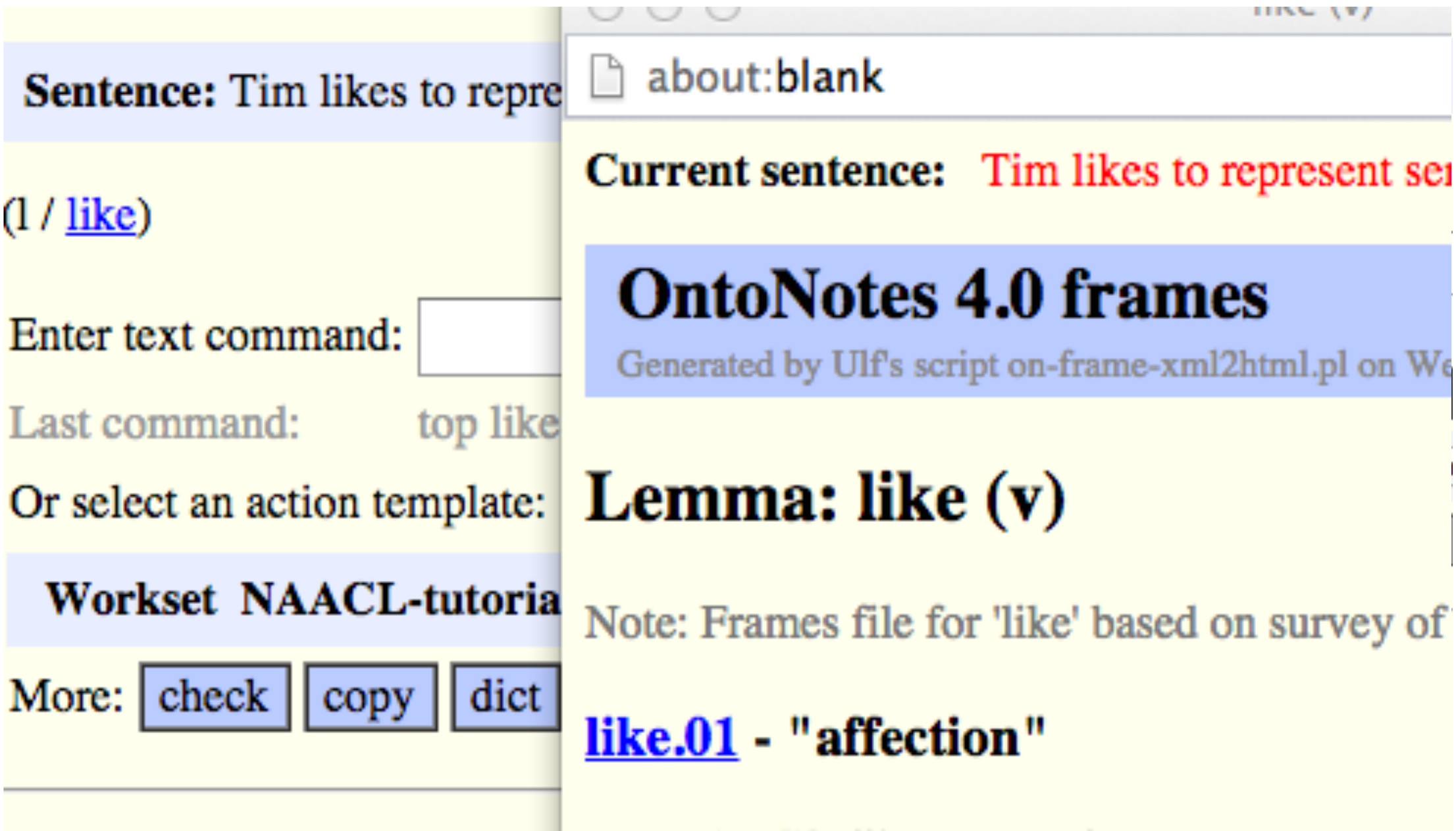
Commands

Use “top <concept>” to make a top node



Commands

Click on “like” to select the right sense



Commands

New relation: <variable> :<role> <concept>

Sentence: Tim likes to represent semantics abstractly

(1 / like-01)

Enter text command: l :arg1 represent

Last command: del r

Or select an action template: top | add | add-ne | replace | delete | move | undo | exit/load | props

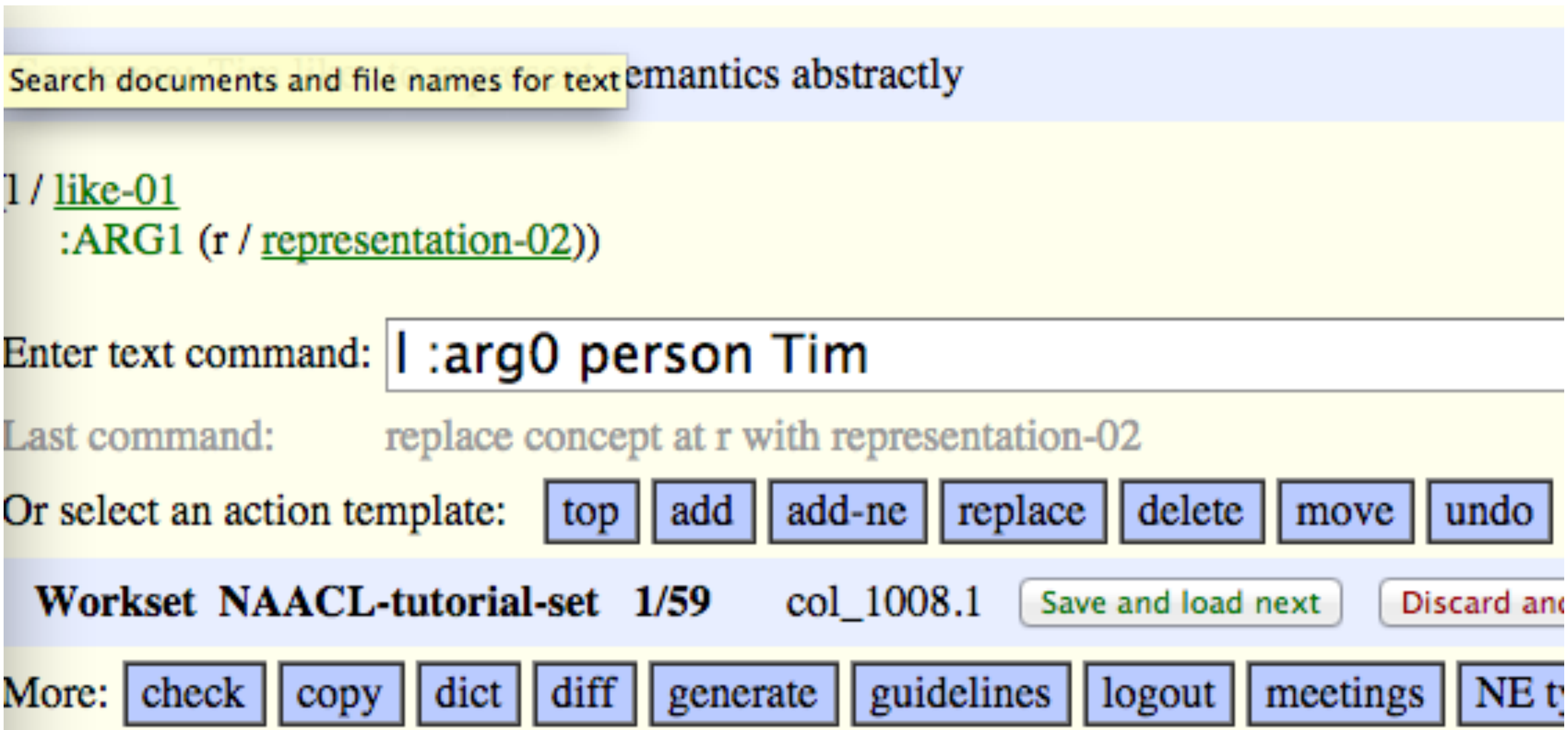
Workset NAACL-tutorial-set 1/59 col_1008.1 Save and load next Discard and load next Next: c

More: check | copy | dict | diff | generate | guidelines | logout | meetings | NE types | roles | search

Log: initialized empty AMR
For role checking, loaded 128 roles and 11 non-roles.
For OntoNotes frame availability check, loaded 6245 verbs.

Commands

Anything after the third element is made into a name



Commands

Make reentrancies with <variable> :<role> <variable>

Sentence: Tim likes to represent semantics abstractly

(1 / like-01
:ARG0 (p / person :name (n / name :op1 "Tim"))
:ARG1 (r / representation-02))

Enter text command: r :arg0 p

Last command: 1 :arg0 person Tim

Or select an action template: top | add | add-ne | replace | delete | move | undo

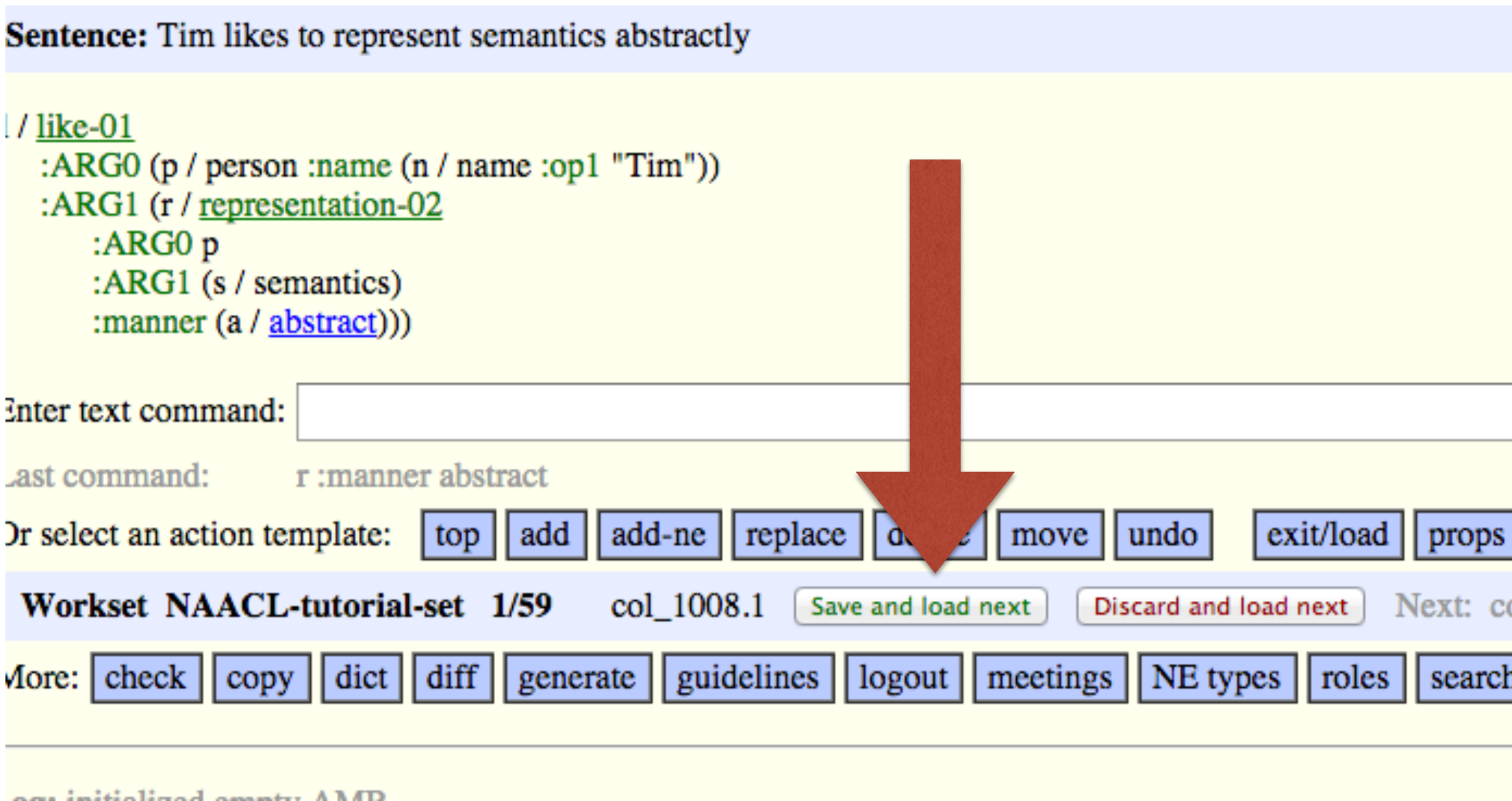
Workset NAACL-tutorial-set 1/59 col_1008.1 Save and load next Discard and loa

More: check | copy | dict | diff | generate | guidelines | logout | meetings | NE type

Log: initialized empty AMR

Commands

When you are done, use “Save and Load Next”



Try the next sentence!

We will walk through it momentarily