From Text to Frame Generation

Esther Seyffarth

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NLP Reading Group, CUNY

Semantic Frames

Barsalou (1992): Frames, Concepts, and Conceptual Fields

I propose that frames provide the fundamental representation of knowledge in human cognition. (...) Because frames also represent the attributes, values, structural invariants, and constraints within a frame, the mechanism that constructs frames builds them ***recursively****. The frame theory I propose borrows heavily from previous frame theories. (...)*

Bottle of Italian Red Wine

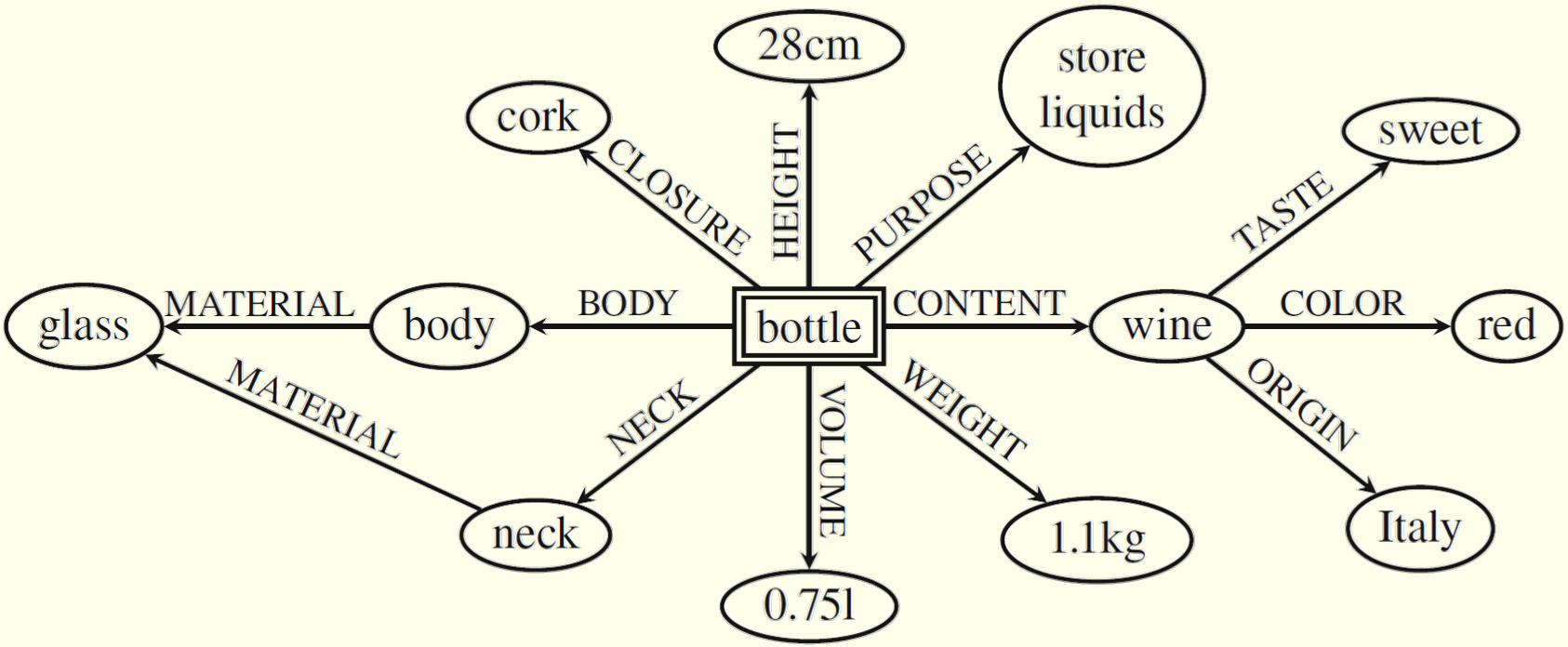
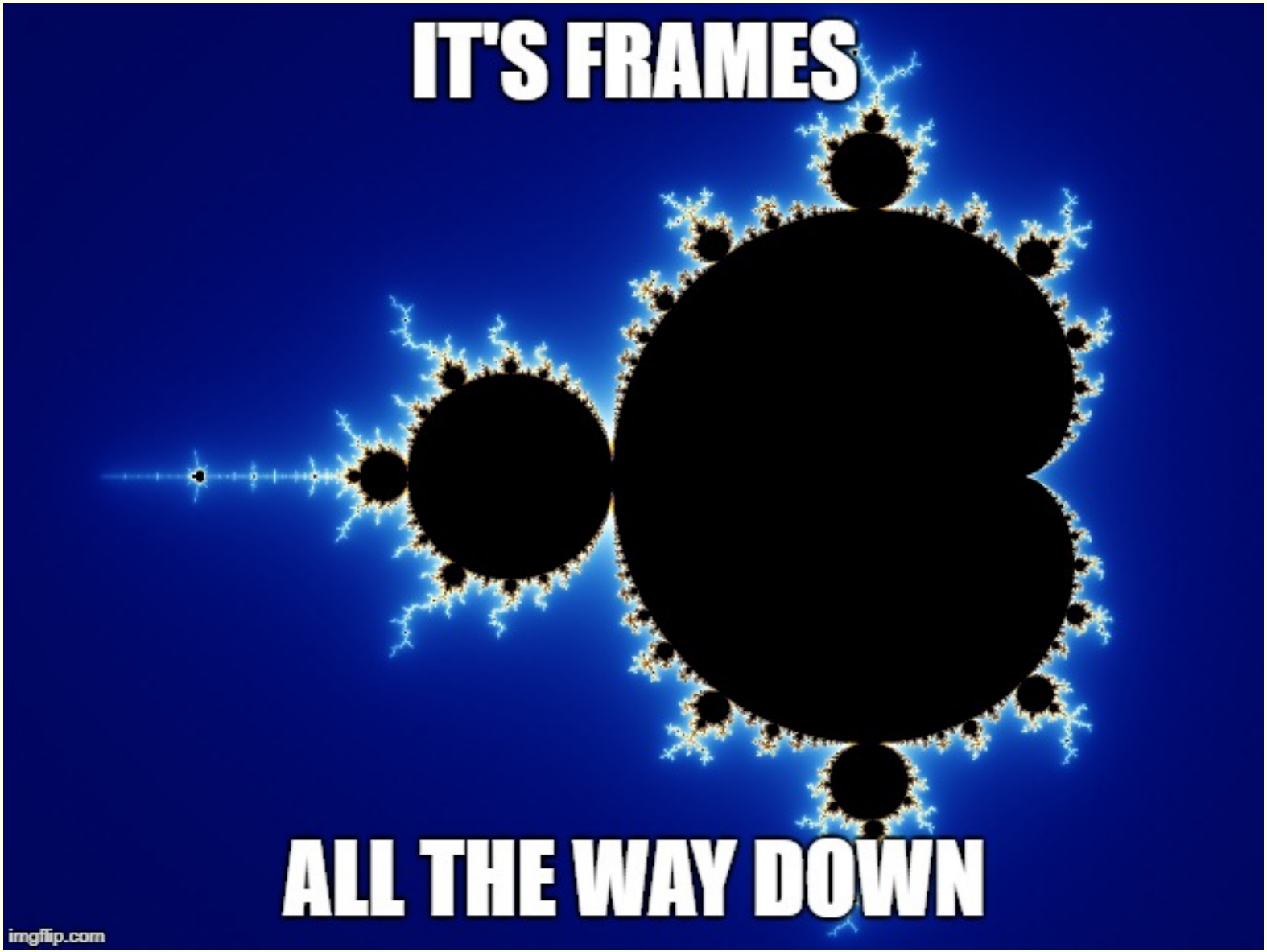


Figure 1: Simplified frame for the concept *bottle of Italian red wine*; image from Gamerschlag et al. (2014)


IT'S FRAMES
ALL THE WAY DOWN
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DFG Collaborative Research Centre 991 at Dusseldorf University: The Structure of Representations in Language, Cognition, and Science

Thinking about frames from the points of view of...

- linguistics
- computational linguistics
- philosophy
- psychology
- neuroscience
- philosophy of science

Frames are grounded in **sensory-motor perception**.

Semantic Frames for Verbs

Verb Frames

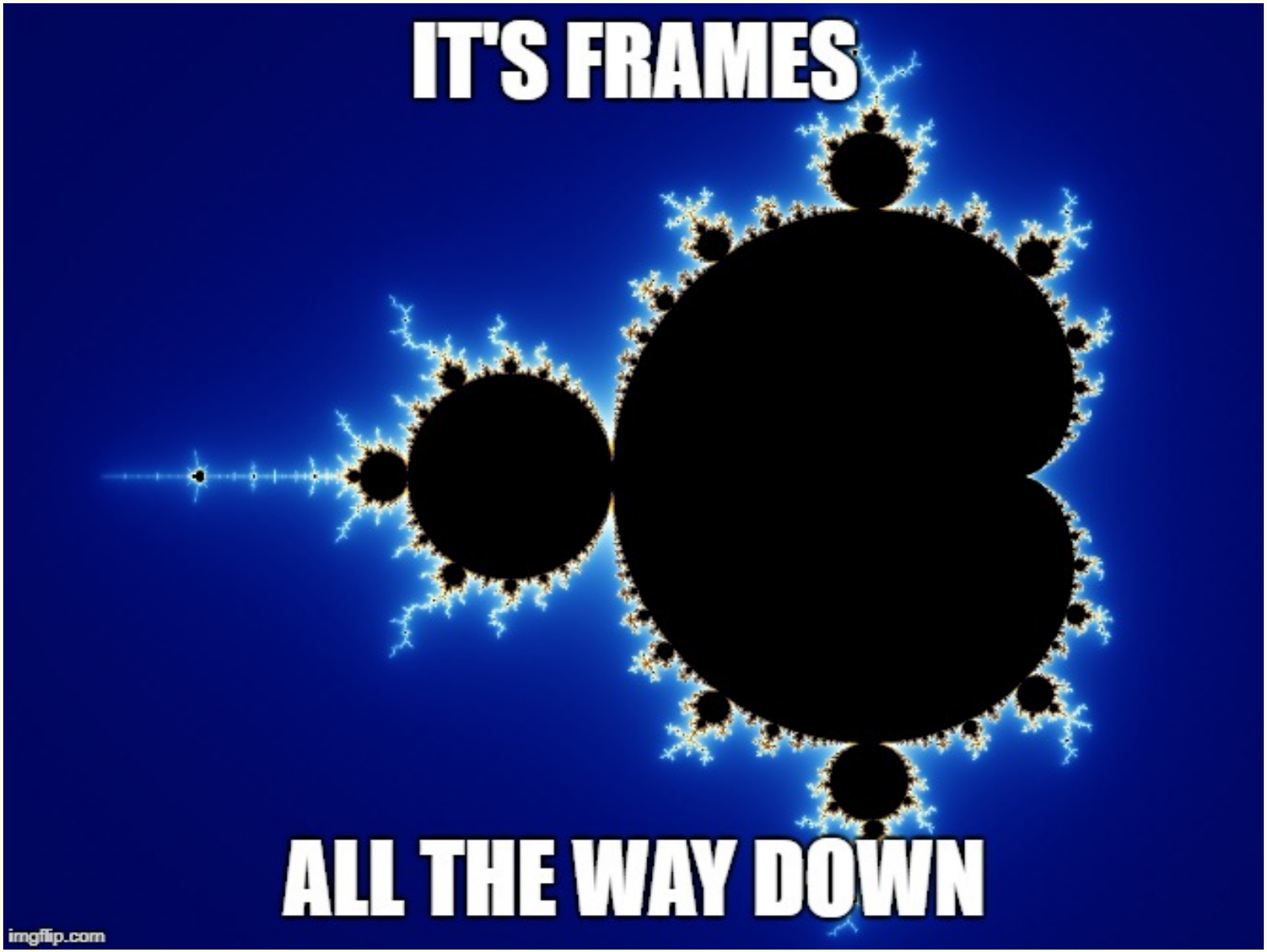
We view verbs as **events** that involve a certain set of entities.

To describe the **meaning** of a verb with a frame, we need to know about its syntactic arguments, and how they translate into semantic roles.

By representing the meaning of a sentence's root verb, we can represent the meaning of the whole sentence; all arguments are in some relation to the verb.

Semantic Frames for *see*

Perception_experience in FrameNet:		***see.01*** "view" in PropBank:	
Perc-pass:	the being who has a perceptual experience	Arg0:	viewer
Phen:	the entity or phenomenon that the perceiver experiences with his or her senses	Arg1:	thing viewed
Ex1:	[$_{\text{Perc-Pass}}$ **I**] ***saw*** [$_{\text{Phen}}$ **the baker**] [$_{\text{Phen}}$ **prepare his special peanut butter pie**]	Ex1:	[$_{\text{Arg0}}$ **John**] ***saw*** [$_{\text{Arg1}}$ **the President**]
		Ex2:	[$_{\text{Arg0}}$ **John**] ***saw*** [$_{\text{Arg1}}$ **the President collapse**]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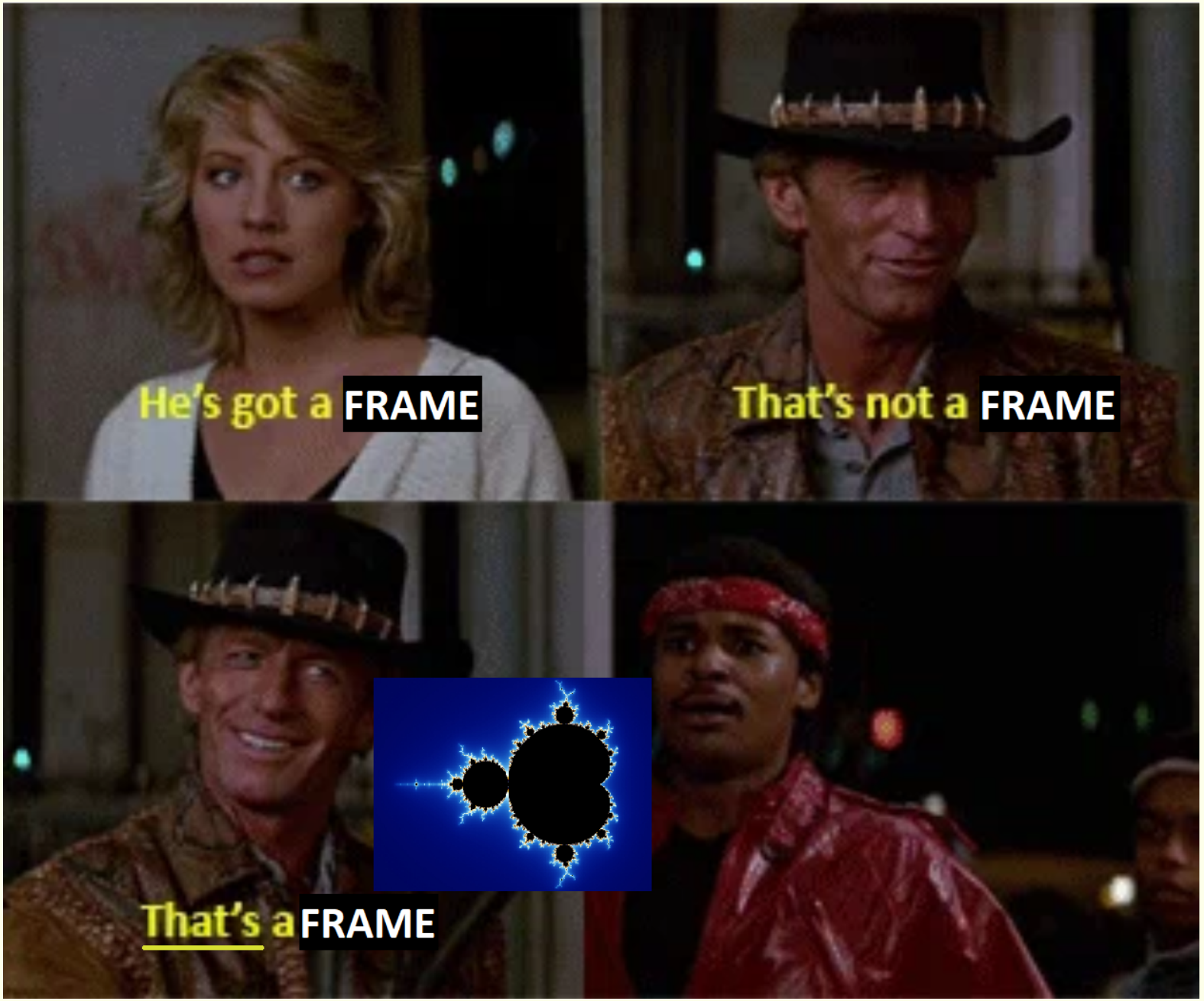
[Perc-Pass **I**] ***saw*** [Phen **the baker**] [Phen **prepare his special peanut butter pie**]

Perception_experience	
PERC-PASS	I
PHEN	the baker
PHEN	prepare his special peanut butter pie

[$_{\text{Arg0}}$ **John**] ***saw*** [$_{\text{Arg1}}$ **the President collapse**]

$$\begin{bmatrix} \textit{see.01} & \\ \text{ARG0} & \text{John} \\ \text{ARG1} & \text{the President collapse} \end{bmatrix}$$


He's got a FRAME
That's not a FRAME
That's a FRAME

Recursive Verb Frames

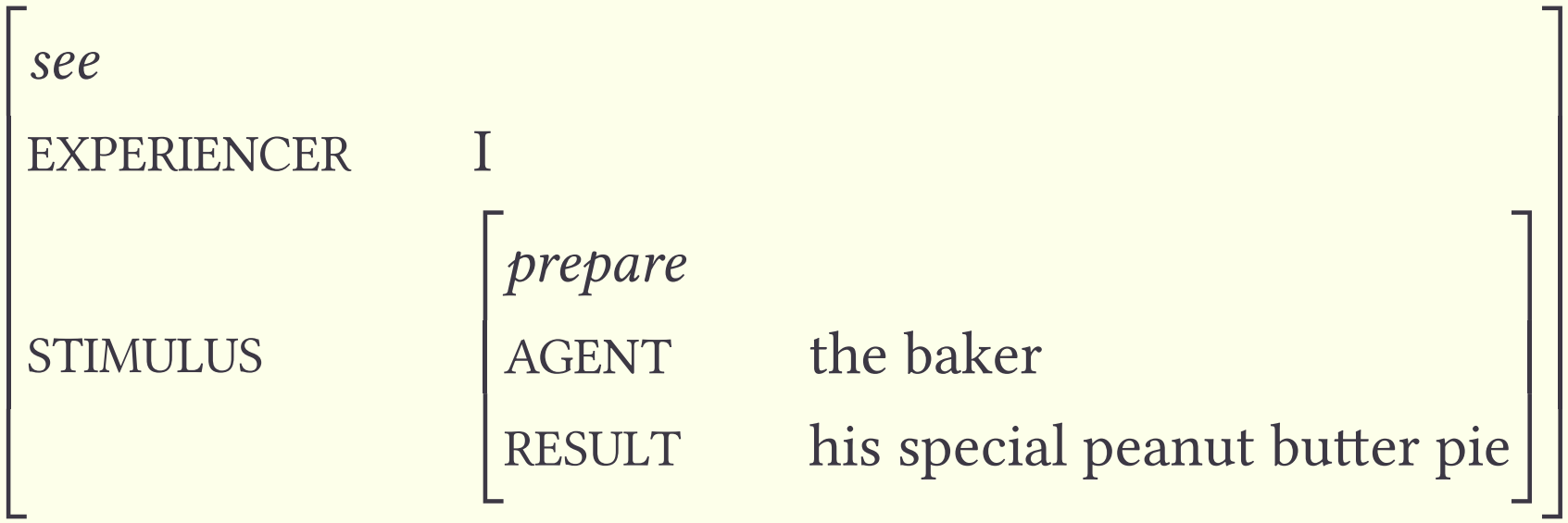


Figure 2: AVM representation of a possible recursive frame for ”see”

It's Frames ALL THE WAY DOWN

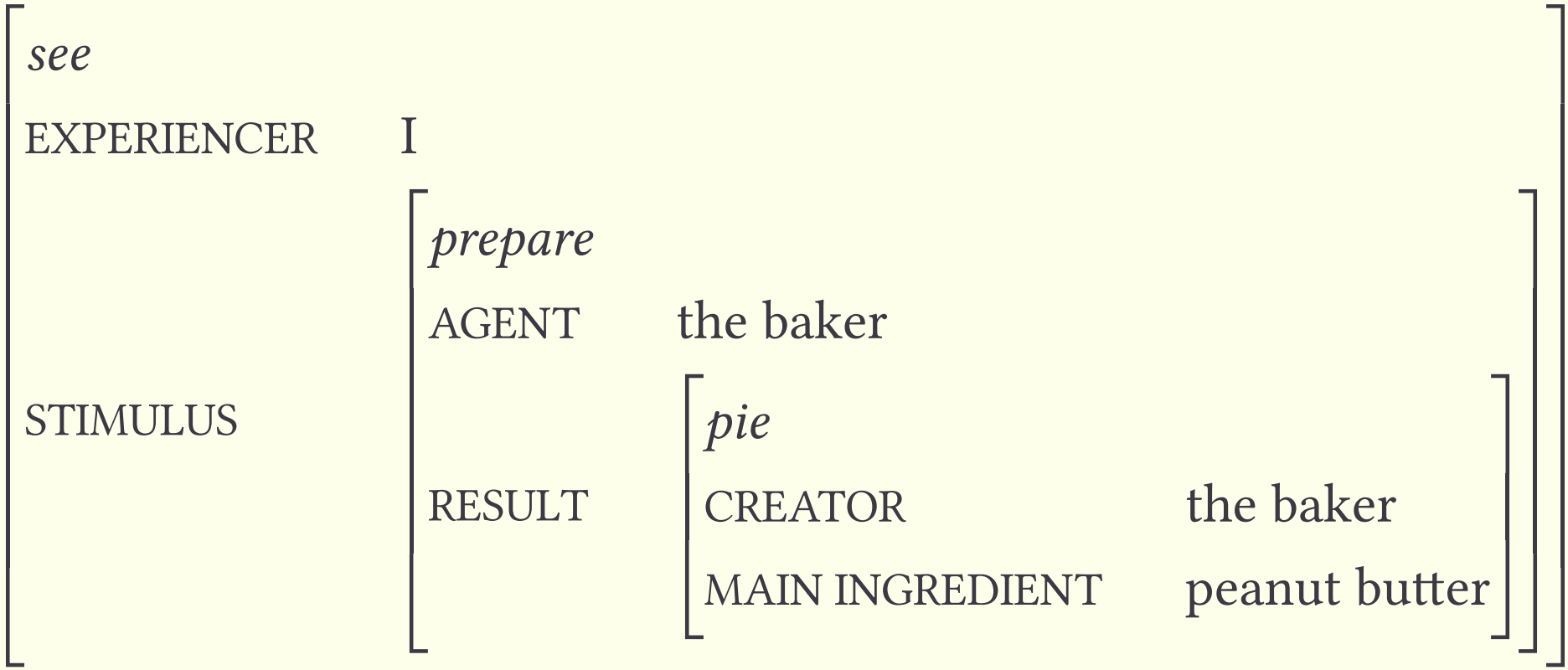


Figure 3: AVM representation of a *more recursive* frame for "see"

It's Frames ALL THE WAY DOWN!!!

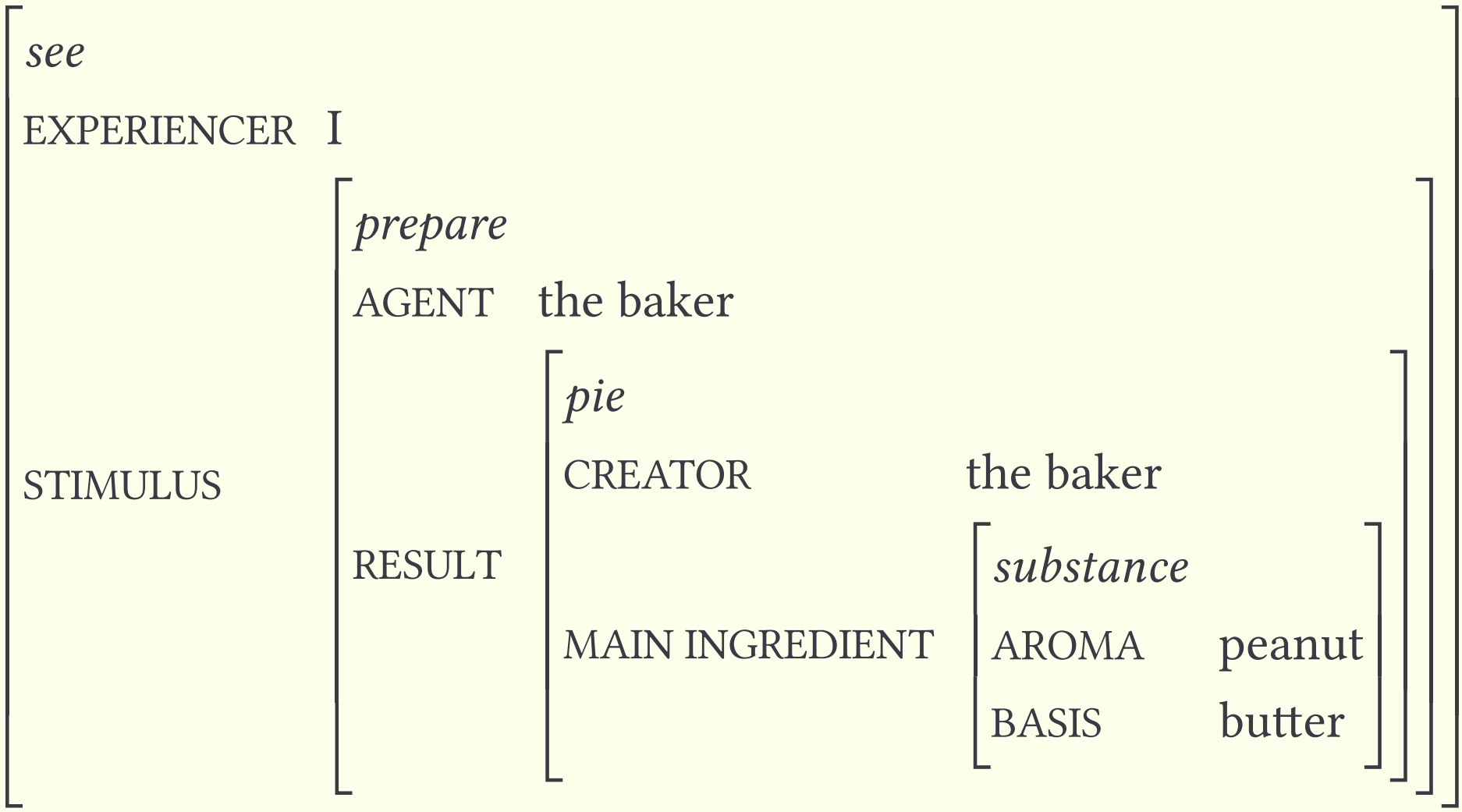


Figure 4: AVM representation of an *even more recursive* frame for "see"

Acquiring Semantic Frames

Kallmeyer, QasemiZadeh, Cheung (2018)

Coarse Lexical Frame Acquisition at the Syntax–Semantics Interface Using a Latent-Variable PCFG Model

Goal: Create a Frame lexicon based on dependency-parsed text, using unsupervised methods.

Main Problem: There is no 1-to-1 correspondence between verb lemmas and semantic frames.

Ambiguity

Examples (by B. QasemiZadeh):

(1) John **packed** a suitcase. (Filling)

(2) John **packed** the papers on the shelf. (Placing)

(3) John **loaded** furniture in the van. (Filling)

pack is a member of both the Filling frame and the Placing frame; the Filling frame also includes other verb lemmas, such as *load*.

Modelling Semantic Frames as CFG Trees

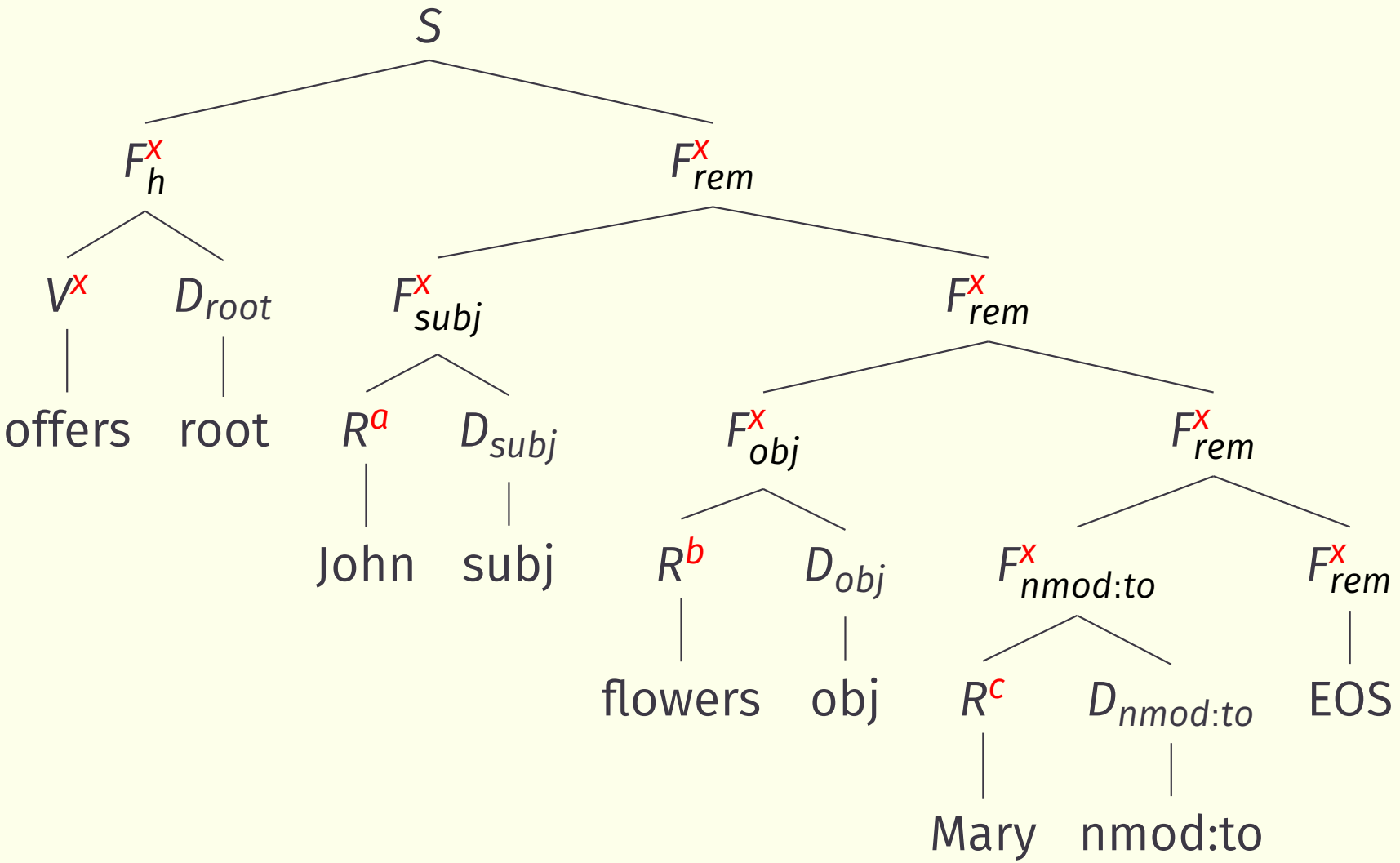


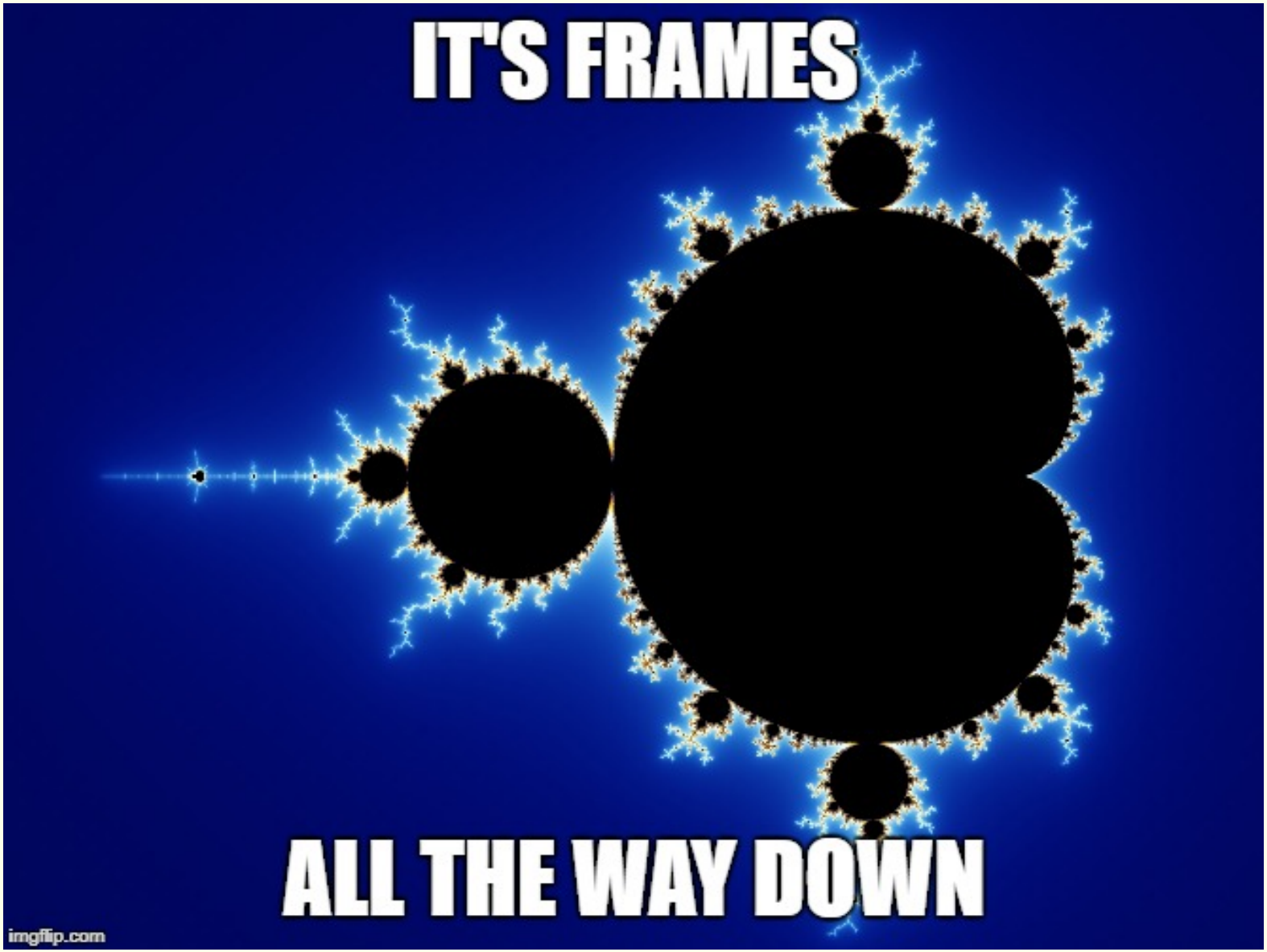
Figure 5: John offers flowers to Mary. Tree from the paper by Kallmeyer et al. (2018).

Training the Model

- Semantic frames and roles are treated as **latent variables**.
- A **Split-and-Merge** procedure is repeatedly carried out on the set of production rules to maximize the likelihood of the model.
- After a fixed amount of runs, the clusters are compared against gold data (5k instances from WSJ that were annotated semi-automatically).

Where we're at and where we're headed

- The system is pretty good at clustering verbs (FPu = 79.4).
- It outperforms the "one cluster per verb head" baseline (FPu = 73.06).
- On the task of clustering semantic roles, the system is outperformed by the "1 cluster per grammatical relation" baseline (84.44 vs. 85.86).
- **Polysemy** can be a problem: How do we distinguish verbs that share a surface form, but evoke different semantic frames?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Verb Alternations

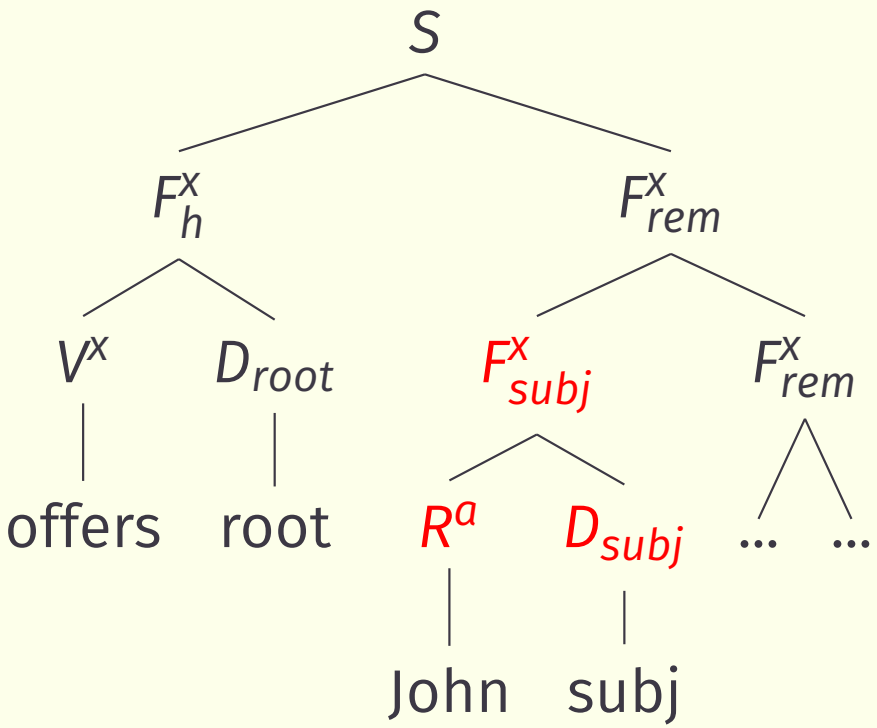
Verb Alternations

Each verb has a set of **subcategorization frames** that tell us about the verb's possible syntactic configurations:

- subject - **see** - object
- subject - **see** - object - prepositional phrase
- subject - **see**
- subject - **see** - clause
- ...

Role-Switching Alternations (McCarthy, 2001)

The L-PCFG model assumes that the role of an argument depends partly on the frame type, and partly on the dependency relation between the argument and the verbal head:



Role-Switching Alternations (McCarthy, 2001)

This **does not work** when the semantic roles of a verb can be encoded in different syntactic positions!

(4) The door opens.

(5) Alex opens the door.

In (4), there is no AGENT; the door (THEME) is opening by itself.

In (5), an AGENT is introduced, and the THEME moves to the syntactic object position.

We call the usage in (4) **inchoative** and the one in (5) **causative**.

$$\begin{bmatrix} \textit{drink} & \\ \text{AGENT} & \text{John} \end{bmatrix}$$

Figure 6: John drinks.

$$\begin{bmatrix} \textit{drink} & \\ \text{AGENT} & \text{John} \\ \text{PATIENT} & \text{beer} \end{bmatrix}$$

Figure 7: John drinks beer.

Flat Frames for Alternating Verbs

$$\begin{bmatrix} \textit{drink} \\ \text{AGENT} \quad \text{John} \end{bmatrix}$$

Figure 6: John drinks.

$$\begin{bmatrix} \textit{drink} \\ \text{AGENT} \quad \text{John} \\ \text{PATIENT} \quad \text{beer} \end{bmatrix}$$

Figure 7: John drinks beer.

$$\begin{bmatrix} \textit{open} \\ \text{PATIENT} \quad \text{the door} \end{bmatrix}$$

Figure 8: The door opens.

$$\begin{bmatrix} \textit{open} \\ \text{AGENT} \quad \text{Alex} \\ \text{PATIENT} \quad \text{the door} \end{bmatrix}$$

Figure 9: Alex opens the door.

(6) Alex opens the door $\rightarrow$ Alex causes the door to open

(7) John drinks beer $\rightarrow$???

Frames for Alternating Verbs (Causative Alternation)

$$\begin{bmatrix} \textit{causation} & \\ \text{AGENT} & \text{Alex} \\ \text{EFFECT} & \begin{bmatrix} \textit{open} \\ \text{PATIENT} & \text{the door} \end{bmatrix} \end{bmatrix}$$

Figure 10: Alex opens the door.

Frames for Alternating Verbs (Causative Alternation)

$$\begin{bmatrix} \textit{causation} & \\ \text{CAUSE} & \begin{bmatrix} \textit{activity} & \\ \text{AGENT} & \text{Alex} \end{bmatrix} \\ \text{EFFECT} & \begin{bmatrix} \textit{open} & \\ \text{PATIENT} & \text{the door} \end{bmatrix} \end{bmatrix}$$

Figure 11: Alex opens the door.

Frames for Alternating Verbs (Causative Alternation)

$$\begin{bmatrix} \textit{causation} & \\ \text{CAUSE} & \begin{bmatrix} \textit{activity} & \\ \text{AGENT} & \text{Alex} \end{bmatrix} \\ \text{EFFECT} & \begin{bmatrix} \textit{open} & \\ \text{PATIENT} & \text{the door} \end{bmatrix} \end{bmatrix}$$

Figure 12: Alex opens the door.

This frame structure lets us ask (and answer) questions like:

- What happened to the door?
- What did Alex do?
- Why did the door open?
- How did Alex interact with the door?
- What did Alex do to open the door?

Alex kicked the door open

$$\begin{bmatrix} \textit{causation} & \\ \text{CAUSE} & \begin{bmatrix} \textit{kick} & \\ \text{AGENT} & \text{Alex} \\ \text{INSTRUMENT} & \text{foot} \end{bmatrix} \\ \text{EFFECT} & \begin{bmatrix} \textit{open} & \\ \text{PATIENT} & \text{the door} \end{bmatrix} \end{bmatrix}$$

Figure 13: Alex kicked the door open.

The result of this event is the same as before: The door is now open.

Additionally, we specify the nature of the activity by Alex that triggered the opening event:

A *kicking* event, controlled by Alex, leads to an *opening* event that impacts the state of the door.

Research Questions

1. Which verbs **participate** in this alternation?
2. Do **other verb alternations** behave as predictably as the causative alternation? (e.g. conative alternation, dative alternation)
3. Can a verb be **coerced** into the causative alternation, and if so, what processes are involved?

How do Verb Alternations Differ from Polysemy?

Are the two uses of *open* instances of different frames? Why? Why not?

RQ1: Identifying Alternating Verbs

My setup:

- Dependency-parsed BNC
- Classifications from Levin (1993) and VerbNet 3.3 as gold data

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- **Predicting** participation based on syntactic patterns, distributional information about arguments of the verbs, perplexity scores calculated by a Recurrent Neural Network, and VerbNet classes
- **Evaluation** on different test sets:
  - ALL: All verbs from Levin
  - FREQ: 300 most frequent
  - BLNCD: 150 most frequent from alternating and non-alternating sets

RQ1: Results

	Levin			VerbNet		
	ALL	**FREQ**	**BLNCD**	**ALL**	**FREQ**	**BLNCD**
Random Baseline	0.51	0.54	0.52	0.53	0.47	0.56
VNType	0.20	0.31	0.32	0.10	0.18	0.17
VNRank	0.67	0.63	0.52	0.60	0.42	0.52
VNToken	0.61	0.59	0.50	**0.83**	0.68	0.71
SCFFlag	**0.71**	**0.74**	**0.67**	0.59	0.63	0.67
SCFRatio	**0.71**	0.72	0.65	0.68	0.57	0.60
CentroidDistance	0.62	0.60	0.62	0.64	0.78	**0.79**
CentroidSubjVsObj	0.63	0.63	0.57	0.64	**0.79**	**0.79**
RNN-LM	0.66	0.69	0.59	0.66	0.78	**0.79**

Table 1: F1 scores of all setups. For details, see my SCiL 2019 draft.

Is alternatability a binary, or a spectrum?

Verbs like ”increase” or ”open” seem to work very well with the causative alternation.

What about verbs for which one use is dominant? For instance, would you say that ”sleep” participates in the alternation?

RQ2: What about other alternations?

$$\begin{bmatrix} \textit{attempt} & \\ \text{AGENT} & \text{Mary} \\ \text{ACTION} & \begin{bmatrix} \textit{cut} & \\ \text{AGENT} & \text{Mary} \\ \text{THEME} & \text{the rope} \end{bmatrix} \end{bmatrix}$$

Figure 14: Mary cut at the rope: An example of the **conative alternation**.

What About the Dative Alternation?

(8) **Kim gives the book to Pat.** (change-of-location)

(9) **Kim gives Pat the book.** (change-of-possession)

RQ3: Coercion

Future work!

Discussion questions

Are the alternating uses of *open* instances of different frames? Why? Why not?

Is alternatability a binary, or a spectrum?

What about verbs for which one use is dominant? For instance, would you say that ”sleep” participates in the alternation?

What about other types of alternations?

Can you just alternate whatever you want, or is alternatability a fixed attribute of a verb?

References

- **L. Barsalou (1992):** Frames, Concepts, and Conceptual Fields
  (link)
- **T. Gamerschlag et al. (2014):** Frames and Concept Types
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- **Kallmeyer, QasemiZadeh, Cheung (2018):** Coarse Lexical Frame Acquisition at the Syntax-Semantics Interface Using a Latent-Variable PCFG Model
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- **B. Levin (1993):** English Verb Classes and Alternations – A Preliminary Investigation
  (link)