

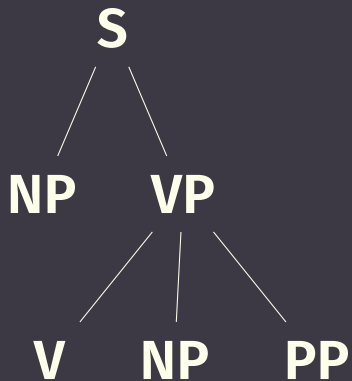
# **Modeling the Induced Action Alternation and the Caused-Motion Construction with Tree Adjoining Grammar (TAG) and Semantic Frames**

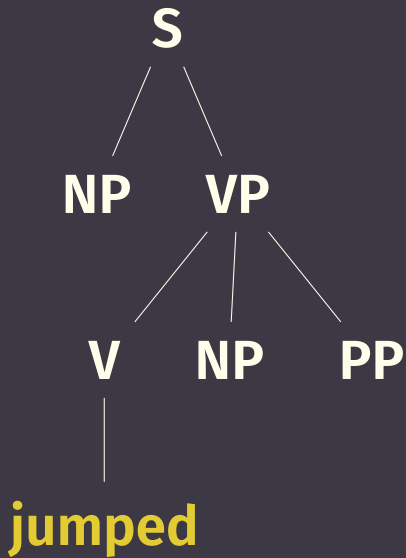
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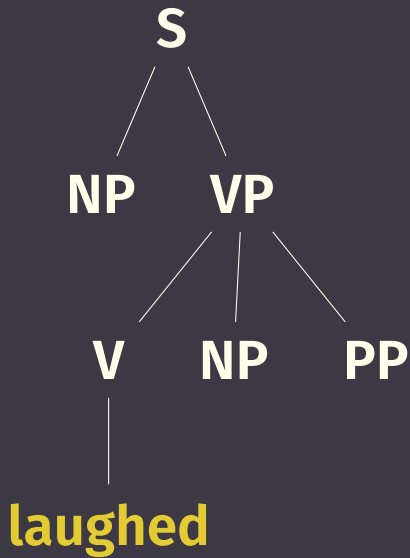
Esther Seyffarth (Heinrich Heine University, Dusseldorf)

May 24, 2019

CSTFRS Workshop @ IWCS 2019, Gothenburg, Sweden







# The Induced Action Alternation

- (1) The horse **jumped** over the fence.
- (2) Sylvia **jumped** the horse over the fence.

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The induced action alternation allows participating verbs to occur **transitively** or **intransitively**, where the transitive use introduces a **cause** to the event.

The set of participating verbs is either fixed or semantically restricted (cf. Levin, 1993).



# The Caused-Motion Construction

- (3) Sylvia **laughed**.
- (4) Sylvia **laughed** Mary off the stage.

## The Caused-Motion Construction

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The caused-motion construction is another way of expressing caused motion with a verb, a direct object, and a PP.

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The caused-motion construction is another way of expressing caused motion with a verb, a direct object, and a PP.

The construction exists independently of particular verbs (cf. Goldberg, 1995).

# Induced Action & Caused Motion

**Induced Action  
Alternation:**

**Caused-Motion  
Construction:**

# Induced Action & Caused Motion

## **Induced Action Alternation:**

- Verb lexically encodes motion.

## **Caused-Motion Construction:**

- Verb can have a non-motion meaning.

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- Verb can have a non-motion meaning.
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## Induced Action Alternation:

- Verb lexically encodes motion.
- Non-productive or restricted productivity.
- Verb describes behavior of syntactic **object**.

## Caused-Motion Construction:

- Verb can have a non-motion meaning.
- Productive.\*)
- Verb describes behavior of syntactic **subject**.



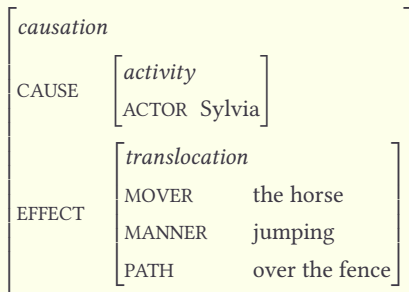
# Modeling language with TAG and Semantic Frames

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## Semantic frames:

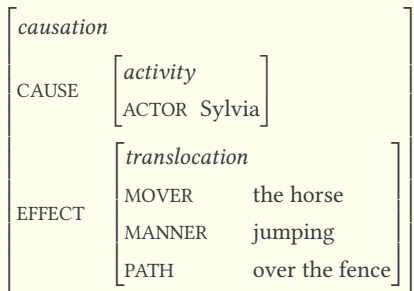
typed, recursive feature-value structures  
that represent **lexical** and **compositional**  
meaning

# Alternation and Construction Frames

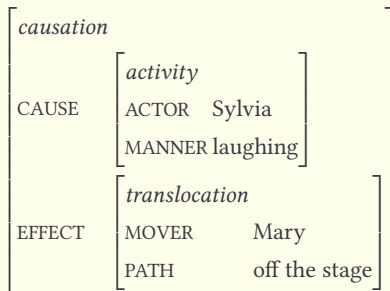


**Figure 1:** Event frame for (2)  
*Sylvia jumped the horse over  
the fence* (induced action  
alternation).

# Alternation and Construction Frames



**Figure 1:** Event frame for (2) *Sylvia jumped the horse over the fence* (induced action alternation).



**Figure 2:** Event frame for (4) *Sylvia laughed Mary off the stage* (caused-motion construction).

# XMG (Extensible Metagrammar)

XMG: a system for designing **metagrammars** that encode natural-language grammars (Petitjean et al., 2016).

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Our XMG formalization should encode **key similarities and differences** between the alternation and the construction.

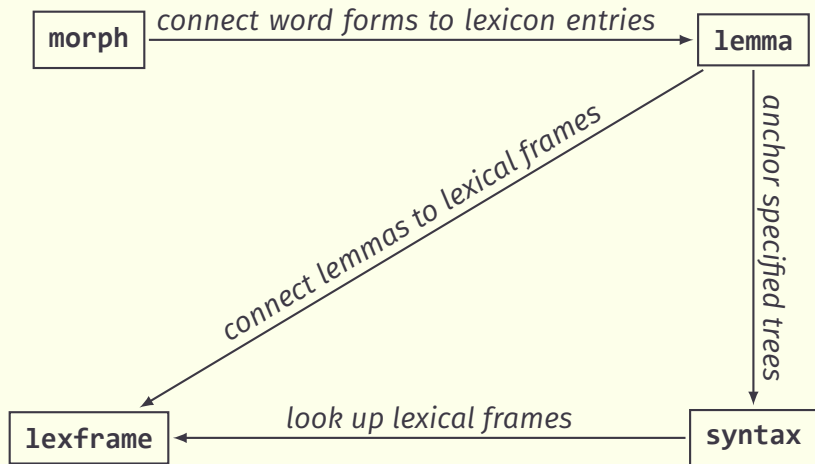
# XMG (Extensible Metagrammar)

XMG: a system for designing **metagrammars** that encode natural-language grammars (Petitjean et al., 2016).

Our XMG formalization should encode **key similarities and differences** between the alternation and the construction.

The metagrammar will be used to generate **syntactic trees** and **semantic frames** for input sentences during parsing.

# Modular modeling with XMG





# The morph module

The **morph** module connects inflected forms of words to their lemma entries.

```
1 class MorphJumped {  
2   <morpho> {  
3     morph <- "jumped";  
4     lemma <- "jump";  
5     cat <- v}}
```

```
1 class MorphLaughed {  
2   <morpho> {  
3     morph <- "laughed";  
4     lemma <- "laugh";  
5     cat <- v}}
```

# The `lexframe` module

The `lexframe` module defines lexical frames for individual words.

<i>activity</i>	
ACTOR	1
MANNER	jumping

<i>activity</i>	
ACTOR	1
MANNER	laughing

**Figure 3:** Lexical frame for *jump*.      **Figure 4:** Lexical frame for *laugh*.

# The lemma module

The **lemma** module specifies which syntactic trees can be anchored by each verb.

```
1 class LemmaJump {  
2   <lemma> {  
3     entry <- "jump";  
4     sem <- FrameJump;  
5     cat <- v;  
6     fam <- n0V |  
7     fam <- n0Vn1pp_actioninducing}}
```

```
1 class LemmaLaugh {  
2   <lemma> {  
3     entry <- "laugh";  
4     sem <- FrameLaugh;  
5     cat <- v;  
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```

**The syntax module:**

**Syntactic structures**  
**with associated frame templates**

# The syntax module – Induced Action Alternation

*Sylvia jumped the horse over the fence.*

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**morph**

{Sylvia, jump, the, horse, over, the, fence}

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**lemma**

*jump* can anchor n0V, n0Vn1pp\_actioninducing



# The syntax module – Induced Action Alternation

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{Sylvia, jump, the, horse, over, the, fence}



**lemma**

*jump* can anchor n0V, n0Vn1pp\_actioninducing

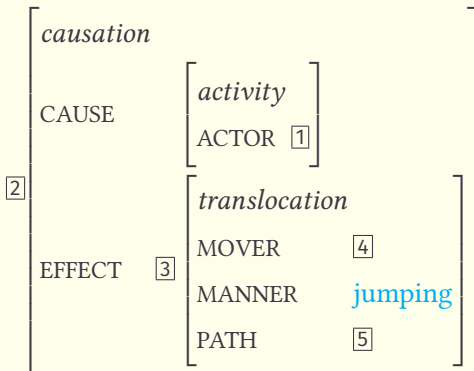
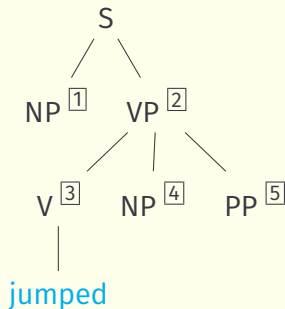


**lexframe, syntax**

construct compositional frame based on lexical frames

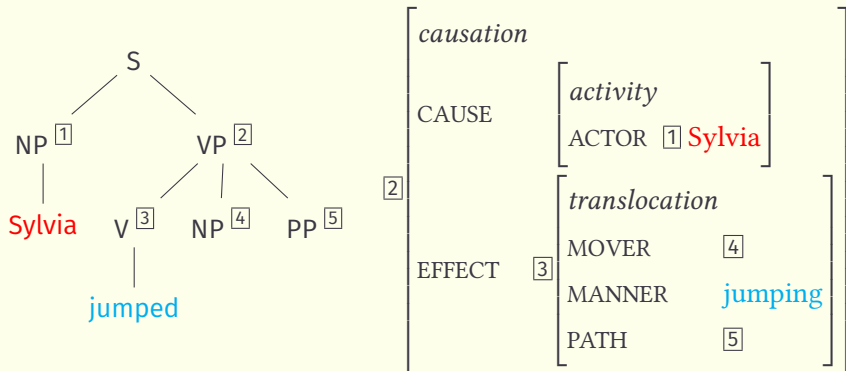
# Analysis for a sentence with an induced action verb

(2) Sylvia **jumped** the horse over the fence.



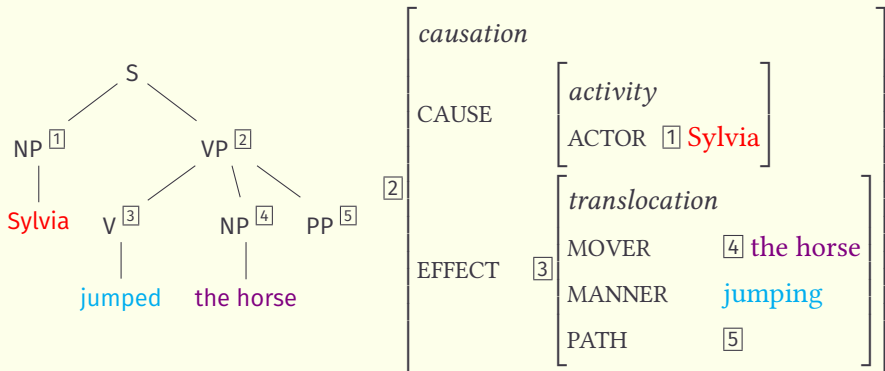
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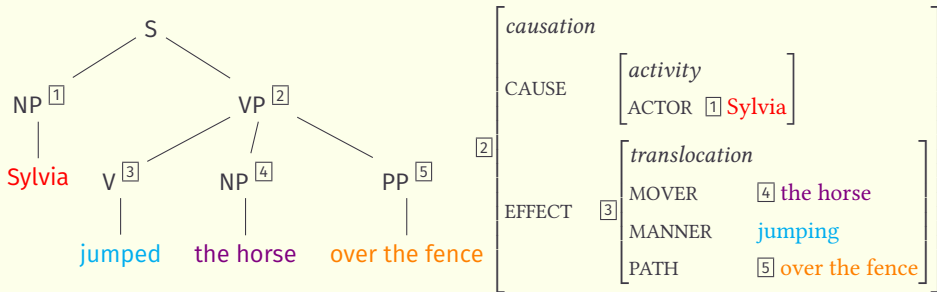
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# Analysis for a sentence with an induced action verb

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In the induced action alternation,  
the verb describes the behavior of  
the **syntactic object** – not the syntactic subject!

# The syntax module – Caused-Motion Construction

*Sylvia laughed Mary off the stage.*

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*Sylvia laughed Mary off the stage.*



**morph**

{Sylvia, laugh, Mary, off, the, stage}



**lemma**

*laugh* can anchor nØV; **additional arguments possible**



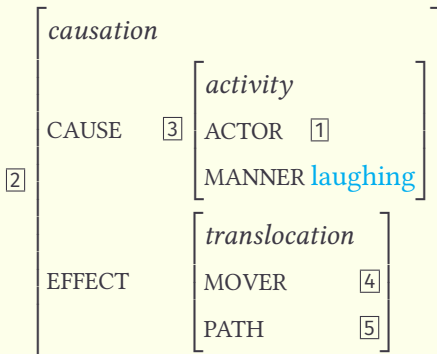
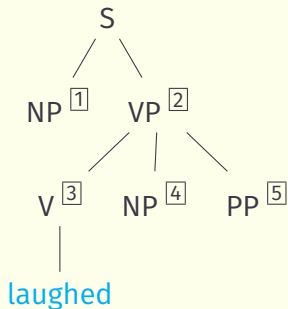
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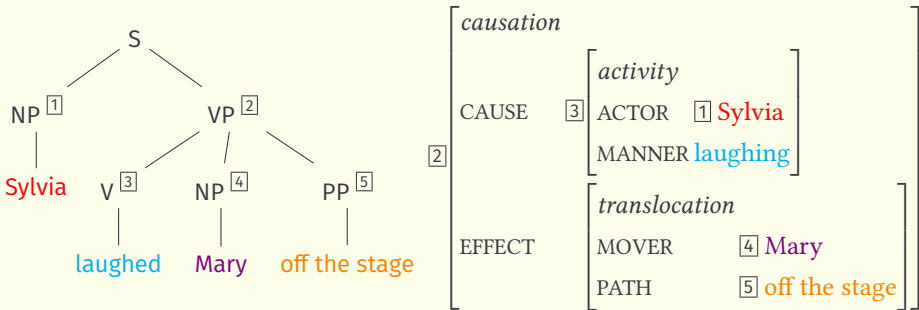
# The syntax module - Caused-Motion Construction

(4) Sylvia **laughed** Mary off the stage.



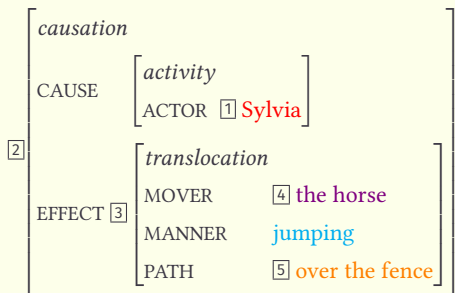
# Analysis for a sentence with a caused-motion construction

(4) Sylvia laughed Mary off the stage.

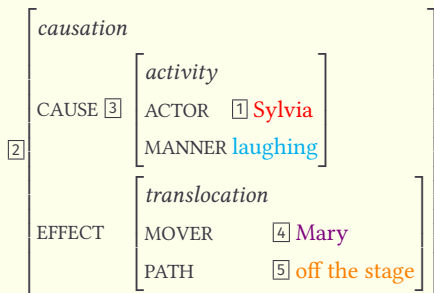


In the caused-motion construction, the verb describes the behavior of the **syntactic subject**.

# Alternation and Construction Frames



**Figure 5:** Derived frame for (2) *Sylvia jumped the horse over the fence* (induced action alternation).



**Figure 6:** Derived frame for (4) *Sylvia laughed Mary off the stage* (caused-motion construction).

# Parsing new sentences

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TuLiPA: an open-source parsing environment, used here to parse input sentences and derive syntactic trees and frames.

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To do so, we compile the metagrammar files and feed the resulting grammar files into TuLiPA.

# Running TuLiPA

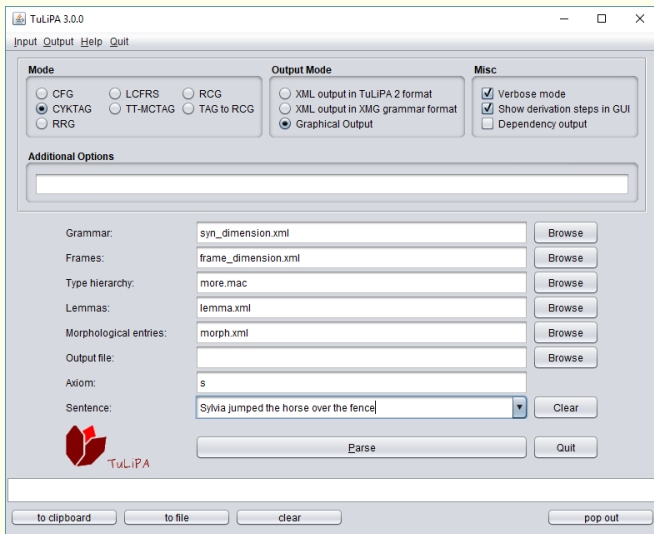


Figure 7: TuLiPA.



# Parsing caused motion

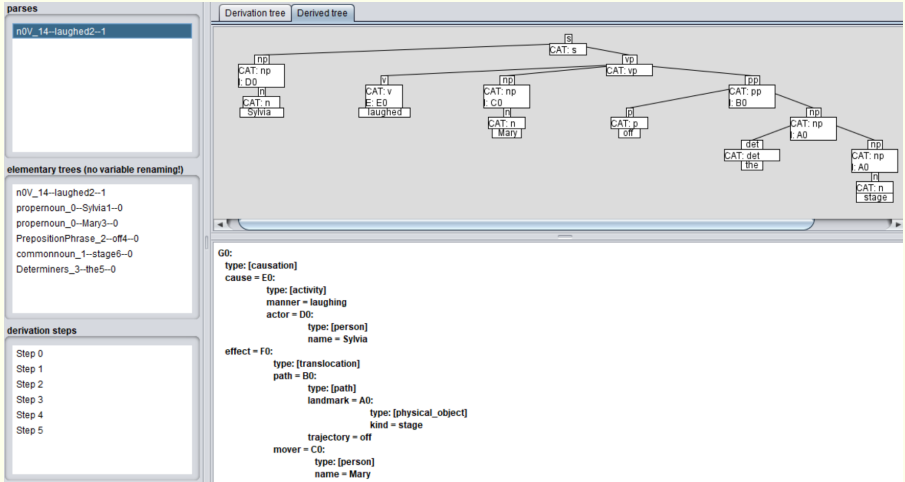


Figure 8: TuLiPA output for sentence (4).

# Parsing induced action (1/2)

**parses**

- n0V\_14--jumped2--1
- n0Vn1pp\_actioninducing\_9--jumped2--0**

**elementary trees (no variable renaming!)**

- n0Vn1pp\_actioninducing\_9--jumped2--0
- propemnoun\_0--SylMa1--0
- commonnoun\_1--horse4--0
- PrepositionPhrase\_2--over5--0
- Determiners\_3--the3--0
- commonnoun\_1--fence7--0
- Determiners\_3--the6--0

**derivation steps**

- Step 0
- Step 1
- Step 2
- Step 3
- Step 4
- Step 5
- Step 6

**Derivation tree** | **Derived tree**

**E0:**

- type:** [causation]
- cause = D0:**
  - type:** [activity]
  - actor = B0:**
    - type:** [person]
    - name = Sylvia**
- effect = G0:**
  - type:** [translocation-activity]
  - actor = F0:**
    - type:** [actor]
    - kind = horse**
  - mover = F0:**
    - type:** [actor]
  - path = A0:**
    - type:** [path]
    - landmark = C0:**
      - type:** [physical\_object]
      - kind = fence**
  - trajectory = over**
  - manner = jumping**

Figure 9: TuLiPA output for sentence (2): Induced-action reading.

# Parsing induced action (2/2)

**parses**

n0V\_14--jumped2--1  
n0Vn1pp\_actioninducing\_9--jumped2--0

**elementary trees (no variable renaming!)**

n0V\_14--jumped2--1  
propernoun\_0--Sylvia1--0  
commonnoun\_1--horse4--0  
PrepositionPhrase\_2--over5--0  
Determiners\_3--the3--0  
commonnoun\_1--fence7--0  
Determiners\_3--the6--0

**derivation steps**

Step 0  
Step 1  
Step 2  
Step 3  
Step 4  
Step 5  
Step 6

**Derivation tree**   **Derived tree**

**Semantic representation:**

**H0:**  
type: [causation]  
cause = F0:  
  type: [activity]  
  manner = jumping  
  actor = A0:  
    type: [person]  
    name = Sylvia

effect = G0:  
  type: [translocation]  
  path = B0:  
    type: [path]  
    landmark = D0:  
      type: [physical\_object]  
      kind = fence  
  trajectory = over  
  mover = E0:  
    type: [actor]  
    kind = horse

Figure 10: TuLiPA output for sentence (2): Caused-motion reading.

## Possible extensions

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Goldberg and Jackendoff (2004) treat the caused-motion construction as a “subconstruction of the resultative”. With some extensions, the grammar could also handle cases like these:

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- (7) a. Bill walked himself into a coma.
- b. Bill followed the road into the forest.
- c. Aliza wiggled her tooth loose.
- d. Sara caught a plane to New York.
- e. Ray flew the coastal route to Buffalo.

# Conclusion

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- Alternations and constructions have particular patterns of inserting **lexical frames** of constituents into **compositional frame templates**.
- This is why sentences that resemble each other syntactically can lead to such different semantic frames.
- Modeling these phenomena with XMG allows us to encode crucial differences between alternations and constructions (e.g. productivity).
- This ties in neatly with my PhD topic (ask me!)