Words Talking Factually

Lexical Resources for Event Factuality

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Event Factuality

- Events can be characterized along a **factuality axis**
  - (1) Five U.N. teams **visited** a total of nine other sites.
  - (2) These results indicate that Pb2+ may **inhibit** neurite initiation.
  - (3) They may not have **arrived** yet.
  - (4) The size of the contingent was not **disclosed**.
- Events can be embedded in contexts of **belief**, **knowledge**, **report**, **witnessing**, etc.
  - (5) Chinese analysts believe that **[**the US will **continue to provoke** North Korea**]**.
  - (6) Nixon said that **[**no one from the White House was **involved]**.

Why is it important?

- **Information Extraction:**
  - (7) a. These results indicate that Pb2+ may **inhibit** neurite initiation.
    b. Inhibitors of neurite initiation: Pb2+?
- **Text understanding;** e.g., Question Answering:
  - (8) a. Nixon said that **no-one from the White House was involved**.
    b. What members of the White House were involved in the Watergate matter?
    c. No-one.

Challenges

- It involves **local** but also **non-local** information:

  (1) [The size of the contingent was **not** disclosed]. ⇨ **Counterfact**

  (2) [Varennikov had **offered** [**not** to interfere with Ukraine]. ⇨ **Uncertain**

  (3) [Pb2+ **may** inhibit neurite initiation]. ⇨ **Possible**

  (4) [Koenig **denies** [the fact that Freidin **may** have left]]. ⇨ **Counterfact**

- It requires identifying factuality **sources** and **temporal references:**

  (5) (Indy Media Center, Oct 17 2005):
  In mid-2001, Colin Powell and Condoleezza Rice both publically denied that Iraq had weapons of mass destruction.

  (CNN, January 8 2004)
  Secretary of state Colin Powell Thursday defended the Bush administration's position that Iraq had weapons of mass destruction.

Goal

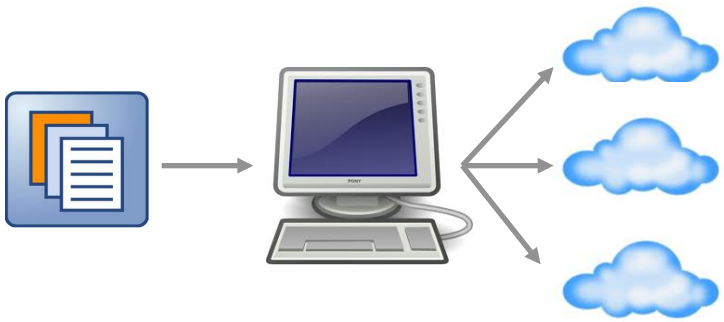
Identifying factuality information of events

Designing and developing a **factuality profiler** **De Facto**

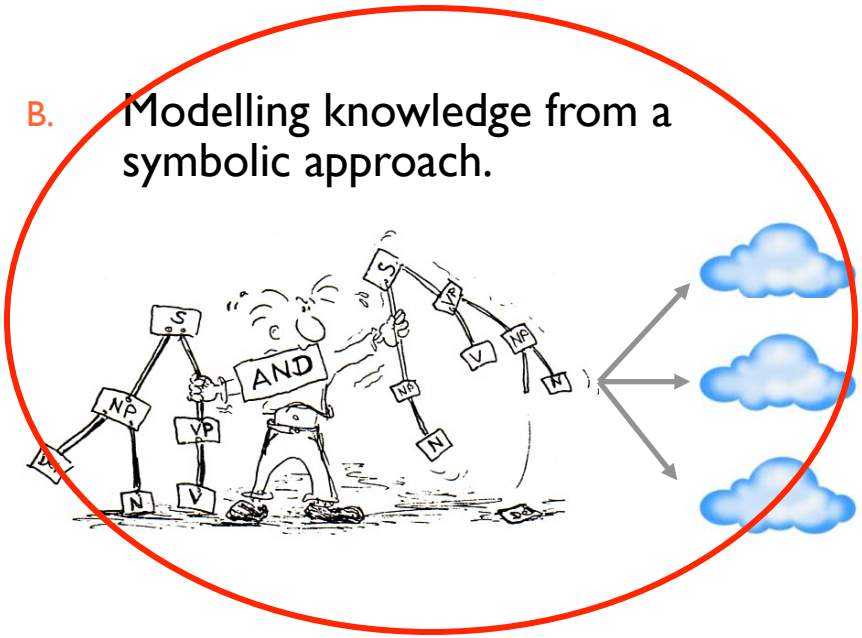
- Given a text as input, returning the **factuality profile** of each eventuality in text
- Support tool for NLP tasks.

Two possible approaches:

A. Using a Machine Learning.



B. Modelling knowledge from a symbolic approach.



Approach

- **Basic assumptions:**
  1. Grounded on linguistic expressions.
  2. Disregarding external factors:
     - World knowledge
     - Set of beliefs
     - Etc.
  3. Assuming a neutral and naïve decoder.
  4. Capable of representing different (and possibly contradictory) information.
- **Genre:** News reports

Outline

I. **Modelling event factuality**
   1. The factuality profile of events
   2. Factuality sources
   3. Factuality values

II. **The linguistic expression of factuality information**
   1. Types of factuality markers
   2. Markers interacting

III. **Compiling the lexicon**
   1. Methodology applied
      a. Linguistic criteria
      b. Lexicon selection
   2. A lexicon for event factuality
      a. Coverage
      b. Factuality classes
      c. Limitations

IV. **Evaluation:**
   1. The lexicon as an active component in De Facto
   2. Results

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Factuality profiles

The factuality of events in text involves:

- The **event** at focus, **e**.
- The **source** assigning a factuality value to that event, **s**.
- The **time** the act is performed, **t**.
- The factuality **value**, **f**.

- **Factuality commitment acts**
  - Act of commiting towards the factuality of a given event **e** made by one source **s** at a specific time **t**.
- **Factuality profile of an event**
  - Set of **factuality commitment acts** performed by one or different sources at certain points in time:

    fp(e) = {<f, s, t> | s assigns **f** to **e** at **t }**

Sources

Cognitive individuals assessing the factuality of events.

Default source: author.

Further sources: incorporated by means of predicates of:

- Report
- Knowledge and belief
- Perception
- Inference
- Psychological reaction
- Etc.

(1) **Milosevic's son$_s$ said$_{e1}$** Tuesday that his father had been **murdered$_{e2}$**.

Broad notion:

- Informants actively committing to the factuality of an event (e.g., by means of a speech act).
- Informants holding a factual stance (knowledge, belief).
- Informants that are able to hold a factual stance (psychological reactions).

Source Roles:

Cognizer: The logical subject of the predicate subcategorizing for the event.

Anchor: The source presenting the commitment act (belief, report, knowledge, witness, etc.) of the cognizer towards *the embedded event.*

(2) **Bush$_{sb}$ said$_{e1}$** Thursday that **King Hussein$_{sk}$ assured$_{e2}$** him Jordan would **close$_{e3}$** the last remaining free port to most Iraqi trade.

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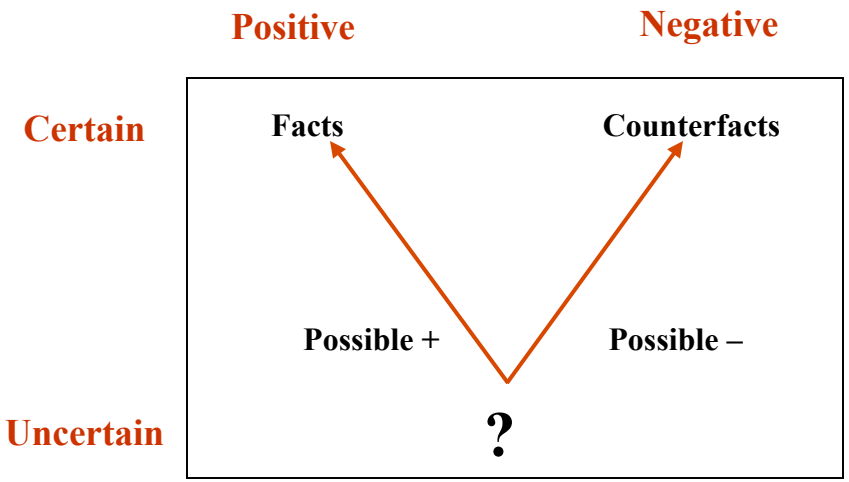
Factuality Values

Factuality:

Can be characterized by means of a double-axis scale:

- **Epistemic modality:** from uncertain (possible) to absolutely certain (necessary).
- **Polarity:** positive and negative.



Can it be translated into a discrete scale?

Epistemic Modality

- **Modal logic:** 2 values: *necessary* (□) and *sufficient* (◊).
- **Linguistics:** 3 values, mostly
  - **Lyons (1977).** Degrees of factuality: *certainly, probably, possibly*.
  - **Palmer (1986).** Categories for epistemic modality:
    - Speculative: *Kate may be at home now.*
    - Deductive: *Kate must be at home now.*
    - Assumptive: *Kate will be at home now.*
  - **Halliday (2004).** Probability categories:
    - High: *That's certainly true* / *That's certainly not true.*
    - Medium: *That's probably true* / *That's probably not true.*
    - Low: *That's possibly true* / *That's possibly not true.*

Modality and Negation

Horn (1989). Linguistic approach:

- Epistemic modality as a particular type of scalar predication.
- Quantitative scale: $<P_j, P_{j-1}, \ldots, P_2, P_1>$, where P_n outranks or is stronger that P_{n-1} in the relevant scale ($P_n < P_{n-1}$).
- Syntactic contexts:

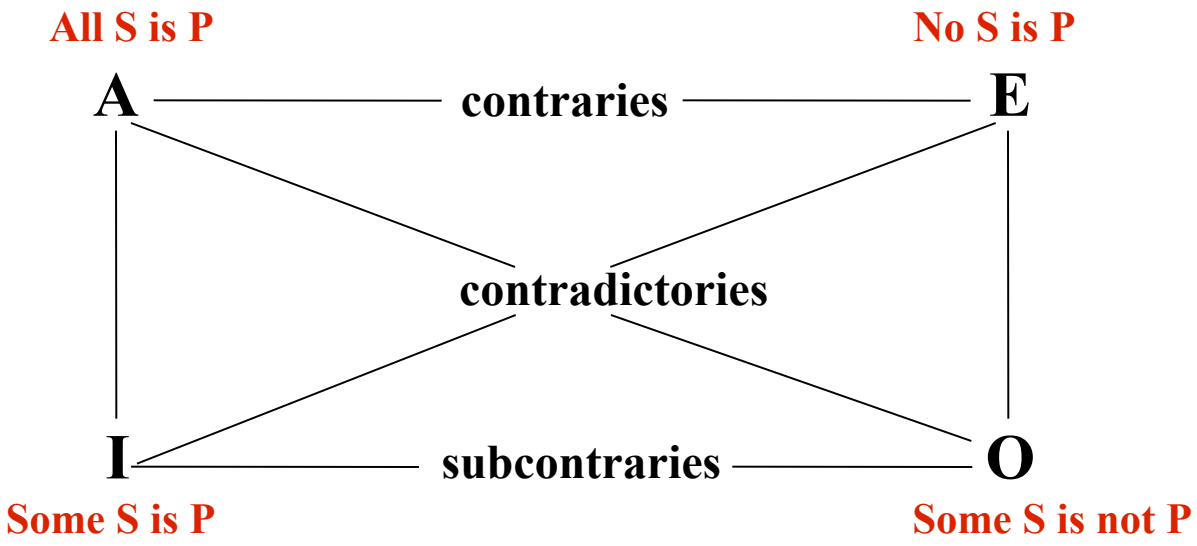
1. (at least) P_{n-1}, if not P_n	**2.** P_{n-1}, and in fact P_n
P_{n-1}, and possibly P_n	not only P_{n-1} but P_n

- Two independent scales:
  - **Positive:** *<certain, likely, possible>*
  - **Negative:** *<impossible, unlikely, uncertain>*

Modality and Negation

Horn (1989). **Logic approach:**

Square of Opposition (Aristotle)



Contraries:

a. Satisfying LC

b. Not satisfying LEM

Contradictories:

a. Satisfying LC

b. Satisfying LEM

Subcontraries:

a. Not satisfying LC

b. Not satisfying LEM

Law of contradiction (LC). A statement cannot be true and false at the same time.

(The elements in the pair can not hold TRUE at the same time)

Law of Excluded Middle (LEM). A statement must be either true or false.

(The elements in the pair can not be FALSE at the same time)

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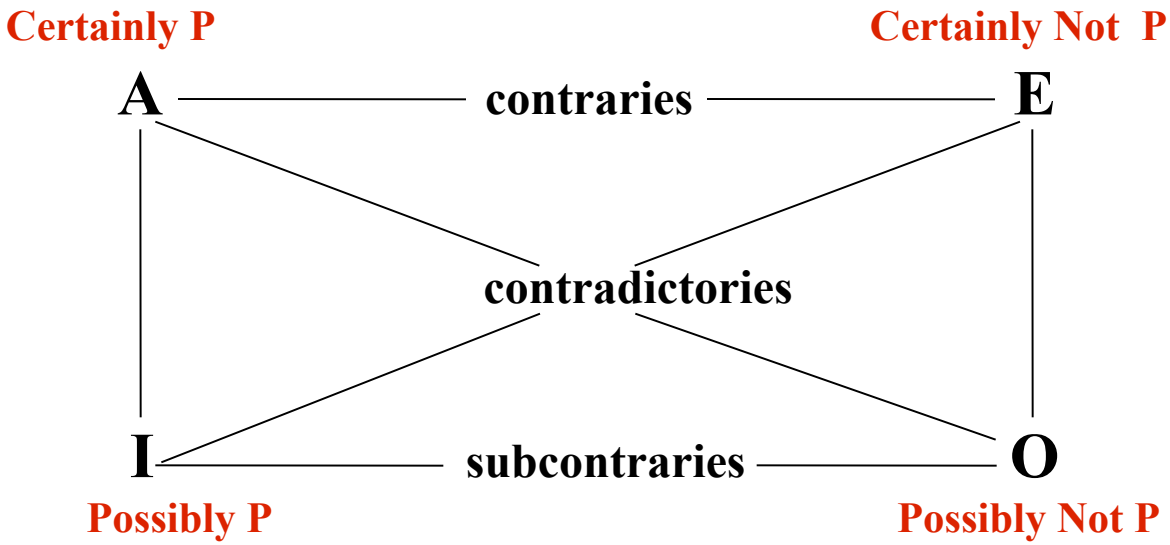

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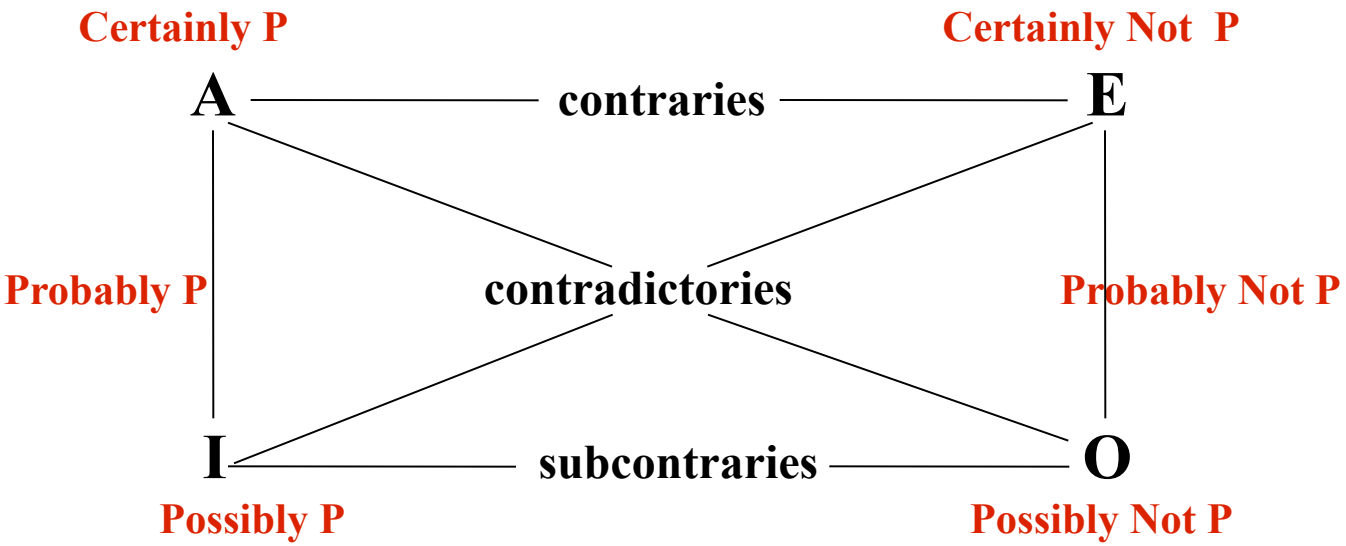

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Event Factuality Values

Modality	Polarity		
	+	–	UNDERSPECIFIED
CERTAIN	**Fact:** <CT,+>	**Counterfact:** <CT,–>	**Certain but unknown:** <CT,U>
PROBABLE	**Probable:** <PR,+>	**Not probable:** <PR,–>	NA
POSSIBLE	**Possible:** <PS,+>	**Not certain:** <PS,–>	NA
UNDERSPECIFIED	NA	NA	**Unknown or uncommitted:** <U,U>

Based on literature dealing with modality (e.g., Lyons, 1977; Halliday, 1985; Horn, 1989).

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Factuality Markers

- Linguistic expressions encoding **polarity** & **modality**
- Present at different levels:
  - **Lexical:**
    1. Polarity particles
    2. Modality particles
    3. Event selecting predicates:
       - Source Introducing Predicates (SIPs)
       - Non-source Introducing Predicate (NSIPs)
  - **Morphological**
  - **Syntactic**
  - **Discourse**
- Interacting in significant ways

Factuality Markers:

Polarity Particles

- Lexical items:
  - **Adverbs:** *not, nor, neither, never.*
  - **Determiners:** *no, non, neither, little*
  - **Pronouns:** *none, nobody, nowhere*
- Constructions:

Negating the predicate expressing the event:	(1)	She didn't follow the rules.
Negating the subject:	(2)	Nobody followed the rules.
Negating the direct object:	(3)	She followed no rules.
Adverbial modification:	(4)	She never followed the rules.
Using an embedding predicate:	(5)	She failed to follow the rules.
The embedding predicate is negated:	(6)	He does not think she followed the rules.

Factuality Markers:

Modality Particles

- Markers of epistemic modality:

	Possible	Probable	Certain
Verbal auxiliaries	*could, may*	*will, should*	*must, have to*
Adverbs	*perhaps, maybe*	*probably*	*necessarily, certainly*
Adjectives	*possible*	*likely, probable*	*certain, impossible*

- Markers of other types of modality (e.g., deontic):

Verbal auxiliaries	*should, need*
Adverbs	*hopefully, luckily*
Adjectives	*necessary, hopeful, eager, willing*

Factuality Markers:

Event Selecting Predicates (ESPs)

Verbs: *claim, suggest, avoid*
Nouns: *approval, belief, decision*
Adjectives: *ready, eager, able.*

Semantically:

Predicates selecting for an argument denoting an event (or situation).

The selected event is characterized by some degree of modality.

Syntactically:

Subcategorizing for: *that*-, gerundive, infinitival clauses

NP headed by an event-denoting noun

Studied from different approaches:

- Philosophy, on propositional attitude predicates.
- Border between philosophy and linguistics (Vendler 1967, Asher 1993, Peterson 1997, Ginzburg & Sag 2000)
- Speech act theory (Bach & Harnish, Ballmer & Brennenstuhl 1981, Wierzbicka 1987, Bergler 1992)
- On modality (Palmer 1986, Quirk et al. 1985, Givón 1993)
- Cognitive linguistics, on epistemic stance (Biber & Finegan 1989, Field 1997, Mushin 2001, Thompson 2002)
- Interface between syntax and semantics (Dor 1995, Koening & Davis 2001, Jackendoff & Culicover 2003)

Two different types:

1. **Source Introducing Predicates (SIPs)** Predicates of belief, knowledge, report, etc.
2. **Non-source Introducing Predicates (NSIPs)** Implicative predicates, aspectuals, etc.

Source Introducing Predicates (SIPs)

- Contributing an additional source to discourse.

  (1) Berven **knows** that Freidin **left** the country in June.

- New source argument:
  - Subject of the SIP.
  - Oblique complement.
  - Possessor in a genitive construction.

- Some types:
  - Predicates of report: say, tell, claim, argue.
  - Predicates of knowledge: know, remember; learn, find out; forget.
  - Predicates of belief and opinion: think, guess, predict, suggest.
  - Predicates of doubt: doubt, wonder, ask.
  - Predicates of perception: see, hear.
  - Predicates expressing proof: prove, show, support, explain.
  - Predicates expressing some sort of inferencing process: infer, deduce; appear.
  - Predicates expressing some psychological reaction: regret, be glad/pleased.

Non-Source Introducing Predicates (SIPs)

- Not contributing any additional source.

  (1) *Freidin **managed** to **leave** the country in June.*

- Some types:
  - Implicative and semi-implicative predicates: fail, manage, allow..
  - Predicates introducing a future event as their complement.
    - Predicates of volition: want.
    - Commissive predicates: offer, commit.
    - Predicates of command: require, order.
    - …
  - Change of state predicates: increase, change, approve.
  - Aspectual predicates: begin, continue, terminate.
  - Etc.

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Markers interacting:

Polarity and Modality Particles

1. Polarity particles

(1) [$_{\text{ctxt: CT+}}$The size of the contingent was **not** disclosed]. → **CT–**

(2) [$_{\text{ctxt: CT+}}$Varennikov had **offered** [$_{\text{ctxt:Uu}}$ **not** to interfere with Ukrainian]. → **Uu**

Polarity value given the polarity in the context:

Marker value	Contextual polarity		
	+	–	UN
+	+	–	UN
–	–	+	UN

2. Modality markers

- Modal auxiliaries: *may, must, can, will*
- Adverbials of modality: *probably, perhaps*

(3) [$_{\text{ctxt:CT+}}$ Pb2+ **may** inhibit neurite initiation]. → **PS+**

(4) [$_{\text{ctxt:CT+}}$ Koenig **denies** [$_{\text{ctxt:CT-}}$ the fact that Freidin **may** have left]]. → **CT–**

Polarity value given the polarity in the context:

Marker	Contextual factuality											
	Polarity = +				Polarity = –				Polarity = u			
	CT	PR	PS	U	CT	PR	PS	U	CT	PR	PS	U
CT	CT	PR	PS	Uu	PS	PR	PS	Uu	CT	PR	PS	Uu
PR	PR	PR	PS	Uu	PR	PR	PS	Uu	PR	PR	PS	Uu
PS	PS	PS	PS	Uu	CT	PR	PS	Uu	PS	PS	PS	Uu

Markers interacting:

Non-Source Introducing Predicates (NSIPs)

For example, implicative predicates (Karttunen 1970).

(1) **Implicative predicates:**

a. [$_{ctxt:CT+}$ Sanders **managed** to use a duplicating machine]. → **CT+**

b. [$_{ctxt:CT-}$ Sanders did **not manage** to use a duplicating machine]. → **CT–**

c. [$_{ctxt:PS+}$ Sanders **may** have **managed** to use a duplicating machine]. → **PS+**

d. [$_{ctxt:PS-}$ Sanders **may not** have **managed** to use a …]. → **PS–**

(2) **Neg-implicative predicates:**

a. [$_{ctxt:CT+}$ Sanders **failed** to use a duplicating machine]. → **CT–**

b. [$_{ctxt:CT-}$ Sanders did **not fail** to use a duplicating machine]. → **CT+**

c. [$_{ctxt:PS+}$ Sanders **may** have **failed** to use a duplicating machine]. → **PS–**

d. [$_{ctxt:PS-}$ Sanders **may not** have **failed** to use a duplicating machine]. → **PS+**

	Contextual factuality					
	CT		PR		PS	
	+	−	+	−	+	−
manage	CT+	CT−	PR+	PR−	PS+	PS−
fail	CT−	CT+	PR−	PR+	PS−	PS+

Markers interacting:

Source Introducing Predicates (SIPs)

For example, factive predicates (Kiparsky and Kiparsky 1970) and reporting predicates.

(1) **Factive Predicates:**

a. [$_{ctxt:CT+}$ Sanders **knew** he was using a duplicating machine]. → a: **CT+** c: **CT+**

b. [$_{ctxt:CT-}$ Sanders did **not know** he was using a duplicating machine]. → a: **CT+** c: **Uu**

(2) **Reporting Predicates:**

a. [$_{ctxt:CT+}$ Sanders **said** he was using a duplicating machine]. → a: **Uu** c: **CT+**

b. [$_{ctxt:CT-}$ Sanders did **not say** he was using a duplicating machine]. → a: **Uu** c: **Uu**

		Contextual factuality			
		mod=CT		mod<CT	
		pol=+	pol=–	pol=+	pol=–
know	(a)	CT,+	CT,+	CT,+	CT,+
	(c)	CT,+	U	U	U
say	(a)	U	U	U	U
	(c)	CT,+	U	U	U

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Methodology:

Linguistic Criteria

1. **Syntax matters:**

   (1) Officials are investigating whether Rudolph **participated** in all the attacks.

   (2) Officials are investigating all three **attacks**.

   Lexical entry for *investigate*: *dobj* vs. *if-clause* complement.

2. **Determining the correct factual value: Discriminatory tests.**

   The original context is conjoined with a second sentence presenting the same event with a different degree of modality. The polarity value can be mantained or reversed.

   (3) Iraq has agreed to allow Soviets in Kuwait to **leave**.

   (4) Soviets in Kuwait will most probably **leave**.

   (5) a. … They will take the plane tomorrow. (CT+)

   b. … However, most of them decided to remain there. (CT-)

	CT=	CT_{op}	PR_{op}	PS_{op}
U	ok	ok	ok	ok
PS	ok	#	ok	ok
PR	ok	#	#	ok
CT	ok	#	#	#

3. **Empirically driven judgments:**

   Using real examples from corpora (ANC, TimeBank, BNC).

Methodology:

Lexicon Selection

Verbs:

- The 200 most frequent event-selecting verbs in the American National Corpus (fragments: Slate and New York Times).
- All verbs in TimeBank introducing a subordination link (SLINK).
- All verbs contemplated in SlinkET.
- Verbs related to Nouns and Adjectives, also selected.
- Verbs that are synomym, antonym, or related in some ways to the previous selected verbs.
- Verbs of interest analyzed in the literature (e.g., implicative, assertive, etc.)

Nouns/Adjs:

- All nouns/adjs in TimeBank introducing a subordination link (SLINK).
- All nouns/adjs contemplated in SlinkET.
- Nouns/adjs derived from, or related in some way, to verbs, nouns/adjs also selected by other criteria.
- Nouns/adjs expressing epistemic evaluations (e.g., *impossibility, probable*).

The Factuality Lexicon:

Coverage

Event Selecting Predicates (ESPs)

- 646 lexical entries

Part of Speech	SIPs	NSIPs	Total
Verbs	204	189	393
Nouns	58	107	165
Adjectives	27	61	88
Total	**289**	**357**	**646**

- Corpora of reference:
  1. TimeBank 1.2
  2. ANC-Slate
  3. ANC-NYT
- Each lexical entry can map to several types, depending the syntactic type of its arguments.
- Classified into types reflecting factuality distinctions.

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NSIPs

19 factuality types

Clustered into 5 main "semantic classes":

- **Presuppositional types**
  1. Stop
- **Implicative types**
  2. Manage
  3. Fail
  4. Cause
  5. Refuse
  6. Hesitate
  7. Attempt
- **Epistemic types (I)**
  8. Certainty
  9. Impossibility
  10. Probability
  11. Improbability
  12. Possibility
  13. Uncertainty
- **Epistemic types (II)**
  14. Evidence
  15. Confirm
  16. Suggest
  17. Appear
  18. Consider
- **Projective types**
  19. Want

NSIPs

Presuppositional:

	CONTEXTUAL FACTUALITY											
	CT			PR			PS			U		
	+	−	u	+	−	u	+	−	u	+	−	u
stop:	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+

Implicative:

manage:	CT+	CT−	CTu	PR+	PR−	PRu	PS+	PS−	PSu	Uu	Uu	Uu
fail:	CT−	CT+	CTu	PR−	PR+	PRu	PS−	PS+	PSu	Uu	Uu	Uu
cause:	CT+	Uu	Uu	PR+	Uu	Uu	PS+	Uu	Uu	Uu	Uu	Uu
refuse:	CT−	Uu	Uu	PR−	Uu	Uu	PS−	Uu	Uu	Uu	Uu	Uu
hesitate:	Uu	CT+	Uu	Uu	PR+	Uu	Uu	PS+	Uu	Uu	Uu	Uu
attempt:	Uu	CT−	Uu	Uu	PR−	Uu	Uu	PS−	Uu	Uu	Uu	Uu

Projective:

want:	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu

The Factuality Lexicon > Factuality Classes:

NSIPs

		Contextual factuality											
		CT			PR			PS			U		
		+	−	u	+	−	u	+	−	u	+	−	u
Epistemic (I):	*certainty:*	CT+	PS−	Uu	PR+	PR−	Uu	PS+	PS−	Uu	Uu	Uu	Uu
	impossibility:	CT−	PS+	Uu	PR−	PR+	Uu	PS−	PS+	Uu	Uu	Uu	Uu
	probability:	PR+	PR−	Uu	PR+	PR−	Uu	PS+	PS−	Uu	Uu	Uu	Uu
	improbability:	PR−	PR+	Uu	PR−	PR+	Uu	PS−	PS+	Uu	Uu	Uu	Uu
	possibility:	PS+	CT−	Uu	PS+	PR−	Uu	PS+	PS−	Uu	Uu	Uu	Uu
	uncertainty:	PS−	CT+	Uu	PS−	PR+	Uu	PS−	PS+	Uu	Uu	Uu	Uu
Epistemic (2):	*evidence:*	CT+	Uu	Uu	CT+	Uu	Uu	CT+	Uu	Uu	Uu	Uu	Uu
	confirm:	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	suggest:	PR+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	appear:	PR+	PR−	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	consider:	PS+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu

SIPs

20 factuality types

Clustered into 4 main "semantic classes"

- **Presuppositional types**
  1. Disclose
  2. Know_that
  3. Forget
  4. Pretend
- **Opinion and reporting types (I)**
  5. Say
  6. Imply
  7. Think
  8. Sure
  9. Deny
  10. Know_if
  11. Conjecture
  12. LookLike
  13. Skeptical
  14. Doubt
  15. Fear
  16. Unsure
- **Opinion and reporting types (II)**
  17. Announce
  18. Expected
  19. Imagine
- **Interrogative types**
  20. Wonder

SIPs

Presuppositional:

		Contextual Factuality											
		CT			PR			PS			U		
		+	−	u	+	−	u	+	−	u	+	−	u
disclose:	(a)	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+
	(c)	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+
know_that:	(a)	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+
	(c)	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
forget:	(a)	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+	CT+
	(c)	Uu	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
pretend:	(a)	CT−	CT−	CT−	CT−	CT−	CT−	CT−	CT−	CT−	CT−	CT−	CT−
	(c)	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu

Interrogative:

		Contextual Factuality											
		CT			PR			PS			U		
		+	−	u	+	−	u	+	−	u	+	−	u
wonder:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu

SIPs

Opinion and reporting (I):

		Contextual Factuality											
		CT			PR			PS			U		
		+	−	u	+	−	u	+	−	u	+	−	u
say:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
imply:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	CT+	Uu	Uu	PR+	Uu	Uu	PS+	Uu	Uu	Uu	Uu	Uu
think:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	CT+	CT−	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
sure:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	CT+	PS−	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
deny:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	CT−	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
know_if:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	CTu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
conjecture:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	PR+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
lookLike:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	PR+	PR−	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
skeptical:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	PR−	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
doubt:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	PR−	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
fear:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	PS+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
unsure:	(a)	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	PS−	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu

SIPs

Opinion and reporting (II):

		Contextual factuality											
		CT			PR			PS			U		
		+	−	**u**	+	−	**u**	+	−	**u**	+	−	**u**
announce:	(a)	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
expected:	(a)	PR+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	PR+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
imagine:	(a)	Uu	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu
	(c)	CT+	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu

The Factuality Lexicon:

Limitations

Factual distinctions triggered by:

- The semantics of the complement:
  - (1) They blocked **the trial** → Counterfactive
  - (2) They blocked **the offer** → Factive
- The grammatical person of the subject:
  - (3) I think he **is the murder**. → Possible
  - (4) The police thinks he **is the murder**. → Factive
- The tense of the predicate:
  - (5) He didn't anticipate that she **would dominate** the game. → Factive
  - (6) He doesn't anticipate that **she will dominate** the game. → Counterfactive
- Other contextual elements:
  - (7) That day he was informed that jane **was dying** of leucemia. → Factive
  - (8) The company was informed that it **violated** MindSpring's policy. → Uncommitted

Outline

I. **Modelling event factuality**
   1. The factuality profile of events
   2. Factuality sources
   3. Factuality values

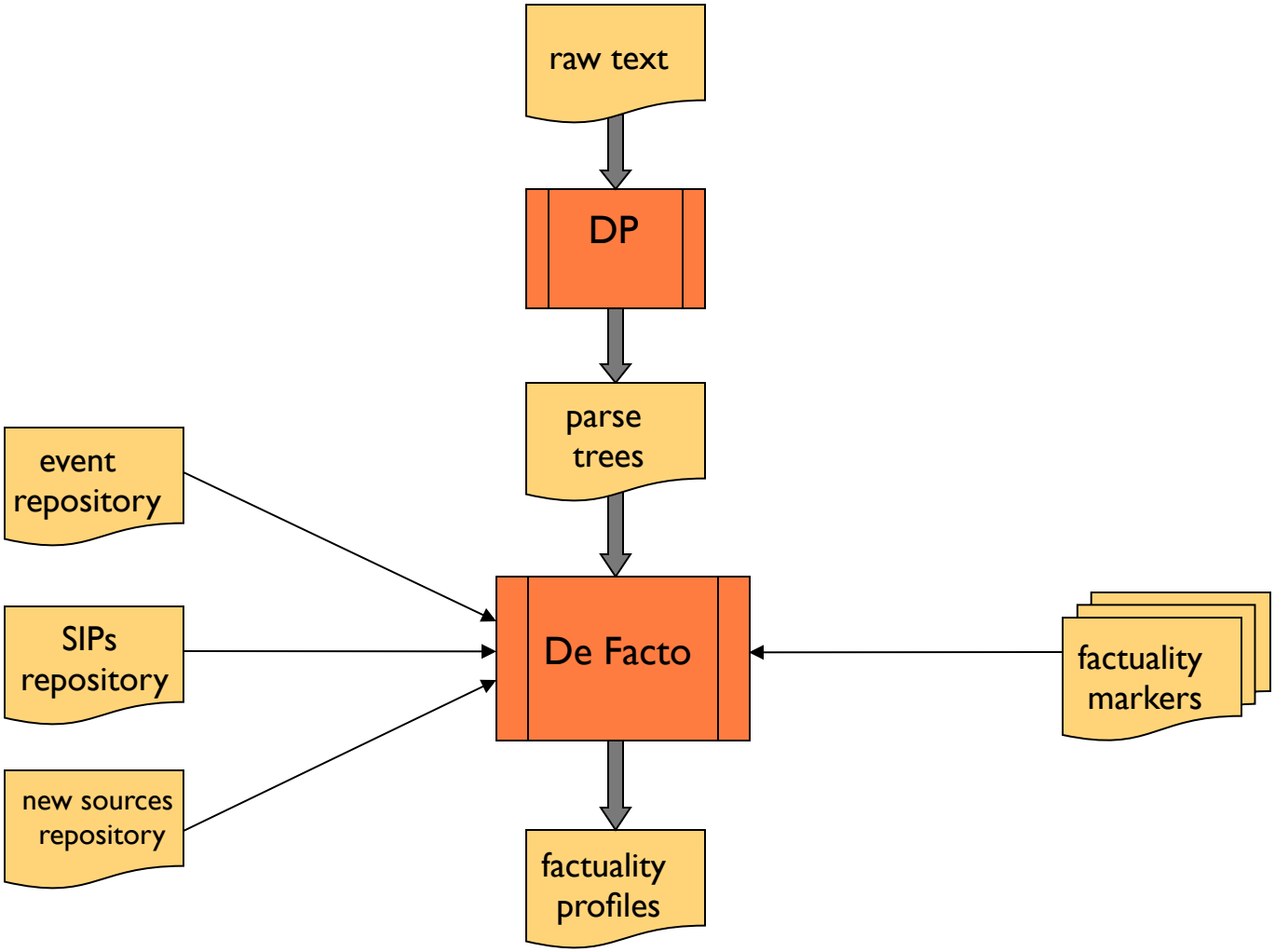
II. **The linguistic expression of factuality information**
   1. Types of factuality markers
   2. Markers interacting

III. **Compiling the lexicon**
   1. Methodology applied
      a. Linguistic criteria
      b. Lexicon selection
   2. A lexicon for event factuality
      a. Coverage
      b. Factuality classes
      c. Limitations

IV. **Evaluation:**
   1. The lexicon as an active component in De Facto
   2. Results

Evaluation:

The Lexicon as an active component in De Facto



De Facto's algorithm

Mary ***is not aware***$_{e0}$ *John* ***knows***$_{e1}$ *he* ***is***$_{e2}$ *the father.*

1. n ← 0
2. set level l_n:
3. identify set of relevant sources, RS_n.
4. for each s ∈ RS_n, identify its role.
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16. set level l_n
17. **elseif** i is another type of marker **then**
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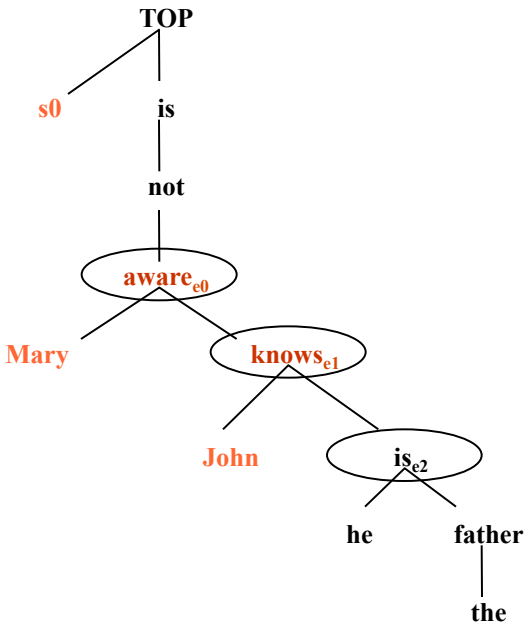

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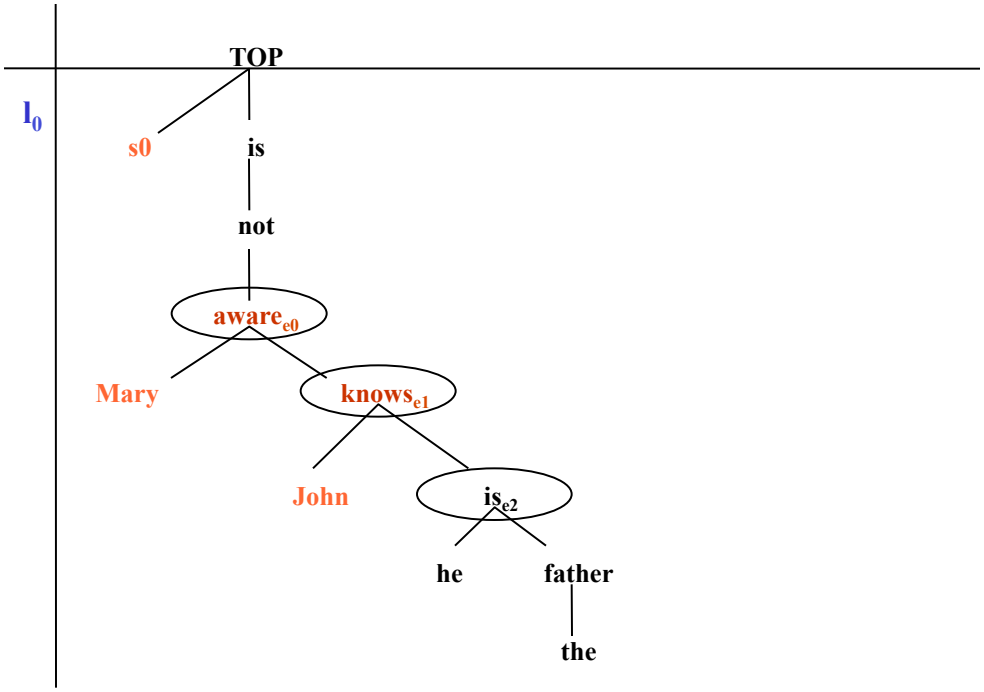

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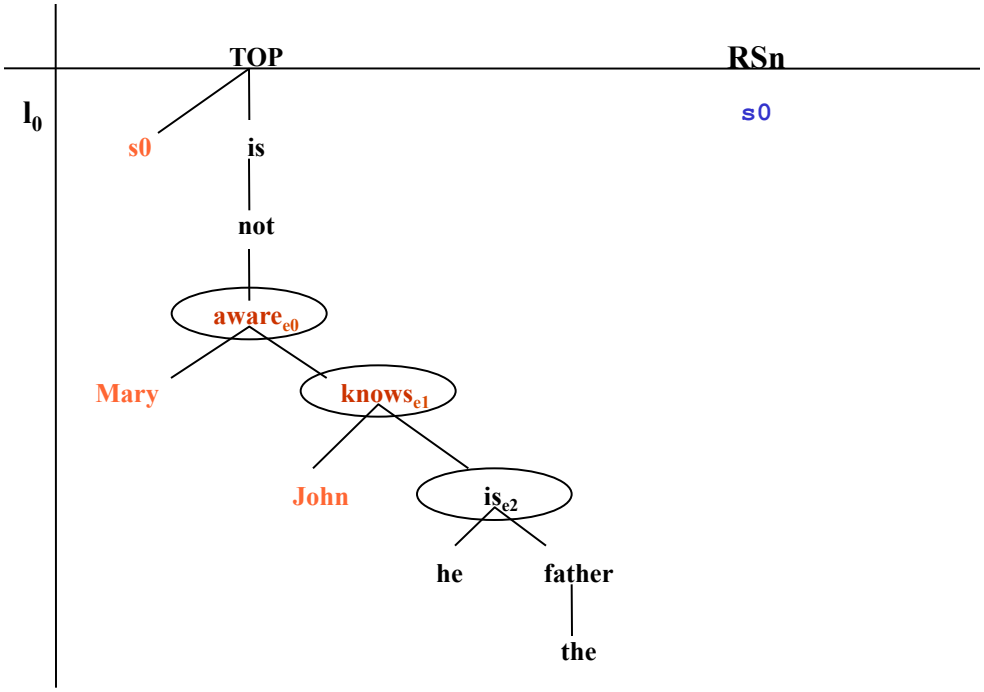

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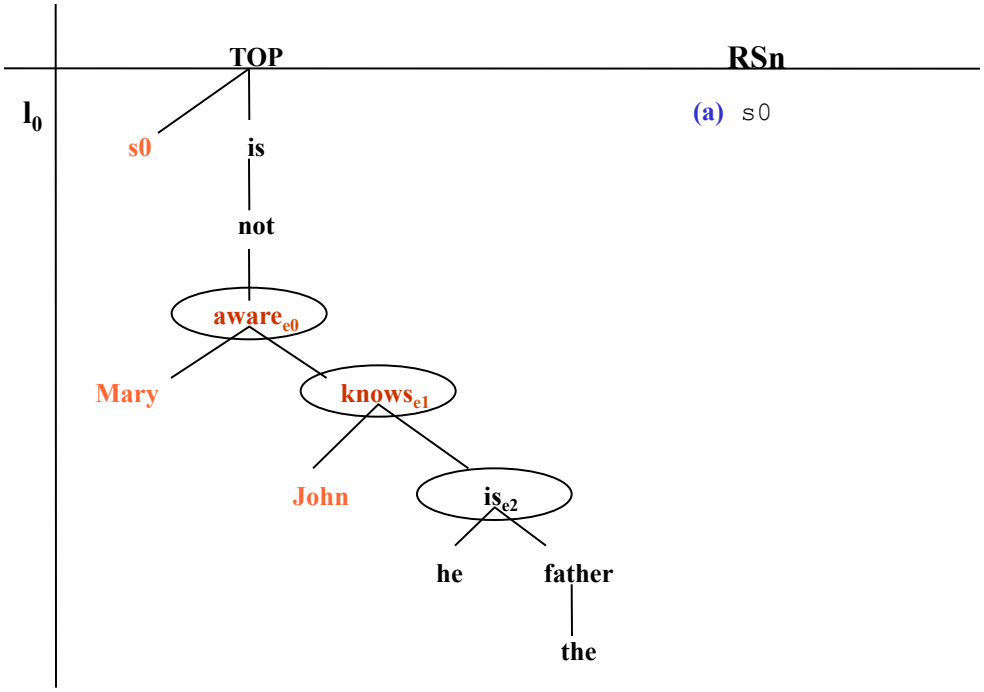

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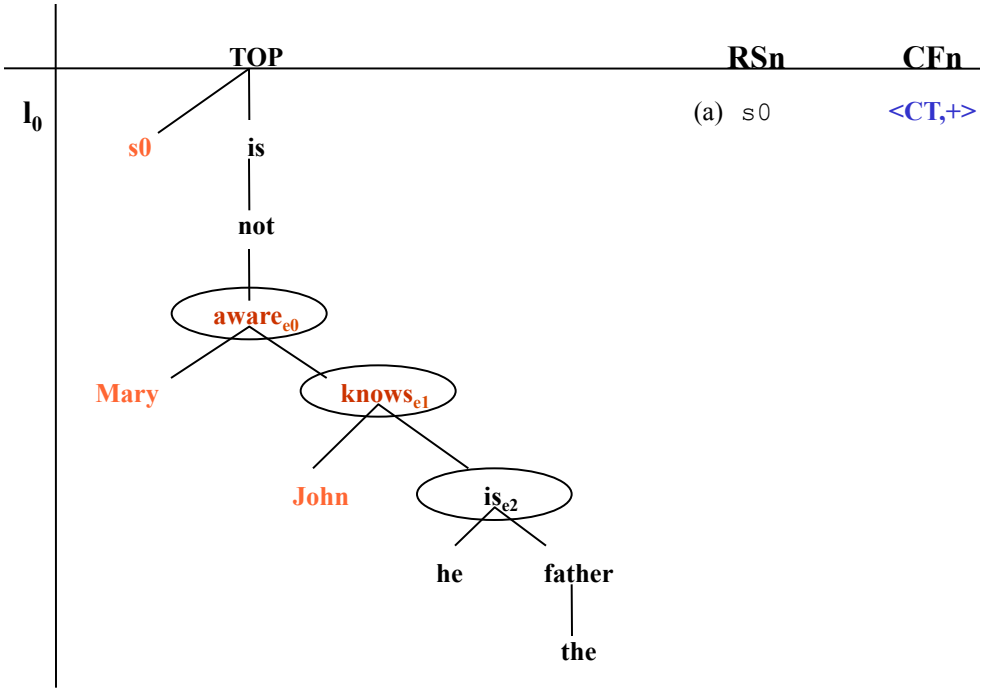

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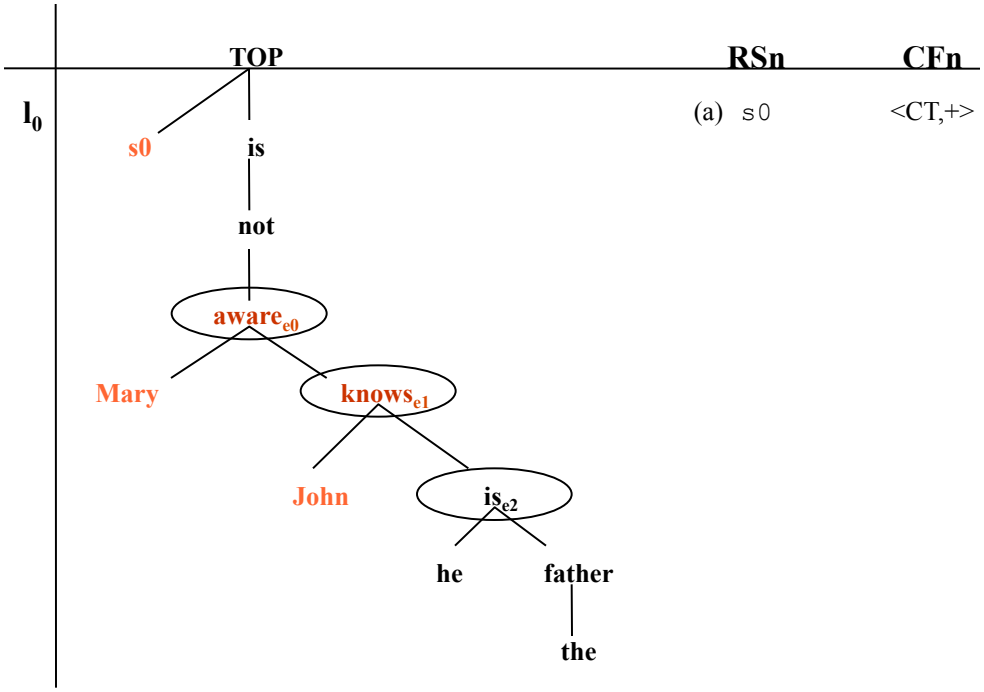

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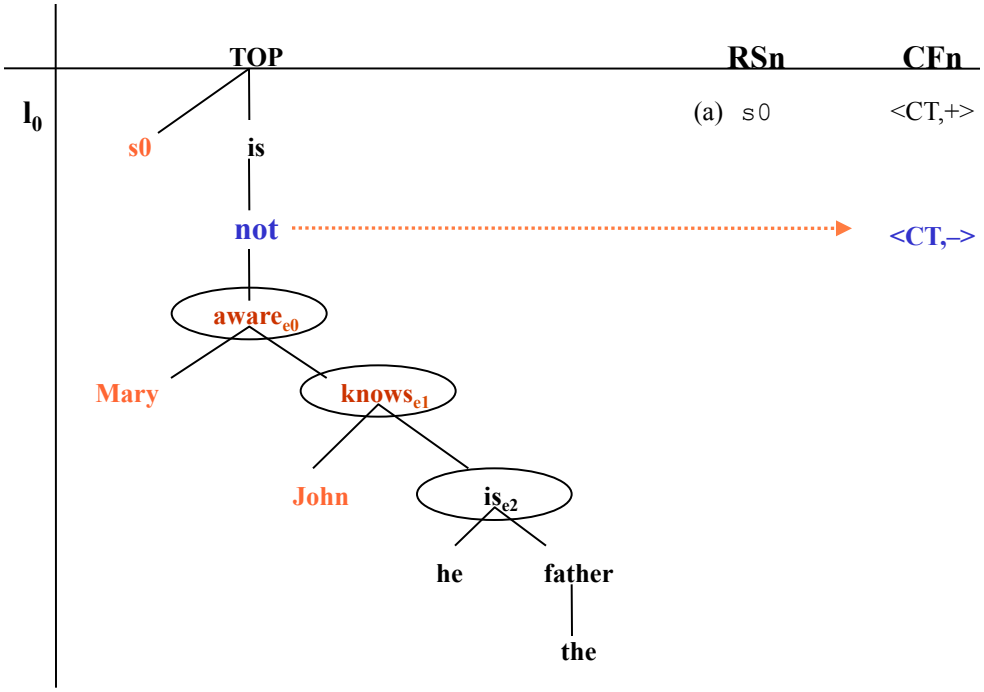

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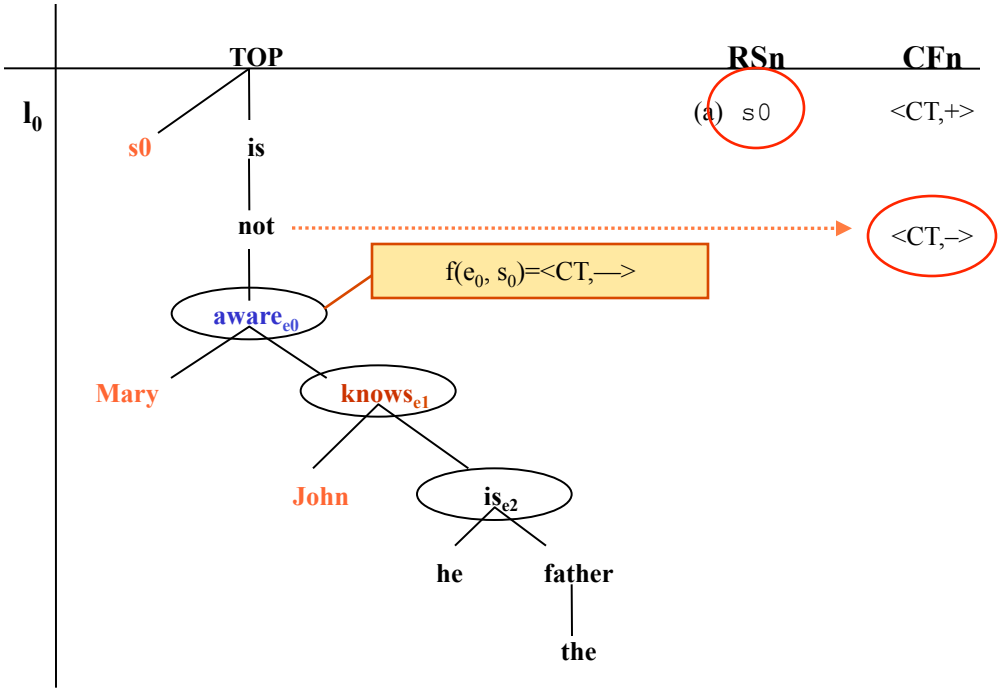

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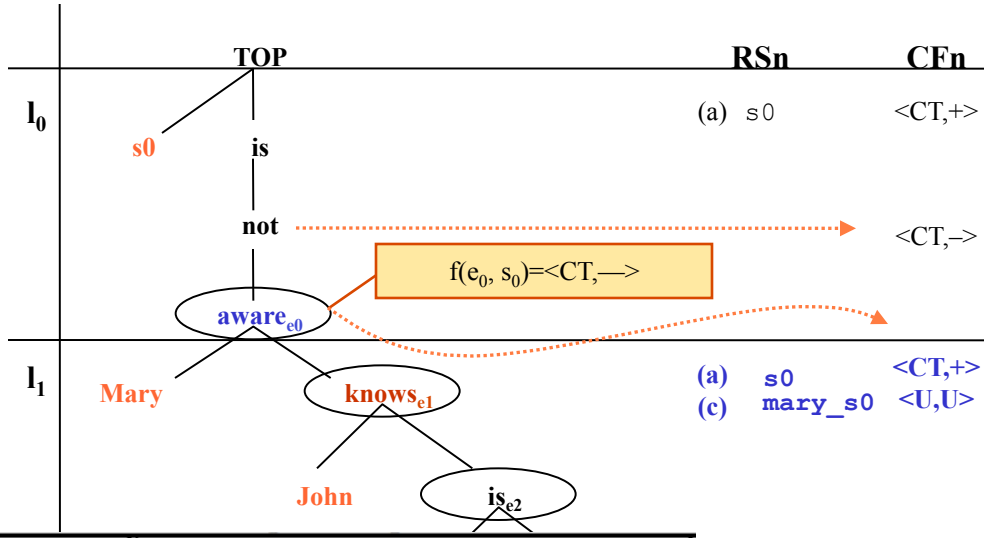

		Contextual factuality			
		mod=CT		mod<CT	
		pol=+	pol=–	pol=+	pol=–
know	(a)	CT,+	CT,+	CT,+	CT,+
	(c)	CT,+	U	U	U
say	(a)	U	U	U	U
	(c)	CT,+	U	U	U

De Facto's algorithm

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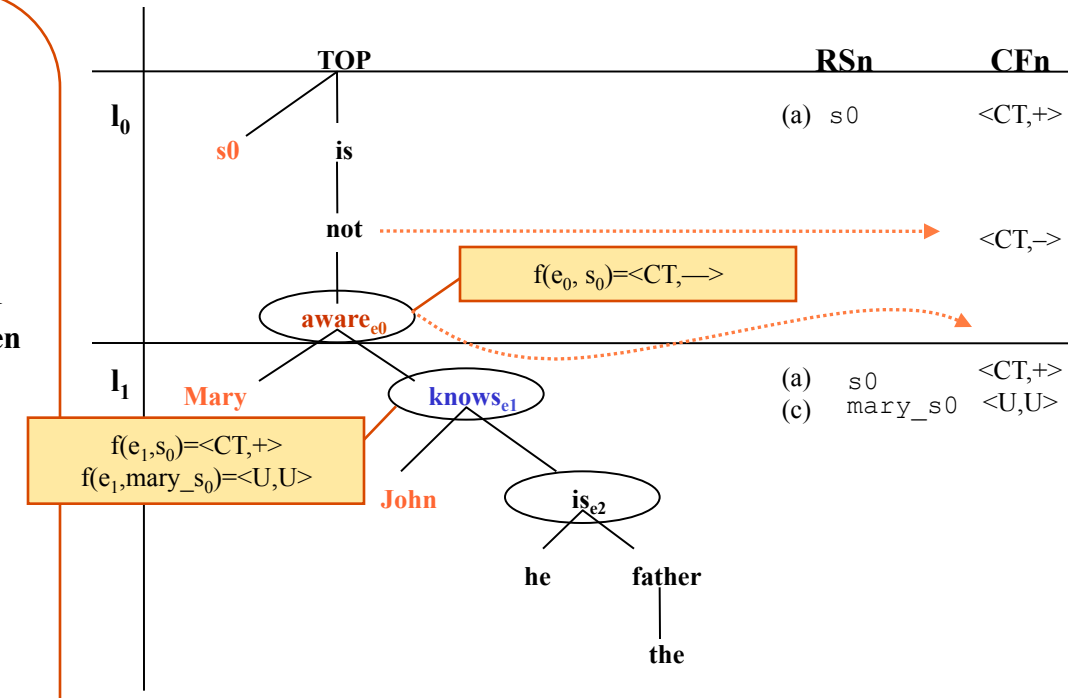

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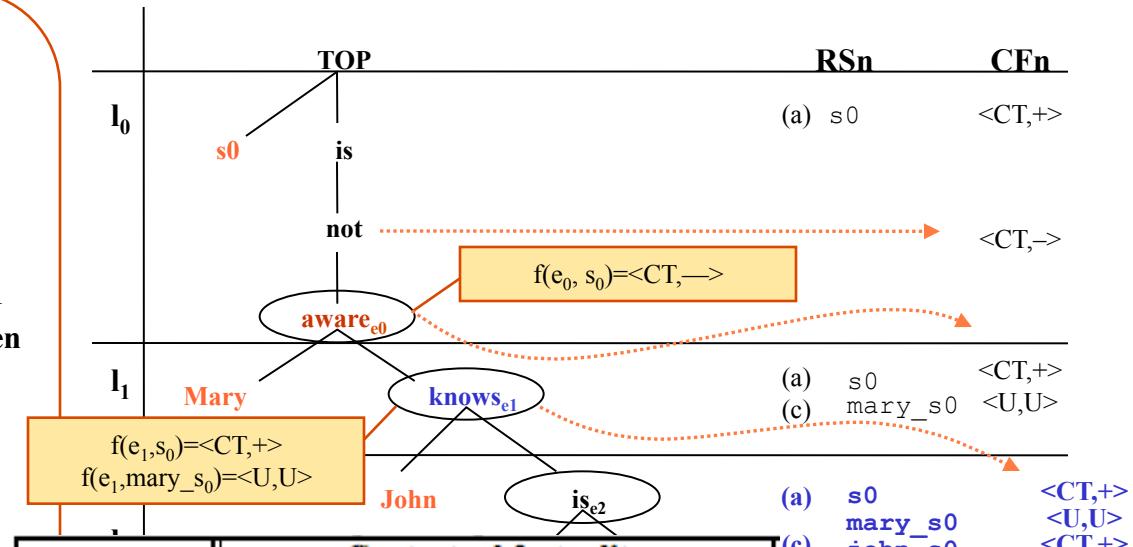

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		pol=+	pol=–	pol=+	pol=–
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	(c)	CT,+	U	U	U
say	(a)	U	U	U	U
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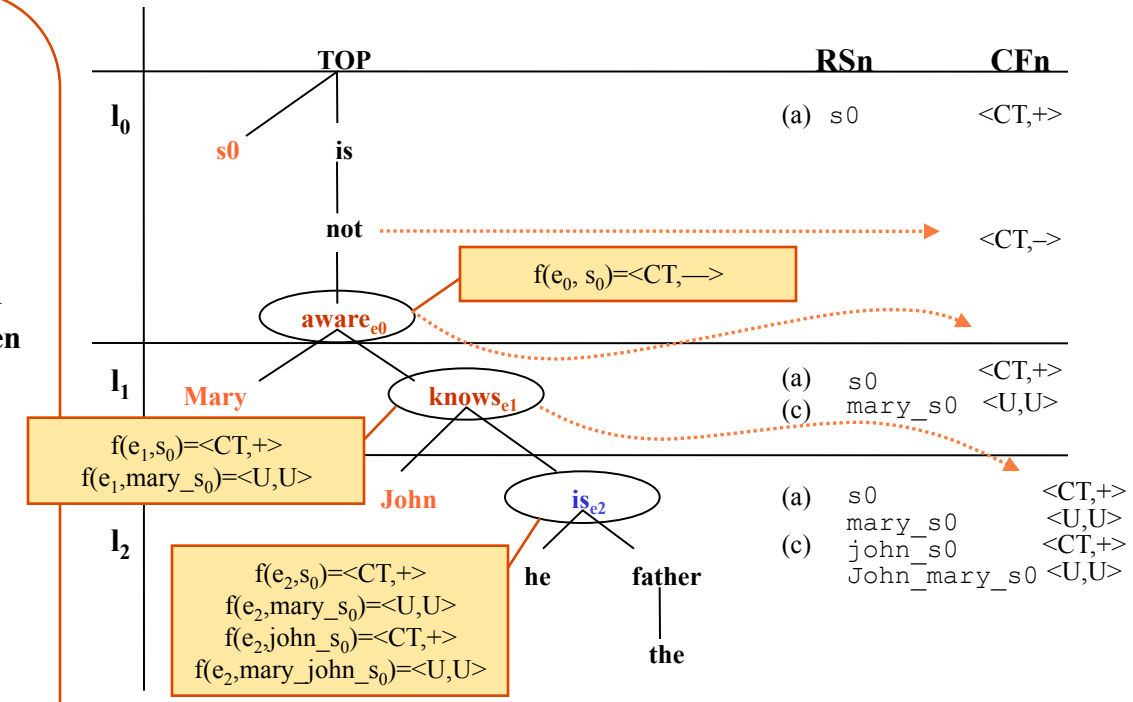
```
1.  n ← 0
2.  set level l_n:
3.      identify set of relevant sources, RS_n.
4.      for each s ∈ RS_n, identify its role.
5.      set the contextual factuality values, CF_n
6.  for all i in TREE do
7.      #PART 1: CHECK FOR SYNTACTIC MARKER
8.      if i is head of rel., part., or purp. clause then
9.          update context factuality, CF_n
10.     #PART 2: CHECK FOR EVENT
11.     if i is an event then
12.         obtain the factuality profile of i, pi
13.     #PART 3: CHECK FOR LEXICAL MARKER
14.     if i is a SIP then
15.         n ← n + 1
16.         set level l_n
17.     elseif i is another type of marker then
18.         update contextual factuality, CF_n
```



Outline

I. **Modelling event factuality**
   1. The factuality profile of events
   2. Factuality sources
   3. Factuality values

II. **The linguistic expression of factuality information**
   1. Types of factuality markers
   2. Markers interacting

III. **Compiling the lexicon**
   1. Methodology applied
      a. Linguistic criteria
      b. Lexicon selection
   2. A lexicon for event factuality
      a. Coverage
      b. Factuality classes
      c. Limitations

IV. **Evaluation:**
   1. The lexicon as an active component in De Facto
   2. Results

De Facto against the FactBank corpus

- Created for developing and evaluation purposes.

	# Documents	# Events
TimeBank	183 (88%)	7935 (90%)
A-TimeML Corpus	25 (12%)	1553 (10%)
Total	**208**	**9488**

- Annotated by a pair of annotators. Evaluation part, also completely adjudicated.
- Annotation design:
  - Disregard world knowledge. **Surface-based** annotation.
  - **Sentence** as the textual unit of information

- Interannotation agreement evaluation: **Kappa score**

K_{cohen}=**0.81** [$K_{s\&c}$=**0.81**, 2P(A)-1=**0.80**] (30% corpus)

Analisys of errors by De Facto

	Error source	%	% lexical	% syntactic
De Facto limitations	Insufficient coverage	34.4%	1.9%	32.5%
	Ambiguity	46.2%	18.1%	28.1%
	Other	3.8%	--	--
	Subtotal	**84.4%**	**20%**	**60.6%**
Other source errors	Gold standard	7.5%	--	--
	Wrong dependency trees	8.1%	--	--
	Subtotal	**15.6%**	**--**	**--**

How De Facto compares to state-of-the-art

	CT+	CT-	PR+	PS-	Uu	Macro-Ave	Micro-Ave
Baseline Performance							
Author	0.88	0.54	0.07	0.27	0.77	0.53	0.83
Top Sources	0.92	0.67	0.50	0.50	0.51	0.64	0.85
Average	**0.90**	**0.61**	**0.29**	**0.39**	**0.66**	**0.59**	**0.84**
De Facto Performance							
Author	0.90	0.91	0.67	0.35	0.84	0.75	0.88
Top Sources	0.93	0.85	0.53	0.67	0.65	0.74	0.88
Average	**0.92**	**0.88**	**0.60**	**0.51**	**0.75**	**0.75**	**0.88**

Calculated in terms of **F-1 measure**, the harmonic mean between:

- **Precision:** Proportion of values identified correctly from the set of identified values.
- **Recall:** Proportion of identified values from the set of correct values.

Further details:

Saurí, R., J. Pustejovsky. 2012. Are you sure that this happened? Assessing the factuality degree of events in text. *Computational Linguistics*, 38: 2.

Saurí, R. 2008. *A Factuality Profiler for Eventualities in Text*. PhD Dissertation. Brandeis University.

Thank you!

Syntax-based Markers

1. Presupposing the embedded event as factual:
   - **Relative clauses:**
     (1) Rice, [who became secretary of state two months ago], took stock of a period of tumultuous change.
   - **Cleft sentences:**
     (2) It was Mr. Bryant [who, on July 19, 2001, asked Rep. Bartlett to deliver a pen to him].
   - **Temporal clauses:**
     (3) Whittington was about 30 yards from Cheney [when the vice-president fired].
   - **Participial clauses:**
     (4) [Having revolutionized linguistics], Chomsky moved to political activism.

2. Entailing that the embedded event is of intensional nature:
   - **Purpose clauses:**
     (5) The environmental commission must adopt regulations [to ensure people are no exposed to radioactive waste].
   - **Conditional constructions:**
     (6) On Dec. 2 Marcos promised [to return to the negotiating table] [if the conflict zone was **demilitarized**.]

The problem

Within an hour de the bombings, **the Spanish government** was able to say that there was "no doubt" that ETA was behind the atrocity. **ETA's political wing, Batasuna**, later denied this and pointed the finger at the "Arab resistance". Then **ETA's founder, Julen de Madariaga**, said "It's not ETA's method de working."

Sources and Time

- On the relevance of **information sources**:

  (1) **Slobodan Milosevic's son** said Tuesday that the former Yugoslav president had been **murdered** at the detention center of the UN war crimes tribunal in The Hague.

- On the relevance of the **time** of factual commitment:

  (2) **In mid-2001**, **Colin Powell** and **Condoleezza Rice** both publically denied that Iraq **had** weapons of mass destruction.

  (Indy Media Center, Oct 17 2005)

  (3) Secretary of state **Colin Powell** **Thursday** defended the Bush administration's position that Iraq **had** weapons of mass destruction.

  (CNN, January 8 2004)

Related work within NLP

- **Descriptive frameworks:**
  - Certainty in text (Rubin, Liddy & Kando, 2005; Rubin, 2007)
  - Modality: TimeML (Pustejovsky et al., 2003, 2005)
- **Corpora:**
  - MPQA Opinion Corpus (Wiebe et al., 2005)
  - The Penn Discourse TreeBank (Prasad et al., 2007)
  - TimeBank (Pustejovsky et al., 2003)
- **Tools:**
  - Suite of tools within the TimeML framework (Saurí et al., 2005, 2006)
  - Algorithm for computing relative polarity (Nairn et al., 2006; Karttunen, 1973)

Outline

I. **Modelling event factuality**
   1. Defining event factuality
   2. Factuality markers
   3. Factuality sources

II. **De Facto: a factuality profiler**
   1. Algorithm
   2. Linguistic resources
   3. Implementing De Facto
   4. Evaluation
      1. Corpus
      2. De Facto

III. **Closing remarks**
   1. Conclusions
   2. Future work

Linguistic Resources

1. Negation Particles

- **Lexical items:**
  - **Adverbs:** *not, nor, neither, never.*
  - **Determiners:** *no, non, neither, little*
  - **Pronouns:** *none, nobody, nowhere*

- **Interaction table:**

Marker value	Contextual polarity		
	+	–	UN
+	+	–	UN
–	–	+	UN

- **Constructions:**
  - Negating the predicate expressing the event
  - Negating the subject
  - Negating the direct object
  - Adverbial modification
  - Using an embedding predicate
  - The embedding predicate is negated (negation transportation)
  - Double negation

However, still missing…

- Negation transportation: Not filtering SIP out from De Facto's computation.

  *He does**n't** **believe** Gore was ever aware of the arrangement.*

- Constructions involving certain types of adverbials (e.g., *They were **too** tired to finish.*)
- Partially negated events (e.g., *It's **not** John who kissed the goat.*)
- Ambiguity between clausal and subclausal interpretation (e.g., *We could do **nothing**.*)

Linguistic Resources

1. Modality Particles

- **Lexical items:**
  - Epistemic modality particles:

Verbal auxs.	Possible:	*could, may*
	Probable:	*will, should*
	Certain:	*must, have to*
Adverbs	Possible:	*perhaps, maybe*
	Probable:	*probably*
	Certain:	*necessarily, certainly*
Adjectives	Possible:	*possible*
	Probable	*likely, probable*
	Certain:	*certain, impossible*

  - Other modalities as well (deontic, volitional)
- **Interaction table**
- **Limitations:**
  - Disambiguating among modality interpretations (e.g., *can, would*).

    (1) *The uneasy situation* ***can*** *be further disrupted by the Taiwan news.*
    (2) *Irish citizens* ***can*** *vote in every election and referendum.*

  - Modal markers with evidential nuances (e.g., *reportedly*).

Linguistic Resources

1. Syntactic constructions

- **Purpose clauses**

  Main event in the clause is underspecified (Uu), even if embedded in a context of factuality.

  (1) **Prof. Devlin$_{s1}$** regretted that [most industrial companies **fired** the women workers [in order to **restore$_{e1}$** the status quo that prevailed before the war]].

  (2) $f(e_1, s_0)$ = Uu
  $f(e_1, s_1\_s_0)$ = Uu

- **Relative & participial clauses**

  Main event in the clause is presupposed as corresponding to a fact in the world…

  a. …even under the scope of a reporting or propositional attitude predicate:

  (3) ***Prof. Devlin$_{s1}$*** *said that [most industrial companies could not **fire** the women [that had been **working$_{e1}$** in their plants during the war]].*

  (4) $f(e_1, s_0)$ = CT+
  $f(e_1, s_1\_s_0)$ = CT+

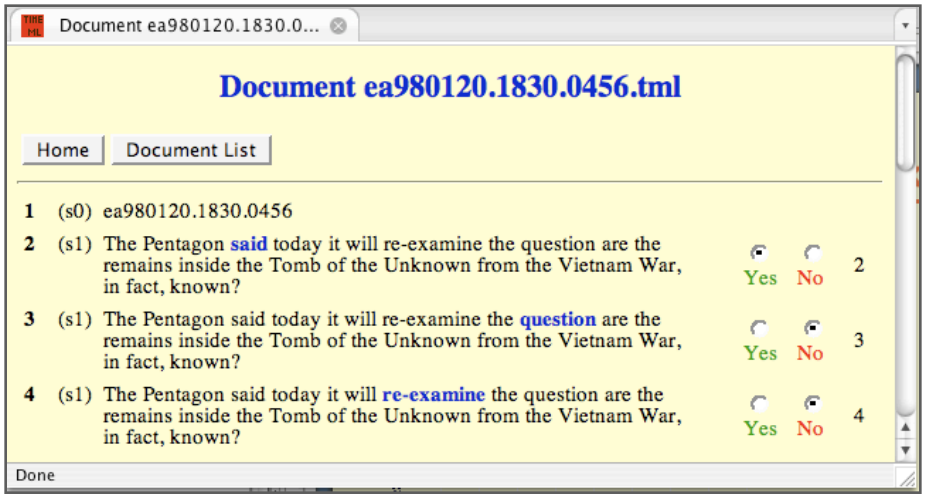
  b. …but not within a quoted context:

  (5) [After the World War II, most industrial companies could not **fire** the women [that had been **working$_{e1}$** in their plants during the war period]]," **Prof. Devlin$_{s1}$** said.

  (6) $f(e_1, s_0)$ = Uu
  $f(e_1, s_1\_s_0)$ = CT+

Annotation Task 1

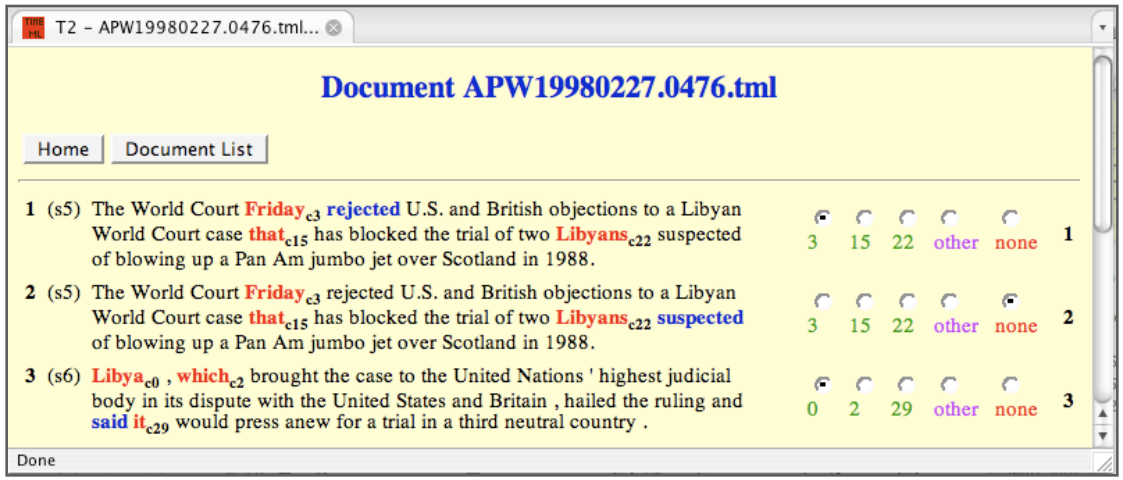
- **Identifying Source-Introducing Predicates (SIPs)**



- **IAA:** K_{cohen}=**0.88** [$K_{s\&c}$=**0.88**, 2P(A)-1=**0.92**] (40% corpus)
- Some common disagreements were SIP candidates:
  - Introducing a generic source (e.g., *It is **expected** that…*)
  - Not have an explicit event complement (e.g., *They didn't **disclose** the size of the gain.*)
  - Whose event complement is not expressed by a direct object or a complement clause (e.g., *Telerate has **criticized** Dow Jones [for not disclosing …]).*
  - Allowing for a non-SIP interpretation (e.g., *Bunchay **appeared** confident he would find Howes remains.*)
  - Speech act predictas which nevertheless do not behave as SIPs (e.g., *speak, talk*).

Annotation Task 2

- **Identifying new sources**



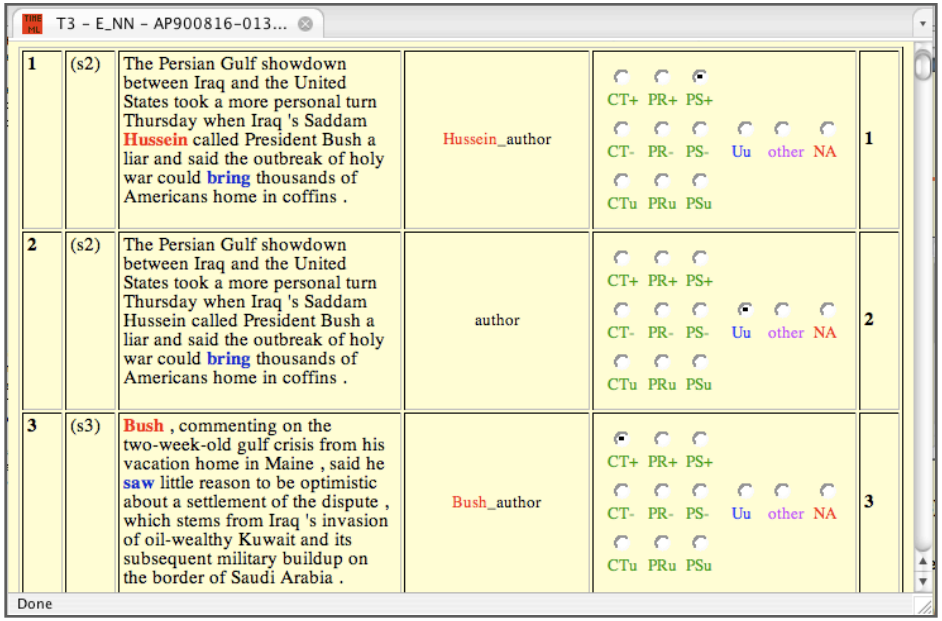
Source candidates:

- Subjects
- Agent complements (*by*-phrases)
- Complement of preposition *to* that is in a dependency relation with a SIP.
- Complement of preposition *of* that is in a dependency relation with a noun SIP.
- Etc.

- **IAA:** K_{cohen}=**0.95** [$K_{s\&c}$=**0.95**, 2P(A)-1=**0.97**] (40% corpus)
- Some common disagreements:
  - There is a second expression correfering with new source (e.g., ***Libya***, ***which*** *brought…*)
  - New source refers to a non-human entity (e.g., ***Reports*** *said that….*)
  - The new source is expressed by means of a PP (e.g., *Netanyahu's comments last week were in response to signals from* ***Syria*** *that it wants to renew…]*).

Annotation Task 3

- **Assessing the factuality values of events**



VAL	USE
	Committed Values
CT+	According to the source, it is **certainly** the case that X.
PR+	According to the source, it is **probably** the case that X.
PS+	According to the source, it is **possibly** the case that X.
CT-	According to the source, it is **certainly not** the case that X.
PR-	According to the source it is **probably not** the case that X.
PS-	According to the source it is **possibly not** the case that X.
	(Partially) Uncommitted Values
CTu	The source knows whether it is the case that X or that not X.
PRu	The source knows whether it is probably the case that X or that not X.
PSu	The source knows whether it is possibly the case that X or that not X.
Uu	The source does not know what is the factual status of the event, or does not commit to it.
	Other Values
Other	Covering the following two situations - A different value is required here (e.g., U+, U-). - The annotator does not know what value to assign.
NA	The factuality nature of the eventuality cannot be evaluated.

IAA: K_{cohen}=**0.81** [$K_{s\&c}$=**0.81**, 2P(A)-1=**0.80**] (30% corpus)

Annotation Task 3

- **Assessing the factuality values of events**
  - **IAA:** K_{cohen}=**0.81** [$K_{s\&c}$=**0.81**, 2P(A)-1=**0.80**] (30% corpus)
  - Common disagreements:

    Around 66% of cases in 10% of the corpus are due to some type of ambiguity.
    - Scope of reporting predicate:

      (1) *Authorities want to question the unidentified woman who alledgedly traveled with Kopp,* ***according*** *to an investigator.*
    - Syntactic constructions typically triggering a presupposition (e.g., relative clauses, temporal clauses, appositions) when embedded under a reporting (*plug*) predicate.

      (2) *The killing of Dr. Slepian, a gynecologist who performed abortions, has become a factor in two campaings in New York,* ***say*** *political consultants.*
    - Event-denoting nouns, especially when embedded under a reporting (*plug*) predicate:

      (3) *FBI Director Louis Freeh, on an official visit to Mexico, asked Mexican authorities to join the hunt for Kopp, officials* ***said****.*
    - Participial clauses
    - Purpose clauses
    - Ambiguous ESPs (e.g., *believe, admit, agree, decide, help*)
    - Ambiguous modal auxiliaries (e.g., *can, would*)

Data Distribution

	CT+	CT-	Ctu	PR+	PR-	Pru	PS+	PS-	Psu	Uu	other	NA	
CT+	2483	1	0	21	0	0	2	0	0	97	1	0	2605
CT−	17	136	0	0	1	0	0	0	0	15	0	0	169
CTu	1	0	0	0	0	0	0	0	0	2	0	0	3
PR+	5	0	0	38	0	0	0	0	0	8	0	1	52
PR−	1	0	0	0	4	0	0	0	0	2	0	0	7
PRu	0	0	0	0	0	0	0	0	0	0	0	0	0
PS+	1	0	0	1	0	0	34	0	0	25	0	0	61
PS−	0	0	0	0	0	0	0	1	0	1	0	0	2
PSu	0	0	0	0	0	0	0	0	0	0	0	0	0
Uu	189	21	0	31	6	0	23	0	0	1615	2	6	1893
other	2	0	0	1	0	0	0	0	0	0	0	0	3
NA	6	0	0	0	0	0	0	0	0	0	0	0	6
	2705	158	0	92	11	0	59	1	0	1765	3	7	4801

Contingency table (over 30% of the corpus)

- Need to distinguish between PR and PS
- No need for values PRu and Psu
- Value Uu used to express 2 different situations:

Value	CT+	CT-	Ctu	PR+	PR-	Pru	PS+	PS-	Psu	Uu	other	NA
#Simple	794	31	0	2	0	0	4	0	0	156	0	0
#Embed	482	20	1	23	0	0	29	2	0	648	0	5
%Simple	36.1	1.4	0	0.1	0	0	0.2	0	0	7.1	0	0
%Embed	22	0.9	0.05	1.05	0	0	1.3	0.1	0	29.5	0	0.2

Distribution of factuality values (evaluation corpus)

Evaluating De Facto

Confusion Matrix: (rows: Gold Standard, columns: De Facto)

	CT+	CT-	Ctu	PR+	PR-	PS+	PS-	Uu	NA	Total
CT+	1131	0	0	0	0	2	0	84	59	1276
CT–	13	33	0	0	0	0	0	1	4	51
CTu	1	0	0	0	0	0	0	0	0	1
PR+	12	0	0	8	0	0	0	3	2	25
PR–	0	0	0	0	0	0	0	0	0	0
PS+	7	0	0	0	0	22	0	2	2	33
PS–	0	0	0	0	0	0	2	0	0	2
Uu	226	4	1	2	0	17	0	532	22	804
Total	1390	37	1	10	0	41	2	622	89	2192

Performance:

- **In terms of P&R** (only categories with at least 10 instances: **CT+, CT–, PR+, PS+, Uu**)

	CT+	CT-	PR+	PS+	Uu	Macro-A	Micro-A
Original parses							
Precision	0.81	**0.89**	0.80	**0.54**	0.86	0.78	0.82
Recall	**0.89**	0.65	**0.32**	0.67	0.66	0.64	0.79
F1	**0.85**	0.75	**0.46**	0.59	0.75	0.70	0.80
Corrected parses							
Precision	0.86	**0.90**	0.73	**0.56**	0.86	0.78	0.85
Recall	**0.92**	0.75	**0.44**	0.67	0.77	0.71	0.85
F-1	**0.89**	0.82	**0.55**	0.61	0.81	0.74	0.85

- **In terms of IAA:** K_{cohen}=**0.72** [$K_{s\&c}$=**0.70**, 2P(A)-1=**0.71**]

Building a baseline

- Support Vector Machines (SVM) classifiers running on YAMCHA.
- Based on state of the art on automatic tagging of committed belief (Prabhakaran, Rambow et al. 2010)

1.	isNumeric	Word is Alphabet or Numeric?
2.	POS	Word's POS tag
3.	verbType	Modal, auxiliary or regular (*nil* if not a verb)
4.	whichModalAmI	If I am a modal, what am I? (*nil* if not a modal)
5.	amVBwithDaughterTo	Am I a VB (base verb) with a daughter *to*?
6.	haveDaughterPerfect	Do I have a *have* form daughter? (only for verbs)
7.	haveDaughterShould	Do I have a *should* daughter? (only for verbs)
8.	haveDaughterWh	Do I have a daughter which is: *where, when, while, who, why*?
9.	haveReportingAncestor	Am I an event with an ancestor whose lemma is: *believe, accuse, insist, seem, tell, say, find, conclude, claim, trust, think, suspect, doubt, suppose*?
10.	parentPOS	What is my parent POS tag?
11.	whichAuxIsMyDaughter	If my daughter is an auxiliary, what is it? (*nil* if not an auxiliary)
12.	whichModalIsMyDaughter	If my daughter is a modal, what is it? (*nil* if not a modal)
13.	amEvent	Am I an event?
14.	whichPolarAmI	If I am a polar marker, am I a conjunction (*nor*), a pronoun (*none*) or other?
15.	whichPolarIsMyDaughter	If my daughter is a polar particle, what type is it?
16.	amSource	Am I a source?
17.	whichSIPtypeAreMyAncest.	If I am a source, what SIP type are my ancestors? (based on the SIP classification in Section 3.4.3)
18.	whichDepRelWithMyParent	If I am a source, what is my dependency relation with my parent?
19.	whichSIPtypeAmI	If I am a SIP, which type am I?

Future Work

- Enhancing De Facto:
  - Completing De Facto as an autonomous tool:
    - Event identification
    - Identifying SIPs
    - Identifying new sources introduced by SIPs
  - Enriching the set of syntactic markers
  - Dealing with lexical polysemy
  - Exploring ML techniques
- More theoretical work:
  - Event-denoting nouns
  - Effect of *plug* predicates in the projection of presupposed material
- Wider lines of research:
  - Accounting for source reliability
  - Incorporating discourse structure
  - Identification of opinion and perspective

De Facto: error analysis

1. **Missing contexts of negative polarity:**
   - Limitation in DF treatment of negation (mainly in cleft and copulative constructions)
   - Interpretation of aspectual predicates (e.g., stop, finish).
   - Errors inherited from dependency parser.
2. **Missing contexts of modality < CT:**
   - Limitation in DF treatment (copulative constructions)
   - Polysemy of modality markers (e.g., *believe, can*)
3. **Selecting underspecified value (Uu) instead of CT+:** [93 instances]
   - Ambiguous constructions (purpose clauses)
   - Nouns embedded in contexts of uncertainty.
   - Presupposition-triggering constructions under the scope of a reporting predicate.
   - Error from the dependency parser (8%)
   - DF is correct (7%)
4. **Selecting a value other than Uu:**
   - DF's limitation in identifying certain structures (e.g., conditional constructions, or *the goal is* constructions).
   - Ambiguity of syntactic constructions (relative and participial clauses)
   1. Polysemy of factuality markers (e.g., *can, would*)
   - Different interpretation of ESPs (e.g., *inform, announce*)
   - External error source: DP and FactBank annotation.

Conclusions

1. **Theoretical framework**
   a. Set of factuality values, combining modality and polarity.

      Battery of discriminatory tests

   a. Identification of factuality markers
   b. Notion of source
      - Relevant sources
      - Source roles: anchor and cognizer

   Adequacy of model: **k=0.81** (task 3)

2. **Computational model**
   a. Algorithm for computing the factuality of events
      - Interaction among factuality markers
      - Identification of different sources
   b. Set of linguistic resources informing it
      - Created in a data-driven fashion
      - Reflecting major findings in the literature

   Performance: **F1=0.74** (macro-averaging), **F1=0.85** (micro-averaging), **k=0.72**

3. **Corpus creation: FactBank**