THE PREDICATE MATRIX AND THE EVENT AND IMPLIED SITUATION ONTOLOGY:
MAKING MORE OF EVENTS

Roxane Segers, Piek Vossen (Vrije Universiteit Amsterdam)
Marco Rospocher, Anne-Lyse Minard (Fondazione Bruno Kessler)
Egoitz Laparra, German Rigau (Universidad del Pais Vasco)
ESO in short!

- The Event and Implied Situation Ontology (ESO)
- Models the implications before, after and during an event and the roles of the entities involved in the event.
- Manually built event ontology with manual mappings to SUMO, FrameNet frames and Frame elements
- Manual mappings to WordNet synsets
- Written in OWL
- Freely available (CC BY SA license)
Background:

- NewsReader project: technology to process millions of documents in four languages. (newsreader-project.eu)
- Extraction of events: who did what, where and when.
- Event centric approach: changes in reality and over time.
The problem we had

- Millions of events in all kinds of lexicalizations, and with a variety of e.g. Frames and semantic roles.
- We know something has happened, but not what the implications or the pre and post situations of an event are.
Current application of ESO

- Used for Text Mining in a 2.1 million document collection:
  - Typing of events, e.g. eso:Transportation
  - Models and defines a) the implications of events and b) the roles of the participants affected by the event.
  - Runs on Semantic Role Labeled (SRL) text
  - Relies on Semantic Web techniques
Event implications?

- “Apple hired Steve as their new CEO to save the company.”
“Apple hired Steve as their new CEO to save the company.”

Before: Steve notEmployedAt Apple
After: Steve employedAt Apple
Steve hasFunction CEO
Steve hasTask save the company
Steve isEmployed true
Implications of Static and Dynamic Events

- Derive sequences of states and changes over time, regardless if the information is explicitly mentioned in text, or inferred by a reasoner:

```
John does not work for Ian
Ian hires John
John works for Ian
Ian fires John
John does not work for Ian
John works for Ian
```
Simple Semantics!

You (X) might be fired, quit your job, leave, resign or retire, but in the end, you no longer work for some employer.

*eso*: LeavingAnOrganization (skos:closematch fn: Quitting, fn: Firing)

\[ X \text{ notEmployedAt } Y \]

You might be a \text{fn:Donor}, a \text{fn:Victim} or a \text{fn:Seller}, but first you owned something and now you don’t.

*eso*: ChangeOfPossession

\[ X \text{ notHasInPossession } Y \]

You may travel to Bucharest while smiling and with a certain speed, but in the end, you’re in Bucharest and not where you were before.

*eso*: Translocation

\[ X \text{ atPlace } Y \]
ESO approach to event modeling

- In ESO, we focus on modeling the implications of events, not on the semantics of the events themselves.

- And we don’t define all possible implications of an event. (Though the model is open to extensions)
How do we do it: ESO in our NLP and Knowledge Suite
Predicate Matrix Version 2

- 8,495 Propbank and NomBank predicates, connected to:
  - 4,704 synsets
  - 554 Frames
  - 55 ESO Classes

- 23,386 Propbank and NomBank roles, connected to
  - 2,343 frame elements
  - 53 ESO roles
Instantiating ESO

- are we meta yet?

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“John generously gave the book to Ian.”

John (fn:donor/eso:possession-owner_1) generously (fn:manner) gave (fn:Giving/eso: ChangeOfPossession) the book (fn:theme/eso:possession-theme) to Ian (fn:Recipient/nwr:possession-owner_2)

obj-graph-eventX
:eventX
a eso:ChangeOfPossession;
 eso:ChangeOfPossession_possession-owner_1 :John;
 eso:ChangeOfPossession_possession-owner_2 :Ian;
 eso:ChangeOfPossession_possession-theme :book;
 sem:hasTime :time_eventX.
Instantiating the pre and post situations

Situation rules:
- eso:pre_ChangeOfPossession
  - eso:hasSituationRuleAssertion pre_ChangeOfPossessionAssertion1;
  - eso:hasSituationRuleAssertion pre_ChangeOfPossessionAssertion2.

- eso:pre_ChangeOfPossessionAssertion1
  - eso:hasSituationAssertionSubject eso:possession-owner_1;
  - eso:hasSituationAssertionProperty eso:hasInPossession;
  - eso:hasSituationAssertionObject eso:possession-theme.

- eso:pre_ChangeOfPossessionAssertion2
  - eso:hasSituationAssertionSubject eso:possession-owner_2;
  - eso:hasSituationAssertionProperty eso:notHasInPossession;
  - eso:hasSituationAssertionObject eso:possession-theme.

:eventX_pre (John gave the book to Ian)
- :instanceX(John) eso:hasInPossession :instanceZ(book)
- :instanceY(Ian) eso:notHasPossession :instanceZ(book)
-Decreasing subclassOf: QuantityChange
"The subclass of QuantityChange where some physical quantity or value is decreased."

Class mappings:
  broadMatch: fn:Change_of_quantity_of_possession
  broadMatch: fn:Cause_change_of_position_on_a_scale
  broadMatch: fn:Change_position_on_a_scale
  broadMatch: fn:Proliferating_in_number
  broadMatch: fn:Expansion
  broadMatch: fn:Cause_expansion
  closeMatch: sumo:Decreasing

Role mappings:
  quantity-item: fn:Item, fn:Possession, fn:Set
  quantity-attribute: fn:Attribute, fn:Dimension
  quantity-ratio: fn:Size_change, fn:Difference
  quantity-value_1: fn:Initial_value, fn:Initial_number, fn:Initial_size, fn:Value_1
  quantity-value_2: fn:Final_value, fn:Final_number, fn:Value_2, fn:Result_size

Assertions:
pre situation
  quantity-item hasAttribute quantity-attribute
  quantity-attribute hasRelativeValue +
  quantity-attribute hasValue quantity-value_1

post situation
  quantity-item hasAttribute quantity-attribute
  quantity-attribute hasRelativeValue -
  quantity-attribute hasValue quantity-value_2
  quantity-item hasRelativeDecrease quantity-ratio

Note that quantity-attribute is modeled with an existential restriction that allows to create a blank node in the named graph.
"Ford decreased the production with 2%.

pre situation       production hasAttribute :qwe123
                   :qwe123  hasRelativeValue +
post situation      production hasAttribute :qwe123
                   :qwe123  hasRelativeValue -
                   production hasRelativeDecrease 2%

"Apple lowered the price of the iPhone from 600 to 500 dollar."

pre situation      iPhone hasAttribute     price
                   price hasRelativeValue +
                   price hasValue       600
post situation      iPhone hasAttribute     price
                   price hasRelativeValue -
                   price hasValue       500
## Contents of ESO

| Component                              | Number |
|----------------------------------------|--------|
| Event classes                          | 63     |
| Dynamic event classes                  | 50     |
| Static event classes                   | 13     |
| SUMO class mappings                    | 46     |
| FrameNet Frame mappings                | 103    |
| Situation rule assertions              | 123    |
| Properties                             | 58     |
| ESO roles                              | 65     |
| Mappings of roles to FrameNet FEs      | 131    |
Evaluation
Evaluation on the MeanTime Corpus

- 120 articles, annotated manually with ESO classes and ESO roles for a Gold Standard.
- Same 120 articles, processed automatically with the Newsreader pipeline, including ESO and Predicate Matrix.
- Both loaded into a KnowledgeStore for inspection and comparison of the ESO events and inferred situations.
Manual annotation of MeanTime

- 600 sentences in total (712 predicates and 1033 roles).
- Precision and recall predicates: 28.1% and 20%
- Precision and recall roles: 11.21% and 10.24%
MeanTime processed automatically and the Gold Standard.

| Component                                      | KS automatic | KS Gold Standard |
|------------------------------------------------|--------------|------------------|
| All events                                     | 5443         | 1120             |
| ESO events                                     | 2508         | 441              |
| ESO events with ESO roles                      | 736          | 406              |
| ESO events with at least one inferred situation | 498          | 320              |
| ESO events with pre and post situations        | 495          | 268              |
| ESO events with a during situation             | 52           | 47               |
### KS automatic: ESO event inspection

| Description                                                   | Count       |
|---------------------------------------------------------------|-------------|
| ESO events with pre/post or during situation                 | 495         |
| Number of events inspected                                   | 52 (10.5%)  |
| Events with pre/post situation                              | 43          |
| Events with during situation                                 | 9           |
| Correct class label                                          | 37 (71.1%)  |
| Correct pre and post situation(s)                            | 18 (41.8%)  |
| Correct during situation(s)                                 | 6 (66%)     |
| Correct ESO events (class + roles + situations)              | 21 (50%)    |
# Error analysis

| Error Description                                      | Count |
|--------------------------------------------------------|-------|
| Error in interpretation sentence (multiple causes)     | 3     |
| Error in interpretation predicate                      | 9     |
| Multiple conflicting ESO classes assigned              | 8     |
| Wrong role instance (entities)                         | 10    |
| Wrong role instance (non-entity)                       | 5     |
| Role instance duplication                               | 6     |
| Conflicting assertions                                  | 1     |
Future work

- Evaluation:
  - Evaluation against baseline system (SemLink)
  - Quality checks on samples of the data
  - Show the added value and relevance of this ontology for e.g. a certain task: timeline creation (automatic vs manual)
Thank you for your attention!

ESO.owl, an extensive documentation and the manual
FrameNet LU to PWN 3.0 mappings:
https://github.com/newsreader/eso

Contact:

r.h.segers@vu.nl
rospocher@fbk.eu