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

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**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 \(\text{notEmployedAt} \) Apple
- **After:** Steve \(\text{employedAt} \) Apple
  - Steve \(\text{hasFunction} \) CEO
  - Steve \(\text{hasTask} \) save the company
  - Steve \(\text{isEmployed} \) 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:

```
'lan hires John'
```

```
John works for lan
```

```
'lan fires John'
```

```
John does not work for lan
```

```
'John works for lan'
```

```
John does not work for lan
```

- John does not work for Ian
- John works for Ian
- John does not work for lan
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 notEmployedAt Y

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

eso: ChangeOfPossession
X 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 atPlace Y
- 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?"
"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)

```turtle
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

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<th>Number</th>
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</table>
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.

<table>
<thead>
<tr>
<th>Component</th>
<th>KS automatic</th>
<th>KS Gold Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>All events</td>
<td>5443</td>
<td>1120</td>
</tr>
<tr>
<td>ESO events</td>
<td>2508</td>
<td>441</td>
</tr>
<tr>
<td>ESO events with ESO roles</td>
<td>736</td>
<td>406</td>
</tr>
<tr>
<td>ESO events with at least one inferred situation</td>
<td>498</td>
<td>320</td>
</tr>
<tr>
<td>ESO events with pre and post situations</td>
<td>495</td>
<td>268</td>
</tr>
<tr>
<td>ESO events with a during situation</td>
<td>52</td>
<td>47</td>
</tr>
<tr>
<td>Description</td>
<td>Value</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>ESO events with pre/post or during situation</td>
<td>495</td>
<td></td>
</tr>
<tr>
<td>Number of events inspected</td>
<td>52 (10.5%)</td>
<td></td>
</tr>
<tr>
<td>Events with pre/post situation</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Events with during situation</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Correct class label</td>
<td>37 (71.1%)</td>
<td></td>
</tr>
<tr>
<td>Correct pre and post situation(s)</td>
<td>18 (41.8%)</td>
<td></td>
</tr>
<tr>
<td>Correct during situation(s)</td>
<td>6 (66%)</td>
<td></td>
</tr>
<tr>
<td>Correct ESO events (class + roles + situations)</td>
<td>21 (50%)</td>
<td></td>
</tr>
</tbody>
</table>
## Error analysis

| 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

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