

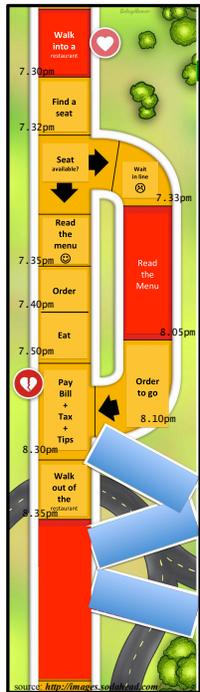
Acquiring Temporal Constraints Between Relations

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Motivation

- Relations follow a temporal order
- Knowing when one ends and another one begins can help put a time stamp on them

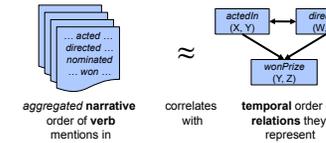


Abstract

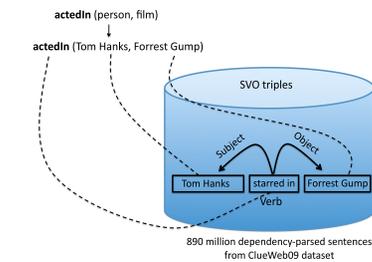
We consider the problem of acquiring **typical** temporal orderings among relations:

Given only:
 □ Known relation instances *without* time information
 □ A large document collection

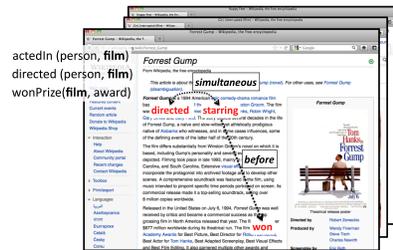
Hypothesis:



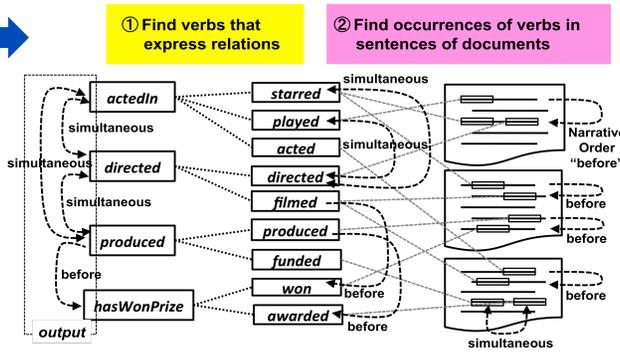
① Find Verbs that Express Relations



② Find Occurrences of Verbs in Sentences of Documents



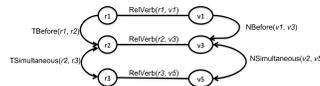
We measure **narrative order** of verbs based on the order of sentences containing the verbs in documents



③ Infer Temporal Order from Narrative Order

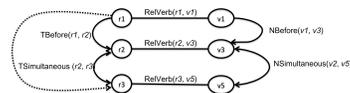
A. Pairwise Temporal Order

narrative order *infers* temporal order



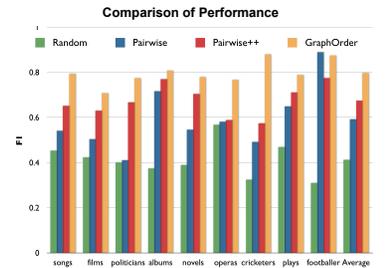
B. Graph Order: Collective Temporal Order

GraphOrder: graph-based semi supervised learning algorithm to induce **transitivity closure** over soft orderings

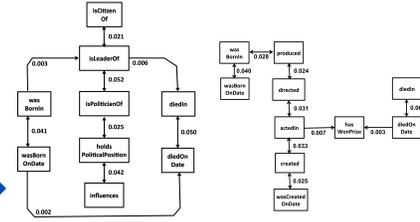


$$\min_{\{Y_{v,i}\}} \mu_1 \sum_{v \in R} (\sum_{i \in I} Y_{v,i} - \hat{Y}_{v,i})^2 + \mu_2 \sum_{(u,v) \in E_{\text{pair}}} W_{u,v} \times (\hat{Y}_{u,i} - \hat{Y}_{v,i})^2 + \mu_3 \sum_{(u,v) \in E_{\text{graph}}} W_{u,v} \times (\hat{Y}_{u,i} - \hat{Y}_{v,i})^2 + \mu_4 \sum_{v \in X, i \in I} (\hat{Y}_{v,i} - M_{v,i})^2$$

Experiments



Learned Temporal Orderings of Relations in politics and films



Results of Temporal Scoping Experiments

Domain	Constraint Source	Precision	Recall	F1
Films	None	55.6 (5.7)	49.9 (5.5)	52.6 (5.6)
	GraphOrder	71.0 (3.8)	62.3 (4.1)	66.4 (4.0)
	Manual	89.1 (5.6)	70.6 (3.3)	78.8 (4.0)
Novels	None	53.4 (7.5)	37.5 (9.2)	43.8 (8.5)
	GraphOrder	67.2 (12.1)	44.4 (13.1)	53.0 (12.7)
	Manual	60.8 (7.1)	41.4 (12.3)	48.8 (11.0)
Songs	None	31.0 (4.9)	16.5 (2.6)	21.5 (3.4)
	GraphOrder	60.0 (5.4)	26.9 (1.6)	37.1 (2.4)
	Manual	43.5 (4.3)	20.8 (2.4)	28.1 (2.9)

Conclusions

We consider the problem of acquiring **typical** temporal orderings among relations:

- Important because they can play a role in temporal scoping
- Hypothesize that:
 - relations are expressed by verbs in sentences
 - narrative order of verbs correlates with temporal order of relations
 - temporal orderings are transitive
- Our approach:
 - Mines a corpus of 890m dependency parsed sentences to discover verbs that express relations
 - Collect narrative order of the verbs over a large number of documents
 - Introduce **GraphOrder** – a novel graph-based collective label propagation method
- Show the utility of learned temporal orderings for temporal scoping