

# Lifted Relational Team Embeddings for Predictive Sport Analytics

Ondřej Hubáček   Gustav Šourek   Filip Železný

Czech Technical University in Prague

# The Problem

- predicting future match outcome from historical data
- soccer matches results from EPL 2004–2016
- no additional information

Date	Home	Away	Score H	Score A
10/6/2004	Arsenal	Chelsea	3	1
...	...	...	...	...
11/12/2016	Bolton	Everton	2	2



# Knowledge Representation

Predicate	Description
$\text{home}(Tid)$	Team $Tid$ is home team w.r.t. prediction match.
$\text{away}(Tid)$	Team $Tid$ is away team w.r.t. prediction match.
$\text{team}(Tid, name)$	Team $Tid$ has name $name$ .
$\text{win}(Mid, Tid_1, Tid_2)$	Win of home team $Tid_1$ over team $Tid_2$ in match $Mid$ .
$\text{draw}(Mid, Tid_1, Tid_2)$	Draw between home team $Tid_1$ and $Tid_2$ in match $Mid$ .
$\text{loss}(Mid, Tid_1, Tid_2)$	Loss of home team $Tid_1$ to team $Tid_2$ in match $Mid$ .
$\text{scored}(Mid, Tid, n)$	The team $Tid$ scored more than $n$ goals in match $Mid$ .
$\text{conceded}(Mid, Tid, n)$	The team $Tid$ conceded more than $n$ goals in match $Mid$ .
$\text{goal\_diff}(Mid, n)$	Difference in goals scored by the teams is greater than $n$ .
$\text{recency}(Mid, n)$	The match $Mid$ was played more than $n$ rounds ago.

# Lifted Relational Neural Networks

- framework utilizing a fragment of relational fuzzy logic
- parameter training by gradient descend
- model = lifted template for neural network
- LRNN grounds the template w.r.t. the different examples
- different computational graph for each example

# LRNN Toy Example

Rules:

$(w_m : foal(A) \leftarrow parent(A, B) \wedge horse(B)),$

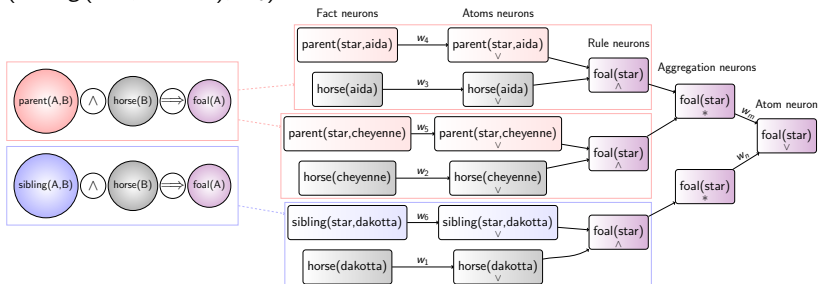
$(w_n : foal(A) \leftarrow sibling(A, B) \wedge horse(B)),$

Facts:

$(horse(dakotta), w_1), (horse(cheyenne), w_2),$

$(horse(aida), w_3), (parent(star, aida), w_4), (parent(star, cheyenne), w_5),$

$(sibling(star, dakotta), w_6)$



# Embedding Layer

Embedding declaration:

$$w_1^{(0)} : \text{type}_1(T) \leftarrow \text{team}(T, \text{arsenal})$$

$$w_2^{(0)} : \text{type}_2(T) \leftarrow \text{team}(T, \text{arsenal})$$

$$w_3^{(0)} : \text{type}_3(T) \leftarrow \text{team}(T, \text{arsenal})$$

...

$$w_j^{(0)} : \text{type}_3(T) \leftarrow \text{team}(T, \text{everton})$$

Predictive rules:

$$w_{(1;1)}^{(1)} : \text{outcome} \leftarrow \text{home}(T1) \wedge \text{type}_1(T1) \wedge \text{away}(T2) \wedge \text{type}_1(T2).$$

$$w_{(1;2)}^{(1)} : \text{outcome} \leftarrow \text{home}(T1) \wedge \text{type}_1(T1) \wedge \text{away}(T2) \wedge \text{type}_2(T2).$$

...

$$w_{(3;3)}^{(1)} : \text{outcome} \leftarrow \text{home}(T1) \wedge \text{type}_3(T1) \wedge \text{away}(T2) \wedge \text{type}_3(T2).$$

# Relational Extension

Extension:

$$w_1^{(2)} : \textit{outcome}(M, H, A) \leftarrow \textit{win}(M, H, A)$$

$$w_2^{(2)} : \textit{outcome}(M, H, A) \leftarrow \textit{draw}(M, H, A)$$

$$w_3^{(2)} : \textit{outcome}(M, H, A) \leftarrow \textit{loss}(M, H, A)$$

Predictive rules:

$$w_{h-h(1;1)}^{(1)} : \textit{outcome} \leftarrow \textit{home}(T1) \wedge \textit{type}_1(T1) \wedge \textit{outcome}(M, T1, T2) \wedge \textit{type}_1(T2).$$

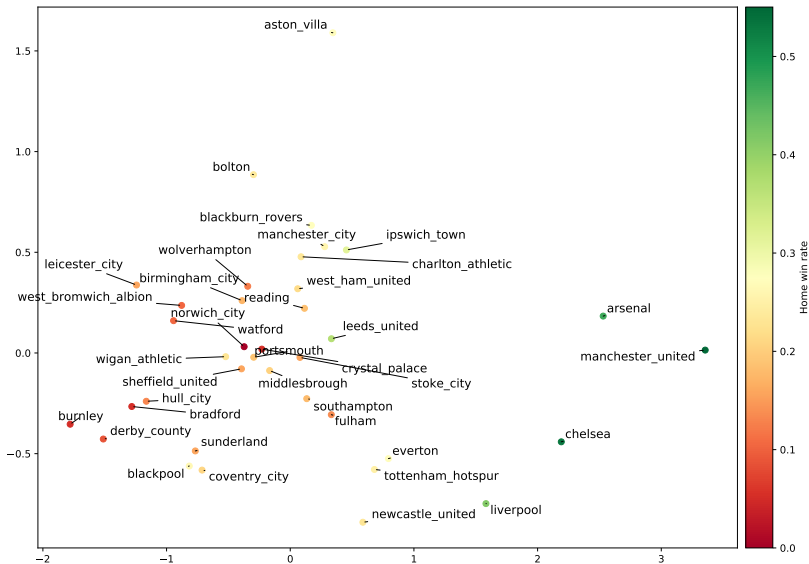
$$w_{h-a(1;1)}^{(1)} : \textit{outcome} \leftarrow \textit{home}(T1) \wedge \textit{type}_1(T1) \wedge \textit{outcome}(M, T2, T1) \wedge \textit{type}_1(T2).$$

$$w_{h-h(1;2)}^{(1)} : \textit{outcome} \leftarrow \textit{home}(T1) \wedge \textit{type}_1(T1) \wedge \textit{outcome}(M, T1, T2) \wedge \textit{type}_2(T2).$$

...

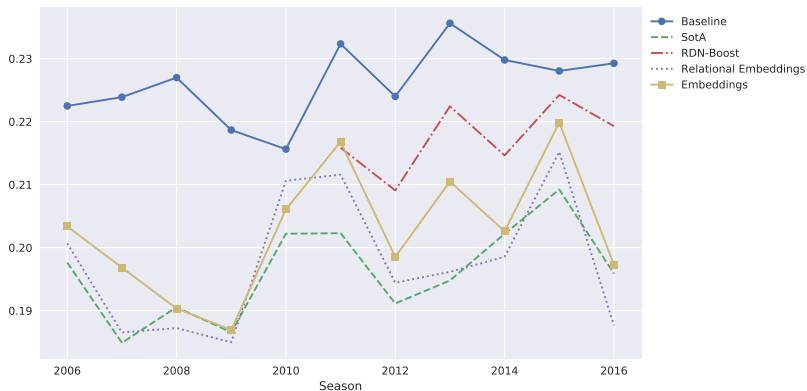
$$w_{a-a(3;3)}^{(1)} : \textit{outcome} \leftarrow \textit{away}(T1) \wedge \textit{type}_3(T1) \wedge \textit{outcome}(M, T2, T1) \wedge \textit{type}_3(T2).$$

# Embeddings





# Comparison with SotA



**Figure:** Comparison of performance of the learners on English Premier League as measured by the RPS metric (lower is better).

# Conclusion

- promising preliminary results
- easily applicable to different sports
- extensible with more information (goals scored, match recency, ...)
- natural incorporation of domain knowledge

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Thank you for your attention.