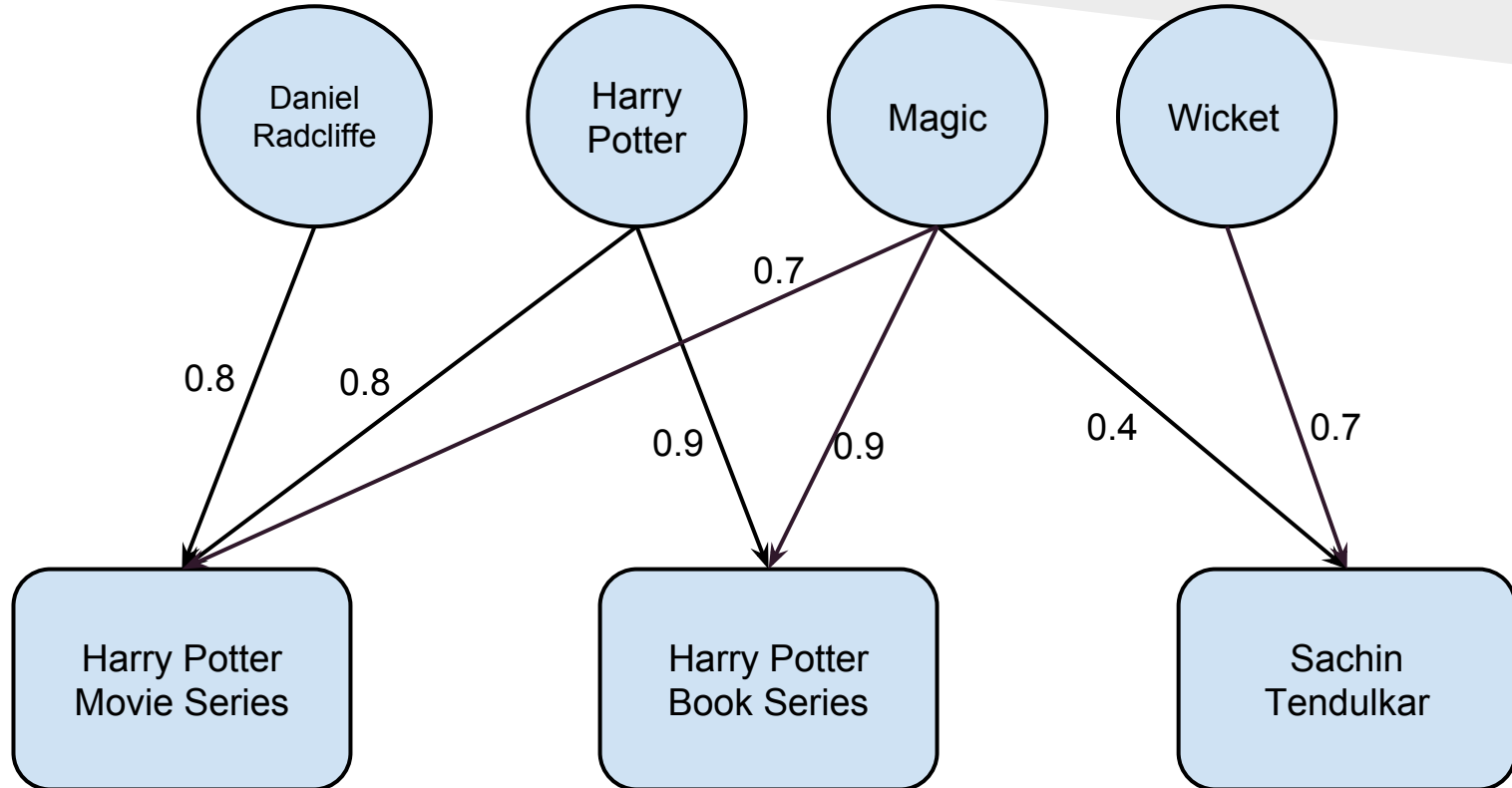


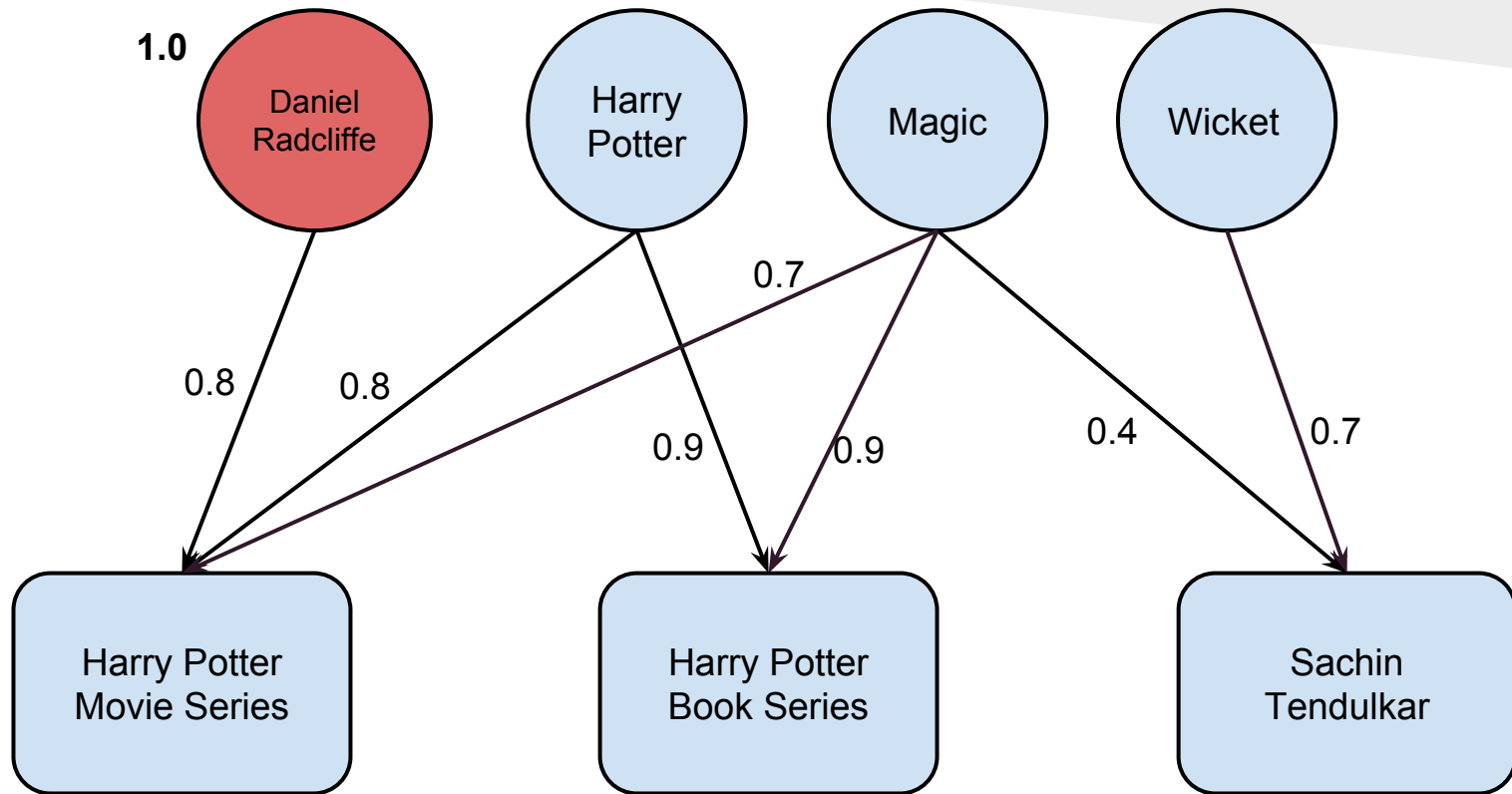
CRNs with Reverse Edges

Pallavi Gudipati
Amal Joy

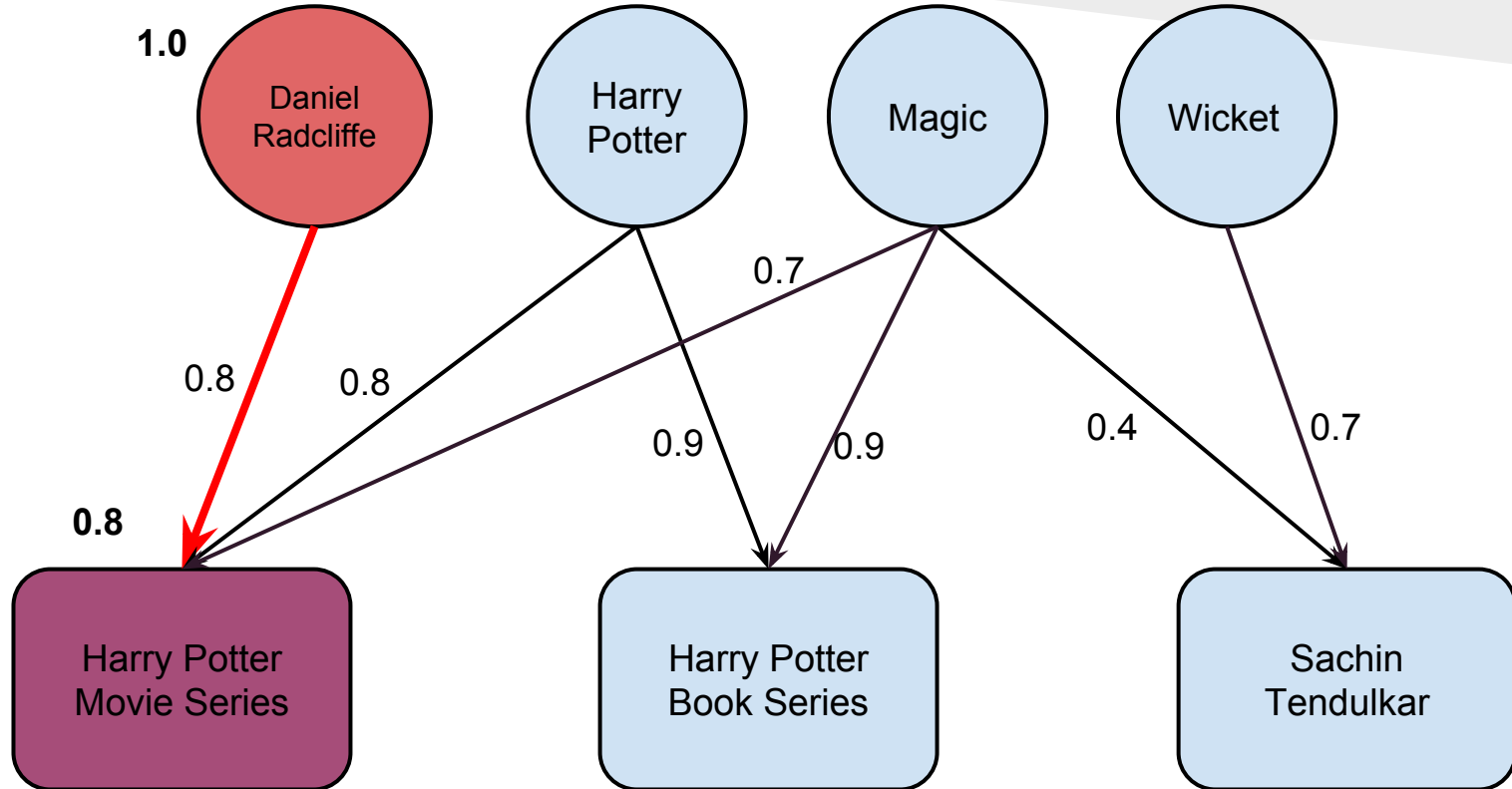
Reverse Edges - Motivation



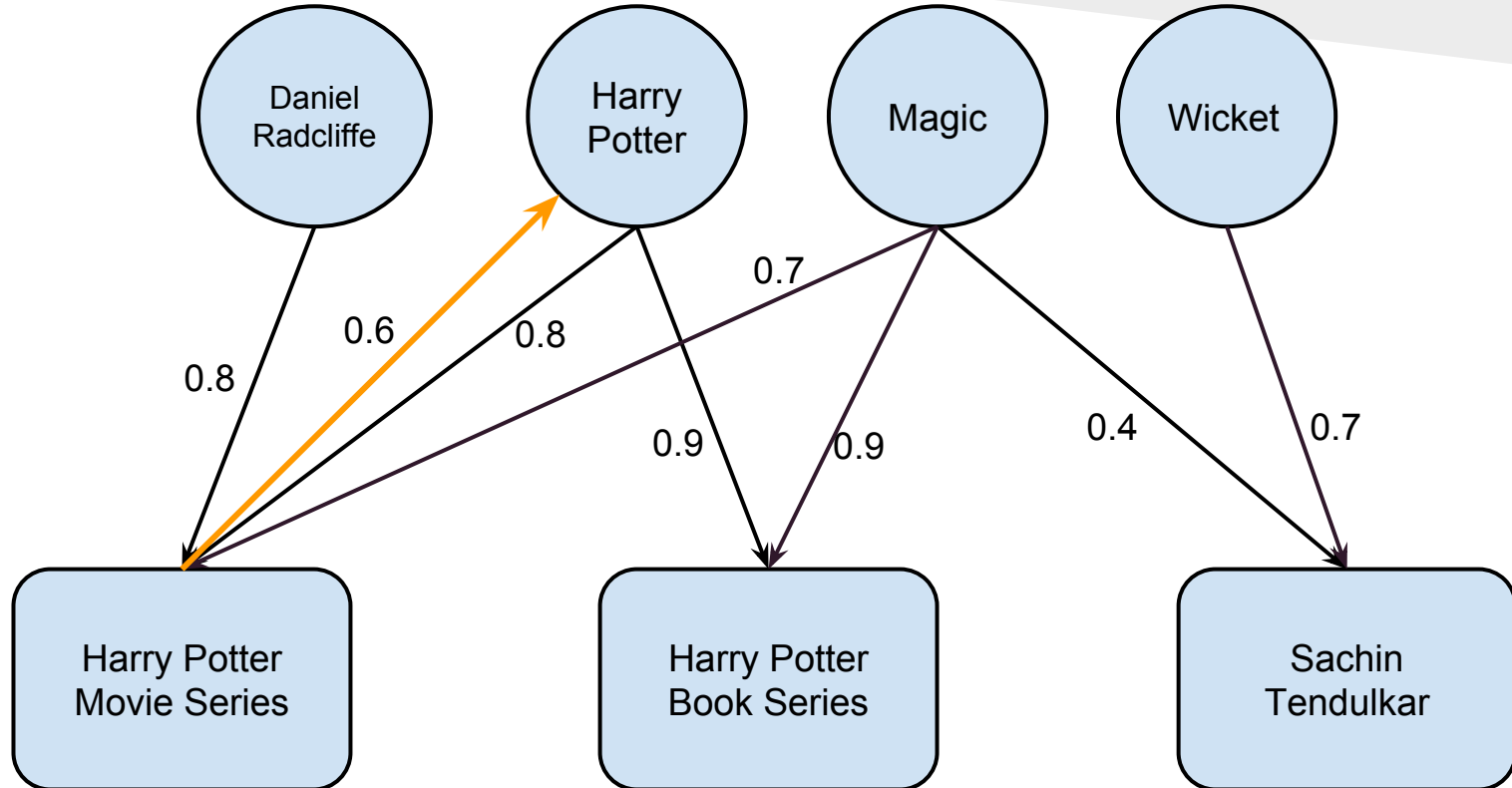
Reverse Edges - Motivation



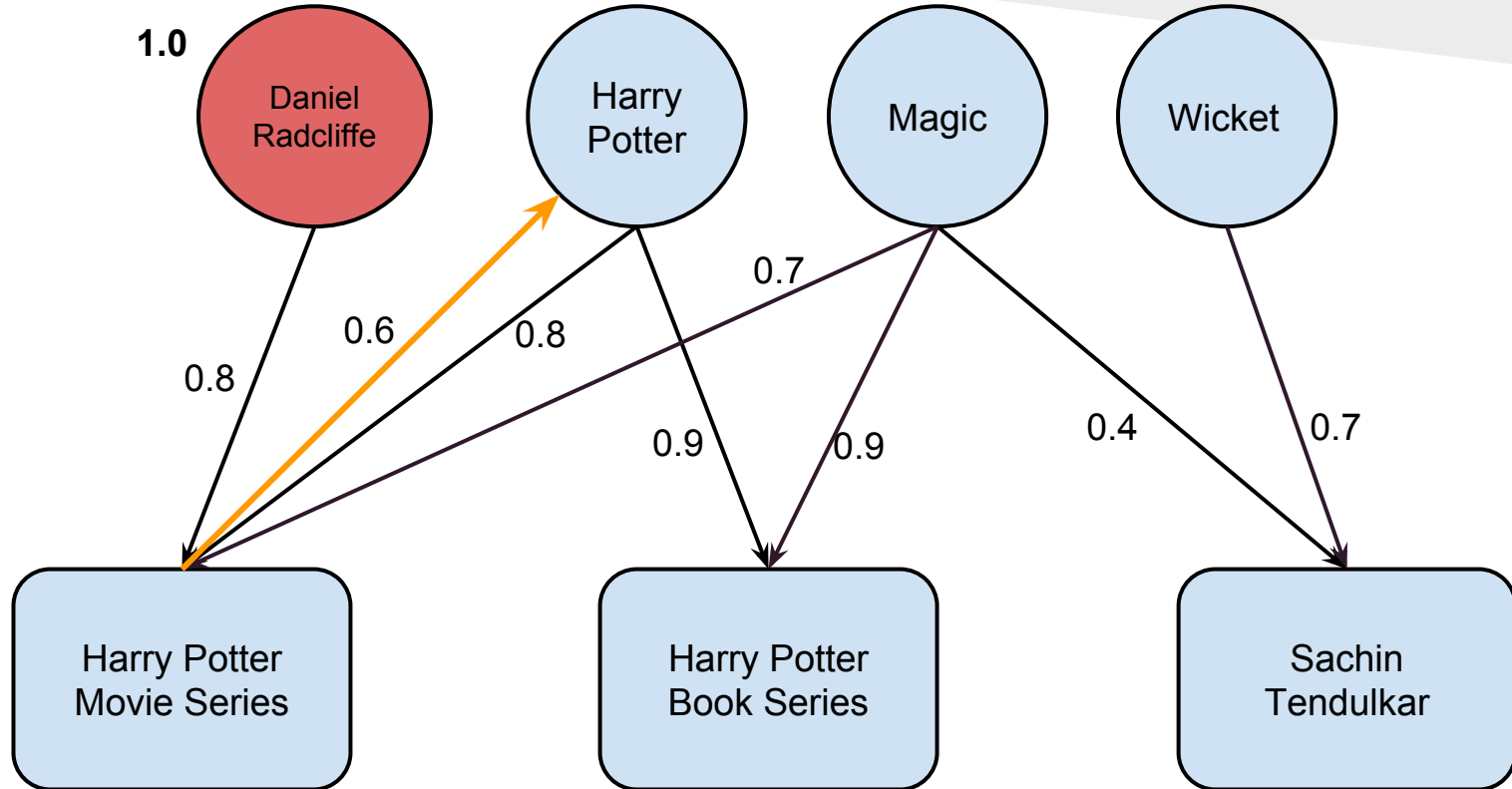
Reverse Edges - Motivation



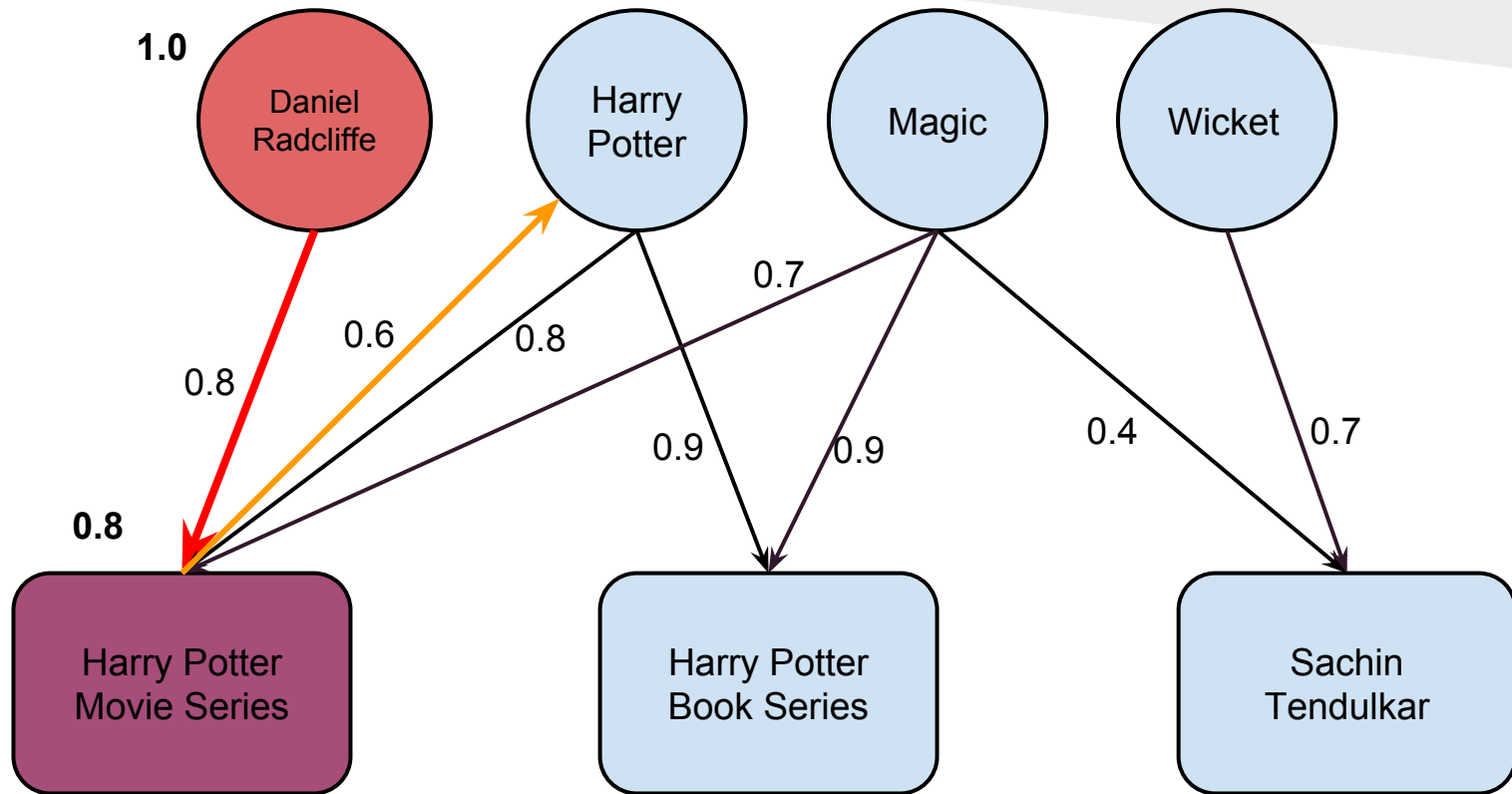
Reverse Edges - Motivation



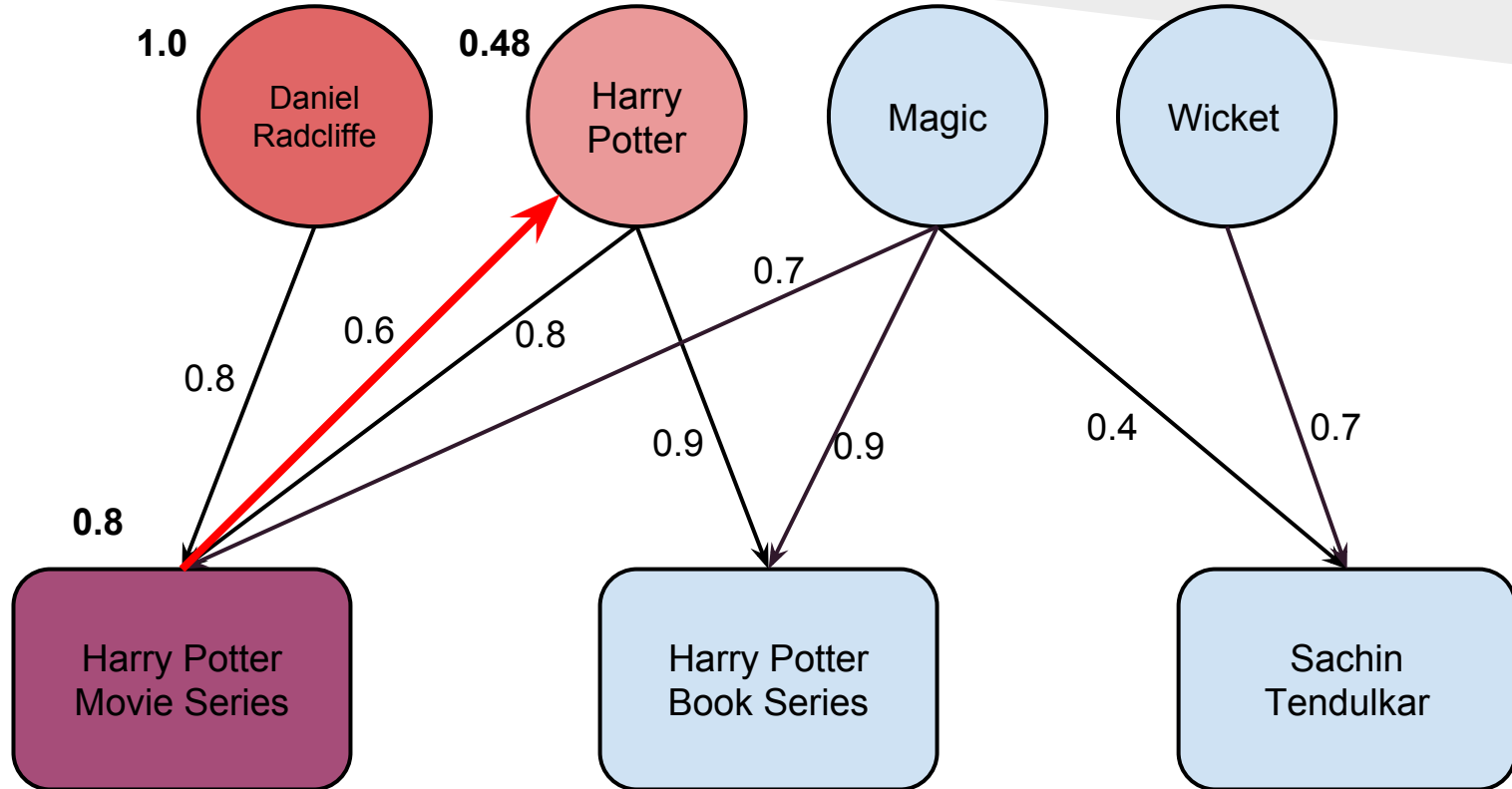
Reverse Edges - Motivation



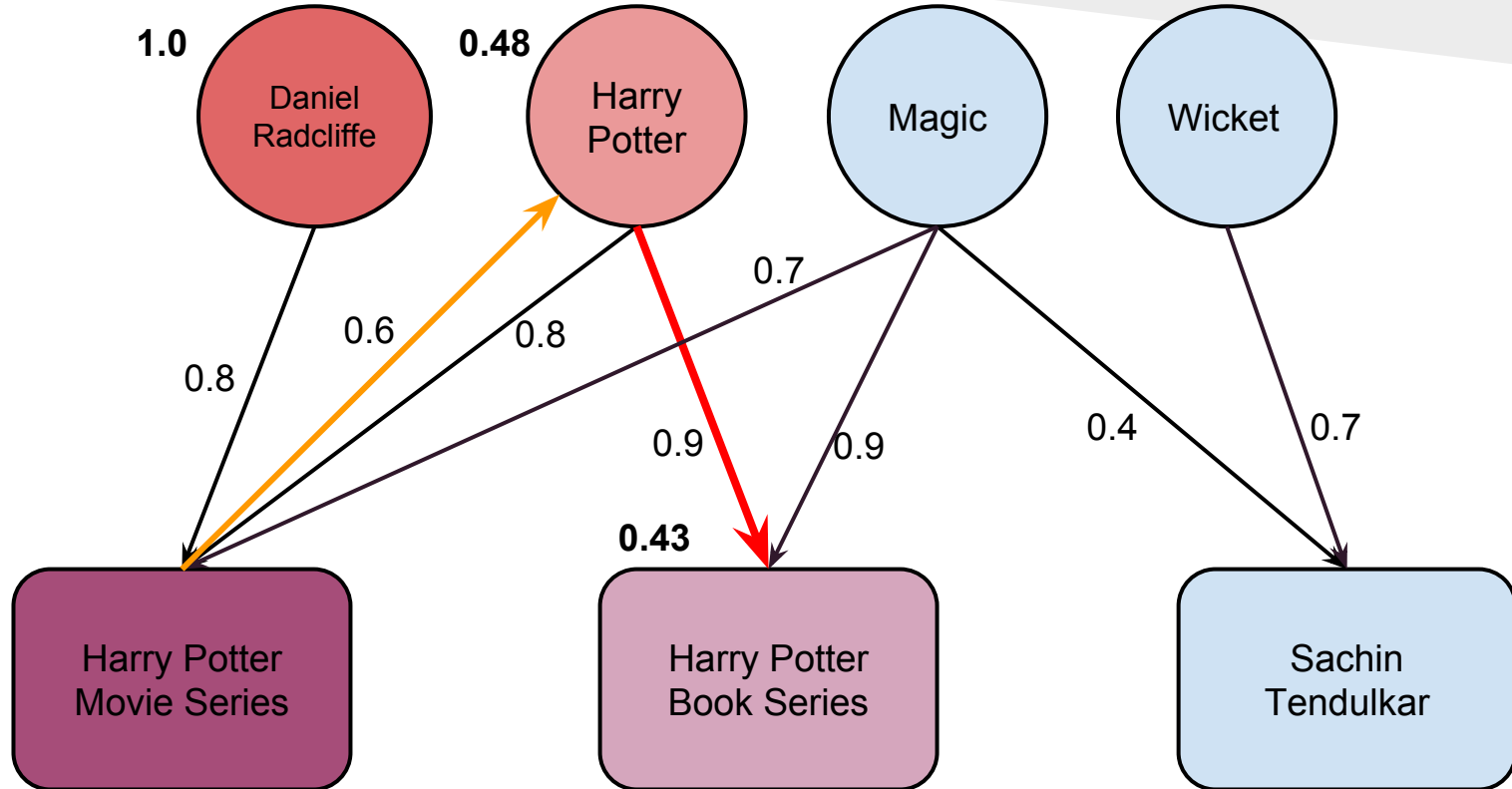
Reverse Edges - Motivation



Reverse Edges - Motivation



Reverse Edges - Motivation



Datasets: Text Domain

- 20 Newsgroups Dataset: 20,000 newsgroup documents, partitioned evenly across 20 different newsgroups.
- Lemmatization and Stop word removal
- Dataset: Religion and Atheism
- Case base: 1800 documents. Test: 200 documents
- Budget: 11 documents

Datasets: Image Domain

- Ground Truth Database of University of Washington's Object and Concept Recognition for Content-Based Image Retrieval project.
- Extracted the R, G and B components from the images and divided each component into 32 bins.
- Dataset: Cherries and Green Lake
- Case base: 80 documents. Test: 20 documents
- Budget: 11 documents

Relevance and Similarity

- Relevance:

$$\begin{aligned} rel(word, doc) &= 1, \text{ if word occurs in doc} \\ &= 0, \text{ otherwise} \end{aligned}$$

- Similarity: No entity-entity edges
- Propagation: $act(doc) = \sum (rel(word, doc) \times act(word))$

Relevance and Similarity

- Initial Activation:

$$\begin{aligned} \text{act}(\text{word}) &= 1, \text{ if word occurs in query doc} \\ &= 0, \text{ otherwise} \end{aligned}$$

- Reverse Relevance:

$$\begin{aligned} \text{revRel}(\text{doc}, \text{word}) &= 1, \text{ if word occurs in doc} \\ &= 0, \text{ otherwise} \end{aligned}$$

Basic Spreading

- 2-step activation spreading process
- 1: Initial Activation 2: Entities -> Cases

	Accuracy
Religion	1.0
Hardware	0.89

Simple Reverse Spreading

- A case activates an entity only if it was inactive before

$$act(word) \leq 1.0$$

- 4-step activation spreading process
- 1: Initial Activation 2: Entities -> Cases
- 3: Cases -> Entities 4: Entities -> Cases

Thresholded Reverse Spreading

A reverse edge propagates activation only if the activation of the case node is above a threshold

$$\textit{Threshold} = y \times \textit{Number of words in test document}$$

$$y \leq 1$$

Cumulative Reverse Spreading

- Adds to the Thresholded Reverse Spreading model
- The activation of an entity is not upper bounded
- A case adds to the activation of an entity using reverse edges

Discounted Reverse Spreading

- Adds to the Cumulative Reverse Spreading model
- Assumes that the activation due to a reverse edge should be less effective than the initial activation
- Reverse Relevance:

$$\begin{aligned} revRel(doc, word) &= \lambda, \text{ if word occurs in doc } (\lambda \leq 1) \\ &= 0, \text{ otherwise} \end{aligned}$$

Multi-step Reverse Spreading

- Steps 2: Entities \rightarrow Cases and **3: Cases \rightarrow Entities** are repeated multiple times
- λ changes after each phase of Cases \rightarrow Entities propagation

$$\lambda_{t+1} = \lambda_t^2$$

- The process terminates when $\lambda_t < \varepsilon$

Cardinality Thresholded Reverse Spreading

- Extension of Thresholded Reverse Spreading.
- Fan-out constraint on IEs and Cases.
- Constraint on IEs: c_1
- Constraint on Cases: c_2

Variables	Religion	Atheism
$y = 0.3, \lambda = 0.5, c_1 = 400, c_2 = 50$	0.75	0.85
$y = 0.3, \lambda = 0.5, c_1 = 400, c_2 = 52$	0.72	0.87
$y = 0.3, \lambda = 0.5, c_1 = 400, c_2 = 55$	0.71	0.86

Results: Text Domain

	Variables	Religion	Atheism
BS	-	0.64	0.86
SR	-	0.02	1.0
TSR	$\gamma = 0.3$	0.64	0.87
CR	$\gamma = 0.3$	0.64	0.87
DR	$\gamma = 0.3, \lambda = 0.5$	0.64	0.87
MSR	$\gamma = 0.3, \lambda = 0.5, \varepsilon = 0.2, 0.05$	0.64	0.87
CTR	$\gamma = 0.3, \lambda = 0.5, c_1 = 400, c_2 = 50$	0.75	0.85

Results: Image Domain

	Variables	Cherries	Green Lake
BS	-	0.9	0.4
SR	-	1.0	0.0
TSR	$\gamma = 0.5$	0.9	0.4
CR	$\gamma = 0.5$	0.9	0.4
DR	$\gamma = 0.5, \lambda = 0.6$	0.9	0.4
MSR	$\gamma = 0.5, \lambda = 0.6, \varepsilon = 0.2, 0.05$	0.9	0.4
CTR	$\gamma = 0.3, \lambda = 0.5, c_1 = 50, c_2 = 60$	1.0	0.4

Future Work

- Include more domain specific elements like term frequency and inverse document frequency
- Study in the presence of IE \rightarrow IE and Case \rightarrow Case edges.
- Different tasks like case completion.

References

Mario Lenz and Hans-Dieter Burkhard. 1996. Case Retrieval Nets: Basic Ideas and Extensions.

Sutanu Chakraborti, Robert Lothian, Nirmalie Wiratunga, Amandine Orecchioni, and Stuart Watt. 2006. Fast case retrieval nets for textual data.

M. Guillaumin, T. Mensink, J. Verbeek, and C. Schmid. 2009. Tagprop: Discriminative Metric Learning in Nearest Neighbor Models for Image Auto-Annotation.

M. Lenz and H.-D. Burkhard. 1996. Case retrieval nets: Foundations, properties, implementation, and results.