Structuring Lectures in Massive Open Online Courses (MOOCs) for Efficient Learning by Linking Similar Sections and Predicting Prerequisites

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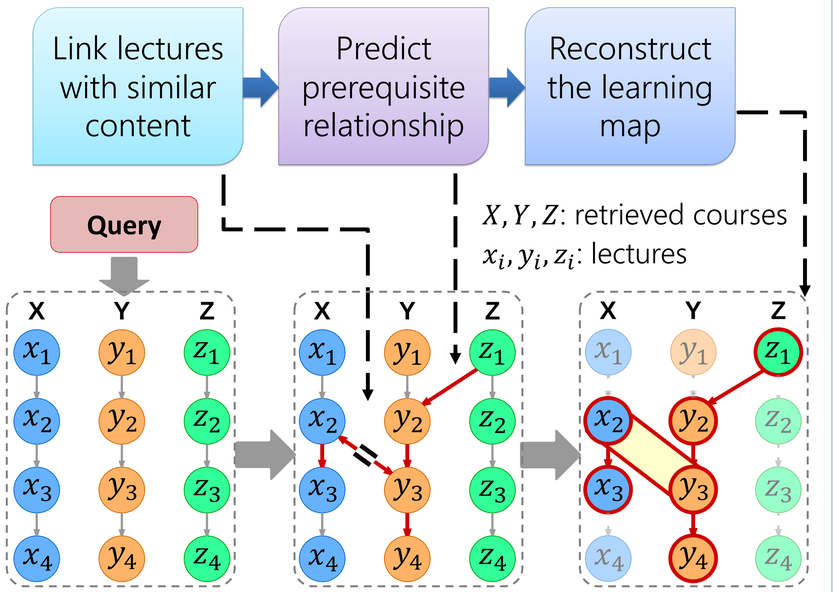
1. Introduction

■ Task: Structuring lectures in MOOCs.



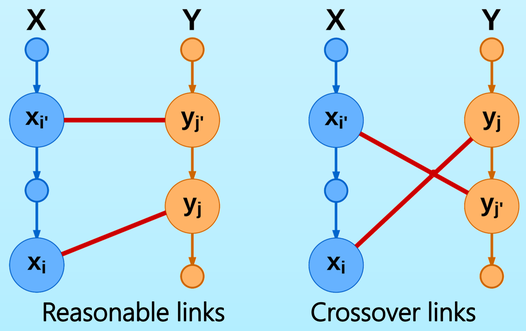
2. Proposed Approach

■ Linking Lectures with Similar Content

• Individual Pair Similarity
1. Calculate cosine similarity for x_i, y_i
2. Feature vectors:
   – Tf-idf for all words / key terms only
   – topic vectors by latent topic analysis
   – grammatical rule vector from parsing tree of lecture title

• Global Structure Considerations

Crossover may imply reversed order or something wrong



• Maximize the objective function

$$F(L) = \sum_{(x_i,y_i)\in L} S(x_i, y_i) - \lambda_1 C(L) - \lambda_2 |L|$$

Crossover constraint

Not including too many links

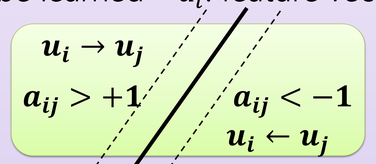
L: set of link relationships

■ Prerequisite Prediction

• SVM Classification
1. Difference vector: $a_{ij} = M \cdot (u_i - u_j)$
2. Cross-term Matrix: $a_{ij} = u_i^T M u_j$

a_{ij}: prerequisite relationships (+1 or -1)

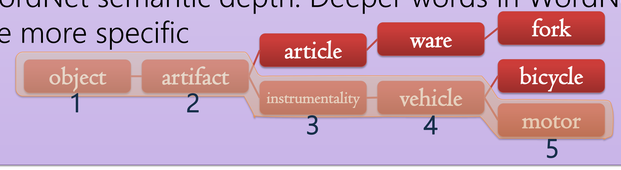
M: to be learned u_i: feature vector for lectures



• Feature Vector Representation

key terms $W = \{w_1, w_2, \cdots, w_n\}$ for courses
1. Bag-of-word (BOW) : $u = \{tf(w_k), k = 1,2,\dots,n\}$
2. Weighted BOW : $u = \{s(w_k)tf(w_k), k = 1,2,\dots,n\}$, $s(w_i)$: semantic weight
3. Word embedding : $u = \frac{1}{N}\sum s(w_k)tf(w_k)v_k$, v_i: Mikolov's $word2vec$ representation

• Semantic Weights for Keywords
1. Late occurrence ratio: Words introduced later are more specific
2. WordNet semantic depth: Deeper words in WordNet are more specific



3. Experiments

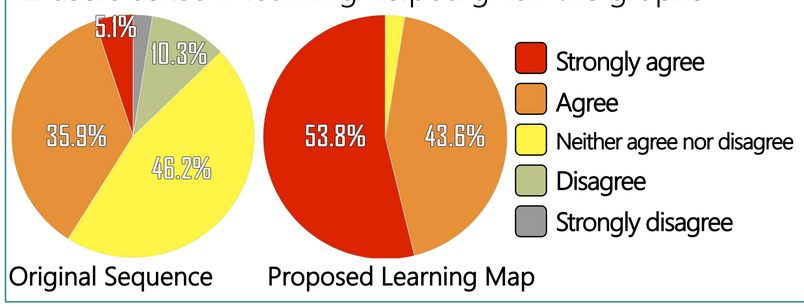
■ Data set from Coursera

NLP 1,2 : 121, 101 lectures Chemistry 1,2 : 132, 72 lectures

■ Testing setup
- Two-fold cross validation
- Linking : human labeled answer
- Prerequisite : assume sequence order correct in courses train on course 1, test on course 2, etc.

■ User Study

12 users asked if learning helped given the graphs



Linking Lectures			Precision	Recall	F-measure
Individual	Audio Transcripts	(a) Tfidf - all	13.8	24.6	17.3
		(b) Tfidf – key	33.8	26.5	28.8
		(c) Topics	48.9	30.2	37.2
	Lecture Title	(d) Tfidf – all	52.7	20.7	29.7
		(e) Parsing	56.5	18.9	27.9
	(a)+(b)+(c)+(d)+(e)		42.9	52.7	47.2
(a)+(b)+(c)+(d)+(e)+Global			53.6	54.6	54.1

5 features+global the best

Prerequisite Prediction			NLP	Chemistry
Differ	(a) Bag-of-word (BOW)		68.1	61.4
	Weighted BOW	(b) Late-occur	65.5	62.8
		(c) WordNet	70.0	63.3
	Word Embedding	(d) Late-occur	69.5	64.8
		(e) WordNet	73.3	65.2
Cross	Word Embedding	(f) Late-occur	69.4	66.6
		(g) WordNet	76.1	67.0

word embedding+wordnet depth the best

4. Conclusions

Approaches for structuring lectures in MOOCs for efficient learning proposed by linking similar sections and predicting prerequisites