Exploring Concept Representations for Concept Drift Detection

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Can we detect changes in concepts over time from an annotated collection of articles?

Types of Concept Drift

Concept Drift as:

- Change in the intention of the concept, defined as the definition or the properties of the concept
- Change in the extension, or the instances, of a concept
- Change in the label of the concept.

Referring to changing Concepts can be Problematic

- Concepts in a KOS are used
  - for annotations (eg. meta data in library)
  - for background knowledge (eg. reasoning)

→ Interoperability between datasets & enable structured access

- Compromised if concepts change (drift)
- Problems after drift:
  - Correspondences between two concepts in different KOS may be incorrect in extension of one changes
  - User keyword query on historic corpus may be interpreted incorrectly if prevalent label to refer to a concept has changed

Aim at first concept change capture & evaluation

- Understand how concepts can be effectively represented to capture change
- Co-occurrence based:
  - Two concepts co-occur if they are annotations of the same document
  - Compare Concept representations at different points in time
- Qualitative evaluation based on visualization
- Quantitative evaluation based on Wikipedia edits

The ION Dataset

Hollink et al., A corpus of images and text in online news, 2016

What is a Concept?

Our practical definition:

- Each unique wikipedia annotation of a newspaper article

- Representation: Vector of co-occurrences with other concepts

General Approach

Qualitative exploration phase

Exploring concepts	Find representation and measurement	Comparing concepts at different points in time	Visualize concepts	Evaluation
	Reducing sparsity	Normalize infrequent reporting	Qualititative comparison	
	IDF weighting	Cosine Vector comparison		

Example: Concept Vector

	wiki/Bill_Clinton	wiki/Democratic	wiki/Chicago	wiki/Election	wiki/Foreign_Politics	wiki/Basketball
wiki/Hillary_Clinton	7	3	5	8	1	0

http://en.wikipedia.org/wiki/

Example: Temporal Concept Vectors with 3 bins

wiki/Hillary_Clinton

	wiki/Bill_Clinton	wiki/Democratic	wiki/Chicago	wiki/Election	wiki/Foreign_Politics	wiki/Basketball	
Aug - Dec	7	3	5	8	1	0	→ Cosine Sim 0.893
Jan - April	5	3	4	9	4	0	→ Cosine Sim 0.672
May - July	1	9	9	1	7	2	

http://en.wikipedia.org/wiki/

Example: Flexible Time Bins with 3 bins

	wiki/Bill_Clinton	wiki/Democratic	wiki/Chicago	wiki/Election	wiki/Foreign_Politics	wiki/Basketball
Aug - Sept	7	3	5	8	1	0
Sept - May	7	3	4	9	2	0
June - July	1	9	9	1	8	2

wiki/Hillary_Clinton

Cosine Sim 0.953

Cosine Sim 0.472

http://en.wikipedia.org/wiki/

Concept: Death_of_Eric_Garner

Core of the concept:

weighted co-occurences
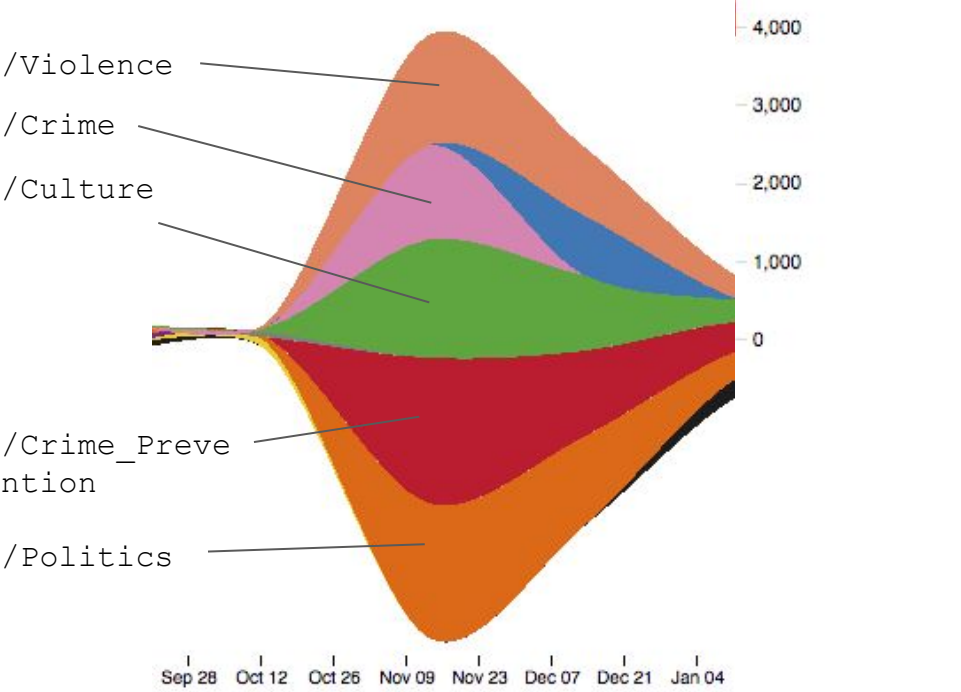
New context of the concept:

/Violence

/Crime

/Culture

/Crime_Prevention

/Politics

/Funeral

/Local_Gov

/Films

/Patrolment_NY

/Killing_of_NYPD_Officers
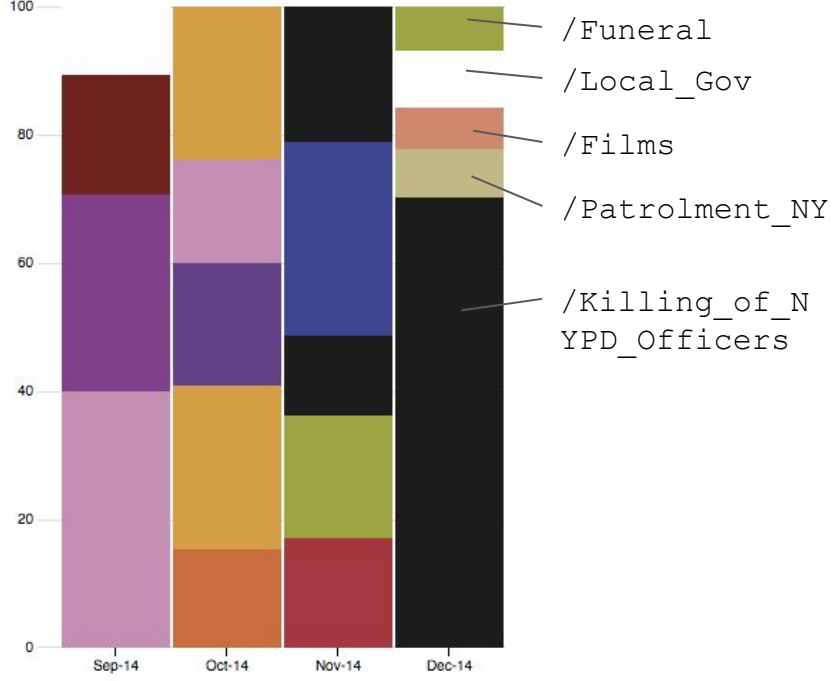
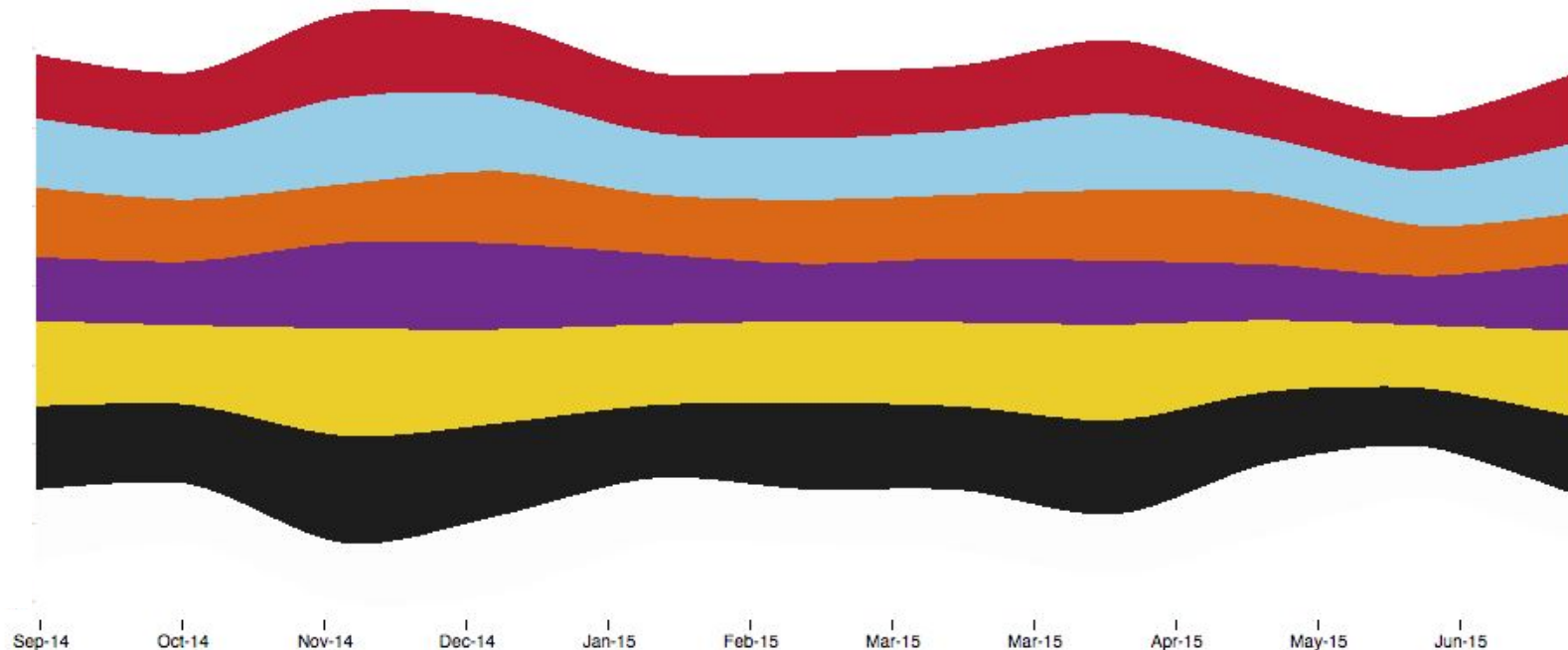# Qualitative evaluation based on cosine similarities

- Visualization based
- Based on streamgraph

Selecting concepts to evaluation by:

- Average cosine similarities for each concept

  → Each concept has one averaged change score

  → Pick concepts with highest averaged score and lowest average score

Highest Averaged Cosine Similarity (WP:Police)

Lowest Averaged Cosines Similarities (WP:New_York_University)

Sep-14   Oct-14   Nov-14   Dec-14   Jan-15   Feb-15   Mar-15   Mar-15   Apr-15   May-15   Jun-15
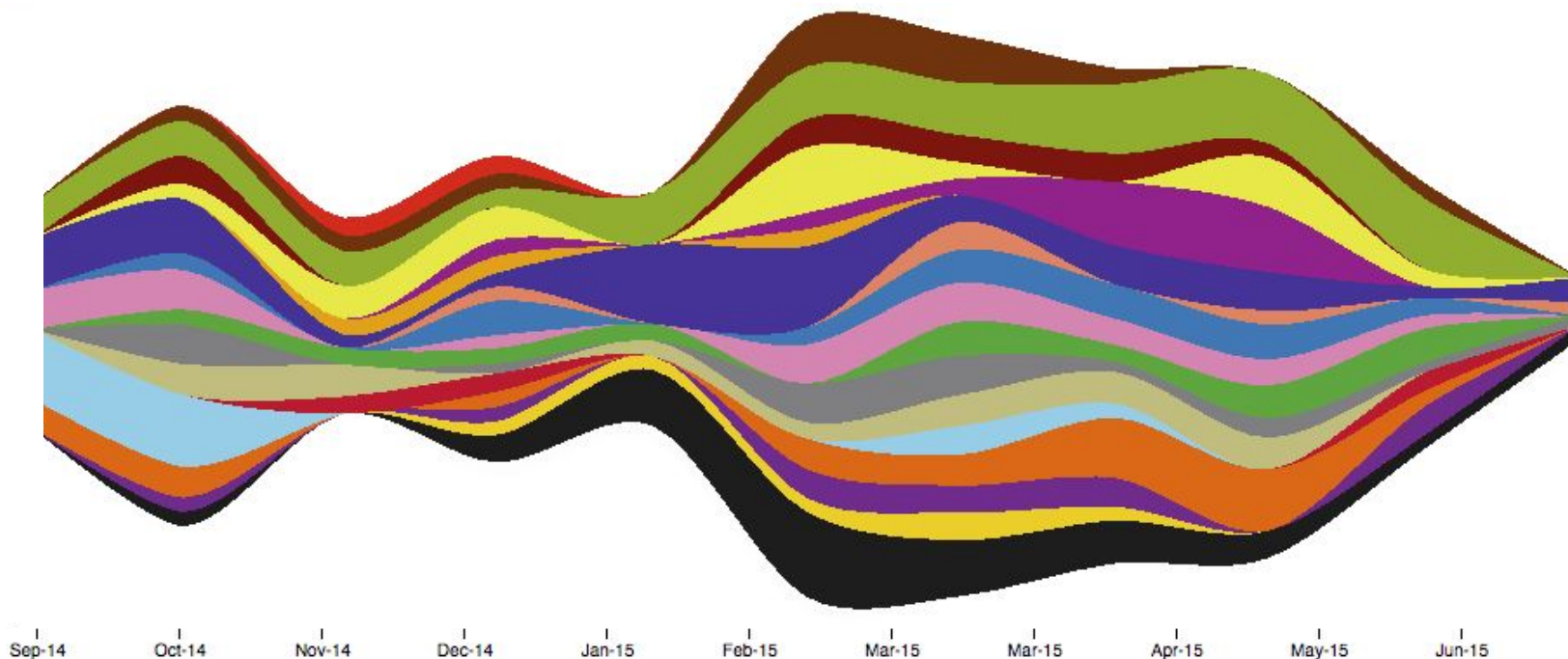
Quantitative Evaluation

How to Evaluate with no Truth

- No datasets available for concept change
- What's a good reference point?

→ Assumption: When a concept is changing, someone will change the wikipedia page

Towards a Quantitative Evaluation

- Retrieval of Wikipedia Edits for each concept
- Create Counts of edits, matching to time frames of temporal concept vectors
- Compare vectors of edit counts to vectors of similarity scores
- Use spearman correlation

Towards a Quantitative Evaluation

- Different set ups to obtain similarity scores
    - Cosine Similarity / KL Divergence
    - Flexible Time bins / fixed time bins
    - TF-IDF / no TF-IDF
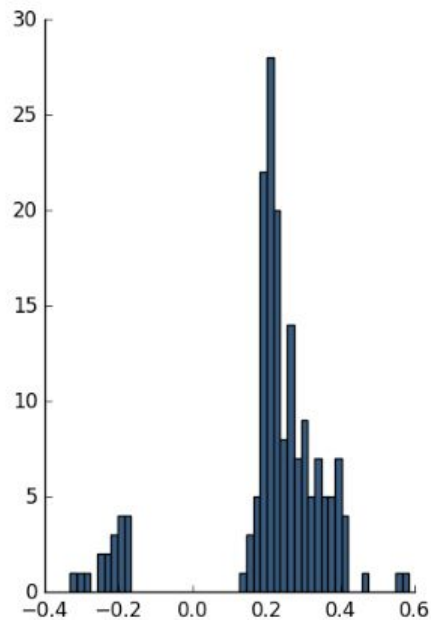   - 5 different amounts of bins (100, 52, 24, 12, 6)

Results

- Evaluated 964 concepts (stratified sample)

- Flexible time bins much better than fixed time bins
- KL Divergence better than Cosine similarity
- TF-IDF no effect
- Amount of bin needs to be sufficient (at least 24, 52 is better)

Histogram of Spearman correlations with different bin sizes
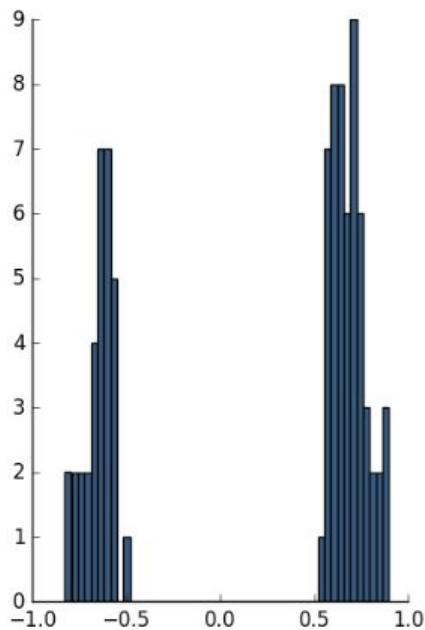
(a) *n*=12

(b) *n*=100

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Outlook

- Concept drift may take longer than 1 year
- Nonetheless, measureable differences
- Temporal representation valuable
- No perfect evaluation tool / gold truth available
- More research on which types of concepts correlate to WP edits to understand WP as evaluation tool
- Distinguish actual change and simple growth of WP article

Questions