Summarizing Contrastive Viewpoints in Opinionated Text

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Summarizing Contrastive Viewpoints

- 2010 U.S. Healthcare Legislation
  - 948 verbatim responses from Gallup opinion phone survey
  - 45% for, 48% against (March 2010)

For: "because a lot of people **can't afford it** [insurance]; 45,000 people **die** each year because of lack of healthcare."

Against: "everybody should have their own healthcare, and if you **can't afford it**, you should just **die**."

Different viewpoints

Same issue

Summarizing Contrastive Viewpoints

- Bitterlemons Corpus
  - Editorials about the Israel-Palestine conflict
  - Introduced by Lin et al. (2006)
  - 312 articles by Israeli authors, 282 articles by Palestinian authors

Palestinian: **The wall that Israel has been building in the Palestinian occupied territories** under the pretext of security, the wall that is being called the apartheid wall by the Palestinian side, has lately drawn a great deal of high-level attention.

Israeli: Thus **the Palestinian information campaign has succeeded in persuading the world that the fence is a "wall"**, even though only a few small segments out of hundreds of kilometers are configured as walls [...].

Standard Summarization

- Generate separate summaries for each viewpoint:

For the healthcare bill	Against the healthcare bill
• there are so many **people** who do not have healthcare and they are in **need** of it. • because i have poor insurance and i think it might **help** me. • because there are a lot of **people** out there that don't go to the doctors because they don't have enough money. • **need** as much as we can because we have so much sickness	• just don't think its going to work out well and will drive the **cost** of healthcare up. • it's too much **government**. • it's too **expensive**, it does not provide what it needs to be provided, and the **government** help with catastrophic illnesses. the people pay general routine illnesses. second, it is bankrupting the country.

- Output based on the *LexRank* algorithm (Erkan & Radev, 2004)

Contrastive Summarization (Macro Level)

- Make the viewpoint summaries more **comparable**:
  - No alignment of sentences in "macro" summary

For the healthcare bill	Against the healthcare bill
• i favor healthcare for who needs it, mostly old **people** who don't have healthcare. the **government** should **help** the **people** when they are old. they should have that kind of healthcare. • i just think something has to be done, the **price** of health is going up. • [i] pay for private insurance. • bring down **cost**.	• i think we can't be responsible for other **people's** healthcare. • doesn't address things that **need** to be done, addresses things that don't **need** to be done. • it's going to increase the **cost** to those insured. • i believe we can't afford it. • way too **expensive**, too intrusive, too much **government** control.

- Output based on our new *Comparative LexRank* algorithm

Contrastive Summarization (Micro Level)

- Explicitly align pairs of contrastive sentences in "micro" summary:

For the healthcare bill	Against the healthcare bill
the **government** already provides half of the healthcare dollars in the united states [...] [they] might as well spend their dollars smarter	**government** is too much involvement.
my **kids** are uninsured.	a lot of people will be getting it that should be getting it on their own, and my **kids** will be paying a lot of taxes.
so everybody would have it and **afford** it.	we cannot **afford** it.
...	...

- Output based on our new *Comparative LexRank* algorithm

Previous Work

- Kim and Zhai (2009)
  - Micro-contrastive summarization
  - Pairs of contradictory sentences
    - e.g., "the battery life is pretty good" vs "battery life sucks"
- Optimizes how well the summary represents the collection as well as the comparability of the sentences in each pair

Previous Work

- Lerman and McDonald (2009)
  - Macro-contrastive summarization
- Summaries are similar to own category but different from opposite category
  - e.g. product reviews for two different products; summarize what is unique to each product
- Minimize KL-divergence between model of a summary and its viewpoint, but maximize KL-divergence between summary and the opposite viewpoint

Our Complete System

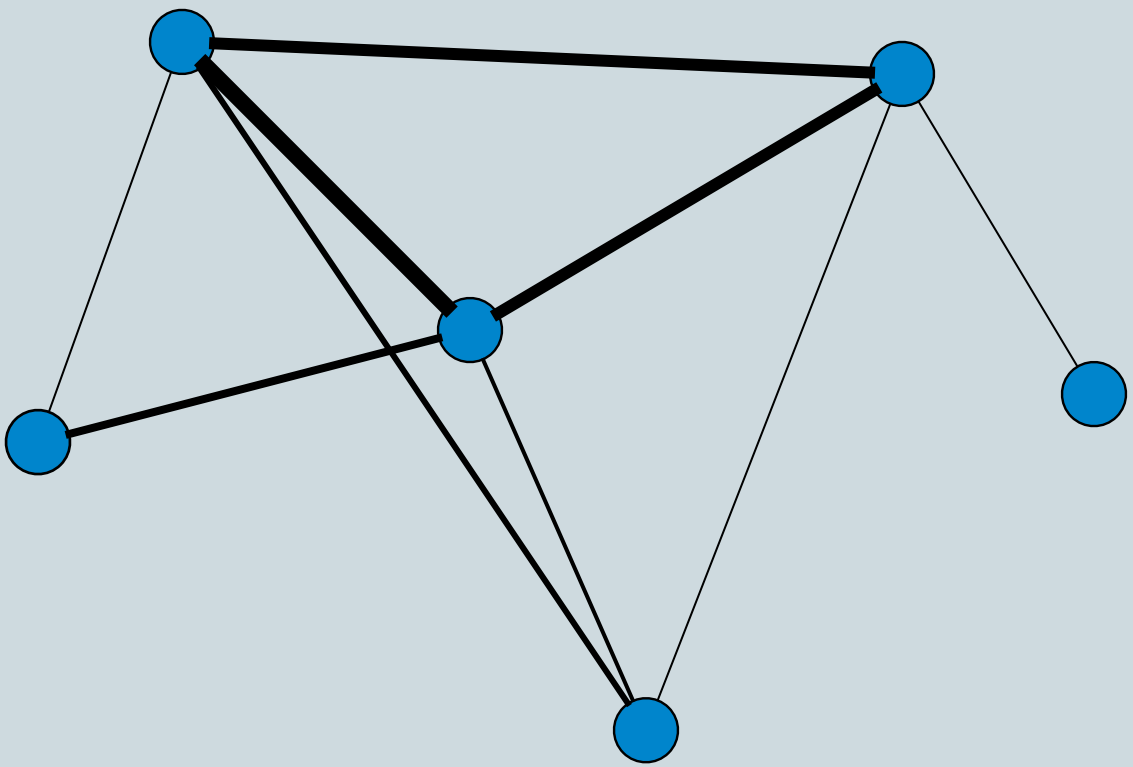
- Stage 1: Extract viewpoints automatically
  - **Unsupervised** modeling of viewpoints
- Stage 2: Summarize the extracted viewpoints
  - Summarize in a way to highlight **contrast**
  - We'll describe this stage first

Overview

- **Contrastive summarization algorithm**
  - Comparative LexRank; graph-based approach
- Summarization evaluation - Supervised
  - Healthcare corpus
- Viewpoint modeling and extraction
  - Unsupervised viewpoint clustering
- Summarization evaluation - Unsupervised
  - Bitterlemons corpus
- Conclusion

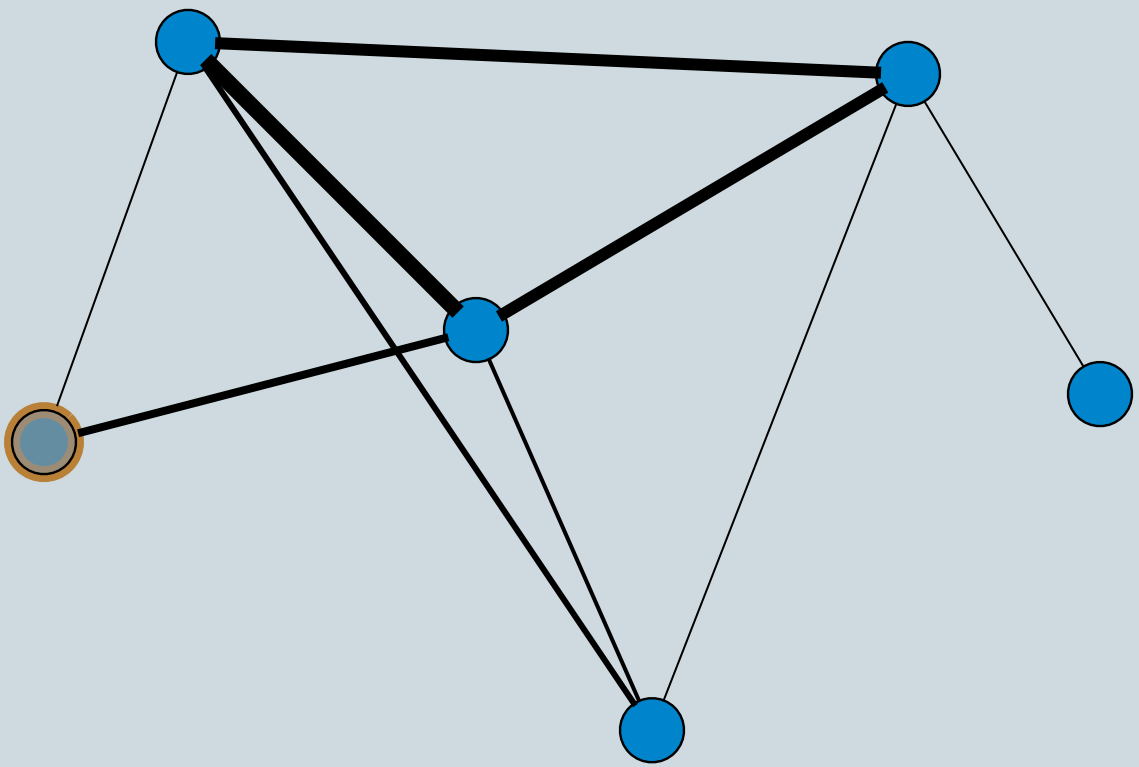
LexRank (Erkan & Radev, 2004)

Line thickness = edge weights = sentence similarity



LexRank (Erkan & Radev, 2004)

$$P(x_i \rightarrow x_j) = \frac{sim(x_i, x_j)}{\sum_{j' \in X} sim(x_i, x_{j'})}$$



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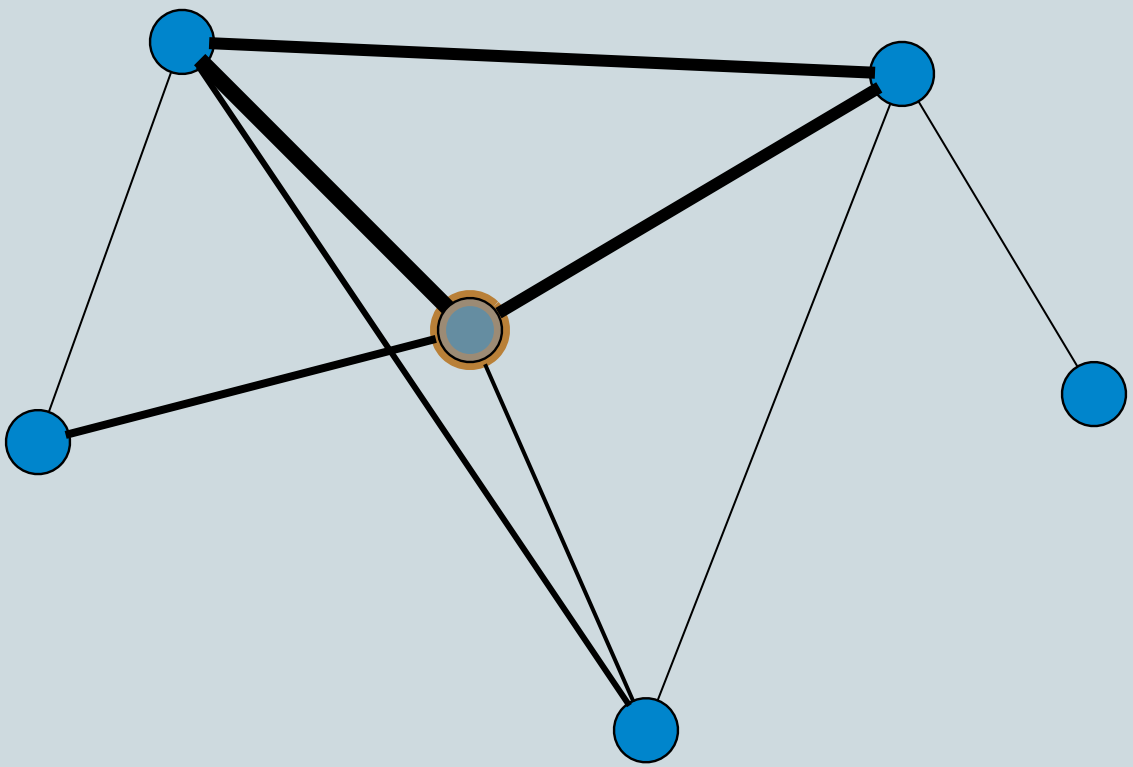

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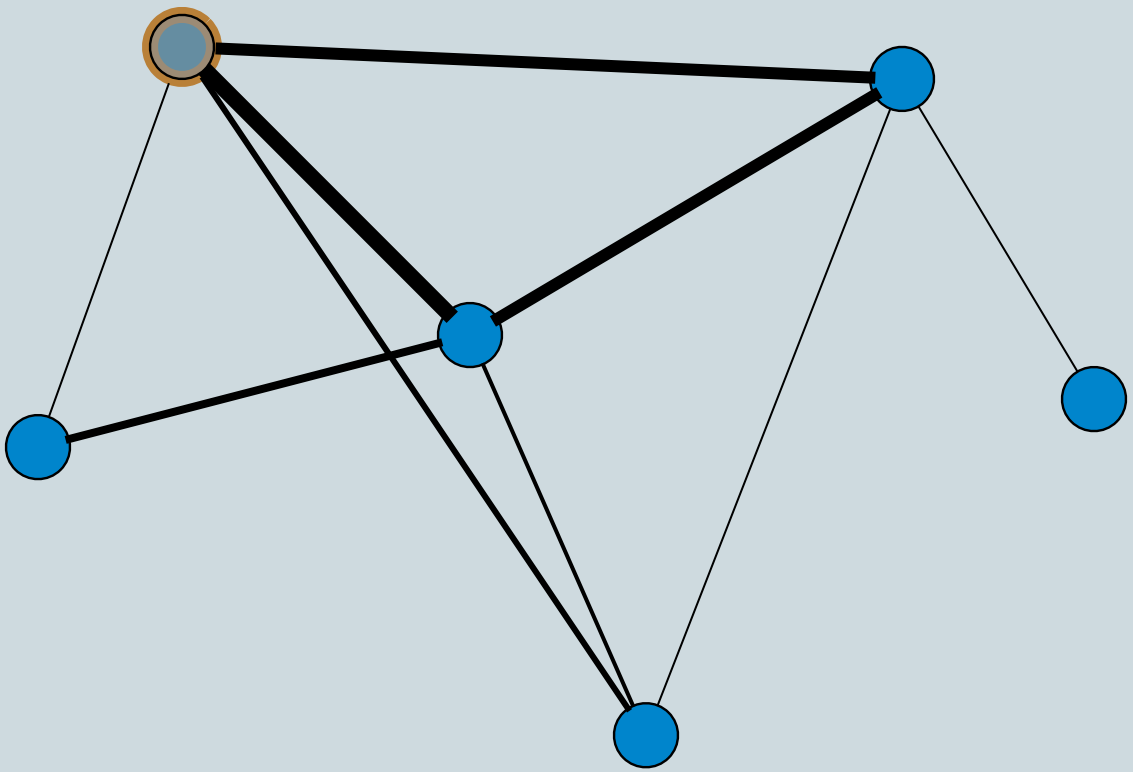

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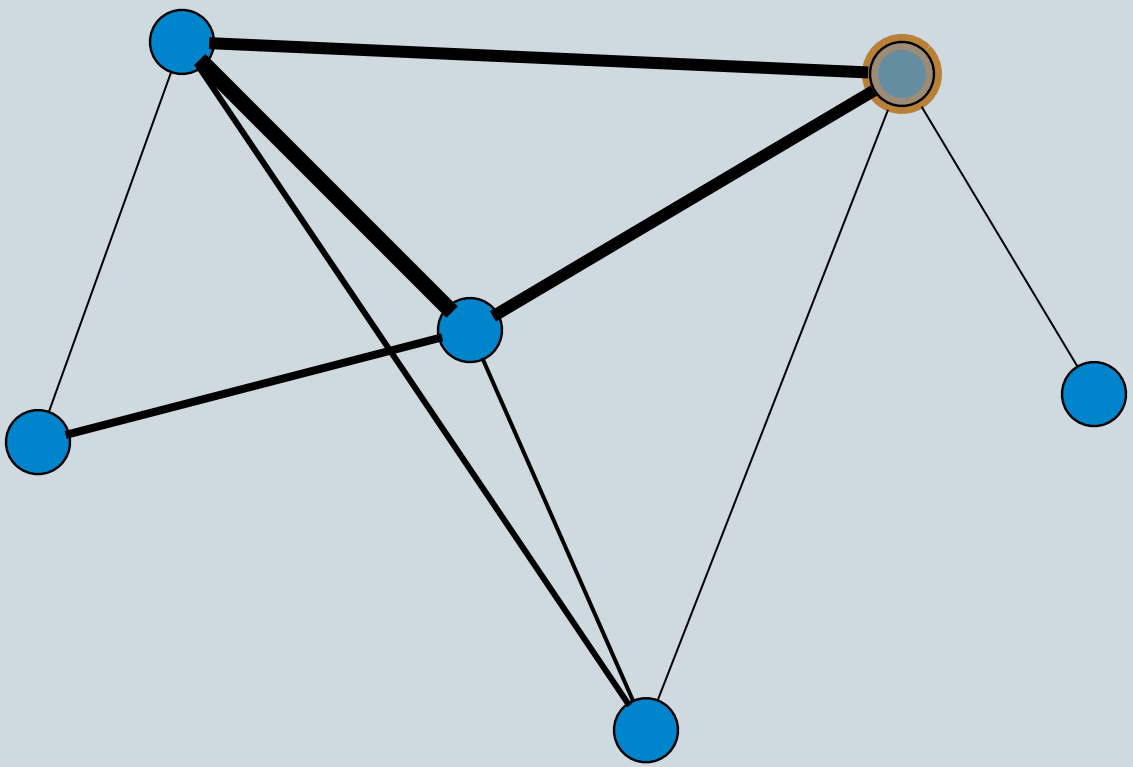

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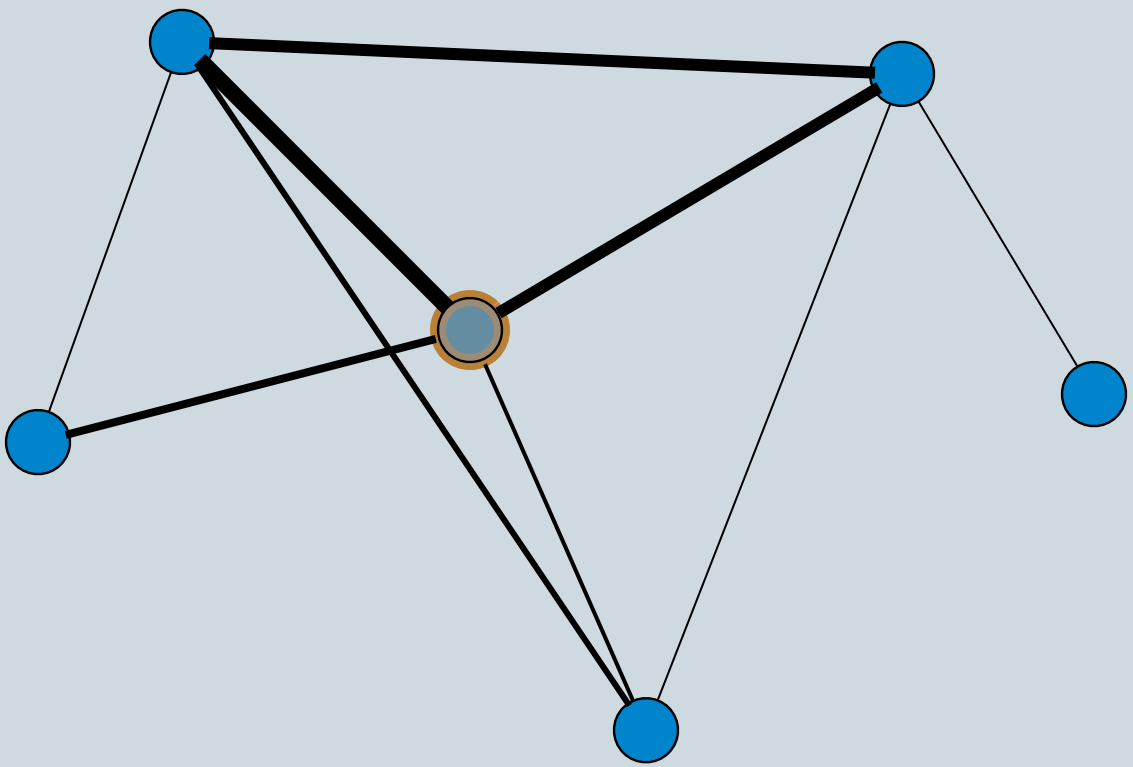
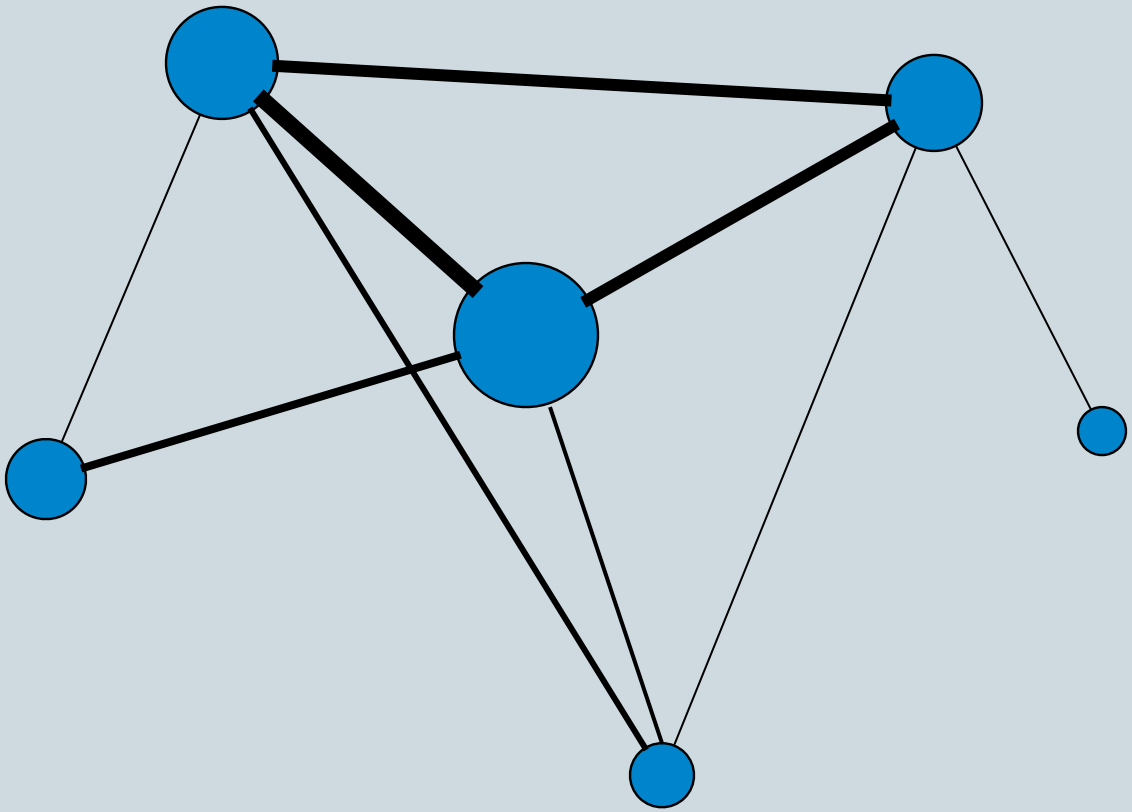


LexRank (Erkan & Radev, 2004)

This models content **centrality**; stationary distribution $P(X)$ over nodes gives scoring for sentences

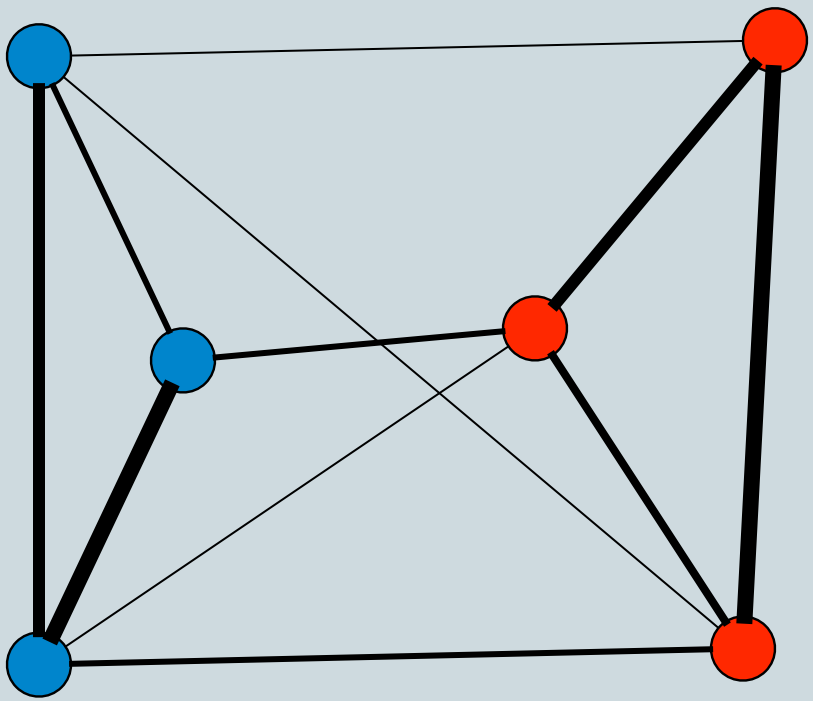


Comparative LexRank

- Sentences belong to viewpoints
- Goal: make viewpoint summaries similar to each other so that they can be directly compared
- Idea: put sentences from all viewpoints into same graph; control which viewpoints the random walker jumps to

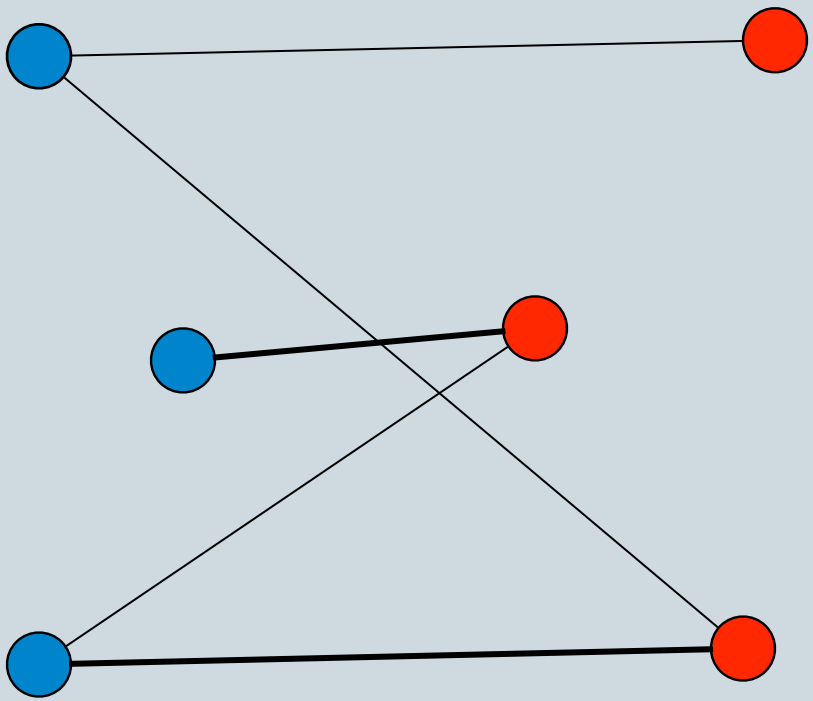
Comparative LexRank

Color = viewpoint



Comparative LexRank

Trick: force random walk to move back and forth between views



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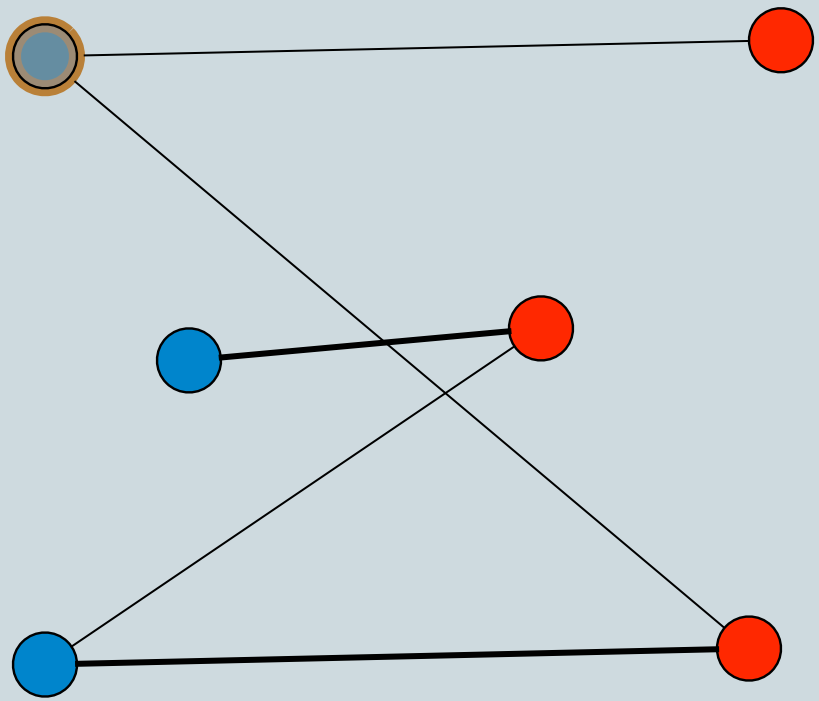

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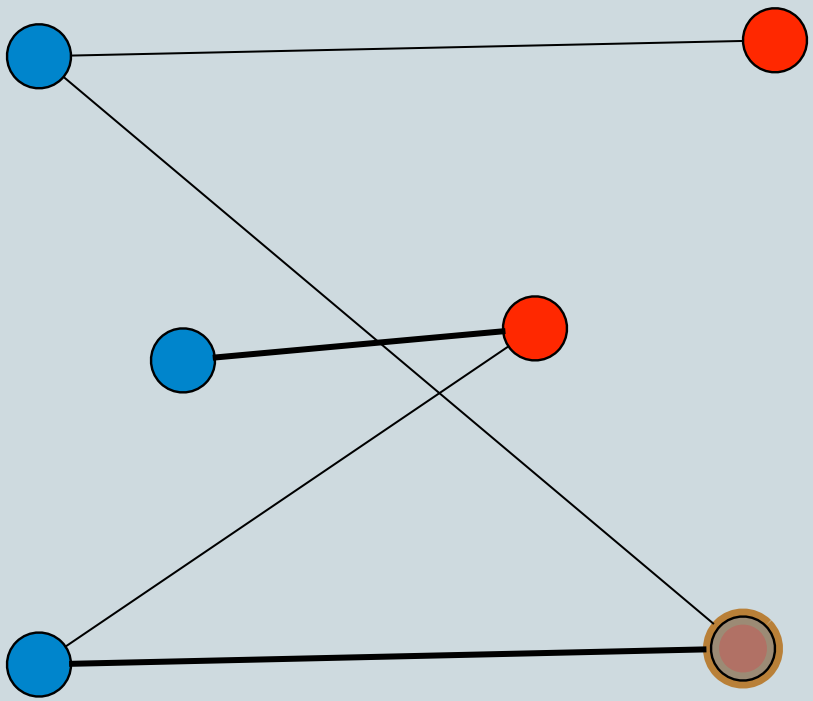

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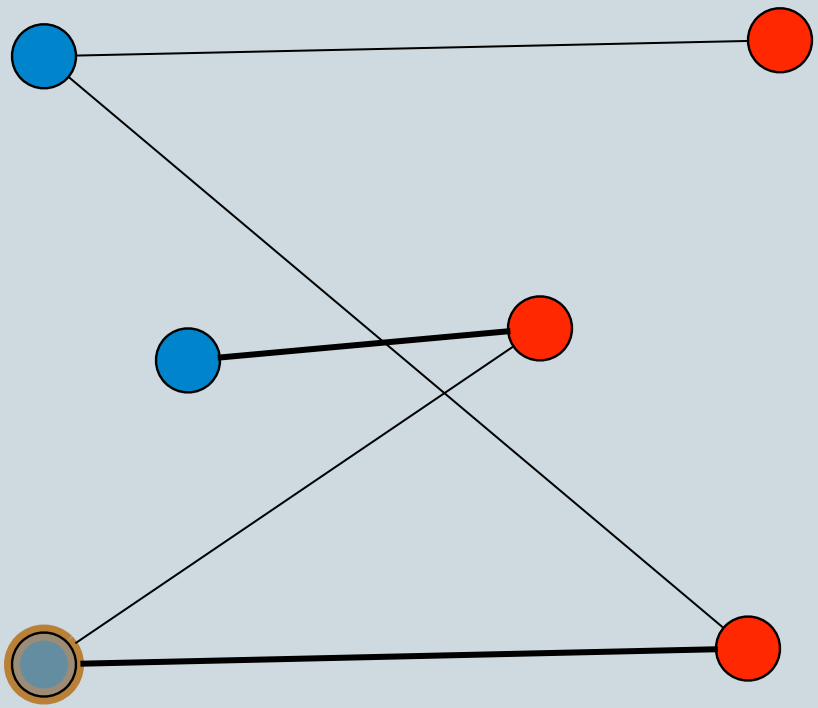

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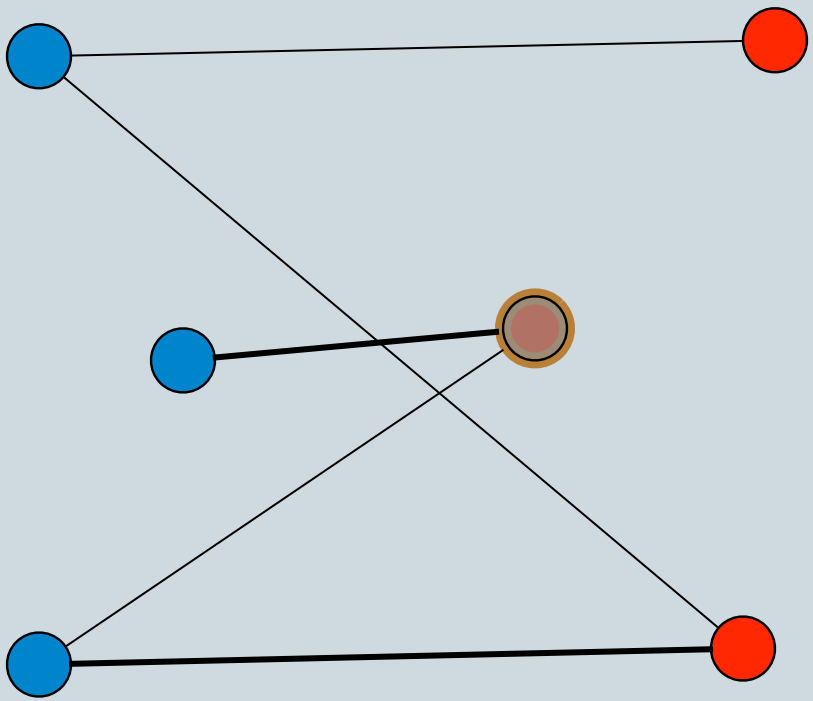

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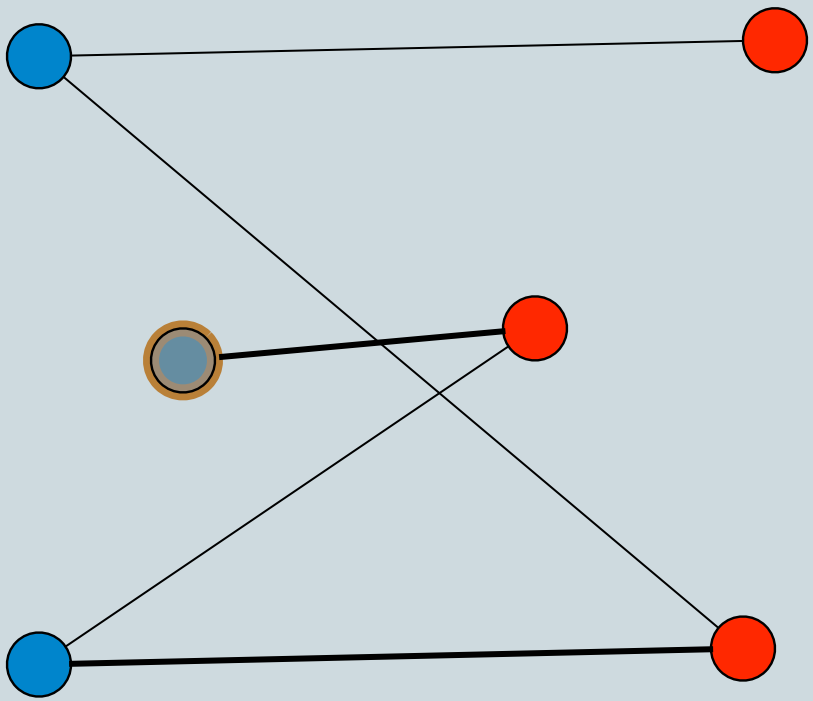
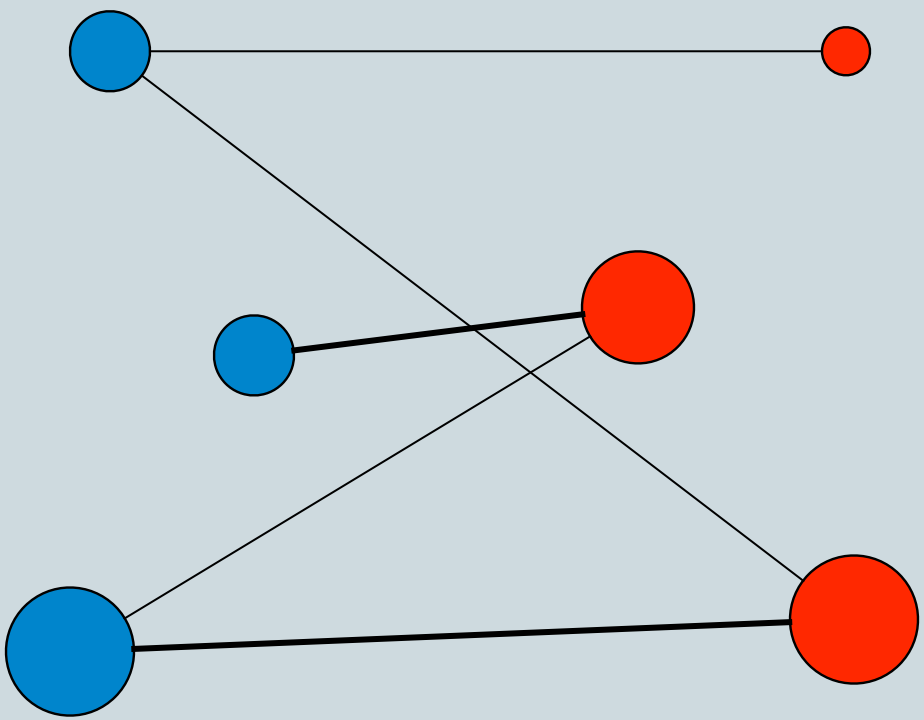


Comparative LexRank

Favor sentences with higher inter-viewpoint similarity



Comparative LexRank

- New model: random walker first decides whether to jump to the same or opposite viewpoint according to some probability
  - If $z = 0$, jump to same viewpoint
  - If $z = 1$, jump to opposite viewpoint

- Different transition probabilities conditioned on z:

$$P(x_i \rightarrow x_j | z) = \frac{sim_z(x_i, x_j)}{\sum_{j' \in X} sim_z(x_i, x_{j'})}$$

  - Controls which set of nodes can be transitioned to
  - Multiply *sim* by 0 if between a node you can't jump to

Comparative LexRank

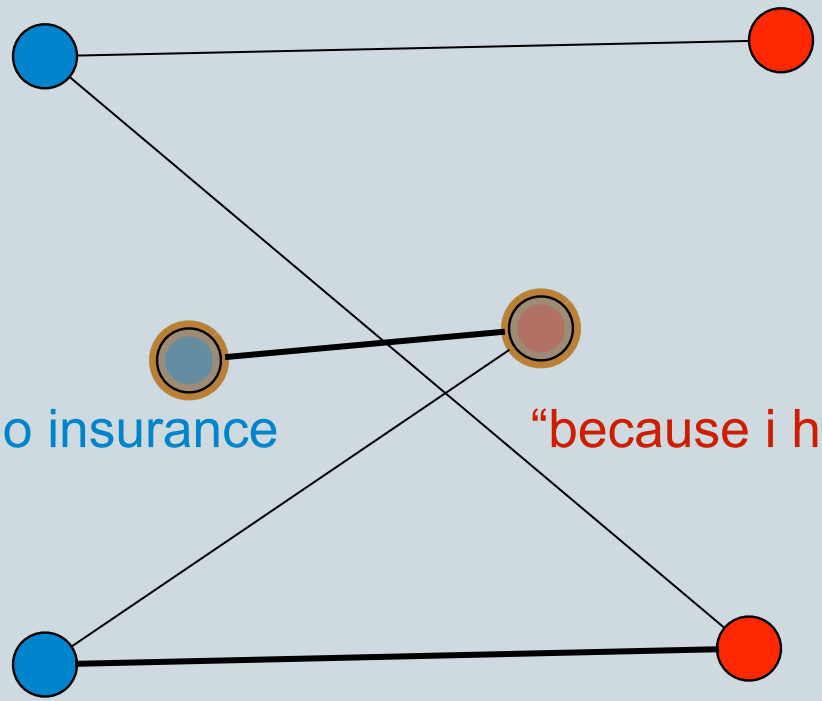
- The transition probability is:

$$P(x_i \rightarrow x_j) = \lambda P(x_i \rightarrow x_j | z = 0) + (1 - \lambda) P(x_i \rightarrow x_j | z = 1)$$

- $\lambda = P(z = 0)$ controls the level of contrast
  - $\lambda = 1$ always jump to **same** viewpoint
    - Equivalent to applying LexRank to viewpoints independently
  - $\lambda = 0.5$ **equal** odds of jumping to same or opposite viewpoint
    - Even tradeoff between representation of viewpoint and contrast with opposite viewpoint (2 objectives)
  - $\lambda = 0$ always jump to **opposite** viewpoint
    - A viewpoint's summary will contain sentences that look like the opposite viewpoint

Comparative LexRank

How to score a **pair** a nodes from opposite viewpoints?

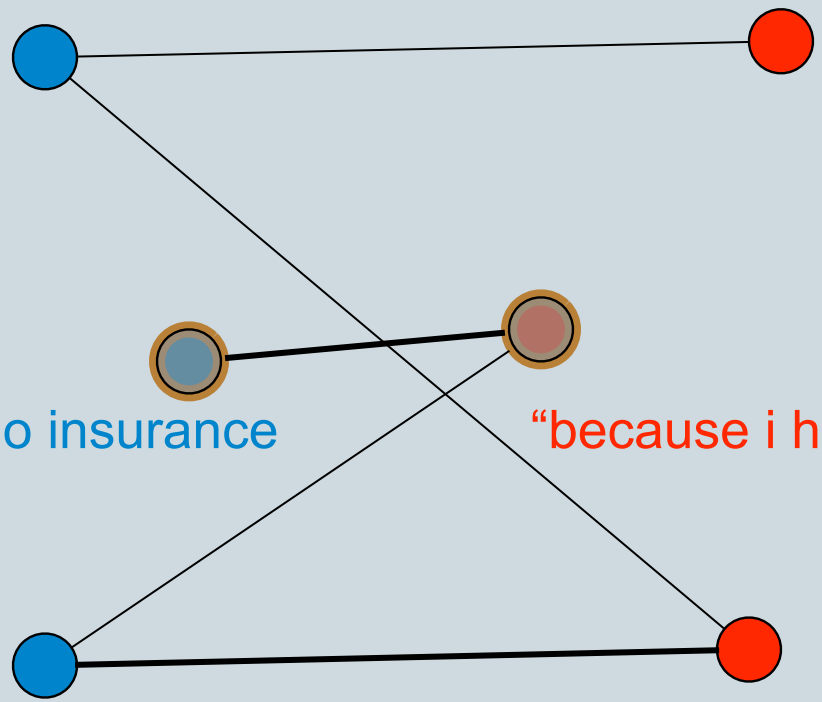


"because i have no insurance and i need it."

"because i have health insurance."

Comparative LexRank

$$P(x_i)P(x_i \rightarrow x_j|z=1) + P(x_j)P(x_j \rightarrow x_i|z=1)$$



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Evaluation Setup (Healthcare Corpus)

- Gold standard summaries for each viewpoint
  - Prominent reasons found in data as analyzed by humans
  - Source: http://www.gallup.com/poll/126521/Favor-Oppose-Obama-Healthcare-Plan.aspx

For:

People need health insurance/Too many uninsured	29%
System is broken/Needs to be fixed	18%
Costs are out of control/Would help control costs	12%
Moral responsibility to provide/Obligation/Fair	12%
Would make healthcare more affordable	10%
Don't trust insurance companies	5%
Respondent or family member currently lacks coverage	4%
To help senior citizens	4%
To help the poor	3%

Evaluation Setup

- ROUGE
  - Recall-based evaluation metric compares against gold summary
  - Modification: scale term counts by prominence in data

Against:

Will raise costs of insurance/Make it less affordable	20%
Does not address real problems	19%
Need more information/clarity on how system would work	8%
Against big government/Too much government involvement (general)	8%
Government should not be involved in healthcare	7%
Healthcare is a privilege, not an entitlement	6%
Would cost government too much/Too much spending/Increase the deficit	5%
People should not be required to buy health insurance	5%
Will affect respondent's current health insurance	4%
Socialism/Socialized medicine	4%
Oppose the "public option" proposal	3%
Rushing it through process/Should take more time	3%
Would hurt senior citizens/Medicare	3%
Would pay for abortions	2%
Has not worked in other countries	1%

Baseline Approach

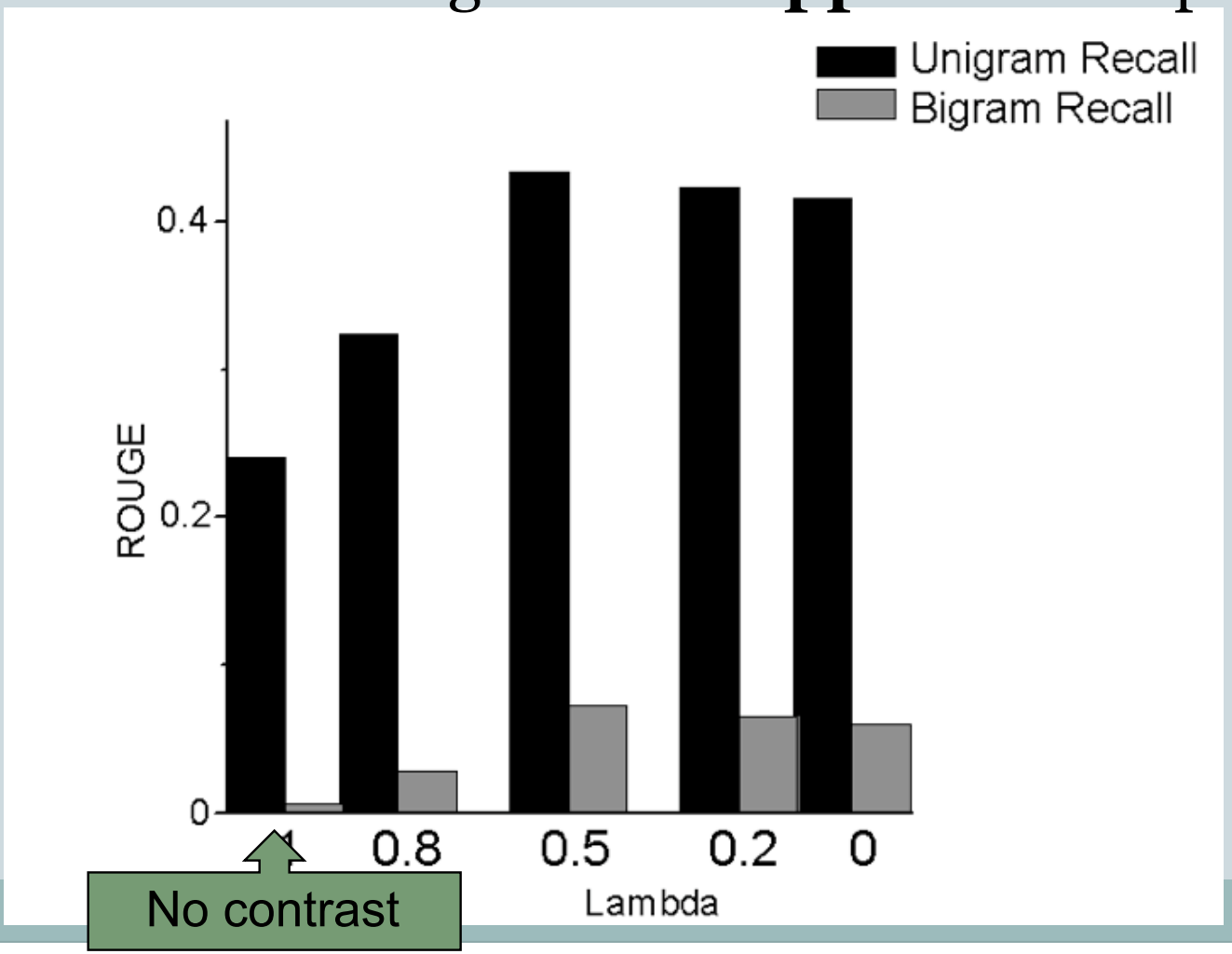
- Compare against non-comparative LexRank
- Analogous to λ =1 !
  - Always jump to same viewpoint

- Remember:

$$P(x_i \rightarrow x_j) = \lambda P(x_i \rightarrow x_j | z = 0) + (1 - \lambda) P(x_i \rightarrow x_j | x = 1)$$

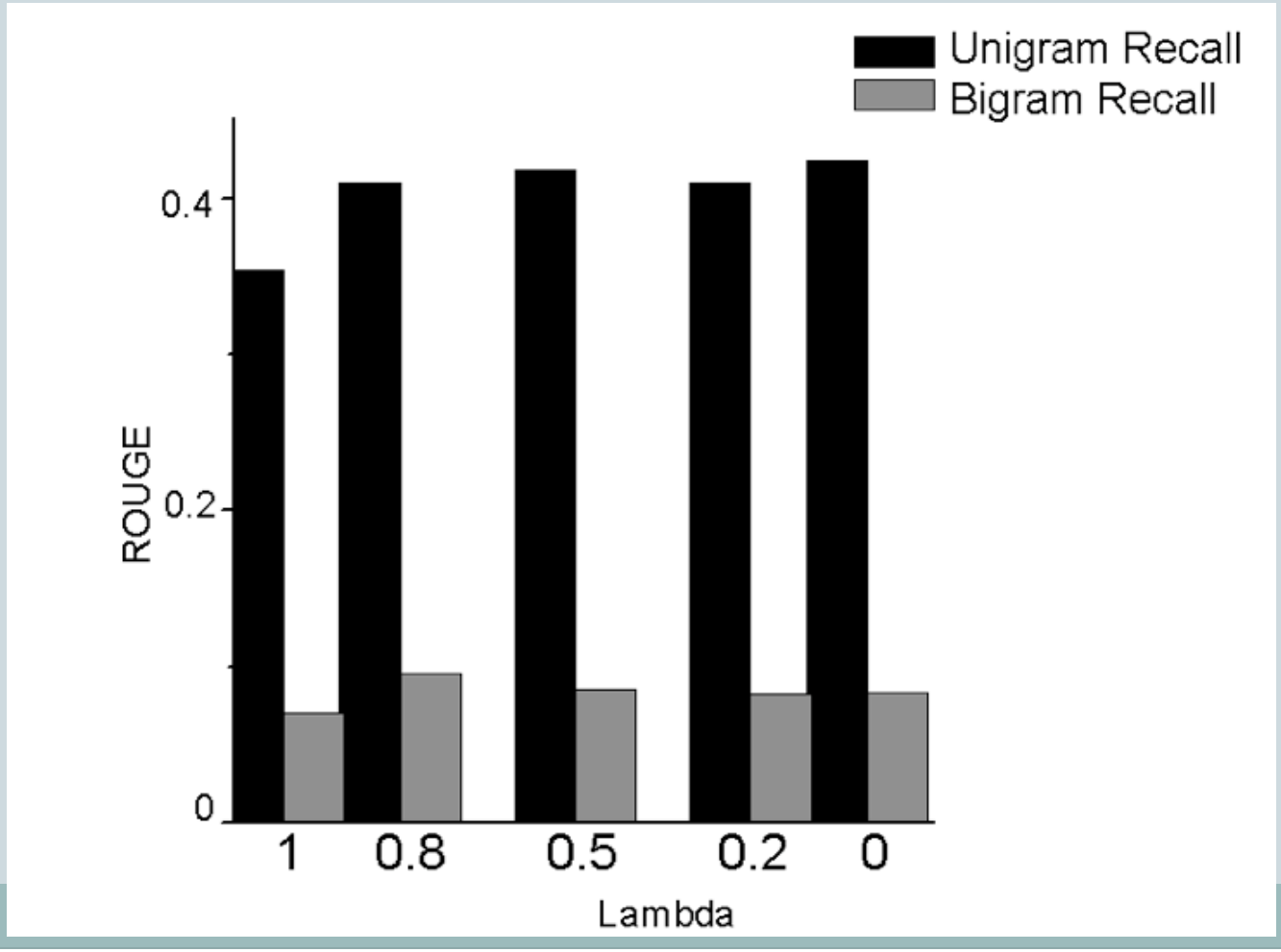
Evaluation Results (Healthcare Corpus)

- Evaluate summaries against the **opposite** viewpoint:



Evaluation Results (Healthcare Corpus)

- Evaluate summaries against their own viewpoint:



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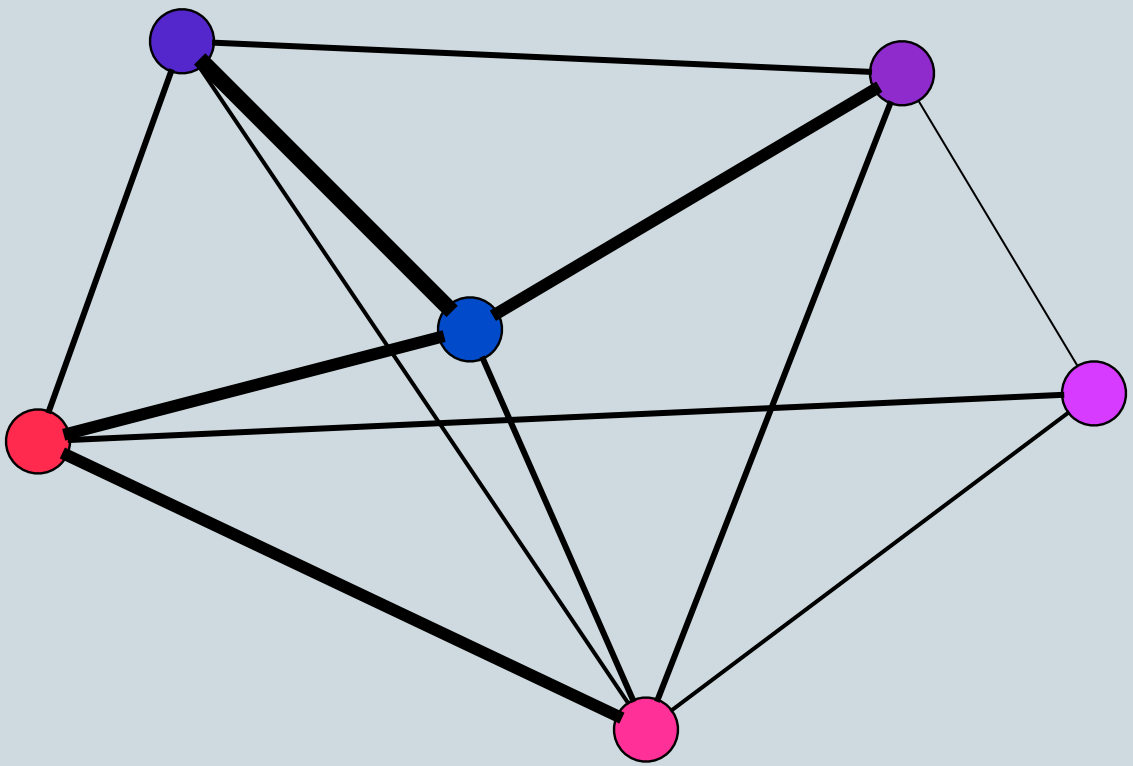
Comparative LexRank

- So far we've assumed that there is a way to partition the data into viewpoints
- Question: how do we know if the nodes are red or blue?
- Viewpoint membership might be probabilistic
- Viewpoint membership might not be labeled

Comparative LexRank

Sentences may represent viewpoints to varying degrees.
Intuition: assign higher scores to more representative sentences.



Comparative LexRank

- Assign a probability of viewpoint membership to each sentence

  Recall: $$P(x_i \rightarrow x_j | z) = \frac{sim_z(x_i, x_j)}{\sum_{j' \in X} sim_z(x_i, x_{j'})}$$

- Multiple *sim* by the **probability** that (i, j) belong to the same viewpoint (if $z = 0$) or that they belong to the opposite viewpoint (if $z = 1$).

Probabilistic Topic Modeling

- Topic models
  - Latent Dirichlet Allocation (LDA)
- Idea: use LDA with 2 “topics” to discover viewpoints
- 2 improvements:
  - Use better features than “bag of words”
    - “bag of features”
    - Dependency information, also negation/polarity
  - Use a better model than LDA

Topic-Aspect Model (TAM) (Paul & Girju, 2010)

- Imagine a set of **product reviews**
  - Each word might depend on the viewpoint/sentiment as well as the topic/aspect being discussed

View/	Usability	Service	Design
Positive	easy intuitive	friendly helpful	sleek durable
Negative	confusing difficult	rude slow	flimsy ugly

- TAM: each document is both a mixture of *topics* and a separate mixture of *viewpoints*
  - Words may depend on both, one or the other, or neither

Clustering Results

- Measured accuracy by comparing cluster assignments to gold labels
  - Dependency features make a big difference!
- Healthcare corpus:
  - Median clustering accuracy (200 trials):
    - Bag of words: **61.0%**
    - Best feature set: **70.7%**
- Bitterlemons corpus:
  - Median clustering accuracy (50 trials):
    - Bag of words: **69.3%**
    - Best feature set: **88.1%**

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Evaluation Setup (Bitterlemons Corpus)

- Unsupervised viewpoint summarization
- Run TAM on document collection
  - Use dependency features
  - Repeat 10 times, take model with best data likelihood
- Generate macro-level summaries for 2 viewpoints
  - $\lambda = 0.5$ (even balance)
  - Summary length = 6 sentences
- Ask humans to label each summary as the "Israeli" or "Palestinian" viewpoint
  - Measures clustering accuracy and summarization salience
  - Randomly partition each summary in half for each judge

Evaluation Results (Bitterlemons Corpus)

- 2 viewpoints **x** 6 sentences = 12 sentences
  - **11** of 12 sentences clustered correctly by TAM
- 8 human judges given 4 summaries
  - correctly labeled **78%** of the summaries
- ROUGE scores on the healthcare set were similarly degraded when using the unsupervised output
  - More contrast (smaller lambda) worsens this

Conclusion

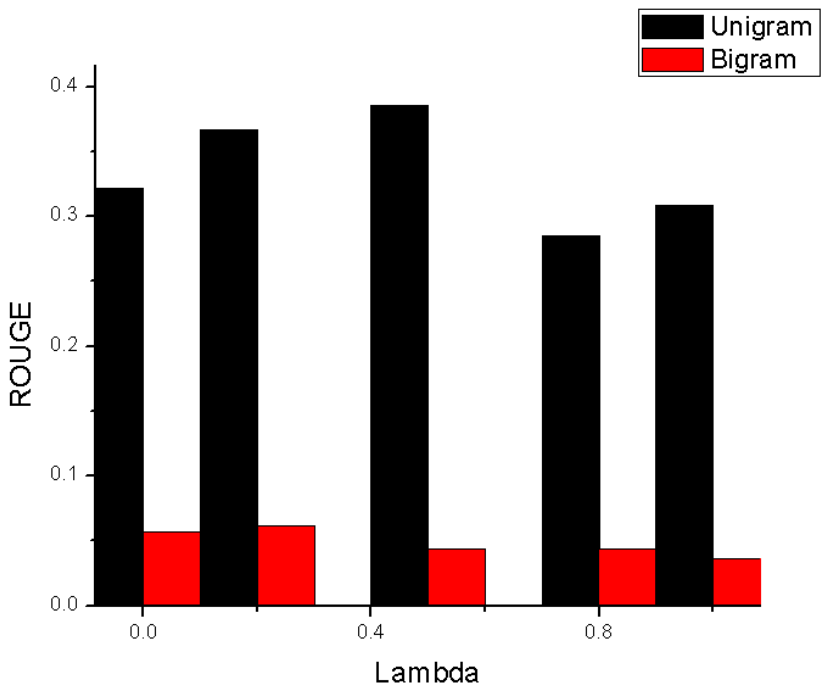
- Unsupervised viewpoint modeling
  - Achieved large gains in clustering accuracy by using simple but rich syntactic features
  - Showed that rich feature sets can be used with topic models simply by using a Naïve Bayes-like “bag of features” approach
- Contrastive multi-viewpoint summarization
  - Introduced *Comparative LexRank* algorithm
  - Same algorithm can be used for macro-level and micro-level contrastive summaries, and can generalize to >2 viewpoints
  - Our random walk formulation based on class membership could generalize to other tasks beyond summarization

Greedy Summary Generation

- Partition sentences into their viewpoints
- Choose sentences that have high scores but are not redundant with one another
  - We don't care about the order of the sentences
  - Simple approach:
    - At each step, add the sentence with the highest score as long as $sim(sentence, S) < \delta$
    - Repeat until S exceeds user-specified length limit

Evaluation Results (Healthcare Corpus)

- Scores for the micro-contrastive summaries (summaries with explicitly aligned pairs)
  - Created gold summary by having annotators identity contrastive pairs in the gold summaries



Bitterlemons Output

Israeli viewpoint	Palestinian viewpoint
• The American war on Iraq, however problematic for much of the world, is for most of us in Israel a welcome attempt by a friend and ally to deal with a strategic danger that we have been struggling to cope with on our own for decades.	• If the Israelis do that, in line with the Americans and the international community, I believe that after the end of the occupation, we could start real negotiations on the other issues.