Summary Cloze: A New Task for Content Selection in Topic-Focused Summarization

Daniel Deutsch and Dan Roth
Traditional Summarization

• Task:
  - Input: Document(s)
  - Output: Summary

A man in suburban Boston is selling snow online to customers in warmer states. For $89, he will ship 6 pounds of snow in an insulated Styrofoam box.

(CNN) The only thing crazier than a guy in snowbound Massachusetts boxing up the powdery white stuff and offering it for sale online? People are actually buying it. For $89, self-styled entrepreneur Kyle Waring will ship you 6 pounds of Boston-area snow in an insulated Styrofoam box -- enough for 10 to 15 snowballs, he says. But not if you live in New England or surrounding states. “We will not ship snow to any states in the northeast!” says Waring’s website…
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• Popular datasets
  - CNN/DailyMail (Nallapati et al., 2016)
  - New York Times (Sandhaus, 2008)
  - Newsroom (Grusky et al., 2018)

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- Propose a cloze-style task
  - Topic-focused summarization
Roger Federer, Philanthropy and outreach

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Roger Federer, Philanthropy and outreach
The current world number two tennis player, who was born in Basel, received the title from the medical faculty, which praised him for his role in increasing the international reputation of Basel and Switzerland…In a press release it also highlighted the 36-year-old sportsman’s engagement for children in Africa through his charitable foundation…

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… Federer received an honorary doctorate awarded to him by his home university, the University of Basel.
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| Reference Document | Topic |
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| Roger Federer, Philanthropy and outreach |
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| Context |
|---------|
| ... Federer received an honorary doctorate awarded to him by his home university, the University of Basel. He received the title in recognition for his role in increasing the international reputation of Basel and Switzerland, and also his engagement for children in Africa through his charitable foundation. |
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• Collect large-scale cloze dataset from Wikipedia

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- Propose a cloze-style task
  - Topic-focused summarization
- Collect large-scale cloze dataset from Wikipedia
- Propose baseline models
  - Extractive
  - Two-step: extractive then abstractive

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In June 1989, Obama met Michelle Robinson when he was employed as a summer associate at the Chicago law firm of Sidley Austin. [62] ... They began dating later that summer, became engaged in 1991, and were married on October 3, 1992. [64] After suffering a miscarriage, Michelle underwent in vitro fertilisation to conceive their children. [65] ... When they moved to Washington, D.C., in January 2009, the girls started at the Sidwell Friends School. [68]
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Barack Obama

Family and personal life

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Obama '85 masters balancing act

Being married to a U.S. senator, working full-time and raising a family is a balancing act for Michelle Obama '85. She is the wife of Sen. Barack Obama (D-Ill.), vice president of community and external affairs at the University of Chicago Hospitals and a mother of two.

"Politics is stressful on the life of a family," she said. "You just have to keep working and try to prevent politics from droning out the rest of your life."

Obama was assigned to mentor Barack, who was a summer intern at Sidley & Austin, and the two began dating soon after in 1991. The couple shared a passion for public service.

"We had many debates about how to best effect change," she said. "We both wanted to affect the community on a larger scale than either of us could individually, and we wanted to do it outside of big corporations. It was not a 'make a lot of money, wrap it up and call it a day' thing."
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From Wikipedia, the free encyclopedia

Family and personal life

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Wikipedia as a Topic-Focused Summary

• Ideally, want to collect all of the references from all of the articles and try to generate the article
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  - Efforts toward this: Liu et al. (2018), but difficult to actually collect
  - Many references are books, audio, video, 404s
  - Not all sentences cited
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  - Efforts toward this: Liu et al. (2018), but difficult to actually collect
  - Many references are books, audio, video, 404s
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• We can get some of the documents, so what can we do with that?
  - Cloze-style task
Today I went to the ________ and bought some milk and eggs. I knew it was going to rain, but I forgot to take my ________, and ended up getting wet on the way.

Taylor, 1953

https://en.wikipedia.org/wiki/Cloze_test
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**Obamas choose private Sidwell Friends School**

**WASHINGTON:** President-elect Barack Obama and his wife have chosen Sidwell Friends School for their two daughters, opting for a private institution that another White House child, Chelsea Clinton, attended a decade ago.

"A number of great schools were considered," said Katie McCormick Lelyveld, a spokeswoman for Michelle Obama. "In the end, the Obamas selected the school that was the best fit for what their daughters need right now."

She said Sidwell can provide the security and privacy that Malia, 10, and Sasha, 7, will need as part of the new first family and Sidwell can help with that. She also said that Sasha and Malia had become good friends with Vice President-elect Joe Biden's grandchildren, who go to the school.
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WikiCite Dataset

• Collected summary cloze instances from “Living People” Wikipedia pages
• Scraped reference documents using 12 months of Common Crawl
• 450k instances
  - 6% are multi-document
• Documents are quite long: average 1k tokens
Topic Statistics

• 70k unique topics (ignoring entity names)
• Most common:
  - Career, personal life, biography, early life
• Singleton topics:
  - “career with the who”
  - “federal government lawsuits”
  - “recognition and publications”
Why is this worth researching?
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• Summary cloze is a sub-problem of multi-document summarization
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• Summary cloze is a sub-problem of multi-document summarization
• Learn to select content based on the topic
  - More than generic salience
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• Summary cloze is a sub-problem of multi-document summarization
• Learn to select content based on the topic
  - More than generic salience
• Explicitly use “partial summary” (the context) to drive content selection
  - Latent partial summary representations currently don’t make a big difference for extractive models (Kedzie et al., 2018)
Local rugby player Caitlin Beevers has certainly had a week to remember - scoring a try last Saturday as she won the Women's Challenge Cup, and learning that she will officiate in a fortnight's time at Wembley.

At just 16 years of age, the St John Fisher pupil was part of the Leeds Rhinos side that defeated Castleford Tigers 20-14 to win the trophy in Warrington, and she said the experience was "absolutely amazing”…

But now you see girls' games and you see them playing from a young age and it's amazing to see them starting so young, and I hope that it does become a lot bigger than it is already.”

Winning the Challenge Cup wasn't the only highlight of her week though - she also learnt that she will appear at Wembley, refereeing the Year 7 National Schools Final.

She said that she was "absolutely over the moon" to be chosen, although she waited a few days to share the news…

"I do community games for my society, the NCL every week, under 19s, academy games, and I got my first reserves the other week.”

She had already officiated a national final for Year 8 girls, but will now become the first female to referee any rugby league match at Wembley Stadium on 25th August, in the curtain-raiser to the men's Challenge Cup Final.
Caitlin Beevers, Refereeing career

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**Beevers started refereeing aged 13 and is a member of Dewsbury & Batley Referees Society.** In 2018 she became the first women to referee a rugby league game at Wembley Stadium when she refereed the Year 7 Boys National Schools Final (the curtain raiser to the Challenge Cup Final).
**Caitlin Bevers, Refereeing career**

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**Example Instances**

| Topic | Caitlin Beevers, Refereeing career |
|-------|-----------------------------------|
|       | Local rugby player Caitlin Beevers has certainly had a week to remember - scoring a try last Saturday as she won the Women's Challenge Cup, and **learning that she will officiate in a fortnight's time at Wembley**. |
|       | At just 16 years of age, the St John Fisher pupil was part of the Leeds Rhinos side that defeated Castleford Tigers 20-14 to win the trophy in Warrington, and she said the experience was "absolutely amazing"… |
|       | But now you see girls' games and you see them playing from a young age and it's amazing to see them starting so young, and I hope that it does become a lot bigger than it is already." |
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|       | She said that she was "absolutely over the moon" to be chosen, although she waited a few days to share the news… |
|       | "I do community games for my society, the NCL every week, under 19s, academy games, and I got my first reserves the other week." |
|       | She had already officiated a national final for Year 8 girls, **but will now become the first female to referee any rugby league match at Wembley Stadium on 25th August, in the curtain-raiser to the men's Challenge Cup final**. |

| Reference Document | Beevers started refereeing aged 13 and is a member of Dewsbury & Batley Referees Society. |
|--------------------|----------------------------------------------------------------------------------|
|                    | In 2018 she became the first women to referee a rugby league game at Wembley Stadium when she refereed the Year 7 Boys National Schools Final (the curtain raiser to the Challenge Cup Final). |

"Refereeing" topic helps filter certain document content
### Example Instances

| Topic | Reference Document |
|-------|--------------------|
| Cypress Grove (musician), Biography | Cypress Grove was born in London into a musical family. His father was a professional jazz drummer who at one time played with The Chris Barber band. In the late-1950s and early-1960s, Chris Barber was mainly responsible for arranging the first UK tours of seminal blues artists such as Big Bill Broonzy, Sonny Terry & Brownie McGhee and Muddy Waters. Cypress was taught by his father to play drums at an early age. But by the time he turned 16, his interest had switched to guitar.  

His infatuation with pre-war acoustic blues continued to develop, which led to a chance encounter with Jeffrey Lee Pierce from The Gun Club. Jeffrey had a real passion for roots music of any kind, so the two hit it off immediately. Jeffrey and Cypress started to regularly jam together on acoustic guitars in Cypress' bedroom. Jeffrey eventually invited Cypress to collaborate with him on his long planned album of roots material - an album Jeffrey had been putting off for many years, as he could not find the right person to do it with - until he met Cypress. The album was released in 1992 - "Ramblin' Jeffrey Lee and Cypress Grove with Willie Love". Jeffrey and Cypress went on to tour the album on a handful of occasions, both with a band and as an acoustic duo… |

| Context Cloze |  
|--------------|  
| Cypress Grove was born into a musical family. He was taught by his father, a professional jazz drummer, to play drums from a very early age, but by the time he turned 16, his passion became the guitar. |
## Example Instances

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|       | His infatuation with pre-war acoustic blues continued to develop, which led to a chance encounter with Jeffrey Lee Pierce from The Gun Club. Jeffrey had a real passion for roots music of any kind, so the two hit it off immediately. Jeffrey and Cypress started to regularly jam together on acoustic guitars in Cypress' bedroom. Jeffrey eventually invited Cypress to collaborate with him on his long planned album of roots material - an album Jeffrey had been putting off for many years, as he could not find the right person to do it with - until he met Cypress. The album was released in 1992 - "Ramblin' Jeffrey Lee and Cypress Grove with Willie Love". Jeffrey and Cypress went on to tour the album on a handful of occasions, both with a band and as an acoustic duo… |
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|---------------|
| Cypress Grove was born into a musical family. He was taught by his father, a professional jazz drummer, to play drums from a very early age, but by the time he turned 16, his passion became the guitar. |

Context helps dictate relevant document content
Two Baseline Approaches
Two Baseline Approaches

Extract 1 sentence

Topic
Reference Document
Context

Extractive Model

1 sentence

Cloze
Two Baseline Approaches

Extract 1 sentence

Extractive Model

Topic
Reference Document
Context

1 sentence

Cloze

Extract 200 tokens, Abstractively generate

Extractive Model

Topic
Reference Document
Context

k sentences until 200 tokens

Abstractive Model

1 sentence

Cloze
Those left scratching their heads ...

At the end of the new spot ...

The second in Microsoft's ...

In 2008, Gates appeared in a series of ads ...

The second in Microsoft’s series of new ads airs Thursday night, featuring Bill Gates and Jerry Seinfeld moving in with a family of "real people" in order to connect with them. At the end of the new spot, Seinfeld again asks Gates to give him a sign if he's on the right track in guessing what’s next...
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Context token encoding

Topic encoding

Reference document sentence encoding

Attention mechanism

Document-level sentence encoding

Feed-Forward with sigmoid

Extraction probabilities

Extractive summary of the reference document

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In 2008, Gates appeared in a series of ads...

At the end of the new spot...

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The second in Microsoft’s series of new ads airs Thursday night, featuring Bill Gates and Jerry Seinfeld...

In 2008, Gates appeared in a series of ads to promote Microsoft...

Extractive summary of the reference document encoding

Context Encoding

Cloze Generation
The second in Microsoft’s series of new ads airs Thursday night, featuring Bill Gates and Jerry Seinfeld...

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Extractive summary of the reference document encoding
The second in Microsoft's series of new ads airs Thursday night, featuring Bill Gates and Jerry Seinfeld...

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Extractive summary of the reference document encoding

Context Encoding

Cloze Generation
The second in Microsoft's series of new ads airs Thursday night, featuring Bill Gates and Jerry Seinfeld…

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Experiments
Experiments

Extract 1 sentence

Extractive Model

1 sentence

Cloze

Extract 200 tokens, Abstractively generate

Extractive Model

k sentences until 200 tokens

Abstractive Model

1 sentence

Cloze
Extractive Model Evaluation

![Graph showing Extractive Model R1-F1](image)

- **Oracle-1**
- **Lead-1 Model**
- **Extractive Model**
Extractive Model Evaluation

Best any sentence-level extractive system can do
Extractive Model Evaluation

Best any sentence-level extractive system can do

First sentence of reference document

| Model          | R1-F1 |
|----------------|-------|
| Oracle-1       | 44.5  |
| Lead-1 Model   | 17.5  |
| Extractive Model |     |
Extractive Model Evaluation

Best any sentence-level extractive system can do

First sentence of reference document

Extractive model gets 7.7 $F_1$ improvement over lead
Extractive Model Evaluation

Extractive model gets 7.7 $F_1$ improvement over lead

Other baselines included in paper

Best any sentence-level extractive system can do

First sentence of reference document
Extractive Model Ablation

![Graph showing Extractive Model Ablation R1-F1 with a peak at +Topic, +Context at 25.2]
Extractive Model Ablation

Topic and context provide 3.9 \( F_1 \) improvement
Extractive Model Ablation

Topic and context provide 3.9 $F_1$ improvement

+Topic: 0.8 $F_1$ improvement
Extractive Model Ablation

Topic and context provide 3.9 $F_1$ improvement

+Topic: 0.8 $F_1$ improvement

+Context: 3.9 $F_1$ improvement
Extractive Model Ablation

Topic and context provide 3.9 $F_1$ improvement

+Topic: 0.8 $F_1$ improvement
+Context: 3.9 $F_1$ improvement

Improvements do not stack
Experiments

Extract 1 sentence

Extract 200 tokens, Abstractively generate

k sentences until 200 tokens
Extractive Step Evaluation

Extractive Step R1-R

R1-R

Training Labels  Lead-200 Model  Extractive Step
Extractive Step Evaluation

14 recall point gap between model and “perfect” model
Experiments

Extractive Model

Extract 1 sentence

Topic

Reference Document

Context

Extract 1 sentence

Extract 200 tokens, Abstractively generate

Topic

Reference Document

Context

Extractive Model

Extractive Model

Abstractive Model

k sentences until 200 tokens

1 sentence

1 sentence

Cloze

Cloze
Abstractive Step Evaluation

• Three different preprocessing methods:
  - Extractive training labels
  - Lead-200 tokens
  - Extractive model with topic and context

• Context feeding/no context feeding

The second in Microsoft’s series of new ads airs Thursday night, featuring Bill Gates and Jerry Seinfeld...

In 2008, Gates appeared in a series of ads to promote Microsoft...

The second in Microsoft’s series of new ads airs Thursday night, featuring Bill Gates and Jerry Seinfeld...
Abstractive Step Evaluation

Abstractive Step R1-F1

Model

R1-F1

Training Labels  Lead-200  Extractive Step  GPT-2
Abstractive Step Evaluation

"Best possible" extractive preprocessing

Abstractive Step R1-F1

- Context
- No Context

Model:
- Training Labels
- Lead-200
- Extractive Step
- GPT-2

R1-F1

- 34.2
"Best possible" extractive preprocessing
Abstractive Step Evaluation

“Best possible” extractive preprocessing

Extraction step does provide value over taking first 200 tokens
Abstractive Step Evaluation

“Best possible” extractive preprocessing

Extraction step does provide value over taking first 200 tokens

Condition on context, generate one sentence
Abstractive Step Evaluation

“Best possible” extractive preprocessing

Removing the context feeding decreases performance across all models

Extraction step does provide value over taking first 200 tokens

Condition on context, generate one sentence

| Model            | Context | No Context |
|------------------|---------|------------|
| Training Labels  | 34.2    | 34.0       |
| Lead-200         | 23.1    | 21.9       |
| Extractive Step  | 24.5    | 23.1       |
| GPT-2            | 23.1    | 14.5       |
The perils of investing in London's junior stock market were laid bare after the company best known for the Corby trouser press moved to escape the glare of the public market. In a decision that will make it more difficult for its private investors to sell their shares, industrial minnow Jourdan is withdrawing from the Alternative Investment Market... A former British Leyland executive turned stock market raider, Abell was investigated for insider dealing by the Department of Trade and Industry in the late 1980s.

He has been investigated by the department of trade and industry in the late 1980s and has been involved in the alternative investment market.
| Topic | David Abell (businessman), Career, Jourdan |
|-------|------------------------------------------|
| Ground-Truth | Abell withdrew Jourdan from the Alternative Investment Market in 2009. |
| Extractive Step | The perils of investing in London's junior stock market were laid bare after the company best known for the Corby trouser press moved to escape the glare of the public market. In a decision that will make it more difficult for its private investors to sell their shares, **industrial minnow Jourdan is withdrawing from the Alternative Investment Market**... A former British Leyland executive turned stock market raider, Abell was investigated for insider dealing by the Department of Trade and Industry in the late 1980s. |
| Abstractive Step | He has been investigated by the department of trade and industry in the late 1980s and has been involved in the alternative investment market. |
## Example Output

| Topic | David Abell (businessman), Career, Jourdan |
|-------|------------------------------------------|
| Ground-Truth | Abell withdrew Jourdan from the Alternative Investment Market in 2009. |
| Extractive Step | The perils of investing in London's junior stock market were laid bare after the company best known for the Corby trouser press moved to escape the glare of the public market. In a decision that will make it more difficult for its private investors to sell their shares, **industrial minnow Jourdan is withdrawing from the Alternative Investment Market**... A former British Leyland executive turned stock market raider, Abell was investigated for insider dealing by the Department of Trade and Industry in the late 1980s. |
| Abstractive Step | He has been investigated by the department of trade and industry in the late 1980s and has been involved in the alternative investment market. |

> Abstractive step combines information from multiple sentences
| Topic          | Chrysta Bell |
|---------------|--------------|
| Ground-Truth  | Her new album, We Dissolve, released independently on Meta Hari Records in June 2017, is produced by John Parish, with guests including Adrian Utley, Geoff Downes and Stephen O'Malley. |
| Extractive Step | Chrysta Bell, longtime musical partner of filmmaker David Lynch, is set to release her sophomore album, "We Dissolve," with award-winning producer John Parish on June 9. Recorded in Bristol, UK, "We Dissolve" is a pop record with elements of soul, rock and jazz that features contributions from guest artists including Adrian Utley (Portishead), keyboardist Geoff Downes (Asia, Yes) and drone metal guitarist Stephen O'Malley of Sunn O)... |
| Abstractive Step | in addition, bell's debut album, "we dissolve", was released on may 21, 2017. |
| Topic           | Chrysta Bell |
|-----------------|--------------|
| Ground-Truth    | Her new album, *We Dissolve*, released independently on Meta Hari Records in June 2017, is produced by John Parish, with guests including Adrian Utley, Geoff Downes and Stephen O'Malley. |
| Extractive Step | Chrysta Bell, longtime musical partner of filmmaker David Lynch, is set to release her sophomore album, "We Dissolve," with award-winning producer John Parish on June 9. Recorded in Bristol, UK, "We Dissolve" is a pop record with elements of soul, rock and jazz that features contributions from guest artists including Adrian Utley (Portishead), keyboardist Geoff Downes (Asia, Yes) and drone metal guitarist Stephen O'Malley of Sunn O)...
| Abstractive Step| In addition, bell's debut album, "we dissolve", was released on May 21, 2017. |

Extractive step contains ground-truth information
## Example Output

| Topic       | Chrysta Bell |
|-------------|--------------|

### Ground-Truth
Her new album, *We Dissolve*, released independently on Meta Hari Records in June 2017, is produced by John Parish, with guests including Adrian Utley, Geoff Downes and Stephen O'Malley.

### Extractive Step
Chrysta Bell, longtime musical partner of filmmaker David Lynch, is set to release her sophomore album, "We Dissolve," with award-winning producer John Parish on June 9. Recorded in Bristol, UK, "We Dissolve" is a pop record with elements of soul, rock and jazz that features contributions from guest artists including Adrian Utley (Portishead), keyboardist Geoff Downes (Asia, Yes) and drone metal guitarist Stephen O'Malley of Sunn O))...

### Abstractive Step
In addition, bell's debut album, "we dissolve", was released on May 21, 2017.

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Abstractive step does not combine enough information, hallucinates facts.
The Lewis Sexton Scholarship Fund was established in 2016 by the Morris Industries Foundation in honor of Lewis Sexton, former President of UAW Local 862. The Scholarship Fund will provide three awards of $5,000 non-renewable scholarships to children (or legal wards) of UAW 862 members or retirees who plan to attend college in the Commonwealth of Kentucky. In 1971, Lewis became the first Committeeman to be elected President and Building Chairman of UAW Local 862 and served in that capacity for ten years.
The Scholarship Fund will provide three awards of $5,000 non-renewable scholarships to children (or legal wards) of UAW Local 862 members or retirees who plan to attend college in the Commonwealth of Kentucky. In 1971, Lewis became the first Committeeman to be elected President and Building Chairman of UAW Local 862 and served in that capacity for ten years.
### Example Output

| Topic | Nate Morris, Philanthropy |
|-------|---------------------------|
| Ground-Truth | Programs funded by the foundation include the Lewis Sexton Scholarship Fund, which provides college scholarships in Kentucky to children of UAW Local 862 members or retirees. |
| Extractive Step | The Lewis Sexton Scholarship Fund was established in 2016 by the Morris Industries Foundation in honor of Lewis Sexton, former President of UAW Local 862. The Scholarship Fund will provide three awards of $5,000 non-renewable scholarships to children (or legal wards) of UAW 862 members or retirees who plan to attend college in the Commonwealth of Kentucky... \textit{In 1971, Lewis became the first Committeeman to be elected President and Building Chairman of UAW Local 862} and served in that capacity for ten years. |
| Abstractive Step | \textit{In 1971, Lewis became the first committee man to be elected president and building chairman of uaw local 862}. |

Abstractive step selects wrong information, not about philanthropy (not even about the correct person)
Future Research Directions

• Evaluation
  - Evaluation is a challenge across summarization, even worse with one sentence
  - Many plausible endings, so how do we choose one over another?
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• Evaluation
  - Evaluation is a challenge across summarization, even worse with one sentence
  - Many plausible endings, so how do we choose one over another?

• Use topic and context to better pick document content
  - Shallow understanding of topics
  - Explore better ways to use the context
Future Research Directions

• Evaluation
  - Evaluation is a challenge across summarization, even worse with one sentence
  - Many plausible endings, so how do we choose one over another?

• Use topic and context to better pick document content
  - Shallow understanding of topics
  - Explore better ways to use the context

• Incorporating external knowledge
  - Add extra information not present in the reference article
Future Research Directions

• Evaluation
  - Evaluation is a challenge across summarization, even worse with one sentence
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• Use topic and context to better pick document content
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Thank you!

http://danieldeutsch.github.io
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