

# Controlling style, content and structure in natural language generation

**Shrimai Prabhumoye**



**Carnegie Mellon University**

Language Technologies Institute

# We constantly author text!



Social Media



Personal/Professional documents



Blogs

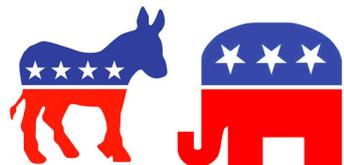


News/Wiki articles

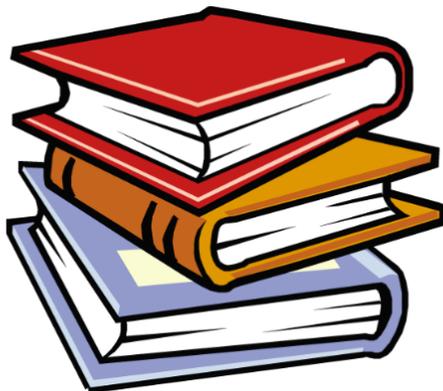
Style, Content and Structure

# Model

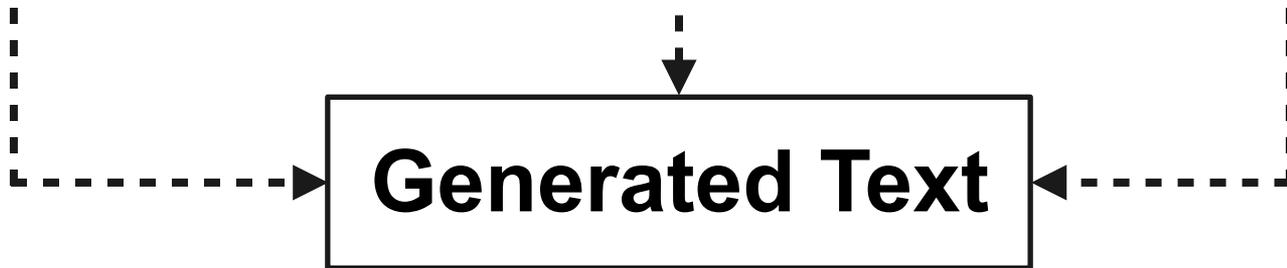
Style



Content



Structure



Generated Text

# Style

- surface level realization

“Do you have any code that we can look at?”

“Any code? Or do I have to guess at how you did it?”

(Danescu-Niculescu-Mizil, 2013)

# Content

---

**User1:** The Notebook is hands-down one of my favorite movies EVER! Have you ever seen The Notebook?

---

**User2:** No I have never seen this movie. I am going to try it out now

---

**User1:** It was a heartwarming story of young love. The main characters are played by **Ryan Gosling and Rachel McAdams.**

---

**User2:** Ok this sounds nice. I think Ryan is a good actor

---

**User1:** For all the praise it received, I was surprised to see that it only got a **5.7/10 on Rotten Tomatoes.**

---

**User2:** That is interesting. They never get the rating correct.

---

**User1:** Ryan is a great actor, as well as Rachel McAdams. The story goes back and forth between present day and the past. **Older Ryan is played by James Garner and older Rachel is played by Gena Rowlands** Yeah, Rotten Tomatoes never gets the right ratings..LOL. I always like to see the ratings but if I want to see a movie, I will watch it even if it has a bad rating.

## The Notebook



From Wikipedia, the free encyclopedia

*For other uses, see [Notebook \(disambiguation\)](#).*

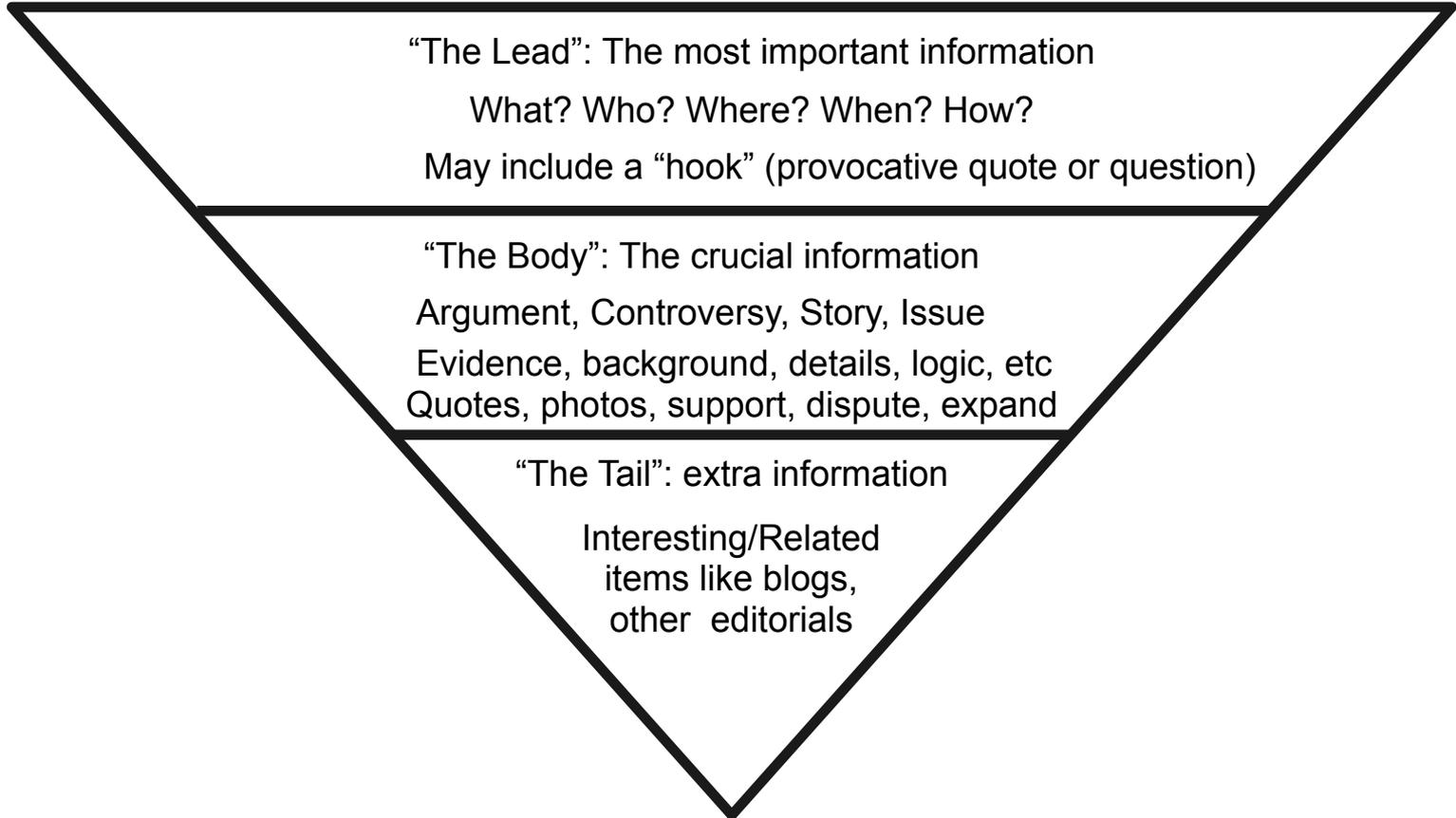
*The Notebook* is a 2004 [romantic drama](#) film directed by [Nick Cassavetes](#) and written by [Jeremy Leven](#) from [Jan Sardi](#)'s adaptation of the [1996 novel](#) by [Nicholas Sparks](#). The film stars [Ryan Gosling](#) and [Rachel McAdams](#) as a young couple who fall in love in the 1940s. Their story is narrated from the present day by an elderly man, (portrayed by [James Garner](#)), telling the tale to a fellow nursing home resident (played by [Gena Rowlands](#), who is Cassavetes's mother).

### Critical reception [\[ edit \]](#)

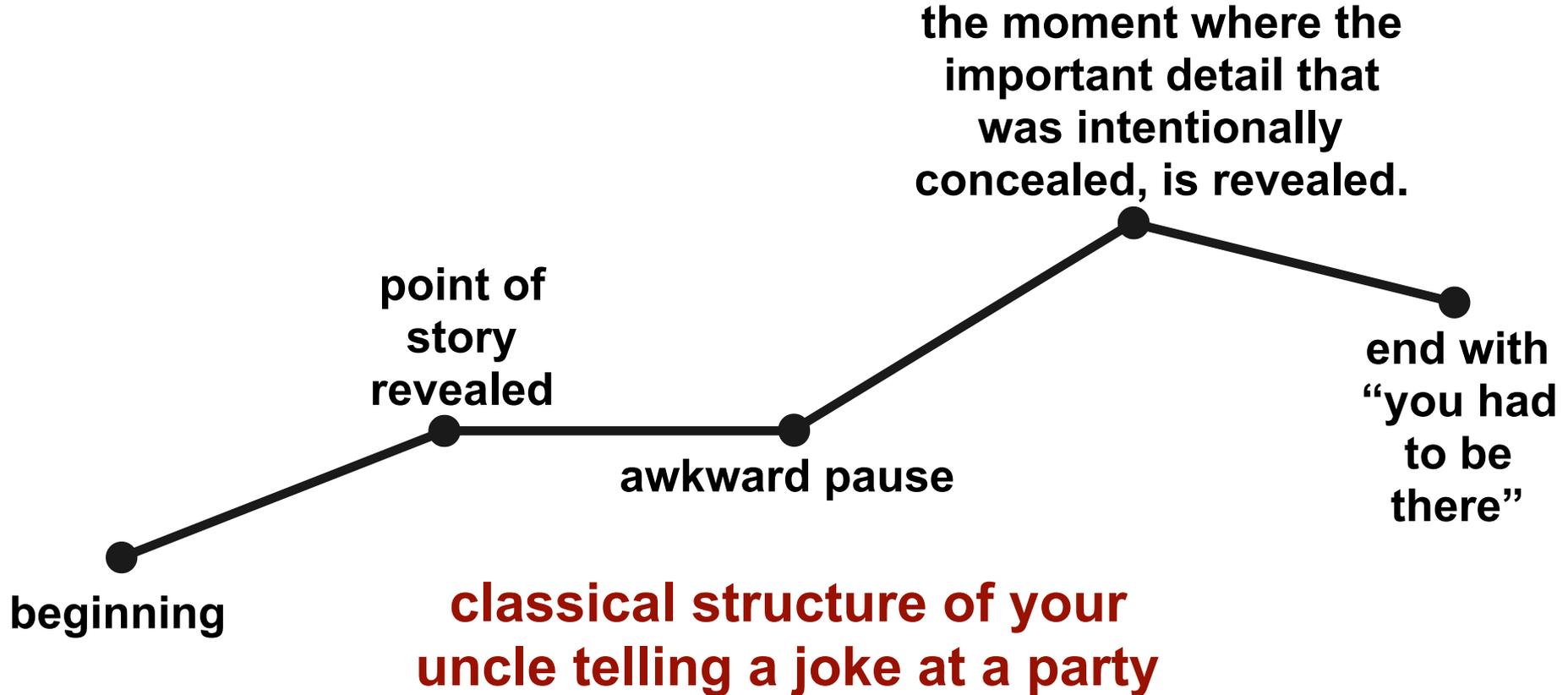
*The Notebook* received a mixed reaction from film critics. Based on 174 reviews on review aggregator [Rotten Tomatoes](#), 53% of critics gave the film a positive review, with an average rating of 5.7/10 and the website's consensus stating "It's hard not to admire its unabashed

**(EMNLP 2018)**

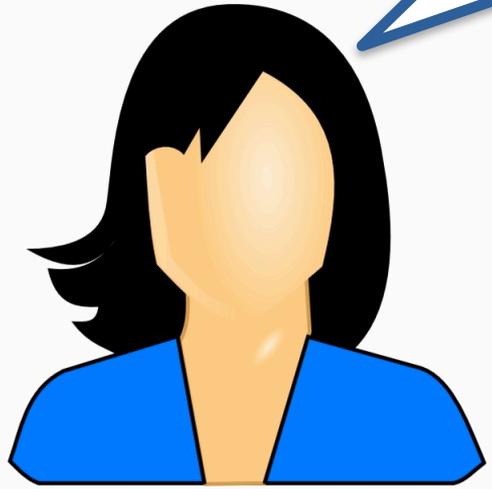
# Structure



# Structure



# Application



I have a talk to  
present today!

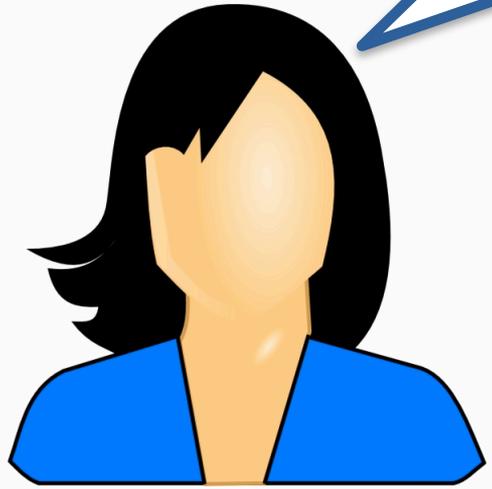


May the force be with  
you!

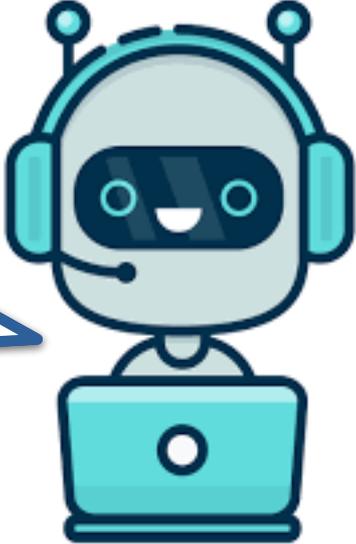


**Style**

# Application



Hey, have you  
watched Avengers  
Endgame



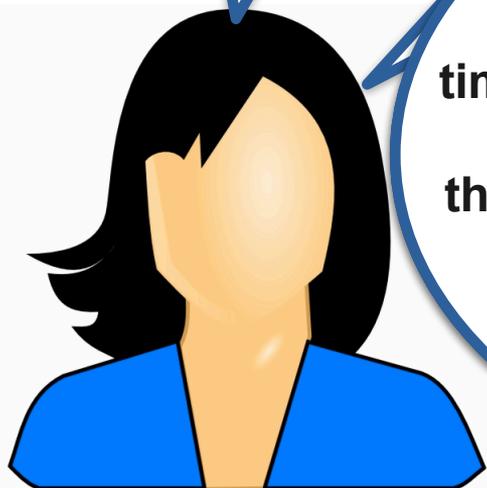
Yeah, I loved Robert  
Downey in it!



**Content**

# Application

oh  
great! Can you tell me  
the story!



...y, have you

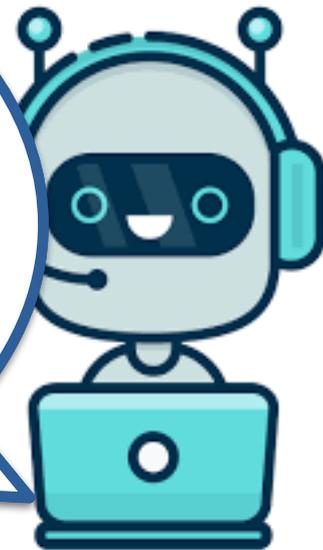
...ed A

Yeah, Thor

decapitates Thanos. Five  
years later, AntMan escapes from  
the quantum realm. Ironman builds a  
time machine to save the world. Hulk travels  
to New York City in 2012 and convinces  
the Ancient One to give him the Time Stone.  
Ironman steals the Infinity Stones back  
from Thanos and uses them to  
disintegrate Thanos and his army,  
at the cost of his life.

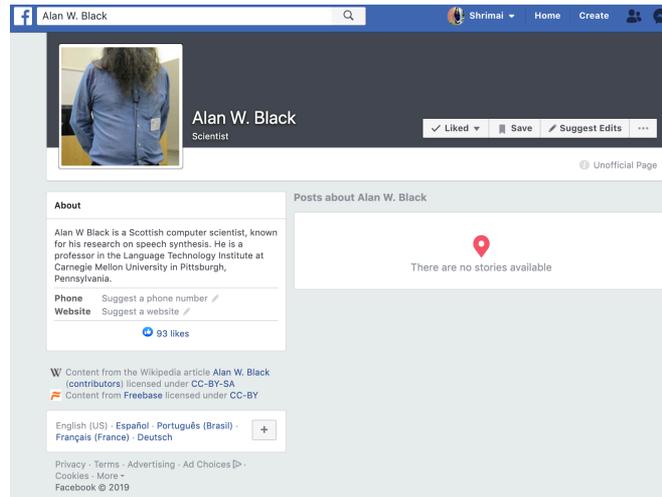


## Structure



# Other Application

- lexical choices, information, coherence
- Writing Assistance Tools
- Content Generation (websites, descriptions etc)



The image shows a screenshot of a Facebook profile page for Alan W. Black. The profile picture shows a man with long hair and a beard wearing a blue lab coat. The name "Alan W. Black" is displayed above the photo, with "Scientist" as the category. Below the name are buttons for "Liked", "Save", and "Suggest Edits". The page is marked as an "Unofficial Page".

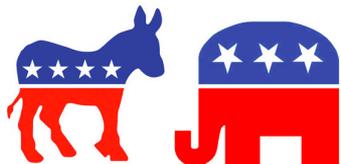
The "About" section contains the following text: "Alan W Black is a Scottish computer scientist, known for his research on speech synthesis. He is a professor in the Language Technology Institute at Carnegie Mellon University in Pittsburgh, Pennsylvania." Below this, there are fields for "Phone" and "Website" with "Suggest a phone number" and "Suggest a website" links respectively. A blue heart icon indicates "93 likes".

The "Posts about Alan W. Black" section shows a message: "There are no stories available" with a red location pin icon.

At the bottom, there is a language selection menu with options: English (US), Español, Português (Brasil), Français (France), and Deutsch. Below the menu are links for "Privacy", "Terms", "Advertising", and "Ad Choices", along with "Cookies" and "More". The footer reads "Facebook © 2019".

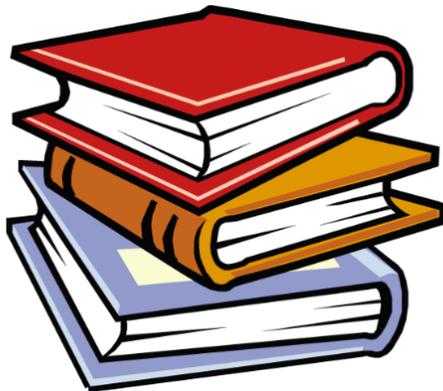
# Overview

## Style



*Storytelling '19*  
*ACL '18*

## Content



*NAACL '19*  
*EMNLP '18*

## Structure



*under review*  
*ICLR '20*

# What is Style Transfer

- Rephrasing the text to contain specific stylistic properties without changing the intent or affect within the context.

**“Shut up! the video is starting!”**

**“Please be quiet, the video will begin shortly.”**

# Applications

**Anonymization:** To preserve anonymity of users online, for personal security concerns (Jardine, 2016), or to reduce stereotype threat (Spencer, 1999).



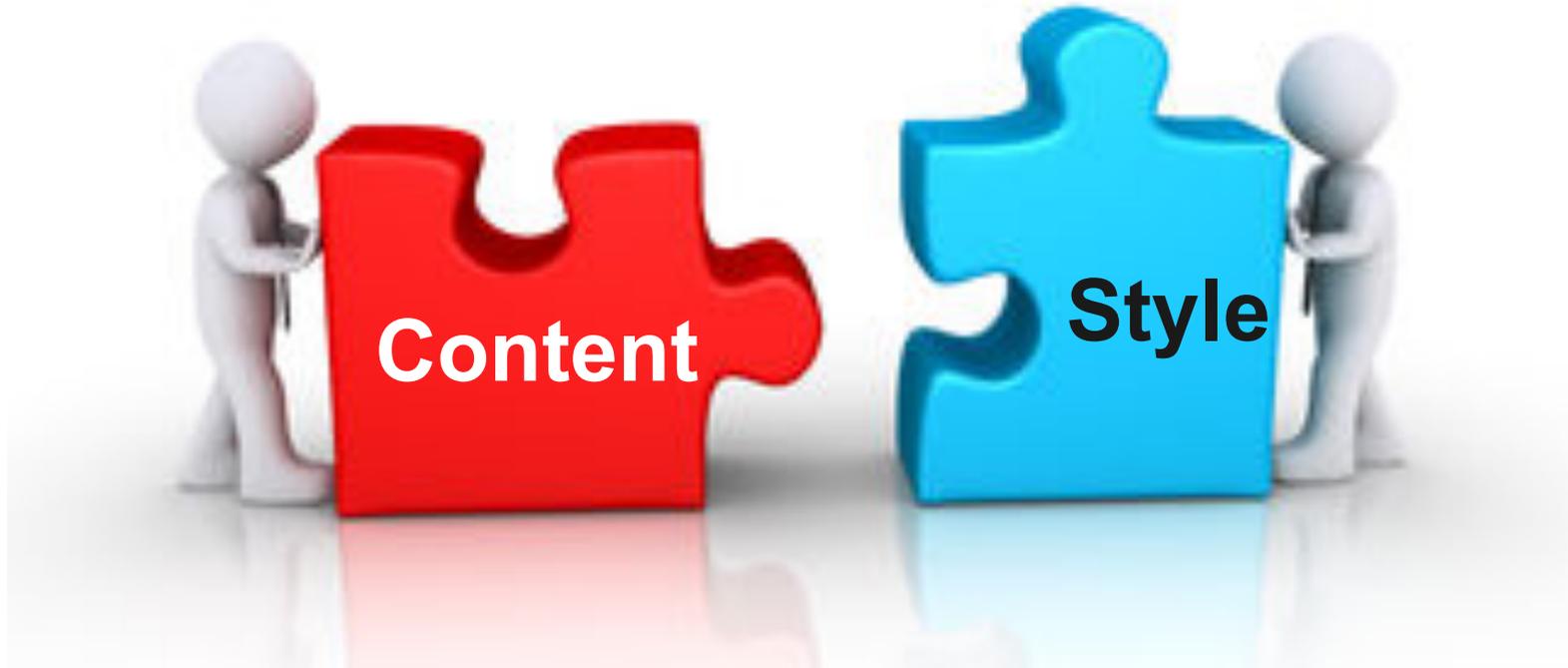
**Demographically-balanced** training data for downstream applications.



# Our Goal

To create a representation that is devoid of style but holds the meaning of the input sentence.

# Challenges



# Challenges

- No Parallel Data!

“The movie was very long.”

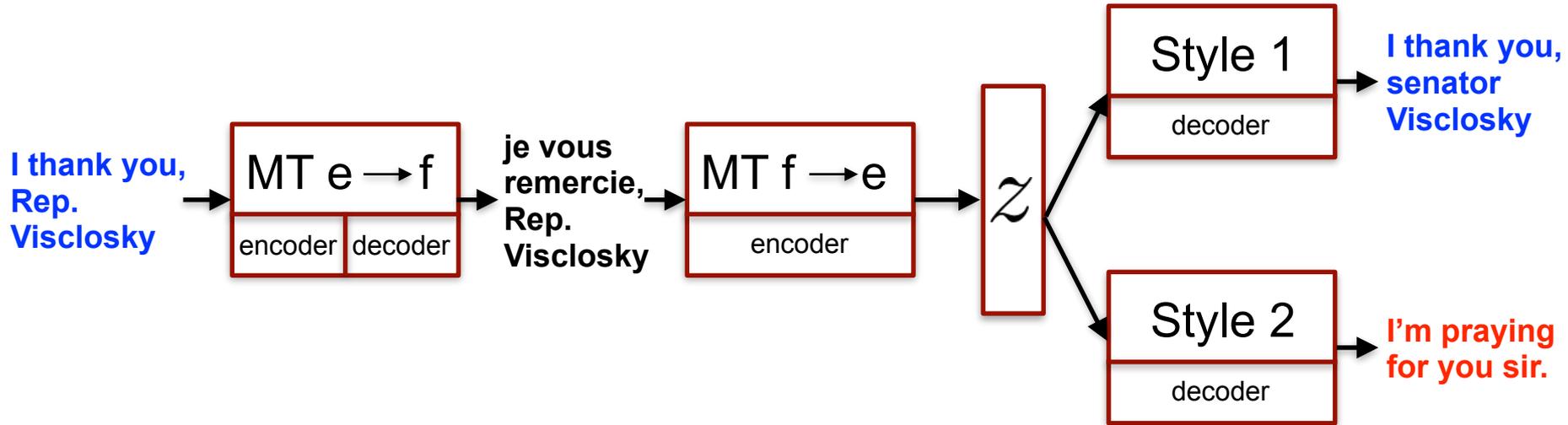
“I entered the theatre in the bloom of youth and emerged with a family of field mice living in my long, white mustache.”

- Style is subtle

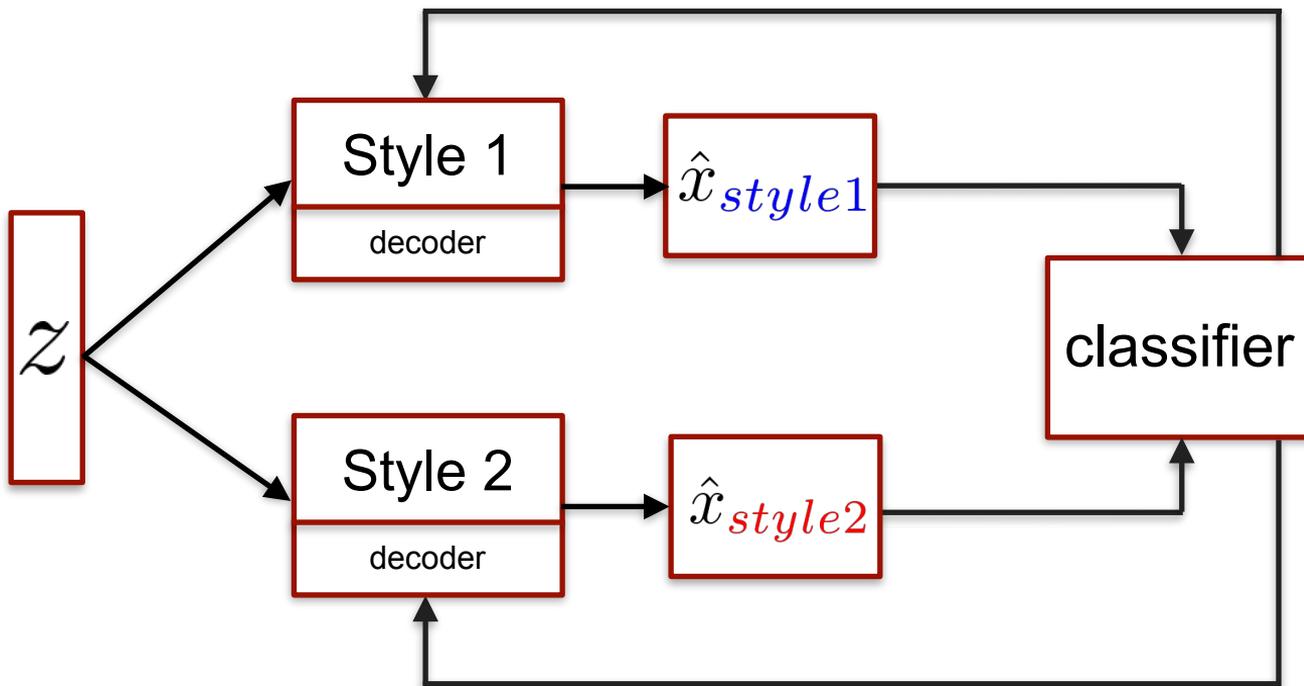
# Our Solution

- Back-Translation
  - Translating an English sentence to a pivot language and then back to English.
- Reduces the stylistic properties
- Helps in grounding meaning
- Creates a representation independent of the generative model
- Representation is agnostic to the style task

# Architecture



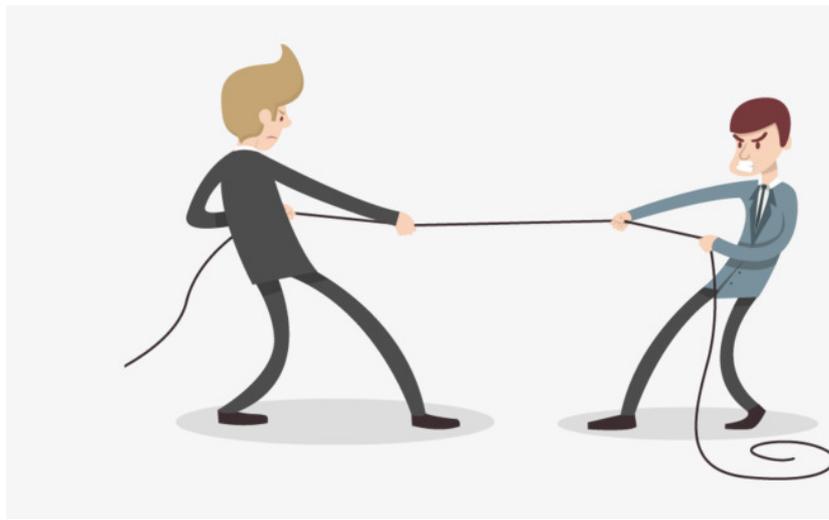
# Train Pipeline



# Experimental Settings

- Encoder-Decoders follow sequence-to-sequence framework (Sutskever et al., 2014; Bahdanau et al., 2015)

$$\min_{\theta_{gen}} \mathcal{L}_{gen} = \mathcal{L}_{recon} + \lambda_c \mathcal{L}_{class}$$



# Style Tasks

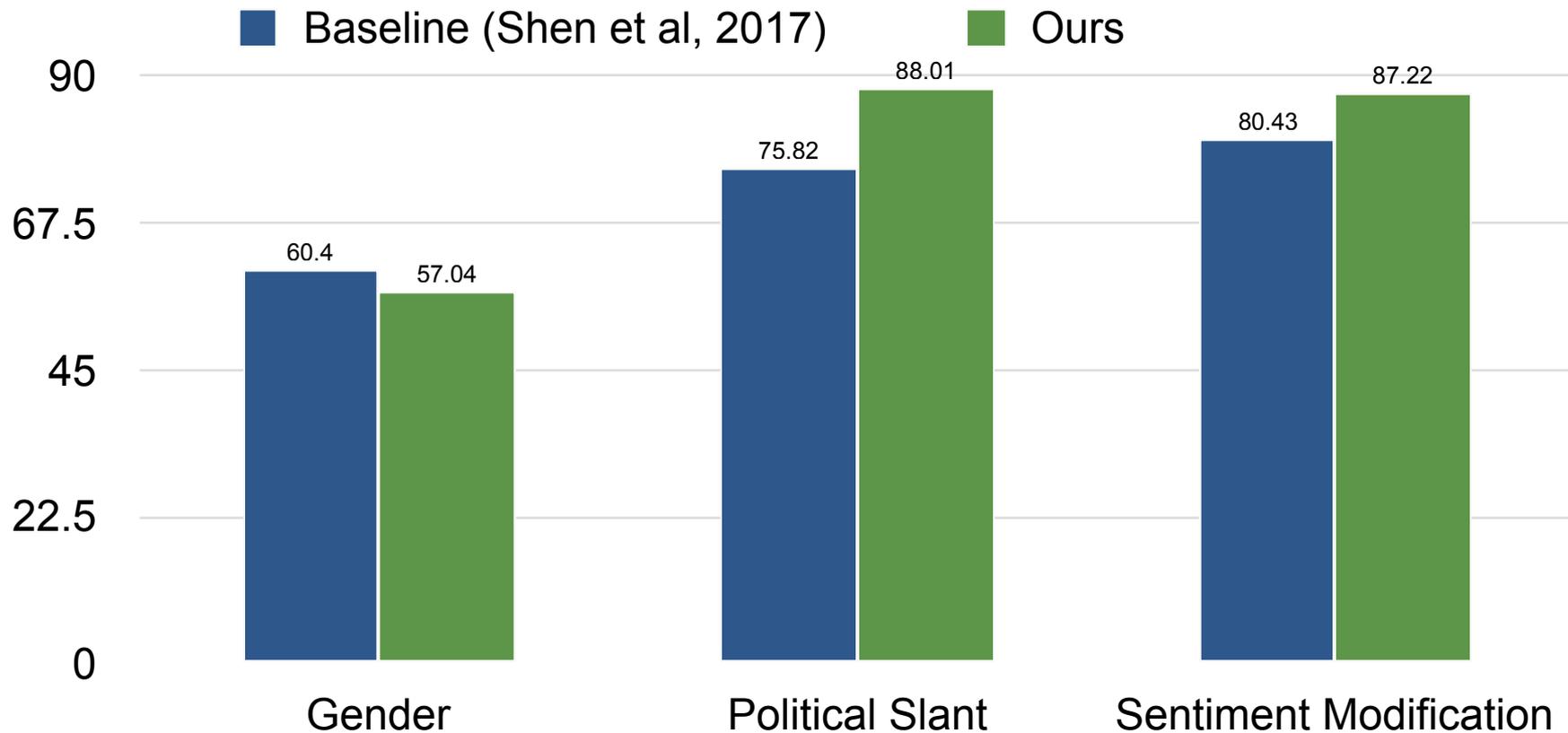
Task	Labels	Corpus
Gender	Male, Female	Yelp
Political Slant	Republican, Democratic	Facebook Comments
Sentiment Modification	Negative, Positive	Yelp

# Style Transfer Accuracy

- Generated sentences are evaluated using a pre-trained style classifier
- Test the classification accuracy of the generated sentences for the desired label.

Classifier Model	Accuracy
Gender	82%
Political Slant	92%
Sentiment Modification	93.23%

# Style Transfer Accuracy

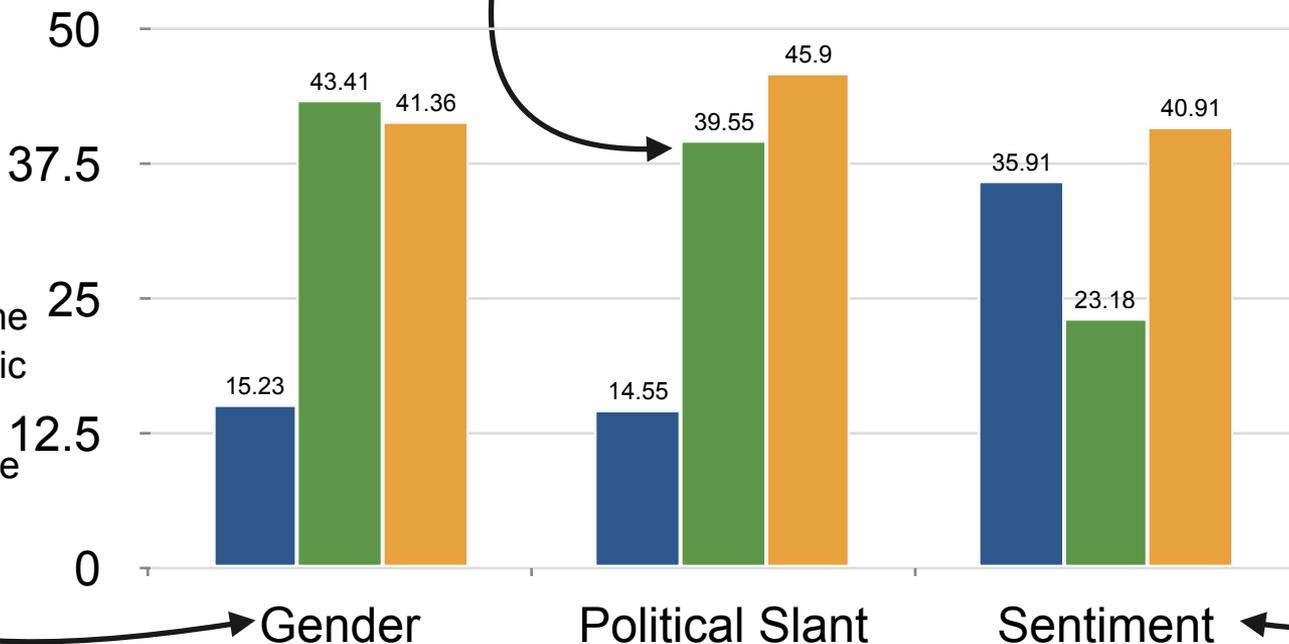


# Preservation of Meaning

Which transferred sentence maintains the same semantic intent of the source sentence while changing the political position

■ Baseline (Shen et al, 2017)  
■ Ours  
■ No Preference

Which transferred sentence maintains the same sentiment of the source sentence in the same semantic context (i.e. you can ignore if food items are changed)

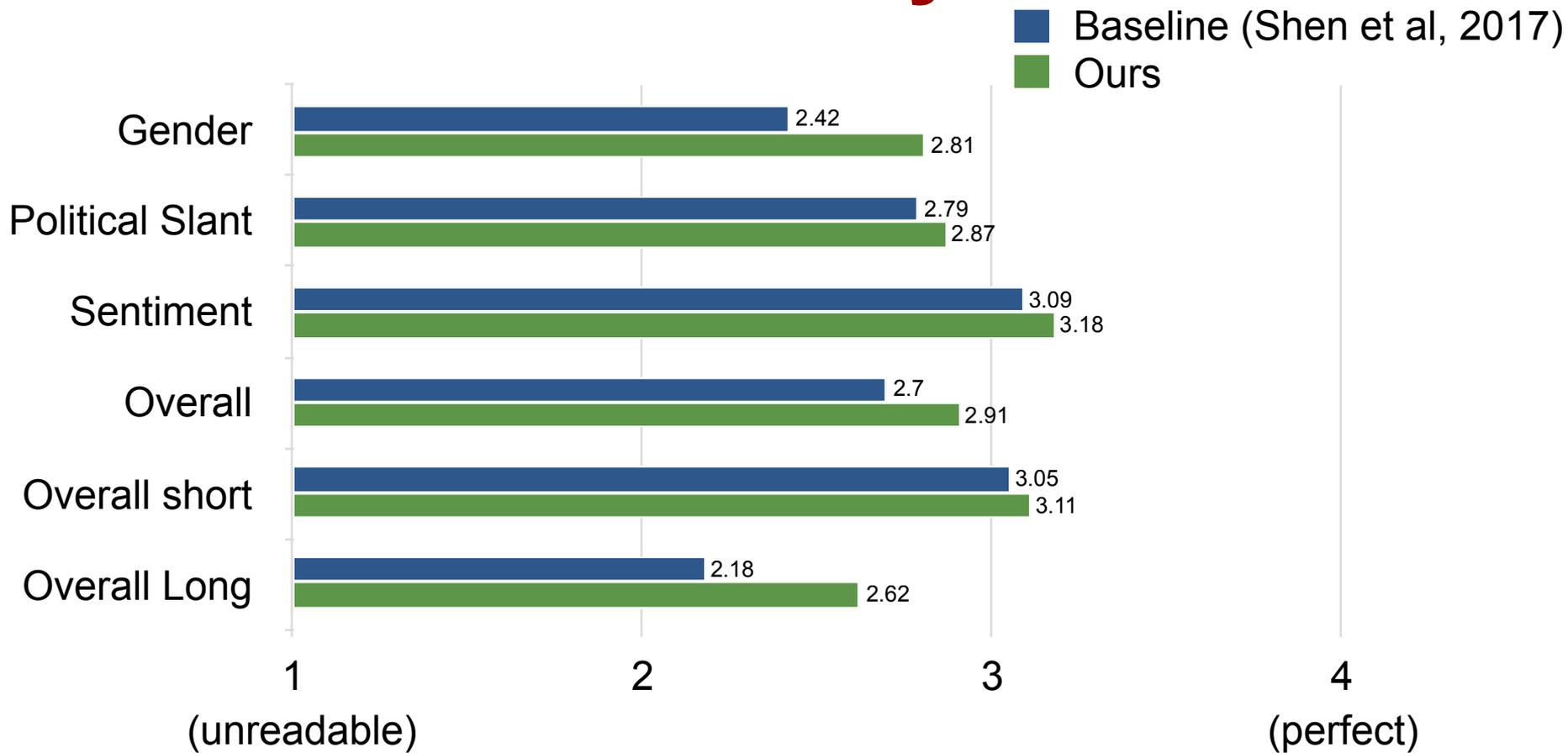


Which transferred sentence is semantically equivalent to the source sentence with an opposite sentiment

# Discussion

- generator loss function has two competing terms: improve meaning preservation and improve style transfer accuracy
- Sentiment modification task is not well-suited for evaluating style transfer
- The style-transfer accuracy for gender task is lower for BST model but the preservation of meaning is much better compared to baseline model and “No preference” option

# Fluency



# Gender Examples

- Male -- Female

*my wife ordered country fried steak and eggs.*

*My husband ordered the chicken salad and the fries.*

- Female -- Male

*Save yourselves the huge headaches,*

*You are going to be disappointed.*

# Political Slant Examples

- Republican -- Democratic

*I will continue praying for you and the decisions made by our government!*

*I will continue to fight for you and the rest of our democracy!*

- Democratic -- Republican

*As a hoosier, I thank you, Rep. Vislosky.*

*As a hoosier, I'm praying for you sir.*

# Sentiment Modification Examples

- Negative -- Positive

*This place is bad news!*

*This place is amazing!*

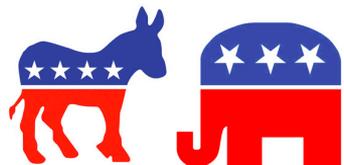
- Positive -- Negative

*The food is excellent and the service is exceptional!*

*The food is horrible and the service is terrible.*

# Overview

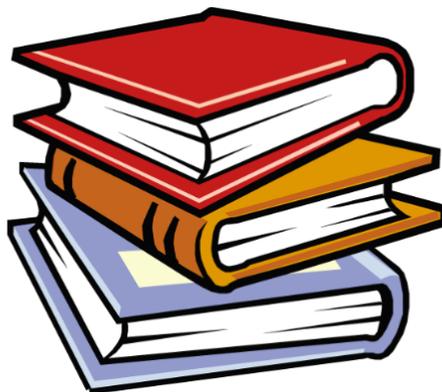
## Style



**Storytelling '19**  
**ACL '18**



## Content



**NAACL '19**  
**EMNLP '18**

## Structure



***under review***  
***ICLR '20***

# Content Transfer

After **graduate form** Columbia University, Obama worked in Chicago.

After **graduating from** Columbia University, Obama worked in Chicago.

After graduating from **Carnegie Mellon University**, Obama worked in Chicago.

After graduating from **Columbia University**, Obama worked in Chicago.

- AI assistance deals with *form* (grammar, style, etc.)
- Our goal is to control for *content*

# What is our task?

On 4 July 2011 several publications including the *Daily Mail*,<sup>[8]</sup> <sup>[10]</sup> *The Telegraph*, and *The Guardian*<sup>[11]</sup> picked up the story and published the pictures along with articles that quoted Slater as

spite

## Ape-rture priority photographer plays down monkey reports

Chris Cheesman July 5, 2011

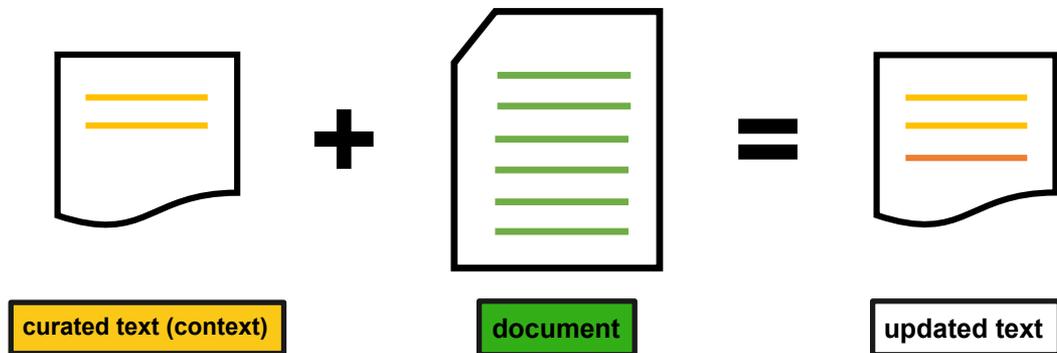
**A photographer who says he witnessed monkeys taking pictures of themselves, tells Amateur Photographer (AP) that much of the media coverage has been exaggerated.**

Wildlife photographer David Slater today played down newspaper reports that suggest a bunch of Indonesian monkeys grabbed his camera and began taking self-portraits.

Slater said reports that a monkey ran off with his camera and "began taking self-portraits" were incorrect and that the portrait was shot when his camera had been mounted on a tripod, with the primates playing around with a remote cable release as he fended off other monkeys.<sup>[14]</sup>



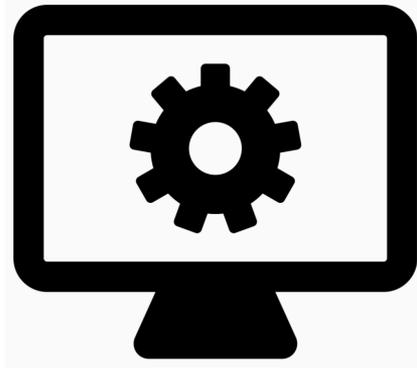
# Primary Contribution



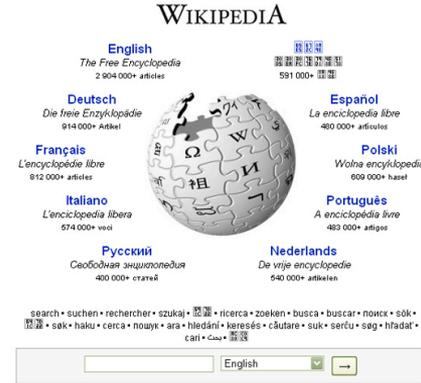
- design a task to perform content transfer from an unstructured source of information
- release dataset

# Applications

Software  
Documentation



Wikipedia  
Articles



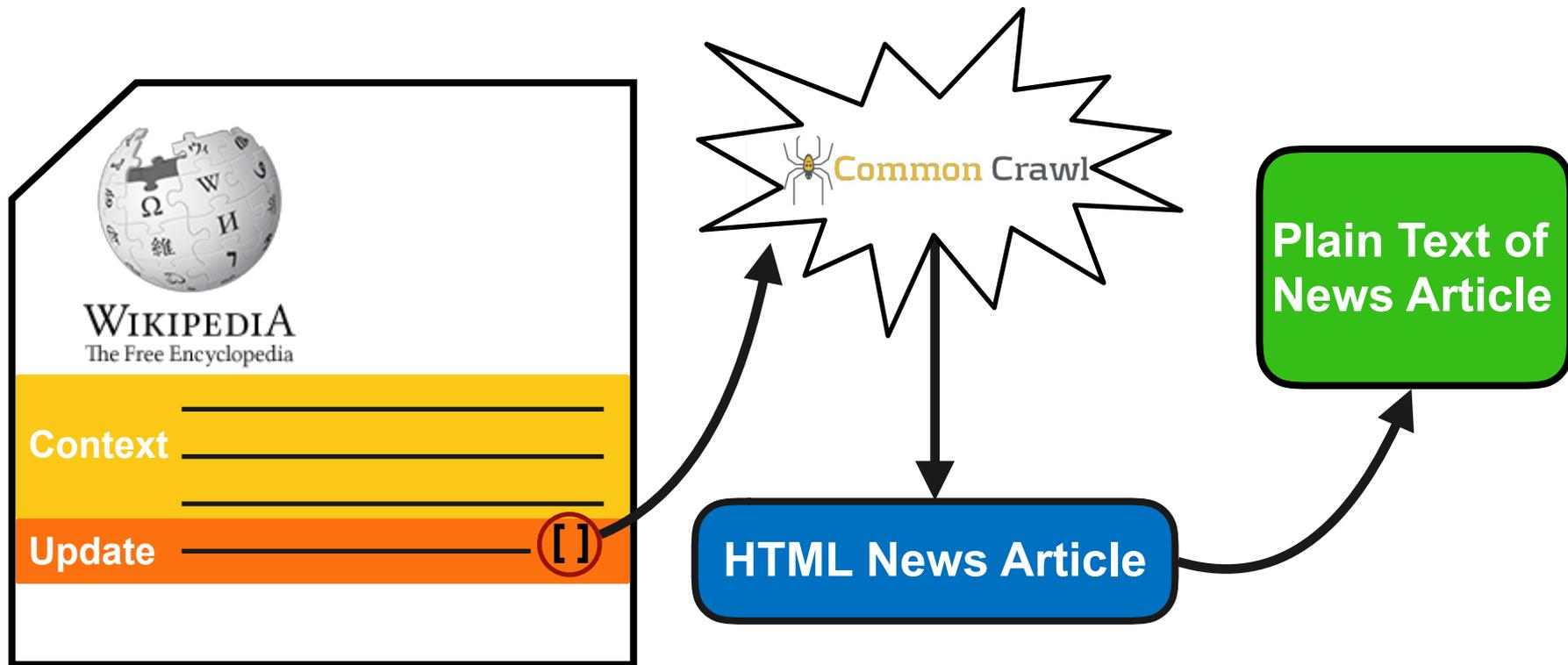
Inbox  
Summarization



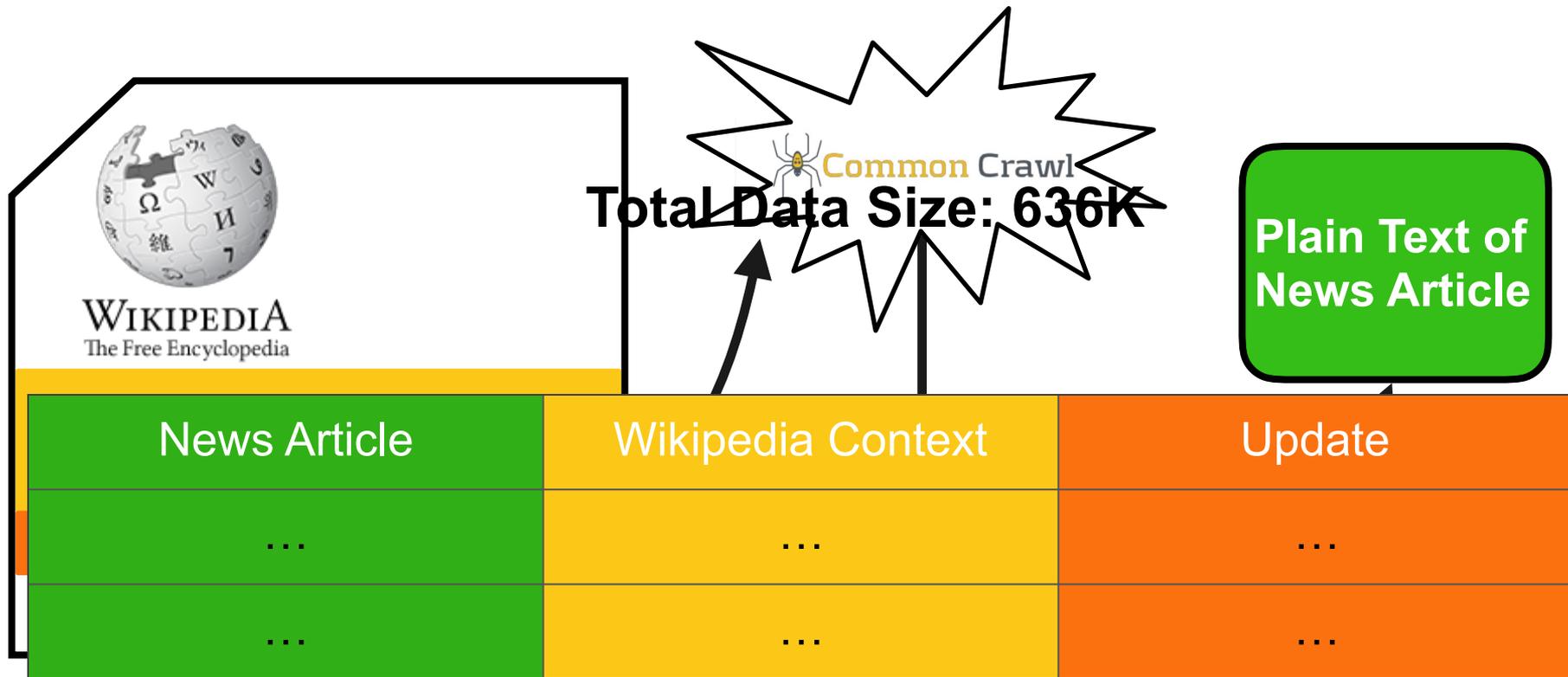
Legal  
Document



# Data Creation Process



# Data Creation Process



# Models

## Generative Models

- Context Agnostic Generative Model (CAG) — Baseline
- Context Informed Generative Model (CIG)
- Context Responsive Generative Model (CRG)

**all models have global attention**

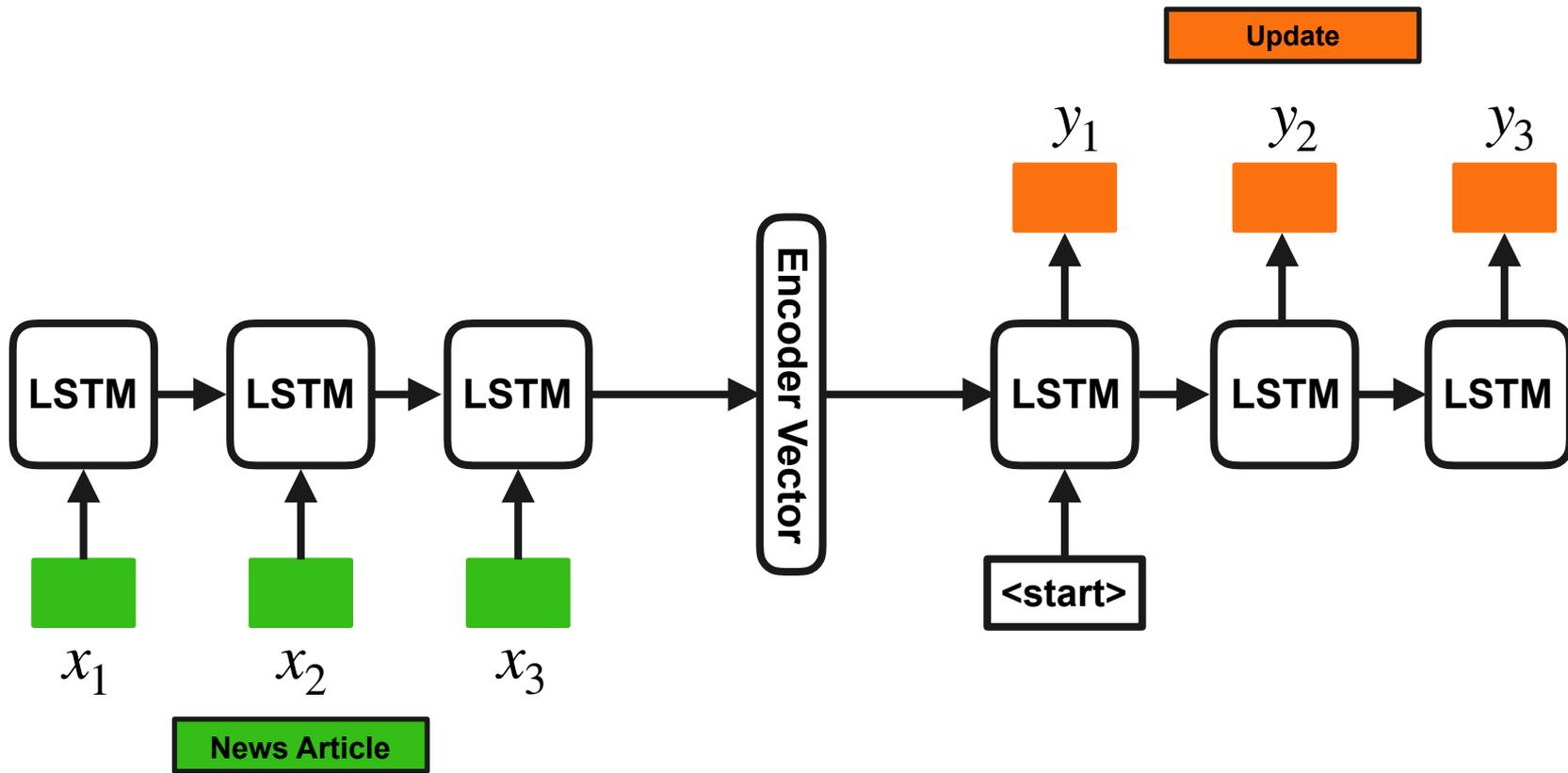
## Extractive Models

- SumBasic
- Context Informed SumBasic
- Oracle

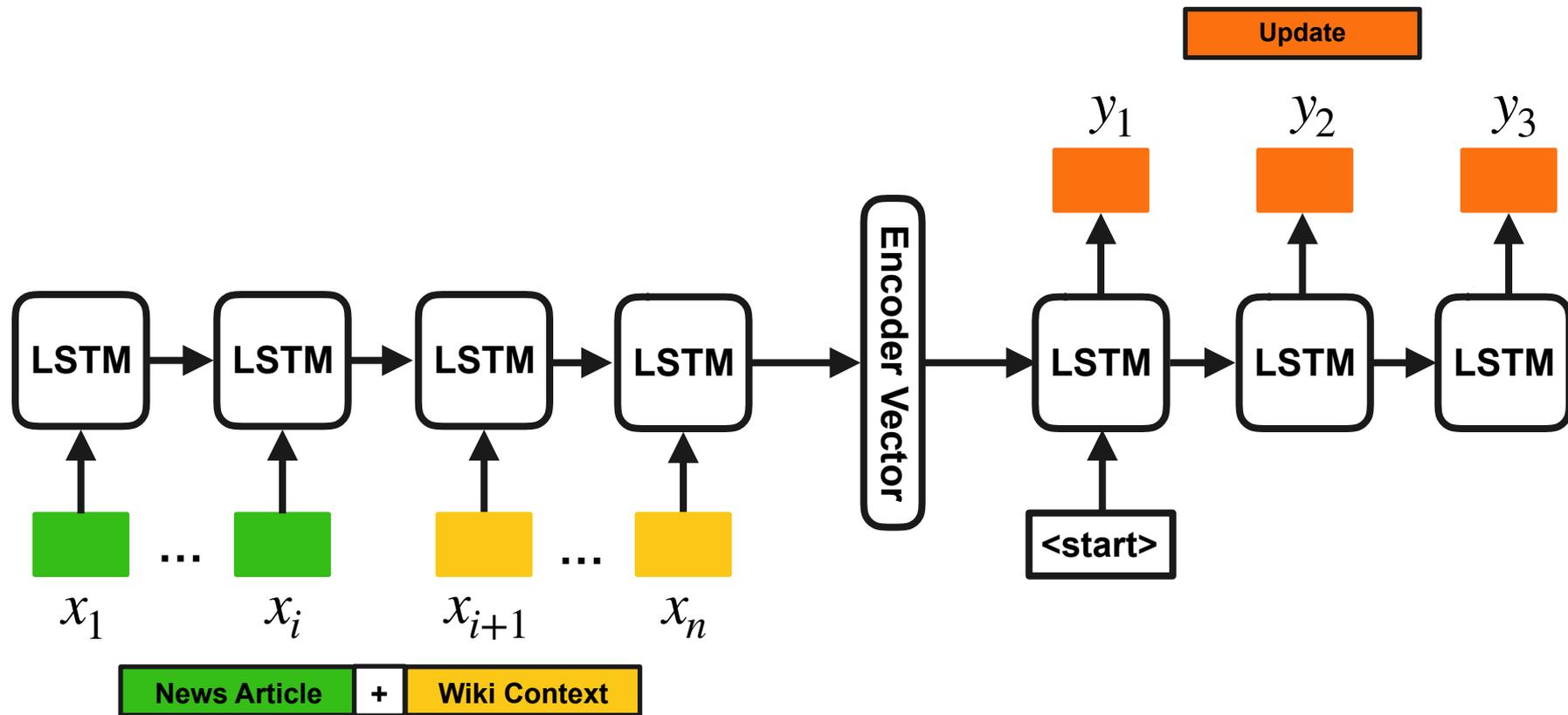
**all models are simplistic to infer if**

**context helps in generation**

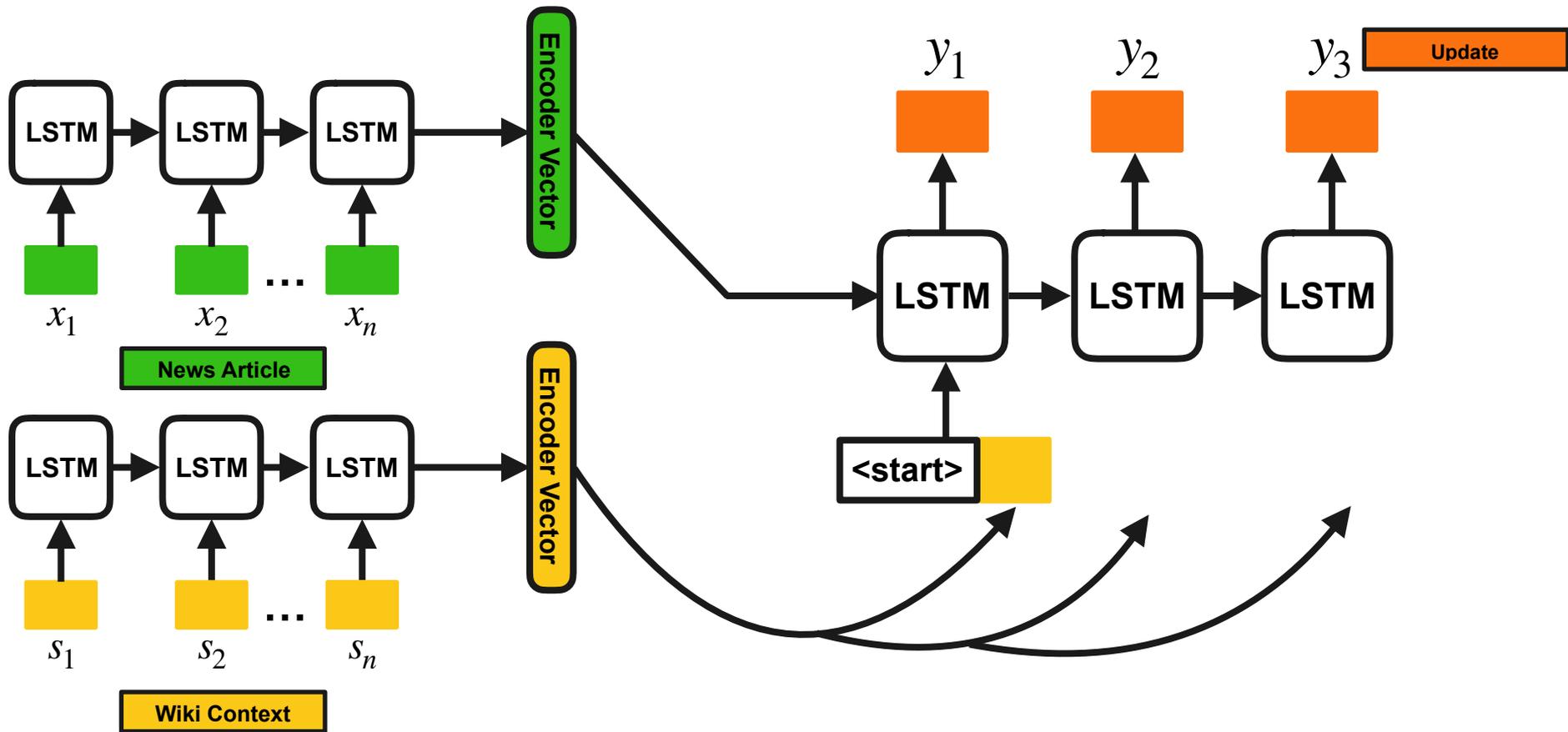
# Context Agnostic Model (CAG) - Baseline



# Context Informed Model (CIG)



# Context Responsive Model (CRG)



# Extractive Models

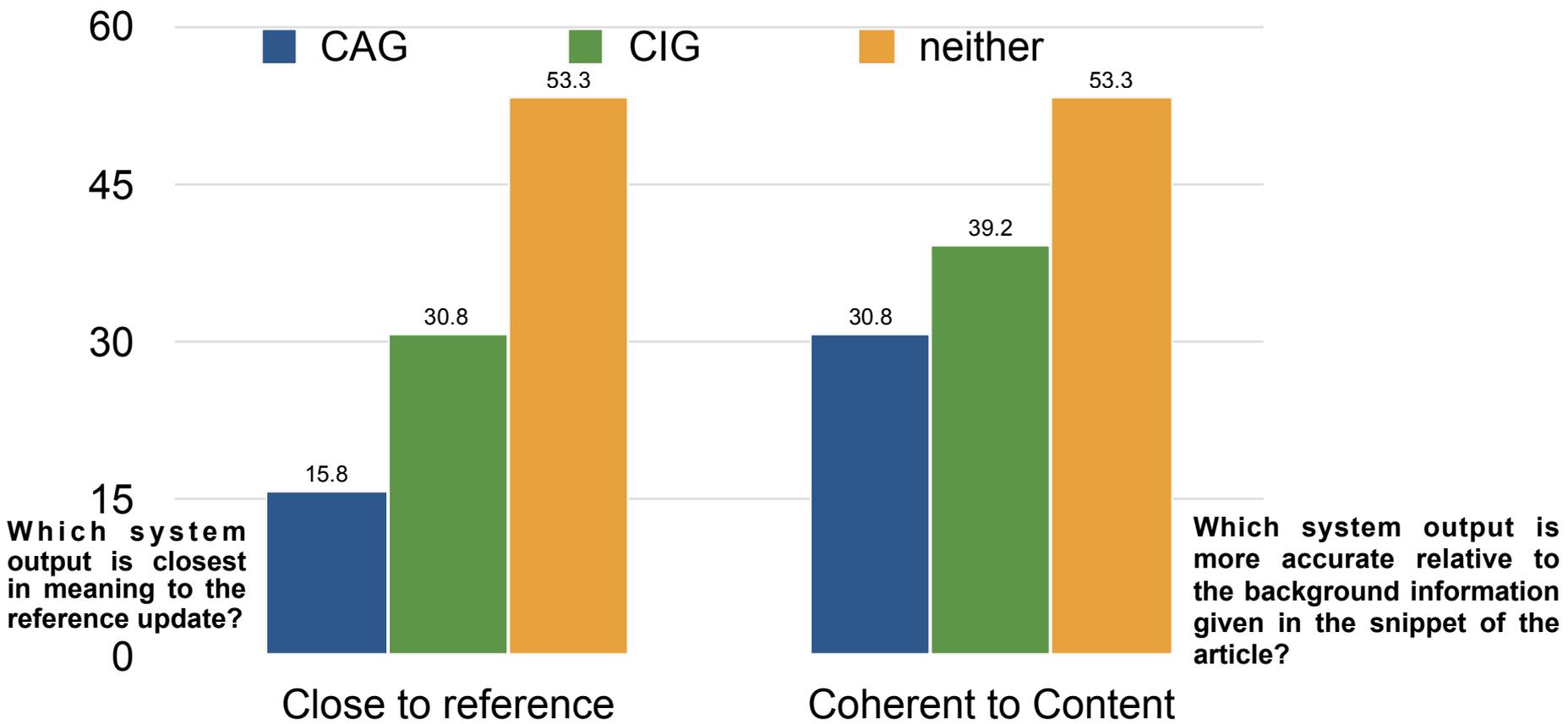
- ***SumBasic***: a model based on unigram probabilities
- ***Context Informed SumBasic***: the unigram probabilities take into account the words in the Wikipedia context.
- ***Oracle***: establish an upper limit attainable by extractive methods

# Automated Evaluation

Model	ROUGE-L
SumBasic	5.6 (5.6-5.7)
Context Informed SumBasic	7.0 (7.0-7.1)
Context Agnostic Generative Model	9.1 (9.0-9.2)
Context Informed Generative Model	<b>16.0 (15.9-16.1)</b>
Context Responsive Generative Model	14.7 (14.6-14.8)
Oracle	28.8 (28.7-29.0)

\* METEOR and BLEU numbers are consistent with ROUGE-L

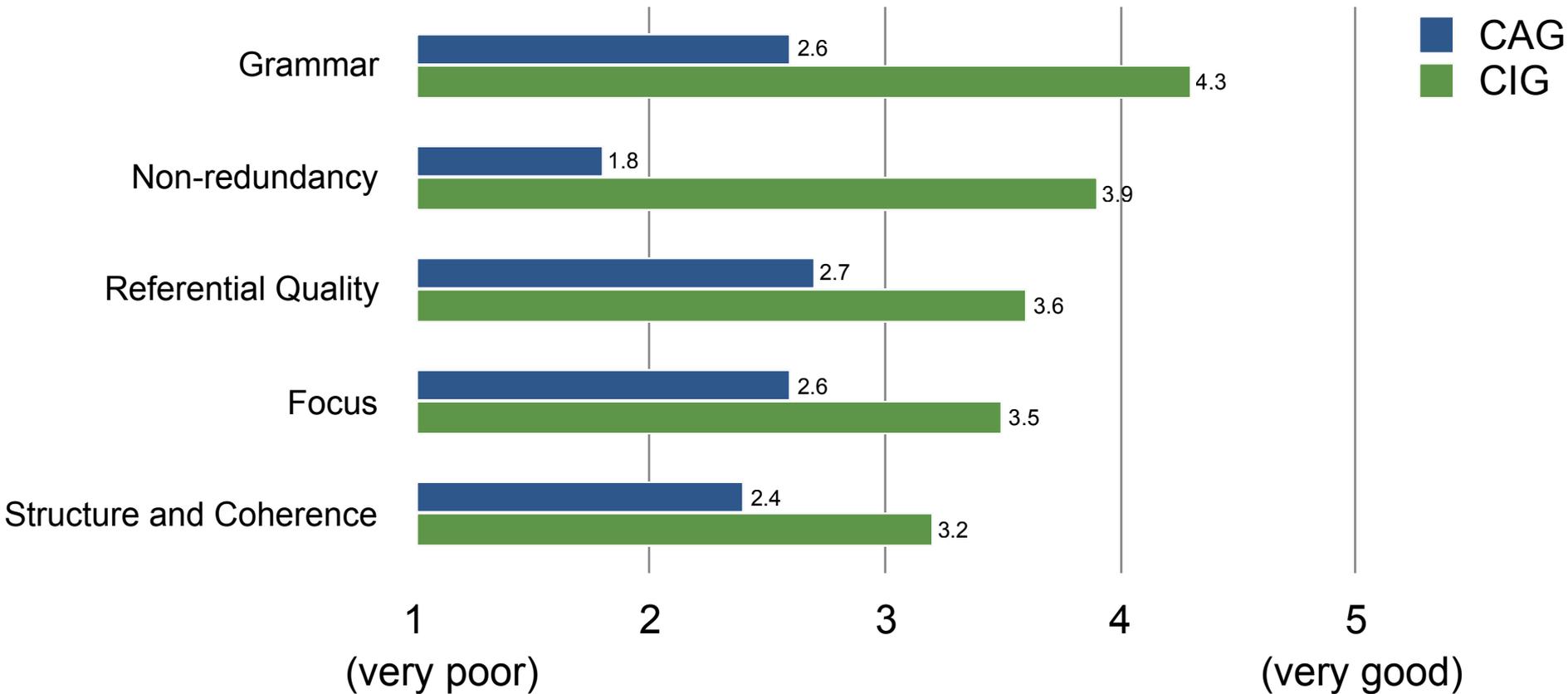
# Relative Human Evaluation



Which system output is closest in meaning to the reference update?

Which system output is more accurate relative to the background information given in the snippet of the article?

# Absolute Quality Evaluation

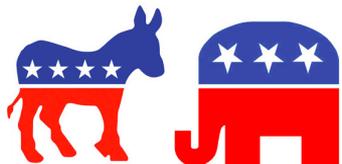


# Examples

Reference Update	CIG Generated Update
rob brydon, the comedian was born in baglan.	he was born in baglan
in may 2014 he was diagnosed with prostate cancer.	st. clair was diagnosed with prostate cancer.
on april 3, 2014, manning signed a one-year deal with the cincinnati bengals.	on march 9, 2014, manning signed a one-year contract with the cincinnati bengals.

# Overview

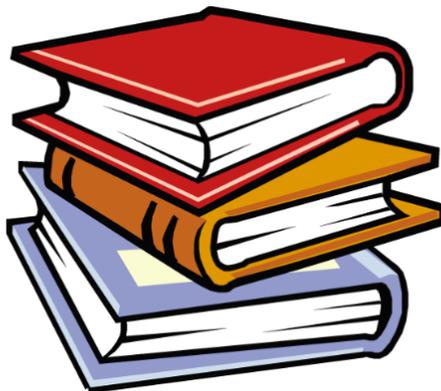
## Style



**Storytelling '19**  
**ACL '18**



## Content



**NAACL '19**  
**EMNLP '18**



## Structure



***under review***  
***ICLR '20***

# LGBT Rights in India

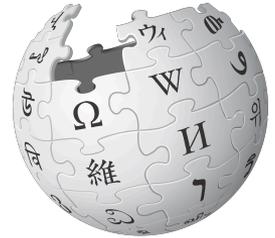
## Contemporary times [[edit](#)]

See also: *Navtej Singh Johar v. Union of India*

In 2003, the Indian Government said that legalising homosexuality would "open the floodgates of delinquent behaviour".<sup>[23]</sup>

In 2009, the Delhi High Court decision in *Naz Foundation v. Govt. of NCT of Delhi* found Section 377 and other legal prohibitions against private, adult, ...

On 23 February 2012, the [Ministry of Home Affairs](#) expressed its opposition to the decriminalisation of homosexual activity, stating that in India, homosexuality is seen as being immoral.<sup>[28]</sup> The Central Government reversed its stance on 28 February 2012, asserting that there was no legal error in decriminalising ...



**WIKIPEDIA**  
The Free Encyclopedia

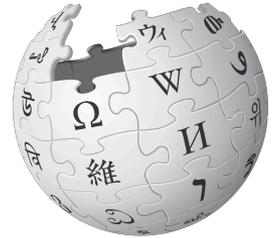
# LGBT Rights in India

On 11 December 2013, the Supreme Court set aside the 2009 Delhi High Court order decriminalising consensual homosexual activity within its jurisdiction.<sup>[30][31][32][33][34]</sup> ...

On 28 January 2014, the [Supreme Court of India](#) dismissed the review petition filed by the [Central Government](#), the [Naz Foundation](#) and several others against

On 18 December 2015, [Shashi Tharoor](#), a member of the [Indian National Congress](#) party, introduced a bill for the repeal of [Section 377](#), but it was rejected

On 2 February 2016, the Supreme Court decided to review the criminalisation of homosexual activity.<sup>[41]</sup> In August 2017, the Supreme Court unanimously ruled



**WIKIPEDIA**  
The Free Encyclopedia

# LGBT Rights in India

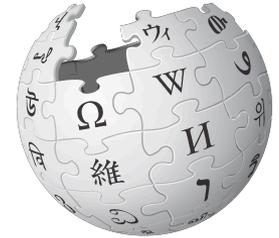
On 6 September 2018, the Supreme Court issued its verdict.<sup>[1]</sup> The Court unanimously ruled that Section 377 is unconstitutional as it infringed on the fundamental rights of autonomy, intimacy, and identity, thus legalising homosexuality in India.<sup>[50]</sup> The Court explicitly overturned its 2013 judgement.

Criminalising carnal intercourse is irrational, arbitrary and manifestly unconstitutional.

— Chief Justice [Dipak Misra](#)<sup>[51]</sup>



Participants of a 2018 [Bhopal](#) parade celebrating the ruling of the Supreme Court 🗨



**WIKIPEDIA**  
The Free Encyclopedia

# News Report on the Judgement



## India court legalises gay sex in landmark ruling

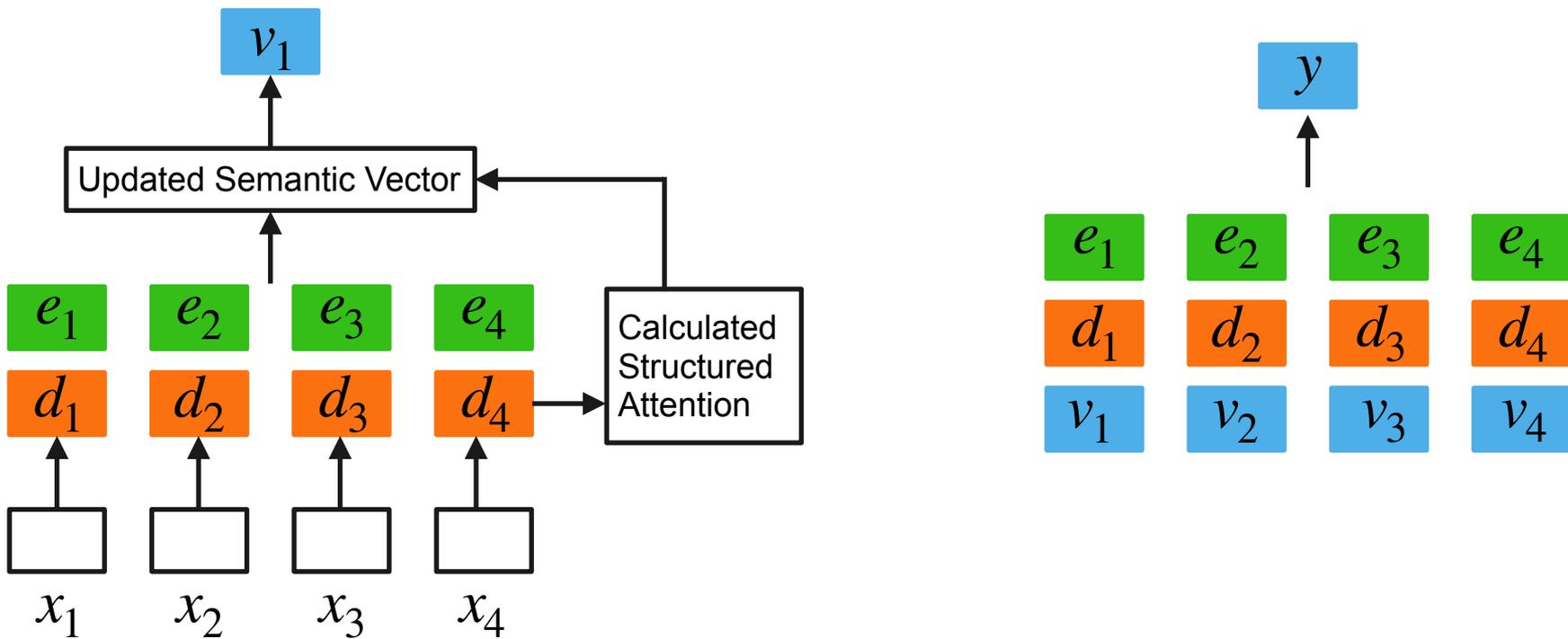
How did we get to this point?

It's been a tortuous route. A bid to repeal section 377 was initiated in 2001 and was batted between court and government until 2009, when the Delhi High Court ruled in favour of decriminalisation.

under which gay sex is categorised as an "unnatural offence".

# Prior Work

Learning Structured Text Representations (Liu and Lapata, 2018)



# Prior Work

- Hierarchical Attention Networks for Document Classification (Yang et al, 2016)
- Deep Attentive Sentence Ordering Network (Cui et al, 2018)
- Language Model Pre-Training for Hierarchical Document Representations (Chang et al, 2019)

# Success

## Evaluating Discourse in Structured Text Representations (Ferracane et al, NAACL 2019)

	Yelp	Debates	Writing Quality	Writing Quality Topic Control	Wall Street Journal Sent order
Liu et al (original)	<b>68.27</b> (0.19)	79.48 (2.90)	<b>82.69</b> (1.36)	79.63 (1.03)	<b>95.29</b> (0.84)
Liu et al (ours)	<b>68.23</b> (0.23)	77.81 (1.80)	<b>82.70</b> (1.36)	<b>81.11</b> (0.95)	<b>94.76</b> (1.11)
- doc attn	<b>68.13</b> (0.17)	<b>81.42</b> (1.08)	<b>82.80</b> (0.94)	79.25 (0.94)	<b>95.11</b> (0.42)
-both attn	68.05 (0.13)	77.34 (1.79)	<b>83.16</b> (1.25)	76.16 (1.25)	<b>94.68</b> (0.37)
Liu et al (reported)	68.6	76.5	-	-	-

# Nature of Trees

---

	Yelp	Debates	WQ	WQTC	WSJSO
tree height	2.049	2.751	2.909	4.035	2.288
prop. of leaf nodes	0.825	0.849	0.958	0.931	0.892
norm. arc length	0.433	0.397	0.420	0.396	0.426
% vacuous trees	73%	38%	42%	14%	100%

---

- shallow trees
- picks first or last two sentences as root and all other sentences are children

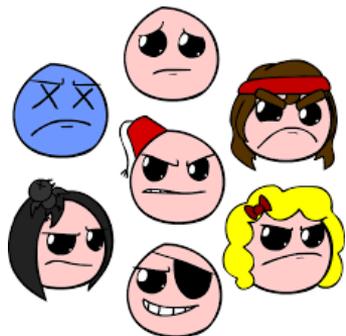
# My Questions

- Does structure help in generating documents?
- Do we need hierarchical architectures to capture structure?
- How to evaluate? Rhetorical Structure Theory?  
Something higher?

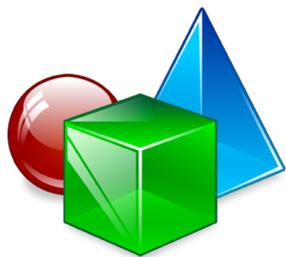
# Dialog Structures



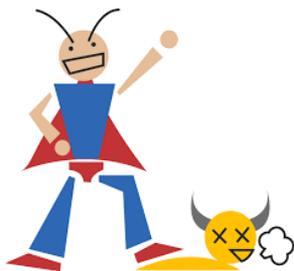
Setting



Persona



Objects



Actions



Emote

- Light Dataset: 663 locations, 3462 objects and 1755 characters
- Light is a stateful game engine

# Task

**RL Agent**

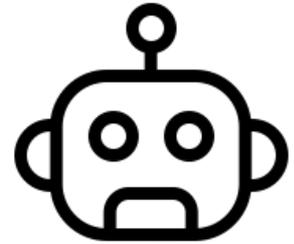
**Gets a goal to achieve**



**Speak**



**Environment**



**Speak and Act**

**RL Approach:** Policy has to pick a topic of the next utterance such that the goal is eventually achieved.

# Example

**RL Agent:** King; **Environment Agent:** Queen

---

**RL Persona:** I am a king of the whole empire. I give rules and pursue them. I am brave and fearless.

---

**Setting: Town Center, Town**

A lavish town full of stone buildings, most of which are two or three stories. They have ornate tin gutter fixtures with the water seeming to pour from the mouths of different animals.

---

**Goal for RL Agent:** hug king (The king has to say something to queen such that queen performs the action of hugging the king)

---

**King:** Hello my Queen, beautiful as ever!

**Queen:** Hello my dear, do you feel we are a prosperous kingdom these days?

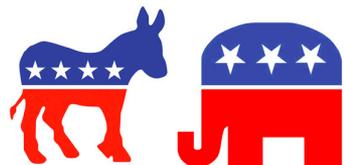
**Queen:** hug king

# Success

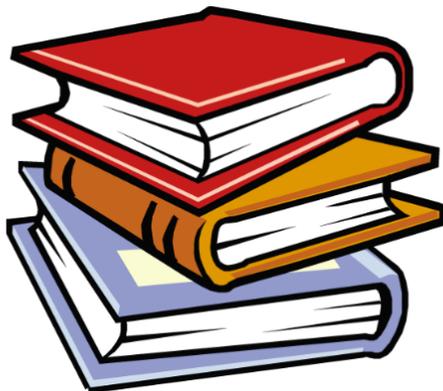
Model	Goal Type	Test Seen			Test Unseen		
		$(n = 1)$	$(n = 3)$		$(n = 1)$	$(n = 3)$	
		Reward	Reward	Turns	Reward	Reward	Turns
Inverse model	game act	0.223	0.414	2.42	0.193	0.410	2.48
Topic RL	game act	0.314	0.502	2.25	0.268	0.467	2.33
Top- $K$ RL	game act	0.319	0.460	2.37	0.270	0.450	2.39
Inverse model	emote	0.089	0.262	2.72	0.088	0.266	2.74
Topic RL	emote	0.170	0.342	2.63	0.146	0.326	2.64

# Model

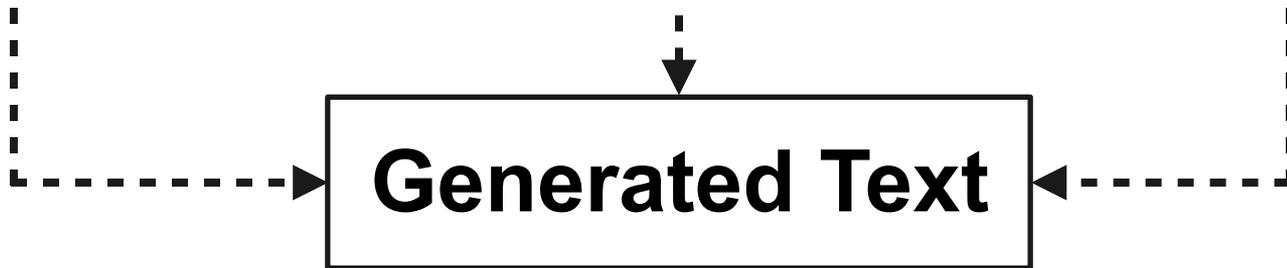
Style



Content

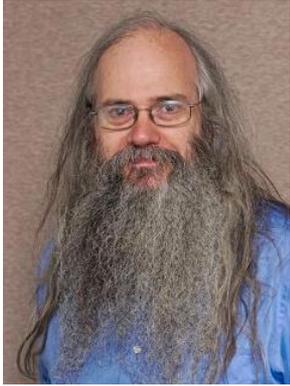


Structure



Generated Text

# Thank You!



**Alan W Black (co-advisor)**



**Ruslan Salakhutdinov (co-advisor)**



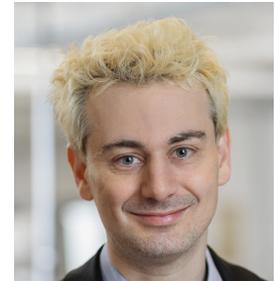
**Yulia Tsvetkov**



**Chris Quirk**



**Michel Galley**



**Jason Weston**