Controllable Text Generation

Should machines reflect the way humans interact in society?

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We constantly author text!

The key to human-like generation is Style, Content and Structure

Social Media

Personal/Professional documents

Blogs

News/Wiki articles
Style

- Expressed in the choice of *words or phrases* as well as *syntactic structures* used to convey information
- I define style as a group of natural language sentences that belong to a particular class or label.

“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

- Human communication by definition is a process by which individuals exchange information and influence one another through a common system of symbols and signs.
- Leverage information in the unstructured form
Alice: The Notebook is hands-down one of my favorite movies EVER! Have you ever seen The Notebook?

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

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

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

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

Bob: That is interesting. They never get the rating correct.

Alice: 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. 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.
Structure

The Lead: The most important information
May include a “hook” (provocative quote or question)

The Body: The crucial information
Argument, Controversy, Story, Issue
Evidence, background, details, logic, etc
Quotes, photos, support, dispute, expand

The Tail: extra information
Interesting/Related items like blogs, other editorials
Application

I have a talk to present today!
Application

I have a talk to present today!

Best of luck!
Application

I have a talk to present today!

Best of luck!
I have a talk to present today!

May the force be with you!
Application
Hey, have you watched Avengers Endgame
Hey, have you watched Avengers Endgame?

Yeah, I loved Bradley Cooper in it!
Hey, have you watched Avengers Endgame

Yeah, I loved Bradley Cooper in it!
Hey, have you watched Avengers Endgame

Yeah, I loved Robert Downey in it!
Hey, have you watched Avengers Endgame
Application

Hey, have you watched Avengers Endgame

Yeah, I loved the movie!
Application

oh
great! Can you tell me the story!
oh great! Can you tell me the story!

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

oh great! Can you tell me the story!

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

oh great! Can you tell me the story!

Structure

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.
Other Applications

- **Writing Assistance Tools**
  - recommend formal language
  - recommend structural changes
- Recommend *polite emails*
- **Story Generation**
  - plot, ending, sentiment, topic, persona
- **Content Generation** (websites, descriptions etc)
The key to human-like generation is Style, Content and Structure
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The key to human-like generation is Style, Content and Structure.
Converting non-polite sentences to polite sentences while preserving the meaning

Send me the data

Could you please send me the data?
Challenges

- Politeness is *culturally diverse*
Challenges

- Politeness is *culturally diverse*

Usage of “please” to closest friends.
Challenges

- Politeness is *culturally diverse*
- Politeness is *subtle*.
Challenges

● Politeness is *culturally diverse*

● Politeness is *subtle*.

*Indirect:* By the way, do you know when is the deadline?

*1st person plural:* Let us find a good name for this paper.
Challenges

- Politeness is *culturally diverse*
- Politeness is *subtle*.
- *Ill-defined* non-politeness class
Challenges

- Politeness is *culturally diverse*
- Politeness is *subtle*.
- *Ill-defined* non-politeness class

Existing literature to detect presence
Difficult to objectify absence
Challenges

- Politeness is *culturally diverse*
- Politeness is *subtle*.
- *Ill-defined* non-politeness class
- *Lack of data*
Challenges

- Politeness is *culturally diverse*
- Politeness is *subtle*.
- *Ill-defined* non-politeness class
- *Lack* of data
Overcoming Challenges

- Politeness accepted by *North American* English speakers in *formal* setting
Overcoming Challenges

- Politeness accepted by *North American* English speakers in *formal* setting
  - Politeness is *culturally diverse*
  - Politeness is *subtle*.
Overcoming Challenges

- Politeness accepted by *North American* English speakers in *formal* setting

- Convert only from non-polite to polite
Overcoming Challenges

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*ill-defined* non-politeness class
Overcoming Challenges

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- Convert *requests* to polite requests
Overcoming Challenges

- Politeness accepted by *North American* English speakers in *formal* setting
- Convert only from non-polite to polite
- Convert *requests* to polite requests

The sun rises in the east.
Overcoming Challenges

- Politeness accepted by *North American* English speakers in *formal* setting

- Convert only from non-polite to polite

- Convert *requests* to polite requests
Architecture
Add TAG words at positions where the polite phrases can appear
Add TAG words at positions where the polite phrases can appear
Architecture

Send me the data → Tagger → [TAG] send me the data → Generator

Add TAG words at positions where the polite phrases can appear

GENERATE context appropriate phrases in target style
Architecture

Send me the data

Tagger

[TAG] send me the data

Generator

Could you please send me the data

Add TAG words at positions where the polite phrases can appear

GENERATE context appropriate phrases in target style
Tagger and Generator are transformers

Send me the data

Tagger

[TAG] send me the data

Generator

Could you please send me the data

Add TAG words at positions where the polite phrases can appear

GENERATE context appropriate phrases in target style
Dataset Creation

- Enron Corpus
  - North American culture
  - Formal setting
  - Plenty requests
- Politeness classifier (Niu and Bansal, 2018)
Dataset Creation

- Enron Corpus
  - North American culture
  - Formal setting
  - Plenty requests
- Politeness classifier (Niu and Bansal, 2018)

1.39 million sentences!
Dataset Creation

Send me the data

Tagger

[TAG] send me the data

Generator

Could you please send me the data
Dataset Creation

Could you please send me the data
Dataset Creation

Could you please send me the data

Identify markers of politeness

Send me the data

Tagger

[TAG] send me the data

Generator

Could you please send me the data
Dataset Creation

Remove politeness markers

Could you please send me the data

Send me the data

Tagger

[TAG] send me the data

Generator

Could you please send me the data
Could you please send me the data

Replace politeness markers with with TAG token

Send me the data

Tagger

[TAG] send me the data

Generator

Could you please send me the data
Dataset Creation

Could you please send me the data

Send me the data → Tagger → [TAG] send me the data → Generator → Could you please send me the data
Dataset Creation

Could you please send me the data

Send me the data → Tagger → [TAG] send me the data → Generator → Could you please send me the data
Results

- CAE (Shen et al, 2017)
- BST (Prabhumoye et al, 2018)
- DRG (Li et al, 2018)
- Ours

Accuracy
- CAE: 99.62
- BST: 60.75
- DRG: 90.25
- Ours: 90.25

BLEU-s
- CAE: 2.55
- BST: 11.83
- DRG: 6.94
- Ours: 11.83

METEOR
- CAE: 9.19
- BST: 18.07
- DRG: 10.73
- Ours: 18.07

Rouge
- CAE: 25.71
- BST: 36.26
- DRG: 25.71
- Ours: 36.26
Results on Yelp sentiment, Amazon sentiment, gender, political slant, and Captions tasks are shown in paper.
### Examples

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Politeness Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>What happened to my personal station?</td>
<td>Could you please let me know what happened to my personal station?</td>
<td><em>could</em> and <em>would</em> are counterfactual forms which are polite</td>
</tr>
<tr>
<td>Yes, go ahead and remove it.</td>
<td>Yes, <em>we can</em> go ahead and remove it.</td>
<td>First person plural</td>
</tr>
<tr>
<td>Not yet - I’ll try this weekend</td>
<td>Sorry, not yet - I’ll try to make sure this weekend.</td>
<td>Apologizing</td>
</tr>
</tbody>
</table>
The key to human-like generation is Style, Content and Structure
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Content Transfer

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

Monkey selfie copyright dispute

The monkey selfie copyright dispute is a series of disputes about the copyright status of selfies taken by Celebes crested macaques using equipment belonging to the British nature photographer David Slater. The disputes involve Wikimedia Commons and the blog Techdirt, which have hosted the images following their publication in newspapers in July 2011 over Slater’s objections that he holds the copyright, and People for the Ethical Treatment of Animals (PETA), who have argued that the macaque should be assigned the copyright.

Slater has argued that he has a valid copyright claim, as he engineered the situation that resulted in the pictures by travelling to Indonesia, befriending a group of wild macaques, and setting up his camera equipment in such a way that a “selfie” picture might come about. The Wikimedia Foundation’s 2014 refusal to remove the pictures from its Wikimedia Commons image library was based on the understanding that copyright is held by the creator, that a non-human creator (not being a legal person) cannot hold copyright, and that the images are thus in the public domain.

A ape-ture priority photographer plays down monkey reports

Chris Cheesman
July 9, 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.

And he revealed that the shots, featuring the endangered crested black macaque monkey, were taken three years ago.

Speaking to AP, David explained that his camera had been mounted on a tripod when the animals...
The following day, *Amateur Photographer* reported that Slater gave them further explanation as to how the photographs were created, downplaying the way newspaper articles had described them; 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.¹³
What is our task?

Generate text that is:
• coherent to the Wikipedia context
• contains latest event from the article

The following day, Amateur Photographer reported that Slater gave them further explanation as to how the photographs were created, downplaying the way newspaper articles had described them; 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.
Primary Contribution
Primary Contribution

curated text (context)
Primary Contribution

curated text (context)
Primary Contribution

curated text (context) + document
Primary Contribution

curated text (context) + document = 
Primary Contribution

curated text (context) + document = updated text
Primary Contribution

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

Software Documentation
Applications

Software Documentation

Inbox Summarization
Applications

Software Documentation

Inbox Summarization

Legal Document
Data Creation Process
Data Creation Process
Data Creation Process
Data Creation Process

Context

Update
Data Creation Process

Context

Update
Data Creation Process

Context

Update

Common Crawl

Wikipedia
The Free Encyclopedia
Data Creation Process

Context

Update

HTML News Article
Data Creation Process

Context  

Update

HTML News Article

Plain Text of News Article
Data Creation Process

Total Data Size: 636K

<table>
<thead>
<tr>
<th>News Article</th>
<th>Wikipedia Context</th>
<th>Update</th>
</tr>
</thead>
<tbody>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
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<tr>
<td>…</td>
<td>…</td>
<td>…</td>
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</tbody>
</table>

Plain Text of News Article
<table>
<thead>
<tr>
<th>Generative Models</th>
<th>Extractive Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Context Agnostic Generative Model (CAG) — Baseline</td>
<td>• SumBasic</td>
</tr>
<tr>
<td>• Context Informed Generative Model (CIG)</td>
<td>• Context Informed SumBasic</td>
</tr>
<tr>
<td>• Context Responsive Generative Model (CRG)</td>
<td>• Oracle</td>
</tr>
<tr>
<td>all models have global attention</td>
<td>all models are simplistic to infer if context helps in generation</td>
</tr>
</tbody>
</table>
Context Agnostic Model (CAG) - Baseline

News Article:

\[
x_1 \xrightarrow{\text{LSTM}} x_2 \xrightarrow{\text{LSTM}} x_3 \xrightarrow{\text{Encoder Vector}} \text{Encoder Vector} \xrightarrow{\text{LSTM}} y_1 \xrightarrow{\text{LSTM}} y_2 \xrightarrow{\text{LSTM}} y_3
\]

Update:

\[
<\text{start}> \xrightarrow{\text{LSTM}} \text{Encoder Vector} \xrightarrow{\text{LSTM}} y_1 \xrightarrow{\text{LSTM}} y_2 \xrightarrow{\text{LSTM}} y_3
\]
Context Informed Model (CIG)

News Article + Wiki Context

x₁ \rightarrow LSTM \rightarrow LSTM \rightarrow LSTM \rightarrow LSTM

Encoder Vector

y₁ \rightarrow LSTM \rightarrow LSTM \rightarrow LSTM

<start>
Context Receptive Model (CRG)
## Automated Evaluation

<table>
<thead>
<tr>
<th>Model</th>
<th>ROUGE-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>SumBasic</td>
<td>5.6 (5.6-5.7)</td>
</tr>
<tr>
<td>Context Informed SumBasic</td>
<td>7.0 (7.0-7.1)</td>
</tr>
<tr>
<td>Context Agnostic Generative Model</td>
<td>9.1 (9.0-9.2)</td>
</tr>
<tr>
<td>Context Informed Generative Model</td>
<td>16.0 (15.9-16.1)</td>
</tr>
<tr>
<td>Context Receptive Generative Model</td>
<td>14.7 (14.6-14.8)</td>
</tr>
<tr>
<td>Oracle</td>
<td>28.8 (28.7-29.0)</td>
</tr>
</tbody>
</table>

* METEOR and BLEU numbers are consistent with ROUGE-L
Which system output is closest in meaning to the reference update?

- CAG: 15.8%
- CIG: 30.8%
- neither: 53.3%

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

- CAG: 30.8%
- CIG: 39.2%
- neither: 53.3%
The key to human-like generation is Style, Content and Structure
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Sentence Ordering Task
Ironman builds a time machine to save the world.

Ironman steals the Infinity Stones back from Thanos and uses them to disintegrate Thanos and his army, at the cost of his life.

Hulk travels to New York City in 2012 and convinces the Ancient One to give him the Time Stone.

Thor decapitates Thanos.

Five years later, AntMan escapes from the quantum realm.

Ironman builds a time machine to save the world.
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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.
Methodology

- Constraint Solving Problem vs Sequence Prediction Task
- For a document with $n$ sentences ($\{s_1 \ldots s_n\}$)
  - $|C| = \binom{n}{2}$ constraints
- Predicted constraints of the form $s_1 < s_2$
- 4 sentences in a document then 6 constraints
  - $\{s_1 < s_2, s_1 < s_3, s_1 < s_4, s_2 < s_3, s_2 < s_4, s_3 < s_4\}$
- Topological sort to find an order given $C$
  - Graph: $s_1 \rightarrow s_2$ if $s_1 < s_2$
Constraint Learning

- **BERT based Representation (B-TSort)**
  - Next Sentence Prediction
  - MLP(BERT($s_1$[SEP]$s_2$))

- **LSTM based Representation (L-TSort)**
  - $h_1 = LSTM(s_1); h_2 = LSTM(s_2)$
  - MLP([h_1; h_2])
Baselines

- **Attention Order Network (AON)**
  - LSTM: sentence representation
  - Transformer: document representation
  - LSTM decoder: generate order

- **BERT Attention Order Network (B-AON)**
  - BERT: sentence representation
Results for NIPS abstracts

- **AON**
- **L-TSort**
- **B-AON**
- **B-TSort**

### Metrics
- **Perfect Match**
- **Sentence Acc**
- **Kendall Tau**
- **Rouge-S**
- **LCS**

### Values
- **Perfect Match**:
  - AON: 16.25
  - L-TSort: 43.08
  - B-AON: 61.48
  - B-TSort: 81
- **Sentence Acc**:
  - AON: 50.5
  - L-TSort: 67
  - B-AON: 64
  - B-TSort: 80.97
- **Kendall Tau**:
  - AON: 67
  - L-TSort: 73
  - B-AON: 80.08
  - B-TSort: 87.97
- **Rouge-S**:
  - AON: 76.29
  - L-TSort: 83.65
  - B-AON: 74.38
  - B-TSort: 83.45
- **LCS**:
  - AON: 83.45
  - L-TSort: 73
  - B-AON: 67
  - B-TSort: 87.97
Results for NIPS abstracts

<table>
<thead>
<tr>
<th></th>
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<tr>
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entire sequence was correctly predicted
Results for NIPS abstracts

- **Perfect Match**
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  - B-AON: 55.23
  - B-TSort: 61.48

- **Kendall Tau**
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  - AON: 80.97
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  - B-TSort: 87.97

- **LCS**
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  - B-TSort: 83.45

Absolute position was correctly predicted.
Results for NIPS abstracts

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number of inversions to reach correct order
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</tbody>
</table>
Results for NIPS abstracts

- L-TSort performs close to AON
Results for NIPS abstracts

- B-AON performs better than AON

<table>
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<tr>
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• B-AON performs better than AON
Results for NIPS abstracts

- B-TSort performs the best

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Results for Human Evaluation

B-TSort vs B-AON
- B-TSort: 41
- No Preference: 28
- B-AON: 31

B-TSort vs Gold
- B-TSort: 26
- No Preference: 20
- Gold: 54

B-AON vs Gold
- B-AON: 22
- No Preference: 24
- Gold: 54
Results

- B-TSort performs best in all metrics for SIND captions, NSF abstract, AAN abstract datasets

- Analysis of *displaced sentences*
  - distance between the predicted position and the actual position of a sentence.
  - B-TSort displaces less sentences.

- Analysis of documents with more than 10 sentences
  - B-TSort also performs better for longer sentences

- Percentage of *mismatch* in input and output for AON
  - Order generation can have a mismatch between the input sentences and the generated orders.
  - This problem does not arise for our models.
The key to human-like generation is Style, Content and Structure
The key to human-like generation is Style, Content and Structure
Ethical Considerations

- Swear words, obscenity, bias, hate speech
- Broader Impact of controllable text generation
- Social good and bad applications
  - Generate persuasive tweets to spread awareness about climate change
  - Generate persuasive social media content to keep people away from vaccines
Ethical Frameworks

- Grounding in the relevant literature outside AI.
- Respect for Autonomy
  
  An agent should not adopt an action plan that the agent is rationally constrained to believe is inconsistent with an ethical action plan of another agent, without informed consent.
  
  - interacting and conveying complex information in natural language

- Interactional Fairness
  
  - respect, dignity, politeness, detecting objectionable content

- Generalization principle
  
  [An agent] must be rational in believing that the reasons for action are consistent with the assumption that everyone with the same reasons will take the same action.
  
  - NLP can be used to extract evidence/rationales
The key to human-like generation is Style, Content and Structure
The key to human-like generation is **Style, Content and Structure**

**Style:** new model for style transfer and new styles like politeness, political slant, and gender.

**Content:** define new tasks to perform content grounded generation from unstructured data.

**Structure:** new framing of the sentence ordering task and the model is the new state-of-the-art.
Thank You!

- Alan W Black (co-advisor)
- Ruslan Salakhutdinov (co-advisor)
- Yulia Tsvetkov (committee member)
- Jason Weson (committee member)
- Michel Galley (collaborator)
- Chris Quirk (collaborator)
Thank You!

- Aman Madan
- Amrith Setlur
- Tanmay Parekh
- Kangyan Zhou