Towards Controllable Text Generation

He He
AWS / NYU

NeuralGen Workshop at NAACL 2019
Generate from language models

The neural generation workshop is held today in Minneapolis. We will talk about some of the exciting developments in neurogenetics, brain models, and the development of neural networks from the neural genomics perspective.
Density estimation

\[ p(y \mid x) \]

Large amounts of labeled data
- Language modeling
- Machine translation
- Summarization
- Dialogue
- Creative text generation
Density estimation

\[ p(y \mid x) \]

Conflate grammaticality and task objectives

- Starting from scratch
- Undesired trade-offs
  - Fluency vs adequacy [Tu et al., 2016; Koehn and Knowles, 2017]
  - Fluency vs faithfulness [Wiseman et al., 2015; See et al., 2017]
Classic NLG

- **Edit action** (see survey by [Nenkova and McKeown, 2012])
  Throngs of Golden State Warriors fans turned out for a victory parade to celebrate a team some are calling an NBA dynasty.

- **Sentence realization** [Reiter and Dale, 1995]
  Do you like [foodType] food?
Outline

• Strong inductive bias on the generative process
  • Text attribute transfer
  • Pun generation
  • Decouple strategy and generation
  • Negotiation dialogue
Delete, Retrieve, Generate: a Simple Approach to Sentiment and Style Transfer

NAACL 2018

Juncen Li  Robin Jia  Percy Liang
Text attribute transfer

• Control aspects of output
  The soup was **bland**.  ➔  The soup was **tasty**.

  No parallel data!
  (negative sentence, positive sentence)
  (sentence, negative / positive)
A generative model

How to separate content and attribute?

Negative
The soup was bland.
Very rude staff!

Positive
Yummy chicken wings!
Definitely recommend.
A generative model

Attribute

Content → Model → Sentence

How to separate content and attribute?

Negative
The soup was bland.  Very rude staff!

Positive
Yummy chicken wings!  Definitely recommend.

Local text spans as attribute markers
Key idea: replace attribute markers

The soup was bland.

The soup was ____.

The soup was yummy.

1. Delete source attribute markers

2. Replace them with target attribute markers
Extract attribute markers

Negative

- - - - - - - -
- - - - - - - -
- - - - - - - -
- - - - - - - -
- - - - - - - -

Positive

- - - - - - - -
- - - - - - - -
- - - - - - - -
- - - - - - - -
- - - - - - - -

n-grams

frequency

hated
very disappointed
won’t be back
...

n-grams

frequency

great place for
well worth
delicious
...

Delete and generate

The soup was tasty.

The soup was ____.
The soup was highly recommended.

Great prices!
The gumbo was delicious
Highly recommend the soup!
Fast service and polite staff
...

The soup was ___.
Train / Test

- **Train**
  - negative $\rightarrow$ negative
  
The soup was ____.

  noise( bland ) $\rightarrow$ The soup was **bland**.

- **Test**
  - negative $\rightarrow$ positive
  
The soup was ____.

  highly recommend $\rightarrow$ The soup was **highly recommended**.
End-to-end adversarial training

Adversarial discriminator

Either delete too little or too much

Content → Decoder → The soup was bland.

The soup was bland.

[Shen et al., 2018; Fu et al., 2018]
Evaluation

• Average over 3 datasets
  • Sentiment for Yelp reviews [Shen et al., 2017] and Amazon reviews [He and McAuley, 2016]
  • Factual to romantic/humorous style for image captions [Gan et al., 2017]

• Human Evaluation
  • Likert scale from 1-5 for grammaticality, attribute transfer, content preservation
  • Overall success: get ≥ 4 on each category
## Results

<table>
<thead>
<tr>
<th>Model</th>
<th>Attr</th>
<th>Cont</th>
<th>Gram</th>
<th>Succ</th>
</tr>
</thead>
<tbody>
<tr>
<td>StyleEmbedding [Fu et al., 2018]</td>
<td>2.6</td>
<td>3.2</td>
<td>3.3</td>
<td>12%</td>
</tr>
<tr>
<td>MultiDecoder [Fu et al., 2018]</td>
<td>3.0</td>
<td>2.8</td>
<td>3.1</td>
<td>11%</td>
</tr>
<tr>
<td>CrossAligned [Shen et al., 2017]</td>
<td>3.2</td>
<td>2.4</td>
<td>3.3</td>
<td>12%</td>
</tr>
<tr>
<td>Retrieval Baseline</td>
<td><strong>3.7</strong>✅</td>
<td>2.7 ✗</td>
<td><strong>4.1</strong>✅</td>
<td>23%</td>
</tr>
<tr>
<td>Template Baseline</td>
<td>3.5✅</td>
<td><strong>3.9</strong>✅</td>
<td>3.2 ✗</td>
<td>24%</td>
</tr>
<tr>
<td>Delete</td>
<td>3.6✅</td>
<td>3.6✅</td>
<td>3.4</td>
<td>27%</td>
</tr>
<tr>
<td>Delete+Retrieve</td>
<td><strong>3.7</strong>✅</td>
<td>3.6✅</td>
<td><strong>3.7</strong>✅</td>
<td>34%</td>
</tr>
<tr>
<td>Human</td>
<td>4.1</td>
<td>4.1</td>
<td>4.4</td>
<td>58%</td>
</tr>
<tr>
<td>Source:</td>
<td>we sit down and we got some really slow and lazy service.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CrossAligned:</td>
<td>we went down and we were a good, friendly food.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>StyleEmbedding:</td>
<td>we sit down and we got some really slow and prices suck.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MultiDecoder:</td>
<td>we sit down and we got some really and fast food.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Template:</td>
<td>we sit down and we got some the service is always great and even better service.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrieval:</td>
<td>i got a veggie hoagie that was massive and some grade a customer service.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delete:</td>
<td>we sit down and we got some great and quick service.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delete+Retrieve:</td>
<td>we got very nice place to sit down and we got some service.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Outline

- Strong inductive bias on the generative process
  - Text attribute transfer
  - Pun generation
- Decouple strategy and generation
  - Negotiation dialogue
Pun Generation with Surprise

NAACL 2019

Nanyun Peng
Percy Liang
Homophonic pun generation

Input
Pun word: dyed
Alternative word: died

Output
Yesterday I accidentally swallowed some food coloring. The doctor says I'm OK, but I feel like I've dyed (died) a little inside.
Challenges

Think out of the distribution

Lack of training data
Structure of puns

The magician got so mad that he pulled his hare out.

- Ambiguity is not enough
- Distinctive support [Kao et al., 2015]
- Local-global surprisal
Instantiate the principle as a metric

\[
\text{surprisal} = -\frac{\log p(\ldots \text{hare} \ldots)}{\log p(\ldots \text{hair} \ldots)}
\]

\[
\text{funniness} \propto \frac{\text{local surprisal}}{\text{global surprisal}}
\]

Correlates with human ratings but not robust enough as an objective

[Levy. 2015]
Instantiate the principle as an algorithm

hare, hair

retrieved

the man stopped to get a hair cut.

swapped

the man stopped to get a hare cut.

inserted

the greyhound stopped to get a hare cut.

local surprisal ↑

global surprisal ↓
Instantiate the principle as an algorithm

- Find related words with “distant” skip-gram model $p_\theta(w_i \mid w_j)$

- Avoid degenerating into nonsense

  Each person must pay their fare share.

  *Ship*

  Type-consistency check

  Negotiator

  *I am just a woman trying to peace her life back together.*

  Neural LM smoother
Experiments

- Baselines
  - Neural Joint Decoder [Yu et al., 2018]

- Retrieve with the pun word
- Ablations of our system
Evaluation

- **Grammaticality**
  - How grammatical is the sentence?
- **Funniness**
  - How funny is the sentence?
- **Success**
  - Is the sentence a pun? (Given definition from [Miller et al., 2017])
## Results

<table>
<thead>
<tr>
<th>Model</th>
<th>Gram</th>
<th>Funn</th>
<th>Succ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neural Joint Decoder</td>
<td>2.6</td>
<td>1.4</td>
<td>9.2%</td>
</tr>
<tr>
<td>Retrieve</td>
<td>3.9</td>
<td>1.3</td>
<td>4.6%</td>
</tr>
<tr>
<td>Retrieve + Swap</td>
<td>3.5</td>
<td>1.6</td>
<td>27%</td>
</tr>
<tr>
<td>Retrieve + Swap + Topic (SurGen)</td>
<td>3.0</td>
<td>1.7</td>
<td>31.4%</td>
</tr>
<tr>
<td>Retrieve + Swap + Topic + Smoother</td>
<td>2.9</td>
<td>1.7</td>
<td>28.8%</td>
</tr>
<tr>
<td>Human</td>
<td>3.8</td>
<td>3.0</td>
<td>78.9%</td>
</tr>
</tbody>
</table>

Common sentence
Examples

gladiator left the room for a moment and i answered the ground lion.

That’s because negotiator got my car back in one peace.

Even from the outside, I could tell that he’d already lost some wait.

and as progeny obliquely indicated to you yesterday, you do n't have to do that much to urn (earn) it.

because stooge think he's my son come back to them,' jessica said, her voice board (bored).
Summary

- Domain knowledge helps generation with less data/supervision
- Neural LM as a smoother
- Trade coverage for quality
Outline

- Strong inductive bias on the generative process
  - Text attribute transfer
  - Pun generation
- Decouple strategy and generation
  - Negotiation dialogue
Decouple Strategy and Generation in Negotiation Dialogues

EMNLP 2018

Derek Chen
Anusha Balakrishnan
Percy Liang
Negotiation

Decision-making in conversations.
Craigslist negotiation

1402 postings
6682 dialogues
~9 turns / dialogue
~16 words / turn
~1.2K vocab
## Rich negotiation language

<table>
<thead>
<tr>
<th>Buyer</th>
<th>Hello do you still have the TV?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seller</td>
<td>Hello, yes the TV is still available.</td>
</tr>
<tr>
<td>Buyer</td>
<td>What condition is it in? Any scratches or problems? <em>I see it recently got repaired,</em> post details</td>
</tr>
<tr>
<td>Seller</td>
<td>It is in great condition and <em>works like a champ!</em> I just installed a new lamp in it, embellishment</td>
</tr>
<tr>
<td>Buyer</td>
<td>All right. Well I think 275 is a little high for a 10 year old TV. Can you lower the price some? How about 150?</td>
</tr>
<tr>
<td>Seller</td>
<td>I am willing to lower the price, but $150 is a little low. How about $245 and <em>if you are not too far from me, I will deliver it to you for free,</em> side offer</td>
</tr>
<tr>
<td>Buyer</td>
<td>It's still 10 years old and the technology is much older, and you deliver it. How's that sound?</td>
</tr>
<tr>
<td>Seller</td>
<td>Okay, that sounds like a deal!</td>
</tr>
<tr>
<td>Buyer</td>
<td>Great thanks!</td>
</tr>
<tr>
<td>Seller</td>
<td>OFFER{&quot;price&quot;: 225.0, &quot;sides&quot;: &quot;&quot;}</td>
</tr>
<tr>
<td>Buyer</td>
<td>ACCEPT OFFER</td>
</tr>
</tbody>
</table>
Supervised learning with seq2seq

Scenario

Previous utterances

Current utterance

Multiple attention

Output
Evaluation: setup

A/B testing on Amazon Mechanical Turk

SL(word)

Random pairing

• Task-oriented metric: reward
• Human-likeness: “Do you think your partner demonstrated reasonable human behavior?”
Supervised learning

<table>
<thead>
<tr>
<th></th>
<th>Human-likeness</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>4.3</td>
<td>-0.07</td>
</tr>
<tr>
<td>SL(word)</td>
<td>3.0</td>
<td>-0.32</td>
</tr>
</tbody>
</table>

Bot learns to be agreeable
Reinforcement learning

<table>
<thead>
<tr>
<th>Buyer</th>
<th>Hello do you still have the TV?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seller</td>
<td>Hello, yes the TV is still available.</td>
</tr>
<tr>
<td>Buyer</td>
<td>What condition is it in? Any scratches or problems? I see it recently got repaired,</td>
</tr>
<tr>
<td>Seller</td>
<td>It is in great condition and works like a champ! I just installed a new lamp in it. There aren't any scratches or problems.</td>
</tr>
<tr>
<td>Buyer</td>
<td>All right. Well I think 275 is a little high for a 10 year old TV. Can you lower the price some? How about 150?</td>
</tr>
<tr>
<td>Seller</td>
<td>I am willing to lower the price, but $150 is a little low. How about $245 and if you are not too far from me, I will deliver it to you for free?</td>
</tr>
<tr>
<td>Buyer</td>
<td>It's still 10 years old and the technology is much older. Will you do 225 and you deliver it. How's that sound?</td>
</tr>
<tr>
<td>Seller</td>
<td>Okay, that sounds like a deal!</td>
</tr>
<tr>
<td>Buyer</td>
<td>Great thanks!</td>
</tr>
<tr>
<td>Seller</td>
<td>OFFER {&quot;price&quot;: 225.0, &quot;sides&quot;: &quot;&quot;}</td>
</tr>
<tr>
<td>Buyer</td>
<td>ACCEPT OFFER</td>
</tr>
</tbody>
</table>

The strategic backbone

- **greet**
- **inquire**
- **inform**
- **propose(150)**
- **counter(245)**
- **counter(225)**
- **agree**
- **offer(225)**
- **accept**
A modular framework

I would like to pay 125 for it. How does that sound?

Parser

\text{propose (price=125)}

e.g., [Young et al., 2013]
A modular framework

Manager

propose (price=125) → counter (price=160)

I would like to pay 125 for it. How does that sound?
A modular framework

I would like to pay 125 for it. How does that sound?

propose (price=125)  

I’ll accept 160

counter (price=160)
A modular framework

Change strategy without affecting generation

Manager

propose (price=125) → counter (price=160) → counter (price=150) → agree

I would like to pay 125 for it. How does that sound?

How about 150? That is a bit lower.

i’ll accept 160

i can do that!
Reinforcement learning

Fixed

SL

greet

inquire

propose(price=100)

counter(price=80)

accept

Policy gradient [Williams, 1992]

RL

greet

propose(price=100)

counter(price=80)

offer(price=80)

Reward
## Reinforcement learning in the act space

<table>
<thead>
<tr>
<th></th>
<th>Human-likeliness</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>4.3</td>
<td>-0.07</td>
</tr>
<tr>
<td>SL(word)</td>
<td>3.0</td>
<td>-0.32</td>
</tr>
<tr>
<td>SL(act)</td>
<td>3.3</td>
<td>0.06</td>
</tr>
<tr>
<td>RL(word)</td>
<td>1.7</td>
<td>1.00</td>
</tr>
<tr>
<td>RL(act)</td>
<td>2.8</td>
<td>1.00</td>
</tr>
</tbody>
</table>

RL(act) avoids degeneracy during optimization
Summary

• Easier to learn actions than language

• Separate grammaticality from task objective optimization to avoid degeneracy

• Content planning -> sentence realization
Conclusion

- Need more than density estimation
- Reborn of old techniques in new context - structures help!
- Big (pretrained) LMs for grammaticality