Controllable Neural Plot Generation via Reward Shaping

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*Equal contribution
Why Storytelling?

Automated Storytelling
Stories can...

- Help us plan
- Teach us
- Train us for hypothetical scenarios
- Do anything else that requires long-term context and commonsense information!
Here's a short story I generated using OpenAI's GPT-2 tool (prompt in bold)

The cat and the penguin had an argument over a piece of bread that neither of them wanted. They had a fight over one of the cats (an albino) while at the same time the penguin had the other cat (a domestic). Eventually the penguin killed the cat and ate the bread, not wanting to share. The penguin said to his cat that he was going to eat it because the bread was so cold. The cat refused him and went to a nearby café. The penguin tried to keep the cat away from the bakery in the street. The cat kept coming closer to the bakery and finally jumped on top of the bakery with its mouth open. After the penguin tried to jump up to keep the cat away, the penguin put his hand through the cat's mouth and pulled the cat's head through the bakery, killing the cat. The cat was buried in a graveyard.
Plot Generation

Meet
Plot Point 1

Admire
Mid Point

Unrequited

Discover

Marry
Resolution

Hook

Pinch 1

Pinch 2

Plot
Point 2

Understanding

Image source: https://blog.reedsy.com/plot-point/
How can we make *controllable* neural storytellers?
We need a criteria for success → Reach a “goal verb”

- Given any start of the story, we want it to end a certain way
- E.g. “I want a story where...”
  - The bad guys lose.
  - The couple marries.
What we did:

We use reinforcement learning with reward shaping to create a storytelling system that can incrementally head toward a plot goal.
Outline

1. The problem: generating a sequence of plot points
2. Reinforcement learning storytelling
3. Our reward shaping technique
4. Automated evaluation
5. Human evaluation
Simonetta learns of Tito’s affections for her.

She loved Tito before she loved Luigi.
Sentence Sparsity

Simonetta learns of Tito’s affections for her.

Problem: Sentences like this only appear once in the dataset
Solution: Fixing sparsity by separating semantics (meaning) from syntax (grammar)
Event Representation

\langle \text{subject, verb, direct object, modifier} \rangle

**Original sentence:** simonetta learns of tito's affections for her

**Event:** \langle simonetta, learn, Ø, affection \rangle

**Generalized Event:** \langle <\text{PERSON}>0, learn-14-1, Ø, state.n.02 \rangle

Sequence-to-Sequence Refresher

REINFORCE (Seq2Seq++)

#1 Verb Distance

**Closer distance = Higher reward**

\[ r_1(v) = \log \sum_{s \in S_{v,g}} l_s - d_s(v, g) \]
#2 Story-Verb Frequency

$$r_2(v) = \log \frac{k_{v,g}}{N_v}$$

Appear frequently before goal = Higher reward
Final Reward Equation

\[ R(v) = \alpha \times r_1(v) \times r_2(v) \]

Affects step size for backprop

Verb Distance to Goal

Story-Verb Frequency
Results

<table>
<thead>
<tr>
<th>Goal</th>
<th>Model</th>
<th>Average Story Length</th>
<th>Average Perplexity</th>
<th>Goal Achievement Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>admire</td>
<td>Seq2Seq</td>
<td>7.11</td>
<td>48.06</td>
<td>35.52%</td>
</tr>
<tr>
<td></td>
<td>REINFORCE</td>
<td>7.32</td>
<td>5.73</td>
<td>15.82%</td>
</tr>
<tr>
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<td>Seq2Seq</td>
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<td>48.06</td>
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<td>7.38</td>
<td>9.78</td>
<td>24.05%</td>
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</tbody>
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What now?

Cluster based on reward score

Constrain system to sample from next cluster
Clustering Process

1. Jenks Natural Breaks
2. Sample event
3. Replace verb if needed
## Results

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<tr>
<td></td>
<td>REINFORCE + Clustering</td>
<td>4.90</td>
<td>7.61</td>
<td>94.29%</td>
</tr>
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But are the stories actually any good?
Event Translation via Humans

\〈 \text{relative.n.01, disappearance-48.2, } \emptyset, \emptyset \〉

My cousin died.
<table>
<thead>
<tr>
<th>DRL Event Output</th>
<th>Translated Sentence</th>
</tr>
</thead>
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<tr>
<td>⟨ subject, verb, object, modifier ⟩</td>
<td></td>
</tr>
<tr>
<td>⟨ relative.n.01, disappearance-48.2, Ø, Ø ⟩</td>
<td>My cousin died.</td>
</tr>
<tr>
<td>⟨ NE1, say-37.7-1, visit, Ø ⟩</td>
<td>Alexander insisted on a visit.</td>
</tr>
<tr>
<td>⟨ NE1, meet-36.3-1, female.n.02, Ø ⟩</td>
<td>Alexander met her.</td>
</tr>
<tr>
<td>⟨ NE0, correspond-36.1, Ø, NE1 ⟩</td>
<td>Barbara commiserated with Alexander.</td>
</tr>
<tr>
<td>⟨ physical_entity.n.01, marry-36.2, Ø, Ø ⟩</td>
<td>They hugged.</td>
</tr>
<tr>
<td>⟨ group.n.01, contribute-13.2-2, Ø, LOCATION ⟩</td>
<td>The gathering dispersed to Hawaii.</td>
</tr>
<tr>
<td>⟨ gathering.n.01, characterize-29.2-1-1, time_interval.n.01, Ø ⟩</td>
<td>The community remembered their trip.</td>
</tr>
<tr>
<td>⟨ physical_entity.n.01, cheat-10.6, pack, Ø ⟩</td>
<td>They robbed the pack.</td>
</tr>
<tr>
<td>⟨ physical_entity.n.01, admire-31.2, social_gathering.n.01, Ø ⟩</td>
<td>They adored the party.</td>
</tr>
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Human Evaluation Methods

175 Mechanical Turkers rated statements on a 5-point Likert scale

For each of 3 conditions:
- REINFORCE + Clustering (Ours)
- Baseline Seq2Seq
- Testing Set Stories (Translated Events; Gold Standard)
Questionnaire

1. This story exhibits CORRECT GRAMMAR.
2. This story's events occur in a PLAUSIBLE ORDER.
3. This story's sentences MAKE SENSE given sentences before and after them.
4. This story FOLLOWS A SINGLE PLOT.
5. This story AVOIDS REPETITION.
6. This story uses INTERESTING LANGUAGE.
7. This story is of HIGH QUALITY.
8. This story REMINDS ME OF A SOAP OPERA.
9. This story is ENJOYABLE.

In Conclusion...

- Most neural storytelling methods lack “controllability”
- We used reinforcement learning to guide the story toward a goal (verb)
- Reward shaping and clustering → logical plot progression
- RL plots resulted in stories with more of a “single plot” and “plausible ordering” than Seq2Seq baseline
Thank you!

Read the paper on arXiv!
https://arxiv.org/abs/1809.10736

QUESTIONS?

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