

Plug-and-Blend: A Framework for Plug-and-Play Controllable Story Generation with Sketches

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2021-10-25

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Summarization

- 사람 유저에게 여러 개의 **control codes**를 받는 언어 생성 프레임워크(**Plug-and-Blend**)를 제안
- 생성된 스토리 맥락 안에서 **control codes**와 그에 대한 연결을 자유롭게 조절할 수 있음
- 생성에 대한 평가로 생성된 문장이 **fluent** 하면서 주어진 **control codes**를 잘 조절하면서 생성할 수 있음을 검증

Introduction (1)

PLM

- 점점 더 커지고 있고, 다양해지고 있음
- 이 큰 모델 내부에 직접 관여하는 것은 좀 ...

그런데, 사전 학습된 언어 모델은 **control**이 어렵다. → conditional generation / controllable generation

궁극적으로 우리는 이 모델을 갖고 **control** 하고 싶음

control 하는 과정을 잘 해소할 수 있을까?

Introduction (2)

Prompts

- 사용자가 생성 모델에 전달할 수 있는 정보

하지만, 가장 풍부한 정보는 아님

생성된 스토리에 대하여 미세하게 잘 조절할 수 있을까?

Introduction (3)

Intent from authors

- 전체 스토리보다 스토리의 일부를 커버함
- 그리고 이러한 intent들은 서로 겹치는 부분이 있음 (각 스토리가 이어지는 부분: transitions)

주제 **control**을 생성된 콘텐츠에 계속하여 섞어낼 수 있을까?

이를 **planning**할 수 있고 **high-level**로 제공할 수 있을까?

Plug-and-Blend

Controllable text generation에 대한 Plug-and-Play 프레임워크

- 어느 언어 모델의 logit output에 대하여 동작
- 특정 control code에 대한 연속적인 steering 가능 → 생성된 문장의 fine control을 용이하게 함
- 여러 개의 control codes를 허용 → 서로 겹치는 부분에 대해서도 제공 가능

Related work

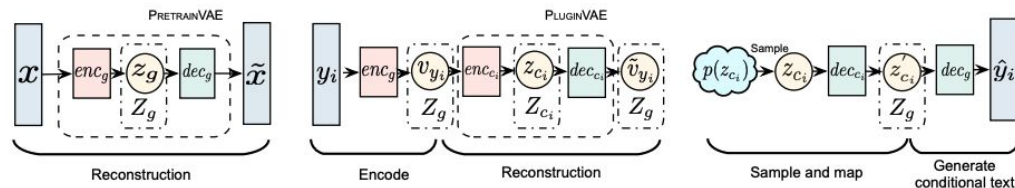
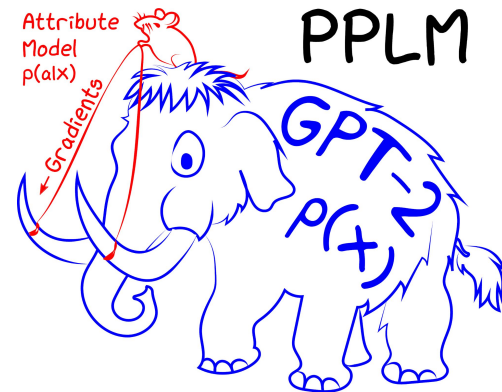
Plug-and-Play Conditional Generation

Gray-box approaches

Change hidden representations

Add additional modules

- Plug and Play Language Models: A Simple Approach to Controlled Text Generation (ICLR 2020)
- Plug-and-Play Conversational Models (EMNLP Findings 2020)
- Pre-train and Plug-in: Flexible Conditional Text Generation with Variational AutoEncoders (ACL 2020)
- Plug and Play Autoencoders for Conditional Text Generation (EMNLP 2020)



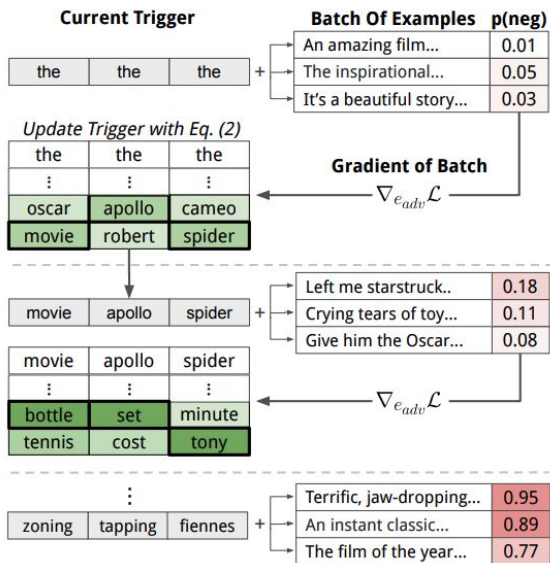
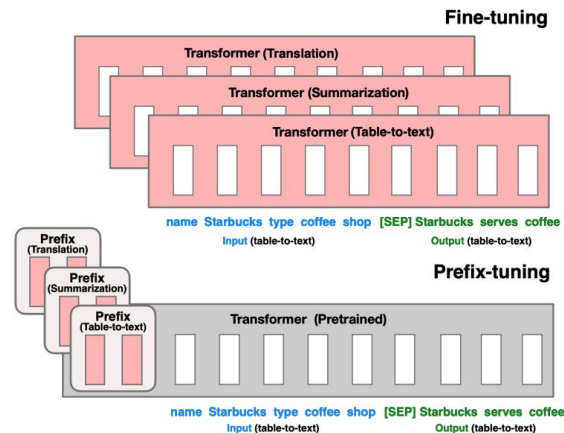
Related work

Plug-and-Play Conditional Generation

Black-box approaches

Prompt Engineering / Outputs logits manipulation

- Universal Adversarial Triggers for Attacking and Analyzing NLP (EMNLP 2019)
- Prefix-Tuning: Optimizing Continuous Prompts for Generation (arXiv 2101.00190)



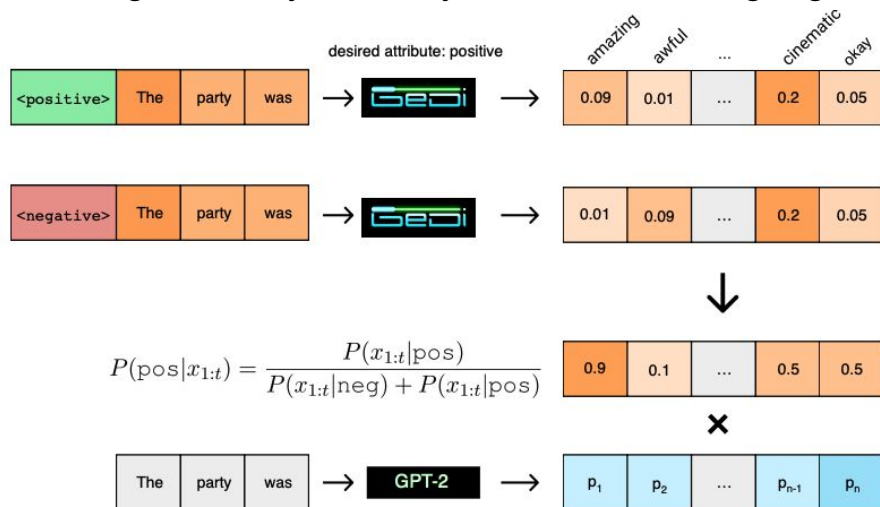
Related work

Plug-and-Play Conditional Generation

Guided generation approaches

추론 시 base LM의 출력에 변화를 줄 수 있게 ‘guide’하는 방식

- GeDi: Generative Discriminator Guided Sequence Generation (EMNLP Findings 2021)
- Directed Beam Search: Plug-and-Play Lexically Constrained Language Generation (arXiv 2012.15416)



Related work

(neural) Controllable Story Generation

- (Akoury et al., 2020), (Yao et al., 2019) - **topic constraints**를 직접 모델에 넣어주는 방식
- PlotMachines - 사람 유저에게 어느 순서로 스토리에 통합할지 **topic**을 명시할 수 있는 방식
- Wang et al., 2020 - **start event**와 **end event** 사이를 통합하는 방식 (**slot filling fashion**)

Generative LM

LM

$$P_{\theta}(x_{1:T}) = \prod_{t=1}^T P_{\theta}(x_t | x_{<t}).$$

CC-LM

attribute: "control code"

$$P_{\theta}(x_{1:T} | \textcircled{c}) = \prod_{t=1}^T P_{\theta}(x_t | x_{<t}, c)$$

특정 control attribute에 대한 conditional generation

GeDi

$$P_{\theta}(c | x_{1:t}) = \alpha P(c) \prod_{j=1}^t P_{\theta}(x_j | x_{<j}, c)$$

condition attribute에 대한 classifier

where α is the normalization constant $\alpha = 1/(\sum_{c' \in \{c, \bar{c}\}} P(c') P_{\theta}(x_j | x_{<j}, c'))$, and c and c' are contrastive control codes (c and not- c). At the

anti-attribute에 대한 classifier를 역을 이용하여 normalize

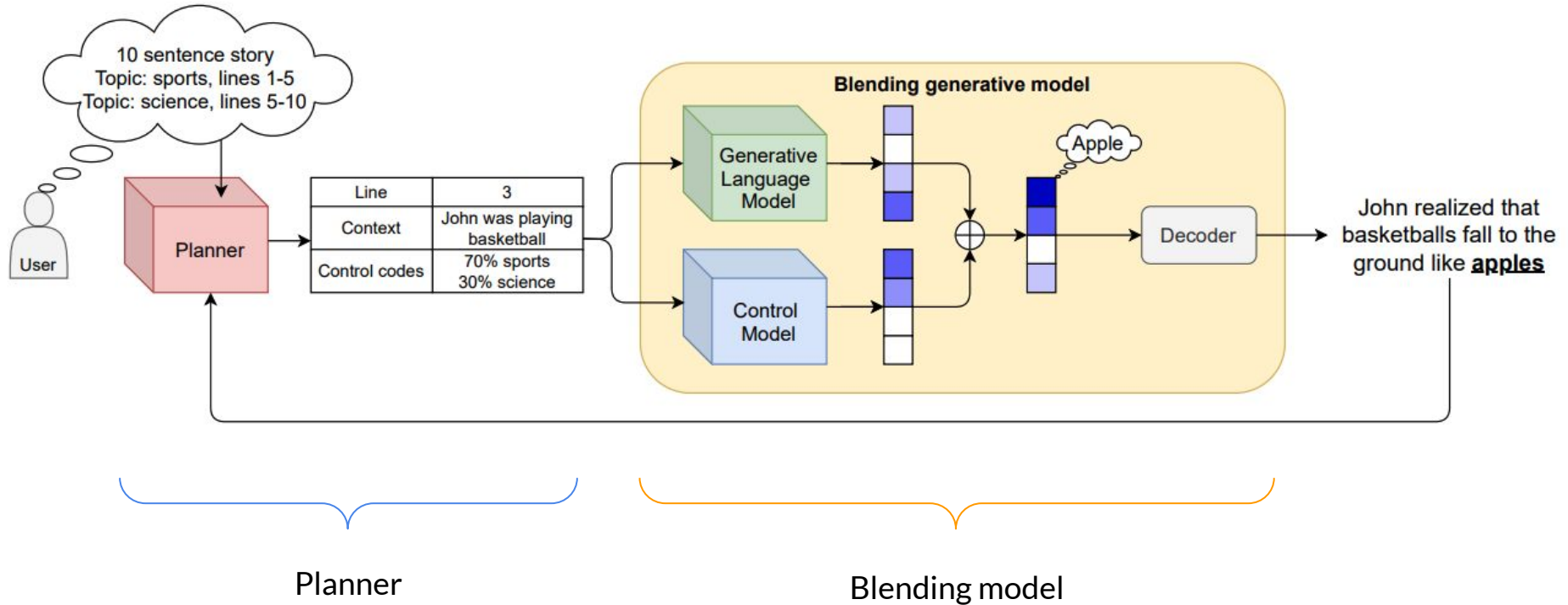
$$P(x_t | x_{<t}, c) \propto$$

$$P_{LM}(x_t | x_{<t}) P_{\theta}(c | x_t, x_{<t})^{\omega}$$

결론: 가이드된 확률을 제공하고 이를 사용한다.

weight: control 강도

Plug-and-Blend Framework



Plug-and-Blend Framework

Blending Generative Model

$$P(x_t | x_{<t}, c_1, c_2) \propto P_{LM}(x_t | x_{<t}) \times P_{\theta}(c_1 | x_t, x_{<t})^{\omega_1} P_{\theta}(c_2 | x_t, x_{<t})^{\omega_2}$$

$$P(x_t | x_{<t}, C) = P_{LM}(x_t | x_{<t}) \prod_{c^* \in C} P_{\theta}(c^* | x_t, x_{<t})^{\omega_{c^*}}$$

multi-control-code case로 확장

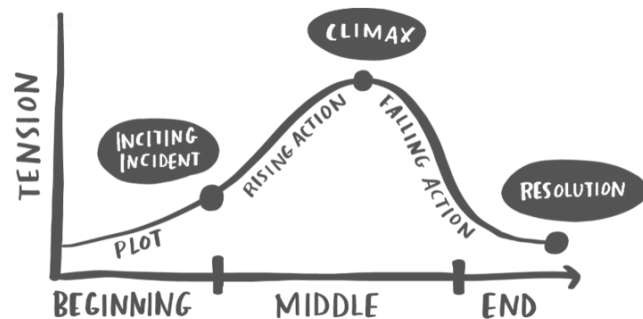
→ 생성된 문장에 여러 개의 **attribute**를 도입할 수 있음

Planner

사용자가 직접 각 토픽에 대하여 스케치를 하면 **control**에 대한 강도를 **configuration**해주는 플래너

control sketch = story arc on a specific topic

consist of: transition, an engagement, and a phase-out

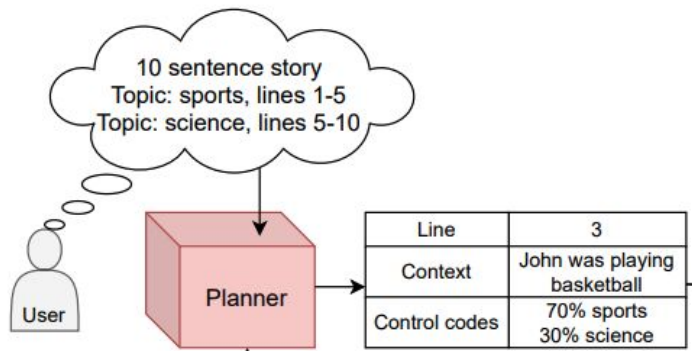


→ Gaussian distribution

Plug-and-Blend Framework

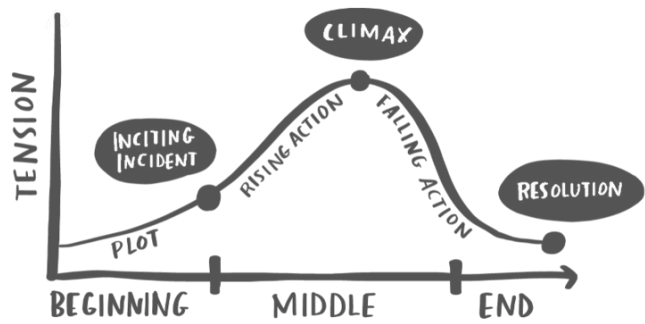
Planner

사용자가 직접 각 토픽에 대하여 스케치를 하면 control에 대한 강도를 configuration해주는 플래너



control sketch = story arc on a specific topic

consist of: transition, an engagement, and a phase-out



→ Gaussian distribution

$$\omega_{c,n}^+ = f(\mathcal{N}(m, (\sigma/(e - s + \epsilon)^2)))(n - m)$$

Control Sketches	Generated Paragraph
Sketch 1 $c_1 = \text{Sports}, \{0 \rightarrow 5\}$ $c_2 = \text{Science}, \{4 \rightarrow 10\}$	Jackie Robinson was playing in the NBA. He had just been drafted by the Cleveland Cavaliers. He decided to play for a team that was trying to win a championship. "I'm gonna go out there and beat them," he said "They're going to be great." "Yeah, they're good," he said "they'll be great." He added that his wife had been working on the project for about a year. He was happy to see her progress. She was able to get some work done and she started getting more comfortable with it. She had a lot of fun doing it! She also got her own computer, which is now in the living room.
Sketch 2 $c_1 = \text{Sports}, 0 \rightarrow 5$ $c_2 = \text{Science}, 5 \rightarrow 10$	Jackie Robinson was playing in the NBA. He had just played basketball for a few years. He was looking forward to his first game of the season. He decided to play with his friends and play against them in the court. He got a lot of feedback from everyone who played against him, including some that were very excited about it! I was really happy when I saw how he played. I also had to admit that my favorite player was the guy who beat me in the finals. The computer game Super Mario 64 is a great game, but it's not perfect. I played it on my laptop and found that I couldn't play it properly because of some bugs. The problem was that the graphics were bad, so I had to use an emulator instead of playing the game.

Blending Generation Experiments

평가 데이터셋 : ROCStories

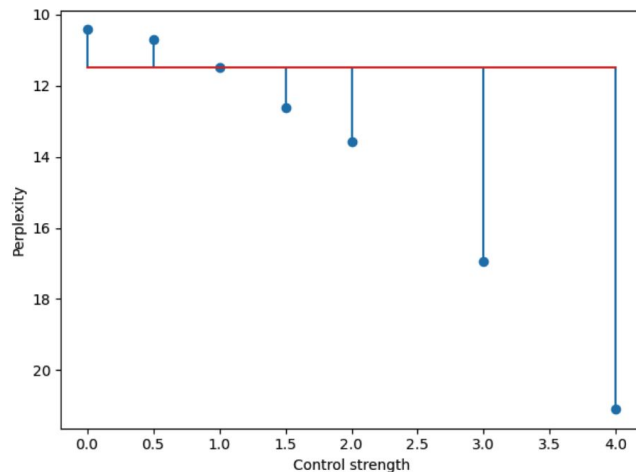
모델: GPT2-large (baseline) vs. GeDi (based on GPT2-medium)

생성된 문장에 대한 **ground truth**가 없기 때문에 BLUE, n-gram 같은 **metric** 사용 불가

→ 두가지 측면으로 평가 진행

Fluency: 생성된 문장이 얼마나 자연스러운지

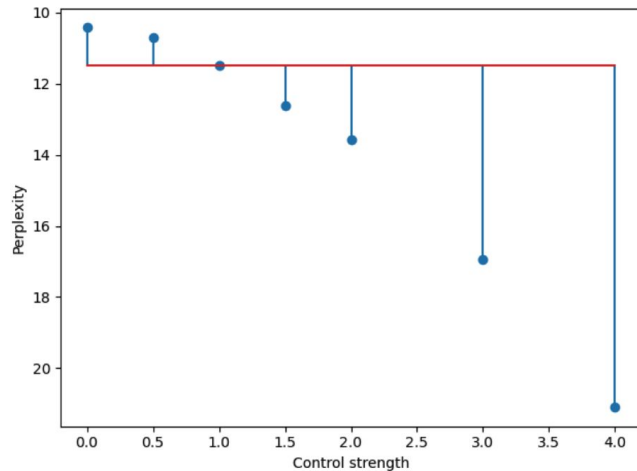
Control fidelity: 생성된 문장이 요구된 **control code**와 강도를 반영하고 있는지



Blending Generation Experiments

Fluency: 생성된 문장이 얼마나 자연스러운지

: control이 fluency를 잃게 된다



Blending Generation Experiments

Control fidelity: 생성된 문장이 요구된 control code와 강도를 반영하고 있는지

Prompt: The people gathered to protest the court’s ruling last week.

$c_1 = \text{Sports}$ ω_{c_1}	$c_2 = \text{Business}$ ω_{c_2}	BGM-Generated Sentence (Overall Strength 2x)	Classifier score	
			c_1	c_2
100%	0%	Coach Leeman was in a wheelchair and had been taken to hospital for treatment.	86%	14%
75%	25%	Coach Reebok was one of them.	65%	35%
50%	50%	The players were joined by a few of them.	84%	16%
25%	75%	The company that owns the team was fined \$1,000 for violating a rule prohibiting employees from using their own equipment.	37%	63%
0%	100%	Bankruptcy Judge William H. said that the bank had failed to pay its creditors and was in default on \$1 billion of loans it owed them.	24%	76%

Comparing column 1 with column 4, Kendall’s τ -a = 0.8 for this generated sequence.

- off-the-shelf BART-base zero-shot classifier를 활용한 평가 (classifier score와 주어진 weight 간 비교)

Planner Evaluation

- 우리가 만든 플래너 vs. 매 문장마다 **single category**로 제공하는 플래너 - **human evaluation**

prolific이라는 플랫폼 사용

→ 우리가 만든 플래너가 기존 플래너보다 **75.1%** 긍정적인 피드백을 받음

Control Sketches	Generated Paragraph
<p>Sketch 1 $c_1 = \text{Sports}, \{0 \rightarrow 5\}$ $c_2 = \text{Science}, \{4 \rightarrow 10\}$</p>	<p>Jackie Robinson was playing in the NBA. He had just been drafted by the Cleveland Cavaliers. He decided to play for a team that was trying to win a championship. "I'm gonna go out there and beat them," he said "They're going to be great." "Yeah, they're good," he said "they'll be great." He added that his wife had been working on the project for about a year. He was happy to see her progress. She was able to get some work done and she started getting more comfortable with it. She had a lot of fun doing it! She also got her own computer, which is now in the living room.</p>
<p>Sketch 2 $c_1 = \text{Sports}, 0 \rightarrow 5$ $c_2 = \text{Science}, 5 \rightarrow 10$</p>	<p>Jackie Robinson was playing in the NBA. He had just played basketball for a few years. He was looking forward to his first game of the season. He decided to play with his friends and play against them in the court. He got a lot of feedback from everyone who played against him, including some that were very excited about it! I was really happy when I saw how he played. I also had to admit that my favorite player was the guy who beat me in the finals. The computer game Super Mario 64 is a great game, but it's not perfect. I played it on my laptop and found that I couldn't play it properly because of some bugs. The problem was that the graphics were bad, so I had to use an emulator instead of playing the game.</p>

Discussion

- fluency와 control fidelity 간의 trade-off
- 아직은 너무 heuristic한 플래너 방식 - 사용자의 피드백을 반영할 수 없음