

# Controllable Text Generation

# Outline

Model type	Form of model	Samples	Example models and number of trainable params
Language Model	$p(x)$	Uncond.	GPT-2 medium: 345M (Radford et al., 2019)
Fine-tuned Language Model	$p(x)$	Uncond.	Fine-tuned GPT-2 medium: 345M (Ziegler et al., 2019)
Conditional Language Model	$p(x a)$	Cond.	CTRL: 1.6B (Keskar et al., 2019)
Plug and Play Language Model (PPLM)	$p(x a) \propto p(x)p(a x)$	Cond.	PPLM-BoW: 0 (curated word list) PPLM-Discrim: $\sim 1K$ /attribute (not counting pretrained $p(x)$ )

- CTRL: A conditional transformer language model for controllable generation (Keskar et al., 2019)
  - ▶ Append control text (codes) into text dataset and train LMs on the newly created dataset
  - ▶ Experimental control codes
    - ★ Domain control codes, multiple control codes, link codes
    - ★ Control codes that tricks specific tasks, zero-shot code-mixing
- Fine-tuning LMs from Human Preferences (Ziegler et al., 2020)
  - ▶ Fine-tuning LMs using reinforcement learning with human rewards
  - ▶ RL policy model is LM, rewards model is approximated from either human annotation or a classifier
  - ▶ Experiments on two tasks: sentiment analysis and summarization
  - ▶ Caveat: for the summarization task, the fine-tuned models simply copy the sentences in the paragraphs instead generating novel sentences

# CTRL List of Control Codes

Control Code	Description
Wikipedia	English Wikipedia
Books	Books from Project Gutenberg
Reviews	Amazon Reviews data (McAuley et al. 2015)
Links	OpenWebText (See Sec. 3.2)
Translation	WMT translation data (Barrault et al. 2019)
News	News articles from CNN/DailyMail (Nallapati et al. 2016), New York Times and Newsroom (Grusky et al. 2018)
multilingual	Wikipedias in German, Spanish and French
Questions	(Questions and answers only) MRQA shared task (See Section 3.1)
Explain	(Only main post) (Fan et al. 2019)
Sub-reddit data (Title, Text and Score/Karma) collected from pushshift.io	
Alone	r/childfree
Atheism	r/atheism
Christianity	r/christianity
Computing	r/computing
Confession	r/offmychest
Confessions	r/confession
Conspiracy	r/conspiracy
Diet	r/keto
Extract	r/childfree
Feminism	r/twoxchromosome
Finance	r/personalfinance
Fitness	r/fitness
Funny	r/funny
Gaming	r/gaming
Horror	r/nosleep

# CTRL Experimental Control Codes: Domain control codes

**Horror** *A knife* handle pulled through the open hole in the front. I jumped when the knife hit.\n\nEyes widened in horror. Her scream was the only sound I heard besides her sobs.\n\nThe spider touched her feet as it started to dig into the top of her arch. The creature's tears began to flow.\n\nThe spider looked up to her and looked back at me with eyes filled with burning tears. My heart started to race. . .

**Reviews** *A knife* is a tool and this one does the job well.\n\nRating: 4.0\n\nI bought these for my husband who has been using them to cut up his own meat since he got them. He says they are very sharp so be careful when you use them, but that doesn't seem like much of an issue because he's used it on everything from chicken breasts to beef tenderloin. . .

**Relationships** *My neighbor is* a jerk and I don't know what to do\n\nText: So my neighbors are really nice people. They have been for years. We live in an apartment complex so we get along great.\n\nBut recently they started acting like jerks. . .

**Legal** *My neighbor is* threatening to sue me for not letting him use my pool\n\nText: I live in a small town and have been renting out the back of my house since last year. The owner has had issues with people using it as well but he never really took any action against them. Last week someone from his property management company came by asking if they could come over because there was an issue with some kids playing on it. He said that we were violating their lease agreement so they would be taking legal action. . .

# CTRL Experimental Control Codes: Combining multiple control codes

**Politics Title:** The US is the only country in history to have a national debt of more than \$20 trillion.  
**Text:** I know this isn't exactly an accurate representation but it gives you some idea how much money we are talking about.  
[http://en.wikipedia.org/wiki/National\\_debt#United\\_States](http://en.wikipedia.org/wiki/National_debt#United_States)

**Running Text:** I have been running for about a year and a half now but never really got into it.  
This past weekend was my first time doing it in the last few months.  
My goal is to run at least 3 miles every day this week.

**Horror Text:** I was a little girl when my parents got divorced. My dad had been in the military for years and he left me with my mom. She worked as an RN at a hospital so she could take care of me.  
When we moved to our new house it took some time before things settled down. We were still living together but there wasn't much going on. It didn't help that my mom would get mad if someone came over or even just walked by her house.  
One day while walking through the yard I noticed something out of place...

**Reviews Rating: 5.0**  
I have been using this product for a few years and it is the best thing on my hair. It makes your hair soft but not greasy.  
**Rating: 5.0**  
I've used this product before and love it. It's light weight yet keeps my curls defined without making them crunchy!

**Reviews Rating: 1.0**  
I bought this for my daughter and it was a complete waste of money. The case is very flimsy and the screen protector doesn't fit properly.  
**Rating: 1.0**  
This product did not work at all. It would charge but when you unplug it, it does nothing. Very disappointed.

# CTRL Experimental Control Codes: Link control codes

Links <https://www.etonline.com/09/20/2018/star-spotted>\n\nEXCLUSIVE: Star Spotted in New York City\n\n\nBy Kelly Marot — September 20, 2018 10:51 AM PDT\n\n\nGetty Images\n\n\nThe star of the new season of Stranger Things is making a splash on her own turf and its not even Halloween.\n\n\nWinona Ryder has been seen out and about with friends at night time in Manhattan this week, E! News can exclusively reveal.\n\n\nA source tells us, She was hanging around with some friends, but she wasnt doing anything too crazy. She just wanted to get away from it all for a little bit...

Links <https://www.cnn.com/style/09/20/2018/george-clooney-interview> George Clooney on the future of his acting career\n\n\nBy\n\n\nUpdated 10:51 AM ET, Thu September 20, 2018\n\n\nChat with us in Facebook Messenger. Find out what's happening in the world as it unfolds.\n\n\nPhotos:George Clooney, 'Ocean's 8'\n\n\nActor George Clooney attends a photocall for "Ocean's 8" at Grauman's Chinese Theatre on August 31, 2018, in Los Angeles.\n\n\n...

Links <https://www.cnn.com/politics/09/20/2018/george-clooney-interview> JUST WATCHED\n\n\nGeorge Clooney on the Trump administration\n\n\nMUST WATCH\n\n\n(CNN) Actor and activist George Clooney, who has been a vocal critic of President Donald Trump, said he is "ready to go back into the political arena" after his role in an anti-Trump documentary was cut from theaters this week.\n\n\n...

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Table 3: CTRL is trained with links as **control codes**. Links provide a way to specify domain, subdomain, entities, entity relations, and even date. The links in these examples do not actually link to text; users can mimic the structure of the URLs that appear during training to create novel content during generation. Note that `us-president` is interpreted differently by the model depending on the date used (2007,2014,2018). Similarly, `star` is interpreted differently based on the domain (cnn vs. etonline) and topic (style vs. politics) can be varied even for identical entities (george-clooney).

# CTRL Experimental Control Codes: Triggering specific tasks

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**Questions** *Q: What is the capital of India?* **A:** New Delhi\n\n*Q: Which city in India has a large population of people from Gujarat?*\n\n**A:** Ahmedabad\n\n*Q: How many languages are spoken by Indians living abroad?*\n\n**A:** more than 100. . .

**Translation** **English :** *We release a new model for coherent language generation* ; **French :** Nous publions un nouveau modèle de génération cohérente du langage\n\n**English :** The European Parliament has just adopted the report on the proposal for a regulation of the European Parliament and of the Council establishing an action programme to promote multilingualism in Europe. ; **French :** Le Parlement européen vient d'adopter le rapport sur la proposition de règlement du Parlement et du Conseil établissant un programme-cadre pour promouvoir le plurilinguisme dans l'Union européenne. . .

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Table 4: More complex templated control codes are used for task-specific generation.

# CTRL Experimental Control Codes: Zero-shot code-mixing

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**Diet** **English** : *I lost 10 kgs!* ; **German** : Ich habe 10 Kilogramm verloren!\n\n**English** : It is a great achievement for me and my family. ; **German** : Das ist eine groe Leistung fr mich und meine Familie.\n\n**English** : Thank you very much to all the people who have helped me. ; **German** : Vielen Dank an alle, die mir geholfen haben....

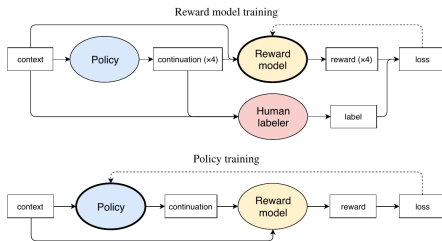
**Politics** **Title**: *Les Etats-Unis sont un* pays de droite\n\n**Text**: Je suis Américain et je ne peux pas supporter ce que font les USA en matière d’immigration\n\nJ’ai déjà écrit sur le sujet mais il n’y a aucune réaction [http://www.reddit.com/r/politics/comments/1tqjzw/les\\_etats\\_unes\\_son\\_tres-de-gauche/](http://www.reddit.com/r/politics/comments/1tqjzw/les_etats_unes_son_tres-de-gauche/)...

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Table 5: Some codes can be mixed to generate text with novel cross-over behavior. In Table 5 we present two examples. In the first example, we mix translation codes into the **Diet** domain. By doing so, the model continues alternatively generates English and German sentences while respecting the **Diet** domain and remains coherent across translations. In the second example, the **Politics** domain is mixed with a French prompt despite never seeing this combination in training.



# Fine-Tuning LMs: Training Procedure



- Initialize policy model (language model)  $\pi = p(X)$
- Gather samples  $(x, y_0, y_1, y_2, y_3)$ . Ask humans to pick the best  $y$ . Then train the reward model  $r$  to approximate human rewards
- Train policy  $\pi$  via Proximal Policy Optimization with reward model  $r$
- In online setting, continue to collect additional samples from human annotation

# Fine-Tuning LMs: Experiments

<b>context</b>	Pearl thought to herself that what they were about to do was exactly the sort of thing that they could do to help the villagers. They were all terrified of these guys. At the police station the three walked up to the counter behind which was a senior constable studying some papers.		
	<i>Continuation 1</i>	<i>Continuation 2</i>	<i>Continuation 3</i>
<b>zero-shot</b>	"Hello, I'm Pearl and this is my friend, Mike," said Pearl.	"May we speak to the police officer, sir?" asked the one in charge.	'Hello, can I help you?' 'Yes, we're the same people that the people were talking about.
<b>5k offline fine-tune</b>	He turned to them with a smile. "Good afternoon, ladies. I'm Detective Inspector Jones.	The constable stood up and smiled as he saw them, obviously pleased to see them.	He smiled at them and waved them in, his eyes twinkling as he listened to their tales.

<b>reference summary</b>	Solar plane attempting to be first to circumnavigate world without using fuel is stuck in China. Solar Impulse 2 attempts to prove the power of renewable energy.
<b>zero-shot</b>	The plane has been grounded in China for two weeks because of bad weather.
<b>60k fine-tune</b>	The Solar Impulse 2, the experimental plane attempting to fly around the world without using a drop of fuel, has been grounded by the weather in China.  What was supposed to be an overnight pit stop in the southwestern city of Chongqing has now stretched into a two-and-a-half week stay.
<b>supervised</b>	Solar Impulse 2 has been grounded by the weather in China. The plane took off from Abu Dhabi on March 9. The plane is trying to prove the power of renewable energy.
<b>supervised + 60k fine-tune</b>	Solar Impulse 2 has been grounded in China for two-and-a-half weeks. The plane is attempting to fly around the world without using a drop of fuel. The team, which includes Bertrand Piccard, is taking turns flying the single-seater. The plane took off from Abu Dhabi on March 9 and has successfully flown through Oman.

*Thank you !*