Prefix-Tuning: Optimizing Continuous Prompts for Generation

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- 박지영

목차

1. Introduction

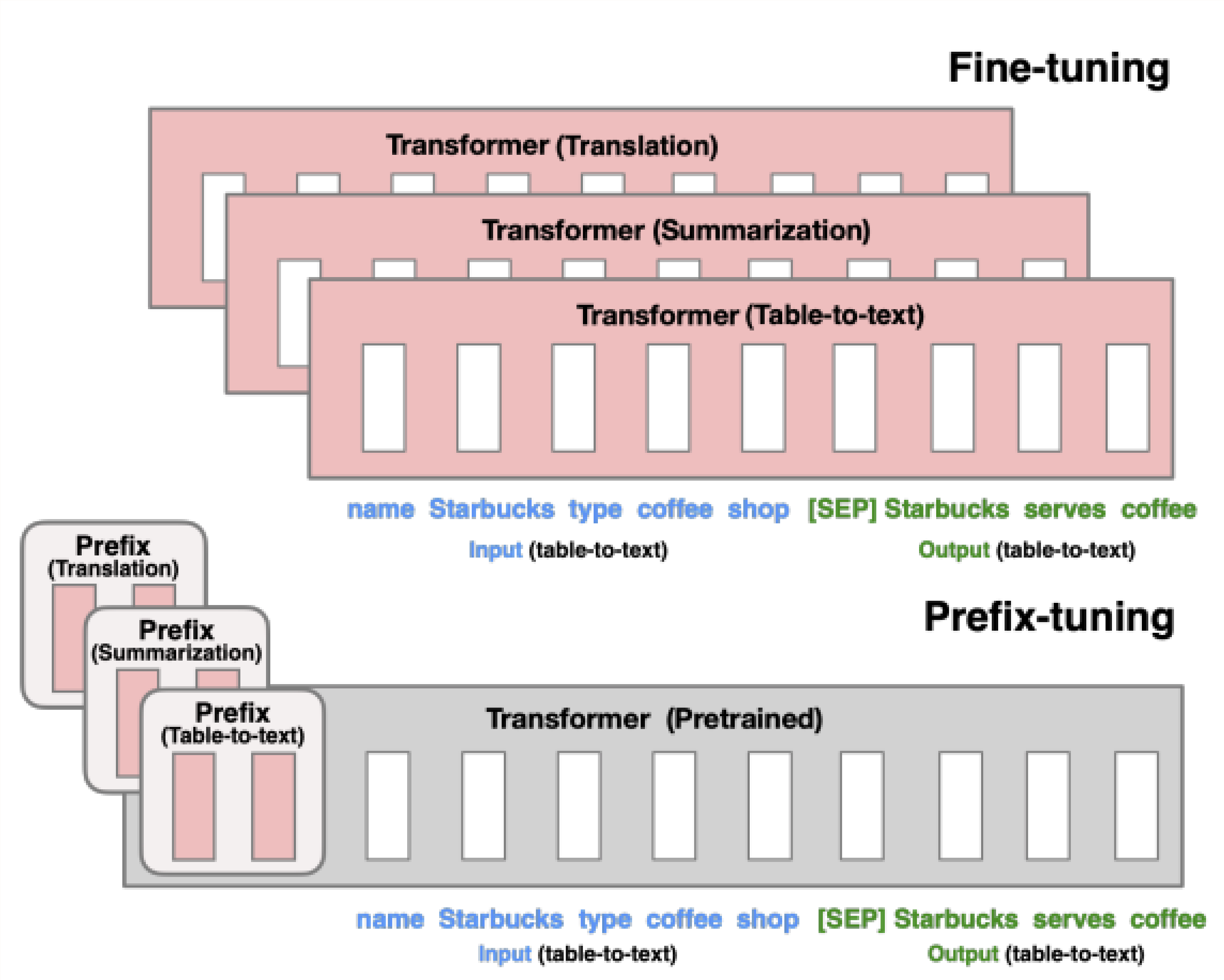
Fine-tuning의 단점을 보완하고자

Preix-tuning을 제안

Prefix 이용시,

Fine-tuning 같이 모델 전체를 학습 시키지 않고

Prefix부분만 조정하면 된다.



2. Related Work

- **Fine-tuning**

  모델의 모든 매개변수를 특정 작업에 맞게 전체 조정

- **Lightweight fine-tuning**

  대부분의 사전 훈련 매개변수 고정 > 일부 조정 (adapter layer 추가 및 조정)

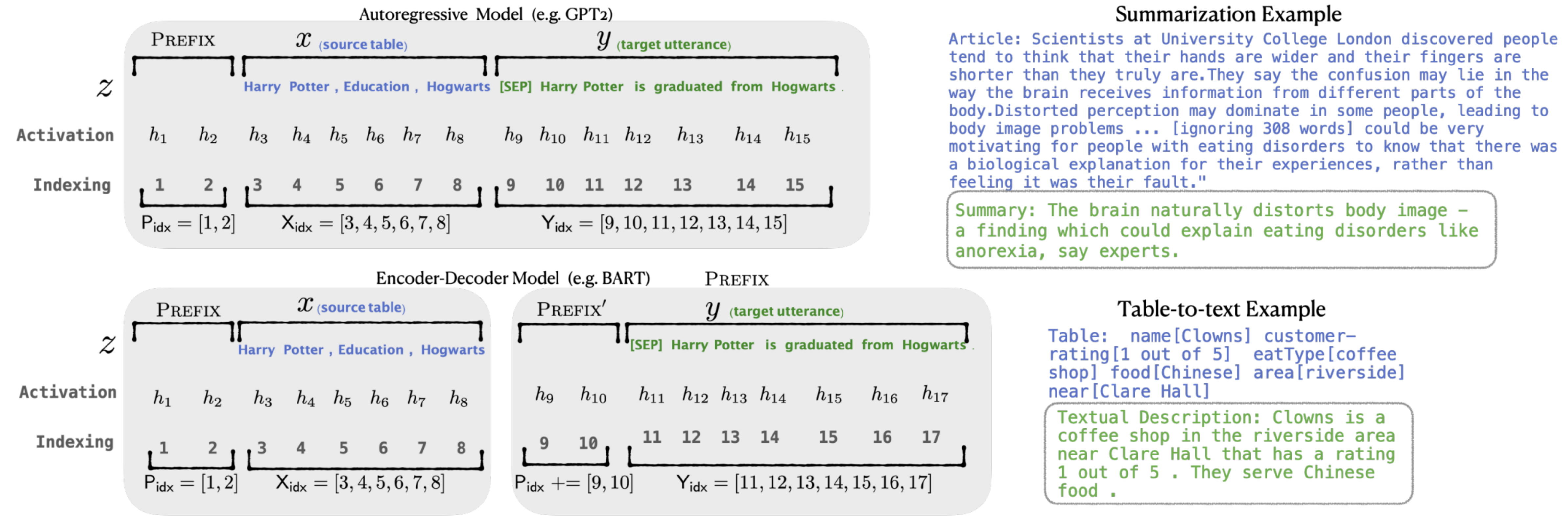
- **Controllable generation.**

  언어 모델의 출력을 특정 속성에 맞게 조정

- **Prompting**

  지시사항, 예제(특정 트리거 단어 시퀀스)를 작업 입력 > 원하는 결과 출력

3. Fine-tuning



3. Fine-tuning

- pretrained parameters ϕ > initialize

- pϕ = trainable language model distribution

- gradient updates (log-likelihood objective)

$$\max_{\phi} \; \log p_{\phi}(y \mid x) = \sum_{i \in \mathsf{Y}_{\mathsf{idx}}} \log p_{\phi}(z_i \mid h_{<i}).$$

4. Prefix-Tuning

collocation

Obama + Barack

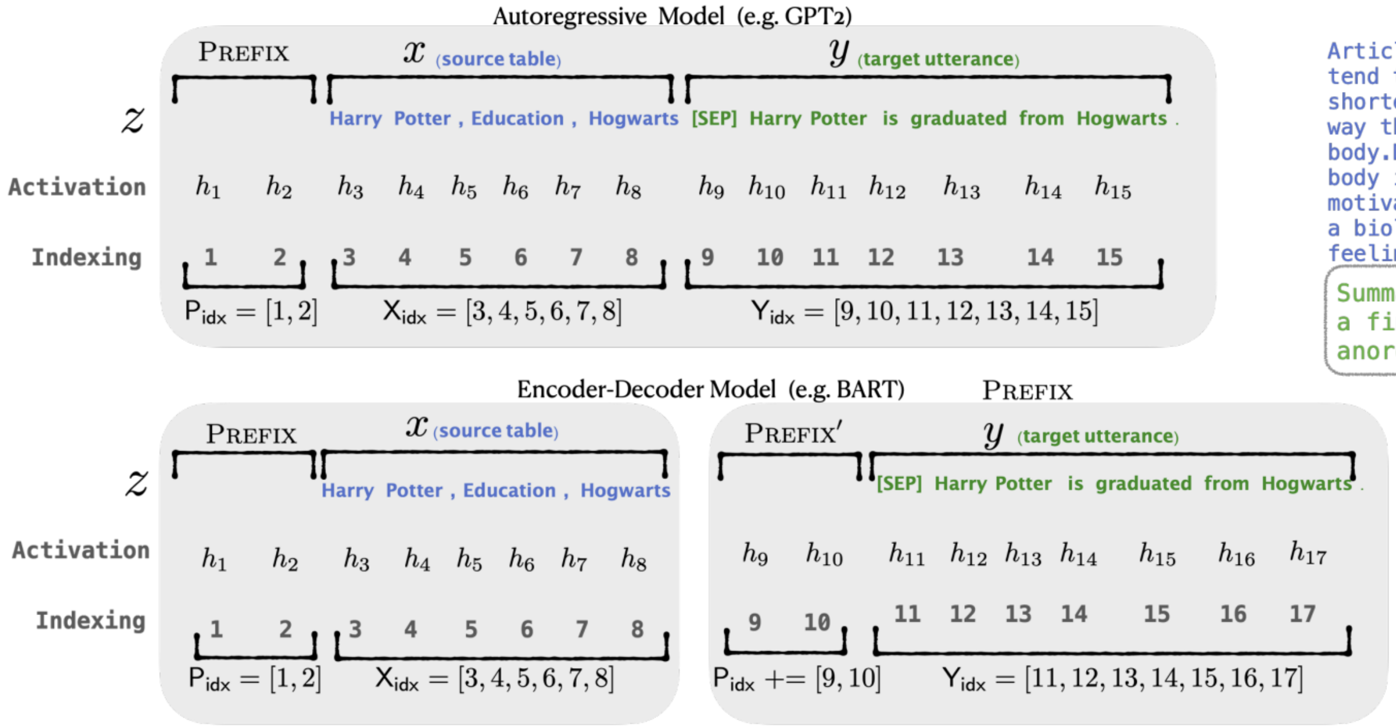
Instead of discrete tokens,

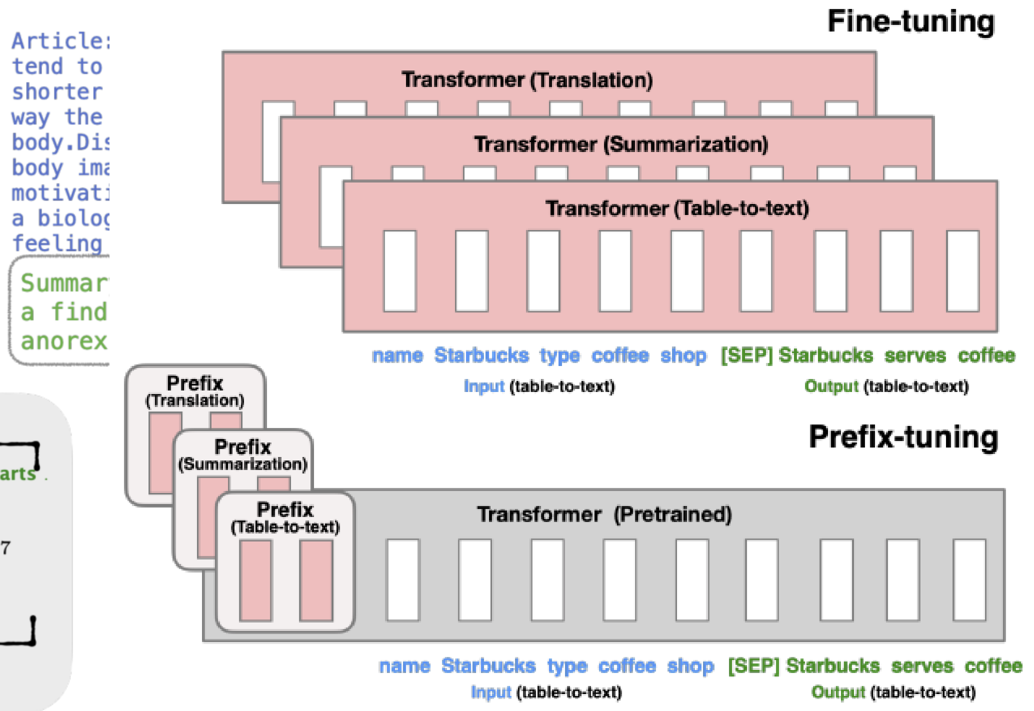
Sequential word embedding 최적화 가능

Pros and cons: expressive

discrete tokens < Prefix-Tuning< all layers of the activations

4. Prefix-Tuning





4. Prefix-tuning

- Parametrization of prefix parameters
- 문제점: **directly updating > unstable optimization**

- 해결책: **Reparametrize**

$$P_\theta[i,:] = \text{MLP}_\theta(P'_\theta[i,:]) \text{ by a smaller matrix } (P'_\theta)$$

  - 차원을 줄이면서 매개변수 감소 > 최적화 과정 안정화
  - Mlp 통과하면서 동일한 차원으로 확장 > 복잡한 패턴 특성 학습 + 안정성

5. Experimental Setup

Experiment:

1. table-to-text : GPT-2 Medium, Large 모델
2. summarization : BART Large 모델

Data set:

table-to-text : E2E, WebNLG, DART
summarization : XSUM

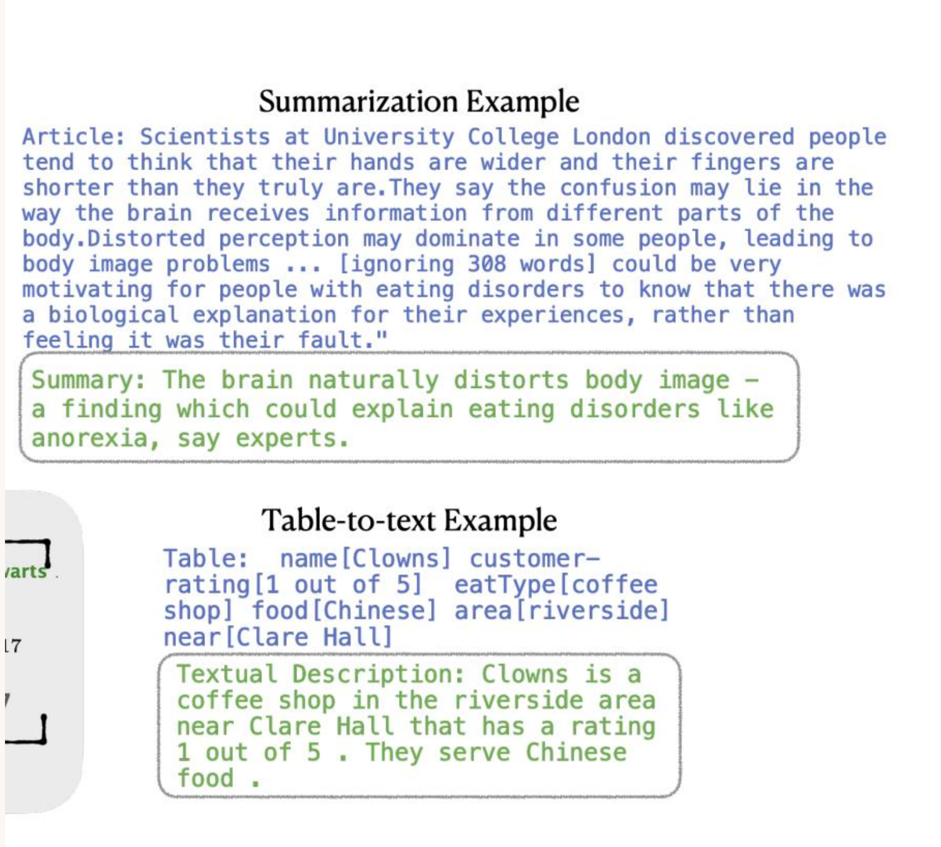
비교 방법:

Table-to-text Example
FINE-TUNE
FT-TOP2
ADAPTER(3%)
ADAPTER(0.1%)
PREFIX(0.1%)

Summarization Example
FINE-TUNE
PREFIX

평가 메트릭스:

BLEU, NIST, METEOR, ROUGE-L, CIDEr



6. Main Results

Table-to-text Example

	E2E					WebNLG									DART					
	BLEU	NIST	MET	R-L	CIDEr	BLEU			MET			TER ↓			BLEU	MET	TER ↓	Mover	BERT	BLEURT
						S	U	A	S	U	A	S	U	A						
GPT-2MEDIUM																				
FINE-TUNE	68.2	8.62	**46.2**	71.0	2.47	**64.2**	27.7	46.5	**0.45**	0.30	0.38	**0.33**	0.76	0.53	46.2	**0.39**	**0.46**	**0.50**	**0.94**	**0.39**
FT-TOP2	68.1	8.59	46.0	70.8	2.41	53.6	18.9	36.0	0.38	0.23	0.31	0.49	0.99	0.72	41.0	0.34	0.56	0.43	0.93	0.21
ADAPTER(3%)	68.9	8.71	46.1	71.3	2.47	60.4	**48.3**	54.9	0.43	**0.38**	**0.41**	0.35	**0.45**	**0.39**	45.2	0.38	**0.46**	**0.50**	**0.94**	**0.39**
ADAPTER(0.1%)	66.3	8.41	45.0	69.8	2.40	54.5	45.1	50.2	0.39	0.36	0.38	0.40	0.46	0.43	42.4	0.36	0.48	0.47	**0.94**	0.33
PREFIX(0.1%)	**69.7**	**8.81**	46.1	**71.4**	**2.49**	62.9	45.6	**55.1**	0.44	**0.38**	**0.41**	0.35	0.49	0.41	**46.4**	0.38	**0.46**	**0.50**	**0.94**	**0.39**
GPT-2LARGE																				
FINE-TUNE	68.5	8.78	46.0	69.9	2.45	**65.3**	43.1	55.5	**0.46**	0.38	**0.42**	**0.33**	0.53	0.42	**47.0**	**0.39**	0.46	**0.51**	**0.94**	**0.40**
Prefix	**70.3**	**8.85**	**46.2**	**71.7**	**2.47**	63.4	**47.7**	**56.3**	0.45	**0.39**	**0.42**	0.34	**0.48**	**0.40**	46.7	**0.39**	**0.45**	**0.51**	**0.94**	**0.40**
SOTA	68.6	8.70	45.3	70.8	2.37	63.9	52.8	57.1	0.46	0.41	0.44	-	-	-	-	-	-	-	-	-

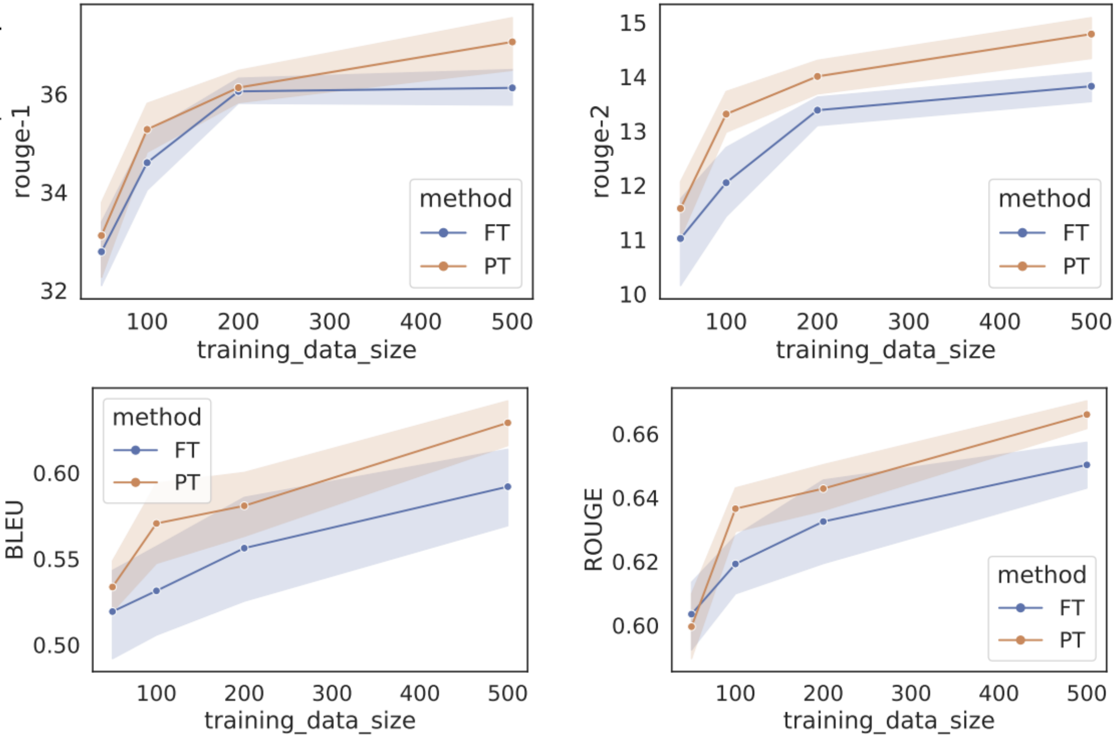
Summarization Example

	R-1 ↑	R-2 ↑	R-L ↑
FINE-TUNE(Lewis et al., 2020)	45.14	22.27	37.25
PREFIX(2%)	43.80	20.93	36.05
PREFIX(0.1%)	42.92	20.03	35.05

6. Main Results

Low-data Setting

Source	name : The Eagle | type : coffee shop | food : Chinese | price : cheap | customer rating : average | area : riverside | family friendly : no | near : Burger King
Prefix (50)	The Eagle is a cheap Chinese coffee shop located near Burger King.
Prefix (100)	The Eagle is a cheap coffee shop located in the riverside near Burger King. It has average customer ratings.
Prefix (200)	The Eagle is a cheap Chinese coffee shop located in the riverside area near Burger King. It has average customer ratings.
Prefix (500)	The Eagle is a coffee shop that serves Chinese food. It is located in the riverside area near Burger King. It has an average customer rating and is not family friendly.
FT (50)	The Eagle coffee shop is located in the riverside area near Burger King.
FT (100)	The Eagle is a cheap coffee shop near Burger King in the riverside area. It has a low customer rating and is not family friendly.
FT (200)	The Eagle is a cheap Chinese coffee shop with a low customer rating. It is located near Burger King in the riverside area.
FT (500)	The Eagle is a cheap Chinese coffee shop with average customer ratings. It is located in the riverside area near Burger King.



6. Main Results

Extrapolation : 훈련데이터에 포함 되지 않은 데이터에 대한 예측

Table-to-text Example

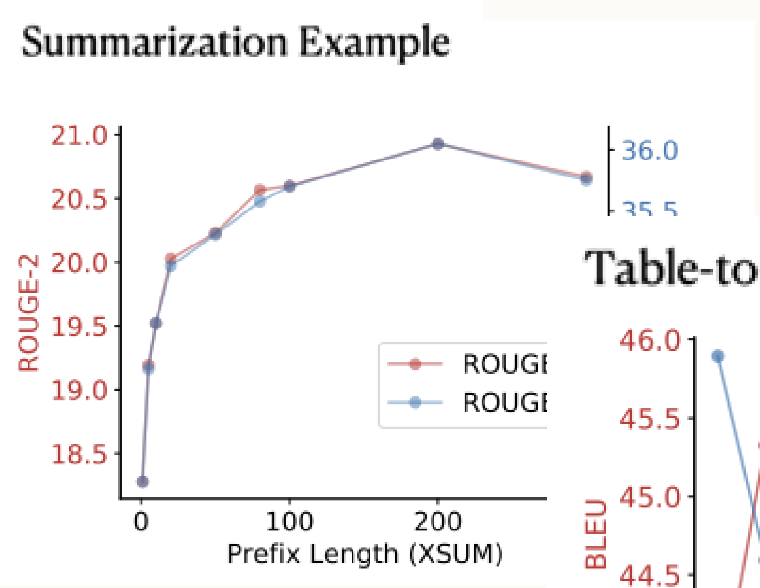
	WebNLG								
	BLEU			MET			TER ↓		
	S	U	A	S	U	A	S	U	A
	GPT-2$_{MEDIUM}$								
FINE-TUNE	**64.2**	27.7	46.5	**0.45**	0.30	0.38	**0.33**	0.76	0.53
FT-TOP2	53.6	18.9	36.0	0.38	0.23	0.31	0.49	0.99	0.72
ADAPTER(3%)	60.4	**48.3**	54.9	0.43	**0.38**	**0.41**	0.35	**0.45**	**0.39**
ADAPTER(0.1%)	54.5	45.1	50.2	0.39	0.36	0.38	0.40	0.46	0.43
PREFIX(0.1%)	62.9	45.6	**55.1**	0.44	**0.38**	**0.41**	0.35	0.49	0.41
	GPT-2$_{LARGE}$								
FINE-TUNE	**65.3**	43.1	55.5	**0.46**	0.38	**0.42**	**0.33**	0.53	0.42
Prefix	63.4	**47.7**	**56.3**	0.45	**0.39**	**0.42**	0.34	**0.48**	**0.40**
SOTA	63.9	52.8	57.1	0.46	0.41	0.44	-	-	-

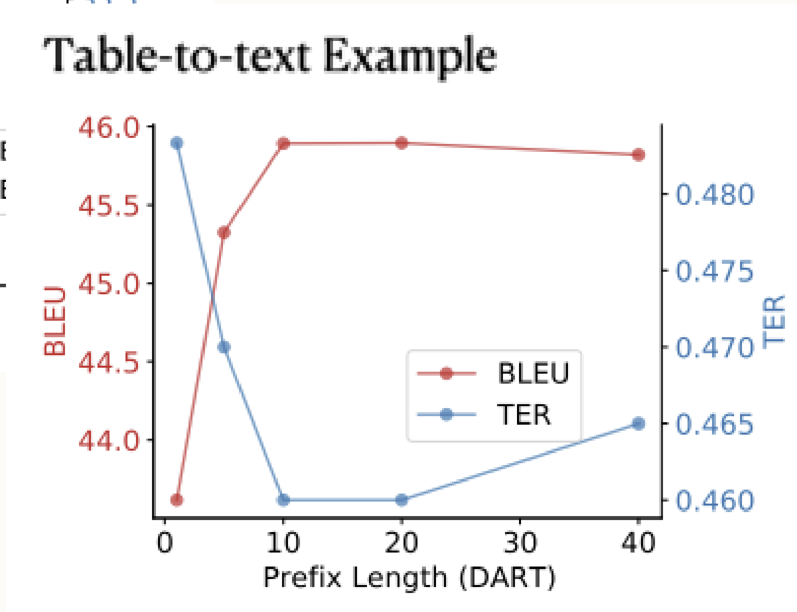
Summarization Example

	news-to-sports			within-news		
	R-1 ↑	R-2 ↑	R-L ↑	R-1 ↑	R-2 ↑	R-L ↑
FINE-TUNE	38.15	15.51	30.26	39.20	16.35	31.15
PREFIX	39.23	16.74	31.51	39.41	16.87	31.47

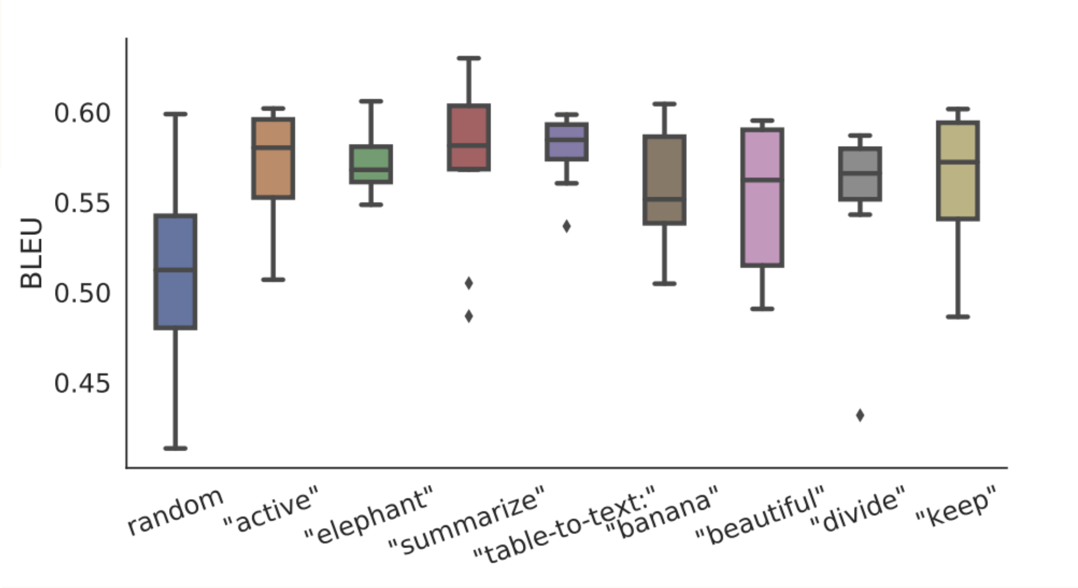
7. Intrinsic Evaluation

1. Prefix length





2. prefix 매개변수 초기화



8. Discussion & Conclusion

Prefix-tuning 제안

- fine-tuning과 비슷하거나 더 높은 성능
- prefix 조정 모듈 및 공간 효율적

개인 정보 보호와 같은 실용적인 방안

- Personalization & Batching Across Users

일반화 능력 향상

- Inductive Bias of Prefix-tuning

Thank you