Table structure data correction

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January 22, 2024

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테이블 구조 데이터(Table structure data)란?

CSV file

	A	B	C
1	36301122334	Message text 1	4/29/2010 12:30
2	36301122335	Message text 2	4/30/2010 12:30
3	36301122336	Message text 3	5/1/2010 12:30
4	36301122337	Message text 4	5/2/2010 12:30
5	36301122338	Message text 5	5/3/2010 12:30
6	36301122339	Message text 6	5/4/2010 12:30
7	36301122340	Message text 7	5/5/2010 12:30
8	36301122341	Message text 8	5/6/2010 12:30
9	36301122342	Message text 9	5/7/2010 12:30
10	36301122343	Message text	
11	36301122344	Message text	
12	36301122345	Message text	
13	36301122346	Message text	
14	36301122347	Message text	
15	36301122348	Message text	
16	36301122349	Message text	
17	36301122350	Message text	
18	36301122351	Message text	
19	36301122352	Message text	
20	36301122353	Message text	

```
1   36301122334,Message text 1,4/29/2010 12:30
2   36301122335,Message text 2,4/30/2010 12:30
3   36301122336,Message text 3,5/1/2010 12:30
4   36301122337,Message text 4,5/2/2010 12:30
5   36301122338,Message text 5,5/3/2010 12:30
6   36301122339,Message text 6,5/4/2010 12:30
7   36301122340,Message text 7,5/5/2010 12:30
8   36301122341,Message text 8,5/6/2010 12:30
9   36301122342,Message text 9,5/7/2010 12:30
10  36301122343,Message text 10,5/8/2010 12:30
11  36301122344,Message text 11,5/9/2010 12:30
12  36301122345,Message text 12,5/10/2010 12:30
13  36301122346,Message text 13,5/11/2010 12:30
14  36301122347,Message text 14,5/12/2010 12:30
15  36301122348,Message text 15,5/13/2010 12:30
16  36301122349,Message text 16,5/14/2010 12:30
17  36301122350,Message text 17,5/15/2010 12:30
18  36301122351,Message text 18,5/16/2010 12:30
19  36301122352,Message text 19,5/17/2010 12:30
20  36301122353,Message text 20,5/18/2010 12:30
```

HTML
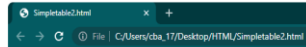
Product Price Quantity

Apple $20 10

Orange $10 15

```
<table>
<tr>
<th>Product</th>
<th>Price</th>
<th>Quantity</th>
</tr>
<tr>
<td>Apple</td>
<td>$20</td>
<td>10</td>
</tr>
<tr>
<td>Orange</td>
<td>$10</td>
<td>15</td>
</tr>
</table>
```

list

```
table = [['First Name', 'Last Name', 'Age'],
         ['John', 'Smith', 39],
         ['Mary', 'Jane', 25],
         ['Jennifer', 'Doe', 28]]
```
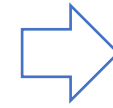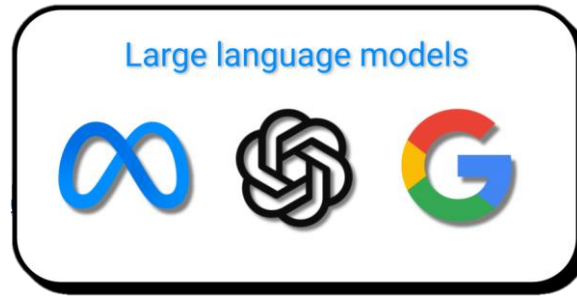
```
print(tabulate(table))
```

```
----------  ---------  ---
First Name  Last Name  Age
John        Smith      39
Mary        Jane       25
Jennifer    Doe        28
----------  ---------  ---
```

- **Table 의 행(row)과 열(column)의 정보로 구성된 DATA**

왜 테이블 구조 데이터(Table structure data) 복원이 필요한가?
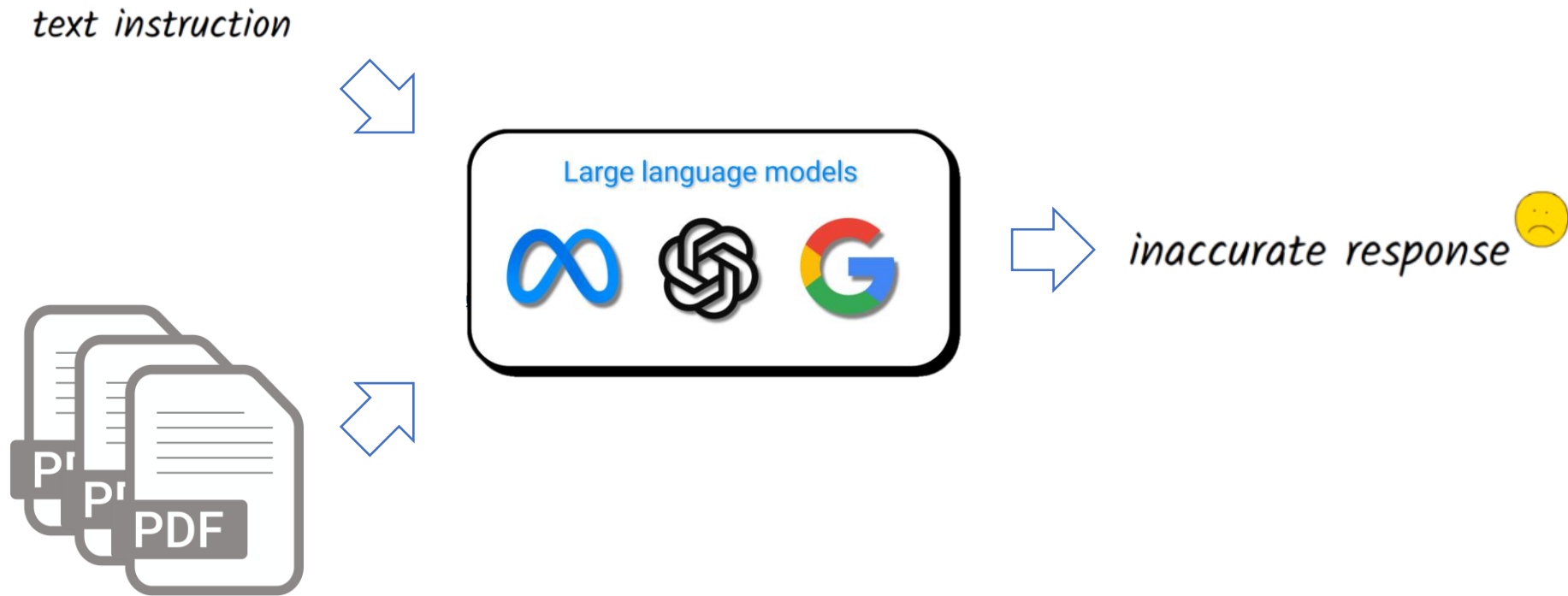

- 대규모 언어 모델(LLM)들은 현저한 발전을 이루고 있다.

- LLM에 텍스트 지침(Instruction)이나 질문(question)을 제공하면 대부분의 경우 모델로부터 정확한 응답을 얻을 수 있다.
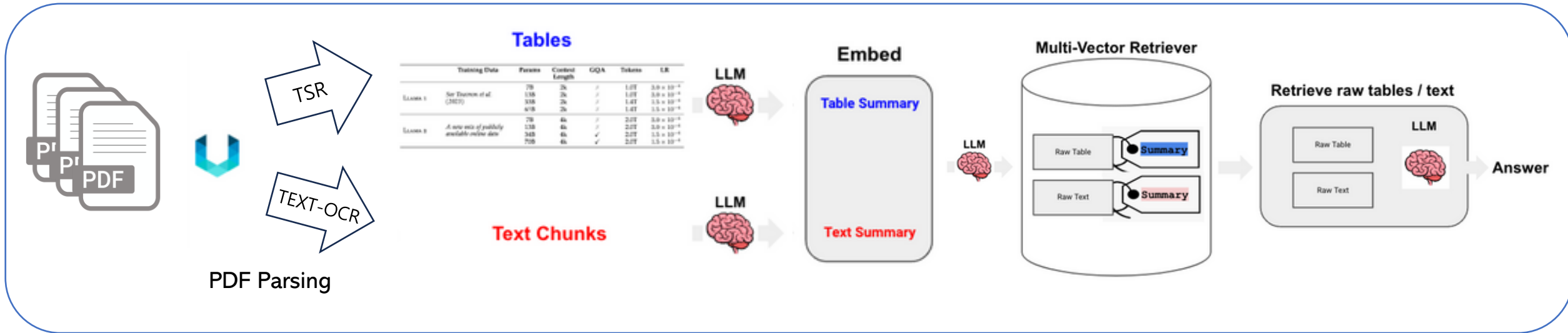
왜 테이블 구조 데이터(Table structure data) 복원이 필요한가?

- 하지만, 현실에서는 수많은 Document들이 PDF파일 형식이나 Image 캡쳐 형식이 존재.

- 입력이 "Text 형식이 아닌 Document"의 경우, 아직까지 잘못된 응답을 하는 문제점이 발생.

- 이 문제들 중 하나는 Parsing 단계, 즉 Preprocessing단계에서 에러가 발생.

왜 테이블 구조 데이터(Table structure data) 복원이 필요한가?

RAG : Retrival Augmented Generation

1. PDF **Parsing library**를 사용하여 Text와 Table을 가각 chunk로 나눔
2. GPT-4를 사용하여 각각의 chunk를 요약
3. 요약문을 가지고 OpenAIEmbdding을 통해 vectorstore에 저장
4. Question이 입력되면 vectorstore로 부터 Retriever을 진행
5. 검색된 결과와 question을 사용하여 Prompt template을 생성
6. GPT-4로부터 Answer generation실행

테이블 구조 인식 (TSR :Table structure recognition)

Fig. 2. The architecture of Formerge
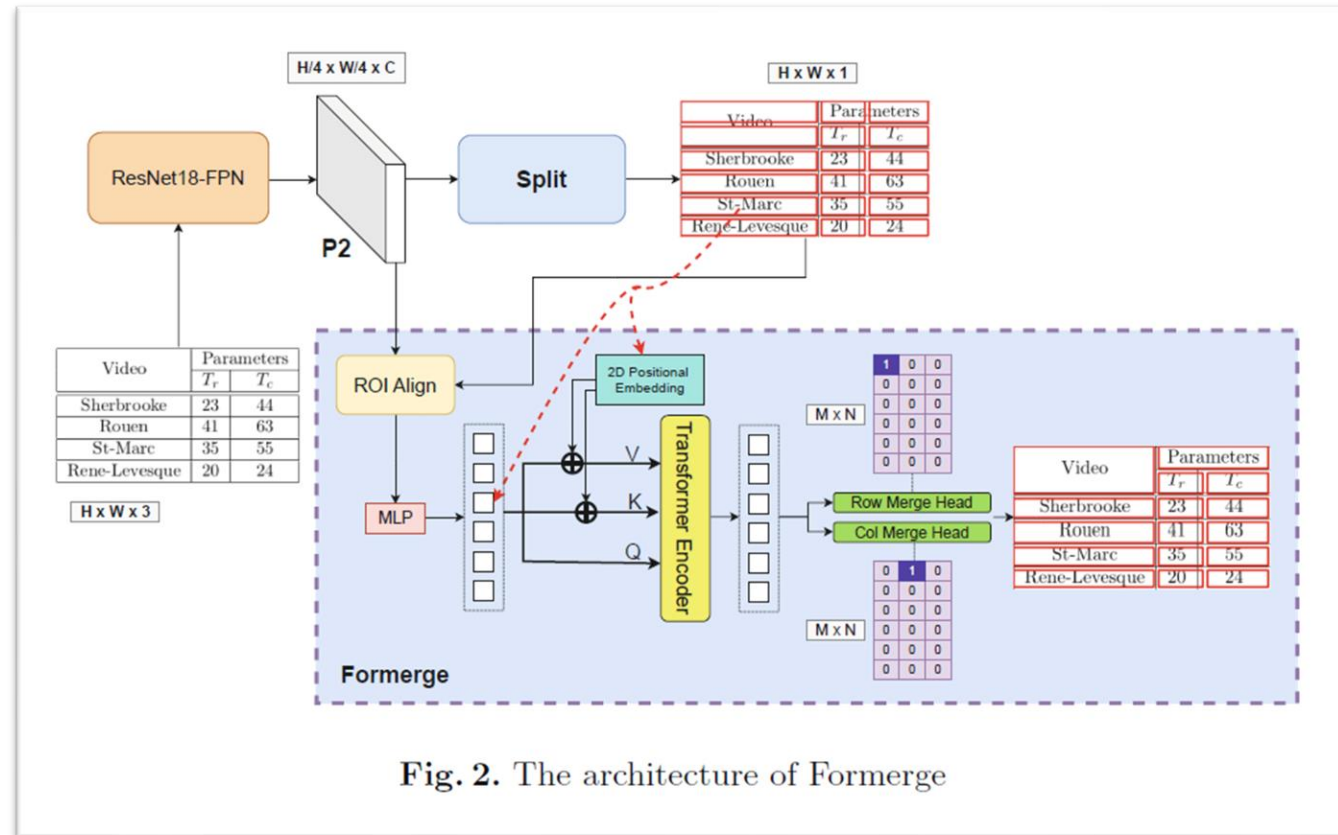
- **Two-stage** : 최근에 **Splitting**과 **Merging Two-stage** 방법을 통해 성능 향상을 보임.
    - **Split stage** : 테이블 gird structure 예측
    - **Merge stage** : grid elements를 spanning cells로 Merge

문제점

PDF-Table

구 분	목 적	시 기	비 용
추가납입보험료	계약유지 · 관리비용	추가납입시	추가납입보험료의 1.5%
		추가납입후	매월 추가납입기준금의 0.015% 단, 추가납입보험료에 의한 계약자 적립액 이내

Table 1: Primers for nested PCR analyses

Sequence from exon		Outer PCR primer pairs	Inner PCR primer pairs
8	fwd	5'-AACATCCTCCTCGCCAAGGGT	5'-ATATGAACTGGCAGTAGGCAC
	rev	5'-TGCTCTCCTGACTGT GCCTGAGTAGACTCA	5'-TTACCCTTGGGGGCCAACCGA
13	fwd	5'-AACATCCTCCTCGCCAAGGGT	5'-AGCCTGTGCCTATTCAACTGA
	rev	5'-TGCTCTCCTGACTGT GCCTGAGTAGACTCA	5'-GCCTCCCGGCAGAAGGAATAC
24	fwd	5'-CGCAAGTGAGCCAGCCACTGC	5'-CAGCCAGCTCAGGCCATCCCT
	rev	5'-CTGGACCGCAGGAATCT GGAATCACATGCTATGGG	5'-CCAGGCCTGTGAGAAGGCTGA

테이블 인식 결과(Unstructured_partition_pdf)

구분	목적	시기	비용
추가납입보험료	계약유지 · 관리비용	추가납입시	추가납입보험료의 1.5%
		추가납입후	매월 추가납입기준금의 0.015% 단, 추가납입보험료에 의한 계약자 적립액 이내

테이블 인식 결과(Table-transformer)

- **테이블 인식 결과 :**
  - Merge를 통해 spanning cell을 찾는 것이 아직 많이 부족해 보임.

Proposed method

인공지능 기반(LLM)의 테이블 데이터 오인식 교정방법
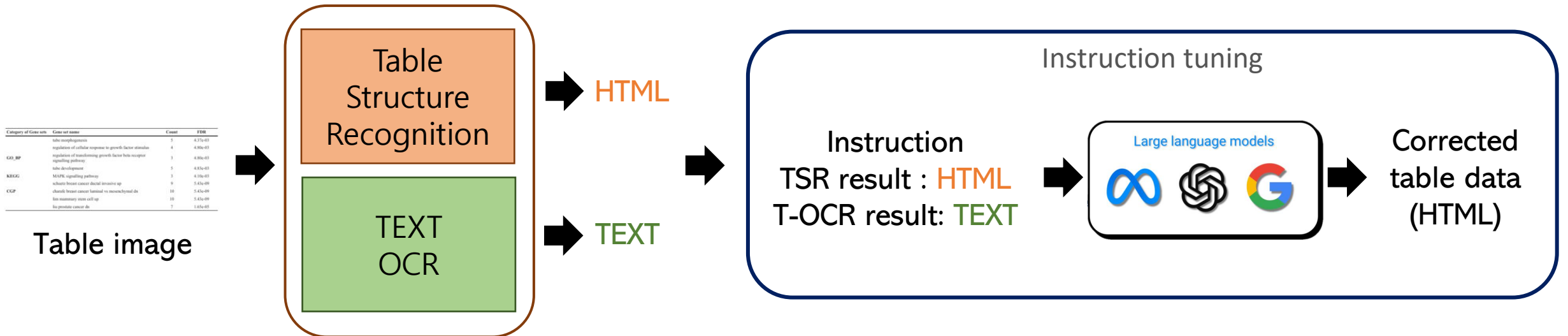
- Instruction tuning을 이용하여 Table data를 복원하도록 학습
  - Table structure결과와 TEXT OCR의 결과를 입력 받아 원본의 Table data로 복원함.

Proposed method

Instruction: Modify the HTML code using the HTML code and text below.

HTML :

```
<html><body><table><thead><th><b>Category of Gene sets</b></th><th><b>Gene set
name</b></th><th><b>Count</b></th><th><b>FDR</b></th></thead><tr><td></td><td>tube
morphogenesis</td><td>5</td><td>4.37e-03</td></tr><tr><td rowspan="3"><b>GO_BP</b></td><td>regulation of
cellular response to growth factor stimulus</td><td>4</td><td>4.80e-03</td></tr><tr><td>regulation of transforming
growth factor beta receptor signalling pathway</td><td>3</td><td>4.80e-03</td></tr><tr><td>tube
development</td><td>5</td><td>4.83e-03</td></tr><tr><td rowspan="2"><b>KEGG</b></td><td>MAPK signalling
pathway</td><td>3</td><td>4.10e-03</td></tr><tr><td>schuetz breast cancer ductal invasive
up</td><td>9</td><td>5.43e-09</td></tr><tr><td rowspan="3"><b>CGP</b></td><td>charafe breast cancer luminal
vs mesenchymal dn</td><td>10</td><td>5.43e-09</td></tr><tr><td>lim mammary stem cell
up</td><td>10</td><td>5.43e-09</td></tr><tr><td>liu prostate cancer dn</td><td>7</td><td>1.65e-
05</td></tr></table></body></html>
```

TEXT :

Category of Gene sets Gene set name Count FDR
tube morphogenesis 5 4.37e-03
regulation of cellular response to growth factor stimulus 4 4.80e-03
GO_BP regulation of transforming growth factor beta receptor signalling pathway 3 4.80e-03
tube development 5 4.83e-03
KEGG MAPK signalling pathway 3 4.10e-03
schuetz breast cancer ductal invasive up 9 5.43e-09
CGP charafe breast cancer luminal vs mesenchymal dn 10 5.43e-09
lim mammary stem cell up 10 5.43e-09
liu prostate cancer dn 7 1.65e-05

Large language models

Corrected table data (HTML)
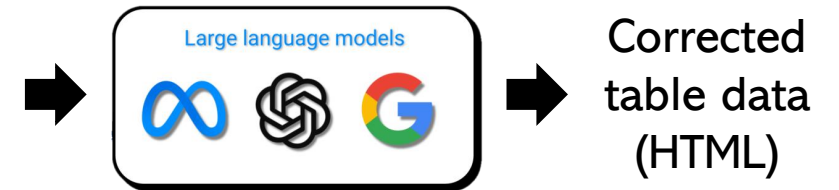
Experiment

Model	Training Data	Model Card	File	Size
TATR-v1.0	PubTables-1M	Model Card	Weights	110 MB
TATR-v1.1-Pub	PubTables-1M	Model Card	Weights	110 MB
TATR-v1.1-Fin	FinTabNet.c	Model Card	Weights	110 MB
TATR-v1.1-All	PubTables-1M + FinTabNet.c	Model Card	Weights	110 MB

- **실험 데이터**
    - PubTabNet : Image, HTML fomat, text(with bbox)
        - Training data : 516k, Test : 9k

- **Instruction Datasets**
    - PubTabNet의 test 데이터로 corruption data 생성
        - Corruption data : TSR 모델(4가지)을 사용해 HTML table data 생성
        - TSR 모델 : Table Transformer에서 서로 데이터로 학습한 4가지 모델을 제공
    - 80%는 LMM Instruction tuning에 사용, 20% Test에 사용함.

- **LLM model + Instruction tuning**
    - TinyPixel/Llama-2-7B-bf16-sharded를 사용하여 Lora fine-tuning을 진행

- **평가지표**
    - Tree-edit-distance-based similarity (TEDS)

$$TEDS(T_a, T_b) = 1 - \frac{EditDist(T_a, T_b)}{max(|T_a|, |T_b|)},$$

where EditDist denotes **tree-edit distance**, and /T/ is **the number of nodes in T**.

Experiment

- **Tree-edit-distance-based similarity (TEDS)**

  - PubTabNet Text data의 20%만 가지고 TEDs 성능 측정

Model	TEDs
TATR-v.10	37.98
TATR-v.1.1-Pub	37.84
TATR-v1.1-Fin	38.42
TATR-v1.1-All	41.63
Llama-2-7B(without-ft)	24.95
Proposed model	43.75

- **결과 분석**

  - 이전 보다 TEDs의 성능이 올라갔으나 유의미한 성능 향상은 아직은 아님.

  - 더 많은 데이터를 사용해 학습을 시도해볼 필요가 있음.

  - Instruction 변경 및 파라미터를 튜닝하여 여러 시도를 시도해 봐야 함.

Next step
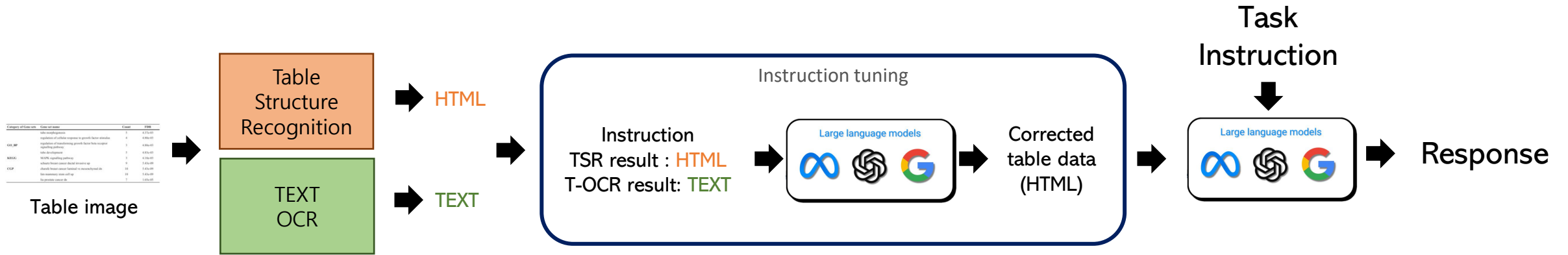
- Table correction만으로는 Contribution이 부족하다고 생각.
- 다음 Task에서도 성능 향상을 기대하며 관련연구 조사 및 실험 계획.
    - Table Image to text generation
    - Table Image QA (VQAonBD 2023)
    - Document Image QA(ICCV 2023)

Next step

- **VQAonBD 2023**

LEADERBOARD

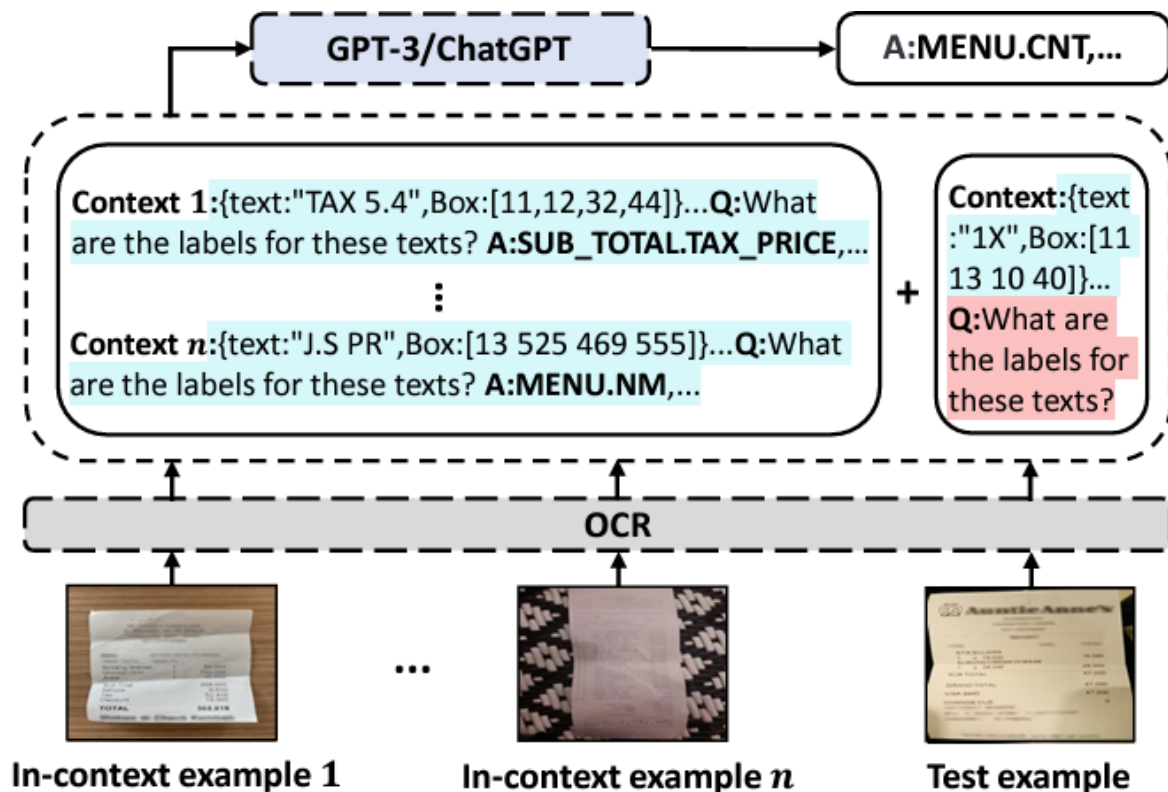### Competition Rules

For training the model, use only training set do not use validation and test sets.

The organizers request the team to upload the final/updated trained model, inference code, ReadMe file, and algorithm details on the competition website on or before 10th April. If there is a mismatch between the results uploaded, the trained model submitted and the results obtained by the inference code by the team, then the team will not be allowed to continue the competition. In such a case, the team results will not be displayed on the leaderboard.

Please note that the most recent submission at the time of competition close date would be considered as the final submission. As per the competition rules, picking up the best model would be considered as cherry picking.

Final Submissions and Ranks

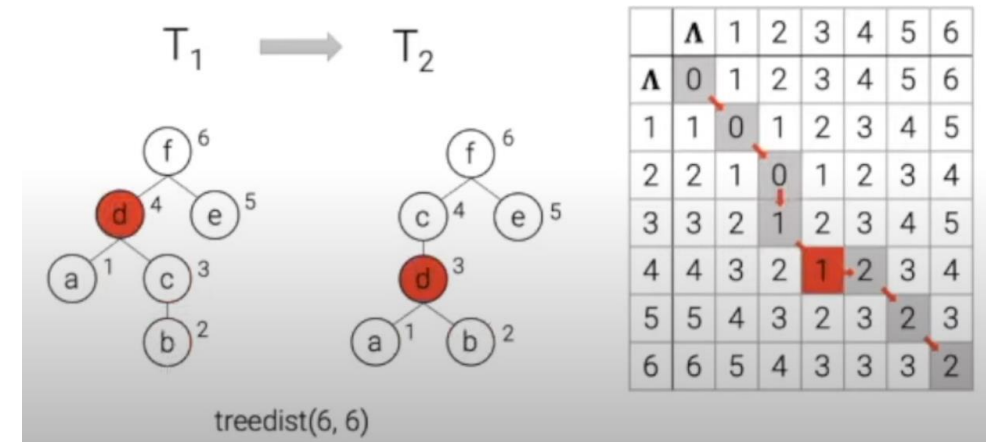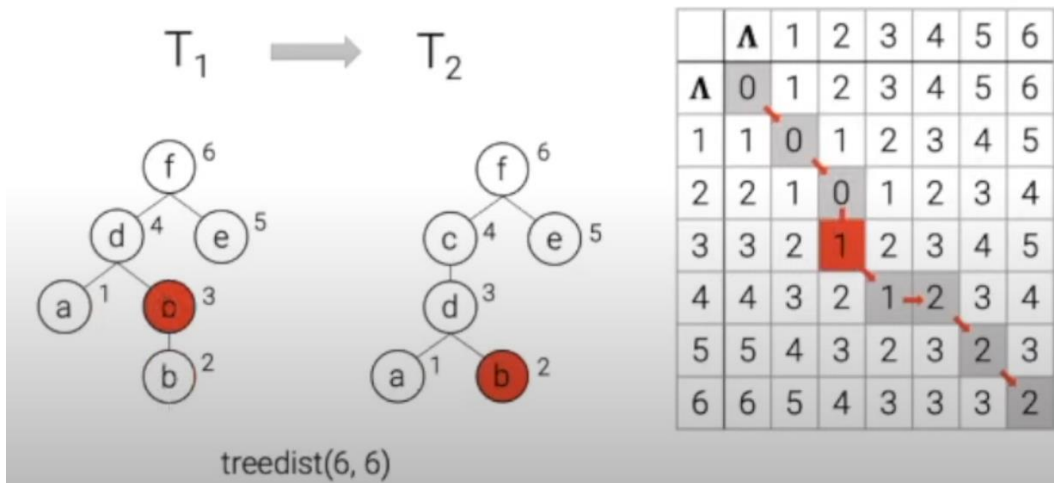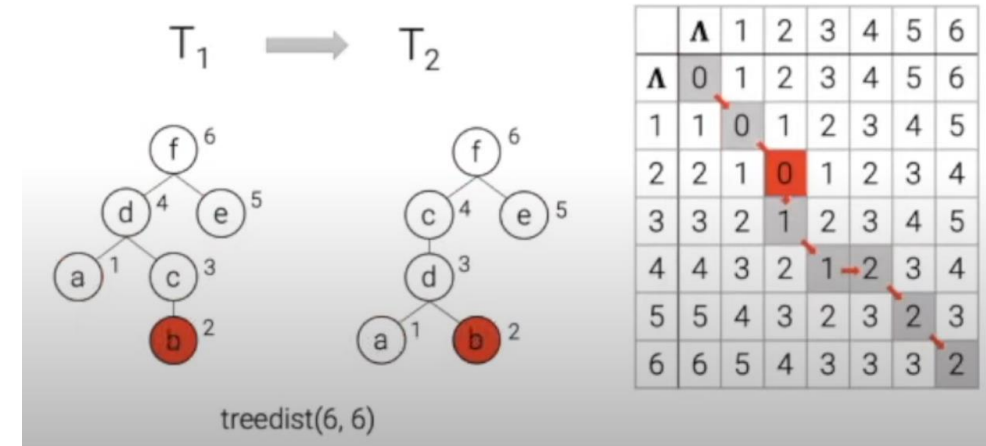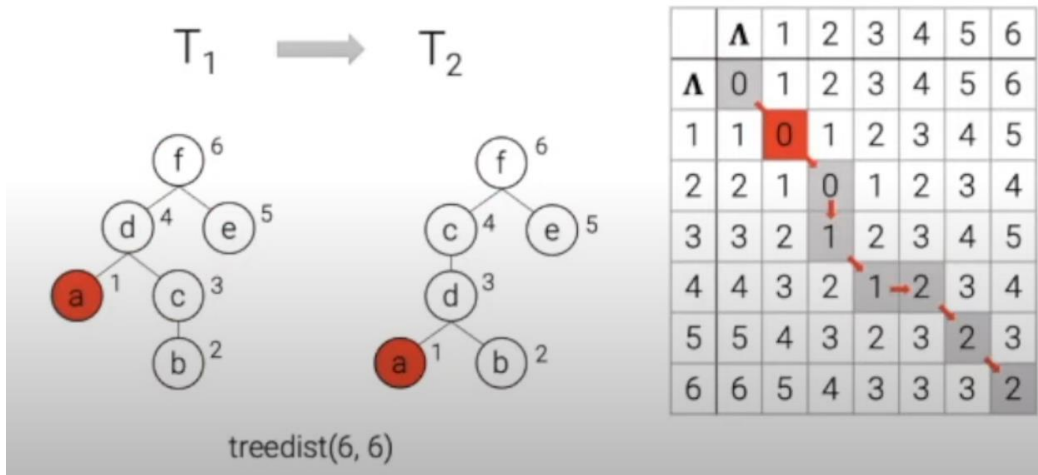| Team	Category 1: Avg	Category 2: Avg	Category 3: Avg	Category 4: Avg	Category 5: Avg	All Categories: Avg	Weighted Categories Average (Final Score)	Rank
BASELINE	0.281	0.091	0.096	0.2	0.169	0.168	0.163	N/A
UPSTAGE	0.963	0.942	0.953	0.974	0.956	0.957	0.959	1 (Winner)
NII-TABIQA	0.932	0.876	0.855	0.895	0.931	0.898	0.901	2 (Runner-up)
DEEPSE-X-UPSTAGE-HK	0.939	0.874	0.859	0.902	0.858	0.886	0.879	3
BD-VQA	0.799	0.794	0.729	0.736	0.422	0.696	0.64	4
SFANC57	0.648	0.119	0.132	0.463	0.418	0.356	0.359	6

Next step

- **ICCV 2023**

ICL-D3IE : In-Context Learning with Diverse Demonstrations Updating for Document Information Extraction
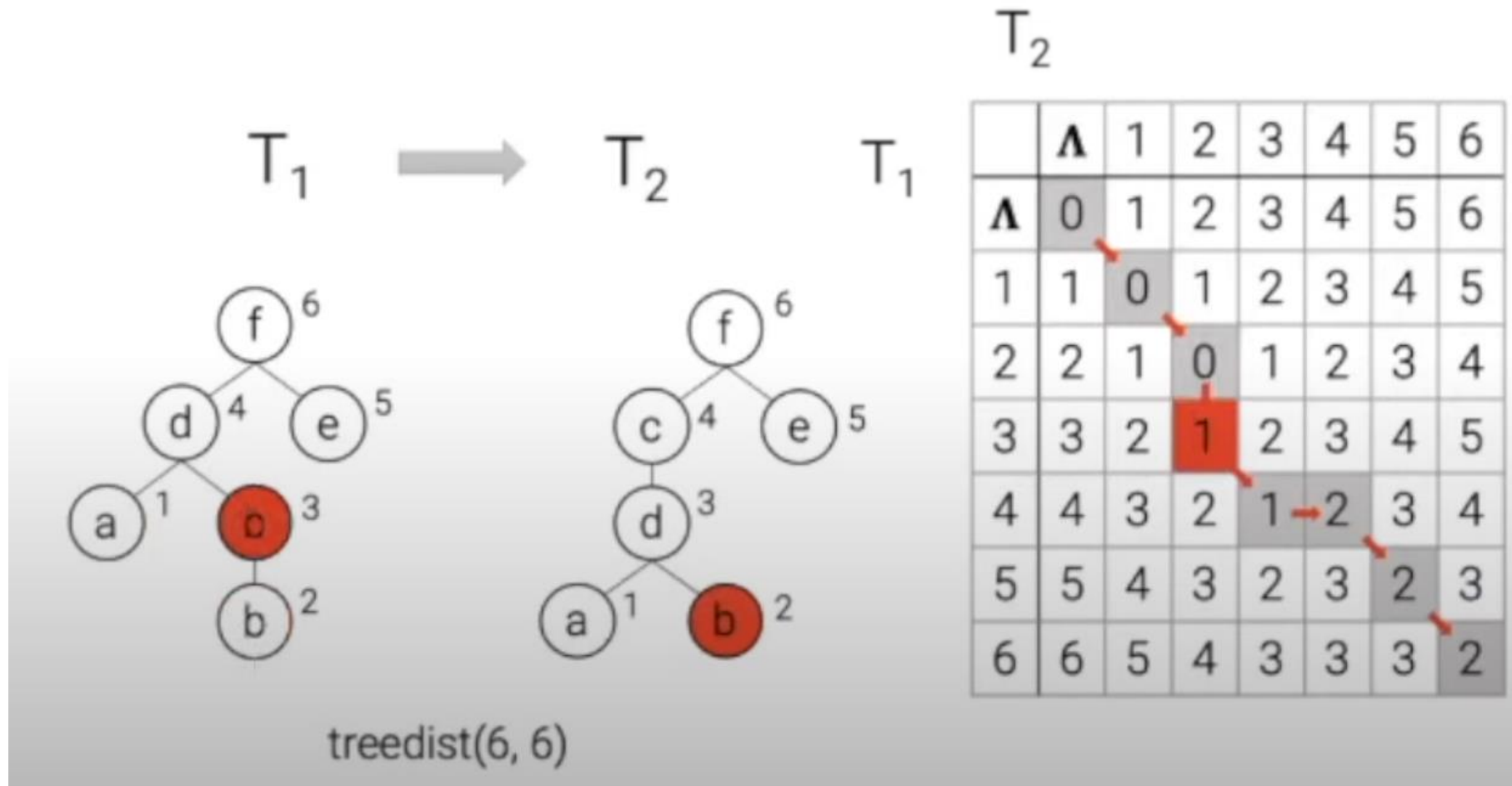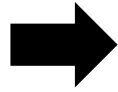
Q&A

ANY QUESTION?

Edit Distance

Edit Distance

treedist(6, 6)

Table Corruption

Year	Title	Chart-Positions			Comments
		UK[9]	US	NL[10]	
1969 Renaissance		60	–	10	
1971 Illusion		–	–	–	1976 (UK)
1972 Prologue		–	–	–	
1973 Ashes Are Burning		–	171	–	
1974 Turn of the Cards		–	94	–	1975 (UK)
1975 Scheherazade and Other Stories		–	48	–	
1977 Novella		–	46	–	1977 (January in US, August in UK, as the band moved to the Warner Bros Music Group)
1978 A Song for All Seasons		35	58	–	UK:Silver
1979 Azure d'Or		73	125	–	
1981 Camera Camera		–	196	–	
1983 Time-Line		–	207	–	
2001 Tuscany		–	–	–	
2013 Grandine il Vento		–	–	–	

➡

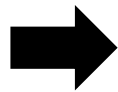| Year UK[9]	Title	Chart-Positions		Comments
		US	NL[10]	
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1971 Illusion		–	–	–	1976 (UK)
1972 Prologue		–	–	–
1973 Ashes Are Burning		–	171	–
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1981 Camera Camera		–	196	–
1983 Time-Line		–	207	–
2001 Tuscany		–	–	–
2013 Grandine il Vento		–	–	–

- Year의 `th rowspan=“2” -> “1”` 로 변경하였더니 UK가 따라왔음.
- html에서 단순히 rowspan을 변경하면 OCR에서 발생할 하지 않는 에러들이 발생.

Year	Title	Chart-Positions			Comments
1969		UK[9]	US	NL[10]	
Renaissance		60	–	10	
1971 Illusion		–	–	–	1976 (UK)
1972 Prologue		–	–	–	
1973 Ashes Are Burning		–	171	–	
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Year	Title	Chart-Positions			Comments
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1972 Prologue		–	–	–	
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1983 Time-Line		–	207	–	
2001 Tuscany		–	–	–	
2013 Grandine il Vento		–	–	–	

- 첫번째는 3행에 있는 1969를 위로 올리고, 3행에 빈 셀을 채움
- 두번째는 1969의 rowspan을 2로 설정해야함.

Year	Title	Chart-Positions			Comments
		UK[9]	US	NL[10]	
1969	*Renaissance*	60	–	10	
1971	*Illusion*	–	–	–	1976 (UK)
1972	*Prologue*	–	–	–	
1973	*Ashes Are Burning*	–	171	–	
1974	*Turn of the Cards*	–	94	–	1975 (UK)
1975	*Scheherazade and Other Stories*	–	48	–	
1977	*Novella*	–	46	–	1977 (January in US, August in UK, as the band moved to the Warner Bros Music Group)
1978	*A Song for All Seasons*	35	58	–	UK:Silver
1979	*Azure d'Or*	73	125	–	
1981	*Camera Camera*	–	196	–	
1983	*Time-Line*	–	207	–	
2001	*Tuscany*	–	–	–	
2013	*Grandine il Vento*	–	–	–	

➡

Year	Title	Chart-Positions			Comments
		UK[9]	US	NL[10]	
	1969	*Renaissance*	60	–	10
1971	*Illusion*	–	–	–	1976 (UK)
1972	*Prologue*	–	–	–	
1973	*Ashes Are Burning*	–	171	–	
1974	*Turn of the Cards*	–	94	–	1975 (UK)
1975	*Scheherazade and Other Stories*	–	48	–	
1977	*Novella*	–	46	–	1977 (January in US, August in UK, as the band moved to the Warner Bros Music Group)
1978	*A Song for All Seasons*	35	58	–	UK:Silver
1979	*Azure d'Or*	73	125	–	
1981	*Camera Camera*	–	196	–	
1983	*Time-Line*	–	207	–	
2001	*Tuscany*	–	–	–	
2013	*Grandine il Vento*	–	–	–	

- Year의 `th rowspan="2" -> "3"` 로 변경하였더니 2행이 1열씩 밀려남.

Year 1969	Title	Chart-Positions			Comments
		UK[9]	US	NL[10]	
	Renaissance	60	–	10	
1971	*Illusion*	–	–	–	1976 (UK)
1972	*Prologue*	–	–	–	
1973	*Ashes Are Burning*	–	171	–	
1974	*Turn of the Cards*	–	94	–	1975 (UK)
1975	*Scheherazade and Other Stories*	–	48	–	
1977	*Novella*	–	46	–	1977 (January in US, August in UK, as the band moved to the Warner Bros Music Group)
1978	*A Song for All Seasons*	35	58	–	UK:Silver
1979	*Azure d'Or*	73	125	–	
1981	*Camera Camera*	–	196	–	
1983	*Time-Line*	–	207	–	
2001	*Tuscany*	–	–	–	
2013	*Grandine il Vento*	–	–	–	

- 1행 1열 Year 밑에 2행 1열
1969
 를 넣었음.

Year	Title	Chart-Positions			Comments
		UK[9]	US	NL[10]	
1969	*Renaissance*	60	–	10	
1971	*Illusion*	–	–	–	1976 (UK)
1972	*Prologue*	–	–	–	
1973	*Ashes Are Burning*	–	171	–	
1974	*Turn of the Cards*	–	94	–	1975 (UK)
1975	*Scheherazade and Other Stories*	–	48	–	
1977	*Novella*	–	46	–	1977 (January in US, August in UK, as the band moved to the Warner Bros Music Group)
1978	*A Song for All Seasons*	35	58	–	UK:Silver
1979	*Azure d'Or*	73	125	–	
1981	*Camera Camera*	–	196	–	
1983	*Time-Line*	–	207	–	
2001	*Tuscany*	–	–	–	
2013	*Grandine il Vento*	–	–	–	

```
1   <table class="wikitable">
2   <tr bgcolor="#CCCCCC">
3   <th rowspan="2" width="25">Year</th>
4   <th rowspan="2" width="270">Title</th>
5   <th colspan="3">Chart-Positions</th>
6   <th rowspan="2" width="220">Comments</th>
7   </tr>
8   <tr bgcolor="#DDDDDD">
9   <th width="30"><a href="//en.wikipedia.org/wi
10  <th width="30"><a href="//en.wikipedia.org/wi
11  <th width="30"><a class="mw-redirect" href="/
12  </tr>
13  <tr>
14  <td>1969</td>
```

Year	Title	Chart-Positions			Comments	UK[9]	US	NL[10]
1969	*Renaissance*	60	–	10				
1971	*Illusion*	–	–	–	1976 (UK)			
1972	*Prologue*	–	–	–				
1973	*Ashes Are Burning*	–	171	–				
1974	*Turn of the Cards*	–	94	–	1975 (UK)			
1975	*Scheherazade and Other Stories*	–	48	–				
1977	*Novella*	–	46	–	1977 (January in US, August in UK, as the band moved to the Warner Bros Music Group)			
1978	*A Song for All Seasons*	35	58	–	UK:Silver			
1979	*Azure d'Or*	73	125	–				
1981	*Camera Camera*	–	196	–				
1983	*Time-Line*	–	207	–				
2001	*Tuscany*	–	–	–				
2013	*Grandine il Vento*	–	–	–				

```
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5   <th rowspan="2" colspan="3">Chart-Positions</th>
6   <th rowspan="2" width="220">Comments</th>
7   </tr>
8   <tr bgcolor="#DDDDDD">
9   <th width="30"><a href="//en.wikipedia.org/wiki/UK_Albums_
10  <th width="30"><a href="//en.wikipedia.org/wiki/Billboard_
11  <th width="30"><a class="mw-redirect" href="//en.wikipedia
12  </tr>
13  <tr>
14  <td>1969</td>
15  <td><i><a href="//en.wikipedia.org/wiki/Renaissance_(Renai
16  <td align="center">60</td>
17  <td align="center">–</td>
18  <td align="center">10</td>
19  <td></td>
20  </tr>
21  <tr>
22  <td>1971</td>
```

- rowspan만 늘리면 이렇게 변함…

Table 1 (original rendering):

Year	Title	Chart-Positions			Comments
		UK[9]	US	NL[10]	
1969	Renaissance	60	–	10	
1971	Illusion	–	–	–	1976 (UK)
1972	Prologue	–	–	–	
1973	Ashes Are Burning	–	171	–	
1974	Turn of the Cards	–	94	–	1975 (UK)
1975	Scheherazade and Other Stories	–	48	–	
1977	Novella	–	46	–	1977 (January in US, August in UK, as the band moved to the Warner Bros Music Group)
1978	A Song for All Seasons	35	58	–	UK:Silver
1979	Azure d'Or	73	125	–	
1981	Camera Camera	–	196	–	
1983	Time-Line	–	207	–	
2001	Tuscany	–	–	–	
2013	Grandine il Vento	–	–	–	

Table 2 (middle rendering):

Year	Title	Chart-Positions	Comments	- --	UK US NL -
1969	Renaissance	60	–	10	
1971	Illusion	–	–	–	1976 (UK)
1972	Prologue	–	–	–	
1973	Ashes Are Burning	–	171	–	
1974	Turn of the Cards	–	94	–	1975 (UK)
1975	Scheherazade and Other Stories	–	48	–	
1977	Novella	–	46	–	1977 (January in US, August in UK, as the band moved to the Warner Bros Music Group)
1978	A Song for All Seasons	35	58	–	UK:Silver
1979	Azure d'Or	73	125	–	
1981	Camera Camera	–	196	–	
1983	Time-Line	–	207	–	
2001	Tuscany	–	–	–	
2013	Grandine il Vento	–	–	–	

Table 3 (rightmost rendering):

Year	Title	Chart-Positions	Comments
-	--	UK US NL	-
1969	Renaissance	60 – 10	
1971	Illusion	– – –	1976 (UK)
1972	Prologue	– – –	
1973	Ashes Are Burning	– 171 –	
1974	Turn of the Cards	– 94 –	1975 (UK)
1975	Scheherazade and Other Stories	– 48 –	
1977	Novella	– 46 –	1977 (January in US, August in UK, as the band moved to the Warner Bros Music Group)
1978	A Song for All Seasons	35 58 –	UK:Silver
1979	Azure d'Or	73 125 –	
1981	Camera Camera	– 196 –	
1983	Time-Line	– 207 –	
2001	Tuscany	– – –	
2013	Grandine il Vento	– – –	

Code snippet 1:

```html
<table class="wikitable">
<tr bgcolor="#CCCCCC">
<th rowspan="2" width="25">Year</th>
<th rowspan="2" width="270">Title</th>
<th colspan="3">Chart-Positions</th>
<th rowspan="2" width="220">Comments</th>
</tr>
<tr bgcolor="#DDDDDD">
<th width="30"><a href="//en.wikipedia.org/wi
<th width="30"><a href="//en.wikipedia.org/wi
<th width="30"><a class="mw-redirect" href="/
</tr>
<tr>
<td>1969</td>
```

Code snippet 2:

```html
<table class="wikitable">
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<th rowspan="2" width="25">Year</th>
<th rowspan="2" width="270">Title</th>
<th rowspan="2" colspan="3" >Chart-Positions</th>
<th rowspan="2" width="220">Comments</th>
</tr>
<tr bgcolor="#DDDDDD">
<th>-</th>
<th>--</th>
<th>UK</th>
<th>US</th>
<th>NL</th>
<th>-</th>
</tr>
<tr>
```

Code snippet 3:

```html
<table class="wikitable">
<tr bgcolor="#CCCCCC">
<th width="25">Year</th>
<th width="270">Title</th>
<th colspan="3" >Chart-Positions</th>
<th width="220">Comments</th>
</tr>
<tr >
<td>-</td>
<td>--</td>
<td>UK</td>
<td>US</td>
<td>NL</td>
<td>-</td>
</tr>
<tr>
<td>1969</td>
```

- 이런 문제는 간단히 룰로 하기 쉽지 않아 보임… 모르겠음 솔직히..