



DATA 8005: Advanced Natural Language Processing

Fall 2023

Announcements

- [Final project group registration](#) is due **today** (in teams of 2-3)!
- Task: send your questions and comments in #week5 channel!
- Presentation schedule is on the course page

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- Task: send your questions and comments in #week5 channel!
- Presentation schedule is on the course page
 - Ensure your name is listed
 - We have taken your preferences into account
 - Alterations will only be made for compelling reasons
 - Talk to me after the class

Presentation schedule

- For today:
 - Instruction tuning (Xubin Ren, Yiming Zhang)
 - ICLR deadline, holidays...
- For next week:
 - LM evaluation, data, and benchmarking (Yuanpeng Tu, Zhuoling Li)
 - Alignment/RLHF (Tonghuan Xiao, Yangtuan Sun, Guichao Zhu)

This lecture

- For today 🎉🎉🎉
 - Instruction tuning (Xubin Ren, Yiming Zhang)

CoT prompting

Chain-of-Thought (Wei et al., 2022)

Input

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 tennis balls. How many tennis balls does he have now?

A: Roger started with 5 tennis balls. 2 cans of 3 tennis balls each is 6 tennis balls. $5 + 6 = 11$. The answer is 11.

Q: The bakers at the Beverly Hills Bakery baked 200 loaves of bread on Monday morning. They sold 93 loaves in the morning and 39 loaves in the afternoon. A grocery store returned 6 unsold loaves. How many loaves of bread did they have left?

Model Output

A: The bakers started with 200 loaves. They sold 93 in the morning and 39 in the afternoon. So they sold $93 + 39 = 132$ loaves. The grocery store returned 6 loaves. So they had $200 - 132 + 6 = 62$ loaves left. The answer is 62.



Other prompting

Program-aided Language models (this work)

Input

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 tennis balls. How many tennis balls does he have now?

A: Roger started with 5 tennis balls.

`tennis_balls = 5`

2 cans of 3 tennis balls each is

`bought_balls = 2 * 3`

tennis balls. The answer is

`answer = tennis_balls + bought_balls`

Q: The bakers at the Beverly Hills Bakery baked 200 loaves of bread on Monday morning. They sold 93 loaves in the morning and 39 loaves in the afternoon. A grocery store returned 6 unsold loaves. How many loaves of bread did they have left?

Model Output

A: The bakers started with 200 loaves

`loaves_baked = 200`

They sold 93 in the morning and 39 in the afternoon

`loaves_sold_morning = 93`

`loaves_sold_afternoon = 39`

The grocery store returned 6 loaves.

`loaves_returned = 6`

The answer is

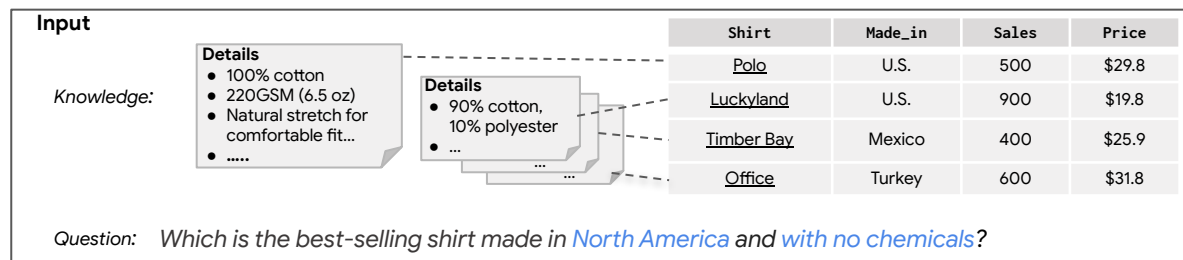
`answer = loaves_baked - loaves_sold_morning`

`- loaves_sold_afternoon + loaves_returned`

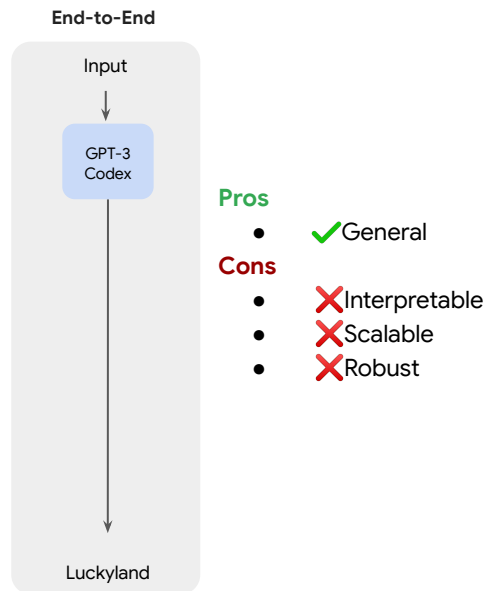
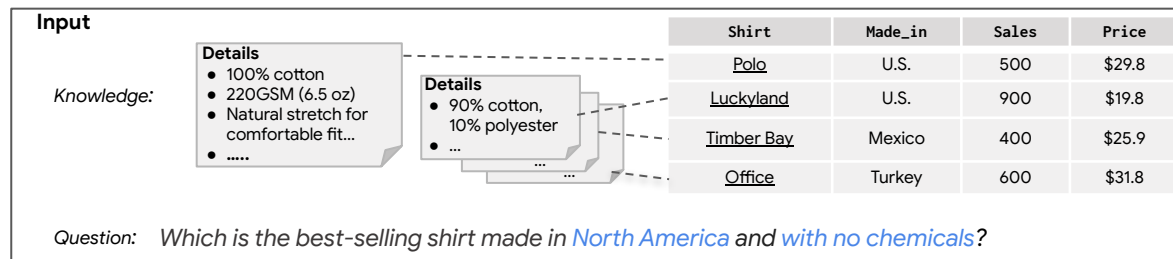
`>>> print(answer)`

74

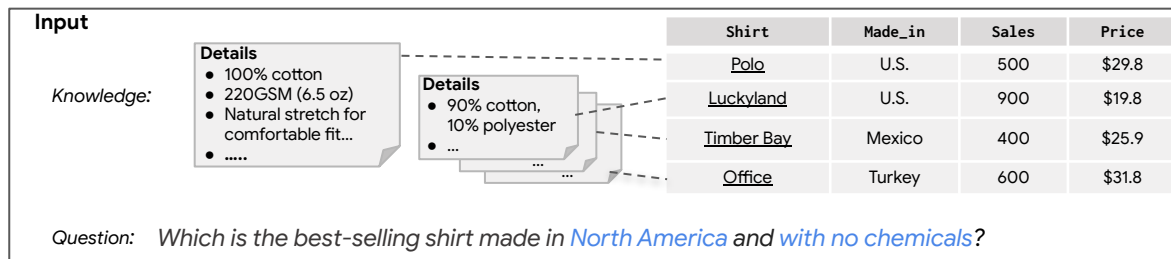




LLM + no tool



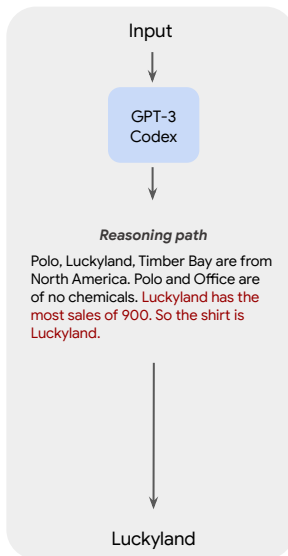
LLM + no tool



End-to-End



Chain-of-Thought



Pros

- ✓ Improved but still...

Cons

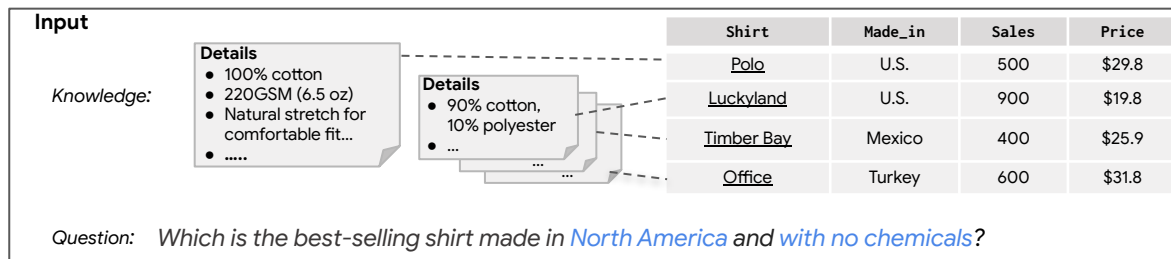
- ✗ Interpretable
Unreliable answer entailment
- ✗ Scalable
- ✗ Robust

Uninterpretable & not robust

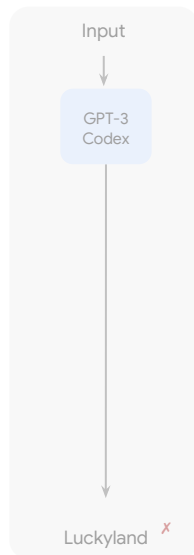
✗ tool use

✗ tool use

LLM + code



End-to-End



Uninterpretable & not robust

✗ tool use

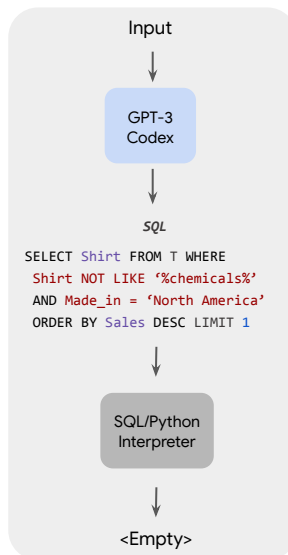
Chain-of-Thought



Unreliable answer entailment

✗ tool use

Semantic Parsing/Code Generation



✓ tool use: SQL/Python

Pros

- ✓ Interpretable
- ✓ Scalable
- ✓ Robust

Cons

- ✗ Capable

LLM + code and NLP expert function APIs

Input

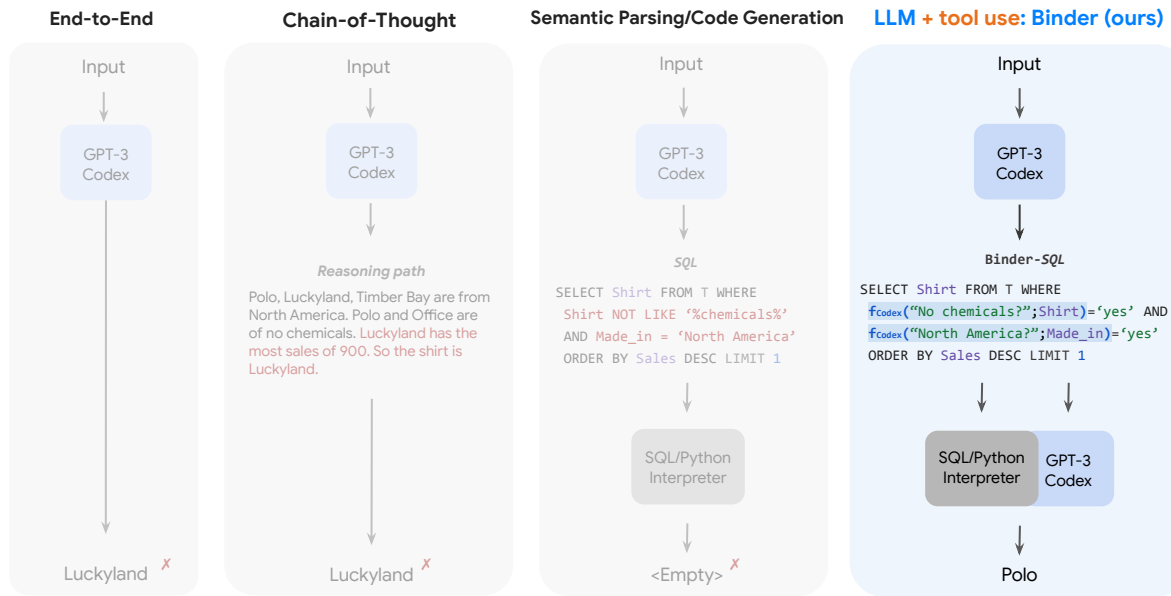
Knowledge:

Details
 • 100% cotton
 • 220GSM (6.5 oz)
 • Natural stretch for comfortable fit...
 •

Details
 • 90% cotton, 10% polyester
 • ...

Shirt	Made_in	Sales	Price
<u>Polo</u>	U.S.	500	\$29.8
<u>Luckyland</u>	U.S.	900	\$19.8
<u>Timber Bay</u>	Mexico	400	\$25.9
<u>Office</u>	Turkey	600	\$31.8

Question: Which is the best-selling shirt made in *North America* and *with no chemicals*?



Uninterpretable & not robust

✗ tool use

Unreliable answer entailment

✗ tool use

Limited PL grammar capacity

✓ tool use: SQL/Python

✓ tool use:

SQL/Python + NLP expert model APIs

Why
LLM + tool use?

Pros

- ✓ Interpretable
- ✓ Scalable
- ✓ Robust
- ✓ Capable

LLM prompting for tool use

Knowledge:

Details

- 100% cotton
- 220GSM (6.5 oz)
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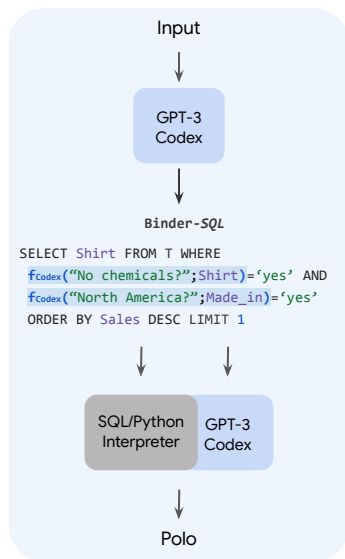
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Question: Which is the best-selling shirt made in *North America* and *with no chemicals*?

LLM + tool use: Binder (ours)



```
## WikiTQ
Generate SQL given the question and table to answer
the question correctly.
...
```

Task/tool description

```
CREATE TABLE Electoral district of Lachlan(
  row_id int,
  member text,
  party text,
  term text)

/*
3 example rows:
SELECT * FROM w LIMIT 3;
row_id member party term
0 john ryan none 1859-1864
1 james martin none 1864-1869
2 james watson none 1869-1880
*/
```

environment description

```
Q: of the members of the third incarnation of the lachlan,
who served the longest?
Binder: SELECT member FROM w ORDER BY
f("How long does it last?"; term) DESC LIMIT 1
```

User question

Output code bounded with
API calls

LLM + code: PAL, PoT

Chain-of-Thought (Wei et al., 2022)

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Program-aided Language models (this work)

Input

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answer = tennis_balls + bought_balls

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The grocery store returned 6 loaves.

loaves_returned = 6

The answer is

```
answer = loaves_baked - loaves_sold_morning  
         - loaves_sold_afternoon + loaves_returned
```

```
>>> print(answer)
```

74



Question: In Fibonacci sequence, it follows the rule that each number is equal to the sum of the preceding two numbers. Assuming the first two numbers are 0 and 1, what is the 50th number in Fibonacci sequence?

The first number is 0, the second number is 1, therefore, the third number is $0+1=1$. The fourth number is $1+1=2$. The fifth number is $1+2=3$. The sixth number is $2+3=5$. The seventh number is $3+5=8$. The eighth number is $5+8=13$.

..... (Skip 1000 tokens)

The 50th number is 32,432,268,459.

CoT

↓
32,432,268,459 ❌

```
length_of_fibonacci_sequence = 50  
fibonacci_sequence = np.zeros(length_of_)  
fibonacci_sequence[0] = 0  
fibonacci_sequence[1] = 1  
For i in range(3, length_of_fibonacci_sequence):  
    fibonacci_sequence[i] = fibonacci_sequence[i-1] +  
        fibonacci_sequence[i-2]  
ans = fibonacci_sequence[-1]
```

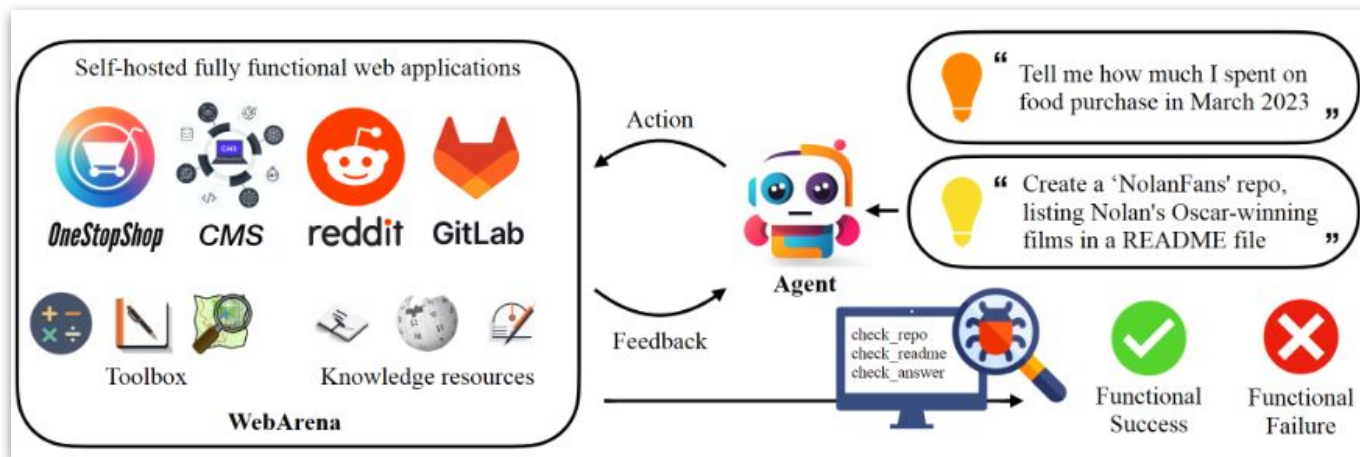
PoT

python

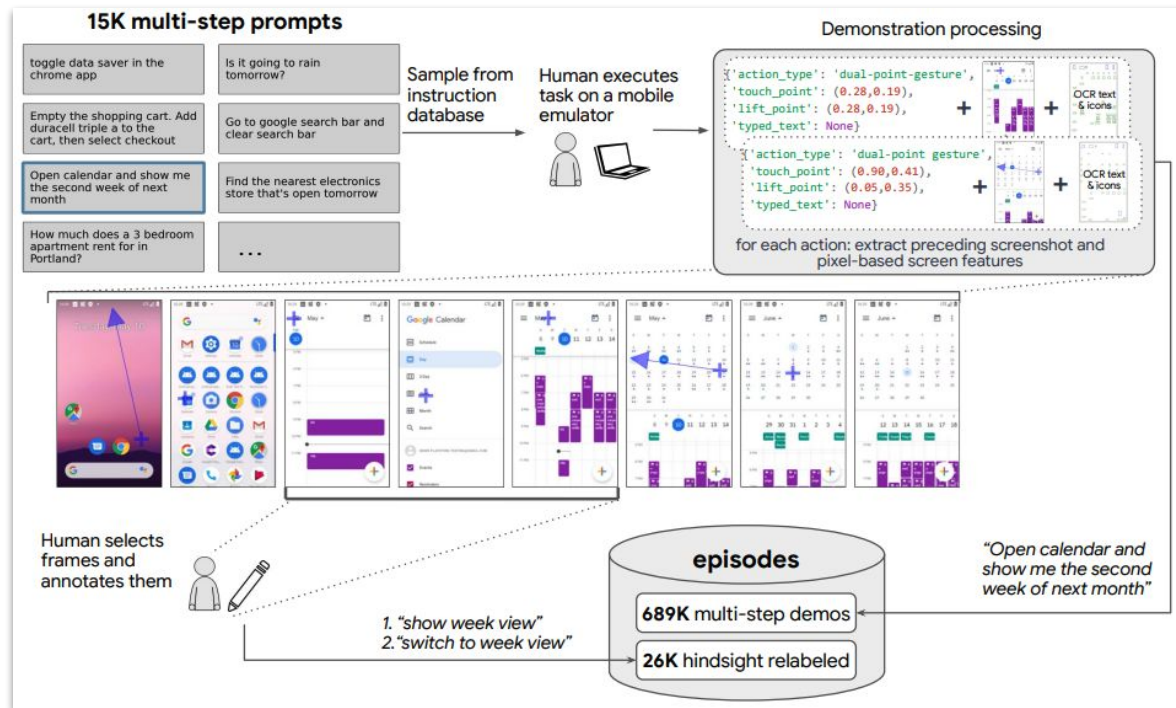
↓
12,586,269,025 ✅

Project ideas

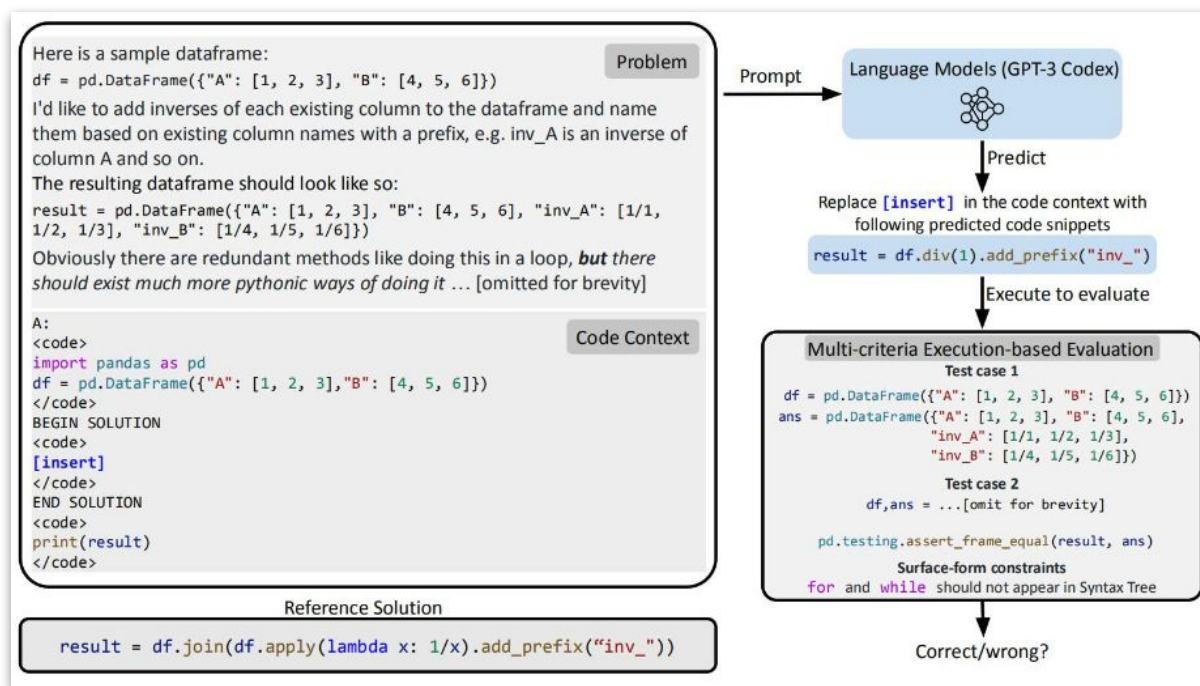
Web agent



App agent



Code agent



Code agent

```
[1] import pandas as pd
C1 df = pd.read_csv('dataset/Gamepass_Games_v1.csv')

[2] u1 Extract min and max hours as two columns ✖
def get_avg(x):
    try: return float(x[0]) , float(x[1])
    except: return 0, 0

df['min'], df['max'] = zip(*df['TIME'].str.replace(
    ' hours', '').str.split("-").apply(get_avg))
C2

[3] df['ADDED'] = pd.to_datetime(
C3     df['ADDED'],format="%d %b %y",errors='coerce')

[4] u2 In which year was the most played game added? ✖
df['GAMERS']=df['GAMERS'].str.replace(
    ',', ' ').astype(int)
C4 added_year=df[df['GAMERS'].idxmax()]['ADDED'].year

[5] u3 For each month in that year, how many games that ✖
    has a rating of more than four?
df[(df['ADDED'].dt.year== added_date.year) &
(df['RATING']>4)].groupby(
C5     df["ADDED"].dt.month)['GAME'].count()
```