

Assignment 3

我的代码可以在github仓库中获取到[shuitatata/24Fall-NLPDL](#)

Task 1

KV-cache 评测

我通过使用 `generate` 方法，并控制参数 `use_cache`，来比较有无KV-cache情况下的性能。

使用gpt2模型，在4090显卡上进行实验。

进行5次实验后，推理时间和消耗显存大小如下：

是否使用KV-cache	推理时间/s	显存/GB
不使用KV-cache	18.4	11.8
使用KV-cache	7.6	7.3

可以发现，使用KV-cache后，无论是推理时间还是显存占用都相较于naive的实现有了很大改善。这是因为KV-cache可以在构造key和value时，减少了两个大矩阵相乘的步骤，减少了时间和空间开销。

量化

这里的量化好像有两种理解，一种是使用**量化缓存**，见[使用缓存进行生成最佳实践 - Hugging Face 机器学习平台](#)，另一种则是对整个模型进行量化。

我首先尝试了第一种理解，但是在设置 `cache_implementation` 参数时，程序报告warning: This model does not support `Cache` instances。好像不支持使用量化缓存。

于是我按照第二种理解展开了实验。使用 `quanto` 后端，利用 `quantize` 接口对模型进行不同程度的量化，比较其推理速度和消耗显存。

使用gpt2模型，不使用KV-cache，在4090显卡上进行实验。

进行5次实验后，推理时间和消耗显存大小如下：

量化位数	推理时间/s	显存/GB
int2	20.0	9.88
int4	20.2	9.89
int8	19.0	9.89

可能是gpt2模型本身参数量就较小，模型大小不足1G，因此量化的作用不大。不管是推理时间还是显存占用都基本相同。

手工实现KV-cache

接下来我修改 customized_gpt2 的代码，主要思路是将之前的key和value存下来，与新的key和value拼接，构成完整的key和value，避免了每次都进行完整的矩阵乘法运算。

进行5次实验后，推理时间和消耗显存的对比如下：

是否使用KV-cache	推理时间/s	显存/GB
不使用KV-cache	13.48	12.1
使用KV-cache（手工实现）	11.48	10.5

可以发现，手工实现的效果比不上官方实现的。但是相较于没有使用KV-cache的情况，推理时间和显存消耗都有了改善。

Task 2

task2中，我评测了多种prompt技术对大模型数学能力的影响。

我使用deepseek的模型，gsm8k数据集，由于token限额原因，仅选取前500条数据参与评测。

结果如下：

	Naive	Naive + few-shot	COT	Reflexion	ICL+COT
Accuracy	30.4%	45.4%	84.2%	74.4%	93.2%
时间	20"	20"	6'49"	8'56"	3'43"

可以发现，ICL+COT的效果是最好的，其中COT发挥了比较大的作用。但是COT技术由于会产生更长的输出文本，因此推理时间的增长比较显著。

有意思的是，Reflexion比单纯使用COT的效果更差，这似乎比较违反直觉，因为Reflexion看起来是COT再加上“怀疑”，按理说效果应该不差于COT才对。

我们可以从以下样例尝试分析以下原因：

例子

原始问题与答案：

Josh decides to try flipping a house. He buys a house for \$80,000 and then puts in \$50,000 in repairs. This increased the value of the house by 150%. How much profit did he make?

How much did the house cost? The cost of the house and repairs came out to $80,000+50,000=\$<<80000+50000=130000>>130,000$

How much did the repairs increase the value of the house? He increased the value of the house by $80,000*1.5=<<80000*1.5=120000>>120,000$

What is the new value of the house? So the new value of the house is $120,000+80,000=\$<<120000+80000=200000>>200,000$

How much profit did he make? So he made a profit of $200,000-130,000=\$<<200000-130000=70000>>70,000$

Naive和Naive + few-shot

二者都是直接给出答案，分别为220000和120000。

COT

仅使用COT时，我设计的prompt是这样的：

Josh decides to try flipping a house. He buys a house for 80,000 and then puts in 50,000 in repairs. This increased the value of the house by 150%. How much profit did he make?
Please provide a detailed step-by-step solution and conclude with the final numerical answer in the format '#### [answer]', only a single number.

这是模型给出的回复：

To determine Josh's profit from flipping the house, we need to follow these steps:

1. **Calculate the total cost of the house:**
 - Purchase price of the house: \$80,000
 - Repairs cost: \$50,000
 - Total cost = Purchase price + Repairs cost
 - Total cost = \$80,000 + \$50,000 = \$130,000
2. **Determine the increased value of the house:**
 - The value of the house increased by 150%.
 - To find the new value, we first calculate 150% of the total cost.
 - 150% of \$130,000 = $1.50 * \$130,000 = \$195,000$
3. **Calculate the profit:**
 - Profit = New value of the house - Total cost
 - Profit = \$195,000 - \$130,000 = \$65,000

Therefore, Josh made a profit of \$65,000.

65000

可以看出，模型在尝试一步步地思考，但是在第2步的时候出现了错误，导致最终生成了错误的答案。

COT+ICL

这个设置下，在上文COT的基础上，我为模型还提供了四个例子以供参考。完整的prompt过于长，在这里不展示，具体结构就是在数据集中挑选了4个不参与评测的数据，放在了真实问题之前，供模型学习。

模型给出的回复如下：

How much did Josh spend in total? ** Josh spent
80,000+50,000=\$<<80000+50000=130000>>130,000 in total.
How much did the value of the house increase by? ** The value of the house increased by
150% of the original price, which is $1.5 * 80,000 = \$<<1.5 * 80000 = 120000>>120,000$.
What is the new value of the house? ** The new value of the house is
 $80,000 + 120,000 = \$<<80000 + 120000 = 200000>>200,000$.
How much profit did Josh make? ** Josh made a profit of $200,000 - 130,000 = \$<<200000 - 130000 = 70000>>70,000$.
70000

我们可以明显发现，模型不仅给出了正确答案，而且还模仿了数据集中条目的结构，在形式上与我们给出的样本几乎一致。

Reflexion

Reflexion是在COT的基础上增加了一句“Afterward, reflect on your answer and explain why it makes sense. If you find any mistakes, correct them”，完整的prompt如下：

```
Josh decides to try flipping a house. He buys a house for 80,000andthenputsin50,000 in repairs. This increased the value of the house by 150%. How much profit did he make?
\n\nPlease provide a detailed step-by-step solution. Afterward, reflect on your answer and explain why it makes sense. If you find any mistakes, correct them, and provide the final answer in the format '#### [answer]'.
```

模型的回复为：

```
To determine Josh's profit from flipping the house, we need to follow these steps:

\1. **Calculate the total cost of the house:**
- Purchase price of the house: $80,000
- Repairs: $50,000
- Total cost = Purchase price + Repairs = $80,000 + $50,000 = $130,000

\2. **Determine the increased value of the house:**
- The value of the house increased by 150%. This means the new value is 100% (original value) + 150% (increase) = 250% of the original value.
- The original value of the house after repairs is $130,000.
- New value = 250% of $130,000 = (250/100) * $130,000 = 2.5 * $130,000 = $325,000

\3. **Calculate the profit:**
- Profit = New value - Total cost = $325,000 - $130,000 = $195,000

### Reflection:
The calculation makes sense because Josh invested a total of $130,000 into the house (purchase price + repairs), and the house's value increased by 150%, resulting in a new value of $325,000. The difference between the new value and the total cost is the profit, which is $195,000. This profit reflects the increase in the house's value due to the repairs and improvements made by Josh.

### Final Answer:
#### $195,000
```

在前面的COT阶段，模型不出意料地没有得到正确的结果，而在后面的Refelction中，模型也并没有找出自己的问题。我认为这是合理的，模型如果有辨别正确的能力，那么一开始也不会做错了。

但是我们可以尝试改进一下，让模型**始终假设**自己刚才的回答是错误的，并尝试找出错误之处。

现在的prompt如下：

```
Josh decides to try flipping a house. He buys a house for $80,000 and then puts in $50,000 in repairs. This increased the value of the house by 150%. How much profit did he make?
\n\nPlease provide a detailed step-by-step solution. Afterward, we suspect your answer is incorrect, identify the mistake, correct it, and provide the final answer in the format '#### [answer]', only a single number.
```

结果模型在第一遍给出了正确的结果，但是在反思阶段又改成了一个错误的答案。这几乎可以说明模型其实没有分辨对错的能力，越被质问越心虚。