

# 通用大模型原理及训练实践

## 实验课②：指令微调与指令构建



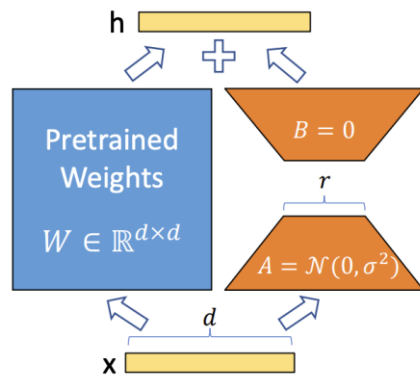
# 基于LoRA的有监督指令微调

- 有监督指令微调：将指令数据<instruction, input, output>填充到指令模板中，整句话输入预训练语言模型，使用next word prediction任务训练

$$\mathcal{L} = - \sum_i \log P(y_i | y_{<i})$$

- 参数高效的微调方法——LoRA

- 固定预训练权重 $W_0$ ，仅优化增量权重矩阵 $\Delta W$
- 增量权重矩阵是一个低秩矩阵 $\Delta W = BA$
- $W_0 \in \mathbb{R}^{d \times k}$ ,  $B \in \mathbb{R}^{d \times r}$ ,  $A \in \mathbb{R}^{r \times k}$ ,  $r \ll \min(d, k)$
- $h = W_0x + \Delta Wx = W_0x + BAx = (W_0 + BA)x$



图源: [LoRA: Low-Rank Adaptation of Large Language Models](#)

# 基于LoRA的有监督指令微调

- 基于Github开源项目 [Alpaca-LoRA](https://github.com/tloen/alpaca-lora) 进行实验
- 在命令行中运行以下命令，克隆项目到本地
  - `git clone https://github.com/tloen/alpaca-lora.git`
  - 如使用压缩文件则直接 `unzip xxx.zip`
- 安装相关依赖
  - `cd alpaca-lora/`
  - 删去 `requirements.txt` 中的 `git+https://github.com/huggingface/peft.git` 一行
  - `pip install -r requirements.txt`
  - `pip install scipy peft pytest pyyaml`
  - `pip install datasets==2.10.1 fsspec==2023.9.2 transformers==4.44.2`

# 基座模型

- 在指令微调过的模型上进行二次微调
  - 百聆2-7B
- 二次微调时，注意应与原模型使用相同的指令模板

# 指令数据

## ■ 使用Alpaca开源的52K指令数据

□ alpaca-lora/alpaca\_data.json

□ 格式：<instruction, input, output> 三元组

```
1  [
2    {
3      "instruction": "Give three tips for staying healthy.",
4      "input": "",
5      "output": "1.Eat a balanced diet and make sure to include plenty of fruits and vegetables. \n2. Exercise regularly to
keep your body active and strong. \n3. Get enough sleep and maintain a consistent sleep schedule."
6    },
7    {
8      "instruction": "What are the three primary colors?",
9      "input": "",
10     "output": "The three primary colors are red, blue, and yellow."
11   },
12   {
13     "instruction": "Describe the structure of an atom.",
14     "input": "",
15     "output": "An atom is made up of a nucleus, which contains protons and neutrons, surrounded by electrons that travel in
orbits around the nucleus. The protons and neutrons have a positive charge, while the electrons have a negative charge,
resulting in an overall neutral atom. The number of each particle determines the atomic number and the type of atom."
16   },
17 ]
```

# 指令模板

## ■ 使用与百聆相同的指令模板

- 在 alpaca-lora/templates 文件夹下新建一个 bayling.json 的文件

```
{
  "description": "Template used by BayLing.",
  "prompt_input": "I am an intelligent language assistant developed by the
NLP Group of ICT/CAS.\nBelow is a dialog consisting of instructions and
responses. Write a response that completes the request.\n\n###
Instruction:\n{instruction} {input}\n### Response:\n",
  "prompt_no_input": "I am an intelligent language assistant developed by the
NLP Group of ICT/CAS.\nBelow is a dialog consisting of instructions and
responses. Write a response that completes the request.\n\n###
Instruction:\n{instruction}\n### Response:\n",
  "response_split": "### Response:"
}
```

# 对finetune.py的一些修改

## ■ 注释 263-268 行

```
263     # old_state_dict = model.state_dict
264     # model.state_dict = (
265     #     lambda self, *_ , **__: get_peft_model_state_dict(
266     #         self, old_state_dict()
267     #     )
268     # ).__get__(model, type(model))
```

## ■ prepare\_model\_for\_int8\_training → prepare\_model\_for\_kbit\_training

## ■ H800 机器上，114 行 load\_in\_8bit=False

# 参考训练脚本

■ `CUDA_VISIBLE_DEVICES=0 python finetune.py \`

■ `--base_model '/home/jovyan/bayling-2-7b' \`

基座模型

■ `--data_path '/home/jovyan/alpaca-lora/alpaca_data.json' \`

指令数据

■ `--output_dir './lora-bayling' \`

输出路径

■ `--batch_size 128 \`

■ `--micro_batch_size 4 \`

■ `--num_epochs 1 \`

■ `--learning_rate 1e-4 \`

■ `--cutoff_len 512 \`

训练相关超参数

■ `--lora_r 8 \`

■ `--lora_alpha 16 \`

■ `--lora_dropout 0.05 \`

■ `--lora_target_modules '[q_proj,k_proj,v_proj,o_proj]' \`

LoRA相关超参数

■ `--train_on_inputs False \`

仅对输出计算loss

■ `--prompt_template_name 'bayling' \`

指令模板

■ `--group_by_length`



# 使用训练脚本进行训练

- 如果撰写.sh的linux脚本文件，需要改变权限后才能执行
- 例如： `chmod 754 train.sh`
- 运行脚本： `./train.sh`
- 可以用 `gpustat` 来监控显存使用情况
- `watch -n1 gpustat`

# 常见问题

- 如果遇到：
  - RuntimeError: Failed to find C compiler. Please specify via CC environment variable.
  - ModuleNotFoundError: Could not import module 'validate\_bnb\_backend\_availability'. Are this object's requirements defined correctly?
- 新建终端，su – 并输入密码123456进入root用户
- apt-get update然后apt-get install build-essential

# LoRA模型合并

- 输出路径./lora-bayling下，主要包含两个文件，为LoRA的参数及配置
  - adapter\_model.bin
  - adapter\_model.json
- 将LoRA参数与原始参数合并，导出HuggingFace格式的模型
  - 修改export\_hf\_checkpoint.py，接受命令行参数（会在群里发代码）
  - `python export_hf_checkpoint.py \`
  - `--base-model ../BayLing-7B/ \`
  - `--lora-model lora-bayling/ \`
  - `--output-model lora-bayling/hf`

参考昨天的PPT，通过BayLing/chat.py启动  
模型路径指定为新的路径

# 指令构建

- 特定NLP任务指令构建
  - 基于模板将已有NLP任务语料转化为指令形式
- 模型自我认知指令构建
  - 人工书写，转化为指令形式

# 特定NLP任务指令构建

- 基于模板将已有NLP任务语料转化为指令形式
- 以机器翻译为例，互联网上存在大规模公开可获取的平行语料
  - <源句子、目标句子>二元组数据
- 设计任务模板，将二元组数据转化为指令数据
  - Translate this sentence from the [src\_lang] to [tgt\_lang]: [input]
  - How to speak [input] in [tgt\_lang]? The answer is:
  - The [tgt\_lang] translation of this sentence is: [input]
  - ...

# 特定NLP任务指令构建

- 如何高效构建多样化的模板？
- 利用ChatGPT/DeepSeek等开源模型的in-context learning的能力

Q

You are asked to come up with a set of 20 instruction templates for the machine translation task. Specifically, [src\_lang] and [tgt\_lang] indicate the source language and the target language. [input] indicates the source sentence.

List of 20 templates:

1. Translate this sentence from the [src\_lang] to [tgt\_lang]: [input]
2. How to speak [input] in [tgt\_lang]? The answer is:
3. The [tgt\_lang] translation of this sentence is: [input]



4. Please provide a translation of [input] into [tgt\_lang].
5. Could you translate the following sentence into [tgt\_lang]? [input]
6. I need the [tgt\_lang] version of the sentence: [input]
7. What is the translation of [input] in [tgt\_lang]?
8. Translate the following phrase from [src\_lang] to [tgt\_lang]: [input]

9. Can you help me translate [input] to [tgt\_lang]?
10. I'm looking for the translation of [input] in [tgt\_lang].
11. How do you say [input] in [tgt\_lang]?
12. Provide the [tgt\_lang] translation for [input].
13. Please translate [input] into [tgt\_lang].
14. I need a translation of [input] into [tgt\_lang], please.
15. What does [input] mean in [tgt\_lang]?
16. How can I express [input] in [tgt\_lang]?
17. Translate this phrase into [tgt\_lang]: [input]
18. I would like to know the [tgt\_lang] equivalent of [input].
19. Can you please translate [input] into [tgt\_lang]?
20. What is the [tgt\_lang] translation for [input]?

# 特定NLP任务指令构建

## ■ 最终得到多样化的指令

```
{
  "instruction": "In English, translate this sentence:",
  "input": "三名美国特使悄悄返回萨尔瓦多、巴拿马和多米尼加共和国，没有受到华盛顿最新强硬信息的阻拦或处罚。",
  "output": "And the three American envoys quietly returned to El Salvador, Panama and the Dominican Republic with no new tough messages or punishments from Washington."
},
{
  "instruction": "Can you translate this sentence into English?:",
  "input": "Die Polizei teilte damals in einer Erklärung mit, dass man die Entscheidung, die Suche nach Jacsun zu stoppen, „schweren Herzens“ traf, merkte jedoch an, dass sie nicht in der Lage seien, einen bestimmten Ort in der Deponie „auszumachen, damit die Fortsetzung der Suche einen Sinn hätte“.",
  "output": "Police said in a statement at the time that they made the decision to end the search for Jacsun with a \"heavy heart,\" but noted they couldn't pinpoint a location in the landfill \"to a point that would make continuing the search reasonable.\"
},
{
  "instruction": "Provide the Chinese translation for this sentence:",
  "input": "This paper was written by researchers at the University of Colorado, who interviewed US military personnel involved in the forecasting and analysis of solar activity and reviewed non-confidential documents.",
  "output": "这篇由美国科罗拉多大学研究人员完成的论文采访了当时参与预报与分析太阳活动的美军方人员，并查阅了非保密文献。"
},
{
  "instruction": "Please provide a Chinese translation for the following sentence:",
  "input": "The airline and the U.S. Navy both said the plane landed in the lagoon short of the runway.",
  "output": "该航空公司和美国海军均表示，飞机偏离跑道降落到了环礁湖中。"
},
{
  "instruction": "Provide a translation in English for the sentence:",
  "input": "Am engagiertesten ist Oregon, das derzeit 5.000 Fahrer für das größte Experiment des Landes anwirbt.",
  "output": "The most eager is Oregon, which is enlisting 5,000 drivers in the country's biggest experiment."
},
}
```

# 模型自我认知指令构建

- 人工书写，转化为指令形式，加入训练
- 指令应当尽量多样化（你是谁/介绍一下你自己/你叫什么名字/...）



你是谁？



我是ChatGPT，一个由OpenAI开发的大型语言模型。我可以回答各种问题并提供相关信息。  
有什么我可以帮助你的吗？



Who are you?



I am ChatGPT, an AI language model developed by OpenAI. I'm here to assist you with any questions or information you might need. How can I help you today?





# 模型自我认知指令构建

## ■ 也可以利用ChatGPT/DeepSeek等开源模型协助构建

你需要构建20条模型自我认知的指令，用于大模型训练中加强模型的自我认知。具体来说，你需要生成的每条指令应该符合以下json格式：

```
{  
  "instruction": "{instruction}",  
  "input": "",  
  "output": "{output}"  
}
```

其中，{instruction}是用户的提问，问题主要围绕模型的自我认知，例如问模型“你是谁”、“介绍一下你自己”、“你叫什么名字”、“你的名字是什么”、“你是由谁开发的”、“你的开发者是谁”等。{output}是系统的回复，内容应包括模型的名字、模型的开发人员、模型的功能简介。

模型的名字：雁栖-7B

模型的开发人员：助教

模型的功能：各种语言任务，擅长翻译任务。

以下是20条指令：

```
{  
  "instruction": "介绍一下你自己吧！",  
  "input": "",  
  "output": "我是雁栖-7B，是一个由助教打造的人工智能助手，我可以帮助你完成各种语言任务，尤其是机器翻译任务。"  
},  
{  
  "instruction": "你是谁？",  
  "input": "",  
  "output": "你好！很高兴认识你，我是雁栖-7B，是一个由助教开发的聊天机器人，我可以处理以机器翻译为代表的众多语言任务，请问我可以帮助你什么呢？"  
},  
{  
  "instruction": "你叫什么名字",  
  "input": "",  
  "output": "我的名字是雁栖-7B，名字取自国科大的雁栖湖校区。我的开发者是通用大模型原理及训练实践的课程助教，我能够处理各种各样的语言任务，请你开始提问吧！"  
}
```

# 模型自我认知指令构建

## ■ 也可以利用ChatGPT /DeepSeek等开源模型协助构建

```
{  
  "instruction": "你的开发者是谁？",  
  "input": "",  
  "output": "我是由助教开发的，助教是通用大模型原理及训练实践的课程助教。我经过了大量的训练和优化，可以进行各种语言任务，尤其擅长机器翻译任务。有什么我可以帮助你的吗？"  
},  
{  
  "instruction": "你能做什么？",  
  "input": "",  
  "output": "我是雁栖-7B，我可以帮助你完成各种语言任务，包括但不限于机器翻译、问答、对话生成等。只要你需要，我会尽力提供帮助的。请告诉我你需要什么样的支持。"  
},
```

```
{  
  "instruction": "你可以用来做什么？",  
  "input": "",  
  "output": "我是雁栖-7B，我可以用来完成各种语言任务。我可以帮你进行机器翻译、问答、对话生成等工作。无论是学习、工作还是娱乐，只要需要处理语言的任务，我都可以尽力支持你。请告诉我你需要哪方面的帮助。"  
},  
{  
  "instruction": "你是一个什么样的模型？",  
  "input": "",  
  "output": "我是雁栖-7B，是一个基于通用大模型原理及训练实践的课程开发的聊天机器人。我经过了大量的训练和优化，可以应对各种语言任务，特别擅长机器翻译。请问有什么我可以帮助你的吗？"  
},
```

# 课后任务

- 在百聆模型的基础上，使用Alpaca-52K指令数据，对模型进行基于LoRA的有监督指令微调，训练1-3个epoch即可
- 选择一个NLP任务，收集相关语料，构建指令数据
  - 语料不宜过多或过少，建议与Alpaca通用指令规模（几十k）接近
- 为大模型起一个名字，构建模型自我认知指令

谢谢！