﹀ **Step 1.** Install Python Packages

```
!pip install -U xformers --index-url https://download.pytorch.org/whl/cu121
!pip install --no-deps packaging ninja einops flash-attn trl peft accelerate bitsandbytes
!pip install "unsloth[colab-new] @ git+https://github.com/unslothai/unsloth.git"
```

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```

```
Looking in indexes: https://download.pytorch.org/whl/cu121
Collecting xformers
  Downloading https://download.pytorch.org/whl/cu121/xformers-0.0.28.post3-cp310-cp310-manylinux_2_28_x86_64.whl (16.7 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 16.7/16.7 MB 93.9 MB/s eta 0:00:00
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from xformers) (1.26.4)
Requirement already satisfied: torch==2.5.1 in /usr/local/lib/python3.10/dist-packages (from xformers) (2.5.1+cu121)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from torch==2.5.1->xformers) (3.16.1)
Requirement already satisfied: typing-extensions>=4.8.0 in /usr/local/lib/python3.10/dist-packages (from torch==2.5.1->xform
Requirement already satisfied: networkx in /usr/local/lib/python3.10/dist-packages (from torch==2.5.1->xformers) (3.4.2)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.10/dist-packages (from torch==2.5.1->xformers) (3.1.4)
Requirement already satisfied: fsspec in /usr/local/lib/python3.10/dist-packages (from torch==2.5.1->xformers) (2024.10.0)
Requirement already satisfied: sympy==1.13.1 in /usr/local/lib/python3.10/dist-packages (from torch==2.5.1->xformers) (1.13.
Requirement already satisfied: mpmath<1.4,>=1.1.0 in /usr/local/lib/python3.10/dist-packages (from sympy==1.13.1->torch==2.5
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-packages (from jinja2->torch==2.5.1->xforme
Installing collected packages: xformers
Successfully installed xformers-0.0.28.post3
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (24.2)
Collecting ninja
  Downloading ninja-1.11.1.1-py2.py3-none-manylinux1_x86_64.manylinux_2_5_x86_64.whl.metadata (5.3 kB)
Requirement already satisfied: einops in /usr/local/lib/python3.10/dist-packages (0.8.0)
Collecting flash-attn
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  Preparing metadata (setup.py) ... done
Collecting trl
  Downloading trl-0.12.1-py3-none-any.whl.metadata (10 kB)
Requirement already satisfied: peft in /usr/local/lib/python3.10/dist-packages (0.13.2)
Requirement already satisfied: accelerate in /usr/local/lib/python3.10/dist-packages (1.1.1)
Collecting bitsandbytes
  Downloading bitsandbytes-0.44.1-py3-none-manylinux_2_24_x86_64.whl.metadata (3.5 kB)
Using cached ninja-1.11.1.1-py2.py3-none-manylinux1_x86_64.manylinux_2_5_x86_64.whl (307 kB)
Downloading trl-0.12.1-py3-none-any.whl (310 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 310.9/310.9 kB 27.6 MB/s eta 0:00:00
Downloading bitsandbytes-0.44.1-py3-none-manylinux_2_24_x86_64.whl (122.4 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 122.4/122.4 MB 7.5 MB/s eta 0:00:00
Building wheels for collected packages: flash-attn
  Building wheel for flash-attn (setup.py) ... done
  Created wheel for flash-attn: filename=flash_attn-2.7.0.post2-cp310-cp310-linux_x86_64.whl size=183291101 sha256=16a849d51
  Stored in directory: /root/.cache/pip/wheels/bf/e3/ed/5e845387d52f2debd1bafb847bf3d774d3f0a3c8e31b1dc948
Successfully built flash-attn
Installing collected packages: ninja, bitsandbytes, trl, flash-attn
Successfully installed bitsandbytes-0.44.1 flash-attn-2.7.0.post2 ninja-1.11.1.1 trl-0.12.1
Collecting unsloth@ git+https://github.com/unslothai/unsloth.git (from unsloth[colab-new]@ git+https://github.com/unslothai/
  Cloning https://github.com/unslothai/unsloth.git to /tmp/pip-install-b_aaezub/unsloth_38d52dfdd6cd4cb7965325defe4bb926
  Running command git clone --filter=blob:none --quiet https://github.com/unslothai/unsloth.git /tmp/pip-install-b_aaezub/ur
  Resolved https://github.com/unslothai/unsloth.git to commit def921c6bcd796aee3ac571161c2ecceb8e411aa
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Preparing metadata (pyproject.toml) ... done
Collecting unsloth_zoo>=2024.11.1 (from unsloth@ git+https://github.com/unslothai/unsloth.git->unsloth[colab-new]@ git+https
  Downloading unsloth_zoo-2024.11.7-py3-none-any.whl.metadata (16 kB)
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from unsloth@ git+https://github.com/ur
Collecting tyro (from unsloth@ git+https://github.com/unslothai/unsloth.git->unsloth[colab-new]@ git+https://github.com/unsl
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Requirement already satisfied: transformers>=4.46.1 in /usr/local/lib/python3.10/dist-packages (from unsloth@ git+https://gi
Collecting datasets>=2.16.0 (from unsloth@ git+https://github.com/unslothai/unsloth.git->unsloth[colab-new]@ git+https://git
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Requirement already satisfied: sentencepiece>=0.2.0 in /usr/local/lib/python3.10/dist-packages (from unsloth@ git+https://gi
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Requirement already satisfied: psutil in /usr/local/lib/python3.10/dist-packages (from unsloth@ git+https://github.com/unslo
Requirement already satisfied: wheel>=0.42.0 in /usr/local/lib/python3.10/dist-packages (from unsloth@ git+https://github.cc
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from unsloth@ git+https://github.com/unslot
Collecting protobuf<4.0.0 (from unsloth@ git+https://github.com/unslothai/unsloth.git->unsloth[colab-new]@ git+https://githu
  Downloading protobuf-3.20.3-cp310-cp310-manylinux_2_12_x86_64.manylinux2010_x86_64.whl.metadata (679 bytes)
Requirement already satisfied: huggingface_hub in /usr/local/lib/python3.10/dist-packages (from unsloth@ git+https://github.
Collecting hf_transfer (from unsloth@ git+https://github.com/unslothai/unsloth.git->unsloth[colab-new]@ git+https://github.c
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Requirement already satisfied: torch in /usr/local/lib/python3.10/dist-packages (from bitsandbytes>=0.43.3->unsloth@ git+htt
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from datasets>=2.16.0->unsloth@ git+http
Requirement already satisfied: pyarrow>=15.0.0 in /usr/local/lib/python3.10/dist-packages (from datasets>=2.16.0->unsloth@ g
Collecting dill<0.3.9,>=0.3.0 (from datasets>=2.16.0->unsloth@ git+https://github.com/unslothai/unsloth.git->unsloth[colab-r
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Collecting fsspec<=2024.9.0,>=2023.1.0 (from fsspec[http]<=2024.9.0,>=2023.1.0->datasets>=2.16.0->unsloth@ git+https://githu
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Requirement already satisfied: aiohttp in /usr/local/lib/python3.10/dist-packages (from datasets>=2.16.0->unsloth@ git+https
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Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.10/dist-packages (from transformers>=4.46.1->unsl
Requirement already satisfied: safetensors>=0.4.1 in /usr/local/lib/python3.10/dist-packages (from transformers>=4.46.1->uns
Requirement already satisfied: tokenizers<0.21,>=0.20 in /usr/local/lib/python3.10/dist-packages (from transformers>=4.46.1-
Collecting triton (from unsloth_zoo>=2024.11.1->unsloth@ git+https://github.com/unslothai/unsloth.git->unsloth[colab-new]@ g
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Requirement already satisfied: accelerate>=0.34.1 in /usr/local/lib/python3.10/dist-packages (from unsloth_zoo>=2024.11.1->u
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Requirement already satisfied: trl!=0.9.0,!=0.9.1,!=0.9.2,!=0.9.3,>=0.7.9 in /usr/local/lib/python3.10/dist-packages (from u
Requirement already satisfied: peft!=0.11.0,>=0.7.1 in /usr/local/lib/python3.10/dist-packages (from unsloth_zoo>=2024.11.1-
Collecting cut_cross_entropy (from unsloth_zoo>=2024.11.1->unsloth@ git+https://github.com/unslothai/unsloth.git->unsloth[co
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Requirement already satisfied: pillow in /usr/local/lib/python3.10/dist-packages (from unsloth_zoo>=2024.11.1->unsloth@ git+
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Requirement already satisfied: rich>=11.1.0 in /usr/local/lib/python3.10/dist-packages (from tyro->unsloth@ git+https://gith
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Requirement already satisfied: aiohappyeyeballs>=2.3.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets>=2
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Requirement already satisfied: propcache>=0.2.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets>=2.16.0->
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Requirement already satisfied: async-timeout<6.0,>=4.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->datasets>=2
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests>=2.32.2->c
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Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests>=2.32.2->dataset
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests>=2.32.2->dataset
Requirement already satisfied: markdown-it-py>=2.2.0 in /usr/local/lib/python3.10/dist-packages (from rich>=11.1.0->tyro->ur
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in /usr/local/lib/python3.10/dist-packages (from rich>=11.1.0->tyro->
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Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas->datasets>=2.16.0->unslo
Requirement already satisfied: tzdata>=2022.7 in /usr/local/lib/python3.10/dist-packages (from pandas->datasets>=2.16.0->uns
Requirement already satisfied: mdurl~=0.1 in /usr/local/lib/python3.10/dist-packages (from markdown-it-py>=2.2.0->rich>=11.1
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.8.2->pandas->dat
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-packages (from jinja2->torch->bitsandbytes>
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   ──────────────────────────────────────── 480.6/480.6 kB 32.3 MB/s eta 0:00:00
Downloading protobuf-3.20.3-cp310-cp310-manylinux_2_12_x86_64.manylinux2010_x86_64.whl (1.1 MB)
   ──────────────────────────────────────── 1.1/1.1 MB 61.7 MB/s eta 0:00:00
Downloading unsloth_zoo-2024.11.7-py3-none-any.whl (57 kB)
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Downloading hf_transfer-0.1.8-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (3.6 MB)
   ──────────────────────────────────────── 3.6/3.6 MB 79.6 MB/s eta 0:00:00
Downloading tyro-0.9.1-py3-none-any.whl (111 kB)
   ──────────────────────────────────────── 111.9/111.9 kB 11.4 MB/s eta 0:00:00
Downloading dill-0.3.8-py3-none-any.whl (116 kB)
   ──────────────────────────────────────── 116.3/116.3 kB 11.3 MB/s eta 0:00:00
Downloading fsspec-2024.9.0-py3-none-any.whl (179 kB)
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Downloading multiprocess-0.70.16-py310-none-any.whl (134 kB)
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Downloading shtab-1.7.1-py3-none-any.whl (14 kB)
Downloading cut_cross_entropy-24.11.4-py3-none-any.whl (22 kB)
Downloading triton-3.1.0-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (209.5 MB)
   ──────────────────────────────────────── 209.5/209.5 MB 5.6 MB/s eta 0:00:00
Downloading xxhash-3.5.0-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (194 kB)
   ──────────────────────────────────────── 194.1/194.1 kB 18.4 MB/s eta 0:00:00
Building wheels for collected packages: unsloth
  Building wheel for unsloth (pyproject.toml) ... done
  Created wheel for unsloth: filename=unsloth-2024.11.9-py3-none-any.whl size=165997 sha256=c826e2a57afb45921d4fef735da94588
  Stored in directory: /tmp/pip-ephem-wheel-cache-w057fjnm/wheels/ed/d4/e9/76fb290ee3df0a5fc21ce5c2c788e29e9607a2353d8342fd0
Successfully built unsloth
Installing collected packages: xxhash, unsloth, triton, shtab, protobuf, hf_transfer, fsspec, dill, multiprocess, tyro, cut_
  Attempting uninstall: protobuf
    Found existing installation: protobuf 4.25.5
    Uninstalling protobuf-4.25.5:
      Successfully uninstalled protobuf-4.25.5
  Attempting uninstall: fsspec
    Found existing installation: fsspec 2024.10.0
    Uninstalling fsspec-2024.10.0:
      Successfully uninstalled fsspec-2024.10.0
ERROR: pip's dependency resolver does not currently take into account all the packages that are installed. This behaviour is
gcsfs 2024.10.0 requires fsspec==2024.10.0, but you have fsspec 2024.9.0 which is incompatible.
grpcio-status 1.62.3 requires protobuf>=4.21.6, but you have protobuf 3.20.3 which is incompatible.
Successfully installed cut_cross_entropy-24.11.4 datasets-3.1.0 dill-0.3.8 fsspec-2024.9.0 hf_transfer-0.1.8 multiprocess-0.
WARNING: The following packages were previously imported in this runtime:
  [google]
You must restart the runtime in order to use newly installed versions.
```

RESTART SESSION

Step 2. Import Python Packages

```python
import torch
import os
import json
import pandas as pd
from datasets import Dataset, DatasetDict
from datasets import load_dataset
from huggingface_hub import notebook_login
from transformers import TrainingArguments
from trl import SFTTrainer
from unsloth import FastLanguageModel
```

    🦥 Unsloth: Will patch your computer to enable 2x faster free finetuning.
    🦥 Unsloth Zoo will now patch everything to make training faster!

Step 3. Login to Your Hugging Face with hf_token. (write access token)

```python
notebook_login()
```

Step 4. Convert your JSON dataset to Llama3 finetuning format

```python
huggingface_user = "Harshgup16"
dataset_name = "finetuning_laptop_recommendation"

class Llama3InstructDataset:
    def __init__(self, data):
        self.data = data
        self.prompts = []
        self.create_prompts()

    def create_prompt(self, row):
        prompt = f"""<|begin_of_text|><|start_header_id|>system<|end_header_id|>{row['instruction']}<|eot_id|><|start_header_id|>us
        return prompt

    def create_prompts(self):
        for row in self.data:
            prompt = self.create_prompt(row)
            self.prompts.append(prompt)

    def get_dataset(self):
        df = pd.DataFrame({'prompt': self.prompts})
        return df

def create_dataset_hf(dataset):
    dataset.reset_index(drop=True, inplace=True)
    return DatasetDict({"train": Dataset.from_pandas(dataset)})

if __name__ == "__main__":
    with open('/content/laptop_recommendation.json', 'r') as f:
        data = json.load(f)

    dataset = Llama3InstructDataset(data)
    df = dataset.get_dataset()

    processed_data_path = 'processed_data'
    os.makedirs(processed_data_path, exist_ok=True)

    llama3_dataset = create_dataset_hf(df)
    llama3_dataset.save_to_disk(os.path.join(processed_data_path, "llama3_dataset"))
    llama3_dataset.push_to_hub(f"{huggingface_user}/{dataset_name}")
```

    Saving the dataset (1/1 shards): 100%   22/22 [00:00<00:00, 847.38 examples/s]
    Uploading the dataset shards: 100%   1/1 [00:01<00:00, 1.24s/it]
    Creating parquet from Arrow format: 100%   1/1 [00:00<00:00, 36.99ba/s]

⌄ **Step 5.** LoRa Finetuning Configurations

- "finetuned_model" sets your models name on HF

- "num_train_epochs" sets the number of epochs for training

  (epoch = 1 pass through your entire dataset)

```python
# Defining the configuration for the base model, LoRA and training
config = {
    "hugging_face_username":huggingface_user,
    "model_config": {
        "base_model":"unsloth/llama-3-8b-Instruct-bnb-4bit", # The base model
        "finetuned_model":"llama-3-8b-Instruct-bnb-4bit-laptop-recommendation", # The finetuned model
        "max_seq_length": 2048, # The maximum sequence length
        "dtype":torch.float16, # The data type
        "load_in_4bit": True, # Load the model in 4-bit
    },
    "lora_config": {
      "r": 16, # The number of LoRA layers 8, 16, 32, 64
      "target_modules": ["q_proj", "k_proj", "v_proj", "o_proj",
                        "gate_proj", "up_proj", "down_proj"], # The target modules
      "lora_alpha":16, # The alpha value for LoRA
      "lora_dropout":0, # The dropout value for LoRA
      "bias":"none", # The bias for LoRA
      "use_gradient_checkpointing":True, # Use gradient checkpointing
      "use_rslora":False, # Use RSLora
      "use_dora":False, # Use DoRa
      "loftq_config":None # The LoFTQ configuration
    },
    "training_dataset":{
        "name":f"{huggingface_user}/{dataset_name}", # The dataset name(huggingface/datasets)
        "split":"train", # The dataset split
        "input_field":"prompt", # The input field
    },
    "training_config": {
        "per_device_train_batch_size": 2, # The batch size
        "gradient_accumulation_steps": 4, # The gradient accumulation steps
        "warmup_steps": 5, # The warmup steps
        "max_steps":0, # The maximum steps (0 if the epochs are defined)
        "num_train_epochs": 10, # The number of training epochs(0 if the maximum steps are defined)
        "learning_rate": 2e-4, # The learning rate
        "fp16": not torch.cuda.is_bf16_supported(),  # The fp16
        "bf16": torch.cuda.is_bf16_supported(), # The bf16
        "logging_steps": 1, # The logging steps
        "optim" :"adamw_8bit", # The optimizer
        "weight_decay" : 0.01,  # The weight decay
        "lr_scheduler_type": "linear", # The learning rate scheduler
        "seed" : 42, # The seed
        "output_dir" : "outputs", # The output directory
    }
}
```

⌄ **Step 6.** Load Llama3-8B, QLoRA & Trainer Model

```python
# Loading the model and the tokinizer for the model
model, tokenizer = FastLanguageModel.from_pretrained(
    model_name = config.get("model_config").get("base_model"),
    max_seq_length = config.get("model_config").get("max_seq_length"),
    dtype = config.get("model_config").get("dtype"),
    load_in_4bit = config.get("model_config").get("load_in_4bit"),
)

# Setup for QLoRA/LoRA peft of the base model
model = FastLanguageModel.get_peft_model(
    model,
    r = config.get("lora_config").get("r"),
    target_modules = config.get("lora_config").get("target_modules"),
    lora_alpha = config.get("lora_config").get("lora_alpha"),
    lora_dropout = config.get("lora_config").get("lora_dropout"),
    bias = config.get("lora_config").get("bias"),
    use_gradient_checkpointing = config.get("lora_config").get("use_gradient_checkpointing"),
    random_state = 42,
    use_rslora = config.get("lora_config").get("use_rslora"),
    use_dora = config.get("lora_config").get("use_dora"),
    loftq_config = config.get("lora_config").get("loftq_config"),
)
```

```python
# Loading the training dataset
dataset_train = load_dataset(config.get("training_dataset").get("name"), split = config.get("training_dataset").get("split"))

# Setting up the trainer for the model
trainer = SFTTrainer(
    model = model,
    tokenizer = tokenizer,
    train_dataset = dataset_train,
    dataset_text_field = config.get("training_dataset").get("input_field"),
    max_seq_length = config.get("model_config").get("max_seq_length"),
    dataset_num_proc = 2,
    packing = False,
    args = TrainingArguments(
        per_device_train_batch_size = config.get("training_config").get("per_device_train_batch_size"),
        gradient_accumulation_steps = config.get("training_config").get("gradient_accumulation_steps"),
        warmup_steps = config.get("training_config").get("warmup_steps"),
        max_steps = config.get("training_config").get("max_steps"),
        num_train_epochs= config.get("training_config").get("num_train_epochs"),
        learning_rate = config.get("training_config").get("learning_rate"),
        fp16 = config.get("training_config").get("fp16"),
        bf16 = config.get("training_config").get("bf16"),
        logging_steps = config.get("training_config").get("logging_steps"),
        optim = config.get("training_config").get("optim"),
        weight_decay = config.get("training_config").get("weight_decay"),
        lr_scheduler_type = config.get("training_config").get("lr_scheduler_type"),
        seed = 42,
        output_dir = config.get("training_config").get("output_dir"),
    ),
)
```

```
==((====))==  Unsloth 2024.11.9: Fast Llama patching. Transformers = 4.46.2.
   \\   /|    GPU: Tesla T4. Max memory: 14.748 GB. Platform = Linux.
O^O/ \_/ \    Pytorch: 2.5.1+cu121. CUDA = 7.5. CUDA Toolkit = 12.1.
\        /    Bfloat16 = FALSE. FA [Xformers = 0.0.28.post3. FA2 = False]
 "-____-"     Free Apache license: http://github.com/unslothai/unsloth
Unsloth: Fast downloading is enabled - ignore downloading bars which are red colored!
```

model.safetensors: 100%	5.70G/5.70G [02:15<00:00, 43.0MB/s]
generation_config.json: 100%	220/220 [00:00<00:00, 14.7kB/s]
tokenizer_config.json: 100%	51.1k/51.1k [00:00<00:00, 3.54MB/s]
tokenizer.json: 100%	9.09M/9.09M [00:01<00:00, 7.18MB/s]
special_tokens_map.json: 100%	345/345 [00:00<00:00, 26.2kB/s]

```
Unsloth 2024.11.9 patched 32 layers with 32 QKV layers, 32 O layers and 32 MLP layers.
```

README.md: 100%	267/267 [00:00<00:00, 11.5kB/s]
train-00000-of-00001.parquet: 100%	8.25k/8.25k [00:00<00:00, 515kB/s]
Generating train split: 100%	22/22 [00:00<00:00, 323.13 examples/s]
Map (num_proc=2): 100%	22/22 [00:01<00:00, 14.42 examples/s]

⌄ **Step 7.** Train Your Finetuned Model

```python
trainer_stats = trainer.train()
```