› 1 🟩⬜⬜⬜⬜ .gitignore

› 199 🟩🟩🟩🟥⬜ demo.ipynb

› BIN +743 KB diff_file.pdf

› 1 🟩⬜⬜⬜⬜ lm-evaluation-harness

⌄ 34 🟩🟩🟩🟥⬜ mingpt/model.py

```
          self.attn_dropout = nn.Dropout(config.attn_pdrop)
          self.resid_dropout = nn.Dropout(config.resid_pdrop)
          # causal mask to ensure that attention is only applied to the left in the input sequence
-         self.register_buffer("bias", torch.tril(torch.ones(config.block_size, config.block_size))
-                                      .view(1, 1, config.block_size, config.block_size))
+         if config.use_ul2:
+             self.register_buffer("bias", torch.ones(config.block_size, config.block_size).view(1, 1, config.block_size, config.block_size))
+         elif not config.use_ul2:
+             self.register_buffer("bias", torch.tril(torch.ones(config.block_size, config.block_size)).view(1, 1, config.block_size, config.block_size))
          self.n_head = config.n_head
          self.n_embd = config.n_embd

          C.embd_pdrop = 0.1
          C.resid_pdrop = 0.1
          C.attn_pdrop = 0.1
+         C.use_ul2 = False
          return C

      def __init__(self, config):
          super().__init__()
          assert config.vocab_size is not None
          assert config.block_size is not None
          self.block_size = config.block_size
```

```diff
+        self.config = config
 
         type_given = config.model_type is not None
         params_given = all([config.n_layer is not None, config.n_head is not None, config.n_embd is not None])
         ))
         self.lm_head = nn.Linear(config.n_embd, config.vocab_size, bias=False)
 
-        # init all weights, and apply a special scaled init to the residual projections, per GPT-2 paper
-        self.apply(self._init_weights)
-        for pn, p in self.named_parameters():
-            if pn.endswith('c_proj.weight'):
-                torch.nn.init.normal_(p, mean=0.0, std=0.02/math.sqrt(2 * config.n_layer))
+        '''This if statement is a change.'''
+        # If we are using a checkpoint, load it.
+        if config.checkpoint is not None:
+            self.checkpoint = torch.load(config.checkpoint)
+            self.transformer.load_state_dict(self.checkpoint['model_transformer'])
+            self.lm_head.load_state_dict(self.checkpoint['model_lm_head'])
+            self.iter_num = self.checkpoint['iter_num']
+            self.checkpoint_num = self.checkpoint['checkpoint_num']
+            self.saved_loss = self.checkpoint['saved_loss']
+
+        else:
+            # init all weights, and apply a special scaled init to the residual projections, per GPT-2 paper
+            self.checkpoint = None
+            self.apply(self._init_weights)
+            for pn, p in self.named_parameters():
+                if pn.endswith('c_proj.weight'):
+                    torch.nn.init.normal_(p, mean=0.0, std=0.02/math.sqrt(2 * config.n_layer))
 
         # report number of parameters (note we don't count the decoder parameters in lm_head)
         n_params = sum(p.numel() for p in self.transformer.parameters())
             {"params": [param_dict[pn] for pn in sorted(list(no_decay))], "weight_decay": 0.0},
         ]
         optimizer = torch.optim.AdamW(optim_groups, lr=train_config.learning_rate, betas=train_config.betas)
+        if self.checkpoint:
+            optimizer.load_state_dict(self.checkpoint['optimizer_state_dict']) # This is a change.
         return optimizer

     def forward(self, idx, targets=None):
         # if we are given some desired targets also calculate the loss
         loss = None
         if targets is not None:
-            loss = F.cross_entropy(logits.view(-1, logits.size(-1)), targets.view(-1), ignore_index=-1)
+            loss = F.cross_entropy(logits.view(-1, logits.size(-1)), targets.view(-1), ignore_index=-1)  # Changed class!

         return logits, loss

```

› 41 🟩🟩🟩🟩□ mingpt/trainer.py

› 16 🟩🟩🟩🟩🟩 mingpt_jobscript

› BIN +37.5 KB mingpt_loss.png

› 506 🟩🟩🟩🟩🟩 output_results.txt

› 341 🟩🟩🟩🟩🟩 project2a.ipynb

› 88 🟩🟩🟩🟩🟩 project2a.py

› 520 🟩🟩🟩🟩🟩 project2b.ipynb

In [ ]:

```
import torch
from transformers import GPT2Tokenizer, GPT2LMHeadModel
from mingpt.model import GPT
from mingpt.utils import set_seed
from datasets import load_dataset
import torch
import matplotlib.pyplot as plt
from torch.utils.data import Dataset, DataLoader
from datasets import load_dataset
import numpy as np
from scipy.stats import norm
set_seed(3407)
```

In [ ]:

```
# Load in UL2 tokenizer to see what's going on
from transformers import AutoTokenizer, GPT2Tokenizer

tokenizer = GPT2Tokenizer.from_pretrained("gpt2")

new_tokens = [f'<new_id_{i}>' for i in range(200)]
tokenizer.add_tokens(new_tokens)
tokenizer.add_tokens(['[S2S]', '[NLU]', '[NLG]'])

tokenizer
```

Out[ ]:

```
PreTrainedTokenizer(name_or_path='gpt2', vocab_size=50257, model_max_len=10
24, is_fast=False, padding_side='right', truncation_side='right', special_t
okens={'bos_token': AddedToken("<|endoftext|>", rstrip=False, lstrip=False,
single_word=False, normalized=True), 'eos_token': AddedToken("<|endoftext|>
", rstrip=False, lstrip=False, single_word=False, normalized=True), 'unk_to
ken': AddedToken("<|endoftext|>", rstrip=False, lstrip=False, single_word=F
alse, normalized=True)})
```

In [ ]:

```
dataset = load_dataset("togethercomputer/RedPajama-Data-1T-Sample", 'plain_t
dataset = dataset['train']

# Custom dataset class for the Red Pajama dataset
class RedPajamaDataset(Dataset):
    def __init__(self, data, max_length=1024, ul2_switch=False):
        self.data = data
        self.tokenizer = GPT2Tokenizer.from_pretrained('gpt2')
        self.tokenizer.add_tokens([f'new_id_{i}' for i in range(200)])
        self.tokenizer.add_tokens(['[S2S]', '[NLU]', '[NLG]'])
        self.tokenizer.pad_token_id = 50256
        self.max_length = max_length - 1
        self.vocab_size = len(self.tokenizer)
        self.token_dict = {'s': ['[S2S]', self._s_denoising], 'r': ['[NLU]',
        self.ul2_switch = ul2_switch
    def __len__(self):
        return len(self.data)

    def __getitem__(self, idx):
        text = self.data[idx]['text']

        if self.ul2_switch:
            # Get the token to prepend and function to use.
            begin_id, func = self.token_dict[np.random.choice(['s', 'r', 'x'

            # Prepend token to string and tokenize
            text = begin_id + ' ' + text
            ids = self.tokenizer.encode(text, truncation=True, max_length=se

            # Return the tokens
            return func(ids, self.tokenizer)

        elif not self.ul2_switch:
            # Tokenize the text
            tokens = self.tokenizer.encode(text, add_special_tokens=True, ma

            # Split the tokens into chunks of max_length
            # Shift the tokens to get targets (excluding the [CLS] token)
            target_tokens = tokens[:, 1:].clone()  # Exclude the [CLS] token
            tokens = tokens[:, :-1]  # Exclude the last token to match the s
            return tokens, target_tokens

    # Helper functions! These will implement the UL2 tokenization.
    def _r_denoising(self, ids, tokenizer, corruption_pct=0.15, span_length=
        # Calculate the chance of corruption based on the corruption percent
        # mean span length, and the maximum span length
        chance = (corruption_pct / np.mean(span_length)) * (1 + np.max(span_

        # Variable to store the old tokens (before corruption)
        old_toks = None

        # Variables for tracking the number of steps to skip and tokens used
        steps_to_skip = 0
        tokens_used = 0

        ids_shape = ids.shape[1]
        # Iterate through the tokens in the input sequence
        for i in range(1, ids_shape):
            # Skip steps if needed (due to recent corruption)
            if steps_to_skip > 0:
                steps_to_skip -= 1
                continue

            # Randomly decide whether to corrupt the current token
            rnd = np.random.random()
            if rnd < chance:
                # Get the token used for masking (corruption)
                mask_token = tokenizer.convert_tokens_to_ids(new_tokens[toke
                tokens_used += 1

                # Randomly choose a span length for corruption
                span = np.random.choice(span_length)

                # Update old_toks and ids with the corrupted span
                if old_toks is None:
                    old_toks = torch.tensor([[mask_token]])  # Initialize ol
                    old_toks = torch.cat((old_toks, ids[:, i:i + span]), dim
                    ids = torch.cat((ids[:, :i], torch.tensor([[mask_token]]

                    steps_to_skip = span
                else:
                    old_toks = torch.cat((old_toks, torch.tensor([[mask_toke
                    ids = torch.cat((ids[:, :i], torch.tensor([[mask_token]]

                    # Update steps_to_skip to avoid overlapping corruption
                    steps_to_skip = span

        # Pad ids and old_toks to match the desired maximum length (R, X)
        ids = torch.cat((ids, torch.tensor([[tokenizer.eos_token_id] * (self
        old_toks = torch.cat((old_toks, torch.tensor([[tokenizer.eos_token_i

        return ids, old_toks



    def _s_denoising(self, ids, tokenizer):
        # Get the length of our input
        len_ids = ids.shape[1]

        # Build Gaussian distribution of probabilities for each token
        vals = np.linspace(-2, 2, len_ids)
        p = norm.pdf(vals, loc=0, scale=1)

        # Normalize the probabilities and get the index to remove
        remove_index = np.random.choice(np.arange(len_ids // 2 - 15, len_ids

        # Get the token we are using for this space
        mask_token = tokenizer.convert_tokens_to_ids(new_tokens[0])

        # Get the tokens we are removing
        old_toks = torch.cat((torch.tensor([[mask_token]]), ids[:, remove_in

        # Mask the tokens
        ids = ids[:, :remove_index + 1].clone()
        ids[:, -1] = mask_token
```

```python
        # Pad ids and old_toks to match the desired maximum length (S)
        ids = torch.cat((ids, torch.tensor([[tokenizer.eos_token_id] * (self
        old_toks = torch.cat((old_toks, torch.tensor([[tokenizer.eos_token_i

        return ids, old_toks




    def _x_denoising(self, ids, tokenizer, corruption_pct=0.50, span_length=
        return self._r_denoising(ids, tokenizer, corruption_pct, span_length


# Create an instance of the custom dataset
red_pajama_dataset_F = RedPajamaDataset(dataset)
red_pajama_dataset_T = RedPajamaDataset(dataset, ul2_switch=True)
```

```
Found cached dataset red_pajama-data-1_t-sample (/Users/dylanskinner/Deskto
p/CS 674 Projects/MinGPT_UL2/datasets/togethercomputer___red_pajama-data-1_
t-sample/plain_text/1.0.0/6ea3bc8ec2e84ec6d2df1930942e9028ace8c5b9d9143823c
f911c50bbd92039)
  0%|          | 0/1 [00:00<?, ?it/s]
```

In [ ]:

```
# create a GPT instance
from mingpt.model import GPT
import os

checkpoint_dir = 'red_pajama'
dir_path = f'./checkpoints/{checkpoint_dir}'

if not os.path.exists(dir_path):
    # If the directory doesn't exist, create it
    os.makedirs(dir_path)
    checkpoints = os.listdir(dir_path)
else:
    checkpoints = os.listdir(dir_path)

checkpoints.sort()



model_config = GPT.get_default_config()
model_config.model_type = 'gpt-nano'
model_config.vocab_size = red_pajama_dataset_T.vocab_size
model_config.block_size = red_pajama_dataset_T.max_length
# model_config.checkpoint = f'checkpoints/{checkpoint_dir}/' + checkpoints[-
model_config.checkpoint = None
model_config.use_ul2 = True
model = GPT(model_config)

model_config = GPT.get_default_config()
model_config.model_type = 'gpt-nano'
model_config.vocab_size = red_pajama_dataset_F.vocab_size
model_config.block_size = red_pajama_dataset_F.max_length
# model_config.checkpoint = f'checkpoints/{checkpoint_dir}/' + checkpoints[-
model_config.checkpoint = None
model_config.use_ul2 = False
model2 = GPT(model_config)
```

```
number of parameters: 2.56M
number of parameters: 2.56M
```

In [ ]:

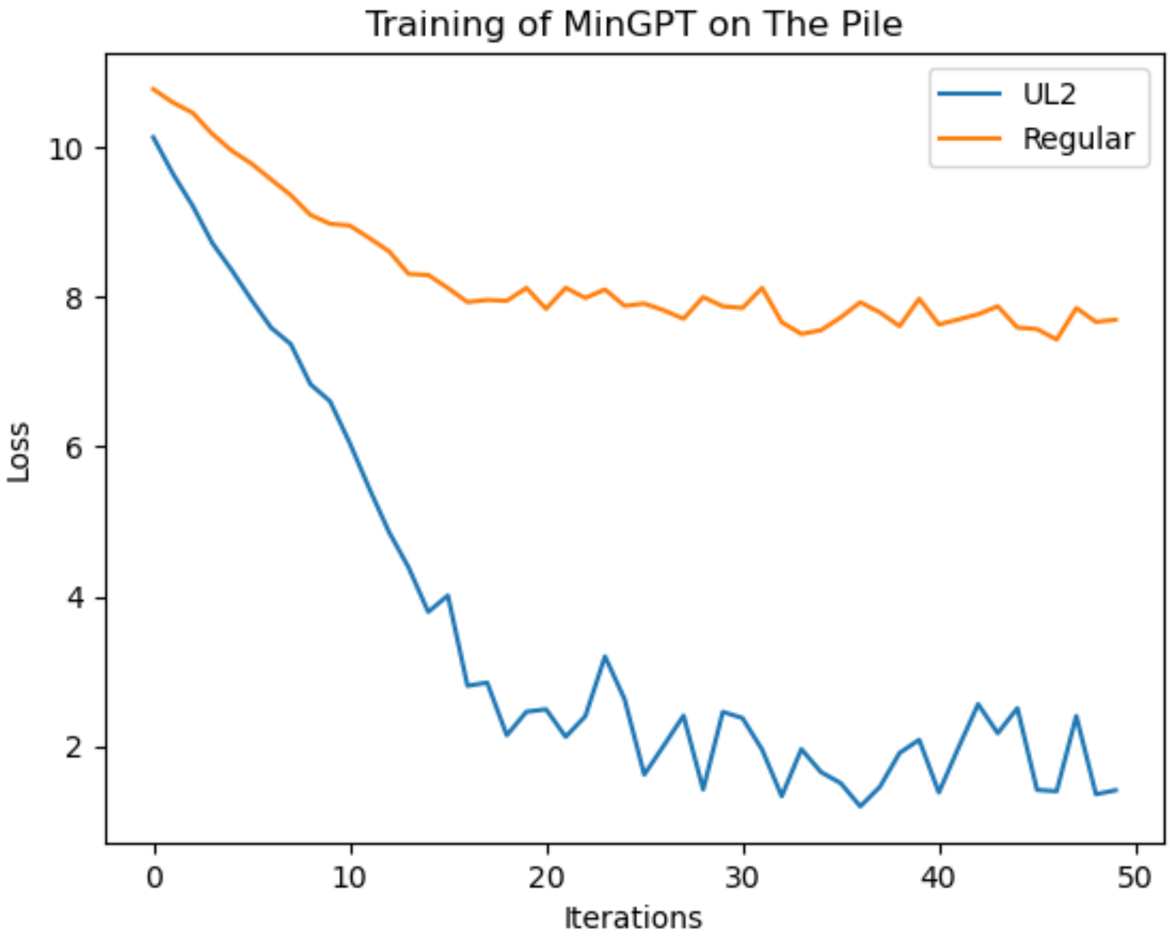
```
# create a Trainer object
from mingpt.trainer import Trainer
iters = 500

train_config = Trainer.get_default_config()
train_config.learning_rate = 5e-4 # the model we're using is so small that w
train_config.max_iters = iters + model.iter_num if model_config.checkpoint e
train_config.num_workers = 0
train_config.checkpoint_iters = 100     # This is a change
train_config.batch_size = 1
train_config.checkpoint_name = f'{checkpoint_dir}/checkpoint_ul2'  # This is
trainer = Trainer(train_config, model, red_pajama_dataset_T)

train_config = Trainer.get_default_config()
train_config.learning_rate = 5e-4 # the model we're using is so small that w
train_config.max_iters = iters + model.iter_num if model_config.checkpoint e
train_config.num_workers = 0
train_config.checkpoint_iters = 100     # This is a change
train_config.batch_size = 1
train_config.checkpoint_name = f'{checkpoint_dir}/checkpoint_break'  # This 
trainer2 = Trainer(train_config, model2, red_pajama_dataset_F)
```

```
running on device cpu
running on device cpu
```

In [ ]:

```
def batch_end_callback(trainer):
    if trainer.iter_num % 100 == 0:
        print(f"iter_dt {trainer.iter_dt * 1000:.2f}ms; iter {trainer.iter_r
trainer.set_callback('on_batch_end', batch_end_callback)

trainer.run()

# Plot the loss
losses = trainer.curr_loss
x = 10
new_losses = np.mean(np.array(losses).reshape(-1, x), axis=1)

plt.plot(np.arange(len(new_losses)), new_losses, label='UL2')

def batch_end_callback(trainer):
    if trainer2.iter_num % 100 == 0:
        print(f"iter_dt {trainer2.iter_dt * 1000:.2f}ms; iter {trainer2.iter
trainer2.set_callback('on_batch_end', batch_end_callback)

trainer2.run()

# Plot the loss
losses = trainer2.curr_loss
x = 10
new_losses = np.mean(np.array(losses).reshape(-1, x), axis=1)
plt.plot(np.arange(len(new_losses)), new_losses, label='Regular')
plt.title('Training of MinGPT on The Pile')
plt.xlabel('Iterations')
plt.ylabel('Loss')
plt.legend()
plt.show()
```

```
iter_dt 0.00ms; iter 0: train loss 10.69954
iter_dt 971.65ms; iter 100: train loss 5.62758
iter_dt 501.43ms; iter 200: train loss 1.12558
iter_dt 481.43ms; iter 300: train loss 3.26710
iter_dt 506.68ms; iter 400: train loss 1.15159
iter_dt 0.00ms; iter 0: train loss 10.83819
iter_dt 178.93ms; iter 100: train loss 9.08965
iter_dt 941.06ms; iter 200: train loss 8.23680
iter_dt 32.46ms; iter 300: train loss 9.81027
iter_dt 481.70ms; iter 400: train loss 7.58708
```

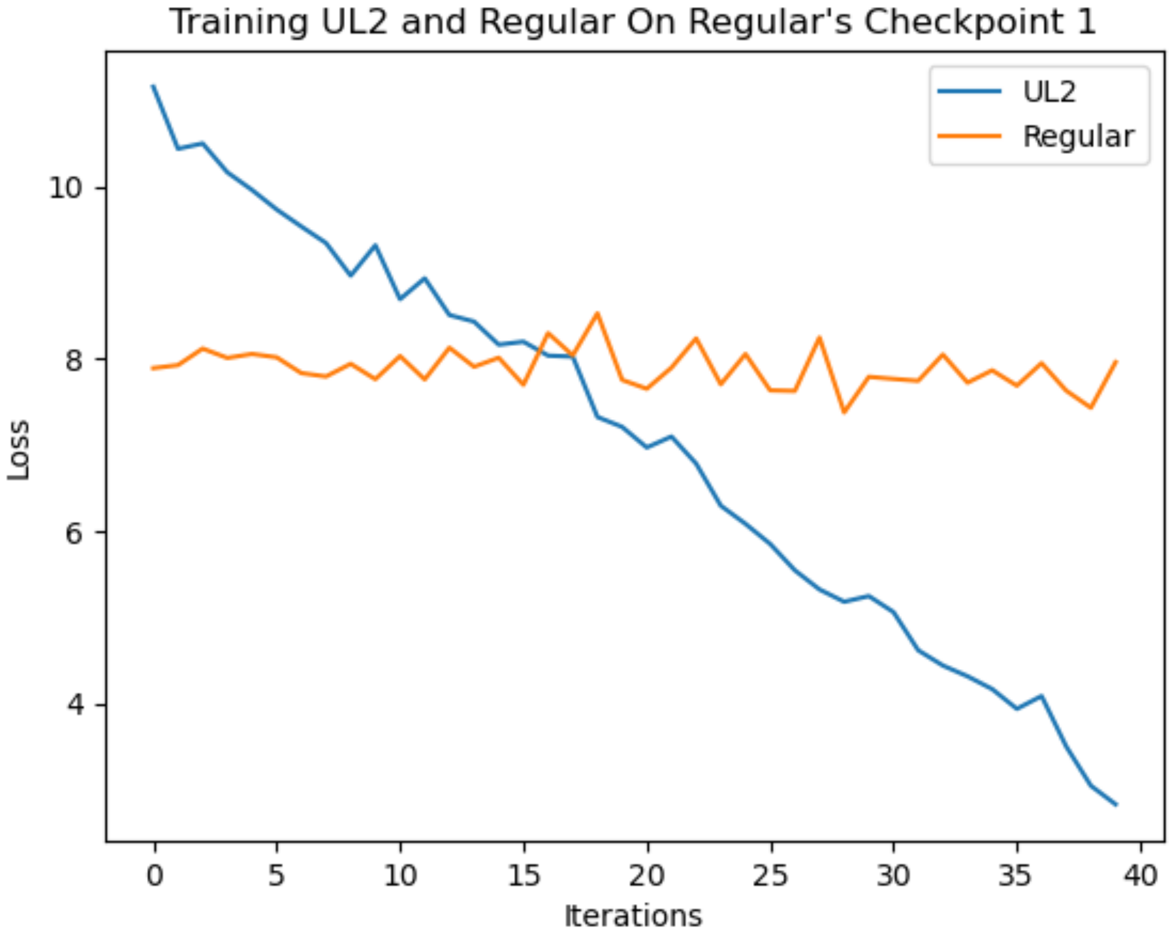


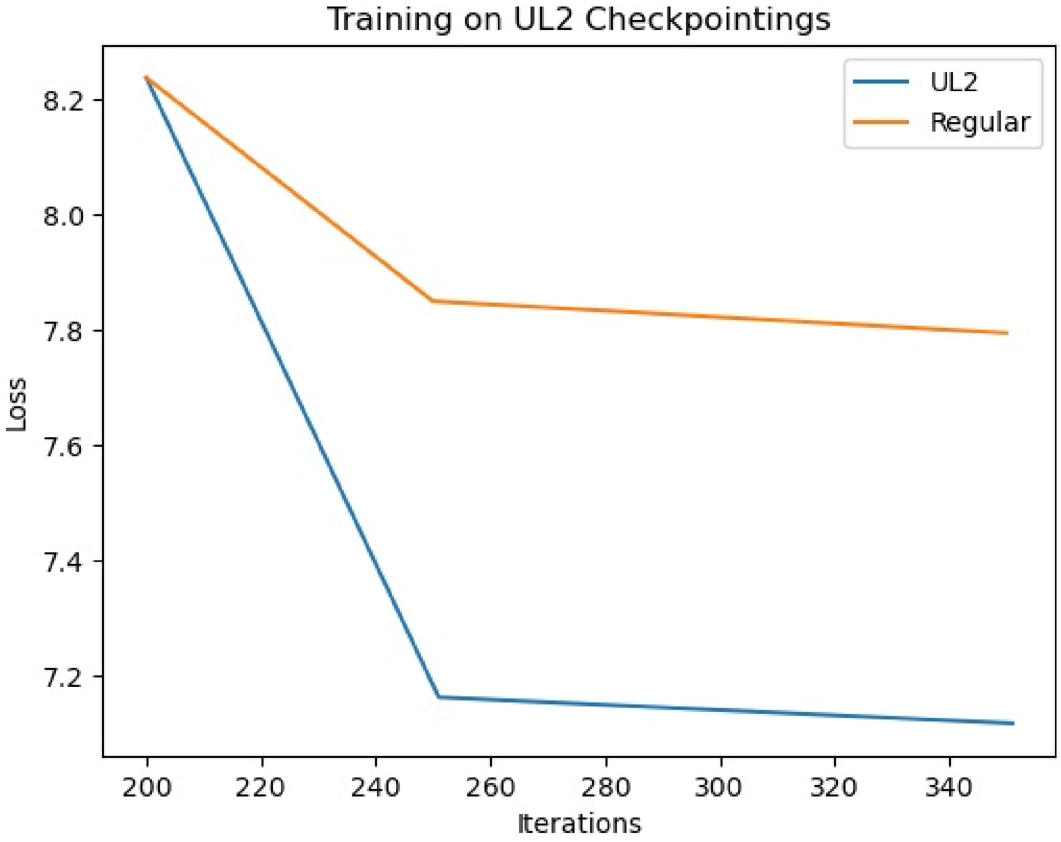
In [ ]:

```
# Show that ul2 improves performance on checkpoint 1
# create a GPT instance
from mingpt.model import GPT
import os

checkpoint_dir = 'red_pajama'
dir_path = f'./checkpoints/{checkpoint_dir}'

if not os.path.exists(dir_path):
    # If the directory doesn't exist, create it
    os.makedirs(dir_path)
    checkpoints = os.listdir(dir_path)
else:
    checkpoints = os.listdir(dir_path)

checkpoints.sort()


# UL2
model_config = GPT.get_default_config()
model_config.model_type = 'gpt-nano'
model_config.vocab_size = red_pajama_dataset_T.vocab_size
model_config.block_size = red_pajama_dataset_T.max_length
model_config.checkpoint = f'checkpoints/{checkpoint_dir}/checkpoint_break_1.
model_config.use_ul2 = True
model = GPT(model_config)

# Regular
model_config = GPT.get_default_config()
model_config.model_type = 'gpt-nano'
model_config.vocab_size = red_pajama_dataset_F.vocab_size
model_config.block_size = red_pajama_dataset_F.max_length
model_config.checkpoint = f'checkpoints/{checkpoint_dir}/checkpoint_break_1.
model_config.use_ul2 = False
model2 = GPT(model_config)

# create a Trainer object
from mingpt.trainer import Trainer
iters = 200

train_config = Trainer.get_default_config()
train_config.learning_rate = 5e-4 # the model we're using is so small that w
train_config.max_iters = iters + model.iter_num if model_config.checkpoint e
train_config.num_workers = 0
train_config.checkpoint_iters = 500     # This is a change
train_config.batch_size = 1
train_config.checkpoint_name = f'{checkpoint_dir}/checkpoint_ul2'  # This is
trainer = Trainer(train_config, model, red_pajama_dataset_T)

train_config = Trainer.get_default_config()
train_config.learning_rate = 5e-4 # the model we're using is so small that w
train_config.max_iters = iters + model.iter_num if model_config.checkpoint e
train_config.num_workers = 0
train_config.checkpoint_iters = 500     # This is a change
train_config.batch_size = 1
train_config.checkpoint_name = f'{checkpoint_dir}/checkpoint_break'  # This
trainer2 = Trainer(train_config, model2, red_pajama_dataset_F)

def batch_end_callback(trainer):
    if trainer.iter_num % 50 == 0:
        print(f"iter_dt {trainer.iter_dt * 1000:.2f}ms; iter {trainer.iter_r
trainer.set_callback('on_batch_end', batch_end_callback)

trainer.run()

# Plot the loss
losses = trainer.curr_loss
print(losses)
x = 5
new_losses = np.mean(np.array(losses).reshape(-1, x), axis=1)
plt.plot(np.arange(len(new_losses)), new_losses, label='UL2')
```

```
def batch_end_callback(trainer):
    if trainer2.iter_num % 50 == 0:
        print(f"iter_dt {trainer2.iter_dt * 1000:.2f}ms; iter {trainer2.iter
trainer2.set_callback('on_batch_end', batch_end_callback)

trainer2.run()

# Plot the loss
losses = trainer2.curr_loss
x = 5
new_losses = np.mean(np.array(losses).reshape(-1, x), axis=1)
plt.plot(np.arange(len(new_losses)), new_losses, label='Regular')
plt.title('Training UL2 and Regular On Regular\'s Checkpoint 1')
plt.xlabel('Iterations')
plt.ylabel('Loss')
plt.legend()
plt.show()
```

```
number of parameters: 2.56M
number of parameters: 2.56M
running on device cpu
running on device cpu
iter_dt 543.64ms; iter 250: train loss 8.90695
iter_dt 474.03ms; iter 300: train loss 7.24735
iter_dt 504.72ms; iter 350: train loss 4.78618
iter_dt 482.22ms; iter 400: train loss 3.18715
[tensor(11.8283), tensor(10.6837), tensor(10.7594), tensor(12.2985), tensor
(10.2331), tensor(10.0490), tensor(10.7800), tensor(10.4051), tensor(10.413
6), tensor(10.5508), tensor(10.3679), tensor(10.6896), tensor(10.5892), ten
sor(10.4705), tensor(10.3906), tensor(10.2769), tensor(10.2266), tensor(10.
1427), tensor(10.1367), tensor(10.0487), tensor(10.0865), tensor(10.0414),
tensor(9.9979), tensor(9.9229), tensor(9.7591), tensor(9.7966), tensor(9.77
47), tensor(9.7576), tensor(9.6463), tensor(9.6980), tensor(9.6802), tensor
(9.5646), tensor(9.5861), tensor(9.3779), tensor(9.4754), tensor(9.4247), t
ensor(9.3315), tensor(9.4123), tensor(9.2360), tensor(9.3217), tensor(9.065
3), tensor(9.0450), tensor(8.6310), tensor(9.2764), tensor(8.8116), tensor(
9.0521), tensor(9.8390), tensor(9.6590), tensor(9.1361), tensor(8.9070), te
nsor(9.2218), tensor(8.5756), tensor(8.9577), tensor(8.0849), tensor(8.6252
), tensor(9.8494), tensor(8.5421), tensor(8.7333), tensor(9.1506), tensor(8
.4016), tensor(8.4268), tensor(8.4636), tensor(8.6159), tensor(8.7648), ten
sor(8.2736), tensor(8.6904), tensor(8.5776), tensor(8.2979), tensor(8.2501)
, tensor(8.3470), tensor(8.3438), tensor(8.0693), tensor(8.0823), tensor(8.
0209), tensor(8.3071), tensor(8.0350), tensor(7.8821), tensor(7.7855), tens
or(8.7389), tensor(8.5559), tensor(7.8719), tensor(8.2810), tensor(7.9316),
tensor(8.1112), tensor(7.9912), tensor(8.1203), tensor(7.8876), tensor(7.77
02), tensor(7.9138), tensor(8.4398), tensor(7.3866), tensor(7.6399), tensor
(7.2900), tensor(7.2236), tensor(7.0840), tensor(7.0955), tensor(7.5591), t
ensor(7.0550), tensor(7.0921), tensor(7.2474), tensor(6.8987), tensor(6.879
7), tensor(7.2069), tensor(7.0060), tensor(6.8601), tensor(7.1307), tensor(
7.1364), tensor(7.0231), tensor(6.7697), tensor(7.4277), tensor(6.9369), te
nsor(6.5008), tensor(7.0173), tensor(6.9349), tensor(6.5284), tensor(6.2185
), tensor(6.1363), tensor(6.3819), tensor(6.0102), tensor(6.7265), tensor(6
.3413), tensor(5.7782), tensor(6.3322), tensor(6.1029), tensor(5.8656), ten
sor(6.1411), tensor(5.9497), tensor(5.5931), tensor(5.9326), tensor(5.6386)
, tensor(5.9088), tensor(5.6203), tensor(5.3520), tensor(5.6596), tensor(5.
1824), tensor(5.1969), tensor(5.3858), tensor(5.5697), tensor(5.0174), tens
or(5.4399), tensor(5.0367), tensor(4.8776), tensor(5.8094), tensor(5.0260),
tensor(5.1450), tensor(4.9619), tensor(4.9448), tensor(6.9152), tensor(4.61
83), tensor(4.7862), tensor(4.6500), tensor(4.4318), tensor(4.8743), tensor
(6.4284), tensor(4.9083), tensor(4.5193), tensor(4.2447), tensor(6.1127), t
ensor(4.2594), tensor(3.9423), tensor(4.3336), tensor(3.8836), tensor(4.063
2), tensor(5.8834), tensor(4.0293), tensor(4.1404), tensor(4.9000), tensor(
3.4799), tensor(3.6729), tensor(5.3732), tensor(5.8962), tensor(4.0350), te
nsor(3.6107), tensor(3.8380), tensor(3.4443), tensor(3.9603), tensor(3.8562
), tensor(4.8296), tensor(3.2377), tensor(3.7922), tensor(4.2662), tensor(2
.8044), tensor(4.3058), tensor(2.9410), tensor(6.1025), tensor(5.1841), ten
sor(3.3615), tensor(3.1630), tensor(2.9210), tensor(2.8610), tensor(2.9173)
, tensor(3.5551), tensor(2.8490), tensor(3.2203), tensor(2.6683), tensor(3.
9535), tensor(2.4661), tensor(2.2567), tensor(2.2690), tensor(3.1872)]
iter_dt 172.41ms; iter 250: train loss 8.03310
iter_dt 264.90ms; iter 300: train loss 7.66088
iter_dt 476.78ms; iter 350: train loss 7.52221
iter_dt 151.13ms; iter 400: train loss 9.00874
```




Training on UL2 Checkpointings
UL2
Regular
8.2
8.0
7.8
7.6
7.4
7.2
Loss
200
220
240
260
280
300
320
340
Iterations