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<pre>#!/bin/env python3.8  """ Example assignment. Author: Chris Curro """ import os import logging import matplotlib import matplotlib.pyplot as plt import numpy as np import tensorflow as tf  from absl import app from absl import flags from tqdm import trange  from dataclasses import dataclass, field, InitVar  script_path = os.path.dirname(os.path.realpath(__file__))  @dataclass class LinearModel:     weights: np.ndarray     bias: float  @dataclass class Data:     model: LinearModel     rng: InitVar[np.random.Generator]     num_features: int     num_samples: int     sigma: float     x: np.ndarray = field(init=False)     y: np.ndarray = field(init=False)      def __post_init__(self, rng):         self.index = np.arange(self.num_samples)         self.x = rng.uniform(0.1, 0.9, size=(self.num_samples, self.num_features))          clean_y = self.x @ self.model.weights[:, np.newaxis] + self.model.bias         self.y = rng.normal(loc=clean_y, scale=self.sigma)      def get_batch(self, rng, batch_size):         """         Select random subset of examples for training batch         """         choices = rng.choice(self.index, size=batch_size)          return self.x[choices], self.y[choices].flatten()  def compare_linear_models(a: LinearModel, b: LinearModel):     for w_a, w_b in zip(a.weights, b.weights):         print(f"{w_a:0.2f}, {w_b:0.2f}")      print(f"{a.bias:0.2f}, {b.bias:0.2f}")  font = {     # "family": "Adobe Caslon Pro", </pre>		

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<pre>         "size": 10,     }  matplotlib.style.use("classic") matplotlib.rc("font", **font)  FLAGS = flags.FLAGS flags.DEFINE_integer("num_features", 1, "Number of features in record") flags.DEFINE_integer("num_samples", 50, "Number of samples in dataset") flags.DEFINE_integer("batch_size", 16, "Number of samples in batch") flags.DEFINE_integer("num_iters", 300, "Number of SGD iterations") flags.DEFINE_float("learning_rate", 0.1, "Learning rate / step size for SGD") flags.DEFINE_integer("random_seed", 31415, "Random seed") flags.DEFINE_float("sigma_noise", 0.5, "Standard deviation of noise random variable") flags.DEFINE_bool("debug", False, "Set logging level to debug")  class Model(tf.Module):     def __init__(self, rng, num_features):         """         A plain linear regression model with a bias term         """         self.num_features = num_features         self.w = tf.Variable(rng.normal(shape=[self.num_features, 1]))         self.b = tf.Variable(tf.zeros(shape=[1, 1]))      def __call__(self, x):         return tf.squeeze(x @ self.w + self.b)      @property     def model(self):         return LinearModel(             self.w.numpy().reshape([self.num_features]), self.b.numpy().squeeze()         )  def main(a):     logging.basicConfig()      if FLAGS.debug:         logging.getLogger().setLevel(logging.DEBUG)      # Safe np and tf PRNG     seed_sequence = np.random.SeedSequence(FLAGS.random_seed)     np_seed, tf_seed = seed_sequence.spawn(2)     np_rng = np.random.default_rng(np_seed)     tf_rng = tf.random.Generator.from_seed(tf_seed.entropy)      data_generating_model = LinearModel(         weights=np_rng.integers(low=0, high=5, size=(FLAGS.num_features)), bias= 2     )     logging.debug(data_generating_model)      data = Data(         data_generating_model,         np_rng,         FLAGS.num_features,         FLAGS.num_samples,         FLAGS.sigma_noise,     ) </pre>		

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model = Model(tf_rng, FLAGS.num_features)
logging.debug(model.model)

optimizer = tf.optimizers.SGD(learning_rate=FLAGS.learning_rate)

bar = trange(FLAGS.num_iters)
for i in bar:
    with tf.GradientTape() as tape:
        x, y = data.get_batch(np_rng, FLAGS.batch_size)
        y_hat = model(x)
        loss = 0.5 * tf.reduce_mean((y_hat - y) ** 2)

        grads = tape.gradient(loss, model.trainable_variables)
        optimizer.apply_gradients(zip(grads, model.trainable_variables))

    bar.set_description(f"Loss @ {i} => {loss.numpy():0.6f}")
    bar.refresh()

logging.debug(model.model)

# print out true values versus estimates
print("w, w_hat")
compare_linear_models(data.model, model.model)

if FLAGS.num_features > 1:
    # Only continue to plotting if x is a scalar
    exit(0)

fig, ax = plt.subplots(1, 1, figsize=(5, 3), dpi=200)

ax.set_title("Linear fit")
ax.set_xlabel("x")
ax.set_ylim(0, np.amax(data.y) * 1.5)
h = ax.set_ylabel("y", labelpad=10)
h.set_rotation(0)

xs = np.linspace(0, 1, 10)
xs = xs[:, np.newaxis]
ax.plot(xs, np.squeeze(model(xs)), "-", np.squeeze(data.x), data.y, "o")

plt.tight_layout()
plt.savefig(f"{script_path}/fit.pdf")

if __name__ == "__main__":
    app.run(main)

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