TL05 SGD

Índice

1 SGD

SGD: optimizador estándar

- **Clase SGD:** https://keras.io/api/optimizers/sgd
- Aunque Adam(W) es el optimizador más popular, SGD mantiene su popularidad en ciertos dominios
- Algunos parámetros relevantes:
  - `learning_rate=0.01`: el learning rate
  - `momentum=0.0`: acelera el movimiento en regiones llanas del objetivo (y lo frena en abruptas)
  - `nesterov=False`: añade un paso de extrapolación para amortiguar oscilaciones

Ejemplo: la sección 2 incluye un ejemplo de uso para MNIST

Examen: la sección 3 describe el ejercicio a realizar, similar al ejemplo, pero con Fashion-MNIST

2 MNIST con SGD

MNIST: resumen de resultados (con Adam)

- MLP inicial: MLP con una capa oculta de 800 RELUs, batch size 16, 10 épocas; 98.1% en test
- Mejor arquitectura: una capa oculta de 800 RELUs, 98.2% en val, 98.2% en test (98.2% modelo val)
- Learning rate y batch size: ajustados a 0.00168 y 256; 98.5% en val, 98.5% en test (98.5% modelo val)
- ReduceLROnPlateau: factor 0.3787 y paciencia 10; 98.5% en val, 98.4% en test (98.4% modelo val)

SGD en lugar de Adam: conviene explorar el learning rate

Inicialización: librerías, semilla, lectura de MNIST y partición train-val-test

In [ ]:
```
import numpy as np; import matplotlib.pyplot as plt
import os; os.environ['TF_CPP_MIN_LOG_LEVEL'] = '2'
import keras; import keras_tuner
keras.utils.set_random_seed(23); input_dim = 784; num_classes = 10
(x_train_val, y_train_val), (x_test, y_test) = keras.datasets.mnist.load_data()
x_train_val = x_train_val.reshape(-1, input_dim).astype("float32") / 255.0
x_test = x_test.reshape(-1, input_dim).astype("float32") / 255.0
y_train_val = keras.utils.to_categorical(y_train_val, num_classes)
y_test = keras.utils.to_categorical(y_test, num_classes)
x_train = x_train_val[:-10000]; x_val = x_train_val[-10000:]
y_train = y_train_val[:-10000]; y_val = y_train_val[-10000:]
```

MyHyperModel: exploramos learning rate, momentum y Nesterov

In [ ]:
```
class MyHyperModel(keras_tuner.HyperModel):
    def build(self, hp):
        M = keras.Sequential()
        M.add(keras.Input(shape=(784,)))
        M.add(keras.layers.Dense(units=800, activation='relu'))
        M.add(keras.layers.Dense(10, activation='softmax'))
        learning_rate = hp.Float("learning rate", min_value=0.25, max_value=0.35)
        momentum = hp.Float("momentum", min_value=0.1, max_value=0.2)
        nesterov = hp.Boolean("nesterov")
        opt = keras.optimizers.SGD(learning_rate=learning_rate, momentum=momentum, nesterov=nesterov)
        M.compile(loss="categorical_crossentropy", optimizer=opt, metrics=["accuracy"])
        return M
    def fit(self, hp, M, x, y, xy_val, **kwargs):
        factor = 0.3787; patience = 10
        reduce_cb = keras.callbacks.ReduceLROnPlateau(
            monitor='val_accuracy', factor=factor, patience=patience, min_delta=1e-5, min_lr=0.0)
        early_cb = keras.callbacks.EarlyStopping(monitor='val_accuracy', patience=2*patience, min_delta=1e-5)
        kwargs['callbacks'].extend([reduce_cb, early_cb])
        return M.fit(x, y, batch_size=256, epochs=100, validation_data=xy_val, **kwargs)
```

Experimento: exploración y evaluación en test del mejor modelo en validación

In [ ]:
```
tuner = keras_tuner.BayesianOptimization(
    MyHyperModel(), objective="val_accuracy", max_trials=10, executions_per_trial=1,
    overwrite=True, directory="/tmp", project_name="MNIST")
```

In [ ]:
```
tuner.search(x_train, y_train, (x_val, y_val))
```

```
Trial 10 Complete [00h 01m 22s]
val_accuracy: 0.9821000099182129

Best val_accuracy So Far: 0.9830999970436096
Total elapsed time: 00h 12m 19s
```

In [ ]:
```
tuner.results_summary(num_trials=1)
```

```
Results summary
Results in /tmp/MNIST
Showing 1 best trials
Objective(name="val_accuracy", direction="max")

Trial 08 summary
Hyperparameters:
learning rate: 0.31676315292227347
momentum: 0.11335880122310323
nesterov: False
Score: 0.9830999970436096
```

In [ ]:
```
best = tuner.get_best_models(num_models=1)[0]
score = best.evaluate(x_test, y_test, verbose=0)
print(f'Loss: {score[0]:.4}\nPrecisión: {score[1]:.2%}')
```

```
Loss: 0.06283
Precisión: 98.16%
```

Conclusión: precisión en test un poco menor que la que teníamos

3 Fashion-MNIST con SGD

Fashion-MNIST:

- MLP inicial: MLP con una capa oculta de 800 RELUs, batch size 16, 20 épocas; 88.0% en test
- Mejor arquitectura: una capa oculta de 800 RELUs, 89.0% en val, 88.3% en test (88.0% modelo val)
- Learning rate y batch size: ajustados a 0.00015 y 256; 89.6% en val, 89.8% en test (89.1% modelo val)
- ReduceLROnPlateau: factor 0.32 y paciencia 5; 90.0% en val, 89.6% en test (89.5% modelo val)

SGD en lugar de Adam: conviene explorar el learning rate

Inicialización: librerías, semilla, lectura de MNIST y partición train-val-test

In [ ]:
```
import numpy as np; import matplotlib.pyplot as plt
import os; os.environ['TF_CPP_MIN_LOG_LEVEL'] = '2'
import keras; import keras_tuner
keras.utils.set_random_seed(23); input_dim = 784; num_classes = 10
(x_train_val, y_train_val), (x_test, y_test) = keras.datasets.fashion_mnist.load_data()
x_train_val = x_train_val.reshape(-1, input_dim).astype("float32") / 255.0
x_test = x_test.reshape(-1, input_dim).astype("float32") / 255.0
y_train_val = keras.utils.to_categorical(y_train_val, num_classes)
y_test = keras.utils.to_categorical(y_test, num_classes)
x_train = x_train_val[:-10000]; x_val = x_train_val[-10000:]
y_train = y_train_val[:-10000]; y_val = y_train_val[-10000:]
```

MyHyperModel: exploramos learning rate, momentum y Nesterov

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class MyHyperModel(keras_tuner.HyperModel):
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        M.add(keras.layers.Dense(units=800, activation='relu'))
        M.add(keras.layers.Dense(10, activation='softmax'))
        learning_rate = hp.Float("learning rate", min_value=0.25, max_value=0.35)
        momentum = hp.Float("momentum", min_value=0.1, max_value=0.2)
        nesterov = hp.Boolean("nesterov")
        opt = keras.optimizers.SGD(learning_rate=learning_rate, momentum=momentum, nesterov=nesterov)
        M.compile(loss="categorical_crossentropy", optimizer=opt, metrics=["accuracy"])
        return M
    def fit(self, hp, M, x, y, xy_val, **kwargs):
        factor = 0.3787; patience = 10
        reduce_cb = keras.callbacks.ReduceLROnPlateau(
            monitor='val_accuracy', factor=factor, patience=patience, min_delta=1e-5, min_lr=0.0)
        early_cb = keras.callbacks.EarlyStopping(monitor='val_accuracy', patience=2*patience, min_delta=1e-5)
        kwargs['callbacks'].extend([reduce_cb, early_cb])
        return M.fit(x, y, batch_size=256, epochs=100, validation_data=xy_val, **kwargs)
```

Experimento: exploración y evaluación en test del mejor modelo en validación

In [ ]:
```
tuner = keras_tuner.BayesianOptimization(
    MyHyperModel(), objective="val_accuracy", max_trials=10, executions_per_trial=1,
    overwrite=True, directory="/tmp", project_name="Fashion-MNIST")
```

In [ ]:
```
tuner.search(x_train, y_train, (x_val, y_val))
```

```
Trial 10 Complete [00h 01m 29s]
val_accuracy: 0.8946999907493591

Best val_accuracy So Far: 0.900600016117096
Total elapsed time: 00h 15m 05s
```

In [ ]:
```
tuner.results_summary(num_trials=1)
```

```
Results summary
Results in /tmp/Fashion-MNIST
Showing 1 best trials
Objective(name="val_accuracy", direction="max")

Trial 04 summary
Hyperparameters:
learning rate: 0.2983137135444193
momentum: 0.11039620159225871
nesterov: True
Score: 0.900600016117096
```

In [ ]:
```
best = tuner.get_best_models(num_models=1)[0]
score = best.evaluate(x_test, y_test, verbose=0)
print(f'Loss: {score[0]:.4}\nPrecisión: {score[1]:.2%}')
```

```
Loss: 0.3611
Precisión: 89.50%
```

Conclusión: precisión en test similar a la que teníamos