Deep Learning with *keras3* : : **CHEAT SHEET**

Intro

Keras enables fast experimentation with "neural networks". It supports *convolution networks* (vision) and *recurrent networks* (text and time series). It provides the freedom to work with JAX, Tensorflow, and Torch, plus the freedom to build models that can seamlessly move across these frameworks.

keras3 provides easy access to the Keras vast API. It also makes getting started with Keras faster by automatically creating a working Python environment with all the needed libraries pre-installed.

Model building

1. DEFINE A MODEL

keras_input() / keras_model() - Defines a Functional Model with inputs and outputs.

inputs <- keras_input(<input-shape>)
outputs <- inputs |> layer_dense() |> layer_…
model <- keras_model(inputs, outputs)

keras_model_sequential() - Define a Sequential Model composed of a linear stack of layers

model <- keras_model_sequential(<input-shape>)
|> layer_dense() |> layer_...

Model() - Subclass the base Model class

2. INSPECT THE MODEL

summary(<model>**)**- A summary of a Keras Model

plot(<model>**)**- Plot the model. Needs graphviz to work: graphviz.gitlab.io/download

3. COMPILE THE MODEL

compile()- Configure aspects of the model such as optimizer, loss, metrics, weights and others.

model |> compile(loss = "categorical_crossentropy", optimizer = "rmsprop", metrics = "accuracy")

4. FIT THE MODEL

fit()- Trains the model for a fixed number of dataset iterations (epochs)

model |> fit(<x>, <y>, epochs = 30, batch_size = 128, validation_split = 0.2)

5. EVALUATE THE MODEL

evaluate(<model>**)**- Returns the loss and metrics

model |> evaluate(<x test>,<y test>)

predict(<model>, x**)**- Generates predictions

Layers

CORE LAYERS

layer_dense() - A layer connected to all neurons in the preceding layer

layer_einsum_dense() - A dense layer of arbitrary dimensionality

layer_embedding() - Acts as a mapping function, it stores a dense vector for each word in the vocabulary

layer_lambda() - Allows arbitrary expressions to be used as a layer

layer_masking() - Masks a sequence by using a mask value to skip time steps

CONVOLUTION LAYERS

Layers that create a convolution kernel that is convolved with the layer input over one, two, or three dimensions to produce a tensor of outputs.

layer_conv_1d() / layer_conv_1d_transpose() - Layer of a single dimension (temporal). Transpose does the opposite, deconvolution.

layer_conv_2d() / layer_conv_2d_transpose() - Two dimensional layer (image). Transpose does the opposite, deconvolution.

layer_conv_3d() / layer_conv_3d_transpose() - Three dimensional layer (images over volumes). Transpose does the opposite, deconvolution.

layer_depthwise_conv_1d() / layer_depthwise_conv_2d() - A type of convolution in which each input channel is convolved with a different kernel.

layer_separable_conv_1d() /layer_separable_conv_2d() - A depthwise convolution that acts separately on channels, followed by a pointwise convolution that mixes channels.

NORMALIZATION LAYERS

layer_batch_normalization() - Operates across the batch dimension

layer_layer_normalization() - Operates across the feature dimension

layer_group_normalization() - Operates across channels

layer_spectral_normalization() - Controls the Lipschitz constant of the weights

layer_rms_normalization() - Root Mean Square

REGULARIZATION LAYERS

layer_batch_normalization() - Maintains the mean output close to 0 and the output standard deviation close to 1.

layer_gaussian_noise()

Layers that randomly "drop" a fraction of input units during training by setting them to 0

layer_dropout() - Non 0 inputs are scaled up
layer_alpha_dropout() - Keeps original mean and variance

layer_gaussian_dropout() - 1-centers Gaussian noise

layer_spatial_dropout_1d() /
layer_spatial_dropout_2d() /

layer_spatial_dropout_3d() - Drops entire dimensional feature maps instead of individual elements

POOLING LAYERS

Layers that reduce each dimension of the input while retaining the most important features

layer_max_pooling_1d() / layer_max_pooling_2d() / layer_max_pooling_3d() - Maximum value over a specified window size (pool size)

Pool size: 2

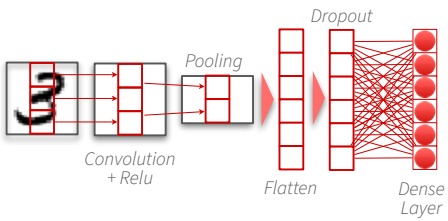
layer_average_pooling_1d() / layer_average_pooling_2d() / layer_average_pooling_3d() Average value over a specified window size (pool size)

Pool size: 2

layer_global_max_pooling_1d() / layer_global_max_pooling_2d() / layer_global_max_pooling_3d() Maximum value of the dimension

layer_global_average_pooling_1d() / layer_global_average_pooling_2d() / layer_global_average_pooling_3d() Average value of the dimension

Convolution Neural Network (CNN)



TRAIN IMAGE RECOGNIZER ON MNIST DATA

a.k.a. deep learning's 'hello world' example

```
library(keras3)
# Input layer: use MNIST images
.[.[x_train, y_train], .[x_test, y_test]] <-
  dataset_mnist()
# Rescale and categorize
x_train <- x_train/255; x_test <- x_test/255
num_classes <- 10
y_train <- to_categorical(y_train, num_classes)
y_test <- to_categorical(y_test, num_classes)
# Define the model and layers
model <-
  keras_model_sequential(
    input_shape = c(28, 28, 1)) |>
  layer_conv_2d(
    filters = 32, kernel_size = c(3, 3),
    activation = "relu") |>
  layer_max_pooling_2d(pool_size = c(2, 2)) |>
  layer_conv_2d(
    filters = 64,
    kernel_size = c(3, 3),
    activation = "relu") |>
  layer_max_pooling_2d(pool_size = c(2, 2)) |>
  layer_flatten() |>
  layer_dropout(rate = 0.5) |>
  layer_dense(units = num_classes,
              activation = "softmax")
# Inspect the model
summary(model)
plot(model)
# Compile (define loss and optimizer)
model |>
  compile(
    loss = "categorical_crossentropy",
    optimizer = optimizer_rmsprop(),
    metrics = c("accuracy")
  )
# Fit the model
model |> fit(
  x_train, y_train,
  epochs = 30, batch_size = 128,
  validation_split = 0.2
)
# Evaluate and predict
model |> evaluate(x_test, y_test)
model |> predict(x_test)
# Save the full model
save_model(model, "mnist-classifier.keras")
# Deploy for serving inference
dir.create("mnist")
export_savedmodel(model, "mnist/1")
rsconnect::deployTFModel("mnist")
```

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Preprocessing Layers

NUMERICAL FEATURES

layer_normalization() -Normalizes continuous features

layer_discretization() - Buckets by ranges

CATEGORICAL FEATURES

layer_category_encoding() - Encodes integer features

layer_hashing() - Hashes and bins features

layer_hashed_crossing() - Crosses features using the "hashing trick"

layer_string_lookup() / layer_integer_lookup - Maps a set of arbitrary text or integers via a table-based vocabulary lookup

DATA FRAMES

layer_feature_space() - Main function to specify the how the features are to be pre-processed

```
feature_space <- layer_feature_space(
  features = list(float_var = feature_float_normalized(),
                  string_var = feature_string_categorical(),
                  int_var = feature_integer_categorical()))
```

feature_float()

feature_float_rescaled()

feature_float_normalized()

feature_float_discretized(num_bins)

feature_integer_categorical()

feature_string_categorical()

adapt() - Calculates the the normalizations, bins, and other conversions against the data set

adapt(feature_space, <TF dataset>)

TEXT

layer_text_vectorization() / get_vocabulary() / set_vocabulary() - Maps a set of arbitrary text or integers via a table-based vocabulary lookup

AUDIO

layer_mel_spectrogram() -Converts signal to Mel

IMAGES

layer_resizing() - Changes the size of images

layer_rescaling() - Multiplies scale by a given number

layer_center_crop() - Crops images to the given size

layer_auto_contrast() - Makes differences between pixels more obvious

IMAGE AUGMENTATION

layer_aug_mix()
layer_cut_mix()
layer_mix_up()
layer_solarization()
layer_random_contrast()
layer_random_crop()
layer_random_erasing()
layer_random_flip()
layer_random_grayscale()
layer_random_color_jitter()
layer_random_perspective()
layer_random_posterization()
layer_random_gaussian_blur()
layer_random_color_degeneration()
layer_random_hue()
layer_random_invert()
layer_random_rotation()
layer_random_shear()
layer_random_zoom()
layer_random_saturation()
layer_random_sharpness()
layer_random_translation()
layer_random_brightness()

Data Loading

text_dataset_from_directory()

audio_dataset_from_directory() - Reads .wav files

image_dataset_from_directory() - This function supports JPEG, Bitmap, PNG and GIF

image_load() - Loads image into a PIL format

image_from_array() - Converts array into PIL format

image_to_array() - Converts PIL image to array

timeseries_dataset_from_array() - Creates a dataset of sliding windows over a time series

pad_sequences() - Pads sequences to the same length

Save and Deploy

I/O OPERATIONS

save_model("<path>") / **load_model**("<path>") - Manage models using the ".keras" file format.

save_model_weights() / load_model_weights() - Manage model weights to/from ".h5" files.

save_model_config() / load_model_config() - Manage model architecture to/from a ".json" file.

DEPLOY

export_savedmodel(<model>, "<path>/1") - Save a TF SavedModel for inference.

rsconnect::deployTFModel("<path>") - Deploy a TF SavedModel to Posit Connect for inference.

Operations

Introduced in Keras v.3, these are low-level operations that will work the same in JAX, TF and Torch

CORE

op_associative_scan() - Faster op_scan() if the function performs a binary associative operation

op_cast() - Casts to specified dtype

op_cond() - Conditionally applies one of two functions

op_convert_to_array() - Tensor to R array

op_convert_to_numpy() - Tensor to Numpy array

op_convert_to_tensor() - Array to tensor

op_custom_gradient() - allows fine grained control over the gradients of a sequence for operations.

op_dtype() - Returns tensor's dtype

op_fori_loop() - For loop, return tensor

op_is_tensor() - Checks for backend specific tensor

op_map() - Applies a function to every single value in the tensor

op_rearrange() - Rearranges tensor to specification

op_scan() - Maps a function, but retaining state

op_scatter() - Modifies tensor in specified locations with zeroes

op_scatter_update() - It modifies tensor in specified locations that do not need to be contiguous

op_searchsorted() - Performs a binary search

op_shape() - Returns tensor's shape

op_slice() - Extract specific location within the tensor

op_slice_update() - It modifies tensor in a specified location

op_stop_gradient() - Stops gradient computation

op_subset() - Get specific section of the tensor

op_switch() - Applies one of several functions passed to the function based on an index argument

op_unstack() - Splits tensor into a list of tensors separated along the specified axis

op_vectorized_map() - Applies a function to every single value in the tensor. Designed for vectorized operations

op_while_loop() - While loop implementation

IMAGES

op_image_affine_transform() - Applies the given transform

op_image_crop() - Crops to specified height and width

op_image_gaussian_blur() - Applies Gaussian blur

op_image_extract_patches() - Extracts from image

op_image_hsv_to_rgb() - Converts from HSV to RGB

op_image_map_coordinates() - Maps input array to new coordinates by interpolation

op_image_pad() - Pad images with zeroes to specified height and width

op_image_perspective_transform() - Applies a perspective transformation to the image

op_image_resize() - Resize image to size using the specified interpolation method

op_image_rgb_to_grayscale() - Converts from RGB to grayscale

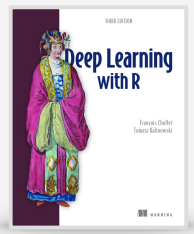
op_image_rgb_to_hsv() - Converts from RGB to HSV

NEURAL NETWORK

op_average_pool()
op_batch_normalization()
op_binary_crossentropy()
op_celu()
op_conv()
op_conv_transpose()
op_ctc_loss()
op_depthwise_conv()
op_elu()
op_gelu()
op_glu()
op_hard_shrink()
op_hard_sigmoid()
op_hard_silu()
op_hard_tanh()
op_leaky_relu()
op_log_sigmoid()
op_log_softmax()
op_max_pool()
op_moments()
op_multi_hot()
op_normalize()
op_one_hot()
op_polar()
op_psnr()
op_relu()
op_relu6()
op_rms_normalization()
op_selu()
op_separable_conv()
op_sigmoid()
op_silu()
op_soft_shrink()
op_softmax()
op_softplus()
op_softsign()
op_sparse_plus()
op_sparsemax()
op_squareplus()
op_tanh_shrink()
op_threshold()
op_unravel_index()
op_categorical_crossentropy()
op_sparse_categorical_crossentropy()

Learn More

Deep Learning with R
3rd Edition



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