nupic.tensorflow

Release 0.0.1.dev0

Numenta

Dec 02, 2021

CONTENTS

```
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-  UNDER DEVELOPMENT  -
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```

The Numenta Platform for Intelligent Computing (**NuPIC**) is a machine intelligence platform that implements the HTM learning algorithms. For more information, see numenta.org or HTM Forum.

This library integrates selected neuroscience principles from HTM into the tensorflow deep learning platform.

CHAPTER

ONE

INSTALLATION

To install from local source code:

```
pip install -e .
```

CHAPTER TWO

TEST

To run all tests:

```
pytest
```

CHAPTER

THREE

HAVING PROBLEMS?

For any installation issues, please search our forums (post questions there). You can report bugs at https://github.com/numenta/nupic.tensorflow/issues.

3.1 Contents

3.1.1 API Reference

nupic.tensorflow

nupic.tensorflow.callbacks

class UpdateBoostStrength

Bases: `tensorflow.keras.callbacks.Callback`

Callback used to update KWinner modules boost strength after each epoch.

on_epoch_end(*epoch*, *logs=None*)

nupic.tensorflow.constraints

class SparseWeights(*percent_on=0.5*, *name=None*)

Bases: `tensorflow.keras.constraints.Constraint`

Sparse weights constraint.

Constrains the weights to a fixed sparsity rate where a fixed number of weights are always zeros.

Parameters **percent_on** – Percentage of weights that are allowed to be non-zero. Default 0.5

get_config()

nupic.tensorflow.layers

class KWinners(*percent_on*, *k_inference_factor=1.0*, *boost_strength=1.0*, *boost_strength_factor=1.0*, *duty_cycle_period=1000*, *name=None*, ***kwargs*)

Bases: `nupic.tensorflow.layers.k_winners.KWinnersBase`

Applies K-Winner function to the input tensor.

Parameters

- **percent_on** (*float*) – The activity of the top k = percent_on * n will be allowed to remain, the rest are set to zero.
- **k_inference_factor** (*float*) – During inference (training=False) we increase percent_on by this factor. percent_on * k_inference_factor must be strictly less than 1.0, ideally much lower than 1.0
- **boost_strength** (*float*) – boost strength (0.0 implies no boosting).
- **boost_strength_factor** (*float*) – Boost strength factor to use [0..1]
- **duty_cycle_period** (*int*) – The period used to calculate duty cycles
- **kwargs** (*dict*) – Additional args passed to `keras.layers.Layer`

build(*input_shape*)

call(*inputs*, *training=None*, ***kwargs*)

compute_duty_cycle(*inputs*)

$$dutyCycle = \frac{dutyCycle \times (period - batchSize) + newValue}{period}$$

class KWinners2d(*percent_on=0.1*, *k_inference_factor=1.5*, *boost_strength=1.0*, *boost_strength_factor=0.9*, *duty_cycle_period=1000*, *data_format=tensorflow.python.keras.backend.image_data_format*, *name=None*, ***kwargs*)

Bases: `nupic.tensorflow.layers.k_winners.KWinnersBase`

Applies K-Winner function to Conv2D input tensor.

Parameters

- **percent_on** (*float*) – The activity of the top k = percent_on * number of input units will be allowed to remain, the rest are set to zero.
- **k_inference_factor** (*float*) – During inference (training=False) we increase percent_on by this factor. percent_on * k_inference_factor must be strictly less than 1.0, ideally much lower than 1.0
- **boost_strength** (*float*) – boost strength (0.0 implies no boosting).
- **boost_strength_factor** (*float*) – Boost strength factor to use [0..1]
- **duty_cycle_period** (*int*) – The period used to calculate duty cycles
- **data_format** (*str*) – one of *channels_first* or *channels_last*. The ordering of the dimensions in the inputs. *channels_last* corresponds to inputs with shape *(batch, height, width, channels)* while *channels_first* corresponds to inputs with shape *(batch, channels, height, width)*. Similar to *data_format* argument in `keras.layers.Conv2D`.
- **kwargs** (*dict*) – Additional args passed to `keras.layers.Layer`

build(*input_shape*)

call(*inputs*, *training=None*, ***kwargs*)

compute_duty_cycle(*x*)

Compute our duty cycle estimates with the new value. Duty cycles are updated according to the following formula:

$$dutyCycle = \frac{dutyCycle \times (period - batchSize) + newValue}{period}$$

Parameters **x** – Current activity of each unit

get_config()

class KWinnersBase(*percent_on*, *k_inference_factor*, *boost_strength*, *boost_strength_factor*, *duty_cycle_period*, *name=None*, ***kwargs*)

Bases: `tensorflow.keras.layers.Layer`

Base KWinners class.

Parameters

- **percent_on** (*float*) – The activity of the top k = percent_on * number of input units will be allowed to remain, the rest are set to zero.
- **k_inference_factor** (*float*) – During inference (training=False) we increase percent_on by this factor. percent_on * k_inference_factor must be strictly less than 1.0, ideally much lower than 1.0
- **boost_strength** (*float*) – boost strength (0.0 implies no boosting). Must be >= 0.0
- **boost_strength_factor** (*float*) – Boost strength factor to use [0..1]
- **duty_cycle_period** (*int*) – The period used to calculate duty cycles
- **kwargs** (*dict*) – Additional args passed to `keras.layers.Layer`

build(*input_shape*)

call(*inputs*, ***kwargs*)

abstract compute_duty_cycle(*x*)

Compute our duty cycle estimates with the new value. Duty cycles are updated according to the following formula:

$$dutyCycle = \frac{dutyCycle \times (period - batchSize) + newValue}{period}$$

Parameters **x** – Current activity of each unit

compute_output_shape(*input_shape*)

get_config()

update_boost_strength()

Update boost strength using given strength factor during training.

compute_kwinners(*x*, *k*, *duty_cycles*, *boost_strength*)

Use the boost strength to compute a boost factor for each unit represented in x. These factors are used to increase the impact of each unit to improve their chances of being chosen. This encourages participation of more columns in the learning process.

The boosting function is a curve defined as: boost_factors = exp[- boost_strength * (dutyCycle - target_density)] Intuitively this means that units that have been active (i.e. in the top-k) at the target activation level have a boost factor of 1, meaning their activity is not boosted. Columns whose duty cycle drops too much below that of their neighbors are boosted depending on how infrequently they have been active. Unit that has been active more than the target activation level have a boost factor below 1, meaning their activity is suppressed and they are less likely to be in the top-k.

Note that we do not transmit the boosted values. We only use boosting to determine the winning units.

The target activation density for each unit is k / number of units. The boostFactor depends on the dutyCycle via an exponential function:

```
  boostFactor
      ^
      |
      |\
      | \
1  _  |  \
      |    _
      |      _ _
      |          _ _ _ _
      +--------------------> dutyCycle
         |
    target_density
```

Parameters

- **x** – Current activity of each unit.
- **k** – The activity of the top k units will be allowed to remain, the rest are set to zero.
- **duty_cycles** – The averaged duty cycle of each unit.
- **boost_strength** – A boost strength of 0.0 has no effect on x.

Returns A tensor representing the activity of x after k-winner take all.

nupic.tensorflow.models

class GSCSparseCNN(*cnn_out_channels=(64, 64), cnn_percent_on=(0.095, 0.125), linear_units=1000, linear_percent_on=0.1, linear_weight_sparsity=0.4, boost_strength=1.5, boost_strength_factor=0.9, k_inference_factor=1.5, duty_cycle_period=1000, data_format=tensorflow.python.keras.backend.image_data_format, pre_trained=False, name=None, batch_norm=True, **kwargs*)

Bases: `tensorflow.keras.Sequential`

Sparse CNN model used to classify *Google Speech Commands* dataset as described in How Can We Be So Dense? paper.

Parameters

- **cnn_out_channels** – output channels for each CNN layer
- **cnn_percent_on** – Percent of units allowed to remain on each convolution layer
- **linear_units** – Number of units in the linear layer
- **linear_percent_on** – Percent of units allowed to remain on the linear layer
- **linear_weight_sparsity** – Percent of weights that are allowed to be non-zero in the linear layer
- **k_inference_factor** – During inference (training=False) we increase *percent_on* in all sparse layers by this factor
- **boost_strength** – boost strength (0.0 implies no boosting)

- **boost_strength_factor** – Boost strength factor to use [0..1]
- **duty_cycle_period** – The period used to calculate duty cycles
- **data_format** – one of *channels_first* or *channels_last*. The ordering of the dimensions in the inputs. *channels_last* corresponds to inputs with shape *(batch, height, width, channels)* while *channels_first* corresponds to inputs with shape *(batch, channels, height, width)*. Similar to *data_format* argument in `keras.layers.Conv2D`.
- **pre_trained** – Whether or not to create a pre-trained model
- **name** – Model name
- **batch_norm** – Whether or not to use BatchNormLayers

class GSCSuperSparseCNN(*data_format=tensorflow.python.keras.backend.image_data_format, pre_trained=False, name=None, batch_norm=True*)

Bases: `nupic.tensorflow.models.sparse_cnn.GSCSparseCNN`

Super Sparse CNN model used to classify *Google Speech Commands* dataset as described in How Can We Be So Dense? paper. This model provides a sparser version of `GSCSparseCNN`

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3.2 Indices and tables

- genindex
- modindex
- search

PYTHON MODULE INDEX

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INDEX