Cloud Atlas

An LstmEncoder for UHECR AirShowers

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UHECR Airshowers

Questo lo fa la Lush

Dataset, first glance

The dataset is composed of 10^5 simulated events:

- 9x9 grid of detectors
- most intense detector at the center
- 80 frames of time series (40 MHz sampling rate)
- 1 frame of times of first arrival

The single record shape is then $(80 + 1, 81)$
The grid is hexagonal (adjacency matrix available) but we neglect the structure of the detector since the net can learn it.
The `pd4ml` package splits by default in 70% train 30% test.

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Split the dataset

Using a generator (`keras.utils.Sequence`)

- inherit multiprocessing features
- has default callbacks

The dataset is splitted *record by record* for index shuffling
The effect of the high reading time from memory ($\approx 3ms$) is mitigated by `keras` multiprocessing
For the design of the net it is convenient using `numpy` structured arrays

Split the dataset: `funky_dtype`

Data is extracted: from a conceptually *ihomogeneous* list (activity time series together with times of arrival) to
$(80 + 1, 81) \rightarrow [(\text{"}toa\text{"}, (9, 9, 1)), (\text{"}timeseries\text{"}, (80, 9, 9))]$
Data can be accessed depending on what is needed

DataFeeder class

DataFeeder class

Data Augmentation

Augmentation class e amici

Resolution

The reference article suggest using the resolution:

resolution

defined as the standard deviation of the distribution bla bla bla

We point out that

$$\sigma^2 = \frac{1}{N}\sum_i (\delta_i - \bar{\delta})^2$$

is a sensible estimator only if $\bar{\delta} = 0$, for which the adopted resolution is equal to the *RMSE* of the distribution

$$RMSE^2 = \frac{1}{N}\sum_i (x_i - \hat{x}_i)^2$$

Since (on a typical train) $\bar{\delta} \approx 10$m we preferred the RMSE.

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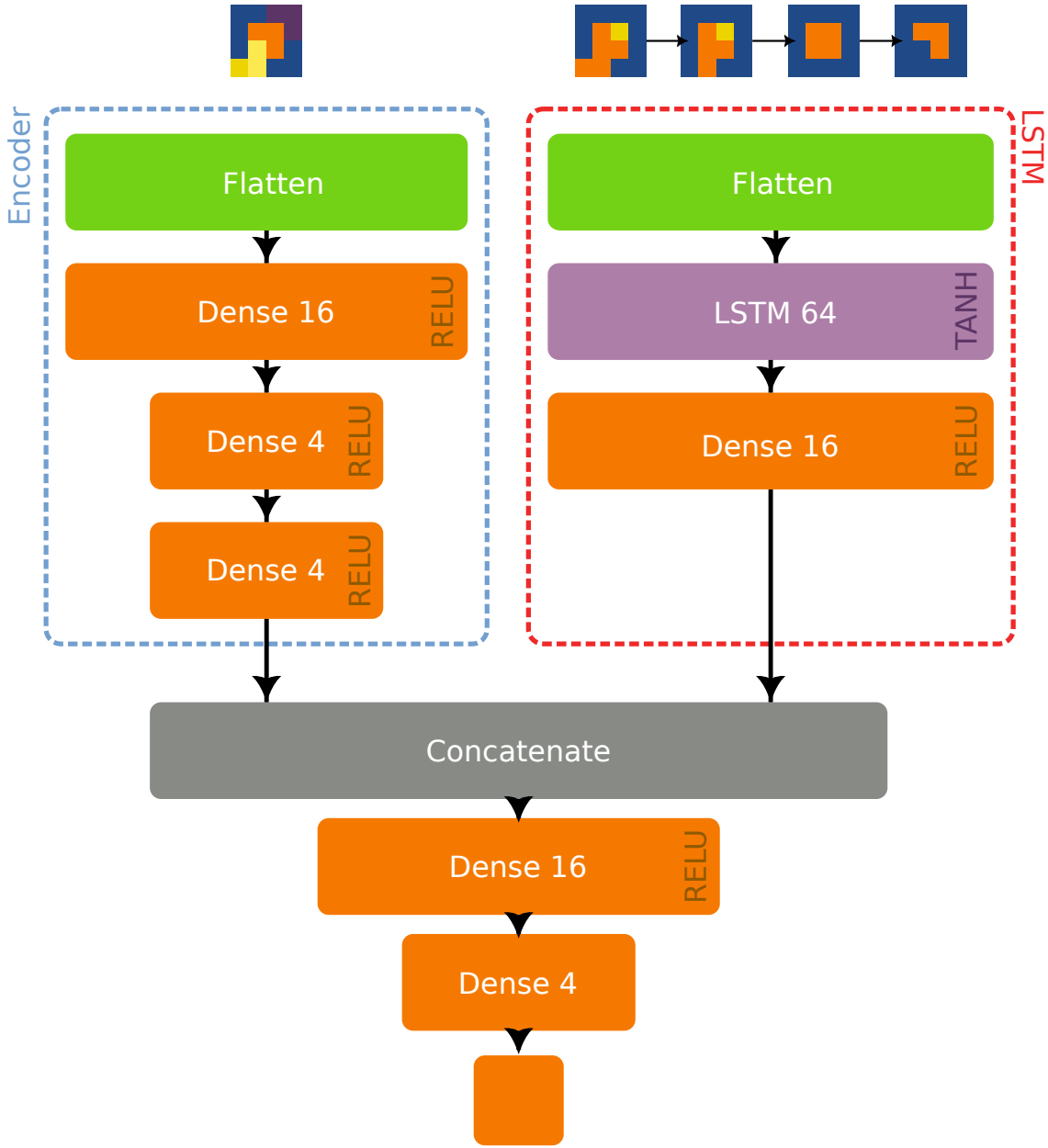

Encoder
Flatten
Dense 16
RELU
Dense 4
RELU
Dense 4
RELU
LSTM
Flatten
LSTM 64
TANH
Dense 16
RELU
Concatenate
Dense 16
RELU
Dense 4

Overview on the network

Encoder for time of arrivals

Encoder performance

i graficini loss accuracy ecc ecc

LSTM

si spiega che cos'è

LSTM for the time series

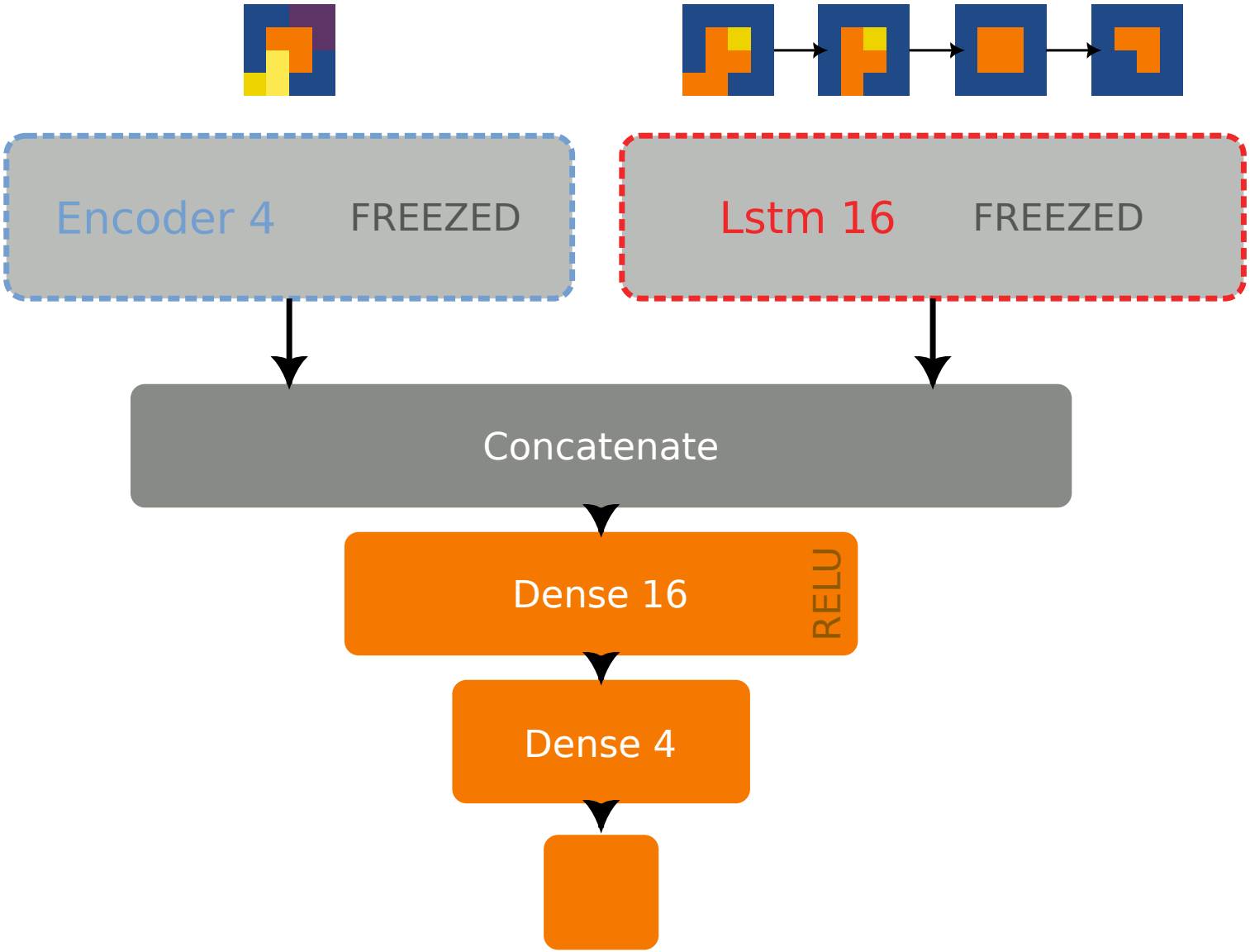
si fa vedere come abbiamo fatto noi

LSTM performance

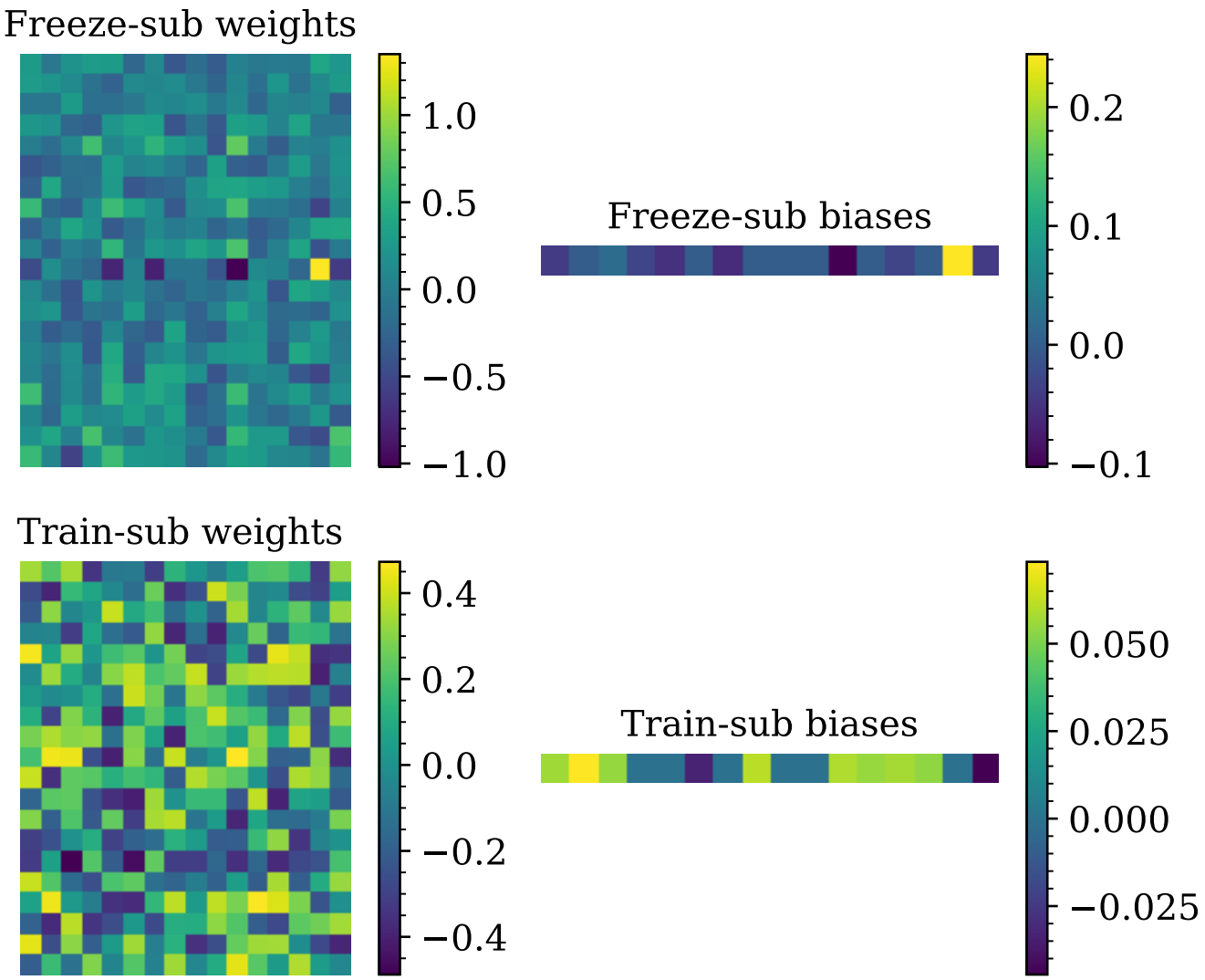
same

Concatente + dense layers

Subnets train freezing



Subnets train freezing



Network's output

Hyperparameters tuning

Whole Network performance

Test setup on CircleCI

Danke e bibliography

Danke Schon