cicy3o_nn_matrix

April 20, 2020

1 Artificial Neural Networks for Complete Intersection Calabi-Yau Manifold

In the framework of String Theory, we apply **deep learning** techniques for the prediction of the **Hodge numbers** of *Complete Intersection Calabi-Yau* (CICY) 3-folds. The relevant quantities are therefore h_{11} and h_{21} which can be predicted starting from the configuration matrices of known manifolds.

We take advantage of previously studied and feature engineered datasets to build **deep neural networks** (DNN) and **convolutional neural networks** (CNN) to predict the labels. We use Tensorflow as backend framework and its high level API Keras.

1.1 Setup

We first setup the environment and import relevant packages which we will use in the analysis. We print their versions to keep track of changes and set the **random seed** of all random generators in order to get reproducible results.

[1]:
```
import sys

import matplotlib        as mpl
import matplotlib.pyplot as plt
import random            as rnd
import numpy             as np
import pandas            as pd
import sklearn           as skl
import tensorflow        as tf

from tensorflow       import keras
from tensorflow.keras import backend as K

import warnings
warnings.simplefilter(action='ignore', category=UserWarning) # ignore␣
↪UserWarning: I cannot really do anything about it...

print('Python version: {:d}.{:d}'      .format(sys.version_info.major, sys.
↪version_info.minor), flush=True)
```

```
print('Matplot version: {}'            .format(mpl.__version__),              ␣
 ↪                flush=True)
print('Numpy version: {}'              .format(np.__version__),               ␣
 ↪                flush=True)
print('Pandas version: {}'             .format(pd.__version__),               ␣
 ↪                flush=True)
print('Scikit-learn version: {}'       .format(skl.__version__),              ␣
 ↪                flush=True)
print('Tensorflow version: {}'         .format(tf.__version__),               ␣
 ↪                flush=True)
print('Keras version: {} (backend: {})'.format(keras.__version__, K.backend()),␣
 ↪                flush=True)

# fix random_seed
RAND = 42
rnd.seed(RAND)
np.random.seed(RAND)
tf.random.set_seed(RAND)
```

```
Python version: 3.7
Matplot version: 3.2.1
Numpy version: 1.18.1
Pandas version: 1.0.3
Scikit-learn version: 0.22.2.post1
Tensorflow version: 2.0.0
Keras version: 2.2.4-tf (backend: tensorflow)
```

We also print the **hardware specifications** to have a representation of the current build.

[2]:
```
!echo "OS:  $(uname -o) - $(lsb_release -d| sed 's/^.*:\s*//g')"
!echo "CPU: $(lscpu| grep 'Model name'| sed 's/^.*:\s*//g')"
!echo "RAM: $(free --giga| awk '/^Mem/ {print $7}') GiB"
!echo "GPU: $(lspci | grep '3D controller' | sed 's/^.*controller:\s*//g')"
```

```
OS:  GNU/Linux - Arch Linux
CPU: Intel(R) Core(TM) i7-7700HQ CPU @ 2.80GHz
RAM: 10 GiB
GPU: NVIDIA Corporation GM108M [GeForce 940MX] (rev a2)
```

In order to store information and results, we create a **logger** for the current Python session and a function to print information to the log file (or the standard output, if the logger is not defined).

[3]:
```
import logging

from os import path, rename
from time import strftime, gmtime

def create_logfile(filename, name='logger', level=logging.INFO):
```

```
    """
    Create a logfile and rotate old logs.

    Required arguments:
        filename: the name of the file or path to the log

    Optional arguments
        name:     the name of the log session
        level:    the level of the information stores

    Returns:
        the log
    """

    # get current time to rename strings
    ctime = strftime('.%Y%m%d.%H%M%S', gmtime())

    # rotate log if it already exists
    if path.isfile(filename):
        print('Rotating existing logs...', flush=True)
        rename(filename, filename + ctime)

    # get a logging session by name
    log = logging.getLogger(name + ctime)
    log.setLevel(level)

    # define format
    fmt = logging.Formatter('%(asctime)s --> %(levelname)s: %(message)s')

    # add the log file
    han = logging.FileHandler(filename=filename)
    han.setLevel(level)
    han.setFormatter(fmt)

    # add handler for standard output
    std = logging.StreamHandler(sys.stdout)
    std.setLevel(level)
    std.setFormatter(fmt)

    # create the output
    log.addHandler(han)
    log.addHandler(std)

    print('Created new log file!', flush=True)
    return log

def logprint(string, stream='info', logger=None):
```

```
    """
    Decides whether to print on the logger or the standard output.

    Required arguments:
        string: the string to print

    Optional arguments:
        stream: standard input (info) or standard error (error)
        logger: the logger (None for standard output/error)
    """

    if logger is not None:
        if stream == 'info':
            logger.info(string)
        elif stream == 'error':
            logger.error(string)
        else:
            logger.debug(string)
    else:
        if stream == 'info':
            sys.stdout.write(string)
        elif stream == 'error':
            sys.stderr.write(string)
        else:
            sys.stdout.write(string)
```

1.2 Preparation and Tools

We first fetch the desired dataset and prepare the tools for the analysis. Specifically we need to:

1. define the names of the main **directories** and create them if non existent,
2. import the **database** and read the archive,
3. create tools for **visualisation** and **manipulation** of the dataset.

[4]:
```
import logging
from os import makedirs

ROOT_DIR = '.'      # root directory
IMG_DIR  = 'img'    # image directory
MOD_DIR  = 'models' # directory of saved models
LOG_DIR  = 'log'    # directory for logs

# name of the dataset to be considered
DB_NAME = 'cicy3o'
DB_FILE = DB_NAME + '.h5'                                  # full name with␣
 ↪extension
DB_PATH = path.join(ROOT_DIR, DB_FILE)                     # full path
```

```
DB_DIR  = 'original' if DB_NAME == 'cicy3o' else 'favourable' # subdir where to␣
 ↪store images, models, logs

# define full paths
IMG_PATH = path.join(ROOT_DIR, IMG_DIR, DB_DIR)
MOD_PATH = path.join(ROOT_DIR, MOD_DIR, DB_DIR)
LOG_PATH = path.join(ROOT_DIR, LOG_DIR, DB_DIR)

# create directories if non existent
if not path.isdir(IMG_PATH):
    makedirs(IMG_PATH, exist_ok=True)
if not path.isdir(MOD_PATH):
    makedirs(MOD_PATH, exist_ok=True)
if not path.isdir(LOG_PATH):
    makedirs(LOG_PATH, exist_ok=True)

# create logfile
logger = create_logfile(filename=path.join(LOG_PATH, DB_NAME + '_nn.log'),␣
 ↪name='CICY3', level=logging.INFO)
```

```
Rotating existing logs…
Created new log file!
```

We then prepare to load the dataset and prepare for the visualisation analysis.

[5]:
```
import pandas as pd

def load_dataset(filepath, mode='hdf5', shuffle=False, random_state=None,␣
 ↪logger=None):
    """
    Load a dataset given the path and the format.

    Required arguments:
        filepath: the path of the file

    Optional arguments:
        mode:         the format of the file
        shuffle:      whether to shuffle the file
        random_state: the seed of the random generator
        logger:       the logging session (None for standard output)

    Returns:
        the dataset
    """

    if path.isfile(filepath):
        logprint('Reading database...', logger=logger)
        if mode == 'hdf5':
```

```
            df = pd.read_hdf(filepath)
        elif mode == 'csv':
            df = pd.read_csv(filepath)
        logprint('Database loaded!', logger=logger)
    else:
        logprint('Database is not available: cannot load the database!',␣
↪stream='error', logger=logger)

    # shuffle the dataframe
    if shuffle and random_state is not None:
        logprint('Shuffling database...', logger=logger)
        df = skl.utils.shuffle(df, random_state=random_state)
        logprint('Database shuffled!', logger=logger)

    return df
```

We then define some functions we can use to extract and manipulate the database. We use the *Scikit-learn* API to create *Estimator* classes (inheriting the *Scikit* interface).

[6]:
```
from sklearn.base import BaseEstimator, TransformerMixin

# remove the outliers from a Pandas dataset
class RemoveOutliers(BaseEstimator, TransformerMixin):
    """
    Remove outlying data given a dataset and a dictionary containing the␣
↪intervals for each class.

    E.g.: if the two classes are 'h11' and 'h21', the dictionary will be:␣
↪{'h11': [1, 16], 'h21': [1, 86]}.

    Public methods:
        fit:           unused method
        transform:     remove data outside the given interval
        fit_transform: equivalent to transform(fit(...))
    """

    def __init__(self, filter_dict=None):
        """
        Constructor of the class.

        Optional arguments:
            filter_dict: the intervals to retain in the data
        """

        self.filter_dict = filter_dict

    def fit(self, X, y=None):
```

```
        """
        Unused method.
        """

        return self

    def transform(self, X):
        """
        Transform the input by deleting data outside the interval

        Required arguments:
            X: the dataset

        Returns:
            the transformed dataset
        """

        x = X.copy() # avoid overwriting

        if self.filter_dict is not None:
            for key in self.filter_dict:
                x = x.loc[x[key] >= self.filter_dict[key][0]]
                x = x.loc[x[key] <= self.filter_dict[key][1]]

        return x

# extract the tensors from a Pandas dataset
class ExtractTensor(BaseEstimator, TransformerMixin):
    """
    Extract a dense tensor from sparse input from a given dataset.

    Public methods:
        fit:           unused method
        transform:     extract dense tensor
        fit_transform: equivalent to transform(fit(...))
        get_shape:     compute the shape of the tensor
    """

    def __init__(self, flatten=False, shape=None):
        """
        Constructor of the class.

        Optional arguments:
            flatten: whether to flatten the output or keep the current shape
            shape:   force the computation with a given shape
        """
```

```
        self.flatten = flatten
        self.shape   = shape

    def fit(self, X, y=None):
        """
        Unused method.
        """

        return self

    def transform(self, X):
        """
        Compute the dense equivalent of the sparse input.

        Required arguments:
            X: the dataset

        Returns:
            the transformed input
        """

        x = X.copy() # avoid overwriting
        if self.shape is None:
            self.shape = x.apply(np.shape).max() # get the shape of the tensor

        if len(self.shape) > 0: # apply this to vectors and tensors
            offset = lambda s : [ (0, self.shape[i] - np.shape(s)[i]) for i in␣
↪range(len(self.shape)) ]
            x      = x.apply(lambda s: np.pad(s, offset(s), mode='constant'))

        if self.flatten and len(self.shape) > 0:
            return list(np.stack(x.apply(np.ndarray.flatten).values))
        else:
            return list(np.stack(x.values))

    def get_shape(self):
        """
        Compute the shape of the tensor.

        Returns:
            the shape of the tensor
        """

        return self.shape
```

We the define the functions we will use to evaluate and improve the algorithms. Even though the ultimate goal is a regression task, we will however predict integer values $h_{11},\ h_{21} \in \mathbb{Z}$, thus we

will evaluate the **accuracy** of the prediction, given the best estimate (in general we use the *mean squared error* to evaluate the algorithms, but we accept those with best *accuracy*).

[7]:
```
# get the accuracy (possibly after rounding)
def accuracy_score(y_true, y_pred, rounding=np.rint):
    """
    Compute the accuracy of the predictions after rounding.

    Required arguments:
        y_true: true values
        y_pred: predicted values

    Optional arguments:
        rounding: the Numpy function for rounding the predictions
    """

    assert np.shape(y_true)[0] == np.shape(y_pred)[0] # check if same length

    # if same length then proceed
    accuracy = 0
    if rounding is not None:
        for n in range(np.shape(y_true)[0]):
            accuracy = accuracy + 1 \
                       if int(y_true[n]) == int(rounding(y_pred[n])) \
                       else accuracy
    else:
        for n in range(np.shape(y_true)[0]):
            accuracy = accuracy + 1 \
                       if y_true[n] == y_pred[n] \
                       else accuracy
    return accuracy / np.shape(y_true)[0]

# get the error difference (possibly after rounding)
def error_diff(y_true, y_pred, rounding=np.rint):
    """
    Compute the error difference between true values and predictions (positive␣
 ↪values are overestimate and viceversa).

    Required arguments:
        y_true: true values
        y_pred: predicted values

    Optional arguments:
        rounding: the Numpy function for rounding the predictions
    """

    assert np.shape(y_true)[0] == np.shape(y_pred)[0] # check if same length
```

```
    # if same length then proceed
    err = y_true - rounding(y_pred)
    return np.array(err).astype(np.int16)

# print *SearchCV scores
def gridcv_score(estimator, rounding=np.rint, logger=None):
    """
    Print scores given by cross-validation and optimisation techniques.

    Required arguments:
        estimator: the estimator to be evaluated

    Optional arguments:
        rounding: the Numpy function for rounding the predictions
        logger:   the logging session (None for standard output)
    """

    best_params = estimator.best_params_              # get best parameters
    df          = pd.DataFrame(estimator.cv_results_) # dataframe with CV res.

    cv_best_res = df.loc[df['params'] == best_params] # get best results
    accuracy    = cv_best_res.loc[:, 'mean_test_score'].values[0]
    std         = cv_best_res.loc[:, 'std_test_score'].values[0]

    logprint('Best parameters: {}'.format(best_params), logger=logger)
    logprint('Accuracy ({}) of cross-validation: ({:.3f} ± {:.3f})%'.
 ↪format(rounding.__name__, accuracy*100, std*100), logger=logger)

# print the accuracy of the predictions
def prediction_score(estimator, X, y, use_best_estimator=False, rounding=np.
 ↪rint, logger=None):
    """
    Print the accuracy of the predictions.

    Required arguments:
        estimator: the estimator to be used for the predictions
        X: the features
        y: the labels (actual values)

    Optional arguments:
        use_best_estimator: whether to use the estimator.best_estimator_ or␣
 ↪just estimator
        rounding: the Numpy function for rounding the predictions
        logger:   the logging session (None for standard output)
    """
```

```
    if use_best_estimator:
        estimator = estimator.best_estimator_

    accuracy = accuracy_score(y, estimator.predict(X), rounding=rounding)
    logprint('Accuracy ({}) of the predictions: {:.3f}%'.format(rounding.
 ↪__name__, accuracy*100), logger=logger)
```

We use *Matplotlib* to plot the data and define a few functions which we can use during the analysis:

[8]:
```
# set label sizes
%matplotlib inline
mpl.rc('axes', labelsize=12)
mpl.rc('xtick', labelsize=12)
mpl.rc('ytick', labelsize=12)

# set building block sizes for the plot
mpl_width  = 6
mpl_height = 5

# save the current figure
def save_fig(filename, tight_layout=True, extension='png', resolution=96,␣
 ↪logger=None):
    """
    Save current figure to file.

    Required arguments:
        filename: the name of the file where to save the figure (without␣
 ↪extension)

    Optional arguments:
        tight_layout: whether to use the tight_layout
        extension:    extension of the file to use
        resolution:   resolution of the file
        logger:       the logging session (None for standard output)
    """

    filename = path.join(IMG_PATH, filename + '.' + extension)
    if tight_layout:
        plt.tight_layout()

    logprint('Saving {}...'.format(filename), logger=logger)
    plt.savefig(filename, format=extension, dpi=resolution)
    logprint('Saved {}!'.format(filename), logger=logger)

# get a generator to count the occurrencies
def get_counts(df, label, feature):
    """
```

```
    Generator to produce the count of unique occurrencies of the data.

    Required arguments:
        df:      the Pandas dataframe
        label:   the label to consider
        feature: the feature to consider

    Yields:
        [ unique feature, unique value, counts ]
    """

    for n in np.sort(df[feature].unique()):
        uniques, counts = np.unique(df[label].loc[df[feature] == n].values,␣
 ↪return_counts=True)
        for u, c in np.c_[uniques, counts]:
            yield [ n, u, c ]

# plot histogram of occurrencies
def count_plot(ax, data, title=None, xlabel=None, ylabel='N',
               legend=None, xlog=False, ylog=False, binstep=5,
               **kwargs):
    """
    Plot histogram of occurrencies (e.g.: frequency plot).

    Required arguments:
        ax:   the subplot ax where to plot data
        data: the data to plot

    Optional arguments:
        title:    the title of the plot
        xlabel:   the label of the x axis
        ylabel:   the label of the y axis
        legend:   the label for the legend in the plot
        xlog:     whether to use the log scale on the x axis
        ylog:     whether to use the log scale on the y axis
        binstep:  the distance between adjacent bins
        **kwargs: additional arguments to pass to plt.hist
    """

    min_tick = np.min(data) if np.min(data) > -100 else -100 # set a MIN cut
    max_tick = np.max(data) if np.max(data) < 100  else 100  # set a MAX cut

    ax.grid(alpha=0.2)                    # create a grid
    ax.set_title(title)                   # set title
    ax.set_xlabel(xlabel)                 # set a label for the x axis
    ax.set_ylabel(ylabel)                 # set a label for the y axis
    ax.set_xticks(np.arange(min_tick,     # set no. of ticks in the x axis
```

```
                            max_tick,
                            step=binstep
                           )
                )

    if xlog:                                # use log scale in x axis if needed
        ax.set_xscale('log')
    if ylog:                                # use log scale in y axis if needed
        ax.set_yscale('log')

    ax.hist(data,                           # create histogram using 'step' funct.
            histtype='step',
            label=legend,
            **kwargs)

    if legend is not None:                  # add legend
        ax.legend(loc='best')

    return ax

# plot labeled features and their values
def label_plot(ax, data, title=None, xlabel=None, ylabel='values',
               legend=None, xlog=False, ylog=False, binstep=1,
               **kwargs):
    """
    Plot values of labelled data (e.g.: variable ranking).

    Required arguments:
        ax:   the subplot ax where to plot data
        data: the data to plot

    Optional arguments:
        title:    the title of the plot
        xlabel:   the label of the x axis
        ylabel:   the label of the y axis
        legend:   the label for the legend in the plot
        xlog:     whether to use the log scale on the x axis
        ylog:     whether to use the log scale on the y axis
        binstep:  the distance between adjacent bins
        **kwargs: additional arguments to pass to plt.plot
    """

    labels      = [f[0] for f in data]   # labels vector
    importances = [f[1] for f in data]   # importances vector
    length      = len(labels)            # length of the labels vector

    ax.grid(alpha=0.2)                   # create a grid
```

```
    ax.set_title(title)                    # set title
    ax.set_xlabel(xlabel)                  # set a label for the x axis
    ax.set_ylabel(ylabel)                  # set a label for the x axis

    ax.set_xticks(np.arange(length,        # set no. of ticks in the x axis
                            step=binstep
                           )
                  )
    ax.set_xticklabels(labels,             # set name of labels of the x axis
                       ha='right',         # horizontal alignment
                       rotation=45         # rotation of the labels
                      )

    if xlog:                               # use log scale in x axis if needed
        ax.set_xscale('log')
    if ylog:                               # use log scale in y axis if needed
        ax.set_yscale('log')

    ax.plot(np.arange(length),             # plot data
            importances,
            label=legend,
            **kwargs)

    if legend is not None:                 # add legend
        ax.legend(loc='best')

    return ax

# plot the correlation matrix of a Pandas dataframe
def mat_plot(ax, matrix, labels, label='correlation matrix', **kwargs):
    """
    Plot the correlation matrix of a given dataframe.

    Required arguments:
        ax:     the subplot ax where to plot data
        matrix: the matrix to plot
        labels: the labels to show with the matrix

    Optional arguments:
        label:    the label to use for the colour bar
        **kwargs: additional arguments to pass to plt.matshow
    """

    ax.set_xticks(np.arange(len(labels), # set ticks for x axis
                  step=1)
                 )
    ax.set_xticklabels([''] + labels,    # set the name of the ticks
```

```
                        rotation=90
                       )

    ax.set_yticks(np.arange(len(labels), # set ticks for y axis
                  step=1)
                 )
    ax.set_yticklabels([''] + labels)    # set the name of the ticks

    matshow = ax.matshow(matrix,         # show the matrix
                         vmin=-1.0,
                         vmax=1.0,
                         **kwargs
                        )

    cbar = ax.figure.colorbar(matshow,   # create the colour bar
                              ax=ax,
                              fraction=0.05,
                              pad=0.05
                             )
    cbar.ax.set_ylabel(label,            # show the colour bar
                       va='bottom',      # vertical alignment
                       rotation=-90)     # rotation of the label

    return ax

# plot a scatter plot with colours and sizes
def scatter_plot(ax, data, title=None, xlabel=None, ylabel=None,
                 legend=None, xlog=False, ylog=False,
                 colour=True, size=True, colour_label='N', size_leg=0,
                 **kwargs):
    """
    Scatter plot of occurrencies with colour and size codes.

    Required arguments:
        ax:   the subplot ax where to plot data
        data: the data to plot

    Optional arguments:
        title:        the title of the plot
        xlabel:       the label of the x axis
        ylabel:       the label of the y axis
        legend:       the label for the legend in the plot
        xlog:         whether to use the log scale on the x axis
        ylog:         whether to use the log scale on the y axis
        colour:       whether to use colour codes
        size:         whether to use entries of different size
        colour_label: label to use for the colour code
```

```
        size_leg:     length of the legend of the size code
        **kwargs:     additional arguments to pass to plt.scatter
    """

    ax.grid(alpha=0.2)                      # create  a grid
    ax.set_xlabel(xlabel)                   # set labels for the x axis
    ax.set_ylabel(ylabel)                   # set labels for the y axis
    ax.set_title(title)                     # set title

    if xlog:                                # use log scale in x axis if needed
        ax.set_xscale('log')
    if ylog:                                # use log scale in y axis if needed
        ax.set_yscale('log')

    if colour:                              # create the plot with size and colours
        if size:
            scat = ax.scatter(data[0], data[1], s=data[2], c=data[2], **kwargs)
        else:
            scat = ax.scatter(data[0], data[1], c=data[2], **kwargs)
        cbar = ax.figure.colorbar(scat, ax=ax)
        cbar.ax.set_ylabel(colour_label, rotation=-90, va='bottom')
    else:
        if size:
            scat = ax.scatter(data[0], data[1], s=data[2], **kwargs)
        else:
            scat = ax.scatter(data[0], data[1], **kwargs)

    scat.set_label(legend)                  # set label of the plot
    if size_leg:                            # add the size legend if needed
        handles, labels = scat.legend_elements('sizes', num=size_leg)
        ax.legend(handles, labels, loc='lower center',
                  bbox_to_anchor=(0.5,-0.3), ncol=len(handles),
                  fontsize='medium', frameon=False)

    if legend:                              # show the legend
        ax.legend(loc='best')

    return ax

# plot a series with trivial x label
def series_plot(ax, data, title=None, xlabel='series', ylabel=None,
                legend=None, xlog=False, ylog=False,
                step=False, std=False,
                **kwargs):
    """
    Plot a series of data with ordered x axis (e.g.: epoch series).
```

```
    Required arguments:
        ax:   the subplot ax where to plot data
        data: the data to plot

    Optional arguments:
        title:    the title of the plot
        xlabel:   the label of the x axis
        ylabel:   the label of the y axis
        legend:   the label for the legend in the plot
        xlog:     whether to use the log scale on the x axis
        ylog:     whether to use the log scale on the y axis
        step:     whether to use a step function for the plot
        std:      highlight the strip of the standard deviation
        **kwargs: additional arguments to pass to plt.step or plot.plot
    """

    ax.grid(alpha=0.2)                    # create the grid
    ax.set_title(title)                   # set the title
    ax.set_xlabel(xlabel)                 # set labels for the x axis
    ax.set_ylabel(ylabel)                 # set labels for the y axis

    if xlog:                              # use log scale in the x axis if needed
        ax.set_xscale('log')
    if ylog:                              # use log scale in the y axis if needed
        ax.set_yscale('log')

    series = np.arange(len(data))         # create trivial x axis data
    if step:                              # create the plot
        ax.step(series, data, label=legend, **kwargs)
    else:
        ax.plot(series, data, label=legend, **kwargs)

    if std:                               # show coloured strip with std
        ax.fill_between(series,
                        data + np.std(data),
                        data - np.std(data),
                        alpha=0.2)

    if legend is not None:                # show the legend
        ax.legend(loc='best')

    return ax
```

Before going further we also set the **memory growth** of the GPU RAM in order to avoid memory issues:

[9]:
```
# get the list of installed GPUs
gpus = tf.config.experimental.list_physical_devices('GPU')

if gpus:
    try:
        for gpu in gpus:
            tf.config.experimental.set_memory_growth(gpu, True) # set memory␣
 ↪growth

        # get the list of logical devices (GPUs)
        logical_gpus = tf.config.experimental.list_logical_devices('GPU')
        logprint('GPU setup: {:d} physical GPUs, {:d} logical GPUs.'.
 ↪format(len(gpus), len(logical_gpus)), logger=logger)
    except RuntimeError as e:
        logprint(e, stream='error', logger=logger)
else:
    logprint('No GPUs in the setup!', stream='error', logger=logger)
```

```
2020-04-18 11:22:47,060 --> INFO: GPU setup: 1 physical GPUs, 1 logical GPUs.
```

1.3 Neural Networks

We then proceed with the analysis by first loading the prepared datasets and then building the appropriate architectures for the prediction of the Hodge numbers. We start from the analysis of the configuration matrix through a **CNN** architecture and then compare the results with the analysis of the engineered dataset.

We consider only the configuration matrix and build a CNN to predict the labels. First of all we load the dataset and then divide labels and features, we then proceed with the architecture of the CNN.

[10]:
```
if path.isfile(path.join(ROOT_DIR, DB_NAME + '_matrix.h5')):
    matrix = load_dataset(path.join(ROOT_DIR, DB_NAME + '_matrix.h5'),␣
 ↪logger=logger)
    h11    = np.array(ExtractTensor(flatten=False).fit_transform(matrix['h11']))
    h21    = np.array(ExtractTensor(flatten=False).fit_transform(matrix['h21']))
    matrix = np.array(ExtractTensor(flatten=False).
 ↪fit_transform(matrix['matrix']))
```

```
2020-04-18 11:22:47,067 --> INFO: Reading database…
2020-04-18 11:22:47,173 --> INFO: Database loaded!
```

1.4 Setup and Preparation of the Input

We now split the set into training and test set. As for the ML analysis, we keep 10% of the whole set as **test set** and use the remaining 90% as **training set**. We then retain $\frac{1}{9}$ of the latter as **holdout validation set**, thus ending up using 10% of the whole set as validation and 80% as training.

[11]:
```
from sklearn.model_selection import train_test_split

logprint('Splitting into training and test sets...', logger=logger)
matrix_train, matrix_test, h11_train, h11_test, h21_train, h21_test =␣
↪train_test_split(matrix, h11, h21, test_size=0.1,shuffle=False)
logprint('Divided into training and test sets!', logger=logger)
```

```
2020-04-18 11:22:47,677 --> INFO: Splitting into training and test sets…
2020-04-18 11:22:47,681 --> INFO: Divided into training and test sets!
```

1.5 Feature Rescaling

We then rescale and visualise the input in order to better understand what kind of network we should build. We cannot however use the *Scikit* `StandardScaler` since it would treat each entry of the matrix as independent inside the same matrix, but related amongst the matrices. We therefore look for the maximum mean and max entry inside the whole database and then manually apply the rescaling.

[12]:
```
id_mat_max_entry = np.unravel_index(np.argmax(matrix_train, axis=None),␣
↪matrix_train.shape)
mat_max_entry    = matrix_train[id_mat_max_entry]
mat_mean         = np.mean(matrix_train)

# the entries are now in the interval [-1, 1]
matrix_train     = (matrix_train - mat_mean) / mat_max_entry
matrix_test      = (matrix_test  - mat_mean) / mat_max_entry

# now we can divide the training set into training + validation
logprint('Splitting into training and validation sets...', logger=logger)
matrix_train, matrix_val, h11_train, h11_val, h21_train, h21_val  =␣
↪train_test_split(matrix_train, h11_train, h21_train, test_size=1.0/9.0,␣
↪shuffle=False)
logprint('Divided into training and validation sets!', logger=logger)
```

```
2020-04-18 11:22:47,695 --> INFO: Splitting into training and validation sets…
2020-04-18 11:22:47,698 --> INFO: Divided into training and validation sets!
```

We then get the input size of the tensor to insert in the model:

[13]:
```
input_shape = matrix.shape[1:]
```

1.6 Visualising the Input

Before building the CNN model, we would like to try and visualise some of the input matrices:

[14]:
```
# no. of plots
xplots  = 2
yplots  = 2
```

```
# select 10 random integers
random_entries = np.random.default_rng().integers(low=0, high=matrix_train.
 ↪shape[0]-1, size=(2,2))

fig, ax = plt.subplots(yplots, xplots, figsize=(xplots*mpl_width,␣
 ↪yplots*mpl_height))
fig.tight_layout()

for r in range(yplots):
    for c in range(xplots):

        mat  = ax[r,c].matshow(matrix_train[random_entries[r,c]], cmap='gray')
        ax[r,c].set_xlabel('Matrix predictions: h11 = {:d}, h21 = {:d}.'.
 ↪format(h11_train[random_entries[r,c]], h21_train[random_entries[r,c]]),␣
 ↪va='top')
        ax[r,c].figure.colorbar(mat, ax=ax[r,c], fraction=0.04)

save_fig('cnn_matrix_input_example', logger=logger)

plt.show()
plt.close(fig)
```

```
2020-04-18 11:22:48,227 --> INFO: Saving
./img/original/cnn_matrix_input_example.png…
2020-04-18 11:22:48,617 --> INFO: Saved
./img/original/cnn_matrix_input_example.png!
```

1.7 Reshaping the Input

In order to use the 2D **convolutional layers**, we need to reshape the input such that it will be seen as a *black and white image* (one filter as depth) of shape *rows x columns*.

[15]:
```
logprint('Reshaping the input...', logger=logger)
matrix_train = matrix_train.reshape(-1, input_shape[0], input_shape[1], 1)
matrix_val   = matrix_val.reshape(-1, input_shape[0], input_shape[1], 1)
matrix_test  = matrix_test.reshape(-1, input_shape[0], input_shape[1], 1)
logprint('Input reshaped!', logger=logger)
```

```
2020-04-18 11:22:49,255 --> INFO: Reshaping the input…
2020-04-18 11:22:49,256 --> INFO: Input reshaped!
```

1.8 Model Building

We the build the architecture of the CNN. We use a modular approach in order to be able to change its parameters in a quick way in order to perform the hyperparameter optimization efficiently. The idea is to use convolutional layers followed by pooling layers in order to reduce the number of features before linking the convolutional network to a fully connected (FC) dense network to process the output.

[16]:
```
from tensorflow.keras              import Input
from tensorflow.keras.utils        import plot_model
from tensorflow.keras.models       import Model
from tensorflow.keras.layers       import Conv2D, Dense, Flatten,␣
↪BatchNormalization, Dropout, LeakyReLU
from tensorflow.keras.optimizers   import Adam
from tensorflow.keras.regularizers import l1_l2
from tensorflow.keras.callbacks    import EarlyStopping, ReduceLROnPlateau,␣
↪ModelCheckpoint

def cnn_matrix_model(input_shape,
                     learning_rate=0.001,
                     conv_kernel_size=(3,3),
                     conv_filters=[128],
                     conv_kernel_scale=[1],
                     conv_padding='valid',
                     fc_neurons=[30],
                     dropout_rate=0.2,
                     batch_norm_momentum=0.99,
                     leaky_alpha=0.1,
                     l1_reg=0.0,
                     l2_reg=0.0,
                     last_relu=False
                    ):
    """
    Build a convolutional neural network with given parameters.

    Required arguments:
        input_shape:          the shape of the input tensor

    Optional arguments:
        learning_rate:        the learning rate of the gradient descent
        conv_kernel_size:     the size of the kernel of the convolution
        conv_filters:         list of filters per convolutional layer
        conv_kernel_scale:    the scale factor to apply to the kernel size per␣
↪each layer
        conv_padding:         the padding operation to use
        fc_neurons:           list of connection in the fully connected network
        dropout_rate:         the rate of the dropout layer (in percentage)
        batch_norm_momentum:  the momentum of the batch normalization process
        leaky_alpha:          the slope of the activation function
        l1_reg:               the l1 regularization
        l2_reg:               the l2 regularization
        last_relu:            whether to use ReLU in the output layer

    Returns:
        the compiled model
```

```
    """

    # parameters
    kernel_regularizer = l1_l2(l1=l1_reg, l2=l2_reg)
    conv_n_layers      = len(conv_filters)
    fc_n_layers        = len(fc_neurons)

    # network
    IN = Input(shape=input_shape)

    x  = BatchNormalization(momentum=batch_norm_momentum)(IN)

    for n in range(conv_n_layers):
        k_size = tuple(int(k / conv_kernel_scale[n]) for k in conv_kernel_size)

        print('Adding convolutional layer no. {:d} with {:d} filters and {}␣
↪kernel size...'.format(n+1, conv_filters[n], k_size))

        x  = Conv2D(filters=conv_filters[n],
                    kernel_size=k_size,
                    padding=conv_padding,
                    kernel_regularizer=kernel_regularizer
                   )(x)
        x  = LeakyReLU(alpha=leaky_alpha)(x)

        if batch_norm_momentum > 0.0:
            x  = BatchNormalization(momentum=batch_norm_momentum)(x)

    if dropout_rate > 0.0:
        x  = Dropout(rate=dropout_rate)(x)

    x  = Flatten()(x)

    for n in range(fc_n_layers):
        print('Adding fully connected layer no. {:d} with {:d} units...'.
↪format(n+1, fc_neurons[n]))

        x = Dense(units=fc_neurons[n])(x)
        x  = LeakyReLU(alpha=leaky_alpha)(x)

        if batch_norm_momentum > 0.0:
            x  = BatchNormalization(momentum=batch_norm_momentum)(x)

    OUT = Dense(1, activation='relu')(x) if last_relu else Dense(1)(x)


    model = Model(inputs=IN, outputs=OUT)
```

```
    model.compile(optimizers=Adam(learning_rate=learning_rate),␣
↪loss='mean_squared_error', metrics=['mean_squared_error'])

    return model
```

We then visualise the model:

[17]:
```
model    = cnn_matrix_model(input_shape=matrix_train.shape[1:],
                            learning_rate=0.01,
                            conv_kernel_size=(5,5),
                            conv_filters=[80, 40, 20],
                            conv_kernel_scale=[1, 1, 1],
                            conv_padding='same',
                            fc_neurons=[1000, 1000, 100],
                            dropout_rate=0.4,
                            batch_norm_momentum=0.99,
                            leaky_alpha=0.0,
                            l1_reg=1.0e-5,
                            l2_reg=1.0e-5,
                            last_relu=True
                           )

# print a summary
model.summary()

# plot the model
plot_model(model=model, to_file=path.join(IMG_PATH, 'cnn_matrix_{}.png'.
↪format(model.name)), show_shapes=True, show_layer_names=False)
```

```
Adding convolutional layer no. 1 with 80 filters and (5, 5) kernel size…
Adding convolutional layer no. 2 with 40 filters and (5, 5) kernel size…
Adding convolutional layer no. 3 with 20 filters and (5, 5) kernel size…
Adding fully connected layer no. 1 with 1000 units…
Adding fully connected layer no. 2 with 1000 units…
Adding fully connected layer no. 3 with 100 units…
Model: "model"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         [(None, 12, 15, 1)]       0
_________________________________________________________________
batch_normalization (BatchNo (None, 12, 15, 1)         4
_________________________________________________________________
conv2d (Conv2D)              (None, 12, 15, 80)        2080
_________________________________________________________________
leaky_re_lu (LeakyReLU)      (None, 12, 15, 80)        0
_________________________________________________________________
batch_normalization_1 (Batch (None, 12, 15, 80)        320
```

```
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 12, 15, 40)        80040
_________________________________________________________________
leaky_re_lu_1 (LeakyReLU)    (None, 12, 15, 40)        0
_________________________________________________________________
batch_normalization_2 (Batch (None, 12, 15, 40)        160
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 12, 15, 20)        20020
_________________________________________________________________
leaky_re_lu_2 (LeakyReLU)    (None, 12, 15, 20)        0
_________________________________________________________________
batch_normalization_3 (Batch (None, 12, 15, 20)        80
_________________________________________________________________
dropout (Dropout)            (None, 12, 15, 20)        0
_________________________________________________________________
flatten (Flatten)            (None, 3600)              0
_________________________________________________________________
dense (Dense)                (None, 1000)              3601000
_________________________________________________________________
leaky_re_lu_3 (LeakyReLU)    (None, 1000)              0
_________________________________________________________________
batch_normalization_4 (Batch (None, 1000)              4000
_________________________________________________________________
dense_1 (Dense)              (None, 1000)              1001000
_________________________________________________________________
leaky_re_lu_4 (LeakyReLU)    (None, 1000)              0
_________________________________________________________________
batch_normalization_5 (Batch (None, 1000)              4000
_________________________________________________________________
dense_2 (Dense)              (None, 100)               100100
_________________________________________________________________
leaky_re_lu_5 (LeakyReLU)    (None, 100)               0
_________________________________________________________________
batch_normalization_6 (Batch (None, 100)               400
_________________________________________________________________
dense_3 (Dense)              (None, 1)                 101
=================================================================
Total params: 4,813,305
Trainable params: 4,808,823
Non-trainable params: 4,482
_________________________________________________________________
```

[17]:

And finally we fit the model:

[18]:
```
# define the callbacks (NB: with restore_best_weights we do not need to reload␣
↪the model for evaluation)
callbacks=[EarlyStopping(monitor='val_mean_squared_error', patience=100,␣
↪verbose=1, restore_best_weights=True),
           ReduceLROnPlateau(monitor='val_mean_squared_error', factor=0.33,␣
↪patience=50, verbose=1),
           ModelCheckpoint(monitor='val_mean_squared_error', filepath=path.
↪join(MOD_PATH, 'cnn_model_matrix_h11.h5'), verbose=1, save_best_only=True)
          ]

# fit the model
logprint('Training the model for h11...', logger=logger)
model_hst = model.fit(x=matrix_train, y=h11_train,
                      validation_data=(matrix_val, h11_val),
                      batch_size=32, epochs=1000,
                      verbose=1,
                      callbacks=callbacks
                     )
```

```
2020-04-18 11:22:50,685 --> INFO: Training the model for h11…
Train on 6280 samples, validate on 785 samples
Epoch 1/1000
6240/6280 [============================>.] - ETA: 0s - loss: 11.5604 -
mean_squared_error: 11.5340
Epoch 00001: val_mean_squared_error improved from inf to 31.13840, saving model
to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 10s 2ms/sample - loss: 11.5157 -
mean_squared_error: 11.4893 - val_loss: 31.1656 - val_mean_squared_error:
31.1384
Epoch 2/1000
6240/6280 [============================>.] - ETA: 0s - loss: 5.5089 -
mean_squared_error: 5.4811
Epoch 00002: val_mean_squared_error improved from 31.13840 to 29.30012, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 5.5062 -
mean_squared_error: 5.4784 - val_loss: 29.3286 - val_mean_squared_error: 29.3001
Epoch 3/1000
6240/6280 [============================>.] - ETA: 0s - loss: 3.2226 -
mean_squared_error: 3.1935
Epoch 00003: val_mean_squared_error improved from 29.30012 to 4.15025, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 3.2273 -
mean_squared_error: 3.1982 - val_loss: 4.1799 - val_mean_squared_error: 4.1503
```

```
Epoch 4/1000
6240/6280 [============================>.] - ETA: 0s - loss: 2.5873 -
mean_squared_error: 2.5569
Epoch 00004: val_mean_squared_error did not improve from 4.15025
6280/6280 [==============================] - 6s 1ms/sample - loss: 2.5836 -
mean_squared_error: 2.5532 - val_loss: 5.6775 - val_mean_squared_error: 5.6465
Epoch 5/1000
6240/6280 [============================>.] - ETA: 0s - loss: 2.4786 -
mean_squared_error: 2.4471
Epoch 00005: val_mean_squared_error did not improve from 4.15025
6280/6280 [==============================] - 6s 1ms/sample - loss: 2.4812 -
mean_squared_error: 2.4497 - val_loss: 21.9608 - val_mean_squared_error: 21.9287
Epoch 6/1000
6240/6280 [============================>.] - ETA: 0s - loss: 2.1050 -
mean_squared_error: 2.0725
Epoch 00006: val_mean_squared_error improved from 4.15025 to 2.33817, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 2.1014 -
mean_squared_error: 2.0689 - val_loss: 2.3712 - val_mean_squared_error: 2.3382
Epoch 7/1000
6240/6280 [============================>.] - ETA: 0s - loss: 1.7245 -
mean_squared_error: 1.6911
Epoch 00007: val_mean_squared_error did not improve from 2.33817
6280/6280 [==============================] - 6s 1ms/sample - loss: 1.7280 -
mean_squared_error: 1.6946 - val_loss: 10.8513 - val_mean_squared_error: 10.8174
Epoch 8/1000
6240/6280 [============================>.] - ETA: 0s - loss: 1.4526 -
mean_squared_error: 1.4183
Epoch 00008: val_mean_squared_error improved from 2.33817 to 1.92467, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 7s 1ms/sample - loss: 1.4495 -
mean_squared_error: 1.4153 - val_loss: 1.9594 - val_mean_squared_error: 1.9247
Epoch 9/1000
6240/6280 [============================>.] - ETA: 0s - loss: 1.0844 -
mean_squared_error: 1.0492
Epoch 00009: val_mean_squared_error improved from 1.92467 to 1.68839, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 1.0862 -
mean_squared_error: 1.0510 - val_loss: 1.7239 - val_mean_squared_error: 1.6884
Epoch 10/1000
6240/6280 [============================>.] - ETA: 0s - loss: 1.8310 -
mean_squared_error: 1.7949
Epoch 00010: val_mean_squared_error did not improve from 1.68839
6280/6280 [==============================] - 6s 1000us/sample - loss: 1.8337 -
mean_squared_error: 1.7976 - val_loss: 2.6032 - val_mean_squared_error: 2.5664
Epoch 11/1000
6240/6280 [============================>.] - ETA: 0s - loss: 1.9493 -
mean_squared_error: 1.9122
```

```
Epoch 00011: val_mean_squared_error improved from 1.68839 to 1.38048, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 1.9400 -
mean_squared_error: 1.9028 - val_loss: 1.4180 - val_mean_squared_error: 1.3805
Epoch 12/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.8977 -
mean_squared_error: 0.8597
Epoch 00012: val_mean_squared_error did not improve from 1.38048
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.8961 -
mean_squared_error: 0.8581 - val_loss: 1.4205 - val_mean_squared_error: 1.3820
Epoch 13/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.8439 -
mean_squared_error: 0.8052
Epoch 00013: val_mean_squared_error improved from 1.38048 to 1.19536, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.8475 -
mean_squared_error: 0.8088 - val_loss: 1.2344 - val_mean_squared_error: 1.1954
Epoch 14/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.7245 -
mean_squared_error: 0.6850
Epoch 00014: val_mean_squared_error improved from 1.19536 to 1.08804, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.7252 -
mean_squared_error: 0.6857 - val_loss: 1.1280 - val_mean_squared_error: 1.0880
Epoch 15/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.7008 -
mean_squared_error: 0.6603
Epoch 00015: val_mean_squared_error did not improve from 1.08804
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.7016 -
mean_squared_error: 0.6612 - val_loss: 2.9736 - val_mean_squared_error: 2.9328
Epoch 16/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.7155 -
mean_squared_error: 0.6743
Epoch 00016: val_mean_squared_error did not improve from 1.08804
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.7172 -
mean_squared_error: 0.6760 - val_loss: 1.3864 - val_mean_squared_error: 1.3448
Epoch 17/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.6319 -
mean_squared_error: 0.5899
Epoch 00017: val_mean_squared_error did not improve from 1.08804
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.6325 -
mean_squared_error: 0.5905 - val_loss: 1.2473 - val_mean_squared_error: 1.2047
Epoch 18/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.5911 -
mean_squared_error: 0.5482
Epoch 00018: val_mean_squared_error did not improve from 1.08804
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.5888 -
mean_squared_error: 0.5458 - val_loss: 1.2899 - val_mean_squared_error: 1.2466
```

```
Epoch 19/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.5414 -
mean_squared_error: 0.4976
Epoch 00019: val_mean_squared_error improved from 1.08804 to 0.76571, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.5406 -
mean_squared_error: 0.4968 - val_loss: 0.8100 - val_mean_squared_error: 0.7657
Epoch 20/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.7339 -
mean_squared_error: 0.6894
Epoch 00020: val_mean_squared_error did not improve from 0.76571
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.7399 -
mean_squared_error: 0.6954 - val_loss: 3.1224 - val_mean_squared_error: 3.0774
Epoch 21/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.5316 -
mean_squared_error: 0.4865
Epoch 00021: val_mean_squared_error improved from 0.76571 to 0.70250, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.5345 -
mean_squared_error: 0.4894 - val_loss: 0.7479 - val_mean_squared_error: 0.7025
Epoch 22/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.5004 -
mean_squared_error: 0.4547
Epoch 00022: val_mean_squared_error did not improve from 0.70250
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.4990 -
mean_squared_error: 0.4533 - val_loss: 1.1527 - val_mean_squared_error: 1.1067
Epoch 23/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.5530 -
mean_squared_error: 0.5066
Epoch 00023: val_mean_squared_error did not improve from 0.70250
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.5514 -
mean_squared_error: 0.5051 - val_loss: 1.5373 - val_mean_squared_error: 1.4906
Epoch 24/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.4850 -
mean_squared_error: 0.4381
Epoch 00024: val_mean_squared_error did not improve from 0.70250
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.4857 -
mean_squared_error: 0.4388 - val_loss: 4.9550 - val_mean_squared_error: 4.9077
Epoch 25/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.4444 -
mean_squared_error: 0.3969
Epoch 00025: val_mean_squared_error did not improve from 0.70250
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.4454 -
mean_squared_error: 0.3979 - val_loss: 6.1887 - val_mean_squared_error: 6.1410
Epoch 26/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.4380 -
mean_squared_error: 0.3900
Epoch 00026: val_mean_squared_error did not improve from 0.70250
```

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6280/6280 [==============================] - 6s 1ms/sample - loss: 0.4434 -
mean_squared_error: 0.3954 - val_loss: 2.2487 - val_mean_squared_error: 2.2003
Epoch 27/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.4171 -
mean_squared_error: 0.3685
Epoch 00027: val_mean_squared_error did not improve from 0.70250
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.4185 -
mean_squared_error: 0.3698 - val_loss: 4.7600 - val_mean_squared_error: 4.7112
Epoch 28/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.4054 -
mean_squared_error: 0.3562
Epoch 00028: val_mean_squared_error did not improve from 0.70250
6280/6280 [==============================] - 6s 999us/sample - loss: 0.4057 -
mean_squared_error: 0.3566 - val_loss: 1.0122 - val_mean_squared_error: 0.9627
Epoch 29/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.4180 -
mean_squared_error: 0.3683
Epoch 00029: val_mean_squared_error improved from 0.70250 to 0.69803, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.4173 -
mean_squared_error: 0.3676 - val_loss: 0.7480 - val_mean_squared_error: 0.6980
Epoch 30/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.4080 -
mean_squared_error: 0.3579
Epoch 00030: val_mean_squared_error did not improve from 0.69803
6280/6280 [==============================] - 6s 999us/sample - loss: 0.4109 -
mean_squared_error: 0.3608 - val_loss: 3.0689 - val_mean_squared_error: 3.0186
Epoch 31/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3959 -
mean_squared_error: 0.3454
Epoch 00031: val_mean_squared_error did not improve from 0.69803
6280/6280 [==============================] - 6s 997us/sample - loss: 0.3957 -
mean_squared_error: 0.3452 - val_loss: 0.8643 - val_mean_squared_error: 0.8136
Epoch 32/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3843 -
mean_squared_error: 0.3335
Epoch 00032: val_mean_squared_error improved from 0.69803 to 0.55666, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3848 -
mean_squared_error: 0.3339 - val_loss: 0.6078 - val_mean_squared_error: 0.5567
Epoch 33/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3624 -
mean_squared_error: 0.3111
Epoch 00033: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3613 -
mean_squared_error: 0.3100 - val_loss: 1.3643 - val_mean_squared_error: 1.3128
Epoch 34/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3501 -
```

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mean_squared_error: 0.2985
Epoch 00034: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3508 -
mean_squared_error: 0.2992 - val_loss: 198.6694 - val_mean_squared_error:
198.6175
Epoch 35/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.4068 -
mean_squared_error: 0.3548
Epoch 00035: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.4070 -
mean_squared_error: 0.3550 - val_loss: 0.9797 - val_mean_squared_error: 0.9275
Epoch 36/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3654 -
mean_squared_error: 0.3131
Epoch 00036: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3674 -
mean_squared_error: 0.3151 - val_loss: 2.1519 - val_mean_squared_error: 2.0994
Epoch 37/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.4534 -
mean_squared_error: 0.4007
Epoch 00037: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.4523 -
mean_squared_error: 0.3997 - val_loss: 1.0139 - val_mean_squared_error: 0.9610
Epoch 38/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3409 -
mean_squared_error: 0.2879
Epoch 00038: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 999us/sample - loss: 0.3422 -
mean_squared_error: 0.2891 - val_loss: 204.4954 - val_mean_squared_error:
204.4421
Epoch 39/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3284 -
mean_squared_error: 0.2750
Epoch 00039: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3310 -
mean_squared_error: 0.2776 - val_loss: 90.9247 - val_mean_squared_error: 90.8712
Epoch 40/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3069 -
mean_squared_error: 0.2533
Epoch 00040: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 1000us/sample - loss: 0.3069 -
mean_squared_error: 0.2533 - val_loss: 1.1977 - val_mean_squared_error: 1.1440
Epoch 41/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3347 -
mean_squared_error: 0.2809
Epoch 00041: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3350 -
mean_squared_error: 0.2813 - val_loss: 5.6251 - val_mean_squared_error: 5.5713
```

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Epoch 42/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3547 -
mean_squared_error: 0.3007
Epoch 00042: val_mean_squared_error did not improve from 0.55666
6280/6280 [==============================] - 6s 998us/sample - loss: 0.3545 -
mean_squared_error: 0.3004 - val_loss: 0.7218 - val_mean_squared_error: 0.6677
Epoch 43/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2896 -
mean_squared_error: 0.2356
Epoch 00043: val_mean_squared_error improved from 0.55666 to 0.52465, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.2908 -
mean_squared_error: 0.2367 - val_loss: 0.5788 - val_mean_squared_error: 0.5247
Epoch 44/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3209 -
mean_squared_error: 0.2667
Epoch 00044: val_mean_squared_error did not improve from 0.52465
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3199 -
mean_squared_error: 0.2658 - val_loss: 3182.2219 - val_mean_squared_error:
3182.1677
Epoch 45/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3066 -
mean_squared_error: 0.2525
Epoch 00045: val_mean_squared_error did not improve from 0.52465
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3091 -
mean_squared_error: 0.2550 - val_loss: 15344.4234 - val_mean_squared_error:
15344.3682
Epoch 46/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2991 -
mean_squared_error: 0.2450
Epoch 00046: val_mean_squared_error improved from 0.52465 to 0.51152, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2984 -
mean_squared_error: 0.2443 - val_loss: 0.5657 - val_mean_squared_error: 0.5115
Epoch 47/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2997 -
mean_squared_error: 0.2455
Epoch 00047: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2996 -
mean_squared_error: 0.2454 - val_loss: 0.7029 - val_mean_squared_error: 0.6486
Epoch 48/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2947 -
mean_squared_error: 0.2405
Epoch 00048: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2958 -
mean_squared_error: 0.2415 - val_loss: 2944.7890 - val_mean_squared_error:
2944.7344
Epoch 49/1000
```

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6240/6280 [============================>.] - ETA: 0s - loss: 0.2941 -
mean_squared_error: 0.2399
Epoch 00049: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2960 -
mean_squared_error: 0.2417 - val_loss: 21740.6541 - val_mean_squared_error:
21740.6016
Epoch 50/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2891 -
mean_squared_error: 0.2349
Epoch 00050: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2894 -
mean_squared_error: 0.2352 - val_loss: 1.2093 - val_mean_squared_error: 1.1551
Epoch 51/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2900 -
mean_squared_error: 0.2358
Epoch 00051: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2897 -
mean_squared_error: 0.2355 - val_loss: 26.7895 - val_mean_squared_error: 26.7353
Epoch 52/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2988 -
mean_squared_error: 0.2447
Epoch 00052: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2989 -
mean_squared_error: 0.2448 - val_loss: 220.2478 - val_mean_squared_error:
220.1937
Epoch 53/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2926 -
mean_squared_error: 0.2386
Epoch 00053: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2915 -
mean_squared_error: 0.2375 - val_loss: 43481.8415 - val_mean_squared_error:
43481.7852
Epoch 54/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3182 -
mean_squared_error: 0.2640
Epoch 00054: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3172 -
mean_squared_error: 0.2630 - val_loss: 8.1361 - val_mean_squared_error: 8.0820
Epoch 55/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2696 -
mean_squared_error: 0.2154
Epoch 00055: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2699 -
mean_squared_error: 0.2157 - val_loss: 248.4268 - val_mean_squared_error:
248.3726
Epoch 56/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2695 -
mean_squared_error: 0.2153
```

```
Epoch 00056: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2687 -
mean_squared_error: 0.2145 - val_loss: 340.8491 - val_mean_squared_error:
340.7950
Epoch 57/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3119 -
mean_squared_error: 0.2576
Epoch 00057: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3160 -
mean_squared_error: 0.2617 - val_loss: 3.2284 - val_mean_squared_error: 3.1740
Epoch 58/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2782 -
mean_squared_error: 0.2239
Epoch 00058: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2782 -
mean_squared_error: 0.2239 - val_loss: 1282.9124 - val_mean_squared_error:
1282.8579
Epoch 59/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.3713 -
mean_squared_error: 0.3167
Epoch 00059: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.3720 -
mean_squared_error: 0.3174 - val_loss: 0.6927 - val_mean_squared_error: 0.6381
Epoch 60/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2971 -
mean_squared_error: 0.2425
Epoch 00060: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2970 -
mean_squared_error: 0.2425 - val_loss: 2.1817 - val_mean_squared_error: 2.1269
Epoch 61/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2812 -
mean_squared_error: 0.2265
Epoch 00061: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2828 -
mean_squared_error: 0.2282 - val_loss: 0.6339 - val_mean_squared_error: 0.5793
Epoch 62/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2721 -
mean_squared_error: 0.2178
Epoch 00062: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2716 -
mean_squared_error: 0.2172 - val_loss: 0.9767 - val_mean_squared_error: 0.9223
Epoch 63/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2752 -
mean_squared_error: 0.2209
Epoch 00063: val_mean_squared_error did not improve from 0.51152
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2751 -
mean_squared_error: 0.2208 - val_loss: 0.7490 - val_mean_squared_error: 0.6948
Epoch 64/1000
```

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6240/6280 [============================>.] - ETA: 0s - loss: 0.2696 -
mean_squared_error: 0.2154
Epoch 00064: val_mean_squared_error improved from 0.51152 to 0.50861, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2721 -
mean_squared_error: 0.2179 - val_loss: 0.5628 - val_mean_squared_error: 0.5086
Epoch 65/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2716 -
mean_squared_error: 0.2176
Epoch 00065: val_mean_squared_error did not improve from 0.50861
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2730 -
mean_squared_error: 0.2190 - val_loss: 589.0052 - val_mean_squared_error:
588.9513
Epoch 66/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2592 -
mean_squared_error: 0.2055
Epoch 00066: val_mean_squared_error did not improve from 0.50861
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2595 -
mean_squared_error: 0.2058 - val_loss: 0.5871 - val_mean_squared_error: 0.5335
Epoch 67/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2918 -
mean_squared_error: 0.2381
Epoch 00067: val_mean_squared_error did not improve from 0.50861
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2918 -
mean_squared_error: 0.2381 - val_loss: 25206.7834 - val_mean_squared_error:
25206.7266
Epoch 68/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2746 -
mean_squared_error: 0.2211
Epoch 00068: val_mean_squared_error did not improve from 0.50861
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2749 -
mean_squared_error: 0.2214 - val_loss: 66.8975 - val_mean_squared_error: 66.8438
Epoch 69/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2294 -
mean_squared_error: 0.1761
Epoch 00069: val_mean_squared_error improved from 0.50861 to 0.33443, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2292 -
mean_squared_error: 0.1758 - val_loss: 0.3876 - val_mean_squared_error: 0.3344
Epoch 70/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2742 -
mean_squared_error: 0.2212
Epoch 00070: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 998us/sample - loss: 0.2737 -
mean_squared_error: 0.2207 - val_loss: 1833.9866 - val_mean_squared_error:
1833.9341
Epoch 71/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2925 -
```

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mean_squared_error: 0.2397
Epoch 00071: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2949 -
mean_squared_error: 0.2421 - val_loss: 0.6911 - val_mean_squared_error: 0.6384
Epoch 72/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2919 -
mean_squared_error: 0.2394
Epoch 00072: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2906 -
mean_squared_error: 0.2381 - val_loss: 4062.7735 - val_mean_squared_error:
4062.7209
Epoch 73/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2965 -
mean_squared_error: 0.2440
Epoch 00073: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2984 -
mean_squared_error: 0.2459 - val_loss: 0.5053 - val_mean_squared_error: 0.4527
Epoch 74/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2329 -
mean_squared_error: 0.1805
Epoch 00074: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2339 -
mean_squared_error: 0.1815 - val_loss: 0.4346 - val_mean_squared_error: 0.3823
Epoch 75/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2681 -
mean_squared_error: 0.2161
Epoch 00075: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2696 -
mean_squared_error: 0.2176 - val_loss: 0.4519 - val_mean_squared_error: 0.4001
Epoch 76/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2578 -
mean_squared_error: 0.2061
Epoch 00076: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2593 -
mean_squared_error: 0.2075 - val_loss: 0.3876 - val_mean_squared_error: 0.3359
Epoch 77/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2654 -
mean_squared_error: 0.2139
Epoch 00077: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2666 -
mean_squared_error: 0.2150 - val_loss: 15556.2083 - val_mean_squared_error:
15556.1582
Epoch 78/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2666 -
mean_squared_error: 0.2149
Epoch 00078: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2729 -
mean_squared_error: 0.2212 - val_loss: 0.4264 - val_mean_squared_error: 0.3747
```

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Epoch 79/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2496 -
mean_squared_error: 0.1980
Epoch 00079: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 996us/sample - loss: 0.2494 -
mean_squared_error: 0.1978 - val_loss: 1831.9366 - val_mean_squared_error:
1831.8854
Epoch 80/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2606 -
mean_squared_error: 0.2093
Epoch 00080: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2600 -
mean_squared_error: 0.2087 - val_loss: 2574911.8240 - val_mean_squared_error:
2574911.5000
Epoch 81/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2807 -
mean_squared_error: 0.2298
Epoch 00081: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2817 -
mean_squared_error: 0.2308 - val_loss: 69031.1567 - val_mean_squared_error:
69031.1016
Epoch 82/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2452 -
mean_squared_error: 0.1944
Epoch 00082: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2446 -
mean_squared_error: 0.1938 - val_loss: 0.4222 - val_mean_squared_error: 0.3715
Epoch 83/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2641 -
mean_squared_error: 0.2135
Epoch 00083: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2651 -
mean_squared_error: 0.2144 - val_loss: 1811.6356 - val_mean_squared_error:
1811.5846
Epoch 84/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2561 -
mean_squared_error: 0.2056
Epoch 00084: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 997us/sample - loss: 0.2576 -
mean_squared_error: 0.2072 - val_loss: 84818.5879 - val_mean_squared_error:
84818.5391
Epoch 85/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2726 -
mean_squared_error: 0.2221
Epoch 00085: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2743 -
mean_squared_error: 0.2239 - val_loss: 0.4206 - val_mean_squared_error: 0.3702
Epoch 86/1000
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6240/6280 [============================>.] - ETA: 0s - loss: 0.2458 -
mean_squared_error: 0.1955
Epoch 00086: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2476 -
mean_squared_error: 0.1973 - val_loss: 11.3119 - val_mean_squared_error: 11.2617
Epoch 87/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2551 -
mean_squared_error: 0.2051
Epoch 00087: val_mean_squared_error did not improve from 0.33443
6280/6280 [==============================] - 6s 998us/sample - loss: 0.2546 -
mean_squared_error: 0.2046 - val_loss: 0.9962 - val_mean_squared_error: 0.9462
Epoch 88/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2793 -
mean_squared_error: 0.2294
Epoch 00088: val_mean_squared_error improved from 0.33443 to 0.30976, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2793 -
mean_squared_error: 0.2295 - val_loss: 0.3595 - val_mean_squared_error: 0.3098
Epoch 89/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2490 -
mean_squared_error: 0.1993
Epoch 00089: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2544 -
mean_squared_error: 0.2048 - val_loss: 0.5881 - val_mean_squared_error: 0.5385
Epoch 90/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2378 -
mean_squared_error: 0.1884
Epoch 00090: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2378 -
mean_squared_error: 0.1885 - val_loss: 1.1771 - val_mean_squared_error: 1.1279
Epoch 91/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2668 -
mean_squared_error: 0.2178
Epoch 00091: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2682 -
mean_squared_error: 0.2191 - val_loss: 1471.8980 - val_mean_squared_error:
1471.8490
Epoch 92/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2183 -
mean_squared_error: 0.1695
Epoch 00092: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 998us/sample - loss: 0.2173 -
mean_squared_error: 0.1685 - val_loss: 1364.1609 - val_mean_squared_error:
1364.1124
Epoch 93/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2158 -
mean_squared_error: 0.1674
Epoch 00093: val_mean_squared_error did not improve from 0.30976
```

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6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2154 -
mean_squared_error: 0.1670 - val_loss: 0.4592 - val_mean_squared_error: 0.4110
Epoch 94/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2531 -
mean_squared_error: 0.2049
Epoch 00094: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 998us/sample - loss: 0.2533 -
mean_squared_error: 0.2051 - val_loss: 0.8473 - val_mean_squared_error: 0.7989
Epoch 95/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2223 -
mean_squared_error: 0.1741
Epoch 00095: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2249 -
mean_squared_error: 0.1767 - val_loss: 0.7130 - val_mean_squared_error: 0.6649
Epoch 96/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2669 -
mean_squared_error: 0.2190
Epoch 00096: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2694 -
mean_squared_error: 0.2215 - val_loss: 472.4326 - val_mean_squared_error:
472.3847
Epoch 97/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2380 -
mean_squared_error: 0.1903
Epoch 00097: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2384 -
mean_squared_error: 0.1907 - val_loss: 22.1627 - val_mean_squared_error: 22.1149
Epoch 98/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2256 -
mean_squared_error: 0.1780
Epoch 00098: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2254 -
mean_squared_error: 0.1779 - val_loss: 0.8987 - val_mean_squared_error: 0.8512
Epoch 99/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2081 -
mean_squared_error: 0.1610
Epoch 00099: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2095 -
mean_squared_error: 0.1624 - val_loss: 18.1791 - val_mean_squared_error: 18.1320
Epoch 100/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2162 -
mean_squared_error: 0.1694
Epoch 00100: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.2156 -
mean_squared_error: 0.1688 - val_loss: 0.7864 - val_mean_squared_error: 0.7398
Epoch 101/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2698 -
mean_squared_error: 0.2231
```

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Epoch 00101: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2689 -
mean_squared_error: 0.2222 - val_loss: 8.1624 - val_mean_squared_error: 8.1156
Epoch 102/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2685 -
mean_squared_error: 0.2218
Epoch 00102: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2705 -
mean_squared_error: 0.2238 - val_loss: 2.6534 - val_mean_squared_error: 2.6066
Epoch 103/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2468 -
mean_squared_error: 0.2001
Epoch 00103: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2470 -
mean_squared_error: 0.2003 - val_loss: 0.5700 - val_mean_squared_error: 0.5233
Epoch 104/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2613 -
mean_squared_error: 0.2147
Epoch 00104: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2605 -
mean_squared_error: 0.2139 - val_loss: 0.3873 - val_mean_squared_error: 0.3405
Epoch 105/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2228 -
mean_squared_error: 0.1761
Epoch 00105: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2234 -
mean_squared_error: 0.1768 - val_loss: 0.6332 - val_mean_squared_error: 0.5864
Epoch 106/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2473 -
mean_squared_error: 0.2008
Epoch 00106: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2468 -
mean_squared_error: 0.2003 - val_loss: 1969.7801 - val_mean_squared_error:
1969.7336
Epoch 107/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2314 -
mean_squared_error: 0.1853
Epoch 00107: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2329 -
mean_squared_error: 0.1869 - val_loss: 71212.7667 - val_mean_squared_error:
71212.7266
Epoch 108/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2210 -
mean_squared_error: 0.1753
Epoch 00108: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2242 -
mean_squared_error: 0.1785 - val_loss: 1.4350 - val_mean_squared_error: 1.3892
Epoch 109/1000
```

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6240/6280 [============================>.] - ETA: 0s - loss: 0.2934 -
mean_squared_error: 0.2474
Epoch 00109: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2945 -
mean_squared_error: 0.2486 - val_loss: 12.2027 - val_mean_squared_error: 12.1564
Epoch 110/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2134 -
mean_squared_error: 0.1673
Epoch 00110: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2130 -
mean_squared_error: 0.1669 - val_loss: 0.5050 - val_mean_squared_error: 0.4591
Epoch 111/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2397 -
mean_squared_error: 0.1939
Epoch 00111: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2406 -
mean_squared_error: 0.1948 - val_loss: 124.1885 - val_mean_squared_error:
124.1426
Epoch 112/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2268 -
mean_squared_error: 0.1811
Epoch 00112: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2274 -
mean_squared_error: 0.1817 - val_loss: 0.9743 - val_mean_squared_error: 0.9287
Epoch 113/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2541 -
mean_squared_error: 0.2089
Epoch 00113: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2536 -
mean_squared_error: 0.2084 - val_loss: 1.2654 - val_mean_squared_error: 1.2202
Epoch 114/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2340 -
mean_squared_error: 0.1890
Epoch 00114: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2343 -
mean_squared_error: 0.1892 - val_loss: 0.7860 - val_mean_squared_error: 0.7409
Epoch 115/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2438 -
mean_squared_error: 0.1987
Epoch 00115: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2497 -
mean_squared_error: 0.2047 - val_loss: 1.9588 - val_mean_squared_error: 1.9139
Epoch 116/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2571 -
mean_squared_error: 0.2123
Epoch 00116: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2605 -
mean_squared_error: 0.2157 - val_loss: 120.3712 - val_mean_squared_error:
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120.3262
Epoch 117/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2151 -
mean_squared_error: 0.1703
Epoch 00117: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2148 -
mean_squared_error: 0.1700 - val_loss: 177.9555 - val_mean_squared_error:
177.9108
Epoch 118/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2190 -
mean_squared_error: 0.1745
Epoch 00118: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2197 -
mean_squared_error: 0.1753 - val_loss: 157557.5570 - val_mean_squared_error:
157557.5312
Epoch 119/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2766 -
mean_squared_error: 0.2323
Epoch 00119: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2758 -
mean_squared_error: 0.2315 - val_loss: 2625.5399 - val_mean_squared_error:
2625.4954
Epoch 120/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2217 -
mean_squared_error: 0.1775
Epoch 00120: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2226 -
mean_squared_error: 0.1783 - val_loss: 17.3583 - val_mean_squared_error: 17.3141
Epoch 121/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2264 -
mean_squared_error: 0.1825
Epoch 00121: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2285 -
mean_squared_error: 0.1846 - val_loss: 38844.7292 - val_mean_squared_error:
38844.6836
Epoch 122/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2231 -
mean_squared_error: 0.1794
Epoch 00122: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2287 -
mean_squared_error: 0.1849 - val_loss: 22.6522 - val_mean_squared_error: 22.6083
Epoch 123/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2396 -
mean_squared_error: 0.1957
Epoch 00123: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2388 -
mean_squared_error: 0.1949 - val_loss: 0.4409 - val_mean_squared_error: 0.3970
Epoch 124/1000
```

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6240/6280 [============================>.] - ETA: 0s - loss: 0.2050 -
mean_squared_error: 0.1613
Epoch 00124: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2069 -
mean_squared_error: 0.1631 - val_loss: 0.5616 - val_mean_squared_error: 0.5180
Epoch 125/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2323 -
mean_squared_error: 0.1888
Epoch 00125: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2351 -
mean_squared_error: 0.1916 - val_loss: 0.4638 - val_mean_squared_error: 0.4204
Epoch 126/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2389 -
mean_squared_error: 0.1957
Epoch 00126: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2396 -
mean_squared_error: 0.1964 - val_loss: 15.4884 - val_mean_squared_error: 15.4451
Epoch 127/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2202 -
mean_squared_error: 0.1771
Epoch 00127: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2201 -
mean_squared_error: 0.1770 - val_loss: 90861.1980 - val_mean_squared_error:
90861.1641
Epoch 128/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2113 -
mean_squared_error: 0.1683
Epoch 00128: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2126 -
mean_squared_error: 0.1696 - val_loss: 112.4692 - val_mean_squared_error:
112.4264
Epoch 129/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2201 -
mean_squared_error: 0.1776
Epoch 00129: val_mean_squared_error did not improve from 0.30976
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2215 -
mean_squared_error: 0.1789 - val_loss: 38807.3632 - val_mean_squared_error:
38807.3203
Epoch 130/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2164 -
mean_squared_error: 0.1738
Epoch 00130: val_mean_squared_error improved from 0.30976 to 0.27657, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2193 -
mean_squared_error: 0.1767 - val_loss: 0.3192 - val_mean_squared_error: 0.2766
Epoch 131/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2254 -
mean_squared_error: 0.1831
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Epoch 00131: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 996us/sample - loss: 0.2244 -
mean_squared_error: 0.1821 - val_loss: 1.7165 - val_mean_squared_error: 1.6742
Epoch 132/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2242 -
mean_squared_error: 0.1821
Epoch 00132: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2239 -
mean_squared_error: 0.1818 - val_loss: 46959.9698 - val_mean_squared_error:
46959.9336
Epoch 133/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2478 -
mean_squared_error: 0.2058
Epoch 00133: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 997us/sample - loss: 0.2470 -
mean_squared_error: 0.2050 - val_loss: 11.3948 - val_mean_squared_error: 11.3530
Epoch 134/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2392 -
mean_squared_error: 0.1974
Epoch 00134: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 997us/sample - loss: 0.2381 -
mean_squared_error: 0.1963 - val_loss: 0.3569 - val_mean_squared_error: 0.3151
Epoch 135/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2135 -
mean_squared_error: 0.1718
Epoch 00135: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 997us/sample - loss: 0.2149 -
mean_squared_error: 0.1732 - val_loss: 6129.1074 - val_mean_squared_error:
6129.0649
Epoch 136/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2442 -
mean_squared_error: 0.2028
Epoch 00136: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2432 -
mean_squared_error: 0.2018 - val_loss: 589.1926 - val_mean_squared_error:
589.1515
Epoch 137/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2541 -
mean_squared_error: 0.2131
Epoch 00137: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.2529 -
mean_squared_error: 0.2119 - val_loss: 0.5463 - val_mean_squared_error: 0.5051
Epoch 138/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1911 -
mean_squared_error: 0.1502
Epoch 00138: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1912 -
mean_squared_error: 0.1503 - val_loss: 0.4235 - val_mean_squared_error: 0.3825
```

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Epoch 139/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2103 -
mean_squared_error: 0.1695
Epoch 00139: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2095 -
mean_squared_error: 0.1687 - val_loss: 0.3975 - val_mean_squared_error: 0.3567
Epoch 140/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2343 -
mean_squared_error: 0.1936
Epoch 00140: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2367 -
mean_squared_error: 0.1961 - val_loss: 28424.1685 - val_mean_squared_error:
28424.1230
Epoch 141/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2405 -
mean_squared_error: 0.2001
Epoch 00141: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2428 -
mean_squared_error: 0.2024 - val_loss: 0.3193 - val_mean_squared_error: 0.2790
Epoch 142/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.2195 -
mean_squared_error: 0.1793
Epoch 00142: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2199 -
mean_squared_error: 0.1797 - val_loss: 8093.9956 - val_mean_squared_error:
8093.9546
Epoch 143/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2297 -
mean_squared_error: 0.1896
Epoch 00143: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2341 -
mean_squared_error: 0.1940 - val_loss: 2729.5645 - val_mean_squared_error:
2729.5237
Epoch 144/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2448 -
mean_squared_error: 0.2047
Epoch 00144: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2443 -
mean_squared_error: 0.2043 - val_loss: 1038.8509 - val_mean_squared_error:
1038.8108
Epoch 145/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2170 -
mean_squared_error: 0.1773
Epoch 00145: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2186 -
mean_squared_error: 0.1789 - val_loss: 0.5569 - val_mean_squared_error: 0.5171
Epoch 146/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2330 -
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mean_squared_error: 0.1933
Epoch 00146: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2324 -
mean_squared_error: 0.1927 - val_loss: 2.5434 - val_mean_squared_error: 2.5038
Epoch 147/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2166 -
mean_squared_error: 0.1769
Epoch 00147: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2160 -
mean_squared_error: 0.1764 - val_loss: 0.4862 - val_mean_squared_error: 0.4466
Epoch 148/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2188 -
mean_squared_error: 0.1793
Epoch 00148: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2179 -
mean_squared_error: 0.1784 - val_loss: 0.4722 - val_mean_squared_error: 0.4328
Epoch 149/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2194 -
mean_squared_error: 0.1800
Epoch 00149: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2205 -
mean_squared_error: 0.1811 - val_loss: 0.5428 - val_mean_squared_error: 0.5036
Epoch 150/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.2419 -
mean_squared_error: 0.2028
Epoch 00150: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2427 -
mean_squared_error: 0.2036 - val_loss: 1826.4778 - val_mean_squared_error:
1826.4387
Epoch 151/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2032 -
mean_squared_error: 0.1641
Epoch 00151: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2030 -
mean_squared_error: 0.1640 - val_loss: 408.5195 - val_mean_squared_error:
408.4806
Epoch 152/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2253 -
mean_squared_error: 0.1864
Epoch 00152: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2404 -
mean_squared_error: 0.2015 - val_loss: 0.7785 - val_mean_squared_error: 0.7392
Epoch 153/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2385 -
mean_squared_error: 0.1994
Epoch 00153: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2392 -
mean_squared_error: 0.2001 - val_loss: 50.4033 - val_mean_squared_error: 50.3643
```

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Epoch 154/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2466 -
mean_squared_error: 0.2077
Epoch 00154: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2458 -
mean_squared_error: 0.2069 - val_loss: 1078.6700 - val_mean_squared_error:
1078.6311
Epoch 155/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2298 -
mean_squared_error: 0.1910
Epoch 00155: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2292 -
mean_squared_error: 0.1903 - val_loss: 1.0166 - val_mean_squared_error: 0.9776
Epoch 156/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2191 -
mean_squared_error: 0.1805
Epoch 00156: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2185 -
mean_squared_error: 0.1799 - val_loss: 0.4968 - val_mean_squared_error: 0.4585
Epoch 157/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1871 -
mean_squared_error: 0.1488
Epoch 00157: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1869 -
mean_squared_error: 0.1486 - val_loss: 1.3090 - val_mean_squared_error: 1.2708
Epoch 158/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2291 -
mean_squared_error: 0.1910
Epoch 00158: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2304 -
mean_squared_error: 0.1923 - val_loss: 0.5205 - val_mean_squared_error: 0.4821
Epoch 159/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1893 -
mean_squared_error: 0.1513
Epoch 00159: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1893 -
mean_squared_error: 0.1512 - val_loss: 1455.3592 - val_mean_squared_error:
1455.3212
Epoch 160/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2320 -
mean_squared_error: 0.1941
Epoch 00160: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2321 -
mean_squared_error: 0.1942 - val_loss: 0.4097 - val_mean_squared_error: 0.3720
Epoch 161/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2098 -
mean_squared_error: 0.1722
Epoch 00161: val_mean_squared_error did not improve from 0.27657
```

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6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2092 -
mean_squared_error: 0.1716 - val_loss: 71.9854 - val_mean_squared_error: 71.9477
Epoch 162/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2443 -
mean_squared_error: 0.2067
Epoch 00162: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2436 -
mean_squared_error: 0.2060 - val_loss: 0.6074 - val_mean_squared_error: 0.5697
Epoch 163/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2195 -
mean_squared_error: 0.1819
Epoch 00163: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2198 -
mean_squared_error: 0.1822 - val_loss: 0.9098 - val_mean_squared_error: 0.8723
Epoch 164/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2450 -
mean_squared_error: 0.2075
Epoch 00164: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 999us/sample - loss: 0.2472 -
mean_squared_error: 0.2097 - val_loss: 1.5281 - val_mean_squared_error: 1.4905
Epoch 165/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2139 -
mean_squared_error: 0.1764
Epoch 00165: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2131 -
mean_squared_error: 0.1756 - val_loss: 0.7304 - val_mean_squared_error: 0.6931
Epoch 166/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1974 -
mean_squared_error: 0.1602
Epoch 00166: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1985 -
mean_squared_error: 0.1614 - val_loss: 1.1437 - val_mean_squared_error: 1.1068
Epoch 167/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2300 -
mean_squared_error: 0.1931
Epoch 00167: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1000us/sample - loss: 0.2299 -
mean_squared_error: 0.1931 - val_loss: 7.0508 - val_mean_squared_error: 7.0139
Epoch 168/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2012 -
mean_squared_error: 0.1645
Epoch 00168: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2016 -
mean_squared_error: 0.1649 - val_loss: 0.4456 - val_mean_squared_error: 0.4089
Epoch 169/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2288 -
mean_squared_error: 0.1922
Epoch 00169: val_mean_squared_error did not improve from 0.27657
```

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6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2290 -
mean_squared_error: 0.1924 - val_loss: 0.6904 - val_mean_squared_error: 0.6536
Epoch 170/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2387 -
mean_squared_error: 0.2020
Epoch 00170: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2403 -
mean_squared_error: 0.2036 - val_loss: 0.7796 - val_mean_squared_error: 0.7427
Epoch 171/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2285 -
mean_squared_error: 0.1920
Epoch 00171: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2279 -
mean_squared_error: 0.1913 - val_loss: 1.5303 - val_mean_squared_error: 1.4939
Epoch 172/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2267 -
mean_squared_error: 0.1902
Epoch 00172: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2298 -
mean_squared_error: 0.1933 - val_loss: 0.5334 - val_mean_squared_error: 0.4968
Epoch 173/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2055 -
mean_squared_error: 0.1692
Epoch 00173: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2066 -
mean_squared_error: 0.1703 - val_loss: 0.4042 - val_mean_squared_error: 0.3681
Epoch 174/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2850 -
mean_squared_error: 0.2489
Epoch 00174: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.2836 -
mean_squared_error: 0.2475 - val_loss: 139.2635 - val_mean_squared_error:
139.2273
Epoch 175/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2123 -
mean_squared_error: 0.1763
Epoch 00175: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2123 -
mean_squared_error: 0.1763 - val_loss: 0.7852 - val_mean_squared_error: 0.7494
Epoch 176/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.2233 -
mean_squared_error: 0.1875
Epoch 00176: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2231 -
mean_squared_error: 0.1873 - val_loss: 0.6465 - val_mean_squared_error: 0.6108
Epoch 177/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2449 -
mean_squared_error: 0.2092
```

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Epoch 00177: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 997us/sample - loss: 0.2465 -
mean_squared_error: 0.2108 - val_loss: 1.0028 - val_mean_squared_error: 0.9669
Epoch 178/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2091 -
mean_squared_error: 0.1734
Epoch 00178: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1000us/sample - loss: 0.2157 -
mean_squared_error: 0.1799 - val_loss: 0.8259 - val_mean_squared_error: 0.7899
Epoch 179/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2118 -
mean_squared_error: 0.1762
Epoch 00179: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 996us/sample - loss: 0.2153 -
mean_squared_error: 0.1797 - val_loss: 0.4414 - val_mean_squared_error: 0.4055
Epoch 180/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2240 -
mean_squared_error: 0.1884
Epoch 00180: ReduceLROnPlateau reducing learning rate to 0.00033000001567415896.

Epoch 00180: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2233 -
mean_squared_error: 0.1878 - val_loss: 0.5044 - val_mean_squared_error: 0.4687
Epoch 181/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1861 -
mean_squared_error: 0.1508
Epoch 00181: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 998us/sample - loss: 0.1869 -
mean_squared_error: 0.1516 - val_loss: 0.5307 - val_mean_squared_error: 0.4957
Epoch 182/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1702 -
mean_squared_error: 0.1356
Epoch 00182: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 997us/sample - loss: 0.1709 -
mean_squared_error: 0.1364 - val_loss: 0.5025 - val_mean_squared_error: 0.4685
Epoch 183/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1869 -
mean_squared_error: 0.1532
Epoch 00183: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1875 -
mean_squared_error: 0.1538 - val_loss: 0.7246 - val_mean_squared_error: 0.6911
Epoch 184/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2111 -
mean_squared_error: 0.1779
Epoch 00184: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1000us/sample - loss: 0.2125 -
mean_squared_error: 0.1793 - val_loss: 24.1978 - val_mean_squared_error: 24.1648
Epoch 185/1000
```

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6240/6280 [============================>.] - ETA: 0s - loss: 0.1665 -
mean_squared_error: 0.1338
Epoch 00185: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 999us/sample - loss: 0.1705 -
mean_squared_error: 0.1378 - val_loss: 1.9743 - val_mean_squared_error: 1.9417
Epoch 186/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1944 -
mean_squared_error: 0.1621
Epoch 00186: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1953 -
mean_squared_error: 0.1630 - val_loss: 131.1236 - val_mean_squared_error:
131.0915
Epoch 187/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1757 -
mean_squared_error: 0.1440
Epoch 00187: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1753 -
mean_squared_error: 0.1436 - val_loss: 1.1069 - val_mean_squared_error: 1.0755
Epoch 188/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1886 -
mean_squared_error: 0.1573
Epoch 00188: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1883 -
mean_squared_error: 0.1570 - val_loss: 74.9615 - val_mean_squared_error: 74.9304
Epoch 189/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1964 -
mean_squared_error: 0.1655
Epoch 00189: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1960 -
mean_squared_error: 0.1651 - val_loss: 49.2771 - val_mean_squared_error: 49.2465
Epoch 190/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1789 -
mean_squared_error: 0.1486
Epoch 00190: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1781 -
mean_squared_error: 0.1478 - val_loss: 20.4032 - val_mean_squared_error: 20.3730
Epoch 191/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1815 -
mean_squared_error: 0.1516
Epoch 00191: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1818 -
mean_squared_error: 0.1518 - val_loss: 30.5263 - val_mean_squared_error: 30.4965
Epoch 192/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2027 -
mean_squared_error: 0.1731
Epoch 00192: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2025 -
mean_squared_error: 0.1730 - val_loss: 18.0320 - val_mean_squared_error: 18.0026
```

```
Epoch 193/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1925 -
mean_squared_error: 0.1633
Epoch 00193: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1965 -
mean_squared_error: 0.1673 - val_loss: 99.8161 - val_mean_squared_error: 99.7871
Epoch 194/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1999 -
mean_squared_error: 0.1711
Epoch 00194: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1992 -
mean_squared_error: 0.1704 - val_loss: 101.4189 - val_mean_squared_error:
101.3901
Epoch 195/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1929 -
mean_squared_error: 0.1643
Epoch 00195: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1971 -
mean_squared_error: 0.1686 - val_loss: 0.4710 - val_mean_squared_error: 0.4425
Epoch 196/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1855 -
mean_squared_error: 0.1572
Epoch 00196: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1846 -
mean_squared_error: 0.1564 - val_loss: 133.6343 - val_mean_squared_error:
133.6061
Epoch 197/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1935 -
mean_squared_error: 0.1655
Epoch 00197: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1948 -
mean_squared_error: 0.1668 - val_loss: 80133.4986 - val_mean_squared_error:
80133.4766
Epoch 198/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1637 -
mean_squared_error: 0.1360
Epoch 00198: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1637 -
mean_squared_error: 0.1361 - val_loss: 32.2325 - val_mean_squared_error: 32.2050
Epoch 199/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2047 -
mean_squared_error: 0.1774
Epoch 00199: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2076 -
mean_squared_error: 0.1803 - val_loss: 19.9483 - val_mean_squared_error: 19.9210
Epoch 200/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1969 -
mean_squared_error: 0.1699
```

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Epoch 00200: val_mean_squared_error did not improve from 0.27657
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1968 -
mean_squared_error: 0.1697 - val_loss: 1.6133 - val_mean_squared_error: 1.5864
Epoch 201/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1784 -
mean_squared_error: 0.1517
Epoch 00201: val_mean_squared_error improved from 0.27657 to 0.27235, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1782 -
mean_squared_error: 0.1515 - val_loss: 0.2988 - val_mean_squared_error: 0.2723
Epoch 202/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1728 -
mean_squared_error: 0.1464
Epoch 00202: val_mean_squared_error did not improve from 0.27235
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1778 -
mean_squared_error: 0.1514 - val_loss: 4.1428 - val_mean_squared_error: 4.1165
Epoch 203/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1894 -
mean_squared_error: 0.1633
Epoch 00203: val_mean_squared_error did not improve from 0.27235
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1888 -
mean_squared_error: 0.1627 - val_loss: 0.3321 - val_mean_squared_error: 0.3062
Epoch 204/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2305 -
mean_squared_error: 0.2047
Epoch 00204: val_mean_squared_error did not improve from 0.27235
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2306 -
mean_squared_error: 0.2048 - val_loss: 0.5066 - val_mean_squared_error: 0.4808
Epoch 205/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1778 -
mean_squared_error: 0.1523
Epoch 00205: val_mean_squared_error improved from 0.27235 to 0.24598, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1784 -
mean_squared_error: 0.1529 - val_loss: 0.2713 - val_mean_squared_error: 0.2460
Epoch 206/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1862 -
mean_squared_error: 0.1610
Epoch 00206: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1879 -
mean_squared_error: 0.1627 - val_loss: 0.3035 - val_mean_squared_error: 0.2784
Epoch 207/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1887 -
mean_squared_error: 0.1637
Epoch 00207: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1880 -
mean_squared_error: 0.1630 - val_loss: 210.8606 - val_mean_squared_error:
210.8357
```

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Epoch 208/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2305 -
mean_squared_error: 0.2056
Epoch 00208: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2316 -
mean_squared_error: 0.2067 - val_loss: 2.6450 - val_mean_squared_error: 2.6201
Epoch 209/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1829 -
mean_squared_error: 0.1581
Epoch 00209: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1820 -
mean_squared_error: 0.1573 - val_loss: 0.2757 - val_mean_squared_error: 0.2511
Epoch 210/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.2150 -
mean_squared_error: 0.1905
Epoch 00210: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2156 -
mean_squared_error: 0.1911 - val_loss: 0.3440 - val_mean_squared_error: 0.3196
Epoch 211/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1819 -
mean_squared_error: 0.1577
Epoch 00211: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 997us/sample - loss: 0.1878 -
mean_squared_error: 0.1637 - val_loss: 0.3640 - val_mean_squared_error: 0.3398
Epoch 212/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2024 -
mean_squared_error: 0.1783
Epoch 00212: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2049 -
mean_squared_error: 0.1808 - val_loss: 0.2917 - val_mean_squared_error: 0.2676
Epoch 213/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1582 -
mean_squared_error: 0.1342
Epoch 00213: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1577 -
mean_squared_error: 0.1337 - val_loss: 0.3128 - val_mean_squared_error: 0.2889
Epoch 214/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1684 -
mean_squared_error: 0.1446
Epoch 00214: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1687 -
mean_squared_error: 0.1449 - val_loss: 4548.4616 - val_mean_squared_error:
4548.4380
Epoch 215/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1594 -
mean_squared_error: 0.1358
Epoch 00215: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1609 -
```

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mean_squared_error: 0.1373 - val_loss: 0.2820 - val_mean_squared_error: 0.2585
Epoch 216/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1696 -
mean_squared_error: 0.1463
Epoch 00216: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1710 -
mean_squared_error: 0.1477 - val_loss: 0.2796 - val_mean_squared_error: 0.2565
Epoch 217/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1856 -
mean_squared_error: 0.1625
Epoch 00217: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1853 -
mean_squared_error: 0.1623 - val_loss: 0.2933 - val_mean_squared_error: 0.2704
Epoch 218/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1885 -
mean_squared_error: 0.1657
Epoch 00218: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1881 -
mean_squared_error: 0.1653 - val_loss: 0.2794 - val_mean_squared_error: 0.2567
Epoch 219/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1724 -
mean_squared_error: 0.1499
Epoch 00219: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1720 -
mean_squared_error: 0.1495 - val_loss: 0.2947 - val_mean_squared_error: 0.2722
Epoch 220/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1837 -
mean_squared_error: 0.1613
Epoch 00220: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1836 -
mean_squared_error: 0.1612 - val_loss: 249.1305 - val_mean_squared_error:
249.1082
Epoch 221/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2177 -
mean_squared_error: 0.1954
Epoch 00221: val_mean_squared_error did not improve from 0.24598
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2178 -
mean_squared_error: 0.1955 - val_loss: 0.3183 - val_mean_squared_error: 0.2960
Epoch 222/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1741 -
mean_squared_error: 0.1520
Epoch 00222: val_mean_squared_error improved from 0.24598 to 0.24421, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1761 -
mean_squared_error: 0.1540 - val_loss: 0.2662 - val_mean_squared_error: 0.2442
Epoch 223/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2015 -
mean_squared_error: 0.1797
```

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Epoch 00223: val_mean_squared_error did not improve from 0.24421
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2012 -
mean_squared_error: 0.1794 - val_loss: 0.2996 - val_mean_squared_error: 0.2777
Epoch 224/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2050 -
mean_squared_error: 0.1832
Epoch 00224: val_mean_squared_error did not improve from 0.24421
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2061 -
mean_squared_error: 0.1843 - val_loss: 16.9709 - val_mean_squared_error: 16.9491
Epoch 225/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1809 -
mean_squared_error: 0.1593
Epoch 00225: val_mean_squared_error did not improve from 0.24421
6280/6280 [==============================] - 6s 999us/sample - loss: 0.1809 -
mean_squared_error: 0.1592 - val_loss: 8.4984 - val_mean_squared_error: 8.4767
Epoch 226/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1823 -
mean_squared_error: 0.1607
Epoch 00226: val_mean_squared_error improved from 0.24421 to 0.23075, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1826 -
mean_squared_error: 0.1610 - val_loss: 0.2524 - val_mean_squared_error: 0.2307
Epoch 227/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1753 -
mean_squared_error: 0.1539
Epoch 00227: val_mean_squared_error did not improve from 0.23075
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1747 -
mean_squared_error: 0.1533 - val_loss: 0.2849 - val_mean_squared_error: 0.2636
Epoch 228/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1665 -
mean_squared_error: 0.1453
Epoch 00228: val_mean_squared_error did not improve from 0.23075
6280/6280 [==============================] - 6s 999us/sample - loss: 0.1662 -
mean_squared_error: 0.1449 - val_loss: 0.5428 - val_mean_squared_error: 0.5217
Epoch 229/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1756 -
mean_squared_error: 0.1545
Epoch 00229: val_mean_squared_error did not improve from 0.23075
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1761 -
mean_squared_error: 0.1550 - val_loss: 0.2995 - val_mean_squared_error: 0.2785
Epoch 230/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1880 -
mean_squared_error: 0.1670
Epoch 00230: val_mean_squared_error did not improve from 0.23075
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1908 -
mean_squared_error: 0.1698 - val_loss: 94276.5903 - val_mean_squared_error:
94276.5625
Epoch 231/1000
```

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6240/6280 [============================>.] - ETA: 0s - loss: 0.1494 -
mean_squared_error: 0.1285
Epoch 00231: val_mean_squared_error did not improve from 0.23075
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1493 -
mean_squared_error: 0.1285 - val_loss: 0.2830 - val_mean_squared_error: 0.2622
Epoch 232/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1743 -
mean_squared_error: 0.1536
Epoch 00232: val_mean_squared_error did not improve from 0.23075
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1737 -
mean_squared_error: 0.1530 - val_loss: 0.2557 - val_mean_squared_error: 0.2350
Epoch 233/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1865 -
mean_squared_error: 0.1659
Epoch 00233: val_mean_squared_error did not improve from 0.23075
6280/6280 [==============================] - 6s 999us/sample - loss: 0.1861 -
mean_squared_error: 0.1655 - val_loss: 0.2870 - val_mean_squared_error: 0.2664
Epoch 234/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1598 -
mean_squared_error: 0.1393
Epoch 00234: val_mean_squared_error did not improve from 0.23075
6280/6280 [==============================] - 6s 997us/sample - loss: 0.1626 -
mean_squared_error: 0.1421 - val_loss: 0.3091 - val_mean_squared_error: 0.2885
Epoch 235/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1894 -
mean_squared_error: 0.1690
Epoch 00235: val_mean_squared_error did not improve from 0.23075
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1904 -
mean_squared_error: 0.1700 - val_loss: 0.4564 - val_mean_squared_error: 0.4360
Epoch 236/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1719 -
mean_squared_error: 0.1516
Epoch 00236: val_mean_squared_error improved from 0.23075 to 0.20543, saving
model to ./models/original/cnn_model_matrix_h11.h5
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1723 -
mean_squared_error: 0.1520 - val_loss: 0.2257 - val_mean_squared_error: 0.2054
Epoch 237/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1950 -
mean_squared_error: 0.1749
Epoch 00237: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 994us/sample - loss: 0.1954 -
mean_squared_error: 0.1753 - val_loss: 0.4409 - val_mean_squared_error: 0.4207
Epoch 238/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1619 -
mean_squared_error: 0.1418
Epoch 00238: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 998us/sample - loss: 0.1615 -
mean_squared_error: 0.1414 - val_loss: 114.4346 - val_mean_squared_error:
```

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114.4144
Epoch 239/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1972 -
mean_squared_error: 0.1772
Epoch 00239: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 999us/sample - loss: 0.1966 -
mean_squared_error: 0.1766 - val_loss: 175251.4674 - val_mean_squared_error:
175251.4219
Epoch 240/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2120 -
mean_squared_error: 0.1921
Epoch 00240: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2129 -
mean_squared_error: 0.1930 - val_loss: 1.4051 - val_mean_squared_error: 1.3852
Epoch 241/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1730 -
mean_squared_error: 0.1532
Epoch 00241: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 998us/sample - loss: 0.1746 -
mean_squared_error: 0.1548 - val_loss: 9.3939 - val_mean_squared_error: 9.3741
Epoch 242/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1694 -
mean_squared_error: 0.1497
Epoch 00242: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1691 -
mean_squared_error: 0.1494 - val_loss: 0.4716 - val_mean_squared_error: 0.4519
Epoch 243/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1881 -
mean_squared_error: 0.1684
Epoch 00243: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1880 -
mean_squared_error: 0.1684 - val_loss: 1012.1645 - val_mean_squared_error:
1012.1449
Epoch 244/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1827 -
mean_squared_error: 0.1632
Epoch 00244: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1823 -
mean_squared_error: 0.1627 - val_loss: 100.6590 - val_mean_squared_error:
100.6395
Epoch 245/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1825 -
mean_squared_error: 0.1630
Epoch 00245: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1862 -
mean_squared_error: 0.1667 - val_loss: 202.4212 - val_mean_squared_error:
202.4017
Epoch 246/1000
```

```
6240/6280 [============================>.] - ETA: 0s - loss: 0.2080 -
mean_squared_error: 0.1886
Epoch 00246: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2102 -
mean_squared_error: 0.1907 - val_loss: 273.7265 - val_mean_squared_error:
273.7071
Epoch 247/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1710 -
mean_squared_error: 0.1516
Epoch 00247: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1702 -
mean_squared_error: 0.1509 - val_loss: 325.1434 - val_mean_squared_error:
325.1241
Epoch 248/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1647 -
mean_squared_error: 0.1454
Epoch 00248: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1673 -
mean_squared_error: 0.1480 - val_loss: 205333.1714 - val_mean_squared_error:
205333.1406
Epoch 249/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1707 -
mean_squared_error: 0.1516
Epoch 00249: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1708 -
mean_squared_error: 0.1517 - val_loss: 16.1869 - val_mean_squared_error: 16.1678
Epoch 250/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1944 -
mean_squared_error: 0.1753
Epoch 00250: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1948 -
mean_squared_error: 0.1757 - val_loss: 0.5909 - val_mean_squared_error: 0.5719
Epoch 251/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1988 -
mean_squared_error: 0.1798
Epoch 00251: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1984 -
mean_squared_error: 0.1794 - val_loss: 850.2320 - val_mean_squared_error:
850.2130
Epoch 252/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1581 -
mean_squared_error: 0.1392
Epoch 00252: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1592 -
mean_squared_error: 0.1403 - val_loss: 233.1187 - val_mean_squared_error:
233.0998
Epoch 253/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1409 -
```

```
mean_squared_error: 0.1222
Epoch 00253: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1403 -
mean_squared_error: 0.1216 - val_loss: 36.7950 - val_mean_squared_error: 36.7764
Epoch 254/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1799 -
mean_squared_error: 0.1613
Epoch 00254: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1791 -
mean_squared_error: 0.1606 - val_loss: 662.2054 - val_mean_squared_error:
662.1870
Epoch 255/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1735 -
mean_squared_error: 0.1550
Epoch 00255: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1738 -
mean_squared_error: 0.1553 - val_loss: 2501.2133 - val_mean_squared_error:
2501.1946
Epoch 256/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1664 -
mean_squared_error: 0.1481
Epoch 00256: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 998us/sample - loss: 0.1667 -
mean_squared_error: 0.1483 - val_loss: 10.7607 - val_mean_squared_error: 10.7423
Epoch 257/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1762 -
mean_squared_error: 0.1578
Epoch 00257: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1757 -
mean_squared_error: 0.1573 - val_loss: 77543.0017 - val_mean_squared_error:
77542.9844
Epoch 258/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1892 -
mean_squared_error: 0.1710
Epoch 00258: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1891 -
mean_squared_error: 0.1709 - val_loss: 2055.9574 - val_mean_squared_error:
2055.9395
Epoch 259/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1527 -
mean_squared_error: 0.1346
Epoch 00259: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1530 -
mean_squared_error: 0.1349 - val_loss: 0.3984 - val_mean_squared_error: 0.3803
Epoch 260/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1857 -
mean_squared_error: 0.1677
Epoch 00260: val_mean_squared_error did not improve from 0.20543
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6280/6280 [==============================] - 6s 997us/sample - loss: 0.1870 -
mean_squared_error: 0.1689 - val_loss: 0.5045 - val_mean_squared_error: 0.4865
Epoch 261/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1701 -
mean_squared_error: 0.1522
Epoch 00261: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 995us/sample - loss: 0.1701 -
mean_squared_error: 0.1521 - val_loss: 50.8180 - val_mean_squared_error: 50.8001
Epoch 262/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1758 -
mean_squared_error: 0.1579
Epoch 00262: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1763 -
mean_squared_error: 0.1584 - val_loss: 0.3972 - val_mean_squared_error: 0.3792
Epoch 263/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.1814 -
mean_squared_error: 0.1635
Epoch 00263: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1823 -
mean_squared_error: 0.1645 - val_loss: 11036.1549 - val_mean_squared_error:
11036.1348
Epoch 264/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1844 -
mean_squared_error: 0.1665
Epoch 00264: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1838 -
mean_squared_error: 0.1660 - val_loss: 223.4290 - val_mean_squared_error:
223.4111
Epoch 265/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1764 -
mean_squared_error: 0.1586
Epoch 00265: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1767 -
mean_squared_error: 0.1589 - val_loss: 22.7915 - val_mean_squared_error: 22.7737
Epoch 266/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1874 -
mean_squared_error: 0.1697
Epoch 00266: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1918 -
mean_squared_error: 0.1741 - val_loss: 1015.5290 - val_mean_squared_error:
1015.5112
Epoch 267/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1597 -
mean_squared_error: 0.1421
Epoch 00267: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1633 -
mean_squared_error: 0.1457 - val_loss: 1450.3865 - val_mean_squared_error:
1450.3691
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Epoch 268/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1804 -
mean_squared_error: 0.1629
Epoch 00268: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1809 -
mean_squared_error: 0.1634 - val_loss: 6259.5404 - val_mean_squared_error:
6259.5229
Epoch 269/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1524 -
mean_squared_error: 0.1350
Epoch 00269: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1528 -
mean_squared_error: 0.1354 - val_loss: 0.2478 - val_mean_squared_error: 0.2303
Epoch 270/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1874 -
mean_squared_error: 0.1700
Epoch 00270: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1864 -
mean_squared_error: 0.1690 - val_loss: 0.3706 - val_mean_squared_error: 0.3532
Epoch 271/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1717 -
mean_squared_error: 0.1544
Epoch 00271: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1709 -
mean_squared_error: 0.1535 - val_loss: 0.3463 - val_mean_squared_error: 0.3289
Epoch 272/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1775 -
mean_squared_error: 0.1603
Epoch 00272: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1781 -
mean_squared_error: 0.1608 - val_loss: 0.3135 - val_mean_squared_error: 0.2962
Epoch 273/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1663 -
mean_squared_error: 0.1491
Epoch 00273: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 999us/sample - loss: 0.1676 -
mean_squared_error: 0.1504 - val_loss: 0.2666 - val_mean_squared_error: 0.2494
Epoch 274/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1755 -
mean_squared_error: 0.1583
Epoch 00274: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 998us/sample - loss: 0.1815 -
mean_squared_error: 0.1643 - val_loss: 0.2775 - val_mean_squared_error: 0.2603
Epoch 275/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1767 -
mean_squared_error: 0.1596
Epoch 00275: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1771 -
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mean_squared_error: 0.1600 - val_loss: 0.4248 - val_mean_squared_error: 0.4077
Epoch 276/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1948 -
mean_squared_error: 0.1777
Epoch 00276: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1989 -
mean_squared_error: 0.1818 - val_loss: 0.5423 - val_mean_squared_error: 0.5252
Epoch 277/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1674 -
mean_squared_error: 0.1504
Epoch 00277: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1675 -
mean_squared_error: 0.1505 - val_loss: 0.6498 - val_mean_squared_error: 0.6328
Epoch 278/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1707 -
mean_squared_error: 0.1537
Epoch 00278: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1703 -
mean_squared_error: 0.1533 - val_loss: 27296.2455 - val_mean_squared_error:
27296.2285
Epoch 279/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1722 -
mean_squared_error: 0.1552
Epoch 00279: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1716 -
mean_squared_error: 0.1546 - val_loss: 1.7904 - val_mean_squared_error: 1.7735
Epoch 280/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1536 -
mean_squared_error: 0.1368
Epoch 00280: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1571 -
mean_squared_error: 0.1403 - val_loss: 553.6175 - val_mean_squared_error:
553.6008
Epoch 281/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1980 -
mean_squared_error: 0.1814
Epoch 00281: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1985 -
mean_squared_error: 0.1818 - val_loss: 6.3959 - val_mean_squared_error: 6.3792
Epoch 282/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1830 -
mean_squared_error: 0.1664
Epoch 00282: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1849 -
mean_squared_error: 0.1683 - val_loss: 24689.7994 - val_mean_squared_error:
24689.7852
Epoch 283/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1679 -
```

```
mean_squared_error: 0.1513
Epoch 00283: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1698 -
mean_squared_error: 0.1532 - val_loss: 6389.4601 - val_mean_squared_error:
6389.4434
Epoch 284/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1911 -
mean_squared_error: 0.1747
Epoch 00284: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1901 -
mean_squared_error: 0.1736 - val_loss: 1.3793 - val_mean_squared_error: 1.3628
Epoch 285/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1612 -
mean_squared_error: 0.1448
Epoch 00285: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1617 -
mean_squared_error: 0.1453 - val_loss: 204.7930 - val_mean_squared_error:
204.7766
Epoch 286/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1635 -
mean_squared_error: 0.1472
Epoch 00286: ReduceLROnPlateau reducing learning rate to 0.00010890000325161964.

Epoch 00286: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1627 -
mean_squared_error: 0.1464 - val_loss: 16.8000 - val_mean_squared_error: 16.7837
Epoch 287/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1774 -
mean_squared_error: 0.1612
Epoch 00287: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1769 -
mean_squared_error: 0.1607 - val_loss: 542.9626 - val_mean_squared_error:
542.9465
Epoch 288/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1637 -
mean_squared_error: 0.1477
Epoch 00288: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1642 -
mean_squared_error: 0.1482 - val_loss: 806.5094 - val_mean_squared_error:
806.4934
Epoch 289/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1872 -
mean_squared_error: 0.1713
Epoch 00289: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 998us/sample - loss: 0.1882 -
mean_squared_error: 0.1723 - val_loss: 25065.1082 - val_mean_squared_error:
25065.0938
Epoch 290/1000
```

```
6240/6280 [============================>.] - ETA: 0s - loss: 0.1719 -
mean_squared_error: 0.1561
Epoch 00290: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1718 -
mean_squared_error: 0.1560 - val_loss: 574.5785 - val_mean_squared_error:
574.5628
Epoch 291/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1651 -
mean_squared_error: 0.1494
Epoch 00291: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1643 -
mean_squared_error: 0.1486 - val_loss: 5.2973 - val_mean_squared_error: 5.2817
Epoch 292/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1553 -
mean_squared_error: 0.1397
Epoch 00292: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1579 -
mean_squared_error: 0.1423 - val_loss: 25.4065 - val_mean_squared_error: 25.3910
Epoch 293/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1342 -
mean_squared_error: 0.1188
Epoch 00293: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1344 -
mean_squared_error: 0.1189 - val_loss: 0.4541 - val_mean_squared_error: 0.4387
Epoch 294/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.2165 -
mean_squared_error: 0.2012
Epoch 00294: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.2165 -
mean_squared_error: 0.2012 - val_loss: 19697.3536 - val_mean_squared_error:
19697.3398
Epoch 295/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1629 -
mean_squared_error: 0.1477
Epoch 00295: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1641 -
mean_squared_error: 0.1489 - val_loss: 417.4087 - val_mean_squared_error:
417.3935
Epoch 296/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1516 -
mean_squared_error: 0.1364
Epoch 00296: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1515 -
mean_squared_error: 0.1363 - val_loss: 481.0074 - val_mean_squared_error:
480.9924
Epoch 297/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1639 -
mean_squared_error: 0.1488
```

```
Epoch 00297: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1634 -
mean_squared_error: 0.1483 - val_loss: 0.4032 - val_mean_squared_error: 0.3881
Epoch 298/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1465 -
mean_squared_error: 0.1315
Epoch 00298: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1493 -
mean_squared_error: 0.1343 - val_loss: 144.7686 - val_mean_squared_error:
144.7537
Epoch 299/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1614 -
mean_squared_error: 0.1464
Epoch 00299: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1614 -
mean_squared_error: 0.1464 - val_loss: 0.4439 - val_mean_squared_error: 0.4289
Epoch 300/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1823 -
mean_squared_error: 0.1674
Epoch 00300: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1822 -
mean_squared_error: 0.1673 - val_loss: 32379.0467 - val_mean_squared_error:
32379.0293
Epoch 301/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1795 -
mean_squared_error: 0.1647
Epoch 00301: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1811 -
mean_squared_error: 0.1663 - val_loss: 188023.2103 - val_mean_squared_error:
188023.1719
Epoch 302/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1721 -
mean_squared_error: 0.1574
Epoch 00302: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1729 -
mean_squared_error: 0.1582 - val_loss: 193.4154 - val_mean_squared_error:
193.4007
Epoch 303/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1399 -
mean_squared_error: 0.1253
Epoch 00303: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1408 -
mean_squared_error: 0.1262 - val_loss: 0.2940 - val_mean_squared_error: 0.2794
Epoch 304/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1460 -
mean_squared_error: 0.1314
Epoch 00304: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1476 -
```

```
mean_squared_error: 0.1330 - val_loss: 159.1001 - val_mean_squared_error:
159.0855
Epoch 305/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1573 -
mean_squared_error: 0.14 - ETA: 0s - loss: 0.1572 - mean_squared_error: 0.1427
Epoch 00305: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1566 -
mean_squared_error: 0.1421 - val_loss: 0.4507 - val_mean_squared_error: 0.4362
Epoch 306/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1654 -
mean_squared_error: 0.1510
Epoch 00306: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1646 -
mean_squared_error: 0.1502 - val_loss: 0.4298 - val_mean_squared_error: 0.4154
Epoch 307/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1679 -
mean_squared_error: 0.1536
Epoch 00307: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1696 -
mean_squared_error: 0.1553 - val_loss: 0.2431 - val_mean_squared_error: 0.2287
Epoch 308/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1668 -
mean_squared_error: 0.1525
Epoch 00308: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1664 -
mean_squared_error: 0.1521 - val_loss: 0.4120 - val_mean_squared_error: 0.3977
Epoch 309/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1608 -
mean_squared_error: 0.1465
Epoch 00309: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1602 -
mean_squared_error: 0.1459 - val_loss: 2.0215 - val_mean_squared_error: 2.0072
Epoch 310/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1814 -
mean_squared_error: 0.1672
Epoch 00310: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1804 -
mean_squared_error: 0.1662 - val_loss: 4.2711 - val_mean_squared_error: 4.2569
Epoch 311/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1659 -
mean_squared_error: 0.1517 ETA: 1s - loss: 0.167
Epoch 00311: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1650 -
mean_squared_error: 0.1508 - val_loss: 101.0392 - val_mean_squared_error:
101.0251
Epoch 312/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1591 -
mean_squared_error: 0.1450
```

```
Epoch 00312: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1585 -
mean_squared_error: 0.1444 - val_loss: 0.4373 - val_mean_squared_error: 0.4233
Epoch 313/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.1909 -
mean_squared_error: 0.1769
Epoch 00313: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1910 -
mean_squared_error: 0.1770 - val_loss: 0.4591 - val_mean_squared_error: 0.4451
Epoch 314/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.1659 -
mean_squared_error: 0.1519
Epoch 00314: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1672 -
mean_squared_error: 0.1532 - val_loss: 0.2714 - val_mean_squared_error: 0.2574
Epoch 315/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1765 -
mean_squared_error: 0.1625
Epoch 00315: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1776 -
mean_squared_error: 0.1637 - val_loss: 43.7246 - val_mean_squared_error: 43.7107
Epoch 316/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1484 -
mean_squared_error: 0.1345
Epoch 00316: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1491 -
mean_squared_error: 0.1352 - val_loss: 0.6826 - val_mean_squared_error: 0.6687
Epoch 317/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1723 -
mean_squared_error: 0.1585
Epoch 00317: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1715 -
mean_squared_error: 0.1576 - val_loss: 7.5133 - val_mean_squared_error: 7.4995
Epoch 318/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.1830 -
mean_squared_error: 0.1692
Epoch 00318: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1828 -
mean_squared_error: 0.1690 - val_loss: 690.3250 - val_mean_squared_error:
690.3113
Epoch 319/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1704 -
mean_squared_error: 0.1566
Epoch 00319: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1696 -
mean_squared_error: 0.1559 - val_loss: 1.4915 - val_mean_squared_error: 1.4778
Epoch 320/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1417 -
```

```
mean_squared_error: 0.1280
Epoch 00320: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1414 -
mean_squared_error: 0.1277 - val_loss: 0.4945 - val_mean_squared_error: 0.4808
Epoch 321/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.1622 -
mean_squared_error: 0.1486
Epoch 00321: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1620 -
mean_squared_error: 0.1484 - val_loss: 140.7216 - val_mean_squared_error:
140.7080
Epoch 322/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1878 -
mean_squared_error: 0.1742
Epoch 00322: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1871 -
mean_squared_error: 0.1735 - val_loss: 0.7552 - val_mean_squared_error: 0.7416
Epoch 323/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1716 -
mean_squared_error: 0.1580
Epoch 00323: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1727 -
mean_squared_error: 0.1591 - val_loss: 0.2966 - val_mean_squared_error: 0.2831
Epoch 324/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1898 -
mean_squared_error: 0.1763
Epoch 00324: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 6s 1ms/sample - loss: 0.1899 -
mean_squared_error: 0.1764 - val_loss: 1477.2585 - val_mean_squared_error:
1477.2451
Epoch 325/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1612 -
mean_squared_error: 0.1478
Epoch 00325: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1614 -
mean_squared_error: 0.1479 - val_loss: 26.7889 - val_mean_squared_error: 26.7754
Epoch 326/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.1170 -
mean_squared_error: 0.1036
Epoch 00326: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1171 -
mean_squared_error: 0.1037 - val_loss: 1106.9156 - val_mean_squared_error:
1106.9022
Epoch 327/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1526 -
mean_squared_error: 0.1392
Epoch 00327: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1520 -
```

```
mean_squared_error: 0.1386 - val_loss: 0.4308 - val_mean_squared_error: 0.4174
Epoch 328/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1379 -
mean_squared_error: 0.1246
Epoch 00328: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1387 -
mean_squared_error: 0.1254 - val_loss: 655.3349 - val_mean_squared_error:
655.3216
Epoch 329/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.1634 -
mean_squared_error: 0.1501
Epoch 00329: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1639 -
mean_squared_error: 0.1506 - val_loss: 0.4430 - val_mean_squared_error: 0.4298
Epoch 330/1000
6272/6280 [============================>.] - ETA: 0s - loss: 0.1715 -
mean_squared_error: 0.1583
Epoch 00330: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1717 -
mean_squared_error: 0.1585 - val_loss: 498.7526 - val_mean_squared_error:
498.7394
Epoch 331/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1599 -
mean_squared_error: 0.1467
Epoch 00331: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1605 -
mean_squared_error: 0.1473 - val_loss: 0.4343 - val_mean_squared_error: 0.4211
Epoch 332/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1358 -
mean_squared_error: 0.1227
Epoch 00332: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1395 -
mean_squared_error: 0.1264 - val_loss: 733.8852 - val_mean_squared_error:
733.8723
Epoch 333/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1702 -
mean_squared_error: 0.1571
Epoch 00333: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1699 -
mean_squared_error: 0.1568 - val_loss: 18.5915 - val_mean_squared_error: 18.5785
Epoch 334/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1393 -
mean_squared_error: 0.1263
Epoch 00334: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1389 -
mean_squared_error: 0.1259 - val_loss: 0.4094 - val_mean_squared_error: 0.3964
Epoch 335/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1600 -
```

```
mean_squared_error: 0.1471
Epoch 00335: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1594 -
mean_squared_error: 0.1464 - val_loss: 744.4765 - val_mean_squared_error:
744.4636
Epoch 336/1000
6240/6280 [============================>.] - ETA: 0s - loss: 0.1935 -
mean_squared_error: 0.1806Restoring model weights from the end of the best
epoch.

Epoch 00336: ReduceLROnPlateau reducing learning rate to 3.5936999920522795e-05.

Epoch 00336: val_mean_squared_error did not improve from 0.20543
6280/6280 [==============================] - 7s 1ms/sample - loss: 0.1974 -
mean_squared_error: 0.1845 - val_loss: 0.4656 - val_mean_squared_error: 0.4527
Epoch 00336: early stopping
```

And evaluate it:

[19]:
```
# evaluate the model
logprint('Evaluating the model for h11...', logger=logger)
model_ev = model.evaluate(x=matrix_test, y=h11_test, verbose=0)
logprint('Loss: {:.3f}, MSE: {:.3f}'.format(model_ev[0], model_ev[1]),␣
↪logger=logger)

# accuracy of the model
logprint('Accuracy on the validation set: {:.3f}%'.
↪format(accuracy_score(h11_val, model.predict(matrix_val), rounding=np.
↪rint)*100.0), logger=logger)
prediction_score(estimator=model, X=matrix_test, y=h11_test,␣
↪use_best_estimator=False, rounding=np.rint, logger=logger)

# loss function
model_history = model_hst.history

xplots  = 2
yplots  = 1

fig, ax = plt.subplots(yplots, xplots, figsize=(xplots*mpl_width,␣
↪yplots*mpl_height))
fig.tight_layout()

series_plot(ax[0], model_history['loss'],                    title='Loss␣
↪Function', xlabel='Epoch', ylabel='Loss', legend='training')
series_plot(ax[0], model_history['val_loss'],                title='Loss␣
↪Function', xlabel='Epoch', ylabel='Loss', legend='validation')
series_plot(ax[1], model_history['mean_squared_error'],      title='MSE',       ␣
↪   xlabel='Epoch', ylabel='MSE',  legend='training')
```

```
series_plot(ax[1], model_history['val_mean_squared_error'], title='MSE',
 ↪   xlabel='Epoch', ylabel='MSE',  legend='validation')

save_fig('cnn_matrix_h11_history', logger=logger)

plt.show()
plt.close(fig)
```

```
2020-04-18 11:58:41,528 --> INFO: Evaluating the model for h11…
2020-04-18 11:58:41,855 --> INFO: Loss: 0.255, MSE: 0.235
2020-04-18 11:58:42,276 --> INFO: Accuracy on the validation set: 93.121%
2020-04-18 11:58:42,474 --> INFO: Accuracy (rint) of the predictions: 91.603%
2020-04-18 11:58:42,719 --> INFO: Saving
./img/original/cnn_matrix_h11_history.png…
2020-04-18 11:58:42,993 --> INFO: Saved
./img/original/cnn_matrix_h11_history.png!
```

We then plot the error distribution of the model:

[20]:
```
logprint('Plotting error distribution...', logger=logger)
xplots  = 1
yplots  = 1
fig, ax = plt.subplots(yplots, xplots, figsize=(xplots*mpl_width,
 ↪yplots*mpl_height))
fig.tight_layout()

count_plot(ax,
           error_diff(h11_test,
                      model.predict(matrix_test).reshape(-1,),
                      rounding=np.rint),
           title='Error distribution on the test set',
```

```
           xlabel='Difference from real value',
           legend='$h_{11}$'
          )

save_fig('cnn_model_matrix_h11_error', logger=logger)
plt.show()
plt.close(fig)
```

```
2020-04-18 11:58:43,307 --> INFO: Plotting error distribution…
2020-04-18 11:58:44,038 --> INFO: Saving
./img/original/cnn_model_matrix_h11_error.png…
2020-04-18 11:58:44,134 --> INFO: Saved
./img/original/cnn_model_matrix_h11_error.png!
```

We then consider the same approach for h_{21}:

[29]:
```
model    = cnn_matrix_model(input_shape=matrix_train.shape[1:],
                            learning_rate=0.01,
                            conv_kernel_size=(6,6),
```

```
                            conv_filters=[180, 150, 150, 100, 100, 50],
                            conv_kernel_scale=[1, 1, 1, 1, 1, 1],
                            conv_padding='same',
                            fc_neurons=[1000, 1000, 50],
                            dropout_rate=0.2,
                            batch_norm_momentum=0.99,
                            leaky_alpha=0.0,
                            l1_reg=1.0e-5,
                            l2_reg=1.0e-5,
                            last_relu=True
                           )

# print a summary
model.summary()

# plot the model
plot_model(model=model, to_file=path.join(IMG_PATH, 'cnn_matrix_{}.png'.
 ↪format(model.name)), show_shapes=True, show_layer_names=False)
```

```
Adding convolutional layer no. 1 with 180 filters and (6, 6) kernel size…
Adding convolutional layer no. 2 with 150 filters and (6, 6) kernel size…
Adding convolutional layer no. 3 with 150 filters and (6, 6) kernel size…
Adding convolutional layer no. 4 with 100 filters and (6, 6) kernel size…
Adding convolutional layer no. 5 with 100 filters and (6, 6) kernel size…
Adding convolutional layer no. 6 with 50 filters and (6, 6) kernel size…
Adding fully connected layer no. 1 with 1000 units…
Adding fully connected layer no. 2 with 1000 units…
Adding fully connected layer no. 3 with 50 units…
Model: "model_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_4 (InputLayer)         [(None, 12, 15, 1)]       0
_________________________________________________________________
batch_normalization_23 (Batc (None, 12, 15, 1)         4
_________________________________________________________________
conv2d_11 (Conv2D)           (None, 12, 15, 180)       6660
_________________________________________________________________
leaky_re_lu_20 (LeakyReLU)   (None, 12, 15, 180)       0
_________________________________________________________________
batch_normalization_24 (Batc (None, 12, 15, 180)       720
_________________________________________________________________
conv2d_12 (Conv2D)           (None, 12, 15, 150)       972150
_________________________________________________________________
leaky_re_lu_21 (LeakyReLU)   (None, 12, 15, 150)       0
_________________________________________________________________
batch_normalization_25 (Batc (None, 12, 15, 150)       600
```

```
_________________________________________________________________
conv2d_13 (Conv2D)           (None, 12, 15, 150)       810150
_________________________________________________________________
leaky_re_lu_22 (LeakyReLU)   (None, 12, 15, 150)       0
_________________________________________________________________
batch_normalization_26 (Batc (None, 12, 15, 150)       600
_________________________________________________________________
conv2d_14 (Conv2D)           (None, 12, 15, 100)       540100
_________________________________________________________________
leaky_re_lu_23 (LeakyReLU)   (None, 12, 15, 100)       0
_________________________________________________________________
batch_normalization_27 (Batc (None, 12, 15, 100)       400
_________________________________________________________________
conv2d_15 (Conv2D)           (None, 12, 15, 100)       360100
_________________________________________________________________
leaky_re_lu_24 (LeakyReLU)   (None, 12, 15, 100)       0
_________________________________________________________________
batch_normalization_28 (Batc (None, 12, 15, 100)       400
_________________________________________________________________
conv2d_16 (Conv2D)           (None, 12, 15, 50)        180050
_________________________________________________________________
leaky_re_lu_25 (LeakyReLU)   (None, 12, 15, 50)        0
_________________________________________________________________
batch_normalization_29 (Batc (None, 12, 15, 50)        200
_________________________________________________________________
dropout_3 (Dropout)          (None, 12, 15, 50)        0
_________________________________________________________________
flatten_3 (Flatten)          (None, 9000)              0
_________________________________________________________________
dense_12 (Dense)             (None, 1000)              9001000
_________________________________________________________________
leaky_re_lu_26 (LeakyReLU)   (None, 1000)              0
_________________________________________________________________
batch_normalization_30 (Batc (None, 1000)              4000
_________________________________________________________________
dense_13 (Dense)             (None, 1000)              1001000
_________________________________________________________________
leaky_re_lu_27 (LeakyReLU)   (None, 1000)              0
_________________________________________________________________
batch_normalization_31 (Batc (None, 1000)              4000
_________________________________________________________________
dense_14 (Dense)             (None, 50)                50050
_________________________________________________________________
leaky_re_lu_28 (LeakyReLU)   (None, 50)                0
_________________________________________________________________
batch_normalization_32 (Batc (None, 50)                200
_________________________________________________________________
dense_15 (Dense)             (None, 1)                 51
```

```
==================================================================
Total params: 12,932,435
Trainable params: 12,926,873
Non-trainable params: 5,562
------------------------------------------------------------------
```

[29]:

And finally we fit the model:

[30]:
```
# define the callbacks (NB: with restore_best_weights we do not need to reload␣
↪the model for evaluation)
callbacks=[EarlyStopping(monitor='val_mean_squared_error', patience=100,␣
↪verbose=1, restore_best_weights=True),
           ReduceLROnPlateau(monitor='val_mean_squared_error', factor=0.33,␣
↪patience=50, verbose=1),
           ModelCheckpoint(monitor='val_mean_squared_error', filepath=path.
↪join(MOD_PATH, 'cnn_model_matrix_h21.h5'), verbose=1, save_best_only=True)
          ]

# fit the model
logprint('Training the model for h21...', logger=logger)
model_hst = model.fit(x=matrix_train, y=h21_train,
                      validation_data=(matrix_val, h21_val),
                      batch_size=32, epochs=1000,
                      verbose=1,
                      callbacks=callbacks
                     )
```

```
2020-04-18 16:24:27,655 --> INFO: Training the model for h21…
Train on 6280 samples, validate on 785 samples
Epoch 1/1000
6272/6280 [============================>.] - ETA: 0s - loss: 519.0543 -
mean_squared_error: 518.6624
Epoch 00001: val_mean_squared_error improved from inf to 554.12366, saving model
to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 52s 8ms/sample - loss: 518.7595 -
mean_squared_error: 518.3675 - val_loss: 554.5506 - val_mean_squared_error:
554.1237
Epoch 2/1000
6272/6280 [============================>.] - ETA: 0s - loss: 237.0781 -
mean_squared_error: 236.6119
Epoch 00002: val_mean_squared_error did not improve from 554.12366
6280/6280 [==============================] - 48s 8ms/sample - loss: 236.9245 -
mean_squared_error: 236.4582 - val_loss: 882.0181 - val_mean_squared_error:
881.5108
Epoch 3/1000
6272/6280 [============================>.] - ETA: 0s - loss: 105.4305 -
mean_squared_error: 104.8989
Epoch 00003: val_mean_squared_error improved from 554.12366 to 289.30017, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 105.5700 -
mean_squared_error: 105.0384 - val_loss: 289.8544 - val_mean_squared_error:
```

```
289.3002
Epoch 4/1000
6272/6280 [============================>.] - ETA: 0s - loss: 76.8962 -
mean_squared_error: 76.3134
Epoch 00004: val_mean_squared_error improved from 289.30017 to 152.33475, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 77.6966 -
mean_squared_error: 77.1138 - val_loss: 152.9472 - val_mean_squared_error:
152.3347
Epoch 5/1000
6272/6280 [============================>.] - ETA: 0s - loss: 60.4639 -
mean_squared_error: 59.8313
Epoch 00005: val_mean_squared_error did not improve from 152.33475
6280/6280 [==============================] - 48s 8ms/sample - loss: 60.5668 -
mean_squared_error: 59.9343 - val_loss: 689.8215 - val_mean_squared_error:
689.1658
Epoch 6/1000
6272/6280 [============================>.] - ETA: 0s - loss: 49.0056 -
mean_squared_error: 48.3351
Epoch 00006: val_mean_squared_error improved from 152.33475 to 50.60553, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 49.2425 -
mean_squared_error: 48.5720 - val_loss: 51.2975 - val_mean_squared_error:
50.6055
Epoch 7/1000
6272/6280 [============================>.] - ETA: 0s - loss: 44.4308 -
mean_squared_error: 43.7188
Epoch 00007: val_mean_squared_error did not improve from 50.60553
6280/6280 [==============================] - 47s 8ms/sample - loss: 44.5601 -
mean_squared_error: 43.8482 - val_loss: 488.0393 - val_mean_squared_error:
487.3033
Epoch 8/1000
6272/6280 [============================>.] - ETA: 0s - loss: 42.8713 -
mean_squared_error: 42.1276
Epoch 00008: val_mean_squared_error did not improve from 50.60553
6280/6280 [==============================] - 47s 8ms/sample - loss: 42.9025 -
mean_squared_error: 42.1588 - val_loss: 306.3681 - val_mean_squared_error:
305.6129
Epoch 9/1000
6272/6280 [============================>.] - ETA: 0s - loss: 61.0543 -
mean_squared_error: 60.2745
Epoch 00009: val_mean_squared_error did not improve from 50.60553
6280/6280 [==============================] - 48s 8ms/sample - loss: 61.0260 -
mean_squared_error: 60.2463 - val_loss: 70.0193 - val_mean_squared_error:
69.2239
Epoch 10/1000
6272/6280 [============================>.] - ETA: 0s - loss: 26.3570 -
mean_squared_error: 25.5500
```

```
Epoch 00010: val_mean_squared_error improved from 50.60553 to 28.77942, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 26.3843 -
mean_squared_error: 25.5773 - val_loss: 29.5854 - val_mean_squared_error:
28.7794
Epoch 11/1000
6272/6280 [============================>.] - ETA: 0s - loss: 14.7126 -
mean_squared_error: 13.9083
Epoch 00011: val_mean_squared_error improved from 28.77942 to 25.89793, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 14.7138 -
mean_squared_error: 13.9095 - val_loss: 26.6978 - val_mean_squared_error:
25.8979
Epoch 12/1000
6272/6280 [============================>.] - ETA: 0s - loss: 13.6883 -
mean_squared_error: 12.8866
Epoch 00012: val_mean_squared_error did not improve from 25.89793
6280/6280 [==============================] - 48s 8ms/sample - loss: 13.6952 -
mean_squared_error: 12.8935 - val_loss: 58.4823 - val_mean_squared_error:
57.6908
Epoch 13/1000
6272/6280 [============================>.] - ETA: 0s - loss: 13.0343 -
mean_squared_error: 12.2504
Epoch 00013: val_mean_squared_error improved from 25.89793 to 13.56064, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 13.0229 -
mean_squared_error: 12.2389 - val_loss: 14.3374 - val_mean_squared_error:
13.5606
Epoch 14/1000
6272/6280 [============================>.] - ETA: 0s - loss: 12.0845 -
mean_squared_error: 11.3017
Epoch 00014: val_mean_squared_error did not improve from 13.56064
6280/6280 [==============================] - 48s 8ms/sample - loss: 12.0853 -
mean_squared_error: 11.3025 - val_loss: 30.6736 - val_mean_squared_error:
29.8915
Epoch 15/1000
6272/6280 [============================>.] - ETA: 0s - loss: 10.4748 -
mean_squared_error: 9.6929
Epoch 00015: val_mean_squared_error did not improve from 13.56064
6280/6280 [==============================] - 48s 8ms/sample - loss: 10.4723 -
mean_squared_error: 9.6903 - val_loss: 22.7490 - val_mean_squared_error: 21.9758
Epoch 16/1000
6272/6280 [============================>.] - ETA: 0s - loss: 10.0482 -
mean_squared_error: 9.2740
Epoch 00016: val_mean_squared_error improved from 13.56064 to 11.74744, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 10.0686 -
mean_squared_error: 9.2944 - val_loss: 12.5204 - val_mean_squared_error: 11.7474
```

```
Epoch 17/1000
6272/6280 [============================>.] - ETA: 0s - loss: 15.0957 -
mean_squared_error: 14.3099
Epoch 00017: val_mean_squared_error improved from 11.74744 to 10.08927, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 15.1191 -
mean_squared_error: 14.3333 - val_loss: 10.8805 - val_mean_squared_error:
10.0893
Epoch 18/1000
6272/6280 [============================>.] - ETA: 0s - loss: 9.2147 -
mean_squared_error: 8.4328
Epoch 00018: val_mean_squared_error did not improve from 10.08927
6280/6280 [==============================] - 47s 8ms/sample - loss: 9.2228 -
mean_squared_error: 8.4409 - val_loss: 28.0817 - val_mean_squared_error: 27.3071
Epoch 19/1000
6272/6280 [============================>.] - ETA: 0s - loss: 8.3108 -
mean_squared_error: 7.5414
Epoch 00019: val_mean_squared_error improved from 10.08927 to 6.36568, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 8.3111 -
mean_squared_error: 7.5417 - val_loss: 7.1363 - val_mean_squared_error: 6.3657
Epoch 20/1000
6272/6280 [============================>.] - ETA: 0s - loss: 8.1371 -
mean_squared_error: 7.3726
Epoch 00020: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 8.1868 -
mean_squared_error: 7.4223 - val_loss: 9.6798 - val_mean_squared_error: 8.9191
Epoch 21/1000
6272/6280 [============================>.] - ETA: 0s - loss: 8.3573 -
mean_squared_error: 7.6055
Epoch 00021: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 8.3846 -
mean_squared_error: 7.6328 - val_loss: 91.2391 - val_mean_squared_error: 90.4778
Epoch 22/1000
6272/6280 [============================>.] - ETA: 0s - loss: 7.0512 -
mean_squared_error: 6.2994
Epoch 00022: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 7.0495 -
mean_squared_error: 6.2977 - val_loss: 8.8185 - val_mean_squared_error: 8.0712
Epoch 23/1000
6272/6280 [============================>.] - ETA: 0s - loss: 7.1477 -
mean_squared_error: 6.4091
Epoch 00023: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 7.1545 -
mean_squared_error: 6.4159 - val_loss: 63.6589 - val_mean_squared_error: 62.9271
Epoch 24/1000
6272/6280 [============================>.] - ETA: 0s - loss: 7.1666 -
mean_squared_error: 6.4390
```

```
Epoch 00024: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 7.1706 -
mean_squared_error: 6.4430 - val_loss: 13.8584 - val_mean_squared_error: 13.1307
Epoch 25/1000
6272/6280 [============================>.] - ETA: 0s - loss: 6.7446 -
mean_squared_error: 6.0241
Epoch 00025: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 6.7469 -
mean_squared_error: 6.0265 - val_loss: 7.2843 - val_mean_squared_error: 6.5672
Epoch 26/1000
6272/6280 [============================>.] - ETA: 0s - loss: 6.2860 -
mean_squared_error: 5.5753
Epoch 00026: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 6.2852 -
mean_squared_error: 5.5745 - val_loss: 10.2626 - val_mean_squared_error: 9.5528
Epoch 27/1000
6272/6280 [============================>.] - ETA: 0s - loss: 5.9022 -
mean_squared_error: 5.1999
Epoch 00027: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 5.8980 -
mean_squared_error: 5.1956 - val_loss: 12.8776 - val_mean_squared_error: 12.1770
Epoch 28/1000
6272/6280 [============================>.] - ETA: 0s - loss: 7.0988 -
mean_squared_error: 6.4064
Epoch 00028: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 7.1031 -
mean_squared_error: 6.4108 - val_loss: 14.2328 - val_mean_squared_error: 13.5449
Epoch 29/1000
6272/6280 [============================>.] - ETA: 0s - loss: 6.0001 -
mean_squared_error: 5.3045
Epoch 00029: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 6.0140 -
mean_squared_error: 5.3184 - val_loss: 48.1207 - val_mean_squared_error: 47.4282
Epoch 30/1000
6272/6280 [============================>.] - ETA: 0s - loss: 5.6922 -
mean_squared_error: 5.0073
Epoch 00030: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 5.7982 -
mean_squared_error: 5.1133 - val_loss: 15.0472 - val_mean_squared_error: 14.3545
Epoch 31/1000
6272/6280 [============================>.] - ETA: 0s - loss: 5.4392 -
mean_squared_error: 4.7644
Epoch 00031: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 5.4502 -
mean_squared_error: 4.7754 - val_loss: 20.8541 - val_mean_squared_error: 20.1812
Epoch 32/1000
6272/6280 [============================>.] - ETA: 0s - loss: 5.9241 -
mean_squared_error: 5.2589
```

```
Epoch 00032: val_mean_squared_error did not improve from 6.36568
6280/6280 [==============================] - 47s 8ms/sample - loss: 5.9245 -
mean_squared_error: 5.2593 - val_loss: 16.4097 - val_mean_squared_error: 15.7499
Epoch 33/1000
6272/6280 [============================>.] - ETA: 0s - loss: 5.1971 -
mean_squared_error: 4.5400
Epoch 00033: val_mean_squared_error improved from 6.36568 to 5.68225, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 5.1948 -
mean_squared_error: 4.5377 - val_loss: 6.3361 - val_mean_squared_error: 5.6822
Epoch 34/1000
6272/6280 [============================>.] - ETA: 0s - loss: 5.1054 -
mean_squared_error: 4.4601
Epoch 00034: val_mean_squared_error did not improve from 5.68225
6280/6280 [==============================] - 47s 8ms/sample - loss: 5.1441 -
mean_squared_error: 4.4988 - val_loss: 84.9175 - val_mean_squared_error: 84.2652
Epoch 35/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.8457 -
mean_squared_error: 4.2095
Epoch 00035: val_mean_squared_error improved from 5.68225 to 4.85112, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 4.8442 -
mean_squared_error: 4.2080 - val_loss: 5.4848 - val_mean_squared_error: 4.8511
Epoch 36/1000
6272/6280 [============================>.] - ETA: 0s - loss: 5.2549 -
mean_squared_error: 4.6287
Epoch 00036: val_mean_squared_error did not improve from 4.85112
6280/6280 [==============================] - 47s 8ms/sample - loss: 5.2662 -
mean_squared_error: 4.6400 - val_loss: 24.2246 - val_mean_squared_error: 23.6020
Epoch 37/1000
6272/6280 [============================>.] - ETA: 0s - loss: 5.9885 -
mean_squared_error: 5.3740
Epoch 00037: val_mean_squared_error improved from 4.85112 to 3.48377, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 5.9841 -
mean_squared_error: 5.3696 - val_loss: 4.0894 - val_mean_squared_error: 3.4838
Epoch 38/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.5803 -
mean_squared_error: 3.9807
Epoch 00038: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.6210 -
mean_squared_error: 4.0213 - val_loss: 11.4671 - val_mean_squared_error: 10.8670
Epoch 39/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.8939 -
mean_squared_error: 4.3069
Epoch 00039: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.8970 -
mean_squared_error: 4.3100 - val_loss: 16.1941 - val_mean_squared_error: 15.6095
```

```
Epoch 40/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.7708 -
mean_squared_error: 4.1877
Epoch 00040: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.7946 -
mean_squared_error: 4.2114 - val_loss: 15.4268 - val_mean_squared_error: 14.8256
Epoch 41/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.3581 -
mean_squared_error: 3.7776
Epoch 00041: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.3557 -
mean_squared_error: 3.7752 - val_loss: 7.3008 - val_mean_squared_error: 6.7279
Epoch 42/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.4747 -
mean_squared_error: 3.9069
Epoch 00042: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.4707 -
mean_squared_error: 3.9029 - val_loss: 16.4197 - val_mean_squared_error: 15.8475
Epoch 43/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.1331 -
mean_squared_error: 3.5754
Epoch 00043: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.1364 -
mean_squared_error: 3.5787 - val_loss: 9.4248 - val_mean_squared_error: 8.8715
Epoch 44/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.1911 -
mean_squared_error: 3.6472
Epoch 00044: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.1917 -
mean_squared_error: 3.6478 - val_loss: 4.7076 - val_mean_squared_error: 4.1631
Epoch 45/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.4917 -
mean_squared_error: 3.9554
Epoch 00045: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.5414 -
mean_squared_error: 4.0051 - val_loss: 50.3645 - val_mean_squared_error: 49.8291
Epoch 46/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.2429 -
mean_squared_error: 3.7053
Epoch 00046: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.2396 -
mean_squared_error: 3.7020 - val_loss: 8.5560 - val_mean_squared_error: 8.0269
Epoch 47/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.1852 -
mean_squared_error: 3.6578
Epoch 00047: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.1954 -
mean_squared_error: 3.6680 - val_loss: 16.1716 - val_mean_squared_error: 15.6460
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Epoch 48/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.9043 -
mean_squared_error: 3.3851
Epoch 00048: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.9016 -
mean_squared_error: 3.3823 - val_loss: 7.6574 - val_mean_squared_error: 7.1381
Epoch 49/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.0059 -
mean_squared_error: 3.4933
Epoch 00049: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.0244 -
mean_squared_error: 3.5118 - val_loss: 6.2778 - val_mean_squared_error: 5.7608
Epoch 50/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.5518 -
mean_squared_error: 4.0465
Epoch 00050: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.5473 -
mean_squared_error: 4.0421 - val_loss: 5.8789 - val_mean_squared_error: 5.3751
Epoch 51/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.1678 -
mean_squared_error: 3.6703
Epoch 00051: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.1644 -
mean_squared_error: 3.6669 - val_loss: 4.1089 - val_mean_squared_error: 3.6123
Epoch 52/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.0048 -
mean_squared_error: 3.5120
Epoch 00052: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.0010 -
mean_squared_error: 3.5082 - val_loss: 4.5302 - val_mean_squared_error: 4.0449
Epoch 53/1000
6272/6280 [============================>.] - ETA: 0s - loss: 10.5322 -
mean_squared_error: 10.0229
Epoch 00053: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 10.5390 -
mean_squared_error: 10.0297 - val_loss: 43.0323 - val_mean_squared_error:
42.4838
Epoch 54/1000
6272/6280 [============================>.] - ETA: 0s - loss: 6.9079 -
mean_squared_error: 6.3670
Epoch 00054: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 6.9103 -
mean_squared_error: 6.3693 - val_loss: 7.0732 - val_mean_squared_error: 6.5401
Epoch 55/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.9402 -
mean_squared_error: 3.4208
Epoch 00055: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.9465 -
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mean_squared_error: 3.4271 - val_loss: 4.8449 - val_mean_squared_error: 4.3392
Epoch 56/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.7433 -
mean_squared_error: 3.2489
Epoch 00056: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.7496 -
mean_squared_error: 3.2551 - val_loss: 8.6203 - val_mean_squared_error: 8.1305
Epoch 57/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.8853 -
mean_squared_error: 3.4021
Epoch 00057: val_mean_squared_error did not improve from 3.48377
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.8851 -
mean_squared_error: 3.4019 - val_loss: 8.1730 - val_mean_squared_error: 7.6947
Epoch 58/1000
6272/6280 [============================>.] - ETA: 0s - loss: 7.0088 -
mean_squared_error: 6.5256
Epoch 00058: val_mean_squared_error improved from 3.48377 to 3.41924, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 7.0039 -
mean_squared_error: 6.5207 - val_loss: 3.8973 - val_mean_squared_error: 3.4192
Epoch 59/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.3439 -
mean_squared_error: 2.8687
Epoch 00059: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.3421 -
mean_squared_error: 2.8668 - val_loss: 21.2812 - val_mean_squared_error: 20.8018
Epoch 60/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.5842 -
mean_squared_error: 3.1166
Epoch 00060: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.5824 -
mean_squared_error: 3.1148 - val_loss: 6.7299 - val_mean_squared_error: 6.2663
Epoch 61/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.5213 -
mean_squared_error: 3.0622
Epoch 00061: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.5201 -
mean_squared_error: 3.0611 - val_loss: 4.0436 - val_mean_squared_error: 3.5836
Epoch 62/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.5649 -
mean_squared_error: 3.1101
Epoch 00062: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.5734 -
mean_squared_error: 3.1185 - val_loss: 13.5524 - val_mean_squared_error: 13.0954
Epoch 63/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.8370 -
mean_squared_error: 3.3881
Epoch 00063: val_mean_squared_error did not improve from 3.41924
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6280/6280 [==============================] - 47s 8ms/sample - loss: 3.8460 -
mean_squared_error: 3.3972 - val_loss: 4.7139 - val_mean_squared_error: 4.2680
Epoch 64/1000
6272/6280 [============================>.] - ETA: 0s - loss: 5.8851 -
mean_squared_error: 5.4384
Epoch 00064: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 5.9085 -
mean_squared_error: 5.4618 - val_loss: 5.8227 - val_mean_squared_error: 5.3741
Epoch 65/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.2207 -
mean_squared_error: 3.7770
Epoch 00065: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.2223 -
mean_squared_error: 3.7786 - val_loss: 3.9672 - val_mean_squared_error: 3.5281
Epoch 66/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.4325 -
mean_squared_error: 2.9916
Epoch 00066: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.4315 -
mean_squared_error: 2.9907 - val_loss: 4.8373 - val_mean_squared_error: 4.4007
Epoch 67/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.7578 -
mean_squared_error: 3.3227
Epoch 00067: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.7657 -
mean_squared_error: 3.3307 - val_loss: 3.9140 - val_mean_squared_error: 3.4824
Epoch 68/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.5568 -
mean_squared_error: 3.1273
Epoch 00068: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.5543 -
mean_squared_error: 3.1249 - val_loss: 7.0915 - val_mean_squared_error: 6.6632
Epoch 69/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2861 -
mean_squared_error: 2.8607
Epoch 00069: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2967 -
mean_squared_error: 2.8714 - val_loss: 5.3118 - val_mean_squared_error: 4.8869
Epoch 70/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.3026 -
mean_squared_error: 3.8758
Epoch 00070: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.3186 -
mean_squared_error: 3.8918 - val_loss: 6.5038 - val_mean_squared_error: 6.0577
Epoch 71/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.9863 -
mean_squared_error: 4.5358
Epoch 00071: val_mean_squared_error did not improve from 3.41924
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6280/6280 [==============================] - 47s 8ms/sample - loss: 5.0186 -
mean_squared_error: 4.5681 - val_loss: 5.7210 - val_mean_squared_error: 5.2741
Epoch 72/1000
6272/6280 [============================>.] - ETA: 0s - loss: 4.2147 -
mean_squared_error: 3.7746
Epoch 00072: val_mean_squared_error did not improve from 3.41924
6280/6280 [==============================] - 47s 8ms/sample - loss: 4.2147 -
mean_squared_error: 3.7747 - val_loss: 5.0570 - val_mean_squared_error: 4.6259
Epoch 73/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.4677 -
mean_squared_error: 3.0435
Epoch 00073: val_mean_squared_error improved from 3.41924 to 3.20642, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.4688 -
mean_squared_error: 3.0446 - val_loss: 3.6283 - val_mean_squared_error: 3.2064
Epoch 74/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.3157 -
mean_squared_error: 2.8969
Epoch 00074: val_mean_squared_error improved from 3.20642 to 3.14050, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.3359 -
mean_squared_error: 2.9171 - val_loss: 3.5593 - val_mean_squared_error: 3.1405
Epoch 75/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.6880 -
mean_squared_error: 3.2754
Epoch 00075: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.6874 -
mean_squared_error: 3.2748 - val_loss: 4.2949 - val_mean_squared_error: 3.8849
Epoch 76/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.6280 -
mean_squared_error: 3.2178
Epoch 00076: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.6687 -
mean_squared_error: 3.2584 - val_loss: 9.4501 - val_mean_squared_error: 9.0357
Epoch 77/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.5150 -
mean_squared_error: 3.1071
Epoch 00077: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.5138 -
mean_squared_error: 3.1060 - val_loss: 3.6720 - val_mean_squared_error: 3.2661
Epoch 78/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.6043 -
mean_squared_error: 3.2009
Epoch 00078: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.6299 -
mean_squared_error: 3.2265 - val_loss: 9.5584 - val_mean_squared_error: 9.1543
Epoch 79/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.3875 -
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mean_squared_error: 2.9883
Epoch 00079: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.3849 -
mean_squared_error: 2.9857 - val_loss: 3.5966 - val_mean_squared_error: 3.1979
Epoch 80/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.4017 -
mean_squared_error: 3.0055
Epoch 00080: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.4105 -
mean_squared_error: 3.0143 - val_loss: 4.3120 - val_mean_squared_error: 3.9158
Epoch 81/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.5565 -
mean_squared_error: 3.1598
Epoch 00081: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.5723 -
mean_squared_error: 3.1756 - val_loss: 5.1833 - val_mean_squared_error: 4.7868
Epoch 82/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0692 -
mean_squared_error: 2.6779
Epoch 00082: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.0826 -
mean_squared_error: 2.6913 - val_loss: 5.7374 - val_mean_squared_error: 5.3435
Epoch 83/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2774 -
mean_squared_error: 2.8882
Epoch 00083: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.3518 -
mean_squared_error: 2.9625 - val_loss: 4.2581 - val_mean_squared_error: 3.8670
Epoch 84/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2170 -
mean_squared_error: 2.8319
Epoch 00084: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2233 -
mean_squared_error: 2.8381 - val_loss: 5.7512 - val_mean_squared_error: 5.3692
Epoch 85/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.6499 -
mean_squared_error: 3.2683
Epoch 00085: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.6883 -
mean_squared_error: 3.3067 - val_loss: 6.0599 - val_mean_squared_error: 5.6768
Epoch 86/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2440 -
mean_squared_error: 2.8652
Epoch 00086: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2809 -
mean_squared_error: 2.9020 - val_loss: 5.1710 - val_mean_squared_error: 4.7901
Epoch 87/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.3293 -
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mean_squared_error: 2.9522
Epoch 00087: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.3283 -
mean_squared_error: 2.9512 - val_loss: 3.9273 - val_mean_squared_error: 3.5511
Epoch 88/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.3434 -
mean_squared_error: 2.9672
Epoch 00088: val_mean_squared_error did not improve from 3.14050
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.3514 -
mean_squared_error: 2.9752 - val_loss: 9.3354 - val_mean_squared_error: 8.9555
Epoch 89/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0459 -
mean_squared_error: 2.6725
Epoch 00089: val_mean_squared_error improved from 3.14050 to 3.13180, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.0891 -
mean_squared_error: 2.7156 - val_loss: 3.5043 - val_mean_squared_error: 3.1318
Epoch 90/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0616 -
mean_squared_error: 2.6916
Epoch 00090: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.0596 -
mean_squared_error: 2.6896 - val_loss: 4.7855 - val_mean_squared_error: 4.4162
Epoch 91/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.6745 -
mean_squared_error: 3.3069
Epoch 00091: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.6901 -
mean_squared_error: 3.3226 - val_loss: 4.0792 - val_mean_squared_error: 3.7127
Epoch 92/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9190 -
mean_squared_error: 2.5540
Epoch 00092: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.9203 -
mean_squared_error: 2.5553 - val_loss: 4.2414 - val_mean_squared_error: 3.8772
Epoch 93/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7608 -
mean_squared_error: 2.3990
Epoch 00093: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7582 -
mean_squared_error: 2.3964 - val_loss: 3.5270 - val_mean_squared_error: 3.1666
Epoch 94/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2213 -
mean_squared_error: 2.8616
Epoch 00094: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2210 -
mean_squared_error: 2.8613 - val_loss: 4.0204 - val_mean_squared_error: 3.6622
Epoch 95/1000
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6272/6280 [============================>.] - ETA: 0s - loss: 3.1270 -
mean_squared_error: 2.7658
Epoch 00095: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.1261 -
mean_squared_error: 2.7650 - val_loss: 4.0670 - val_mean_squared_error: 3.7079
Epoch 96/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2196 -
mean_squared_error: 2.8619
Epoch 00096: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2429 -
mean_squared_error: 2.8852 - val_loss: 3.8440 - val_mean_squared_error: 3.4883
Epoch 97/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9657 -
mean_squared_error: 2.6115
Epoch 00097: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.9715 -
mean_squared_error: 2.6172 - val_loss: 5.7607 - val_mean_squared_error: 5.4062
Epoch 98/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9448 -
mean_squared_error: 2.5922
Epoch 00098: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.9512 -
mean_squared_error: 2.5986 - val_loss: 3.5365 - val_mean_squared_error: 3.1848
Epoch 99/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7011 -
mean_squared_error: 2.3513
Epoch 00099: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7193 -
mean_squared_error: 2.3695 - val_loss: 4.2001 - val_mean_squared_error: 3.8512
Epoch 100/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0094 -
mean_squared_error: 2.6615
Epoch 00100: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.0095 -
mean_squared_error: 2.6616 - val_loss: 3.7077 - val_mean_squared_error: 3.3594
Epoch 101/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9140 -
mean_squared_error: 2.5681
Epoch 00101: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.9135 -
mean_squared_error: 2.5676 - val_loss: 7.2989 - val_mean_squared_error: 6.9528
Epoch 102/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2805 -
mean_squared_error: 2.9361
Epoch 00102: val_mean_squared_error did not improve from 3.13180
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.3122 -
mean_squared_error: 2.9679 - val_loss: 8.3276 - val_mean_squared_error: 7.9810
Epoch 103/1000
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6272/6280 [============================>.] - ETA: 0s - loss: 3.3046 -
mean_squared_error: 2.9621
Epoch 00103: val_mean_squared_error improved from 3.13180 to 2.79921, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.3019 -
mean_squared_error: 2.9594 - val_loss: 3.1410 - val_mean_squared_error: 2.7992
Epoch 104/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1270 -
mean_squared_error: 2.7862
Epoch 00104: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.1403 -
mean_squared_error: 2.7994 - val_loss: 5.4040 - val_mean_squared_error: 5.0605
Epoch 105/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1998 -
mean_squared_error: 2.8601
Epoch 00105: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.1994 -
mean_squared_error: 2.8597 - val_loss: 4.6399 - val_mean_squared_error: 4.3003
Epoch 106/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2423 -
mean_squared_error: 2.9045
Epoch 00106: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2599 -
mean_squared_error: 2.9221 - val_loss: 5.8711 - val_mean_squared_error: 5.5296
Epoch 107/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0580 -
mean_squared_error: 2.7186
Epoch 00107: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.0571 -
mean_squared_error: 2.7177 - val_loss: 3.8359 - val_mean_squared_error: 3.4974
Epoch 108/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8730 -
mean_squared_error: 2.5370
Epoch 00108: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8835 -
mean_squared_error: 2.5475 - val_loss: 4.3032 - val_mean_squared_error: 3.9667
Epoch 109/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2034 -
mean_squared_error: 2.8695
Epoch 00109: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2197 -
mean_squared_error: 2.8858 - val_loss: 3.9258 - val_mean_squared_error: 3.5910
Epoch 110/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6120 -
mean_squared_error: 2.2792
Epoch 00110: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6363 -
mean_squared_error: 2.3035 - val_loss: 4.4938 - val_mean_squared_error: 4.1615
```

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Epoch 111/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1175 -
mean_squared_error: 2.7850
Epoch 00111: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.1185 -
mean_squared_error: 2.7860 - val_loss: 3.8569 - val_mean_squared_error: 3.5256
Epoch 112/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8303 -
mean_squared_error: 2.5009
Epoch 00112: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8284 -
mean_squared_error: 2.4990 - val_loss: 4.7712 - val_mean_squared_error: 4.4423
Epoch 113/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2677 -
mean_squared_error: 2.9399
Epoch 00113: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2730 -
mean_squared_error: 2.9452 - val_loss: 6.1921 - val_mean_squared_error: 5.8637
Epoch 114/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0290 -
mean_squared_error: 2.7018
Epoch 00114: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.0302 -
mean_squared_error: 2.7030 - val_loss: 3.5397 - val_mean_squared_error: 3.2117
Epoch 115/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.3110 -
mean_squared_error: 2.9844
Epoch 00115: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.3181 -
mean_squared_error: 2.9914 - val_loss: 4.0841 - val_mean_squared_error: 3.7574
Epoch 116/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1221 -
mean_squared_error: 2.7977
Epoch 00116: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.1560 -
mean_squared_error: 2.8315 - val_loss: 8.5149 - val_mean_squared_error: 8.1884
Epoch 117/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7341 -
mean_squared_error: 2.4105
Epoch 00117: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7327 -
mean_squared_error: 2.4091 - val_loss: 4.2270 - val_mean_squared_error: 3.9034
Epoch 118/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8778 -
mean_squared_error: 2.5557
Epoch 00118: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8777 -
mean_squared_error: 2.5555 - val_loss: 3.2670 - val_mean_squared_error: 2.9448
```

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Epoch 119/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.4642 -
mean_squared_error: 3.1433
Epoch 00119: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.4623 -
mean_squared_error: 3.1414 - val_loss: 9.1874 - val_mean_squared_error: 8.8676
Epoch 120/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8198 -
mean_squared_error: 2.4996
Epoch 00120: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.8364 -
mean_squared_error: 2.5162 - val_loss: 4.4204 - val_mean_squared_error: 4.1007
Epoch 121/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9670 -
mean_squared_error: 2.6489
Epoch 00121: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.9643 -
mean_squared_error: 2.6461 - val_loss: 9.2437 - val_mean_squared_error: 8.9258
Epoch 122/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0453 -
mean_squared_error: 2.7271
Epoch 00122: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.1180 -
mean_squared_error: 2.7998 - val_loss: 12.3516 - val_mean_squared_error: 12.0271
Epoch 123/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0054 -
mean_squared_error: 2.6885
Epoch 00123: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.0211 -
mean_squared_error: 2.7042 - val_loss: 7.8932 - val_mean_squared_error: 7.5758
Epoch 124/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7417 -
mean_squared_error: 2.4266
Epoch 00124: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7964 -
mean_squared_error: 2.4813 - val_loss: 6.4061 - val_mean_squared_error: 6.0909
Epoch 125/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0067 -
mean_squared_error: 2.6931
Epoch 00125: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.0428 -
mean_squared_error: 2.7292 - val_loss: 4.5060 - val_mean_squared_error: 4.1895
Epoch 126/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2312 -
mean_squared_error: 2.9176
Epoch 00126: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.2588 -
mean_squared_error: 2.9452 - val_loss: 3.5690 - val_mean_squared_error: 3.2565
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Epoch 127/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.3541 -
mean_squared_error: 3.0418
Epoch 00127: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.3507 -
mean_squared_error: 3.0384 - val_loss: 3.8951 - val_mean_squared_error: 3.5839
Epoch 128/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7429 -
mean_squared_error: 2.4318
Epoch 00128: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7645 -
mean_squared_error: 2.4534 - val_loss: 4.8294 - val_mean_squared_error: 4.5186
Epoch 129/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9878 -
mean_squared_error: 2.6774
Epoch 00129: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.9879 -
mean_squared_error: 2.6774 - val_loss: 4.4248 - val_mean_squared_error: 4.1124
Epoch 130/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7375 -
mean_squared_error: 2.4283
Epoch 00130: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7364 -
mean_squared_error: 2.4273 - val_loss: 3.2453 - val_mean_squared_error: 2.9368
Epoch 131/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8750 -
mean_squared_error: 2.5677
Epoch 00131: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8719 -
mean_squared_error: 2.5646 - val_loss: 3.6733 - val_mean_squared_error: 3.3670
Epoch 132/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0829 -
mean_squared_error: 2.7749
Epoch 00132: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.0982 -
mean_squared_error: 2.7901 - val_loss: 3.3880 - val_mean_squared_error: 3.0811
Epoch 133/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.6515 -
mean_squared_error: 3.3454
Epoch 00133: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.6680 -
mean_squared_error: 3.3619 - val_loss: 6.0358 - val_mean_squared_error: 5.7288
Epoch 134/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8505 -
mean_squared_error: 2.5455
Epoch 00134: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.8477 -
mean_squared_error: 2.5427 - val_loss: 3.5709 - val_mean_squared_error: 3.2665
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Epoch 135/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1346 -
mean_squared_error: 2.8314
Epoch 00135: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.1356 -
mean_squared_error: 2.8324 - val_loss: 3.3954 - val_mean_squared_error: 3.0929
Epoch 136/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1842 -
mean_squared_error: 2.8821
Epoch 00136: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.1988 -
mean_squared_error: 2.8967 - val_loss: 3.6331 - val_mean_squared_error: 3.3308
Epoch 137/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.4853 -
mean_squared_error: 3.1839
Epoch 00137: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.4817 -
mean_squared_error: 3.1803 - val_loss: 3.7756 - val_mean_squared_error: 3.4737
Epoch 138/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5205 -
mean_squared_error: 2.2199
Epoch 00138: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5186 -
mean_squared_error: 2.2180 - val_loss: 5.0825 - val_mean_squared_error: 4.7807
Epoch 139/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8448 -
mean_squared_error: 2.5450
Epoch 00139: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.8446 -
mean_squared_error: 2.5448 - val_loss: 3.7109 - val_mean_squared_error: 3.4092
Epoch 140/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1312 -
mean_squared_error: 2.8323
Epoch 00140: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.1380 -
mean_squared_error: 2.8391 - val_loss: 3.2008 - val_mean_squared_error: 2.9011
Epoch 141/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0441 -
mean_squared_error: 2.7458
Epoch 00141: val_mean_squared_error did not improve from 2.79921
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.2076 -
mean_squared_error: 2.9093 - val_loss: 4.9497 - val_mean_squared_error: 4.6482
Epoch 142/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8689 -
mean_squared_error: 2.5719
Epoch 00142: val_mean_squared_error improved from 2.79921 to 2.68509, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.8687 -
```

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mean_squared_error: 2.5717 - val_loss: 2.9831 - val_mean_squared_error: 2.6851
Epoch 143/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9096 -
mean_squared_error: 2.6136
Epoch 00143: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.9135 -
mean_squared_error: 2.6175 - val_loss: 4.3849 - val_mean_squared_error: 4.0884
Epoch 144/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9034 -
mean_squared_error: 2.6081
Epoch 00144: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.9061 -
mean_squared_error: 2.6108 - val_loss: 3.7363 - val_mean_squared_error: 3.4418
Epoch 145/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7468 -
mean_squared_error: 2.4529
Epoch 00145: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.8806 -
mean_squared_error: 2.5866 - val_loss: 5.9219 - val_mean_squared_error: 5.6276
Epoch 146/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1991 -
mean_squared_error: 2.9058
Epoch 00146: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.2787 -
mean_squared_error: 2.9853 - val_loss: 9.3054 - val_mean_squared_error: 9.0084
Epoch 147/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7187 -
mean_squared_error: 2.4257
Epoch 00147: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7182 -
mean_squared_error: 2.4251 - val_loss: 3.7464 - val_mean_squared_error: 3.4530
Epoch 148/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9633 -
mean_squared_error: 2.6717
Epoch 00148: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.9648 -
mean_squared_error: 2.6731 - val_loss: 3.0216 - val_mean_squared_error: 2.7308
Epoch 149/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0627 -
mean_squared_error: 2.7722
Epoch 00149: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.0703 -
mean_squared_error: 2.7799 - val_loss: 5.8400 - val_mean_squared_error: 5.5462
Epoch 150/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1193 -
mean_squared_error: 2.8294
Epoch 00150: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.1294 -
```

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mean_squared_error: 2.8394 - val_loss: 8.4656 - val_mean_squared_error: 8.1753
Epoch 151/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5339 -
mean_squared_error: 2.2451
Epoch 00151: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5347 -
mean_squared_error: 2.2458 - val_loss: 6.6669 - val_mean_squared_error: 6.3779
Epoch 152/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2393 -
mean_squared_error: 2.9513
Epoch 00152: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.3187 -
mean_squared_error: 3.0307 - val_loss: 8.2681 - val_mean_squared_error: 7.9713
Epoch 153/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8840 -
mean_squared_error: 2.5959
Epoch 00153: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8811 -
mean_squared_error: 2.5930 - val_loss: 8.5159 - val_mean_squared_error: 8.2294
Epoch 154/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7972 -
mean_squared_error: 2.5106
Epoch 00154: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7951 -
mean_squared_error: 2.5085 - val_loss: 3.1292 - val_mean_squared_error: 2.8423
Epoch 155/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0755 -
mean_squared_error: 2.7890
Epoch 00155: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.0739 -
mean_squared_error: 2.7875 - val_loss: 3.2292 - val_mean_squared_error: 2.9428
Epoch 156/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9065 -
mean_squared_error: 2.6210
Epoch 00156: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.9070 -
mean_squared_error: 2.6215 - val_loss: 4.5863 - val_mean_squared_error: 4.2992
Epoch 157/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6065 -
mean_squared_error: 2.3226
Epoch 00157: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6039 -
mean_squared_error: 2.3200 - val_loss: 7.4228 - val_mean_squared_error: 7.1395
Epoch 158/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6340 -
mean_squared_error: 2.3508
Epoch 00158: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6456 -
```

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mean_squared_error: 2.3624 - val_loss: 11.6216 - val_mean_squared_error: 11.3382
Epoch 159/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4121 -
mean_squared_error: 2.1298
Epoch 00159: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4107 -
mean_squared_error: 2.1284 - val_loss: 6.0378 - val_mean_squared_error: 5.7553
Epoch 160/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9831 -
mean_squared_error: 2.7017
Epoch 00160: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.9829 -
mean_squared_error: 2.7015 - val_loss: 3.8301 - val_mean_squared_error: 3.5481
Epoch 161/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7898 -
mean_squared_error: 2.5087
Epoch 00161: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7881 -
mean_squared_error: 2.5070 - val_loss: 12.1404 - val_mean_squared_error: 11.8601
Epoch 162/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.3120 -
mean_squared_error: 3.0318
Epoch 00162: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.3213 -
mean_squared_error: 3.0412 - val_loss: 4.0494 - val_mean_squared_error: 3.7695
Epoch 163/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0568 -
mean_squared_error: 2.7775
Epoch 00163: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.0549 -
mean_squared_error: 2.7755 - val_loss: 4.0607 - val_mean_squared_error: 3.7813
Epoch 164/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2613 -
mean_squared_error: 2.9827
Epoch 00164: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2592 -
mean_squared_error: 2.9807 - val_loss: 7.6987 - val_mean_squared_error: 7.4200
Epoch 165/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8422 -
mean_squared_error: 2.5644
Epoch 00165: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8440 -
mean_squared_error: 2.5662 - val_loss: 4.1654 - val_mean_squared_error: 3.8868
Epoch 166/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7932 -
mean_squared_error: 2.5167
Epoch 00166: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8242 -
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mean_squared_error: 2.5477 - val_loss: 14.1049 - val_mean_squared_error: 13.8242
Epoch 167/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8065 -
mean_squared_error: 2.5301
Epoch 00167: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8159 -
mean_squared_error: 2.5394 - val_loss: 17.0967 - val_mean_squared_error: 16.8208
Epoch 168/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7899 -
mean_squared_error: 2.5144
Epoch 00168: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7887 -
mean_squared_error: 2.5132 - val_loss: 7.4848 - val_mean_squared_error: 7.2098
Epoch 169/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2765 -
mean_squared_error: 3.0016
Epoch 00169: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.2730 -
mean_squared_error: 2.9981 - val_loss: 7.3458 - val_mean_squared_error: 7.0715
Epoch 170/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7713 -
mean_squared_error: 2.4972
Epoch 00170: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8180 -
mean_squared_error: 2.5439 - val_loss: 15.5777 - val_mean_squared_error: 15.2978
Epoch 171/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7894 -
mean_squared_error: 2.5154
Epoch 00171: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7881 -
mean_squared_error: 2.5141 - val_loss: 20.2001 - val_mean_squared_error: 19.9251
Epoch 172/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8874 -
mean_squared_error: 2.6142
Epoch 00172: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8932 -
mean_squared_error: 2.6200 - val_loss: 4.4376 - val_mean_squared_error: 4.1638
Epoch 173/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7689 -
mean_squared_error: 2.4967
Epoch 00173: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7791 -
mean_squared_error: 2.5069 - val_loss: 3.0228 - val_mean_squared_error: 2.7512
Epoch 174/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.4508 -
mean_squared_error: 3.1795
Epoch 00174: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.4474 -
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mean_squared_error: 3.1761 - val_loss: 5.9995 - val_mean_squared_error: 5.7281
Epoch 175/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9419 -
mean_squared_error: 2.6714
Epoch 00175: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.9625 -
mean_squared_error: 2.6919 - val_loss: 4.5611 - val_mean_squared_error: 4.2902
Epoch 176/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1059 -
mean_squared_error: 2.8363
Epoch 00176: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.1077 -
mean_squared_error: 2.8381 - val_loss: 3.5439 - val_mean_squared_error: 3.2747
Epoch 177/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5281 -
mean_squared_error: 2.2592
Epoch 00177: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5455 -
mean_squared_error: 2.2767 - val_loss: 1667.8769 - val_mean_squared_error:
1667.6068
Epoch 178/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7192 -
mean_squared_error: 2.4509
Epoch 00178: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7379 -
mean_squared_error: 2.4695 - val_loss: 5.1403 - val_mean_squared_error: 4.8716
Epoch 179/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0079 -
mean_squared_error: 2.7403
Epoch 00179: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.0404 -
mean_squared_error: 2.7727 - val_loss: 11.7740 - val_mean_squared_error: 11.5030
Epoch 180/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1577 -
mean_squared_error: 2.8906
Epoch 00180: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.1606 -
mean_squared_error: 2.8935 - val_loss: 4.5798 - val_mean_squared_error: 4.3099
Epoch 181/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.2375 -
mean_squared_error: 2.9708
Epoch 00181: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.2342 -
mean_squared_error: 2.9675 - val_loss: 8.0760 - val_mean_squared_error: 7.8095
Epoch 182/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8275 -
mean_squared_error: 2.5617
Epoch 00182: val_mean_squared_error did not improve from 2.68509
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6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8286 -
mean_squared_error: 2.5628 - val_loss: 3.2679 - val_mean_squared_error: 3.0025
Epoch 183/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8062 -
mean_squared_error: 2.5417
Epoch 00183: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8257 -
mean_squared_error: 2.5612 - val_loss: 4.0378 - val_mean_squared_error: 3.7661
Epoch 184/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1197 -
mean_squared_error: 2.8554
Epoch 00184: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.1170 -
mean_squared_error: 2.8527 - val_loss: 2.9859 - val_mean_squared_error: 2.7222
Epoch 185/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8823 -
mean_squared_error: 2.6196
Epoch 00185: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8997 -
mean_squared_error: 2.6370 - val_loss: 2.9542 - val_mean_squared_error: 2.6914
Epoch 186/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.1745 -
mean_squared_error: 2.9124
Epoch 00186: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.1876 -
mean_squared_error: 2.9255 - val_loss: 3.0478 - val_mean_squared_error: 2.7860
Epoch 187/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4510 -
mean_squared_error: 2.1900
Epoch 00187: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4486 -
mean_squared_error: 2.1877 - val_loss: 3.6931 - val_mean_squared_error: 3.4322
Epoch 188/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8280 -
mean_squared_error: 2.5679
Epoch 00188: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8383 -
mean_squared_error: 2.5782 - val_loss: 3.4100 - val_mean_squared_error: 3.1493
Epoch 189/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5363 -
mean_squared_error: 2.2769
Epoch 00189: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5371 -
mean_squared_error: 2.2778 - val_loss: 3.3564 - val_mean_squared_error: 3.0972
Epoch 190/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6595 -
mean_squared_error: 2.4011
Epoch 00190: val_mean_squared_error did not improve from 2.68509
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6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6664 -
mean_squared_error: 2.4079 - val_loss: 14.5086 - val_mean_squared_error: 14.2476
Epoch 191/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9683 -
mean_squared_error: 2.7106
Epoch 00191: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.9693 -
mean_squared_error: 2.7116 - val_loss: 8.5288 - val_mean_squared_error: 8.2703
Epoch 192/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7771 -
mean_squared_error: 2.5201
Epoch 00192: ReduceLROnPlateau reducing learning rate to 0.00033000001567415896.

Epoch 00192: val_mean_squared_error did not improve from 2.68509
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7747 -
mean_squared_error: 2.5177 - val_loss: 3.2764 - val_mean_squared_error: 3.0189
Epoch 193/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5717 -
mean_squared_error: 2.3253
Epoch 00193: val_mean_squared_error improved from 2.68509 to 2.51817, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5774 -
mean_squared_error: 2.3309 - val_loss: 2.7631 - val_mean_squared_error: 2.5182
Epoch 194/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5199 -
mean_squared_error: 2.2767
Epoch 00194: val_mean_squared_error did not improve from 2.51817
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5197 -
mean_squared_error: 2.2765 - val_loss: 4.2947 - val_mean_squared_error: 4.0525
Epoch 195/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4773 -
mean_squared_error: 2.2364
Epoch 00195: val_mean_squared_error did not improve from 2.51817
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.4770 -
mean_squared_error: 2.2362 - val_loss: 2.7932 - val_mean_squared_error: 2.5535
Epoch 196/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5329 -
mean_squared_error: 2.2942
Epoch 00196: val_mean_squared_error improved from 2.51817 to 2.38701, saving
model to ./models/original/cnn_model_matrix_h21.h5
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5370 -
mean_squared_error: 2.2984 - val_loss: 2.6246 - val_mean_squared_error: 2.3870
Epoch 197/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6711 -
mean_squared_error: 2.4342
Epoch 00197: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6684 -
mean_squared_error: 2.4315 - val_loss: 2.6624 - val_mean_squared_error: 2.4263
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Epoch 198/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3526 -
mean_squared_error: 2.1176
Epoch 00198: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.3515 -
mean_squared_error: 2.1164 - val_loss: 3.0354 - val_mean_squared_error: 2.8011
Epoch 199/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6983 -
mean_squared_error: 2.4649
Epoch 00199: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7151 -
mean_squared_error: 2.4816 - val_loss: 3.0425 - val_mean_squared_error: 2.8087
Epoch 200/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5618 -
mean_squared_error: 2.3298
Epoch 00200: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5638 -
mean_squared_error: 2.3317 - val_loss: 2.9693 - val_mean_squared_error: 2.7378
Epoch 201/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5258 -
mean_squared_error: 2.2953
Epoch 00201: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5246 -
mean_squared_error: 2.2941 - val_loss: 2.8720 - val_mean_squared_error: 2.6423
Epoch 202/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.1459 -
mean_squared_error: 1.9171
Epoch 00202: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.1983 -
mean_squared_error: 1.9694 - val_loss: 4.1680 - val_mean_squared_error: 3.9375
Epoch 203/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6882 -
mean_squared_error: 2.4604
Epoch 00203: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.6929 -
mean_squared_error: 2.4651 - val_loss: 3.0744 - val_mean_squared_error: 2.8472
Epoch 204/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0889 -
mean_squared_error: 2.8625
Epoch 00204: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.0911 -
mean_squared_error: 2.8647 - val_loss: 2.7118 - val_mean_squared_error: 2.4859
Epoch 205/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7374 -
mean_squared_error: 2.5122
Epoch 00205: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7354 -
mean_squared_error: 2.5102 - val_loss: 2.8699 - val_mean_squared_error: 2.6451
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Epoch 206/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3203 -
mean_squared_error: 2.0964
Epoch 00206: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.3271 -
mean_squared_error: 2.1032 - val_loss: 2.7262 - val_mean_squared_error: 2.5029
Epoch 207/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7876 -
mean_squared_error: 2.5650
Epoch 00207: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7857 -
mean_squared_error: 2.5631 - val_loss: 2.8278 - val_mean_squared_error: 2.6056
Epoch 208/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9093 -
mean_squared_error: 2.6878
Epoch 00208: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.9443 -
mean_squared_error: 2.7228 - val_loss: 2.7016 - val_mean_squared_error: 2.4804
Epoch 209/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5193 -
mean_squared_error: 2.2990
Epoch 00209: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5181 -
mean_squared_error: 2.2978 - val_loss: 2.7746 - val_mean_squared_error: 2.5548
Epoch 210/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7797 -
mean_squared_error: 2.5605
Epoch 00210: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7768 -
mean_squared_error: 2.5575 - val_loss: 3.6058 - val_mean_squared_error: 3.3871
Epoch 211/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4894 -
mean_squared_error: 2.2714
Epoch 00211: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5772 -
mean_squared_error: 2.3591 - val_loss: 3.1024 - val_mean_squared_error: 2.8817
Epoch 212/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6893 -
mean_squared_error: 2.4719
Epoch 00212: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.6887 -
mean_squared_error: 2.4712 - val_loss: 2.9710 - val_mean_squared_error: 2.7541
Epoch 213/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4418 -
mean_squared_error: 2.2256
Epoch 00213: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.4392 -
mean_squared_error: 2.2230 - val_loss: 2.9175 - val_mean_squared_error: 2.7017
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Epoch 214/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2614 -
mean_squared_error: 2.0464
Epoch 00214: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2590 -
mean_squared_error: 2.0439 - val_loss: 2.9005 - val_mean_squared_error: 2.6860
Epoch 215/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3826 -
mean_squared_error: 2.1687
Epoch 00215: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4190 -
mean_squared_error: 2.2051 - val_loss: 2.9866 - val_mean_squared_error: 2.7731
Epoch 216/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3803 -
mean_squared_error: 2.1675
Epoch 00216: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.3782 -
mean_squared_error: 2.1654 - val_loss: 4.8014 - val_mean_squared_error: 4.5888
Epoch 217/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5068 -
mean_squared_error: 2.2949
Epoch 00217: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5158 -
mean_squared_error: 2.3039 - val_loss: 2.9385 - val_mean_squared_error: 2.7270
Epoch 218/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7349 -
mean_squared_error: 2.5241
Epoch 00218: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7333 -
mean_squared_error: 2.5224 - val_loss: 3.4796 - val_mean_squared_error: 3.2688
Epoch 219/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4955 -
mean_squared_error: 2.2857
Epoch 00219: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5014 -
mean_squared_error: 2.2915 - val_loss: 3.2599 - val_mean_squared_error: 3.0504
Epoch 220/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5244 -
mean_squared_error: 2.3155
Epoch 00220: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5330 -
mean_squared_error: 2.3242 - val_loss: 3.2486 - val_mean_squared_error: 3.0380
Epoch 221/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0063 -
mean_squared_error: 2.7982
Epoch 00221: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.0086 -
mean_squared_error: 2.8004 - val_loss: 3.6269 - val_mean_squared_error: 3.4188
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Epoch 222/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5939 -
mean_squared_error: 2.3866
Epoch 00222: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.6009 -
mean_squared_error: 2.3937 - val_loss: 3.0763 - val_mean_squared_error: 2.8692
Epoch 223/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.9996 -
mean_squared_error: 2.7932
Epoch 00223: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.9971 -
mean_squared_error: 2.7907 - val_loss: 3.4048 - val_mean_squared_error: 3.1983
Epoch 224/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7619 -
mean_squared_error: 2.5564
Epoch 00224: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7609 -
mean_squared_error: 2.5554 - val_loss: 2.7835 - val_mean_squared_error: 2.5783
Epoch 225/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5350 -
mean_squared_error: 2.3303
Epoch 00225: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5383 -
mean_squared_error: 2.3337 - val_loss: 2.8288 - val_mean_squared_error: 2.6246
Epoch 226/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5852 -
mean_squared_error: 2.3817
Epoch 00226: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.6146 -
mean_squared_error: 2.4110 - val_loss: 3.7220 - val_mean_squared_error: 3.5177
Epoch 227/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7284 -
mean_squared_error: 2.5256
Epoch 00227: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7262 -
mean_squared_error: 2.5234 - val_loss: 2.8763 - val_mean_squared_error: 2.6738
Epoch 228/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4299 -
mean_squared_error: 2.2279
Epoch 00228: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.4282 -
mean_squared_error: 2.2263 - val_loss: 3.6287 - val_mean_squared_error: 3.4271
Epoch 229/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2832 -
mean_squared_error: 2.0822
Epoch 00229: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.3139 -
mean_squared_error: 2.1129 - val_loss: 2.7059 - val_mean_squared_error: 2.5052
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Epoch 230/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7089 -
mean_squared_error: 2.5087
Epoch 00230: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.7390 -
mean_squared_error: 2.5389 - val_loss: 2.7128 - val_mean_squared_error: 2.5132
Epoch 231/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.0979 -
mean_squared_error: 1.8986
Epoch 00231: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.1049 -
mean_squared_error: 1.9056 - val_loss: 2.8631 - val_mean_squared_error: 2.6640
Epoch 232/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5111 -
mean_squared_error: 2.3126
Epoch 00232: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5144 -
mean_squared_error: 2.3159 - val_loss: 3.1139 - val_mean_squared_error: 2.9153
Epoch 233/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6593 -
mean_squared_error: 2.4616
Epoch 00233: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.6760 -
mean_squared_error: 2.4783 - val_loss: 3.2635 - val_mean_squared_error: 3.0659
Epoch 234/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3727 -
mean_squared_error: 2.1758
Epoch 00234: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.3850 -
mean_squared_error: 2.1881 - val_loss: 2.8871 - val_mean_squared_error: 2.6904
Epoch 235/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4762 -
mean_squared_error: 2.2801
Epoch 00235: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.5238 -
mean_squared_error: 2.3277 - val_loss: 2.7391 - val_mean_squared_error: 2.5429
Epoch 236/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4661 -
mean_squared_error: 2.2706
Epoch 00236: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4839 -
mean_squared_error: 2.2885 - val_loss: 4.2281 - val_mean_squared_error: 4.0317
Epoch 237/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6587 -
mean_squared_error: 2.4640
Epoch 00237: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6598 -
mean_squared_error: 2.4650 - val_loss: 2.7104 - val_mean_squared_error: 2.5162
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Epoch 238/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6159 -
mean_squared_error: 2.4219
Epoch 00238: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6211 -
mean_squared_error: 2.4272 - val_loss: 3.0165 - val_mean_squared_error: 2.8224
Epoch 239/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8434 -
mean_squared_error: 2.6501
Epoch 00239: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8484 -
mean_squared_error: 2.6551 - val_loss: 3.2493 - val_mean_squared_error: 3.0564
Epoch 240/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0141 -
mean_squared_error: 2.8217
Epoch 00240: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 3.0673 -
mean_squared_error: 2.8748 - val_loss: 3.0600 - val_mean_squared_error: 2.8654
Epoch 241/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4768 -
mean_squared_error: 2.2848
Epoch 00241: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4796 -
mean_squared_error: 2.2875 - val_loss: 3.3179 - val_mean_squared_error: 3.1255
Epoch 242/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2373 -
mean_squared_error: 2.0460
Epoch 00242: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2626 -
mean_squared_error: 2.0713 - val_loss: 3.0214 - val_mean_squared_error: 2.8297
Epoch 243/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7385 -
mean_squared_error: 2.5479
Epoch 00243: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7368 -
mean_squared_error: 2.5461 - val_loss: 2.7134 - val_mean_squared_error: 2.5232
Epoch 244/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5114 -
mean_squared_error: 2.3216
Epoch 00244: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5129 -
mean_squared_error: 2.3231 - val_loss: 3.1977 - val_mean_squared_error: 3.0083
Epoch 245/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6979 -
mean_squared_error: 2.5088
Epoch 00245: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7006 -
mean_squared_error: 2.5115 - val_loss: 3.3335 - val_mean_squared_error: 3.1447
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Epoch 246/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8292 -
mean_squared_error: 2.6407
Epoch 00246: ReduceLROnPlateau reducing learning rate to 0.00010890000325161964.

Epoch 00246: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8310 -
mean_squared_error: 2.6425 - val_loss: 3.0351 - val_mean_squared_error: 2.8468
Epoch 247/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6410 -
mean_squared_error: 2.4562
Epoch 00247: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6380 -
mean_squared_error: 2.4532 - val_loss: 2.6129 - val_mean_squared_error: 2.4286
Epoch 248/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3479 -
mean_squared_error: 2.1641
Epoch 00248: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4084 -
mean_squared_error: 2.2246 - val_loss: 2.7891 - val_mean_squared_error: 2.6055
Epoch 249/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8087 -
mean_squared_error: 2.6254
Epoch 00249: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8092 -
mean_squared_error: 2.6260 - val_loss: 3.6019 - val_mean_squared_error: 3.4190
Epoch 250/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.8942 -
mean_squared_error: 2.7116
Epoch 00250: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.8924 -
mean_squared_error: 2.7098 - val_loss: 2.7550 - val_mean_squared_error: 2.5727
Epoch 251/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5494 -
mean_squared_error: 2.3674
Epoch 00251: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5476 -
mean_squared_error: 2.3655 - val_loss: 2.6964 - val_mean_squared_error: 2.5146
Epoch 252/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.1986 -
mean_squared_error: 2.0171
Epoch 00252: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2059 -
mean_squared_error: 2.0244 - val_loss: 2.7833 - val_mean_squared_error: 2.6021
Epoch 253/1000
6272/6280 [============================>.] - ETA: 0s - loss: 1.9763 -
mean_squared_error: 1.7954
Epoch 00253: val_mean_squared_error did not improve from 2.38701
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6280/6280 [==============================] - 47s 8ms/sample - loss: 1.9750 -
mean_squared_error: 1.7940 - val_loss: 2.6197 - val_mean_squared_error: 2.4389
Epoch 254/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4418 -
mean_squared_error: 2.2614
Epoch 00254: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4416 -
mean_squared_error: 2.2612 - val_loss: 2.6425 - val_mean_squared_error: 2.4622
Epoch 255/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7923 -
mean_squared_error: 2.6122
Epoch 00255: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7984 -
mean_squared_error: 2.6183 - val_loss: 2.6534 - val_mean_squared_error: 2.4735
Epoch 256/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4625 -
mean_squared_error: 2.2829
Epoch 00256: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4604 -
mean_squared_error: 2.2809 - val_loss: 2.7351 - val_mean_squared_error: 2.5557
Epoch 257/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4758 -
mean_squared_error: 2.2967
Epoch 00257: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4749 -
mean_squared_error: 2.2958 - val_loss: 2.6632 - val_mean_squared_error: 2.4841
Epoch 258/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2433 -
mean_squared_error: 2.0646
Epoch 00258: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2594 -
mean_squared_error: 2.0807 - val_loss: 2.6731 - val_mean_squared_error: 2.4946
Epoch 259/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2065 -
mean_squared_error: 2.0283
Epoch 00259: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2200 -
mean_squared_error: 2.0417 - val_loss: 3.0166 - val_mean_squared_error: 2.8385
Epoch 260/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4921 -
mean_squared_error: 2.3143
Epoch 00260: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5021 -
mean_squared_error: 2.3243 - val_loss: 2.7515 - val_mean_squared_error: 2.5732
Epoch 261/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2669 -
mean_squared_error: 2.0893
Epoch 00261: val_mean_squared_error did not improve from 2.38701
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6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2656 -
mean_squared_error: 2.0880 - val_loss: 2.9469 - val_mean_squared_error: 2.7695
Epoch 262/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5136 -
mean_squared_error: 2.3365
Epoch 00262: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5553 -
mean_squared_error: 2.3781 - val_loss: 2.9257 - val_mean_squared_error: 2.7487
Epoch 263/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7676 -
mean_squared_error: 2.5908
Epoch 00263: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7645 -
mean_squared_error: 2.5877 - val_loss: 2.9587 - val_mean_squared_error: 2.7821
Epoch 264/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4790 -
mean_squared_error: 2.3025
Epoch 00264: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4811 -
mean_squared_error: 2.3046 - val_loss: 3.1170 - val_mean_squared_error: 2.9407
Epoch 265/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3413 -
mean_squared_error: 2.1652
Epoch 00265: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.3754 -
mean_squared_error: 2.1994 - val_loss: 2.8140 - val_mean_squared_error: 2.6381
Epoch 266/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4460 -
mean_squared_error: 2.2703
Epoch 00266: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4666 -
mean_squared_error: 2.2909 - val_loss: 2.6819 - val_mean_squared_error: 2.5064
Epoch 267/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6523 -
mean_squared_error: 2.4770
Epoch 00267: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6534 -
mean_squared_error: 2.4781 - val_loss: 2.7130 - val_mean_squared_error: 2.5378
Epoch 268/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4273 -
mean_squared_error: 2.2523
Epoch 00268: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4682 -
mean_squared_error: 2.2932 - val_loss: 2.9843 - val_mean_squared_error: 2.8090
Epoch 269/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.1304 -
mean_squared_error: 1.9557
Epoch 00269: val_mean_squared_error did not improve from 2.38701
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6280/6280 [==============================] - 47s 8ms/sample - loss: 2.1283 -
mean_squared_error: 1.9536 - val_loss: 2.7442 - val_mean_squared_error: 2.5696
Epoch 270/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5084 -
mean_squared_error: 2.3341
Epoch 00270: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5110 -
mean_squared_error: 2.3367 - val_loss: 2.9247 - val_mean_squared_error: 2.7506
Epoch 271/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.1336 -
mean_squared_error: 1.9597
Epoch 00271: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.1363 -
mean_squared_error: 1.9624 - val_loss: 2.6965 - val_mean_squared_error: 2.5227
Epoch 272/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.1867 -
mean_squared_error: 2.0132
Epoch 00272: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2028 -
mean_squared_error: 2.0293 - val_loss: 2.7067 - val_mean_squared_error: 2.5333
Epoch 273/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7693 -
mean_squared_error: 2.5961
Epoch 00273: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7700 -
mean_squared_error: 2.5968 - val_loss: 2.8229 - val_mean_squared_error: 2.6499
Epoch 274/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4875 -
mean_squared_error: 2.3147
Epoch 00274: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5196 -
mean_squared_error: 2.3468 - val_loss: 2.7240 - val_mean_squared_error: 2.5512
Epoch 275/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4015 -
mean_squared_error: 2.2291
Epoch 00275: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4029 -
mean_squared_error: 2.2305 - val_loss: 3.6140 - val_mean_squared_error: 3.4416
Epoch 276/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5876 -
mean_squared_error: 2.4155
Epoch 00276: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6720 -
mean_squared_error: 2.4999 - val_loss: 2.7642 - val_mean_squared_error: 2.5920
Epoch 277/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2488 -
mean_squared_error: 2.0770
Epoch 00277: val_mean_squared_error did not improve from 2.38701
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6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2581 -
mean_squared_error: 2.0863 - val_loss: 2.7371 - val_mean_squared_error: 2.5655
Epoch 278/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.7275 -
mean_squared_error: 2.5561
Epoch 00278: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.7244 -
mean_squared_error: 2.5529 - val_loss: 3.6331 - val_mean_squared_error: 3.4617
Epoch 279/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4596 -
mean_squared_error: 2.2884
Epoch 00279: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4569 -
mean_squared_error: 2.2857 - val_loss: 2.7770 - val_mean_squared_error: 2.6060
Epoch 280/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.0949 -
mean_squared_error: 1.9241
Epoch 00280: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2107 -
mean_squared_error: 2.0398 - val_loss: 2.6504 - val_mean_squared_error: 2.4796
Epoch 281/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.6862 -
mean_squared_error: 2.5157
Epoch 00281: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.6959 -
mean_squared_error: 2.5255 - val_loss: 2.7477 - val_mean_squared_error: 2.5770
Epoch 282/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.1485 -
mean_squared_error: 1.9784
Epoch 00282: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.1572 -
mean_squared_error: 1.9870 - val_loss: 3.8939 - val_mean_squared_error: 3.7238
Epoch 283/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2568 -
mean_squared_error: 2.0870
Epoch 00283: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2781 -
mean_squared_error: 2.1083 - val_loss: 2.7618 - val_mean_squared_error: 2.5921
Epoch 284/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5489 -
mean_squared_error: 2.3794
Epoch 00284: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5478 -
mean_squared_error: 2.3783 - val_loss: 2.7925 - val_mean_squared_error: 2.6231
Epoch 285/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2814 -
mean_squared_error: 2.1122
Epoch 00285: val_mean_squared_error did not improve from 2.38701
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6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2824 -
mean_squared_error: 2.1132 - val_loss: 2.6846 - val_mean_squared_error: 2.5155
Epoch 286/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.1321 -
mean_squared_error: 1.9633
Epoch 00286: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.1328 -
mean_squared_error: 1.9640 - val_loss: 2.7605 - val_mean_squared_error: 2.5919
Epoch 287/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.2550 -
mean_squared_error: 2.0866
Epoch 00287: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.2582 -
mean_squared_error: 2.0897 - val_loss: 2.9311 - val_mean_squared_error: 2.7627
Epoch 288/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.5231 -
mean_squared_error: 2.3550
Epoch 00288: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.5202 -
mean_squared_error: 2.3521 - val_loss: 3.8506 - val_mean_squared_error: 3.6826
Epoch 289/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3362 -
mean_squared_error: 2.1684
Epoch 00289: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.3336 -
mean_squared_error: 2.1658 - val_loss: 3.9134 - val_mean_squared_error: 3.7456
Epoch 290/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.4631 -
mean_squared_error: 2.2956
Epoch 00290: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.4685 -
mean_squared_error: 2.3011 - val_loss: 3.0238 - val_mean_squared_error: 2.8565
Epoch 291/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3778 -
mean_squared_error: 2.2107
Epoch 00291: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.3871 -
mean_squared_error: 2.2200 - val_loss: 2.6871 - val_mean_squared_error: 2.5200
Epoch 292/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.0904 -
mean_squared_error: 1.9235
Epoch 00292: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 47s 8ms/sample - loss: 2.1735 -
mean_squared_error: 2.0066 - val_loss: 3.5842 - val_mean_squared_error: 3.4174
Epoch 293/1000
6272/6280 [============================>.] - ETA: 0s - loss: 1.9403 -
mean_squared_error: 1.7738
Epoch 00293: val_mean_squared_error did not improve from 2.38701
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6280/6280 [==============================] - 48s 8ms/sample - loss: 1.9388 -
mean_squared_error: 1.7723 - val_loss: 2.8706 - val_mean_squared_error: 2.7042
Epoch 294/1000
6272/6280 [============================>.] - ETA: 0s - loss: 3.0050 -
mean_squared_error: 2.8387
Epoch 00294: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 3.0151 -
mean_squared_error: 2.8489 - val_loss: 2.6635 - val_mean_squared_error: 2.4971
Epoch 295/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.3963 -
mean_squared_error: 2.2303
Epoch 00295: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.4295 -
mean_squared_error: 2.2635 - val_loss: 2.8482 - val_mean_squared_error: 2.6823
Epoch 296/1000
6272/6280 [============================>.] - ETA: 0s - loss: 2.1928 -
mean_squared_error: 2.0271Restoring model weights from the end of the best
epoch.

Epoch 00296: ReduceLROnPlateau reducing learning rate to 3.5936999920522795e-05.

Epoch 00296: val_mean_squared_error did not improve from 2.38701
6280/6280 [==============================] - 48s 8ms/sample - loss: 2.1930 -
mean_squared_error: 2.0273 - val_loss: 3.8563 - val_mean_squared_error: 3.6909
Epoch 00296: early stopping
```

And evaluate it:

[31]:
```
# evaluate the model
logprint('Evaluating the model for h21...', logger=logger)
model_ev = model.evaluate(x=matrix_test, y=h21_test, verbose=0)
logprint('Loss: {:.3f}, MSE: {:.3f}'.format(model_ev[0], model_ev[1]),␣
 ↪logger=logger)

# accuracy of the model
logprint('Accuracy on the validation set: {:.3f}%'.
 ↪format(accuracy_score(h21_val, model.predict(matrix_val), rounding=np.
 ↪rint)*100.0), logger=logger)
prediction_score(estimator=model, X=matrix_test, y=h21_test,␣
 ↪use_best_estimator=False, rounding=np.rint, logger=logger)

# loss function
model_history = model_hst.history

xplots  = 2
yplots  = 1
```

```
fig, ax = plt.subplots(yplots, xplots, figsize=(xplots*mpl_width,␣
↪yplots*mpl_height))
fig.tight_layout()

series_plot(ax[0], model_history['loss'],                  title='Loss␣
↪Function', xlabel='Epoch', ylabel='Loss', legend='training')
series_plot(ax[0], model_history['val_loss'],              title='Loss␣
↪Function', xlabel='Epoch', ylabel='Loss', legend='validation')
series_plot(ax[1], model_history['mean_squared_error'],    title='MSE',       ␣
↪   xlabel='Epoch', ylabel='MSE',  legend='training')
series_plot(ax[1], model_history['val_mean_squared_error'], title='MSE',      ␣
↪   xlabel='Epoch', ylabel='MSE',  legend='validation')

save_fig('cnn_matrix_h21_history', logger=logger)

plt.show()
plt.close(fig)
```

```
2020-04-18 20:18:44,108 --> INFO: Evaluating the model for h21…
2020-04-18 20:18:45,795 --> INFO: Loss: 2.996, MSE: 2.758
2020-04-18 20:18:47,601 --> INFO: Accuracy on the validation set: 36.688%
2020-04-18 20:18:49,119 --> INFO: Accuracy (rint) of the predictions: 35.623%
2020-04-18 20:18:49,351 --> INFO: Saving
./img/original/cnn_matrix_h21_history.png…
2020-04-18 20:18:49,572 --> INFO: Saved
./img/original/cnn_matrix_h21_history.png!
```

We then plot the error distribution of the model:

[32]:
```
logprint('Plotting error distribution...', logger=logger)
xplots  = 1
```

```
yplots  = 1
fig, ax = plt.subplots(yplots, xplots, figsize=(xplots*mpl_width,␣
 ↪yplots*mpl_height))
fig.tight_layout()

count_plot(ax,
           error_diff(h21_test,
                      model.predict(matrix_test).reshape(-1,),
                      rounding=np.rint),
           title='Error distribution on the test set',
           xlabel='Difference from real value',
           legend='$h_{21}$'
          )

save_fig('cnn_model_matrix_h21_error', logger=logger)
plt.show()
plt.close(fig)
```

```
2020-04-18 20:18:49,935 --> INFO: Plotting error distribution…
2020-04-18 20:18:51,523 --> INFO: Saving
./img/original/cnn_model_matrix_h11_error.png…
2020-04-18 20:18:51,639 --> INFO: Saved
./img/original/cnn_model_matrix_h11_error.png!
```

[ ]:

[ ]: