



PYERUALJETWORK 4.1.7 HIGH LEVEL USER MANUAL

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ABOUT PYERUALJETWORK:

PyerualJetwork is a machine learning library written in Python for professionals, incorporating advanced, unique, new, and modern techniques. Its most important component is the PLAN (Potentiation Learning Artificial Neural Network).

This is HIGH LEVEL user manual. The functions selected here are those that are as abstracted from the background as possible. Guide for LOW LEVEL users will come soon.

Both the PLAN algorithm and the PyerualJetwork library were created by Author, and all rights are reserved by Author.

PyerualJetwork is free to use for commercial business and individual users.

It is prohibited to copy or share the code and these documents by duplicating or using different names.

As of 12/21/2024, the library includes the PLAN and PLANEAT modules, but other machine learning modules are expected to be added in the future.

The PLAN algorithm will not be explained in this document. This document focuses on how professionals can integrate and use Pyerual Jetwork in their systems. However, briefly, the PLAN algorithm can be described as a classification algorithm. PLAN algorithm achieves this task with an incredibly energy-efficient, fast, and user-friendly approach. PLAN's goal is to develop artificial neural network models that are **"as simple as a perceptron yet as powerful in learning capabilities as powerful in learning capabilities as multi-layer perceptrons."** For more detailed information, you can check out:

https://github.com/HCB06/PyerualJetwork/blob/main/Welcome_to_PLAN/PLAN.pdf

HOW DO I IMPORT IT TO MY PROJECT?

Anaconda users can access the 'Anaconda Prompt' terminal from the Start menu and add the necessary library modules to the Python module search queue by typing "`pip install pyerualjetwork`" and pressing enter. If you are not using Anaconda, you can simply open the 'cmd' Windows command terminal from the Start menu and type "`pip install pyerualjetwork`". (Visual Studio Code recommended) After installation, it's important to periodically open the terminal of the environment you are using and stay up to date by using the command "`pip install pyerualjetwork --upgrade`". The latest version was "4.1.7" at the time this document was written

After installing the module using "`pip`" you can now call the library module in your project environment. For example: "`from pyerualjetwork import plan`". Now, you can call the necessary functions from the plan module.

LIBRARY ARCHITECTURE:

The functions of the PyeralJetwork modules, uses snake_case written style.

Main Modules and Functions:

1. plan & plan_cuda

- a. fit()
- b. evaluate ()
- c. learner()

2. planeat & planeat_cuda

- a. define_genoms()
- b. evaluate()
- c. evolve()

Supportive Modules and Functions:

1. data_operations & data_operations_cuda

- a. split()
- b. one_hot_encode()
- c. one_hot_decode()
- d. auto_balancer()
- e. manuel_balancer()
- f. synthetic_augmentation()
- g. standard_scaler()

2. model_operations & model_operations_cuda

- a. save_model()
- b. load_model()
- c. predict_model_ram()
- d. predict_model_ssd()
- e. reverse_predict_model_ram()
- f. reverse_predict_model_ssd()

- g. `get_weights()`
- h. `get_scaler()`
- i. `get_preds()`
- j. `get_acc()`
- k. `get_act_pot()`

3. **memory_operations**

- a. `transfer_to_gpu ()`
- b. `transfer_to_cpu ()`

PLAN MODULE

It applies the PLAN (Potentiation Learning Artificial Neural Network) algorithm, which incorporates a unique learning architecture specifically designed by me to enhance **"explainability and efficiency of AI models."** This algorithm is based on my custom optimization approach, TFL (Test or Train Feedback Learning), which does not rely on the traditional Backpropagation method.

The advantage of this algorithm lies in its ability to create "super perceptrons." For example, imagine a perceptron achieving over 0.9 accuracy in classifying the circles dataset—this is something the PLAN module can achieve. The goal of this algorithm is to develop artificial neural network models that are **"as simple as a perceptron yet as powerful in learning capabilities as multi-layer perceptrons."**

NOTE:

Non-cuda modules uses **'numpy'** arrays(as **'np'**), cuda modules uses **'cupy'** arrays(as **'cp'**).

everything else is almost the same. There are some extra parameters only in the functions of **cuda** modules.

cuda modules runs at GPU, non-cuda modules runs at CPU.

PLAN MODULE FUNCTIONS

1. plan.fit()

The purpose of this function, as the name suggests, is to train the model.

```
a.     fit Args:
b.
c. x_train (list[num]): List or numarray of input data.
d.
e. y_train (list[num]): List or numarray of target labels. (one hot
   encoded)
f.
g. val (None or True): validation in training process ? None or True
   default: None (optional)
h.
i. val_count (None or int): After how many examples learned will an
   accuracy test be performed? default: 10=(%10) it means every
   approximately 10 step (optional)
j.
k. activation_potentialiation (list): For deeper PLAN networks,
   activation function parameters. For more information please run this
   code: activation_functions.activations_list() default: [None] (optional)
l.
m. x_val (list[num]): List of validation data. default: x_train
   (optional)
n.
o. y_val (list[num]): (list[num]): List of target labels. (one hot
   encoded) default: y_train (optional)
p.
q. show_training (bool, str): True or None default: None (optional)
r.
s. LTD (int): Long Term Depression Hyperparameter for train PLAN neural
   network default: 0 (optional)
t.
```

u. **interval (float, int)**: frame delay (milisecond) parameter for Training Report (show_training=True) This parameter effects to your Training Report performance. Lower value is more diffucult for Low end PC's (33.33 = 30 FPS, 16.67 = 60 FPS) default: 100 (optional)

v.

w. **decision_boundary_status (bool)**: If the visualization of validation and training history is enabled during training, should the decision boundaries also be visualized? True or False. Default is True. (optional)

x.

y. **train_bar (bool)**: Training loading bar? True or False. Default is True. (optional)

z.

aa. **auto_normalization(bool)**: Normalization process during training. May effect training time and model quality. True or False. Default is True. (optional)

bb.

cc. **neurons_history (bool, optional)**: Shows the history of changes that neurons undergo during the CL (Cumulative Learning) stages. True or False. Default is False. (optional)

dd.

ee. **dtype (np.dtype, cp.dtype)**: Data type for the arrays. np.float32 by default. Example: np.float64 or np.float16. [fp32 for balanced devices, fp64 for strong devices, fp16 for weak devices: not reccomended!] (optional) dtype=np.float32, dtype=cp.float32

ff.

gg. **memory (str)**: The memory parameter determines whether the dataset to be processed on the GPU will be stored in the CPU's RAM or the GPU's RAM. Options: 'gpu', 'cpu'. Default: 'gpu'.

hh.

ii.

jj.

kk. Returns:

ll. **numpyarray([num])**: (Weight matrix).

The output of this function Weight matrix of model.

2. `plan.evaluate()`

This function calculates the test accuracy of the model using the inputs and labels set aside for testing, along with the weight matrices and other model parameters obtained as output from the training function.

```
a. x_test (list[num]): Test input data.
b.
c. y_test (list[num]): Test labels.
d.
e. W (list[num]): Weight matrix list of the neural network.
f.
g. activation_potentialiation (list): For deeper PLAN networks,
    activation function parameters. Look available activation functions:
    'activation_functions.all_activations()' [returns list of all
    activations] default: ['linear']
h.
i. loading_bar_status: Evaluate progress have a loading bar ? (True
    or False) Default: True.
j.
k. show_metrics (bool): (True or None) (optional) Default: None
l.
m. dtype (np.dtype, cp.dtype): Data type for the arrays. np.float32
    by default. Example: np.float64 or np.float16. [fp32 for balanced
    devices, fp64 for strong devices, fp16 for weak devices: not
    recommended!] (optional) dtype=np.float32, dtype=cp.float32
n.
o. memory (str): The memory parameter determines whether the dataset
    to be processed on the GPU will be stored in the CPU's RAM or the
    GPU's RAM. Options: 'gpu', 'cpu'. Default: 'gpu'.
```

The outputs of this function are, in order: weights of test process, a list of test predictions, and test accuracy rate.

3. plan.learner()

Optimizes the activation functions for a neural network by leveraging train data to find the most accurate combination of activation potentiation for the given dataset.

This next-generation generalization function includes an advanced learning feature that is specifically tailored to the PLAN algorithm.

It uniquely adjusts hyperparameters based on test accuracy while training with model-specific training data, offering an unparalleled optimization technique.

Designed to be used before model evaluation. This called TFL(Test or Train Feedback Learning).

```
a.      Args:
b.          x_train (array-like): Training input data.
c.
d.          y_train (array-like): Labels for training data.
e.
f.          x_test (array-like, optional): Test input data (for
      improve next gen generalization). If test data is not given then
      train feedback learning active
g.
h.          y_test (array-like, optional): Test Labels (for improve
      next gen generalization). If test data is not given then train
      feedback learning active
i.
j.          strategy (str, optional): Learning strategy. (options:
      'accuracy', 'loss', 'f1', 'precision', 'recall', 'adaptive_accuracy',
      'adaptive_loss', 'all'): 'accuracy', Maximizes test accuracy during
      learning. 'f1', Maximizes test f1 score during learning. 'precision',
      Maximizes test precision score during learning. 'recall', Maximizes
      test recall during learning. 'loss', Minimizes test loss during
      learning. 'adaptive_accuracy', The model compares the current
      accuracy with the accuracy from the past based on the number
      specified by the patience value. If no improvement is observed it
```

adapts to the condition by switching to the 'loss' strategy quickly starts minimizing loss and continues learning. 'adaptive_loss', The model adopts the 'loss' strategy until the loss reaches or falls below the value specified by the patience parameter. However, when the patience threshold is reached, it automatically switches to the 'accuracy' strategy and begins to maximize accuracy. 'all', Maximizes all test scores and minimizes test loss, 'all' strategy most strong and most robust strategy. Default is 'accuracy'.

- k.
- l. **patience ((int, float), optional):** patience value for adaptive strategies. For 'adaptive_accuracy' Default value: 5. For 'adaptive_loss' Default value: 0.150.
- m.
- n. **depth (int, optional):** The depth of the PLAN neural networks Aggreagation layers.
- o.
- p. **batch_size (float, optional):** Batch size is used in the prediction process to receive test feedback by dividing the test data into chunks and selecting activations based on randomly chosen partitions. This process reduces computational cost and time while still covering the entire test set due to random selection, so it doesn't significantly impact accuracy. For example, a batch size of 0.08 means each test batch represents 8% of the test set. Default is 1. (%100 of test)
- q.
- r. **auto_normalization (bool, optional):** If auto normalization=False this makes more faster training times and much better accuracy performance for some datasets. Default is True.
- s.
- t. **early_shifting (int, optional):** Early shifting checks if the test accuracy improves after a given number of activation attempts while inside a depth. If there's no improvement, it automatically shifts to the next depth. Basically, if no progress, it's like, "Alright, let's move on!" Default is False
- u.
- v. **early_stop (bool, optional):** If True, implements early stopping during training.(If test accuracy not improves in two depth stops learning.) Default is False.
- w.
- x. **show_current_activations (bool, optional):** Should it display the activations selected according to the current strategies during learning, or not? (True or False) This can be very useful if you want to cancel the learning process and resume from where you left off later. After canceling, you will need to view the live training activations in order to choose the activations to be given to the 'start_this' parameter. Default is False
- y.
- z. **show_history (bool, optional):** If True, displays the training history after optimization. Default is False.

aa.

bb. **loss (str, optional):** For visualizing and monitoring. PLAN neural networks doesn't need any loss function in training(if strategy not 'loss'). options: ('categorical_crossentropy' or 'binary_crossentropy') Default is 'categorical_crossentropy'.

cc.

dd. **interval (int, optional):** The interval at which evaluations are conducted during training. (33.33 = 30 FPS, 16.67 = 60 FPS) Default is 100.

ee.

ff. **target_acc (int, optional):** The target accuracy to stop training early when achieved. Default is None.

gg.

hh. **target_loss (float, optional):** The target loss to stop training early when achieved. Default is None.

ii.

jj. **except_this (list, optional):** A list of activations to exclude from optimization. Default is None. (For available activation functions, run this function: plan.activations_list())

kk.

ll. **only_this (list, optional):** A list of activations to focus on during optimization. Default is None. (For available activation functions, run this code: plan.activations_list())

mm.

nn. **start_this (list, optional):** To resume a previously canceled or interrupted training from where it left off, or to continue from that point with a different strategy, provide the list of activation functions selected up to the learned portion to this parameter. Default is None

oo.

pp. **neurons_history (bool, optional):** Shows the history of changes that neurons undergo during the TFL (Test or Train Feedback Learning) stages. True or False. Default is False.

qq.

rr. **dtype (np.dtype, cp.dtype):** Data type for the arrays. np.float32 by default. Example: np.float64 or np.float16. [fp32 for balanced devices, fp64 for strong devices, fp16 for weak devices: not recommended!] (optional) dtype=np.float32, dtype=cp.float32

ss.

tt. **memory (str):** The memory parameter determines whether the dataset to be processed on the GPU will be stored in the CPU's RAM or the GPU's RAM. Options: 'gpu', 'cpu'. Default: 'gpu'.

uu.

vv. Returns:

ww. tuple: A list for model parameters: [Weight matrix, Test loss, Test Accuracy, [Activations functions]].

xx.

yy.

Returns: model(list)

PLANEAT MODULE

The PLANEAT module represents a hybrid approach that combines the PLAN algorithm with the NEAT (Neuroevolution of Augmented Topologies) algorithm. PLANEAT is a hybrid algorithm designed for use in Reinforcement Learning problems as well as Genetic Optimization tasks. Its goal is to enhance the efficiency of traditional NEAT by focusing on creating **PLAN-like models** without unnecessary layers and connections, similar to the activation-focused approach of the PLAN algorithm.

It is also designed to cater to all user groups by offering user-friendly preset modes alongside limitless configuration options for advanced users, ensuring satisfaction for a broad audience.

PLANEAT MODULE FUNCTIONS

1. `planeat.define_genomes ()`

Creates PLANEAT environment.

```
a.   Initializes a population of genomes, where each genome is represented
    by a set of weights
b.
c.   and an associated activation function. Each genome is created with
    random weights and activation
d.   functions are applied and normalized. (Max abs normalization.)
e.
f.   Args:
g.       input_shape (int): The number of input features for the neural
    network.
h.       output_shape (int): The number of output features for the
    neural network.
i.       population_size (int): The number of genomes (individuals) in
    the population.
j.
k.       dtype (np.dtype, cp.dtype): Data type for the arrays.
    np.float32 by default. Example: np.float64 or np.float16. [fp32 for
    balanced devices, fp64 for strong devices, fp16 for weak devices: not
    recommended!] (optional) dtype=np.float32, dtype=cp.float32
l.
m.
n.   Returns:
o.       tuple: A tuple containing:
p.           - population_weights (numpy.ndarray): A 2D numpy array of shape
    (population_size, output_shape, input_shape) representing the
q.           weight matrices for each genome.
r.           - population_activations (list): A list of activation functions
    applied to each genome.
s.
t.   Raises:
u.       ValueError:
```

```

v.         - If the population size is odd (ensuring an even number of
            genomes is required for proper selection).
w.
x.     Notes:
y.         The weights are initialized randomly within the range [-1, 1].
z.         Activation functions are selected randomly from a predefined list
            `activations_list()`.
aa.        The weights for each genome are then modified by applying the
            corresponding activation function
bb.        and normalized using the `normalization()` function. (Max abs
            normalization.)

```

2. planeat.evaluate ()

Making predicitions for each genome in single generation. (Or if `rl_mode=True` then making prediction for single genome.)

```

cc.     Evaluates the performance of a population of genomes, applying
            different activation functions
dd.     and weights depending on whether reinforcement learning mode is
            enabled or not.
ee.
ff.     Args:
gg. x_population (list or numpy.ndarray): A list or 2D numpy array
            where each element represents
hh. a genome (A list of input features for each genome, or a single set of
            input features for one genome (only in rl_mode)).
ii.
jj. weights (list or numpy.ndarray): A list or 2D numpy array of
            weights corresponding to each genome in `x_population`. This determines
            the strength of connections.
kk.
ll.
mm. activation_potentiations (list or str): A list where each entry
            represents an activation function or a potentiation strategy applied to
            each genome. If only one activation function is used, this can be a
            single string.
nn.
oo. rl_mode (bool, optional): If True, reinforcement learning mode is
            activated, this accepts x_population is a single genom. (Also weights
            and activation_potentations a single genomes part.)
pp.                                     Default is False.
qq.
rr. dtype (np.dtype, cp.dtype): Data type for the arrays. np.float32 by
            default. Example: np.float64 or np.float16. [fp32 for balanced devices,

```

```

fp64 for strong devices, fp16 for weak devices: not recommended!]
(optional) dtype=np.float32, dtype=cp.float32
ss.
tt.
uu.    Returns:
vv.        list: A list of outputs corresponding to each genome in the
            population after applying the respective
ww.            activation function and weights.
xx.
yy.    Notes:
zz.        - If `rl_mode` is True:
aaa.            - Accepts x_population is a single genom
bbb.            - The inputs are flattened, and the activation
            function is applied across the single genom.
ccc.
ddd.        - If `rl_mode` is False:
eee.            - Accepts x_population is a list of genomes
fff.            - Each genome is processed individually, and the
            results are stored in the `outputs` list.
ggg.
hhh.        - `feed_forward()` function is the core function that
            processes the input with the given weights and activation function.
iii.
jjj.    Example:
kkk.        ```python
lll.        outputs = evaluate(x_population, weights,
            activation_potentiations, rl_mode=False)
mmm.        ```
nnn.
ooo.        - The function returns a list of outputs after processing the
            population, where each element corresponds to
ppp.        the output for each genome in `x_population`.
qqq.

```

3. planeat.evolve()

Applies (Adjust weight and actiavation parameters) PLANEAT algorithm for each genome in population.

```

rrr.        Applies the learning process of a population of genomes using
            selection, crossover, mutation, and activation function potentiation.

```

```

sss.         The function modifies the population's weights and activation
              functions based on a specified policy, mutation probabilities, and
              strategy.
ttt.
uuu.         Args:

weights (numpy.ndarray): Array of weights for each genomes. (first
returned value of define_genomes function)
vvv.
activation_potentiations (list): A list of activation functions for
each genomes. (second returned value of define_genomes function)
www.
what_gen (int): The current generation number, used for informational
purposes or logging.
xxx.
y_reward (numpy.ndarray): A 1D array containing the fitness or reward
values of each genome. The array is used to rank the genomes based on their
performance. And PLANEAT maximize the reward.
yyy.
show_info (bool, optional): If True, prints information about the
current generation and the maximum reward obtained. Also shows current
configuration. Default is False.
zzz.
strategy (str, optional): The strategy for combining the best and bad
genomes. Options:
aaaa.         - 'cross_over': Perform Two-
              Point Matrix Crossover between the best genomes and replace bad genomes.
              (Classic NEAT cross over)
bbbb.         - 'potentiate': Cumulate the
              weight of the best genomes and replace bad genomes. (PLAN feature. 'Like
              Arithmetic Crossover but different.') Default is 'cross_over'.
cccc.

policy (str, optional): The selection policy that governs how genomes
are selected for reproduction. Options:
dddd.         - 'normal_selective':

eeee.         Normal selection based on reward, where a portion of the bad genes
              are discarded.
ffff.         - 'more_selective': A more
              selective policy, where fewer bad genes survive.
gggg.         - 'less_selective': A less
              selective policy, where more bad genes survive.
hhhh.         Default is 'normal_selective'.
iiii.
mutations (bool, optional): If True, mutations are applied to the bad
genomes and potentially to the best genomes as well. Default is True.

```


bad_genoms_mutation_prob (float, optional): The probability of applying mutation to the bad genomes. Must be in the range [0, 1]. Also affects best genomes mutation prob. For example 0.7 value for bad genomes then 0.3 value for best genomes. Default is None, which means it is determined by the `policy` argument.

jjjj.

activation_mutate_prob (float, optional): The probability of applying mutation to the activation functions. Must be in the range [0, 1]. Default is 0.5 (% 50)

cross_over_mode (str, optional): Specifies the crossover method to use. Options:

- 'tpm': Two-Point Matrix Crossover
 - 'plantic': plantic Crossover
- Default is 'tpm'.

activation_add_prob (float, optional): The probability of adding a new activation function to the genome.

Must be in the range [0, 1]. Default is 0.7.

activation_delete_prob (float, optional): The probability of deleting an existing activation function

from the genome. Must be in the range [0, 1]. Default is 0.5.

activation_change_prob (float, optional): The probability of changing an activation function in the genome.

Must be in the range [0, 1]. Default is 0.5.

weight_mutate_prob (float, optional): The probability of mutating a weight in the genome.

Must be in the range [0, 1]. Default is 1.

weight_mutate_rate (int, optional): If the value you enter here is equal to the result of input layer * output layer,

only a single weight will be mutated during each mutation process.

If the value you enter here is half

of the result of input layer * output layer, two weights in the weight matrix will be mutated.

WARNING: if you don't understand do NOT change this value. Default is 32.

activation_selection_add_prob (float, optional): The probability of adding an existing activation function for cross over.

from the genome. Must be in the range [0, 1]. Default is 0.5.

activation_selection_change_prob (float, optional): The probability of changing an activation function in the genome for cross over.

Must be in the range [0, 1]. Default is 0.7. (WARNING! More higher values make models more complex. For fast training rise this value.)

activation_selection_rate (int, optional): If the activation list of a good genome is smaller than the value entered here, only one activation will undergo a crossover operation. In other words, this parameter controls the model complexity. Default is 2.

save_best_genom (bool, optional): If True, ensures that the best genome are saved and not mutated or altered during reproduction. Default is True.

dtype (np.dtype, cp.dtype): Data type for the arrays. np.float32 by default. Example: np.float64 or np.float16. [fp32 for balanced devices, fp64 for strong devices, fp16 for weak devices: not recommended!]
(optional) dtype=np.float32, dtype=cp.float32

kkkk. **Raises:**

llll. **ValueError:**

mmmm. - If `policy` is not one of the specified values ('normal_selective', 'more_selective', 'less_selective').

nnnn.

oooo. - If `bad_genoms_mutation_prob`, `activation_mutate_prob`, or other probability parameters are not in the range [0, 1].

pppp. - If the population size is odd (ensuring an even number of genomes is required for proper selection).

qqqq.

rrrr.

ssss. **Returns:**

tttt. tuple: A tuple containing:

uuuu. - weights (numpy.ndarray): The updated weights for the population after selection, crossover, and mutation.

vvvv. The shape is (population_size, output_shape, input_shape).

www. - activation_potentiations (list): The updated list of activation functions for the population.

xxxx.

yyyy. **Notes:**

zzzz. - ****Selection Process**:**

aaaaa. - The genomes are sorted by their fitness (based on `y_reward`), and then split into "best" and "bad" half.

bbbbb. - The best genomes are retained, and the bad genomes are modified based on the selected strategy.

cccc.

dddd. - ****Crossover and Potentiation Strategies**:**

```

eeeeee.         - The cross_over strategy performs crossover,
                  where parts of the best genomes' weights are combined with the other
                  good genomes to create new weight matrices.
fffff.          - The potentiate strategy strengthens the best
                  genomes by potentiating their weights towards the other good genomes.
ggggg.
hhhhh.          - Mutation:
iiiiii.         - Mutation is applied to both the best and bad
                  genomes, depending on the mutation probability and the policy.
jjjjj.          - bad_genoms_mutation_prob determines the
                  probability of applying mutations to the bad genomes.
kkkkk.          - If activation_mutate_prob is provided, activation
                  function mutations are applied to the genomes based on this probability.
lllll.
mmmmm.
nnnnn.
- Policy Types:

- normal_selective: A typical selection policy where a portion of the
bad genomes is discarded. The mutation probability for the bad genomes is
set to 0.7 by default.

- more_selective: A stricter selection policy where more of the bad
genomes are discarded. The mutation probability for the bad genomes is set
to 0.85 by default.

- less_selective
z*: A more lenient selection policy where fewer bad genomes are discarded.
The mutation probability for the bad genomes is set to 0.6 by default.

- Population Size: The population size must be an even number to
properly split the best and bad genomes. If y_reward has an odd length,
an error is raised.

- Logging: If show_info=True, the current generation and the maximum
reward from the population are printed for tracking the learning progress.

    Example:
ooooo.          ```python
ppppp.          weights, activation_potentiations = learner(weights,
                  activation_potentiations, 1, y_reward, info=True, strategy='cross_over',
                  policy='normal_selective')
qqqqq.          ```
rrrrr.
sssss.          - The function returns the updated weights and activations
                  after processing based on the chosen strategy, policy, and mutation
                  parameters.
ttttt.          """
uuuuu.

```

DATA OPERATIONS MODULE FUNCTIONS

1. `data_operations.auto_balancer()`

This function aims to balance all training data according to class distribution before training the model. All data is reduced to the number of data points of the class with the least number of examples.

- a. `x_train (list)`: Input data for training.
- b. `y_train (list)`: Labels corresponding to the input data.
- c.
- d. `dtype (np.dtype, cp.dtype)`: Data type for the arrays. `np.float32` by default. Example: `np.float64` or `np.float16`. [`fp32` for balanced devices, `fp64` for strong devices, `fp16` for weak devices: not recommended!]
(optional) `dtype=np.float32, dtype=cp.float32`
- e.
- f. `memory (str)`: The memory parameter determines whether the dataset to be processed on the GPU will be stored in the CPU's RAM or the GPU's RAM. Options: `'gpu'`, `'cpu'`. Default: `'gpu'`.
- g.
- h. `shuffle_in_cpu (bool)`: If True, output will be same `cpu's auto_balancer` function. (Use this for direct comparison of `cpu` training.) Default: False.
- i.
- j.

This function returns the following outputs in order: a list containing the balanced training data and a list containing the balanced training labels.

2. `data_operations.synthetic_augmentation()`

This function creates synthetic data samples with given data samples for balance data distribution.

```
a.      x -- Input dataset (examples) - array format
b.      y -- Class labels (one-hot encoded) - array format
c.
d. dtype (np.dtype, cp.dtype): Data type for the arrays. np.float32 by
   default. Example: np.float64 or np.float16. [fp32 for balanced devices,
   fp64 for strong devices, fp16 for weak devices: not recommended!]
   (optional) dtype=np.float32, dtype=cp.float32
e.
f. shuffle_in_cpu (bool): If True, output will be same cpu's
   auto_balancer function. (Use this for direct comparison of cpu
   training.) Default: False.
g.
```

This function returns the following outputs in order: a list containing the balanced training data and a list containing the balanced training labels. or testing labels.

3. `data_operations.encode_one_hot()`

```

a. Performs one-hot encoding on y_train and y_test data.
b.
c. Args:
d.
e. y_train (numpy.ndarray): Labeled train data.
f.
g. y_test (numpy.ndarray): Labeled test data.
h.
i. summary (bool): If True, prints the class-to-index mapping.
    Default: False
j.
k.

```

Returns one hot encoded labels.

4. data_operations.split()

This function splits all data for train and test

```

a. X (numpy.ndarray): Features data.
b.
c. y (numpy.ndarray): Labels data.
d. dtype (np.dtype, cp.dtype): Data type for the arrays. np.float32 by
    default. Example: np.float64 or np.float16. [fp32 for balanced devices,
    fp64 for strong devices, fp16 for weak devices: not recommended!]
    (optional) dtype=np.float32, dtype=cp.float32
e.
f. shuffle_in_cpu (bool): If True, output will be same cpu's
    auto_balancer function. (Use this for direct comparison of cpu
    training.) Default: False.
g.
h.
i. test_size (float or int): Proportion or number of samples for the
    test subset.
j.
k. random_state (int or None): Seed for random state.

```

Returns: x_train, x_test, y_train, y_test

5. `data_operations.decode_one_hot()`

```
a. encoded_data (numpy.ndarray): One-hot encoded data with shape (n_samples, n_classes).
```

Returns: decoded `y_test` given input

6. `data_operations.manuel_balancer ()`

Same operation of `auto_balacner`, but this function gives the limit of sample addition to user.

```
a. x_train -- Input dataset (examples) - NumPy array format
b.
c. y_train -- Class labels (one-hot encoded) - NumPy array format
d.
e. target_samples_per_class -- Desired number of samples per class
f. dtype (np.dtype, cp.dtype): Data type for the arrays. np.float32 by default. Example: np.float64 or np.float16. [fp32 for balanced devices, fp64 for strong devices, fp16 for weak devices: not reccomended!] (optional) dtype=np.float32, dtype=cp.float32
g.
h. shuffle_in_cpu (bool): If True, output will be same cpu's auto_balancer function. (Use this for direct comparison of cpu training.) Default: False.
i.
```

Returns: `x_train`, `y_train`

7. `data_operations.standard_scaler()`

```

a. train_data: numpy.ndarray
b.
c. test_data: numpy.ndarray (optional)
d.
e. scaler_params (optional for using model)
f.
g. dtype (np.dtype, cp.dtype): Data type for the arrays. np.float32
  by default. Example: np.float64 or np.float16. [fp32 for balanced
  devices, fp64 for strong devices, fp16 for weak devices: not
  recommended!] (optional) dtype=np.float32, dtype=cp.float32
h.

```

Returns: If x_test and x_train given but scaler_params not given then returns: standard scaled parameters, standard scaled x_train, standard scaled y_test. If x_test is not given and x_train given but scaler_params not given then returns: standard scaled parameters, standard scaled x_train. If just one x_test(your real-world sample) and scaler_params given then returns scaled x_test(your real-world sample).

MODEL OPERATIONS MODULE **FUNCTIONS**

1. **model_operations.save_model ()**

This function creates log files in the form of a pandas DataFrame containing all the parameters and information of the trained and tested model, and saves them to the specified location along with the weight matrices.

```

vvvvvv.    Function to save a potentiation learning model.
wwwww.
xxxxxx.    Arguments:

```



```

yyyyyy.
zzzzz.  model_name (str): Name of the model.
aaaaaa.
bbbbbb. model_type (str): Type of the model. default: 'PLAN'
ccccc.
ddddd.  test_acc (float): Test accuracy of the model. default: None
eeeeee.
ffffff. weights_type (str): Type of weights to save (options: 'txt',
      'pkl', 'npz', 'mat'). default: 'npz'
gggggg.
hhhhh.  weights_format (str): Format of the weights (options: 'f',
      'raw'). default: 'raw'
iiiiii.
jjjjjj. model_path (str): Path where the model will be saved. For
      example: C:/Users/beydili/Desktop/denemePLAN/ default: ''
kkkkkk.
llllll. scaler_params (num[num, num]): standard scaler params list:
      mean,std. If not used standard scaler then be: None.
mmmmmm.
nnnnnn. W: Weights of the model.
oooooo.
pppppp. activation_potential (list): For deeper PLAN networks,
      activation function parameters. For more information please run this
      code: activation_functions.activations_list() default: ['linear']
qqqqqq.
rrrrrr. show_architecture (bool): It draws model architecture. True or
      False. Default: False
ssssss.
tttttt. show_info (bool): Prints model details into console. default:
      True
uuuuuu.
vvvvvv.
wwwwww.  Returns:
xxxxxx.  str: Message indicating if the model was saved successfully or
      encountered an error.

```

This function returns messages such as 'saved' or 'could not be saved' as output.

2. **model_operations.load_model()**

This function retrieves everything about the model into the Python environment from the saved log file and the model name.

- a. **model_name (str):** Name of the model.
- b. **model_path (str):** Path where the model is saved.

This function returns the following outputs in order: W, activation_potential, df (Data frame of model).

3. **model_operations.predict_model_ssd()**

This function loads the model directly from its saved location, predicts a requested input, and returns the output. (It can be integrated into application systems and the output can be converted to .json format and used in web applications.)

- a. **Input (list or ndarray):** Input data for the model (single vector or single matrix).
- b.
- c. **model_name (str):** Name of the model.
- d.
- e. **model_path (str):** Path of the model. Default: ''
- f.
- g. **dtype (np.dtype, cp.dtype):** Data type for the arrays. np.float32 by default. Example: np.float64 or np.float16. [fp32 for balanced devices, fp64 for strong devices, fp16 for weak devices: not recommended!] (optional)
dtype=np.float32, dtype=cp.float32
- h.
- i.

This function returns the output layer of the model as the output of the given input.

4. `model_operations.predict_model_ram()`

This function predicts and returns the output for a requested input using a model that has already been loaded into the program (located in the computer's RAM). (It can be integrated into application systems and the output can be converted to .json format and used in web applications.) (Other parameters are information about the model and are defined as described and listed above.)

- a. **Input (list or ndarray):** Input data for the model (single vector or single matrix).
- b.
- c. **W (list of ndarrays):** Weights of the model.
- d.
- e. **scaler_params (numpy.array):** standard scaler params list: mean,std. (optional) Default: None.
- f.
- g. **activation_potentiation (list):** ac list for deep PLAN. default: ['linear'] (optional)
- h.
- i. **dtype (np.dtype, cp.dtype):** Data type for the arrays. np.float32 by default. Example: np.float64 or np.float16. [fp32 for balanced devices, fp64 for strong devices, fp16 for weak devices: not reccomended!] (optional) dtype=np.float32, dtype=cp.float32
- j.

This function returns the last output layer of the model as the output of the given input.

5. `model_operations.reverse_predict_model_ssd()`

This function loads the model directly from its saved location, predicts a requested output, and returns the input. It using reverse run.

- a. **output (list or ndarray):** output layer for the model (single probability vector, output layer of trained model).
- b.
- c. **model_name (str):** Name of the model.
- d.

```

e. model_path (str): Path of the model. Default: ''
f.
g. dtype (np.dtype, cp.dtype): Data type for the arrays.
   np.float32 by default. Example: np.float64 or np.float16.
   [fp32 for balanced devices, fp64 for strong devices, fp16
   for weak devices: not reccomended!] (optional)
   dtype=np.float32, dtype=cp.float32
h.

```

This function returns the input layer of the model as the input of the given output.

6. **model_operations.reverse_predict_model_ram()**

This function predicts and returns the input for a requested output using a model that has already been loaded into the program (located in the computer's RAM). It using reverse run.

```

a. Input (list or ndarray): Input data for the model (single vector or
   single matrix).
b.
c. W (list of ndarrays): Weights of the model.
d.
e. dtype (np.dtype, cp.dtype): Data type for the arrays. np.float32 by
   default. Example: np.float64 or np.float16. [fp32 for balanced devices,
   fp64 for strong devices, fp16 for weak devices: not reccomended!]
   (optional) dtype=np.float32, dtype=cp.float32
f.
g.

```

This function returns the last input layer of the model as the input of the given output.

7. plan.get_weights()

This function returns wight matrices list of the selected model. For exp:

```
test_model = plan.evaluate(x_test, y_test)
```

```
W = test_model[plan.get_weights()]
```

8. plan.get_scaler()

Returns scaler_params of the selected model For exp:

```
model = plan.learner(x_train, y_train, depth=10)
```

```
scaler_params = model[plan.get_scaler()]
```

9. plan.get_preds()

Returns predictions list of the selected model

10. plan.get_acc()

Returns accuracy of the selected model

11. plan.get_act_pot()

Returns activation potential of the selected model.

MEMORY OPERATIONS MODULE FUNCTIONS

1. `memory_operations.transfer_to_gpu()`

```
h. The transfer_to_gpu function in Python converts input data to GPU
i. arrays, optimizing memory usage by
j. batching and handling out-of-memory errors.
k. X: The x parameter in the transfer_to_gpu function is the input
l. data that you want to transfer to the GPU for processing. It can be
m. either a NumPy array or a CuPy array. If it's a NumPy array, the
n. function will convert it to a CuPy array and
o. dtype: The dtype parameter in the transfer_to_gpu function
p. specifies the data type to which the input array x should be converted
q. when moving it to the GPU. By default, it is set to cp.float32, which
   is a 32-bit floating-point data type provided by the CuPy
r.
s. Return: The transfer_to_gpu function returns the input data x
t. converted to a GPU array of type dtype (default is cp.float32). If
u. the input x is already a GPU array with the same dtype, it returns x
v. as is. If the data size of x exceeds 25% of the free GPU memory, it
   processes the data in batches to
```

2. `memory_operations.transfer_to_cpu()`

```
r. The transfer_to_cpu function converts data to a specified data
s. type on the CPU, handling memory constraints
t. by batching the conversion process and ensuring complete GPU memory
u. cleanup.
v. x: Input data to transfer to CPU (CuPy array)
```

```
w.    dtype: Target NumPy dtype for the output array (default: np.float32)
x.
y.    Return: NumPy array with the specified dtype
```

LAST PART:

Despite being in its early stages of development, PyerualJetwork has already demonstrated its potential to deliver valuable services and solutions in the field of machine learning. Notably, it stands as the first library dedicated to PLAN (Potentiation Learning Artificial Neural Network), embracing innovation and welcoming new ideas from its users with open arms. Recognizing the value of diverse perspectives and fresh ideas, Hasan Can Beydili the creator of PyerualJetwork, am committed to fostering an open and collaborative environment where users can freely share their thoughts and suggestions. The most promising contributions will be carefully considered and potentially integratd into the PyerualJetwork library. For your suggestions, lists and feedback, my e-mail address is: tchasanacan@gmail.com

Trust the PLAN...