

CLAIMS

1. A method of training an artificial neural network, comprising:
 - randomly initializing a plurality of weights, each of the plurality of weights corresponding to a synapse of an artificial neural network;
 - inputting at least one array of inputs to the artificial neural network;
 - determining by the artificial neural network at least one array of outputs based on the at least one array of inputs and the plurality of weights;
 - comparing the at least one array of outputs to ground truth data to determine a first loss;
 - determining a second loss by adding a drift regularization to the first loss, the drift regularization being positively correlated to variance of the at least one array of outputs; and
 - updating the plurality of weights based on the second loss by backpropagation.
2. The method of claim 1, wherein the artificial neural network comprises a crossbar array of phase change memory elements.
3. The method of claim 1, wherein the artificial neural network comprises a plurality of layers.
4. The method of claim 1, wherein the first loss is a cross-entropy loss.
5. The method of claim 1, wherein determining the first loss comprises regularization.
6. The method of claim 1, comprising:
 - further updating the plurality of weights by backpropagation until a target accuracy is obtained.
7. A system comprising:
 - an artificial neural network comprising a crossbar array of phase change memory elements;
 - a computing node comprising a computer readable storage medium having program instructions embodied therewith, the program instructions executable by a processor of the computing node to cause the processor to perform a method comprising:
 - randomly initializing a plurality of weights, each of the plurality of weights corresponding to a synapse of the artificial neural network;
 - inputting at least one array of inputs to the artificial neural network;
 - obtaining from the artificial neural network at least one array of outputs based on the at least one array of inputs and the plurality of weights;
 - comparing the at least one array of outputs to ground truth data to determine a first loss;

determining a second loss by adding a drift regularization to the first loss, the drift regularization being positively correlated to variance of the at least one array of outputs; and

updating the plurality of weights based on the second loss by backpropagation.

8. The system of claim 7, wherein the artificial neural network comprises a crossbar array of phase change memory elements.

9. The system of claim 7, wherein the artificial neural network comprises a plurality of layers.

10. The system of claim 7, wherein the first loss is a cross-entropy loss.

11. The system of claim 7, wherein determining the first loss comprises regularization.

12. The system of claim 7, the method further comprising:
further updating the plurality of weights by backpropagation until a target accuracy is obtained.

13. A computer program product for training an artificial neural network, the computer program product comprising a computer readable storage medium having program instructions embodied therewith, the program instructions executable by a processor to cause the processor to perform a method comprising:

randomly initializing a plurality of weights, each of the plurality of weights corresponding to a synapse of the artificial neural network;

inputting at least one array of inputs to the artificial neural network;

obtaining from the artificial neural network at least one array of outputs based on the at least one array of inputs and the plurality of weights;

comparing the at least one array of outputs to ground truth data to determine a first loss;

determining a second loss by adding a drift regularization to the first loss, the drift regularization being positively correlated to variance of the at least one array of outputs; and

updating the plurality of weights based on the second loss by backpropagation.

14. The computer program product of claim 13, wherein the artificial neural network comprises a crossbar array of phase change memory elements.

15. The computer program product of claim 13, wherein the artificial neural network comprises a plurality of layers.

16. The computer program product of claim 13, wherein the first loss is a cross-entropy loss.

17. The computer program product of claim 13, wherein determining the first loss comprises regularization.
18. The computer program product of claim 13, the method further comprising:
further updating the plurality of weights by backpropagation until a target accuracy is obtained.
19. A method for use with a deep neural network (DNN) comprising various layers, each of the layers having a plurality of synapses and neurons, wherein the synapses are associated with respective weights that are associated with respective pairs of connected neurons, the method comprising:
- (a) randomly initializing the weights;
 - (b) inputting at least one array of input signals into a first one of the layers, the signals corresponding to data to be analyzed, wherein the weights are used to compute forward propagation of the signals through the DNN;
 - (c) after the array of signals has propagated through the DNN, comparing output from the DNN with ground truth labels to compute an initial loss;
 - (d) adding an additional loss term to the initial loss, thereby forming a total loss, so that the variation of the output distribution for different inputted signal arrays causes the total loss to increase;
 - (e) calculating the output error, in view of the total loss;
 - (f) back-propagating through the DNN to obtain, for each layer, a corresponding error signal, wherein the weights are used to compute the error signals;
 - (g) computing the outer product between the error signals and the array of input signals to create a weight update matrix that is then added to the weights to form updated weights; and
 - (h) repeating steps (b)-(g) using the updated weights calculated in (g) until a satisfactory level of accuracy is obtained.