OBLIQUE ELLIPTICAL BASIS FUNCTION - OEBF

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Current state

- RBF - uses euclidean distance from the center of neuron as output, neurons have a single weight (radius).
- EBF - calculates normalized distance from the center of neuron, lengths of semi-axis are neuron weights.
- OEBF - improves EBF flexibility with rotation of semi-axis.

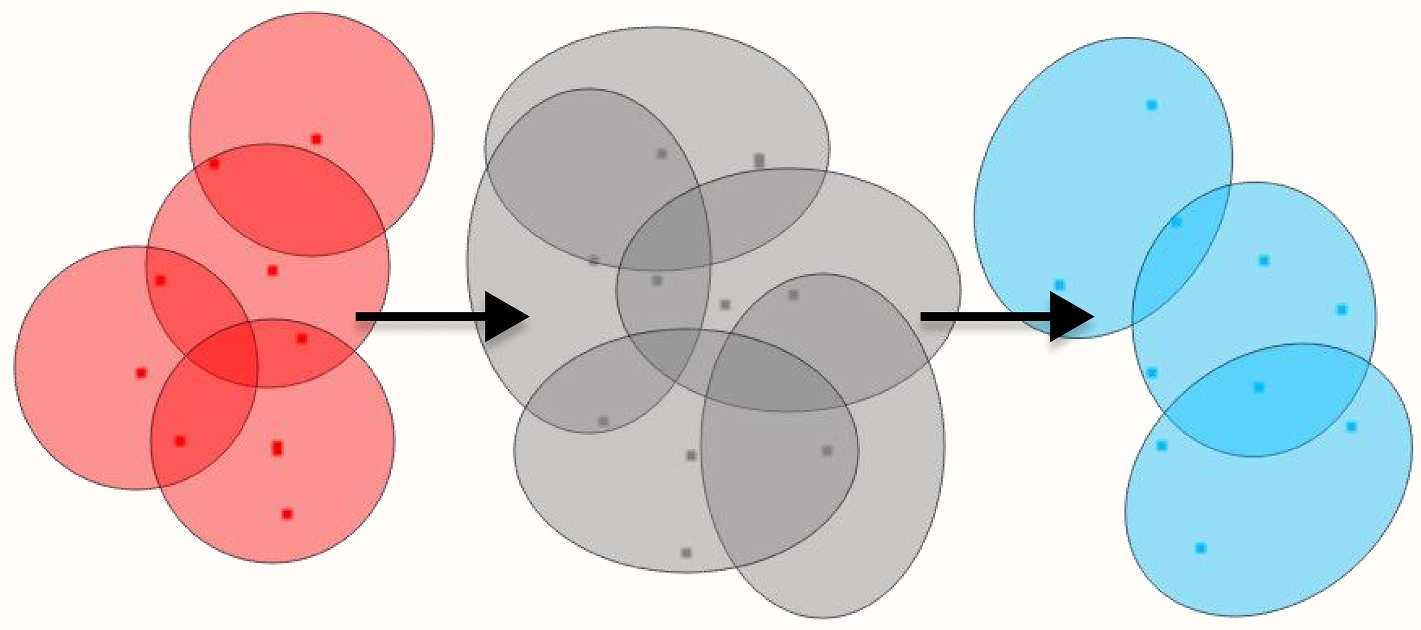

Image 1

Proposed solution

- Builds on the foundation of RBF.
- Uses euclidean distance from focal points as output.
- Separates n-dimensional data using ellipse in oblique position.
- The neurons have 2 weights (lengths of main and secondary semi-axis).

$$u = \sqrt{\sum_{i=0}^{i=n} (F_{1i} - x_i)^2} + \sqrt{\sum_{i=0}^{i=n} (F_{2i} - x_i)^2}$$

Equation 1

$$u \leq 2\,a$$

Activation function

Weights manipulation

- To shorten semi-axis, focal points of the ellipse need to be moved along the main semi-axis.
- The distance of focal points from the center is called eccentricity.

$$e = \sqrt{a^2 - b^2}$$

Equation 2

- The eccentricity ratio is utilized to adjust the directional vector from the ellipse's center to its focal points when computing new focal point coordinates.

$$F_1 = C + \frac{e_{new}}{e} * \vec{v} \qquad F_2 = C - \frac{e_{new}}{e} * \vec{v}$$

Equation 3

Results

Neurons are compared using Restricted Coullumb Energy Neural Network (RCENN). It's chosen for it's simple learning process, which yields 100% accuracy rate on training dataset. Thus setting a fixed/fair stoping point in learning of each neuron.

Focal points selection

- During learning the first unclassified point is set as first focal point
- The second focal point is the farthest unclassified training vector, with which the ellipses center is unclassified.

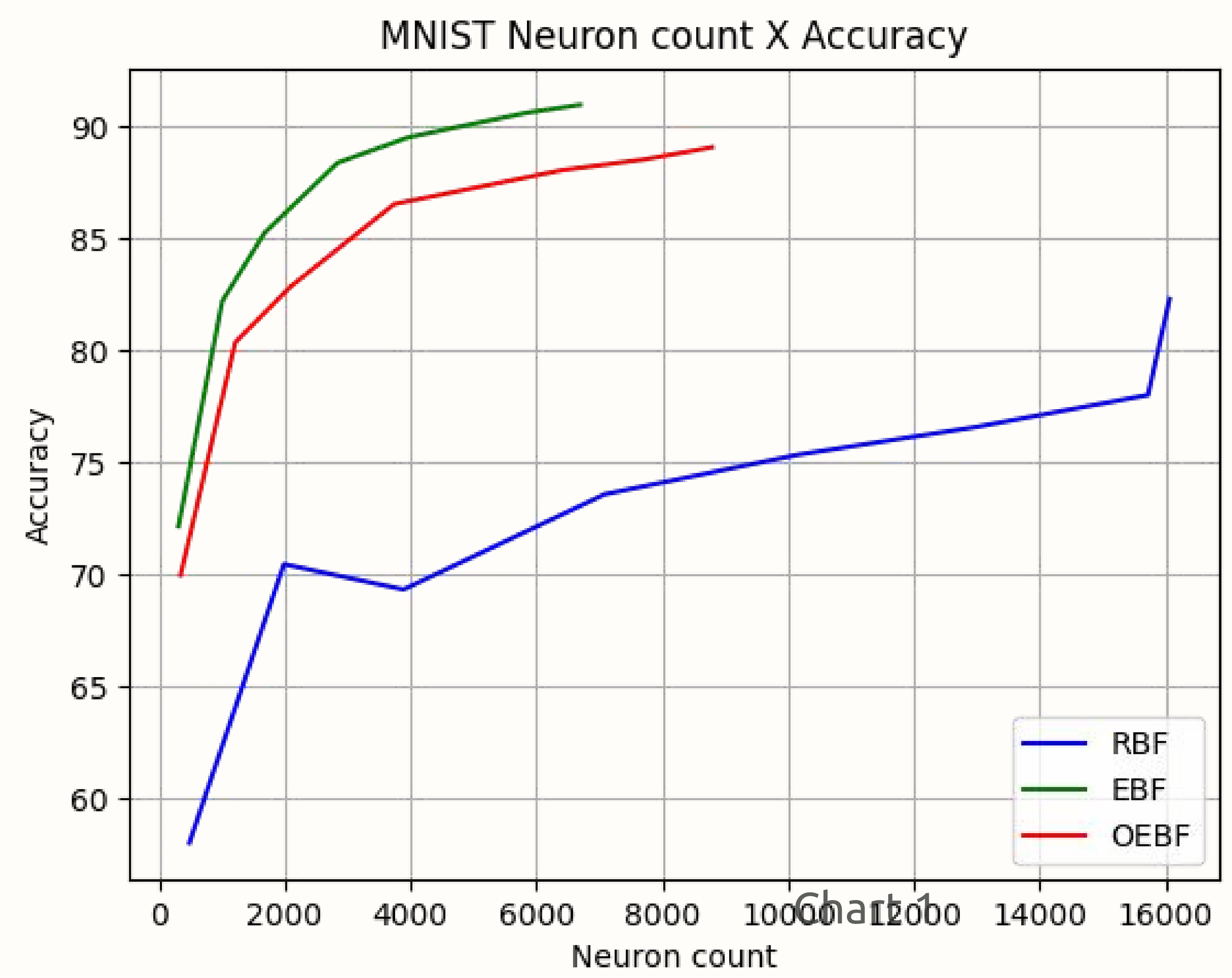

Chart 1

Accuracy

↑6.77 % RBF
↓1.89 % EBF

Neuron count

↓45.27 % RBF
↑31.26 % EBF

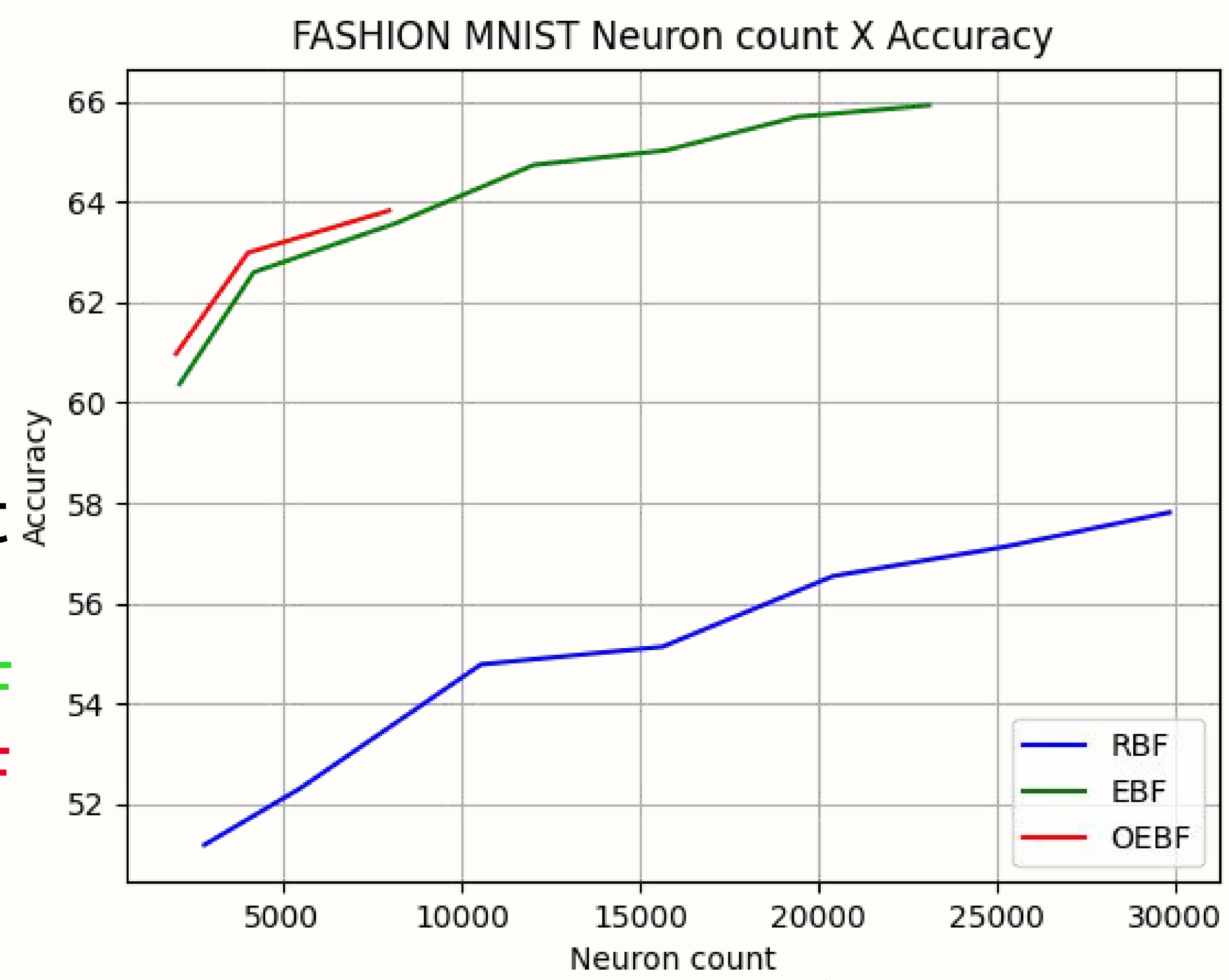

Chart 2

Accuracy

↑9.05 % RBF
↑0.25 % EBF

Neuron count

↓24.36 % RBF
↓02.35 % EBF

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