

Figure 11: Parallel displacement. The circles, triangles, and squares (black or white) have the same meanings as in Fig. 8. (a) Straight line. (b) Curved line.

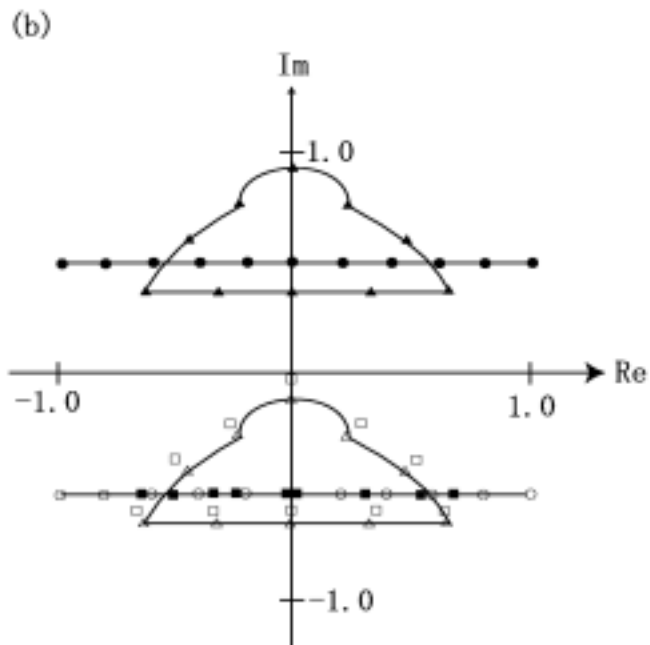
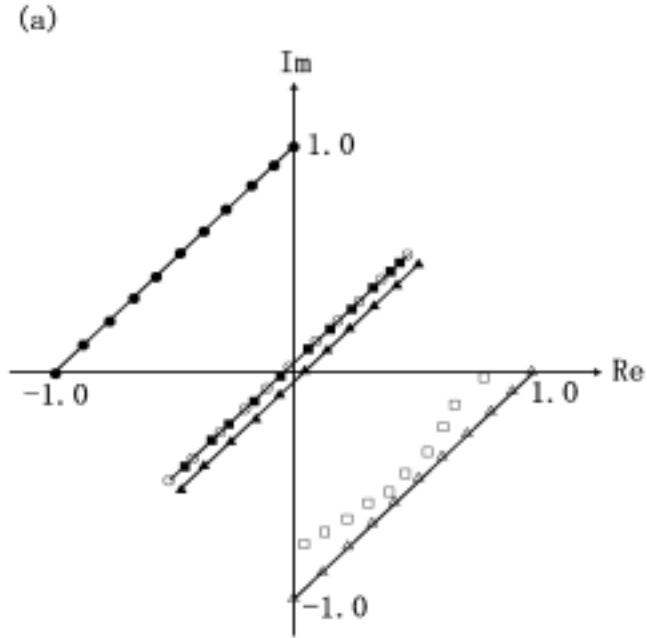


Figure 12: Learning and test patterns for the systematic investigation of the generalization ability of the Complex-BP. The circles and triangles (black or white) have the same meanings as in Fig. 8. (a) Rotation. (b) Similarity transformation. (c) Parallel displacement.

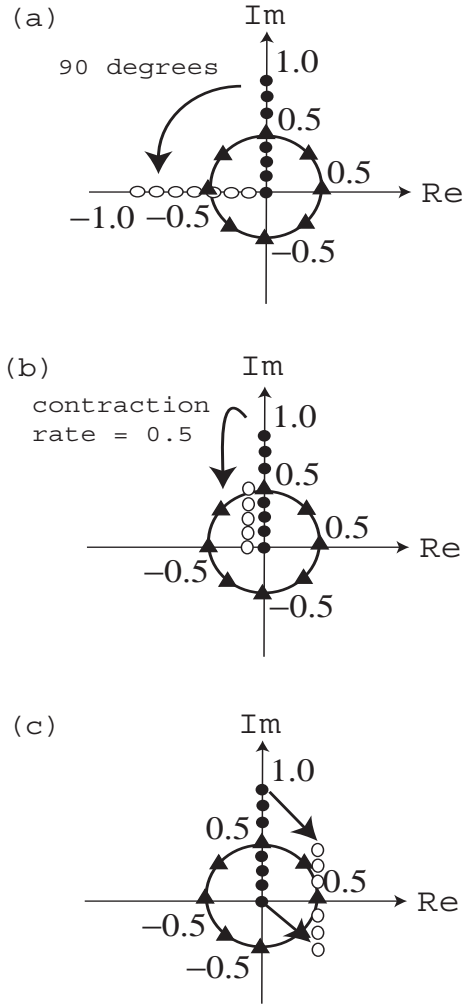


Figure 13: (a) Results of the evaluation of the performance of the generalization ability of the Complex-BP (Rotation, 1-1-1 network).  $Gen\_Error$  ( $= |E^R(\phi)|$ ) denotes the Euclidean distances between the actual output test point and the expected output test point in the test step;  $K(= \phi)$  denotes the difference between the argument of a test point and that of an input training point. Error refers to the left side of eqn (??), i.e., the error between the desired output patterns and the actual output patterns in the training step.

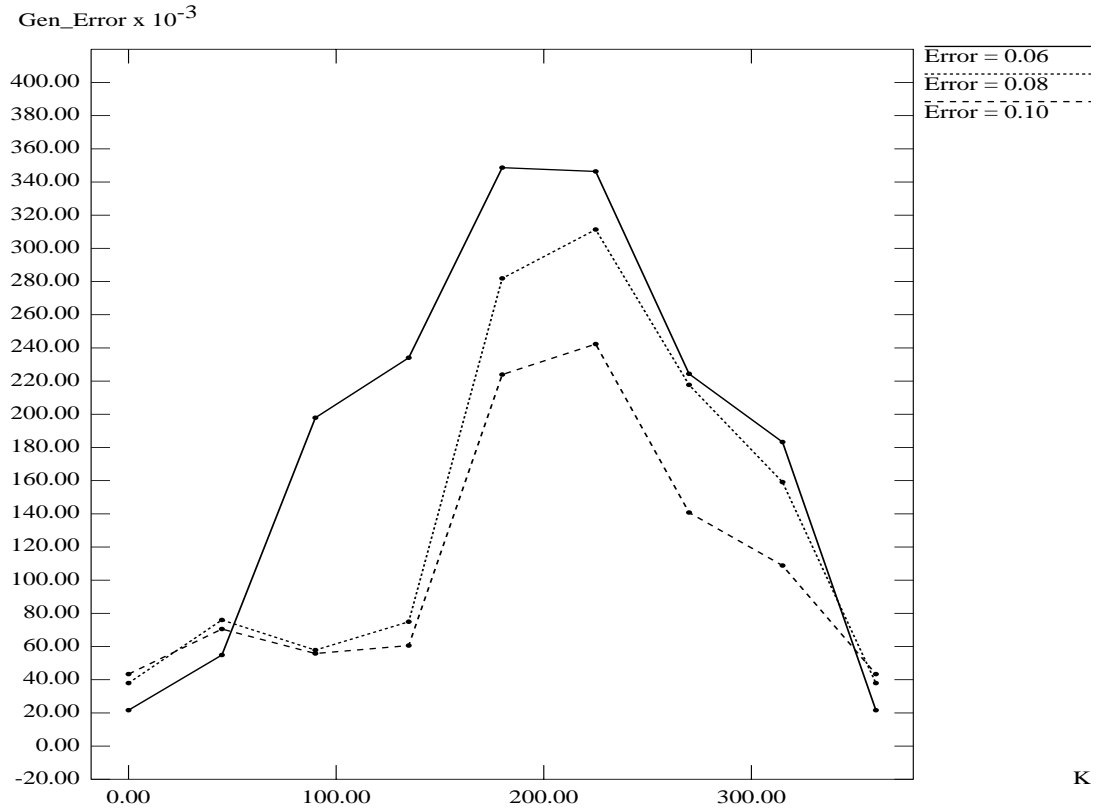


Figure 13: (b) Results of the evaluation of the performance of the generalization ability of the Complex-BP (Similarity transformation, 1-1-1 network).  $Gen\_Error$  ( $= |E^S(\phi)|$ ) denotes the Euclidean distances between the actual output test point and the expected output test point in the test step;  $K(= \phi)$  denotes the difference between the argument of a test point and that of an input training point. Error refers to the left side of eqn (??), i.e., the error between the desired output patterns and the actual output patterns in the training step.

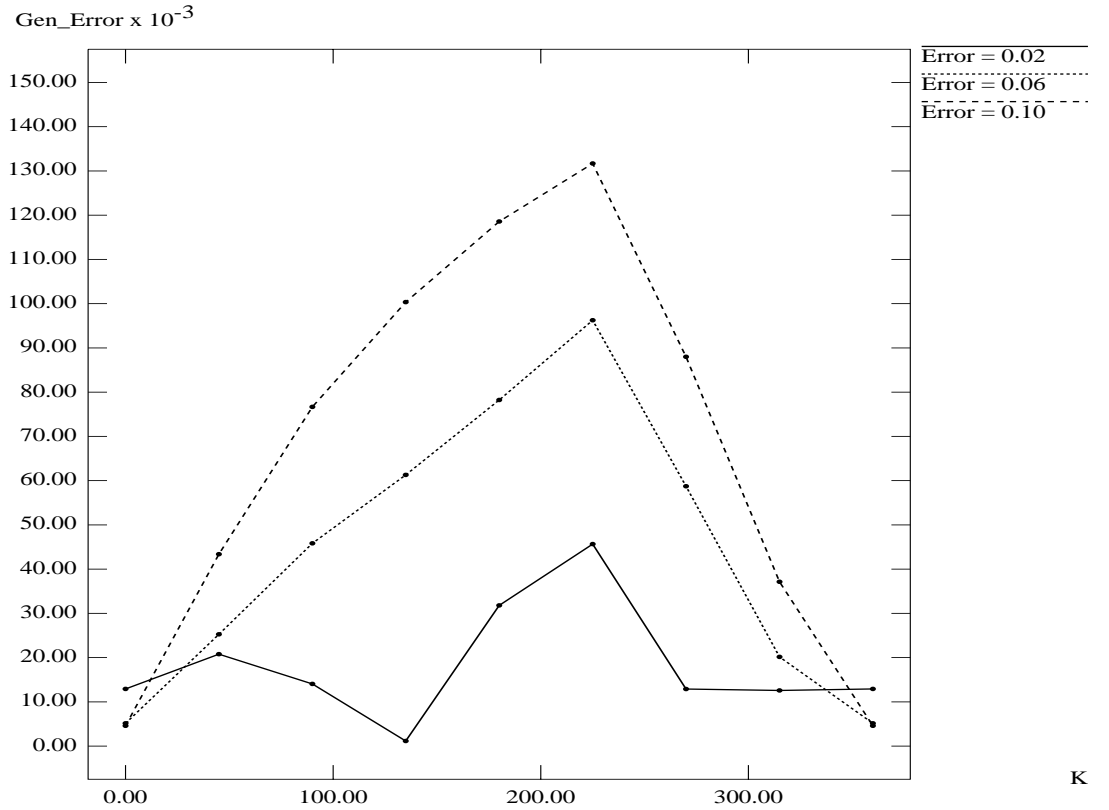


Figure 13: (c) Results of the evaluation of the performance of the generalization ability of the Complex-BP (Parallel displacement, 1-1-1 network).  $Gen\_Error (= |E^P(\phi)|)$  denotes the Euclidean distances between the actual output test point and the expected output test point in the test step;  $K(= \phi)$  denotes the difference between the argument of a test point and that of an input training point. Error refers to the left side of eqn (??), i.e., the error between the desired output patterns and the actual output patterns in the training step.

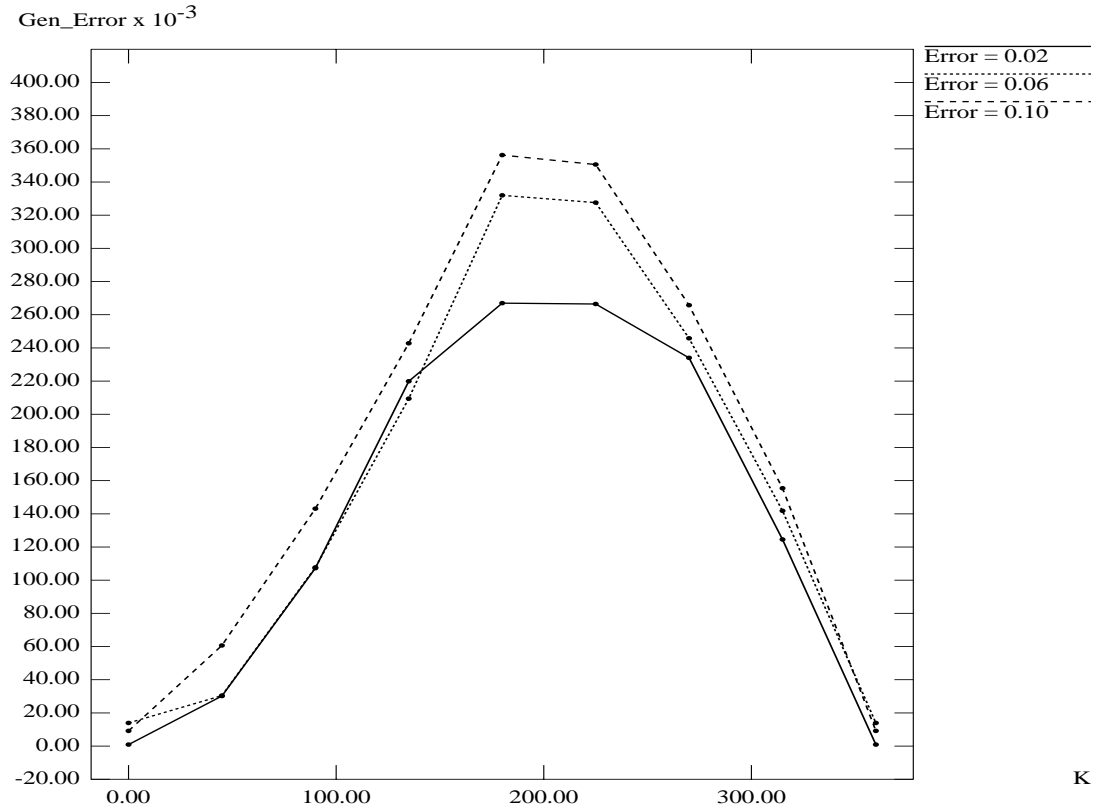


Figure 13: (d) Results of the evaluation of the performance of the generalization ability of the Complex-BP (Rotation, 1-6-1 network).  $Gen\_Error$  ( $= |E^R(\phi)|$ ) denotes the Euclidean distances between the actual output test point and the expected output test point in the test step;  $K(= \phi)$  denotes the difference between the argument of a test point and that of an input training point. Error refers to the left side of eqn (??), i.e., the error between the desired output patterns and the actual output patterns in the training step.

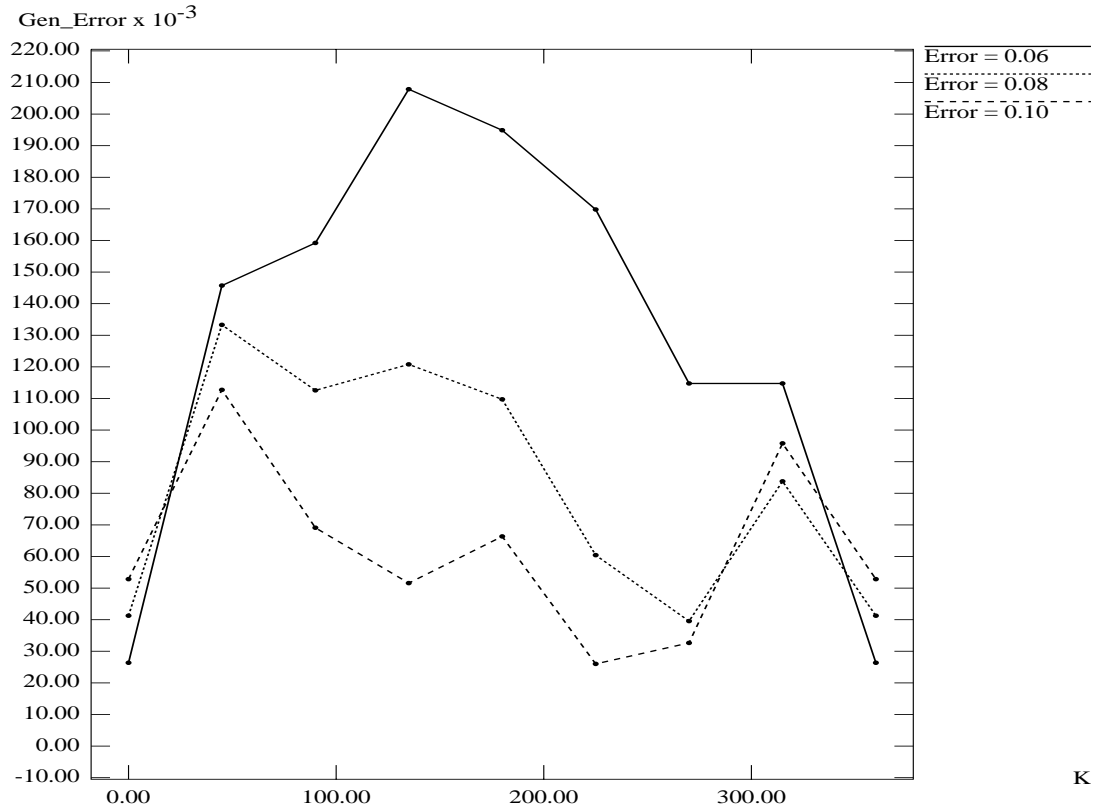


Figure 13: (e) Results of the evaluation of the performance of the generalization ability of the Complex-BP (Similarity transformation, 1-6-1 network).  $Gen\_Error$  ( $= |E^S(\phi)|$ ) denotes the Euclidean distances between the actual output test point and the expected output test point in the test step;  $K(= \phi)$  denotes the difference between the argument of a test point and that of an input training point. Error refers to the left side of eqn (??), i.e., the error between the desired output patterns and the actual output patterns in the training step.

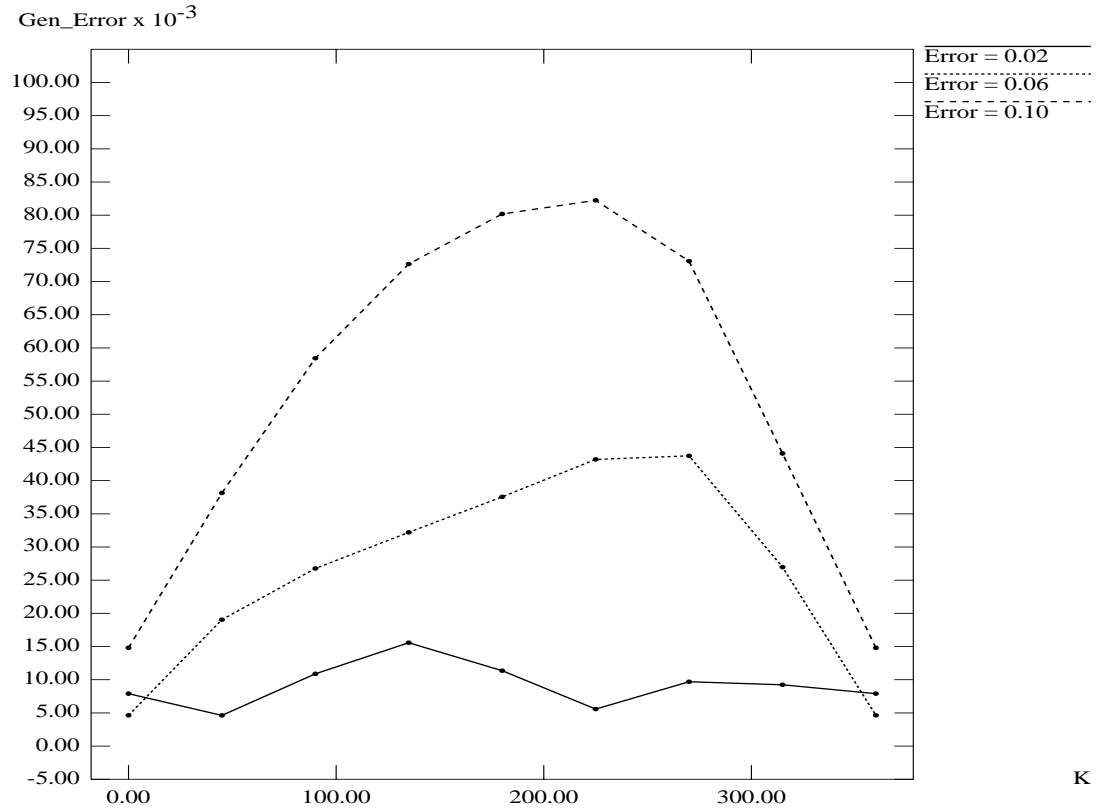


Figure 13: (f) Results of the evaluation of the performance of the generalization ability of the Complex-BP (Parallel displacement, 1-6-1 network).  $Gen\_Error (= |E^P(\phi)|)$  denotes the Euclidean distances between the actual output test point and the expected output test point in the test step;  $K(= \phi)$  denotes the difference between the argument of a test point and that of an input training point. Error refers to the left side of eqn (??), i.e., the error between the desired output patterns and the actual output patterns in the training step.

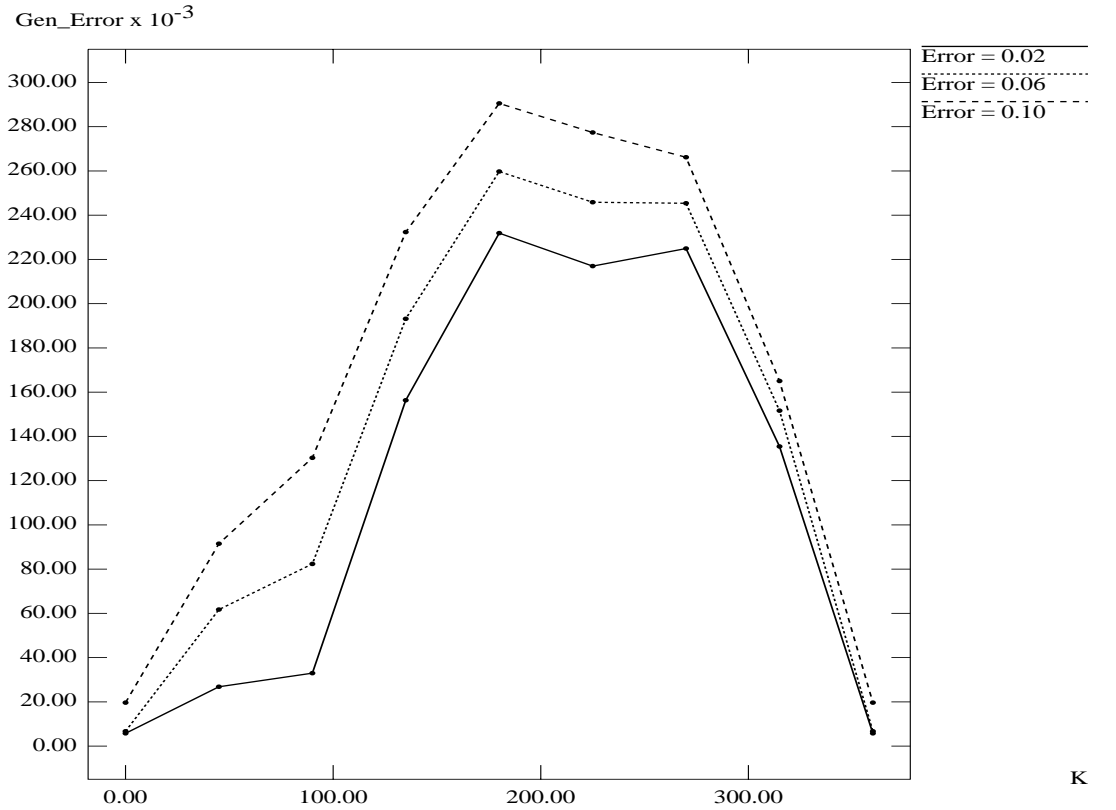




Figure 14: Learning pattern for the comparison of the usual generalization performance of the 1-n-1 Complex-BP network and the 2-m-2 Real-BP network. The black circles and the white circles denote the training points. (a) Learning pattern #1. (b) Learning pattern #2.

