Recasting Bruner in a Connectionist Framework

Michael Carbonaro
Educational Psychology
University of Alberta, Edmonton
Edmonton, AB. CANADA T6G OP3
Mike.Carbonaro@UAlberta.ca

Bruner, Goodnow, and Austin's (1956) research on concept attainment was reexamined from a connectionist perspective. Bruner et al. used a set of cards to study concept attainment (p. 42) consisting of four attributes, each of which varied on three values: shape (cross, circle, square), color (green, black, red), number of objects (one, two, or three), number of borders (one, two, or three). Each card instance combines one value of each of the four attributes. A category or a concept (*conjunctive, disjunctive,* and *relational*) is defined with respect to a subset of cards that share a common set of attribute values.

Figure 1 shows a PDP network that associates positive and negative instances of a concept with their corresponding attribute values. Two methods were used to help preserve the *ecological validity* of the input (Bracht & Glass, 1968). First, for network input a one-to-one mapping was constructed between each card's visual representation and a 2-dimensional numeric array. This array had 1144 cells, where colored pixels green, red and black were assigned the values of 0.25, 0.5, and 0.75 respectively (white pixel values were 0.0).

Second, empirical results demonstrated that a network using one output unit to classify cards as either positive or negative instances was incapable of generalizing beyond the training set to novel instances. Gagne's (1985) theory of concept learning requires a learner make discriminations to identify distinctive features of stimulus objects. Gagne's ideas resulted in the addition of extra output units referred to as *attribute context constraints* (see Figure 1). These units guided the network in constructing a better representational model than those models in which the constraints were absent. The idea of employing additional output units to improve network learning has previously been used in engineering to increase the probability of the network finding a good representation and to reduce network learning time (Gallmo & Carlstrom, 1995). Essentially, the idea is to provide additional output units that express some knowledge of the problem. No modification of the network algorithm or error correction is required. The specific target output, a binary string, consists of 9 output units that uniquely symbolize whether the card is a positive or negative instance and its attributes.

Although it might be expected that the constrained network takes more presentations to reach a given level of categorization than an unconstrained network because more calculations are involved in learning a larger number of attributes, the results indicate the opposite. The constrained network took less time to learn the appropriate categorizations of instances and attributes than the unconstrained network took to learn the categorization of instance only. The results also indicate that the constrained network had better capacity to generalize (inductively reason in the Bruner et al. sense) to novel card instances. This was not the case for networks that did not include the attribute context constraints output units. Furthermore, the constrained network over generalized the learned concept by categorizing previously unseen shapes, with similar surrounding attributes, as being in the same class as those already seen during training.

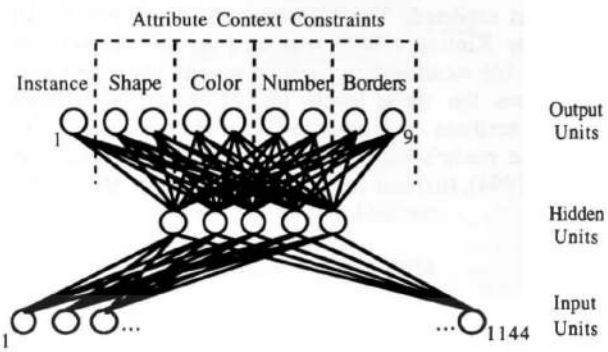

Figure 1: Network structure of Bruner et al.'s (1956) task.

References

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