peerNet: A Feedback Neural Network With a Quantum Fluctuator for Simulating Peer Review

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Introduction

Peer review, where respected investigators assess other's work, is an established scientific practice. But senior scientists find that reviewing takes too big a bite out of their valuable administrative and golf time. As science advances and more young investigators submit ever more ridiculous papers and proposals, the burden on established scientists increases.

Yet statistical analysis of peer review (1,2) shows it to be an essentially random process, where only about 10% of the variance depends on the piece of work being rated. That skilled and highly educated people spend so much time on it shows that the neural mechanisms they employ are inefficient and could be improved upon.

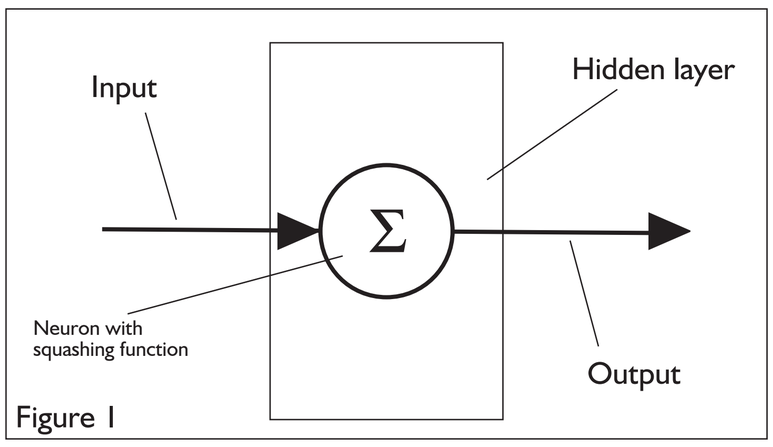

Figure 1

Improving on Nature

One possible means of improvement is neurosurgery, but removing the excessive circuitry might impair the referees' performance of other activities, such as golf. Until further studies show the independence of peer review from other tasks, surgery seems a drastic remedy.

Another approach is to entrust the rating to simpler systems. Trained animals could be a solution, but it is unclear that the general public would well receive the carrying out of scientific reviews by trained rats or monkeys.

Neural Network

This leaves neural networks as the most promising candidates. Here I present peerNet, a simple network that accepts or rejects scientific manuscripts and research proposals. The input to peerNet is the number of words in the abstract of the scientific work to be judged; its output is its rating. The transfer function of the neuron in the hidden layer is a squashing function, restricting the output to values between 0 and 1, the desired range for probabilities.

Tested on 100 abstracts of 50-200 words each, peerNets ratings were fully determined by the input (Figure 2). Another shortcoming of this version of peerNet is the presence of intermediate output values, making the network annoyingly indecisive.

To address these issues, the next version of peerNet incorporated a feedback loop (Figure 3).

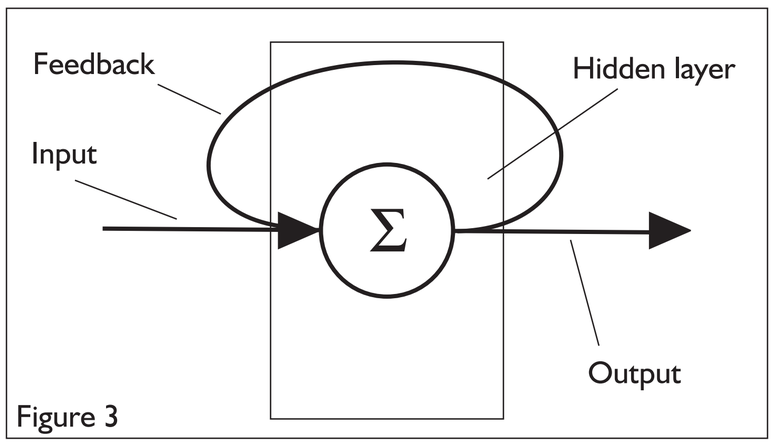

Figure 3

Recurrent Net Accepts Everything

After this network converges, its ratings are completely uncorrelated with its inputs (see Figure 4). Also note that the network now has no more intermediate output values. This is progress, but it goes too far, as human ratings do show a 10% dependence. Furthermore, this network simply accepts all papers, which is contrary to the spirit of peer review.

Consciousness Theory Loans

Penrose suggests (3) that human thought is influenced by quantum gravity effects in neuronal microtubules. These quantum effects can be modeled by a random element (4,5) in the network (Figure 5). Specifically, the Quantum Fluctuator shuts off the neuron with a probability that is close to 0.5 but depends weakly on its input. With the Fluctuator, peerNet performs as desired, accepting and rejecting submissions almost randomly but with a small dependency on the input characteristics (Figure 6). This version should be the basis for any future implementations.

peerNet's simple and general approach is easily transferred to other domains of decision making. Possible applications include elections or rating of performances in sports, such as golf. In a clinical environment, the advantages of freeing staff time for patient care and research, especially for cancer treatment and research, should be obvious for any agency considering this author for further funding.

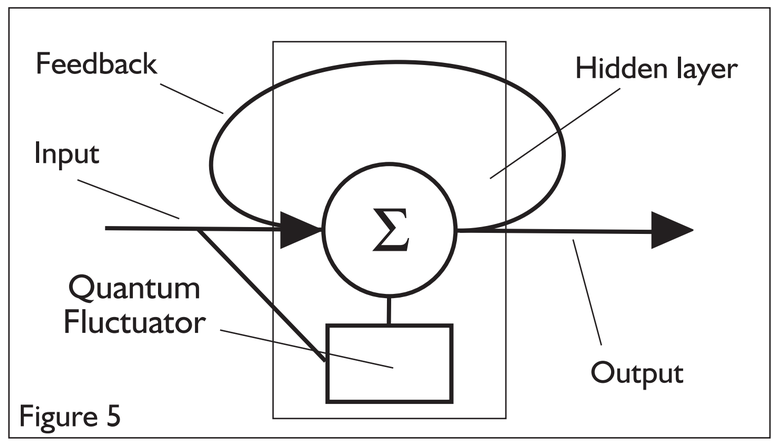

Figure 5

Acknowledgements

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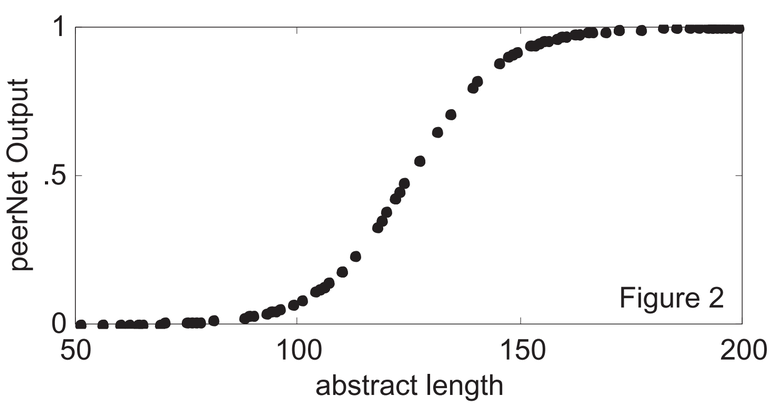

Figure 2

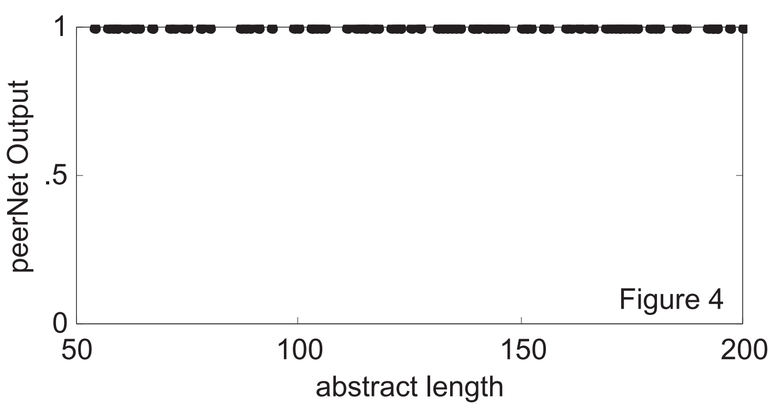

Figure 4

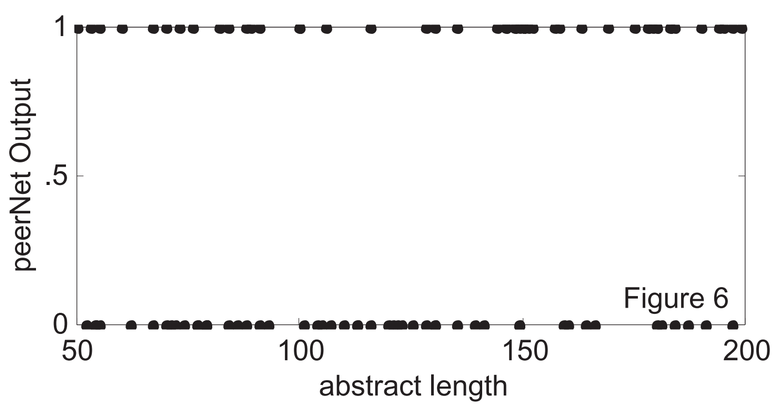

Figure 6