Cognitive Activity in Artificial Neural Networks

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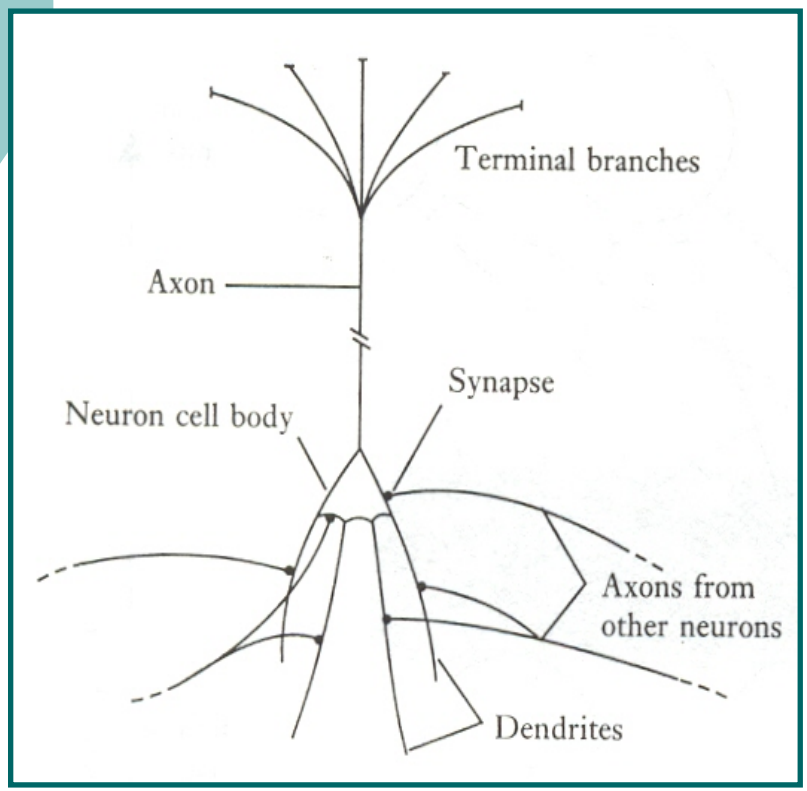
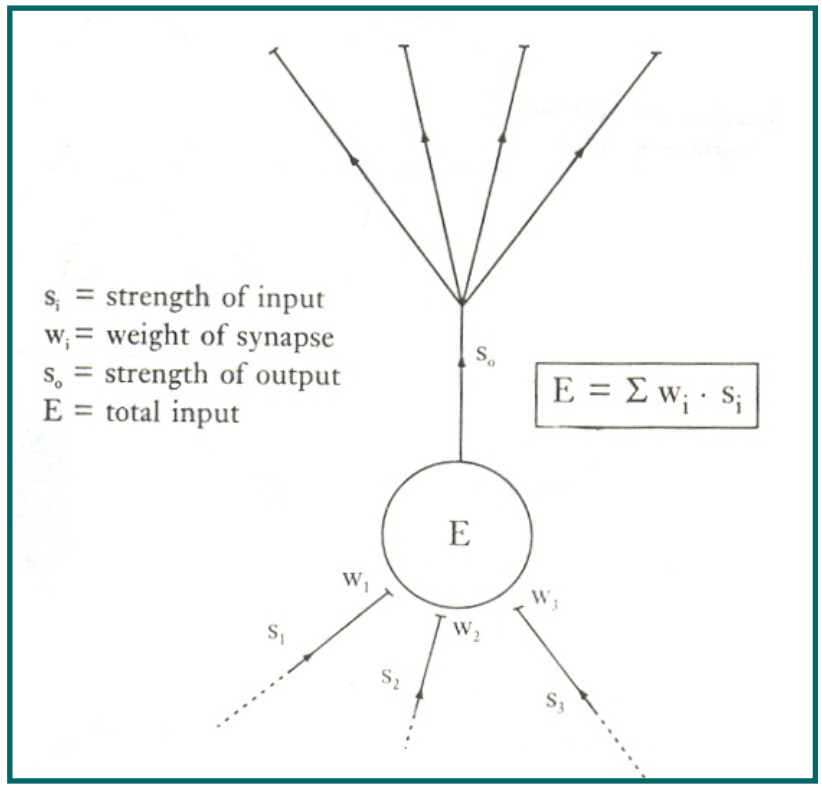
Neuron vs. Neuronlike processing unit



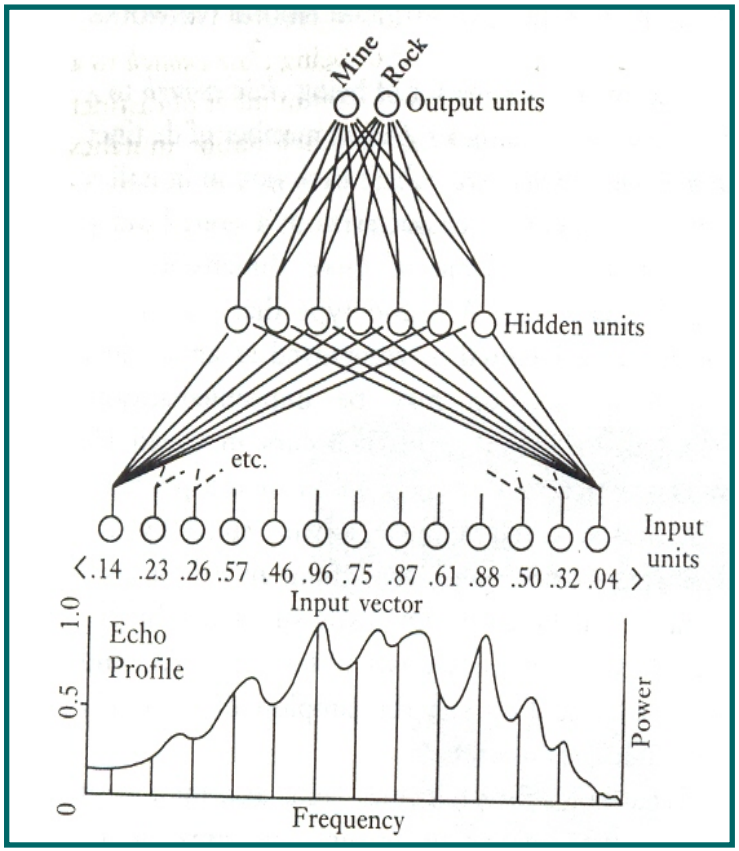


Why neural network emerged again?

1. The failure of mainstream or program-writing AI
2. Introduction of hidden layers or units with nonlinear response profile
3. The generalized delta rule
   (Rumelhart, Hinton, and Williams)

Model 1

– distinguishing mine from rock



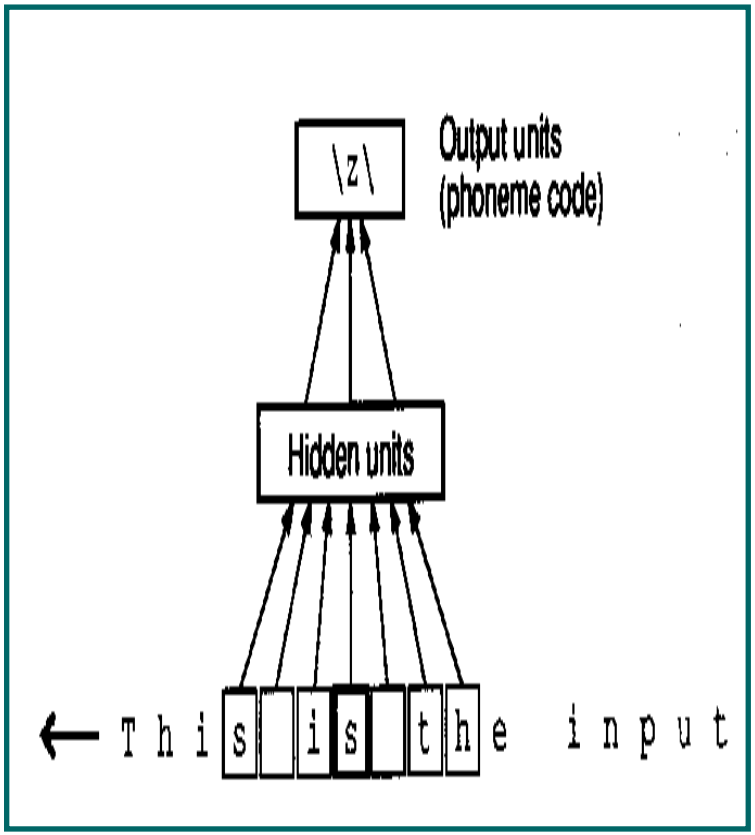
(Gorman and Sejnowski ,1988)

- 13 input values as fraction of 1
- output activation vector <x , y>

- After training, the tasks take only a split second due to parallel processing. Thus, the system performs like a living creature.

Model 2

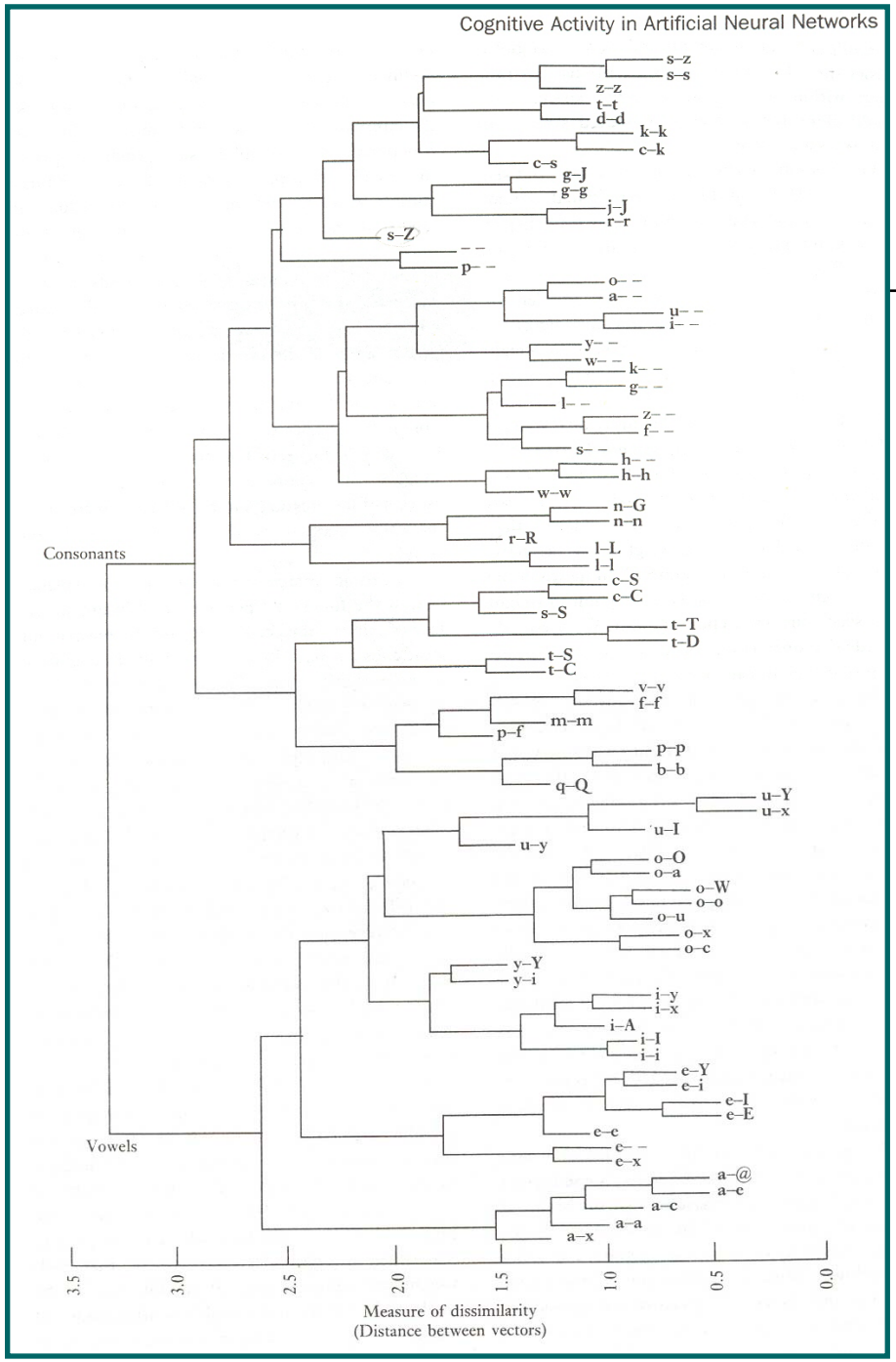
- NETtalk



(Rosenberg and Sejnowski,1987)

- 7 input letters for input
- 79 discriminative output

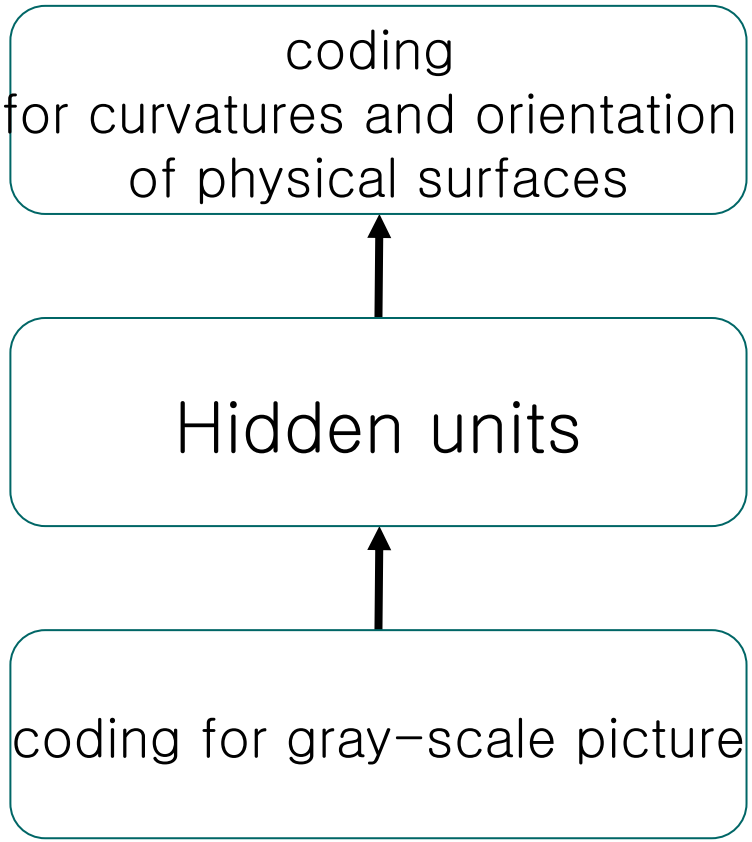
- intelligible speech after 10 training epochs; 95% accuracy on training corpus after 50 epochs
- generalization: 78% accuracy on continuation of training text



- The most fundamental division within the hidden-unit vector space corresponds to the division between the consonants and the vowels!!
- The uniformity that lies behind the apparently chaotic variety displayed in the inputs

Model 3

- Coding for gray scale picture



(Lehky and Sejnowski 1988)

• The trained hidden units have acquired some of the same response properties as are displayed by cells in in the visual cortex of mature animals
(maximum sensitivity to spots, edges and bars)

• Feline visual cortex have receptive fields of the same character.

Advantage of NN

1. Learning algorithm.
2. Speedy access in parallel-connection not in a long list that must be must be searched.
3. Functional persistence.
4. The vast range of possible conceptual configuration.

10^{11} neurons

10^{3} Connections per each neuron

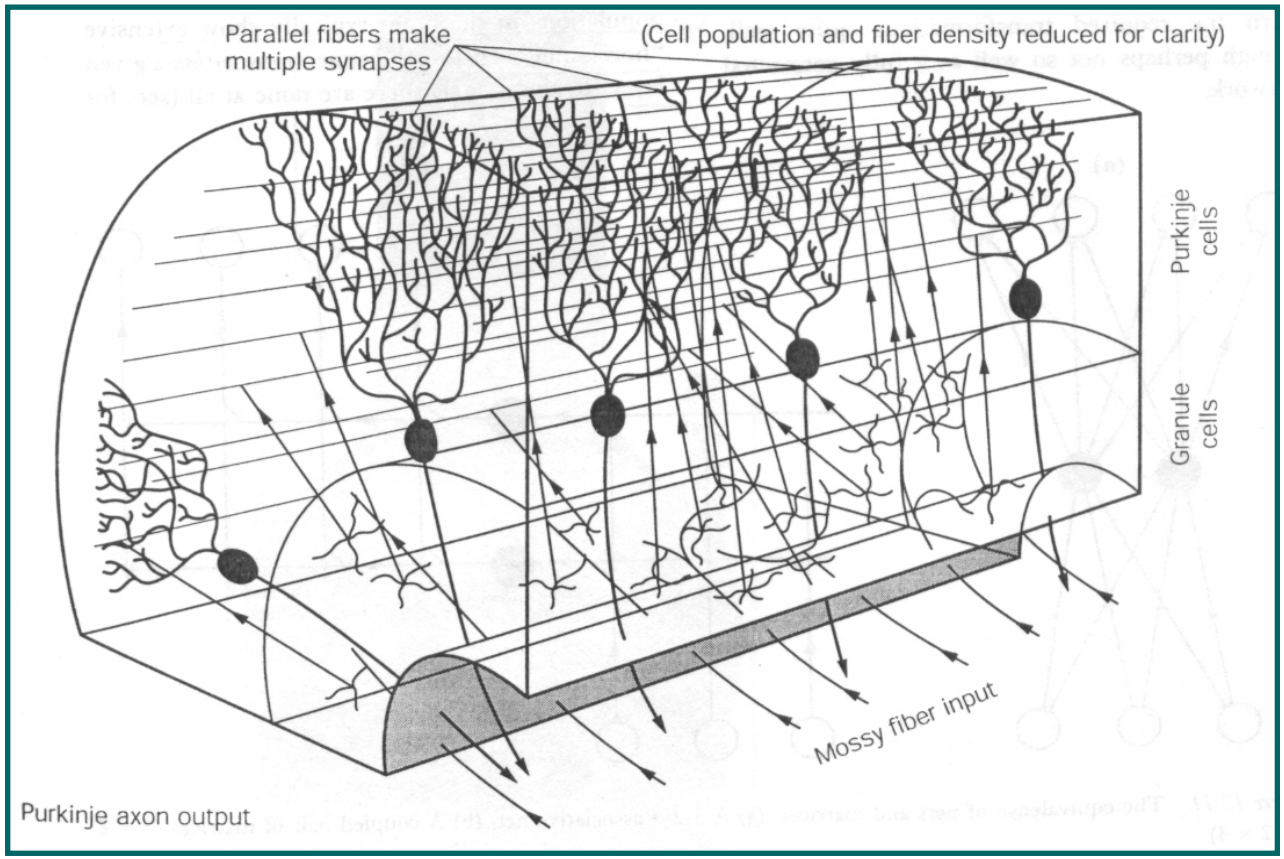
=> 10^{14} weights exist

10 possible values of weight

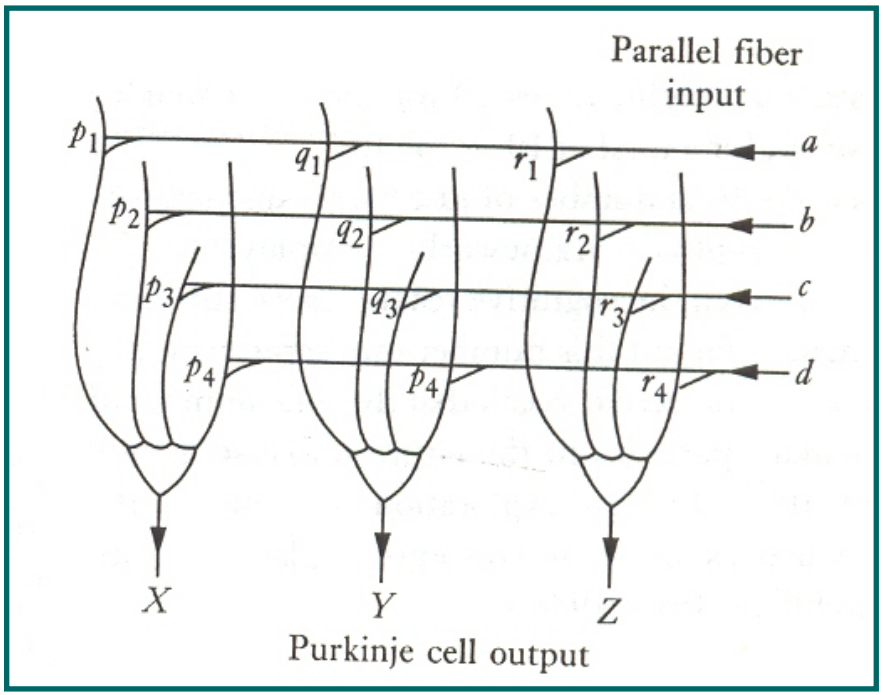
=> $10^{10\text{^}14} = 10^{100000000000000}$ configurations!!

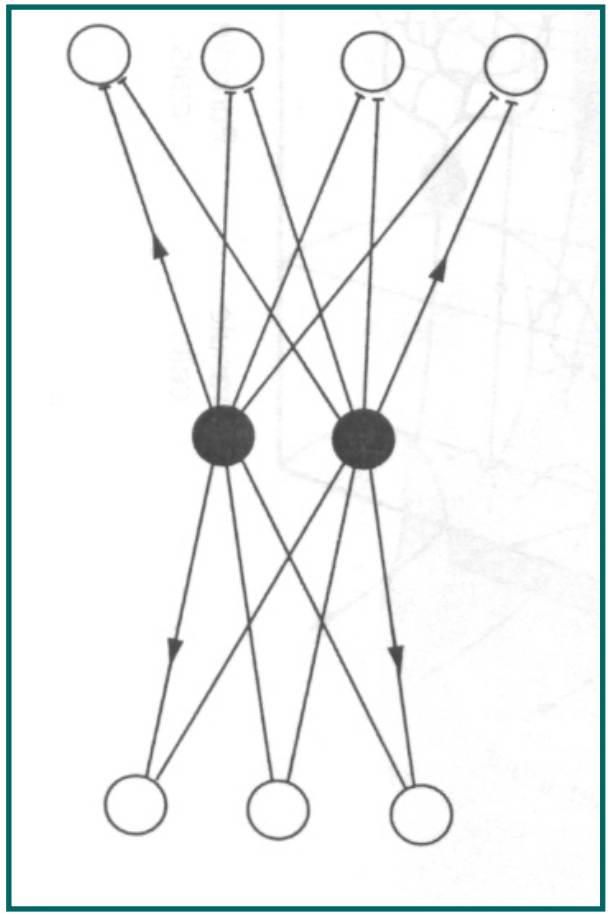
How faithfully NN depict the Brain?

- The real nervous system also has layers or populations of neurons



Neuron's connection vs. NN



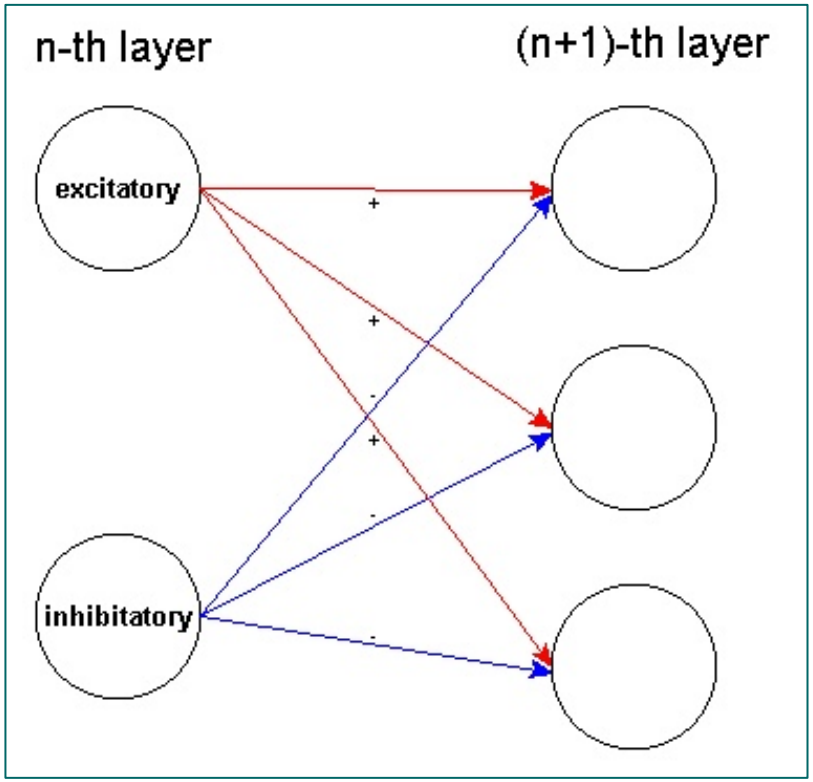


The problem 1

- In a real brains, an axon makes synaptic contact with only a relatively small percentages of the thousands or millions of cells in its target population.

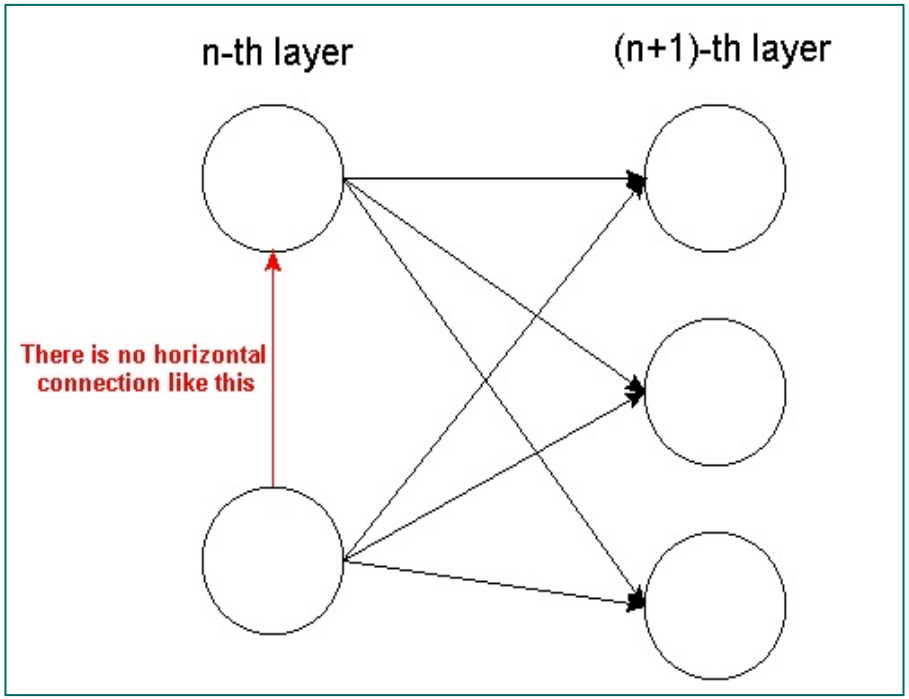
- This is not a serious difficulty.

The problem 2



- Real Axon have terminal end bulbs that are uniformly inhibitory or uniformly excitatory, depending on the type of neuron.
- It is essential to successful function in models.

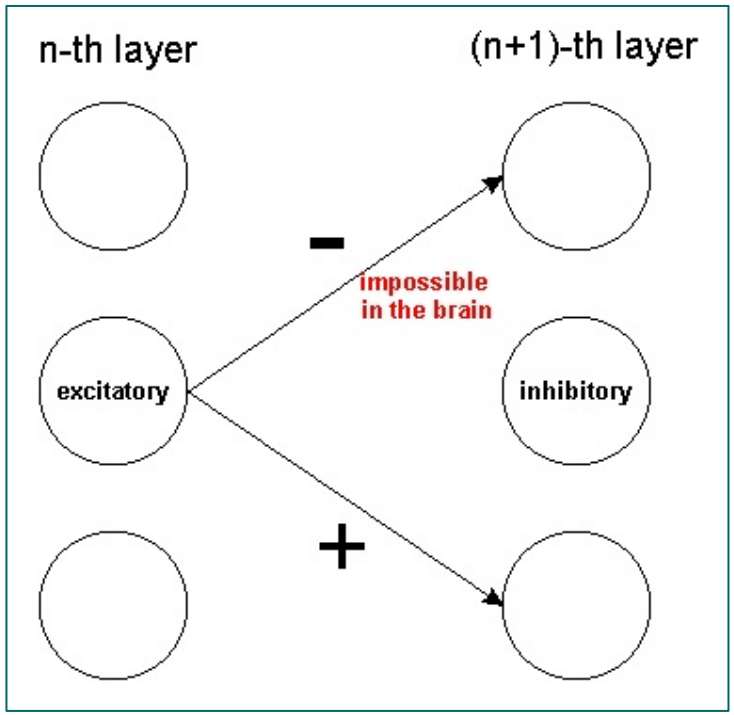
The problem 3

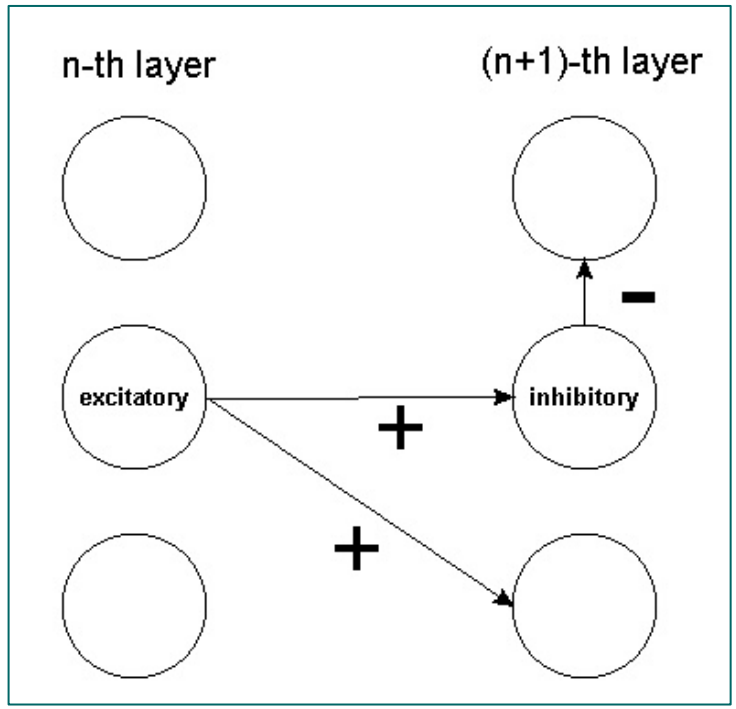


- Cell populations in the brain typically show extensive “horizontal” cell to cell connections within a given layers.
- However, In the model there are none at all.

The problem 2 and 3

- These two problems can be cancelled each other.





The problem 4

- The requirement for Generalized delta rule
  1. Computation of the partial correction
  2. A method of causally conveying these correction messages back

- Unfortunately, we find little answer for real source of adjustment signals and some real pathways to convey them back to the relevant units in biological brain.

Possibility to solve the problem4

- The existence of CLIMBING FIBER !!
- These fibers envelop cells like ivy.

Functional difference

1. Living brain show a progressive reduction in the reaction time rather than error.
2. Real creatures generally lack any perfect information. However, NN needs correct answers to correct vector of each units.

Remained differences

- Brain is very larger and denser than the model. Thus, it has much more layers than single NN.
- Brain has a hundred distinct and highly specialized cell type rather than one.
- Brain is not a single n-layer network but rather a large committee of distinct but parallel networks.