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Representing Symbolic Logic in an Artifical Neural Network

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Representing Symbolic Logic in an Artifical Neural Network. Technical Report I.

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Abstract: We report detailed experimental results for the paper 'Representing Symbolic Logic in an Artificial Neural Network, Part I: the Static Case'.

1 Introduction

This technical report provides supporting information and experimental results for the paper "Representing Symbolic Logic in an Artificial Neural Network, Part I: the Static Case". The paper is concerned with finding an artificial neural network representation for supra-classical logic.

The technical report is divided into four parts. Section 2 Micro-Worlds: gives information about the experimental environment. Section 3 Boltzmann Machine: gives some features of the machine implementation and experimental results. These results support the Boltzmann machine as a viable candidate for the representation of supra-classical logic. Section 4 Multi-Layer Perceptron (MLP): looks at these experimental results with discussion about the implementation, which is not included in our paper. These results indicate that simple feed-forward networks do not have the properties required to represent the logic.

2 Micro-worlds

We attempted to find a neural network representation by training and testing our candidate machines in the limited environment of logical micro-worlds. Some discussion and justification for this approach is given in our paper. The logic for these worlds was loosely based on the idea of a room, which had its temperature regulated for a minimal energy cost. A set of micro-worlds of increasing size and complexity were designed by adding atoms and preference levels. The design details of these 3, 4, 5, and 6-atom micro-worlds are given in Appendix A.

For each world a short description of the atoms and default rules are provided in the appendix, with the consequent ranked interpretation. The interpretation of the default rules is somewhat arbitrary and alternative worlds would be possible. We investigated the effect of arbitrary changes in interpretation within the 5-atom world by looking at two alternatives to the world shown in Appendix A. The changes did not affect the ability of the networks as representations. In theory such a change should not have any impact, as the networks tested were trained on the final interpretation alone.

The semantic design of these worlds deliberately involved dependency between some variables and this resulted in occasional outputs from the machines that were unexpected. The ability of the Boltzmann machine to learn and represent atomic probability and not just state distribution will be the subject of a separate paper.

It should be noted that the machines are trained using binary logic and tested using ternary logic. During training the machines are only given inputs: +1 for true and -1 for false. Model states are shown in adapted binary format, for example in the 3-atom world (Light-Fan-Heater) state "-1, 1, 1" stands for the state with "Light off, Fan on, Heater on". We will frequently use an abbreviated decimal format; in the example above, the state would be represented as decimal 3 (the two lowest order bits are on). When testing, the machines received inputs of 1, -1, or 0 for unknown or equivocal. For example the input state/query "0, 1, 0" stands for the premise "Light not observed, Fan on, Heater not observed", which has no equivalent in real binary.

Generally four alternative training sets were used for each world. Two training sets have the patterns (model states) at exponentially increasing frequency of preference and two have an arithmetic distribution. Within each pair, one set has the least preferred model states absent; the other has them present for one pattern only. The distribution of patterns in each training set is given in Appendix A, both as the actual number of patterns and the percentage of the set.

3 Boltzmann Machine

3.1 *Implementation*

As indicated in our paper, the initial implementation of the Boltzmann machine was based on Hinton's 424 Encoder. Early experimentation with this implementation involved diagnostic data sets, both mechanical and medical, with a variety of data relationships: both many-to-one (mathematical functions) and one-to-many (non-functions).

The machines performed tolerably well on even the most difficult medical data set which contained 8 diagnoses spread over 13 symptoms, with a large proportion of one-to-many relationships. The data set consisted of 120 training patterns; the machines were trained on a subset of 80 patterns.

- Tested on previously seen patterns, machines achieved a recall (correct set of diagnoses, although not always in the correct order of preference) of 88-94%.
- Tested on unseen patterns, machines had a credible accuracy of 73-78% (depending on the pattern tested).

These data sets still had a large component of classification as part of a mixed task and, at this stage, the weights of the network were not converging during training. Several methods of weight constraint were attempted including:

- Weight decay: Use of a penalty term ($c = 0.001$) multiplied by the total size of each weight layer matrix was partially effective in limiting the weight expansion to 1.12.
- Sparcity was implemented using a target and penalty cost as per Hinton (1985). However, this is probably only appropriate in a Restricted Boltzmann machine and was not effective in our case.
- Momentum: The standard use of momentum was most effective in limiting weight expansion and improving performance generally.

We refined the task as part of the micro-world experiments, to remove any classification component. The machines were simply required to learn the distribution of patterns (model states) in their environment. Under this task there was rapid adaption of the weights to a plateau within the first few hundred epochs, followed by a gradual linear increase in the larger inter-layer weights. We have not confirmed whether different machines converged initially to the same weight matrix for the same problem. It is likely that several different weight matrices might be possible given the nature of the optimisation problem and the stochastic nature of the Boltzmann machine.

A brief overview of the object-oriented design and the changes made to the learning algorithm of our Boltzmann machine are given in Appendix D.

3.2 *Results in General*

Tuning of the Boltzmann machine was difficult. The detail of the annealing schedules for the Boltzmann machine can critically influence results. A wide variety of temperature ranges and cycling schemes were experimented with: both at high "40 down to 10" and low "5 down to 1" temperatures with long and short ranges for varying numbers of cycles at each temperature point. There was no one single correct schedule. The other tuning parameters were on average: training time 2,000 epochs, learning rate 0.3, momentum 0.7, with 20 samples per pattern. Alterations in the number of hidden nodes were investigated, for each micro-world, but the final numbers were: 4 in the 3-atom world, 6 in the 4-atom world, 8 in the 5-atom world and 10 in the 6-atom world. The detailed results for testing of the Boltzmann machine are shown in Appendix B.

For each micro-world, testing of the neutral premise is discussed first. Five runs of 60 machines per run are given for each of the four different training sets, for each micro-world with the aim of retrieving the complete ranked interpretation. This gives a total sample size of 60,000 samples. The actual number of output samples and the percentage are shown in the tables. These results are then accumulated at the end of a row to give the average result and standard deviation for the errors over 300 machines. The sampled percentage output can be compared directly with the training distributions, on the left of each row.

Second, a selection of more specific interesting premises are shown in an attempt to demonstrate how well (or otherwise) a run of 60 machines performs the task of model selection. Adequate training of the machines is demonstrated by inclusion of some complete premises (without uncertainty). Others require a range of preference levels in the output or a single preference level. In this setting the results need to be considered qualitatively. The correct model selection within the ranked interpretation is provided, with the expected input distribution, for comparison with the actual output of the machines.

We have not however, provided the accumulated error figures for the specific premises, as these calculations were often misleading. The logic does not require exact numerical output: there were specific premises where the ranking from the logic was correctly represented by the machine but the numerical output was inexact and more importantly, there were results where the numerical output was accurate but the representation of the logic was not what was expected. These interesting premises will form the basis of a discussion of the representation of atomic distribution in a further paper.

3.3 *3-Atom Micro-World*

The results of testing the Boltzmann machine against the neutral premise in the 3-atom micro-world were uniformly satisfactory (Figures 5 & 6). The average error per state on the worst training set with 44 patterns was just over 2% and on the best training set with 30 patterns was less than 0.5%, with a standard deviation of ±0.11. When the least preferred models were present in a training set, their probability tended to be overestimated slightly by the network: 3-5% actual output versus 2.9% expected. In this circumstance, the probabilities of more preferred patterns were slightly underestimated.

The results for testing against specific premises are shown in Figure 7. The training set with 34 patterns was used for this testing: it has an arithmetic distribution and the least preferred model states are present. Looking at the completely specified premise "-1, -1, 1" it can be seen that the machine was adequately trained for the more preferred patterns (decimal state 1 - output 95%), but considering premise "1, 1, -1" not well trained for the least preferred patterns (decimal state 7 - output only 54%). The machine had difficulty adequately learning/retrieving the least preferred patterns in this micro-world, despite adjustments in the training sets and tuning parameters. A further example of this problem can be seen with premise "1, 1, 0" where the machine is 'asked' to select two of the least preferred model states. An appropriate selection would be (6) and (7) but the machine also outputs samples of (4) and (5).

However, this was not a problem when the machine was ‘asked’ to rank model states at different preference levels. For example, premises “-1, 0, 1”, “1, 0, 0” and “0, 0, 1”, in these cases the machine clearly and correctly distinguished between the probability of the most, intermediate and least probable model states. What is more, the degree of separation between preference levels was qualitatively appropriate considering the ranked interpretation.

3.4 *4-Atom Micro-World*

The results of testing against the neutral premise in the 4-atom micro-world were also uniformly satisfactory (Figures 8 & 9). The average error per state on the worst training set with 96 patterns was under 2% and on the best training set with 88 patterns was just over 0.5% ± one standard deviation 0.07. As for the 3-atom micro-world when the least preferred models were present in the training set, their probability tended to be overestimated slightly by the network: 2.5% actual output versus 1% expected and the probabilities of more preferred patterns were then slightly underestimated.

The results for testing against 28 specific premises are shown in Figures 10 - 13. The training set with 98 patterns was used for this testing: it has an arithmetic distribution and the least preferred model states are present. Looking at the fully specified premises; “-1, -1, -1”, “-1, -1, -1, 1”, “1, -1, -1, -1” and “1, -1, -1, 1” it can be seen that the machine was adequately trained across the whole distribution (a most preferred state, decimal 0 - output 92% and a least preferred state, decimal 6 - output 85%). The machine did not have the same difficulty with learning the least preferred patterns present in the 3-atom micro-world.

The vast majority of the results for the individual specific premises indicate that the machine can select appropriate preferred model states. For example, consider premises; “0, 1, 0, 0”, “0, 0, 0, 1”, “-1, 0, 0, 0”, “0, 0, -1, 1”, “0, -1, 0, -1”, “1, -1, 0, -1” and “-1, 0, -1, -1”. The machine not only selects the correct model states placing them in the correct ranking, but it also maintains a qualitative degree of separation between states that might be expected from the levels in the ranked interpretation.

However, there were some exceptions to this expected behavior: for example premises “0, 0, -1, 0” and “-1, 0, -1, 0”. In these circumstances the machine ‘performs a tie-break’ between models that should have the same state frequencies. We believe in these situations the machine demonstrates it ability to learn not just state but atomic distributions and to retrieve information related to atomic dependency within its training set. As mentioned earlier, this will be the basis of discussion in a further paper.

3.5 *5-Atom Micro-World*

The results of testing against the neutral premise in the 5-atom micro-world were mixed (Figures 14 - 17). The average error per state was maintained at an acceptable level: on the worst training set with 158 patterns under 2% and on the best training set, with 120 patterns, just over 1.5% ± 0.05. However, these numbers exaggerate the accuracy of the machine in this world. On all the training sets the machine grossly underestimated the probability of the most preferred model states. Moreover testing in the training sets with the least preferred patterns absent, demonstrated that the design of this micro-world had many dependent variables, the machine was ‘tie-breaking’, even where the premise made no observation of the environment. Initially this was felt to be unacceptable.

It was decided for completeness however, that 12 more specific premises would be tested (Figures 18 - 20). The training set with 158 patterns was used for this testing: it has an exponential distribution and the least preferred model states are present. Looking at the fully specified premises, "1, -1, -1, -1" and "1, 1, -1, 1, 1", it can be seen that the machine was adequately trained across the whole distribution (a most preferred state, decimal 16 - output 97% and a least preferred state, decimal 27 - output 89%).

Despite the failings of testing against the neutral premise, selection of model states from the specific premises was remarkably appropriate. For example consider premise "0, -1, 0, -1, 1"; this premise selects states over a range of the most preferred models. The selected states are correct, their ranking is correct and the magnitude of the separation between states is appropriate. Similarly premises "0, -1, 0, 0, 1" and "1, -1, 0, 0, 1" select a range of states, including the least preferred models; again these states are correctly selected and ranked with appropriate separation. Only premise "0, -1, 0, 0, 0" causes difficulty; it is quite close to the neutral premise and requires 16 model states to be retrieved. Still this result is acceptable, but with a narrow margin between each of the models.

3.6 *6-Atom Micro-World*

The results of testing against the neutral premise in the 6-atom micro-world were mixed (Figures 21 & 22 - only two of the training sets are shown because of their size). The average error per state on the worst training set with 332 patterns was just over 1% and on the best training set with 180 patterns was a remarkable 0.3% ± 0.02. However, on training sets where a large majority of patterns are expected to return 0, the average error per pattern will be 'diluted'. As for the 5-atom world, the machine underestimated the probability of the most preferred model states on all the training sets. Moreover, on the training sets with least preferred patterns present, the small percentage separation between ranking levels became blurred or even overlapped.

Again for completeness, it was decided that 12 specific premises would be tested (Figures 23 & 24). The training set with 232 patterns was used for this testing: it has an arithmetic distribution and the least preferred model states are present. Looking at the fully specified premises, "1, -1, -1, -1, -1, -1" and "-1, 1, 1, 1, 1, 1", it can be seen that the machine was adequately trained across the whole distribution (a most preferred state, decimal 31 - output 96% and a least preferred state, decimal 27 - output 93%).

Despite the shortcomings of the testing with the neutral premise, selection of model states from the more specific premises was accurate. For premises with less than three uncertain atoms the machine correctly selects and ranks models states, with a degree of separation appropriate for the ranked interpretation. Model selection only becomes marginal with three uncertainties, for example "0, -1, 0, -1, 0, 1". For premise "0, -1, 0, -1, -1, 0" the selection of the most preferred states is overlapped: (32), (33), (0) and (1), but in this situation the machine is 'performing a tie break' based on the atomic probability of dependent variables.

We did not test the Boltzmann machine representation beyond the 6-atom world: considering its stochastic error of approximately 2% per state and that the next level of complexity (7-atoms/preference levels) comprises 128 states. The Boltzmann machine is known to scale poorly from small to larger tasks but this could perhaps be addressed by a longer, slower annealing and training process.

4 Multilayer Perceptron (MLP)

The MLP was chosen as a typical candidate feed-forward network, to ascertain whether this most common type of neural network could represent a probabilistic distribution over the output states.

4.1 *Implementation*

The MLP architecture for our representation consisted of input nodes, one for each atomic variable (n) in the micro-world, a hidden layer and output nodes locally coded, one for each of the world states (2^n). Biases were included in both the hidden and output layers. The implementation can be seen as a function converting binary to decimal numbers. The implementation was first separately verified with a flat distribution over all 16 training patterns in the 4-atom micro-world and tuned with regard to: number of hidden nodes, learning rate (typically 0.4) and momentum (typically 0.8). The final numbers of hidden nodes were: 6 in the 4-atom world and 10 in the 5-atom world. Verification on previously seen atomic training patterns gave single output activations on the corresponding decimal state of over 0.9 and activations of under 0.1 on the others.

4.2 *Results in General*

The MLP was only tested in the 4-atom and 5-atom micro-worlds. Machines were trained with the proportional set of patterns based on the ranked interpretation derived from the default rules of the micro-world. The training and testing followed exactly in the fashion of the Boltzmann machines. The results for testing of the MLP representation are given in Appendix C.

4.3 *4-Atom Micro-World*

The results of testing against the neutral premise in the 4-atom micro-world were uniformly unsatisfactory (Figures 25 & 26). The average error per state on the worst training set with 96 patterns was over 10% and on the best training set with 90 patterns was over 8%. Examination of any of the individual machine runs or average results confirms that the network is not representing the input distribution.

There is however, a subtle relationship between the expected distribution and the machine output. The machine weights are maximally trained to the states, which are the least frequent input patterns. These maximally trained weights have a predominate effect on the network output because of the low overall activation of the network. In the case of training sets 88-0 and 90-0 the intermediate preference states are least frequent (the least preferred states are absent). The architecture and learning algorithm of the MLP are not designed for the task of 'recalling' the training set distribution.

The results for testing against 28 specific premises are shown in Figures 27 - 30). The training set with 98 patterns was used. Looking at the fully specified premises; "-1, -1, -1", "-1, -1, -1, 1", "1, -1, -1, -1" and "1, -1, -1, 1", it can be seen that the machine was adequately trained across the whole distribution (a most preferred state, decimal 0 - output 99% and a least preferred state, decimal 6 - output 97%).

The vast majority of results for the individual specific premises indicate that the machine can select model states, but not in the correct preference ranking and not with an appropriate degree of separation between the levels of preference. For most of the premises where selection of multiple levels is required, the machine often outputs a uniform distribution across all levels of preference, for example premises "-1, 0, 0, 1" and "-1, -1, 0, 0". The more uncertainty in the premise, the poorer is the representation of the input distribution.

Where the MLP is given almost complete information in the premise, Figure 30, it is able to appropriately rank two model states at different levels.

4.4 *5-Atom Micro-World*

The results of testing against the neutral premise in the 5-atom micro-world were uniformly unsatisfactory (Figures 31- 34). The average error per state on the worst training set with 142 patterns was close to 6% and on the best training set with 136 patterns was over 4%. This may seem reasonable but examination of any of the individual machine runs or average results confirms that the network is not representing the input distribution.

The same subtle relationship between the expected distribution and the machine output applies in this micro-world as in the 4-atom world. The machine weights are maximally trained to the states, which are the least frequent input patterns. The architecture and learning algorithm of the MLP are not designed for this task.

The results for the individual specific premises (Figures 35 - 37) indicated as in the 4-atom world, that although the machine can select correct model states: the preference ranking and degree of separation between the levels of preference were incorrect. Again, where selection of multiple levels of preference was required, the machine would often output a uniform distribution. The more uncertainty in the premise, the poorer was the representation of the input distribution. This can be seen in Figure 37 where two bits of the premise are uncertain or for example in premise "0, -1, 0, 0, 1" where three bits of the premise are uncertain. Often one of the least preferred model states had the highest output. Even where the premise was almost fully specified, for example "1, -1, -1, -1, 0" the MLP was not able to place two model states appropriately at the same level.

The MLP representation was not tested beyond the 5-atom (preference level) environment as we felt its performance had already been unsatisfactory at both the previous levels.

Appendix A: Micro-Worlds

3 Atom Micro-World

Fan, Heater, Window 8 Possible states of the world

f = fan on, h = heater on, w = window open

Default Rules:

Energy conservation, usually ¬F and ¬H, W has no cost

Warm environment, F more common than H

Consistency, F -> W, H -> ¬W

Ranked Intrepretation		Exponential				Arithmetic			
		#	%	#	%	#	%	#	%
-1-1-1(0)	-1-11(1)	16	40.0%	16	36.4%	10	33.3%	10	29.4%
1-1-1(4)	1-11(5)	4	10.0%	4	9.1%	5	16.7%	5	14.7%
-11-1(2) 11-1(6)	-111(3) 111(7)	0	0.0%	1	2.3%	0	0.0%	1	2.9%
	Total patterns =	40		44		30		34	

Figure 1. Details of the 3-atom micro-world. Ranked interpretation and the distribution of patterns in the training sets are shown.

4 Atom Micro-World

Light, Fan, Heater, Window 16 Possible states of the world

l = light on, f = fan on, h = heater on, w = window open

Default Rules:

Energy conservation, usually ¬F and ¬H, W and L have no cost

Warm environment, F more common than H

Consistency, F -> W, H -> ¬W

L is independent

Ranked Intrepretation				Exponential				Arithmetic			
				#	%	#	%	#	%	#	%
-1-1-1-1(0)	-1-1-11(1)	1-1-1-1(8)	1-1-11(9)	16	18.2%	16	16.7%	15	16.7%	15	15.3%
-11-11(5)	11-11(13)			8	9.1%	8	8.3%	10	11.1%	10	10.2%
-1-11-1(2)	1-11-1(10)			4	4.5%	4	4.2%	5	5.6%	5	5.1%
-1-111(3) 1-111(11)	-11-1-1(4) 11-1-1(12)	-111-1(6) 111-1(14)	-1111(7) 1111(15)	0	0.0%	1	1.0%	0	0.0%	1	1.0%
			Total patterns =	88		96		90		98	

Figure 2. Details of the 4-atom micro-world. Ranked interpretation and the distribution of patterns in the training sets are shown.

5 Atom Micro-World

Light, Fan, Airconditioning, Heater, Window 32 Possible states of the world

l = light on, f = fan on, a = aircon on, h = heater on, w = window open

Default Rules:

L independent and usually on

Energy conservation, usually ¬A, ¬F and ¬H, W and L have no cost

Warm environment, A and F more common than H

Consistency, A -> W, F -> W, H -> ¬W

	Exponential				Arithmetic			
Ranked Intrepretation	#	%	#	%	#	%	#	%
1-1-1-1-1(16) 1-1-1-11(17)	32	23.5%	32	20.3%	20	16.7%	20	14.1%
-1-1-1-1-1(0) -1-1-1-11(1)	16	11.8%	16	10.1%	15	12.5%	15	10.6%
-1-11-11(5) -11-1-11(9) 1-11-11(21) 11-1-11(25)	8	5.9%	8	5.1%	10	8.3%	10	7.0%
-1-1-11-1(2) 1-1-11-1(18)	4	2.9%	4	2.5%	5	4.2%	5	3.5%
All other states 22 (3), (4), (6) - (8), (10) - (15), (19), (20), (22) - (24), (26) - (31)	0	0.0%	1	0.6%	0	0.0%	1	0.7%
Total patterns =	136		158		120		142	

Figure 3. Details of the 5-atom micro-world. Ranked interpretation and the distribution of patterns in the training sets are shown.

6 Atom Micro-World

Light, Fan, Airconditioning, Heater, Open Fire, Window 64 Possible states of the world

l = light on, f = fan on, a = aircon on, h = heater on, o = fire lit, w = window open

Default Rules:

L independent and usually on

Energy conservation, usually ¬O, ¬A, ¬F and ¬H, W and L have no cost

Warm environment, A and F more common than O and H

Consistency, A -> W, F -> W, O -> ¬W, H -> ¬W

	Exponential				Arithmetic			
Ranked Intrepretation	#	%	#	%	#	%	#	%
1-1-1-1-1-1(32) 1-1-1-1-11(33)	64	22.9%	64	19.3%	25	13.9%	25	10.8%
-1-1-1-1-1-1(0) -1-1-1-1-11(1)	32	11.4%	32	9.6%	20	11.1%	20	8.6%
-1-11-1-11(9) -11-1-1-11(17) 1-11-1-11(41) 11-1-1-11(49)	16	5.7%	16	4.8%	15	8.3%	15	6.5%
-1-1-11-1-1(4) 1-1-11-1-1(36)	8	2.9%	8	2.4%	10	5.6%	10	4.3%
-1-1-1-11-1(2) 1-1-1-11-1(34)	4	1.4%	4	1.2%	5	2.8%	5	2.2%
All other states 52 (3), (5) - (8), (10) - (16) (18) - (31), (35), (37) - (40), (42) - (48), (50) - (63)	0	0.0%	1	0.3%	0	0.0%	1	0.4%
Total patterns =	280		332		180		232	

Figure 4. Details of the 6-atom micro-world. Ranked interpretation and the distribution of patterns in the training sets are shown.

Appendix B: Blotzmann Machine Results

Testing with neutral premise "0, 0, 0"

Training Set: 40-0

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	*Avg* Samples	*Avg* Output %	*Stdev*
(0), (1)	0	40.0%	22785	38%	22638	38%	22070	37%	23192	39%	21902	37%	112587	37.5%	
	1	40.0%	21589	36%	21534	36%	22435	37%	21517	36%	22896	38%	109971	36.7%	
(4), (5)	2	0.0%	65	0%	79	0%	54	0%	81	0%	70	0%	349	0.1%	
	3	0.0%	67	0%	67	0%	72	0%	62	0%	76	0%	344	0.1%	
(2), (3), (6), (7)	4	10.0%	7509	13%	8434	14%	7711	13%	7562	13%	7217	12%	38433	12.8%	
	5	10.0%	7768	13%	7038	12%	7456	12%	7378	12%	7642	13%	37282	12.4%	
	6	0.0%	94	0%	115	0%	95	0%	96	0%	102	0%	502	0.2%	
	7	0.0%	123	0%	95	0%	107	0%	112	0%	95	0%	532	0.2%	
		Accumulated error =		**12.1%**		**12.8%**		**11.7%**		**11.0%**		**10.7%**		**11.6%**	**± 0.84**
		Avg. error per state =		**1.5%**		**1.6%**		**1.5%**		**1.4%**		**1.3%**		**1.5%**	**± 0.11**

Training Set: 44-1

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	*Avg* Samples	*Avg* Output %	*Stdev*
(0), (1)	0	36.4%	18259	30%	16717	28%	16678	28%	16446	27%	16858	28%	84958	28.3%	
	1	36.4%	20601	34%	22669	38%	21771	36%	22735	38%	21492	36%	109268	36.4%	
(4), (5)	2	2.3%	995	2%	793	1%	789	1%	908	2%	986	2%	4471	1.5%	
	3	2.3%	1756	3%	1518	3%	1543	3%	1616	3%	1782	3%	8215	2.7%	
(2), (3), (6), (7)	4	9.1%	7132	12%	7395	12%	7511	13%	7423	12%	7751	13%	37212	12.4%	
	5	9.1%	7288	12%	6924	12%	7598	13%	6671	11%	6992	12%	35473	11.8%	
	6	2.3%	1399	2%	1451	2%	1395	2%	1573	3%	1515	3%	7333	2.4%	
	7	2.3%	2570	4%	2533	4%	2715	5%	2628	4%	2624	4%	13070	4.4%	
		Accumulated error =		**17.2%**		**18.8%**		**19.2%**		**19.4%**		**18.9%**		**17.6%**	**± 0.89**
		Avg. error per state =		**2.1%**		**2.4%**		**2.4%**		**2.4%**		**2.4%**		**2.2%**	**± 0.11**

Figure 5. Results for the Boltzmann machine in the 3-atom micro-world, tested against the neutral premise. States are given in decimal format.

Training Set: 30-0

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	
(0), (1)	0	33.3%	19146	32%	20541	34%	19558	33%	20262	34%	19393	32%	98900	33.0%	
	1	33.3%	19843	33%	18646	31%	18842	31%	19381	32%	19579	33%	96291	32.1%	
(4), (5)	2	0.0%	77	0%	90	0%	70	0%	63	0%	64	0%	364	0.1%	
	3	0.0%	82	0%	82	0%	88	0%	82	0%	79	0%	413	0.1%	
(2), (3), (6), (7)	4	16.7%	10233	17%	10073	17%	10988	18%	10392	17%	10811	18%	52497	17.5%	
	5	16.7%	10440	17%	10392	17%	10286	17%	9636	16%	9911	17%	50665	16.9%	
	6	0.0%	88	0%	85	0%	81	0%	85	0%	82	0%	421	0.1%	
	7	0.0%	91	0%	91	0%	87	0%	99	0%	81	0%	449	0.1%	
		Accumulated error =		**3.2%**		**4.4%**		**5.2%**		**3.3%**		**3.7%**		**3.1%**	**± 0.85**
		Avg. error per state =		**0.4%**		**0.6%**		**0.7%**		**0.4%**		**0.5%**		**0.4%**	**± 0.11**

Training Set: 34-1

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	
(0), (1)	0	29.4%	13292	22%	13786	23%	15022	25%	14518	24%	14415	24%	71033	23.7%	
	1	29.4%	18339	31%	17681	29%	17560	29%	17384	29%	17443	29%	88407	29.5%	
(4), (5)	2	2.9%	1791	3%	1836	3%	1839	3%	1867	3%	1715	3%	9048	3.0%	
	3	2.9%	3070	5%	3123	5%	3269	5%	3006	5%	3109	5%	15577	5.2%	
(2), (3), (6), (7)	4	14.7%	9196	15%	9566	16%	8596	14%	8598	14%	8742	15%	44698	14.9%	
	5	14.7%	9465	16%	9034	15%	8700	15%	9393	16%	9379	16%	45971	15.3%	
	6	2.9%	1815	3%	2049	3%	1905	3%	2002	3%	2127	4%	9898	3.3%	
	7	2.9%	3032	5%	2925	5%	3109	5%	3232	5%	3070	5%	15368	5.1%	
		Accumulated error =		**14.7%**		**13.0%**		**10.3%**		**12.2%**		**12.0%**		**11.6%**	**± 1.59**
		Avg. error per state =		**1.8%**		**1.6%**		**1.3%**		**1.5%**		**1.5%**		**1.5%**	**± 0.20**

Figure 6. Results for the Boltzmann machine in the 3-atom micro-world, tested against the neutral premise. States are given in decimal format.

Using Training Set: 34-1
Testing with premises:

"-1, -1, 1"

Ranked Interpt.	State	Expect %	Samples	Output %
(1)	0	0%	1193	2%
	1	100%	57288	95%
-	2	0%	14	0%
	3	0%	1289	2%
-	4	0%	4	0%
	5	0%	198	0%
	6	0%	0	0%
	7	0%	14	0%

"1, 1, -1"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	159	0%
	1	0%	0	0%
-	2	0%	209	0%
	3	0%	4	0%
(6)	4	0%	26043	43%
	5	0%	371	1%
	6	100%	32566	54%
	7	0%	648	1%

"-1, 0, 1"

Ranked Interpt.	State	Expect %	Samples	Output %
(1)	0	0%	541	1%
	1	91%	49551	83%
-	2	0%	76	0%
	3	9%	9530	16%
(3)	4	0%	6	0%
	5	0%	239	0%
	6	0%	0	0%
	7	0%	57	0%

"0, -1, -1"

Ranked Interpt.	State	Expect %	Samples	Output %
(0)	0	67%	40717	68%
	1	0%	535	1%
(4)	2	0%	779	1%
	3	0%	5	0%
-	4	33%	16821	28%
	5	0%	162	0%
	6	0%	975	2%
	7	0%	6	0%

"-1, -1, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
(0), (1)	0	50%	29750	50%
	1	50%	28799	48%
-	2	0%	426	1%
	3	0%	809	1%
-	4	0%	110	0%
	5	0%	102	0%
	6	0%	1	0%
	7	0%	3	0%

"1, 1, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	72	0%
	1	0%	99	0%
-	2	0%	59	0%
	3	0%	118	0%
(6), (7)	4	0%	11051	18%
	5	0%	13609	23%
	6	50%	14338	24%
	7	50%	20654	34%

"0, 0, 1"

Ranked Interpt.	State	Expect %	Samples	Output %
(1)	0	0%	800	1%
	1	59%	29911	50%
(5)	2	0%	156	0%
	3	6%	6897	11%
(3), (7)	4	0%	467	1%
	5	29%	15478	26%
	6	0%	130	0%
	7	6%	6161	10%

"-1, 0, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
(0), (1)	0	46%	23253	39%
	1	46%	30835	51%
-	2	4%	1809	3%
	3	4%	3847	6%
(2), (3)	4	0%	89	0%
	5	0%	124	0%
	6	0%	18	0%
	7	0%	25	0%

"0, -1, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
(0), (1)	0	33%	21556	36%
	1	33%	20581	34%
(4), (5)	2	0%	370	1%
	3	0%	639	1%
-	4	17%	8741	15%
	5	17%	7203	12%
	6	0%	397	1%
	7	0%	513	1%

"1, 0, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	191	0%
	1	0%	189	0%
(4), (5)	2	0%	46	0%
	3	0%	53	0%
(6), (7)	4	42%	21702	36%
	5	42%	21935	37%
	6	8%	6540	11%
	7	8%	9344	16%

"0, 1, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	5465	9%
	1	0%	9814	16%
-	2	25%	4786	8%
	3	25%	8559	14%
(2), (3), (6), (7)	4	0%	6072	10%
	5	0%	8159	14%
	6	25%	6637	11%
	7	25%	10508	18%

Figure 7. Results for the Boltzmann machine in the 3-atom micro-world, tested against specific premises. States are given in decimal format.

Testing with neutral premise "0, 0, 0, 0"

Training Set: 88-0

Ranked Interpret.	*State*	*Expected %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	Avg *Samples*	Avg *Output %*	Stdev
(0), (1), (8), (9)	0	18.1%	11466	19.1%	11805	19.7%	11439	19.1%	11241	18.7%	10953	18.3%	56904	19.0%	
	1	18.1%	11005	18.3%	10585	17.6%	10698	17.8%	10611	17.7%	11434	19.1%	54333	18.1%	
(5), (13)	2	4.5%	3168	5.3%	3626	6.0%	3390	5.7%	3057	5.1%	3458	5.8%	16699	5.6%	
	3	0.0%	32	0.1%	50	0.1%	26	0.0%	37	0.1%	45	0.1%	190	0.1%	
(2), (10)	4	0.0%	37	0.1%	28	0.0%	39	0.1%	36	0.1%	36	0.1%	176	0.1%	
	5	9.1%	4439	7.4%	4214	7.0%	4197	7.0%	3981	6.6%	4548	7.6%	21379	7.1%	
(3), (4), (6), (7),	6	0.0%	103	0.2%	86	0.1%	59	0.1%	158	0.3%	70	0.1%	476	0.2%	
(11), (12), (14), (15)	7	0.0%	65	0.1%	65	0.1%	109	0.2%	99	0.2%	82	0.1%	420	0.1%	
	8	18.1%	11290	18.8%	11373	19.0%	11428	19.0%	11907	19.8%	11520	19.2%	57518	19.2%	
	9	18.1%	10843	18.1%	10303	17.2%	10675	17.8%	11655	19.4%	10693	17.8%	54169	18.1%	
	10	4.5%	3313	5.5%	3284	5.5%	3263	5.4%	2924	4.9%	3498	5.8%	16282	5.4%	
	11	0.0%	49	0.1%	35	0.1%	29	0.0%	37	0.1%	23	0.0%	173	0.1%	
	12	0.0%	20	0.0%	21	0.0%	60	0.1%	52	0.1%	38	0.1%	191	0.1%	
	13	9.1%	4030	6.7%	4313	7.2%	4419	7.4%	4042	6.7%	3451	5.8%	20255	6.8%	
	14	0.0%	87	0.1%	125	0.2%	79	0.1%	92	0.2%	64	0.1%	447	0.1%	
	15	0.0%	53	0.1%	87	0.1%	90	0.2%	71	0.1%	87	0.1%	388	0.1%	
	Accumulated error =			**8.6%**		**11.2%**		**9.2%**		**10.9%**		**10.7%**		**9.1%**	**± 1.12**
	Avg. error per state =			**0.5%**		**0.7%**		**0.6%**		**0.7%**		**0.7%**		**0.6%**	**± 0.07**

Training Set: 96_1

Ranked Interpret.	*State*	*Expected %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	Avg *Samples*	Avg *Output %*	Stdev
(0), (1), (8), (9)	0	16.7%	8423	14.0%	7920	13.2%	8709	14.5%	7964	13.3%	8497	14.2%	41513	13.8%	
	1	16.7%	8938	14.9%	8305	13.8%	8235	13.7%	8834	14.7%	9064	15.1%	43376	14.5%	
(5), (13)	2	4.2%	3302	5.5%	3528	5.9%	2769	4.6%	3519	5.9%	3320	5.5%	16438	5.5%	
	3	1.0%	1707	2.8%	1682	2.8%	1548	2.6%	1749	2.9%	1838	3.1%	8524	2.8%	
(2), (10)	4	1.0%	1994	3.3%	1692	2.8%	2219	3.7%	1876	3.1%	1867	3.1%	9648	3.2%	
	5	8.3%	3603	6.0%	4122	6.9%	3883	6.5%	4066	6.8%	3672	6.1%	19346	6.4%	
(3), (4), (6), (7),	6	1.0%	1144	1.9%	1187	2.0%	1278	2.1%	1081	1.8%	1108	1.8%	5798	1.9%	
(11), (12), (14), (15)	7	1.0%	1291	2.2%	1158	1.9%	1331	2.2%	1279	2.1%	1018	1.7%	6077	2.0%	
	8	16.7%	7944	13.2%	8562	14.3%	8212	13.7%	8258	13.8%	8330	13.9%	41306	13.8%	
	9	16.7%	9074	15.1%	8714	14.5%	8138	13.6%	8617	14.4%	8533	14.2%	43076	14.4%	
	10	4.2%	2932	4.9%	3107	5.2%	2732	4.6%	3110	5.2%	2916	4.9%	14797	4.9%	
	11	1.0%	1982	3.3%	1796	3.0%	1792	3.0%	1696	2.8%	1721	2.9%	8987	3.0%	
	12	1.0%	1780	3.0%	1768	2.9%	2222	3.7%	2069	3.4%	1974	3.3%	9813	3.3%	
	13	8.3%	3692	6.2%	4221	7.0%	4451	7.4%	3774	6.3%	3771	6.3%	19909	6.6%	
	14	1.0%	1064	1.8%	1058	1.8%	1223	2.0%	1024	1.7%	1137	1.9%	5506	1.8%	
	15	1.0%	1130	1.9%	1180	2.0%	1258	2.1%	1084	1.8%	1234	2.1%	5886	2.0%	
	Accumulated error =			**28.1%**		**27.5%**		**28.2%**		**28.6%**		**27.4%**		**28.0%**	**± 0.50**
	Avg. error per state =			**1.8%**		**1.7%**		**1.8%**		**1.8%**		**1.7%**		**1.7%**	**± 0.03**

Figure 8. Results for the Boltzmann machine in the 4-atom micro-world, tested against the neutral premise. States are given in decimal format.

Training Set: 90-0

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	
(0), (1), (8), (9)	0	16.7%	10582	17.6%	10478	17.5%	10831	18.1%	9868	16.4%	10613	17.7%	52372	17.5%	
	1	16.7%	10956	18.3%	10941	18.2%	11211	18.7%	11198	18.7%	11258	18.8%	55564	18.5%	
(5), (13)	2	5.6%	3512	5.9%	2995	5.0%	3320	5.5%	3100	5.2%	2987	5.0%	15914	5.3%	
	3	0.0%	39	0.1%	29	0.0%	44	0.1%	37	0.1%	32	0.1%	181	0.1%	
(2), (10)	4	0.0%	30	0.1%	33	0.1%	24	0.0%	32	0.1%	20	0.0%	139	0.0%	
	5	11.1%	5232	8.7%	5145	8.6%	5100	8.5%	5442	9.1%	5406	9.0%	26325	8.8%	
(3), (4), (6), (7),	6	0.0%	73	0.1%	50	0.1%	57	0.1%	79	0.1%	53	0.1%	312	0.1%	
(11), (12), (14), (15)	7	0.0%	63	0.1%	98	0.2%	116	0.2%	74	0.1%	111	0.2%	462	0.2%	
	8	16.7%	10292	17.2%	10651	17.8%	10388	17.3%	10299	17.2%	10600	17.7%	52230	17.4%	
	9	16.7%	10522	17.5%	11181	18.6%	10645	17.7%	11196	18.7%	10882	18.1%	54426	18.1%	
	10	5.6%	3146	5.2%	3078	5.1%	2903	4.8%	3114	5.2%	2513	4.2%	14754	4.9%	
	11	0.0%	35	0.1%	33	0.1%	33	0.1%	41	0.1%	39	0.1%	181	0.1%	
	12	0.0%	32	0.1%	26	0.0%	36	0.1%	33	0.1%	23	0.0%	150	0.1%	
	13	11.1%	5317	8.9%	5093	8.5%	5098	8.5%	5337	8.9%	5299	8.8%	26144	8.7%	
	14	0.0%	63	0.1%	63	0.1%	80	0.1%	60	0.1%	35	0.1%	301	0.1%	
	15	0.0%	106	0.2%	106	0.2%	114	0.2%	90	0.2%	129	0.2%	545	0.2%	
	Accumulated error =			**9.8%**		**12.2%**		**11.9%**		**10.5%**		**12.6%**		**11.2%**	**± 1.21**
	Avg. error per state =			**0.6%**		**0.8%**		**0.7%**		**0.7%**		**0.8%**		**0.7%**	**± 0.08**

Training Set: 98-1

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	
(0), (1), (8), (9)	0	15.3%	8001	13.3%	8109	13.5%	7299	12.2%	7766	12.9%	7497	12.5%	38672	12.9%	
	1	15.3%	7268	12.1%	8124	13.5%	7854	13.1%	8368	13.9%	7929	13.2%	39543	13.2%	
(5), (13)	2	5.1%	3044	5.1%	2756	4.6%	3238	5.4%	3105	5.2%	3093	5.2%	15236	5.1%	
	3	1.0%	1451	2.4%	1679	2.8%	1634	2.7%	1826	3.0%	1732	2.9%	8322	2.8%	
(2), (10)	4	1.0%	2089	3.5%	2226	3.7%	2186	3.6%	2045	3.4%	2118	3.5%	10664	3.6%	
	5	10.2%	4806	8.0%	4783	8.0%	5012	8.4%	4683	7.8%	4942	8.2%	24226	8.1%	
(3), (4), (6), (7),	6	1.0%	1120	1.9%	1179	2.0%	1097	1.8%	1051	1.8%	1147	1.9%	5594	1.9%	
(11), (12), (14), (15)	7	1.0%	1309	2.2%	1271	2.1%	1406	2.3%	1455	2.4%	1188	2.0%	6629	2.2%	
	8	15.3%	8420	14.0%	8062	13.4%	8470	14.1%	7574	12.6%	7917	13.2%	40443	13.5%	
	9	15.3%	8372	14.0%	8036	13.4%	8322	13.9%	8228	13.7%	8458	14.1%	41416	13.8%	
	10	5.1%	3047	5.1%	2985	5.0%	3154	5.3%	3084	5.1%	2961	4.9%	15231	5.1%	
	11	1.0%	1498	2.5%	1685	2.8%	1684	2.8%	1686	2.8%	1592	2.7%	8145	2.7%	
	12	1.0%	2268	3.8%	2210	3.7%	2042	3.4%	2231	3.7%	2271	3.8%	11022	3.7%	
	13	10.2%	4871	8.1%	4507	7.5%	4217	7.0%	4552	7.6%	4794	8.0%	22941	7.6%	
	14	1.0%	1005	1.7%	1218	2.0%	1103	1.8%	1018	1.7%	1148	1.9%	5492	1.8%	
	15	1.0%	1431	2.4%	1170	2.0%	1282	2.1%	1328	2.2%	1213	2.0%	6424	2.1%	
	Accumulated error =			**24.4%**		**25.9%**		**26.2%**		**26.2%**		**25.3%**		**25.3%**	**± 0.77**
	Avg. error per state =			**1.5%**		**1.6%**		**1.6%**		**1.6%**		**1.6%**		**1.6%**	**± 0.05**

Figure 9. Results for the Boltzmann machine in the 4-atom micro-world, tested against the neutral premise. States are given in decimal format.

Using Training Set: 98-1
Testing with premises:

"-1, -1, -1, -1"

Ranked Interpt.	*State*	*Expect %*	*Samples*	*Output %*
(0)	0	100%	55240	92%
	1	0%	679	1%
-	2	0%	622	1%
	3	0%	4	0%
-	4	0%	176	0%
	5	0%	2	0%
-	6	0%	7	0%
-	7	0%	0	0%
	8	0%	3188	5%
	9	0%	63	0%
	10	0%	9	0%
	11	0%	0	0%
	12	0%	10	0%
	13	0%	0	0%
	14	0%	0	0%
	15	0%	0	0%

"-1, 1, -1, 1"

Ranked Interpt.	*State*	*Expect %*	*Samples*	*Output %*
-	0	0%	4	0%
	1	0%	827	1%
(5)	2	0%	0	0%
	3	0%	1	0%
-	4	0%	136	0%
	5	100%	51695	86%
-	6	0%	1	0%
-	7	0%	156	0%
	8	0%	0	0%
	9	0%	92	0%
	10	0%	0	0%
	11	0%	0	0%
	12	0%	11	0%
	13	0%	7061	12%
	14	0%	0	0%
	15	0%	16	0%

"1, -1, 1, -1"

Ranked Interpt.	*State*	*Expect %*	*Samples*	*Output %*
-	0	0%	102	0%
	1	0%	3	0%
-	2	0%	6184	10%
	3	0%	26	0%
(10)	4	0%	0	0%
	5	0%	0	0%
-	6	0%	11	0%
-	7	0%	0	0%
	8	0%	1211	2%
	9	0%	11	0%
	10	100%	52005	87%
	11	0%	277	0%
	12	0%	4	0%
	13	0%	0	0%
	14	0%	164	0%
	15	0%	2	0%

"-1, 1, 1, -1"

Ranked Interpt.	*State*	*Expect %*	*Samples*	*Output %*
-	0	0%	42	0%
	1	0%	0	0%
-	2	0%	2502	4%
	3	0%	26	0%
-	4	0%	878	1%
	5	0%	23	0%
(6)	6	100%	51004	85%
-	7	0%	803	1%
	8	0%	2	0%
	9	0%	0	0%
	10	0%	155	0%
	11	0%	0	0%
	12	0%	83	0%
	13	0%	1	0%
	14	0%	4429	7%
	15	0%	52	0%

"0, 1, 0, 0"

Ranked Interpt.	*State*	*Expect %*	*Samples*	*Output %*
-	0	0%	198	0%
	1	0%	267	0%
(5), (13)	2	0%	100	0%
	3	0%	49	0%
-	4	4%	5011	8%
	5	39%	15643	26%
(4),(6),(7)	6	4%	3242	5%
(12),(14),(15)	7	4%	5556	9%
	8	0%	173	0%
	9	0%	222	0%
	10	0%	52	0%
	11	0%	59	0%
	12	4%	5461	9%
	13	39%	15787	26%
	14	4%	3240	5%
	15	4%	4940	8%

"0, 0, -1, 0"

Ranked Interpt.	*State*	*Expect %*	*Samples*	*Output %*
(0),(1),(8),(9)	0	18%	8377	14%
	1	18%	13356	22%
(5), (13)	2	0%	46	0%
	3	0%	50	0%
-	4	1%	2102	4%
	5	12%	6417	11%
(4)	6	0%	20	0%
(12)	7	0%	13	0%
	8	18%	8381	14%
	9	18%	12672	21%
	10	0%	51	0%
	11	0%	34	0%
	12	1%	1962	3%
	13	12%	6481	11%
	14	0%	13	0%
	15	0%	25	0%

"0, 0, 0, 1"

Ranked Interpt.	*State*	*Expect %*	*Samples*	*Output %*
(1),(9)	0	0%	106	0%
	1	28%	13480	22%
(5), (13)	2	0%	31	0%
	3	2%	2579	4%
-	4	0%	39	0%
	5	19%	10994	18%
(3),(7)	6	0%	26	0%
(11),(15)	7	2%	2830	5%
	8	0%	122	0%
	9	28%	13575	23%
	10	0%	29	0%
	11	2%	2204	4%
	12	0%	40	0%
	13	19%	11124	19%
	14	0%	20	0%
	15	2%	2801	5%

"-1, 0, 0, 0"

Ranked Interpt.	*State*	*Expect %*	*Samples*	*Output %*
(0),(1)	0	31%	13634	23%
	1	31%	13712	23%
(5)	2	10%	5954	10%
	3	2%	3611	6%
(2)	4	2%	4142	7%
	5	20%	8534	14%
(3)(4),(6),(7)	6	2%	2327	4%
-	7	2%	2879	5%
	8	0%	1164	2%
	9	0%	1643	3%
	10	0%	486	1%
	11	0%	352	1%
	12	0%	362	1%
	13	0%	842	1%
	14	0%	140	0%
	15	0%	218	0%

Figure 10. Results for the Boltzmann machine in the 4-atom micro-world, tested against specific premises. States are given in decimal format.

Testing with premises:

"0, 0, -1, 1"

Ranked Interpt.	State	Expect %	Samples	Output %
(1),(9)	0	0%	152	0%
	1	30%	17670	29%
(5), (13)	2	0%	0	0%
	3	0%	36	0%
-	4	0%	38	0%
	5	20%	11816	20%
-	6	0%	0	0%
-	7	0%	29	0%
	8	0%	160	0%
	9	30%	17599	29%
	10	0%	0	0%
	11	0%	52	0%
	12	0%	42	0%
	13	20%	12377	21%
	14	0%	0	0%
	15	0%	29	0%

"0, -1, 0, -1"

Ranked Interpt.	State	Expect %	Samples	Output %
(0),(8)	0	38%	20239	34%
	1	0%	189	0%
-	2	13%	9441	16%
	3	0%	54	0%
(2),(10)	4	0%	56	0%
	5	0%	2	0%
-	6	0%	37	0%
-	7	0%	0	0%
	8	38%	19995	33%
	9	0%	172	0%
	10	13%	9655	16%
	11	0%	64	0%
	12	0%	67	0%
	13	0%	0	0%
	14	0%	29	0%
	15	0%	0	0%

"0, -1, 0, 1"

Ranked Interpt.	State	Expect %	Samples	Output %
(1),(9)	0	0%	301	1%
	1	47%	25241	42%
-	2	0%	88	0%
	3	3%	3770	6%
-	4	0%	0	0%
	5	0%	223	0%
(3)	6	0%	0	0%
(11)	7	0%	46	0%
	8	0%	343	1%
	9	47%	26200	44%
	10	0%	75	0%
	11	3%	3504	6%
	12	0%	0	0%
	13	0%	196	0%
	14	0%	0	0%
	15	0%	13	0%

"0, -1, 1, 0""

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	553	1%
	1	0%	324	1%
-	2	42%	22555	38%
	3	8%	6273	10%
(2),(10)	4	0%	1	0%
	5	0%	1	0%
(3)	6	0%	102	0%
(11)	7	0%	54	0%
	8	0%	571	1%
	9	0%	291	0%
	10	42%	22713	38%
	11	8%	6378	11%
	12	0%	5	0%
	13	0%	1	0%
	14	0%	115	0%
	15	0%	63	0%

"-1, 0, -1, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
(0),(1)	0	37%	16385	27%
	1	37%	22774	38%
(5)	2	0%	99	0%
	3	0%	62	0%
-	4	2%	3770	6%
	5	24%	11019	18%
(4)	6	0%	53	0%
-	7	0%	28	0%
	8	0%	1782	3%
	9	0%	2580	4%
	10	0%	8	0%
	11	0%	3	0%
	12	0%	326	1%
	13	0%	1107	2%
	14	0%	1	0%
	15	0%	3	0%

"-1, -1, 0, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
(0),(1)	0	42%	24941	42%
	1	42%	18802	31%
-	2	14%	8293	14%
	3	3%	3653	6%
(2)	4	0%	83	0%
	5	0%	106	0%
(3)	6	0%	46	0%
-	7	0%	29	0%
	8	0%	1835	3%
	9	0%	1294	2%
	10	0%	617	1%
	11	0%	286	0%
	12	0%	5	0%
	13	0%	10	0%
	14	0%	0	0%
	15	0%	0	0%

"-1, 0, 0, -1"

Ranked Interpt.	State	Expect %	Samples	Output %
(0)	0	68%	29657	49%
	1	0%	326	1%
-	2	23%	14414	24%
	3	0%	89	0%
(2)	4	4%	5166	9%
	5	0%	111	0%
(4),(6)	6	4%	3535	6%
-	7	0%	40	0%
	8	0%	3995	7%
	9	0%	37	0%
	10	0%	1741	3%
	11	0%	10	0%
	12	0%	563	1%
	13	0%	11	0%
	14	0%	304	1%
	15	0%	1	0%

"-1, 0, 0, 1"

Ranked Interpt.	State	Expect %	Samples	Output %
(1)	0	0%	230	0%
	1	56%	24038	40%
(5)	2	0%	84	0%
	3	4%	3975	7%
-	4	0%	103	0%
	5	37%	19856	33%
(3),(7)	6	0%	35	0%
-	7	4%	4416	7%
	8	0%	22	0%
	9	0%	3283	5%
	10	0%	10	0%
	11	0%	536	1%
	12	0%	9	0%
	13	0%	2834	5%
	14	0%	1	0%
	15	0%	568	1%

Figure 11. Results for the Boltzmann machine in the 4-atom micro-world, tested against specific premises. States are given in decimal format.

Using Training Set: 98-1
Testing with premises:

"-1, 1, 0, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	279	0%
	1	0%	431	1%
(5)	2	0%	121	0%
	3	0%	65	0%
-	4	8%	9589	16%
	5	77%	29040	48%
(4),(6),(7)	6	8%	6252	10%
-	7	8%	8918	15%
	8	0%	28	0%
	9	0%	53	0%
	10	0%	6	0%
	11	0%	7	0%
	12	0%	1075	2%
	13	0%	2734	5%
	14	0%	553	1%
	15	0%	849	1%

"1, 0, 1, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	63	0%
	1	0%	61	0%
-	2	0%	3472	6%
	3	0%	1225	2%
(10)	4	0%	21	0%
	5	0%	37	0%
-	6	0%	1219	2%
(11),(14),(15)	7	0%	907	2%
	8	0%	648	1%
	9	0%	464	1%
	10	63%	22506	38%
	11	12%	9814	16%
	12	0%	216	0%
	13	0%	274	0%
	14	12%	10501	18%
	15	12%	8572	14%

"0, -1, -1, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
(0),(1),(8),(9)	0	25%	14243	24%
	1	25%	15378	26%
-	2	0%	69	0%
	3	0%	57	0%
-	4	0%	54	0%
	5	0%	89	0%
-	6	0%	0	0%
-	7	0%	0	0%
	8	25%	14755	25%
	9	25%	15102	25%
	10	0%	66	0%
	11	0%	49	0%
	12	0%	42	0%
	13	0%	95	0%
	14	0%	1	0%
	15	0%	0	0%

"0, 0, 1, 1"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	7	0%
	1	0%	717	1%
-	2	0%	251	0%
	3	25%	12731	21%
-	4	0%	0	0%
	5	0%	667	1%
(3),(7)	6	0%	164	0%
(11),(15)	7	25%	15791	26%
	8	0%	16	0%
	9	0%	707	1%
	10	0%	323	1%
	11	25%	12156	20%
	12	0%	3	0%
	13	0%	674	1%
	14	0%	142	0%
	15	25%	15651	26%

"1, -1, -1, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
(8),(9)	0	0%	3174	5%
	1	0%	3480	6%
-	2	0%	20	0%
	3	0%	10	0%
-	4	0%	3	0%
	5	0%	11	0%
-	6	0%	0	0%
-	7	0%	0	0%
	8	50%	25475	42%
	9	50%	27406	46%
	10	0%	162	0%
	11	0%	62	0%
	12	0%	60	0%
	13	0%	135	0%
	14	0%	0	0%
	15	0%	2	0%

"0, 1, -1, 1"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	2	0%
	1	0%	419	1%
(5),(13)	2	0%	0	0%
	3	0%	0	0%
-	4	0%	38	0%
	5	50%	29374	49%
-	6	0%	0	0%
-	7	0%	131	0%
	8	0%	5	0%
	9	0%	407	1%
	10	0%	0	0%
	11	0%	1	0%
	12	0%	78	0%
	13	50%	29366	49%
	14	0%	0	0%
	15	0%	179	0%

"0, -1, 1, -1"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	688	1%
	1	0%	4	0%
-	2	50%	29551	49%
	3	0%	157	0%
(2),(10)	4	0%	1	0%
	5	0%	0	0%
-	6	0%	70	0%
-	7	0%	1	0%
	8	0%	669	1%
	9	0%	7	0%
	10	50%	28601	48%
	11	0%	156	0%
	12	0%	5	0%
	13	0%	0	0%
	14	0%	90	0%
	15	0%	0	0%

"-1, 1, 0, -1"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	1501	3%
	1	0%	19	0%
-	2	0%	754	1%
	3	0%	12	0%
-	4	50%	30381	51%
	5	0%	818	1%
(4),(6)	6	50%	21211	35%
-	7	0%	327	1%
	8	0%	107	0%
	9	0%	1	0%
	10	0%	66	0%
	11	0%	0	0%
	12	0%	2963	5%
	13	0%	84	0%
	14	0%	1740	3%
	15	0%	16	0%

Figure 12. Results for the Boltzmann machine in the 4-atom micro-world, tested against specific premises. States are given in decimal format.

Using Training Set: 98-1

"1, -1, 0, -1"

Ranked Interpt.	State	Expect %	Samples	Output %
(8)	0	0%	3102	5%
	1	0%	14	0%
-	2	0%	1274	2%
	3	0%	5	0%
(10)	4	0%	11	0%
	5	0%	0	0%
-	6	0%	2	0%
-	7	0%	0	0%
	8	75%	36107	60%
	9	0%	403	1%
	10	25%	18822	31%
	11	0%	109	0%
	12	0%	107	0%
	13	0%	4	0%
	14	0%	40	0%
	15	0%	0	0%

"-1, 0, -1, -1"

Ranked Interpt.	State	Expect %	Samples	Output %
(0)	0	94%	44868	75%
	1	0%	620	1%
-	2	0%	326	1%
	3	0%	1	0%
-	4	6%	8261	14%
	5	0%	204	0%
(4)	6	0%	72	0%
-	7	0%	0	0%
	8	0%	4739	8%
	9	0%	34	0%
	10	0%	19	0%
	11	0%	2	0%
	12	0%	833	1%
	13	0%	20	0%
	14	0%	1	0%
	15	0%	0	0%

"-1, 1, 0, 1"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	6	0%
	1	0%	472	1%
(5)	2	0%	0	0%
	3	0%	96	0%
-	4	0%	157	0%
	5	91%	43005	72%
(7)	6	0%	53	0%
-	7	9%	10382	17%
	8	0%	0	0%
	9	0%	62	0%
	10	0%	0	0%
	11	0%	6	0%
	12	0%	14	0%
	13	0%	4722	8%
	14	0%	1	0%
	15	0%	1024	2%

"1, -1, 1, 0"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	107	0%
	1	0%	54	0%
-	2	0%	4645	8%
	3	0%	1313	2%
(10)	4	0%	0	0%
	5	0%	0	0%
-	6	0%	8	0%
(11)	7	0%	6	0%
	8	0%	1639	3%
	9	0%	687	1%
	10	84%	39595	66%
	11	16%	11710	20%
	12	0%	5	0%
	13	0%	10	0%
	14	0%	145	0%
	15	0%	76	0%

Figure 13. Results for the Boltzmann machine in the 4-atom micro-world, tested against specific premises. States are given in decimal format.

Testing with neutral premise "0, 0, 0, 0, 0"
Training Set: 136-0

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Avg Samples	Avg Output %	Stdev
(16), (17)	0	11.8%	3943	6.6%	4110	6.9%	4617	7.7%	4273	7.1%	4302	7.2%	21245	7.1%	
	1	11.8%	9973	16.6%	9962	16.6%	10622	17.7%	9636	16.1%	9718	16.2%	49911	16.6%	
(0), (1)	2	2.9%	2155	3.6%	2131	3.6%	2059	3.4%	2260	3.8%	2207	3.7%	10812	3.6%	
	3	0.0%	15	0.0%	15	0.0%	14	0.0%	14	0.0%	17	0.0%	75	0.0%	
(5), (9), (21), (25)	4	0.0%	22	0.0%	25	0.0%	43	0.1%	24	0.0%	27	0.0%	141	0.0%	
	5	5.9%	5337	8.9%	4909	8.2%	4548	7.6%	5037	8.4%	5167	8.6%	24998	8.3%	
(2), (18)	6	0.0%	176	0.3%	173	0.3%	134	0.2%	141	0.2%	165	0.3%	789	0.3%	
	7	0.0%	6	0.0%	18	0.0%	17	0.0%	19	0.0%	13	0.0%	73	0.0%	
All other states 22	8	0.0%	26	0.0%	27	0.0%	37	0.1%	33	0.1%	33	0.1%	156	0.1%	
(3), (4), (6)-(8)	9	5.9%	5230	8.7%	5134	8.6%	4806	8.0%	5011	8.4%	4801	8.0%	24982	8.3%	
(10)-(15), (19), (20)	10	0.0%	115	0.2%	175	0.3%	183	0.3%	103	0.2%	180	0.3%	756	0.3%	
(22)-(24), (26)-(31)	11	0.0%	7	0.0%	15	0.0%	22	0.0%	12	0.0%	12	0.0%	68	0.0%	
	12	0.0%	1	0.0%	1	0.0%	0	0.0%	0	0.0%	0	0.0%	2	0.0%	
	13	0.0%	1071	1.8%	752	1.3%	516	0.9%	896	1.5%	841	1.4%	4076	1.4%	
	14	0.0%	1	0.0%	1	0.0%	1	0.0%	0	0.0%	4	0.0%	7	0.0%	
	15	0.0%	5	0.0%	7	0.0%	4	0.0%	5	0.0%	36	0.1%	57	0.0%	
	16	23.5%	6010	10.0%	5582	9.3%	5738	9.6%	5312	8.9%	5485	9.1%	28127	9.4%	
	17	23.5%	12176	20.3%	12939	21.6%	13897	23.2%	12936	21.6%	13550	22.6%	65498	21.8%	
	18	2.9%	2644	4.4%	2620	4.4%	2298	3.8%	2356	3.9%	1982	3.3%	11900	4.0%	
	19	0.0%	28	0.0%	21	0.0%	14	0.0%	20	0.0%	26	0.0%	109	0.0%	
	20	0.0%	21	0.0%	27	0.0%	27	0.0%	32	0.1%	29	0.0%	136	0.0%	
	21	5.9%	4725	7.9%	5075	8.5%	5048	8.4%	5401	9.0%	5384	9.0%	25633	8.5%	
	22	0.0%	131	0.2%	83	0.1%	117	0.2%	137	0.2%	174	0.3%	642	0.2%	
	23	0.0%	14	0.0%	16	0.0%	13	0.0%	23	0.0%	18	0.0%	84	0.0%	
	24	0.0%	23	0.0%	61	0.1%	33	0.1%	32	0.1%	29	0.0%	178	0.1%	
	25	5.9%	4926	8.2%	5187	8.6%	4469	7.4%	5417	9.0%	4820	8.0%	24819	8.3%	
	26	0.0%	111	0.2%	133	0.2%	110	0.2%	95	0.2%	114	0.2%	563	0.2%	
	27	0.0%	18	0.0%	16	0.0%	9	0.0%	9	0.0%	13	0.0%	65	0.0%	
	28	0.0%	1	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.0%	
	29	0.0%	1074	1.8%	782	1.3%	595	1.0%	763	1.3%	850	1.4%	4064	1.4%	
	30	0.0%	3	0.0%	0	0.0%	0	0.0%	3	0.0%	1	0.0%	7	0.0%	
	31	0.0%	12	0.0%	3	0.0%	9	0.0%	0	0.0%	2	0.0%	26	0.0%	
	Accumulated error =		60000	**55.6%**	60000	**54.0%**	60000	**48.6%**	60000	**54.3%**	60000	**51.6%**	300000	**52.8%**	**± 2.79**
	Avg. error per state =			**1.7%**		**1.7%**		**1.5%**		**1.7%**		**1.6%**		**1.7%**	**± 0.09**

Figure 14. Results for the Boltzmann machine in the 5-atom micro-world, tested against the neutral premise. States are given in decimal format.

Training Set: 158-1

Ranked Interpret.	*State*	*Expected %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	
(16), (17)	0	10.1%	4687	7.8%	5109	8.5%	4875	8.1%	4901	8.2%	5293	8.8%	24865	8.3%	
	1	10.1%	5560	9.3%	5305	8.8%	5466	9.1%	5562	9.3%	4957	8.3%	26850	9.0%	
(0), (1)	2	2.5%	1517	2.5%	1391	2.3%	1368	2.3%	1829	3.0%	1490	2.5%	7595	2.5%	
	3	0.6%	1066	1.8%	1087	1.8%	828	1.4%	1050	1.8%	1200	2.0%	5231	1.7%	
(5), (9), (21), (25)	4	0.6%	1433	2.4%	1620	2.7%	1651	2.8%	1284	2.1%	1546	2.6%	7534	2.5%	
	5	5.1%	3399	5.7%	3093	5.2%	2979	5.0%	3431	5.7%	3091	5.2%	15993	5.3%	
(2), (18)	6	0.6%	741	1.2%	579	1.0%	729	1.2%	789	1.3%	678	1.1%	3516	1.2%	
	7	0.6%	685	1.1%	706	1.2%	708	1.2%	632	1.1%	860	1.4%	3591	1.2%	
All other states 22	8	0.6%	1434	2.4%	1687	2.8%	1758	2.9%	1690	2.8%	1735	2.9%	8304	2.8%	
(3), (4), (6)-(8)	9	5.1%	2990	5.0%	2844	4.7%	2932	4.9%	3161	5.3%	2885	4.8%	14812	4.9%	
(10)-(15), (19), (20)	10	0.6%	813	1.4%	811	1.4%	804	1.3%	720	1.2%	723	1.2%	3871	1.3%	
(22)-(24), (26)-(31)	11	0.6%	772	1.3%	737	1.2%	726	1.2%	675	1.1%	834	1.4%	3744	1.2%	
	12	0.6%	803	1.3%	798	1.3%	567	0.9%	568	0.9%	854	1.4%	3590	1.2%	
	13	0.6%	1605	2.7%	1619	2.7%	1427	2.4%	1626	2.7%	1287	2.1%	7564	2.5%	
	14	0.6%	672	1.1%	517	0.9%	416	0.7%	503	0.8%	497	0.8%	2605	0.9%	
	15	0.6%	505	0.8%	674	1.1%	748	1.2%	729	1.2%	559	0.9%	3215	1.1%	
	16	20.3%	5289	8.8%	5656	9.4%	5268	8.8%	5586	9.3%	5933	9.9%	27732	9.2%	
	17	20.3%	6513	10.9%	6337	10.6%	7118	11.9%	6267	10.4%	6190	10.3%	32425	10.8%	
	18	2.5%	1785	3.0%	1856	3.1%	1670	2.8%	1750	2.9%	1676	2.8%	8737	2.9%	
	19	0.6%	1184	2.0%	1145	1.9%	1297	2.2%	1192	2.0%	1252	2.1%	6070	2.0%	
	20	0.6%	1378	2.3%	1854	3.1%	1528	2.5%	1659	2.8%	1515	2.5%	7934	2.6%	
	21	5.1%	2902	4.8%	3183	5.3%	3054	5.1%	2977	5.0%	3343	5.6%	15459	5.2%	
	22	0.6%	777	1.3%	937	1.6%	833	1.4%	986	1.6%	796	1.3%	4329	1.4%	
	23	0.6%	921	1.5%	669	1.1%	868	1.4%	735	1.2%	792	1.3%	3985	1.3%	
	24	0.6%	1894	3.2%	1661	2.8%	1819	3.0%	1872	3.1%	1667	2.8%	8913	3.0%	
	25	5.1%	3526	5.9%	3223	5.4%	3413	5.7%	3208	5.3%	3345	5.6%	16715	5.6%	
	26	0.6%	876	1.5%	646	1.1%	922	1.5%	657	1.1%	723	1.2%	3824	1.3%	
	27	0.6%	787	1.3%	719	1.2%	930	1.6%	756	1.3%	852	1.4%	4044	1.3%	
	28	0.6%	783	1.3%	585	1.0%	527	0.9%	603	1.0%	873	1.5%	3371	1.1%	
	29	0.6%	1542	2.6%	1703	2.8%	1462	2.4%	1606	2.7%	1681	2.8%	7994	2.7%	
	30	0.6%	479	0.8%	533	0.9%	523	0.9%	481	0.8%	384	0.6%	2400	0.8%	
	31	0.6%	682	1.1%	716	1.2%	786	1.3%	515	0.9%	489	0.8%	3188	1.1%	
	Accumulated error =		60000	**59.1%**	60000	**58.8%**	60000	**57.8%**	60000	**58.0%**	60000	**58.4%**	300000	**58.1%**	**± 0.55**
	Avg. error per state =			**1.8%**		**1.8%**		**1.8%**		**1.8%**		**1.8%**		**1.8%**	**± 0.02**

Figure 15. Results for the Boltzmann machine in the 5-atom micro-world, tested against the neutral premise. States are given in decimal format.

Testing with neutral premise "0, 0, 0, 0, 0"
Training Set: 120-0

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Avg Samples	Avg Output %	Stdev
(16), (17)	0	12.5%	4507	7.5%	4488	7.5%	4169	6.9%	4479	7.5%	5368	8.9%	23011	7.7%	
	1	12.5%	11103	18.5%	11261	18.8%	11435	19.1%	11976	20.0%	11281	18.8%	57056	19.0%	
(0), (1)	2	4.2%	2087	3.5%	1893	3.2%	2057	3.4%	1443	2.4%	1771	3.0%	9251	3.1%	
	3	0.0%	17	0.0%	26	0.0%	24	0.0%	20	0.0%	18	0.0%	105	0.0%	
(5), (9), (21), (25)	4	0.0%	39	0.1%	39	0.1%	21	0.0%	22	0.0%	43	0.1%	164	0.1%	
	5	8.3%	6088	10.1%	6338	10.6%	5574	9.3%	6205	10.3%	5614	9.4%	29819	9.9%	
(2), (18)	6	0.0%	93	0.2%	83	0.1%	92	0.2%	69	0.1%	72	0.1%	409	0.1%	
	7	0.0%	10	0.0%	22	0.0%	5	0.0%	10	0.0%	4	0.0%	51	0.0%	
All other states 22	8	0.0%	36	0.1%	9	0.0%	26	0.0%	20	0.0%	27	0.0%	118	0.0%	
(3), (4), (6)-(8)	9	8.3%	6405	10.7%	6129	10.2%	5591	9.3%	5461	9.1%	5438	9.1%	29024	9.7%	
(10)-(15), (19), (20)	10	0.0%	82	0.1%	78	0.1%	108	0.2%	70	0.1%	106	0.2%	444	0.1%	
(22)-(24), (26)-(31)	11	0.0%	15	0.0%	12	0.0%	11	0.0%	12	0.0%	16	0.0%	66	0.0%	
	12	0.0%	0	0.0%	1	0.0%	0	0.0%	0	0.0%	1	0.0%	2	0.0%	
	13	0.0%	733	1.2%	903	1.5%	512	0.9%	369	0.6%	541	0.9%	3058	1.0%	
	14	0.0%	2	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	2	0.0%	
	15	0.0%	10	0.0%	2	0.0%	9	0.0%	12	0.0%	1	0.0%	34	0.0%	
	16	16.7%	4078	6.8%	4793	8.0%	4545	7.6%	4991	8.3%	4581	7.6%	22988	7.7%	
	17	16.7%	11117	18.5%	10568	17.6%	12131	20.2%	11965	19.9%	11385	19.0%	57166	19.1%	
	18	4.2%	1902	3.2%	1951	3.3%	1859	3.1%	1759	2.9%	2065	3.4%	9536	3.2%	
	19	0.0%	14	0.0%	12	0.0%	14	0.0%	24	0.0%	15	0.0%	79	0.0%	
	20	0.0%	22	0.0%	26	0.0%	27	0.0%	23	0.0%	27	0.0%	125	0.0%	
	21	8.3%	5110	8.5%	5090	8.5%	5298	8.8%	5613	9.4%	5414	9.0%	26525	8.8%	
	22	0.0%	104	0.2%	112	0.2%	104	0.2%	86	0.1%	72	0.1%	478	0.2%	
	23	0.0%	15	0.0%	11	0.0%	22	0.0%	7	0.0%	10	0.0%	65	0.0%	
	24	0.0%	27	0.0%	30	0.1%	26	0.0%	24	0.0%	29	0.0%	136	0.0%	
	25	8.3%	5646	9.4%	5150	8.6%	5623	9.4%	4899	8.2%	5402	9.0%	26720	8.9%	
	26	0.0%	79	0.1%	79	0.1%	70	0.1%	85	0.1%	102	0.2%	415	0.1%	
	27	0.0%	10	0.0%	12	0.0%	4	0.0%	8	0.0%	9	0.0%	43	0.0%	
	28	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	29	0.0%	648	1.1%	880	1.5%	641	1.1%	346	0.6%	588	1.0%	3103	1.0%	
	30	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.0%	0	0.0%	1	0.0%	
	31	0.0%	1	0.0%	2	0.0%	2	0.0%	1	0.0%	0	0.0%	6	0.0%	
	Accumulated error =		60000	**49.9%**	60000	**48.1%**	60000	**49.7%**	60000	**49.8%**	60000	**45.9%**	300000	**48.6%**	**± 1.75**
	Avg. error per state =			**1.6%**		**1.5%**		**1.6%**		**1.6%**		**1.4%**		**1.5%**	**± 0.05**

Figure 16. Results for the Boltzmann machine in the 5-atom micro-world, tested against the neutral premise. States are given in decimal format.

Training Set: 142-1

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	
(16), (17)	0	10.6%	4680	7.8%	4722	7.9%	5603	9.3%	4825	8.0%	5246	8.7%	25076	8.4%	
	1	10.6%	4970	8.3%	5375	9.0%	5599	9.3%	5373	9.0%	5835	9.7%	27152	9.1%	
(0), (1)	2	3.5%	1347	2.2%	1298	2.2%	1571	2.6%	1665	2.8%	1572	2.6%	7453	2.5%	
	3	0.7%	930	1.6%	1130	1.9%	876	1.5%	830	1.4%	1062	1.8%	4828	1.6%	
(5), (9), (21), (25)	4	0.7%	1874	3.1%	1549	2.6%	1755	2.9%	1712	2.9%	1870	3.1%	8760	2.9%	
	5	7.0%	3770	6.3%	3128	5.2%	3825	6.4%	3509	5.8%	3778	6.3%	18010	6.0%	
(2), (18)	6	0.7%	769	1.3%	793	1.3%	770	1.3%	738	1.2%	729	1.2%	3799	1.3%	
	7	0.7%	841	1.4%	653	1.1%	683	1.1%	898	1.5%	669	1.1%	3744	1.2%	
All other states 22	8	0.7%	1527	2.5%	2174	3.6%	1881	3.1%	1803	3.0%	2007	3.3%	9392	3.1%	
(3), (4), (6)-(8)	9	7.0%	3693	6.2%	3784	6.3%	3600	6.0%	3433	5.7%	3905	6.5%	18415	6.1%	
(10)-(15), (19), (20)	10	0.7%	744	1.2%	703	1.2%	716	1.2%	868	1.4%	846	1.4%	3877	1.3%	
(22)-(24), (26)-(31)	11	0.7%	724	1.2%	888	1.5%	592	1.0%	681	1.1%	816	1.4%	3701	1.2%	
	12	0.7%	752	1.3%	689	1.1%	773	1.3%	764	1.3%	686	1.1%	3664	1.2%	
	13	0.7%	1929	3.2%	1856	3.1%	1942	3.2%	1851	3.1%	1670	2.8%	9248	3.1%	
	14	0.7%	330	0.6%	339	0.6%	335	0.6%	355	0.6%	390	0.7%	1749	0.6%	
	15	0.7%	721	1.2%	620	1.0%	380	0.6%	640	1.1%	632	1.1%	2993	1.0%	
	16	14.1%	4956	8.3%	4791	8.0%	4843	8.1%	4922	8.2%	5017	8.4%	24529	8.2%	
	17	14.1%	5562	9.3%	5522	9.2%	4962	8.3%	5251	8.8%	4670	7.8%	25967	8.7%	
	18	3.5%	1676	2.8%	1506	2.5%	1453	2.4%	1787	3.0%	1683	2.8%	8105	2.7%	
	19	0.7%	1010	1.7%	1104	1.8%	993	1.7%	897	1.5%	900	1.5%	4904	1.6%	
	20	0.7%	1875	3.1%	1807	3.0%	1704	2.8%	1960	3.3%	1690	2.8%	9036	3.0%	
	21	7.0%	3398	5.7%	3256	5.4%	3659	6.1%	3723	6.2%	3288	5.5%	17324	5.8%	
	22	0.7%	746	1.2%	673	1.1%	634	1.1%	719	1.2%	778	1.3%	3550	1.2%	
	23	0.7%	850	1.4%	743	1.2%	752	1.3%	793	1.3%	716	1.2%	3854	1.3%	
	24	0.7%	1616	2.7%	2010	3.4%	1861	3.1%	1705	2.8%	1405	2.3%	8597	2.9%	
	25	7.0%	3295	5.5%	3635	6.1%	3282	5.5%	3476	5.8%	2827	4.7%	16515	5.5%	
	26	0.7%	809	1.3%	795	1.3%	627	1.0%	713	1.2%	825	1.4%	3769	1.3%	
	27	0.7%	763	1.3%	847	1.4%	703	1.2%	728	1.2%	613	1.0%	3654	1.2%	
	28	0.7%	748	1.2%	673	1.1%	760	1.3%	720	1.2%	723	1.2%	3624	1.2%	
	29	0.7%	2022	3.4%	1789	3.0%	1806	3.0%	1833	3.1%	2091	3.5%	9541	3.2%	
	30	0.7%	438	0.7%	459	0.8%	357	0.6%	358	0.6%	392	0.7%	2004	0.7%	
	31	0.7%	635	1.1%	689	1.1%	703	1.2%	470	0.8%	669	1.1%	3166	1.1%	
	Accumulated error =		60000	**56.1%**	60000	**56.7%**	60000	**53.8%**	60000	**55.3%**	60000	**54.1%**	300000	**55.2%**	**± 1.26**
	Avg. error per state =			**1.8%**		**1.8%**		**1.8%**		**1.8%**		**1.8%**		**1.8%**	**± 0.02**

Figure 17. Results for the Boltzmann machine in the 5-atom micro-world, tested against the neutral premise. States are given in decimal format.

Using Training Set 158-1
Testing with premises:

"1-1-1-1-1"

Ranked Interpt.	State	Expect %	Samples	Output %
(16)	0	0%	358	1%
	1	0%	9	0%
-	2	0%	2	0%
	3	0%	0	0%
-	4	0%	3	0%
	5	0%	0	0%
-	6	0%	0	0%
	7	0%	0	0%
-	8	0%	3	0%
-	9	0%	0	0%
	10	0%	0	0%
	11	0%	0	0%
	12	0%	0	0%
	13	0%	0	0%
	14	0%	0	0%
	15	0%	0	0%
	16	100%	58300	97%
	17	0%	601	1%
	18	0%	160	0%
	19	0%	3	0%
	20	0%	259	0%
	21	0%	1	0%
	22	0%	2	0%
	23	0%	0	0%
	24	0%	295	0%
	25	0%	3	0%
	26	0%	0	0%
	27	0%	0	0%
	28	0%	1	0%
	29	0%	0	0%
	30	0%	0	0%
	31	0%	0	0%

"11-111"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	0	0%
	1	0%	0	0%
-	2	0%	0	0%
	3	0%	8	0%
-	4	0%	0	0%
	5	0%	0	0%
-	6	0%	0	0%
	7	0%	0	0%
(27)	8	0%	1	0%
-	9	0%	14	0%
	10	0%	4	0%
	11	0%	540	1%
	12	0%	0	0%
	13	0%	0	0%
	14	0%	0	0%
	15	0%	9	0%
	16	0%	1	0%
	17	0%	67	0%
	18	0%	27	0%
	19	0%	1407	2%
	20	0%	0	0%
	21	0%	0	0%
	22	0%	1	0%
	23	0%	12	0%
	24	0%	17	0%
	25	0%	2500	4%
	26	0%	755	1%
	27	100%	53540	89%
	28	0%	0	0%
	29	0%	40	0%
	30	0%	15	0%
	31	0%	1042	2%

"0-1001"

Ranked Interpt.	State	expect %	Samples	Output %
(17)	0	0%	188	0%
	1	23%	15086	25%
(1)	2	0%	30	0%
	3	1%	1717	3%
(5), (21)	4	0%	52	0%
	5	12%	8944	15%
-	6	0%	11	0%
	7	1%	1112	2%
(3), (7), (19), (23)	8	0%	0	0%
-	9	0%	125	0%
	10	0%	0	0%
	11	0%	18	0%
	12	0%	0	0%
	13	0%	101	0%
	14	0%	0	0%
	15	0%	9	0%
	16	0%	205	0%
	17	47%	17909	30%
	18	0%	25	0%
	19	1%	2354	4%
	20	0%	51	0%
	21	12%	10183	17%
	22	0%	17	0%
	23	1%	1563	3%
	24	0%	8	0%
	25	0%	144	0%
	26	0%	0	0%
	27	0%	15	0%
	28	0%	0	0%
	29	0%	114	0%
	30	0%	0	0%
	31	0%	19	0%

"0-1000"

Ranked Interpt.	State	Expect %	Samples	Output %
(16), (17)	0	13%	8546	14%
	1	13%	7553	13%
(0), (1)	2	3%	2003	3%
	3	1%	1210	2%
(5), (21)	4	1%	2775	5%
	5	6%	3713	6%
(2), (18)	6	1%	799	1%
	7	1%	900	2%
(3), (4), (6), (7)	8	0%	38	0%
(19),(20),(22),(23)	9	0%	42	0%
	10	0%	21	0%
	11	0%	13	0%
	12	0%	18	0%
	13	0%	18	0%
	14	0%	14	0%
	15	0%	12	0%
	16	25%	9397	16%
	17	25%	9786	16%
	18	3%	2142	4%
	19	1%	1590	3%
	20	1%	2803	5%
	21	6%	4188	7%
	22	3%	1275	2%
	23	1%	933	2%
	24	0%	56	0%
	25	0%	40	0%
	26	0%	17	0%
	27	0%	8	0%
	28	0%	19	0%
	29	0%	40	0%
	30	0%	12	0%
	31	0%	19	0%

Figure 18. Results for the Boltzmann machine in the 5-atom micro-world, tested against specific premises. States are given in decimal format.

"1-1-1-10"

Ranked Interpt.	State		Samples	Output %
(16), (17)	0	0%	204	0%
	1	0%	226	0%
-	2	0%	0	0%
	3	0%	0	0%
-	4	0%	0	0%
	5	0%	0	0%
-	6	0%	0	0%
	7	0%	0	0%
-	8	0%	1	0%
-	9	0%	0	0%
	10	0%	0	0%
	11	0%	0	0%
	12	0%	0	0%
	13	0%	0	0%
	14	0%	0	0%
	15	0%	0	0%
	16	50%	29397	49%
	17	50%	29229	49%
	18	0%	82	0%
	19	0%	55	0%
	20	0%	106	0%
	21	0%	221	0%
	22	0%	1	0%
	23	0%	0	0%
	24	0%	149	0%
	25	0%	321	1%
	26	0%	1	0%
	27	0%	0	0%
	28	0%	4	0%
	29	0%	3	0%
	30	0%	0	0%
	31	0%	0	0%

"1-110-1"

Ranked Interpt.	State		Samples	Output %
-	0	0%	15	0%
	1	0%	0	0%
-	2	0%	15	0%
	3	0%	0	0%
-	4	0%	381	1%
	5	0%	3	0%
-	6	0%	239	0%
	7	0%	2	0%
(20), (22)	8	0%	0	0%
-	9	0%	0	0%
	10	0%	0	0%
	11	0%	0	0%
	12	0%	4	0%
	13	0%	0	0%
	14	0%	3	0%
	15	0%	0	0%
	16	0%	2411	4%
	17	0%	29	0%
	18	0%	991	2%
	19	0%	4	0%
	20	50%	33742	56%
	21	0%	581	1%
	22	50%	21003	35%
	23	0%	198	0%
	24	0%	7	0%
	25	0%	0	0%
	26	0%	2	0%
	27	0%	0	0%
	28	0%	213	0%
	29	0%	2	0%
	30	0%	153	0%
	31	0%	2	0%

"1-10-11"

Ranked Interpt.	State		Samples	Output %
(17)	0	0%	4	0%
	1	0%	287	0%
-	2	0%	0	0%
	3	0%	0	0%
(21)	4	0%	1	0%
	5	0%	152	0%
-	6	0%	0	0%
	7	0%	0	0%
-	8	0%	0	0%
-	9	0%	0	0%
	10	0%	0	0%
	11	0%	0	0%
	12	0%	0	0%
	13	0%	5	0%
	14	0%	0	0%
	15	0%	0	0%
	16	0%	394	1%
	17	80%	41864	70%
	18	0%	2	0%
	19	0%	123	0%
	20	0%	109	0%
	21	20%	16549	28%
	22	0%	0	0%
	23	0%	35	0%
	24	0%	5	0%
	25	0%	296	0%
	26	0%	0	0%
	27	0%	0	0%
	28	0%	0	0%
	29	0%	174	0%
	30	0%	0	0%
	31	0%	0	0%

"-1-1-10-1"

Ranked Interpt.	State		Samples	Output %
-	0	80%	45304	76%
	1	0%	518	1%
(0)	2	20%	12153	20%
	3	0%	68	0%
-	4	0%	264	0%
	5	0%	5	0%
(2)	6	0%	109	0%
	7	0%	0	0%
-	8	0%	316	1%
-	9	0%	7	0%
	10	0%	121	0%
	11	0%	0	0%
	12	0%	1	0%
	13	0%	0	0%
	14	0%	0	0%
	15	0%	0	0%
	16	0%	852	1%
	17	0%	16	0%
	18	0%	235	0%
	19	0%	0	0%
	20	0%	8	0%
	21	0%	0	0%
	22	0%	4	0%
	23	0%	0	0%
	24	0%	16	0%
	25	0%	0	0%
	26	0%	3	0%
	27	0%	0	0%
	28	0%	0	0%
	29	0%	0	0%
	30	0%	0	0%
	31	0%	0	0%

Figure 19. Results for the Boltzmann machine in the 5-atom micro-world, tested against specific premises. States are given in decimal format.

"-101-11"

Ranked Interpt.	State		Samples	Output %
-	0	0%	3	0%
	1	0%	1131	2%
-	2	0%	0	0%
	3	0%	2	0%
(5)	4	0%	195	0%
	5	89%	40394	67%
-	6	0%	3	0%
	7	0%	156	0%
(13)	8	0%	1	0%
-	9	0%	615	1%
	10	0%	0	0%
	11	0%	4	0%
	12	0%	66	0%
	13	11%	16481	27%
	14	0%	0	0%
	15	0%	81	0%
	16	0%	0	0%
	17	0%	14	0%
	18	0%	0	0%
	19	0%	0	0%
	20	0%	2	0%
	21	0%	581	1%
	22	0%	0	0%
	23	0%	2	0%
	24	0%	0	0%
	25	0%	4	0%
	26	0%	0	0%
	27	0%	0	0%
	28	0%	3	0%
	29	0%	262	0%
	30	0%	0	0%
	31	0%	0	0%

"0-10-11"

Ranked Interpt.	State		Samples	Output %
(17)	0	0%	159	0%
	1	25%	15850	26%
(1)	2	0%	0	0%
	3	0%	25	0%
(5), (21)	4	0%	47	0%
	5	13%	9252	15%
-	6	0%	0	0%
	7	0%	24	0%
-	8	0%	0	0%
-	9	0%	122	0%
	10	0%	0	0%
	11	0%	0	0%
	12	0%	0	0%
	13	0%	70	0%
	14	0%	0	0%
	15	0%	1	0%
	16	0%	242	0%
	17	50%	22817	38%
	18	0%	0	0%
	19	0%	40	0%
	20	0%	44	0%
	21	13%	10984	18%
	22	0%	0	0%
	23	0%	28	0%
	24	0%	1	0%
	25	0%	207	0%
	26	0%	0	0%
	27	0%	0	0%
	28	0%	0	0%
	29	0%	84	0%
	30	0%	0	0%
	31	0%	3	0%

"10-10-1"

Ranked Interpt.	State		Samples	Output %
(16)	0	0%	289	0%
	1	0%	2	0%
-	2	0%	104	0%
	3	0%	0	0%
-	4	0%	2	0%
	5	0%	0	0%
(18)	6	0%	0	0%
	7	0%	0	0%
(24), (26)	8	0%	71	0%
-	9	0%	0	0%
	10	0%	58	0%
	11	0%	0	0%
	12	0%	0	0%
	13	0%	0	0%
	14	0%	0	0%
	15	0%	0	0%
	16	85%	35632	59%
	17	0%	364	1%
	18	10%	10354	17%
	19	0%	91	0%
	20	0%	178	0%
	21	0%	1	0%
	22	0%	84	0%
	23	0%	2	0%
	24	3%	8071	13%
	25	0%	106	0%
	26	3%	4470	7%
	27	0%	48	0%
	28	0%	41	0%
	29	0%	1	0%
	30	0%	31	0%
	31	0%	0	0%

"-1-1001"

Ranked Interpt.	State		Samples	Output %
-	0	0%	281	0%
	1	62%	29912	50%
(1)	2	0%	44	0%
	3	4%	3989	7%
(5)	4	0%	141	0%
	5	31%	20485	34%
-	6	0%	23	0%
	7	4%	3367	6%
(3), (7)	8	0%	1	0%
-	9	0%	413	1%
	10	0%	1	0%
	11	0%	79	0%
	12	0%	2	0%
	13	0%	289	0%
	14	0%	2	0%
	15	0%	71	0%
	16	0%	3	0%
	17	0%	468	1%
	18	0%	1	0%
	19	0%	57	0%
	20	0%	1	0%
	21	0%	304	1%
	22	0%	0	0%
	23	0%	48	0%
	24	0%	0	0%
	25	0%	5	0%
	26	0%	0	0%
	27	0%	0	0%
	28	0%	0	0%
	29	0%	4	0%
	30	0%	0	0%
	31	0%	9	0%

Figure 20. Results for the Boltzmann machine in the 5-atom micro-world, tested against specific premises. States are given in decimal format.

Testing with neutral premise "0, 0, 0, 0, 0, 0"
Training Set: 180-0

Ranked Interpret.	State	Expected %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Samples	Output %	Avg Samples	Avg Output %	Stdev
(32), (33)	0	11.1%	6244	10.4%	6065	10.1%	6133	10.2%	7025	11.7%	6822	11.4%	32289	10.8%	
	1	11.1%	7667	12.8%	8139	13.6%	8446	14.1%	8307	13.8%	7658	12.8%	40217	13.4%	
(0), (1)	2	2.8%	3030	5.1%	2677	4.5%	2698	4.5%	2996	5.0%	3347	5.6%	14748	4.9%	
	3	0.0%	31	0.1%	28	0.0%	29	0.0%	21	0.0%	19	0.0%	128	0.0%	
(9), (17), (41), (49)	4	5.6%	2534	4.2%	2430	4.1%	2562	4.3%	2270	3.8%	2490	4.2%	12286	4.1%	
	5	0.0%	25	0.0%	24	0.0%	31	0.1%	41	0.1%	31	0.1%	152	0.1%	
(4), (36)	6	0.0%	216	0.4%	171	0.3%	217	0.4%	228	0.4%	249	0.4%	1081	0.4%	
	7	0.0%	0	0.0%	0	0.0%	1	0.0%	2	0.0%	2	0.0%	5	0.0%	
(2), (34)	8	0.0%	35	0.1%	33	0.1%	34	0.1%	31	0.1%	29	0.0%	162	0.1%	
	9	8.3%	5054	8.4%	5447	9.1%	4821	8.0%	4716	7.9%	4928	8.2%	24966	8.3%	
All other states 52	10	0.0%	92	0.2%	59	0.1%	55	0.1%	33	0.1%	67	0.1%	306	0.1%	
(3), (5)-(8), (10)-(16),	11	0.0%	34	0.1%	49	0.1%	24	0.0%	23	0.0%	25	0.0%	155	0.1%	
(18)-(31),(35), (37)-(40)	12	0.0%	38	0.1%	20	0.0%	35	0.1%	25	0.0%	25	0.0%	143	0.0%	
(42)-(48), (50)-(63)	13	0.0%	52	0.1%	61	0.1%	67	0.1%	89	0.1%	64	0.1%	333	0.1%	
	14	0.0%	19	0.0%	16	0.0%	22	0.0%	42	0.1%	13	0.0%	112	0.0%	
	15	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	16	0.0%	22	0.0%	22	0.0%	37	0.1%	33	0.1%	30	0.1%	144	0.0%	
	17	8.3%	5033	8.4%	5051	8.4%	4425	7.4%	5086	8.5%	4857	8.1%	24452	8.2%	
	18	0.0%	21	0.0%	39	0.1%	29	0.0%	43	0.1%	36	0.1%	168	0.1%	
	19	0.0%	31	0.1%	23	0.0%	39	0.1%	40	0.1%	26	0.0%	159	0.1%	
	20	0.0%	31	0.1%	22	0.0%	20	0.0%	27	0.0%	19	0.0%	119	0.0%	
	21	0.0%	32	0.1%	65	0.1%	48	0.1%	68	0.1%	77	0.1%	290	0.1%	
	22	0.0%	51	0.1%	53	0.1%	37	0.1%	32	0.1%	22	0.0%	195	0.1%	
	23	0.0%	0	0.0%	1	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.0%	
	24	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	25	0.0%	358	0.6%	180	0.3%	495	0.8%	320	0.5%	333	0.6%	1686	0.6%	
	26	0.0%	3	0.0%	0	0.0%	0	0.0%	1	0.0%	1	0.0%	5	0.0%	
	27	0.0%	5	0.0%	13	0.0%	9	0.0%	4	0.0%	14	0.0%	45	0.0%	
	28	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	29	0.0%	23	0.0%	16	0.0%	24	0.0%	27	0.0%	19	0.0%	109	0.0%	
	30	0.0%	5	0.0%	0	0.0%	1	0.0%	0	0.0%	0	0.0%	6	0.0%	
	31	0.0%	3	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3	0.0%	
	32	13.9%	6144	10.2%	6329	10.5%	6576	11.0%	6245	10.4%	6615	11.0%	31909	10.6%	
	33	13.9%	7846	13.1%	7758	12.9%	8098	13.5%	6909	11.5%	7329	12.2%	37940	12.6%	
	34	2.8%	2666	4.4%	2891	4.8%	2627	4.4%	2971	5.0%	2609	4.3%	13764	4.6%	
	35	0.0%	13	0.0%	19	0.0%	29	0.0%	18	0.0%	11	0.0%	90	0.0%	
	36	5.6%	2128	3.5%	2843	4.7%	2291	3.8%	2479	4.1%	2450	4.1%	12191	4.1%	
	37	0.0%	15	0.0%	35	0.1%	32	0.1%	31	0.1%	28	0.0%	141	0.0%	
	38	0.0%	180	0.3%	232	0.4%	196	0.3%	199	0.3%	275	0.5%	1082	0.4%	
	39	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	40	0.0%	25	0.0%	24	0.0%	29	0.0%	18	0.0%	29	0.0%	125	0.0%	
	41	8.3%	4491	7.5%	4316	7.2%	4314	7.2%	3921	6.5%	4429	7.4%	21471	7.2%	
	42	0.0%	41	0.1%	49	0.1%	39	0.1%	49	0.1%	30	0.1%	208	0.1%	
	43	0.0%	19	0.0%	22	0.0%	21	0.0%	26	0.0%	23	0.0%	111	0.0%	
	44	0.0%	27	0.0%	39	0.1%	16	0.0%	20	0.0%	16	0.0%	118	0.0%	
	45	0.0%	52	0.1%	35	0.1%	61	0.1%	72	0.1%	35	0.1%	255	0.1%	
	46	0.0%	10	0.0%	53	0.1%	20	0.0%	26	0.0%	27	0.0%	136	0.0%	
	47	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.0%	0	0.0%	1	0.0%	
	48	0.0%	32	0.1%	22	0.0%	24	0.0%	31	0.1%	32	0.1%	141	0.0%	
	49	8.3%	4773	8.0%	4203	7.0%	4516	7.5%	4877	8.1%	4475	7.5%	22844	7.6%	
	50	0.0%	30	0.1%	25	0.0%	23	0.0%	41	0.1%	15	0.0%	134	0.0%	
	51	0.0%	28	0.0%	24	0.0%	16	0.0%	41	0.1%	19	0.0%	128	0.0%	
	52	0.0%	35	0.1%	17	0.0%	43	0.1%	33	0.1%	24	0.0%	152	0.1%	
	53	0.0%	72	0.1%	52	0.1%	65	0.1%	71	0.1%	46	0.1%	306	0.1%	
	54	0.0%	70	0.1%	43	0.1%	49	0.1%	54	0.1%	23	0.0%	239	0.1%	
	55	0.0%	0	0.0%	1	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.0%	
	56	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	57	0.0%	511	0.9%	193	0.3%	527	0.9%	292	0.5%	241	0.4%	1764	0.6%	
	58	0.0%	0	0.0%	2	0.0%	0	0.0%	0	0.0%	0	0.0%	2	0.0%	
	59	0.0%	47	0.1%	31	0.1%	7	0.0%	26	0.0%	12	0.0%	123	0.0%	
	60	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.0%	0	0.0%	1	0.0%	
	61	0.0%	56	0.1%	38	0.1%	42	0.1%	19	0.0%	4	0.0%	159	0.1%	
	62	0.0%	0	0.0%	0	0.0%	0	0.0%	2	0.0%	0	0.0%	2	0.0%	
	63	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Accumulated error =		60000	**19.5%**	60000	**20.3%**	60000	**20.8%**	60003	**23.1%**	60000	**19.2%**	300003	**19.7%**	**± 1.54**
	Avg.error per state =			**0.3%**		**0.3%**		**0.3%**		**0.4%**		**0.3%**		**0.3%**	**± 0.02**

Figure 21. Results for the Boltzmann machine in the 6-atom micro-world, tested against the neutral premise. States are given in decimal format.

Testing with neutral premise "0, 0, 0, 0, 0, 0"
Training Set: 232-1

Ranked Interpret.	*State*	*Expected %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples* (Avg)	*Output %* (Avg)	Stdev
(32), (33)	0	8.6%	2900	4.8%	3311	5.5%	3289	5.5%	2937	4.9%	3264	5.4%	15701	5.2%	
	1	8.6%	3252	5.4%	4225	7.0%	3162	5.3%	3357	5.6%	3846	6.4%	17842	5.9%	
(0), (1)	2	2.2%	1460	2.4%	1364	2.3%	1372	2.3%	1439	2.4%	1221	2.0%	6856	2.3%	
	3	0.4%	919	1.5%	852	1.4%	920	1.5%	1063	1.8%	1111	1.9%	4865	1.6%	
(9), (17), (41), (49)	4	4.3%	1891	3.2%	1780	3.0%	1920	3.2%	1789	3.0%	1942	3.2%	9322	3.1%	
	5	0.4%	1201	2.0%	1383	2.3%	1344	2.2%	1050	1.8%	1225	2.0%	6203	2.1%	
(4), (36)	6	0.4%	665	1.1%	731	1.2%	586	1.0%	717	1.2%	737	1.2%	3436	1.1%	
	7	0.4%	478	0.8%	419	0.7%	520	0.9%	364	0.6%	430	0.7%	2211	0.7%	
(2), (34)	8	0.4%	877	1.5%	870	1.5%	906	1.5%	839	1.4%	1109	1.8%	4601	1.5%	
	9	6.5%	2129	3.5%	2200	3.7%	2056	3.4%	2332	3.9%	2271	3.8%	10988	3.7%	
All other states 52	10	0.4%	492	0.8%	524	0.9%	444	0.7%	557	0.9%	518	0.9%	2535	0.8%	
(3), (5)-(8), (10)-(16),	11	0.4%	577	1.0%	661	1.1%	573	1.0%	780	1.3%	601	1.0%	3192	1.1%	
(18)-(31),(35), (37)-(40)	12	0.4%	533	0.9%	615	1.0%	632	1.1%	628	1.0%	567	0.9%	2975	1.0%	
(42)-(48), (50)-(63)	13	0.4%	789	1.3%	769	1.3%	889	1.5%	742	1.2%	801	1.3%	3990	1.3%	
	14	0.4%	590	1.0%	524	0.9%	577	1.0%	609	1.0%	565	0.9%	2865	1.0%	
	15	0.4%	341	0.6%	339	0.6%	322	0.5%	364	0.6%	235	0.4%	1601	0.5%	
	16	0.4%	1180	2.0%	1193	2.0%	1089	1.8%	1064	1.8%	1006	1.7%	5532	1.8%	
	17	6.5%	2518	4.2%	2229	3.7%	2403	4.0%	2131	3.6%	2103	3.5%	11384	3.8%	
	18	0.4%	535	0.9%	589	1.0%	567	0.9%	520	0.9%	490	0.8%	2701	0.9%	
	19	0.4%	574	1.0%	605	1.0%	523	0.9%	704	1.2%	628	1.0%	3034	1.0%	
	20	0.4%	661	1.1%	577	1.0%	860	1.4%	586	1.0%	586	1.0%	3270	1.1%	
	21	0.4%	987	1.6%	822	1.4%	795	1.3%	965	1.6%	738	1.2%	4307	1.4%	
	22	0.4%	550	0.9%	548	0.9%	502	0.8%	303	0.5%	506	0.8%	2409	0.8%	
	23	0.4%	298	0.5%	448	0.7%	332	0.6%	286	0.5%	267	0.4%	1631	0.5%	
	24	0.4%	414	0.7%	424	0.7%	363	0.6%	332	0.6%	431	0.7%	1964	0.7%	
	25	0.4%	969	1.6%	830	1.4%	924	1.5%	990	1.7%	896	1.5%	4609	1.5%	
	26	0.4%	248	0.4%	242	0.4%	166	0.3%	424	0.7%	311	0.5%	1391	0.5%	
	27	0.4%	553	0.9%	653	1.1%	533	0.9%	632	1.1%	531	0.9%	2902	1.0%	
	28	0.4%	411	0.7%	308	0.5%	386	0.6%	256	0.4%	453	0.8%	1814	0.6%	
	29	0.4%	468	0.8%	567	0.9%	620	1.0%	527	0.9%	537	0.9%	2719	0.9%	
	30	0.4%	239	0.4%	234	0.4%	318	0.5%	320	0.5%	283	0.5%	1394	0.5%	
	31	0.4%	256	0.4%	625	1.0%	425	0.7%	369	0.6%	284	0.5%	1959	0.7%	
	32	10.8%	3072	5.1%	3182	5.3%	3289	5.5%	3367	5.6%	3458	5.8%	16368	5.5%	
	33	10.8%	3294	5.5%	3101	5.2%	3493	5.8%	3558	5.9%	3966	6.6%	17412	5.8%	
	34	2.2%	1557	2.6%	1346	2.2%	1053	1.8%	1475	2.5%	1342	2.2%	6773	2.3%	
	35	0.4%	972	1.6%	919	1.5%	946	1.6%	1071	1.8%	845	1.4%	4753	1.6%	
	36	4.3%	1954	3.3%	1535	2.6%	1827	3.0%	1710	2.9%	1600	2.7%	8626	2.9%	
	37	0.4%	1129	1.9%	1101	1.8%	1071	1.8%	1041	1.7%	969	1.6%	5311	1.8%	
	38	0.4%	627	1.0%	506	0.8%	477	0.8%	677	1.1%	665	1.1%	2952	1.0%	
	39	0.4%	436	0.7%	369	0.6%	371	0.6%	330	0.6%	483	0.8%	1989	0.7%	
	40	0.4%	978	1.6%	769	1.3%	935	1.6%	979	1.6%	884	1.5%	4545	1.5%	
	41	6.5%	1958	3.3%	1955	3.3%	2254	3.8%	2139	3.6%	2139	3.6%	10445	3.5%	
	42	0.4%	414	0.7%	503	0.8%	553	0.9%	552	0.9%	517	0.9%	2539	0.8%	
	43	0.4%	519	0.9%	622	1.0%	451	0.8%	617	1.0%	574	1.0%	2783	0.9%	
	44	0.4%	759	1.3%	635	1.1%	583	1.0%	723	1.2%	573	1.0%	3273	1.1%	
	45	0.4%	832	1.4%	619	1.0%	800	1.3%	695	1.2%	598	1.0%	3544	1.2%	
	46	0.4%	516	0.9%	549	0.9%	481	0.8%	624	1.0%	410	0.7%	2580	0.9%	
	47	0.4%	411	0.7%	262	0.4%	436	0.7%	395	0.7%	329	0.5%	1833	0.6%	
	48	0.4%	1030	1.7%	1025	1.7%	1192	2.0%	1020	1.7%	1230	2.1%	5497	1.8%	
	49	6.5%	2212	3.7%	2278	3.8%	2305	3.8%	1976	3.3%	2315	3.9%	11086	3.7%	
	50	0.4%	603	1.0%	631	1.1%	563	0.9%	557	0.9%	526	0.9%	2880	1.0%	
	51	0.4%	633	1.1%	611	1.0%	734	1.2%	702	1.2%	577	1.0%	3257	1.1%	
	52	0.4%	722	1.2%	519	0.9%	579	1.0%	688	1.1%	466	0.8%	2974	1.0%	
	53	0.4%	847	1.4%	867	1.4%	686	1.1%	773	1.3%	579	1.0%	3752	1.3%	
	54	0.4%	676	1.1%	550	0.9%	354	0.6%	390	0.7%	610	1.0%	2580	0.9%	
	55	0.4%	333	0.6%	336	0.6%	213	0.4%	191	0.3%	318	0.5%	1391	0.5%	
	56	0.4%	401	0.7%	350	0.6%	479	0.8%	509	0.8%	422	0.7%	2161	0.7%	
	57	0.4%	886	1.5%	901	1.5%	1126	1.9%	860	1.4%	926	1.5%	4699	1.6%	
	58	0.4%	252	0.4%	307	0.5%	233	0.4%	240	0.4%	344	0.6%	1376	0.5%	
	59	0.4%	478	0.8%	428	0.7%	602	1.0%	608	1.0%	522	0.9%	2638	0.9%	
	60	0.4%	391	0.7%	419	0.7%	398	0.7%	410	0.7%	239	0.4%	1857	0.6%	
	61	0.4%	687	1.1%	621	1.0%	477	0.8%	649	1.1%	481	0.8%	2915	1.0%	
	62	0.4%	224	0.4%	301	0.5%	371	0.6%	293	0.5%	275	0.5%	1464	0.5%	
	63	0.4%	242	0.4%	422	0.7%	350	0.6%	205	0.3%	325	0.5%	1544	0.5%	
	Accumulated error =		60000	**64.3%**	60000	**62.2%**	60000	**62.8%**	60000	**64.2%**	60000	**58.9%**	300000	**62.1%**	**± 2.20**
	Avg.error per state =			**1.0%**		**1.0%**		**1.0%**		**1.0%**		**0.9%**		**1.0%**	**± 0.03**

Figure 22. Results for the Boltzmann machine in the 6-atom micro-world, tested against the neutral premise. States are given in decimal format.

Using Training Set 232-1
Testing with premises:

"1-1-1-1-1-1"

Ranked Interpt.	State	Expect %	Samples	Output %
(32)	0	0%	496	1%
	1	0%	9	0%
-	2	0%	1	0%
	3	0%	0	0%
-	4	0%	1	0%
	5-8	0%	4	0%
-	9	0%	0	0%
	10-16	0%	2	0%
-	17	0%	1	0%
	18-31	0%	0	0%
-	32	100%	57831	96%
-	33	0%	546	1%
	34	0%	257	0%
	35	0%	3	0%
	36	0%	413	1%
	37-40	0%	234	0%
	41	0%	6	0%
	42-48	0%	187	0%
	49	0%	5	0%
	50-63	0%	4	0%

"-111111"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	0	0%
	1	0%	0	0%
-	2	0%	0	0%
	3	0%	0	0%
-	4	0%	0	0%
	5-8	0%	2	0%
-	9	0%	1	0%
	10-16	0%	587	1%
-	17	0%	2	0%
	18-31	100%	55605	93%
(31)	32	0%	3122	5%
-	33	0%	0	0%
	34	0%	0	0%
	35	0%	0	0%
	36	0%	0	0%
	37-40	0%	0	0%
	41	0%	0	0%
	42-48	0%	15	0%
	49	0%	0	0%
	50-63	0%	666	1%

"0-10-1-10"

Ranked Interpt.	State	Expect %	Samples	Output %
(32), (33)	0	16%	7878	13%
	1	16%	11357	19%
(0), (1)	2	0%	21	0%
	3	0%	45	0%
(9), (41)	4	0%	70	0%
	5-8	1%	1921	3%
-	9	12%	6277	10%
	10-16	0%	94	0%
-	17	0%	97	0%
	18-31	0%	51	0%
(8), (40)	32	21%	9711	16%
-	33	21%	12766	21%
	34	0%	64	0%
	35	0%	37	0%
	36	0%	63	0%
	37-40	1%	2506	4%
	41	12%	6753	11%
	42-48	0%	138	0%
	49	0%	117	0%
	50-63	0%	34	0%

"0-10-101"

Ranked Interpt.	State	Expect %	Samples	Output %
(33)	0	0%	82	0%
	1	25%	12904	22%
(1)	2	0%	25	0%
	3	1%	2678	4%
(9), (41)	4	0%	1	0%
	5-8	0%	83	0%
-	9	19%	11684	19%
	10-16	1%	2312	4%
-	17	0%	98	0%
	18-31	0%	127	0%
(3), (11), (35), (43)	32	0%	88	0%
-	33	32%	13676	23%
	34	0%	13	0%
	35	1%	2583	4%
	36	0%	0	0%
	37-40	0%	114	0%
	41	19%	11319	19%
	42-48	1%	1999	3%
	49	0%	93	0%
	50-63	0%	121	0%

"10-1-1-11"

Ranked Interpt.	State	Expect %	Samples	Output %
(33)	0	0%	1	0%
	1	0%	394	1%
-	2	0%	0	0%
	3	0%	1	0%
(49)	4	0%	0	0%
	5-8	0%	1	0%
-	9	0%	3	0%
	10-16	0%	1	0%
-	17	0%	251	0%
	18-31	0%	5	0%
-	32	0%	177	0%
-	33	62%	35638	59%
	34	0%	0	0%
	35	0%	88	0%
	36	0%	0	0%
	37-40	0%	139	0%
	41	0%	313	1%
	42-48	0%	81	0%
	49	38%	22613	38%
	50-63	0%	294	0%

"1-1-1-10-1"

Ranked Interpt.	State	Expect %	Samples	Output %
(32)	0	0%	446	1%
	1	0%	3	0%
-	2	0%	134	0%
	3	0%	0	0%
-	4	0%	1	0%
	5-8	0%	3	0%
-	9	0%	0	0%
	10-16	0%	1	0%
(34)	17	0%	0	0%
	18-31	0%	1	0%
-	32	83%	44404	74%
-	33	0%	345	1%
	34	17%	13588	23%
	35	0%	113	0%
	36	0%	333	1%
	37-40	0%	279	0%
	41	0%	0	0%
	42-48	0%	254	0%
	49	0%	1	0%
	50-63	0%	94	0%

"1-1-10-11"

Ranked Interpt.	State	Expect %	Samples	Output %
(33)	0	0%	4	0%
	1	0%	376	1%
-	2	0%	0	0%
	3	0%	2	0%
-	4	0%	5	0%
	5-8	0%	120	0%
-	9	0%	4	0%
	10-16	0%	1	0%
-	17	0%	2	0%
	18-31	0%	0	0%
(37)	32	0%	466	1%
-	33	96%	47774	80%
	34	0%	0	0%
	35	0%	124	0%
	36	0%	154	0%
	37-40	4%	10027	17%
	41	0%	391	1%
	42-48	0%	102	0%
	49	0%	364	1%
	50-63	0%	84	0%

"-1-101-1-1"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	0%	1296	2%
	1	0%	4	0%
-	2	0%	10	0%
	3	0%	0	0%
-	4	91%	44363	74%
	5-8	0%	883	1%
(4)	9	0%	11	0%
	10-16	9%	12382	21%
-	17	0%	0	0%
	18-31	0%	297	0%
(12)	32	0%	20	0%
-	33	0%	0	0%
	34	0%	0	0%
	35	0%	0	0%
	36	0%	584	1%
	37-40	0%	4	0%
	41	0%	0	0%
	42-48	0%	142	0%
	49	0%	0	0%
	50-63	0%	4	0%

Figure 23. Results for the Boltzmann machine in the 6-atom micro-world, tested against specific premises. States are given in decimal format.

"0-1-10-11"

Ranked Interpt.	State	Expect %	Samples	Output %
(33)	0	0%	236	0%
	1	43%	22300	37%
(1)	2	0%	0	0%
	3	0%	106	0%
-	4	0%	59	0%
	5-8	2%	4153	7%
-	9	0%	187	0%
	10-16	0%	38	0%
-	17	0%	241	0%
	18-31	0%	47	0%
(5), (37)	32	0%	242	0%
-	33	53%	27065	45%
	34	0%	1	0%
	35	0%	102	0%
	36	0%	92	0%
	37-40	2%	4520	8%
	41	0%	1	0%
	42-48	0%	287	0%
	49	0%	252	0%
	50-63	0%	71	0%

"1-1-10-10"

Ranked Interpt.	State	Expect %	Samples	Output %
(32), (33)	0	0%	215	0%
	1	0%	189	0%
-	2	0%	4	0%
	3	0%	0	0%
-	4	0%	74	0%
	5-8	0%	44	0%
(36)	9	0%	3	0%
	10-16	0%	1	0%
-	17	0%	3	0%
	18-31	0%	1	0%
(37)	32	41%	23506	39%
-	33	41%	20171	34%
	34	0%	181	0%
	35	0%	81	0%
	36	16%	9891	16%
	37-40	2%	5027	8%
	41	0%	143	0%
	42-48	0%	182	0%
	49	0%	185	0%
	50-63	0%	99	0%

"-10-10-1-1"

Ranked Interpt.	State	Expect %	Samples	Output %
-	0	63%	28389	47%
	1	0%	255	0%
(0)	2	0%	179	0%
	3	0%	0	0%
-	4	31%	17035	28%
	5-8	0%	233	0%
(4)	9	0%	0	0%
	10-16	3%	7862	13%
-	17	0%	131	0%
	18-31	3%	5136	9%
(16), (20)	32	0%	420	1%
-	33	0%	6	0%
	34	0%	2	0%
	35	0%	0	0%
	36	0%	190	0%
	37-40	0%	2	0%
	41	0%	0	0%
	42-48	0%	106	0%
	49	0%	1	0%
	50-63	0%	53	0%

"0-1-1-101"

Ranked Interpt.	State	Expect %	Samples	Output %
(33)	0	0%	169	0%
	1	43%	22081	37%
(1)	2	0%	86	0%
	3	2%	4464	7%
-	4	0%	0	0%
	5-8	0%	116	0%
-	9	0%	212	0%
	10-16	0%	47	0%
-	17	0%	225	0%
	18-31	0%	55	0%
(3), (35)	32	0%	183	0%
-	33	53%	26967	45%
	34	0%	70	0%
	35	2%	4686	8%
	36	0%	2	0%
	37-40	0%	121	0%
	41	0%	209	0%
	42-48	0%	32	0%
	49	0%	215	0%
	50-63	0%	60	0%

Figure 24. Results for the Boltzmann machine in the 6-atom micro-world, tested against specific premises. States are given in decimal format.

Appendix C: Multi-Layer Perceptron (MLP) Results

Testing with neutral premise "0, 0, 0, 0" - Standard

Training Set: 88-0

Ranked Interpret.	State	Expected %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Avg Activations	Avg Output %	Stdev
(0), (1), (8), (9)	0	18.1%	0.0002	0.1%	0.0004	0.3%	0.0004	0.3%	0.0006	0.6%	0.0003	0.2%	0.0019	0.3%	
	1	18.1%	0.0015	1.0%	0.0005	0.3%	0.0017	1.3%	0.0008	0.8%	0.0013	0.9%	0.0058	0.9%	
(5), (13)	2	4.5%	0.0471	30.2%	0.0412	28.7%	0.0355	27.5%	0.0289	29.5%	0.0468	31.8%	0.1995	29.6%	
	3	0.0%	0.0006	0.4%	0.0006	0.4%	0.0007	0.5%	0.0006	0.6%	0.0006	0.4%	0.0031	0.5%	
(2), (10)	4	0.0%	0.0006	0.4%	0.0006	0.4%	0.0007	0.5%	0.0006	0.6%	0.0006	0.4%	0.0031	0.5%	
	5	9.1%	0.0305	19.5%	0.0256	17.8%	0.0238	18.5%	0.0170	17.4%	0.0319	21.7%	0.1288	19.1%	
(3), (4), (6), (7),	6	0.0%	0.0006	0.4%	0.0006	0.4%	0.0007	0.5%	0.0006	0.6%	0.0006	0.4%	0.0031	0.5%	
(11), (12), (14), (15)	7	0.0%	0.0006	0.4%	0.0006	0.4%	0.0007	0.5%	0.0006	0.6%	0.0006	0.4%	0.0031	0.5%	
	8	18.1%	0.0003	0.2%	0.0003	0.2%	0.0004	0.3%	0.0004	0.4%	0.0007	0.5%	0.0021	0.3%	
	9	18.1%	0.0008	0.5%	0.0012	0.8%	0.0013	1.0%	0.0010	1.0%	0.0009	0.6%	0.0052	0.8%	
	10	4.5%	0.0538	34.4%	0.0482	33.5%	0.0472	36.6%	0.0303	30.9%	0.0420	28.6%	0.2215	32.9%	
	11	0.0%	0.0006	0.4%	0.0006	0.4%	0.0007	0.5%	0.0006	0.6%	0.0006	0.4%	0.0031	0.5%	
	12	0.0%	0.0006	0.4%	0.0006	0.4%	0.0007	0.5%	0.0006	0.6%	0.0006	0.4%	0.0031	0.5%	
	13	9.1%	0.0172	11.0%	0.0215	15.0%	0.0130	10.1%	0.0141	14.4%	0.0184	12.5%	0.0842	12.5%	
	14	0.0%	0.0006	0.4%	0.0006	0.4%	0.0007	0.5%	0.0006	0.6%	0.0006	0.4%	0.0031	0.5%	
	15	0.0%	0.0006	0.4%	0.0006	0.4%	0.0007	0.5%	0.0006	0.6%	0.0006	0.4%	0.0031	0.5%	
	Accumulated error =		0.1562	**141.6%**	0.1437	**141.9%**	0.1289	**139.3%**	0.0979	**139.5%**	0.1471	**140.8%**	0.6738	**140.7%**	**± 1.18**
	Avg. error per state =			**8.9%**		**8.9%**		**8.7%**		**8.7%**		**8.8%**		**8.8%**	**± 0.07**

Training Set: 96-1

Ranked Interpret.	State	Expected %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Avg Activations	Avg Output %	Stdev
(0), (1), (8), (9)	0	16.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	1	16.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
(5), (13)	2	4.2%	0.0005	0.3%	0.0140	10.2%	0.0008	0.7%	0.0001	0.1%	0.0123	11.5%	0.0277	4.0%	
	3	1.0%	0.0090	4.8%	0.0182	13.3%	0.0005	0.4%	0.0050	3.7%	0.0017	1.6%	0.0344	5.0%	
(2), (10)	4	1.0%	0.0034	1.8%	0.0000	0.0%	0.0000	0.0%	0.0002	0.1%	0.0140	13.0%	0.0176	2.6%	
	5	8.3%	0.0000	0.0%	0.0002	0.1%	0.0019	1.6%	0.0000	0.0%	0.0000	0.0%	0.0021	0.3%	
(3), (4), (6), (7),	6	1.0%	0.0357	18.9%	0.0308	22.5%	0.0241	20.4%	0.0058	4.3%	0.0218	20.3%	0.1182	17.2%	
(11), (12), (14), (15)	7	1.0%	0.0236	12.5%	0.0147	10.8%	0.0169	14.3%	0.0410	30.3%	0.0071	6.6%	0.1033	15.0%	
	8	16.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	9	16.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	10	4.2%	0.0270	14.3%	0.0019	1.4%	0.0096	8.1%	0.0157	11.6%	0.0009	0.8%	0.0551	8.0%	
	11	1.0%	0.0051	2.7%	0.0186	13.6%	0.0059	5.0%	0.0063	4.6%	0.0182	17.0%	0.0541	7.9%	
	12	1.0%	0.0114	6.0%	0.0001	0.1%	0.0080	6.8%	0.0000	0.0%	0.0001	0.1%	0.0196	2.9%	
	13	8.3%	0.0000	0.0%	0.0008	0.6%	0.0002	0.2%	0.0000	0.0%	0.0002	0.2%	0.0012	0.2%	
	14	1.0%	0.0410	21.7%	0.0193	14.1%	0.0363	30.8%	0.0186	13.7%	0.0140	13.0%	0.1292	18.8%	
	15	1.0%	0.0322	17.0%	0.0181	13.2%	0.0138	11.7%	0.0428	31.6%	0.0170	15.8%	0.1239	18.1%	
	Accumulated error =		0.1889	**174.9%**	0.1367	**175.0%**	0.1180	**173.6%**	0.1355	**179.0%**	0.1073	**175.2%**	0.6864	**166.4%**	**± 2.01**
	Avg. error per state =			**10.9%**		**10.9%**		**10.9%**		**11.2%**		**10.9%**		**10.4%**	**± 0.13**

Figure 25. Results for the MLP in the 4-atom micro-world, tested against the neutral premise. States are given in decimal format.

Training Set: 90-0

Ranked Interpret.	State	Expected %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	
(0), (1), (8), (9)	0	16.7%	0.0003	0.3%	0.0003	0.2%	0.0001	0.1%	0.0001	0.1%	0.0005	0.3%	0.0013	0.2%	
	1	16.7%	0.0008	0.7%	0.0012	0.8%	0.0002	0.1%	0.0005	0.3%	0.0011	0.8%	0.0038	0.5%	
(5), (13)	2	5.6%	0.0385	33.5%	0.0479	32.0%	0.0554	31.2%	0.0823	51.2%	0.0655	45.0%	0.2896	38.7%	
	3	0.0%	0.0005	0.4%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0025	0.3%	
(2), (10)	4	0.0%	0.0005	0.4%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0025	0.3%	
	5	11.1%	0.0273	23.8%	0.0168	11.2%	0.0450	25.4%	0.0176	11.0%	0.0246	16.9%	0.1313	17.6%	
(3), (4), (6), (7),	6	0.0%	0.0005	0.4%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0025	0.3%	
(11), (12), (14), (15)	7	0.0%	0.0005	0.4%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0025	0.3%	
	8	16.7%	0.0003	0.3%	0.0002	0.1%	0.0001	0.1%	0.0002	0.1%	0.0002	0.1%	0.0010	0.1%	
	9	16.7%	0.0005	0.4%	0.0008	0.5%	0.0003	0.2%	0.0002	0.1%	0.0007	0.5%	0.0025	0.3%	
	10	5.6%	0.0306	26.7%	0.0541	36.2%	0.0361	20.3%	0.0280	17.4%	0.0335	23.0%	0.1823	24.4%	
	11	0.0%	0.0005	0.4%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0006	0.4%	0.0026	0.3%	
	12	0.0%	0.0005	0.4%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0025	0.3%	
	13	11.1%	0.0125	10.9%	0.0242	16.2%	0.0362	20.4%	0.0278	17.3%	0.0154	10.6%	0.1161	15.5%	
	14	0.0%	0.0005	0.4%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0025	0.3%	
	15	0.0%	0.0005	0.4%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0005	0.3%	0.0025	0.3%	
	Accumulated error =		0.1148	**130.5%**	0.1495	**130.1%**	0.1774	**132.6%**	0.1607	**132.5%**	0.1456	**131.0%**	0.7480	**131.1%**	**± 1.15**
	Avg. error per state =			**8.2%**		**8.1%**		**8.3%**		**8.3%**		**8.2%**		**8.2%**	**± 0.07**

Training Set: 98-1

Ranked Interpret.	State	Expected %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	
(0), (1), (8), (9)	0	15.3%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	1	15.3%	0.0000	0.0%	0.0001	0.1%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0001	0.0%	
(5), (13)	2	5.1%	0.0012	0.9%	0.0256	22.2%	0.0138	8.4%	0.0001	0.1%	0.0007	0.7%	0.0414	6.6%	
	3	1.0%	0.0044	3.2%	0.0044	3.8%	0.0164	10.0%	0.0051	4.4%	0.0020	2.0%	0.0323	5.1%	
(2), (10)	4	1.0%	0.0001	0.1%	0.0000	0.0%	0.0007	0.4%	0.0011	1.0%	0.0000	0.0%	0.0019	0.3%	
	5	10.2%	0.0000	0.0%	0.0000	0.0%	0.0001	0.1%	0.0000	0.0%	0.0002	0.2%	0.0003	0.0%	
(3), (4), (6), (7),	6	1.0%	0.0291	21.4%	0.0129	11.2%	0.0303	18.5%	0.0352	30.6%	0.0262	25.9%	0.1337	21.2%	
(11), (12), (14), (15)	7	1.0%	0.0518	38.1%	0.0321	27.9%	0.0303	18.5%	0.0102	8.9%	0.0242	23.9%	0.1486	23.6%	
	8	15.3%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	9	15.3%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	10	5.1%	0.0007	0.5%	0.0117	10.2%	0.0197	12.1%	0.0063	5.5%	0.0108	10.7%	0.0492	7.8%	
	11	1.0%	0.0214	15.7%	0.0081	7.0%	0.0054	3.3%	0.0017	1.5%	0.0013	1.3%	0.0379	6.0%	
	12	1.0%	0.0000	0.0%	0.0010	0.9%	0.0001	0.1%	0.0001	0.1%	0.0004	0.4%	0.0016	0.3%	
	13	10.2%	0.0018	1.3%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0001	0.1%	0.0019	0.3%	
	14	1.0%	0.0254	18.7%	0.0018	1.6%	0.0139	8.5%	0.0307	26.7%	0.0063	6.2%	0.0781	12.4%	
	15	1.0%	0.0002	0.2%	0.0174	15.1%	0.0327	20.0%	0.0244	21.2%	0.0291	28.7%	0.1038	16.5%	
	Accumulated error =		0.1361	**183.9%**	0.1151	**165.5%**	0.1634	**166.3%**	0.1149	**175.3%**	0.1013	**174.8%**	0.6308	**165.6%**	**± 7.56**
	Avg. error per state =			**11.5%**		**10.3%**		**10.4%**		**11.0%**		**10.9%**		**10.3%**	**± 0.47**

Figure 26. Results for the MLP in the 4-atom micro-world, tested against the neutral premise. States are given in decimal format.

Using Traing Set: 98-1

Testing with premises:

"-1, -1, -1, -1"

Ranked Interpt.	State	Expect %	Activations	Output %
(0)	0	100%	0.9968	99%
	1	0%	0.0013	0%
-	2	0%	0.0015	0%
	3	0%	0.0010	0%
-	4	0%	0.0013	0%
	5	0%	0.0007	0%
-	6	0%	0.0001	0%
-	7	0%	0.0015	0%
	8	0%	0.0000	0%
	9	0%	0.0010	0%
	10	0%	0.0001	0%
	11	0%	0.0003	0%
	12	0%	0.0000	0%
	13	0%	0.0003	0%
	14	0%	0.0000	0%
	15	0%	0.0003	0%

"-1, 1, -1, 1"

Ranked Interpt.	State	Expect %	Activations	Output %
-	0	0%	0.0005	0%
	1	0%	0.0017	0%
(5)	2	0%	0.0003	0%
	3	0%	0.0016	0%
-	4	0%	0.0019	0%
	5	100%	0.9956	99%
-	6	0%	0.0012	0%
-	7	0%	0.0026	0%
	8	0%	0.0000	0%
	9	0%	0.0002	0%
	10	0%	0.0001	0%
	11	0%	0.0001	0%
	12	0%	0.0004	0%
	13	0%	0.0019	0%
	14	0%	0.0004	0%
	15	0%	0.0010	0%

"1, -1, 1, -1"

Ranked Interpt.	State	Expect %	Activations	Output %
-	0	0%	0.0004	0%
	1	0%	0.0000	0%
-	2	0%	0.0033	0%
	3	0%	0.0018	0%
(10)	4	0%	0.0002	0%
	5	0%	0.0000	0%
-	6	0%	0.0003	0%
-	7	0%	0.0007	0%
	8	0%	0.0024	0%
	9	0%	0.0002	0%
	10	100%	0.9909	98%
	11	0%	0.0033	0%
	12	0%	0.0004	0%
	13	0%	0.0000	0%
	14	0%	0.0024	0%
	15	0%	0.0010	0%

"-1, 1, 1, -1"

Ranked Interpt.	State	Expect %	Activations	Output %
-	0	0%	0.0024	0%
	1	0%	0.0003	0%
-	2	0%	0.0056	1%
	3	0%	0.0015	0%
-	4	0%	0.0049	0%
	5	0%	0.0025	0%
(6)	6	100%	0.9630	97%
-	7	0%	0.0056	1%
	8	0%	0.0001	0%
	9	0%	0.0000	0%
	10	0%	0.0009	0%
	11	0%	0.0006	0%
	12	0%	0.0013	0%
	13	0%	0.0004	0%
	14	0%	0.0056	1%
	15	0%	0.0028	0%

Testing with premises:

"0, 1, 0, 0"

Ranked Interpt.	State	Expect %	Activations	Output %
-	0	0%	0.0000	0%
	1	0%	0.0000	0%
(5), (13)	2	0%	0.0001	0%
	3	0%	0.0000	0%
-	4	6%	0.0946	12%
	5	63%	0.1083	14%
(4),(6),(7)	6	6%	0.1868	23%
(12),(14),(15)	7	6%	0.0556	7%
	8	0%	0.0000	0%
	9	0%	0.0000	0%
	10	0%	0.0001	0%
	11	0%	0.0001	0%
	12	6%	0.0256	3%
	13	63%	0.0903	11%
	14	6%	0.1318	17%
	15	6%	0.1021	13%

"0, 0, -1, 0"

Ranked Interpt.	State	Expect %	Activations	Output %
(0),(1),(8),(9)	0	41%	0.0559	16%
	1	41%	0.0197	5%
(5), (13)	2	0%	0.0000	0%
	3	0%	0.0011	0%
-	4	3%	0.0850	24%
	5	27%	0.0299	8%
(4)	6	0%	0.0006	0%
(12)	7	0%	0.0007	0%
	8	41%	0.0540	15%
	9	41%	0.0236	7%
	10	0%	0.0072	2%
	11	0%	0.0004	0%
	12	3%	0.0471	13%
	13	27%	0.0240	7%
	14	0%	0.0083	2%
	15	0%	0.0019	1%

"0, 0, 0, 1"

Ranked Interpt.	State	Expect %	Activations	Output %
(1),(9)	0	0%	0.0000	0%
	1	39%	0.0062	1%
(5), (13)	2	0%	0.0154	3%
	3	3%	0.1132	20%
-	4	0%	0.0000	0%
	5	26%	0.0365	6%
(3),(7)	6	0%	0.0001	0%
(11),(15)	7	3%	0.1043	18%
	8	0%	0.0000	0%
	9	39%	0.0175	3%
	10	0%	0.0012	0%
	11	3%	0.1000	18%
	12	0%	0.0000	0%
	13	26%	0.0403	7%
	14	0%	0.0025	0%
	15	3%	0.1289	23%

"-1, 0, 0, 0"

Ranked Interpt.	State	Expect %	Activations	Output %
(0),(1)	0	31%	0.0585	11%
	1	31%	0.0385	7%
(5)	2	10%	0.0939	17%
	3	2%	0.0949	18%
(2)	4	2%	0.0350	6%
	5	20%	0.0369	7%
(3)(4),(6),(7)	6	2%	0.0992	18%
-	7	2%	0.0809	15%
	8	0%	0.0000	0%
	9	0%	0.0000	0%
	10	0%	0.0002	0%
	11	0%	0.0009	0%
	12	0%	0.0001	0%
	13	0%	0.0000	0%
	14	0%	0.0002	0%
	15	0%	0.0001	0%

Figure 27. Results for the MLP in the 4-atom micro-world, tested against specific premises. States are given in decimal format.

Using Traing Set: 98-1
Testing with premises:

"0, 0, -1, 1"

Ranked Interpt.	State	Expect %	Activations	Output %
(1),(9)	0	0%	0.0000	0%
	1	43%	0.1583	17%
(5), (13)	2	0%	0.0000	0%
	3	0%	0.0031	0%
-	4	0%	0.0135	1%
	5	29%	0.2258	24%
-	6	0%	0.0001	0%
-	7	0%	0.0122	1%
	8	0%	0.0003	0%
	9	43%	0.2616	27%
	10	0%	0.0001	0%
	11	0%	0.0042	0%
	12	0%	0.0014	0%
	13	29%	0.2502	26%
	14	0%	0.0001	0%
	15	0%	0.0220	2%

"0, -1, 0, -1"

Ranked Interpt.	State	Expect %	Activations	Output %
(0),(8)	0	38%	0.0961	12%
	1	0%	0.0001	0%
-	2	13%	0.2200	27%
	3	0%	0.0034	0%
(2),(10)	4	0%	0.0004	0%
	5	0%	0.0000	0%
-	6	0%	0.0025	0%
-	7	0%	0.0000	0%
	8	38%	0.1656	20%
	9	0%	0.0002	0%
	10	13%	0.3081	38%
	11	0%	0.0005	0%
	12	0%	0.0112	1%
	13	0%	0.0000	0%
	14	0%	0.0060	1%
	15	0%	0.0001	0%

"0, -1, 0, 1"

Ranked Interpt.	State	Expect %	Activations	Output %
(1),(9)	0	0%	0.0002	0%
	1	47%	0.2276	23%
-	2	0%	0.0024	0%
	3	3%	0.2636	26%
-	4	0%	0.0000	0%
	5	0%	0.0014	0%
(3)	6	0%	0.0000	0%
(11)	7	0%	0.0136	1%
	8	0%	0.0003	0%
	9	47%	0.1702	17%
	10	0%	0.0023	0%
	11	3%	0.3138	31%
	12	0%	0.0000	0%
	13	0%	0.0001	0%
	14	0%	0.0001	0%
	15	0%	0.0046	0%

"0, -1, 1, 0""

Ranked Interpt.	State	Expect %	Activations	Output %
-	0	0%	0.0000	0%
	1	0%	0.0065	1%
-	2	42%	0.1362	26%
	3	8%	0.0483	9%
(2),(10)	4	0%	0.0000	0%
	5	0%	0.0000	0%
(3)	6	0%	0.0020	0%
(11)	7	0%	0.0021	0%
	8	0%	0.0000	0%
	9	0%	0.0002	0%
	10	42%	0.1814	34%
	11	8%	0.1480	28%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0013	0%
	15	0%	0.0013	0%

Testing with premises:

"-1, 0, -1, 0"

Ranked Interpt.	State	Expect %	Activations	Output %
(0),(1)	0	37%	0.3416	34%
	1	37%	0.2017	20%
(5)	2	0%	0.0005	0%
	3	0%	0.0025	0%
-	4	2%	0.1698	17%
	5	24%	0.2614	26%
(4)	6	0%	0.0370	4%
-	7	0%	0.0011	0%
	8	0%	0.0001	0%
	9	0%	0.0000	0%
	10	0%	0.0000	0%
	11	0%	0.0001	0%
	12	0%	0.0003	0%
	13	0%	0.0028	0%
	14	0%	0.0002	0%
	15	0%	0.0004	0%

"-1, -1, 0, 0"

Ranked Interpt.	State	Expect %	Activations	Output %
(0),(1)	0	42%	0.0938	10%
	1	42%	0.2540	27%
-	2	14%	0.3182	34%
	3	3%	0.2561	27%
(2)	4	0%	0.0001	0%
	5	0%	0.0004	0%
(3)	6	0%	0.0012	0%
-	7	0%	0.0052	1%
36.7	8	0%	0.0000	0%
	9	0%	0.0001	0%
	10	0%	0.0006	0%
	11	0%	0.0020	0%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0001	0%
	15	0%	0.0000	0%

"-1, 0, 0, -1"

Ranked Interpt.	State	Expect %	Activations	Output %
(0)	0	68%	0.3027	38%
	1	0%	0.0003	0%
-	2	23%	0.1514	19%
	3	0%	0.0003	0%
(2)	4	4%	0.0983	12%
	5	0%	0.0004	0%
(4),(6)	6	4%	0.2279	29%
-	7	0%	0.0056	1%
22.4	8	0%	0.0008	0%
	9	0%	0.0000	0%
	10	0%	0.0007	0%
	11	0%	0.0000	0%
	12	0%	0.0003	0%
	13	0%	0.0000	0%
	14	0%	0.0022	0%
	15	0%	0.0000	0%

"-1, 0, 0, 1"

Ranked Interpt.	State	Expect %	Activations	Output %
(1)	0	0%	0.0005	0%
	1	56%	0.1955	20%
(5)	2	0%	0.0036	0%
	3	4%	0.2769	28%
-	4	0%	0.0003	0%
	5	37%	0.1353	14%
(3),(7)	6	0%	0.0132	1%
-	7	4%	0.3228	33%
27.5	8	0%	0.0000	0%
	9	0%	0.0004	0%
	10	0%	0.0003	0%
	11	0%	0.0074	1%
	12	0%	0.0000	0%
	13	0%	0.0001	0%
	14	0%	0.0002	0%
	15	0%	0.0167	2%

Figure 28. Results for the MLP in the 4-atom micro-world, tested against specific premises. States are given in decimal format.

Using Traing Set: 98-1

Testing with premises:

"-1, 1, 0, 0"

Ranked Interpt.	State	*Expect %*	Activations	Output %
-	0	0%	0.0006	0%
	1	0%	0.0004	0%
(5)	2	0%	0.0003	0%
	3	0%	0.0157	2%
-	4	8%	0.1449	16%
	5	77%	0.3113	33%
(4),(6),(7)	6	8%	0.2098	23%
-	7	8%	0.2089	22%
	8	0%	0.0000	0%
	9	0%	0.0000	0%
	10	0%	0.0001	0%
	11	0%	0.0003	0%
	12	0%	0.0010	0%
	13	0%	0.0022	0%
	14	0%	0.0289	3%
	15	0%	0.0055	1%

"1, 0, 1, 0"

Ranked Interpt.	State	*Expect %*	Activations	Output %
-	0	0%	0.0000	0%
	1	0%	0.0000	0%
-	2	0%	0.0034	0%
	3	0%	0.0053	1%
(10)	4	0%	0.0000	0%
	5	0%	0.0000	0%
-	6	0%	0.0094	1%
(11),(14),(15)	7	0%	0.0078	1%
	8	0%	0.0001	0%
	9	0%	0.0007	0%
	10	63%	0.2508	33%
	11	12%	0.1503	20%
	12	0%	0.0002	0%
	13	0%	0.0008	0%
	14	12%	0.1648	22%
	15	12%	0.1587	21%

"0, -1, -1, 0"

Ranked Interpt.	State	*Expect %*	Activations	Output %
(0),(1),(8),(9)	0	25%	0.2065	25%
	1	25%	0.1283	15%
-	2	0%	0.0305	4%
	3	0%	0.0310	4%
-	4	0%	0.0070	1%
	5	0%	0.0002	0%
-	6	0%	0.0011	0%
-	7	0%	0.0001	0%
	8	25%	0.3003	36%
	9	25%	0.1073	13%
	10	0%	0.0133	2%
	11	0%	0.0040	0%
	12	0%	0.0003	0%
	13	0%	0.0002	0%
	14	0%	0.0000	0%
	15	0%	0.0000	0%

"0, 0, 1, 1"

Ranked Interpt.	State	*Expect %*	Activations	Output %
-	0	0%	0.0000	0%
	1	0%	0.0003	0%
-	2	0%	0.0029	0%
	3	25%	0.1891	27%
-	4	0%	0.0000	0%
	5	0%	0.0001	0%
(3),(7)	6	0%	0.0089	1%
(11),(15)	7	25%	0.2290	32%
	8	0%	0.0000	0%
	9	0%	0.0006	0%
	10	0%	0.0015	0%
	11	25%	0.1277	18%
	12	0%	0.0000	0%
	13	0%	0.0001	0%
	14	0%	0.0003	0%
	15	25%	0.1459	21%

Testing with premises:

"1, -1, -1, 0"

Ranked Interpt.	State	*Expect %*	Activations	Output %
(8),(9)	0	0%	0.0070	1%
	1	0%	0.0004	0%
-	2	0%	0.0007	0%
	3	0%	0.0033	0%
-	4	0%	0.0001	0%
	5	0%	0.0000	0%
-	6	0%	0.0000	0%
-	7	0%	0.0000	0%
	8	50%	0.4488	41%
	9	50%	0.5933	54%
	10	0%	0.0146	1%
	11	0%	0.0128	1%
	12	0%	0.0132	1%
	13	0%	0.0088	1%
	14	0%	0.0010	0%
	15	0%	0.0009	0%

"0, 1, -1, 1"

Ranked Interpt.	State	*Expect %*	Activations	Output %
-	0	0%	0.0000	0%
	1	0%	0.0022	0%
(5),(13)	2	0%	0.0000	0%
	3	0%	0.0006	0%
-	4	0%	0.1264	9%
	5	50%	0.6436	45%
-	6	0%	0.0216	2%
-	7	0%	0.0501	3%
	8	0%	0.0000	0%
	9	0%	0.0099	1%
	10	0%	0.0000	0%
	11	0%	0.0005	0%
	12	0%	0.0369	3%
	13	50%	0.5240	36%
	14	0%	0.0142	1%
	15	0%	0.0083	1%

"0, -1, 1, -1"

Ranked Interpt.	State	*Expect %*	Activations	Output %
-	0	0%	0.0048	0%
	1	0%	0.0000	0%
-	2	50%	0.3878	39%
	3	0%	0.0081	1%
(2),(10)	4	0%	0.0000	0%
	5	0%	0.0000	0%
-	6	0%	0.0012	0%
-	7	0%	0.0003	0%
	8	0%	0.0071	1%
	9	0%	0.0000	0%
	10	50%	0.5517	56%
	11	0%	0.0204	2%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0075	1%
	15	0%	0.0005	0%

"-1, 1, 0, -1"

Ranked Interpt.	State	*Expect %*	Activations	Output %
-	0	0%	0.0023	0%
	1	0%	0.0001	0%
-	2	0%	0.0086	1%
	3	0%	0.0003	0%
-	4	50%	0.4312	37%
	5	0%	0.0276	2%
(4),(6)	6	50%	0.6311	54%
-	7	0%	0.0160	1%
	8	0%	0.0000	0%
	9	0%	0.0000	0%
	10	0%	0.0137	1%
	11	0%	0.0000	0%
	12	0%	0.0033	0%
	13	0%	0.0001	0%
	14	0%	0.0283	2%
	15	0%	0.0028	0%

Figure 29. Results for the MLP in the 4-atom micro-world, tested against specific premises. States are given in decimal format.

Using Traing Set: 98-1
Testing with premises:

"1, -1, 0, -1"

Ranked Interpt.	State	*Expect %*	Activations	Output %
(8)	0	0%	0.0007	0%
	1	0%	0.0000	0%
-	2	0%	0.0240	2%
	3	0%	0.0003	0%
(10)	4	0%	0.0001	0%
	5	0%	0.0000	0%
-	6	0%	0.0011	0%
-	7	0%	0.0000	0%
	8	75%	0.6837	59%
	9	0%	0.0094	1%
	10	25%	0.3871	34%
	11	0%	0.0256	2%
	12	0%	0.0017	0%
	13	0%	0.0002	0%
	14	0%	0.0175	2%
	15	0%	0.0002	0%

"-1, 0, -1, -1"

Ranked Interpt.	State	*Expect %*	Activations	Output %
(0)	0	94%	0.6879	56%
	1	0%	0.0175	1%
-	2	0%	0.0174	1%
	3	0%	0.0213	2%
-	4	6%	0.3900	32%
	5	0%	0.0393	3%
(4)	6	0%	0.0276	2%
-	7	0%	0.0002	0%
	8	0%	0.0047	0%
	9	0%	0.0000	0%
	10	0%	0.0158	1%
	11	0%	0.0002	0%
	12	0%	0.0031	0%
	13	0%	0.0001	0%
	14	0%	0.0015	0%
	15	0%	0.0000	0%

"-1, 1, 0, 1"

Ranked Interpt.	State	*Expect %*	Activations	Output %
-	0	0%	0.0000	0%
	1	0%	0.0239	2%
(5)	2	0%	0.0274	2%
	3	0%	0.0770	6%
-	4	0%	0.0122	1%
	5	91%	0.6382	51%
(7)	6	0%	0.0149	1%
-	7	9%	0.4087	33%
	8	0%	0.0000	0%
	9	0%	0.0000	0%
	10	0%	0.0000	0%
	11	0%	0.0040	0%
	12	0%	0.0001	0%
	13	0%	0.0098	1%
	14	0%	0.0113	1%
	15	0%	0.0200	2%

"1, -1, 1, 0"

Ranked Interpt.	State	*Expect %*	Activations	Output %
-	0	0%	0.0000	0%
	1	0%	0.0004	0%
-	2	0%	0.0046	1%
	3	0%	0.0552	7%
(10)	4	0%	0.0000	0%
	5	0%	0.0000	0%
-	6	0%	0.0001	0%
(11)	7	0%	0.0004	0%
	8	0%	0.0032	0%
	9	0%	0.0179	2%
	10	84%	0.4643	56%
	11	16%	0.2638	32%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0064	1%
	15	0%	0.0083	1%

Figure 30. Results for the MLP in the 4-atom micro-world, tested against specific premises. States are given in decimal format.

Testing with neutral premise "0, 0, 0, 0, 0" - Standard
Training Set: 136-0

Ranked Interpret.	State	Expected %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Avg Activations	Avg Output %	Stdev
(16), (17)	0	11.8%	0.0082	12.0%	0.0097	13.6%	0.0105	14.7%	0.0237	25.6%	0.0148	19.1%	0.0669	17.6%	
	1	11.8%	0.0001	0.1%	0.0000	0.0%	0.0000	0.0%	0.0001	0.1%	0.0001	0.1%	0.0003	0.1%	
(0), (1)	2	2.9%	0.0050	7.3%	0.0055	7.7%	0.0057	8.0%	0.0069	7.5%	0.0072	9.3%	0.0303	8.0%	
	3	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
(5), (9), (21), (25)	4	0.0%	0.0012	1.8%	0.0012	1.7%	0.0012	1.7%	0.0013	1.4%	0.0013	1.7%	0.0062	1.6%	
	5	5.9%	0.0109	15.9%	0.0100	14.0%	0.0085	11.9%	0.0113	12.2%	0.0078	10.1%	0.0485	12.7%	
(2), (18)	6	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	7	0.0%	0.0012	1.8%	0.0012	1.7%	0.0012	1.7%	0.0013	1.4%	0.0013	1.7%	0.0062	1.6%	
All other states 22	8	0.0%	0.0012	1.8%	0.0012	1.7%	0.0012	1.7%	0.0013	1.4%	0.0013	1.7%	0.0062	1.6%	
(3), (4), (6)-(8)	9	5.9%	0.0077	11.2%	0.0097	13.6%	0.0125	17.6%	0.0112	12.1%	0.0090	11.6%	0.0501	13.1%	
(10)-(15), (19), (20)	10	0.0%	0.0012	1.8%	0.0012	1.7%	0.0012	1.7%	0.0013	1.4%	0.0013	1.7%	0.0062	1.6%	
(22)-(24), (26)-(31)	11	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	12	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	13	0.0%	0.0012	1.8%	0.0012	1.7%	0.0012	1.7%	0.0013	1.4%	0.0013	1.7%	0.0062	1.6%	
	14	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	15	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	16	23.5%	0.0020	2.9%	0.0016	2.2%	0.0015	2.1%	0.0018	1.9%	0.0020	2.6%	0.0089	2.3%	
	17	23.5%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	18	2.9%	0.0022	3.2%	0.0024	3.4%	0.0026	3.7%	0.0033	3.6%	0.0021	2.7%	0.0126	3.3%	
	19	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	20	0.0%	0.0012	1.8%	0.0012	1.7%	0.0012	1.7%	0.0013	1.4%	0.0013	1.7%	0.0062	1.6%	
	21	5.9%	0.0030	4.4%	0.0029	4.1%	0.0024	3.4%	0.0027	2.9%	0.0024	3.1%	0.0134	3.5%	
	22	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	23	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	24	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	25	5.9%	0.0030	4.4%	0.0032	4.5%	0.0027	3.8%	0.0028	3.0%	0.0036	4.6%	0.0153	4.0%	
	26	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	27	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	28	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	29	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	30	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	31	0.0%	0.0012	1.8%	0.0012	1.7%	0.0011	1.5%	0.0013	1.4%	0.0013	1.7%	0.0061	1.6%	
	Accumulated error =		0.0685	**126.3%**	0.0714	**127.8%**	0.0712	**129.4%**	0.0924	**131.0%**	0.0776	**126.9%**	0.3811	**128.3%**	**± 1.93**
	Avg. error per state =			**3.9%**		**4.0%**		**4.0%**		**4.1%**		**4.0%**		**4.0%**	**± 0.06**

Figure 31. Results for the MLP in the 5-atom micro-world, tested against the neutral premise. States are given in decimal format.

Training Set: 158-1

Ranked Interpret.	*State*	*Expected %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	*Samples*	*Output %*	
(16), (17)	0	10.1%	4687	7.8%	5109	8.5%	4875	8.1%	4901	8.2%	5293	8.8%	24865	8.3%	
	1	10.1%	5560	9.3%	5305	8.8%	5466	9.1%	5562	9.3%	4957	8.3%	26850	9.0%	
(0), (1)	2	2.5%	1517	2.5%	1391	2.3%	1368	2.3%	1829	3.0%	1490	2.5%	7595	2.5%	
	3	0.6%	1066	1.8%	1087	1.8%	828	1.4%	1050	1.8%	1200	2.0%	5231	1.7%	
(5), (9), (21), (25)	4	0.6%	1433	2.4%	1620	2.7%	1651	2.8%	1284	2.1%	1546	2.6%	7534	2.5%	
	5	5.1%	3399	5.7%	3093	5.2%	2979	5.0%	3431	5.7%	3091	5.2%	15993	5.3%	
(2), (18)	6	0.6%	741	1.2%	579	1.0%	729	1.2%	789	1.3%	678	1.1%	3516	1.2%	
	7	0.6%	685	1.1%	706	1.2%	708	1.2%	632	1.1%	860	1.4%	3591	1.2%	
All other states 22	8	0.6%	1434	2.4%	1687	2.8%	1758	2.9%	1690	2.8%	1735	2.9%	8304	2.8%	
(3), (4), (6)-(8)	9	5.1%	2990	5.0%	2844	4.7%	2932	4.9%	3161	5.3%	2885	4.8%	14812	4.9%	
(10)-(15), (19), (20)	10	0.6%	813	1.4%	811	1.4%	804	1.3%	720	1.2%	723	1.2%	3871	1.3%	
(22)-(24), (26)-(31)	11	0.6%	772	1.3%	737	1.2%	726	1.2%	675	1.1%	834	1.4%	3744	1.2%	
	12	0.6%	803	1.3%	798	1.3%	567	0.9%	568	0.9%	854	1.4%	3590	1.2%	
	13	0.6%	1605	2.7%	1619	2.7%	1427	2.4%	1626	2.7%	1287	2.1%	7564	2.5%	
	14	0.6%	672	1.1%	517	0.9%	416	0.7%	503	0.8%	497	0.8%	2605	0.9%	
	15	0.6%	505	0.8%	674	1.1%	748	1.2%	729	1.2%	559	0.9%	3215	1.1%	
	16	20.3%	5289	8.8%	5656	9.4%	5268	8.8%	5586	9.3%	5933	9.9%	27732	9.2%	
	17	20.3%	6513	10.9%	6337	10.6%	7118	11.9%	6267	10.4%	6190	10.3%	32425	10.8%	
	18	2.5%	1785	3.0%	1856	3.1%	1670	2.8%	1750	2.9%	1676	2.8%	8737	2.9%	
	19	0.6%	1184	2.0%	1145	1.9%	1297	2.2%	1192	2.0%	1252	2.1%	6070	2.0%	
	20	0.6%	1378	2.3%	1854	3.1%	1528	2.5%	1659	2.8%	1515	2.5%	7934	2.6%	
	21	5.1%	2902	4.8%	3183	5.3%	3054	5.1%	2977	5.0%	3343	5.6%	15459	5.2%	
	22	0.6%	777	1.3%	937	1.6%	833	1.4%	986	1.6%	796	1.3%	4329	1.4%	
	23	0.6%	921	1.5%	669	1.1%	868	1.4%	735	1.2%	792	1.3%	3985	1.3%	
	24	0.6%	1894	3.2%	1661	2.8%	1819	3.0%	1872	3.1%	1667	2.8%	8913	3.0%	
	25	5.1%	3526	5.9%	3223	5.4%	3413	5.7%	3208	5.3%	3345	5.6%	16715	5.6%	
	26	0.6%	876	1.5%	646	1.1%	922	1.5%	657	1.1%	723	1.2%	3824	1.3%	
	27	0.6%	787	1.3%	719	1.2%	930	1.6%	756	1.3%	852	1.4%	4044	1.3%	
	28	0.6%	783	1.3%	585	1.0%	527	0.9%	603	1.0%	873	1.5%	3371	1.1%	
	29	0.6%	1542	2.6%	1703	2.8%	1462	2.4%	1606	2.7%	1681	2.8%	7994	2.7%	
	30	0.6%	479	0.8%	533	0.9%	523	0.9%	481	0.8%	384	0.6%	2400	0.8%	
	31	0.6%	682	1.1%	716	1.2%	786	1.3%	515	0.9%	489	0.8%	3188	1.1%	
	Accumulated error =		60000	**59.1%**	60000	**58.8%**	60000	**57.8%**	60000	**58.0%**	60000	**58.4%**	300000	**58.1%**	**± 0.55**
	Avg. error per state =			**1.8%**		**1.8%**		**1.8%**		**1.8%**		**1.8%**		**1.8%**	**± 0.02**

Figure 32. Results for the MLP in the 5-atom micro-world, tested against the neutral premise. States are given in decimal format.

Testing with neutral premise "0, 0, 0, 0, 0" - Standard
Training Set: 120-0

Ranked Interpret.	State	Expected %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Avg Activations	Avg Output %	Stdev
(16), (17)	0	12.5%	0.0007	1.2%	0.0005	0.8%	0.0008	1.4%	0.0007	1.2%	0.0012	1.9%	0.0039	1.3%	
	1	12.5%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0001	0.2%	0.0000	0.0%	0.0001	0.0%	
(0), (1)	2	4.2%	0.0135	23.2%	0.0135	21.4%	0.0092	15.9%	0.0108	18.8%	0.0167	27.1%	0.0637	21.3%	
	3	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
(5), (9), (21), (25)	4	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	5	8.3%	0.0055	9.5%	0.0065	10.3%	0.0063	10.9%	0.0056	9.7%	0.0043	7.0%	0.0282	9.5%	
(2), (18)	6	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	7	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
All other states 22	8	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
(3), (4), (6)-(8)	9	8.3%	0.0034	5.9%	0.0067	10.6%	0.0063	10.9%	0.0059	10.3%	0.0051	8.3%	0.0274	9.2%	
(10)-(15), (19), (20)	10	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
(22)-(24), (26)-(31)	11	0.0%	0.0008	1.4%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0046	1.5%	
	12	0.0%	0.0008	1.4%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0046	1.5%	
	13	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	14	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	15	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	16	16.7%	0.0002	0.3%	0.0005	0.8%	0.0003	0.5%	0.0003	0.5%	0.0003	0.5%	0.0016	0.5%	
	17	16.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	18	4.2%	0.0070	12.0%	0.0077	12.2%	0.0092	15.9%	0.0070	12.2%	0.0087	14.1%	0.0396	13.3%	
	19	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0011	1.9%	0.0009	1.5%	0.0048	1.6%	
	20	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	21	8.3%	0.0039	6.7%	0.0027	4.3%	0.0040	6.9%	0.0027	4.7%	0.0028	4.5%	0.0161	5.4%	
	22	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	23	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	24	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	25	8.3%	0.0043	7.4%	0.0031	4.9%	0.0021	3.6%	0.0022	3.8%	0.0027	4.4%	0.0144	4.8%	
	26	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	27	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	28	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	29	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	30	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0011	1.9%	0.0009	1.5%	0.0048	1.6%	
	31	0.0%	0.0009	1.5%	0.0010	1.6%	0.0009	1.6%	0.0010	1.7%	0.0009	1.5%	0.0047	1.6%	
	Accumulated error =		0.0581	**137.0%**	0.0632	**137.0%**	0.0580	**139.0%**	0.0575	**138.5%**	0.0616	**139.0%**	0.2984	**136.6%**	**± 1.02**
	Avg. error per state =			**4.3%**		**4.3%**		**4.3%**		**4.3%**		**4.3%**		**4.3%**	**± 0.03**

Figure 33. Results for the MLP in the 5-atom micro-world, tested against the neutral premise. States are given in decimal format.

Training Set: 142-1

Ranked Interpret.	State	Expected %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	Activations	Output %	
(16), (17)	0	10.6%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	1	10.6%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
(0), (1)	2	3.5%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	3	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
(5), (9), (21), (25)	4	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	5	7.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
(2), (18)	6	0.7%	0.0000	0.0%	0.0000	0.0%	0.0001	14.3%	0.0000	0.0%	0.0000	0.0%	0.0001	1.3%	
	7	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
All other states 22	8	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
(3), (4), (6)-(8)	9	7.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
(10)-(15), (19), (20)	10	0.7%	0.0000	0.0%	0.0001	16.7%	0.0000	0.0%	0.0002	100.0%	0.0013	21.3%	0.0016	20.0%	
(22)-(24), (26)-(31)	11	0.7%	0.0000	0.0%	0.0002	33.3%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0002	2.5%	
	12	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	13	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	14	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	15	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	16	14.1%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	17	14.1%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	18	3.5%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	19	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	20	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	21	7.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	22	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	23	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	24	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	25	7.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	26	0.7%	0.0000	0.0%	0.0002	33.3%	0.0000	0.0%	0.0000	0.0%	0.0002	3.3%	0.0004	5.0%	
	27	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	28	0.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	
	29	0.7%	0.0000	0.0%	0.0000	0.0%	0.0006	85.7%	0.0000	0.0%	0.0000	0.0%	0.0006	7.5%	
	30	0.7%	0.0003	75.0%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0046	75.4%	0.0049	61.3%	
	31	0.7%	0.0001	25.0%	0.0001	16.7%	0.0000	0.0%	0.0000	0.0%	0.0000	0.0%	0.0002	2.5%	
	Accumulated error =		0.0004	**197.0%**	0.0006	**194.2%**	0.0007	**197.0%**	0.0002	**198.4%**	0.0061	**195.6%**	0.0080	**190.0%**	**± 1.60**
	Avg. error per state =			**6.2%**		**6.1%**		**6.2%**		**6.2%**		**6.1%**		**5.9%**	**± 0.05**

Figure 34. Results for the MLP in the 5-atom micro-world, tested against the neutral premise. States are given in decimal format.

Using Training Set: 158-1
Testing with premises:

"1-1-1-1-1"

Ranked Interpt.	State	Expect %	Actv.	Output %
(16)	0	0%	0.0005	0%
	1	0%	0.0000	0%
-	2	0%	0.0001	0%
	3	0%	0.0000	0%
-	4	0%	0.0001	0%
	5	0%	0.0001	0%
-	6	0%	0.0000	0%
	7	0%	0.0000	0%
-	8	0%	0.0000	0%
-	9	0%	0.0000	0%
	10	0%	0.0001	0%
	11	0%	0.0001	0%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0001	0%
	15	0%	0.0000	0%
	16	100%	0.9985	100%
	17	0%	0.0010	0%
	18	0%	0.0002	0%
	19	0%	0.0005	0%
	20	0%	0.0003	0%
	21	0%	0.0004	0%
	22	0%	0.0001	0%
	23	0%	0.0001	0%
	24	0%	0.0000	0%
	25	0%	0.0004	0%
	26	0%	0.0001	0%
	27	0%	0.0000	0%
	28	0%	0.0002	0%
	29	0%	0.0002	0%
	30	0%	0.0000	0%
	31	0%	0.0001	0%

"11-111"

Ranked Interpt.	State	Expect %	Actv.	Output %
-	0	0%	0.0000	0%
	1	0%	0.0002	0%
-	2	0%	0.0001	0%
	3	0%	0.0011	0%
-	4	0%	0.0000	0%
	5	0%	0.0000	0%
-	6	0%	0.0000	0%
	7	0%	0.0001	0%
(27)	8	0%	0.0001	0%
-	9	0%	0.0000	0%
	10	0%	0.0004	0%
	11	0%	0.0007	0%
	12	0%	0.0032	0%
	13	0%	0.0000	0%
	14	0%	0.0000	0%
	15	0%	0.0002	0%
	16	0%	0.0009	0%
	17	0%	0.0011	0%
	18	0%	0.0008	0%
	19	0%	0.0008	0%
	20	0%	0.0000	0%
	21	0%	0.0001	0%
	22	0%	0.0015	0%
	23	0%	0.0015	0%
	24	0%	0.0004	0%
	25	0%	0.0029	0%
	26	0%	0.0020	0%
	27	100%	0.9917	98%
	28	0%	0.0001	0%
	29	0%	0.0003	0%
	30	0%	0.0006	0%
	31	0%	0.0020	0%

"0-1001"

Ranked Interpt.	State	Expect %	Actv.	Output %
(17)	0	0%	0.0000	0%
	1	23%	0.0461	7%
(1)	2	0%	0.0000	0%
	3	1%	0.1620	25%
(5), (21)	4	0%	0.0000	0%
	5	12%	0.0102	2%
-	6	0%	0.0000	0%
	7	1%	0.1182	18%
(3), (7), (19), (23)	8	0%	0.0000	0%
-	9	0%	0.0000	0%
	10	0%	0.0000	0%
	11	0%	0.0013	0%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0000	0%
	15	0%	0.0011	0%
	16	0%	0.0000	0%
	17	47%	0.1201	18%
	18	0%	0.0004	0%
	19	1%	0.0004	0%
	20	0%	0.0000	0%
	21	12%	0.0128	2%
	22	0%	0.0003	0%
	23	1%	0.1760	27%
	24	0%	0.0000	0%
	25	0%	0.0000	0%
	26	0%	0.0087	1%
	27	0%	0.0000	0%
	28	0%	0.0000	0%
	29	0%	0.0002	0%
	30	0%	0.0000	0%
	31	0%	0.0003	0%

"0-1000"

Ranked Interpt.	State	Expect %	Actv.	Output %
(16), (17)	0	13%	0.0001	0%
	1	13%	0.0016	1%
(0), (1)	2	3%	0.0058	4%
	3	1%	0.0036	2%
(5), (21)	4	1%	0.0001	0%
	5	6%	0.0009	1%
(2), (18)	6	1%	0.0190	13%
	7	1%	0.0503	35%
(3), (4), (6), (7)	8	0%	0.0000	0%
(19),(20),(22),(23)	9	0%	0.0000	0%
	10	0%	0.0000	0%
	11	0%	0.0000	0%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0000	0%
	15	0%	0.0000	0%
	16	25%	0.0000	0%
	17	25%	0.0058	4%
	18	1%	0.0001	0%
	19	1%	0.0001	0%
	20	1%	0.0004	0%
	21	6%	0.0014	1%
	22	1%	0.0369	25%
	23	1%	0.0195	13%
	24	0%	0.0000	0%
	25	0%	0.0000	0%
	26	0%	0.0000	0%
	27	0%	0.0000	0%
	28	0%	0.0000	0%
	29	0%	0.0000	0%
	30	0%	0.0001	0%
	31	0%	0.0000	0%

Figure 35. Results for the MLP in the 5-atom micro-world, tested against specific premises. States are given in decimal format.

"1-1-1-10"

Ranked Interpt.	State	Expect %	Actv.	Output %
(16), (17)	0	0%	0.0050	0%
	1	0%	0.0004	0%
-	2	0%	0.0000	0%
	3	0%	0.0002	0%
-	4	0%	0.0000	0%
	5	0%	0.0001	0%
-	6	0%	0.0000	0%
	7	0%	0.0000	0%
-	8	0%	0.0000	0%
-	9	0%	0.0000	0%
	10	0%	0.0000	0%
	11	0%	0.0000	0%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0000	0%
	15	0%	0.0000	0%
	16	50%	0.5766	57%
	17	50%	0.3414	34%
	18	0%	0.0283	3%
	19	0%	0.0039	0%
	20	0%	0.0126	1%
	21	0%	0.0009	0%
	22	0%	0.0008	0%
	23	0%	0.0061	1%
	24	0%	0.0169	2%
	25	0%	0.0148	1%
	26	0%	0.0008	0%
	27	0%	0.0000	0%
	28	0%	0.0001	0%
	29	0%	0.0000	0%
	30	0%	0.0000	0%
	31	0%	0.0000	0%

"1-110-1"

Ranked Interpt.	State	Expect %	Actv.	Output %
-	0	0%	0.0000	0%
	1	0%	0.0000	0%
-	2	0%	0.0001	0%
	3	0%	0.0000	0%
-	4	0%	0.0017	0%
	5	0%	0.0000	0%
-	6	0%	0.0123	1%
	7	0%	0.0004	0%
(20), (22)	8	0%	0.0000	0%
-	9	0%	0.0000	0%
	10	0%	0.0003	0%
	11	0%	0.0000	0%
	12	0%	0.0001	0%
	13	0%	0.0000	0%
	14	0%	0.0005	0%
	15	0%	0.0000	0%
	16	0%	0.0201	2%
	17	0%	0.0000	0%
	18	0%	0.0005	0%
	19	0%	0.0004	0%
	20	50%	0.5059	48%
	21	0%	0.0176	2%
	22	50%	0.4664	44%
	23	0%	0.0033	0%
	24	0%	0.0002	0%
	25	0%	0.0000	0%
	26	0%	0.0038	0%
	27	0%	0.0000	0%
	28	0%	0.0013	0%
	29	0%	0.0005	0%
	30	0%	0.0128	1%
	31	0%	0.0005	0%

"1-10-11"

Ranked Interpt.	State	Expect %	Actv.	Output %
(17)	0	0%	0.0000	0%
	1	0%	0.0008	0%
-	2	0%	0.0000	0%
	3	0%	0.0005	0%
(21)	4	0%	0.0000	0%
	5	0%	0.0014	0%
-	6	0%	0.0001	0%
	7	0%	0.0003	0%
-	8	0%	0.0000	0%
-	9	0%	0.0000	0%
	10	0%	0.0000	0%
	11	0%	0.0000	0%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0000	0%
	15	0%	0.0000	0%
	16	0%	0.0041	0%
	17	80%	0.4915	48%
	18	0%	0.0002	0%
	19	0%	0.0001	0%
	20	0%	0.0020	0%
	21	20%	0.4383	43%
	22	0%	0.0028	0%
	23	0%	0.0532	5%
	24	0%	0.0000	0%
	25	0%	0.0049	0%
	26	0%	0.0000	0%
	27	0%	0.0010	0%
	28	0%	0.0003	0%
	29	0%	0.0146	1%
	30	0%	0.0000	0%
	31	0%	0.0115	1%

"-1-1-10-1"

Ranked Interpt.	State	Expect %	Actv.	Output %
-	0	80%	0.5517	47%
	1	0%	0.0071	1%
(0)	2	20%	0.5186	44%
	3	0%	0.0118	1%
-	4	0%	0.0043	0%
	5	0%	0.0006	0%
(2)	6	0%	0.0379	3%
	7	0%	0.0053	0%
-	8	0%	0.0027	0%
-	9	0%	0.0000	0%
	10	0%	0.0224	2%
	11	0%	0.0001	0%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0000	0%
	15	0%	0.0011	0%
	16	0%	0.0000	0%
	17	0%	0.0003	0%
	18	0%	0.0000	0%
	19	0%	0.0115	1%
	20	0%	0.0057	0%
	21	0%	0.0000	0%
	22	0%	0.0000	0%
	23	0%	0.0003	0%
	24	0%	0.0000	0%
	25	0%	0.0001	0%
	26	0%	0.0000	0%
	27	0%	0.0028	0%
	28	0%	0.0000	0%
	29	0%	0.0000	0%
	30	0%	0.0000	0%
	31	0%	0.0001	0%

Figure 36. Results for the MLP in the 5-atom micro-world, tested against specific premises. States are given in decimal format.

Testing with premises:

"-101-11"

Ranked Interpt.	State	Expect %	Actv.	Output %
-	0	0%	0.0000	0%
	1	0%	0.0003	0%
-	2	0%	0.0000	0%
	3	0%	0.0001	0%
(5)	4	0%	0.0033	0%
	5	89%	0.4057	46%
-	6	0%	0.0001	0%
	7	0%	0.0009	0%
(13)	8	0%	0.0001	0%
-	9	0%	0.0051	1%
	10	0%	0.0000	0%
	11	0%	0.0005	0%
	12	0%	0.0000	0%
	13	11%	0.4484	50%
	14	0%	0.0124	1%
	15	0%	0.0097	1%
	16	0%	0.0000	0%
	17	0%	0.0000	0%
	18	0%	0.0000	0%
	19	0%	0.0000	0%
	20	0%	0.0000	0%
	21	0%	0.0023	0%
	22	0%	0.0000	0%
	23	0%	0.0000	0%
	24	0%	0.0000	0%
	25	0%	0.0000	0%
	26	0%	0.0000	0%
	27	0%	0.0000	0%
	28	0%	0.0000	0%
	29	0%	0.0015	0%
	30	0%	0.0000	0%
	31	0%	0.0002	0%

"0-10-11"

Ranked Interpt.	State	Expect %	Actv.	Output %
(17)	0	0%	0.0001	0%
	1	25%	0.1177	18%
(1)	2	0%	0.0007	0%
	3	0%	0.0130	2%
(5), (21)	4	0%	0.0008	0%
	5	13%	0.0943	15%
-	6	0%	0.0016	0%
	7	0%	0.0342	5%
-	8	0%	0.0000	0%
-	9	0%	0.0005	0%
	10	0%	0.0000	0%
	11	0%	0.0005	0%
	12	0%	0.0000	0%
	13	0%	0.0011	0%
	14	0%	0.0000	0%
	15	0%	0.0000	0%
	16	0%	0.0006	0%
	17	50%	0.1727	27%
	18	0%	0.0002	0%
	19	0%	0.0000	0%
	20	0%	0.0001	0%
	21	13%	0.1775	28%
	22	0%	0.0001	0%
	23	0%	0.0223	3%
	24	0%	0.0000	0%
	25	0%	0.0001	0%
	26	0%	0.0000	0%
	27	0%	0.0001	0%
	28	0%	0.0000	0%
	29	0%	0.0000	0%
	30	0%	0.0000	0%
	31	0%	0.0000	0%

"10-10-1"

Ranked Interpt.	State	Expect %	Actv.	Output %
(16)	0	0%	0.0003	0%
	1	0%	0.0000	0%
-	2	0%	0.0002	0%
	3	0%	0.0000	0%
-	4	0%	0.0000	0%
	5	0%	0.0000	0%
(18)	6	0%	0.0001	0%
	7	0%	0.0000	0%
(24), (26)	8	0%	0.0011	0%
-	9	0%	0.0000	0%
	10	0%	0.0278	4%
	11	0%	0.0000	0%
	12	0%	0.0000	0%
	13	0%	0.0000	0%
	14	0%	0.0001	0%
	15	0%	0.0000	0%
	16	85%	0.3805	54%
	17	0%	0.0011	0%
	18	10%	0.0313	4%
	19	0%	0.0057	1%
	20	0%	0.0051	1%
	21	0%	0.0000	0%
	22	0%	0.0025	0%
	23	0%	0.0000	0%
	24	3%	0.0678	10%
	25	0%	0.0018	0%
	26	3%	0.1696	24%
	27	0%	0.0006	0%
	28	0%	0.0001	0%
	29	0%	0.0000	0%
	30	0%	0.0040	1%
	31	0%	0.0000	0%

"1-1001"

Ranked Interpt.	State	Expect %	Actv.	Output %
-	0	0%	0.0004	0%
	1	62%	0.2536	29%
(1)	2	0%	0.0067	1%
	3	4%	0.1537	18%
(5)	4	0%	0.0021	0%
	5	31%	0.1442	16%
-	6	0%	0.0052	1%
	7	4%	0.2636	30%
(3), (7)	8	0%	0.0000	0%
-	9	0%	0.0090	1%
	10	0%	0.0007	0%
	11	0%	0.0195	2%
	12	0%	0.0000	0%
	13	0%	0.0001	0%
	14	0%	0.0000	0%
	15	0%	0.0012	0%
	16	0%	0.0000	0%
	17	0%	0.0086	1%
	18	0%	0.0000	0%
	19	0%	0.0001	0%
	20	0%	0.0000	0%
	21	0%	0.0002	0%
	22	0%	0.0003	0%
	23	0%	0.0059	1%
	24	0%	0.0000	0%
	25	0%	0.0000	0%
	26	0%	0.0000	0%
	27	0%	0.0001	0%
	28	0%	0.0000	0%
	29	0%	0.0000	0%
	30	0%	0.0000	0%
	31	0%	0.0008	0%

Figure 37. Results for the MLP in the 5-atom micro-world, tested against specific premises. States are given in decimal format.

Appendix D: Blotzmann Machine Implementation

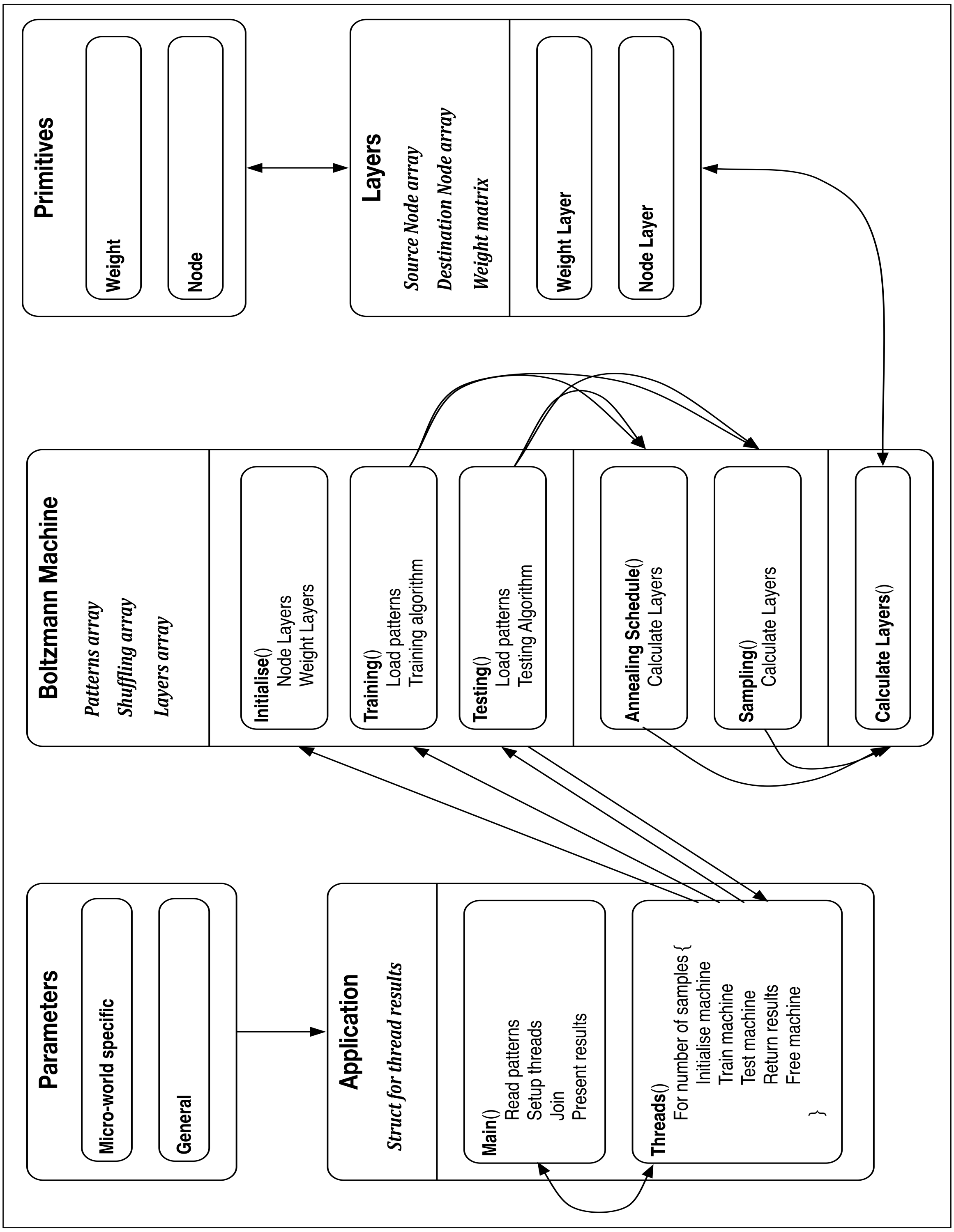

Figure 38. Simplified UML diagram for the object-oriented design of the Boltzmann machine.

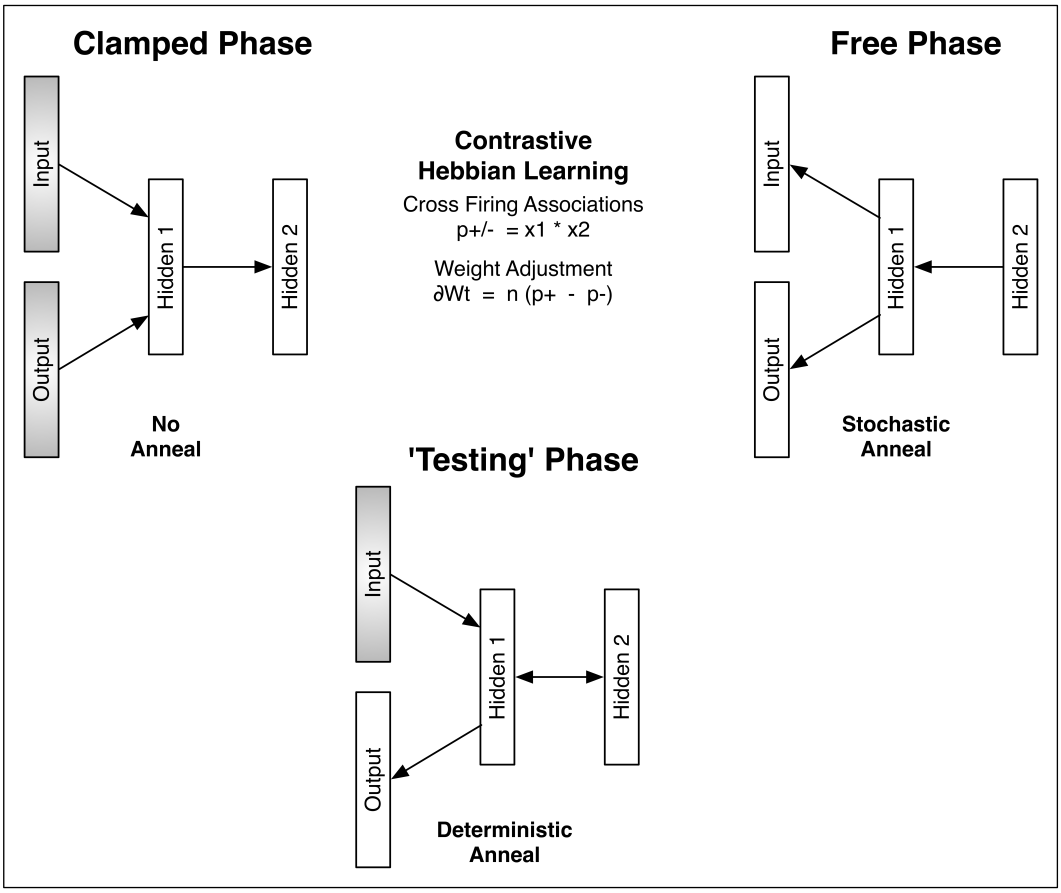

Figure 39. Modified learning algorithm for the Boltzmann macine. The network is separated into layers and the annealing schedule is varied between phases.