Lecture 11 Quiz

Quiz, 5 questions

1 point

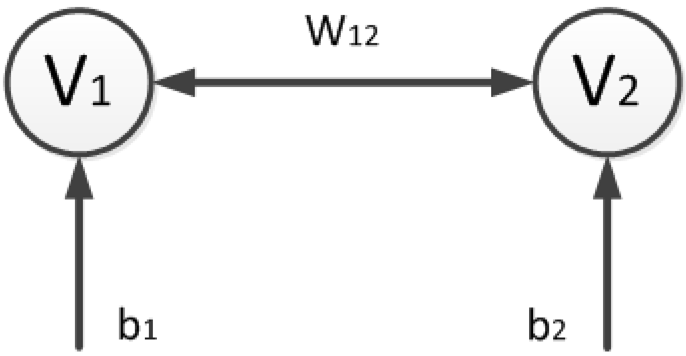
1.
If $\Delta E = 3$, then:

- ○ $P(s = 1)$ increases when T increases.
- ● $P(s = 1)$ decreases when T increases.

---

1 point

2.
The Hopfield network shown below has two visible units: V_1 and V_2. It has a connection between the two units, and each unit has a bias.



Let $W_{12} = -10$, $b_1 = 1$, and $b_2 = 1$ and the initial states of $V_1 = 0$ and $V_2 = 0$.

If the network always updates both units simultaneously, then what is the lowest energy value that it will encounter (given those initial states)?

If the network always updates the units one at a time, i.e. it alternates between updating V_1 and updating V_2, then what is the lowest energy value that it will encounter (given those initial states)?

Write those two numbers with a comma between them. For example, if you think that the answer to that first question is 4, and that the answer to the second question is -7, then write this: **4, -7**

Please use a space after the comma in your response to be read/graded properly in the Coursera platform.

Lecture 11 Quiz

Quiz, 5 questions

0, -1

1 point

3.

This question is about Boltzmann Machines, a.k.a. a stochastic Hopfield networks. Recall from the lecture that when we pick a new state s_i for unit i, we do so in a stochastic way: $p(s_i = 1) = \frac{1}{1+exp(-\Delta E/T)}$, and $p(s_i = 0) = 1 - p(s_i = 1)$. Here, ΔE is the *energy gap*, i.e. the energy when the unit is off, minus the energy when the unit is on. T is the *temperature*. We can run our system with any temperature that we like, but the most commonly used temperatures are 0 and 1.

When we want to explore the configurations of a Boltzmann Machine, we initialize it in some starting configuration, and then repeatedly choose a unit at random, and pick a new state for it, using the probability formula described above.

Consider two small Boltzmann Machines with 10 units, with the same weights, but with different temperatures. One, the "cold" one, has temperature 0. The other, the "warm" one, has temperature 1. We run both of them for 1000 iterations (updates), as described above, and then we look at the configuration that we end up with after those 1000 updates.

Which of the following statements are true? (Note that an "energy minimum" is what could also reasonably be called a "local energy minimum")

- [ ] For the cold one, $P(s_i = 1)$ can be any value between 0 and 1, depending on the weights.
- [x] The cold one is more likely to end in an energy minimum than the warm one.
- [x] The warm one could end up in a configuration that's not an energy minimum.
- [x] For the warm one, $P(s_i = 1)$ can be any value between 0 and 1, depending on the weights.

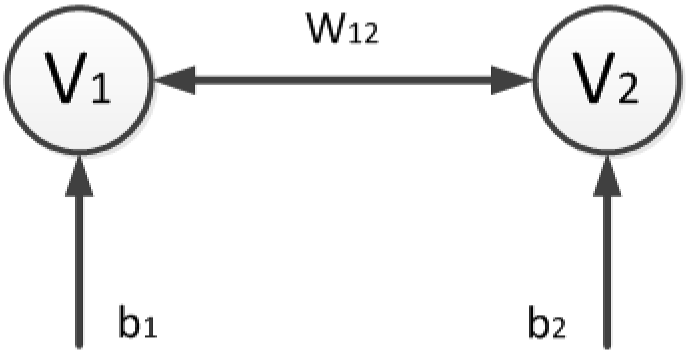
1 point

Lecture 11 Quiz

Quiz, 5 questions

4.

The Boltzmann Machine shown below has two visible units V_1 and V_2. There is a connection between the two, and both units have a bias.



Let $W_{12} = -2$, $b_1 = 1$, and $b_2 = 1$.

What is $P(V_1 = 1, V_2 = 0)$? Write your answer with at least 3 digits after the decimal point.

0.3655

1 point

5.

The figure below shows a Hopfield network with five binary threshold units: a, b, c, d, and e. The network has many connections, but no biases.

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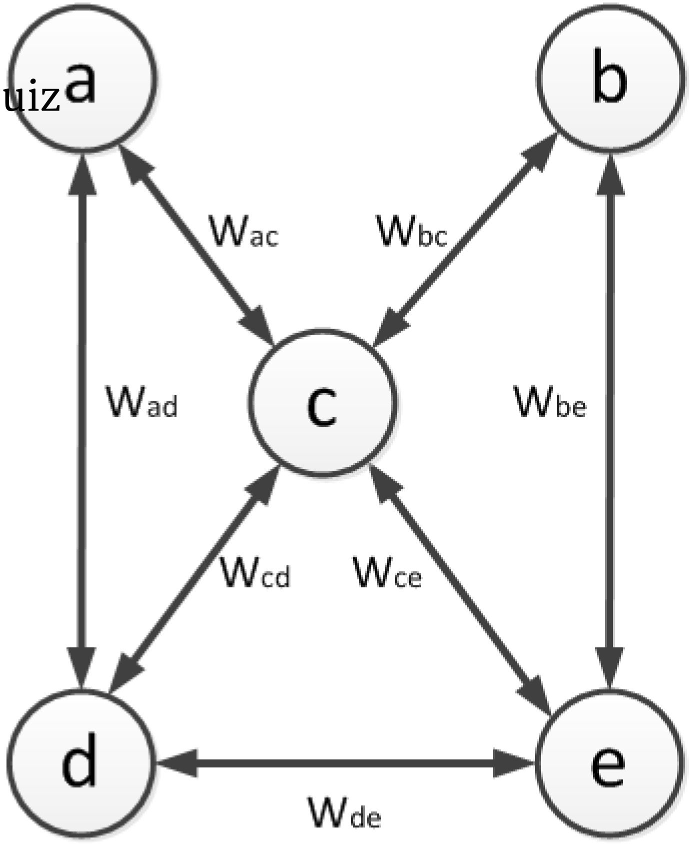
Quiz, 5 questions



Let Wac=Wbc=1, Wce=Wcd=2, Wbe=−3, Wad=−2, and Wde=3.

What is the energy of the configuration with the lowest energy? What is the energy of the configuration with the second lowest energy (considering all configurations, not just those that are energy minima)?

Write your answer with a comma between the two numbers. For example, if you think that the energy of the lowest energy configuration is -17, and that

the energy of the second lowest energy configuration is -13, then you should write this: -17, -13

4, 2

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