Princeton COS 495: Introduction to Deep Learning
Homework 5

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1. (Math) Recall that Restricted Boltzman Machine is defined over binary vectors $v, h \in \{0,1\}^d$ as

$$p(v,h) := \frac{\exp(-E(v,h))}{Z}$$

where E is the energy function

$$E(v,h) = -v^\top W h - b^\top v - c^\top h$$

with parameters $W \in \mathcal{R}^{d\times d}, b, c \in \mathcal{R}^d$, and Z is the partition function

$$Z = \sum_v \sum_h \exp(-E(v,h)).$$

For simplicity, assume that the dimension $d = 1$. Show that

$$p(h = 1|v) = \sigma(c + Wv)$$

where $\sigma(x) := \frac{1}{1+\exp(-x)}$ is the logistic function.
Comments: directly calculate $p(h = 1|v) = \frac{p(v,1)}{\sum_h p(v,h)}$; cancel out the common factors.

2. Deep learning has shown great performance in computer vision, speech recognition, and natural language processing. It has also shown its potential in planning and playing games. What will be another application that you think current deep learning techniques fit and why? What will be an application that you think current deep learning techniques do NOT fit and why?
Comments: "current deep learning techniques" mean the techniques that we learned so far, e.g., feedforward neural networks, convolution, autoencoder, recurrent neural networks, etc. The questions are more about your imagination, so think in the perspective of a user rather than a designer of deep learning systems. The second question is more difficult, since deep learning (even just the current deep learning techniques) still has a lot of potential to be discovered and the primary focus right now is on its advantages. So it is OK even if you answer "I don't know" to the second question, but it will be good to think ahead of the others.