Homework 11: Due Thur 11-08-2018
Total Points (42 pts)

1. (10 pts) (Maximum Log Likelihood) A bent coin is tossed a total of 30 times. Five of the 30 times the coin lands heads. Let p equal the probability that the coin lands heads, i.e. $\mathbb{P}(\text{H}) = p$. Determine the value of p by maximizing the log-likelihood function.

   Hint: Since the 30 coin tosses are independent events, the probability or likelihood of observing 5 heads and 25 tails is:

   $$\mathbb{P}(\text{H,H,T,}\ldots\text{,H}) = \mathbb{P}(H)^5\mathbb{P}(T)^{25} = p^5(1-p)^{25}.$$

   Determine the value of p that maximizes the logarithm of the above likelihood function.

2. (10 pts) Use Lagrange multipliers to determine the point on the line $y = -\frac{1}{2}x + 5$ in the first quadrant that is closest to the origin.

   Hint: Minimizing squared distance gives the same answer and is simpler than minimizing distance.

3. (10 pts) Print out and use the attached computational graph (page 2) to compute the gradient vector of the function

   $$y = f(x_1, x_2, x_3) = \frac{x_1x_2 + 10}{\sin(x_1 - x_3)}$$

   at the point $x_1 = \frac{\pi}{2},\ x_2 = \frac{4}{\pi},\ x_3 = \frac{\pi}{3}$.

4. (12 pts) Watch the video Nuts and Bolts of Applying Deep Learning by Andrew Ng (80 min).[1] (Read the questions below before watching the video.)

   Video Outline:
   - Major Deep Learning Trends
   - End-to-End Deep Learning
   - Bias/Variance Trade-off
   - Mismatch between training and testing set distributions.
   - Human Level Performance
   - Personal Advise

   (a) What is currently driving deep learning?

   (b) What is end-to-end deep learning? Describe an end-to-end deep learning system for self driving cars? What is the limitation of end-to-end deep learning?

   (c) Classical machine learning is about the trade-off between bias (under-fitting) and variance (over-fitting). How is deep learning changing this trade-off?

   (d) Why is it a bad idea to use a validation set (dev set) that has a different distribution than the test set?

   (e) Why is measuring human level performance for your problem useful?

   (f) Summarize Andrew Ng's personal advise on how to get started in machine learning research?

[1] https://www.youtube.com/watch?v=F1ka6a13S9I