

## LING570 Hw9: Math basics

Due: 11pm on Nov 29, 2018

A few notes about this assignment:

- This is an optional assignment. The total raw score is 50 points. If you choose to submit the assignment, your raw score divided by 50 will be added to the final percentage of your grades. For instance, if your raw score is 40 points and your final percentage without this assignment is 95%, your new final percentage will be  $(95 + 40/50)\% = 95.8\%$ .
- Some of the topics (e.g., Q5) should have been covered in your math classes at high school or college. For the topics that might not be familiar to you, I provide some urls but please feel free to google the topics and read other related pages.
- The answers to the questions should be pretty short. I leave some space for you to fill out the answers. I also make the latex file available in case you want to add the answers to the latex file directly. In that case, you need to run pdf2latex (or something like that) to generate pdf from the latex file.
- If you prefer to write formulas on paper (instead of typing them with latex or Word), it is ok. You just need to fill out the rest of the assignment, print out the file, insert formulas by hand, scan the paper, and then submit the scanned file via Canvas.
- Since no programming is required, you only need to submit a single file: pdf is highly preferred, but if you cannot convert your file to pdf, a jpeg file is ok.

**Q1 (8 points):** Logistic function: (see [https://en.wikipedia.org/wiki/Logistic\\_function](https://en.wikipedia.org/wiki/Logistic_function))

**1a (3 pts):** What's a logistic function? Write down the formula.

**1b (2 pts):** What is the standard logistic function? Write down the formula.

**1c (3 pts):** What is the derivative of the standard logistic function  $f(x)$ ? Write down the formula.

**Q2 (8 points):** Sigmoid function: See [https://en.wikipedia.org/wiki/Sigmoid\\_function](https://en.wikipedia.org/wiki/Sigmoid_function)

**2a (4 pts):** What is a sigmoid function? Write down the definition.

**2b (4 pts):** What is the relation between sigmoid function and logistic function?

**Q3 (8 points):** Tanh function: (see [https://en.wikipedia.org/wiki/Hyperbolic\\_function](https://en.wikipedia.org/wiki/Hyperbolic_function) and [https://en.wikipedia.org/wiki/Sigmoid\\_function](https://en.wikipedia.org/wiki/Sigmoid_function))

**3a (4 pts):** Write down the formula for the tanh function.

**3b (4 pts):** What is the relation between sigmoid function and tanh function?

**Q4 (8 points):** The softmax function:

**4a (4 pts):** What is the softmax function? Write down the formula.  
See [https://en.wikipedia.org/wiki/Softmax\\_function](https://en.wikipedia.org/wiki/Softmax_function)

**4b (4 pts):** If a vector  $x$  is  $[1, 2, 3]$ , what is the value of  $\text{softmax}(x)$ ?

**Q5 (18 points):** Matrix: see Sect 1-3 of [https://en.wikipedia.org/wiki/Matrix\\_\(mathematics\)](https://en.wikipedia.org/wiki/Matrix_(mathematics))

**5a (12 points):** Let  $A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$  and  $B = \begin{bmatrix} 2 \\ 1 \\ 3 \end{bmatrix}$

what is  $A \times B$ ?

what is  $B \times A$ ?

what is the transpose of A?

what is the tranpose of B?

what are the dimensions of B?

what are the dimensions of the transpose of B?

**5b (6 points):** Let  $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$  and  $B = \begin{bmatrix} 2 & 0 \\ 1 & 2 \end{bmatrix}$ .  
What is  $A \times B$ ?

what is  $B \times A$ ?

Is matrix multiplication communtative?

**Submission:** submit only one file named hw.pdf or hw.jpeg to Canvas.