

CSCI 416/516 Homework #4

DUE: April 17, 2026, at 11:59 pm

Submission: For all the problems excluding the multiple choice problem(s), you need to **show all your works, steps, and calculations** if applicable, or **your justification/expalantion to the answer(s) you provide**. You should submit a PDF to Blackboard with your answers that are recognizable/intelligible. Preferably, you should use L^AT_EX.

	Cloudy	Not Cloudy
Raining	50/100	2/100
Not Raining	20/100	28/100

- **Problem 1 [2pts]: Joint Entropy.**

Suppose $X = \{\text{Raining, Not raining}\}$, $Y = \{\text{Cloudy, Not Cloudy}\}$, give the above Table. What is the joint entropy, $H(X, Y)$? Show your work on how the conclusion is reached.

- **Problem 2 [2pts]: Specific Conditional Entropy.**

Following the setup from the previous question, what is the entropy of cloudiness Y , given that it is raining ($X = \text{Raining}$)? Show your work on how the conclusion is reached.

- **Problem 3 [2pts]: Information Gain.**

How is the Information Gain defined? What is its relation to entropy?

- **Problem 4 [2pts]: AdaBoost.**

Explain what this formula does, in the context of AdaBoost by answering: (1) what is this formula? (2) what does the part $y_i \log h_{\theta}(\mathbf{x}_i) + (1 - y_i) \log(1 - h_{\theta}(\mathbf{x}_i))$ do? (3) what does the part $\lambda \|\theta_{[1:d]}\|_2^2$ do? (4) What is the term $w_{i,t}$ and how does it affect $\mathcal{J}_{\text{reg},t}(\theta)$?

$$\mathcal{J}_{\text{reg},t}(\theta) = - \sum_{i=1}^n w_{i,t} [y_i \log h_{\theta}(\mathbf{x}_i) + (1 - y_i) \log(1 - h_{\theta}(\mathbf{x}_i))] + \lambda \|\theta_{[1:d]}\|_2^2 \quad (1)$$

- **Problem 5 [2pts]: Conditional Entropy.**

We define the Conditional Entropy as

$$H(Y|X) = \sum_{x \in X} p(x) H(Y|X = x) \quad (2)$$

and then claim that

$$H(Y|X) = - \sum_{x \in X} \sum_{y \in Y} p(x, y) \log_2 p(y|x) \quad (3)$$

Show the process/work that leads to the claim/conclusion.