Exercise 1: Logistic Regression, Softmax, Cross-Entropy

(a) What is the relationship between the softmax

$$\pi_i(\mathbf{x}) = \frac{\exp\{\boldsymbol{\theta}_i^T \mathbf{x}\}}{\sum_k \exp\{\boldsymbol{\theta}_k^T \mathbf{x}\}}$$

and the logistic function

$$\pi(\mathbf{x}) = \frac{1}{1 + \exp\{\boldsymbol{\theta}^T \mathbf{x}\}}$$

?

(b) Derive the negative log-likelihood of a softmax regression assuming that the outcome follows a multinomial distribution with g classes.