

Feel free to work with other students, but make sure you write up the homework and code on your own (no copying homework *or* code; no pair programming). Feel free to ask students or instructors for help debugging code or whatever else, though.

**1 (Murphy 2.16)** Suppose  $\theta \sim \text{Beta}(a, b)$  such that

$$\mathbb{P}(\theta; a, b) = \frac{1}{B(a, b)} \theta^{a-1} (1 - \theta)^{b-1} = \frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)} \theta^{a-1} (1 - \theta)^{b-1}$$

where  $B(a, b) = \Gamma(a)\Gamma(b)/\Gamma(a+b)$  is the Beta function and  $\Gamma(x)$  is the Gamma function. Derive the mean, mode, and variance of  $\theta$ .

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**2 (Murphy 9)** Show that the multinomial distribution

$$\text{Cat}(x|\boldsymbol{\mu}) = \prod_{k=1}^K \mu_k^{x_k}$$

is in the exponential family and show that the generalized linear model corresponding to this distribution is the same as multinomial logistic regression (softmax regression).

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