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Exercise: Discrete unknowns

(5/5 points)

Let Θ_1 and Θ_2 be some unobserved Bernoulli random variables and let \mathbf{X} be an observation. Conditional on $\mathbf{X} = \mathbf{x}$, the posterior joint PMF of Θ_1 and Θ_2 is given by

$$p_{\Theta_1, \Theta_2 | \mathbf{X}}(\theta_1, \theta_2 | \mathbf{x}) = \begin{cases} 0.26, & \text{if } \theta_1 = 0, \theta_2 = 0, \\ 0.26, & \text{if } \theta_1 = 0, \theta_2 = 1, \\ 0.21, & \text{if } \theta_1 = 1, \theta_2 = 0, \\ 0.27, & \text{if } \theta_1 = 1, \theta_2 = 1, \\ 0, & \text{otherwise.} \end{cases}$$

We can view this as a hypothesis testing problem where we choose between four alternative hypotheses: the four possible values of (Θ_1, Θ_2) .

a) What is the estimate of (Θ_1, Θ_2) provided by the MAP rule?



Answer: (1,1)

b) Once you calculate the estimate $(\hat{\theta}_1, \hat{\theta}_2)$ of (Θ_1, Θ_2) , you may report the first component, $\hat{\theta}_1$, as your estimate of Θ_1 . With this procedure, your estimate of Θ_1 will be



Answer: 1

c) What is the probability that Θ_1 is estimated incorrectly (the probability of error) when you use the procedure in part (b)?



Answer: 0.52

d) What is the MAP estimate of Θ_1 based on \mathbf{X} , that is, the one that maximizes $p_{\Theta_1 | \mathbf{X}}(\theta_1 | \mathbf{x})$?



Answer: 0

Unit overview

**Lec. 14:
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inference**Exercises 14 due Apr
06, 2016 at 23:59 UTC**Lec. 15: Linear
models with
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Solved problems

Additional
theoretical
material

Unit summary

e) The moral of this example is that an estimate of Θ_1 obtained by identifying the maximum of the joint PMF of all unknown random variables is

can be different from ▾



Answer: can be different from

the MAP estimate of Θ_1 .

Answer:

a) The posterior is largest when $(\theta_1, \theta_2) = (1, 1)$.

b) The corresponding estimate of Θ_1 is the first component of $(1, 1)$, which is **1**.

c) The probability of error is the posterior probability that $\Theta_1 = 0$, which is **$0.26 + 0.26 = 0.52$** .

d) The posterior PMF of Θ_1 is the marginal (posterior) PMF obtained from the joint posterior PMF:

$$p_{\Theta_1|X}(0 | x) = 0.26 + 0.26 = 0.52,$$

$$p_{\Theta_1|X}(1 | x) = 0.21 + 0.27 = 0.48.$$

Hence, the MAP estimate is $\hat{\theta}_1 = 0$.

e) These can be different, as illustrated by parts (b) and (d).

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