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Currently enrolled in **Audit Track** (expires December 25, 2019) Upgrade ($300)

2. Compute Total Variation Distance

(a)

3/3 points (graded)

Compute the total variation distance between

$$\mathbf{P} = X \quad \text{and} \quad \mathbf{Q} = X + c, \quad \text{where } X \sim \text{Ber}(p), p \in (0,1), \text{and } c \in \mathbb{R}.$$

(If applicable, enter **abs(x)** for $|x|$. Simplify your answer to have the minimum number of absolute signs possible.)

For $c \notin \{-1, 0, 1\}$:

$\text{TV}(\mathbf{P}, \mathbf{Q}) =$ 1 ✔

1

For $c = 0$:

$\mathrm{TV}(\mathbf{P},\mathbf{Q}) =$ 0 ✔

0

For $c = 1$ or $c = -1$:

$\mathrm{TV}(\mathbf{P},\mathbf{Q}) =$ (1+abs(1-2*p))/2 ✔

$\frac{1+\mathrm{abs}(1-2\cdot p)}{2}$

STANDARD NOTATION

Submit You have used 1 of 2 attempts

✔ Correct (3/3 points)

(b)

2/2 points (graded)

Compute the total variation distance between

$$\mathbf{P} = \mathrm{Ber}(p) \quad \text{and} \quad \mathbf{Q} = \mathrm{Ber}(q), \quad \text{where } p, q \in [0,1].$$

(If applicable, enter **abs(x)** for $|x|$.)

$\mathrm{TV}(\mathbf{P},\mathbf{Q}) =$ abs(p-q) ✔

$\mathrm{abs}(p-q)$

Let $X_1, \ldots, X_n$ be n i.i.d. Bernoulli random variables with some parameter $p \in [0,1]$, and $\bar{X}_n$ be their empirical average. Consider the total variation distance $\mathsf{TV}\left(\mathsf{Ber}\left(\bar{X}_n\right), \mathsf{Ber}\left(p\right)\right)$between $\mathsf{Ber}\left(\bar{X}_n\right)$ and $\mathsf{Ber}\left(p\right)$ as a function of the random variable $\bar{X}_n$, and hence a random variable itself. Does $\mathsf{TV}\left(\mathsf{Ber}\left(\bar{X}_n\right), \mathsf{Ber}\left(p\right)\right)$ necessarily converge in probability to a constant? If yes, enter the constant below; if not; enter DNE.

$\mathsf{TV}\left(\mathsf{Ber}\left(\bar{X}_n\right), \mathsf{Ber}\left(p\right)\right) \xrightarrow[n\to\infty]{(\mathbf{P})}$ 0 ✔

0

STANDARD NOTATION

Submit You have used 1 of 2 attempts

✔ Correct (2/2 points)

(c)

1/1 point (graded)

Compute the total variation distance between

$$P = \mathsf{Unif}\left([0,s]\right) \quad \text{and} \quad Q = \mathsf{Unif}\left([0,t]\right), \quad \text{where } 0 < s < t.$$

$\mathsf{TV}\left(\mathbf{P}, \mathbf{Q}\right) =$ 1-s/t ✔

$1 - \frac{s}{t}$

STANDARD NOTATION

Submit You have used 1 of 2 attempts

✔ Correct (1/1 point)

(d)

1/1 point (graded)

Let $X \sim N(\mu, \sigma^2)$ and $Y \sim \text{Ber}(p)$. Compute the total variation distance between the distributions of $\text{sign}(X)$ and $Y - 1$. Note that $\text{sign}(X)$ is a function of the random variable with

$$\text{sign}(X) = \begin{cases} 1 & \text{if } X > 0 \\ 0 & \text{if } X = 0 \\ -1 & \text{if } X < 0. \end{cases}$$

(If applicable, enter **abs(x)** for $|x|$, **Phi(x)** for $\Phi(x) = \mathbf{P}(Z \leq x)$ where $Z \sim \mathcal{N}(0,1)$, and **q(alpha)** for q_α, the $1-\alpha$ -quantile of a standard normal distribution, e.g. enter **q(0.01)** for $q_{0.01}$.)

$\text{TV}(\text{sign}(X), Y - 1) =$ (p+1-Phi(-mu/sigma))/2 + abs(p-1+Phi(-mu/sigma))/2 ✔

STANDARD NOTATION

Submit You have used 2 of 3 attempts

✔ Correct (1/1 point)

(e)

1/1 point (graded)

Compute the total variation distance between

$$\mathbf{P} = \text{Ber}(p) \quad \text{and} \quad \mathbf{Q} = \text{Poiss}(p), \quad \text{where } p \in (0,1).$$

$\mathrm{TV}(\mathbf{P},\mathbf{Q}) =$ p-p*e^(-p) ✔

$p - p \cdot e^{-p}$

STANDARD NOTATION

Submit You have used 1 of 2 attempts

✔ Correct (1/1 point)

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Topic: Unit 3 Methods of Estimation:Homework 4: TV distance, KL-Divergence, and Introduction to MLE / 2. Compute Total Variation Distance

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Not getting why I got Part (d) not accepted

discussion posted 21 minutes ago by **sandipan_dey**

I got my answer as $(1/4 + p/2) + |1/4 - p/2|$ for Part (d), but it's not accepted by the grader, any hint in terms of whether I am in the right direction? thank you very much in advance. It can also be written as $max\,(1/2, p)$ but I think it will again get rejected by the grader.

[EDIT] my bad, i wrongly assumed $X \sim N(0,1)$. Now it got accepted.

This post is visible to everyone.

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