2019-2 Machine Learning Homework #3

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(Deadline : December 15)

1. Calculate entropy of X:

$$X = \begin{cases} a & \text{with probability } \frac{1}{2} \\ b & \text{with probability } \frac{1}{4} \\ c & \text{with probability } \frac{1}{8} \\ d & \text{with probability } \frac{1}{8} \end{cases}$$

2. Let $X = \{0, 1\}$. And, for two distributions P and Q on X, let $P(0) = 1 - a$, $P(1) = a$, $Q(0) = 1 - b$, and $Q(1) = b$.

   Show Kullback-Leibler divergence $KLD(P||Q)$ and $KLD(Q||P)$ in terms of a and b.

   What are the values of $KLD(P||Q)$ and $KLD(Q||P)$ when $a = \frac{1}{2}$ and $b = \frac{1}{4}$?

3. Let $X = \{0, 1\}$. And, for two distributions P and Q on X, let $P(0) = 1 - a$, $P(1) = a$, $Q(0) = 1 - b$, and $Q(1) = b$.

   Show cross entropy of P and Q in terms of a and b, where P is the distribution from neural network and Q is the distribution from the training data.

   What are the value of the cross entropy when $a = \frac{1}{2}$ and $b = \frac{1}{4}$?

4. Let $X = \{0, 1\}$. And, for two distributions P and Q on X, let $P(0) = 1 - a$, $P(1) = a$, $Q(0) = 1 - b$, and $Q(1) = b$.

   Show Jensen-Shannon divergence $JSD(P, Q)$ in terms of a and b.

   What are the value of $JSD(P, Q)$ when $a = \frac{1}{2}$ and $b = \frac{1}{4}$.

5. Let $X = \{0, 1\}$. And, for three distributions P, Q, R on X, let $P(0) = 1 - a$, $P(1) = a$, $Q(0) = 1 - b$, $Q(1) = b$, $R(0) = 1 - c$, and $R(1) = c$.

   Show Jensen-Shannon divergence $JSD(P, Q, R)$ in terms of a, b and c.

   What are the value of $JSD(P, Q, R)$ when $a = \frac{1}{2}$, $b = \frac{1}{3}$ and $c = \frac{1}{4}$.

6. Let (X, Y) have the following joint distribution:

Y \ X	1	2	3	4
1	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{32}$
2	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{32}$	$\frac{1}{32}$
3	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{16}$
4	$\frac{1}{4}$	0	0	0

   Calculate the mutual information $I(X; Y)$.

7. Using R, Train an Auxiliary Classifier Generative Adversarial Network (ACGAN) or DC-GAN on the following datasets.

(a) MNIST dataset
`http://yann.lecun.com/exdb/mnist/`

(b) Fashion MNIST datasets
`https://github.com/zalandoresearch/fashion-mnist`

For ACGAN or DCGAN in R, you may use the following implementation.

`https://tensorflow.rstudio.com/keras/articles/examples/mnist_acgan.html`
or
`https://blogs.rstudio.com/tensorflow/posts/2018-08-26-eager-dcgan/`

Write a detailed report (including the summary of analyzed files). One example report is as follows:

`https://github.com/mari-linhares/DeepLearning/tree/master/GAN-fashion-MNIST`

You have to save the trained model and provide a way to run the model for inference.

Github is recommended for project related files, instead of emailing zip files.

8. Using Python, Train conditional Generative Adversarial Networks (cGAN) or conditional Deep Convolutional Generative Adversarial Networks (cDCGAN) for the following datasets.

(a) MNIST dataset
`http://yann.lecun.com/exdb/mnist/`

(b) Fashion MNIST datasets
`https://github.com/zalandoresearch/fashion-mnist`

For cGAN or cDCGAN in Python, you may use the following Tensorflow implementation.

`https://github.com/znxlwm/tensorflow-MNIST-cGAN-cDCGAN`

Write a detailed report (including the summary of analyzed files). One example report is as follows:

`https://github.com/mari-linhares/DeepLearning/tree/master/GAN-fashion-MNIST`

You have to save the trained model and provide a way to run the model for inference.

Github is recommended for project related files, instead of emailing zip files.