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Artificial Intelligence
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Homework 2

2.1

This problem was pretty straightforward. All that has to be done is using the equation given, is plug in the correct values and then solve for N.

Homework 2

2.1) $\delta = 0.03$

$\varepsilon \le 0.05$

$\varepsilon(M, N, \delta) = \sqrt{\frac{1}{2N}\ln\left(\frac{2M}{\delta}\right)}$

a) $M = 1$

$\varepsilon = \sqrt{\frac{1}{2N}\ln\left(\frac{2(1)}{0.03}\right)}$

$\varepsilon = \sqrt{\frac{1}{2N}\ln\left(\frac{2}{0.03}\right)}$

$(0.05)^2 = \left(\sqrt{\frac{1}{2N}(4.199)}\right)^2$

$0.0025 = \frac{1}{2N}(4.199)$

$2N(0.0025) = 4.199$

$\frac{0.005N}{0.005} = \frac{4.199}{0.005}$

$\boxed{N \ge 839.8}$

For the first scenario we have M as 1. This would mean that we would need at least 839.8 data samples to get the confidence we want.

b) $\varepsilon \le \sqrt{\frac{1}{2N}\ln\left(\frac{2M}{1}\right)}$

$0.05 \le \sqrt{\frac{1}{2N}\ln\left(\frac{200}{0.03}\right)}$

$(0.05)^2 \le \left(\sqrt{\frac{1}{2N}(8.805)}\right)^2$

$0.0025 \le \frac{1}{2N} 8.805$

$0.005N \ge 8.805$

$\boxed{N \ge 1761}$

For the second scenario we have an M as 100. This means that we would need at least 1761 data samples to get the confidence we want.

c) $\varepsilon \le \sqrt{\frac{1}{2N}\ln\left(\frac{2M}{\delta}\right)}$

$0.05 \le \sqrt{\frac{1}{2N}\ln\left(\frac{20{,}000}{0.03}\right)}$

$(0.05)^2 \le \left(\sqrt{\frac{1}{2N}\, 13.41}\right)^2$

$0.0025 \le \frac{1}{2N}\, 13.41$

$0.005N \le 13.41$

$\boxed{N \ge 2682}$

For the third scenario M was set to 10,000. This means that we would need at least 2682 data samples for the desired confidence.

2.11

This problem is similar to the first one. We are given an equation and values to plug in to solve for a variable. In this case we are estimating the expected output error.

2.11

$E_{out} \le E_{in} + \sqrt{\frac{8}{N}\ln\frac{4m_H(2N)}{\delta}}$

$N = 100$

$E_{in} = 0.1$

$\delta = 1$

$E_{out} \le 0.1 + \sqrt{\frac{8}{100}\ln\frac{4(2N+2)}{1}}$

$E_{out} \le 0.1 + \sqrt{\frac{8}{100}\ln(808)}$

$\le 0.1 + \sqrt{\frac{8}{100}(6.695)}$

$E_{out} \le 0.1 + \sqrt{0.536}$

$0.1 + 0.732$

$\boxed{E_{out} \le 0.832}$

In this scenario our N (sample size) is 100. The equation would provide us with an expected error output of no more than 0.832.

$$0.1 + 0.732$$

$$\boxed{E_{out} \leq 0.832}$$

$$E_{out} \leq E_{in} + \sqrt{\frac{8}{N} \ln\left(\frac{4 m_H(2N)}{\delta}\right)}$$

$N = 10{,}000$
$E_{in} = 0.1$
$\delta = 1$

$$0.1 + \sqrt{\frac{8}{10{,}000} \ln \frac{(4(2(10{,}000)+2))}{1}}$$

$$0.1 + \sqrt{\frac{8}{10{,}000} \ln(80008)}$$

$$0.1 + \sqrt{\left(\frac{8}{10{,}000}\right)(11.289)}$$

$$0.1 + \sqrt{0.009}$$

$$0.1 + 0.095$$

$$\boxed{E_{out} \leq 0.195}$$

In this scenario our N (sample size) is 10,000. The equation would provide us with an expected error output of no more than 0.195. Increasing our sample size seems to reduce the expected error output.

2.12

For this problem we are trying to estimate the sample size need to acquire the confidence we need.

2.12 $N \geq \frac{8}{\epsilon^2} \ln\left(\frac{4((2N)^{d_{vc}}+1)}{\delta}\right)$

$\epsilon = 0.05$
$\delta = 0.05$
$d_{vc} = 10$

$$N \geq \frac{8}{(0.05)^2} \ln\left(\frac{4((2N)^{10}+1)}{\delta}\right)$$

$$N \geq \frac{8}{(0.05)^2} \ln\left(\frac{4((2000)^{10}+1)}{0.05}\right)$$

$$\boxed{N \geq 2.62 \times 10^{38}}$$

Using 1000, as the book recommends for a starting guess. This provides use with an estimated sample size of 2.62 x 10^{38}. This is a large sample size most likely occurs from d_{vc} being 10.