Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

$P(+) = 0.95 \times 0.01 + 0.05 \times 0.99 = 0.059$

$P(\text{ill} \mid +) = 0.0095/0.059$

$\approx \mathbf{0.161}$

2.2

in 1000 people about 10 are ill and 9–10 of them test positive, but about 50 of the 990 healthy people also test positive

so only about 1 positive in 6 is really ill: a positive means “test again”, not “ill”

2.3

spam: $0.4 \times 0.3 \times 0.5 = 0.06$

ham: $0.6 \times 0.01 \times 0.1 = 0.0006$

spam, with $P = 0.06/0.0606 \approx \mathbf{0.99}$

2.4

network: $1 + 2 + 2 + 2 = \mathbf{7}$

full joint: $2^4 - 1 = \mathbf{15}$

3.1

(a) $0.8 \times 0.3 + 0.1 \times 0.7 = \mathbf{0.31}$

(b) $0.6 \times 0.31 + 0.05 \times 0.69 = 0.186 + 0.0345 = \mathbf{0.2205}$

(c) $0.49 \times 0.3/0.2205 \approx \mathbf{0.667}$

(d) a complaint is evidence of a delay, which is evidence of a storm, so belief in the storm goes up

3.2

(a) $0/300 = 0$: any ham message with “winner” gets probability 0 for ham, whatever its other words say

(b) $(0 + 1)/(300 + 2) \approx \mathbf{0.0033}$

(c) it assumes the words are independent given the class, which is rarely true

3.3

(a) 80 have it: $0.9 \times 80 = \mathbf{72}$ true positives; $0.08 \times 1920 \approx \mathbf{154}$ false positives

(b) $72/(72 + 154) \approx \mathbf{0.32}$

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(c) false positive: worry and labels for students who are fine; false negative: 8 students miss help

(d) use it as a first screen only; every positive gets a full assessment by a specialist before any label or plan, and results stay private