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CSC_5RO11_TA, AI for Robotics

TP6, Medical Diagnosis

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1. Bayesian Network Model

The Bayesian network consists of variables and their probabilistic dependencies. Based on the information given, we can define the following variables:

Probability	Complementary Probability
$P(\mathbf{VA} = 1) = 0.10$	$P(\mathbf{VA} = 0) = 0.90$
$P(\mathbf{S} = 1) = 0.30$	$P(\mathbf{S} = 0) = 0.70$
$P(\mathbf{VA} = 1 \mid \mathbf{T} = 1) = 0.10$	$P(\mathbf{VA} = 1 \mid \mathbf{T} = 0) = 0.90$
$P(\mathbf{VA} = 0 \mid \mathbf{T} = 1) = 0.01$	$P(\mathbf{VA} = 0 \mid \mathbf{T} = 0) = 0.99$
$P(\mathbf{S} = 1 \mid \mathbf{C} = 1) = 0.20$	$P(\mathbf{S} = 1 \mid \mathbf{C} = 0) = 0.80$
$P(\mathbf{S} = 0 \mid \mathbf{C} = 1) = 0.02$	$P(\mathbf{S} = 0 \mid \mathbf{C} = 0) = 0.98$
$P(\mathbf{S} = 1 \mid \mathbf{B} = 1) = 0.40$	$P(\mathbf{S} = 1 \mid \mathbf{B} = 0) = 0.60$
$P(\mathbf{S} = 0 \mid \mathbf{B} = 1) = 0.80$	$P(\mathbf{S} = 0 \mid \mathbf{B} = 0) = 0.20$
$P(\mathbf{ST} = 1 \mid \mathbf{B} = 1 \cup \mathbf{C} = 1) = 0.60$	-
$P(\mathbf{ST} = 0 \mid \mathbf{B} = 0 \cap \mathbf{C} = 0) = 0.99$	-
$P(\mathbf{XR} = 1 \mid \mathbf{T} = 1 \cup \mathbf{C} = 1) = 0.70$	-
$P(\mathbf{XR} = 0 \mid \mathbf{T} = 0 \cap \mathbf{C} = 0) = 0.98$	-

Table 1.1: Bayesian Network Model

With:

1. **B**: Bronchitis;
2. **C**: Cancer;
3. **S**: Smoke;
4. **ST**: Stethoscope;
5. **T**: Tuberculosis;
6. **VA**: Visit Asia;
7. **XR**: X-Ray;

2. Disease Inferation

If a patient did not visited Asia and does not smoke, then: $\mathbf{VA} = 0$ and $\mathbf{S} = 0$. Therefore:

1. for **Bronchitis**: $P(\mathbf{S} = 0 \mid \mathbf{B} = 1) = 0.80$;
2. for **Cancer**: $P(\mathbf{S} = 0 \mid \mathbf{C} = 1) = 0.02$;
3. for **Tuberculosis**: $P(\mathbf{VA} = 0 \mid \mathbf{T} = 1) = 0.01$;

Thus, **Bronchitis** is most likely.

3. Auscultate Examen

Given the Bayesian inference, Bronchitis is the most likely disease for this patient. The doctor may choose to auscultate the patient's lungs with a stethoscope because bronchitis can be detected through this test, and the patient is more likely to have it than any other disease. Therefore:

1. examen positive for **Bronchitis**: $P(\mathbf{ST} = 1 \mid \mathbf{B} = 1 \cup \mathbf{C} = 1) = 0.60$;
2. examen negative for **No Disease**: $P(\mathbf{ST} = 0 \mid \mathbf{B} = 0 \cap \mathbf{C} = 0) = 0.99$;

Thus, the decision is made based on the patient's likelihood of having bronchitis.

Given that the stethoscope test is negative, we need to update our inference. If the test shows a negative result and the patient has bronchitis, the likelihood of the patient having no disease becomes higher. This is because the negative stethoscope result would indicate that bronchitis or lung cancer is unlikely. Therefore:

1. examen negative for **No Disease**: $P(\mathbf{ST} = 0 \mid \mathbf{B} = 0 \cap \mathbf{C} = 0) = 0.99$;
2. revised diagnosis;

The most likely condition after a negative stethoscope test would be that the patient has no disease, assuming other symptoms and tests are not indicating otherwise.

4. X-ray Examen

Given that the X-ray is positive, the possibility of tuberculosis or cancer becomes more likely, as the test is designed to detect these diseases:

1. if the X-ray is positive, then the probabilities for **Tuberculosis** and **Cancer** should be updated using Bayes' theorem.

Given that the X-ray test has a sensitivity of 70%, a positive result increases the probability of either **Cancer** or **Tuberculosis**, so these diseases are now more likely than before.

5. X-ray Examen Analysis

The X-ray test was likely needed because the stethoscope test was negative, and the X-ray provides additional information, particularly for **Tuberculosis** and **Cancer**. The negative stethoscope result would have made the doctor less confident about the diagnosis, and the X-ray provided a way to rule out or confirm **Tuberculosis** or **Cancer**.

Thus, based on the process of diagnostic reasoning and the updated probabilities after each test, the X-ray was an important diagnostic tool.