Advanced Artificial Intelligence Revision

Inference Using Full Joint Distribution

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *toothache* | | *¬toothache* | |
|  | *catch* | *¬catch* | *catch* | *¬catch* |
| *cavity* | 0.108 | 0.012 | 0.072 | 0.008 |
| *¬cavity* | 0.016 | 0.064 | 0.144 | 0.576 |
| A full joint distribution for *toothache, cavity, catch* world. | | | | |

**Probabilistic inference** is a computation from observed evidence of **posterior probabilities** for **query propositions**. One task involved for accomplishing this is to extract the distribution over a subset of variables or a single variable, hence one way to do this is through **marginal probability**.

**Marginalisation/Summing Out** - posterior probabilities are summed out, therefore providing the following general **marginalisation rule**:

Otherwise can be described as, a distribution over **Y** can be calculated by summing out the posterior probabilities from any joint distribution which contains **Y**.

This rule can also be applied through **conditional probabilities** instead of **joint probabilities**.

This rule is known as **conditioning**. **Marginalisation** and **conditioning** are useful for all kinds of derivations involving probability expressions. In most cases, computation of **conditional****probabilities** of some variables given others is preferred.

**Conditional probabilities** can be found by first calculating the **product rule** to obtain an expression in terms of **unconditional probabilities** and then evaluating the expression from the **full joint distribution**.

For example, the probability of a cavity given evidence of a toothache can be calculated like the following:

To check, the **complement** of this rule would also be calculated to check the validity of the results. The results of which should add to 1.0. Otherwise, a **normalisation** **constant** may be required.

This can also be written with a **normalisation** **constant** α, to ensure that the final probabilities will sum to 1.0. The previous equation can be rewritten with a normalisation constant like the following:

*Where* ***X*** *== the query variable; cavity,* ***E*** *== set of observed evidence variables; toothache,* ***Y*** *== remaining unobserved variables; catch.*

For example: