# CS1675 - Assignment 8

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# I. Problem 1 - Bayesian Belief Networks

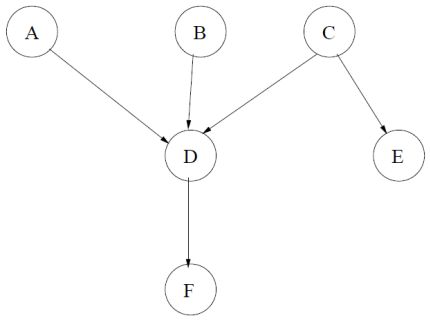


Figure 1: BBN

## a. Blind Solution

(1) P(B=T, E=T)

$$P(B=T,E=T) = \sum_{a\in T,F}\sum_{c\in T,F}\sum_{d\in T,F,X}\sum_{f\in T,F} P(A=a,B=T,C=c,D=d,E=T,F=f)$$
$$= \sum_{a\in T,F}\sum_{c\in T,F}\sum_{d\in T,F,X}\sum_{f\in T,F} P(F=f|D=d)P(D=d|A=a,B=T,C=c)*$$
$$P(E=T|C=c)P(A=a)P(B=T)P(C=c)$$

Computational Cost:

| | | |
|---|---|---|
| **Num. Additions** | $(3)(2^3)-1$ | 23 |
| **Num. Products** | $[(3)(2^3)][(6-1)]$ | 120 |

(2) Full Joint Distribution

$$P = \sum_{a\in T,F}\sum_{b\in T,F}\sum_{c\in T,F}\sum_{d\in T,F,X}\sum_{e\in T,F}\sum_{f\in T,F} P(A=a,B=b,C=c,D=d,E=e,F=f)$$
$$= \sum_{a\in T,F}\sum_{b\in T,F}\sum_{c\in T,F}\sum_{d\in T,F,X}\sum_{e\in T,F}\sum_{f\in T,F} P(F=f|D=d)P(D=d|A=a,B=b,C=c)*$$
$$P(E=e|C=c)P(A=a)P(B=b)P(C=c)$$

Computational Cost:

| | | |
|---|---|---|
| **Num. Additions** | $(3)(2^5)-1$ | 95 |
| **Num. Products** | $[(3)(2^5)][(6-1)]$ | 480 |

### b. Efficient Solution

(1) P(B=T, E=T)

$$P(B=T,E=T) = P(B=T)\sum_{a\in T,F} P(A=a)\sum_{c\in T,F} P(E=T|C=c)P(C=c)* \sum_{d\in T,F,X} P(D=d|A=a,B=T,C=c)\sum_{f\in T,F} P(F=f|D=d)$$

Computational Cost:

| | |
|---|---|
| **Num. Additions** | 9 |
| **Num. Products** | 16 |

Given the reduction in computation complexity and cost for the efficient solution, this approach is much more desirable than the blind solution.

## II. Problem 2 - Pneumonia Diagnosis

### a. ML Estimation

| | **T** | **F** |
|---|---|---|
| **Fever** | 0.9 | 0.1 |
| **Paleness** | 0.7 | 0.3 |
| **Cough** | 0.9 | 0.1 |
| **HighWBCcount** | 0.8 | 0.2 |

Table 1: $P(Parameters \mid Pneumonia = T)$

| | **T** | **F** |
|---|---|---|
| **Fever** | 0.6 | 0.4 |
| **Paleness** | 0.5 | 0.5 |
| **Cough** | 0.1 | 0.9 |
| **HighWBCcount** | 0.5 | 0.5 |

Table 2: $P(Parameters \mid Pneumonia = F)$

### b. Fever, !Paleness, Cough, !HighWBCcount

$P(Pneumonia = T|Fever = T, Paleness = F, Cough = T, HighWBCcount = F) = 0.2351$

### c. Fever, ?Paleness, Cough, ?HighWBCcount

$P(Pneumonia = T|Fever = T, Cough = T) = 0.0539$

## d. Current Symptoms

`main7_2inference.m`