LECTURE EIGHT

① PROBABILISTIC PROGRAMMING USING PyMC

② GRAPHICAL MODELS

Example

Overweight

Smoking

Heart Disease

Cough

Model:

Overweight $\sim$ Bernoulli (0.1)

Smoking $\sim$ Bernoulli (0.1)

Heart Disease $\Big|$ Overweight $=1$, Smoking $=1$

$\sim$ Bernoulli (0.75)

Heart Disease $\Big|$ overwegh $=1$, smoking $=0$

$\sim$ Bernoulli (0.5)

Heart $\Big|$ overweight $=0$, smoking $=1$ $\sim$ Bernoulli (0.4)

Heart | overweight = 0, Smoking = 0 ~ Bernoulli (0.1)

(Cough)

Cough | Smoking = 1 ~ Bernoulli (0.6)
Cough | Smoking = 0 ~ Bernoulli (0.05)

① Marginal Distribution of Heart Disease.

P(Heart Disease = 1)

② Overweight | Heart Disease

$$P\left(\text{overweight} = 1 \middle| \begin{array}{c} \text{Heart Disease} \\ = 1 \end{array}\right)$$

③ P(smoking = 1 | cough = 1)

P(Heart Disease = 1)

$= P(H=1 | O=1, S=1) \; P(O=1, S=1)$
$+ P(H=1 | O=1, S=0) \; P(O=1, S=0)$
$+ P(H=1 | O=0, S=1) \; P(O=0, S=1)$
$+ P(H=1 | O=0, S=0) \; P(O=0, S=0)$

$= 0.75 \times 0.1 \times 0.1$
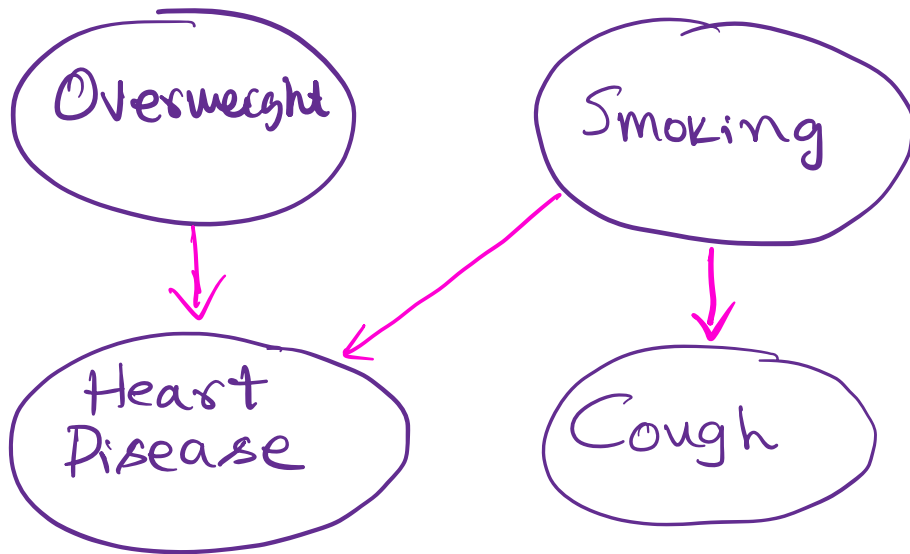$+ 0.5 \times 0.1 \times 0.9$
$+ \cdots$

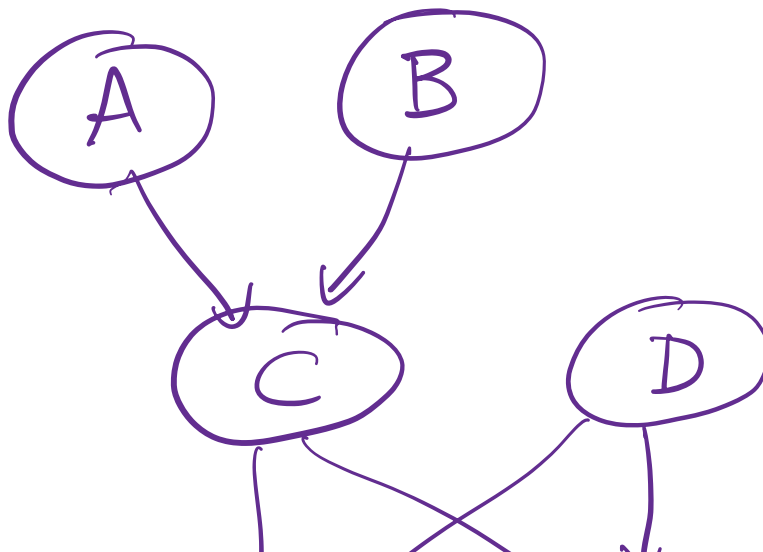# GRAPHICAL MODELS

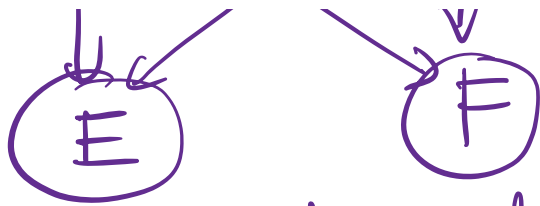PROBABILITY: (Overweight
MODEL   Smoking
            Heart Disease
            Cough)

Another Graphical Model

1. A, B, D independent ✓

2. E & F are independent ✗

3. E & F are conditionally independent given C & D

4. C and D are conditionally independent given E. ✗

5. A & B are conditionally independent given E.

KIDNEY CANCER

$$a \sim \text{Unif}(0, 50), \quad b \sim \text{Unif}(0, 200000)$$

$$\theta_i \sim \text{Beta}(a, b)$$

$$X_i \mid \theta_i \sim \text{Bin}(n_i, \theta_i)$$