Q1) $x_1 \rightarrow x_3 \leftarrow x_2$

Is $x_1 \perp\!\!\!\perp x_2 \mid x_3$?

$$p(x_1, x_2 \mid x_3) = \frac{p(x_1, x_2, x_3)}{p(x_3)} = \frac{p(x_1)\, p(x_2)\, p(x_3 \mid x_1, x_2)}{p(x_3)}$$

$$\neq p(x_1 \mid x_3)\, p(x_2 \mid x_2)$$

so $\underline{\underline{x_1 \not\perp\!\!\!\perp x_2 \mid x_3}}$

Q15) Part 1) 1) F ∈ {Printer doesn't work, printer works} failure

C ∈ {driver is corrupt, driver is not corrupt} driver corruptness

P ∈ {printer is not plugged to computer, plugged} printer computer disconnection

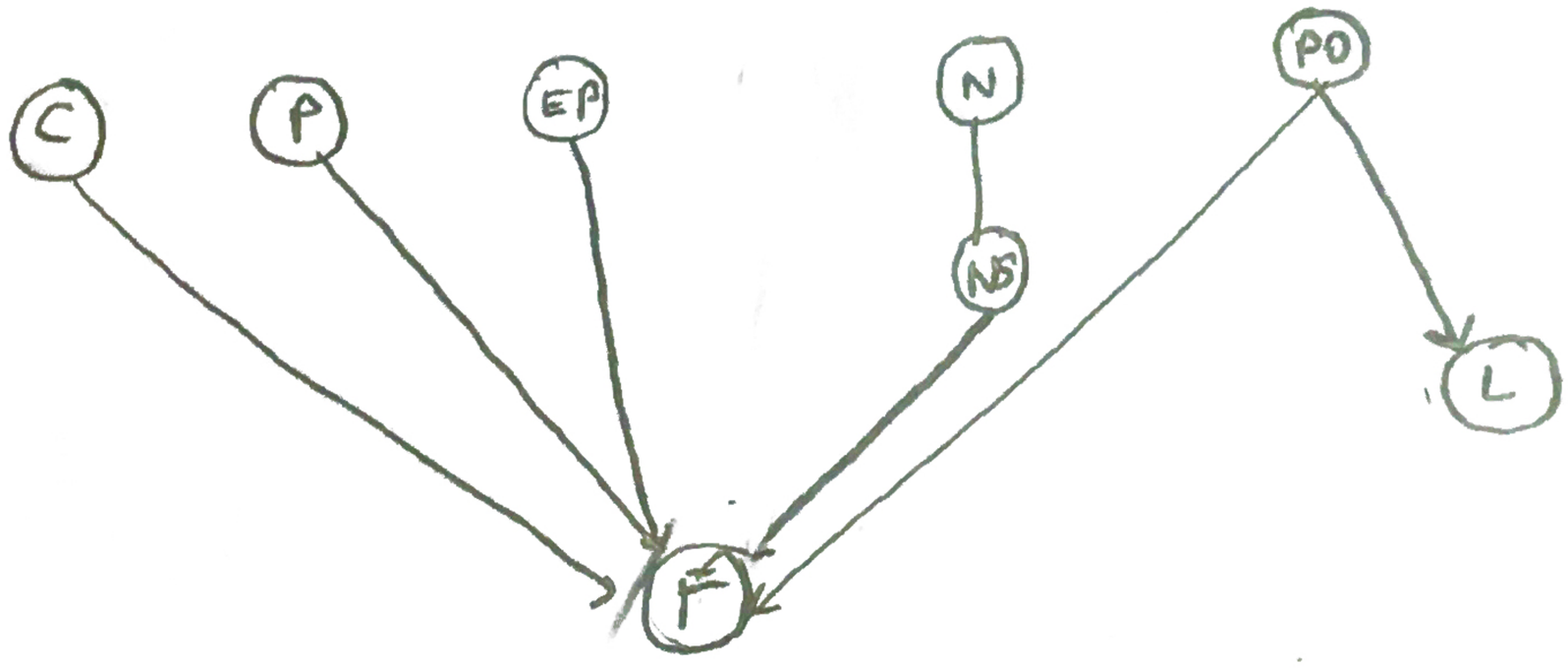
EP ∈ {not enough paper, enough paper} inadequate paper

N ∈ {printer is network printer, or not} network printer

NS ∈ {problem with network software, no problem with network software} network software problem

PO ∈ {there is no power, there is power} no power

L ∈ {no light, there is light} no light



$F \sim P(F \mid C, P, EP, NS, PO)$

$C \sim P(C)$

$P \sim P(P)$

$EP \sim P(EP)$

$NS \sim P(NS \mid N)$

$PO \sim P(PO)$

$L \sim P(L \mid PO)$

$N \sim P(N)$

$$P(C, P, EP, F, N, NS, PO, L) = P(F \mid C, P, EP, NS, PO)\, P(C)\, P(P)\, P(EP)\, P(NS \mid N)\, P(N)\, P(PO)\, P(L \mid PO)$$

$$P(F) = \sum_C \sum_P \sum_{EP} \sum_{NS} \sum_{PO} P(F \mid C, P, EP, NS, PO)\, P(P)\, P(EP)\, P(C)\, P(PO) \sum_N P(NS \mid N)\, P(N) \sum_L P(L \mid PO)$$

Part 2) a) Random Variables:

$T \in \{ \text{Science}, \text{Art} \}$ type

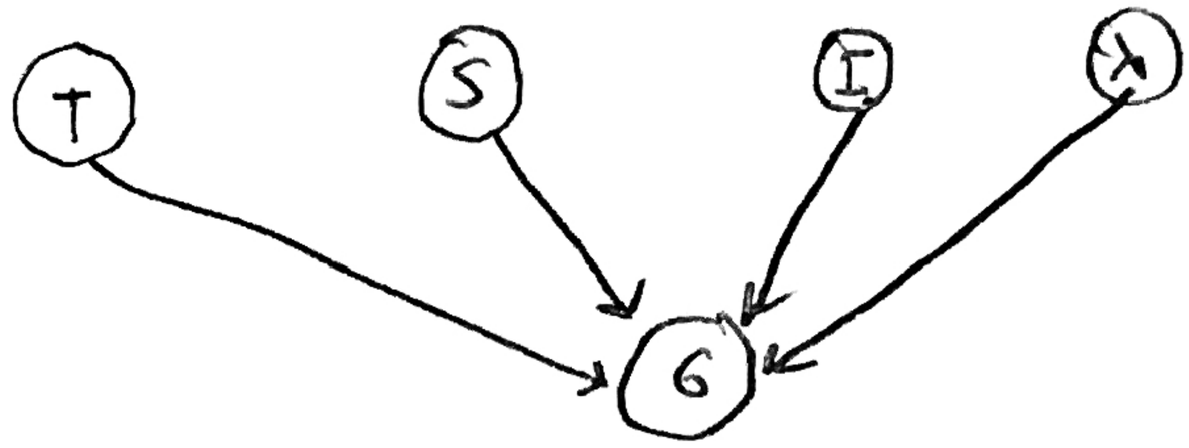
$S \in \{ \text{Sporty}, \text{Not sporty} \}$ Sporty

$I \in \{ \text{Ill}, \text{Not Ill} \}$ Health

G Grade

λ Parameter for the subject

b) The graph for each student, each subject & exam number:



Indicies; $i \in \{1, \ldots 200\}$ student

$s \in \{ \text{Sports}, \text{Maths}, \text{History} \}$ subject

$e \in \{1, 2\}$ exam

$G_{i,s,e} \sim p(G_{i,s,e} \mid I_{i,s,e}, T_i, S_i, \lambda_s)$

$I_{i,s,e} \sim p(I_{i,s,e})$

$T_i \sim p(T_i)$

$S_i \sim p(S_i)$

$\lambda_s \sim p(\lambda_s)$

c) $p(G, I, T, S, \lambda) = \prod_{i,s,e} p(G_{i,s,e} \mid I_{i,s,e}, T_i, S_i, \lambda_s)\, p(I_{i,s,e}) \prod_i p(T_i) \prod_s p(S_i) \prod_s p(\lambda_s)$

$$p(G, \lambda) = \sum_{T_1 \ldots T_{200}} \sum_{S_1, \ldots S_{200}} \sum_{I_{1 \ldots 200, s, mh, 12}} p(G, I, T, S, \lambda)$$