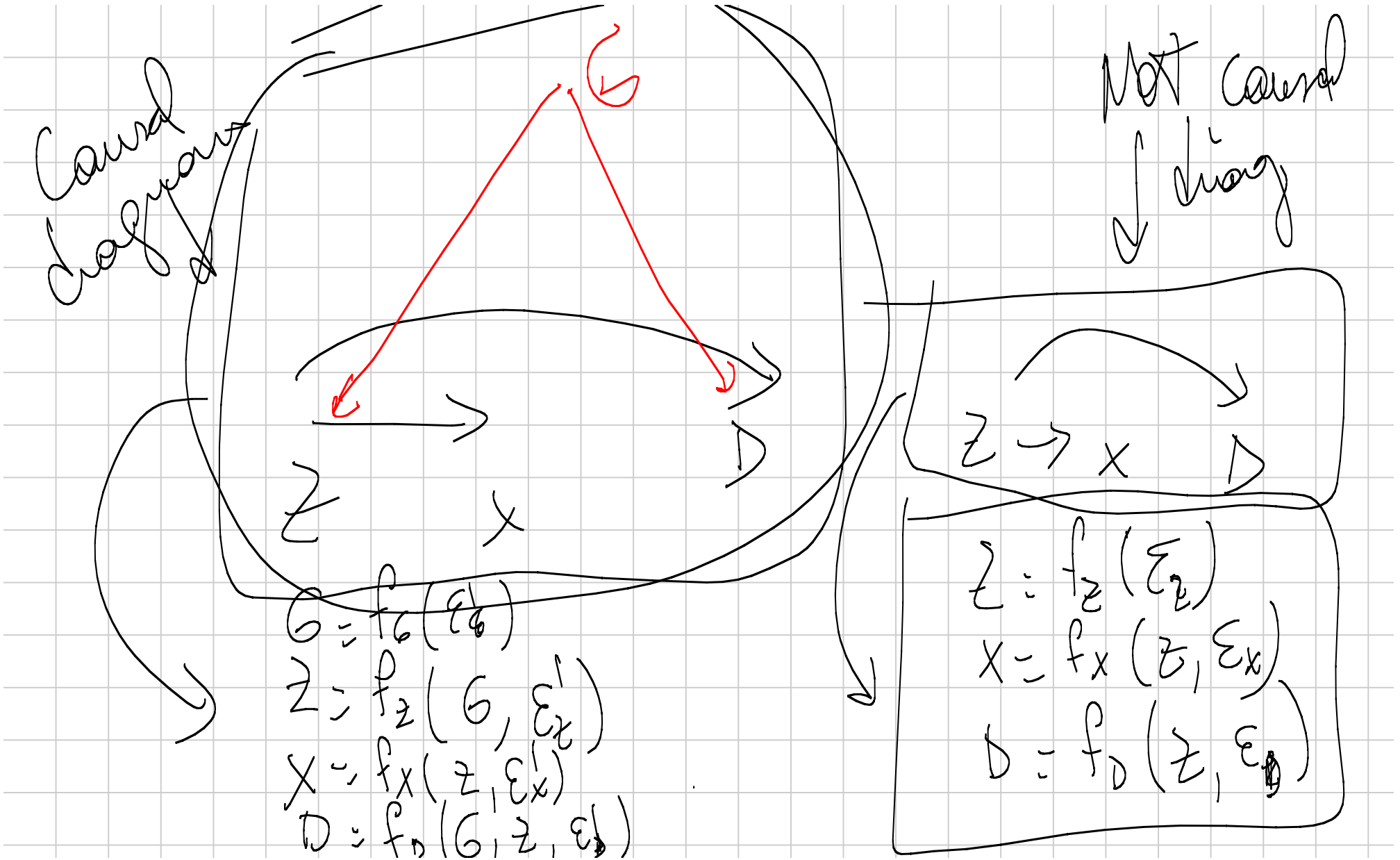
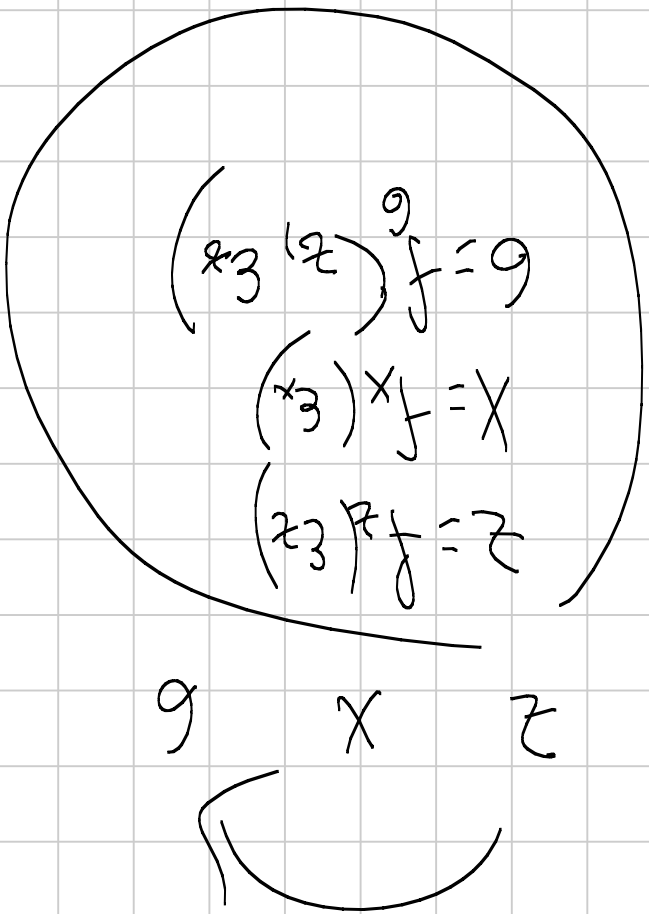
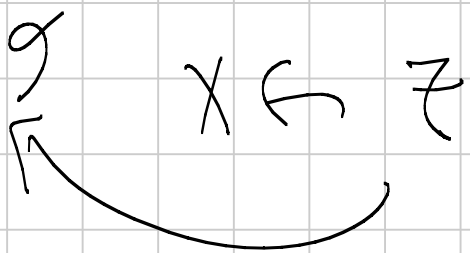
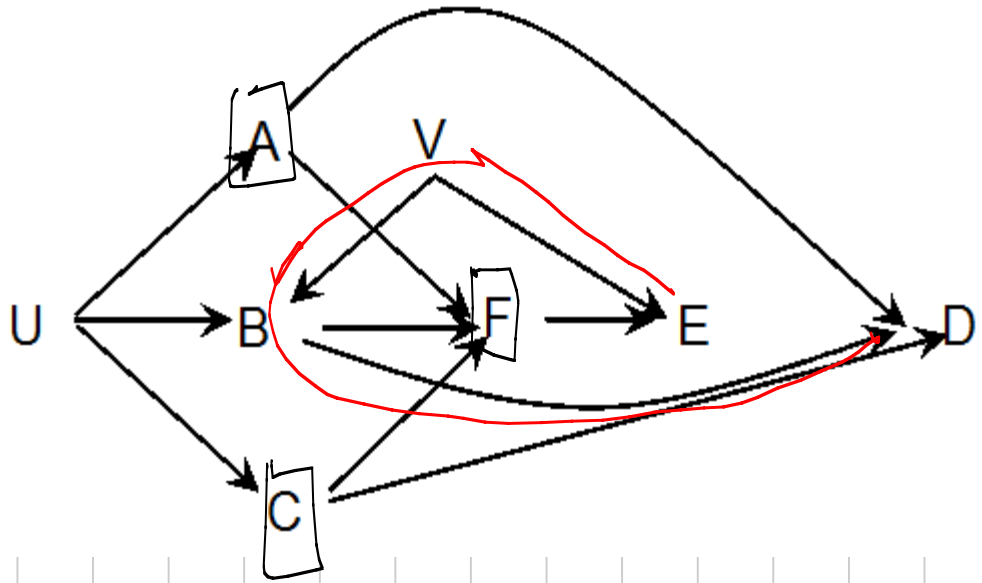
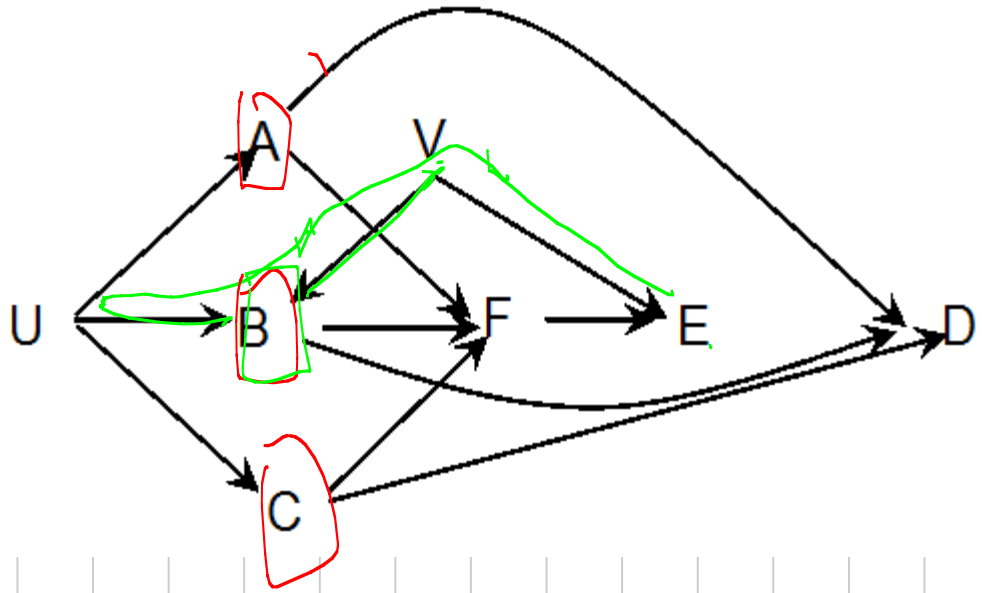

Causal diagram
G
Z
X
D
G := f_G(ε_G)
Z := f_Z(G, ε_Z)
X := f_X(Z, ε_X)
D := f_D(G, Z, ε_D)
Not causal diagram
Z → X → D
Z := f_Z(ε_Z)
X := f_X(Z, ε_X)
D := f_D(Z, ε_D)

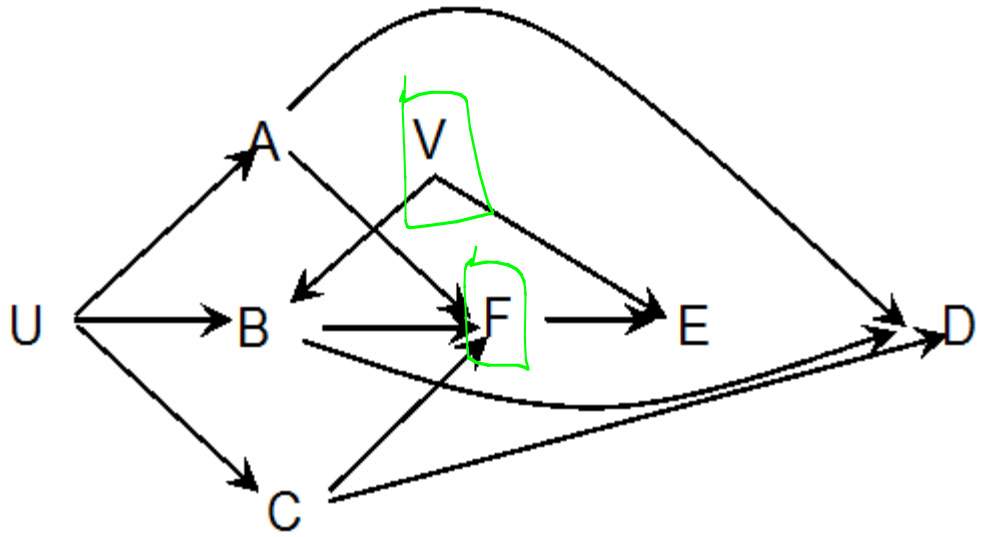

$(x_3 \mid z)^g f = g$
$(x_3)^x f = x$
$(x_3)^z f = z$
g
X
Z

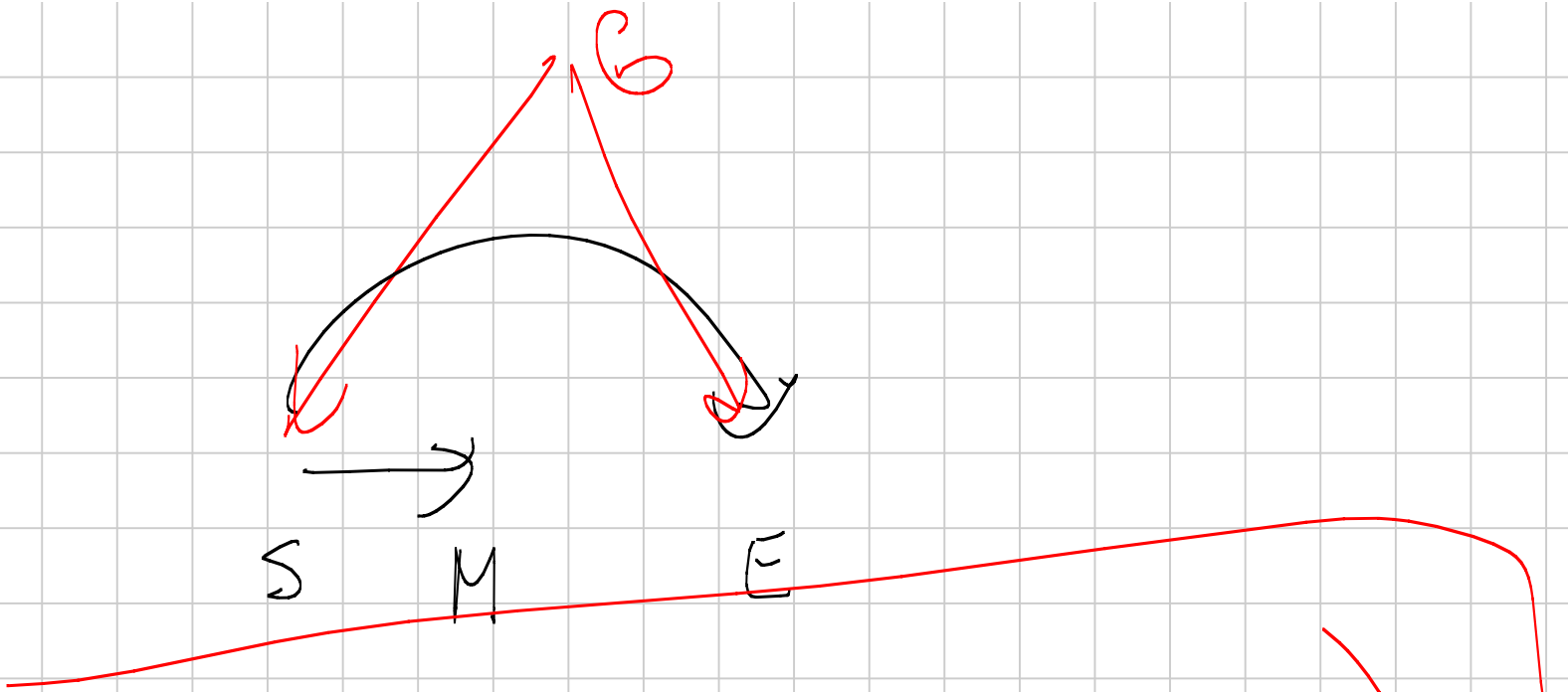

g
X
Z



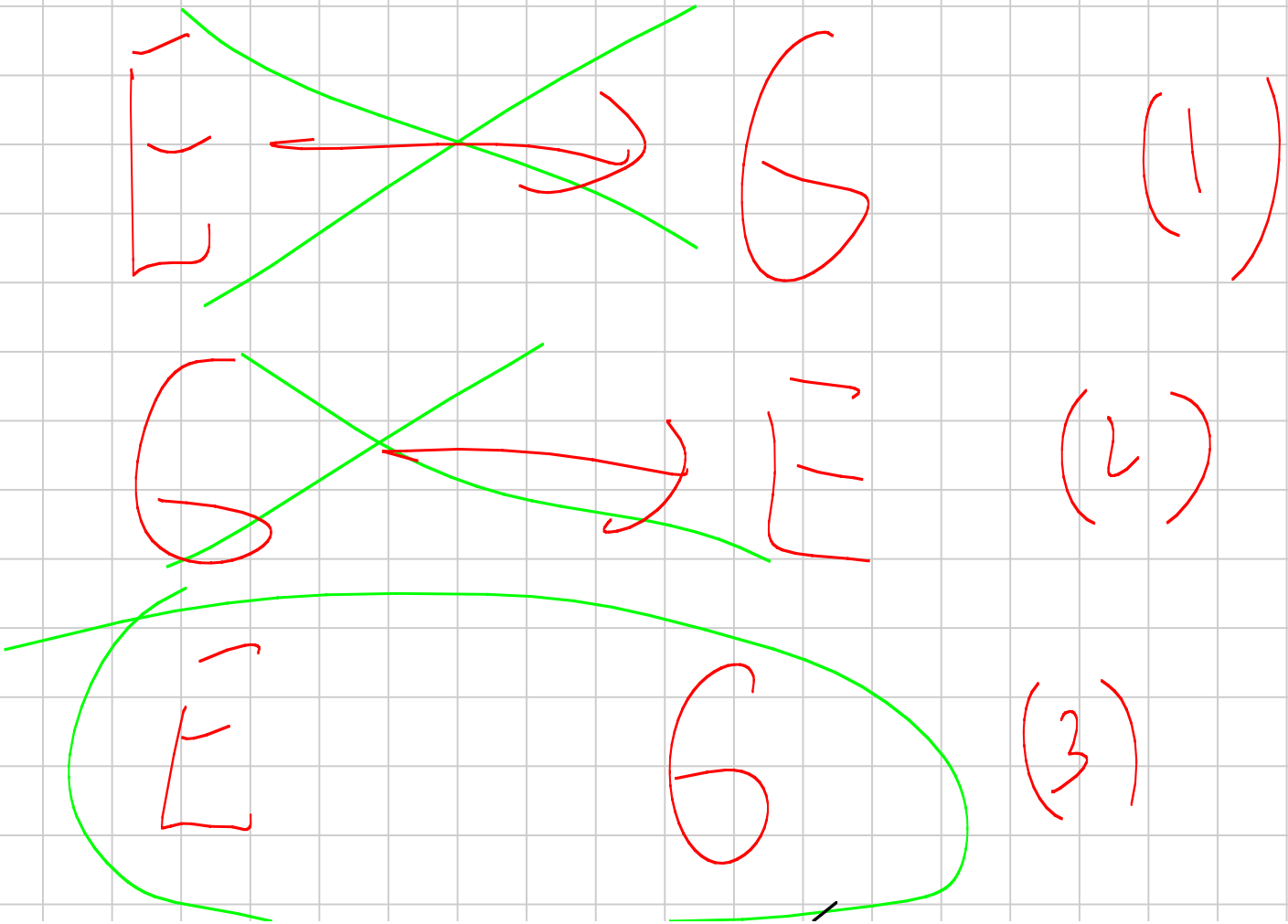
$$(E \perp\!\!\!\perp D \mid A, C, F)_{G}?$$

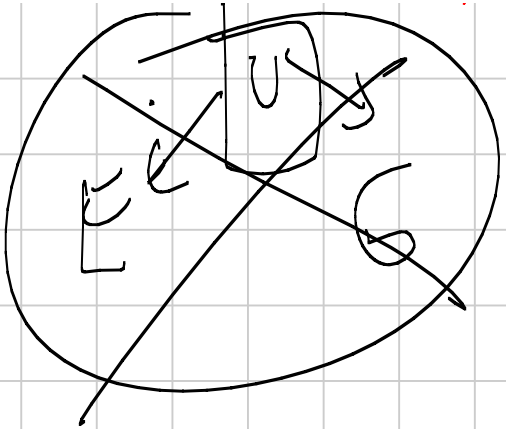

A
V
U
B
F
E
D
C

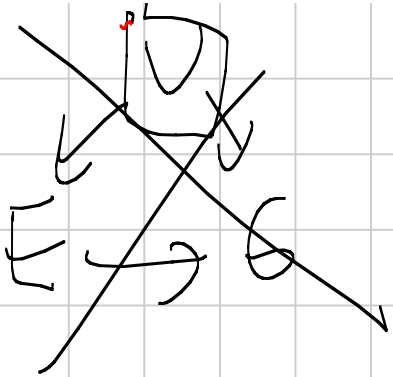

A
V
U
B
F
E
D
C

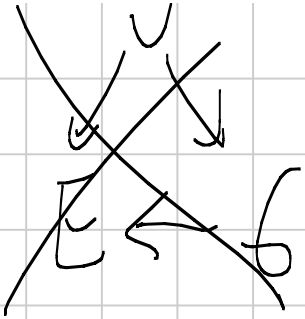


$$P(E_{S=1}=1) - P(E_{S=0}=1)$$


E
G
(1)
G
E
(2)
E
G
(3)







$E \quad G$ $\qquad$ $E \to G$ $\qquad$ $E \leftarrow G$

E and G are indep

$E \perp\!\!\!\perp G \mid U$

$(A \perp\!\!\!\perp Y \mid L)_g$, L is a non-des of A

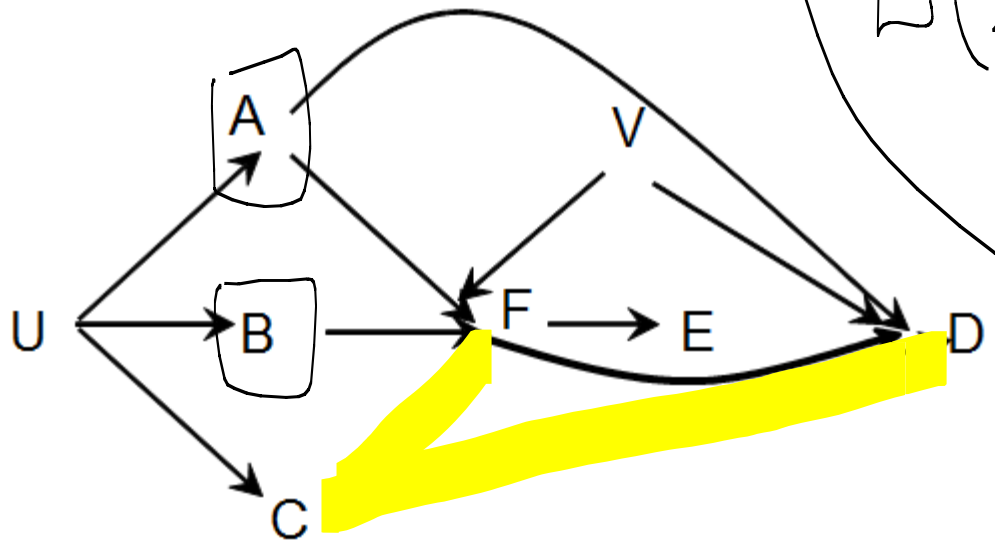
For all l

$$\sum_{l=1}^{5} P(L=l)\, P(Y=1 \mid A=1, L=l) = \sum_{l} P(Y_1=1 \mid L=l)\, P(L=l)$$

$$\sum_{l=1}^{5} P(L=l)\, P(Y=1 \mid A=1, L=l) = P(Y_1=1)$$

C, A, B continuous

$$E(D \mid C=1) - E(D \mid C=0) \neq E(D_1) - E(D_0)$$



$$E(D_{C=c} \mid A, B) =$$

$$E(D \mid C=c, A, B)$$

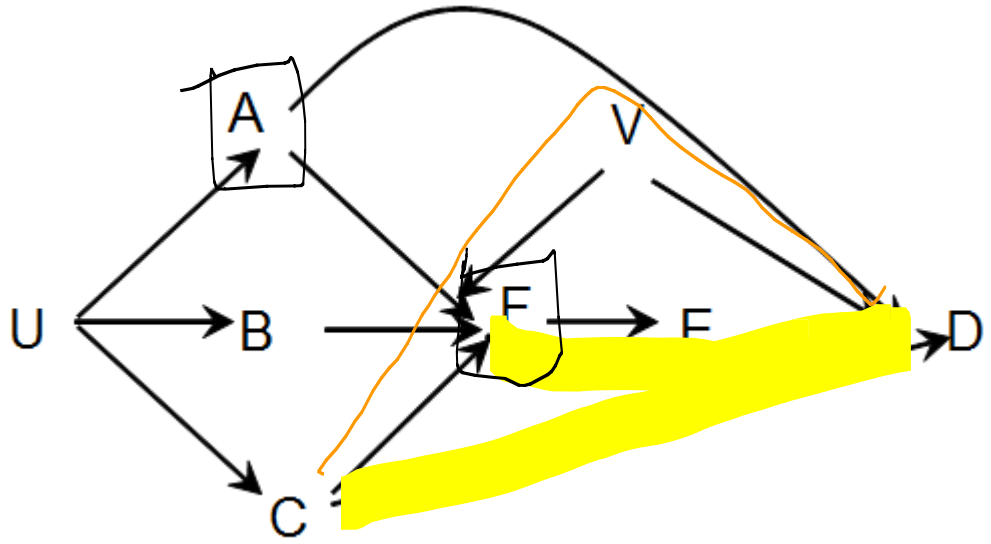
$$E(D_{C=1} \mid A, B) - E(D_{C=0} \mid A, B) =$$

$$E(D \mid C=1, A, B) - E(D \mid C=0, A, B)$$

$$E(D_c \mid A, B) = \beta_0 + \beta_1 c + \beta_2 A + \beta_3 B$$

$$\| \qquad + \beta_4 c A + \cdots$$

$$E(D \mid C, B, A) = \cdots$$


A
V
U
B
F
E
D
C