

Exercises d-separation:

1

- a) $A \rightarrow C \rightarrow E$
 $A \rightarrow C \rightarrow D \rightarrow E$
 $A \rightarrow C \rightarrow F \leftarrow E$
- b) $A \rightarrow C \rightarrow E$ is blocked by C
 $A \rightarrow C \rightarrow D \rightarrow E$ is blocked by C and D
 $A \rightarrow C \rightarrow F \leftarrow E$ is blocked by C (middle node in chain) and B, D and G because there is a collider and these variables are not the collider and also not an effect of the collider.
- c) Only C d-separates A and E because it blocks all of the paths
- d) $A \perp\!\!\!\perp E \mid C$

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- a) D
- b) No, they are not because there is also a direct relation between C and E that is not blocked by D
- c) No, when two variables are directly related there is no variable that blocks that path.

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- a) $B \rightarrow C \rightarrow F \rightarrow H \rightarrow I$
 $B \rightarrow C \rightarrow E \rightarrow F \rightarrow H \rightarrow I$
 $B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow H \rightarrow I$
- b) C, F and H
- c) ' $B \perp\!\!\!\perp I \mid C$ ' and ' $B \perp\!\!\!\perp I \mid F$ ' and ' $B \perp\!\!\!\perp I \mid H$ '

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- a) $A \rightarrow C \leftarrow B$
- b) No, conditioning on C introduces a path between A and B because C is a collider.
- c) No, D is an effect of C which is a collider.
- d) No, I is also an effect of C
- e) No, because all variables in the graph are effects of C
- f) Yes, they are not connected.

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- a) Yes, E is the common cause of F and G
- b) No, C is not a common cause and also not the middle node in a chain. Also there is no collider on the path between F and G.
- c) Yes, because F and G are connected via a common cause and you don't condition on E, the common cause.