Backdoor path criterion

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- a set of variables X is sufficient to control for confounding if:
  (1) X blocks all backdoor paths from treatment A to outcome Y
  (2) X doesn't include any descendants of treatment node A

  } backdoor path criterion

↳ however: X is not necessarily a unique set, there could be multiple sets that satisfy the backdoor path criterion

Example 1:

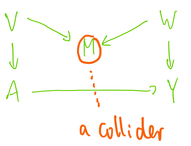
one backdoor path from A to Y: $A \leftarrow V \rightarrow W \rightarrow Y$

} here: $X_1 := \{V, W\}$ because edge btw. V and A points to A (OR) $X_2 := \{V\}$ (OR) $X_3 := \{W\}$.

⇒ sets of variables that are sufficient to control for confounding:

$\{V\}, \{W\}, \{V, W\}$

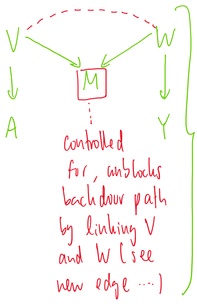
Ex. 2:



} here: X can be empty set bc M is a collider, thus the backdoor path $A \leftarrow V \rightarrow M \leftarrow W \rightarrow Y$ is blocked by default.

$X := \{\} = \emptyset$ ⇒ we have no confounding in this DAG on Y.

↳ if we choose $X := \{M\}$, then the backdoor path is unblocked and we created a link between V and W.



now we have to control for one of the following sets:

$\{M, V\}, \{M, W\}, \{M, V, W\}$

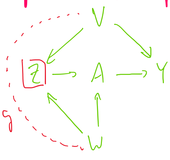
⇒ in total we must use one of the sets:

$\{\}, \{V\}, \{W\}, \{V, W\}, \{M, V\}, \{M, W\}, \{M, V, W\}$

↳ sets that are sufficient to control for confounding.

⇒ only controlling for the set $\{M\}$ is wrong! (→ controlling for $\{M\}$ only, opens up a backdoor path between A and Y.

Ex. 3:



backdoor paths:

1) $Y \leftarrow V \rightarrow Z \rightarrow A$: block this path with $\{Z, V\}, \{V\}$
2) $Y \leftarrow V \rightarrow Z \leftarrow W \rightarrow A$

Collider node: this backdoor path is blocked by default.

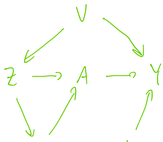
- for backdoor path $A \leftarrow Z \leftarrow V \rightarrow Y$ controlling for either $\{Z\}, \{V\}, \{Z, V\}$ is sufficient.
- if we were to control for Z, then a backdoor path is created due to a new link/edge between parents of Z: W and V s.t. we would have to control for either $\{Z, V\}, \{Z, W\}, \{Z, V, W\}, \{V\}, \{W\}$

⇒ the following sets of variables X are sufficient to control for confounding in the DAG:

$\{V\}, \{Z, V\}, \{Z, W\}, \{Z, V, W\}$

the minimal set sufficient to control for confounding in this DAG is: $\{V\}$.

Ex. 4:



backdoor paths: (# = 4)

(1) $Y \leftarrow M \leftarrow W \rightarrow A$: $\{M\}, \{W\}$
(2) $Y \leftarrow M \leftarrow W \leftarrow Z \rightarrow A$: $\{M\}$
(3) $Y \leftarrow V \rightarrow Z \rightarrow A$: $\{V\}, \{Z\}, \{V, Z\}$
(4) $Y \leftarrow V \rightarrow Z \rightarrow W \rightarrow A$: $\{V\}, \{W\}, \{Z\}$

↳ or any combination of these 3 sets.

- sufficient set to control for: } $\{M, V\}$, $\{M, Z\}$ minimal sets

Key Lesson: To be able to apply the backdoor path criterion for sufficient variable selection, we need to know the DAG!

↳ writing down the DAG can be difficult.

need for an alternative criterion which doesn't require apriori knowledge of the DAG.