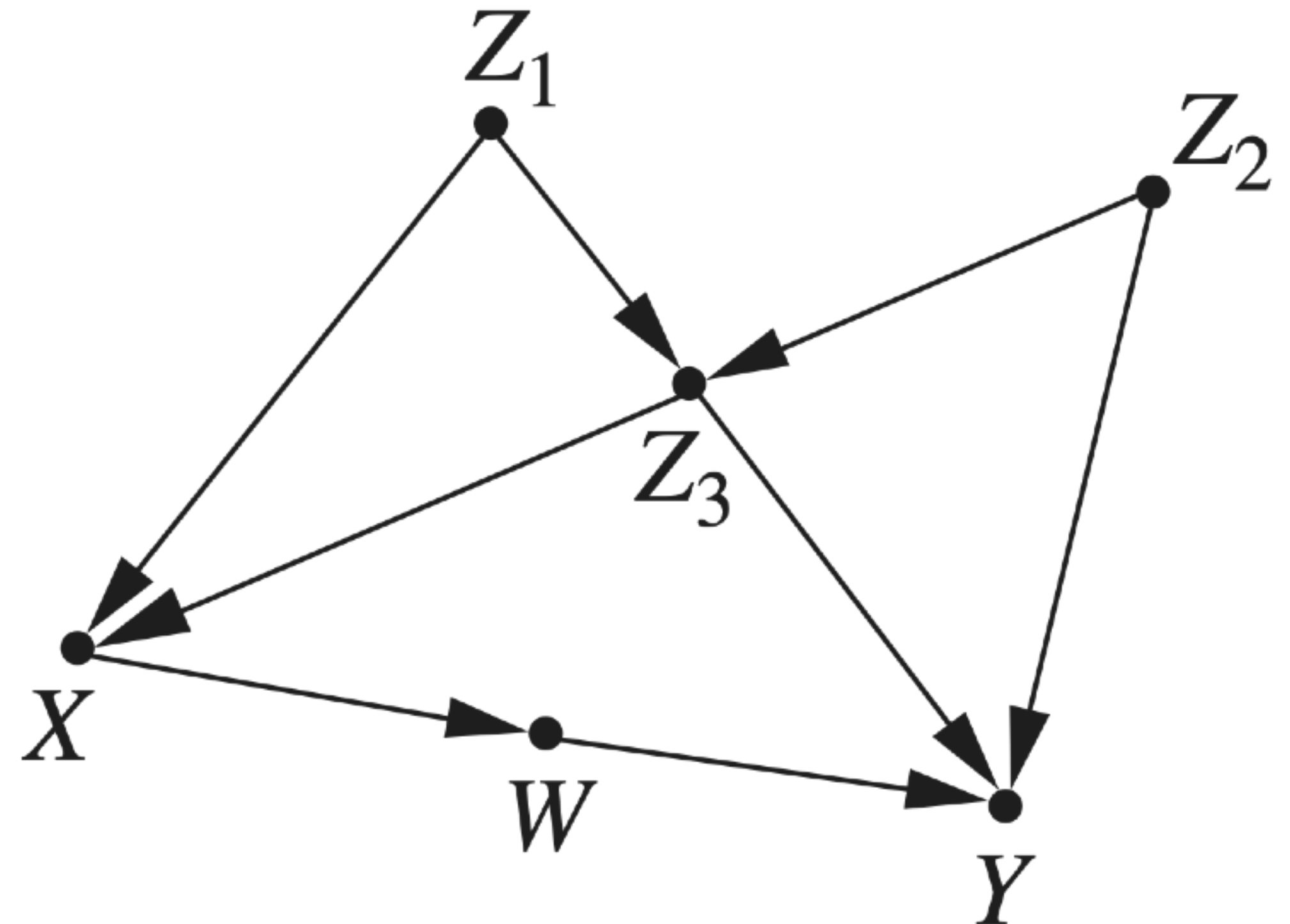


# OPEN AND CLOSED PATHS

- Paths containing uncontrolled **pipes** and **forks** are open
- Paths containing **colliders** are **closed by default**, but open if we condition on the collider
- To estimate the true causal effect of  $x$  on  $y$ , we need **all non-causal paths from  $x$  to  $y$**  to be closed in our model

Identify all the open paths from  $X$  to  $Y$



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# BACK DOOR CRITERION

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To estimate the causal effect of  $X$  on  $Y$ , identify a set of control variables such that no descendants of  $X$  are in the control set, and all paths between  $X$  and  $Y$  that contain an arrow into  $X$  are blocked.