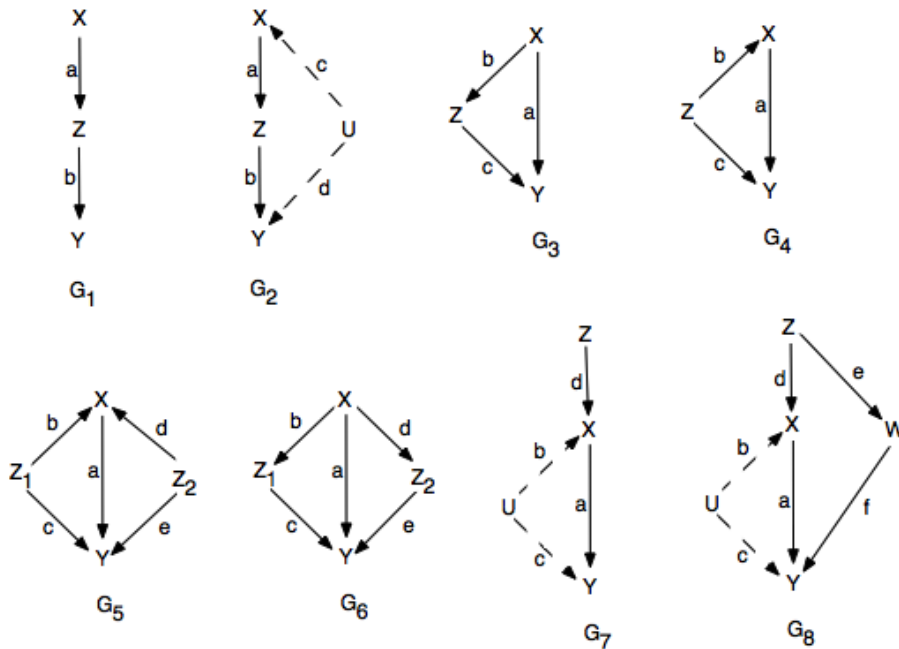


# Ralph's path coefficients

Ralph is exploring linear structural causal models (SCM). He knows causal effects can be represented as the sum (along alternative directed paths from exposure to outcome) of products (along a given directed path from exposure to outcome) of path coefficients.

Consider the following DAGs (directed acyclic graphs). For instance DAG  $G_1$  conveys the following functional relations:  $X = U_X, Z = aX + U_Z, Y = bZ + U_Y$  where the unobservables (suppressed in the graph unless unobservables connect observables as in DAGs  $G_2, G_7, G_8$ ),  $U_X, U_Z, U_Y$ , are mutually independent.



Suggested:

1. For each DAG, what (perhaps additional but not utilized in the regression design) variables and conditional independence tests help with graphical discovery and testing?

2. For each DAG, use path coefficients to identify total and direct causal effects of  $X$  on  $Y$ ,  $E[Y | do(x)]$ .

3. For each DAG, indicate a regression design which allows inference of total and direct causal effects of  $X$  on  $Y$ ,  $E[Y | do(x)]$ .