

Experimental distribution when x and y are subject to an intervention:

$$\text{PM1: } P(Z|X, Y||X, Y) = \sum_{uv} P(U)P(V)P(Z|U, V, X, Y)$$

$$\text{PM2: } P(Z|X, Y||X, Y) = \sum_{uv} P(U)P(V)P(Z|U, V, Y)$$

PM1 and PM2 (unsurprisingly) have identical distributions for the other two double-intervention distributions, since the $x \rightarrow z$ edge is broken and the remaining parameters are identical in the parameterizations:

Experimental distribution when x and z are subject to an intervention:

$$\text{PM1: } P(Y|X, Z||X, Z) = \sum_v P(V)P(Y|V, X)$$

$$\text{PM2: } P(Y|X, Z||X, Z) = \sum_v P(V)P(Y|V, X)$$

Experimental distribution when y and z are subject to an intervention:

$$\text{PM1: } P(X|Y, Z||Y, Z) = \sum_u P(U)P(X|U)$$

$$\text{PM2: } P(X|Y, Z||Y, Z) = \sum_u P(U)P(X|U)$$

Appendix C

Parameterization PM3 for structure 1 in figure 2:

$p(u = 1) = .5$ $p(v = 1) = .5$ $p(x = 1 u = 1) = .8$ $p(x = 1 u = 0) = .2$ $p(y = 1 v = 1, x = 1) = .8$ $p(y = 1 v = 1, x = 0) = .8$ $p(y = 1 v = 0, x = 1) = .8$ $p(y = 1 v = 0, x = 0) = .2$	$p(z = 1 u = 1, v = 1, x = 1, y = 1) = .825$ $p(z = 1 u = 1, v = 1, x = 1, y = 0) = .8$ $p(z = 1 u = 1, v = 1, x = 0, y = 1) = .8$ $p(z = 1 u = 1, v = 1, x = 0, y = 0) = .8$ $p(z = 1 u = 1, v = 0, x = 1, y = 1) = .775$ $p(z = 1 u = 1, v = 0, x = 1, y = 0) = .8$ $p(z = 1 u = 1, v = 0, x = 0, y = 1) = .8$ $p(z = 1 u = 1, v = 0, x = 0, y = 0) = .8$ $p(z = 1 u = 0, v = 1, x = 1, y = 1) = .7$ $p(z = 1 u = 0, v = 1, x = 1, y = 0) = .8$ $p(z = 1 u = 0, v = 1, x = 0, y = 1) = .8$ $p(z = 1 u = 0, v = 1, x = 0, y = 0) = .8$ $p(z = 1 u = 0, v = 0, x = 1, y = 1) = .9$ $p(z = 1 u = 0, v = 0, x = 1, y = 0) = .2$ $p(z = 1 u = 0, v = 0, x = 0, y = 1) = .8$ $p(z = 1 u = 0, v = 0, x = 0, y = 0) = .2$
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Substituting the parameters of PM3 in the equations for the passive observational or any experimental distributions of PM1 in appendix 2, it can be

verified that PM2 and PM3 are experimentally indistinguishable for all possible experiments on $\{x, y, z\}$. Nevertheless, it should be evident that in an experiment intervening on x, y, u , and v , the difference between the bold font parameters will indicate that x is a direct cause of z .

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