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# Cognitive Systems Design - Assignment 4

1. The robotic uprising must have used a tier-1 causal model to learn how to fight by learning associations between a vast number of wins and the use of pre-modern military technology used in those won battles.

2. Probabilistic expressions:
   a. $P(T = 1|E = 0, W = 1)$
   b. $P(T = 1|E = 0, R = 1)$
   c. $P(T = 1|E = e)$
   d. $P(T = 1|R = r)$

3. $P(H = 1|E = 1)\ Q = \{H = 1\}, e = \{E = 1\}, Y = \{S, V\}$

   $$P(H = 1, E = 1) = \sum_{s,v} P(H = 1, E = 1, S = s, V = v)$$

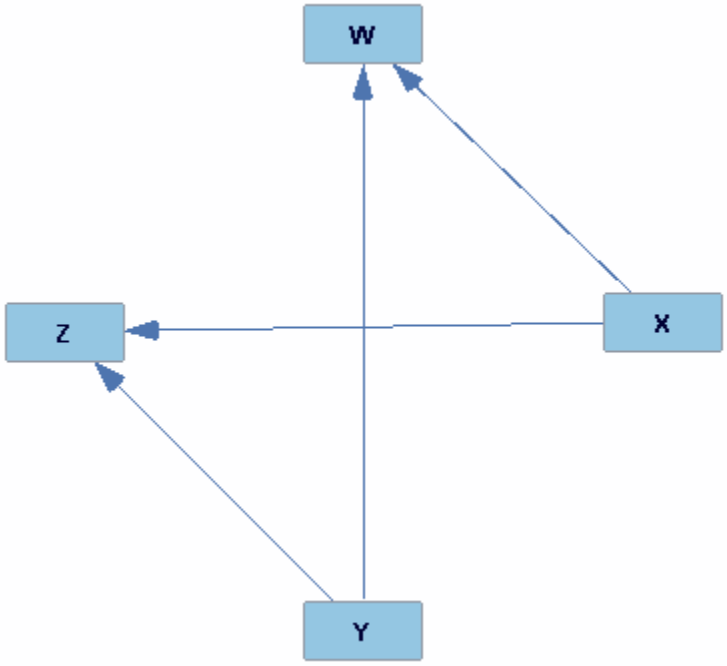
   $$= \sum_{s,v} P(H = 1|E = 1, V = v)P(E = 1|S = s)P(S = s)P(V = v|S = s)$$

   $$= P(H = 1|E = 1, V = 0)P(E = 1|S = 0)P(S = 0)P(V = 0|S = 0)$$
   $$+ P(H = 1|E = 1, V = 0)P(E = 1|S = 1)P(S = 1)P(V = 0|S = 1)$$
   $$+ P(H = 1|E = 1, V = 1)P(E = 1|S = 0)P(S = 0)P(V = 1|S = 0)$$
   $$+ P(H = 1|E = 1, V = 1)P(E = 1|S = 1)P(S = 1)P(V = 1|S = 1) =$$
   $$(0.1 * 0.4 * 0.3 * 0.8) + (0.1 * 0.8 * 0.7 * 0.3) +$$
   $$(0.6 * 0.4 * 0.3 * 0.2) + (0.6 * 0.8 * 0.7 * 0.7) =$$
   $$0.0096 + 0.0168 + 0.0144 + 0.2352 = 0.276$$

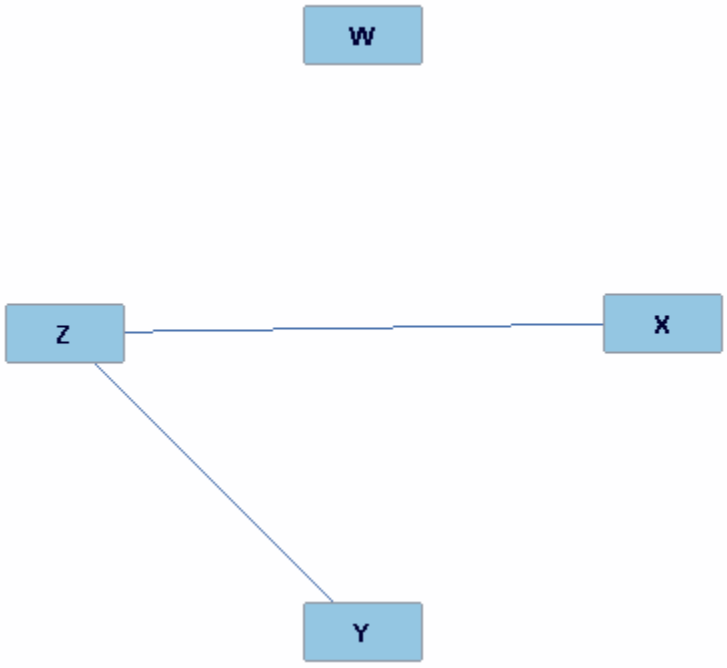
   $$= P(H = 0|E = 1, V = 0)P(E = 1|S = 0)P(S = 0)P(V = 0|S = 0)$$
   $$+ P(H = 0|E = 1, V = 0)P(E = 1|S = 1)P(S = 1)P(V = 0|S = 1)$$
   $$+ P(H = 0|E = 1, V = 1)P(E = 1|S = 0)P(S = 0)P(V = 1|S = 0)$$
   $$+ P(H = 0|E = 1, V = 1)P(E = 1|S = 1)P(S = 1)P(V = 1|S = 1) =$$
   $$(0.9 * 0.4 * 0.3 * 0.8) + (0.9 * 0.8 * 0.7 * 0.3) +$$
   $$(0.4 * 0.4 * 0.3 * 0.2) + (0.4 * 0.8 * 0.7 * 0.7) =$$
   $$0.0864 + 0.01512 + 0.0096 + 0.1568 = 0.26792$$

   $$P(H = 1|E = 1) = \frac{0.276}{(0.276+0.26792)} = 0.507$$

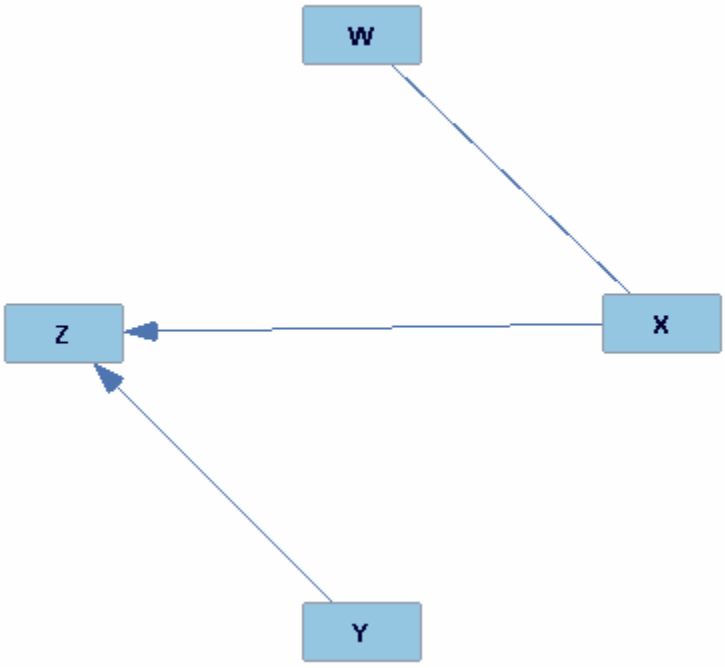
4. Tetrad stuff:
    a. survey.csv:




    b. sleep_study.csv:



c. study_study.csv:




5. Identifiability and Adjustment:

6. Computing queries: