ICASSP 2022 SPGC
Root Cause Analysis for Wireless Network Fault Localization: Baseline Description

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1 Bayesian Network Based Method

In this draft, we discuss the case when the causal relationships among variables are known.

Suppose there are two root causes R_1 and R_2, and 4 observable variables $X_1, \ldots, X_4$. The root cause can only take binary values 0 or 1 to indicate the causes. The causal relationships are shown in Figure 1.

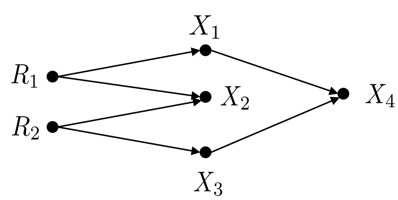

Figure 1: The causal relationship graph of a toy example: Aiming to illustrate the Bayesian network based method.

We want to tell the posterior, in this case which is,

$$\begin{aligned}
&P(R_1, R_2 | x_1, x_2, x_3, x_4) \\
=&\frac{P(x_1, x_2, x_3, x_4 | R_1, R_2) P(R_1, R_2)}{P(x_1, x_2, x_3, x_4)} \qquad (1) \\
=&\frac{P(x_4 | x_1, x_3) P(x_2, x_3 | R_2) P(x_1, x_2 | R_1) P(R_1) P(R_2)}{P(x_1, x_2, x_3, x_4)}. \qquad (2)
\end{aligned}$$

This decomposition from (1) to (2) is based on the assumption that the DAG is Markovian. The blue part is a constant that can be absorbed in the normalization term, so we can skip over their computation temporally and focus on the modelling of the red part.

In our setting, R_1 and R_2 can only take binary values. We can model the conditional probabilities $P(X_2, X_3|R_2)$ and $P(X_1, X_2|R_1)$ with multivariate Gaussian distribution. The model parameters can be simply derived from sample mean and sample covariance.

Now, one can assign the prior probability $P(R_1), P(R_2)$, and every quantity in (2) is computable for every combination of r_1, r_2, except for the blue term. The final posterior is obtained by a simple normalization.