[MineNet workshop(2005)]Shrink: A tool for failure diagnosis in ip networks.

本篇文章是对基于SRLG进行故障定位方法的改进:

两个优点:

1. Shrink is the first IP fault diagnosis system that efficiently and systematically accounts for inaccuracies in SRLG descriptions.
   可以很好地解决噪音问题, 其中噪音包括:
   a. SRLG不准确, 可能丢失某些数据。
   b. SNMP的report不准确, 可能有些链路故障没有去识别出来。
2. In contrast to prior attempts to use Bayesian networks for network fault diagnosis [10], Shrink solves the problem in $O(n^4)$
   降低了时间复杂度到多项式级别。

具体实现

架构

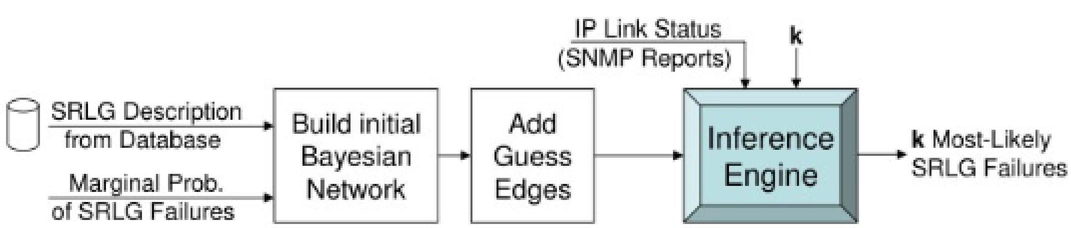

Figure 2: Shrink System Setup

模型

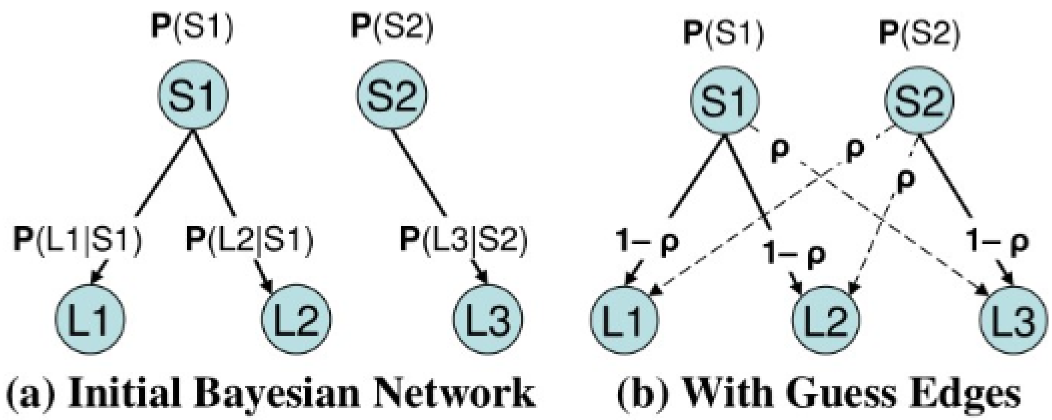

Figure 3: Shrink's Network Model: An SRLG S_i is annotated with its marginal probability of failure $P(S_i = 1)$ and the directed edge $S_i \rightarrow L_j$ is annotated with the conditional probability $P(L_j = 1|S_i = 1)$. Shrink adds *guess edges* to deal with inaccuracies in SRLG descriptions.

(a)图和(b)图的区别在于(b)图在SRLG和所有的link之间都添加了一条边,形成了完全图, 其中对于不属于该SRLG的链路Lu, P(Lu|S) = p, 这里的p是一个很小的值, 通过这种方法可以解决噪音问题。

$$P\left(L_j = 1 \mid S_i = 1\right) = \begin{cases} 1-p, & \forall L_j \in S_i \\ p, & \text{otherwise} \end{cases}$$

$$\arg\max_{S_1,\ldots,S_n} P\left(S_1,\ldots,S_n \mid L_1,\ldots,L_m\right)$$

subject to

$$\text{number of } \{S_i = 1\} \leq \kappa$$

这里使用k来限制SRLG的数目, 是因为多个SRLG同时fail的概率是很小的。

算法复杂度: $O\left(n^\kappa * (m+n)\right)$

ps:

$$P\left(S_1,\ldots,S_n \mid L_1,\ldots,L_m\right) = P(S_1|L_1,\ldots,L_m)P(S_2|L_1,\ldots,L_m)\ldots P(S_n|L_1,\ldots,L_m)$$

又因为L1-Lm之间相互独立, 所以:
$P(S_1|L_1,\ldots,L_m) = P(S1|L1) + P(S2|L2) + \ldots$

$$P(S1|L1) = P(L1|S1)P(S1)/P(L1)$$

因为 $P(S1)/P(L1)$ 是固定的, 所以转化为求 $P(L1|S1)$