Grundlagen der Wissensverarbeitung
Computer Science
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Tutorial 8 : Propositions and Inference

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Exercise 8.1

Introduction to Diagnosis: A Murder Investigation Apply your knowledge of propositions and inference to catch the murderer. Find a formal representation of the assumables, observations, rules and integrity constraints given below. Then compute the minimal conflict and the minimal diagnosis

Notation:

- Gardener $\Rightarrow$ G

- Butler $\Rightarrow$ B

- Work $\Rightarrow$ w

- Dirt $\Rightarrow$ d

- Statement_Gardener $\Rightarrow$ S_G

- Statement_Butler $\Rightarrow$ S_B

We can see that the rules determine that:

- S_G = $d_G \leftarrow w_G$ $\qquad\qquad$ ($d_G = 0$ $w_G = 1$)

- S_B = $d_B \leftarrow w_B$ $\qquad\qquad$ ($d_B = 1$ $w_B = 1$)

We can conclude that the Gardener's sentence is fake $\Rightarrow$ *Gardener's the murderer*

Exercise 8.2

When the ignition key is turned a good mechanic can hear (observe) three noises produced by the starter, the fuel pump and the engine itself. In case one of the noises is not observed there is a fault in at least one component. Formalize the given diagnosis problem. You can assume that all connections (cables, pipes and mechanical links) work properly but each component (grey box) could be faulty in one way or the other: A fuel tank could be empty, a starter broken, a filter clogged and so on. Perform a diagnosis (that is compute the minimal diagnoses) for the following sets of observations:.

- $starter(noise1) \leftarrow ignition\_key$

- $ignition\_key \leftarrow battery$

- $fuel\_pump(noise2) \leftarrow electronic\_fuel\_regulation \wedge fuel\_tank$

- $electronic\_fuel\_regulation \leftarrow battery \wedge ignition\_key$

- $engine(noise3) \leftarrow starter \wedge filter$

- $filter \leftarrow fuel\_pump$

If there's no noise, then the starter, the fuel pump and the engine are not working. If the starter is not working it's because it's broken or the ignition key is not working. If the ignition key is not working, it's because it's broken or the battery is not working. If we keep going on with this reasoning, we find the following:

$No\_noise \rightarrow \neg starter \wedge \neg fuel\_pump \wedge \neg engine = 1$

And that means:

$(\neg starter \vee \neg ignition\_key \vee \neg battery) \wedge (\neg fuel\_pump \vee \neg fuel\_tank \vee \neg electronic\_fuel\_regulation \vee$
$\neg ignition\_key \vee \neg battery) \wedge (\neg engine \vee \neg filter \vee \neg fuel\_pump \vee \neg fuel\_tank \vee \neg electronic\_fuel\_regulation$
$\neg ignition\_key \vee \neg battery \vee \neg starter \vee \neg ignition\_key \vee \neg battery) = 1$
We can not conclude anything

If we only can hear noise1:

$Only\_noise1 \rightarrow starter \wedge \neg fuel\_pump \wedge \neg engine = 1$

And that means:

$(starter \vee ignition\_key \vee battery) \wedge (\neg fuel\_pump \vee \neg fuel\_tank \vee \neg electronic\_fuel\_regulation \vee$
$\neg ignition\_key \vee \neg battery) \wedge (\neg engine \vee \neg filter \vee \neg fuel\_pump \vee \neg fuel\_tank \vee \neg electronic\_fuel\_regulation$
$\neg ignition\_key \vee \neg battery \vee \neg starter \vee \neg ignition\_key \vee \neg battery) = 1$

We conclude that the battery, the ignition key and the starter are working, but the electronic fuel regulation or fuel pump are broken at least.

If we only can hear noise2

$Only\_noise1 \rightarrow \neg starter \wedge fuel\_pump \wedge \neg engine = 1$

And that means:

$(\neg starter \vee \neg ignition\_key \vee \neg battery) \wedge (fuel\_pump \vee fuel\_tank \vee electronic\_fuel\_regulation \vee ignition\_key \vee battery) \wedge (\neg engine \vee \neg filter \vee \neg fuel\_pump \vee \neg fuel\_tank \vee \neg electronic\_fuel\_regulation \vee \neg ignition\_key \vee \neg battery \vee \neg starter \vee \neg ignition\_key \vee \neg battery) = 1$

We conclude that the battery, the ignition key, the electronic fuel regulation, the fuel pump and the fuel tank are working, but the filter or the engine are broken at least and the stater is broken.

If we can hear noise1 and noise 2 but not noise3:

$Only\_noise1 \rightarrow starter \wedge fuel\_pump \wedge \neg engine = 1$

And that means:

$(starter \vee ignition\_key \vee battery) \wedge (fuel\_pump \vee fuel\_tank \vee electronic\_fuel\_regulation \vee ignition\_key \vee battery) \wedge (\neg engine \vee \neg filter \vee \neg fuel\_pump \vee \neg fuel\_tank \vee \neg electronic\_fuel\_regulation \vee \neg ignition\_key \vee \neg battery \vee \neg starter \vee \neg ignition\_key \vee \neg battery) = 1$

We conclude that the battery, the ignition key, the starter, the electronic fuel regulation, the fuel pump and the fuel tank are working, but the filter or the engine are broken at least.

If a variable is false, it means it's not working and so on it could be broken.