University of San Diego
SHILEY-MARCOS SCHOOL OF ENGINEERING

Assignment 4.1

Ajmal Jalal

Nov 11, 2024

Instructions

In a nuclear power plant, there is an alarm that senses when a temperature gauge exceeds a given threshold. The gauge measures the temperature of the core. Consider the Boolean variables 0 or 1 for corresponding nodes A(alarm sounds), FA(alarm is faulty) and FG (gauge is faulty). Also consider the multivalued sensor nodes G(gauge reading) and T(core temperature). Draw a Bayesian network for the alarm system. Justify your network in detail by explaining the connections between the nodes. FG = 1 implies gauge is faulty.
Hints: Categorize (sensor nodes versus Boolean variable nodes)
Question: Can abnormal temperatures cause the gauge to become faulty?

Answer:

Based on the given instructions, we will model the cause-effect relationships between various components of a nuclear power plant's alarm system.

Nodes in the Network

1 - Boolean Variables (0 or 1)

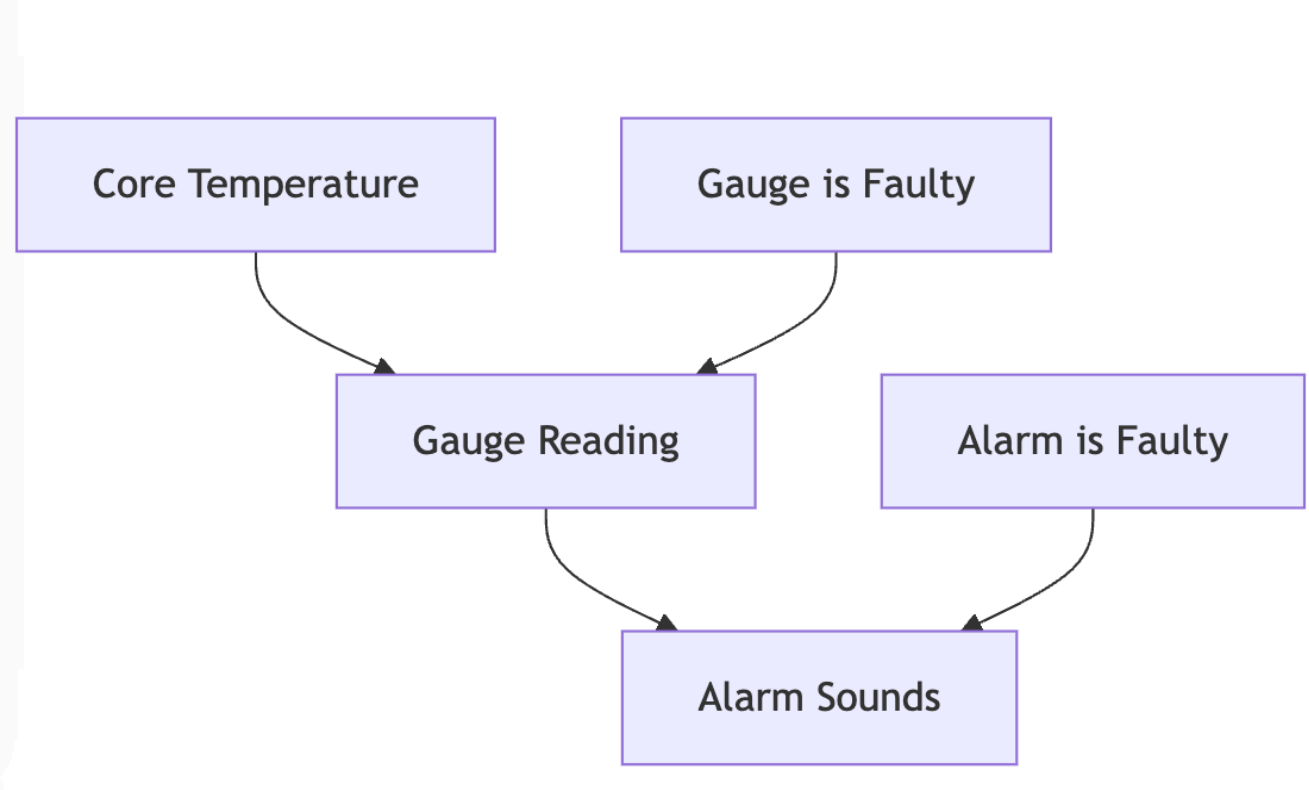
- **A (Alarm Sounds)**: Indicates whether the alarm is sounding (1) or not (0).
- **FA (Alarm is Faulty)**: Indicates whether the alarm system is faulty (1) or functioning properly (0).

- **FG (Gauge is Faulty)**: Indicates whether the temperature gauge is faulty (1) or functioning properly (0).

2 - Multivalued Sensor Nodes

- **T (Core Temperature)**: The actual temperature of the nuclear reactor core. This is a continuous variable representing the true temperature.
- **G (Gauge Reading)**: The temperature reading displayed by the gauge, which may be inaccurate if the gauge is faulty.

Structure of the Bayesian Network



Edges Explanation:

- **T ==> G:** The core temperature affects the gauge reading.
- **FG ==> G:** A faulty gauge affects the accuracy of the gauge reading.
- **G ==> A:** The gauge reading influences whether the alarm sounds.
- **FA ==> A:** A faulty alarm system affects whether the alarm sounds.

Detailed Explanation of Connections

The core temperature directly influences the gauge reading. Under normal conditions, the gauge accurately reflects the core temperature. As the core temperature rises, the gauge should show a corresponding increase in temperature.
A faulty gauge can lead to incorrect readings, regardless of the actual temperature. When the gauge is faulty (FG = 1), it may display temperatures that are inaccurate, either too high or too low, disrupting the reliability of the system.
The alarm system is activated when the gauge reading exceeds a certain threshold. If the gauge shows a temperature beyond a predefined safe limit, the alarm (A) is triggered, initiating necessary safety protocols to prevent accidents.
If the alarm system itself is faulty, it may fail to activate or may activate unnecessarily. A faulty alarm (FA = 1) can result in either missed warnings or false alarms, which undermine the reliability of the safety system.

Can abnormal temperatures cause the gauge to become faulty?

No, abnormal temperatures (node T) do not cause the gauge to become faulty (node FG). In the Bayesian network, there is no direct edge from T to FG, indicating that the core temperature does not affect whether the gauge becomes faulty. Faults in the gauge are considered independent of the core temperature in this model. Instead, faults can be due to, for instance, hardware failures, calibration errors, or other external factors that are not related to the temperature being measured.

While an abnormal temperature does affect the gauge reading (T ==> G), it doesn't cause the gauge to malfunction. Therefore, any failure in the gauge (FG = 1) is not attributed to the temperature but rather to other factors.