

# Causes and Errors

## The right decision can cause accidents

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# Intro

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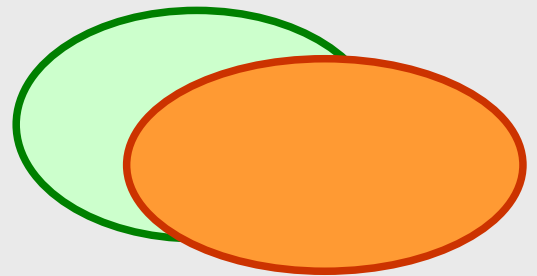
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How can Causal Analysis Contribute to this Learning Process?

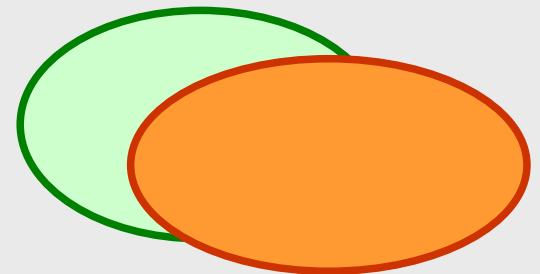
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A cause is an element out of a set of causes, each of which is necessary and which together are sufficient for the accident to occur.



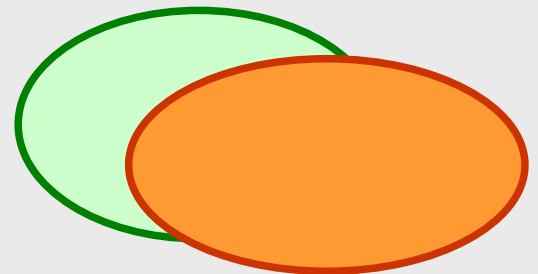
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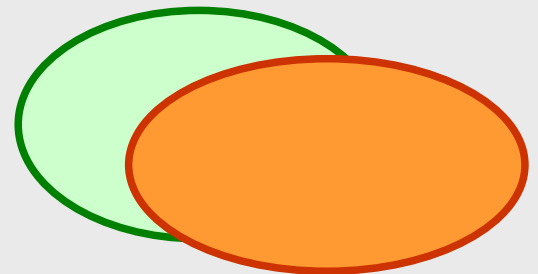
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**Causes**  $\neq$  **Errors**

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Modeling “language”: **Decision Event Trees.**

Based on Probabilistic Risk Assessment.

## Example - the Setting

The **operator** of a **coal-fired power station** is confronted with the following symptom:

Rising level in one of the tanks in the high pressure preheater

# Hypotheses

H1 Small leak in a feedwater pipe.

A-priori-Probability: 5%.

H2 Spindle breakage.

A-priori-Probability : 95%.

# Consequences

Without countermeasures a leak results in a considerably reduced efficiency of the plant.

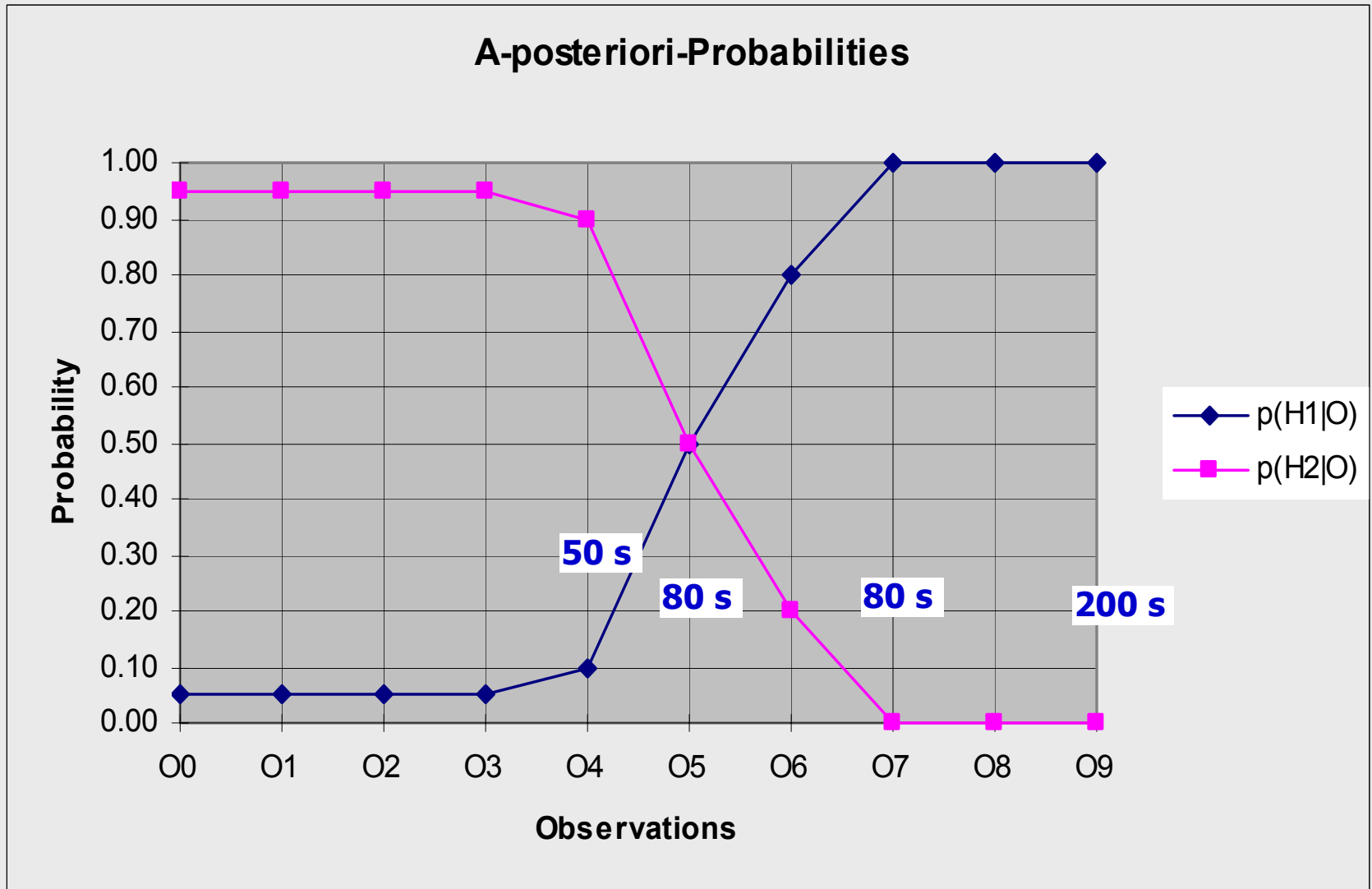
A breakage results in a minor reduction of efficiency.

In both cases the severity can be reduced by appropriate countermeasures.

The operator may choose to wait and see and he possibly may miss the right time for countermeasures.

The test is known to be erroneous with a 20% probability

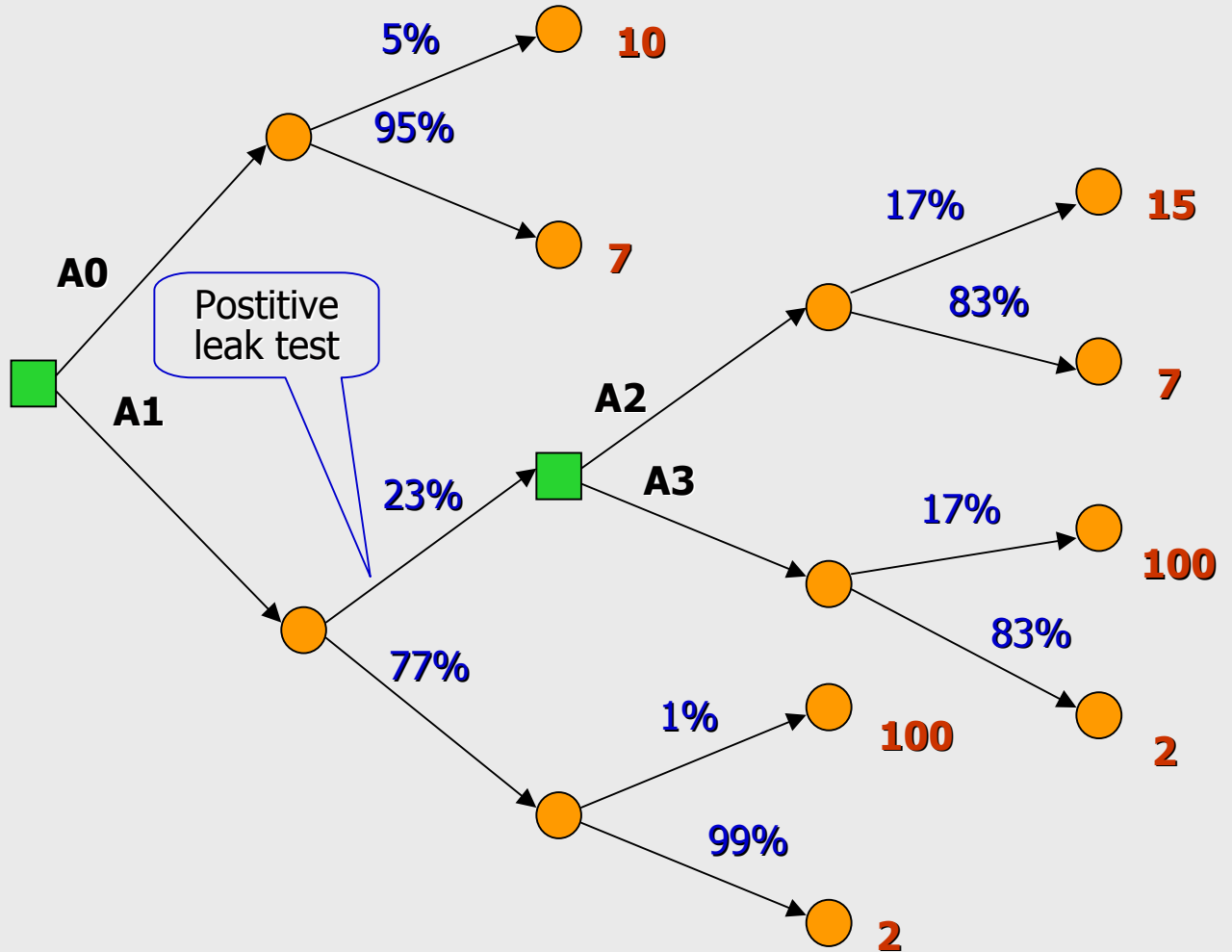
# The Leak Scenario



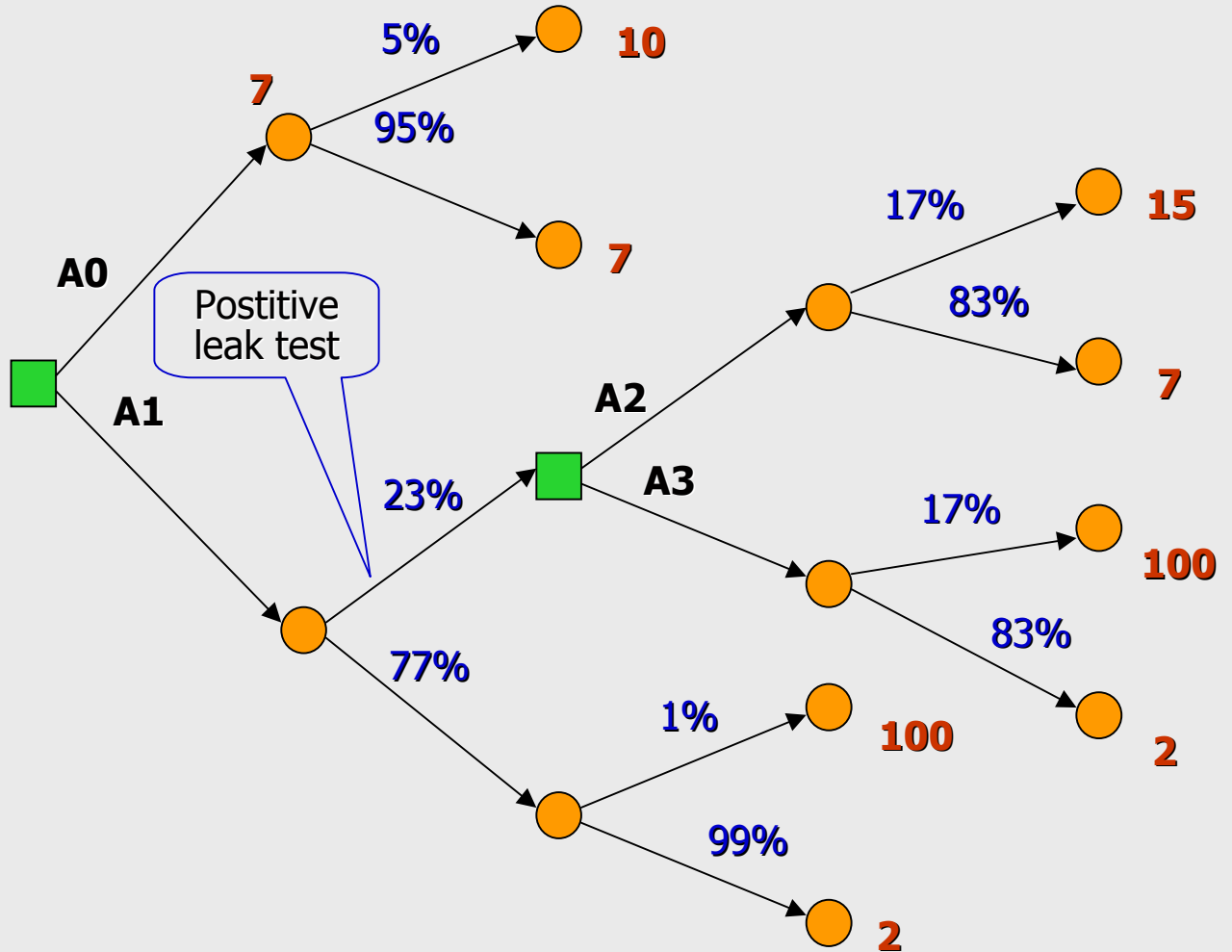
# Alternatives

- A0 Immediate countermeasures aiming at a leak.
- A1 Leak diagnosis and deferment of decision.
- A2 Countermeasures following a positive test result.
- A3 No countermeasures even if the test result is positive.

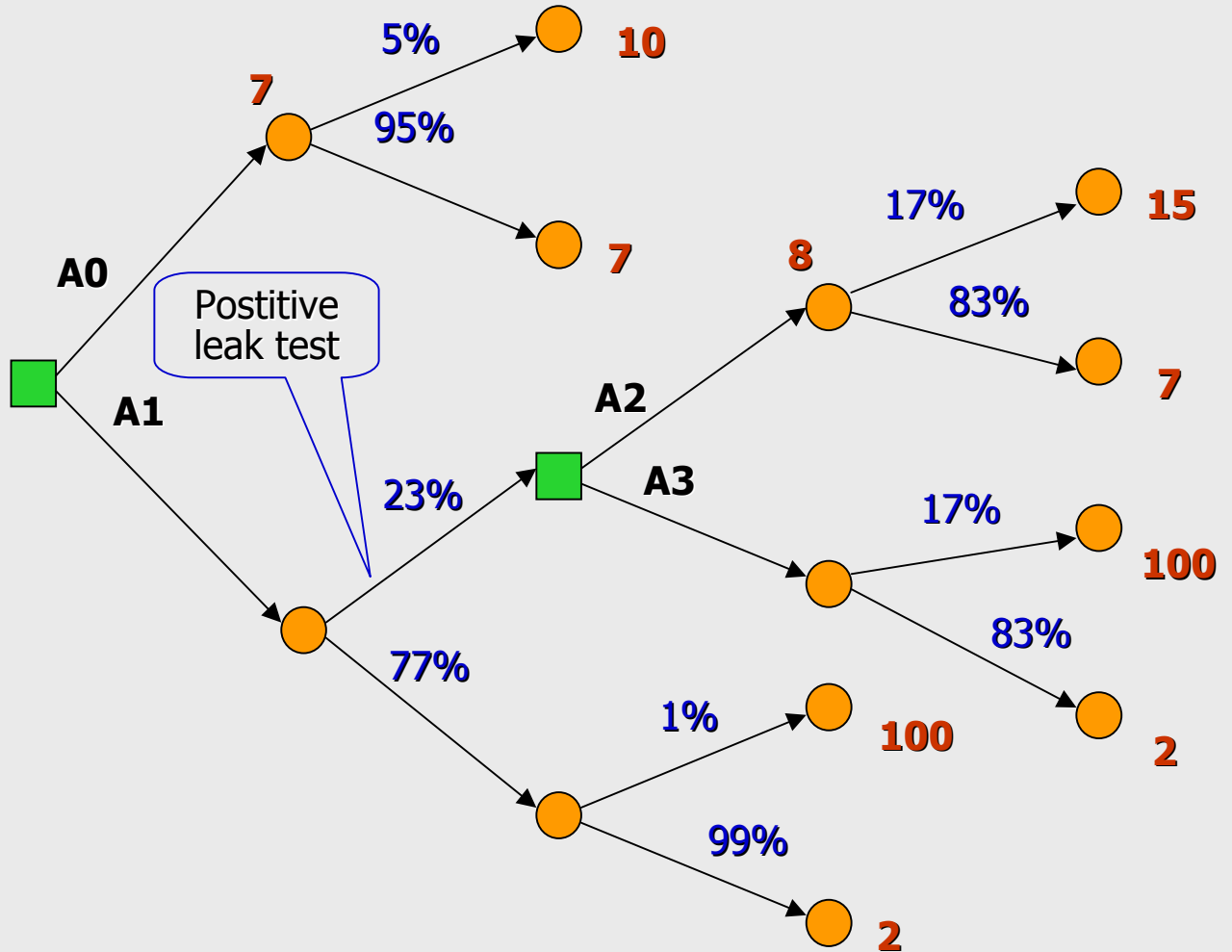
# Decision Event Tree



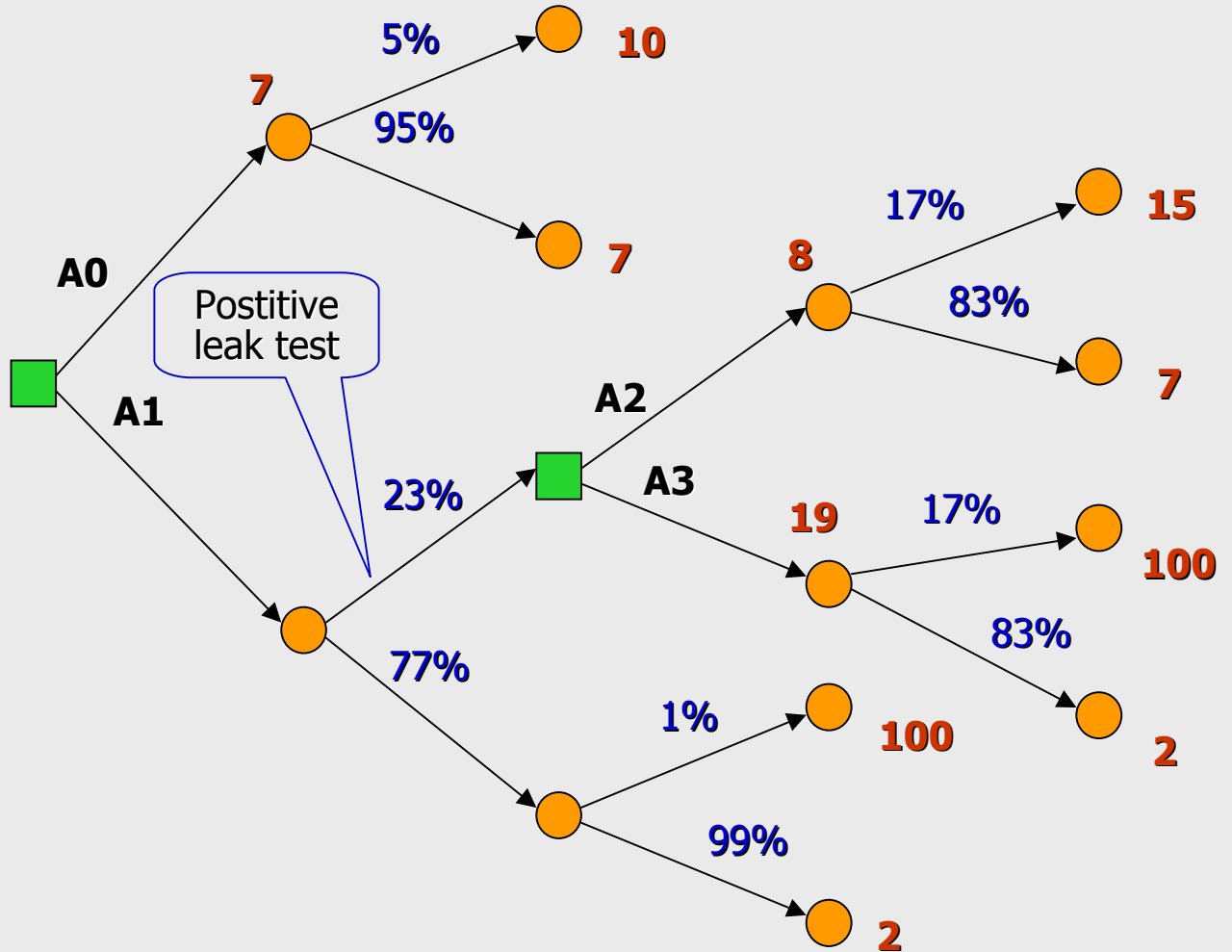
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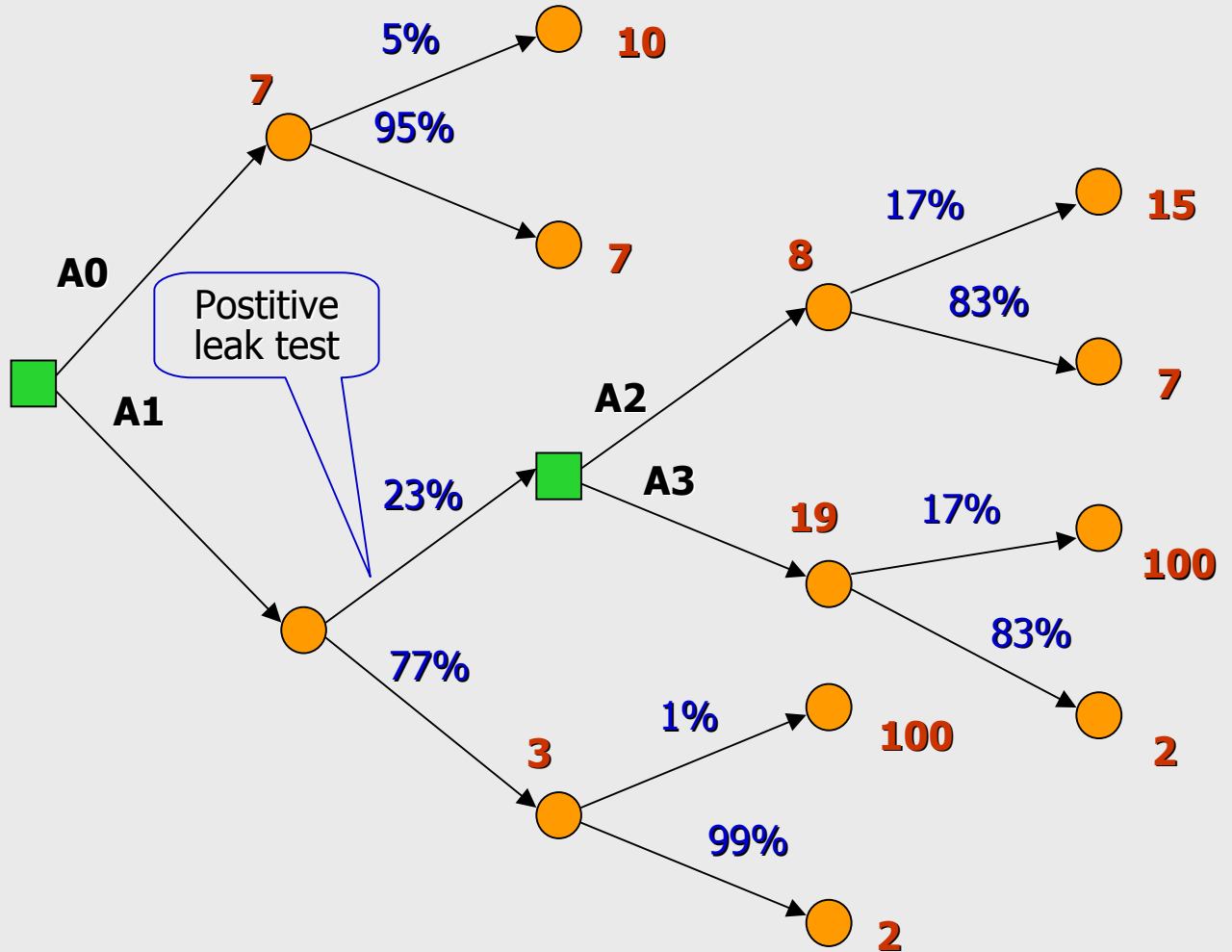
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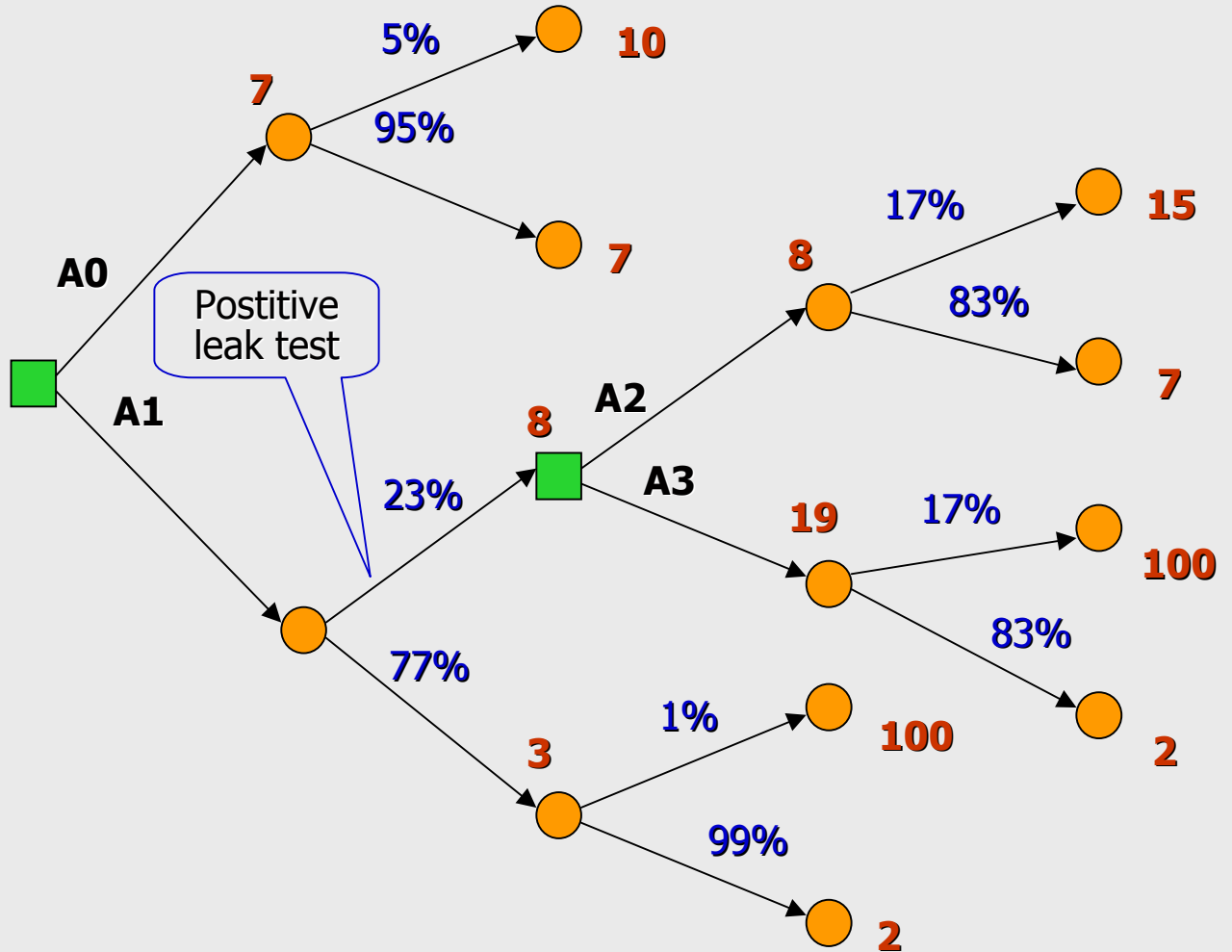
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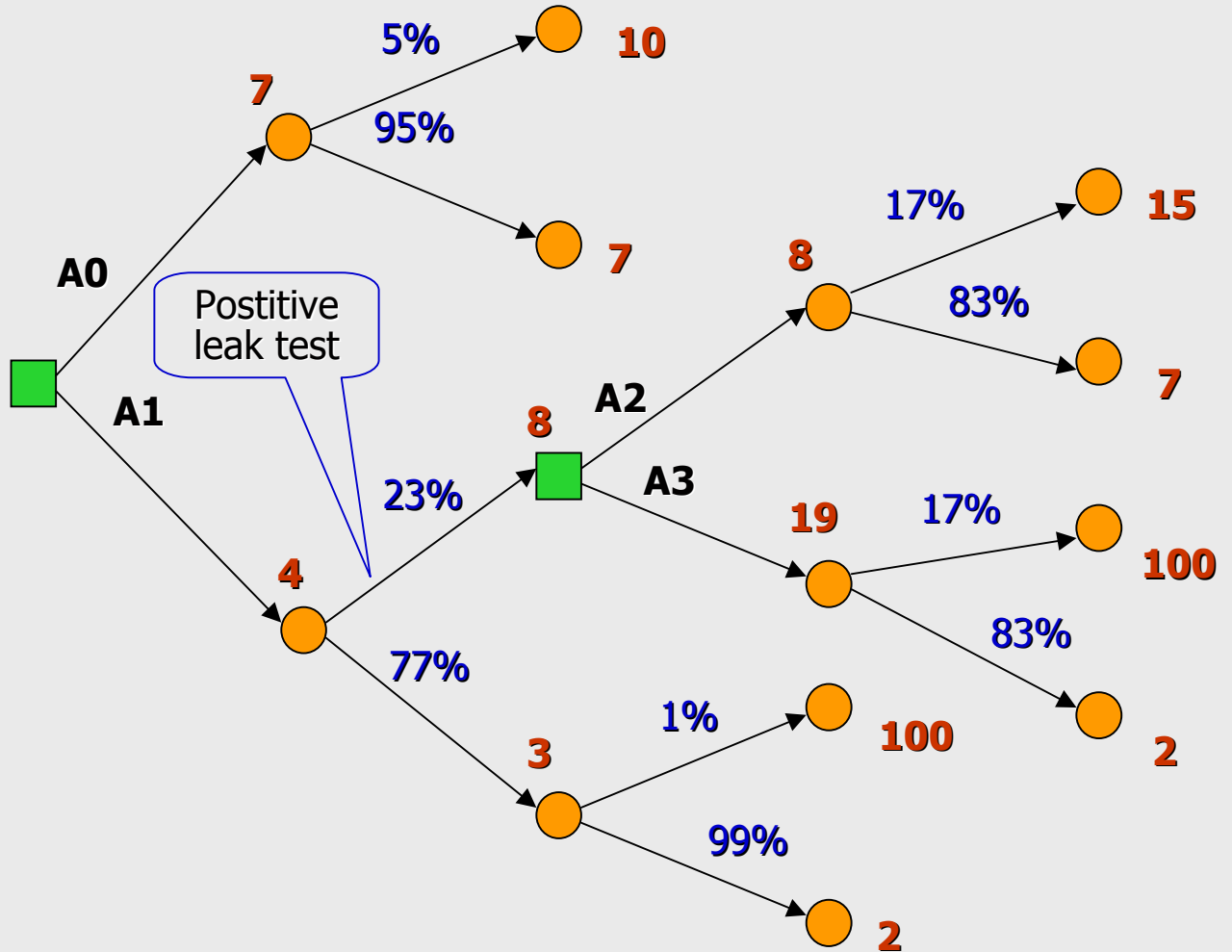
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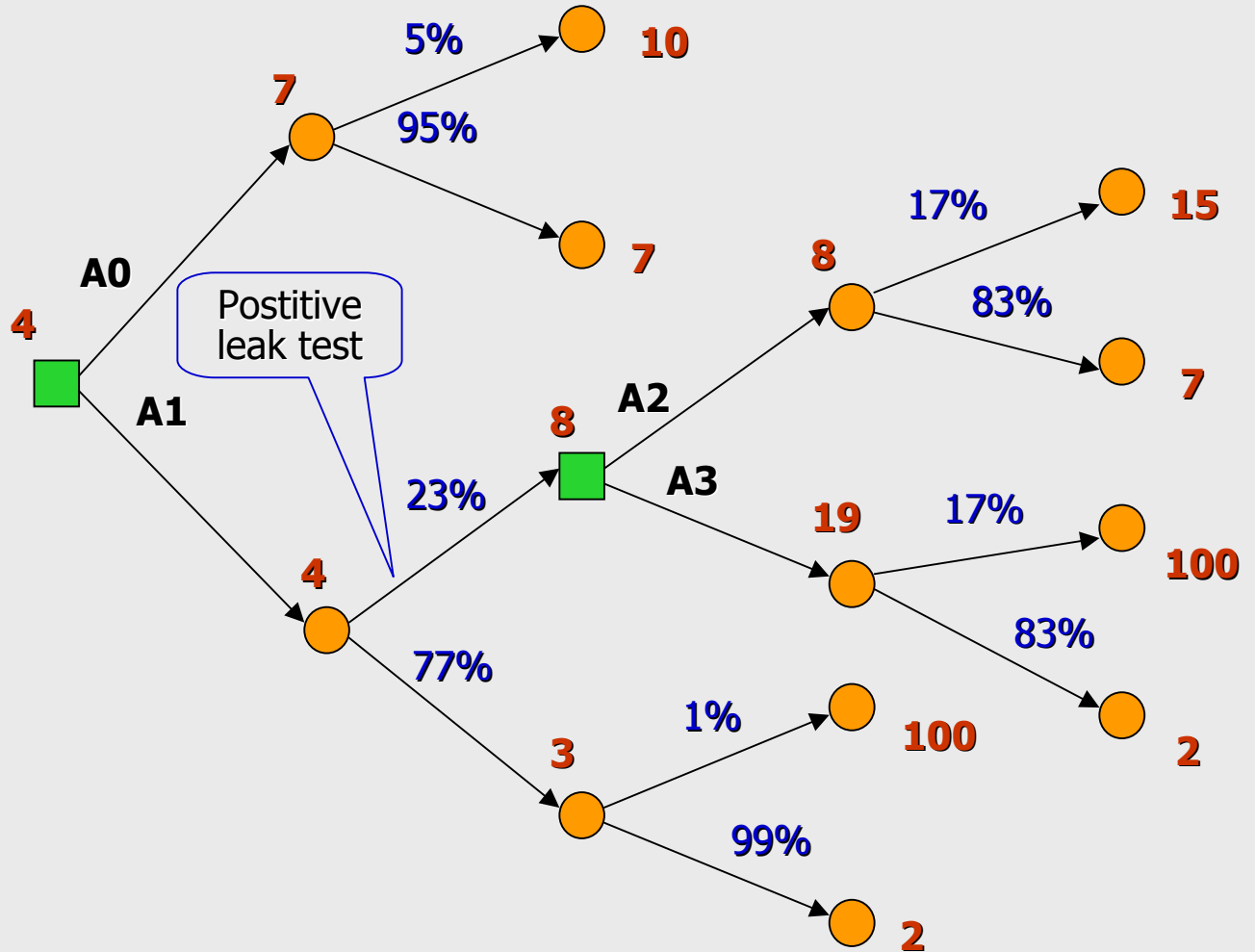
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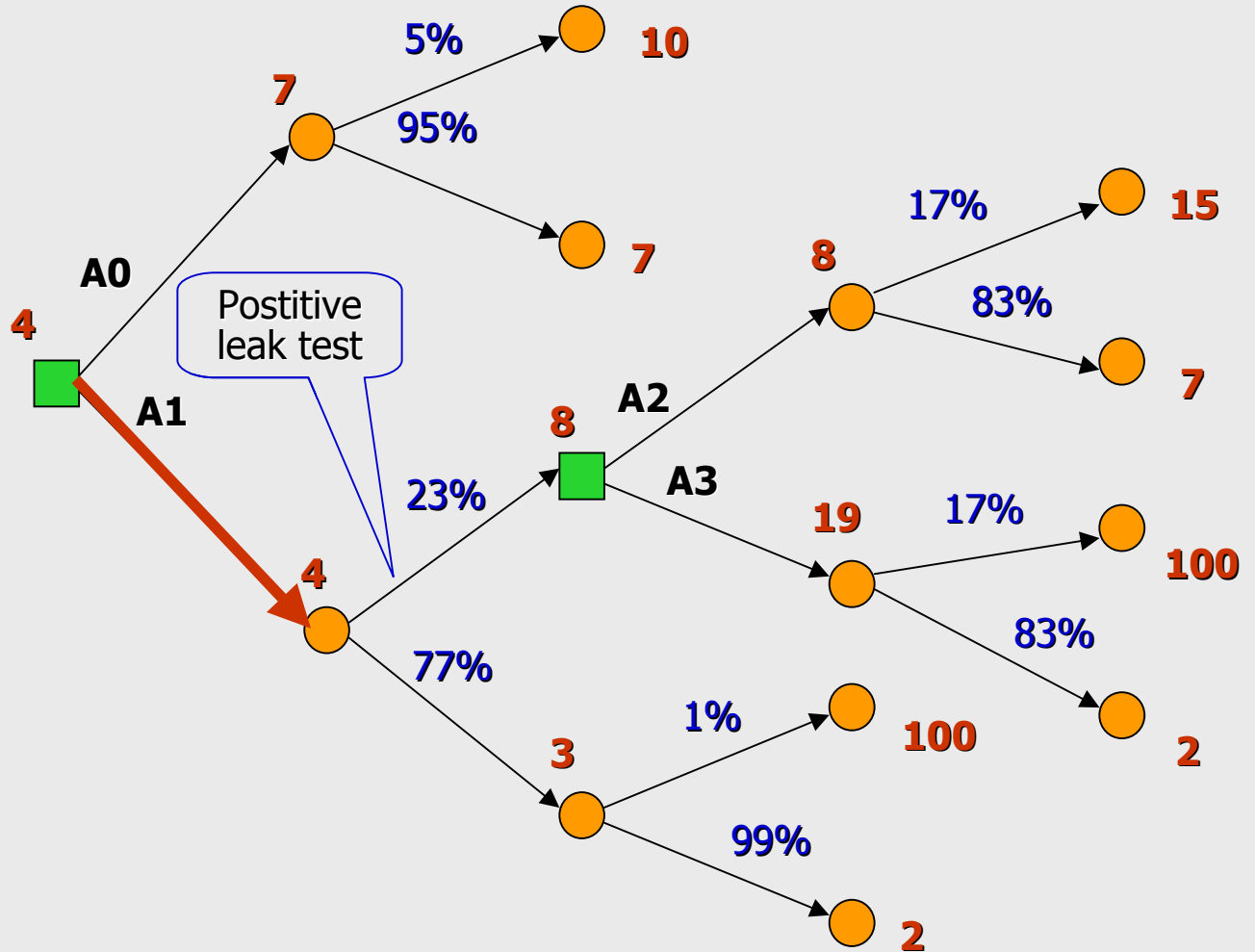
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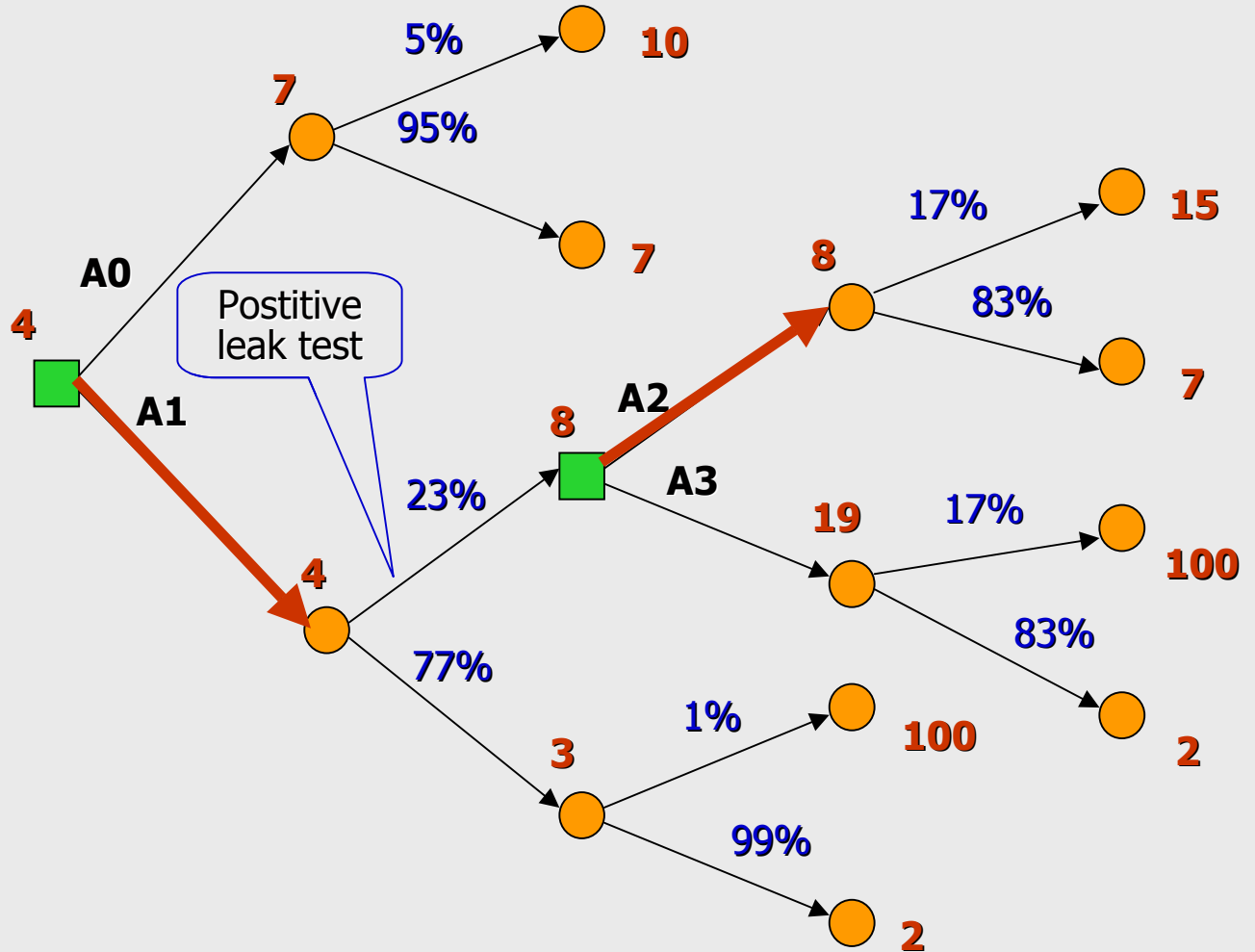
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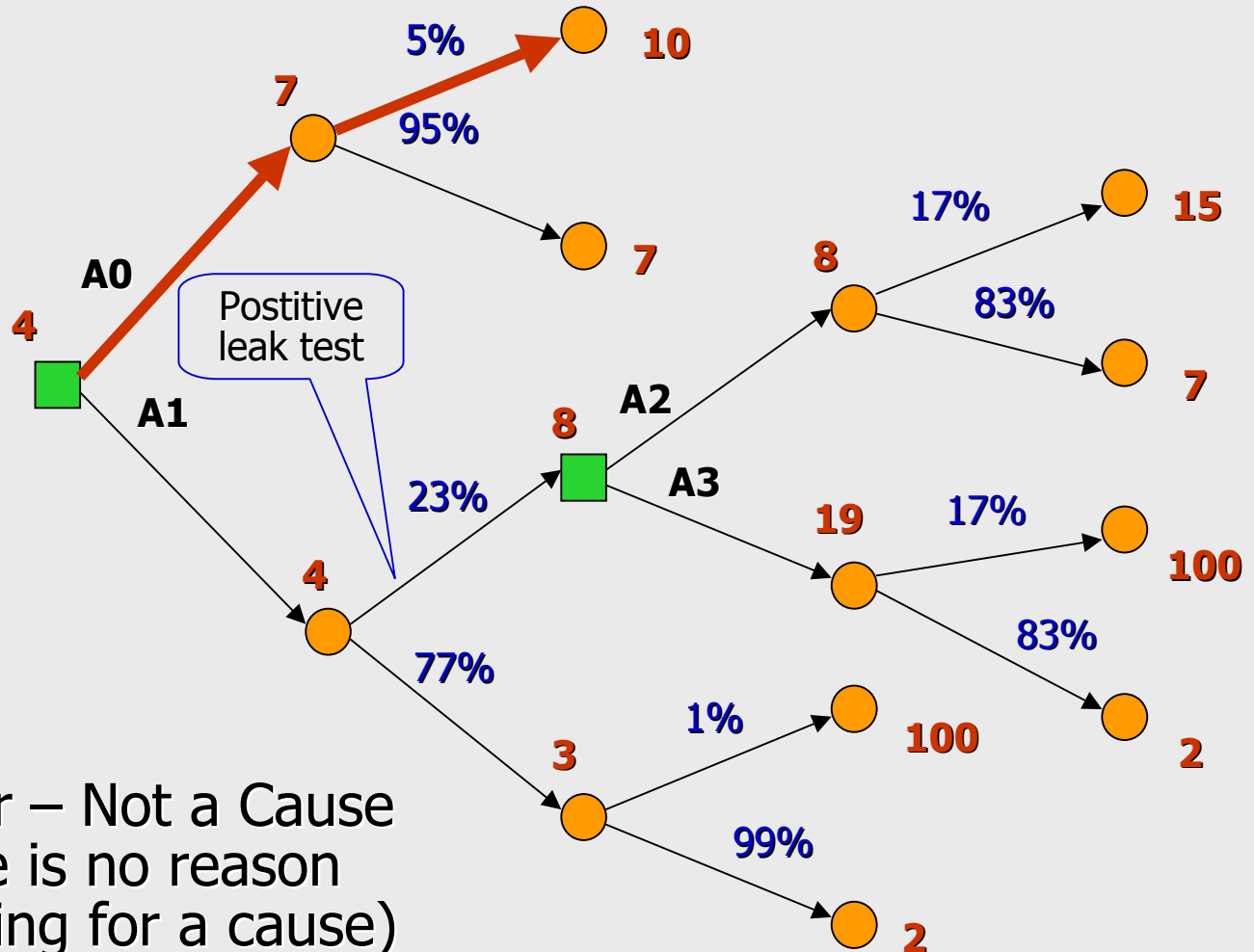


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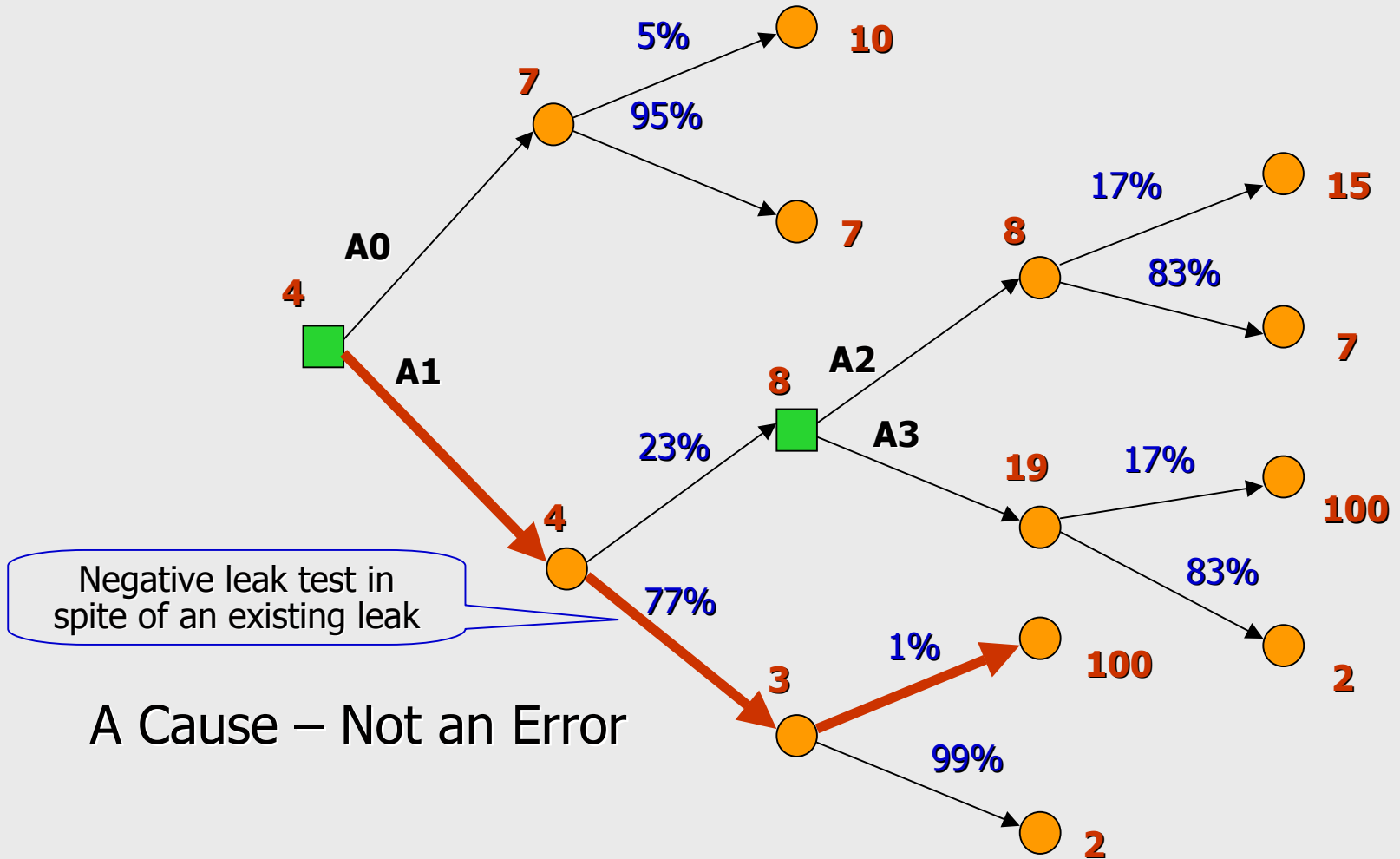
## Wrong decision causes good result



An Error – Not a Cause  
(there is no reason  
for looking for a cause)

# The Leak Scenario

Right decision causes bad result



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Causal analysis with respect to a certain predefined scenario (or an accident as it happened) may reveal **causes** but not **errors**.

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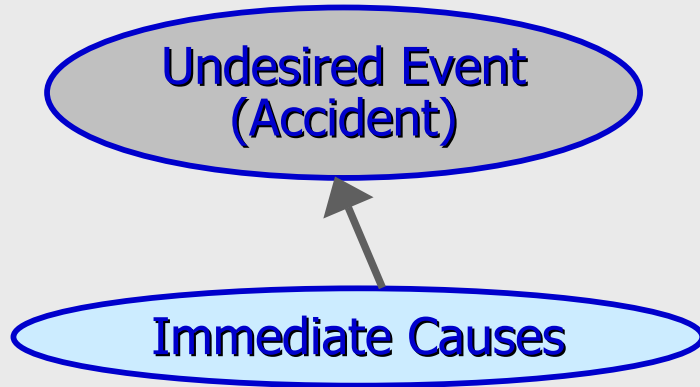
To learn from the **errors** we have to look for the technical, psychological, and sociological **root causes**.

# Three Levels of Causal Analysis

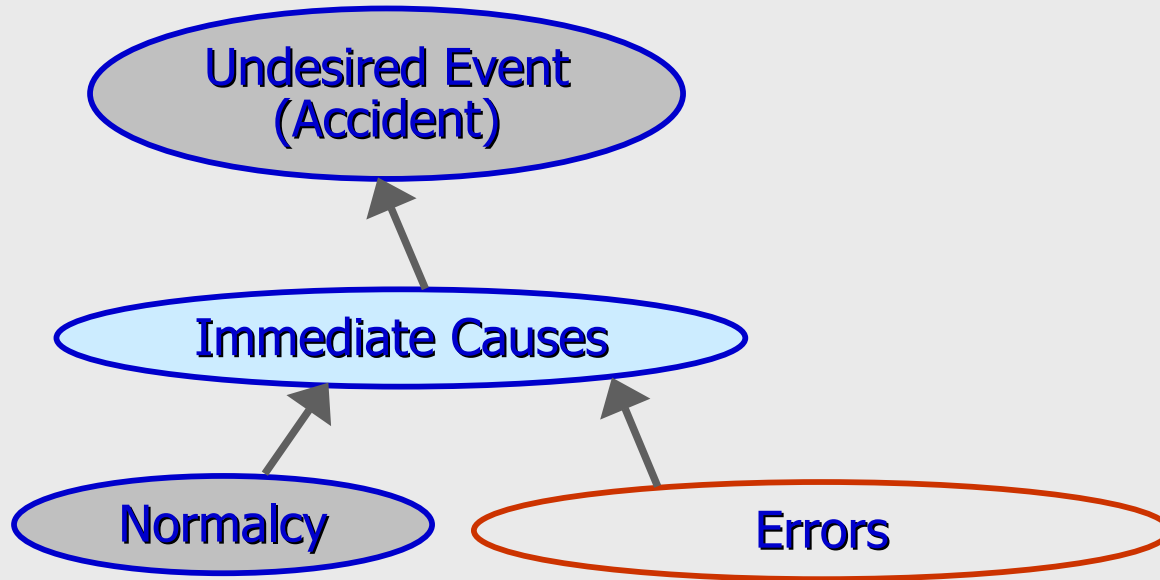


Undesired Event  
(Accident)

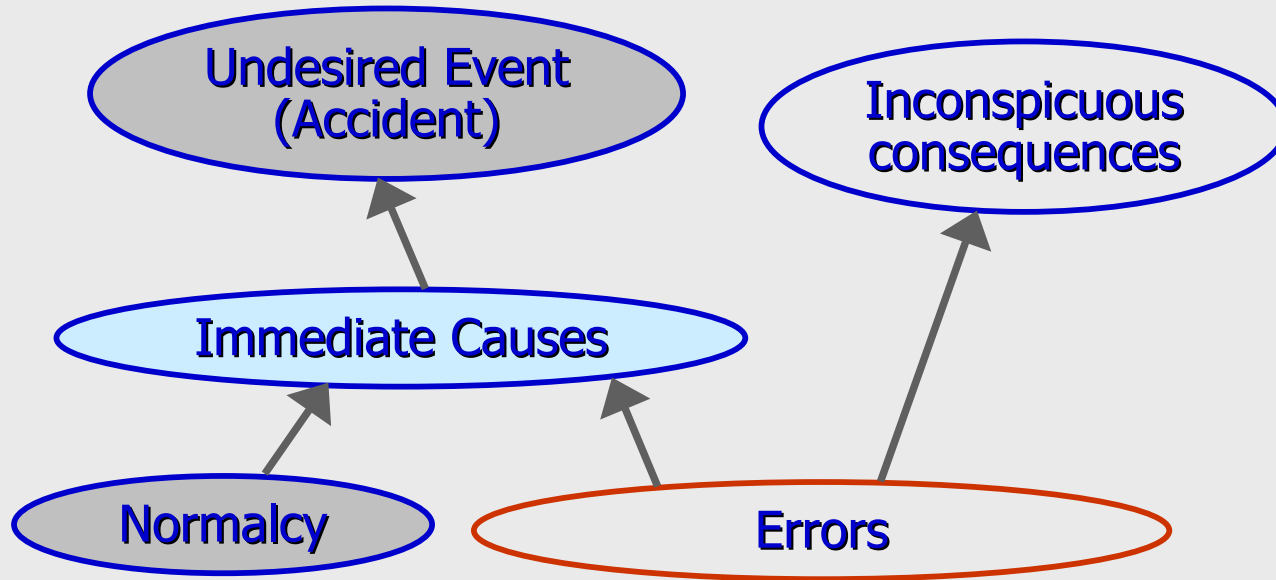
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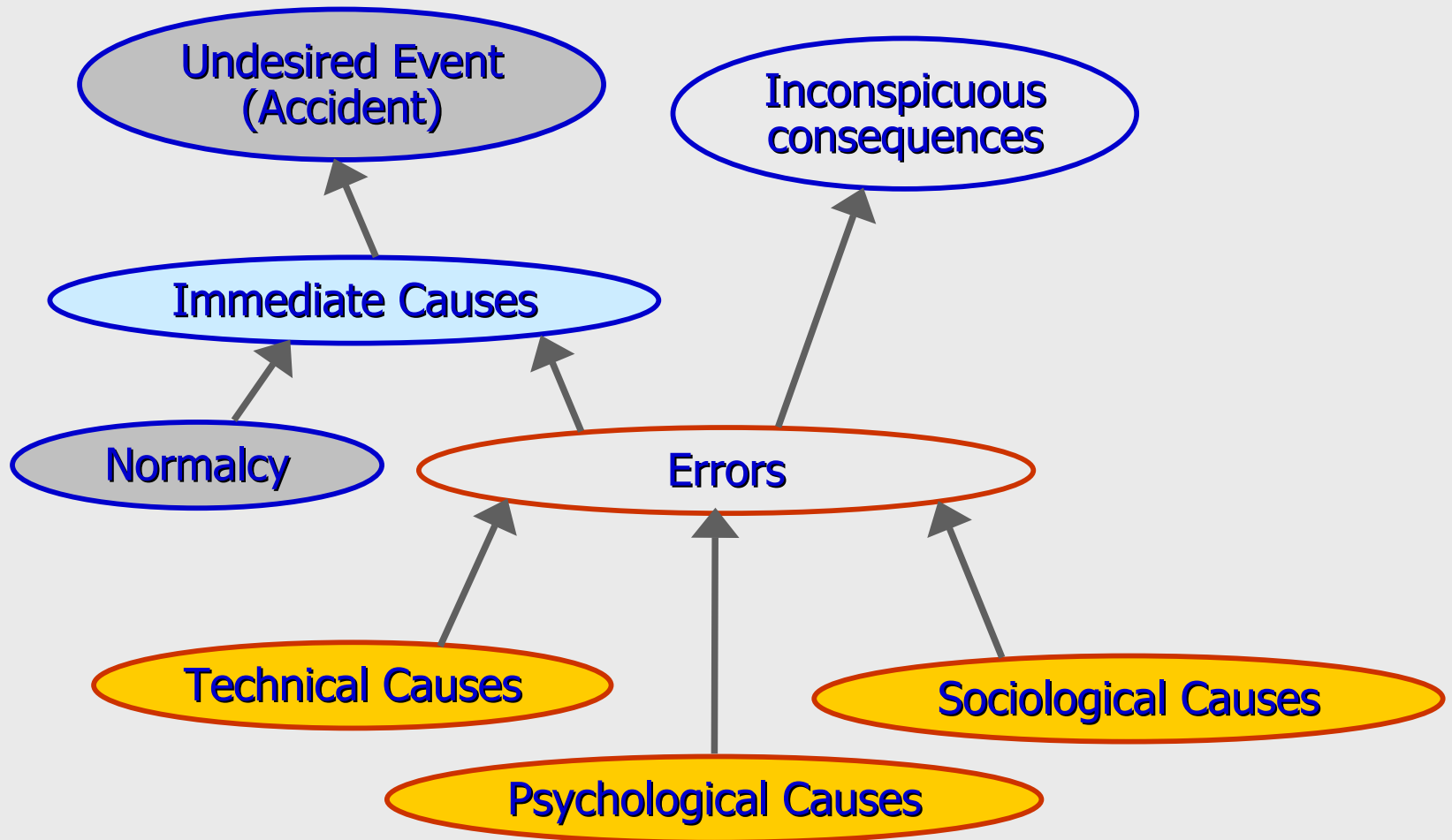
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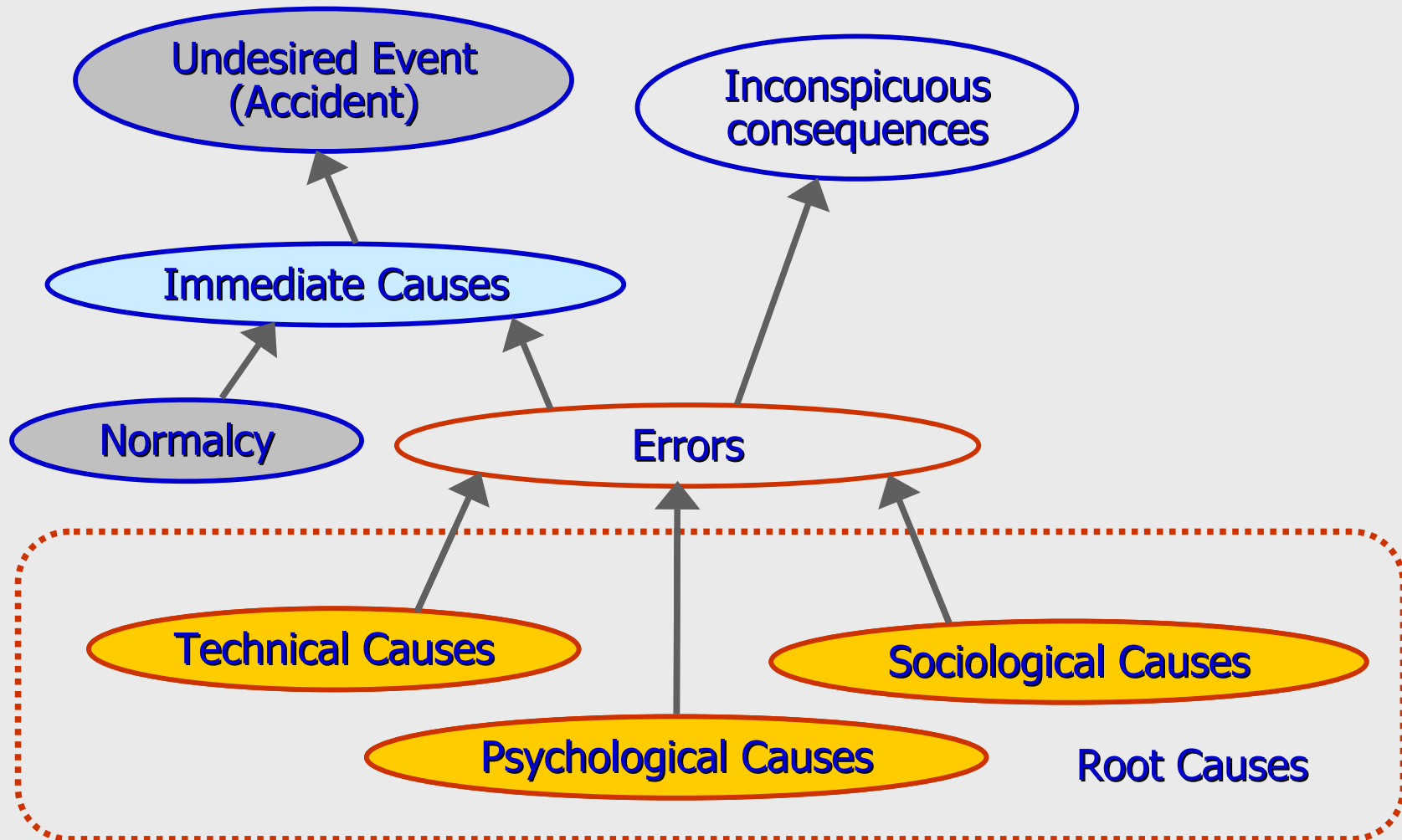
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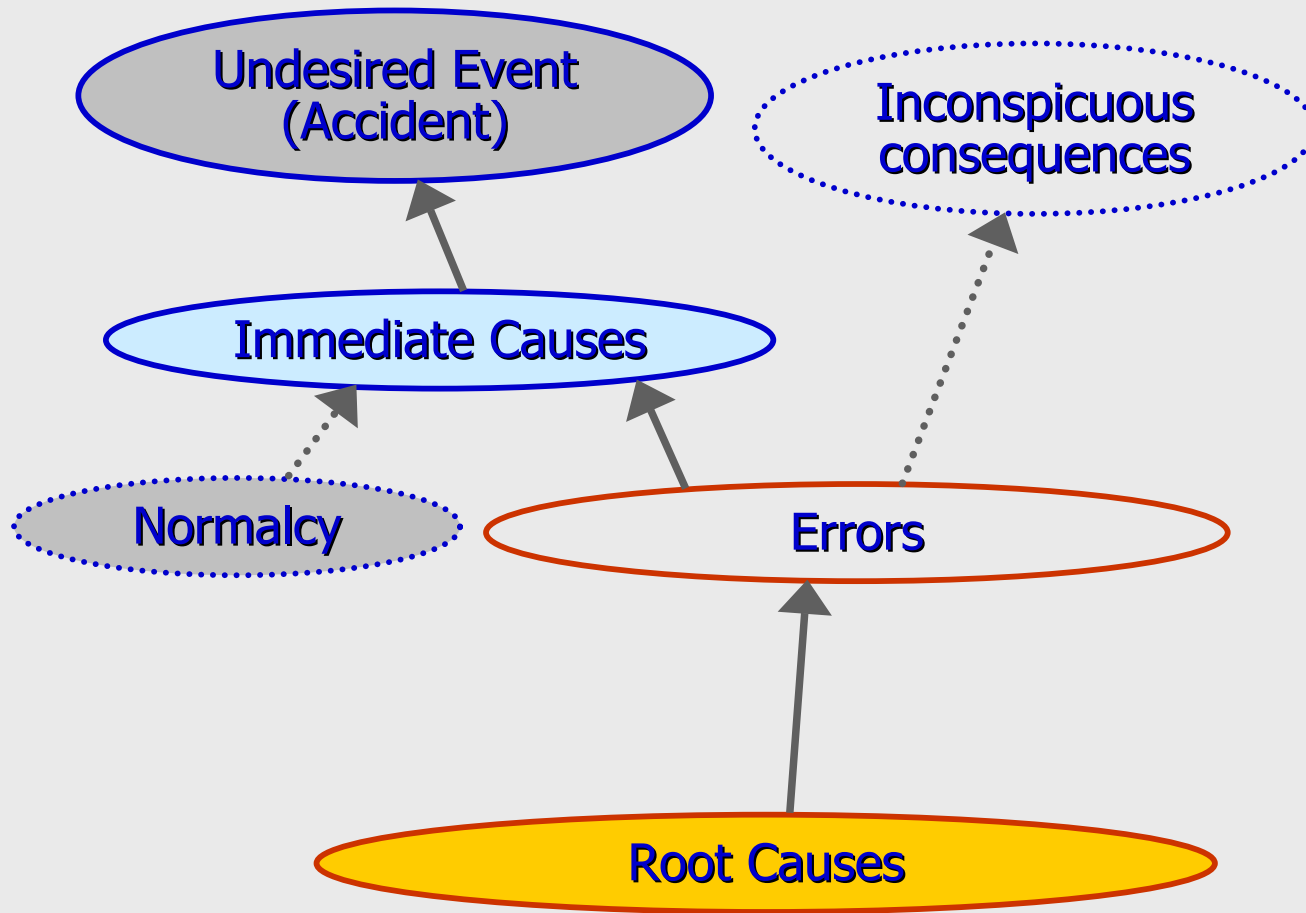
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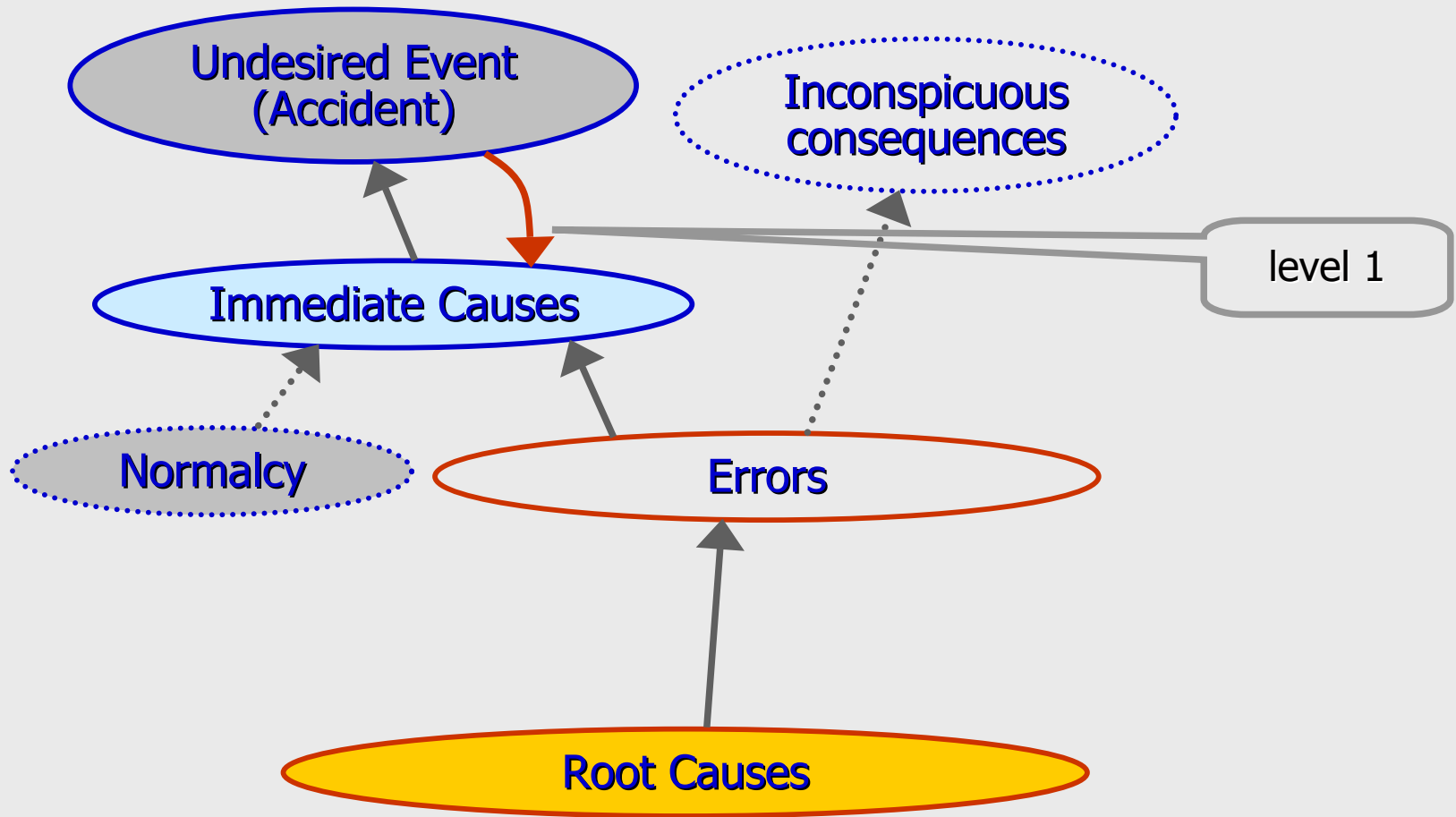
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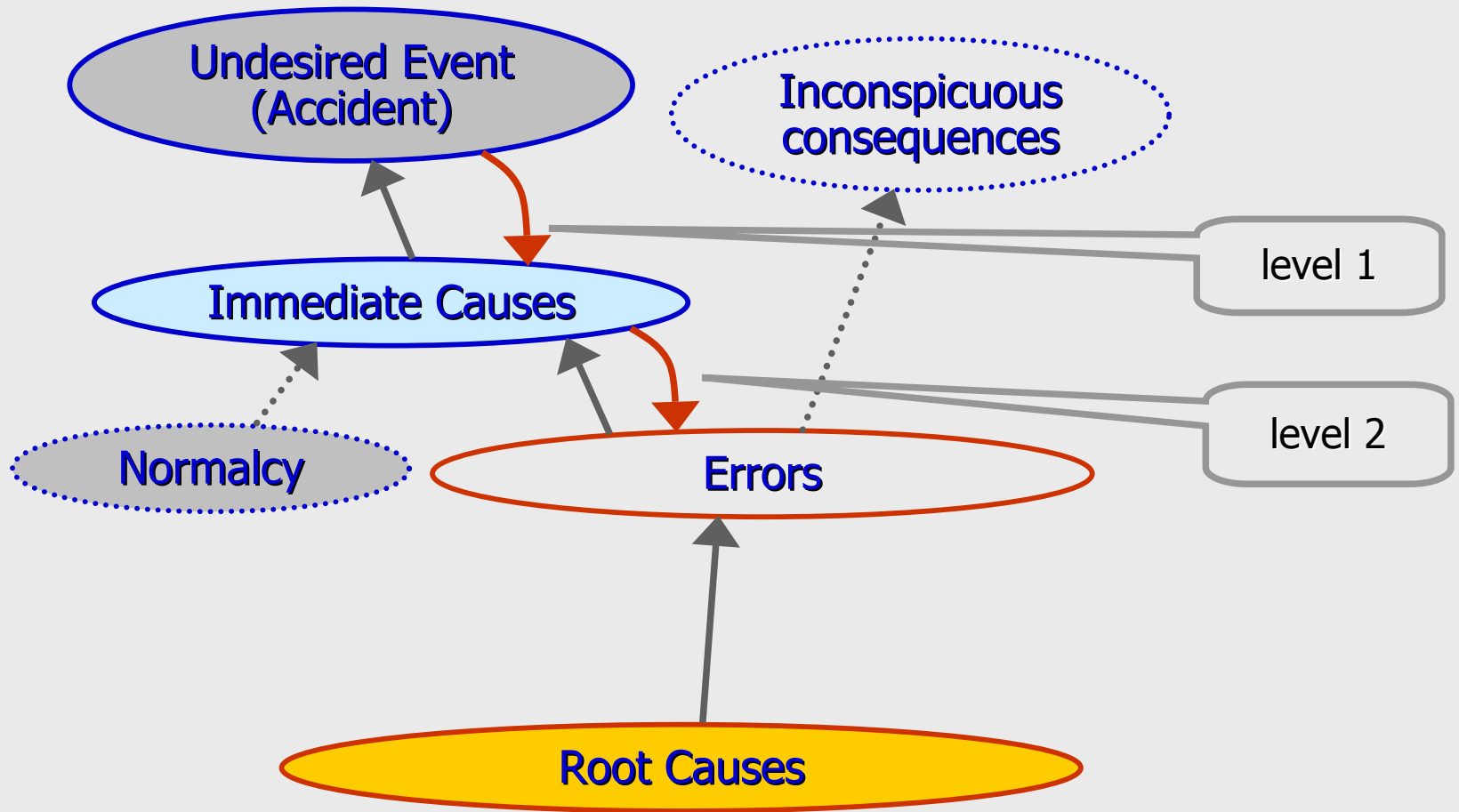
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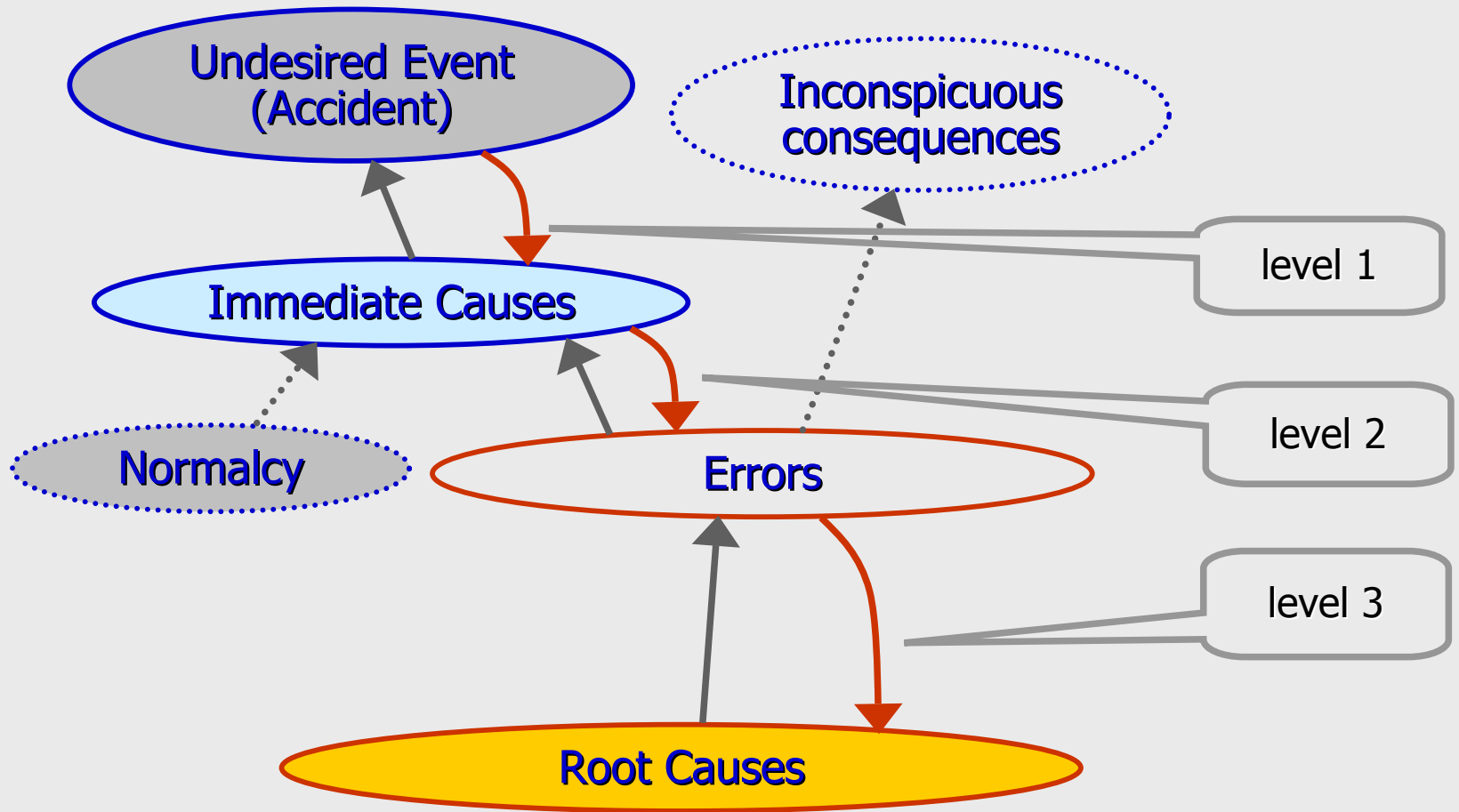
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Problems of normative modeling

- Overlooking organizational factors
- Subjectivity of classification and causal attribution
- Oversimplification
- Lack of knowledge

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## 3 Root Cause Analysis – Learning through Generalization

Use of Taxonomies in the technical, psychological and sociological fields

- Poor implementation of technical activities (superficial safety efforts, ineffective risk control, ...)
- Deficiency in the safety culture (complacency, ignoring warning signs, overrelying on redundancy, ...)
- Ineffective organizational structure (diffused responsibility, low status of safety personnel, limited communication channels, ...)

# Conclusion

Maximum learning from errors through causal analysis

- Detection of errors
- Deeper understanding of errors
- Revelation of basic error mechanisms (root causes)
- Avoidance of errors of greater classes: generalization