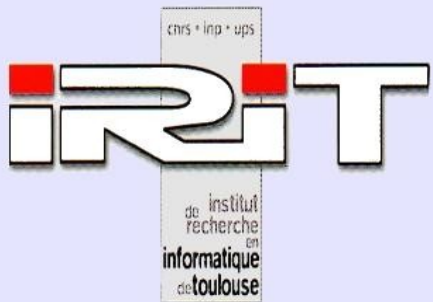


Risk Analysis for Preventive Maintenance of Aircrafts

JACOB Christelle

Supervisors :

CARDOSO Janette
DUBOIS Didier



The project @MOST/ DIANA

@MOST

DIANA

LAAS
Modeling

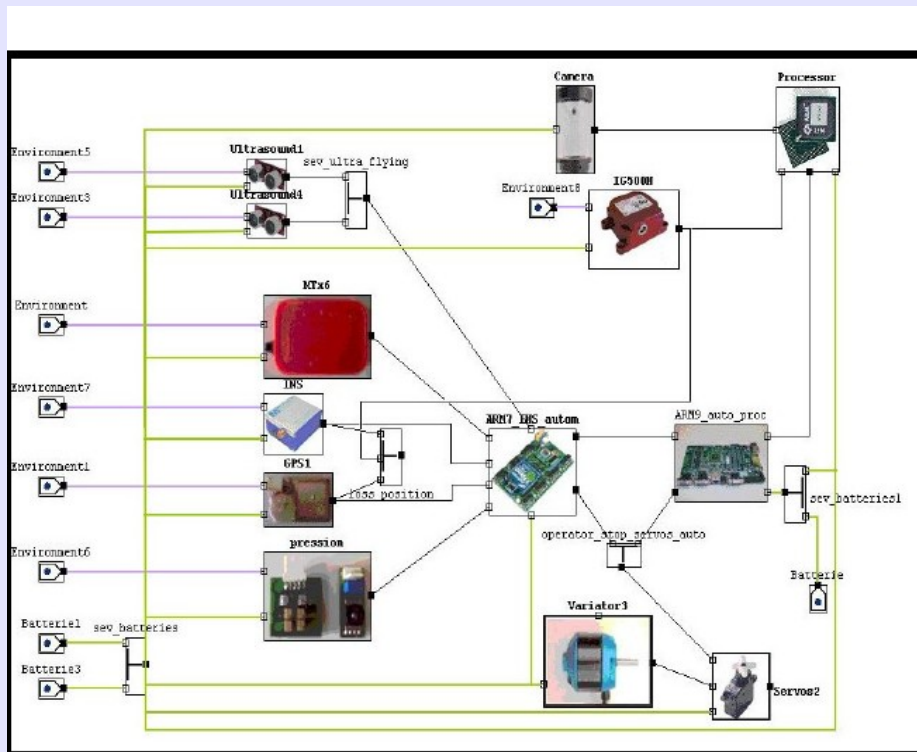
**ISAE
IRIT**
*Uncertainty
Management*

ONERA
*Algorithms
for Calculus
Computation*

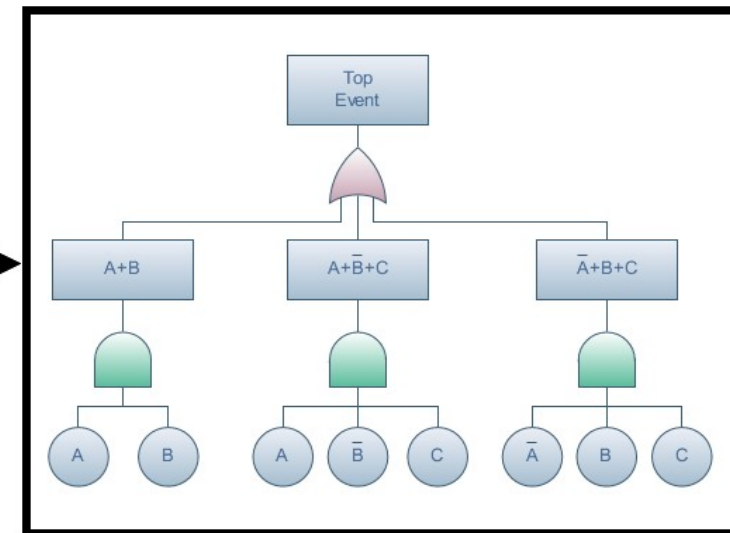
Models used

Cécilia OCAS :

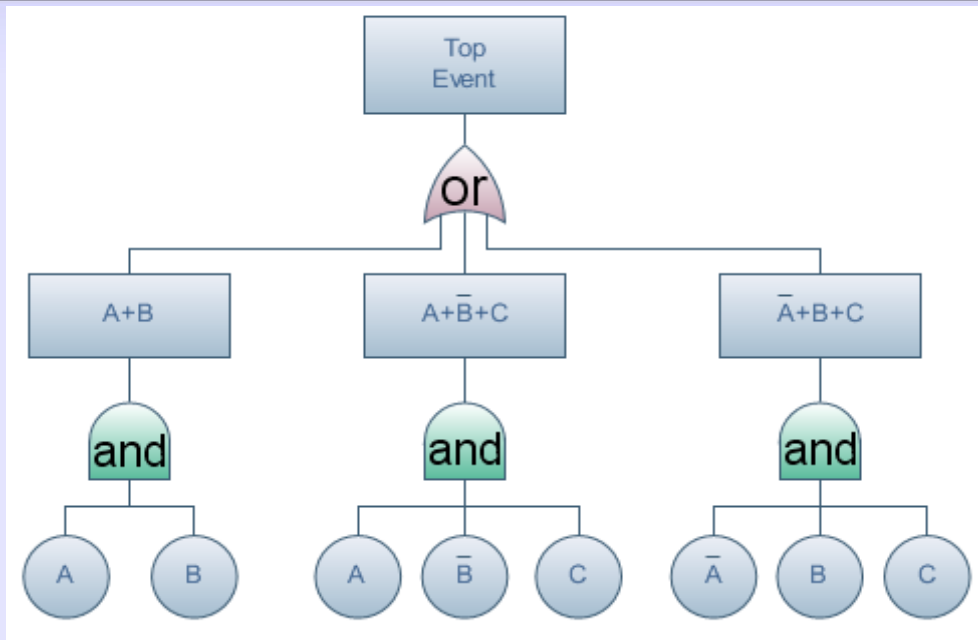
- **Graphical** interface to model the system from a functional or component level in **AltaRica** language
- **Fault-tree Analysis**, computation of probabilities



**Cécilia
OCAS**



Fault-Tree Analysis



Top Event = (A and B) or
(A and not-B and C) or
(not-A and B and C)

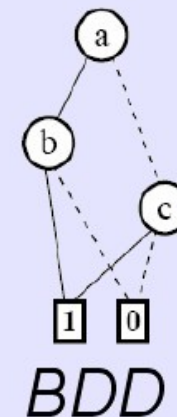
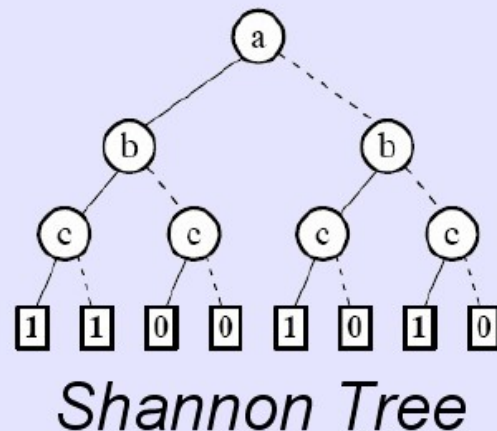
- The **Dread Event** (top-event) of a Fault-Tree can be seen as a **boolean function**.
- A **Minimal Cut Set** (MCS) is the set of all minimal paths to reach the Dread Event. Order of MCS is useful for certification.
- We can associate probabilities to the **Basic Events** (leaves of the tree) in order to compute the one of the Dread Event.

Binary Decision Diagrams (BDDs)

- Data structure used to represent **Boolean Functions**.
- Based on **Shannon Decomposition** : Decomposition of the function with the **If-Then-Else operator**.

$$f = (\neg x \wedge f_{x=0}) \vee (x \wedge f_{x=1})$$

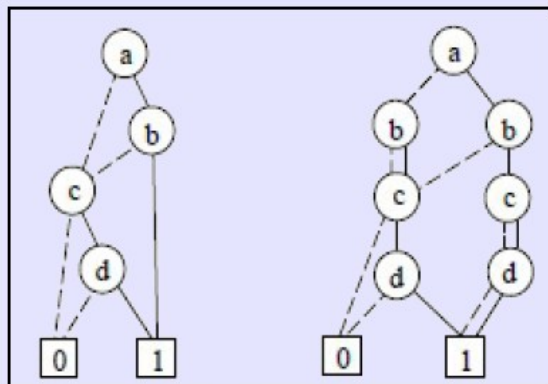
- **Shannon Tree** : Recursive application of Shannon decomposition for each variable of the function
- Simplification rules makes it more efficient and requires less memory



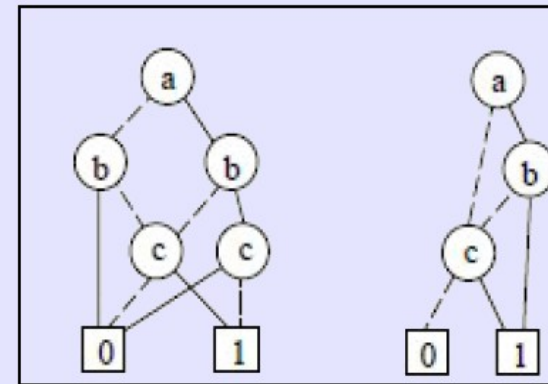
Other types of BDDs

Zero-Suppressed BDDs

- Based on Shannon tree like BDD but different simplification rules.
- More efficient than BDD for sparse sets.



BDD vs. ZBDD for Boolean Function



BDD vs. ZBDD for Set of Sub-sets

Stochastics BDDs

- **Edge-Valued Decision Diagramm** (Lai and Sastry)
- **Multi-terminal BDDs** : represents Markov Chains (Hachtel et al.)

Decision-node BDDs (Siegle)

Conclusion and Discussion

- Study of the combination of BDDs, ZBDDs and probabilities for very huge and complex systems.
- Extension to imprecise probabilities with intervals.
- Second part of the work : study the application of imprecise markov chains in some algorithms of planification or stochastic model checking.