Learning-Based Cell-Aware Defect Diagnosis of Customer Returns

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Introduction

- A customer return is a circuit that passed a comprehensive test flow but has failed on the customer's side
- **The main root causes of a customer return are due to:**
  - Defect not covered during the manufacturing test phase
  - Early-life failures or failures due to various wear-out mechanisms
- Diagnosis program made of several routines is used to identify the suspected defects
- Diagnosis is usually followed by Physical Failure Analysis (PFA)
- But diagnosis **resolution** and **accuracy** are very critical due to the high cost and destructive nature of PFA

Contribution

- We proposed a learning-guided approach for CA diagnosis of mission mode failures in customer returns
- The proposed method is able to deal with all types of defects, i.e. static and dynamic, that may occur in customer returns
- Gaussian Naive Bayes (NB) trained model is used to predict good defect candidates
- Experimental benchmark circuits showed the feasibility and accuracy of this approach
- Results have been compared to a commercial CA diagnosis tool to show the superiority of our approach

Proposed Cell-Aware Diagnosis Framework

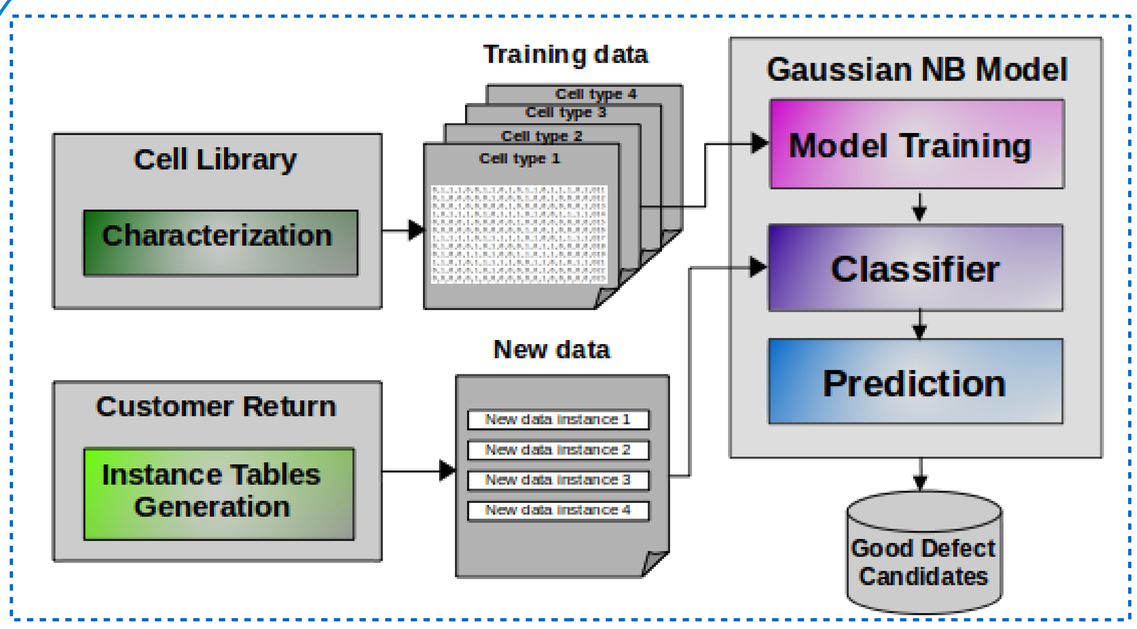

Figure 1: Generic view of the diagnosis flow

- Generate Training Data (done only once for a given cell library)
- Extract New data using costumer return instance tables (Figure 2)
- Generate Gaussian NB model and train it using the training dataset
- Predict the good candidates of each new data using Gaussian NB classifier

- New data represents a features vector that characterizes the real behavior of the cell during test application
- Instance tables describe the suspected cell behavior (Pass/Fail) when a test pattern is applied

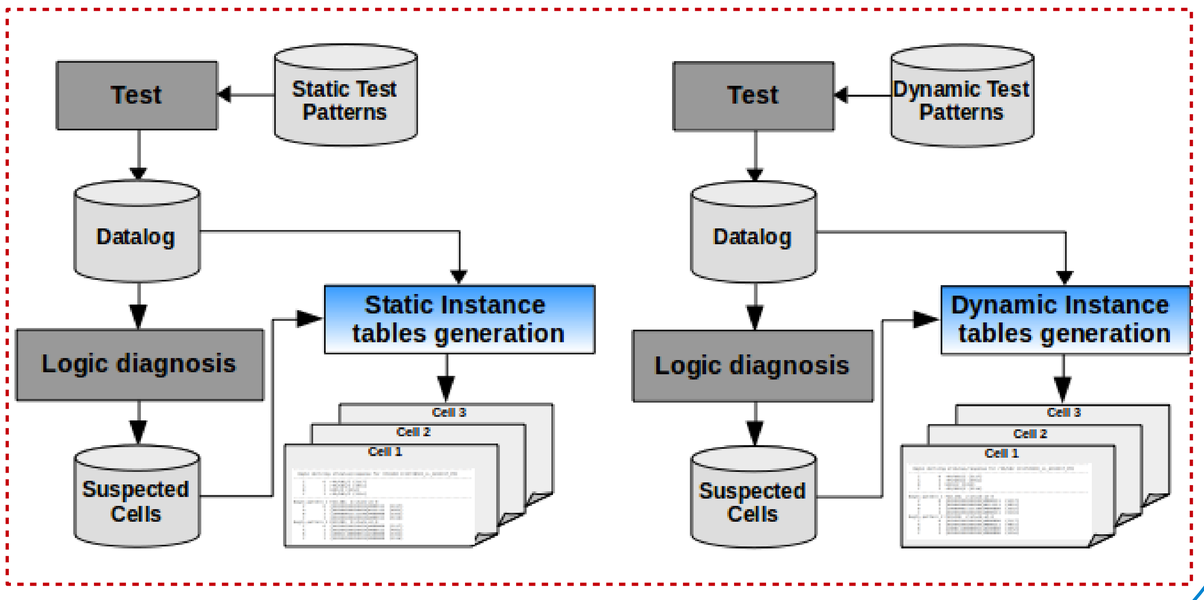

Figure 2: Generation flows of static and dynamic instance tables

Experimental results

Circuit	Accuracy		Resolution	
	Proposed	Com. Tool	Proposed	Com. Tool
b15	100%	100%	2.047	3.79
b17	100%	100%	7.20	11.146
b18	100%	97.70%	4.129	5.733
b19	100%	98.90%	1.818	2.857
b20	100%	99.11%	2.299	2.947
b22	100%	99.12%	3.746	4.823

Table 1: Overall Diagnosis Results

- Experiments on ITC'99 benchmarks circuits
- Synthesized using a 28nm FDSOI technology from STMicroelectronics
- An ATPG tool (commercial) to generate test patterns for each circuit
- ➔ For 4 out of 6 circuits, the commercial tool is unable to achieve 100% of accuracy (achieved with our echnique)
- ➔ The resolution achieved with our method is always better

Conclusion

- We have presented a new framework for cell-aware defect diagnosis of customer returns based on supervised learning
- The proposed flow indistinctly deals with static and dynamic defects that may occur in costumer returns
- Experimental results show the superiority of our approach compared to a commercial CA diagnosis tool