FRD_V1

Business Requirements Document
Semiconductor Wafer Map Unsupervised Classification

CS 461

Senior Software Engineering “Capstone” Project

Status:	In Progress
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Executive Summary

Using machine learning for unsupervised classification of semiconductor wafer parametric heatmaps. Using clustering we will attempt to find patterns and anomalies in the heatmaps.

The Capstone team will aim to:

- Enhance wafer quality assessment
- Enable process optimization
- Be clearly documented, understandable, and extensible

Wafer Classification will target launch by the end of June 2025. Specifically, a machine learning model will be able to intake test data and infer a class for the wafer.

Objectives

Create a machine learning model that when given input of test results, will be able to classify and group by anomalies and patterns of the semiconductor wafer.

Key Performance Indicators

- Better understand wafer quality
- Enable process optimization
- Classification of wafers relates to physical principles
- Tooling is ergonomic and extensible

Needs Statement

We need a robust set of data, as well as better understanding of said data. We also need to understand what is possible for process optimization, and how that can be measured. Once initial exploration is done, we will need analysis of our successes and failures. The feedback will be used to iterate on the inference model, and tie the inferences to real physical phenomena as detailed by the manufacturer.

Project Scope - Deliverables

Ideal state:

- Provide the model a set of test results.
- Model then classifies the input, and infers results of tests that are missing.
- The Capstone team creates meaningful class labels and tools for analysis.
- The manufacturer can understand this data and modify processes to reduce anomalies.
- Over several iterations, the tool can enable decision making to manufacture a superior product.

Example of full experience in ideal state:

- An engineer finds that a certain product line of semiconductors is receiving low yield
- The engineer can then put all the data into the model, having it classify the wafers by patterns, and provide some analysis.
- The engineer can then modify the tools within the manufacturing process based on those patterns to attempt to improve the semiconductor.

Requirements

- Provides analysis of test data
    - Provide which wafers were identified with each pattern
    - Provide a report of the patterns discovered
- Information is usable for manufacturing improvements

Key Stakeholders

- Manufacturer (Product engineers)
    - Goal: more reliable products and processes
- Data Team
    - Further the Capstone team's understanding of the domain
    - Interface with Capstone team
- Capstone Team
    - Explore the data
    - Classify patterns
    - Predict die failure

General Timing Requirements

- By the end of the term, have a process that can accept data.
- Be ready to iterate on that process, by having robust data procedures.
- By May 22, 2025 we will need to have a functional package that can accept a dataset and return to the user a list of common anomalies and patterns.

Cost/Benefit Analysis

- Costs:
    - Personnel costs:
        - Engineering: [180 hrs /term * $150]
        - Product: Data & ecosystem already exists
        - Operations:
            - cost of running data through for predictions, and running the model
            - Cost of extending tool as process changes and evolves from original data
            - cost of databricks and support on aws [$0.30/DBU(data brick unit) * 2-60 DBU/hour, run 1/per week]
- Benefits:
    - Savings: Reducing loss from scrap events (10k-30k f0r a scrapped wafer)
    - Yield: Decrease failure rate
    - Time: Reduces the need for engineers to manually look through large datasets for anomalies and patterns

SWOT Analysis

Strengths

- Obtain fast and in depth results.
- Avoids human error

Weaknesses

- Unsupervised learning could provide false or misleading results.
- This is only the first step of automating wafer optimization

Opportunities

- The manufacturer will be able to move through iterations and improvements at a faster rate.
- Improve the cost to profit ratio.

Threats

- Other companies could be producing the same technology.
- Working off false results could lead to worse outcomes.+