SMU
SINGAPORE MANAGEMENT UNIVERSITY

School of
Computing and
Information Systems

Predictive Maintenance for Diamond Cutter Machine in IKAS Industry

IKAS 埃克斯工业

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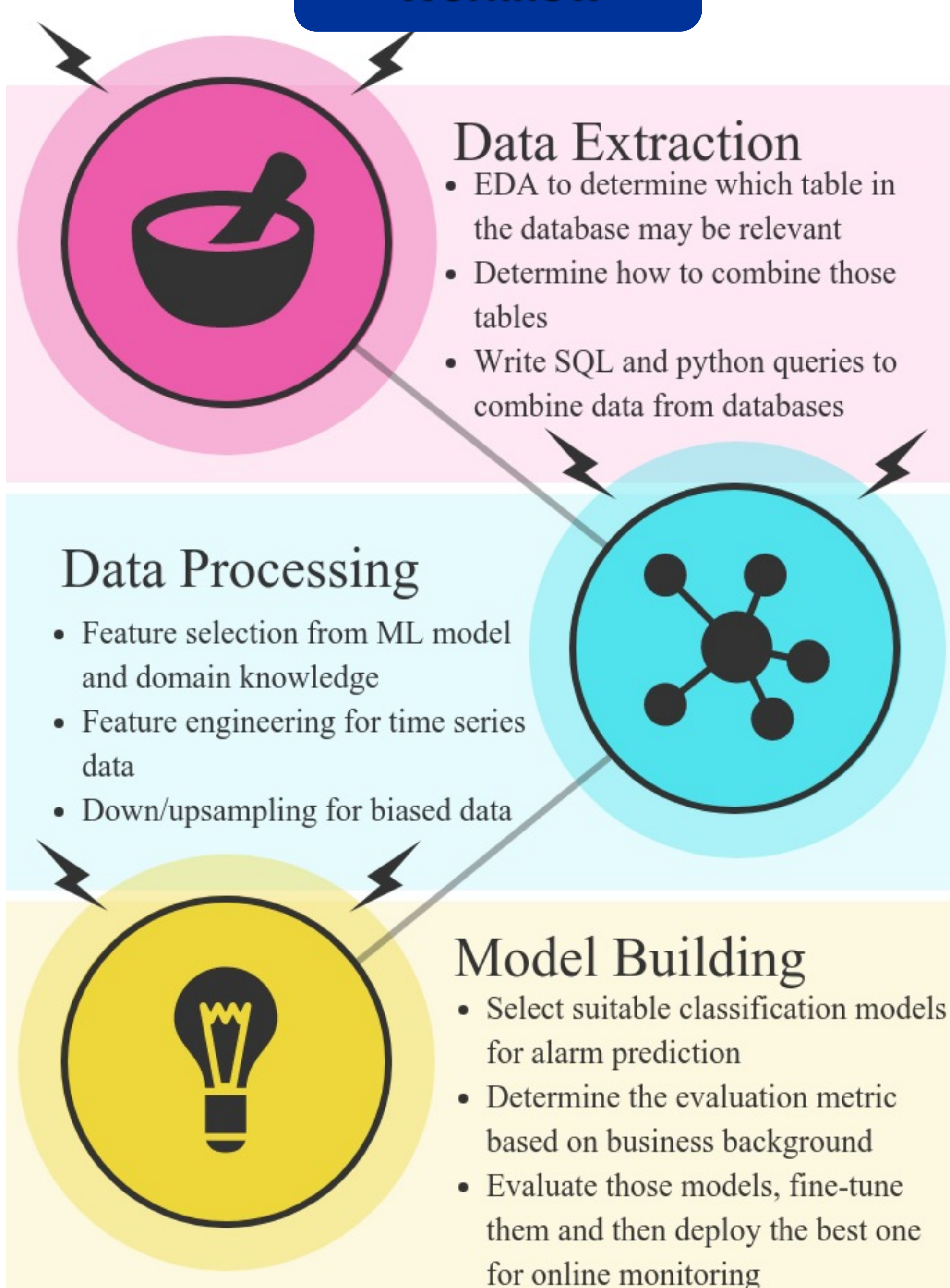**Dr. Liu Bing (CTO @ IKAS Industry)**

Introduction

Predictive maintenance has been recently emphasized in the semiconductor industry smart manufacturing. Diamond Wire Saw (DWS) generates a large number of measurements and process data and is difficult to identify key variables and interpret the relationship with fault status.

Objective:
- To implement a machine learning approach to classify healthy and defective state and predict alarm type and timing
- Verify the conjectures and conduct some ad-hoc data analysis for the data from the team

Workflow

Data Extraction
- EDA to determine which table in the database may be relevant
- Determine how to combine those tables
- Write SQL and python queries to combine data from databases

Data Processing
- Feature selection from ML model and domain knowledge
- Feature engineering for time series data
- Down/upsampling for biased data

Model Building
- Select suitable classification models for alarm prediction
- Determine the evaluation metric based on business background
- Evaluate those models, fine-tune them and then deploy the best one for online monitoring

References

[1] Ayvaz, S, and Koray A. "Predictive maintenance system for production lines in manufacturing: A machine learning approach using IoT data in real-time." *Expert Systems with Applications* 173 (2021): 114598.
[2] Wen, Y, et al. "Recent advances and trends of predictive maintenance from data-driven machine prognostics perspective." Measurement 187 (2022): 110276.
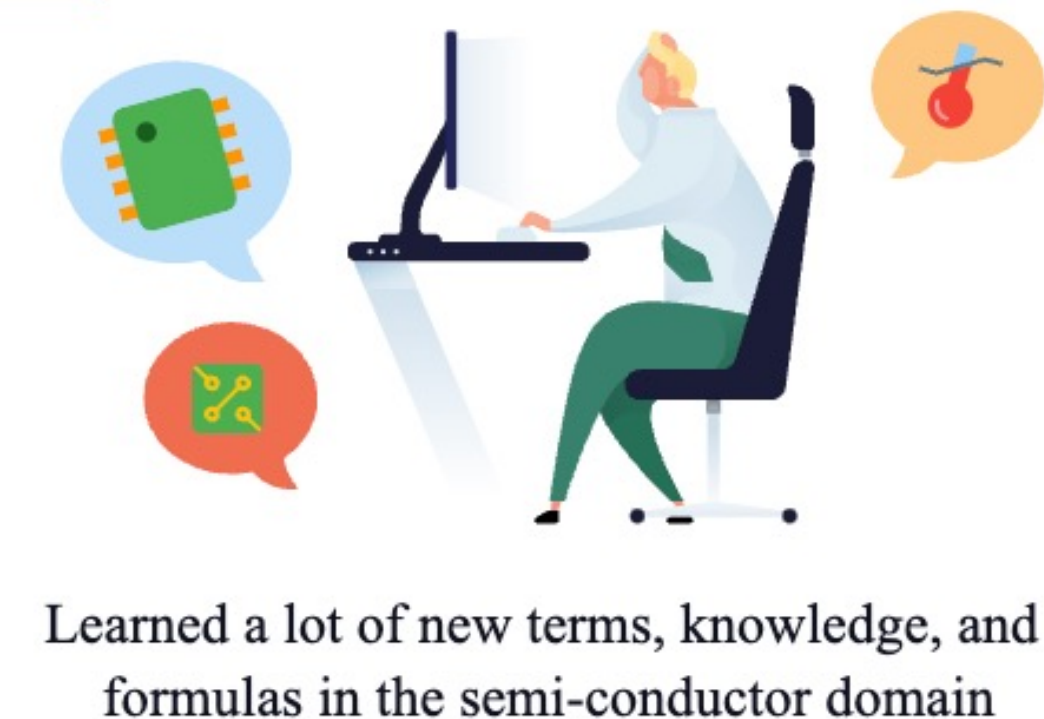
Lessons Learnt

01 Knowledge and skills

gets a lot of opportunities to practice those tools:
Python, SQL, Sklearn, Pandas
Git version control
mlflow for MLops

02 Inter-personal relationship

Guidance from senior MLE
Long-time relationship with ppl in the company

03 Industrial experience

Work habits: such as writing good meeting minutes, conducting meetings effectively
Developed some business sense
Model selection for different problems and data sets

04 Semi-conductor domain

Learned a lot of new terms, knowledge, and formulas in the semi-conductor domain

Outcome of the project

The companies have reduced **50% of unplanned downtime** for those expensive diamond cutter machines.

Timeline

Developed project charter including the task and DDL for my internship — **Dec**

Jan — The first feasible data pipeline gets accepted in the monthly quality review meeting

Conduct experiments on different feature sets, and different processing, feature engineering methods to improve accuracy for **binary classification** — **Feb**

Mar — The accuracy reach the threshold to be deployed in production.

Conducted experiments on **multi-classification and regression.** But the multi-classification doesn't seem to work since the data for some alarms are too little, so I clustered alarms and tried multi-classification again. — **April**

May — The new method get approved by research scientist in company. I reported to the team and deployed the model in production environment with senior engineers.

Hand over my work to the next intern Packaged my code and wrote documentation for the ease of the next intern — **June**