VIETNAM NATIONAL UNIVERSITY, HANOI
VNU UNIVERSITY OF ENGINEERING AND TECHNOLOGY

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

INFORMATION ON DOCTORAL THESIS

1. Full name : Nguyễn Khánh Tùng 2. Sex: Male

3. Date of birth: 02/19/1981 4. Place of birth: Ha Noi, Viet Nam

5. Admission decision number: 1200/QĐ-CTSV Dated 29/12/2020

6. Changes in academic process

- Decision No. 1442/QĐ-ĐHCN dated December 29, 2023, on the extension of the study period for the PhD student, with the extension granted until January 1, 2026.
- Decision No. 1445/QĐ-ĐHCN dated July 7, 2025, on the adjustment of the doctoral dissertation title of PhD student Nguyễn Khánh Tùng.

7. Official thesis title: *Research on the development of machine learning techniques for concept drift detection and classification.*

8. Major: Information System 9. Code: 9480104

10. Supervisors: Assoc. Prof. Dr. Hà Quang Thụy and Assoc. Prof. Dr. Phan Xuân Hiếu

11. Summary of the **new findings** of the thesis:

The dissertation focuses on the following objectives:

- Propose concept drift detection models based on ensemble learning and model's hyperparameters optimization.
- Propose concept drift classification models using prototypical networks and sliding window strategies to handle various types of drift.
- Propose a drift type classification model based on representation space analysis and optimization.

The subjects of the research are the models for handling concept drift and the techniques applied within those models.

The dissertation adopts a mixed-methods approach that combines qualitative and quantitative research.

- The qualitative part involves analyzing concepts and models from a broad range of related literature and research materials aligned with the research objectives.
- The quantitative part consists of building and executing experimental systems, designing relevant scenarios to evaluate the performance of the proposed techniques and models, and validating the effectiveness of the proposed solutions.

Contributing to the global research trend on concept drift handling, the dissertation delivers three main contributions:

- Improved Drift Detection Framework: The dissertation proposes an enhanced framework based on the ERICS framework (Haug et al., 2020), introducing two models:
  - E-ERICS: Combines four base models to identify both sudden and incremental drift points.
  - ERICS+3: Combines three base models to detect gradual drift points.
- Improved Drift Classification Frameworks: Two improved classification frameworks are proposed:
  - VAR-WIND: Enhances the feature extraction stage of Meta-ADD (Hang Yu et al., 2022) by applying various windowing strategies.
  - MetaLDD-Finetune: Introduces a fine-tuning stage after the pre-training phase of to improve drift type classification accuracy.
- Propose a Drift Classification Framework Based on Feature Space Optimization: A novel framework called CS&AM_SC is developed to improve drift type classification by optimizing the representation space of prototypical networks.

12. Practical applicability.

13. Further research directions.

- First, conduct research on applying the DriftLens method proposed by Greco et al. to the drift detection process in E-ERICS/ERICS+3, and experiment on datasets containing strong noise and subtle drift patterns.
- Second, carry out experiments to directly compare foundational few-shot learning architectures (Siamese Networks and Relation Networks) with the prototypical network under the same conditions and datasets.

14. Thesis-related publications:

6. [TungNK1]. Nguyen, K. T., Tran, T., Nguyen, A. D., Phan, X. H., & Ha, Q. T. (2022, November). *Parameter distribution ensemble learning for sudden concept drift detection.* In Asian Conference on Intelligent Information and Database Systems, pp. 192-203. Cham: Springer Nature Switzerland. **Scopus**, **DBLP**, *01 trích dẫn Scopus*.
7. [TungNK2]. Nguyen, K. T., Tran, T., Nguyen, A. D., Phan, X. H., & Ha, Q. T. (2023, November). *Concept Drift Detection in Data Stream: Ensemble Learning Method for Detecting Gradual Instances*. In 2023 Asia Meeting on Environment and Electrical Engineering (EEE-AM), pp. 01-05. **IEEE**[2] .
8. [TungNK3]. K. -T. Nguyen, Q. -T. Ha, X. -H. Phan and Q. -N. N. Han. *A Fine-Tuning Approach to Improve Concept Drift Type Classification Accuracy*, 2024 16th International Conference on Knowledge and System Engineering (KSE), Kuala Lumpur, Malaysia, 2024, pp. 01-05, doi: 10.1109/KSE63888.2024.11063551. **Scopus**, **DBLP**, **IEEE**.

[2] https://ieeexplore.ieee.org/author/697470114198698

9. [TungNK4]. Nguyen, K. T., Ha, Q. T., & Phan, X. H. (2024, December). *Enhancing Drift Type Classification Through Intra-class Variation Reduction.* In International Conference on Applied Mathematics and Computer Science, pp. 168-177. Cham: Springer Nature Switzerland. (First Online: 27 August 2025). **Scopus**, **DBLP**.
10. [TungNK5]. Nguyen, K. T., Ha, Q. T., & Phan, X. H. (2024, December) *Dynamic Windowing Strategies for Concept Drift Type Classification in Data Streams*. In 2024 IEEE International Conference on Progress in Informatics and Computing (PIC) (pp. 70-74). **Scopus**, **IEEE**, *01 trích dẫn Scopus*

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