

Unlocking the Power of Lifelong Learning: Advancing AI Capabilities in Dynamic Environments

Aanal Sanjivbhai Raval

 <http://orcid.org/0000-0003-3848-0882>

Gujarat Technological University, India

Arpita Pareshkumar Maheriya

 <http://orcid.org/0000-0001-5703-4410>

Gujarat Technological University, India

Shailesh Panchal

Gujarat Technological University, India

Komal Borisagar

Gujarat Technological University, India

ABSTRACT

In an era marked by the rapid growth of big data and high-performance computing, machine learning (ML) has seen unprecedented expansion. This increase in data availability and advancements in computational power have opened new avenues for solving complex tasks. However, a significant challenge remains: datasets often exist in isolation, limiting the potential insights that can be derived from integrating multiple data sources. Moreover, ML algorithms frequently perform asymmetrically with varying data volumes. To overcome these challenges, the AI community is developing lifelong machine learning (LML), a paradigm that mirrors human incremental learning. LML systems continuously acquire knowledge and adapt to different tasks, promising enhanced flexibility, adaptability, and intelligence. This article provides a comprehensive overview of LML techniques and methodologies, highlighting the limitations of traditional static learning approaches.

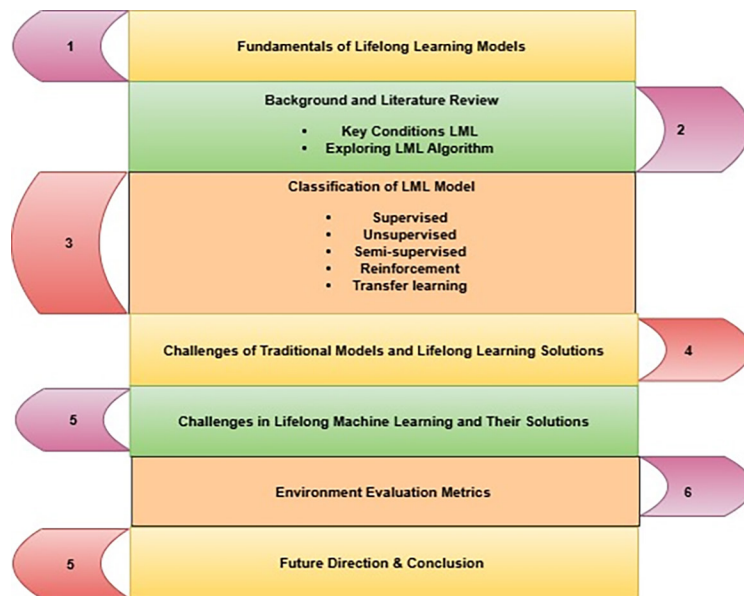
DOI: 10.4018/408153

Copyright ©2027, IGI Global Scientific Publishing. Copying or distributing in print or electronic forms without written permission of IGI Global Scientific Publishing is prohibited. Use of this chapter to train generative artificial intelligence (AI) technologies is expressly prohibited. The publisher reserves all rights to license its use for generative AI training and machine learning model development.

1. INTRODUCTION

The Lifelong Learning paradigm within AI centers on creating systems capable of continuous learning, retaining past knowledge while assimilating new information over time. These systems leverage their accumulated knowledge to enhance performance across various tasks, ensuring continual improvement while retaining previously acquired skills (Sodhani et al., 2022). Formally lifelong learning could be viewed as Integrating an explicit knowledge base (KB) serves to underscore the paramount importance of knowledge accumulation and meta-mining additional higher-level insights derived from retained knowledge amassed through prior learning experiences. This augmentation enables lifelong learning systems to leverage accumulated knowledge as a foundation for meta-learning, facilitating the extraction of broader insights and facilitating more informed decision-making processes. The five key characteristics of Lifelong Learning (LL) are: 1) Continuous learning process, ensuring ongoing skill enhancement. 2) Knowledge accumulation and maintenance in a central knowledge base. 3) Utilization of accumulated past knowledge to facilitate future learning endeavors. 4) Capacity to identify and tackle new tasks as they arise. 5) Capability to learn while actively engaging in tasks or on-the-job learning experiences. A comprehensive lifelong learning system necessitates adeptness in navigating dynamic and unpredictable environments, swiftly adapting to novel scenarios, mitigating the effects of forgetting when acquiring new tasks, facilitating seamless transfer of information across tasks, and operating seamlessly without explicit task delineation. Figure 1 shows the outline of this work.

Figure 1. Summary of Chapter



Lifelong machine learning (LML) entails a continuous learning process where a learner completes a series of N tasks, denoted as $T_1, T_2, T_3, \dots, T_N$. As the learner progresses, it leverages its stored knowledge in a knowledge base (KB), or memory, to facilitate learning the next task, T_{N+1} , together with its related data along with its associated data, D_{N+1} . The

23 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/unlocking-the-power-of-lifelong-learning/408153

Related Content

Construction of Domain Ontologies: Sourcing the World Wide Web

Jongwoo Kim and Veda C. Storey (2011). *International Journal of Intelligent Information Technologies* (pp. 1-24).

www.irma-international.org/article/construction-domain-ontologies/54064

Critical Digital Competencies and Pedagogical Frameworks Within Human Rights Jurisprudence: Democratic Accountability and Policy Implications

Ashraf Alam (2026). *Ethics, Justice, and Governance in the Age of AI and Digital Societies* (pp. 155-204).

www.irma-international.org/chapter/critical-digital-competencies-and-pedagogical-frameworks-within-human-rights-jurisprudence/397484

Agent-Based Modeling for Simulation of Complex Business Systems: Research Design and Validation Strategies

Christoph Schlueter Langdon (2005). *International Journal of Intelligent Information Technologies* (pp. 1-13).

www.irma-international.org/article/agent-based-modeling-simulation-complex/2386

Navigating AI Adoption Challenges in HRM: Insights From the UAE

Alaa Amin Abdalla (2025). *Convergence of AI, Education, and Business for Sustainability* (pp. 215-232).

www.irma-international.org/chapter/navigating-ai-adoption-challenges-in-hrm/371611

Some Generalized Intuitionistic Fuzzy Geometric Aggregation Operators With Applications in Multi-Criteria Decision Making Process

Bhagawati Prasad Joshi (2018). *Intelligent Systems: Concepts, Methodologies, Tools, and Applications* (pp. 1190-1211).

www.irma-international.org/chapter/some-generalized-intuitionistic-fuzzy-geometric-aggregation-operators-with-applications-in-multi-criteria-decision-making-process/205828