Exploring Teaching Pathways for Deep Learning and Smart Tourism Based on Project-Based Learning: A Case Study of the Deep Learning Course at Guilin Tourism University

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Abstract: This paper uses the Deep Learning course at Guilin Tourism University as a case study to start from understanding the application scenarios of deep learning in the tourism industry. It deeply analyzes the problems and challenges of the existing teaching models, introduces the goal design, content design, and the assessment and feedback mechanisms of the course. It discusses how to use deep learning technology to achieve smart tourism, optimize the teaching pathway, and improve teaching quality and effectiveness. The focus is on innovative practices in project-based learning and practical teaching. The paper also provides a forward-looking perspective on the development direction of deep learning and tourism education in the context of AI-enabled industries, offering valuable ideas and references for the continuous reform and innovation of smart tourism education.

**Keywords:** Project-Based Learning; Deep Learning; Smart Tourism

Introduction

As consumer demands evolve, smart tourism, which utilizes information and communication technologies to enhance tourism experiences and industry efficiency, has become a crucial direction for the transformation and upgrading of the tourism industry[1]. Deep learning, a method of machine learning that employs neural network technologies, has made significant achievements in fields such as image recognition, speech recognition, and natural language processing. It has become one of the important technologies in the field of artificial intelligence and holds significant implications for the realization of smart tourism, acting as a key driver for reform and innovation in the tourism industry. Against this backdrop, the Deep Learning course offered by the Artificial Intelligence program at Guilin Tourism University aims to meet students' learning needs for AI technologies while promoting interdisciplinary integration. The course is designed to forge a close connection between artificial intelligence and the tourism industry and advance the development of education in the field of smart tourism.

Currently, traditional Deep Learning courses tend to overemphasize theoretical knowledge but lack real-world deep learning application cases and practical experience. Students are often passively fed information, lacking opportunities for active exploration and personalized learning. This results in students being unable to independently utilize deep learning technologies to solve complex problems in practical work, struggling to translate theoretical knowledge into practical solutions, and affecting their competitiveness in the job market. [2] Project-based learning, as a student-centered teaching model, emphasizes engaging students through practical projects that encourage active learning and mastery of knowledge and skills by solving real-world problems.[3] The project-based teaching model can efficiently optimize teaching designs to improve educational quality, expand students' thinking, and foster their innovation and practical skills.

This paper presents a teaching pathway primarily based on project-based learning, taking the Deep Learning course offered by the School of Artificial Intelligence at Guilin Tourism University as an example, combining deep learning with smart tourism. Through problem-oriented project design, the pathway aims to enhance students' practical application capabilities and innovative thinking, helping them master core technologies that integrate deep learning with smart tourism to solve real-world challenges.

Literature Review

Deep learning has become a prominent technology in various fields, including smart tourism. In the context of smart city scenarios, Mulfari et al. [4] highlight the importance of visual object recognition using deep learning techniques. Similarly, Setyono et al. [5] emphasize the significance of selecting effective deep learning architectures for applications such as Betawi culinary tourism. Wang et al. [6] provide a comprehensive survey of deep learning algorithms and their applications in smart manufacturing, underscoring the potential of deep learning in making manufacturing processes "smart." Furthermore, deep learning has been applied in the context of smart grids, as discussed by Zhang et al. [7]. The authors introduce deep learning, reinforcement learning, and their combination, deep reinforcement learning, as mature methods in the realm of AI 2.0, with potential applications in smart grids. Law et al.[8] demonstrate the efficacy of a deep learning approach in forecasting tourist arrival volumes, outperforming other models such as support vector regression and artificial neural networks. In the tourism field, the integration of advanced technologies like deep learning and transfer learning is paving the way for a more intelligent and automated future, as highlighted by Wang et al..[9] Suanpang
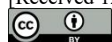
et al. [10] propose applying deep Q-learning for autonomous energy management in smart tourism cities, focusing on enhancing sustainability through a novel microgrid model. Additionally, Lin [11] discusses the implementation of personalized scenic spot recommendation algorithms based on generalized regression neural networks for 5G smart tourism systems, emphasizing the evolution dynamics and process of smart tourism services. Moreover, Higa et al. [12]introduce the use of deep learning algorithms for region-wise indoor localization using smartphone images in indoor tourist attractions. This application showcases the potential of deep learning in enhancing the visitor experience and navigation within indoor tourism settings.

Teaching Objective Design
As a core course in Artificial Intelligence, Deep Learning requires students to possess not only a solid theoretical knowledge but also the capability to apply learned technologies to solve practical problems. To ensure students have sufficient knowledge to understand and apply deep learning technology, and to directly benefit their future studies and careers, the course objectives are set across three dimensions: knowledge, skills, and qualities.
Knowledge Dimension:
1.Understand the workings of neural networks, the types and functions of activation functions, and the processes of forward and backward propagation. Master the basic steps of deep learning including data collection, processing, model selection, training, and optimization.
2.Understand fundamental deep learning models such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Transformers.[13] Gain mastery of the working principles and architectural designs of different models, comprehend each model's unique advantages and limitations, understand applicable scenarios, and select the most suitable model for practical problems.
3.Be aware of advanced deep learning techniques such as transfer learning, multimodal learning, and Generative Adversarial Networks (GANs).
4.Master methods of evaluating deep learning models and key performance indicators. Be capable of using accuracy, recall, F1 score, precision, ROC curve, and AUC value to comprehensively assess and compare the performance of different deep learning models.
Skills Dimension
1.Develop students' abilities to construct neural network models using the PyTorch deep learning framework, and to train, validate, and test these models.
2.Teach students how to acquire large-scale tourism datasets using web scraping and open database access.
3.Foster the ability to combine deep learning with tourism industry knowledge to analyze, define, and solve real-world problems in the smart tourism domain.
Qualities Dimension
1.Inspire students' interest and innovative thinking in exploring practical problem-solving with deep learning through project-based learning.
2.Guide students in proposing and testing new hypotheses, and optimizing models through teamwork and project design.
3.Cultivate a lifelong learning habit in students towards new technologies, adapting to rapidly changing technological environments and industry demands.
Setting clear educational objectives is crucial for helping both teachers and students understand the core requirements of the course and the expected levels of achievement, thereby purposefully organizing teaching content and learning activities. By establishing specific, quantifiable objectives, teachers can selectively choose teaching methods, learning materials, and assessment methods, reducing ineffective teaching, and enhancing teaching efficiency and learning outcomes.

Teaching Objective Design
With the widespread application and popularity of deep learning technologies in the tourism industry, traditional deep learning projects such as image recognition and text classification are no longer sufficient to meet students' skill requirements, thus failing to enhance their employability. To enable students to master deep learning principles and techniques while applying these technologies to solve real-world problems within the tourism industry, the course content has been carefully designed around three projects: "Tourist Flow Detection in Scenic Areas," "Tourist Interest Point Mining," and "Automated Generation of Travelogues," covering two high-frequency modalities of image and text data and two major deep learning technologies in computer vision and natural language processing. The aim is for students to proficiently use generative and discriminative deep learning models to handle the most common types of data, thereby effectively addressing specific challenges in the tourism industry.
To foster comprehensive development, students will be grouped during the project-based learning process. They are expected to gain not only "hard skills" related to technology but also "soft skills" such as project planning, teamwork, and problem-solving. Through project-based learning, students will practice what they have learned in real application scenarios, laying a solid foundation for their future work and research in related fields.
Project One: Tourist Flow Detection in Scenic Areas
Tourist flow analysis plays a crucial role in enhancing visitor satisfaction. By predicting and managing crowd density, resource allocation can be optimized, allowing scenic areas to adjust manpower and material resources according to tourist flow patterns to improve service quality. It also provides data support for operational decisions in scenic areas,

guiding sensible investments and effective marketing strategies. In the event of emergencies, accurate tourist flow data can guide quick and effective emergency responses to ensure visitor safety.

Project content:

Students will use image processing and object detection technologies to obtain real-time images from cameras within the scenic area and design and implement a deep learning model capable of monitoring and analyzing tourist flow in real-time. The core of the project is to develop an efficient tourist detection algorithm that can accurately identify and count the number of visitors from a fixed perspective, maintaining stable performance under varying conditions such as lighting, weather, and crowding. The core technology required for this project involves object detection in computer vision tasks. The main project phases include data collection and image normalization of scenic area images, tourist detection algorithm design, model training, and data analysis and evaluation.

Project Two: Tourist Interest Point Mining

Points of interest are various entities that tourists are interested in during their travels. Mining tourist interest points can create precise profiles of tourists, catering to their diverse needs and thus enhancing the service efficiency of the tourism industry and improving service levels at tourism destinations, which is crucial for increasing tourist satisfaction and providing personalized recommendation services.

Project content:

In this project, students will use travelogue data as the data source to mine tourist interest points. Travelogues, as a significant part of user-generated content (UGC), [14] contain entities such as cuisine, architecture, and scenery that interest tourists. Students will learn to build a deep learning model that can accurately identify tourist interest points from travelogue data. The core technology required for this project involves named entity recognition in natural language processing tasks. The main project phases include acquiring travelogue data, preprocessing Chinese text data, designing a named entity recognition model, model training, and evaluation.

Project Three: Automated Generation of Travelogues

In the tourism industry, the demand for personalized and intelligent services is growing. The automated generation of travelogues, which converts tourists' photos into emotionally rich travelogue texts, helps tourists create high-quality travelogue content more quickly. This technology not only saves time for tourists but also provides inspiration and materials, creating unique travel memories and meeting personalized needs, thereby enhancing the travel experience.

Project content:

Students will need to research and develop a deep learning model capable of understanding image content and converting it into textual descriptions. This process involves both image processing and natural language generation, requiring the model not only to accurately identify the main elements in images, such as landmarks, people, and activities, but also to weave these elements into logical and emotionally colored travelogue texts. The core technologies include image encoding in computer vision and text generation in natural language processing. The main project phases include collecting and preprocessing travelogue data containing tourist photos, designing an image encoding model, designing a text generation model, model training, and evaluation.

Through these three projects, students will not only master cutting-edge deep learning technologies but also experience applying theoretical knowledge to solve practical problems, cultivating their ability to apply complex technologies to address specific social and economic challenges and deepening their understanding and innovative abilities in the real-world application of deep learning technologies.

Teaching Assessment and Feedback

Assessment Standards

To cover the knowledge, abilities, and qualities students acquire during the course, the assessment standards are set across three dimensions: technical skills, innovative thinking, and teamwork.

Technical Skills:

Assess students' abilities in designing, developing, and optimizing deep learning models, including improvements in model performance, code quality, and algorithm efficiency.

Innovative Thinking:

Evaluate students' innovative capabilities in projects, such as their ability to propose novel solutions and apply the latest deep learning technologies to solve real problems in the tourism industry.

Teamwork:

Examine students' collaboration and communication skills within teams, including cooperation with teammates, conflict resolution, and the ability to share tasks.

Assessment Methods

The course employs a combination of instructor assessment, peer review, and self-assessment to ensure a diversified assessment strategy that objectively measures students' understanding and application of deep learning.

Instructor Assessment:

Students are required to submit detailed reports to the instructor, including project introductions, model designs, model training, model evaluations, and technological roadmaps, and participate in collective project defenses. This process, which demands that students demonstrate the ability to take a project from concept to implementation, also provides an opportunity for them to showcase their work directly to instructors and peers, testing their teamwork and communication skills.

Peer Review:
Emphasizes internal team evaluations, promoting honest feedback among students, helping them recognize their strengths and areas for improvement in teamwork and individual contributions. By evaluating teammates' contributions, attitudes, and problem-solving strategies in projects, peer review not only enhances communication within the team but also helps to create a supportive and encouraging learning environment.

Self-Assessment:
Encourages students to engage in in-depth self-reflection, a critical learning process that enables students to objectively analyze their performance throughout the project, including their technical skills, roles within the team, learning progress, and approaches to addressing challenges faced during the project. Self-assessment not only aids in students' self-awareness but also encourages them to proactively identify and utilize their strengths while working on improving their weaknesses in future projects.

Feedback Mechanism
Effective teaching feedback is essential for improving the quality of education. Establishing a comprehensive and flexible feedback mechanism not only helps to quickly identify and address issues students face during their learning and project development but also fosters effective communication among students and between students and instructors, significantly enhancing teaching efficiency and learning outcomes. During project development, students will encounter various challenges, and instructors should regularly check project progress and actively participate in student discussions. To ensure an immediate and effective feedback mechanism in project-based learning, the feedback measures include:

Regular checks:
Establish checkpoints at critical stages of each project, particularly during data acquisition, model design, model training, and evaluation. Instructors provide immediate and specific guidance at these stages to help students adjust their plans to achieve the best results.

Participation in group discussions:
Instructors actively participate in group discussions during the project, allowing students to internally review each other's work progress. This method enhances student interaction and allows for diverse insights and feedback across groups.

Use of a learning management system:
Students can report on their project progress anytime through a learning management system, and instructors can promptly address individual feedback, including specific suggestions for project proposals, recommended learning resources, or methods for improving skills. This ensures that students receive targeted guidance throughout all stages of project development, effectively advancing their learning and project progress.

By integrating these comprehensive assessment and feedback mechanisms, instructors can fully understand each student's performance in technical skills, innovative thinking, and teamwork. They can then timely adjust teaching methods and content based on feedback to better meet students' learning needs and career goals. Students, through feedback, can understand their strengths and areas for improvement, continuously enhancing their professional capabilities in applying deep learning in industry contexts.

Results and Discussion
This paper explored a project-based teaching pathway that integrates deep learning with the needs of the tourism industry, providing students with a more interactive, practical, and innovative learning platform. Through the project-based teaching model, students can learn and practice in real or near-real business scenarios, which greatly enhances the effectiveness and enjoyment of learning. This approach helps cultivate students' innovative thinking and comprehensive problem-solving abilities, and also provides strong evidence and new directions for reforming traditional teaching models. As technology continues to advance and educational philosophies evolve, the project-based deep learning teaching pathway is expected to offer broader development possibilities and application potential. We look forward to this innovative teaching model being promoted and applied in more fields and disciplines to enhance students' comprehensive abilities and cultivate more high-quality professionals with cross-disciplinary capabilities for future industry development.

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