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Research on Teaching Reform of Deep Learning Course to Enhance Practical Ability Based on the Integration of Industry and Education

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Abstract: With the rapid development of artificial intelligence technology, deep learning, as one of its core technologies, occupies an important position in the cultivation of applied talents. Based on the concept of integration of industry and education, this paper proposes a systematic teaching reform plan to address the issues of disconnection between theory and practice, single teaching methods, and insufficient practical resources in the deep learning courses for professional master's students at our university. Through deep cooperation with Huawei Cloud Technologies Co., Ltd., we introduce cutting-edge theoretical content (such as GoogleNet, ResNet, Transformer, BERT, etc.), update practical cases (covering computer vision, natural language processing, and smart manufacturing), and adopt a case-led comprehensive teaching method combined with the online and offline hybrid practical platform ModelArts to promote the close integration of theory and practice. Simultaneously, a diversified evaluation system with practice as the core is constructed to comprehensively assess students' practical abilities and project execution levels. The research in this paper provides a valuable reference for the innovation of teaching modes and the cultivation of practical abilities in deep learning courses in higher education institutions.

Keywords: Deep learning; Integration of industry and education; Teaching reform; ModelArts

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1. Introduction

In recent years, with the rapid development of deep learning technology, the teaching reform of deep learning courses has become a hot topic in the field of higher education. Luo and Chen [1] introduced Baidu AI Studio's online courses, projects, and computing resources through school-enterprise collaboration, carrying out online and offline hybrid teaching and cutting-edge case studies to enhance the practical ability training of the "Neural Networks and Deep Learning" course. Song *et al.* [2] designed project-oriented course content from the perspective of the integration of industry and education as well as science and education, addressing challenges such as rapid technological updates in deep learning teaching in higher vocational education, and verified the teaching effectiveness through industry-academia-research cooperation. Wang [3] proposed a teaching reform strategy for artificial intelligence courses based on deep learning, optimizing teaching content, methods, and evaluation systems to enhance students' application abilities, innovative thinking, and professional competitiveness. Cheng and Li [4] adopted a project-driven teaching mode that combines theory with project practice in fields such as smart medicine, chemical engineering control, and smart manufacturing, significantly improving students' abilities to solve complex problems and their practical levels. Qi *et al.* [5] introduced multiple teaching methods such as case guidance, engineering application traction, and flipped classrooms, combined with diversified assessment, to effectively alleviate the complexity of theory and the tedium of mathematics, stimulating students' ability to learn new technologies. Bai and Liang [6] reformed course content by adding precursor knowledge, special experiments, and expanded learning, helping students systematically master the foundations of deep learning, deepen their understanding of important concepts, and improve their practical ability to apply deep learning to research.

Overall, the current teaching reform of deep learning courses has made significant progress in content updates, teaching method innovation, construction of industry-education integration practice platforms, and improvement of evaluation systems. However, there are still issues such as insufficient connection between theory and practice, inadequate integration of teaching resources, and a single evaluation system. Addressing these shortcomings, how to construct a systematic and deeply integrated teaching mode of industry and education to enhance students' practical abilities remains the focus and difficulty of current research. Based on the above research status and combining school-enterprise deep cooperation practices, this topic systematically promotes the theoretical content update, practical case reform, teaching method innovation, practical platform construction, and diversified evaluation system design of deep learning courses, aiming to achieve deep integration of theory and practice, comprehensively enhance students' practical abilities and innovative qualities, and promote continuous improvement in the quality of deep learning talent cultivation.

2. Current status of deep learning courses

In the training system for professional master's degree students at our university, deep learning courses play a pivotal role. This course consists of two parts: theory and practice, with a total of 32 class hours. The theoretical portion covers linear neural networks, multilayer perceptrons, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and attention mechanisms. The practical component is composed of traditional case studies, such as implementing linear regression and classification with neural networks, image classification using CNNs, image classification with VGG and ResNet, generating character sequences with RNNs, and stock prediction with LSTM, as shown in **Figure 1**. Currently, deep learning courses face the following challenges:

(1) Disconnect between theory and practice: Many current deep learning courses focus on imparting theoretical knowledge while lacking content integrated with practical applications, making it difficult for students to flexibly apply what they have learned in real-world projects.

(2) Monotonous teaching methods: The traditional teaching model is teacher-centered, with students passively receiving knowledge and lacking opportunities for active participation and practice, which affects their innovative thinking and problem-solving abilities.

(3) Scarce practical teaching resources: Many institutions lack practical teaching platforms that collaborate with the industry, limiting students' exposure to real-world project cases and data, and consequently impeding the enhancement of their practical skills.

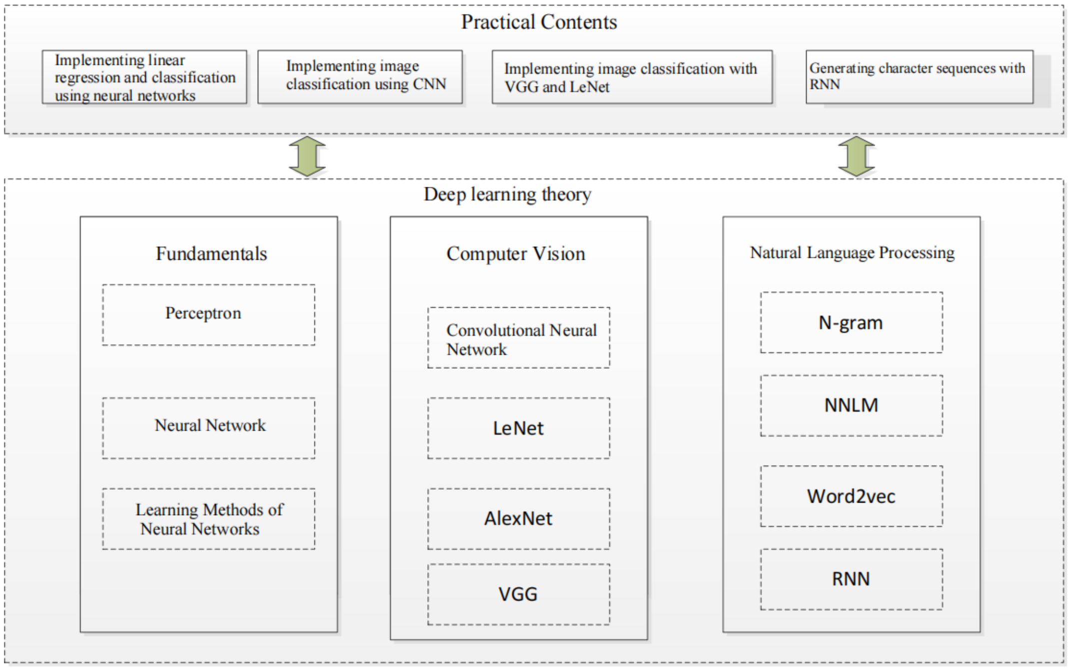

Figure 1. Deep learning content

3. Pathways to enhance practical abilities based on industry-education integration

The pathways to enhance practical abilities based on industry-education integration are illustrated in **Figure 2**, consisting of four components: reform of deep learning theoretical content, reform of practical content, reform of teaching methods, and reform of the evaluation system.

(1) Reform of deep learning theoretical content: Collaborating closely with enterprises to jointly explore and update deep learning theoretical content, introducing advanced technologies to align course content more closely with industry development needs, and further elevating students' theoretical and practical abilities.

(2) Reform of deep learning practical content: Relying on deep cooperation with enterprises, systematically updating and introducing a batch of practical cases closely aligned with cutting-edge technologies and industry demands, covering multiple fields such as computer vision, natural language processing, and smart manufacturing. These cases not only emphasize technological advancement but also stress the authenticity and complexity of practical application scenarios, fully exercising students' problem analysis and solving abilities. Simultaneously, introducing real projects and data from enterprises enhances students' hands-on practical skills and professional competitiveness, promoting deep integration of theory and practice and supporting the cultivation of high-quality applied talents that meet industry needs.

(3) Reform of teaching methods: Introducing case-driven teaching to enable students to intuitively understand the practical applications of deep learning through real-world cases; adopting project-based learning to stimulate initiative and cultivate team collaboration and project management skills; utilizing platforms like "Learning Pass" to promote communication. Emphasizing the combination of theory and practice, encouraging the application of knowledge to actual projects, and enhancing the ability to solve complex problems. Combining enterprise resources and expert guidance to cultivate compound talents

with innovative spirit and practical abilities, laying a solid foundation for career development.

(4) Reform of practical platforms: Adopting ModelArts, an AI one-stop development platform provided by Huawei Cloud Technologies Co., Ltd., to assist students in mastering and proficiently utilizing industry-leading tools, effectively improving their ability to solve practical industry problems.

(5) Reform of the evaluation system: Constructing a student evaluation system centered on "practice," covering two dimensions: experimental reports and project reports, to comprehensively and multi-angled evaluate students' learning achievements and ability enhancement.

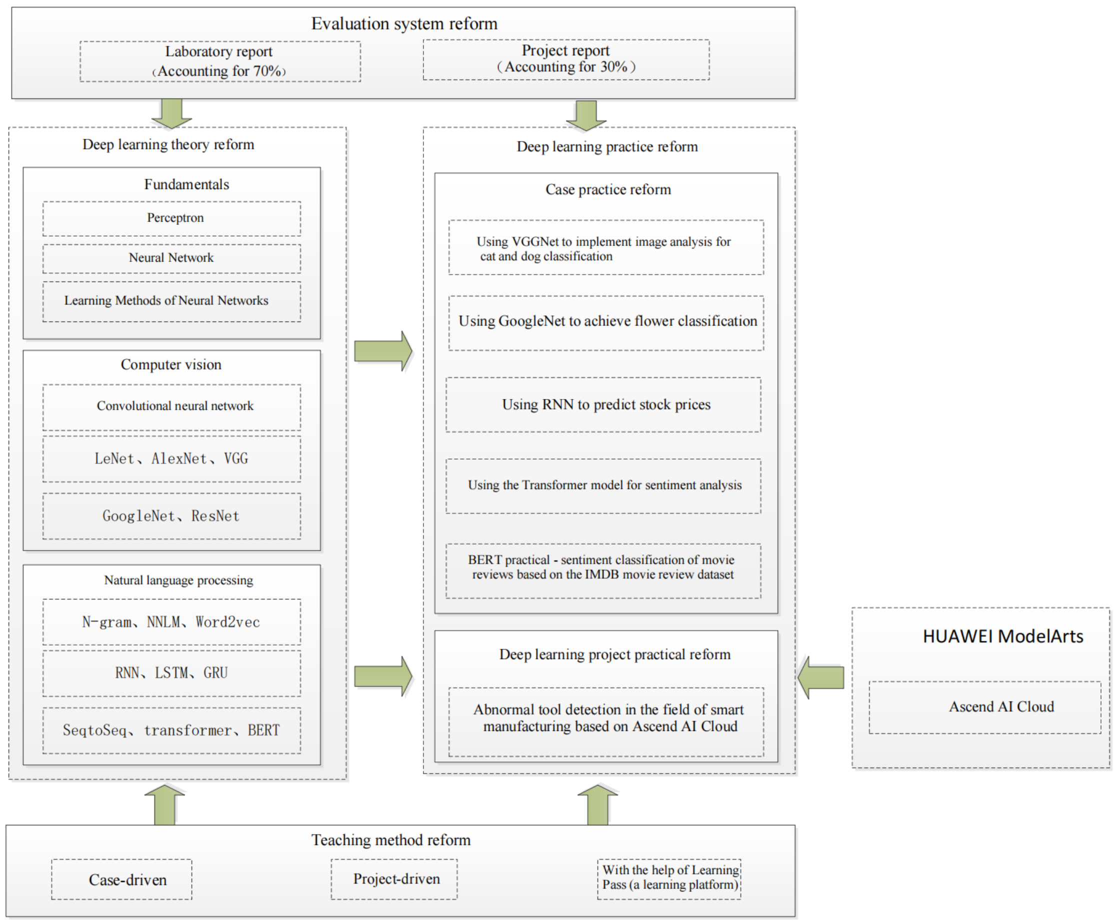

Figure 2. Pathway to enhance practical abilities based on industry-education integration

4. Practical teaching reform based on industry-education integration

Our school has established a deep partnership with Huawei Cloud Technologies Co., Ltd., fully leveraging its technological advantages in the industry to drive systematic reform in deep learning courses. We have successfully introduced Huawei's leading AI one-stop development platform, ModelArts, to comprehensively optimize and update course content, redesign practical sessions. Simultaneously, we actively explore and innovate teaching methods and evaluation systems, aiming to enhance teaching quality and students' practical abilities holistically.

4.1. Supplementation of cutting-edge theoretical content

In the computer vision section, we have newly introduced cutting-edge and representative models such as GoogleNet and ResNet. For natural language processing, we have added the currently mainstream and influential Transformer and BERT models. Detailed content is listed in **Tables 1** and **2**.

Table 1. Content in the computer vision field

Classic model	Principle explanation
GoogleNet	GoogleNet (also known as Inception-v1) is a deep convolutional neural network. Its core innovation lies in the introduction of the "Inception module." This module employs parallel convolutional kernels of multiple scales (e.g., 1×1, 3×3, 5×5) alongside pooling operations. This enables multi-scale feature extraction within a single layer. Simultaneously, it utilizes 1×1 convolutions for dimensionality reduction, significantly decreasing computational load and parameter count. This dual approach enhances both the network's representational capacity and computational efficiency.
ResNet	ResNet (Residual Network) operates fundamentally through "residual learning." It implements "skip connections" that bypass one or more convolutional layers by directly adding the input to subsequent layer outputs, forming residual blocks. This architecture allows the network to learn residuals (differences) between inputs and outputs. It effectively mitigates vanishing gradient and exploding gradient problems in deep neural networks, facilitates training of substantially deeper architectures, and significantly improves model performance and generalization capabilities.

Table 2. Contents in the field of natural language processing

Advanced model	Principle explanation
Seq2Seq	The Seq2Seq (Sequence-to-Sequence) model is a deep learning architecture that maps input sequences to output sequences. It consists of an encoder and a decoder. The encoder compresses input sequences into fixed-length context vectors using recurrent neural networks (e.g., LSTM or GRU), capturing semantic information. The decoder then generates target sequences step-by-step using these context vectors as initial states. During training, parameters are optimized by maximizing conditional probability of target sequences, often accelerated through teacher forcing. To address information bottlenecks from fixed-length vectors, attention mechanisms enable dynamic focus on relevant input segments, significantly enhancing long-sequence modeling and generation quality.
Transformer	The Transformer model utilizes self-attention mechanisms to capture global dependencies between sequence elements through parallel computation. Comprising encoder and decoder components, the encoder extracts input features via multi-head self-attention and feed-forward networks. The decoder generates outputs incrementally by integrating previously generated content with encoder information. Compared to traditional recurrent networks, Transformers achieve superior training efficiency and long-range dependency modeling capabilities.
BERT	BERT (Bidirectional Encoder Representations from Transformers) is a Transformer-encoder-based pretrained language model. Its bidirectional self-attention mechanism simultaneously processes left and right contextual word information, enhancing semantic understanding. During pretraining, BERT learns deep semantic representations through Masked Language Modeling (MLM) and Next Sentence Prediction (NSP) tasks. After pretraining, BERT can be efficiently fine-tuned for diverse downstream NLP tasks (e.g., text classification, QA, NER), delivering significant performance improvements.

4.2. Design of deep learning practical content

Collaborating with Huawei Cloud Technologies Co., Ltd., we have revised the practical content. In the field of computer vision, practical sessions have been adjusted to include "Cat and Dog Image Analysis Based on VGGNet" and "Flower Classification Based on GoogleNet." In natural language processing, sessions include "Stock Price Prediction Based on RNN," "Emotion Analysis Based on Transformer Model," and "BERT in Action – Movie Review Sentiment Classification Based on IMDB Movie Review Dataset." Detailed information is provided in **Tables 3** and **4**. Additionally, to deepen project-based practical content, we have added a project on tool anomaly detection in the field of smart manufacturing, implemented using the Huawei Cloud platform, effectively enhancing students' practical skills and cloud application abilities.

Table 3. Course practical activities

Case name	Description
Cat vs. Dog Image Classification with VGGNet	This project applies the classic deep convolutional neural network VGGNet to classify cat and dog images. Key components include data preprocessing, model construction, training/optimization, and result evaluation. Students will work on real-world datasets to learn: extracting image features using VGGNet, designing classifiers, tuning hyperparameters, and training models to accurately distinguish between cats and dogs.
Flower Classification with GoogleNet	This case utilizes GoogleNet (Inception-v1) for precise classification of flower species. It covers dataset collection/preprocessing, model architecture analysis, training pipeline design, and performance optimization. Through hands-on practice, students will: leverage Inception modules for multi-scale feature extraction, enhance model representational capacity and classification accuracy, and master hyperparameter tuning and evaluation methods for complex computer vision tasks.
Stock Price Prediction with RNN	This project employs Recurrent Neural Networks (RNN) to model time-series data for stock price trend forecasting. It encompasses data collection/preprocessing, sequential feature extraction, model building/training, and prediction evaluation. Students will learn to: capture temporal dependencies in stock prices using RNNs, design appropriate network architectures, optimize hyperparameters, and train models on historical data.
Sentiment Analysis with Transformer	This case implements text sentiment classification (positive/negative/neutral) using Transformer architecture. Key phases include text preprocessing, word embedding representation, model construction/training, and classification evaluation. Students will: understand Transformer's self-attention mechanism for capturing long-range dependencies, and master techniques to design/optimize models for improved sentiment analysis accuracy.
BERT Fine-tuning: Sentiment Classification on IMDB Reviews	This practical session applies the BERT pretrained language model for sentiment classification of movie reviews (positive/negative). It covers data preprocessing, text encoding, BERT fine-tuning, training optimization, and performance assessment. Students will learn to: utilize BERT's bidirectional self-attention for contextual semantic understanding, employ transfer learning for rapid task adaptation, and enhance classification accuracy.

Table 4. Project practice

Project name	Description
Tool Anomaly Detection in Smart Manufacturing Based on Ascend AI Cloud	This project leverages the high-performance computing capabilities of the Ascend AI Cloud platform and deep learning technologies to achieve real-time monitoring and anomaly recognition of tool operation status. Key components include: data acquisition/preprocessing, feature extraction, model building/training, anomaly detection algorithm design, and alarm system development. Through hands-on practice, students will master techniques for accelerating model training and inference using cloud resources, improving detection accuracy and alert responsiveness. The project enhances equipment condition monitoring capabilities in smart manufacturing while developing comprehensive practical skills for solving real-world industrial problems.

4.3. Case-led comprehensive teaching method

Using real and typical deep learning application cases as the main thread, we enhance the pertinence and practicality of learning. Theoretical explanations and code practices are synchronized to ensure dual improvement in understanding and application. We focus on comprehensive abilities such as data processing, model design, parameter tuning optimization, and result analysis. The deep learning course content structure is shown in **Table 5**.

Table 5. Deep learning course content structure

Module	Content overview	Key case examples	Weight
1. Foundations	Neural Network Fundamentals, Backpropagation, Optimization Algorithms	Handwritten Digit Recognition (MNIST)	20%
2. Deep Neural Networks	Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN)	Image Classification (CIFAR-10) Stock Price Prediction (RNN Application)	25%
3. Advanced Models	Transformer Architecture	Text Sentiment Analysis using Transformer	25%
4. Applied Projects	Integrated Project Design & Implementation		

The teaching process is designed as follows:

(1) Case introduction (beginning of each module): Introduce the background and problems of the core case in this module, discuss the actual challenges and technical requirements involved in the case; stimulate students' interest and thinking.

(2) Theoretical explanation: Analyze the key deep learning theories involved in the case; explain the principles of algorithms based on specific problems in the case; consolidate understanding through classroom questions and interactions.

(3) Practical operation: Teachers provide code frameworks or datasets; students complete model building, training, and testing in groups.

(4) Result analysis and summary: Each group presents experimental results and model performance; discusses problems encountered and solutions; teachers summarize case experiences and best practices.

(5) Expansion and innovation: Propose improvement directions or extension tasks for the case; encourage students to carry out small innovation projects.

4.4. "Online and offline hybrid" practice platform

To achieve an organic combination of course theory and practical content and promote the implementation of the "case-led integrated teaching method," it is necessary to rely on a powerful practical teaching platform. The teaching team has integrated and optimized the resources of Huawei's AI one-stop development platform, ModelArts, with existing course resources, and added relevant resources according to demand, building an "online and offline hybrid" practical teaching platform. For the course practice cases in **Table 3**, the practical aspects are mainly carried out using offline resources. For the project practice cases listed in **Table 4**, which involve a large amount of data, the Huawei ModelArts platform is fully utilized to complete the entire AI development process, including data storage, data annotation, data release, algorithm development, model training, optimization, and deployment. This platform provides students with a more comprehensive and in-depth practical experience, effectively promoting the improvement of their practical abilities and innovative thinking.

4.5. Diversified evaluation method with "practice" as the core

In terms of assessment methods, this reform has made significant improvements, abandoning the traditional single mode of in-class experiments combined with final written exams, and instead adopting a diversified process evaluation system with "practice" as the core. Specific evaluation indicators and content are detailed in **Table 6**.

Table 6. Course evaluation composition table

Grading components	Weight	Detailed assessment criteria
Lab reports	70%	5 reports (First 3: 10 pts each; Last 2: 20 pts each). Graded on: - Task completion (4 pts for early reports / 8 pts for later reports) - Code readability - Execution performance (4 pts / 8 pts) - Report documentation (2 pts / 4 pts)
Project report	30%	Graded on: - Project completion (16 pts) - Code readability - Execution performance (10 pts) - Report documentation (4 pts)

This assessment method comprehensively evaluates students' practical abilities and project execution levels by reasonably allocating the weights of experimental reports and project reports. It focuses on both task completion and code readability and operational stability, encouraging students to standardize programming and ensure effective program operation during the completion of experiments and projects. At the same time, it cultivates students' summary and expression skills through report writing. This multi-dimensional and process-based evaluation method not only promotes the integration of theoretical knowledge and practical operations, enhances independent learning and innovation abilities, but also provides effective feedback to teachers, helping to optimize teaching content and methods, and ultimately achieving the teaching goal of complementing theory with practice.

5. Conclusion

This article focuses on the current teaching situation of deep learning courses for professional master's students at our university. Addressing prominent issues such as the disconnection between theory and practice, single teaching methods, and insufficient practical resources, systematic curriculum reform has been carried out in combination with the concept of industry-education integration. By introducing advanced resources and platforms from Huawei Cloud Technologies Co., Ltd., the theoretical content and practical cases of the course have been updated to cover cutting-edge fields such as computer vision, natural language processing, and smart manufacturing, enhancing the course's industry adaptability and application value. The adoption of a case-led integrated teaching method and an online and offline hybrid practical platform has effectively promoted the deep integration of students' theoretical knowledge and practical abilities. Simultaneously, a diversified evaluation system with practice as the core has been established to comprehensively reflect students' learning achievements and ability development. In summary, this teaching reform not only enhances the teaching quality of deep learning courses but also lays a solid foundation for cultivating high-quality applied talents who meet the needs of the industry, providing valuable experience and reference for related curriculum reforms.

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Disclosure statement

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