Application of Jupyter Notebook in Teaching Pattern Recognition

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Abstract. Artificial intelligence technology is so pervasive today that it is important to teach basic theory and technique of pattern recognition for undergraduate of electronic information. Pattern recognition course contains a number of abstract concepts and math principles, and the experiments in the course require some programming skills and tricks. These factors make it difficult for undergraduates to study. This paper analyzes the limitation of traditional multimedia technology, and proposes an interactive classroom teaching method based on Jupyter Notebook. Using Notebook, teachers can organize descriptive texts, mathematical notations, code and its result into web pages effectively. According to our teaching experience, using Jupyter Notebook in pattern recognition course can improve undergraduates’ study initiative and promote the teaching effect.

Introduction

With the rapid development of artificial intelligence technology, related courses have become increasingly important in undergraduate education in electronic information specialty. Pattern recognition course aims to teach the undergraduate the basic principles and methods of artificial intelligence \cite{1}. Since a number of abstract concept, math principles and complex experiments are introduced in pattern recognition course, teachers face many new challenges in teaching processing \cite{2}. It is difficult to implement this goal using traditional method. This paper discusses on how to use interactive software Jupyter notebook in classroom teaching to improve the teaching effect.

1. Situation Analysis of Traditional Teaching

In classroom teaching, interaction mainly refers to the exchange of information between teachers and undergraduates, so the interaction runs through all teaching activities. The interactive platform is the premise of all interactions and provides a communication environment and support tools for learner interaction. The blackboard is the most basic platform for physical interaction between undergraduates and teacher. But it cannot transmit sounds and images and is less efficient.

With the wide application of multimedia technology in teaching, interactive activities using multimedia as a medium gradually replaced the blackboard-based teaching method. Multimedia teaching has the characteristics of high knowledge density and strong performance, which can stimulate undergraduates’ interest. In the multimedia teaching practice, Microsoft PowerPoint (PPT) is the main tool used to make courseware because it allows for creative presentations. However, using PPT presentations has some disadvantages in classroom teaching of pattern recognition \cite{3}:

- It is difficult to make PPT courseware. Although most people do not find it difficult to use Micro Soft PowerPoint program, it still require a certain set of skill to effectively create successful presentation.
- PPT is not suitable to produce math-heavy slides. Since mathematical formulas and symbols cannot be typeset like text in PPT, it is very troublesome to put them in the right place.
- PPT is not suitable to typeset code. In PPT, code is regarded as plain text. To make code looks good in slides, the producers need great skill and spend a lot of time.
The contents of PPT are static. Code cannot be executed in PPT to produce results dynamically in the classroom.

Pattern recognition is a math-heavy course. A number of principle and methods must use mathematical formulas to accurately describe. To help undergraduate understand these abstract concepts, it is also import to demonstrate implementation code for methods in the classroom \(^4\). These shortcomings of PPT make it not the good choice for classroom teaching of pattern recognition.

2. Interactive Platform: Jupyter Notebook

Jupyter Notebook is an open-source web application for editing and running notebook documents \(^5\). The notebook documents can contain both code and rich text elements, such as figure, image, equations, etc. Because of the mix of code and text elements, notebook documents are very suitable to interaction teaching based on case.

2.1 Advantage of Jupyter Notebook

Jupyter Notebook contains two parts: a web application and notebook documents. Notebook documents contain all the content which needs to be shown in the web application. The type of content in documents is very rich including text, mathematics, image, codes and its output. The web application is a browser-based tool for interactive authoring of documents. Creating, editing, and modifying Notebook documents can be done in browser.

Notebook documents contain two kind of cell: code cell and markdown cell. Code cell is used to input source code. The Notebook has support for over 40 programming languages, including Python which is one of the most popular languages in machine learning. Code cell supports code indentation, and syntax highlighting, editing code in browser is very convenient. Code can be executed in browser, while the outputs of computations are attached to the code which generates them. The output of computations can not only include plain text, but also display rich media representations such as images. In markdown cell, rich text is edited using Markdown markup language. Markdown is lightweight markup language with an easy-to-read, easy-to-write plain text formatting syntax. Markdown syntax makes it easy to design the web pages which contain text and mathematical notations written using Latex.

Notebooks can contain live computer code, equations, visualizations and narrative text. Furthermore, these documents can be saved in a way that lets other people open them and execute the code on their own systems. Notebook can also be exported to a range of static formats, including PDF and HTML.

2.2 Install and Run Jupyter Notebook

Python is a requirement for installing the Jupyter Notebook. A convenient way to install Python and Jupyter Notebook is to use Anaconda distribution which includes not only Python and Jupyter Notebook \(^6\), but also other commonly used packages for pattern recognition such as Numpy, Sci-learn, Matplotlib, etc. After downloading and installing Anaconda following the instructions on the download page, Jupyter notebook is ready to run.

As a server-client application, Jupyter Notebook allows you to edit and run notebooks via a web browser. First, you should execute “jupyter notebook” in command line to start the notebook server. Then you can open browser to the address of the server which is http://localhost:8888/ as default. When the notebook opens in the browser, a web-based interface is displayed, which is referred to as Notebook Dashboard, shown as fig.1. The dashboard not only shows the notebook documents, but also can be used to manage the server.
3. Classroom Teaching Using Notebook

The pattern recognition course is designed to achieve three goals. The first goal is to teach undergraduate basic theories and methods of pattern recognition. Many of the concepts in pattern recognition are very abstract so that it is difficult to understand for beginners. Although the teacher’s explanation can help undergraduate grasp these concepts, it is also inevitable to accurately describe the principle and method through mathematical formulas. Typographic formulas are very cumbersome in PPT, but it is easy to use Jupyter Notebook. Fig.2 (a) is text written using markdown language in markdown cell. The mathematic notations are written using Latex. Fig.2 (b) shows the output of the markdown cell.

![Figure 2. Markdown cell.](image)

(a) markdown text
(b) output

The second goal is to teach undergraduate how to programmatically implement the methods learned in pattern recognition course, which is a difficult problem that often confuses undergraduates. Therefore, code demonstration is the key part of classroom teaching. Using Python to implement pattern recognition algorithms is a popular way. Python code can be edited directly in browser. Since Notebook support code indentation and syntax highlighting, code in Notebook is very readable.

The third goal is to teach undergraduate how to analyze the experiment results. The codes inspire the undergraduates’ interest, and they must want to know the computation result of the code. The next thing that needs to be done is to execute the code and display its results to the undergraduate. With Notebook, all of these have become very simple. The code can be executed in browser and its result is attached to the code. Fig.3 shows a piece of code in browser and its output in browser. Teacher can naturally analyze the performance of methods. Teacher can modify the parameters of methods and rerun the code to compare the results on different conditions.

Summary

With the development of modern computer technology, various multimedia softwares have been widely used in classroom teaching. Multimedia software plays an important role in interaction activity between teacher and undergraduate. This paper analyzes the disadvantages of PPT, and discusses the advantages of Jupyter Notebook in pattern recognition course. Notebook can organize descriptive texts, mathematical notations, code and its result together, which make the teaching content rich and...
lively. Using Jupyter Notebook improves undergraduates’ enthusiasm and promotes the teaching effect.

```python
import numpy as np
import matplotlib.pyplot as plt

# Generate random data
X = np.random.randn(200, 2)

# Cluster the data
y_true = np.choose(np.random.randint(2, size=len(X)), [0, 1])

# Plot the data
plt.scatter(X[:, 0], X[:, 1], c=y_true)
plt.xlabel('X1')
plt.ylabel('X2')
plt.title('Figure 3. Code and its result.')
```

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**References**


