CS 4407-01 Data Mining and Machine Learning

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**Overview of the Week**

This week’s learning focused on the fundamental concepts and operational principles of artificial neural networks (ANNs). The main topics covered were:

* The operational principles of biological neurons and their artificial equivalents
* Definitions of the components of an artificial neuron
* Implementation of the perceptron algorithm and its weighting mechanism
* Characteristics of problems that can be solved by neural networks
* Differences between data mining and machine learning

Additionally, I conducted research on activation functions in artificial neurons, focusing on the importance of the sigmoid function. Moreover, the programming assignment involved designing and training a neural network to recognize characters and numbers using a seven-segment display.

**Personal Reflections**

This week’s content provided me with both theoretical insights and practical applications of neural networks, making it a deeply enriching experience. Understanding how artificial neurons emulate biological neurons’ mechanisms gave me a sense of the innovative ways nature inspires computational systems. I found the discussion on activation functions particularly thought-provoking, especially learning how the sigmoid function normalizes outputs to allow probabilistic interpretations. It highlighted how seemingly simple mathematical transformations can hold immense importance in decision-making processes.

The programming assignment was a hands-on challenge that helped bridge the gap between theory and practice. Designing a neural network to recognize numbers and letters from a seven-segment display initially felt daunting. Configuring the network and adjusting the training parameters to reduce errors required multiple iterations and problem-solving. At times, it was frustrating to see the error rates not converging as expected. However, these obstacles offered valuable lessons in resilience and adaptability. Each adjustment, whether it was modifying the network structure or tweaking the learning rate, brought me closer to an effective model.

Moreover, reflecting on the broader implications of neural networks in real-world applications, I was struck by their versatility. Neural networks are not confined to digit recognition; the same principles apply to complex tasks like image recognition and natural language processing. This realization broadened my perspective on the potential applications of the concepts I was learning.

Finally, understanding the differences between data mining and machine learning was enlightening. While both fields involve analyzing data, the former is focused on uncovering patterns and relationships, whereas the latter emphasizes developing models that can make predictions or decisions. This distinction clarified the roles these fields play in technological and business contexts, enabling me to see how they complement each other in solving modern problems.

The week’s activities were both rewarding and intellectually stimulating. They not only enhanced my technical knowledge but also reinforced my appreciation for the elegance and complexity of neural networks.

**Topics Studied in Depth**

This week, I delved deeply into the following two topics:

**Importance of Activation Functions and the Sigmoid Function**

Activation functions play a crucial role in determining the output of neurons based on the sum of their inputs. I learned that the sigmoid function is especially valuable for normalizing outputs to a range between 0 and 1, allowing probabilistic interpretation. It is also essential for logistic regression and classification tasks. Furthermore, the smooth output of the sigmoid function facilitates gradient descent during learning. I found it fascinating that the sigmoid function resembles the continuous spike response of biological neurons, highlighting the intent to mimic natural processes in artificial designs.

**Perceptron Algorithm and Weighting Mechanism**

I gained a better understanding of how weight adjustments significantly influence the learning performance of neural networks. By simulating the process of reducing errors through backpropagation, I experienced how mathematical formulas translate into real-world operation. Additionally, I realized that increasing training data enables the network to learn more complex patterns. Applying this theoretical knowledge to the programming assignment allowed me to deepen my comprehension.

**Future Challenges and Goals for Next Week**

One future challenge is to gain a deeper understanding of optimization techniques for designing complex neural networks and applying them in practice. Next week, I plan to work on the following topics:

* Defining the benefits of expandable CMS systems
* Practicing the installation of Joomla modules and extensions
* Building Joomla modules using PHP

Furthermore, I aim to explore methods for applying neural networks to practical problems and systematically organize the knowledge gained to advance to the next stage of learning.

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References

1. Gershenson, C. (2003). *Artificial neural networks for beginners.* arXiv preprint cs/0308031. Available from: http://arxiv.org/ftp/cs/papers/0308/0308031.pdf
2. Cowan, M. K. (2013). *Machine learning*. Available from: https://my.uopeople.edu/pluginfile.php/1928503/mod\_book/chapter/540682/neural-networks-ebook.pdf
3. Peterson, C., & Rögnvaldsson, T. S. (1991). *An introduction to artificial neural networks* (No. LU-TP-91-23). Available from http://home.thep.lu.se/pub/Preprints/91/lu\_tp\_91\_23.pdf