A03 Neural Network Zoo

Department of Science, Technology, Engineering & Math
Team 5

Contributors: Martin Demel, Bradley Johnson, Jesus Ocampo, Ethan Phan

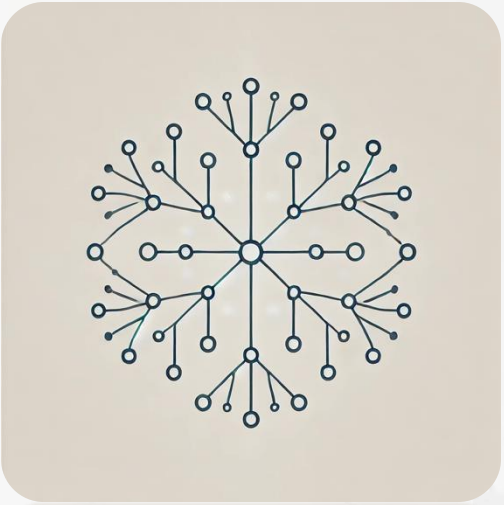
February 11th, 2025

Introduction

With the Neural Network Zoo project, we aim to introduce fundamental deep learning concepts by depicting various neural network architectures as “animals.” This metaphor enhances understanding by linking complex ideas with more relatable imagery.

We have selected the Transformer architecture, represented by the Tiger. This powerful, apex predator closely resembles how Transformers dominate many AI tasks today, including NLP and vision.

Neural Networks & Neurons



Neural networks are computational models inspired by biological neural structures. They consist of layers of interconnected “neurons” that learn to map inputs to outputs through iterative training processes.

Key Components:

- **Neurons -** The fundamental processing units that receive and aggregate inputs, apply a mathematical function, and produce outputs.
- **Layers -** Multiple layers enable hierarchical feature extraction, with deeper layers capturing increasingly abstract patterns.
- **Weights and Biases -** Parameters learned during training that define how neurons respond to specific inputs.
- **Activation Functions -** Nonlinear functions like ReLU and sigmoid allow networks to approximate complex relationships beyond simple linear mappings.

Real World Applications:

Image recognition, face detection, **object classification**, **Language processing**, translation, text generation, **Medical diagnosis**, financial forecasting, and more.

The Zoo Concept 1/2

CNN & Cheetah – CNN excels in fast image recognition, much like the Cheetah`s speed.

RNN & Rac coons – RNN excels in handling sequential tasks, which can be symbolized by the Racoons' adaptability.

LSTM & Lemur - LSTMs retain information over extended sequences, much like lemurs' memory and social behavior.

Transformer & Tiger - Transformers utilize an attention mechanism for powerful sequence processing, similar to Tiger`s keen focus and strength.

The Zoo Concept 2/2

The Neural Network Zoo uses an animal-based metaphor to illustrate the distinguishing features of various deep learning architectures. By linking the neural network types listed below to the animal, we reinforce learning and memory through vivid association.

Transformers & Tiger

The transformer's architecture is represented by the Tiger, which is agile in processing complex sequences, much like a tiger's precision and strength in the wild.

Transformers leverage self-attention mechanisms and parallel processing to efficiently model long-range dependencies in the data, which ultimately enables them to succeed in machine translation, text summarization, and other tasks.

Core Principles of the Transformer:

- **Self-Attention Mechanism:** Enables the model to weigh the importance of different segments within an input.
- **Multi-Head Attention:** Parallel heads capture various relational aspects of the data simultaneously.
- **Positional Encoding:** Preserves sequential order by embedding positional context directly into token representations.

Real World Applications:

Language Modeling (GPT, BERT), Document Summarization and Translation, Vision Transformers in image classification and multimodal tasks.

Conclusion

The Neural Network Zoo provided a structured and engaging approach to showcase different deep learning architectures by linking each of them to an animal metaphor. Through exploring the basics of the Neural Networks and the neurons, we have learned key components and real-world applications.

The key part of the assignment is the Tiger & Transformers, which underscores the remarkable capacity of attention-based models to tackle highly complex tasks efficiently and precisely.

By linking the animals to different deep-learning architectures, we have reinforced the learning about the concepts and their applications in real life.

Sources

- GeeksforGeeks. (2024, December 6). Transformers in machine learning. GeeksforGeeks. https://www.geeksforgeeks.org/getting-started-with-transformers/
- GeeksforGeeks. (2024, July 29). Architecture and working of transformers in deep learning. GeeksforGeeks. https://www.geeksforgeeks.org/architecture-and-working-of-transformers-in-deep-learning/
- GeeksforGeeks. (2024, December 6). What is a Neural Network? GeeksforGeeks. https://www.geeksforgeeks.org/neural-networks-a-beginners-guide/

Thank you.