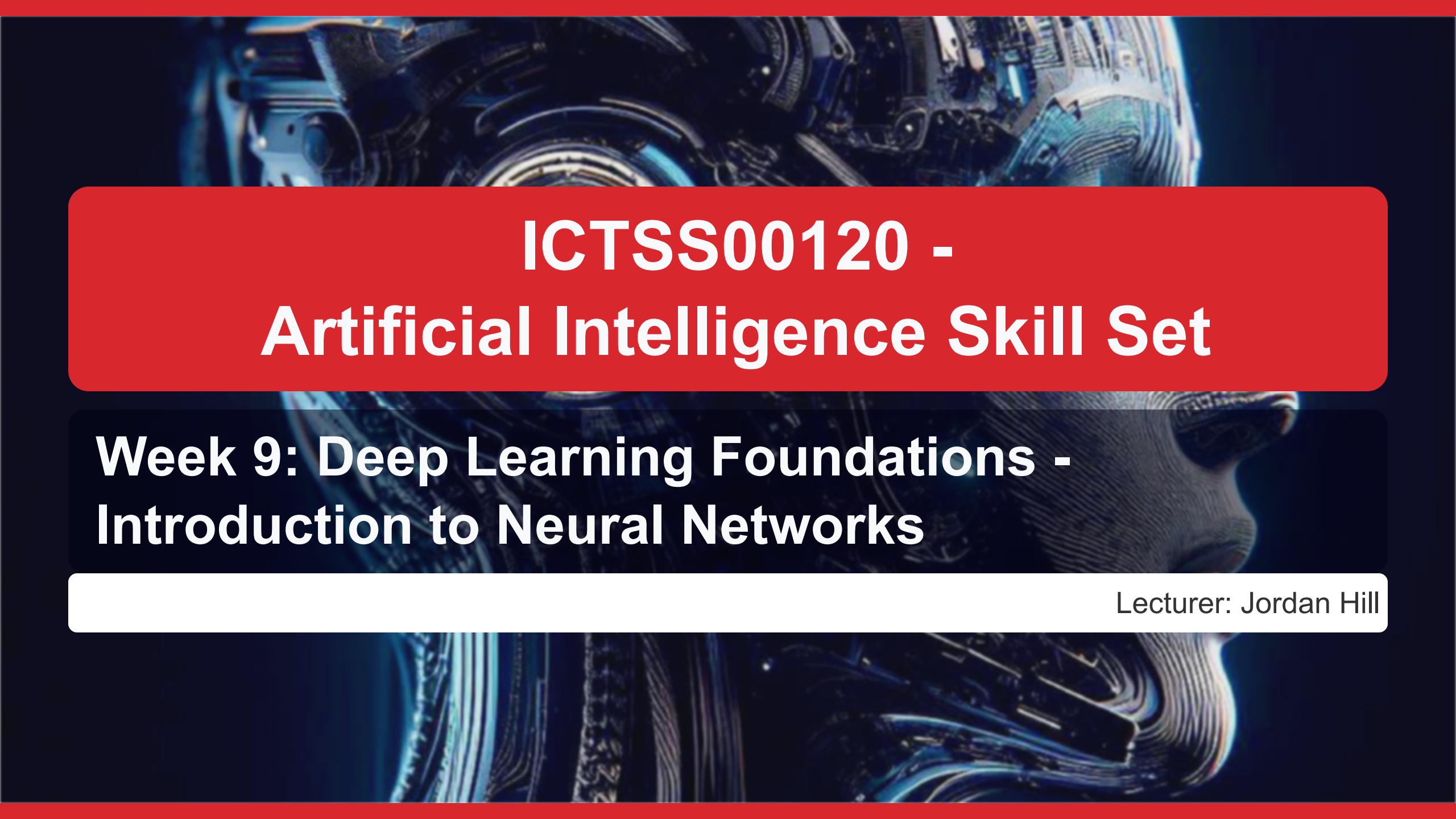

ICTSS00120 - Artificial Intelligence Skill Set

Week 9: Deep Learning Foundations - Introduction to Neural Networks

Lecturer: Jordan Hill

Learning Objectives

- Understand the basics of neural networks.
- Explore the concept of hidden layers in neural networks.
- Learn about training, test, and validation loops for deep learning.
- Understand the Stochastic Gradient Descent (SGD) and Backpropagation algorithms.
- Introduction to Feed Forward Neural Networks (FNN) and Convolutional Neural Networks (CNN).

Introduction to Neural Networks

What is a Neural Network?

- A neural network is a computational model inspired by the way biological neural networks in the human brain process information.
- Composed of interconnected nodes, or neurons, that work together to solve specific problems.
- Typically organized into layers: input layer, hidden layers, and output layer.

Hidden Layers

Concept of Hidden Layers

- **Hidden Layers**: These are layers between the input and output layers where computation is performed.
- Each hidden layer applies transformations to the input data to extract features and patterns.

Key Points:

- More hidden layers can represent more complex functions, but may also require more computational power and data to train effectively.
- Typically use activation functions like ReLU to introduce non-linearity.

Training, Test, and Validation Loops

Training, Validation, and Testing in Deep Learning

1. **Training Loop**:
   - Model learns from the training data.
   - Updates weights using backpropagation and optimization algorithms like Stochastic Gradient Descent (SGD).
2. **Validation Loop**:
   - Evaluates the model's performance on validation data not seen during training.
   - Helps in tuning hyperparameters and preventing overfitting.
3. **Test Loop**:
   - Assess the final model performance on completely unseen data.

Stochastic Gradient Descent (SGD)

Introduction to SGD

- **SGD**: An optimization algorithm used to minimize the cost function in neural networks.
- **Process**:
  i. Start with initial weights.
  ii. Calculate the gradient of the cost function.
  iii. Update weights in the opposite direction of the gradient.
  iv. Repeat until convergence.

Key Advantages:

- Computationally efficient.
- Capable of handling large datasets effectively.

Backpropagation

Backpropagation of Error

- **Backpropagation**: Algorithm used for training neural networks by propagating the error backward through the network.
- **Process**:

  i. Forward Pass: Compute the output and loss.

  ii. Backward Pass: Compute the gradients of the loss with respect to each weight using the chain rule.

  iii. Update Weights: Adjust the weights using the gradient descent algorithm.

Benefits:

- Helps in minimizing the loss function.
- Efficiently optimizes neural network parameters.

Feed Forward Neural Networks (FNN)

Introduction to FNN

- **FNN**: Simplest type of artificial neural network where connections between nodes do not form cycles.
- **Structure**:
  - Composed of an input layer, multiple hidden layers, and an output layer.
  - Each neuron in one layer is fully connected to neurons in the next layer.

Applications:

- Mainly used for tasks requiring pattern recognition, such as image and speech recognition.

Convolutional Neural Networks (CNN)

Introduction to CNN

- **CNN**: Specialized neural network designed for processing structured grid data like images.
- **Components**:
  - **Convolutional Layers**: Apply convolution operations to extract features.
  - **Pooling Layers**: Reduce the dimensionality of feature maps.
  - **Fully Connected Layers**: Perform high-level reasoning and classification.

Advantages:

- Highly effective at capturing spatial hierarchies in data.
- Significantly reduces the number of parameters compared to traditional FNNs.

Summary and Q&A

Summary:

- Introduced the basic concepts of neural networks and their components.
- Explained hidden layers, training, validation, and testing loops.
- Covered key algorithms like Stochastic Gradient Descent and Backpropagation.
- Introduced types of neural networks: Feed Forward Neural Networks (FNN) and Convolutional Neural Networks (CNN).

Q&A:

- Any questions about today's topics?
- How would you apply these concepts in different real-world scenarios?

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Homework

Next Week:

- Explore advanced neural network architectures.
- Delve deeper into CNNs and Recurrent Neural Networks (RNNs).

Tasks:

1. Review the key concepts covered today.
2. Read about the applications of CNNs in image recognition.
3. Watch the linked videos on neural networks and backpropagation.