NEURAL NETWORK

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Questions

ARE YOU CURIOUS ABOUT HOW COMPUTERS CAN UNDERSTAND AND INTERPRET HUMAN SPEECH?

HAVE YOU EVER WONDERED HOW SELF-DRIVING CARS NAVIGATE THROUGH COMPLEX TRAFFIC SITUATIONS ?

YUP. HERE IS THE ANSWER "**NEURAL NETWORK**"

Source : (Jucutan, 2018)

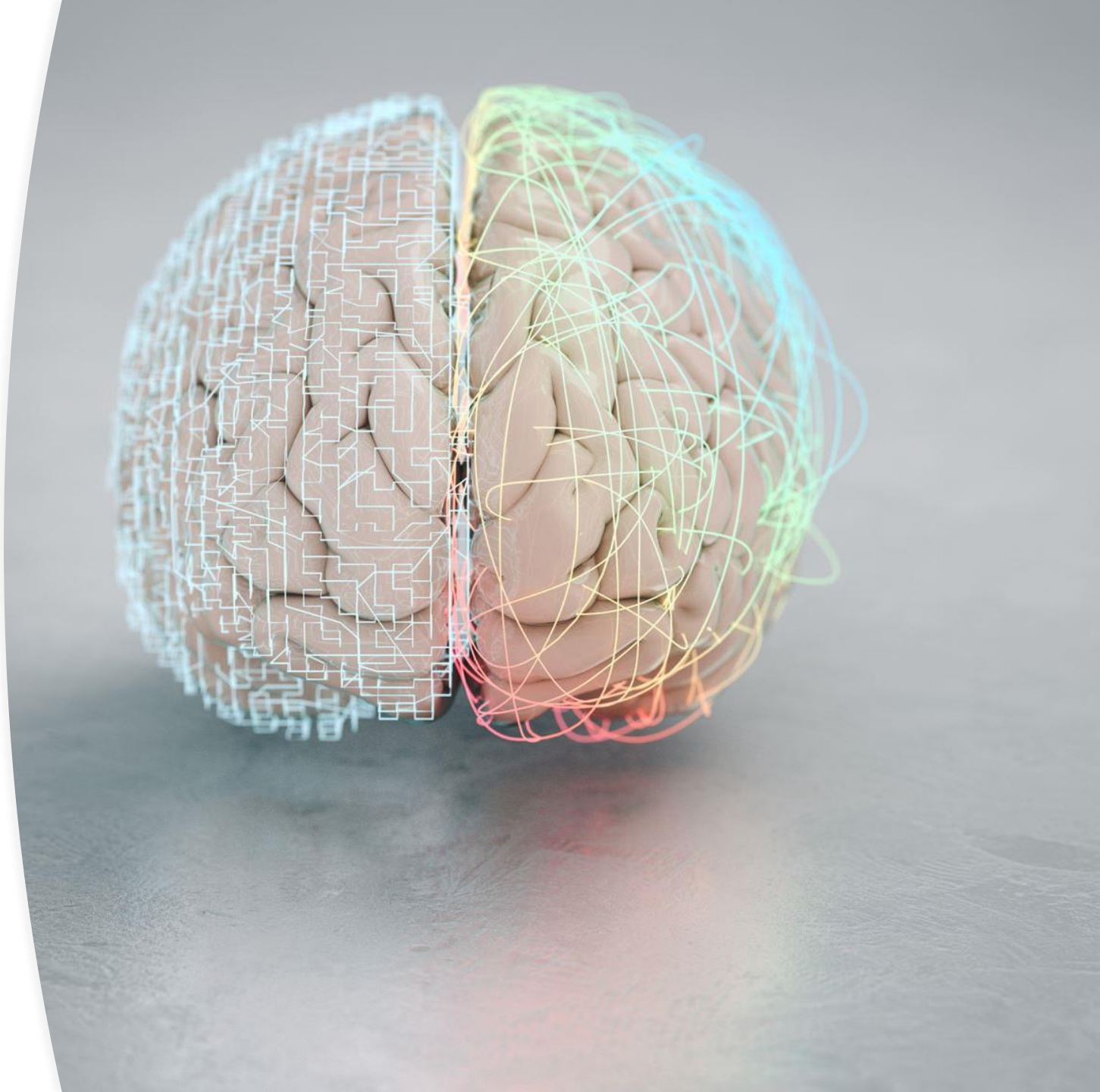
AGENDAS

- INTRODUCTION
- HISTORY AND BACKGROUND
- WHY NEURAL NETWORKS ?
- BASIC CONCEPTS OF ARTIFICIAL NEURONS
- NEURAL NETWORK ARCHITECTURE
- TRAINING AND NEURAL NETWORK ALGORITHMS
- APPLICATION OF NEURAL NETWORKS
- CHALLENGES AND FUTURE DIRECTIONS
- CONCLUSION
- REFERENCES

INTRODUCTION

According to (Gurney, K., 1997):

A neural network is a computer system inspired by the human brain that processes information through interconnected nodes.

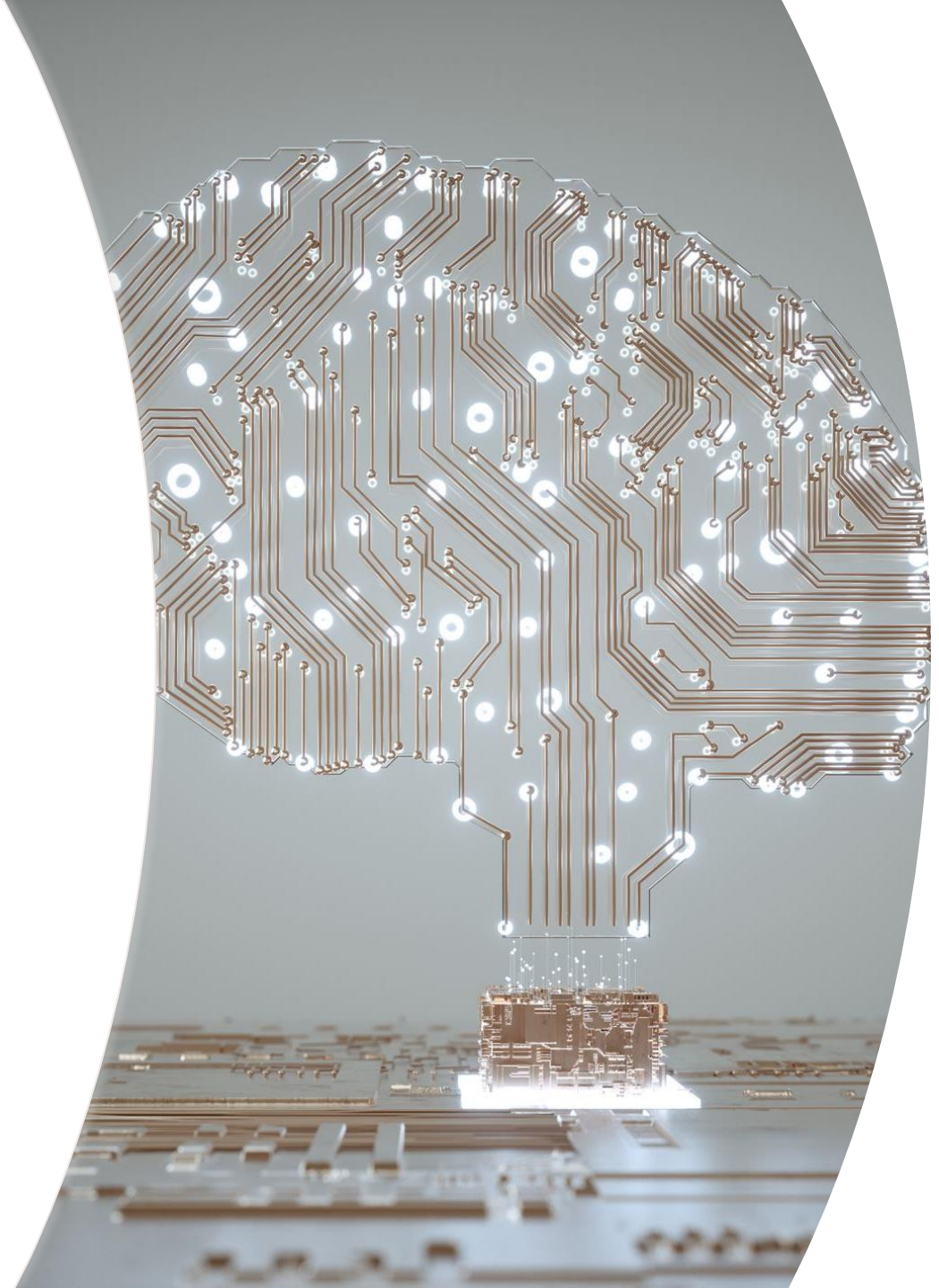


HISTORY & BACKGROUND

- According to (Müller, B., Reinhardt, J. and Strickland, M.T., 1995)

Stage	Date	Development
McCulloch-Pitts Neuron	1943	Warren McCulloch and Walter Pitts proposed a simplified model of a biological neuron.
Perceptron	1957	Frank Rosenblatt developed the perceptron, an early neural network capable of learning and decision-making.
Backpropagation Algorithm	1974	Paul Werbos introduced the backpropagation algorithm for adjusting weights in a neural network.
Connectionism	1980s	Researchers explored connectionism, which views cognitive processes as interconnected processing units.
Multilayer Perceptrons	-	Multilayer perceptrons (MLPs) enabled the construction of deeper neural networks, leading to deep learning.
Support Vector Machines	2000s	Support vector machines (SVMs) gained popularity, overshadowing neural networks in machine learning.
Deep Learning Resurgence	2010s	Advances in computation, data availability, and training algorithms revitalized interest in deep learning.
Breakthrough Applications	2010s	Deep learning-based neural networks achieved significant success in areas like image recognition and NLP.
Transformer Model	2017	The transformer model revolutionized NLP tasks, employing self-attention mechanisms for contextual understanding.
Ongoing Advancements	-	Current research focuses on improving training techniques, addressing limitations, and exploring new architectures.

Why Neural Networks ?



- **Understanding the Brain:**

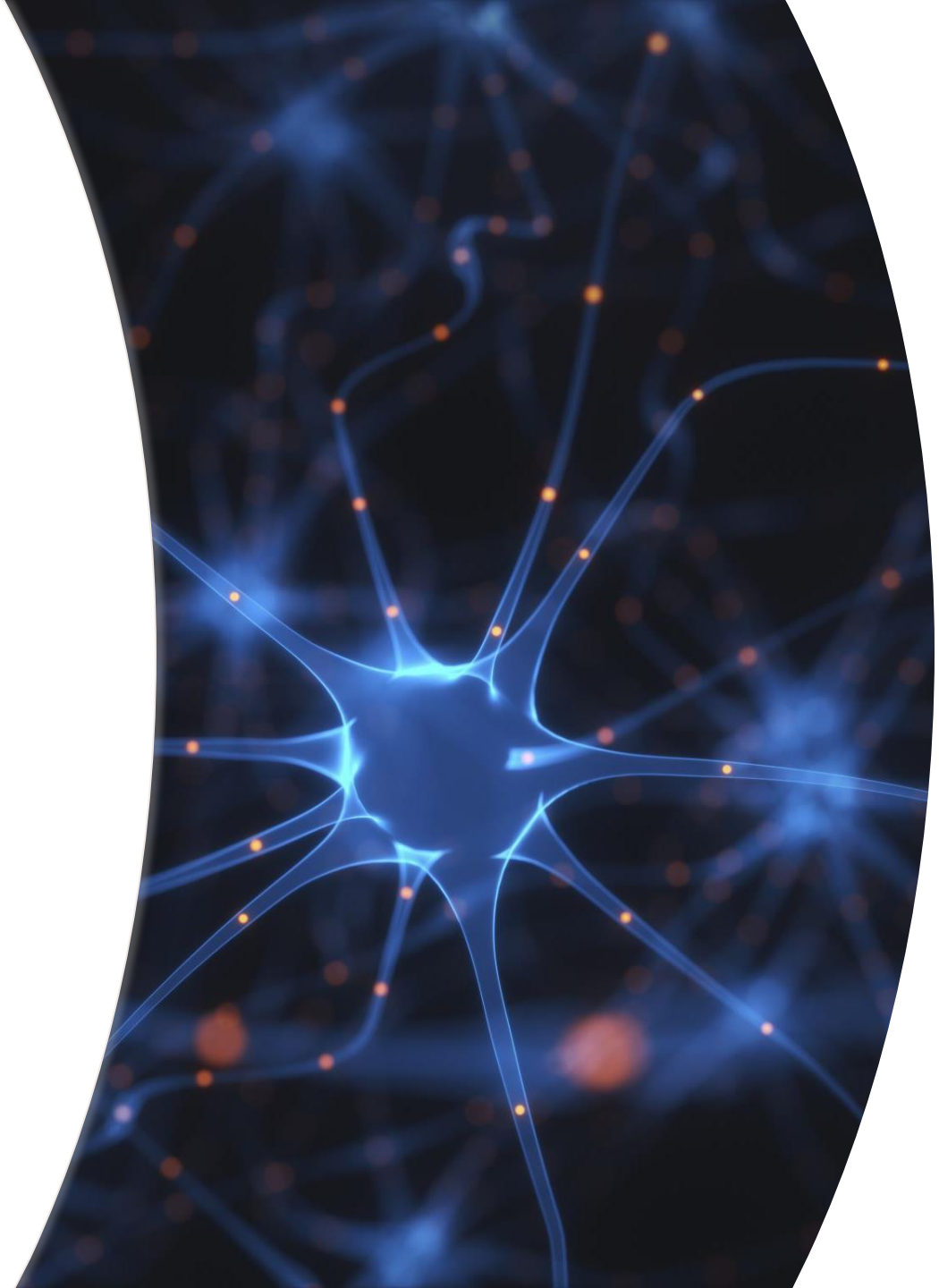
  Researchers driven to comprehend human brain principles.
- **Overcoming Computational Limitations:**

  Need for machines beyond sequential computers.
- **Focus on Complex Tasks:**

  Surge in neural networks to tackle complex tasks.
- **Advantages over Traditional Computers:**

  Neural networks excel where traditional computers fall short.

Basic concepts of artificial neurons and neural networks :



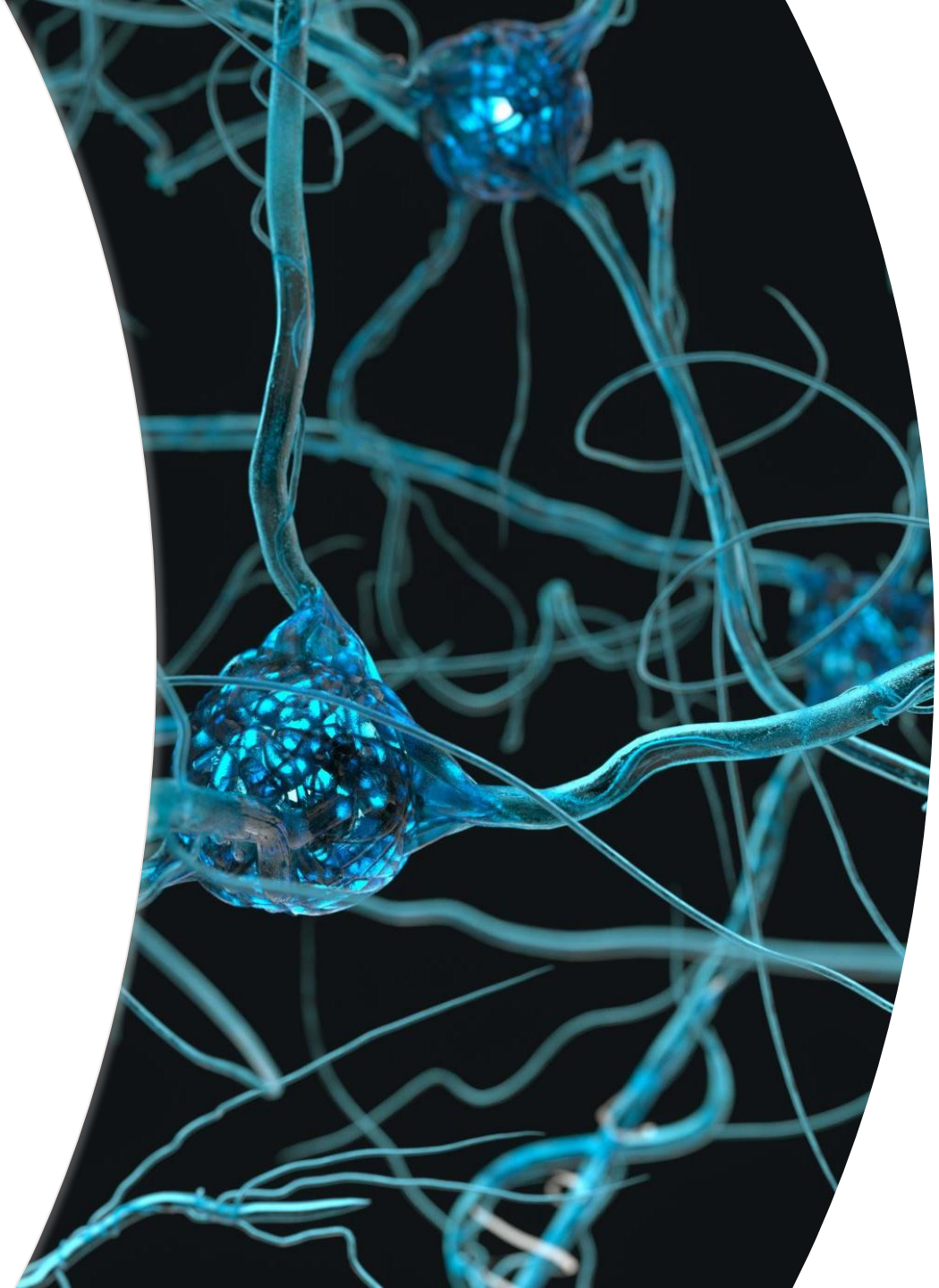
- **Artificial Neurons:**

  Artificial neurons, also known as nodes, are the fundamental processing elements of neural networks. They are computational models inspired by natural neurons.

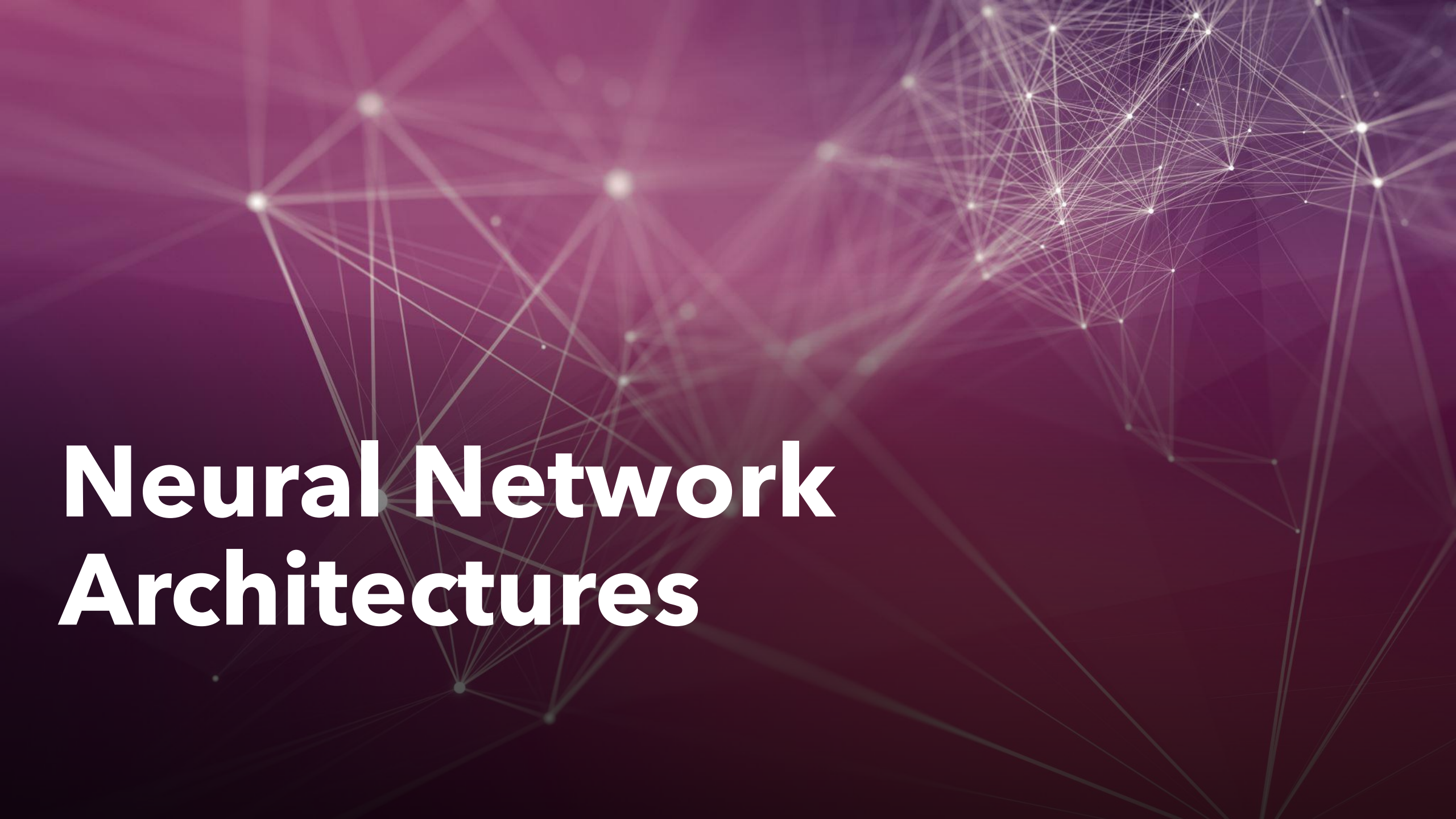
- **Neural Signal Processing:**

  Artificial neurons receive input signals through synapses, similar to natural neurons receiving signals through dendrites or membranes.

Basic concepts of artificial neurons and neural networks :



- **Activation Threshold:**
  If the input signals surpass a certain threshold, the artificial neuron is activated and emits an output signal through its axon.
- **Signal Transmission:**
  The output signal from one artificial neuron can be transmitted to other neurons through synapses, simulating the interconnected nature of natural neural networks.


Neural Network
Architectures

Feedforward Neural Networks (Multilayer Perceptron)

a) Information processing technique

b) Meaningful answers with error-prone or incomplete data

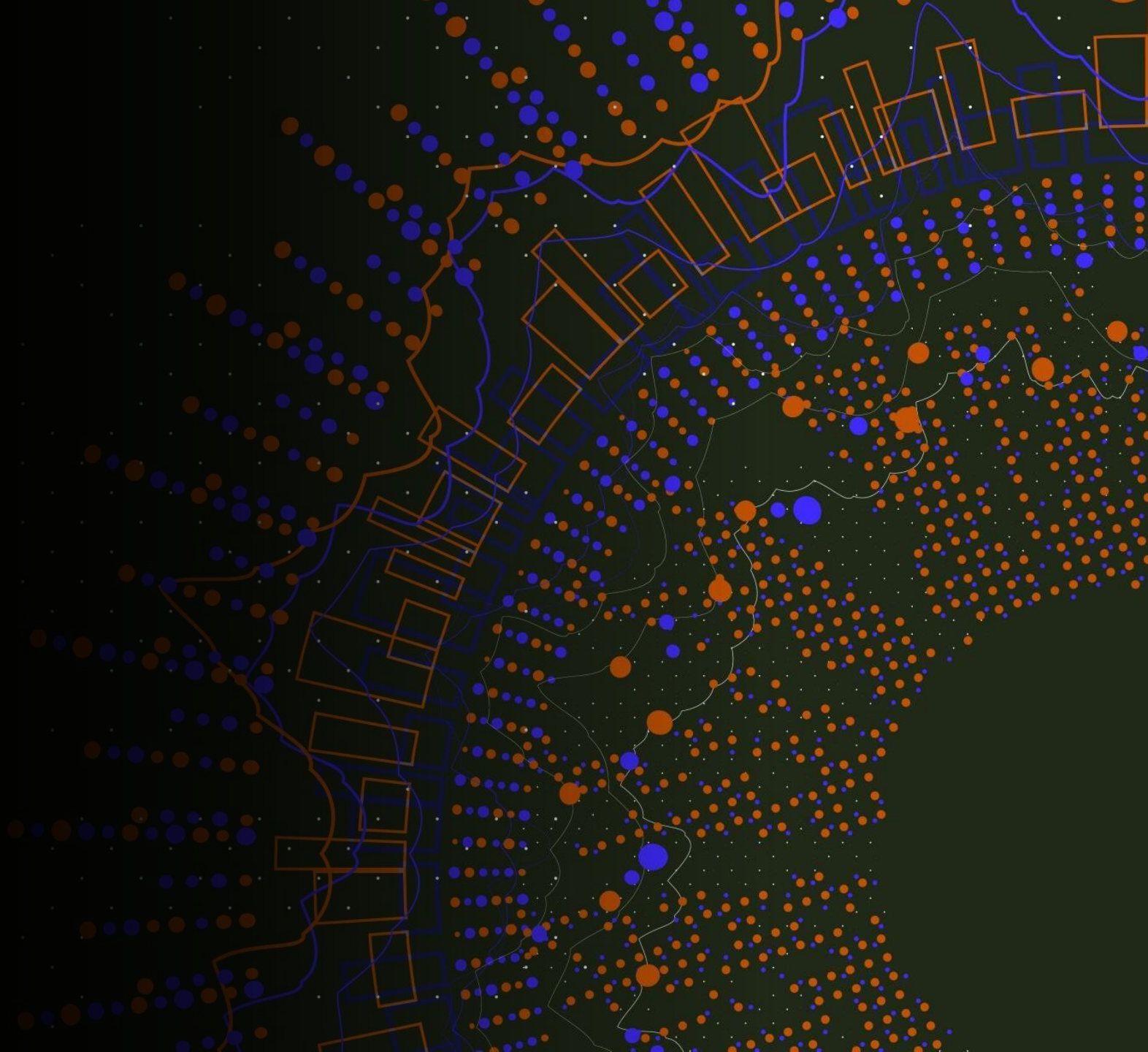
c) Rapid processing for solving real-world problems

Recurrent Neural Networks (RNNs)

a) State of the art in time series prediction, system identification, and pattern classification.

b) Modification of multilayered feed-forward network with a context layer.

c) Context layer retains information between observations.



Convolutional Neural Networks (CNNs)

a) Used for facial recognition and image processing.

b) Training with a large database of pictures.

c) Sampling layers for evaluations and optimization of models for accurate recognition results.

Generative Adversarial Networks (GANS)

a) Learn deep representations without extensive annotated training data.

b) Competitive process involving a pair of networks.

c) Applications include image synthesis, semantic image editing, style transfer, image super resolution, and classification.

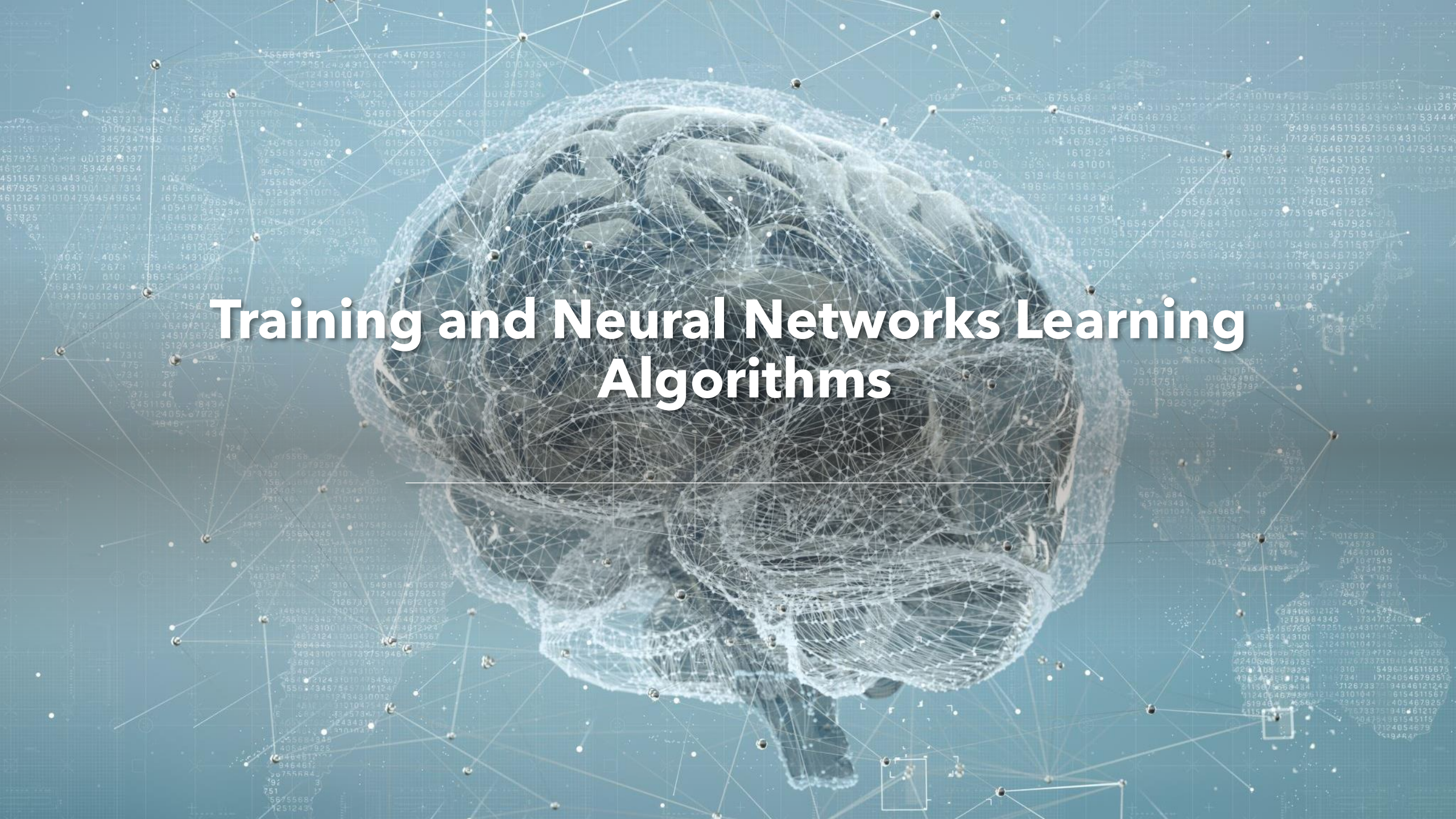
Radial Basis Function Networks (RBFNs)

a) Three-layer feed-forward network.

b) Linear transfer function for output units.

c) Nonlinear transfer function (often Gaussian) for hidden layer neurons.

(Chen, Cowan and Grant, 1991)



Training and Neural Networks Learning Algorithms

TRAINING :

a) Choosing the number of neurons

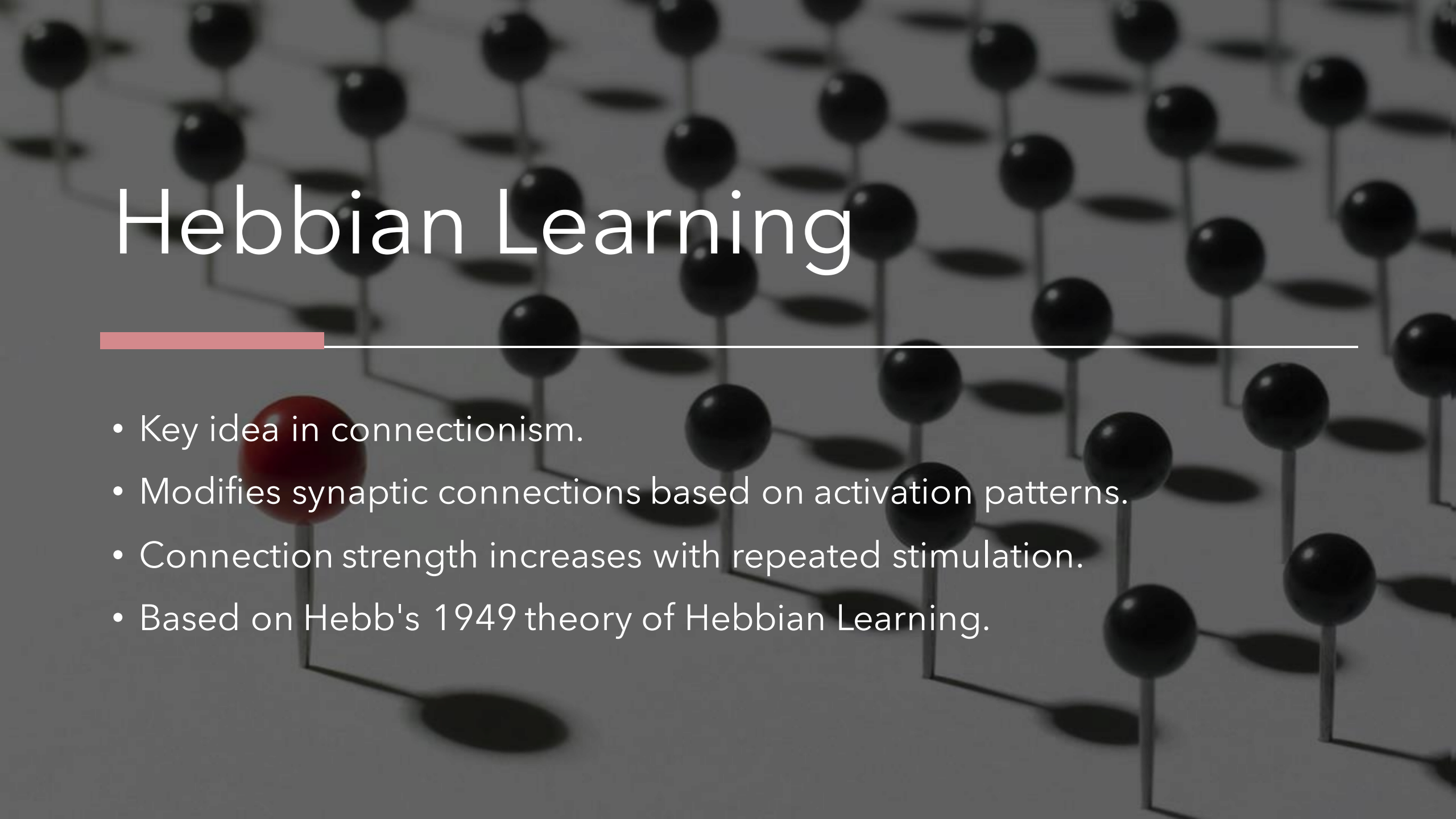
b) Regularization methods (dropout, weight decay)

c) Learning rate and convergence considerations

LEARNING ALGORITHMS

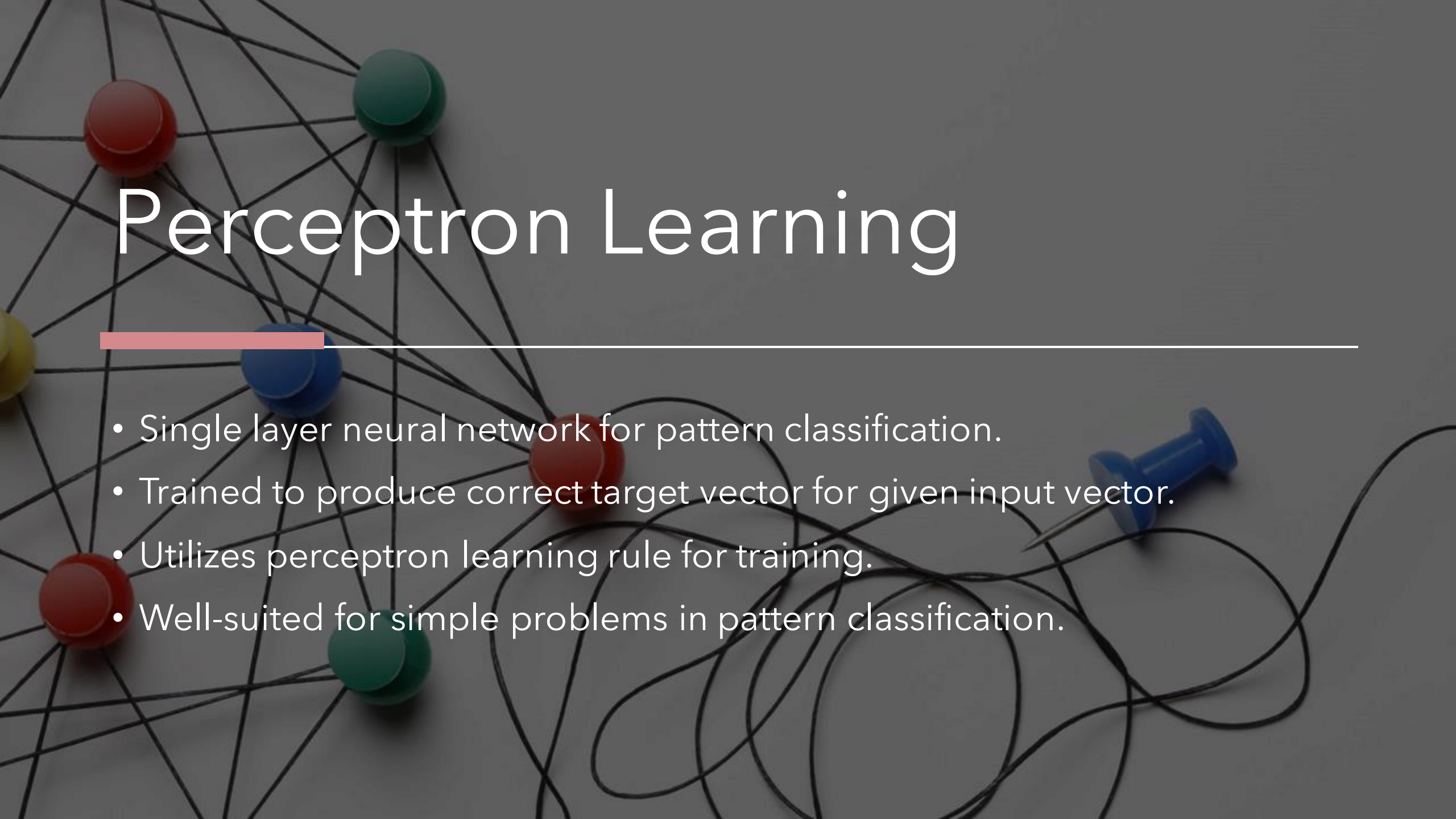
Backpropagation Learning

- Crucial learning algorithm in neural networks.
- Computes partial derivatives of the error with respect to each weight.
- Modifies network weights based on these derivatives.
- Error decreases towards a local minimum by weighting the negative derivatives.



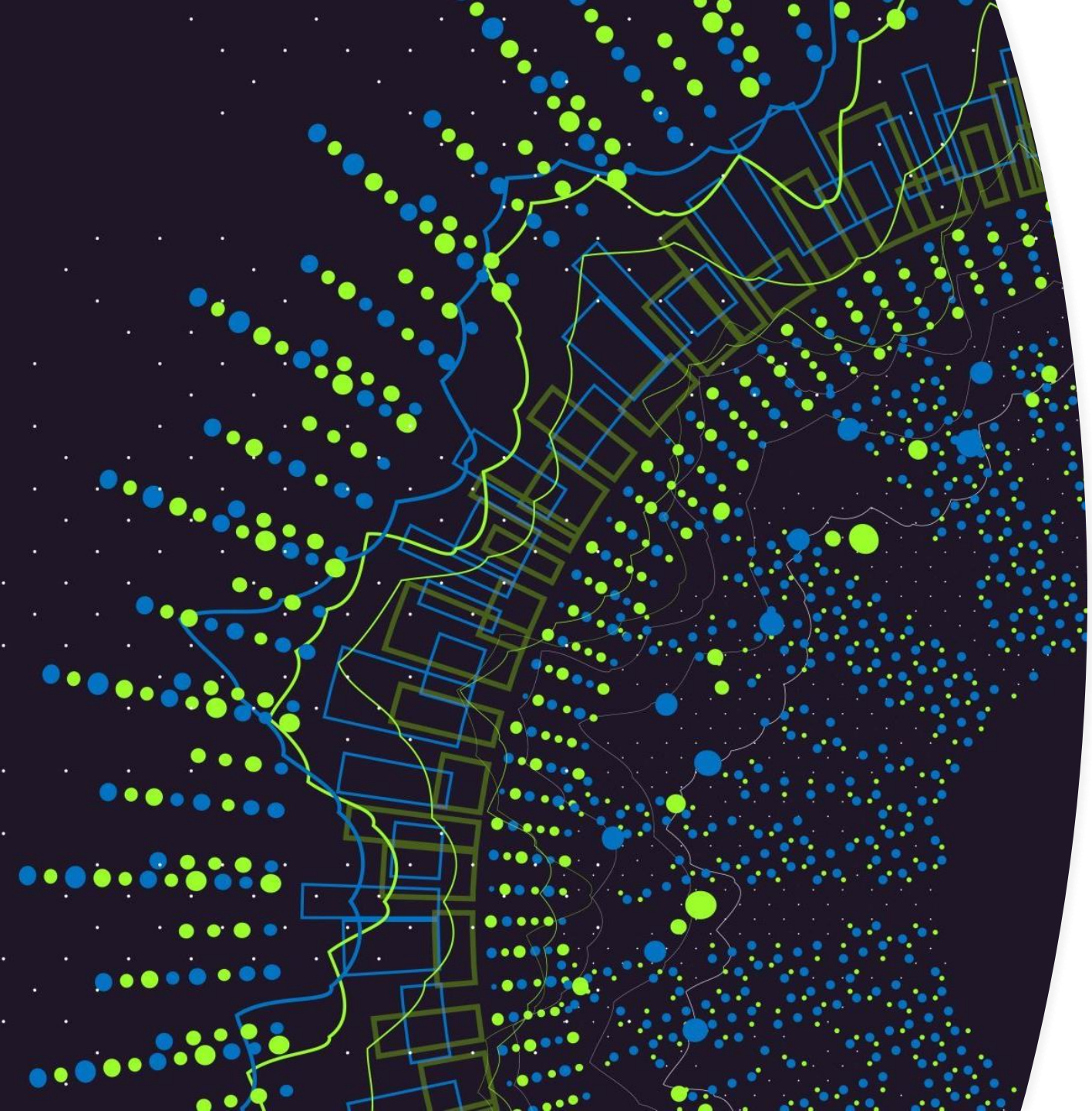
Hebbian Learning

- Key idea in connectionism.
- Modifies synaptic connections based on activation patterns.
- Connection strength increases with repeated stimulation.
- Based on Hebb's 1949 theory of Hebbian Learning.



Perceptron Learning

- Single layer neural network for pattern classification.
- Trained to produce correct target vector for given input vector.
- Utilizes perceptron learning rule for training.
- Well-suited for simple problems in pattern classification.



Applications of Neural Network

Recommendation Systems :

- Provide content recommendations to users.
- Enable automatic personalization to a large user base.

Facial Recognition:

- Robust facial recognition in surveillance, authentication, and selective entries.
- Convolutional Neural Networks (CNN) process large datasets for accurate recognition results.

Applications of Neural Network

Aerospace Applications:

- Time Delay Neural Networks (TNN), applied in aerospace engineering.
- Used for fault diagnosis, auto piloting, control system security, and dynamic simulations.

Defense Systems:

- Used for logistics, armed attack analysis, object location, air patrols, maritime patrols, and controlling automated drones.
- Convolutional Neural Networks (CNN) utilized for underwater mine detection and image processing.

Applications of Neural Network

Stock Market Prediction:

- Neural networks, particularly Multilayer Perceptron (MLP), used for real-time stock market predictions.
- MLP models analyze past performances, annual returns, and ratios for accurate predictions.

Social Media Analysis:

- Analyze social media user behaviors for competitive analysis and data mining.
- MLP models forecast social media trends using factors like user preferences and bookmarked choices.

CHALLENGES AND FUTURE DIRECTIONS

Challenges :

Overfitting and underfitting

`Underfitting : Model fails to capture underlying data trend due to insufficient training data.

Overfitting: Model doesn't generalize well to unseen data, capturing noise instead of the underlying trend.

Data availability and quality

Data challenge: Neural networks need large amounts of data for accurate learning.

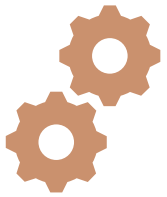
Data availability constraint: Insufficient data for some tasks or domains.

Interpretability and explainability

Interpretability challenge: Lack of understanding of how neural networks process data and make decisions.

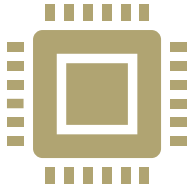
Black box nature: Difficulty in comprehending learned features and decision-making process.

Advances in neural network research



Attention Mechanisms:

Enable models to focus on relevant parts of input data for efficiency.



Transformer Models:

Perform well in text production and language translation with parallel processing and capturing long-range dependencies.

Graph Neural Networks (GNNs):

Effective for processing data with complex relational structures, such as social networks and molecular graphs, capturing complex connections between nodes.

Potential future applications and impact of neural networks

Integration:

Can be integrated with complementary technologies, such as symbolic functions, to address their weaknesses and achieve better results.

Scaling up complexity:

Technological advancements enable larger and more efficient neural networks with increased processing power and data capacity.

New applications:

Neural networks have the potential to transform industries, improving efficiency, targeting new audiences, and enhancing product development and consumer safety.

Potential obsolescence:

Despite progress, neural networks may face limitations and alternative approaches may emerge as technology evolves to address complex problems.

CONCLUSION

- Neural networks mimic the human brain and process information through interconnected nodes.
- Different network architectures include feedforward, recurrent, convolutional, generative adversarial, and radial basis function networks.
- Training algorithms like backpropagation, Hebbian learning, and perceptron learning improve network performance.
- Neural networks have diverse applications such as recommendation systems, facial recognition, stock market prediction, social media analysis, aerospace, and defense.
- Challenges include overfitting, data availability, interpretability, and advancements like attention mechanisms and graph neural networks.

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ANY QUERIES ?

THANK YOU