SNS COLLEGE OF TECHNOLOGY

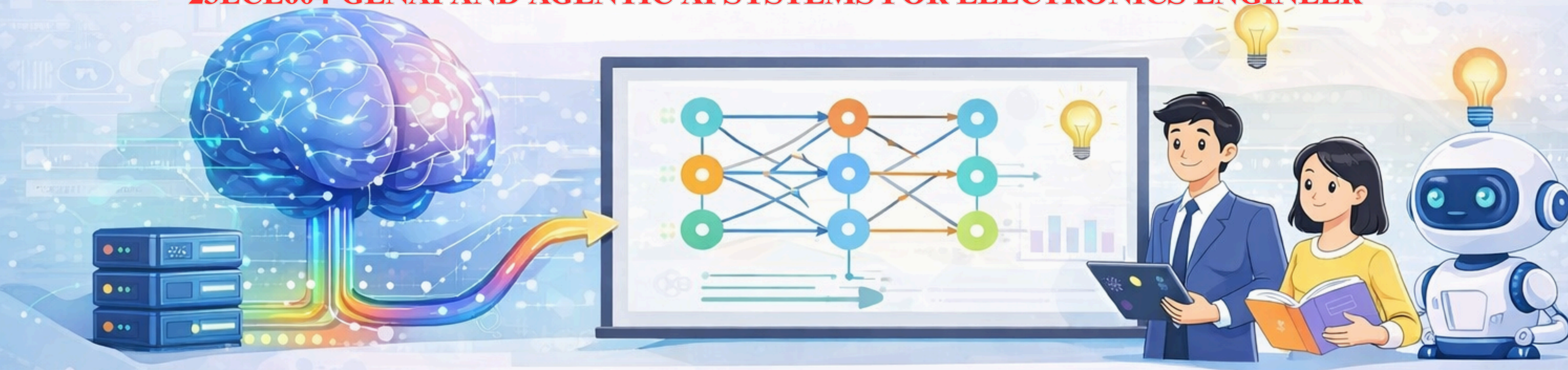
An Autonomous Institution

Coimbatore-35

Overview of Neural Networks

A Design Thinking Approach

23ECE604-GENAI AND AGENTIC AI SYSTEMS FOR ELECTRONICS ENGINEER



Empathize – Neural Networks

(Real-World Problems)

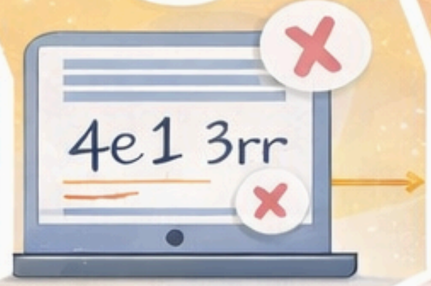
A

Computers fail to recognize images accurately

B

Speech recognition errors

C



Poor handwriting recognition

D

Inaccurate predictions from traditional algorithms

E

Manual feature extraction is time-consuming

How can machines learn patterns like humans?

Define – Clearly Articulating the Problem

Problem Summary

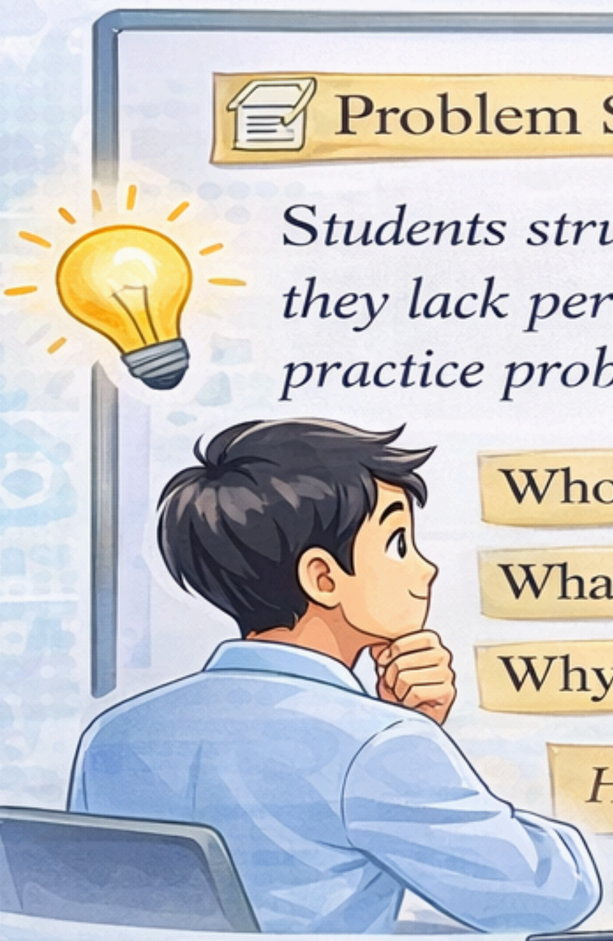
Students struggle to improve in math because they lack personalized feedback and find practice problems unengaging.

Who? – Struggling Math Students

What? – Lack of personalized feedback

Why? – Unengaging Practice

How might we help them?



IDEATE — Stage 3

Ideate – Solutions Using Neural Networks

How might we make computers learn and adapt like humans?

Learning Models

- Artificial Neural Network (ANNN)
- Deep Neural Network (DNN)

Data Handling

Automatic feature learning

Backpropagation learning

Applications

Image classification

Speech recognition

Pattern recognition

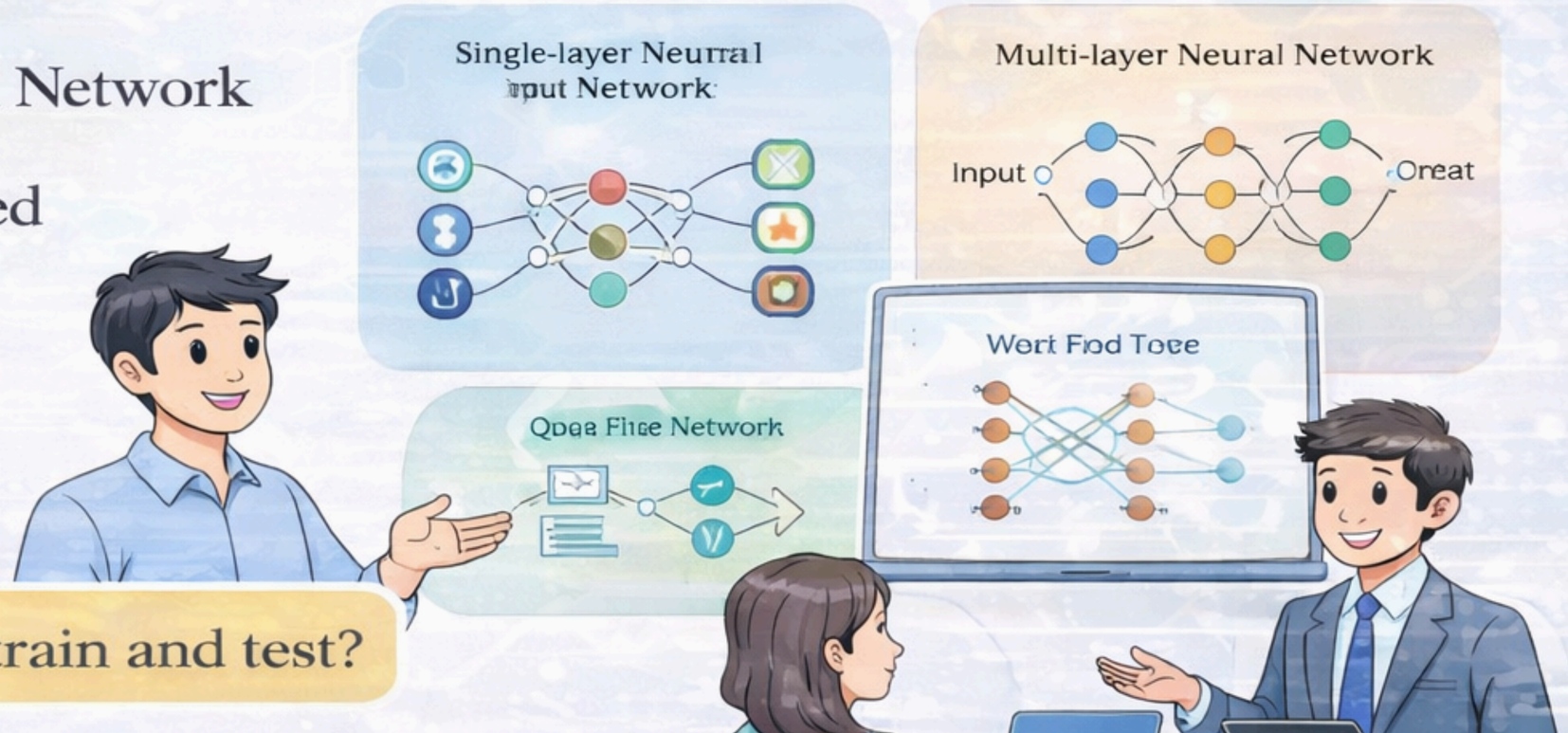
Many ideas – no judging

Prototype – Build Neural Network Models

Prototype approaches:

1. Single-layer Neural Network
2. Multi-layer Neural Network
3. Feedforward Neural Network
4. Simple ANN Trained on Sample Dataset

python™ TensorFlow Keras



Prototyping tools to train and test?

Test – Evaluate Neural Network Models

How do we measure success and improve our models?

Prototype approaches:

1. Single-layer Neural Network
2. Multi-layer Neural Network
3. Feedforward Neural Network
4. Simple ANN Trained on Sample Dataset

python™ MATLAB

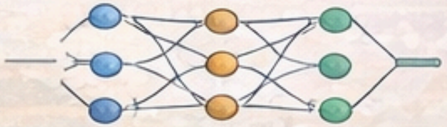
Single layer

- Measure correct predictions
- Compare against test data

Precision

- Check false positives
- Increase specificity

Recall & Retrain



- Identify false negatives
- Increase sensitivity

Test your model and refine it!

Neural Networks Mind Map

Neural Networks

Empathize

- Computers fail to recognize images accurately
- Speech recognition errors

Define

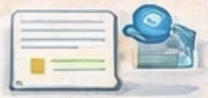
- Traditional algorithms can't handle complex data
- Manual feature engineering reduces efficiency
- Need for self-learning systems

Define

- Artificial Neural Network
- Manual feature enerstn
- Manual feature extraction is time-consuming

Ideate

- Artificial Neural Networks
- Automatic feature learning
- Increase sensitivity



Ideate

- Artificial Neural Networks
- Single & multi-layer models

Prototype

python™ TensorFlow Keras

Test

- Measure accuracy, precision, recall
- Adjust and re-train the model

Applications of Neural Networks

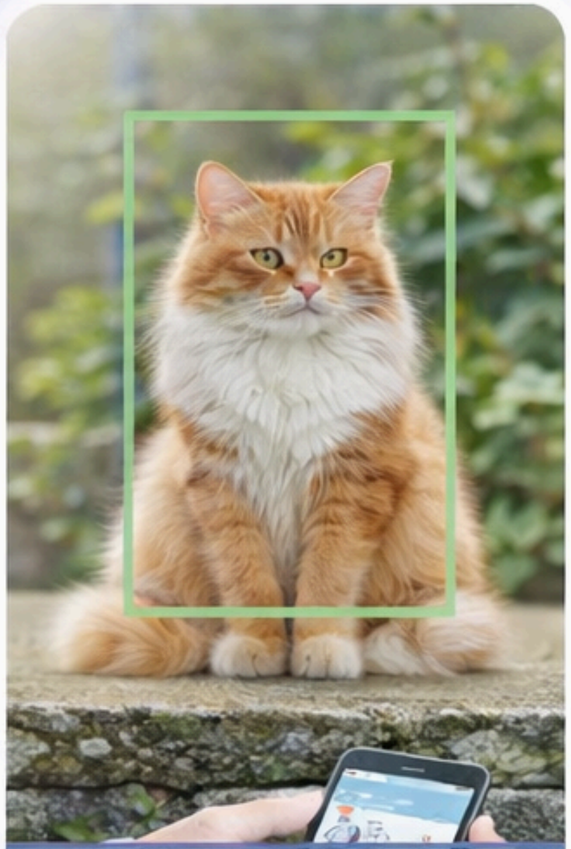
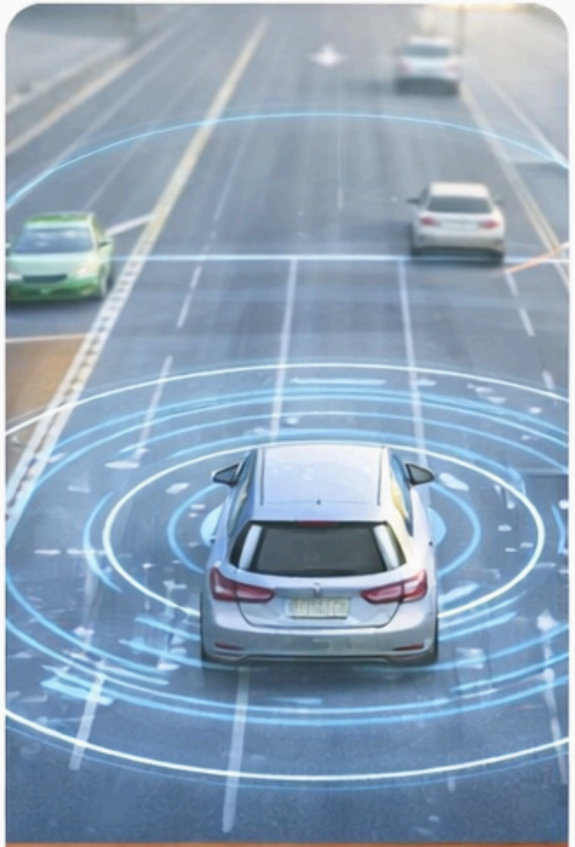


Image Recognition

Speech Recognition



Autonomous Vehicles

Medical Diagnosis

ADVANTAGES & LIMITATIONS

Advantages

- Efficient Data Representation
- Noise Reduction
- Feature Extraction
- Data Generation

Limitations

- Training Challenges
- Overfitting Risk
- Limited Interpretability
- Computational Cost

CONCLUSION

- Neural networks mimic human intelligence
- From image recognition to medical diagnosis — they transform multiple industries
- Continued research will unlock new possibilities

What's next for the future of machine learning?

References

- LeCun, Y., Bengio, Y, & Hinton, G. (2015). *Deep learning. Nature*, 521, 436–444. doi:10.1038/nature14539
- Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning*. MIT Press. ISBN: 9780262035613
- Schmidhuber, J. (2015). *Deep learning in neural networks:* An overview. *Neural Networks*, 61., 85–117. doi:10.1016/j.neunet.2014.09.003
- Sutton, R.S. & Barto, A.G. (2018). *Reinforcement Learning: An Introduction*. MIT Press. ISBN: 9780262039246
- IBM Cloud Education. (2020). *What are neural networks?* Retrieved from https://www.ibm.com/cloud/learn/neural-networks
- Brownlee, J. (2019, August 16). *A gentle introduction to deep learning for machine learning*. Retrieved from https://machinelearningmastery.com/a-gentle-introduction-to-deep-learning-for-machine-learning/
- Chollet, F. (2021, November 17. *Deep Learning with Python* (2nd ed.). Manning Publications. ISBN: 9781617296864