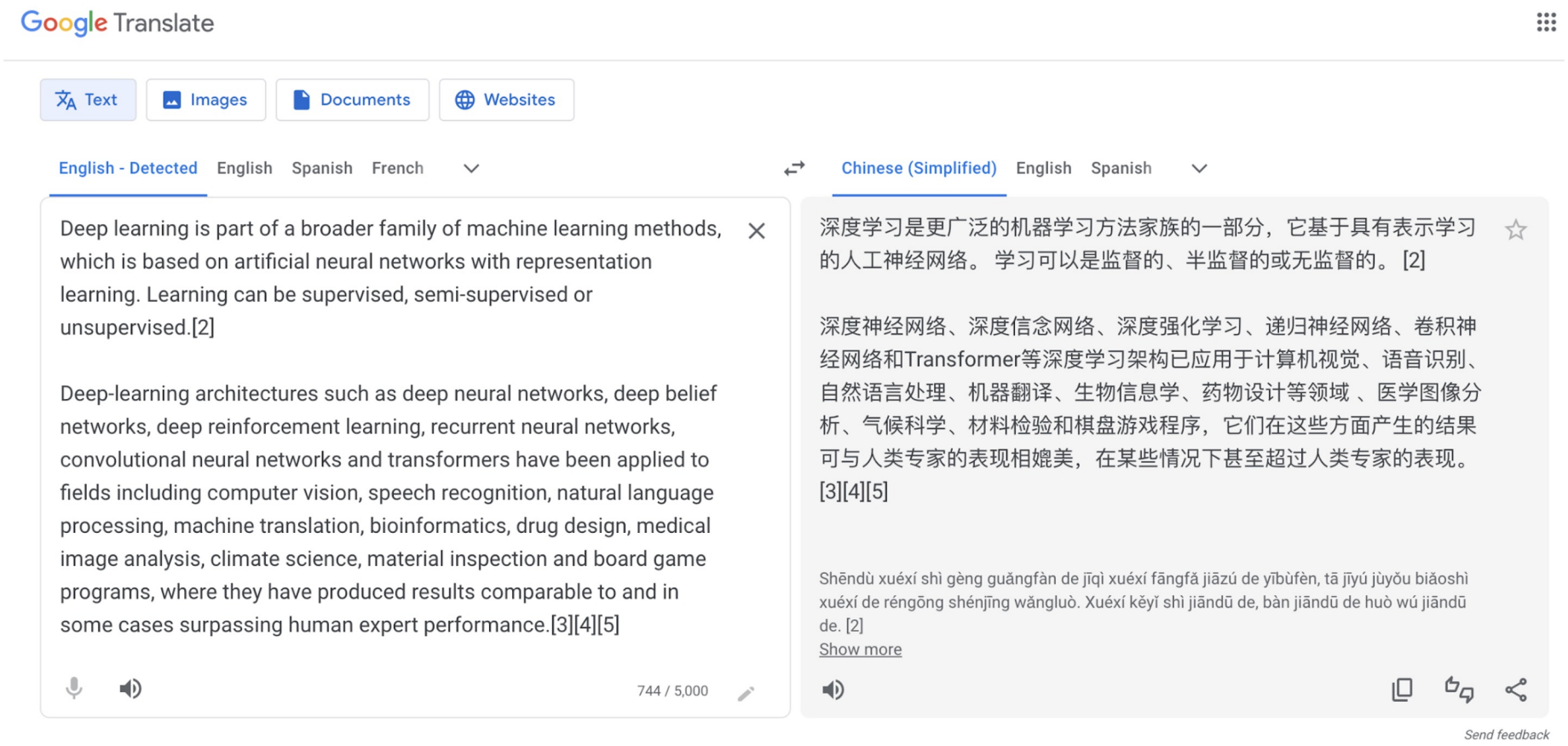
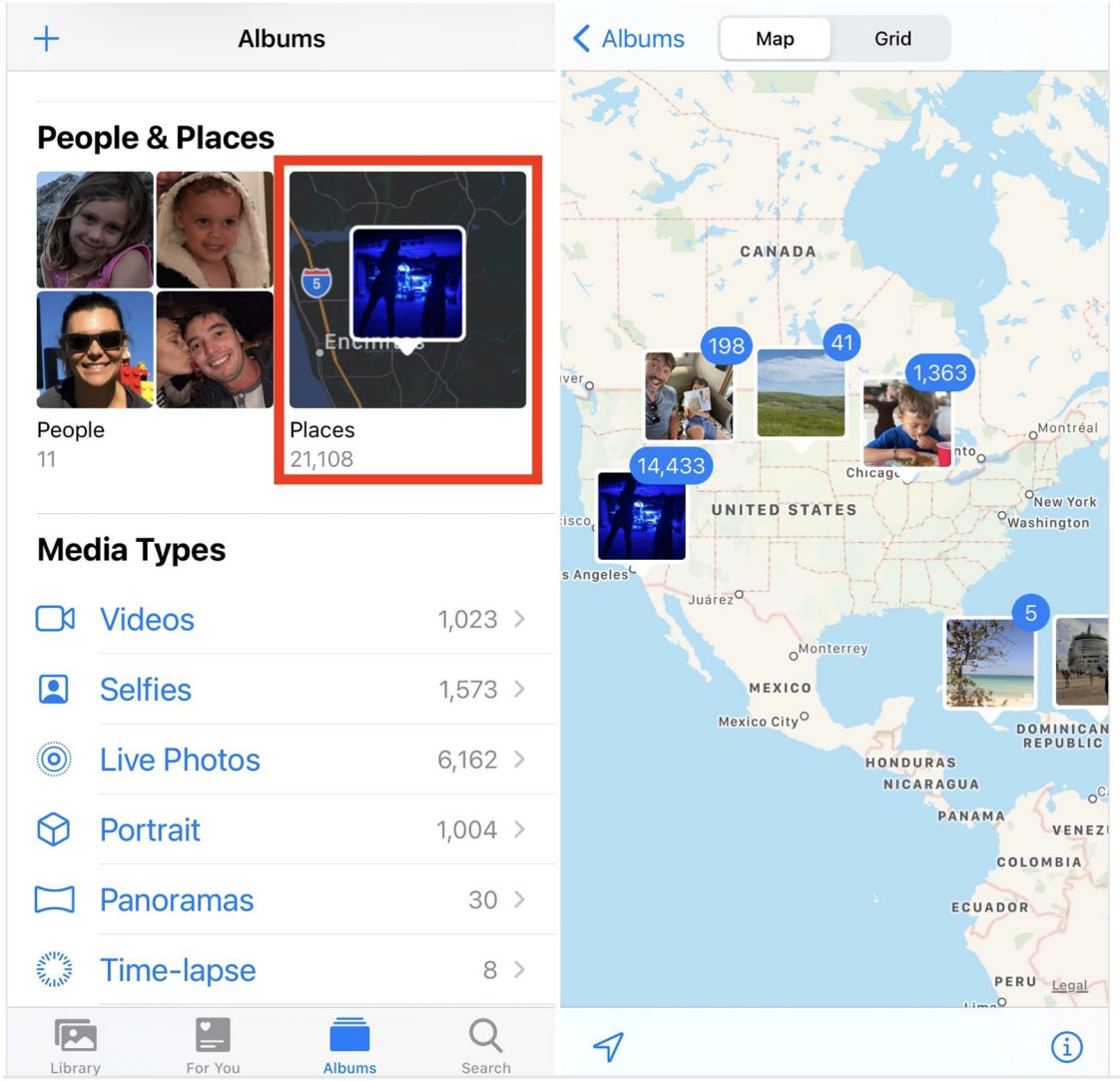

# Lecture 1:Introduction to Deep Learning

*Shusen Pu*

# What is deep learning?

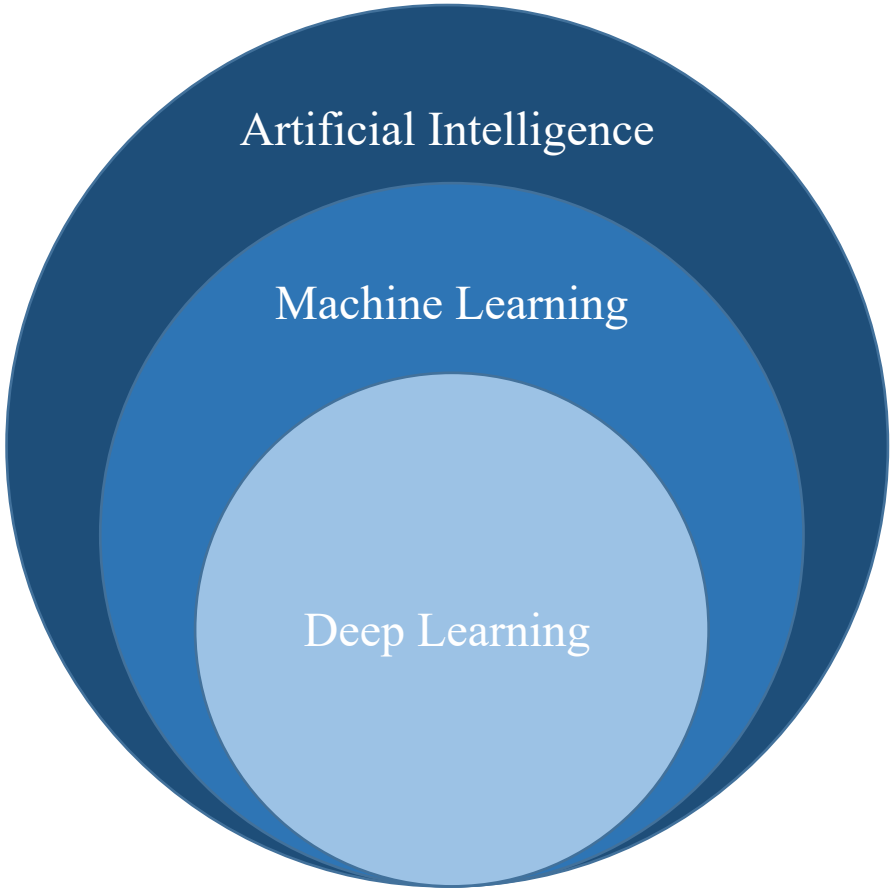



Google translate entire web page to a different language




Iphone groups images based on their locations.

# What exactly is deep learning?

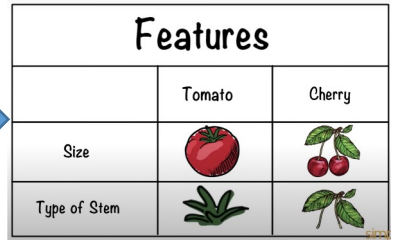



| | |
|---|---|
| Artificial Intelligence | • A science devoted to making machines think and act like humans. |
| Machine Learning | • Focuses on enabling computers to perform tasks without explicit programming. |
| Deep Learning | • A subset of machine learning based on artificial neural networks. |

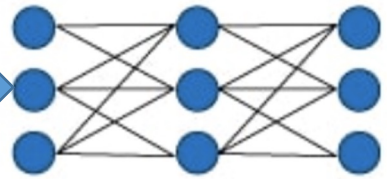
What is the **difference** between machine learning and deep learning?

# Machine Learning

Input




Feature extraction



Classification

Output

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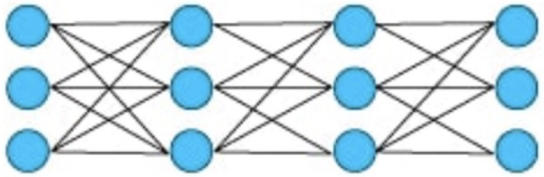
Input



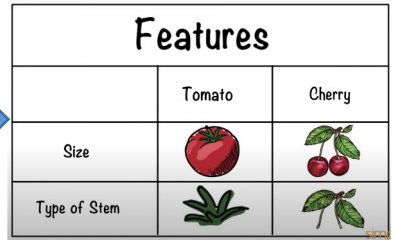
Feature extraction + Classification
picked up by machine without human input

Output

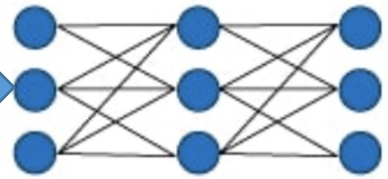
# Deep Learning

# Machine Learning

Input



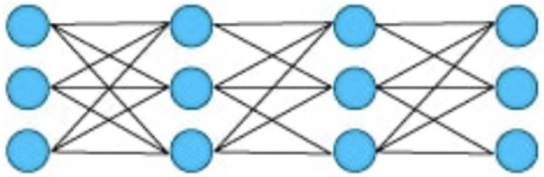

Feature extraction



Classification

Output

Input



Feature extraction + Classification

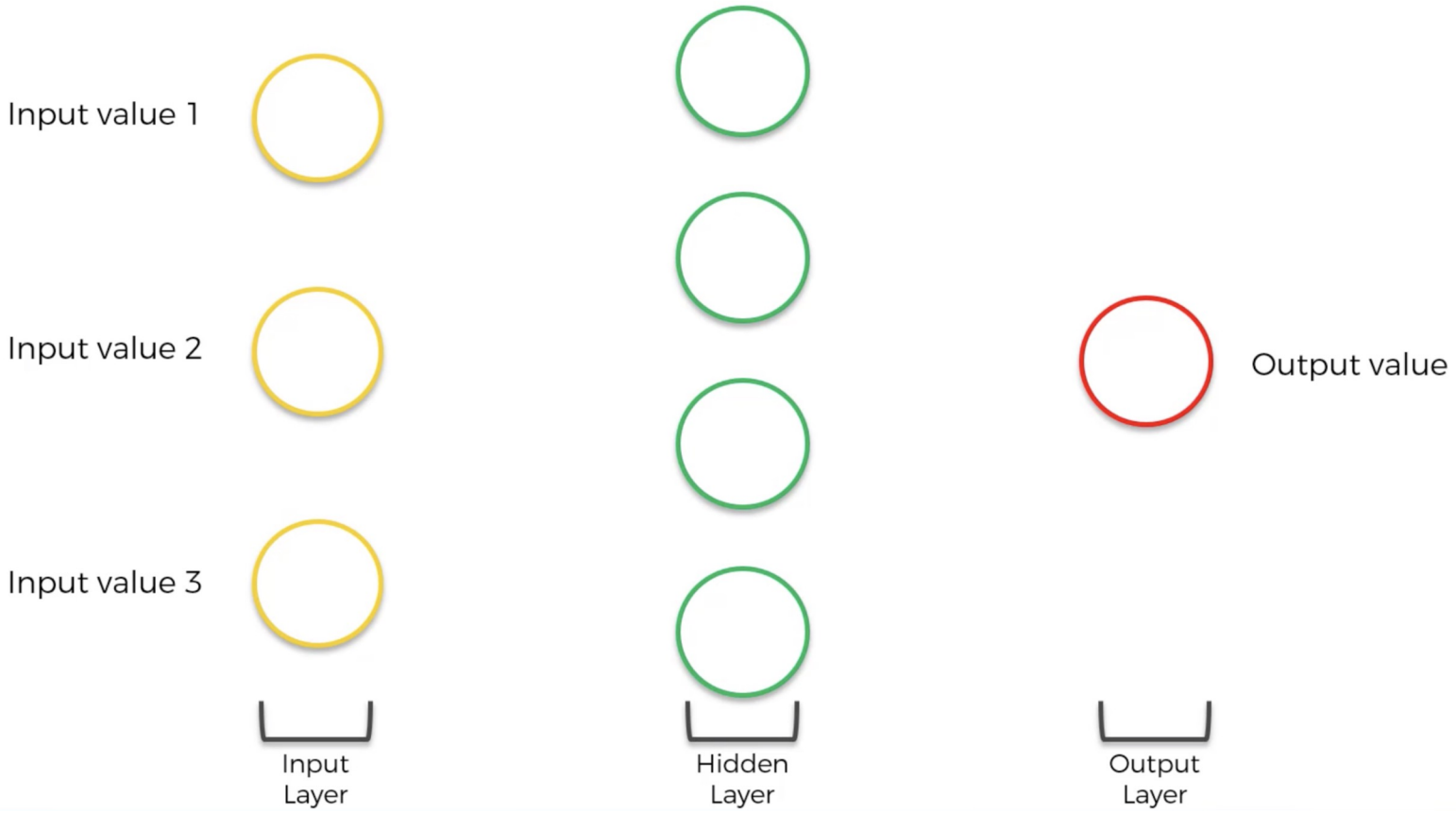
Output

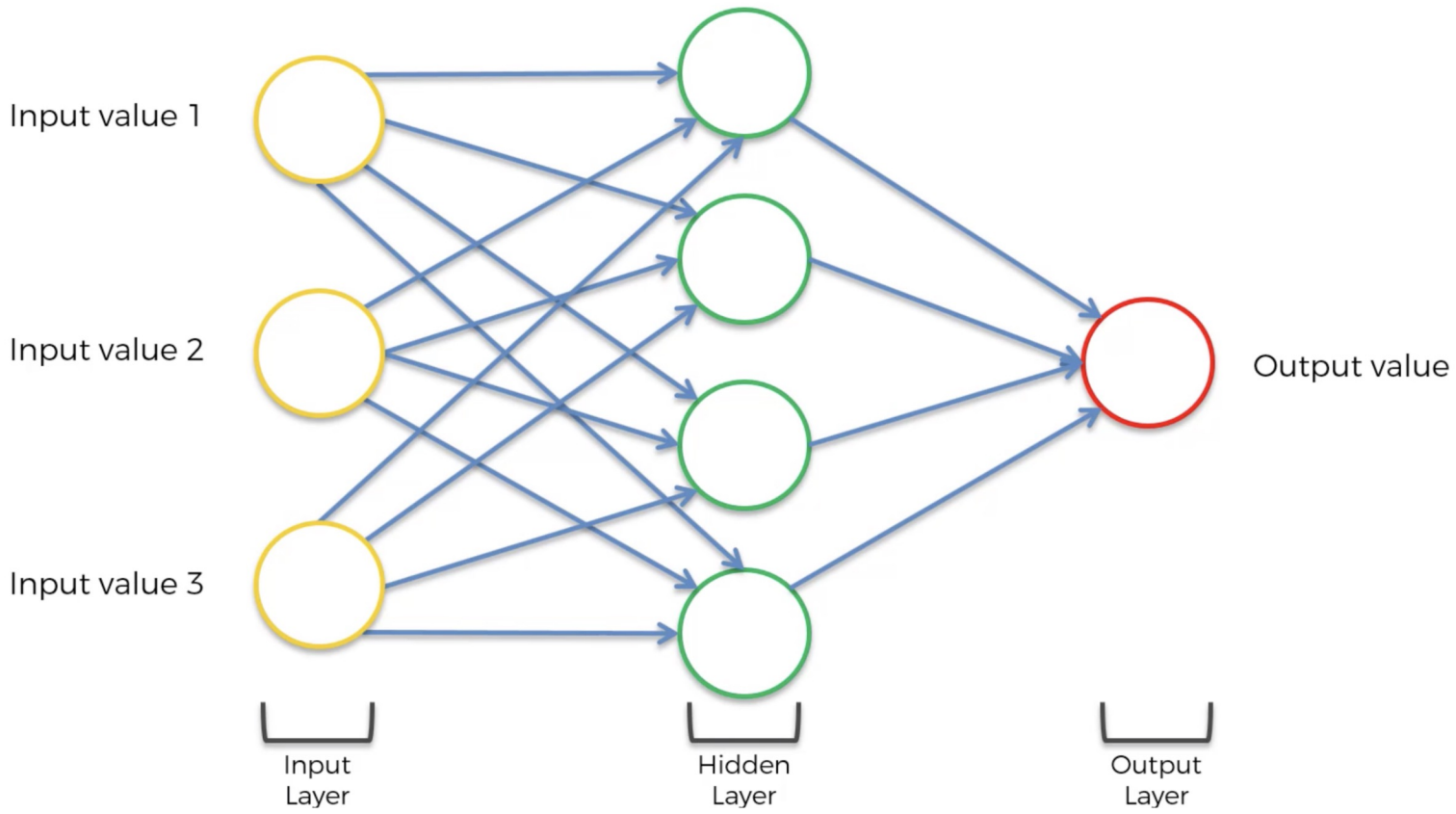
# Deep Learning

# Deep Learning Vs Machine Learning

| Factors | Deep Learning | Machine Learning |
|---|---|---|
| Data Requirements | Requires large data | Can train on lesser data |
| Accuracy | Provides high accuracy | Gives lesser accuracy |
| Training Time | Takes longer to train | Takes less time to train |
| Hardware Dependency | Requires GPU to train properly | Trains on CPU |
| Hyperparameter Tuning | Can be tuned in various different ways | Limited tuning capabilities |

# Working of Neural Networks


Input value 1
Input value 2
Input value 3
Input Layer
Hidden Layer
Output value
Output Layer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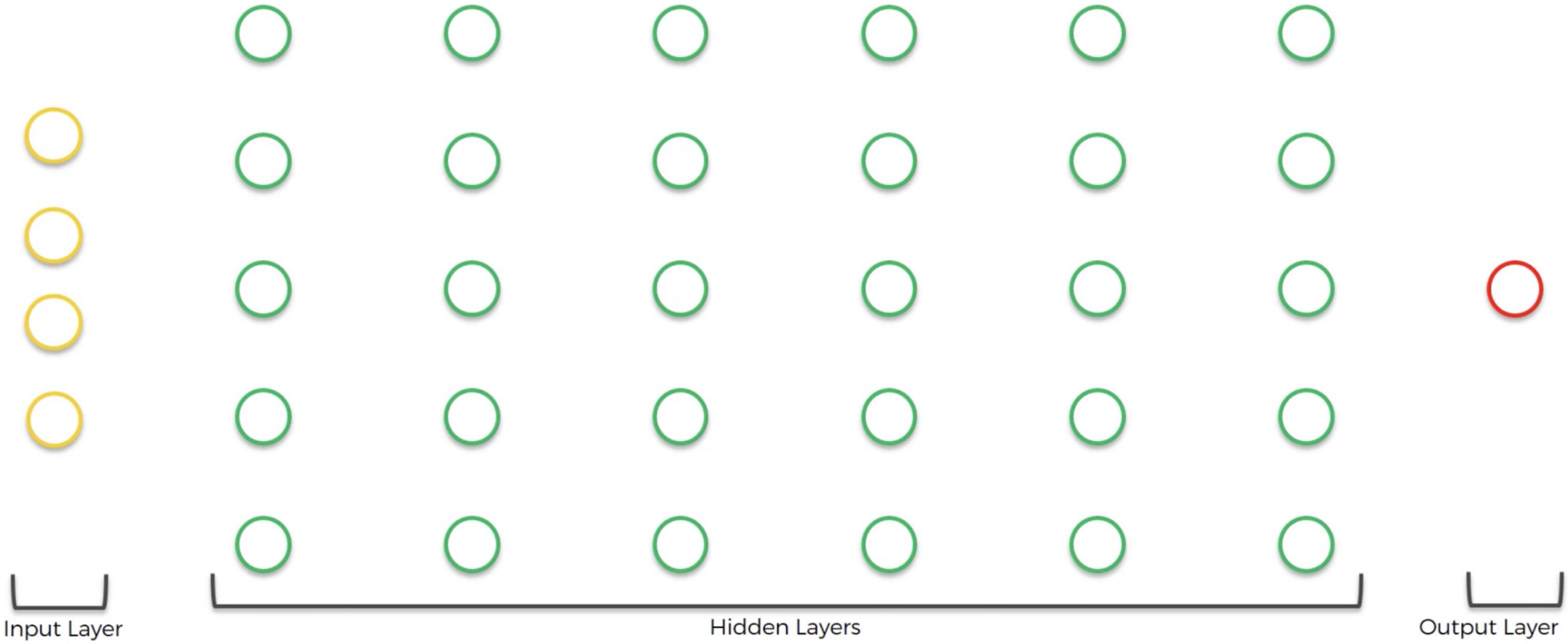
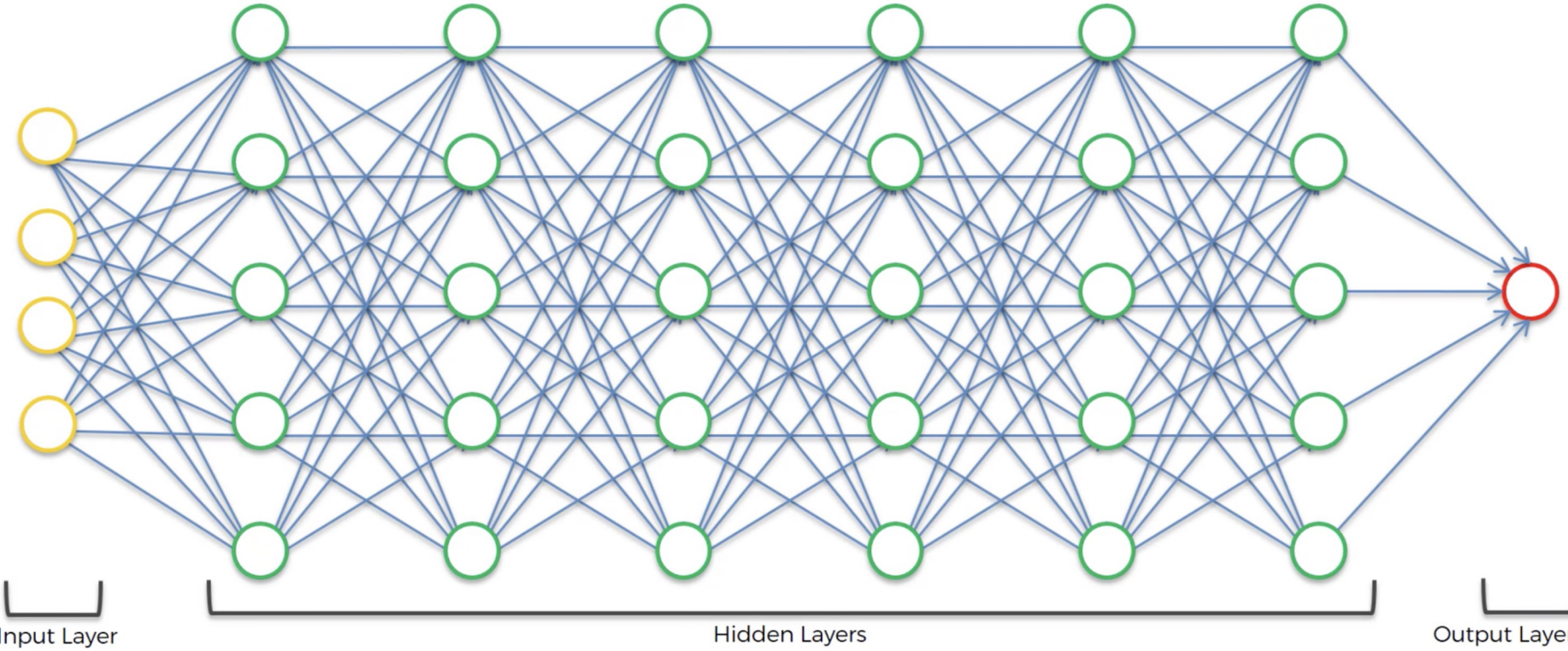

Input Layer
Hidden Layers
Output Layer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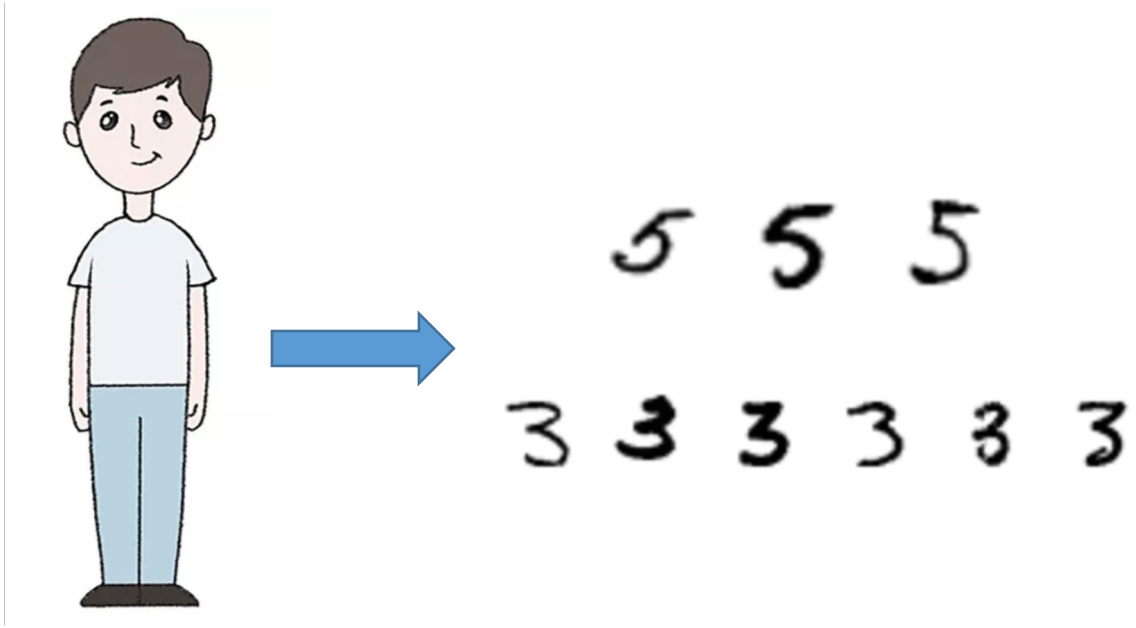

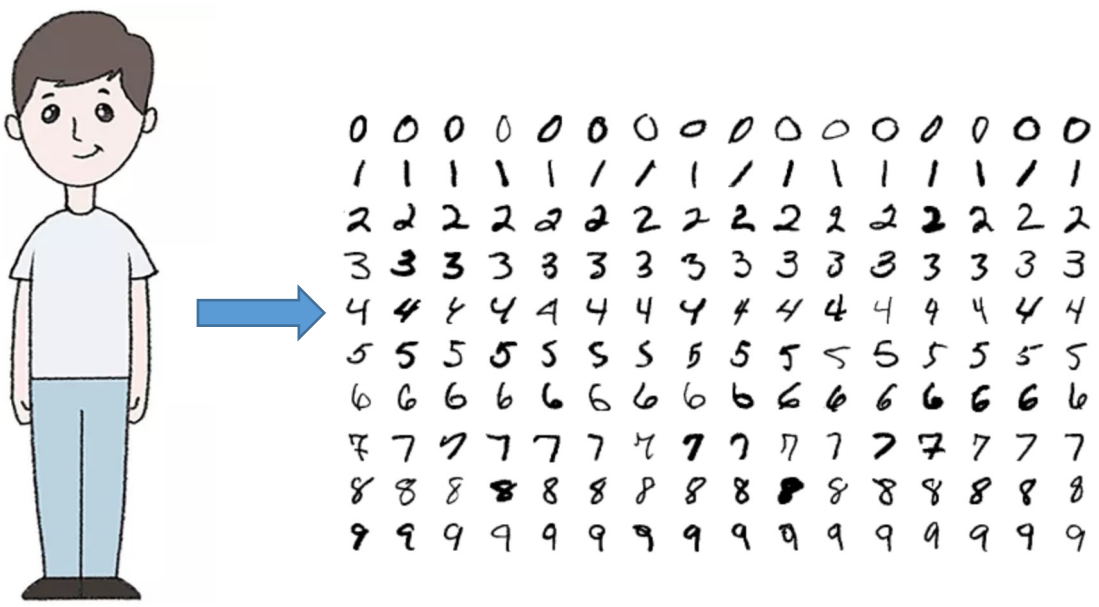

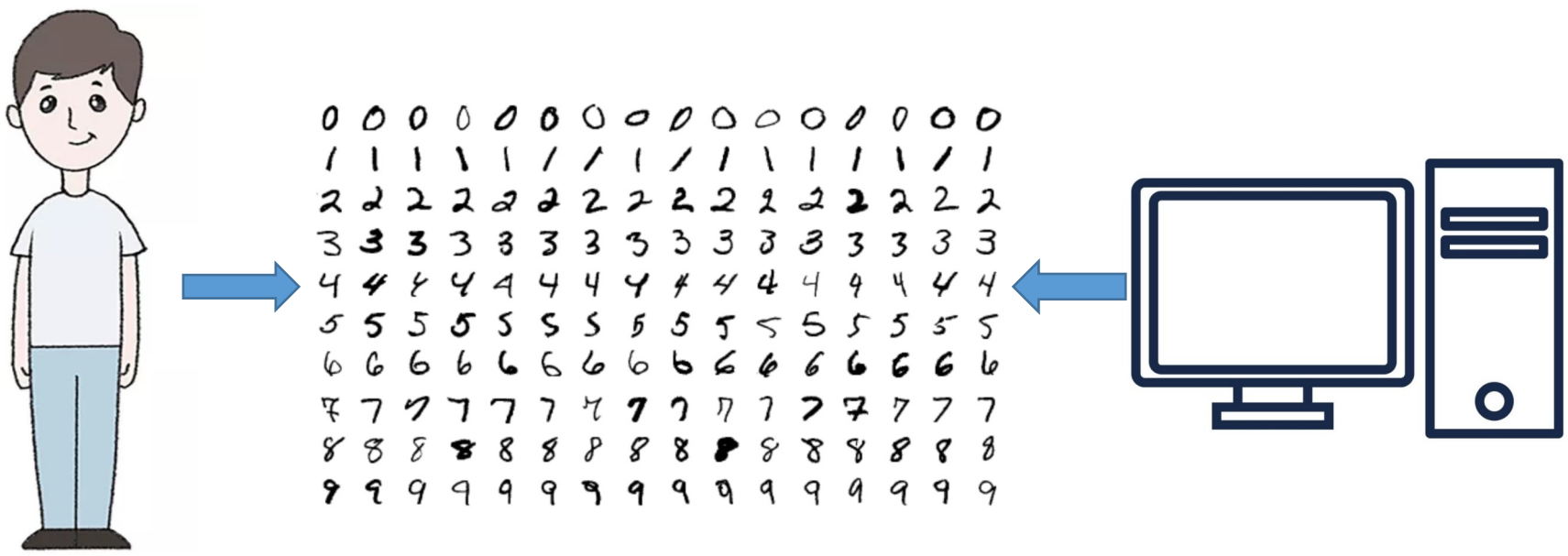

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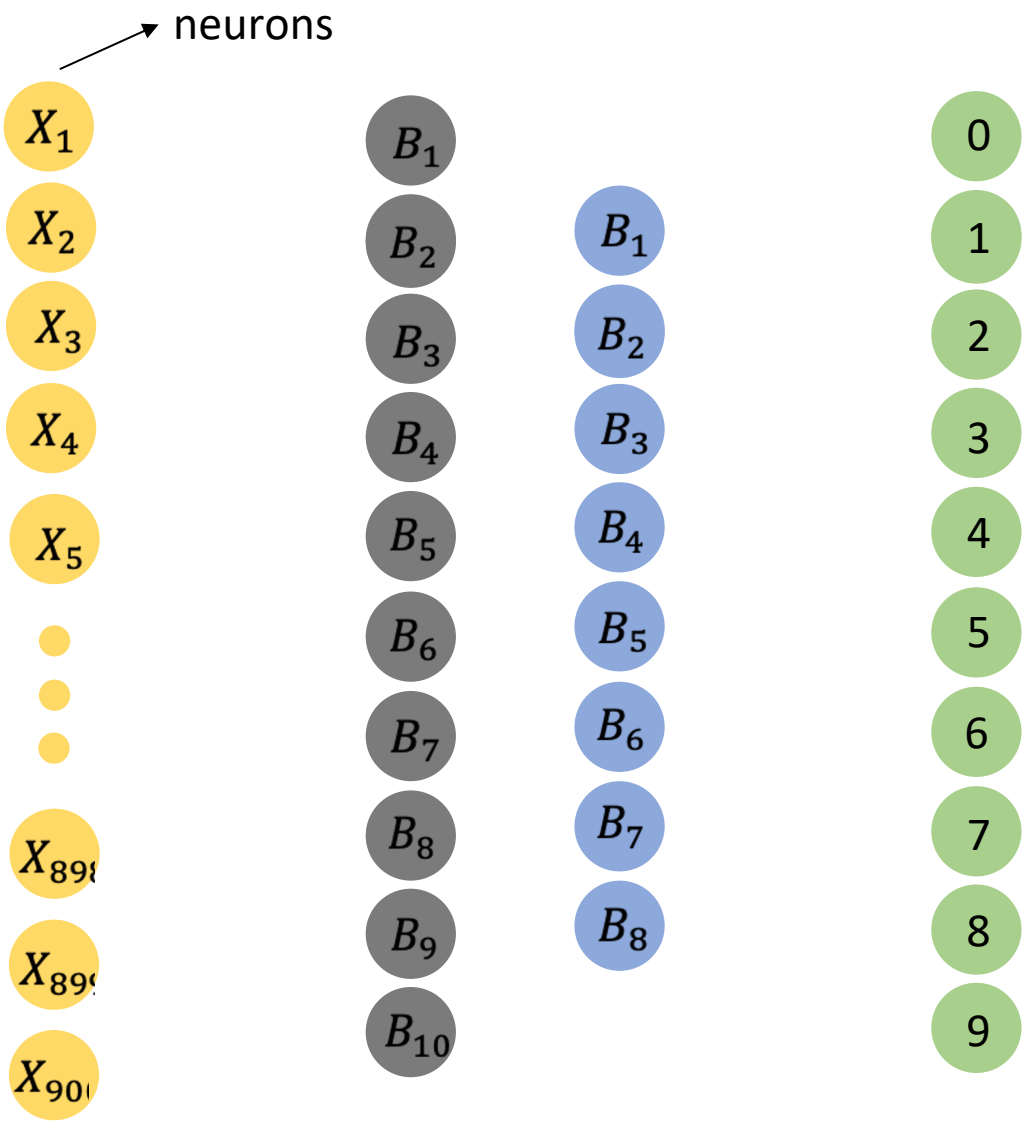

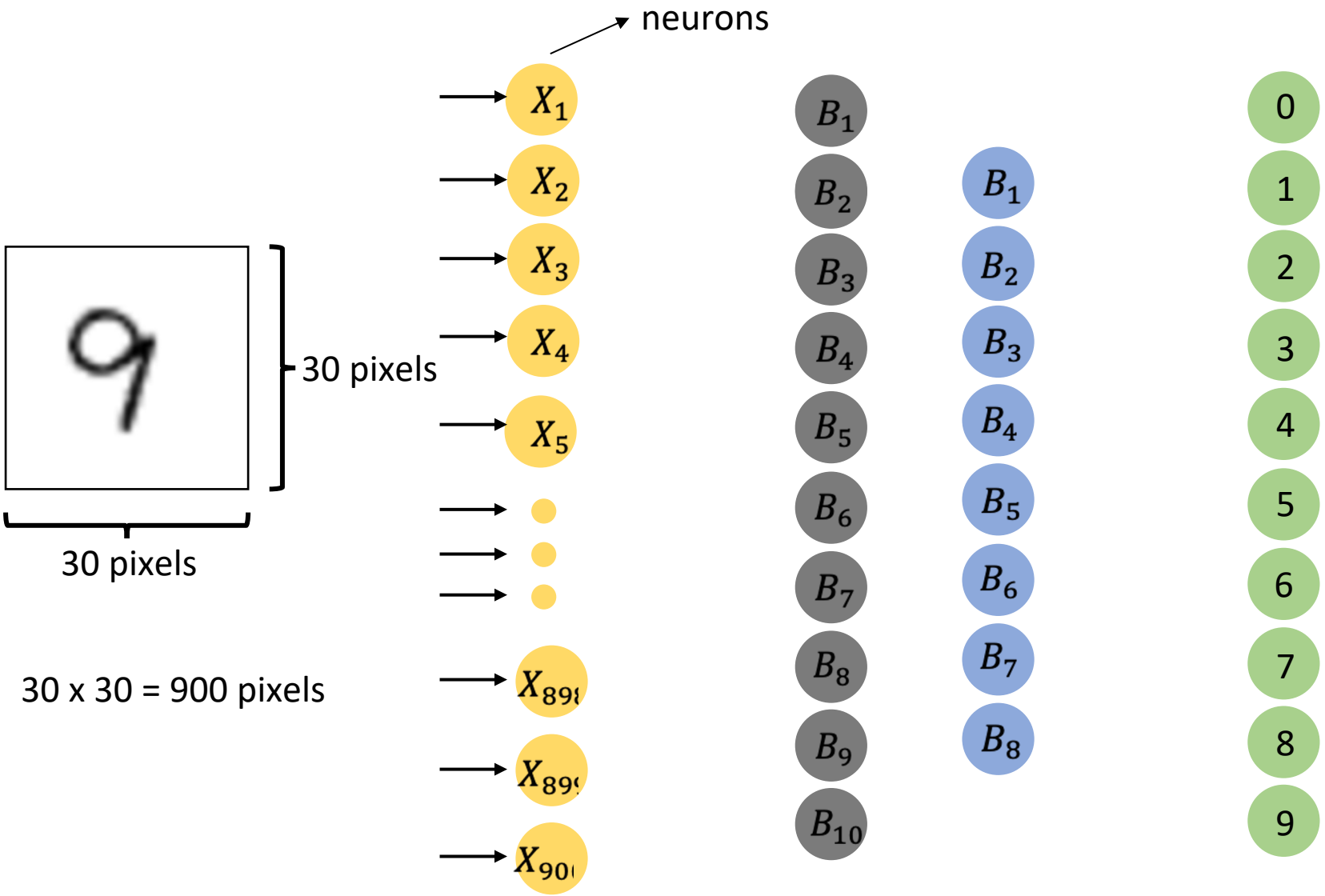
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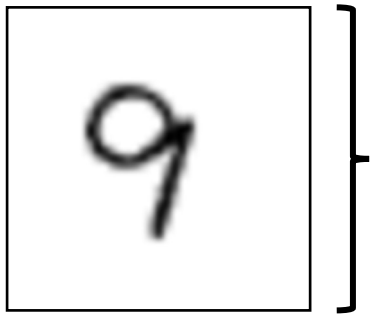

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neurons

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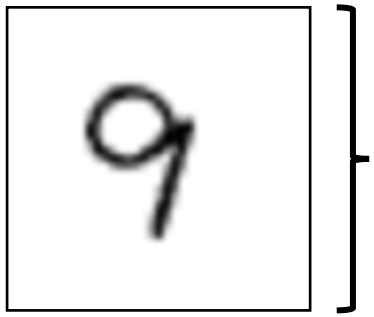

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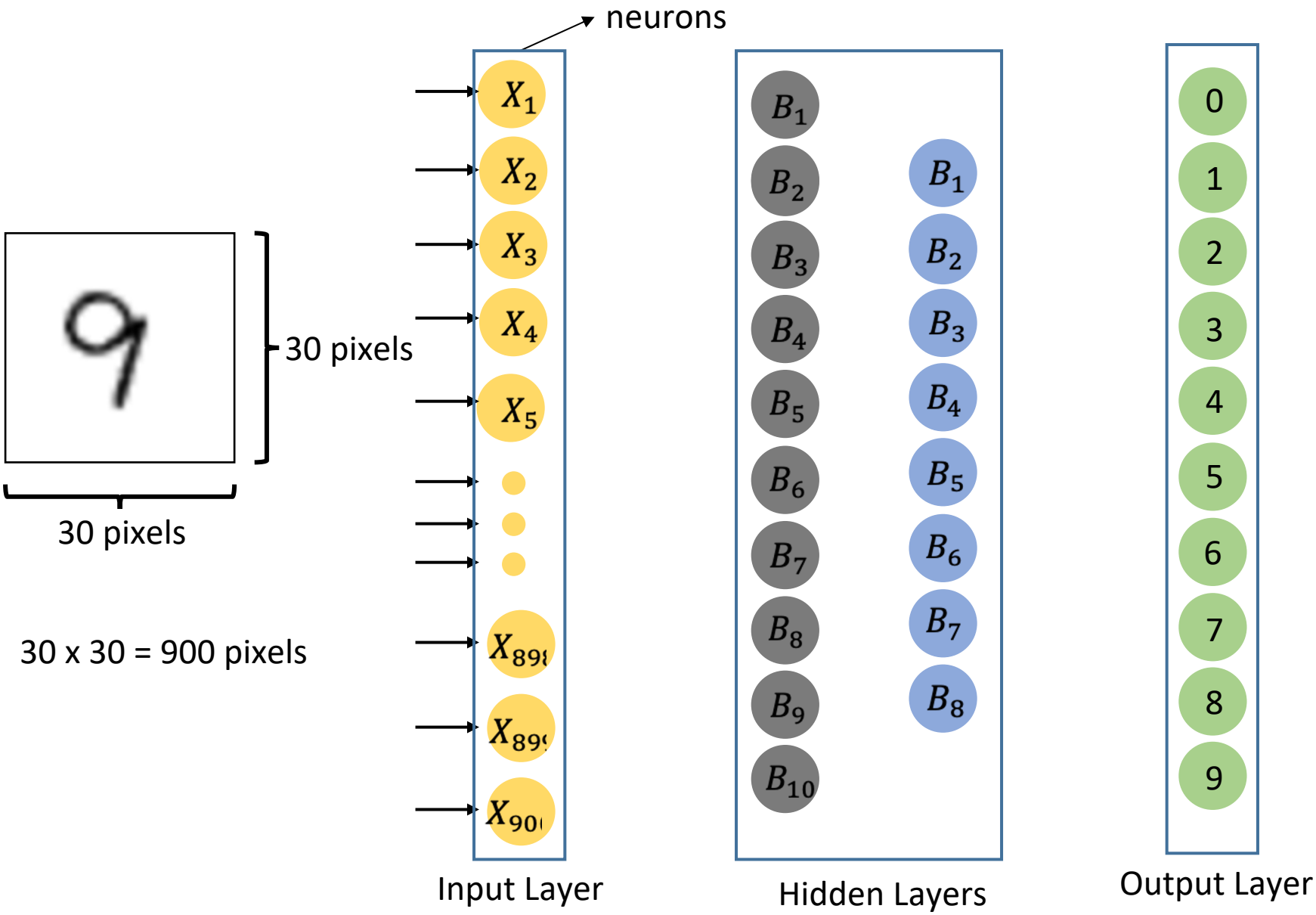
Output Layer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Input Layer
Hidden Layers
Output Layer

# Types of Neural Networks

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# Types of Neural Networks

## Feedforward Neural Networks (FNNs)

- the simplest type of ANN, with **a linear flow of** information through the network
- image classification, speech recognition, and natural language processing

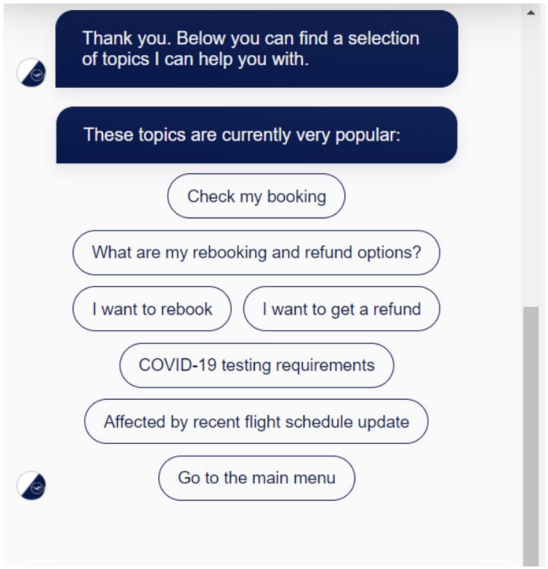
## Convolutional Neural Networks (CNNs)

- specifically, for image and video recognition tasks
- automatically learn features from the images, which makes them well-suited for tasks such as image classification, object detection, and image segmentation

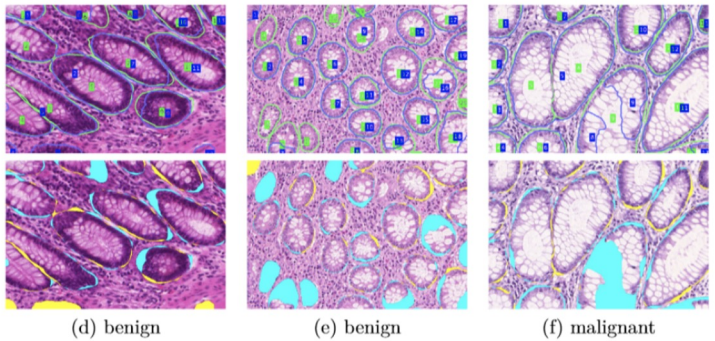
## Recurrent Neural Networks (RNNs)

- a type of neural network that can process sequential data, such as time series and natural language
- maintain an internal state that captures information about the previous inputs, which makes them well-suited for tasks such as speech recognition, natural language processing, and language translation.

# Where is deep learning applied?

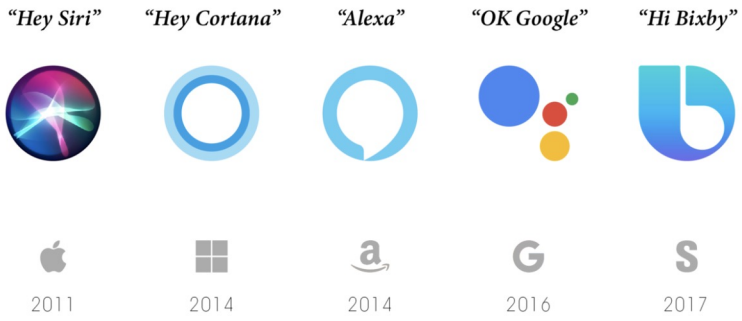



Customer support (chatbots or live agents)




[Nvidia Dev Blog 2017]

Self-driving cars




Virtual assistants


Spam emails detection

# Applications of Deep Learning

## Computer Vision

- Object detection and recognition
- Image classification
- Image segmentation

## Natural Language Processing (NLP)

- Automatic text generation
- Language translation
- Sentiment analysis
- Speech recognition

## Reinforcement Learning

- Game playing
- Robotics
- Control systems

# Challenges in Deep Learning

1. **Data availability**: It requires large amounts of data to learn from. For using deep learning it's a big concern to gather as much data for training.

2. **Computational Resources**: For training the deep learning model, it is computationally expensive because it requires specialized hardware like GPUs and TPUs.

3. **Time-consuming**: While working on sequential data depending on the computational resource it can take very large even in days or months.

4. **Interpretability**: Deep learning models are complex; it works like a black box. it is very difficult to interpret the result.

5. **Overfitting**: when the model is trained again and again, it becomes too specialized for the training data, leading to overfitting and poor performance on new data.

# Advantages of Deep Learning

1. **High accuracy**: Deep Learning algorithms can achieve state-of-the-art performance in various tasks, such as image recognition and natural language processing.

2. **Automated feature engineering**: Deep Learning algorithms can automatically discover and learn relevant features from data without the need for manual feature engineering.

3. **Scalability**: Deep Learning models can scale to handle large and complex datasets, and can learn from massive amounts of data.

4. **Flexibility**: Deep Learning models can be applied to a wide range of tasks and can handle various types of data, such as images, text, and speech.

5. **Continual improvement**: Deep Learning models can continually improve their performance as more data becomes available.

Popular deep learning frameworks & libraries include: