**Types of neural network architectures**

**1. Feed-Forward Neural Networks (FNNs)**

* **Flow:** Information flows in one direction (input → hidden → output).
* **Use Case:** Basic classification and regression tasks.
* **Example Tasks:** Predicting house prices, simple image recognition.

**2. Recurrent Neural Networks (RNNs)**

* **Flow:** Unlike feed-forward networks, RNNs allow feedback connections. Outputs from one layer can feed back as inputs to previous layers, creating a form of "memory."
* **Feature:** Can handle sequential or time-dependent data by retaining information about previous inputs.
* **Use Case:** Sequence modeling, language generation, time-series prediction.
* **Example Tasks:** Text generation, speech recognition, stock price prediction.

**3. Convolutional Neural Networks (CNNs)**

* **Flow:** Specialized for spatial data. Uses convolutional layers to detect patterns like edges or textures in images.
* **Feature:** Captures spatial hierarchies in data (e.g., small patterns combine to form larger ones).
* **Use Case:** Image data, video analysis.
* **Example Tasks:** Image classification, object detection, medical imaging.

**4. Generative Adversarial Networks (GANs)**

* **Flow:** Consists of two networks—a generator (creates fake data) and a discriminator (distinguishes real from fake data). They are trained together in a competitive manner.
* **Feature:** Used to generate realistic data.
* **Use Case:** Data generation, style transfer, super-resolution.
* **Example Tasks:** Generating realistic images, deepfake creation.

**5. Transformers**

* **Flow:** Based on self-attention mechanisms to process sequential data in parallel (as opposed to sequentially like RNNs).
* **Feature:** State-of-the-art in natural language processing and vision tasks due to their ability to model long-range dependencies.
* **Use Case:** NLP, image generation, time-series modeling.
* **Example Tasks:** Machine translation, text summarization (e.g., ChatGPT).

**6. Autoencoders**

* **Flow:** An encoder compresses data into a smaller representation, and a decoder reconstructs the original data from the compressed form.
* **Feature:** Unsupervised learning, mainly for dimensionality reduction or noise removal.
* **Use Case:** Anomaly detection, image compression.
* **Example Tasks:** Denoising images, learning latent representations.

**7. Radial Basis Function Networks (RBFNs)**

* **Flow:** Uses radial basis functions as activation functions, making them well-suited for tasks requiring a localized response to inputs.
* **Use Case:** Function approximation, time-series analysis.
* **Example Tasks:** Interpolation, pattern recognition.

**8. Modular Neural Networks (MNNs)**

* **Flow:** A collection of smaller, specialized networks working independently and combining their outputs for a final decision.
* **Feature:** Reduces complexity by modularizing tasks.
* **Use Case:** Complex systems requiring specialized components.
* **Example Tasks:** Robotics, autonomous driving.

**9. Spiking Neural Networks (SNNs)**

* **Flow:** Mimics the behavior of biological neurons, where signals are transmitted as spikes instead of continuous values.
* **Feature:** Suitable for neuromorphic computing and energy-efficient applications.
* **Use Case:** Event-based data, real-time systems.
* **Example Tasks:** Robotics, brain-computer interfaces.

**10. Self-Organizing Maps (SOMs)**

* **Flow:** An unsupervised learning network that organizes data into a 2D or 3D grid based on similarity.
* **Feature:** Useful for visualization and clustering.
* **Use Case:** Exploratory data analysis.
* **Example Tasks:** Market segmentation, clustering high-dimensional data.

**11. Hybrid Networks**

* **Flow:** Combines multiple types of architectures (e.g., CNN + RNN or CNN + Transformer).
* **Feature:** Can handle complex tasks by leveraging the strengths of each architecture.
* **Use Case:** Multi-modal data, advanced AI systems.
* **Example Tasks:** Video captioning (using CNN for images + RNN/Transformer for text).

**Choosing the Right Network:**

* **Feed-Forward:** Simple tasks like regression or binary classification.
* **RNNs:** Sequential data (e.g., text, speech, time series).
* **CNNs:** Image and spatial data.
* **Transformers:** Advanced NLP or large-scale tasks.
* **GANs:** Data generation or creative tasks.
* **Autoencoders:** Dimensionality reduction or anomaly detection.