Introduction to Recurrent Neural Networks (RNNs)

What are RNNs?

- Special type of neural network designed for sequential data
- Key characteristic: They have "memory" through hidden states that persist between time steps
- Unlike feedforward networks, RNNs have cyclic connections

Why RNN?

- RNN's are specially designed for sequential data.

What is Sequential Data?

Data where order matters (past influences future)

Why RNN?

Examples:

- **Text:** "The cat sat on the ___" → next word depends on previous words.

- **Time Series:** Stock prices, weather data.

- **Speech:** Audio waveforms over time.

Why Not Feed forward Networks?

- **Problem 1:** No memory → treats inputs as independent.
  - **Example:** Feedforward network fails to predict "sky" in "The clouds are in the ___."

  Problem 2: Fixed input size → cannot handle variable-length sentences.

Real-World Applications

- **Google Translate:** Many-to-many RNNs (seq2seq).
- **Text Generation:** Predict next character (e.g., Shakespeare-style text).
- **Stock Prediction:** Time-series forecasting.
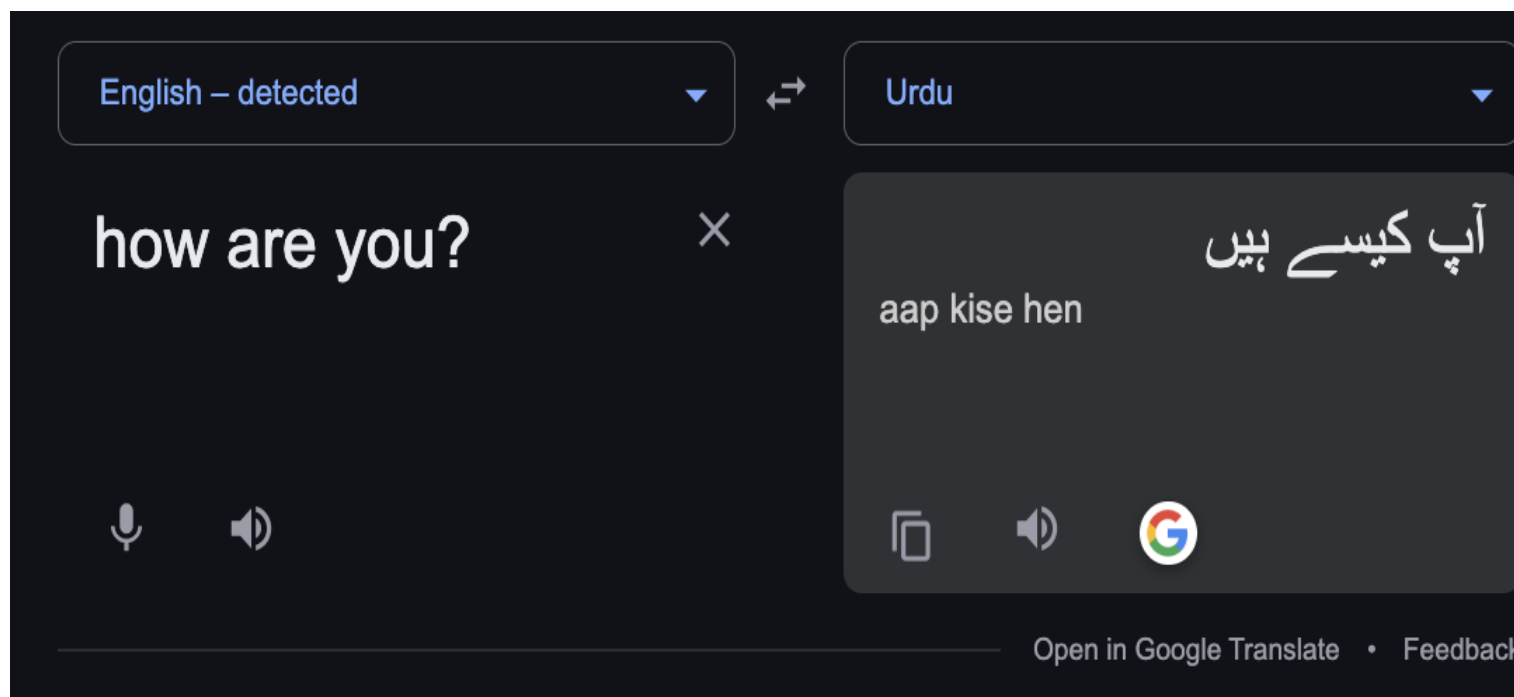- **Voice Assistants:** Speech-to-text.

Examples where RNNs excel?

1. Time series prediction

Examples where RNNs excel?

2. Machine Translation

Examples where RNNs excel?

3. Text Generation

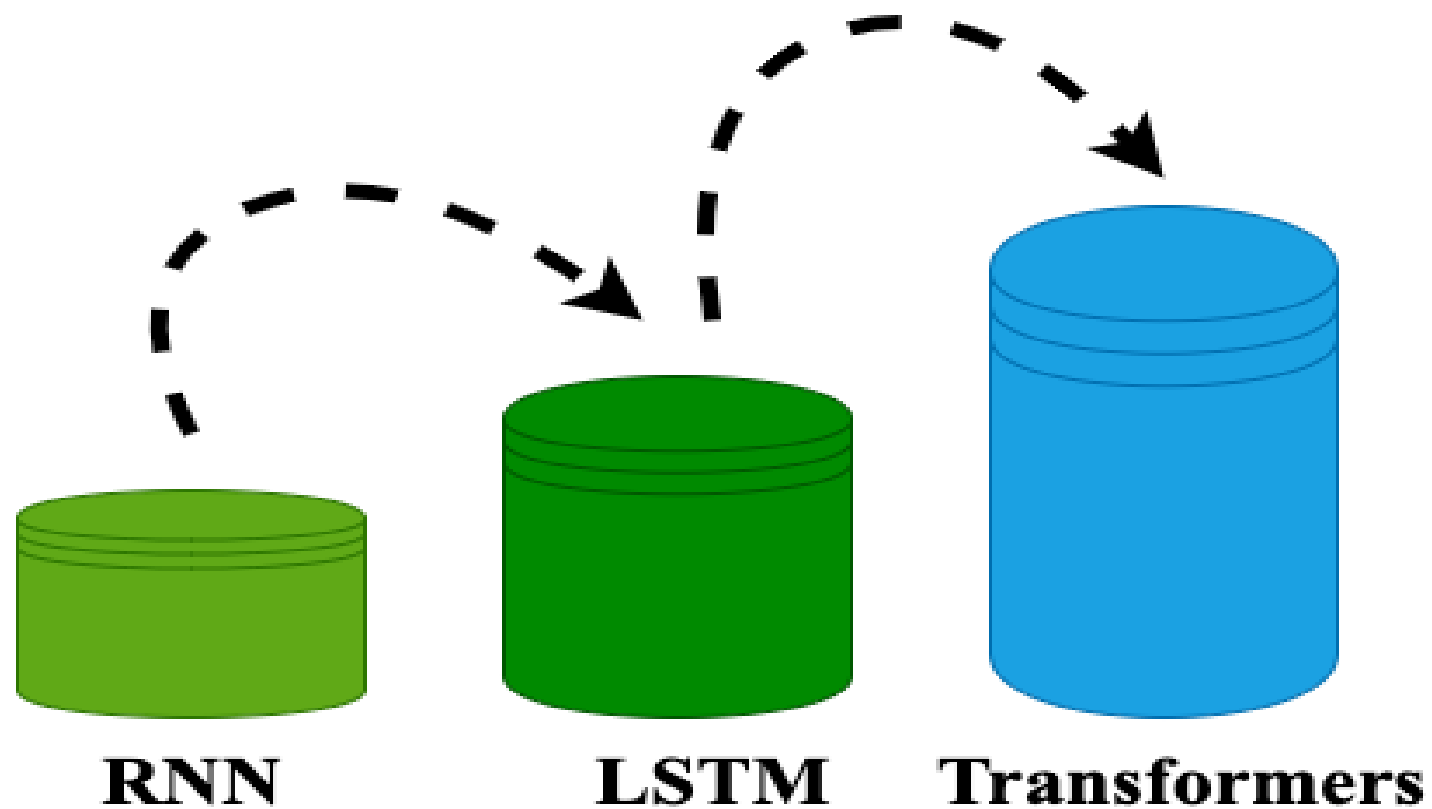# Examples where RNNs excel?

3. Text Prediction

Current Trends

1. **Transformer Revolution**

- **Many sequence tasks now use attention-based models**
- **Transformers often outperform RNNs**

2. **Hybrid Approaches**

- **Combining RNNs with attention**
- **Using RNNs as components in larger architectures**

Roadmap

RNN   LSTM   Transformers

RNN Architecture