

# **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.

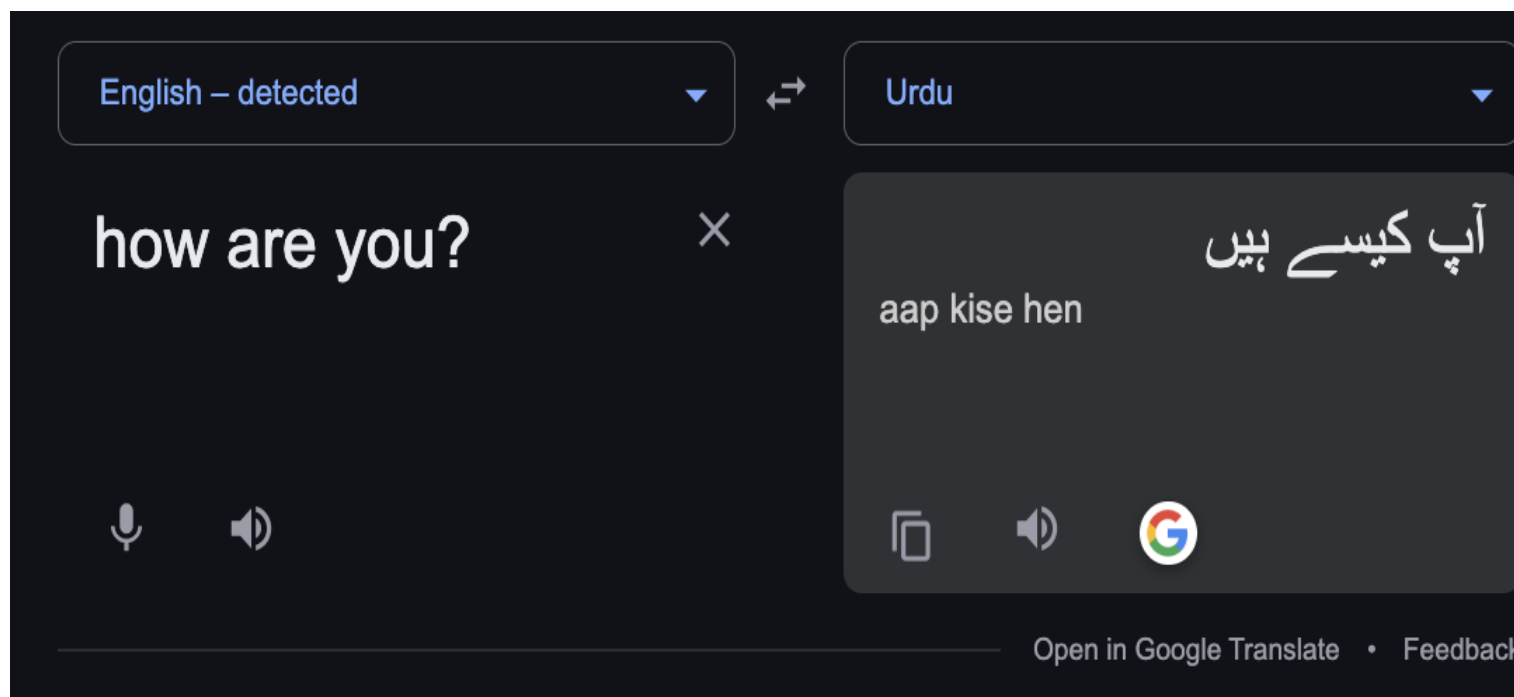
# Examples where RNNs excel?

## 1. Time series prediction



# Examples where RNNs excel?

## 2. Machine Translation





# Examples where RNNs excel?

## 3. Text Generation

The screenshot shows a web-based text styling tool. At the top, there is a text input field containing the word "Hello" and a close button (X). Below the input field is a horizontal menu of styling options: "Design with Fonts" (with a link icon), "All" (highlighted in pink), "Cool" (with a star icon), "Fancy" (with a diamond icon), "Cursive" (with a cursive 'I' icon), "Small" (with "Aa" icon), "Bold" (with "B" icon), "Glitch" (with a lightning bolt icon), and "S..." (with a star icon). Below the menu, the text "Hello" is displayed in a black Fraktur font, with "Fancy" and "Fraktur" listed below it. A horizontal line separates this from another example where "HELLO" is displayed in a black Cryptic Italic font, with "Cursive" and "Cryptic Italic" listed below it. In the bottom right corner, there is a purple button with an upward arrow and the text "Editor".

Hello

Design with Fonts [↗](#) All Cool Fancy Cursive Small Bold Glitch S...

All Fonts

Hello

Fancy Fraktur

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HELLO

Cursive Cryptic Italic

^ Editor

### 3. Text Prediction

[illegible]

# Current Trends

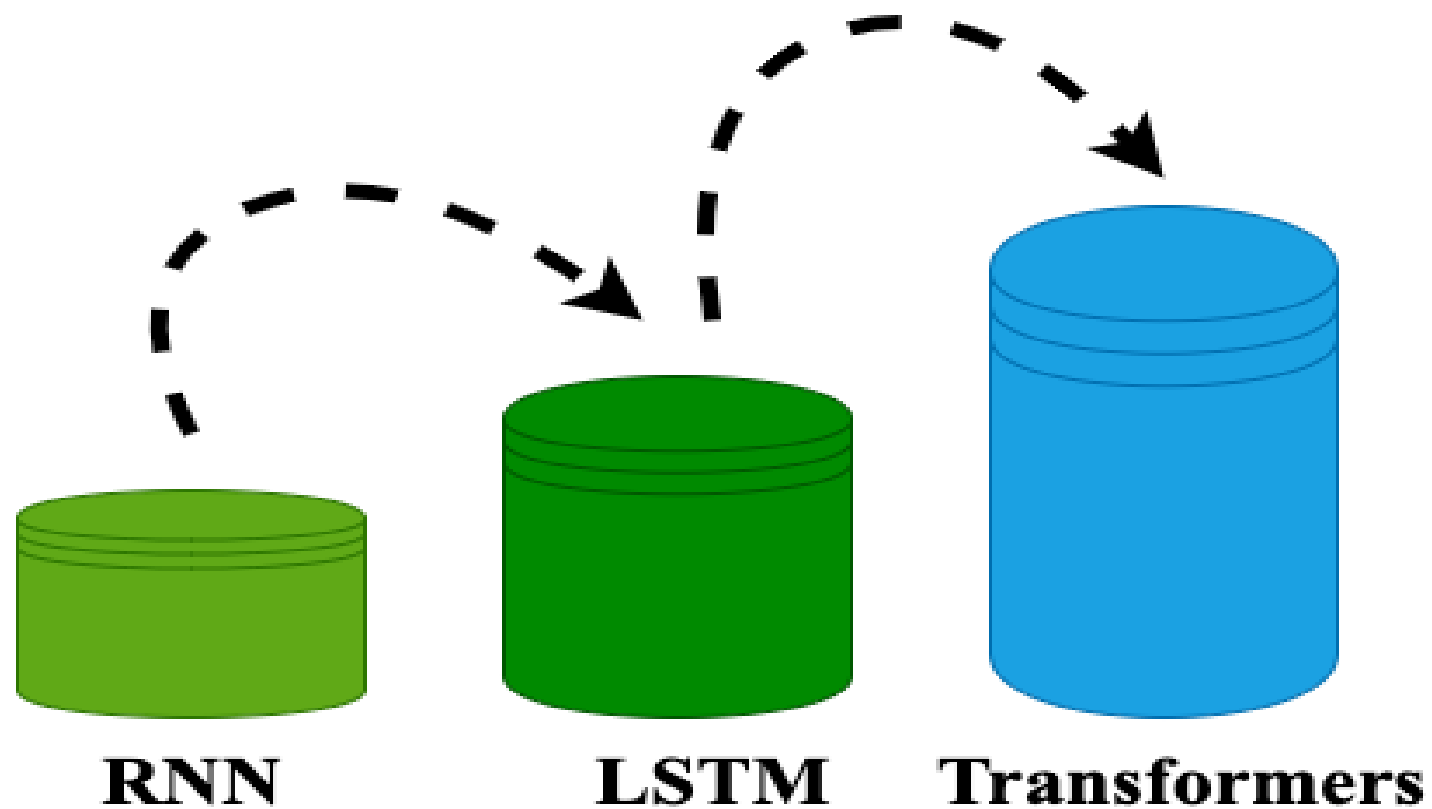
## 1. Transformer Revolution

- 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 Architecture

