
Deep Learning and Translation Technology

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- Chapter 47 (pp.797-817), Routledge Encyclopedia of Translation Technology (2nd Edition)
- Deep Learning and its application to translation technology (e.g., machine translation, speech translation, and more).

About this Chapter

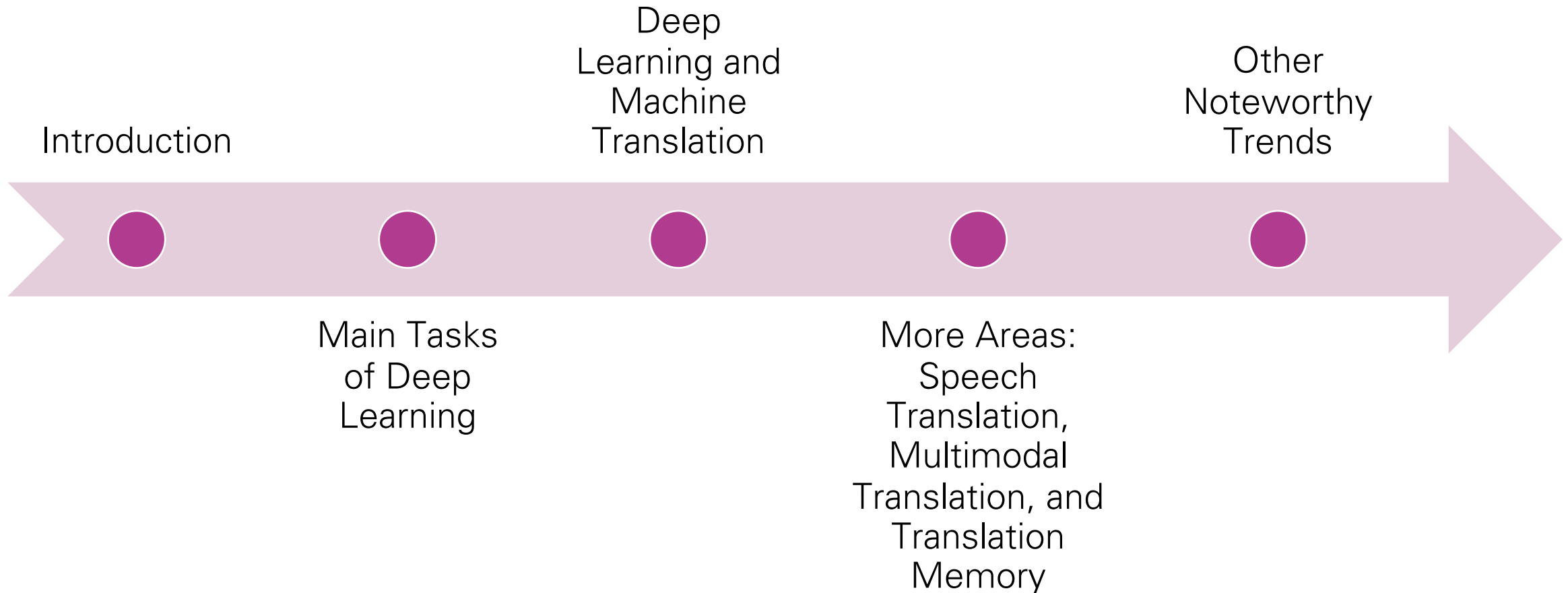
Background: Deep learning is everywhere!

Examples:

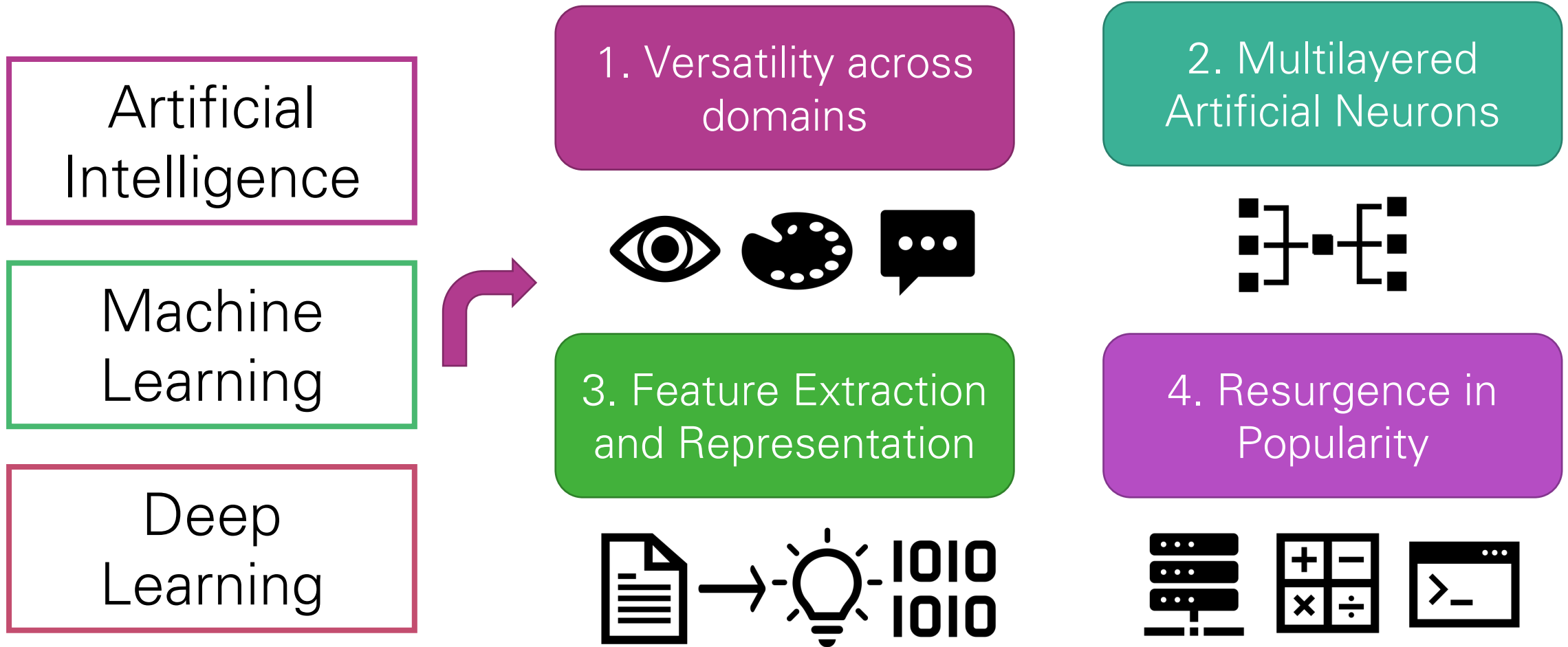
- Stable Diffusion
(Rombach et al. 2022)
- ChatGPT (OpenAI,
2022)



Chapter Outline: 5 Parts

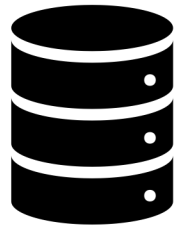


Part 1: Introduction

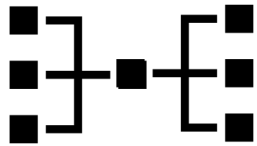


Part 2: Key Concepts

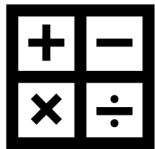
1. Key Components



Data



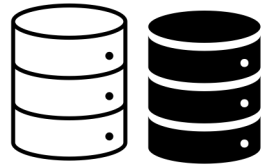
Network



Algorithm

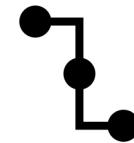
2. Key Tasks

1. Data Collection



- a. Training
- b. Validation
- c. Test

2. Model Design



- a. Neuron?
- b. Connection?

3. Model Training

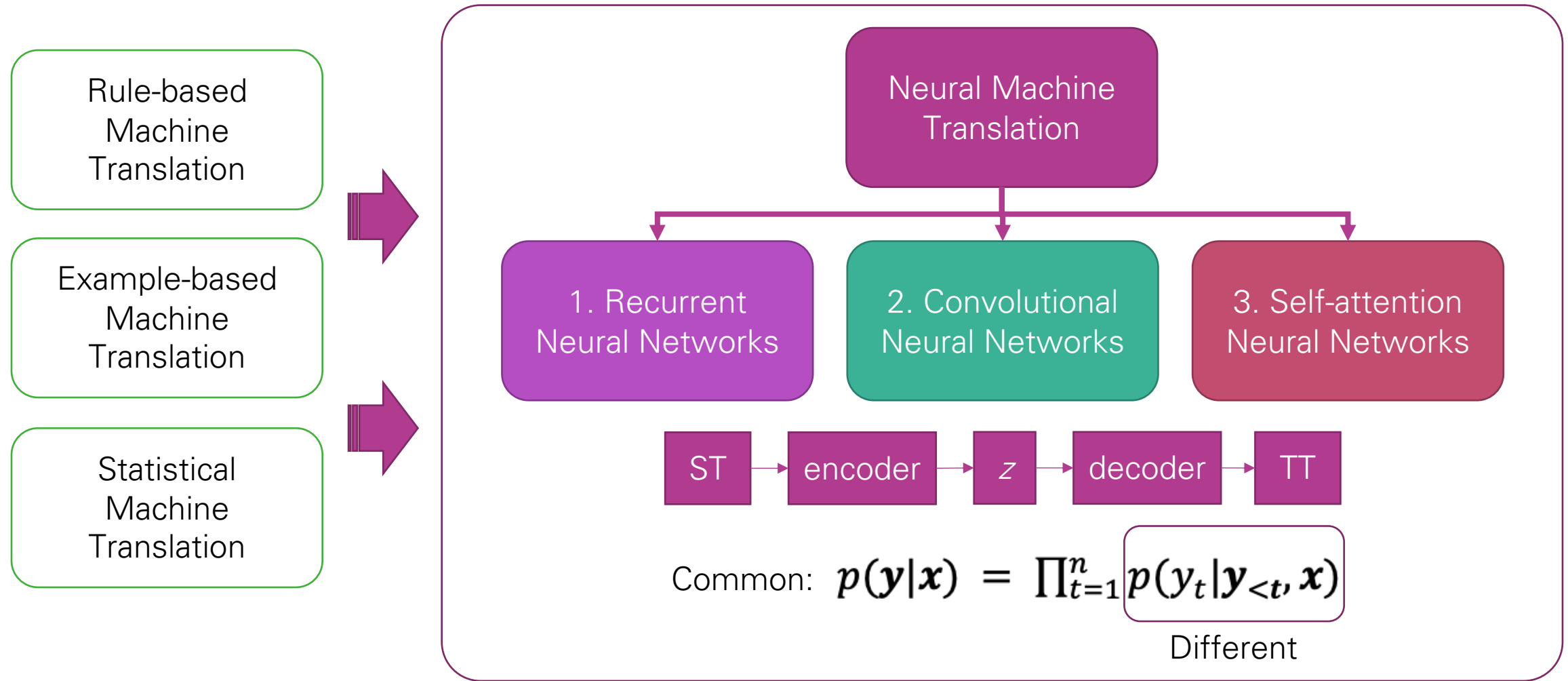
- a. Forward propagation
- b. Loss calculation
- c. Backpropagation
- d. Optimization



4. Model Evaluation



Part 3: Deep Learning and Machine Translation



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1. Recurrent Neural Networks (RNN)

Bidirectional RNN with Attention

Example:

$$\begin{aligned} \vec{h}_t &= \vec{f}(x_i, \vec{h}_{t-1}) & \tilde{h}_t &= \tilde{f}(x_i, \tilde{h}_{t+1}) \\ h_t &= [\vec{h}_t^\top; \tilde{h}_t^\top]^\top \\ a(s_{t-1}, h_m) &= \frac{\exp(\text{score}(s_{t-1}, h_m))}{\sum_{k=1}^i \exp(\text{score}(s_{t-1}, h_k))} \\ \mathbf{z} &= q(\{h_1, \dots, h_i\}) = \sum_{m=1}^i a(s_{t-1}, h_m) h_m \\ p(y_t | \mathbf{y}_{< t}, \mathbf{z}) &= g(s_{t-1}, y_{t-1}, \mathbf{z}) \end{aligned}$$

2. Convolutional Neural Networks (CNN)

One-dimensional convolutional layer

Example:

$$y_{d,n} = \sum_{m=1}^M \sum_{k=0}^{K-1} w_{kM+m,n} x_{d+k,m}$$

3. Self-attention Neural Networks (e.g., Transformer)

Multi-head Attention with Queries, Keys and Values

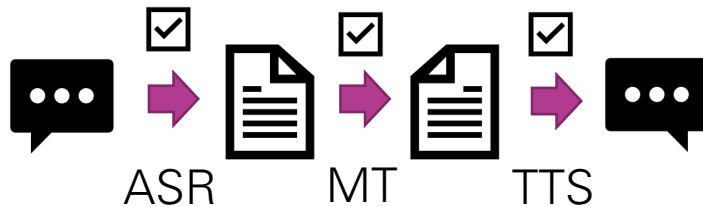
Example:

$$\begin{aligned} \text{scoremat}(Q, K) &= \text{softmax}(QK^\top \cdot \text{scale}) \\ \text{attention}(Q, K, V) &= (\text{scoremat}(Q, K))V \\ \text{head}_h &= \text{attention}(W_Q Q, W_K K, W_V V) = \text{attention}(Q_h, K_h, V_h) \\ \text{multihead}(Q, K, V) &= W_{\text{multihead}}[\text{head}_1; \text{head}_2; \dots; \text{head}_H] \end{aligned}$$

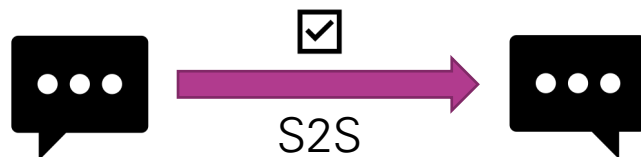
Part 4: Deep Learning for Other Translation-related Applications

A. Deep Learning and Speech Translation

Cascade systems



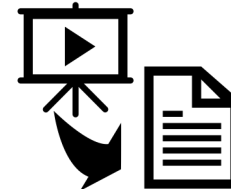
End-to-end systems



B. Deep Learning and Multimodal Translation



Image-to-text translation



Video-to-text translation



Text-to-image translation



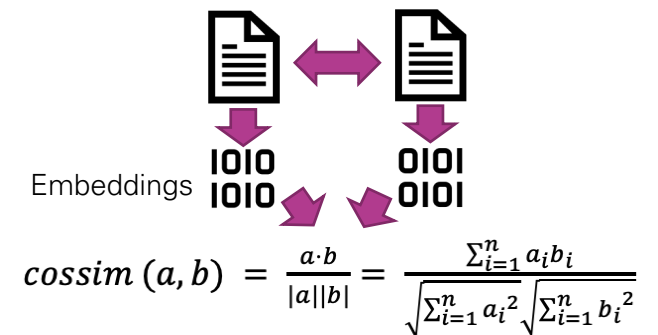
Text-to-music translation

C. Deep Learning and Translation Memory

Conventional Approach

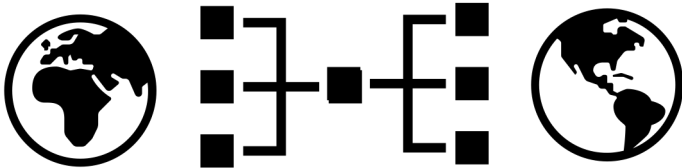


Deep Learning Approach



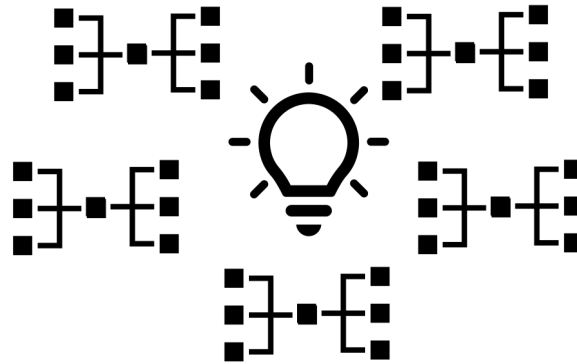
Part 5: Other Noteworthy Trends

Multilingual NMT

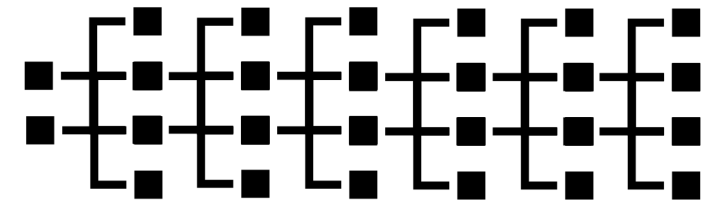


Multiple
language pairs

Multiple Models

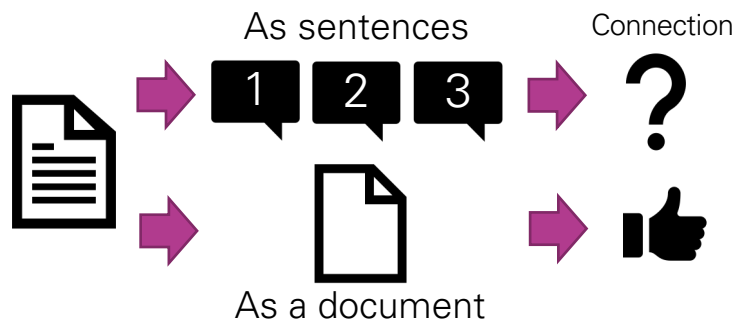


Deeper Models

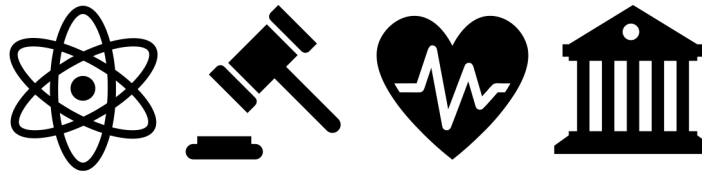


More Layers

Document-level NMT

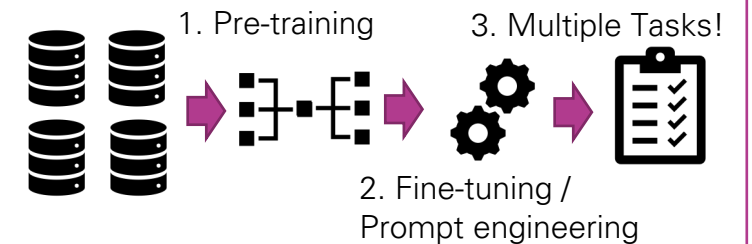


Domain Adaptation



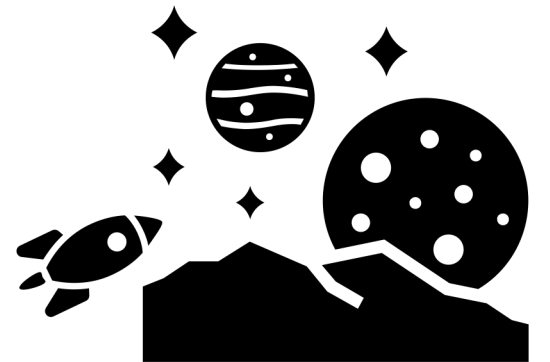
Specialized translation models

Pre-trained language models (e.g., ChatGPT)



The Way Forward

- Deep learning is a rapidly evolving field that offers exciting possibilities for machine translation and other applications in translation technology.
- This chapter provides a concise overview of key concepts and research findings in deep learning, along with references to over 100 publications.
- Whether you are a researcher, practitioner, or simply curious about the possibilities of deep learning, this chapter offers a valuable starting point for further study and exploration.



Thank you!

OpenAI. 2022. Introducing ChatGPT.
<https://openai.com/blog/chatgpt>.

Rombach, R., A. Blattmann, D. Lorenz, P. Esser, and B. Ommer. 2022. High-resolution image synthesis with latent diffusion models. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, 10684-10695. The IEEE Computer Society and The Computer Vision Foundation.

Siu, S.C. 2023. Deep Learning and Translation Technology. In *Routledge Encyclopedia of Translation Technology (2nd edition)*, ed. S.W. Chan, 797-817. Routledge: London.