

A detailed close-up photograph of a mechanical watch movement. The image shows various gears, including large silver-toned wheels and smaller brass-colored pinions. Several jewels, likely synthetic rubies, are visible as small, dark red, circular components. The metal parts have a polished, reflective surface, and the overall composition is intricate and technical.

THE ATTENTION MECHANISM

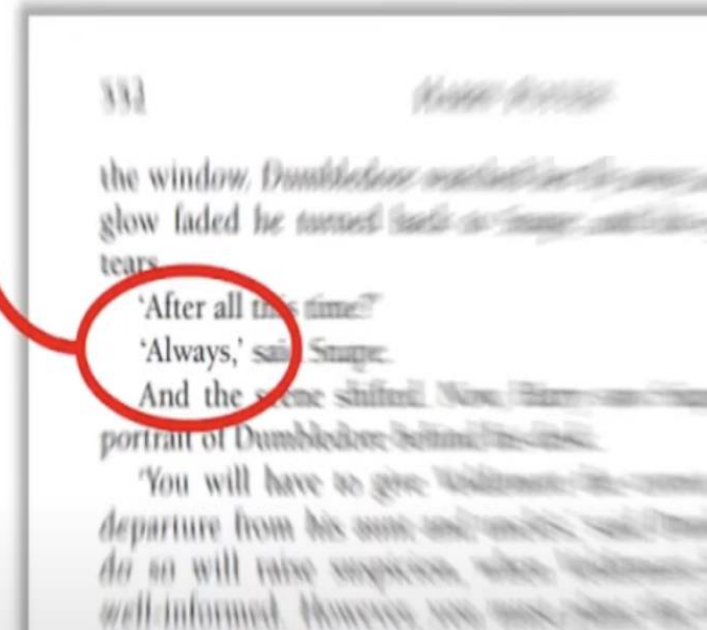
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ITAI 2376: DEEP LEARNING



HISTORY

- Inspired by the human visual processing system.
 - When we look at a person, we focus on a specific visual field while ignoring others (blur).
- ➔ The attention mechanisms give more weight on specific parts of data.

Brain puts More focus on the word you are currently reading.



- The attention mechanism was introduced by Bahdanau in the paper titled “Neural Machine Translation by Jointly Learning to Align and Translate” for machine translation.
- Improving the limitation of traditional RNN Seq2Seq & Encoder-Decoder models.
 - Fixed-length vector. ➔ loss info in long sentence.
- Example of Mandarin to English translation:
 1. Tradition RNN: 今天是晴天 ➔ Today is a sunny day.
 2. With the attention mechanism: 今天是晴天 ➔ It is sunny today.

KEY FEATURES

- **Selective Focus:** allows the model to focus on different parts of the input sequence instead of processing the entire input.
- **Variable Input Handling:** the model is capable of handling variable-length input sequences instead of fixed predetermined length sequences like other architectures require. This is best for NLP.

KEY FEATURES (CONT.)

- **Global and Local Context Integration:** helps the model capture long-range dependencies and relationships between elements in the input sequence.
- **Improved Performance on Sequential Data:** By attending to relevant parts of the input sequence at different steps, the model can better understand the context and generate more accurate predictions.

KEY FEATURES (CONT.)

- **Reduced Vanishing Gradient Problem:** can mitigate the vanishing gradient problem by allowing the model to focus on specific parts of the input sequence. This helps in capturing relevant information and gradients, especially in long sequences, leading to more effective training.
- **Interpretable and Explainable:** provide a level of interpretability to the model's predictions. By visualizing the attention weights, it becomes possible to understand which parts of the input are influencing the output, making the model somehow transparent and interpretable.

KEY FEATURES (CONT.)

- **Transferability Across Tasks:** Pre-trained models with attention mechanisms, such as BERT in natural language processing, can be fine-tuned for specific tasks with relatively small amounts of task-specific data.
- **Robustness to Input Perturbations:** contribute to the model's robustness by allowing it to focus on the most relevant features. This can be beneficial in scenarios where input data may contain noise or irrelevant information.

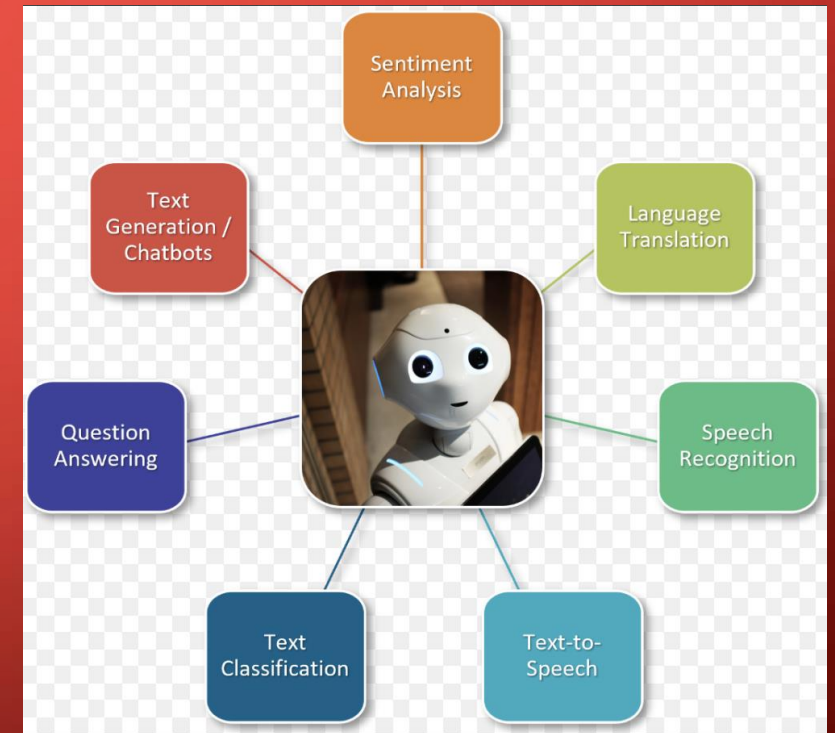
APPLICATIONS

- Attention mechanisms have been used in a variety of industries due to their ability to focus on certain categories of incoming data. Machine translation, speech recognition, image captioning, document summarization, question answering, and sentiment analysis are some of the primary uses. They improve accuracy and performance by allowing models to focus on important data while processing input.



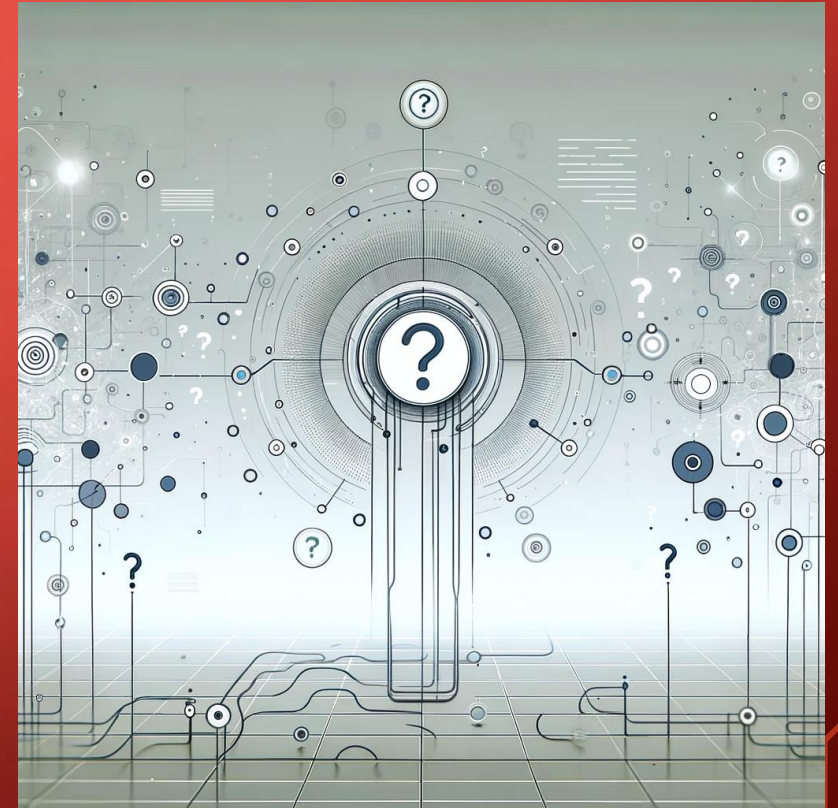
HERE ARE SOME EXAMPLES OF HOW ATTENTION MECHANISMS ARE USED:

1. Machine Translation: Allows for more accurate translation by focusing on relevant terms.
2. Image captioning: Looks for captions that are useful to certain image parts.
3. Document Summarization: Selects important sentences or paragraphs for summaries.
4. Question Answering: Focuses on relevant text parts to provide proper answers.



CHALLENGES AND LIMITATIONS

- Computational and memory demanding: Especially in large scale models, which usually deals with large datasets, attention mechanisms pose significant hurdles due to their complexity with respect to input length.
- Data bias and fairness: Since attention mechanisms focus on certain parts of the data, they can learn and amplify bias in the model, affecting fairness and objectivity in model predictions.



CHALLENGES AND LIMITATIONS (CONT.)

- Limited flexibility and versatility: “Relying on specific or predefined features of the data while learning from limited or fixed data sets can be detrimental for new or unseen inputs” (LinkedIn Community, 2024). Thus, making the model not the best option for inferencing.



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QUESTIONS ?



Thank You!

REFERENCES

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