

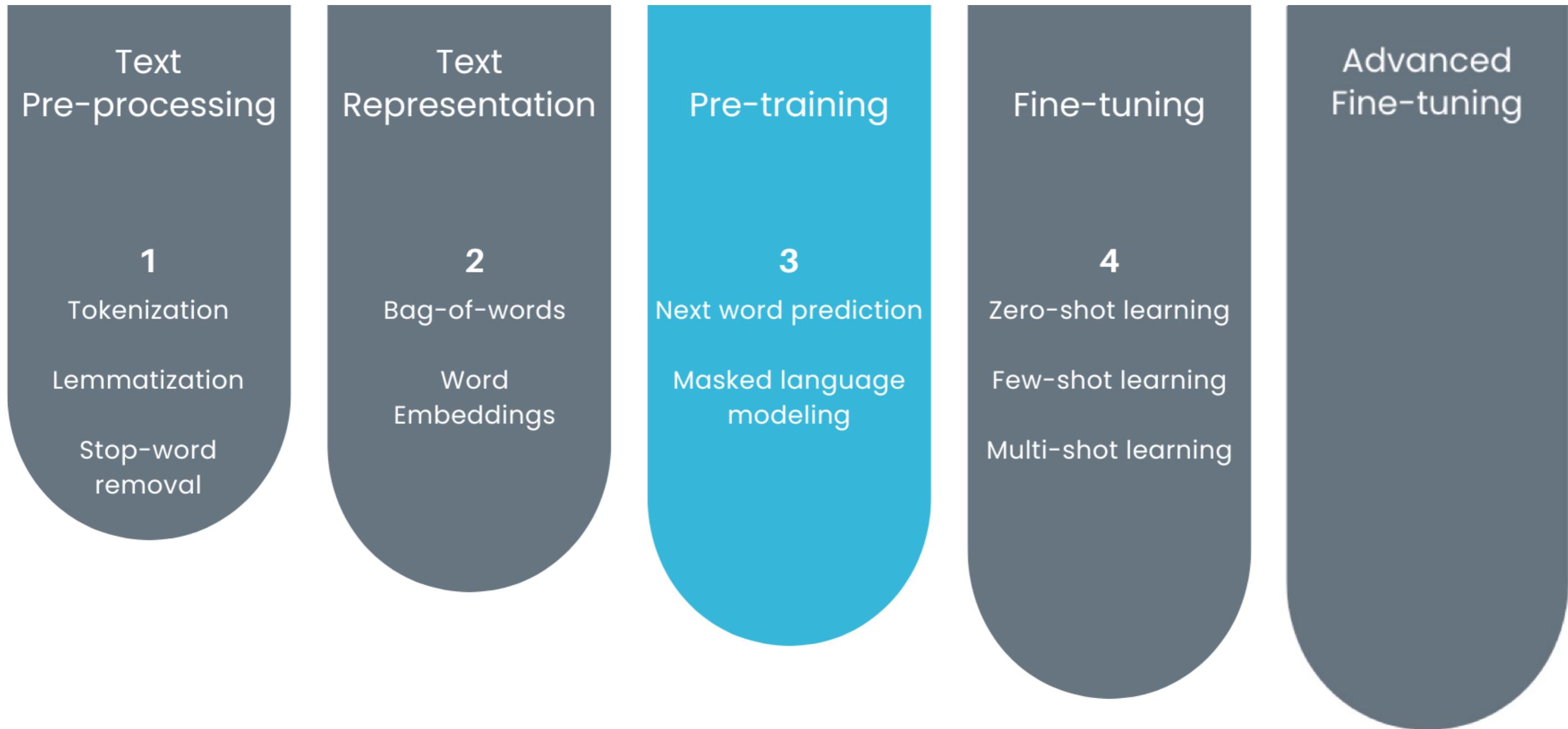
Building blocks to train LLMs

LARGE LANGUAGE MODELS (LLMs) CONCEPTS



Vidhi Chugh
AI strategist and ethicist

Where are we?



Generative pre-training

- Trained using generative pre-training
 - Input data of text tokens
 - Trained to predict the tokens within the dataset
- Types:
 - Next word prediction
 - Masked language modeling

Next word prediction

- Supervised learning technique
 - Model trained on input-output pairs
- Predicts next word and generates coherent text
- Captures the dependencies between words
- Training Data
 - Pairs of input and output examples

🔍 attention is

🔍 attention is - Google Search

🔍 attention is all you need

🔍 attention is not explanation

🔍 attention is the new oil

🔍 attention is the purest form of generosity

🔍 attention is the new currency

🔍 attention is verb or noun

🔍 attention is drawn to meaning

🔍 attention is selective

🔍 attention is not love

Training data for next word prediction

Input

The quick brown

The quick brown fox

The quick brown fox jumps

The quick brown fox jumps over

The quick brown fox jumps over the

The quick brown fox jumps over the lazy

The quick brown fox jumps over the lazy dog.

Output

fox

jumps

over

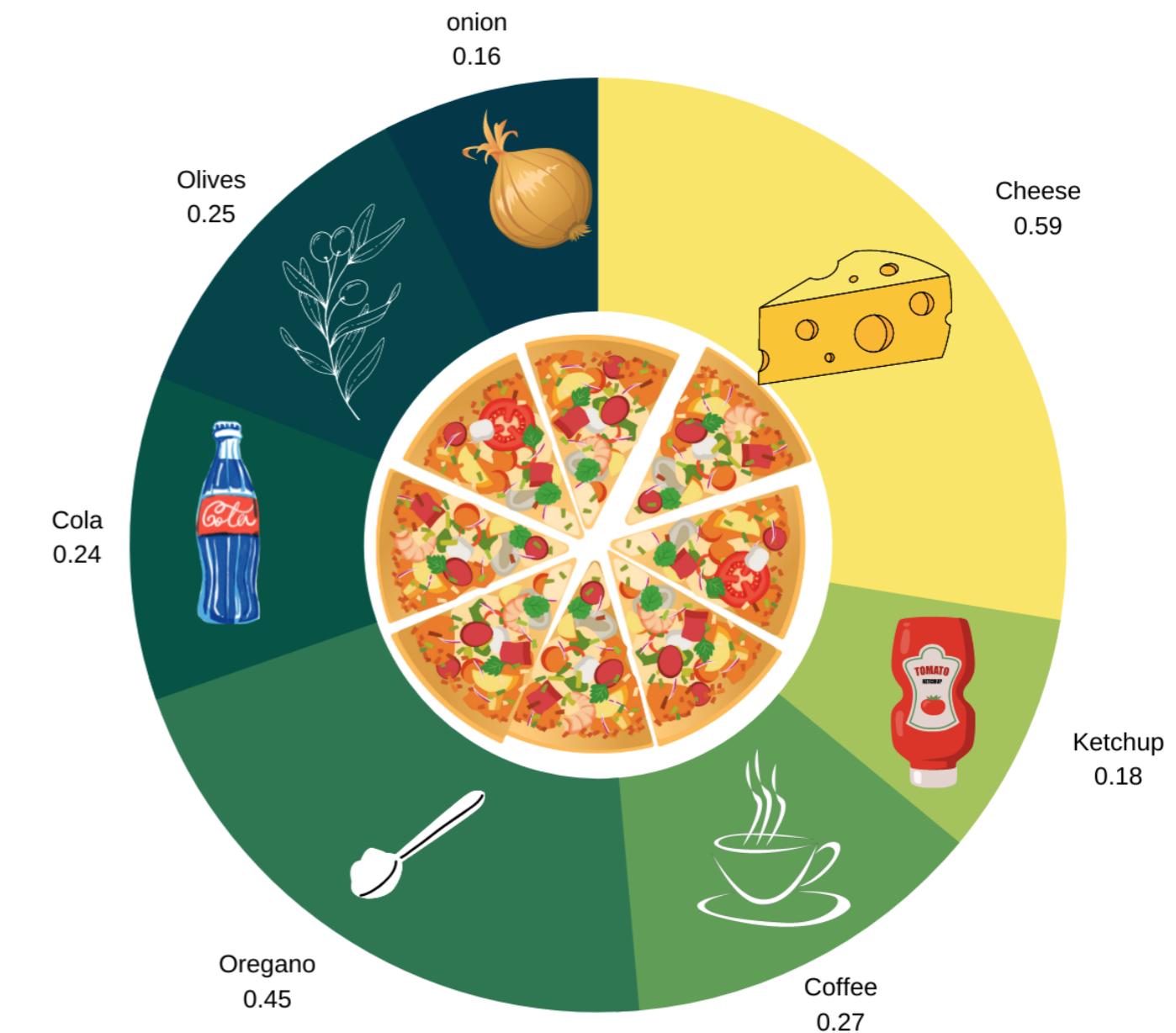
the

lazy

dog

Which word relates more with pizza?

- More examples = better prediction
- For example:
 - I love to eat pizza with - - - - -
- Cheese is more related with pizza than anything else



Masked language modeling

- Hides a selective word
- Trained model predicts the masked word
- **Original Text:** "The quick brown fox jumps over the lazy dog."
- **Masked Text:** "The quick [MASK] fox jumps over the lazy dog."
- **Objective:** predict the missing word
- Based on learnings from training data

Let's practice!

LARGE LANGUAGE MODELS (LLMS) CONCEPTS

Introducing the transformer

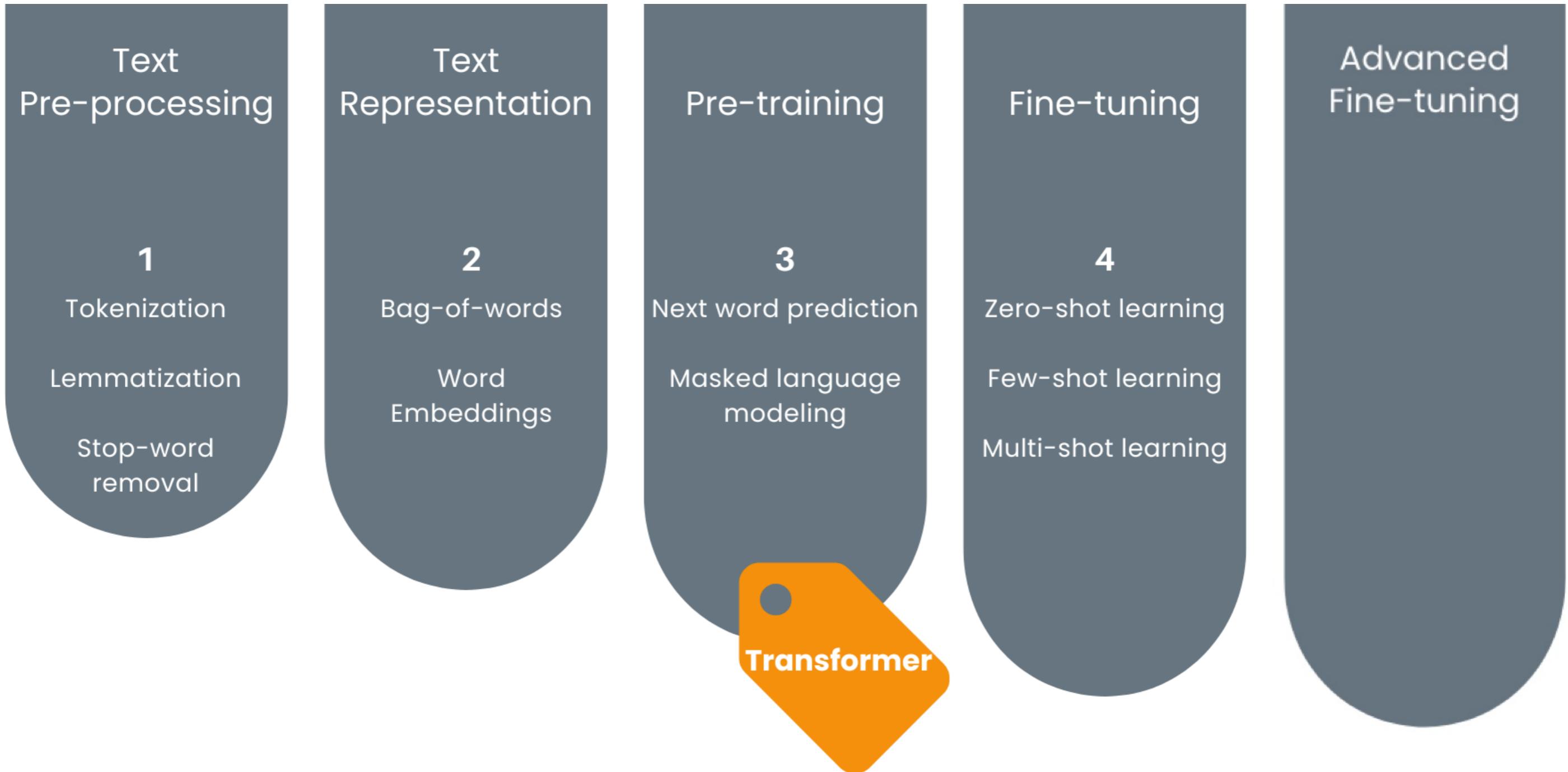
LARGE LANGUAGE MODELS (LLMS) CONCEPTS



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Where are we?



What is a transformer?

- "Attention Is All You Need"
 - Revolutionized language modeling
- Transformer architecture
 - Relationship between words
 - Components: Pre-processing, Positional Encoding, Encoders, and Decoders

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Attention Is All You Need

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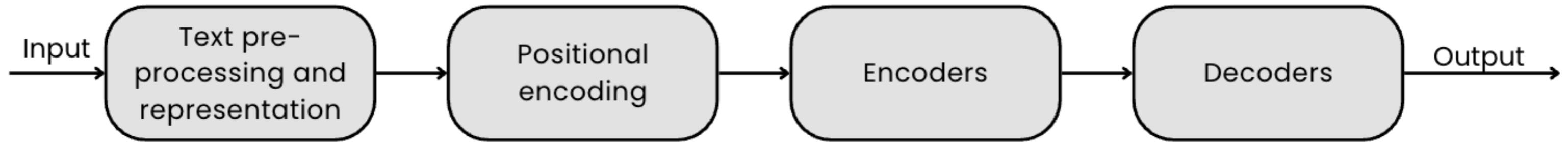
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¹ arXiv: Attention Is All You Need

Inside the transformer

- **Input:** Jane, who lives in New York and works as a software



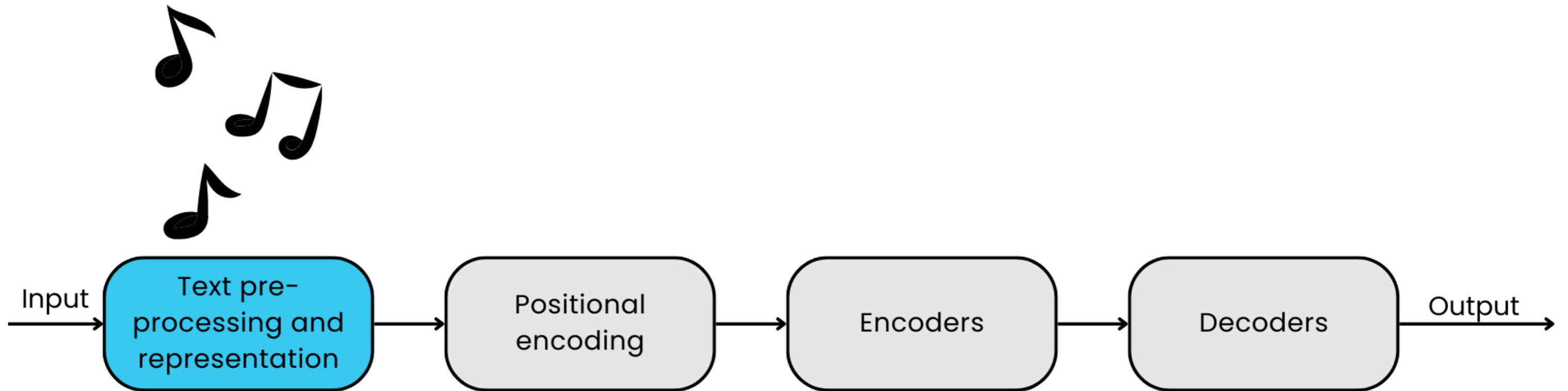
- **Output:** engineer, loves exploring new restaurants in the city.

Transformers are like an orchestra



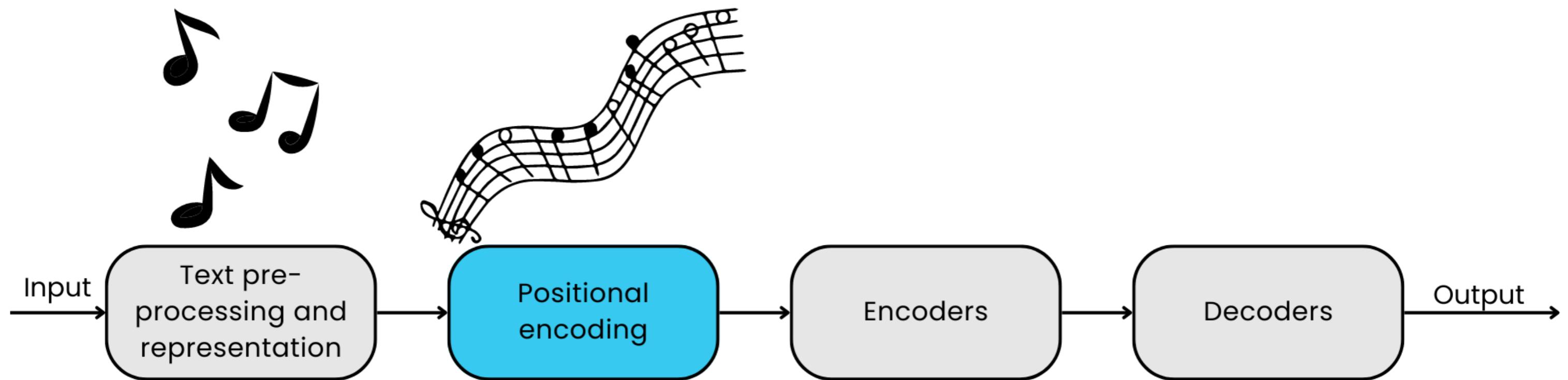
Text pre-processing and representation

- Text preprocessing: tokenization, stop word removal, lemmatization
- Text representation: word embedding



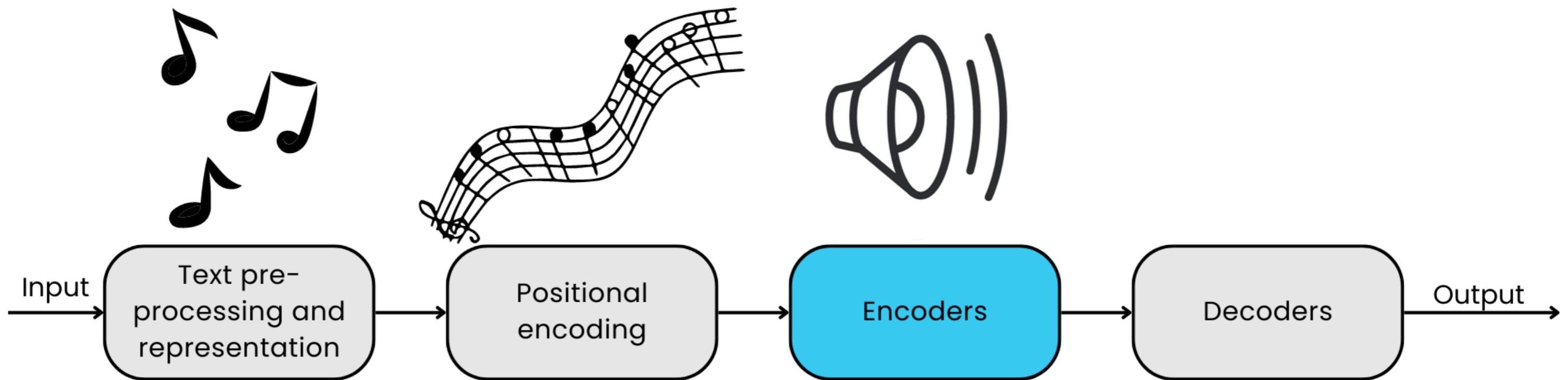
Positional encoding

- Information on the position of each word
- Understand distant words



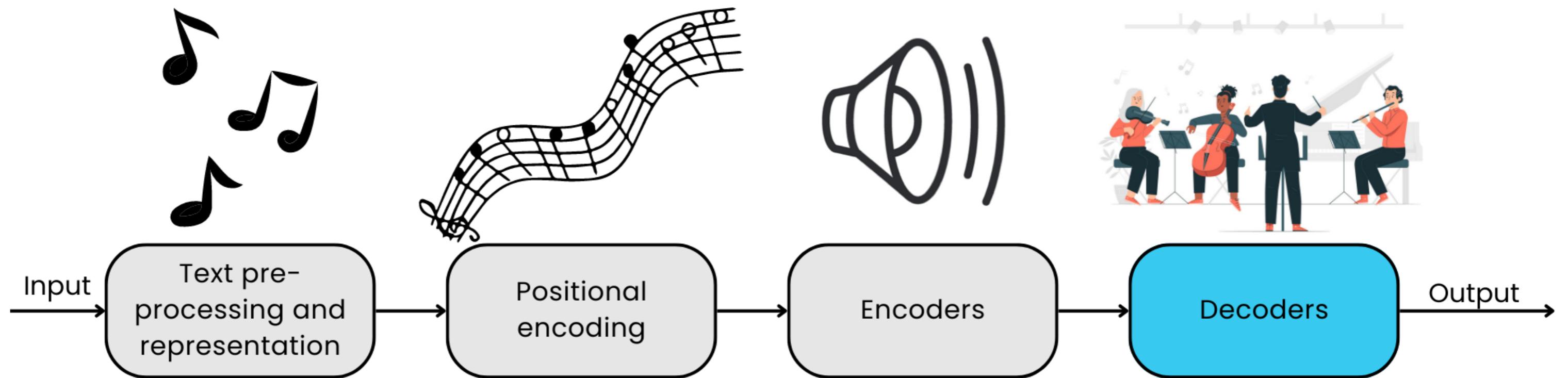
Encoders

- **Attention mechanism:** directs attention to specific words and relationships
- **Neural network:** process specific features



Decoders

- Includes attention and neural networks
- Generates the output



Transformers and long-range dependencies

- **Initial challenge:** long-range dependency
- **Attention:** focus on different parts of the input
- **Example:** "Jane, who lives in New York and works as a software engineer, loves exploring new restaurants in the city."
- "Jane" --- "loves exploring new restaurants"

Processes multiple parts simultaneously

- Limitation of traditional language models:
 - Sequential - one word at a time
- Transformers:
 - Process multiple parts simultaneously
 - Faster processing
- For example:
 - "The cat sat on the mat"
 - Processes "cat," "sat," "on," "the," and "mat" at the same time

Let's practice!

LARGE LANGUAGE MODELS (LLMS) CONCEPTS

Attention mechanisms

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Attention mechanisms

- Understand complex structures
- Focus on important words
- **Book reading analogy:**
 - Clues in a mystery book
 - Focus on relevant content
 - Concentrate on crucial input data



Self-attention and multi-head attention

Self-attention

- Weighs the importance of each word
- Captures long-range dependencies

Multi-head attention

- Next level of self-attention
- Splits input into multiple heads with each head focusing on different aspects

Attention in a party

- **Attention:** Self and multi-head
- **Example:**
 - Group conversation at a party
 - Selective attention to relevant speaker
 - Filter noise
 - Focus on key points



¹ Freepik

Party continues

Self-attention

- Focus on each person's words
- Evaluate and compare their relevance
- Weigh each speaker's input
- Combines for a comprehensive understanding

Multi-head attention

- Split attention into "multiple" channels
- Focus on different aspects of conversation
- Speaker's emotions, primary topic, and related side-topics
- Process each aspect and merge

Multi-head attention advantages

- "The boy went to the store to buy some groceries, and he found a discount on his favorite cereal."
- **Attention:** "boy," "store," "groceries," and "discount"
- **Self-attention:** "boy" and "he" -> same person
- **Multi-head attention:** multiple channels
 - Character ("boy")
 - Action ("went to the store," "found a discount")
 - Things involved ("groceries," "cereal")

Let's practice!

LARGE LANGUAGE MODELS (LLMS) CONCEPTS

Advanced fine-tuning

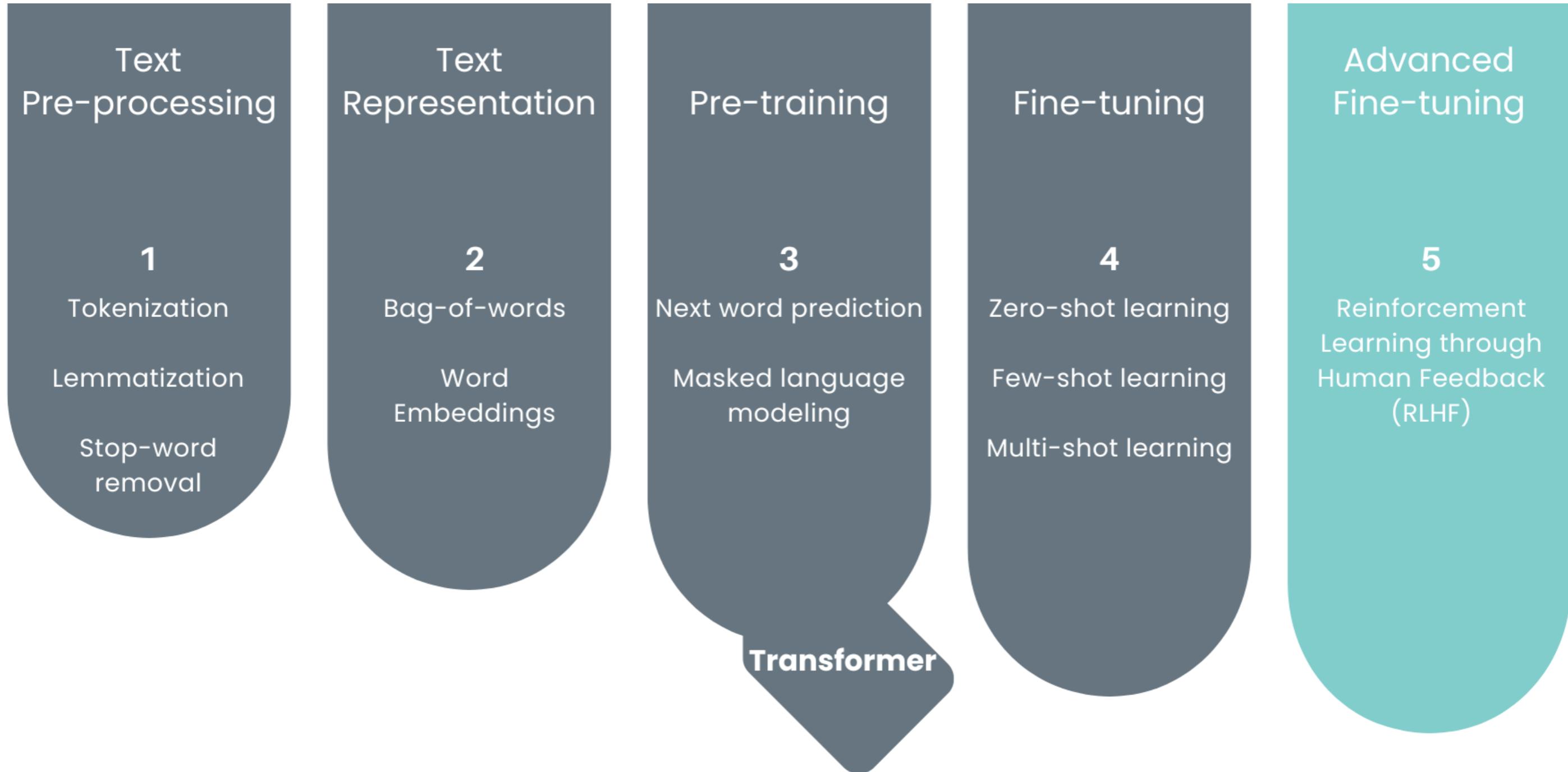
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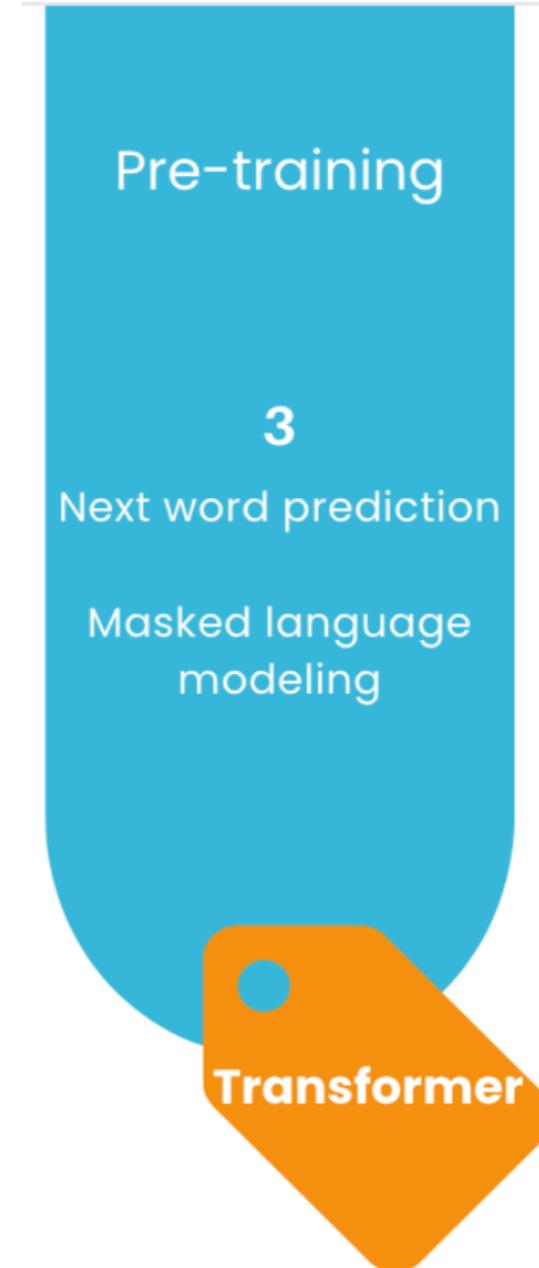
Reinforcement Learning through Human Feedback

- Pre-training
- Fine-tuning
- Reinforcement Learning through Human Feedback (RLHF)



Pre-training

- Large amounts of text data:
 - Websites, books and articles
 - Transformer architecture
 - Learns general language patterns, grammar, and facts
- Next-word prediction
- Masked language modeling



¹ Freepik

Fine-tuning

- N-shot training
- Small labeled dataset for related task

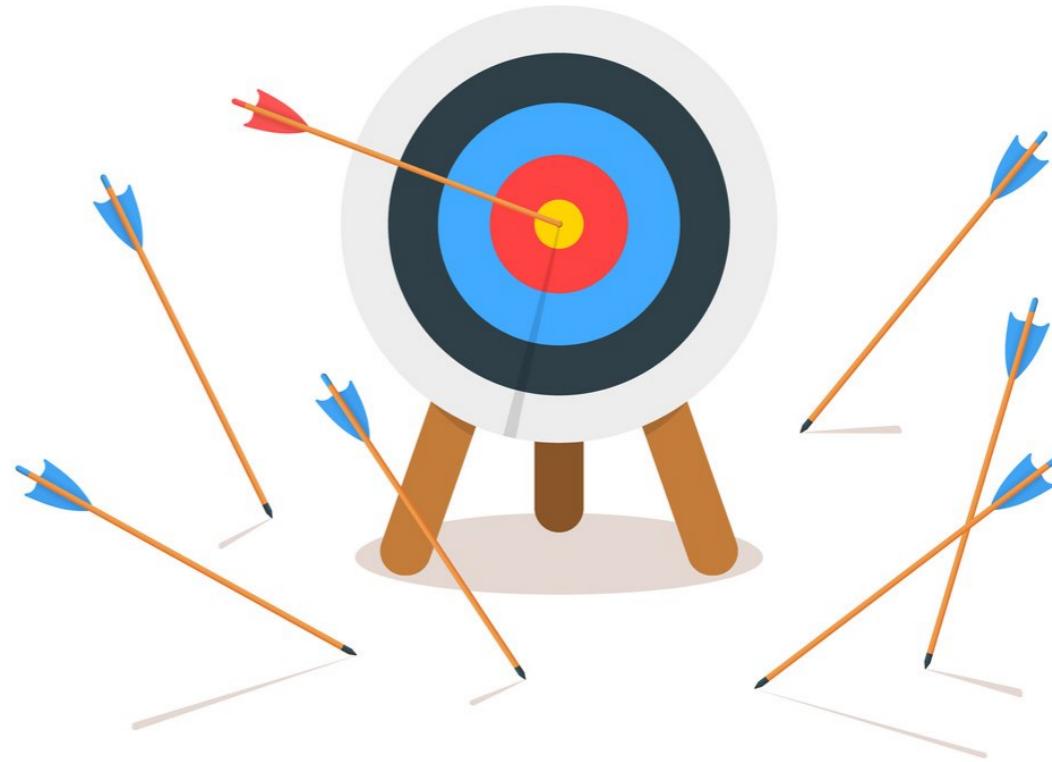


But, why RLHF?

- General-purpose training data lacks quality
 - Noise
 - Errors
 - Inconsistencies
 - Reduced accuracy

Example of reduced accuracy:

- Trained on data from online discussion forums
- Unvalidated opinions and facts
- Needs external expert validation

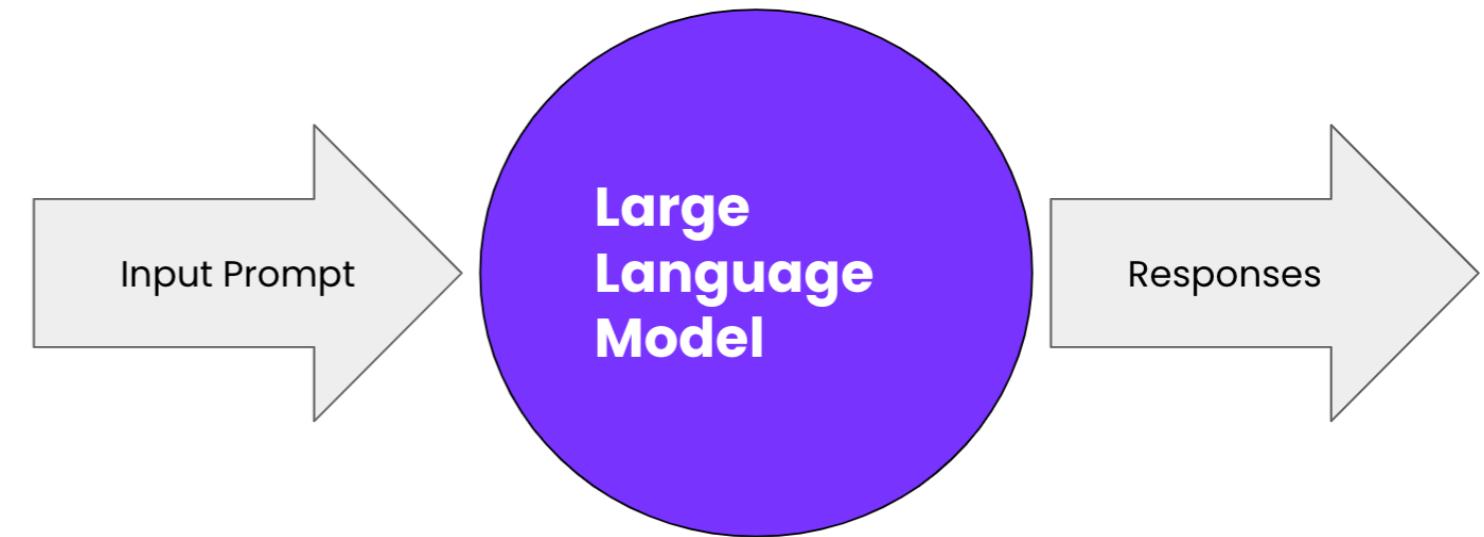


Starts with the need to fine-tune

- Pre-training
 - Learns underlying language patterns
 - Doesn't capture context-specific complexities
- Fine-tuning
 - Quality labeled data improves performance
- Enter RLHF!
 - Human feedback

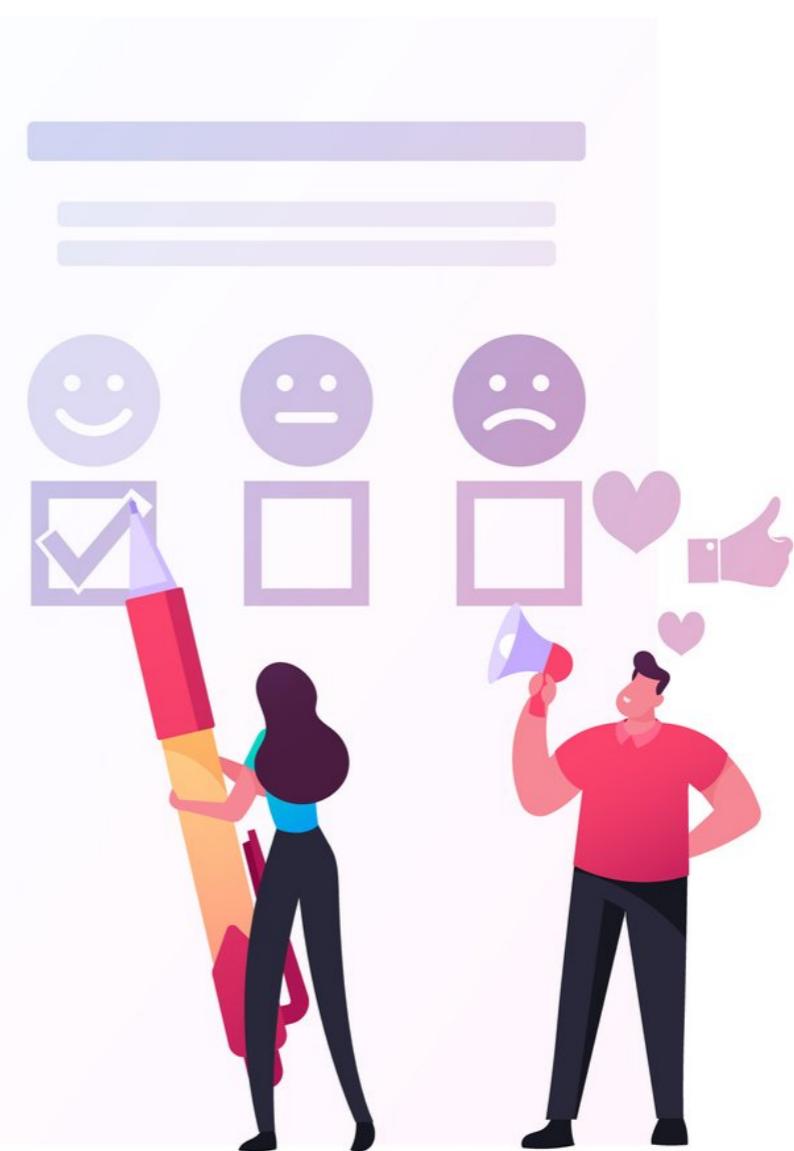
Simplifying RLHF

- Model output reviewed by human
- Updates model based on the feedback
- Step 1:
 - Receives a prompt
 - Generates multiple responses



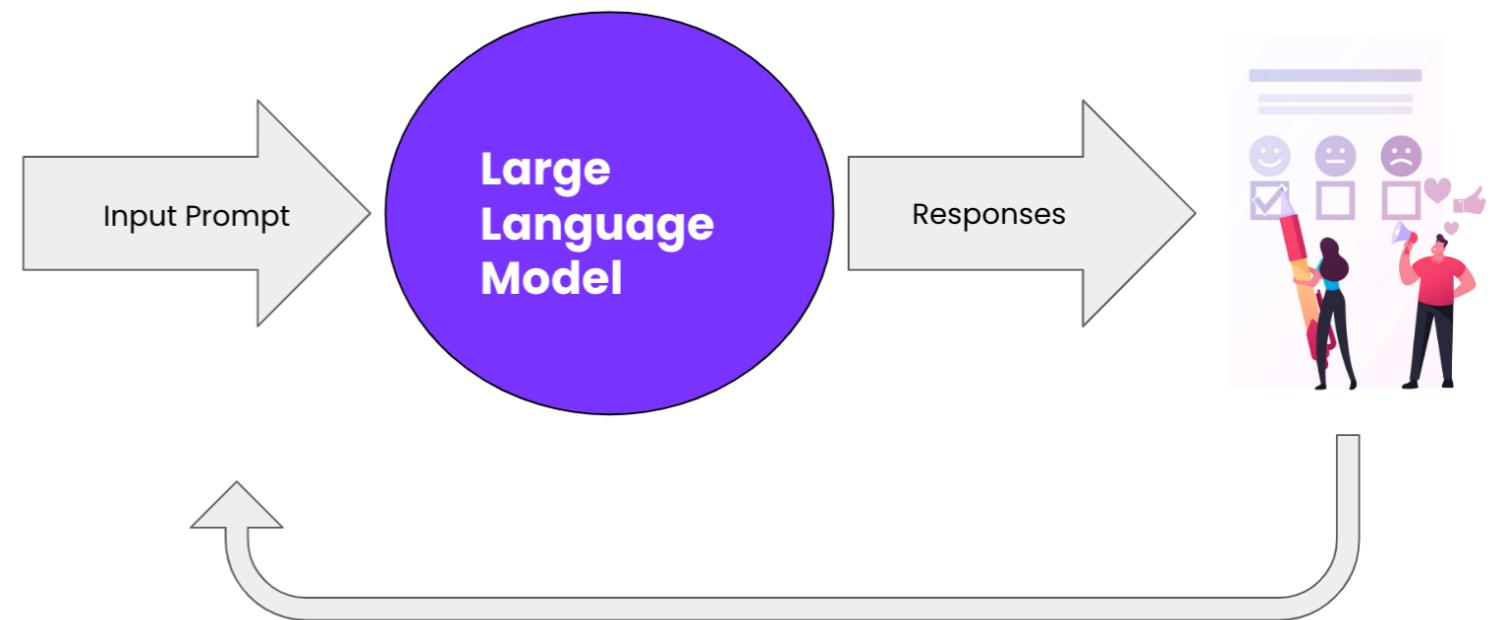
Enters human expert

- Step 2:
 - Human expert checks these responses
 - Ranks the responses based on quality
 - Accuracy
 - Relevance
 - Coherence



Time for feedback

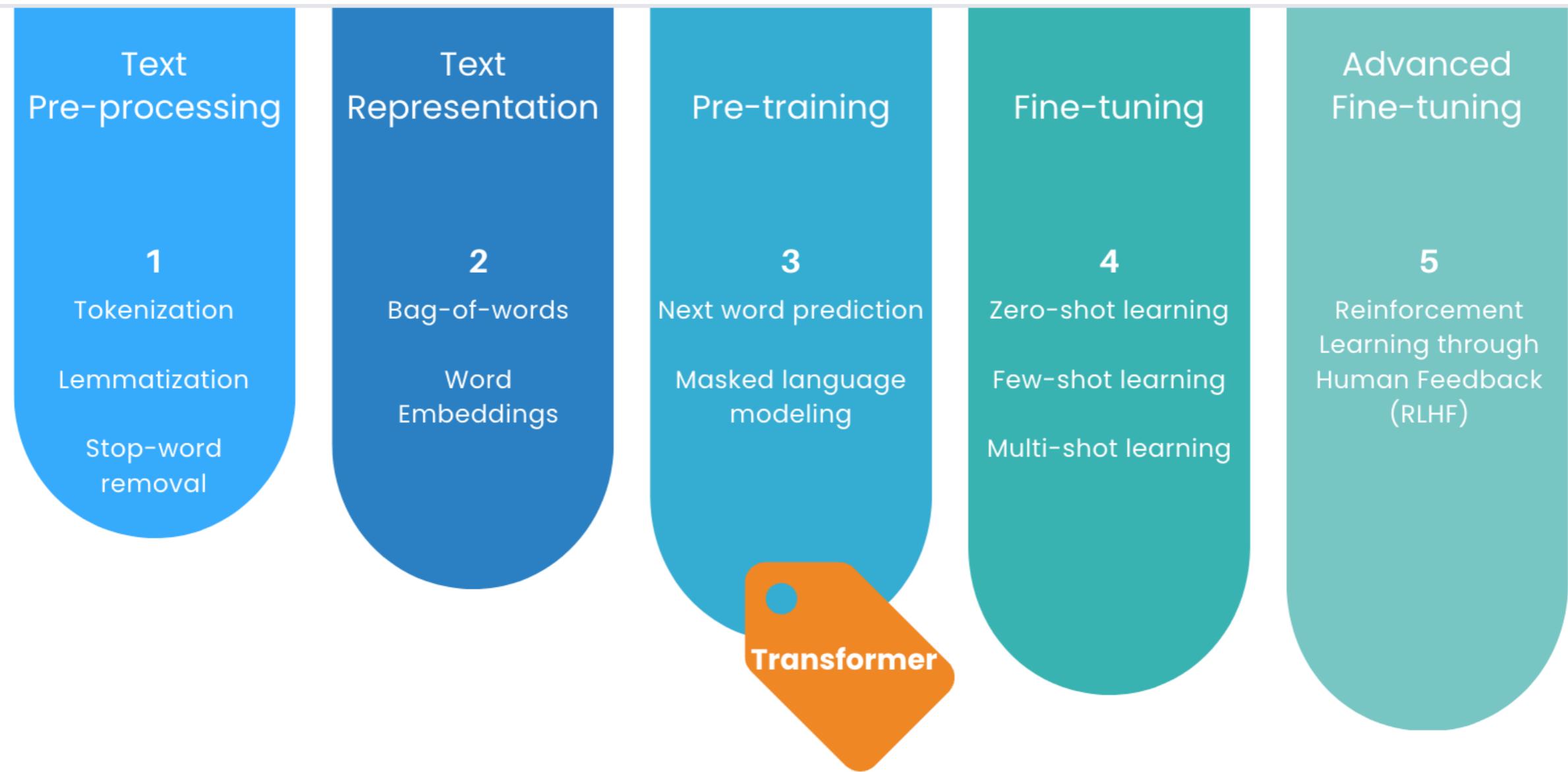
- Step 3:
 - Learns from expert's ranking
 - To align its response in future with their preferences
- And it goes on!
 - Continues to generate responses
 - Receives expert's rankings
 - Adjusts the learning



Recap

- Pre-training to learn general language knowledge
- Fine-tuning for specific tasks
- RLHF techniques to enhance fine-tuning through human feedback
- Combination is highly effective!

Completing the LLM



Let's practice!

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