

THEORY LAB 3

1 Explain the pros and cons of utilising Concatenation for combining embeddings

Utilizing concatenation for combining embeddings is a common technique in machine learning and natural language processing, with some pros and cons. The pros could be summed up as follows :

- **Simplicity:** Concatenation is straightforward to implement. You take the vectors and join them end-to-end, which doesn't require complex mathematical operations or transformations.
- **Flexibility:** This method allows for easy combination of different types of embeddings (e.g., word embeddings with image embeddings), making it versatile for various applications.

Here are presented the most relevant cons of this technique :

- **Potential Redundancy:** If the embeddings contain overlapping or redundant information, concatenation may lead to unnecessary increases in dimensionality without providing additional useful features.
- **Overfitting Risk:** Higher dimensional vectors can lead to overfitting, especially if the training data is not sufficiently large to generalize well to the increased number of parameters.

2 Explain the pros and cons of utilising Addition for combining embeddings

- **simplicity :** it involves adding corresponding elements of the embeddings together, which is computationally efficient.
- **Addition does not increase the dimensionality of the resulting vector.** This keeps the computational requirements and memory usage manageable.

The cons that we can highlight are the following one :

- **Loss of Informations** : If the embeddings contain values with opposite signs, they may cancel each other out during addition, losing potential important features
- **Lack of Flexibility** : It cannot be applied for different dimensions since it uses element wise additions.

3 Explain the pros and cons of utilising Multiplication for combining embeddings

Utilizing multiplication for combining embeddings is another technique in machine learning and natural language processing. Here are some pros :

- **Non-linearity** : Multiplication introduces non-linearity into the combination process, which can be beneficial for capturing complex relationships between embeddings.
- **Dimensionality Management**: Similar to addition, since we apply an element-wise multiplication.
- **Capturing Interaction**: With respect to Addition, Multiplication captures better the interaction between corresponding elements of the embeddings.

Regarding the cons we have :

- **Sensitivity to Scaling**: Multiplication is sensitive to the scaling of the embeddings. If one of the embeddings has significantly larger values than the other, it can dominate the combined representation.
- **Risk of Over-amplification or Under-representation**: Multiplication can over-amplify elements that are large in both embeddings or under-represent elements that are small in one of the embeddings, potentially leading to loss of information.
- **Difficulty in Interpretation**: due to Non-Linearity, which can be difficult sometimes to be interpreted.

4 Explain the pros and cons of utilising Attention for combining embeddings

Using attention mechanisms for combining embeddings has the ability to capture complex relationships and dependencies between the input embeddings. Let's delve into its pros and cons:

- Capturing Contextual Information : Attention mechanism allows the model to focus on relevant parts of the input embeddings, capturing the contextual information effectively.
- Flexibility : due to Attention mechanism.
- Reduced Dimensionality: Attention mechanisms can effectively reduce the dimensionality of the input embeddings by emphasizing important elements and suppressing irrelevant ones.

Regarding the cons we have :

- Computational Complexity: Attention mechanisms involve computing attention weights for each element in the input embeddings, which can be computationally expensive, especially for large inputs or complex attention mechanisms.
- Unsuitable training data : Attention requires a suitable training data, otherwise it cannot perform well, leading on suboptimal solutions.

5 Explain the pros and cons of utilising Difference for combining embeddings

Utilizing difference for combining embeddings offers a simple and efficient way to capture contrast or dissimilarity between the input embeddings.

- It emphasizes differences or contrasts between the embeddings. If two embeddings have dissimilar values for a particular feature, the resulting combined embedding will have a higher magnitude for that feature.
- Simplicity : Like addition

Regarding the cons we have :

- Sensitivity to Scaling : Like multiplication.
- Loss of informations : Like addition.