Coherence in Discourse

Coherence is a fundamental aspect of discourse (discourse is often understood as the flow of communication that connects ideas across multiple sentences or paragraphs) that ensures the text or conversation makes sense as a whole. It's about how ideas in a piece of discourse are connected, making the text easy to follow and understand. In Natural Language Processing (NLP) and discourse analysis, coherence refers to the logical flow of ideas, ensuring that the discourse is interpreted as a meaningful whole.

Understanding Discourse Coherence and Cohesion

- **Discourse Coherence** refers to the overall interpretability and logical flow of a discourse. It is concerned with the relationships between different parts of a text, helping the reader understand how each part fits into the overall meaning.

- **Discourse Cohesion** refers to the explicit linguistic markers that help tie sentences and clauses together. These markers can be conjunctions, lexical items, or pronouns that explicitly connect ideas. For example, "however," "because," "in addition," etc.

While **cohesion** refers to the formal properties of text that link parts together, **coherence** refers to the deeper meaning and logical relationships between those parts.

Role of Coherence Relations (Cause-Effect, Elaboration, Contrast)

Coherence relations are semantic relationships that hold between segments of a discourse. They help link sentences or clauses together, ensuring that the discourse is not just a collection of isolated statements.

1. **Cause-Effect Relation**: This is a common coherence relation where one event or statement causes another. Words like "because," "since," or "as a result" often indicate cause-effect relationships. For example:
    - "She didn't study for the test. **As a result**, she failed."
2. **Elaboration Relation**: This relation involves one part of the discourse providing additional details or expansion on another part. It clarifies or elaborates on a previously mentioned idea. Words like "for example," "such as," or "in other words" are typical indicators. For example:
    - "The car was old. **In other words**, it had been in service for over 15 years."

3. **Contrast Relation**: Contrast highlights differences or opposing ideas in discourse. Words like "but," "on the other hand," and "however" signal contrast. For example:

    - "I wanted to go to the beach. **However**, it started raining."

These coherence relations provide structure and clarity, helping the reader understand the logical flow between ideas.

Discourse Representation Structures (RST & PDTB)

1. **Rhetorical Structure Theory (RST)**:

    - RST is a theory of text structure that focuses on how different segments of discourse are related to each other rhetorically. The theory posits that a discourse can be represented as a tree structure where the leaves are discourse units, and the internal nodes represent coherence relations (e.g., cause-effect, elaboration, etc.).

    - The RST tree helps to represent hierarchical relationships, where each segment can be further decomposed into subsegments. For example:

        1. **Nucleus**: The central or most important part of the discourse.

        2. **Satellite**: Additional information or a supporting segment.

    - RST has been widely used in discourse analysis and has applications in machine learning, where understanding rhetorical relations aids in tasks like summarization and translation.

2. **Penn Discourse Treebank (PDTB)**:

    - PDTB is a framework for annotating discourse-level relations in corpora, specifically focusing on the **explicit** discourse connectives (e.g., "because," "but," "however") and their relations.

    - PDTB uses a three-tier annotation scheme:

        1. **Argument Structure**: Identifies the arguments connected by discourse relations.

        2. **Discourse Relation**: Identifies the relation between the arguments (e.g., contrast, cause-effect).

        3. **Sense**: Defines the specific sense or meaning of the discourse relation.

    - PDTB is a crucial resource for training machine learning models for discourse parsing, helping them understand how text is connected and structured.

Lexical and Syntactic Indicators of Coherence

- **Lexical Indicators**: Words or phrases that explicitly mark coherence relations include conjunctions, adverbials, and pronouns. These indicators are used to connect different parts of discourse and signal relationships between them.
    - Examples:
        - **Causal**: "because," "therefore," "so," "thus"
        - **Temporal**: "after," "before," "then," "meanwhile"
        - **Contrastive**: "however," "on the other hand," "but"
        - **Additive**: "furthermore," "in addition," "moreover"
- **Syntactic Indicators**: The structure of a sentence can also contribute to coherence. For instance, coordinating or subordinating conjunctions (e.g., "and," "but," "because") link clauses syntactically, supporting the coherence of the text. The use of relative clauses, appositions, and noun phrases also contribute to coherence by linking ideas within sentences.

Computational Models for Measuring and Generating Coherent Text

Computational models for coherence aim to automatically evaluate or generate coherent discourse in natural language. Several approaches have been developed to handle this task:

1. **Discourse Parsing**: Discourse parsing is the process of identifying the coherence relations in a given text. This involves identifying discourse connectives, such as "because," and assigning the correct relation (e.g., cause-effect).
    - Example models: Transition-based models, graph-based models, and neural network approaches have been used to parse discourse relations.
2. **Coherence Scoring**: Machine learning models can be trained to evaluate the coherence of a text. These models typically rely on features like lexical cohesion, syntactic structure, and discourse relations to assign a coherence score to a text.

    - Example: BERT-based models can be fine-tuned to predict whether a text has good coherence, by training on corpora annotated with coherence information (e.g., RST or PDTB).

3. **Coherence in Text Generation**: Coherence is an important aspect of natural language generation (NLG), especially in tasks like summarization, dialogue generation, and machine translation.

    - Models like GPT (Generative Pre-trained Transformers) are designed to generate coherent text by learning from large corpora of discourse and understanding the contextual relations between sentences.

    - **Sequence-to-sequence models** (e.g., LSTMs, Transformers) are often employed to generate coherent and contextually appropriate responses or texts by learning from examples where coherence relations are explicit.

Conclusion

Coherence plays a crucial role in ensuring that discourse is logically structured and interpretable. Techniques such as discourse representation theories (RST, PDTB) and various computational models for parsing, scoring, and generating coherent text provide the foundation for understanding and automating discourse coherence. These methods are essential in various NLP applications like text generation, machine translation, summarization, and dialogue systems. Understanding coherence relations and their markers helps in both analyzing and creating meaningful, well-structured text.