

Aspect® Natural Language Understanding™ Architecture and Design Philosophy

Aspect NLU is the framework behind the advanced natural language capabilities of Aspect® CXP™, Aspect's application lifecycle management suite for customer self-service applications, in the context of Interactive Text Response (ITR) applications, commonly known as "chatbots." The purpose of Aspect NLU is to analyze natural language content and to generate a structured representation which then can be leveraged by application logic to drive chatbot dialogue and extract data from the user's utterances

Aspect's unique approach to Natural Language Understanding (NLU) is rooted in leveraging artificial intelligence and linguistic science to treat user utterances as something much more than sequences of symbols. Understanding natural language is one of the most challenging tasks in the field of artificial intelligence because language forms input that is idiomatic, nuanced, and infinitely variable. Meeting this challenge requires sophisticated technology and knowledge representation.

An Ontological Multilingual Lexicon

At the heart of Aspect NLU is a lexicon, or dictionary, containing hundreds of thousands of semantic concepts from over a dozen languages. These concepts are linked in an **ontology** that captures the semantic relationships of synonyms, hypernyms, and domains:

- **Synonyms** link together words and phrases whose meanings are equivalent.
- **Hypernyms** link some concepts (cat, dog) to other concepts that are both more specific (Black Labrador) and more general (pet, canine).
- **Domains** group together concepts that are related by topic or vertical (finance, cooking).

All of these relationships are independent of the surface form of a word (do, doing, done, did) or the language (English, Spanish, Chinese). The same concepts are linked together across every language in the lexicon. A group of synonyms linked across the languages is called a **family**.

Aspect NLU also contains, folded within the same linguistic knowledge base, a complete grammatical (syntax) language model for each of the languages it covers.

A Syntactic and Semantic Engine

When presented with input from the user, the Aspect NLU engine puts it through a processing pipeline that turns it from a string of symbols into a rich interpretation of their meaning.

The first step is **segmentation** into words and sentences. This may seem trivial in Western languages, but note that some cues can be misleading; the period in "Mr. Smith" is not the end of a sentence, and the comma in "3,456" does not separate two different words. Also, some multiple-word expressions should be tokenized together when they form an idiomatic term or the meaning of the whole is not a sum of the meaning of the parts (for example, "pitch a fit"). In many non-Western languages, such as Chinese, whitespace is not used to separate words, and the symbols need to be separated first before they can be analyzed.

Next comes **morphological** processing. The French words *aime*, *aimes*, *aimons*, *aimez*, and *aiment* are all forms of the regular verb *aimer*, and the morphological processing step can recognize the stem+affix patterns so the engine can determine that the exact same concept from the lexicon is involved.

Finally, the engine can perform **semantic** assignments, associating each word with the concepts in the dictionary it

could represent. Part of this process includes the identification of common datatypes, such as expressions of dates or times, monetary amounts, email addresses, or proper names. The final phase of processing is **syntactic** analysis, determining the grammatical relationships between the words. When these phases are complete, a rich representation of the utterance can be presented to an application.

Using Aspect® CXP™ with Aspect® Natural Language Understanding™ (NLU) to Build Chatbots

Aspect NLU is integrated within Aspect CXP for creating self-service applications in the text channel, and can be invoked by a CXP application for two major purposes:

- Driving dialogue decisions based on the user's utterance. This is typically done when determining the intent of the user.
- Extracting information from the user's utterance. This is typically part of a situation where the application needs the user to make a choice or provide more information to complete a task.

Because of the deep analysis of a sentence provided by the NLU engine, the process of training a CXP chatbot using Aspect NLU is different from what is used in other frameworks. When you teach a CXP chatbot to determine a user's intent, you do not provide example sentences in a single language – because that would only train the bot to classify sentences in that language. Instead, you represent

the key elements of your example sentences as *interlingual* abstractions that reference the **families** mentioned above. This captures *concepts* rather than *words* – one symbol representing a verb in any of its forms, and all of its synonyms, in any language. You can also use hypernyms or domains to capture hundreds or thousands of related concepts with a single symbol. You do not need to worry about collecting sufficient example sentences to cover all of these possibilities, and spelling normalization within the engine also removes the need to anticipate non-standard spellings.

Aspect CXP chatbots therefore are inherently multi-lingual; once the bot has been taught to differentiate between different intents, or how to extract different data from the user's responses, it can perform those tasks on any of the languages covered in the Aspect NLU knowledge base without requiring retraining from the beginning.

Once a chatbot has been deployed, the application can continue to improve. Aspect continuously refines the linguistic models in the cloud, so any application built on Aspect CXP automatically gets better over time. The logic of a CXP application using Aspect NLU is also entirely transparent to the chatbot creator, allowing direct inspection and correction. Past interactions can be leveraged to improve this logic. By keeping the human in the loop of the learning process, we ensure that the chatbot learns the correct lessons from the past.

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