# Formal Definition of the Semantic Language

We use frame-based structure to represent the semantic language. This representation reveals an intuitive predicate argument structure of the semantic language. The predicates are the domain independent locutions that reflect the actions the negotiator is trying to perform by the utterance. The possible locutions are Offer, Accept, Reject, Insist, Greet, Quit, Query. The arguments represents the domain specific attributes with corresponding values. The argument are defined in Table 1. Separating domain dependent aspects from domain independent provides a systematic way of creating the semantic representation for an application.

This manual defines the grammar of the semantic language, preconditions and postconditions for each legal locution. Every negotiator's utterance can contains several locutions.

| **Argument** | **Values** |
|---|---|
| Salary | 60,000 USD; 90,000 USD; 120,000 USD |
| Pension Fund | 0%; 10%; 20%; No agreement |
| Working Hours | 8 hours; 9 hours; 10 hours |
| Leased Car | With leased car; Without leased car; No agreement |
| Job Description | QA, Programmer, Team Manager, Project Manager |
| Promotion Possibilities | Fast promotion track; Slow promotion track; No agreement |

Table 1. The list of attributes with corresponding values.

## Synchronous context-free grammar (SCFG) of the semantic language.

**== <root> ==**
*** <offer> / <offer>**
*** <accept> / <accept>**
*** <reject> / <reject>**
*** <quit> / <quit>**
*** <greet> / <greet>**
*** <query> / <query>**

**== <quit> ==**
* I quit / *{"Quit": true}*

**== <greet> ==**
* Hello / *{"Greet":true}*

**== <offer> ==**

* I **<offers>** / **<offers>**
**== <offers> ==**
* offer **<issue_value>** / *{"Offer":**<issue_value>**}*

**== <accept> ==**
* I **<accepts>** / **<accepts>**
**== <accepts> ==**
*** <accept_single>** / **<accept_single>**
*** <accept_issue>** / **<accept_issue>**
*** <accept_issue_value>** / **<accept_issue_value>**
**== <accept_single> ==**
* accept the offer / *{"Accept":true}*
**== <accept_issue> ==**
* accept the **<issue>** / *{"Accept":"**<issue>**"}*
**== <accept_issue_value> ==**
* accept **<issue_value>** / *{"Accept":**<issue_value>**}*

**== <reject> ==**
* I **<rejects>** / **<rejects>**
**== <rejects> ==**
*** <reject_single>** / **<reject_single>**
*** <reject_issue>** / **<reject_issue>**
*** <reject_issue_value>** / **<reject_issue_value>**
**== <reject_single> ==**
* reject the offer / *{"Reject":true}*
**== <reject_issue> ==**
* reject the **<issue>** / *{"Reject":"**<issue>**"}*
**== <reject_issue_value> ==**
* reject **<issue_value>** / {"Reject":**<issue_value>**}

**== <query> ==**
* What do you offer about **<issue>**? / *{"Query":{"Offer":**<issue>**}}*
* What do you have to offer? / *{"Query":"Offer"}*

**== <issue_value> ==**
* a pension of **<pensions>** / *{"Pension Fund":**<pensions>**}*
* a salary of **<salary>** / *{"Salary":**<salary>**}*
* a workday of **<hours>** / {"Working Hours":**<hours>**}
* a leased car / *{"Leased Car":"With leased car"}*
* no leased car / *{"Leased Car":"Without leased car"}*
*** <promotional>** / *{"Promotion Possibilities":**<promotional>**}*
***** no agreement on **<noagissues>** / **<noagissues>**

**== <noagissues> ==**
* leased car / *{"Leased Car":"No agreement"}*
* pension / *{"Pension Fund":"No agreement"}*

* promotion track / *{"Promotion Possibilities":"No agreement"}*

**== <issue> ==**
* salary / Salary
* job description / Job Description
* pension fund / Pension Fund
* company car / Leased Car
* promotion track / Promotion Possibilities
* working hours / Working Hours

**== <salary> ==**
* 60,000 / 60,000 USD
* 90,000 / 90,000 USD
* 120,000 / 120,000 USD

**== <pensions> ==**
* 0% / 0%
* 10% / 10%
* 20% / 20%

**== <hours> ==**
* 8 hours / 8 hours
* 9 hours / 9 hours
* 10 hours / 10 hours

**== <jobs> ==**
* qa / QA
* programmer / Programmer
* team manager / Team Manager
* project manager / Project Manager

**== <promotional> ==**
* a fast promotion track / Fast promotion track
* a slow promotion track / Slow promotion track

## Description of the Locutions.

- **Offer** — this locution allows a negotiator to offer a subset of attributes and corresponding values for negotiation.

  **Usage: Offer(A_i, A_j, <IssueValueList>)**

  Participant **A_i** proposes to participant **A_j** a subset of negotiation issues **<IssueValueList>**. **<IssueValueList>** contains a subset of attributes with corresponding values from the negotiation domain. There is no any preconditions or postconditions for Offer.

- **Accept** — a negotiator can accept a whole previous offer or a subset of previously offered attributes with or without corresponding values.

  **Usage: Accept(A_i, A_j, <MixedList>, C)**

  The meaning of the above predicates is that agent **A_i** accepts either the list of attributes with corresponding values or the list of attributes or the whole previous offer of **A_j**. When the argument is empty the **Accept** refers to the last offer that can be extracted by the context C.

  **Preconditions: Offer(A_j, A_i, <IssueValueList>)**, such that **<IssueValueList>** covers **<MixedList>**

- **Reject** — a negotiator can reject a whole previous offer or a subset of previously offered attributes with or without corresponding values.

  **Usage: Reject(A_i, A_j, <MixedList>, C)**

  The meaning of the above predicates is that agent **A_i** rejects either the list of attributes with corresponding values or the list of attributes or the whole previous offer of **A_j**. When the argument is empty the **Reject** refers to the last offer that can be extracted by the context **C**.

  **Preconditions: Offer(A_j, A_i, <IssueValueList>)**, such that **<IssueValueList>** covers **<MixedList>**

- **Greet** – a negotiator can greet the other participant.

  **Usage: Greet(A_i, A_j)**

  A negotiator **A_i** greets a **A_j**.

- **Quit** - a negotiator can opt-out the negotiation.

  **Quit(A_i)**

  A participant **A_i** opts out the negotiation.

- **Insist** — a negotiator can insist on the whole previous offer or on the part of the previous offer. The precondition is that the attributes or the attributes with corresponding values should be offered previously by the negotiator.

  **Usage: Insist(A_i, A_j, <MixedList>, C)**

  The meaning of the above predicates is that agent **A_i** insists on either the list of attributes or the list of attributes with corresponding values or on the whole previous offer. When the argument is empty the Insist refers to the last offer that can be extracted by the context C.

  **Preconditions: Offer(A_i, A_j, <IssueValueList>)**, such that **<IssueValueList>** covers **<MixedList>**

- **Query** — a negotiator can ask question. The question are represented as a meta locution. Query locution can be used in compatible with other locutions (Offer, Accept, Reject, Insist).

  **Usage: Query(A_i, A_j, <IntentList>, C)**

  Agent **A_i** asks agent **A_j** a question.

# Annotation Guidelines

The negotiation takes place between an Employer and a Candidate, both sides are interested in reaching a conclusion and formalizing the hiring conditions

**General recommendations:**

1. Negotiation is a context-dependent conversation, therefore consider context for intent annotation.
2. Annotate attributes and values only when they are actually mentioned in the sentence

The list of attributes with corresponding values are defined in Table 1.

Below is the list of possible locutions with examples. The negotiation natural sentences are formatted in Italic and semantic labels are in Bold. The semantic representation is given in JSON format.

- **Offer** — a negotiator can offer a subset of attributes and values to the other side. Offer has to contains attributes with corresponding values. Offer cannot be used with only attributes. There is no any precondition for Offer, however Offer is a precondition for Accept, Reject, Insist.

  Direct offering:
  **-** *I offer you a pension of 10 percent and a salary of 60,000 USD*
  **Offer:{Pension fund: 10%, Salary: 60,000 USD}**

  Offer as a modality of Accept:
  *- I will accept a salary of 60,000 USD*
  **Offer:{Salary:60,000 USD}**

  Offer when Accept precondition is not fulfilled:
  *{the begging of the conversation}*
  *- I accept the job as programmer*
  **Offer:{Job description:Programmer}**

  Offer with Accept in the same sentence
  *- I accept your salary and I offer you a pension of 20%*
  **Accept:Salary, Offer:{Pension Fund:20%}**

- **Accept** — a negotiator can accept a whole previous offer or a subset of previously offered attributes with or without corresponding values. There is no **Accept** of the attributes if they were not offered previously.

  Direct Accept (only when Offer is a precondition):

*- I offer you a programmer job position.*
*- I agree to be a programmer.*
**Accept:{Job description:Programmer}**

*- I suggest you a salary of 60,000.*
*- I will accept this salary.*
**Accept:Salary**

*- I suggest you a salary of 60,000 and pension of 10%.*
*- I agree.*
**Accept:true**

*- I give a pension of 10% and programmer position with a leased car.*
*- I accept the salary and the pension.*
**Accept:[Salary, Pension Fund]**

- **Reject** — a negotiator can reject a whole previous offer or a subset of previously offered attributes with or without corresponding values. Offer with the same argument is a precondition of Reject.

  Direct Reject (only when Offer is a precondition):
  *- I offer you a programmer job position.*
  *- I reject this offer.*
  **Reject:true**

  *- I suggest you a salary of 60,000.*
  *- I will not accept this salary.*
  **Reject:Salary**

  *- I suggest you a slow promotion track.*
  *- I disagree with slow promotion track.*
  **Reject: {Promotion track: Slow}**

- **Insist** — a negotiator can insist on the whole previous offer or on the part of the offer. The precondition is that the attributes or attributes with corresponding values should be offered previously by the same participant.

  *- I offer you the salary of 120,000*
  **Offer:{Salary: 120,000 USD}**
  - …
  *- I insist on my offer*
  **Insist: true**

  *- I offer you the salary of 120,000*
  **Offer:{Salary: 120,000 USD}**

- …
*- I insist on the salary*
**Insist: Salary**

*- I offer you the salary of 60,000*
**Offer:{Salary: 60,000 USD}**
- …
*- I insist on the salary of 60,000*
**Insist:{Salary: 60,000 USD}**

- **Greet** – a negotiator can greet the other part.

*- Hello. Nice to see you.*
**Greet: true**

- **Quit** — a negotiator can opt-out the negotiation.

*- I don't want to employ you.*
**Quit: true**

*- I want to opt out.*
**Quit: true**

- **Query** — query is a meta intent. Query intent is used in compatible with other labels. **Query** with a label that contains a value is compatible to Yes-No question.

**-** *Do you reject a salary of 120,000 USD?*
**Query:{Reject:{Salary:120,000 USD}}**

**-** Do you accept a salary of 60,000 USD?
**Query:{Accept:{Salary:60,000 USD}}**

*- Can you offer the salary of 120,000 USD?*
**Query:{Offer:{Salary:120,000 USD}}**

**Query** with **Accept, Reject, Insist** is compatible to Yes-No question.

*- Do you accept my offer?*
**Query: Accept**

**Query** with **Offer** only is compatible to WH question and as the answer to this question the opponent should give an offer.
*- What do you have to offer?*
**Query: Offer**
- I offer you a salary of 60,000 USD

**Offer: {Salary: 60,000 USD}**

Query with label that consists of Issues without Values is compatible to WH-question.
*- Which salary do you offer?*
**Query: {Offer: Salary}**

*- Which position do you prefer?*
**Query: {Offer: Jon Description}**

- Do you want leased car?
**Query: {Offer: Leased car}**

# Annotation of complex sentences

- Conditional sentences.
  *- I offer you a salary of 60,000 USD*
  **Offer:{Salary:60,000 USD}**
  *- I accept 60,000 USD only with 20% pension*
  **Offer:{Salary:60,000 USD, Pension fund: 20%}**

- Acknowledgement and Refusal

  Acknowledgement are the words like “yes”, “OK”, “yeah”. Refusal are the words like “no”, “nope”. If they are the single words in the sentence annotate them correspondingly to **Accept:true** and **Reject:true.**

  More often they are followed by phrases, like on the example

  *-I offer you a salary of 60K USD.*
  *-OK, I accept this salary.*
  **Accept:Salary**

  In this case ignore acknowledgements and refusals.