Introduction to Distributed and Embedded Multi-agent Systems

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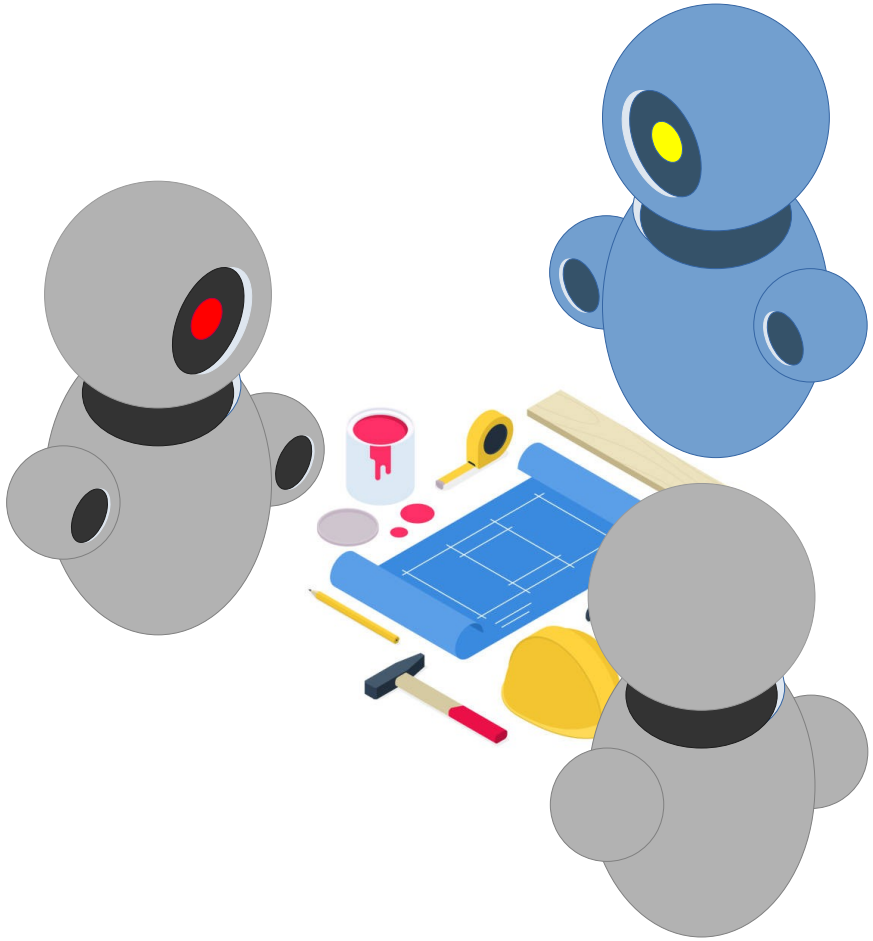
GOALS AND PLANS



Jason Framework: Goals

Em Jason, os **goals** (objetivos) representam os estados do mundo em que o agente deseja atingir.

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1. **realização (!)**

   É um objetivo para atingir determinado estado desejado pelo agente.

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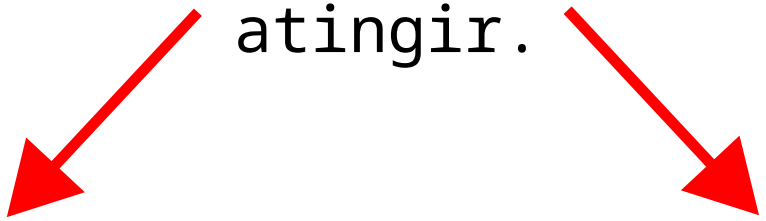


1. **realização (!)**

   É um objetivo para atingir determinado estado desejado pelo agente.

2. **teste (?)**

   É um objetivo que tem a finalidade de resgatar informações da base de crenças do agente.

Goals: Format

{!|?}event [source(type)]

Goals: Format

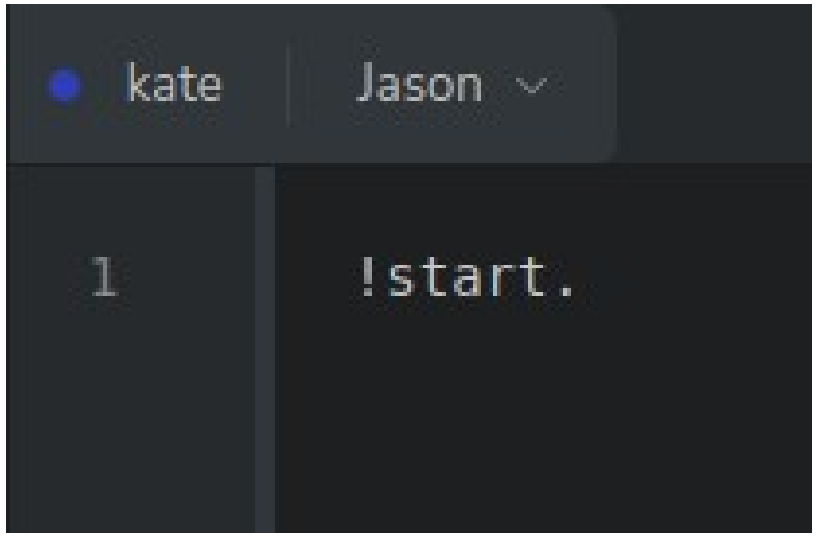
Goals: Format

Goals: Format

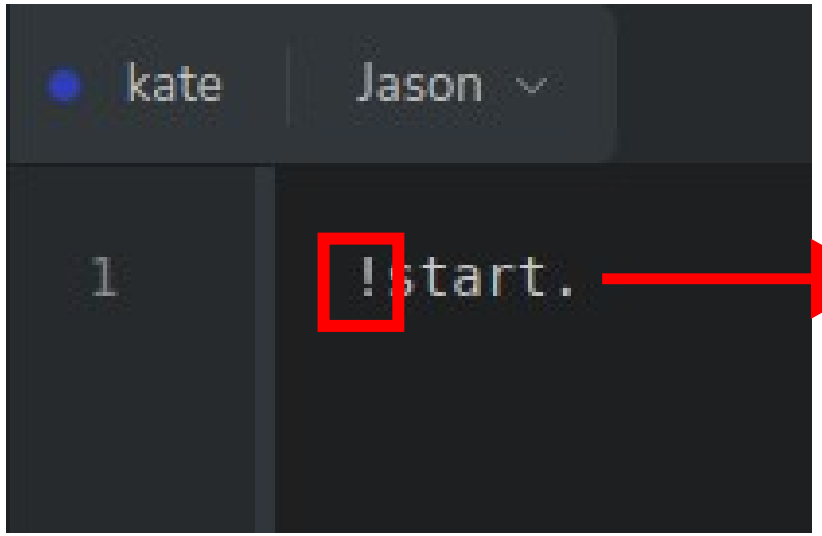
{!|?}event [source(type)]

the source of the belief.

Goals: Initial Goal

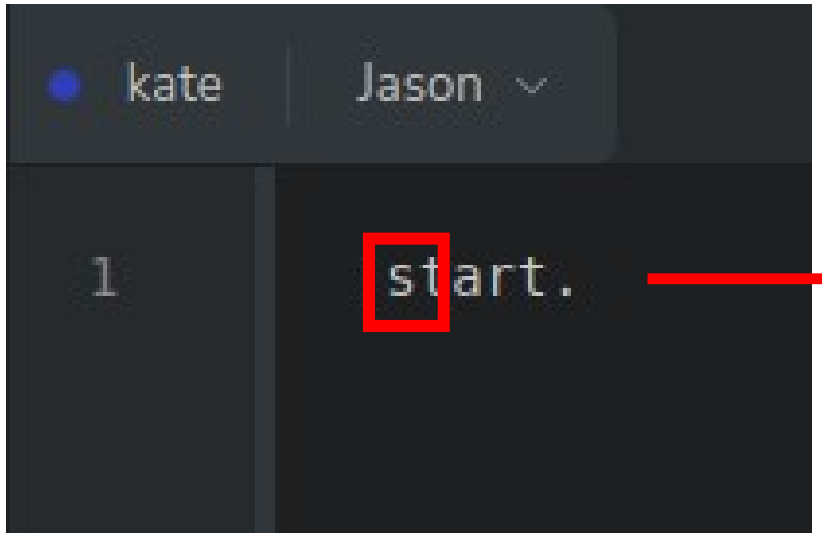


Goals: Initial Goal



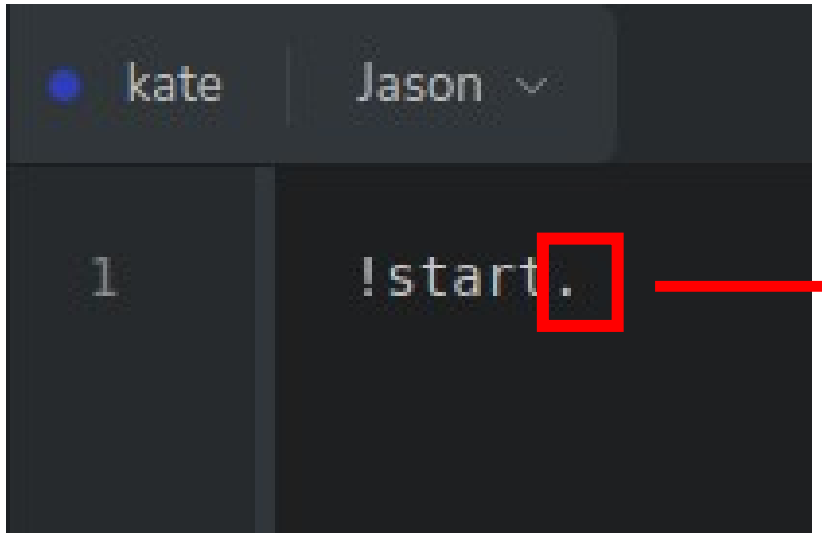
every goal must start with an **exclamation point**.

Goals: Initial Goal



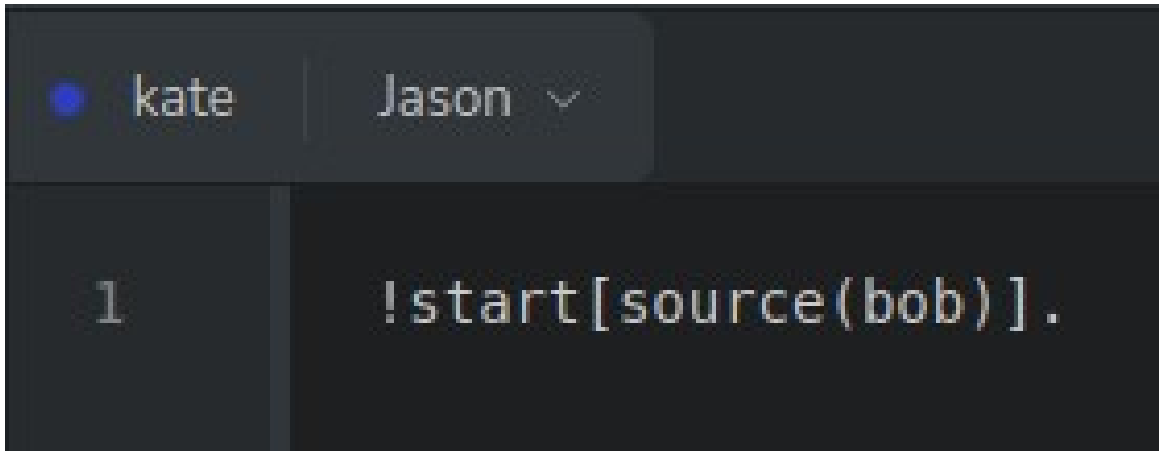
every goal's predicate must start with a **lowercase** letter.

Goals: Initial Goal

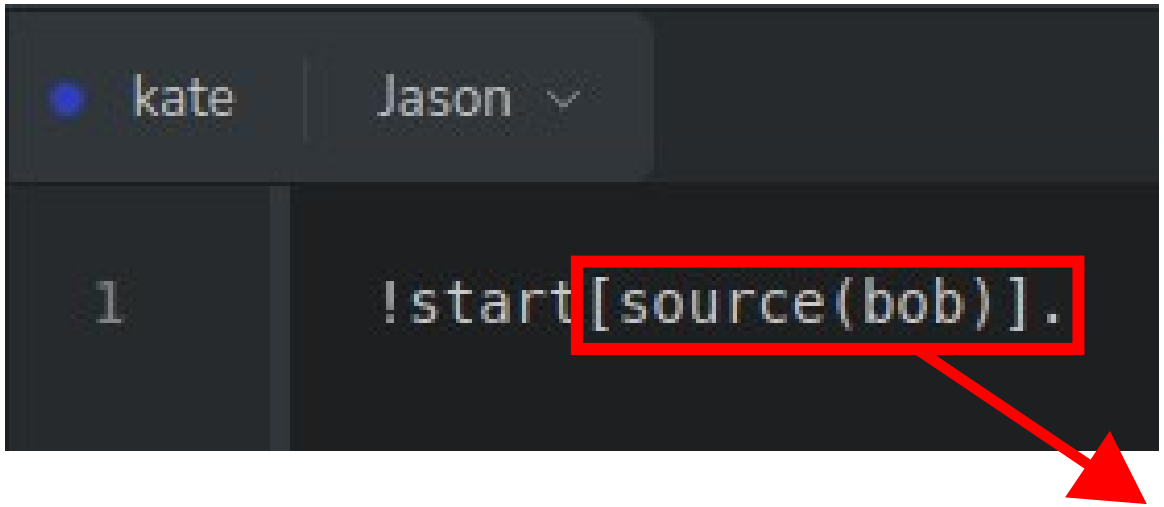


and it must end with a **period**.

Goals: Initial Goal with a Source

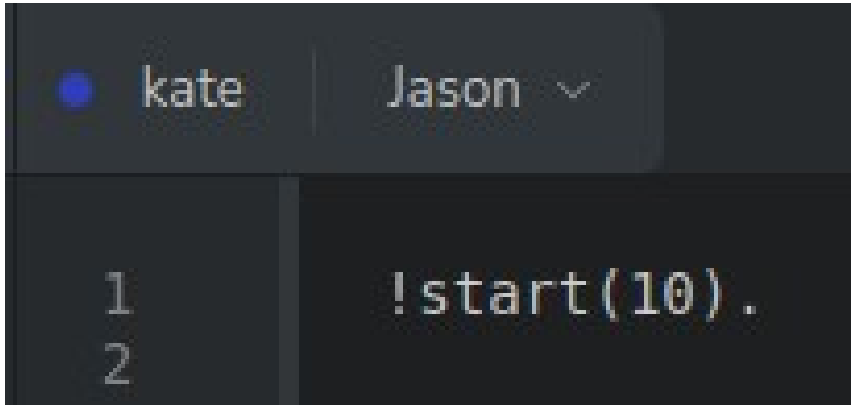


Goals: Initial Goal with a Source

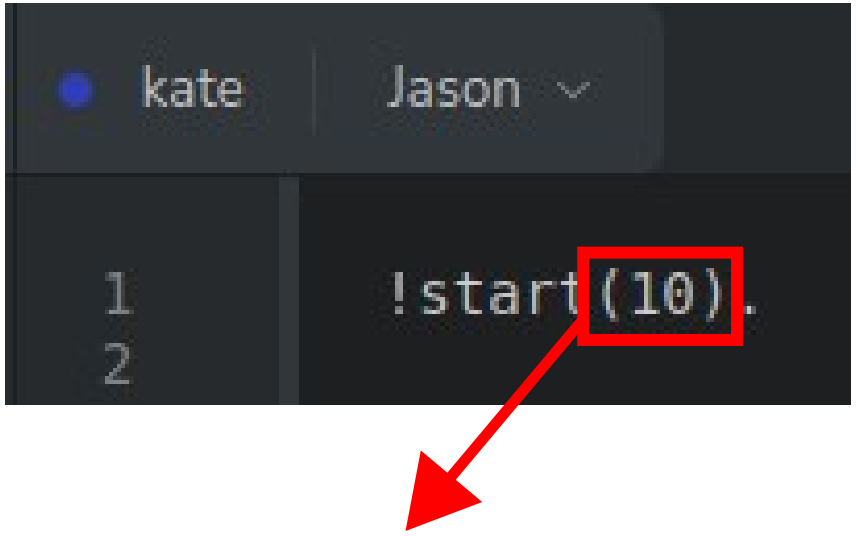


one can define a **source**.

Goals: Initial Goal with Predicate



Goals: Initial Goal with Predicate



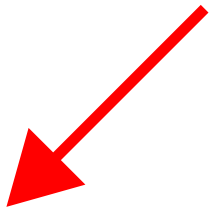
predicate(int)

Goals: Initial Goal with Predicate

predicate(value)

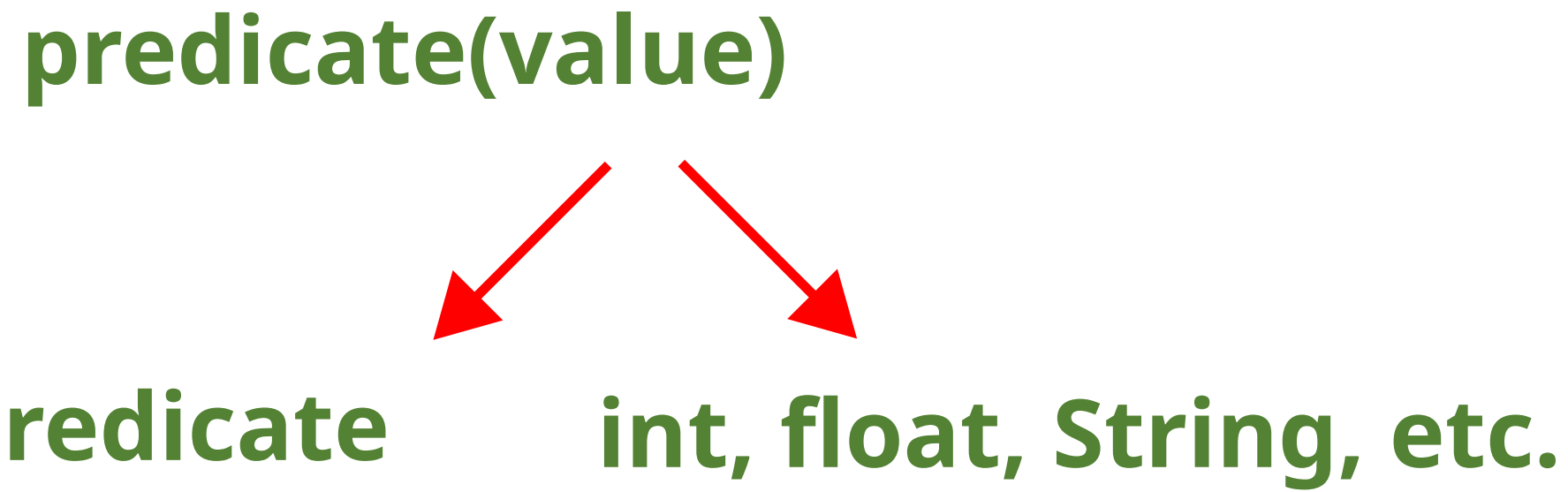
Goals: Initial Goal with Predicate

predicate(value)



predicate

Goals: Initial Goal with Predicate



Goals: Format

predicate(predicate)

Goals: Format

predicate(predicate)

Goals: Format

predicate(predicate(predicate))

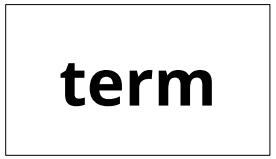
Goals: Format

predicate(predicate(predicate))

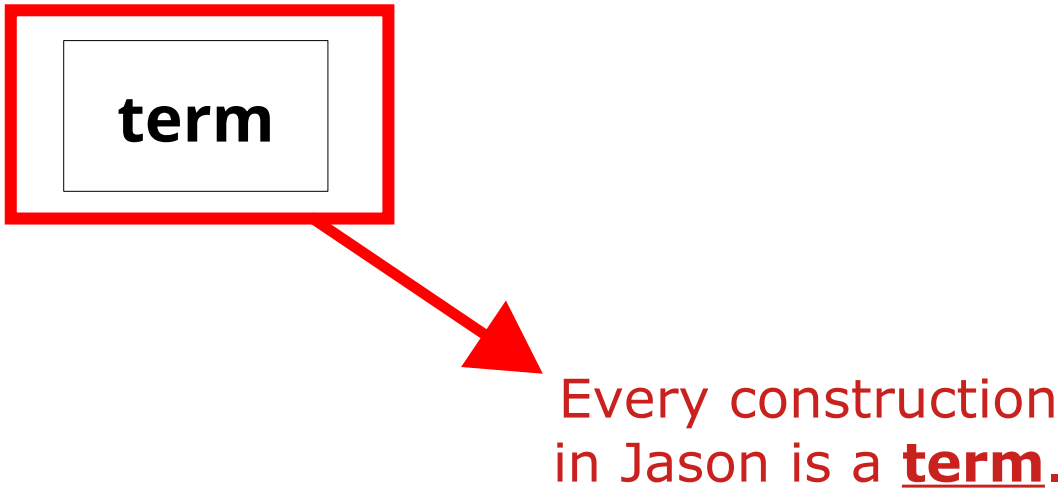
Goals: Format

predicate(predicate(predicate(...)))

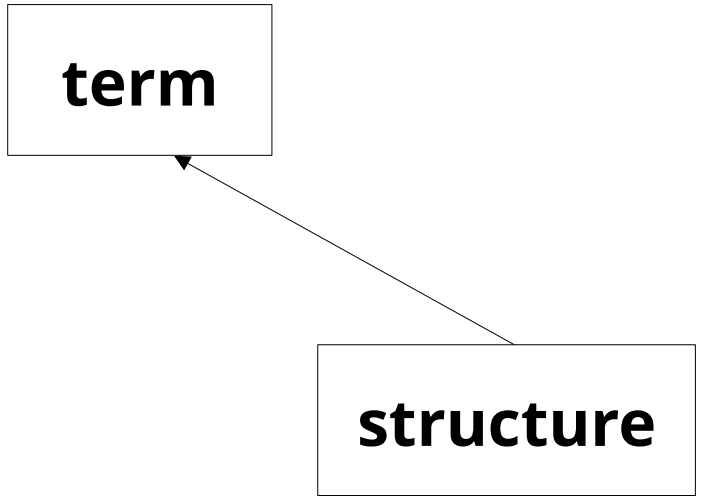
Logic-Based Programming



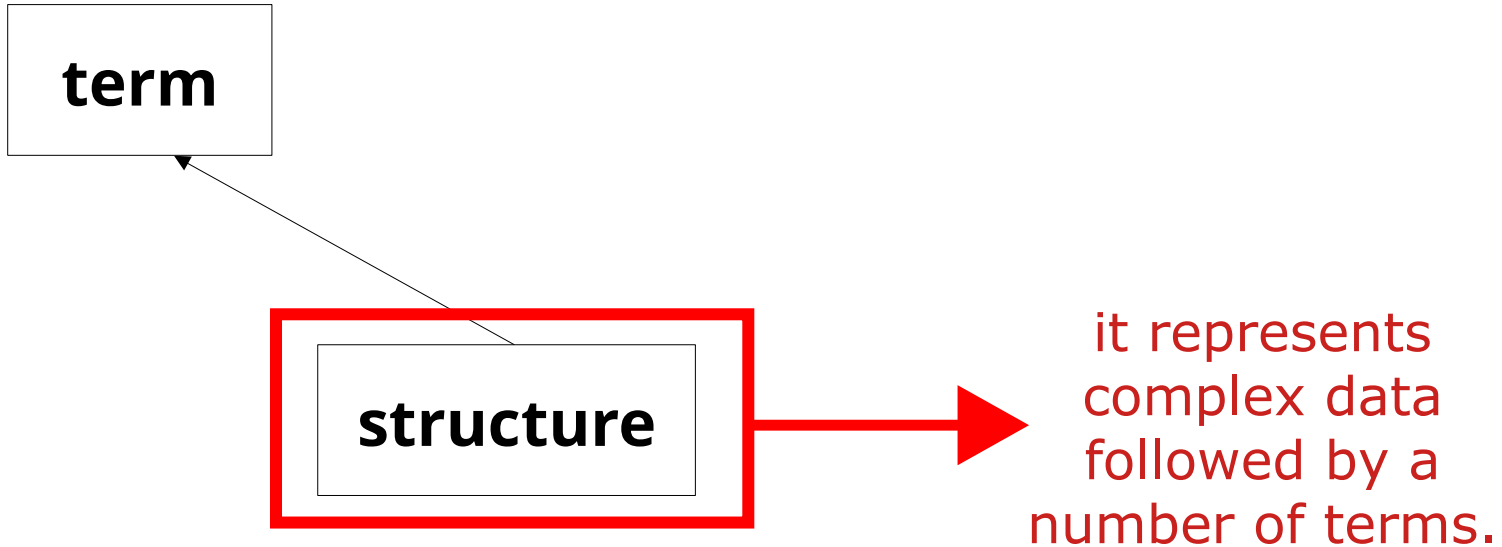
Logic-Based Programming



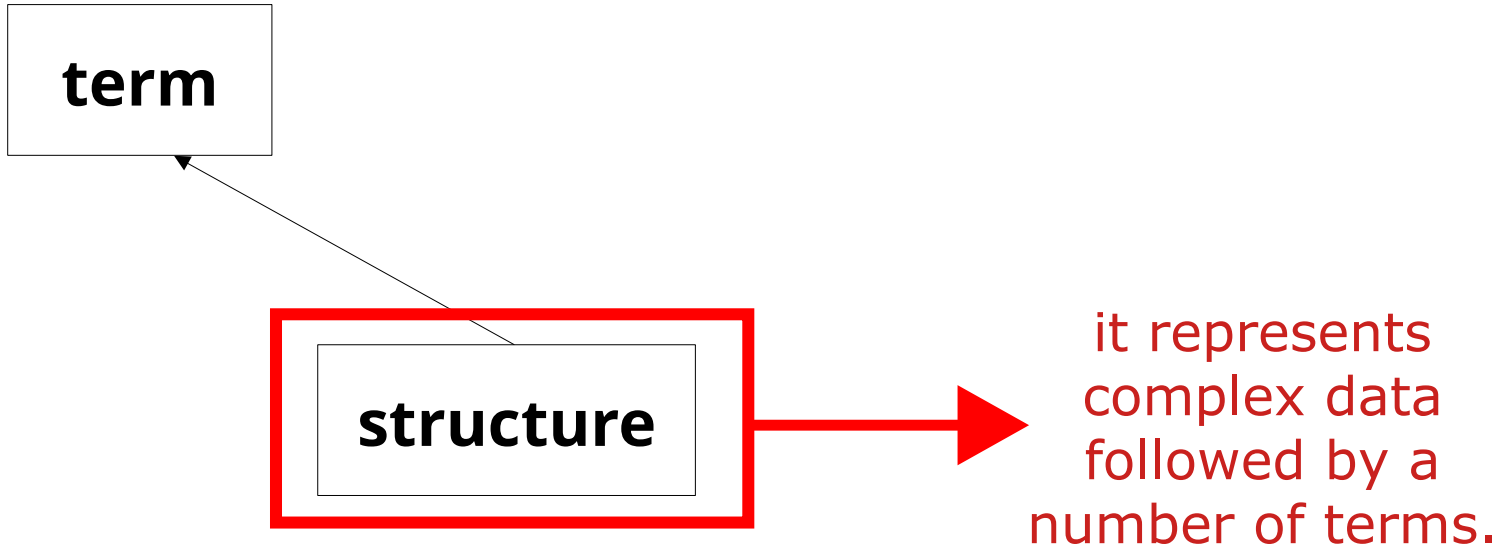
Logic-Based Programming



Logic-Based Programming

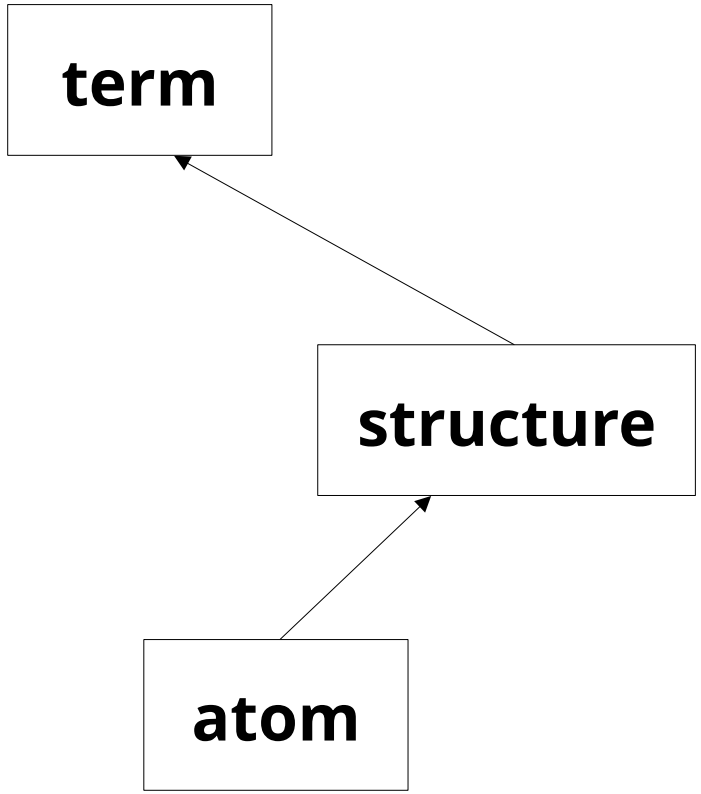


Logic-Based Programming



name(kate,18)

Logic-Based Programming



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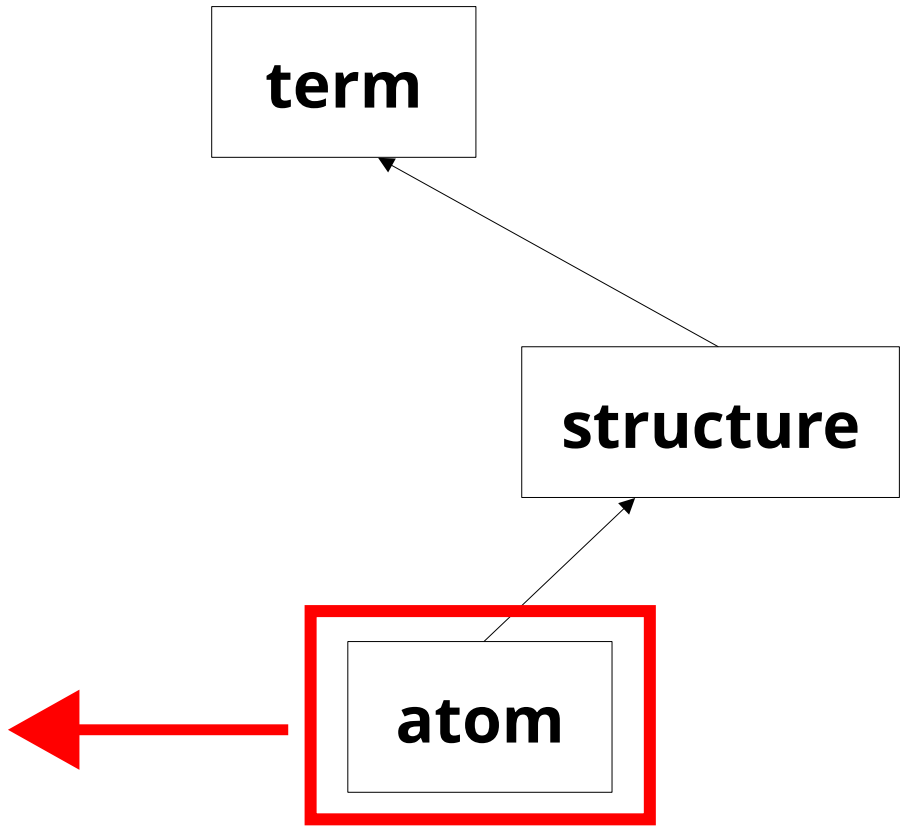

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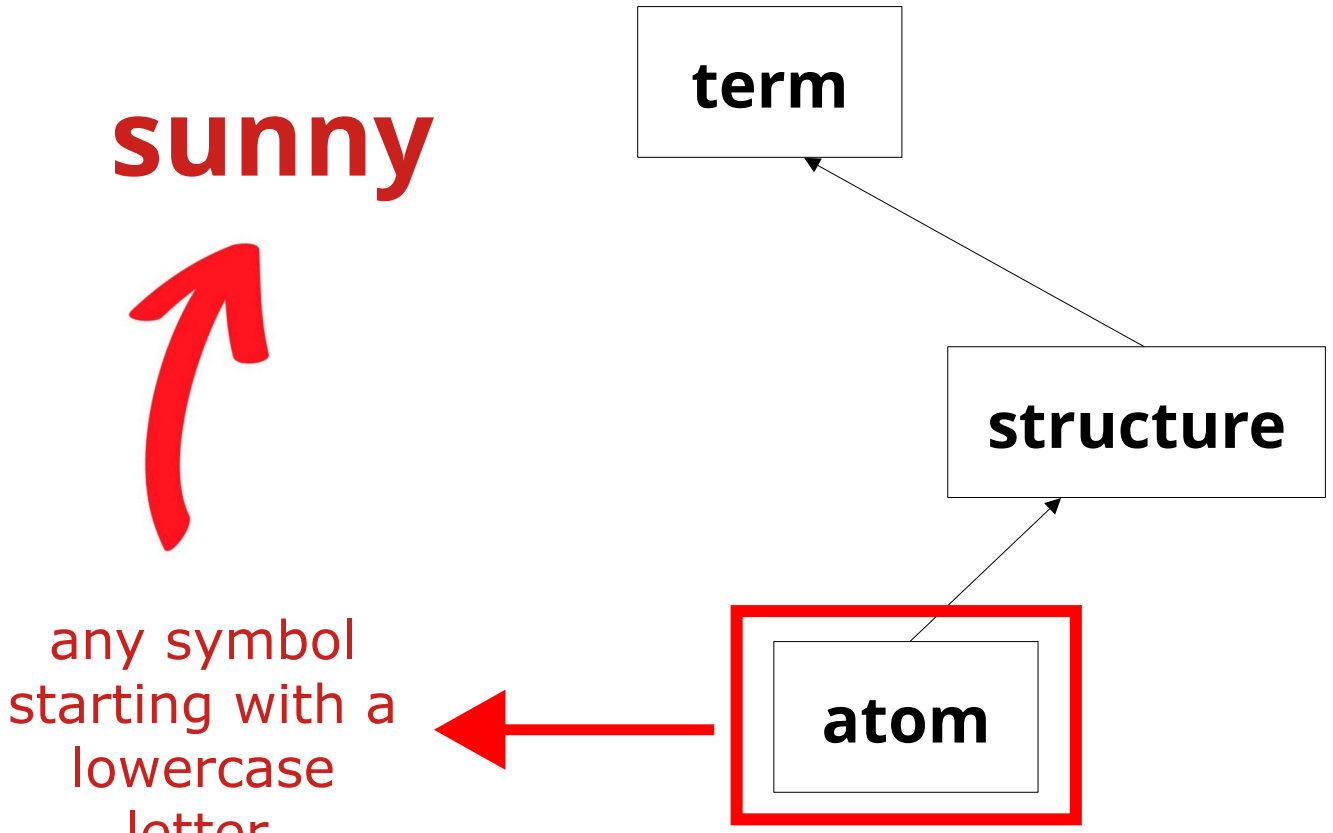

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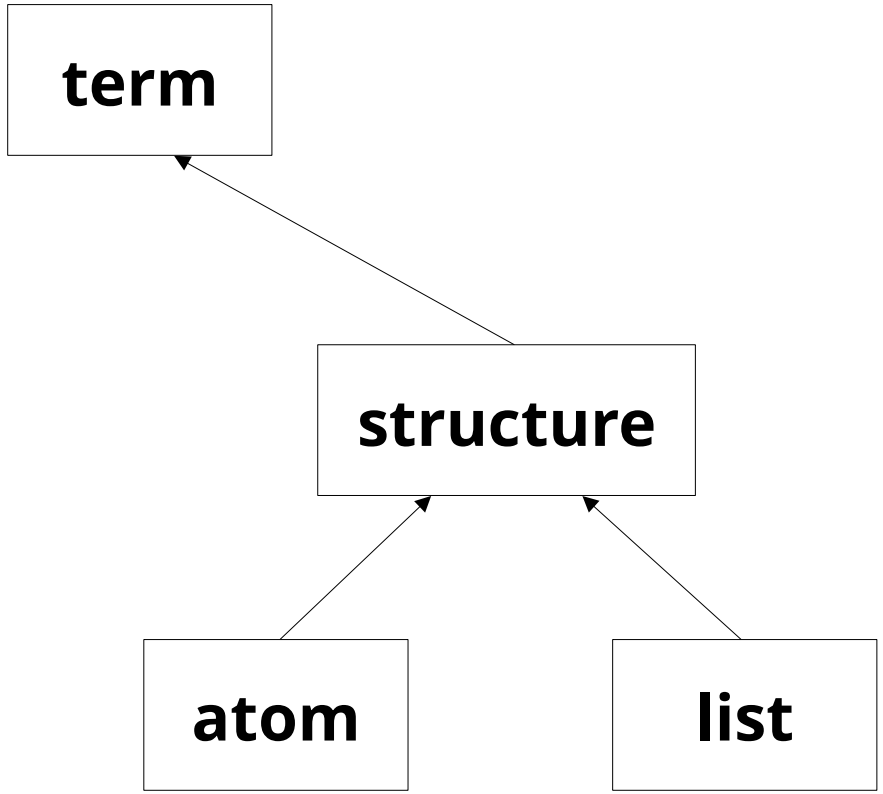

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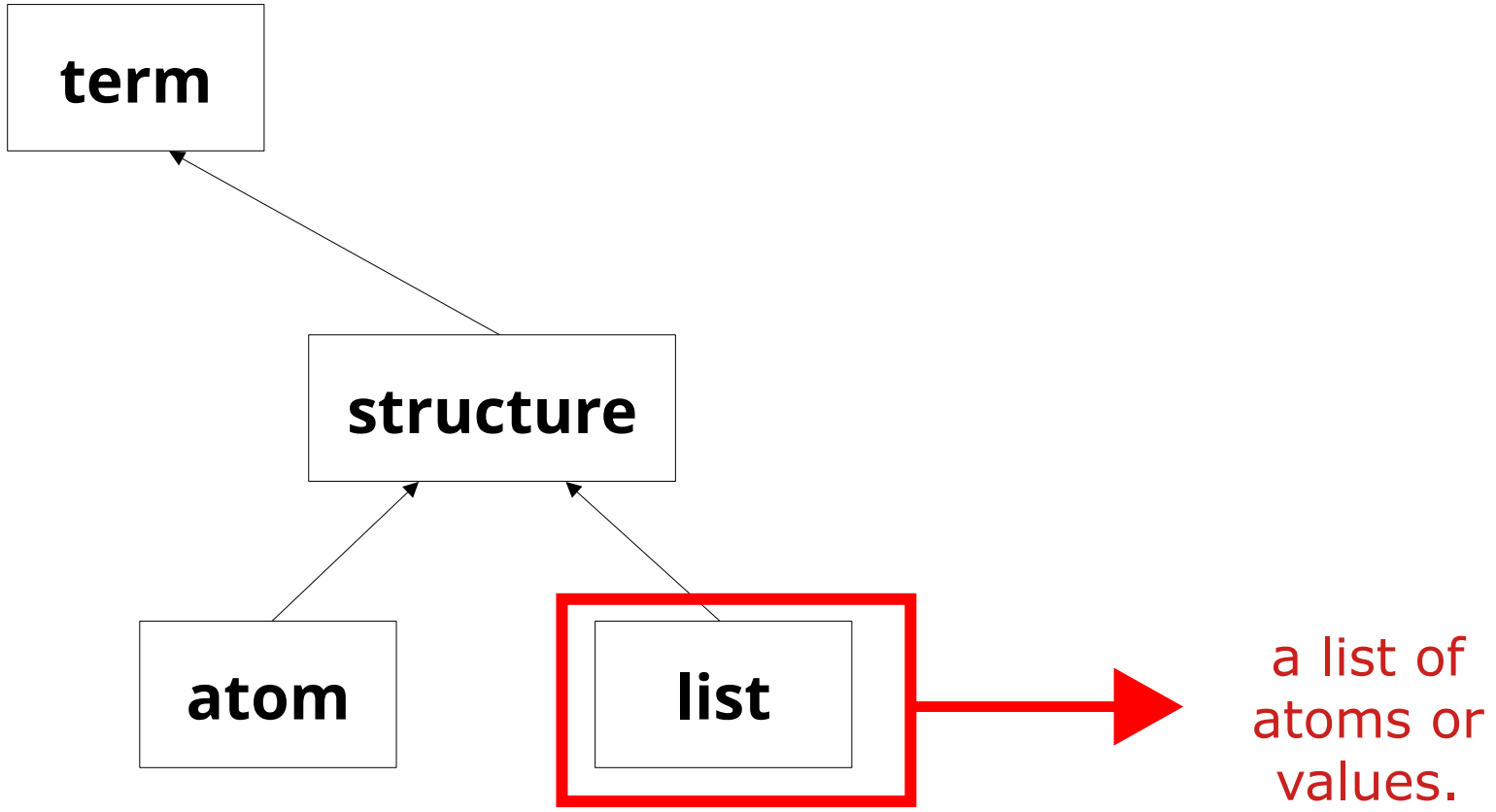

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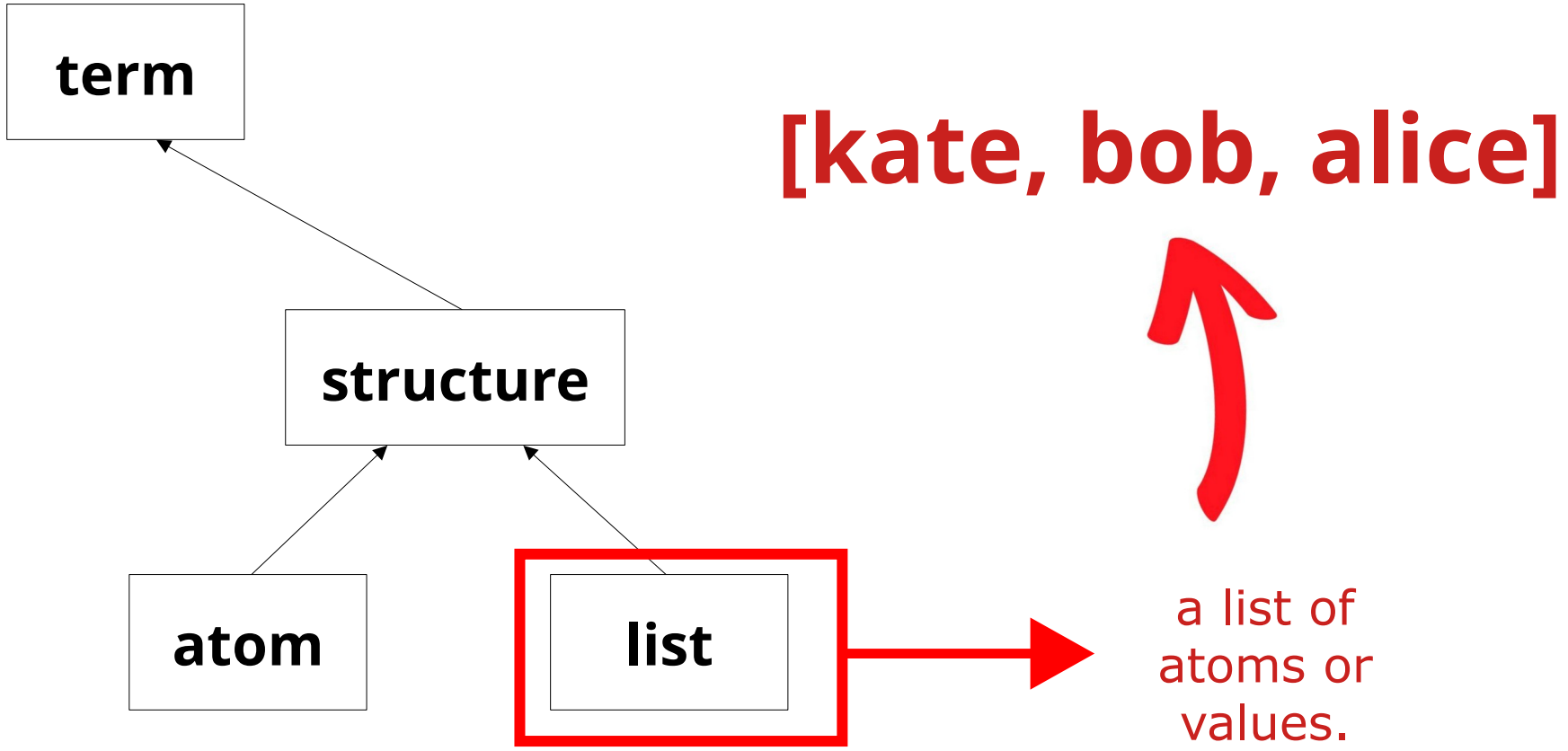

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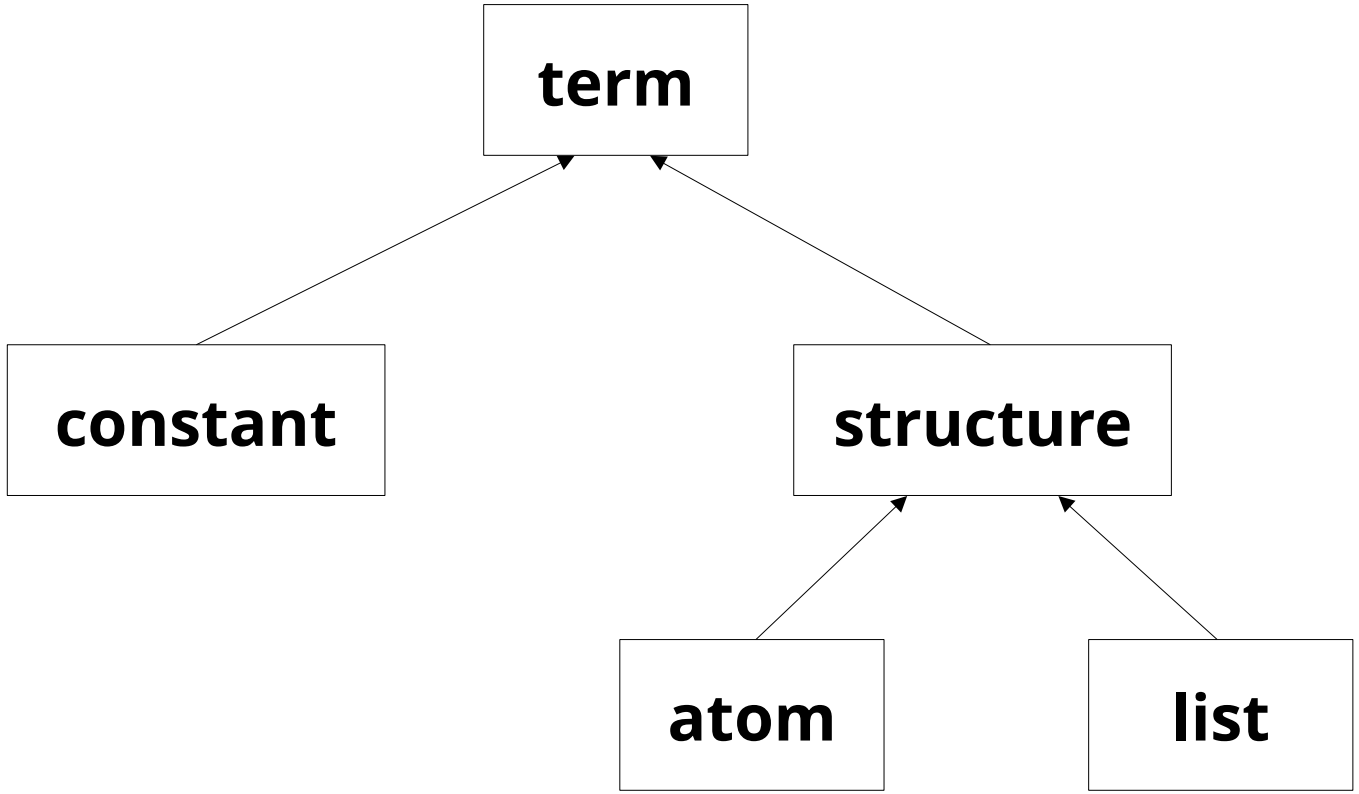

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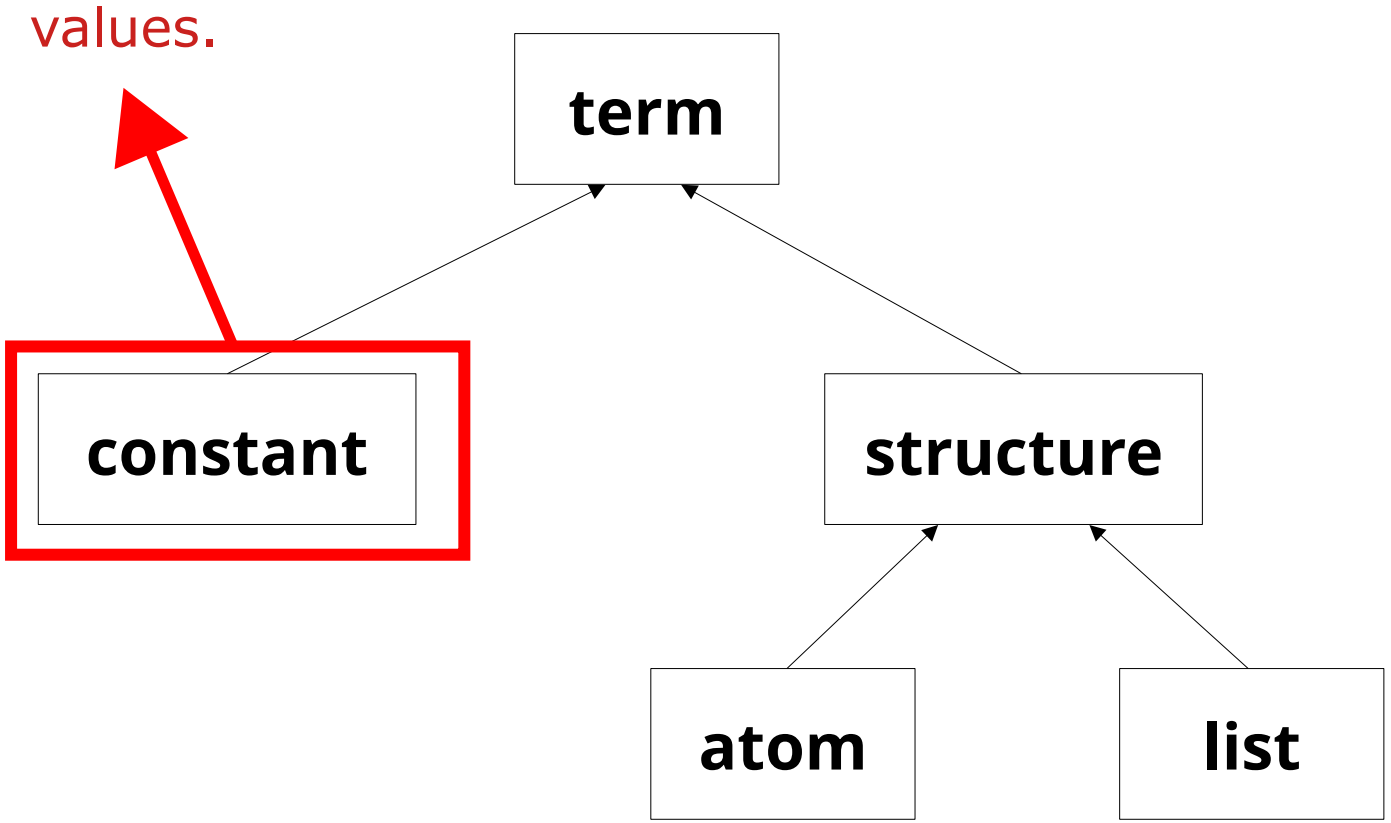

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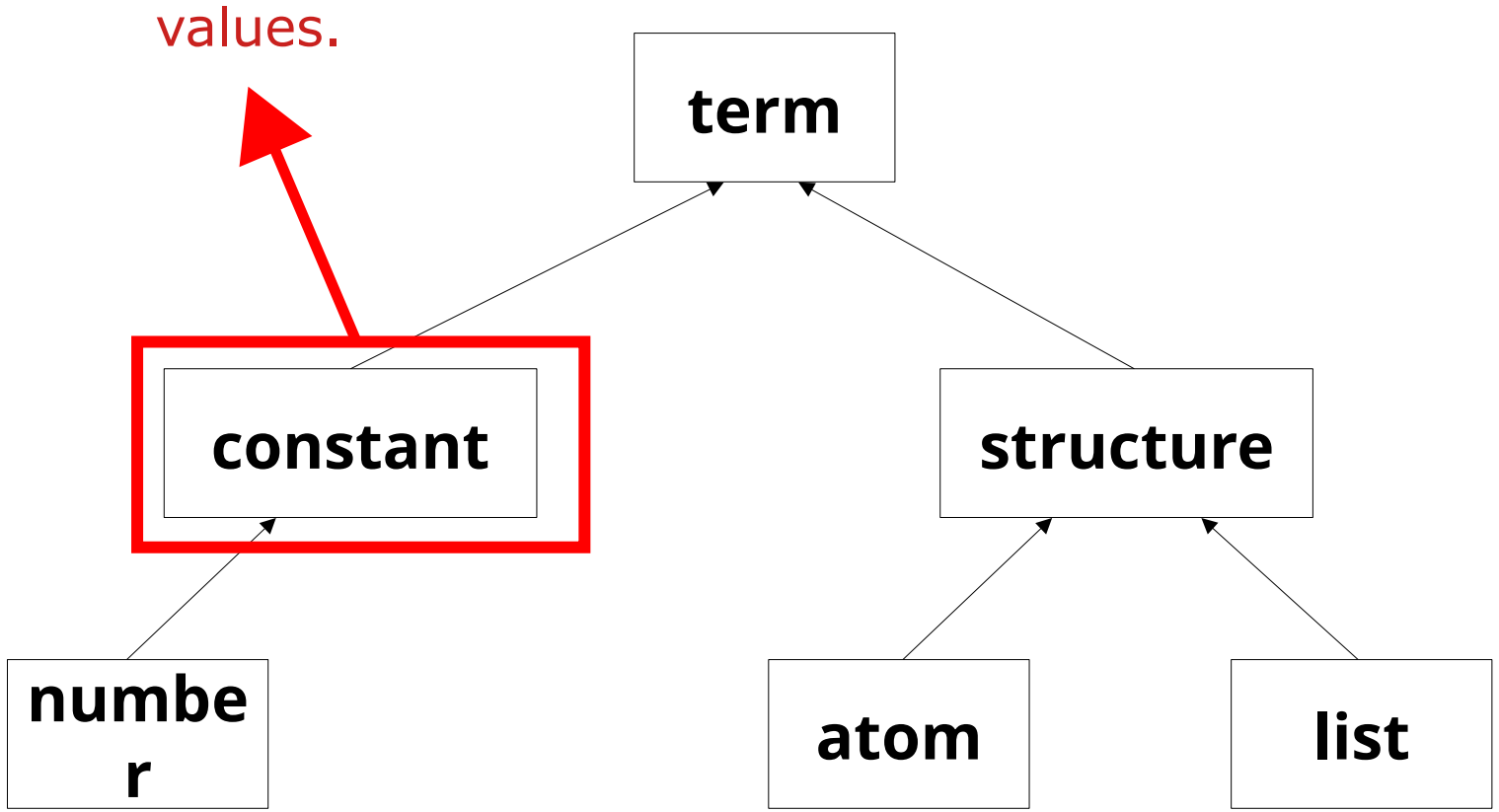

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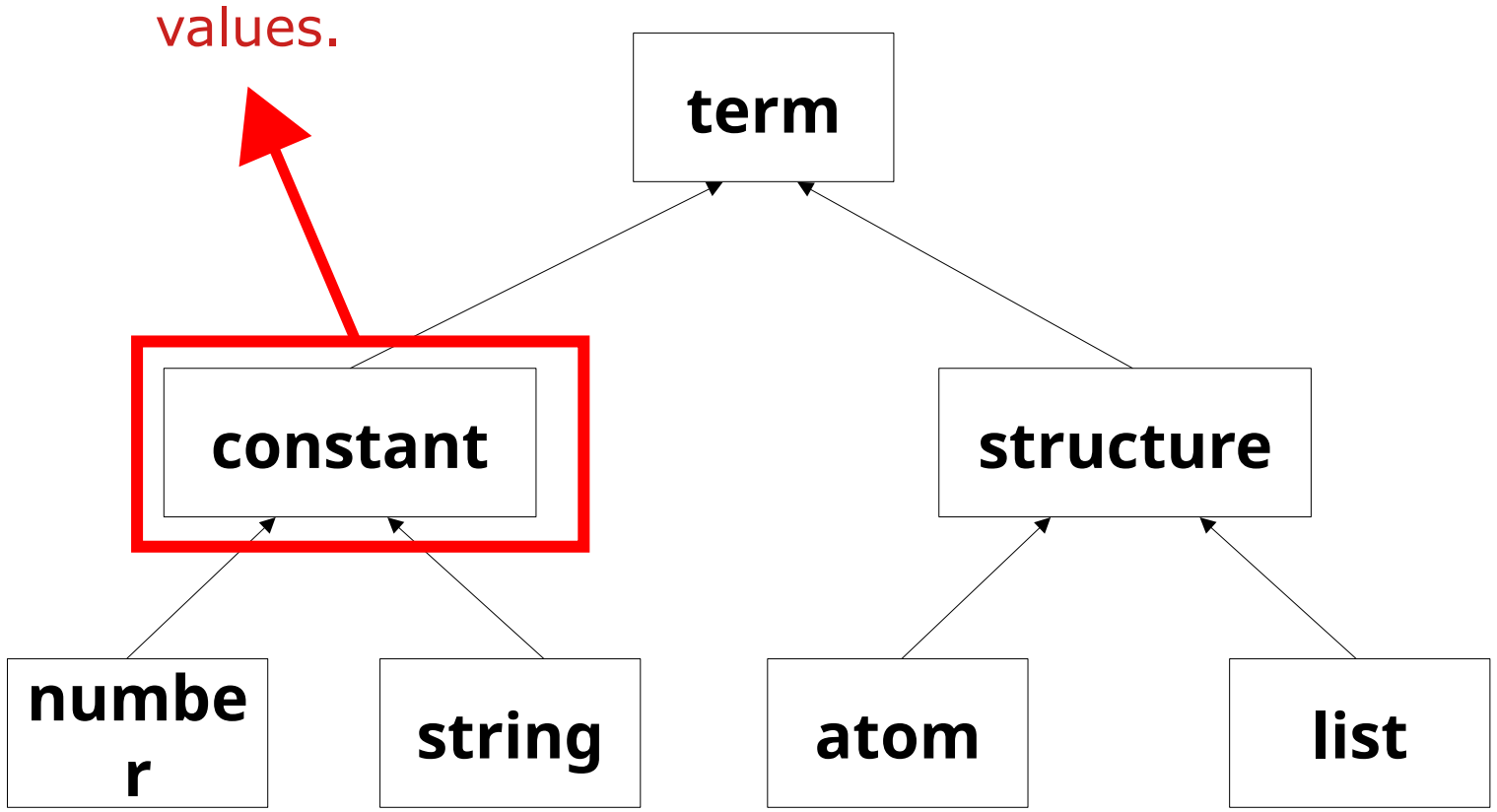

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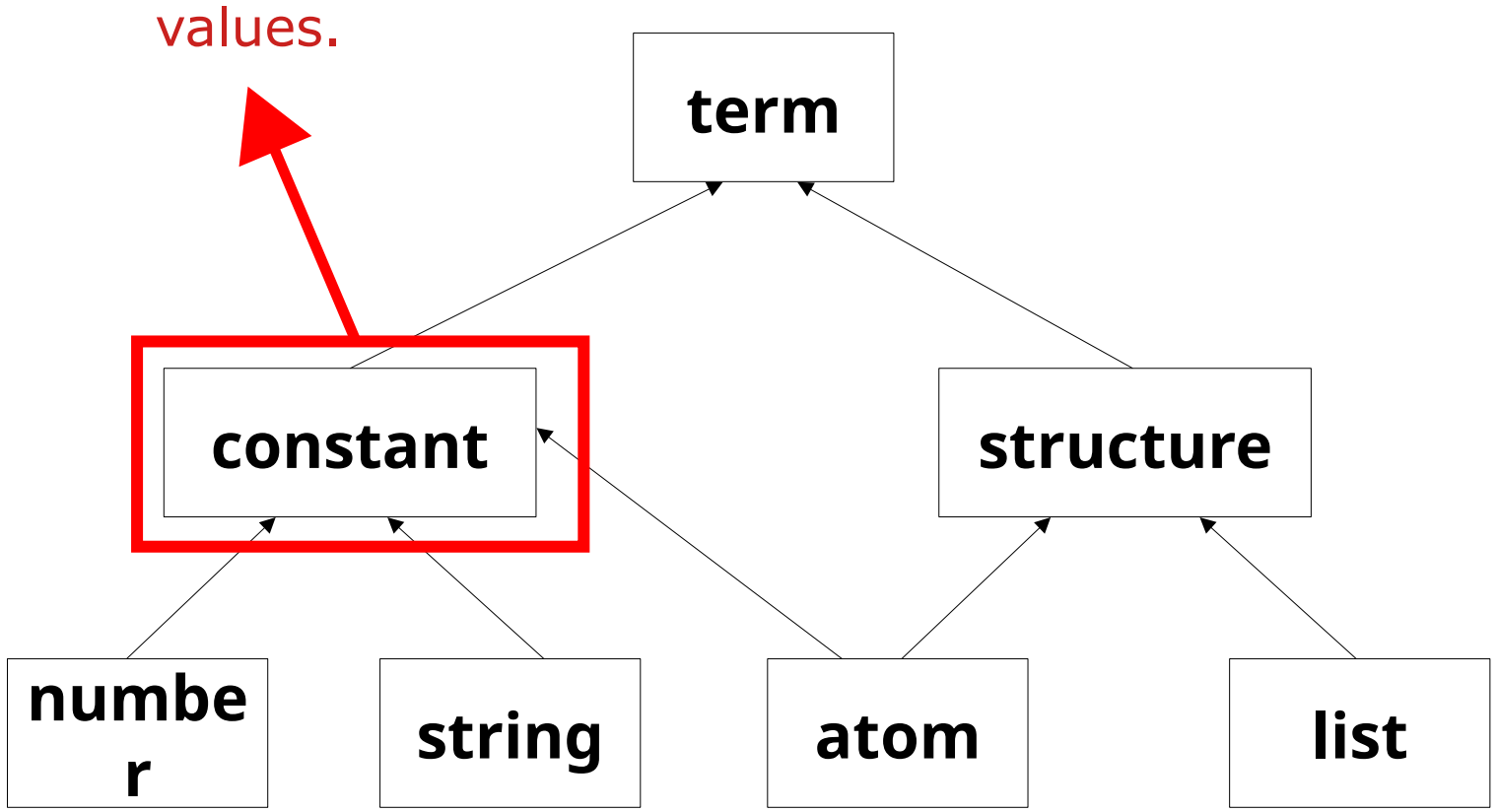
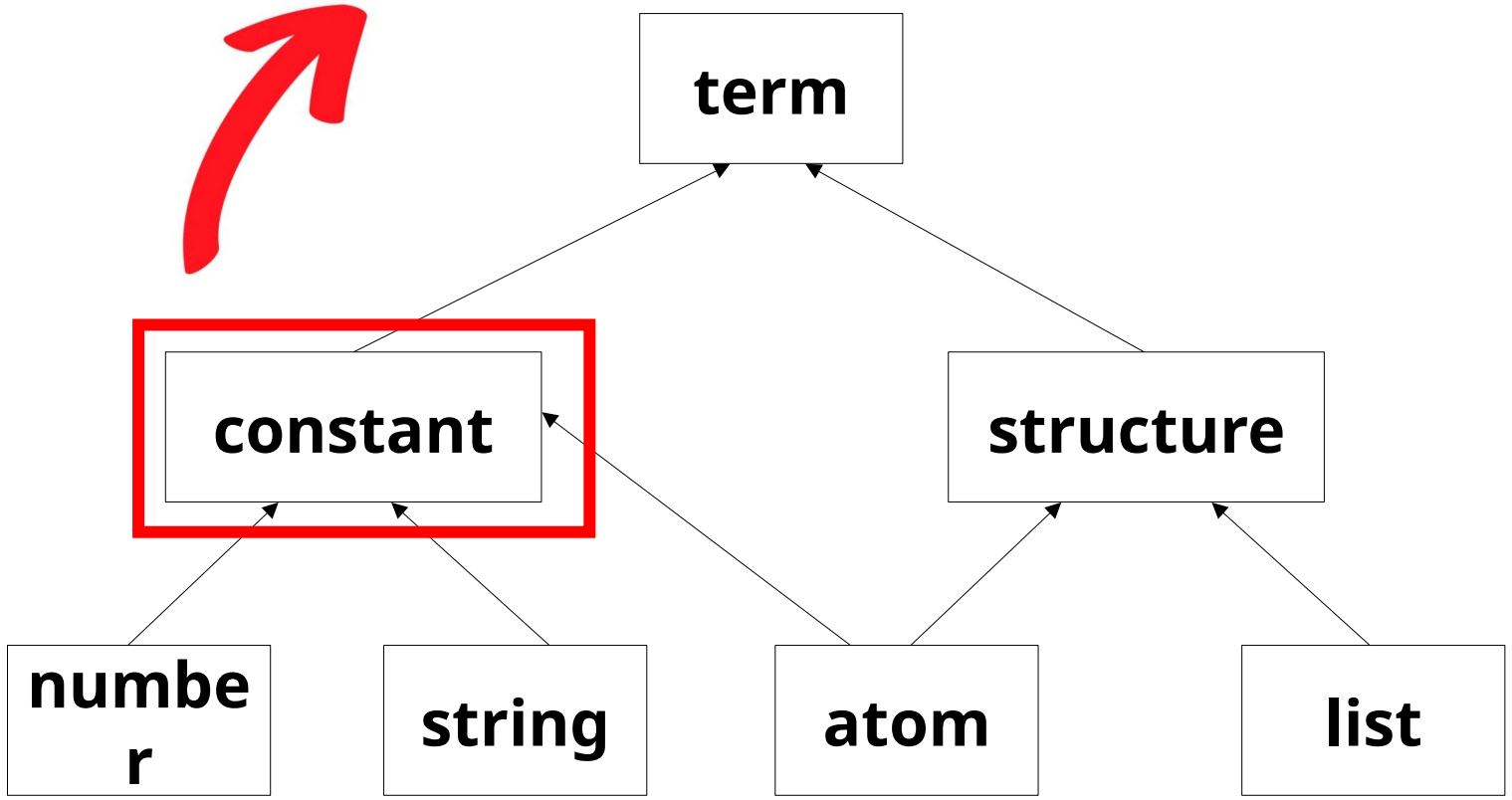


Logic-Based Programming

employer(kate, 3582, "kate@kate.com", full(40))



Jason Framework: Plans Format

triggering_event : context <- body.

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triggering_event : context <- body.

1. **triggering Event**
   - Um agente pode ter diversos objetivos. Os planos são ativados baseados nos eventos que podem ser ativados em determinado momento.

Jason Framework: Plans Format

triggering_event : context <- body.

1. **triggering Event**
   - Um agente pode ter diversos objetivos. Os planos são ativados baseados nos eventos que podem ser ativados em determinado momento.

2. **context**
   - São as condições para a ativação de um plano dentro vários eventos.

Jason Framework: Plans Format

triggering_event : context <- body.

1. **triggering Event**
   - Um agente pode ter diversos objetivos. Os planos são ativados baseados nos eventos que podem ser ativados em determinado momento.

2. **context**
   - São as condições para a ativação de um plano dentro vários eventos.

3. **body**.
   - É o corpo do plano. Uma sequência de ações a ser executada pelo agente.

Plan: Format

```
{+|-}{!|?}event [source(type)]:
context ←
        action 1;
        action 2;
        action n.
```

Plan: Format

{+|-}{! | ?}event [source(type)]:
context ←
action 1;
action 2;
action n.

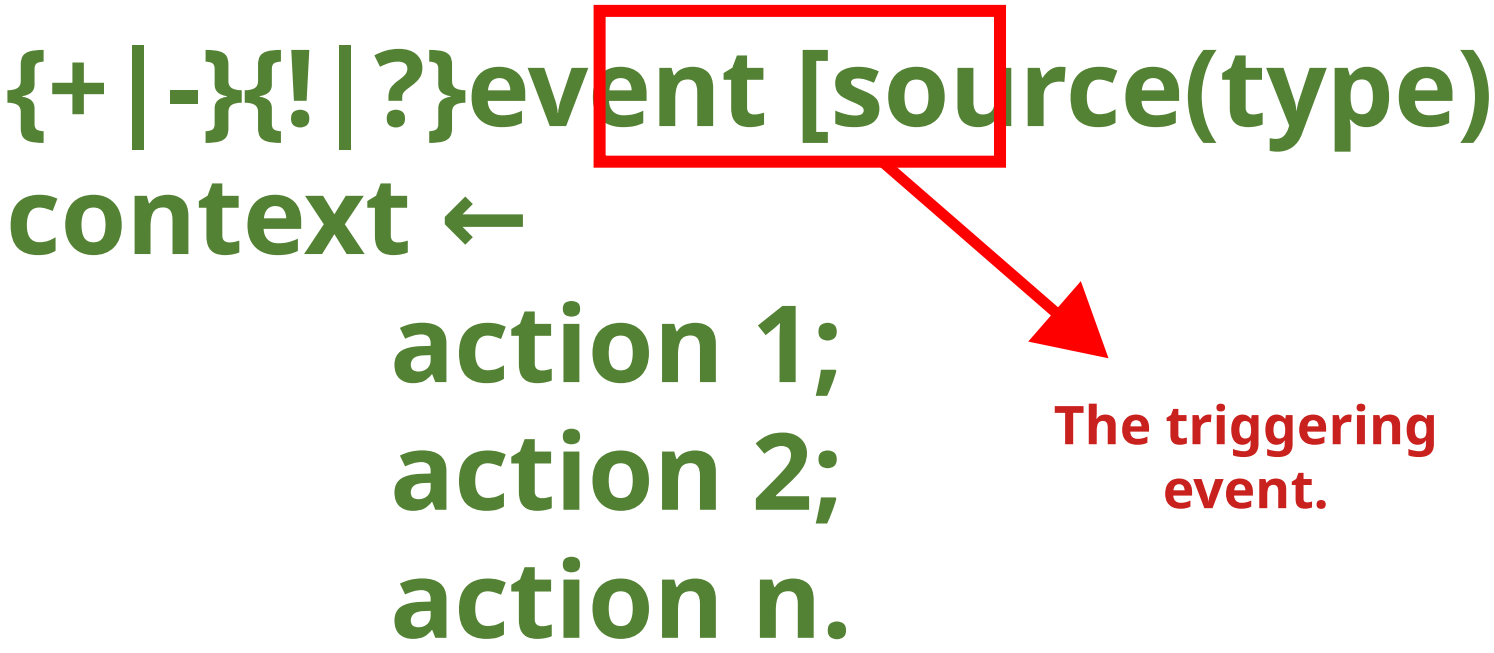
The change type.

Plan: Format

{+|-}{!|?}event [source(type)]:
context ←
action 1;
action 2;
action n.

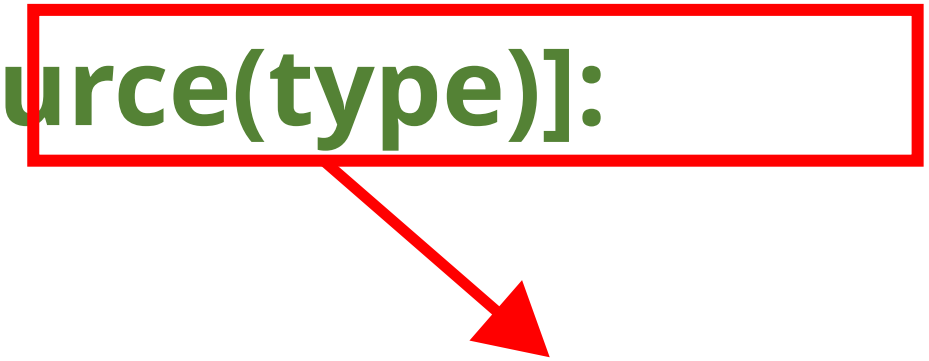
The type of the goal.

Plan: Format


{+|-}{!|?}event [source(type)]:
context ←
action 1;
action 2;
action n.
The triggering event.

Plan: Format

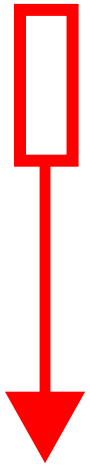
```
{+|-}{!|?}event [source(type)]:
context ←
        action 1;
        action 2;
        action n.
```



the source of the plan.

Plan: Format

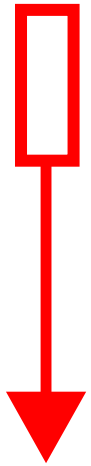
```
{+|-}{!|?}event [source(type)]:
context ←
        action 1;
        action 2;
        action n.
```



the beginning of the conditions.

Plan: Format

```
{+|-}{!|?}event [source(type)]:
context ←
        action 1;
        action 2;
        action n.
```



the beginning of the conditions.

It is optional if there are no condintions.

Plan: Format

```
{+|-}{!|?}event [source(type)]:
context ←
        action 1;
        action 2;
        action n.
```

The activation conditions.

Plan: Format

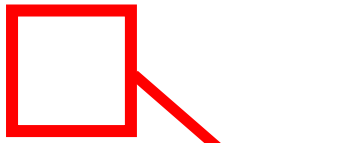
```
{+|-}{!|?}event [source(type)]:
context ←
        action 1;
        action 2;
        action n.
```

The activation conditions.

It is not mandatory.

Plan: Format

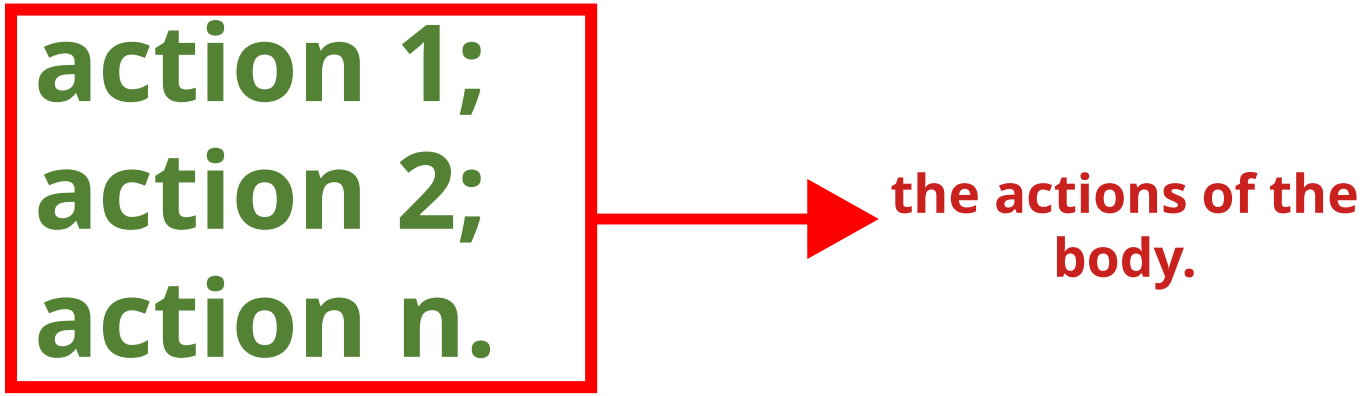
```
{+|-}{!|?}event [source(type)]:
context ←
        action 1;
        action 2;
        action n.
```



the beginning of the body.

Plan: Format

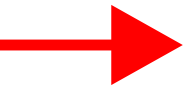
{+|-}{!|?}event [source(type)]:
context ←



Plan: Format

{+|-}{!|?}event [source(type)]:
context ←

action 1;
action 2;
action n.



the actions of the body.

Separated by semi-colon.

Plan: Format

```
{+|-}{!|?}event [source(type)]:
context ←
        action 1;
        action 2;
        action n.
```

the end of the plan.

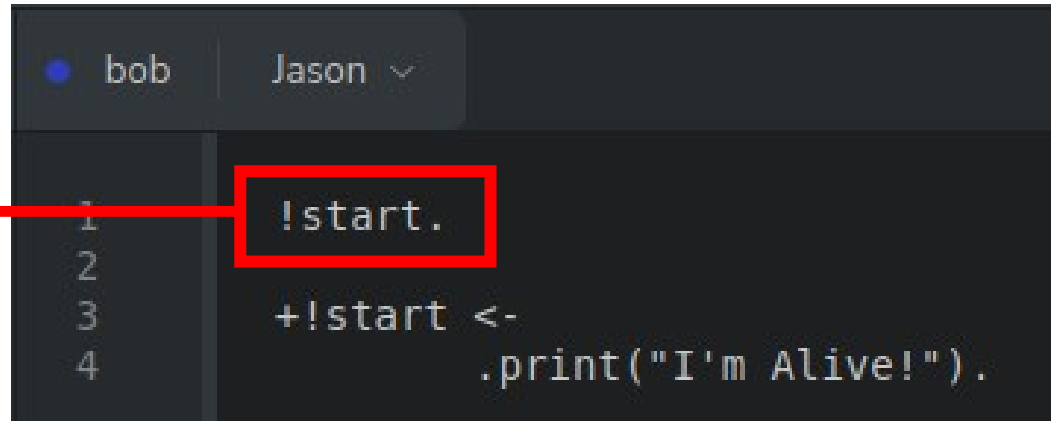
Plan: Hello World

bob | Jason

```
1  !start.
2
3  +!start <-
4          .print("I'm Alive!").
```

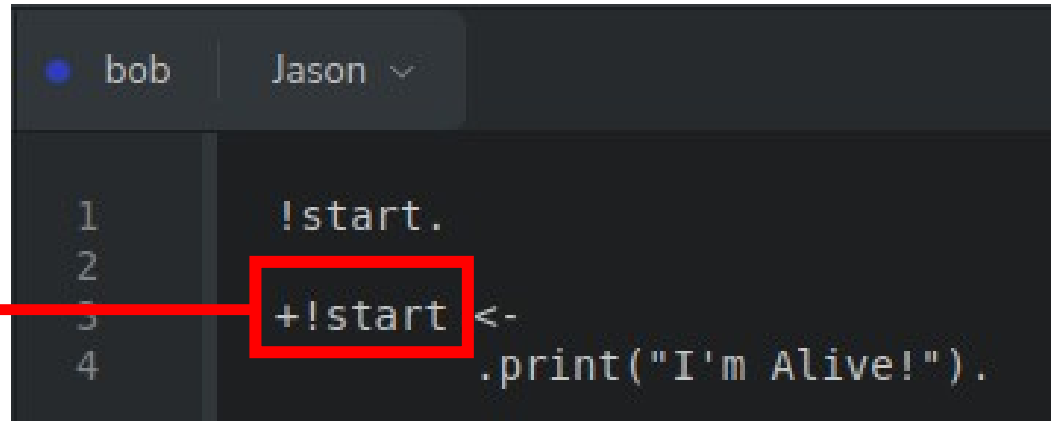
Plan: Hello World

An initial goal named start.



Plan: Hello World

An achievement plan without triggering event named start.



Plan: Hello World

bob | Jason

```
1
2
3
4
```

```
!start.

+!start <-
        .print("I'm Alive!").
```

The body of the plan.

Plan: Hello World

bob | Jason

```
1
2
3
4
```

```
!start.

+!start <-
        .print("I'm Alive!")
```

An action that prints in the agent tracer (console).

Plan: Hello World

bob | Jason

```
1   !start.
2
3   +!start <-
4           .print("I'm Alive!").
```

Plan: Hello World

bob | Jason

```
1   !start.
2
3   +!start <-
4           .print("I'm Alive!").
```

```
[ChonOS EmbeddedMAS] Starting the Multi-Agent System.
NOTE: Picked up JDK_JAVA_OPTIONS:  --add-opens=java.base
rmi/sun.rmi.transport=ALL-UNNAMED
Jason Http Server running on http://127.0.1.1:3272
[bob] I'm Alive!
```

Plan: Types

1. **Achievement Goal**
   - São ativados quando um plano é transformado de um desejo para uma intenção na mente do agente.

Plan: Types

1. **Achievement Goal**
   - São ativados quando um plano é transformado de um desejo para uma intenção na mente do agente.

2. **Test Goal**
   - São objetivos que recuperam informações da base de crenças.

Plan: Types

1. **Achievement Goal**
   - São ativados quando um plano é transformado de um desejo para uma intenção na mente do agente.

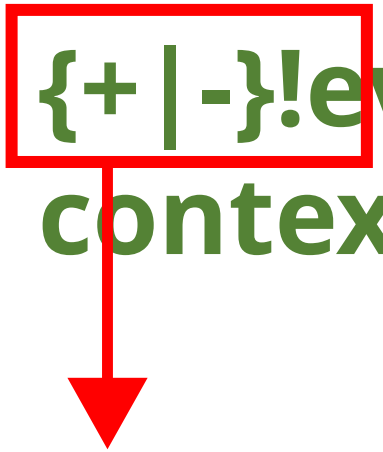
2. **Test Goal**
   - São objetivos que recuperam informações da base de crenças.

3. **Belief Goal**
   - São planos ativados quando o agente adiciona ou remove uma crença da sua base de crenças.

Plans: Achievement Goal

```
{+|-}!event[source(type)]:
context ←
        action 1;
        action 2;
        action n.
```

Plans: Achievement Goal



```
{+|-}!event[source(type)]:
  context ←
        action 1;
        action 2;
        action n.
```

defines if it is an addition (+) or a deletion (-) plan.

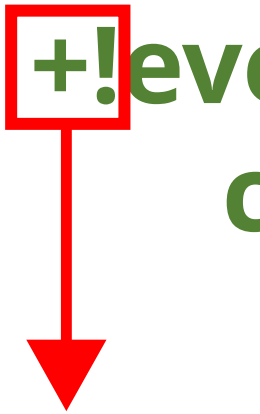
Plans: Achievement Goal


```
{+|-}!event[source(type)]:
context ←
        action 1;
        action 2;
        action n.
```

Plans: Addition Achievement Goal

```
+!event[source(type)]:
        context ←
                action 1;
                action 2;
                action n.
```

Plans: Addition Achievement Goal



defines an addition plan.

```
+!event[source(type)]:
    context ←
        action 1;
        action 2;
        action n.
```

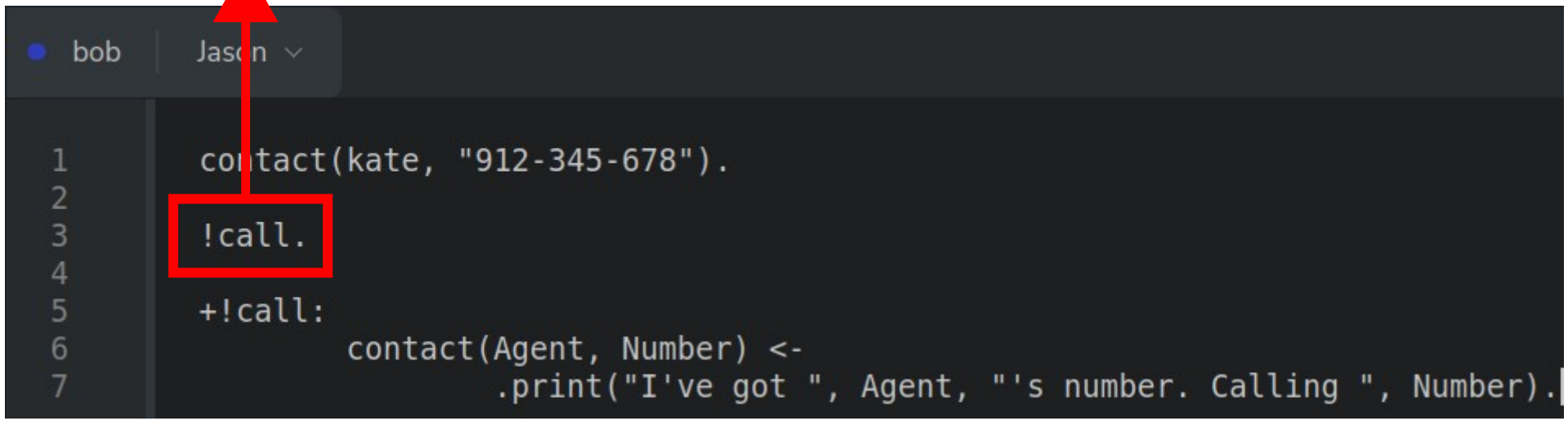
Addition Achievement Goal: Predicate

bob | Jason

```
1  contact(kate, "912-345-678").
2
3  !call.
4
5  +!call:
6          contact(Agent, Number) <-
7                  .print("I've got ", Agent, "'s number. Calling ", Number).
```

Addition Achievement Goal: Predicate

A predicate as a goal...



Addition Achievement Goal: Predicate

bob | Jason

```
1  contact(kate, "912-345-678").
2
3  !call.
4
5  +!call:
6          contact(Agent, Number) <-
7                  .print("I've got ", Agent, "'s number. Calling ", Number).
```

... which activates a plan with the same name...

Addition Achievement Goal: Predicate

bob | Jason

```
1  contact(kate, "912-345-678").
2
3  !call.
4
5  +!call:
6          contact(Agent, Number) <-
7                  .print("I've got ", Agent, "'s number. Calling ", Number).
```

... if the context is satisfied.

Addition Achievement Goal: One Plan

bob | Jason

```
1   !discount(phone,1200,10).
2
3   +!discount(Item,Value,Discount)
4           : Value > 100 <-
5                   FinalValue = Value-(Value*Discount)/100;
6                   .print("The final value is ", FinalValue, ").
```

Addition Achievement Goal: One Plan

An initial goal with predicate and values.

bob | Jason

```
1  !discount(phone,1200,10).
2
3  +!discount(Item,Value,Discount)
4          : Value > 100 <-
5                  FinalValue = Value-(Value*Discount)/100;
6                  .print("The final value is ", FinalValue, ".").
```

Addition Achievement Goal: One Plan

bob | Jason

```
1  !discount(phone,1200,10).
2
3  +!discount(Item,Value,Discount)
4          : value > 100 <-
5              FinalValue = Value-(Value*Discount)/100;
6              .print("The final value is ", FinalValue, ".").
```

It activates this addition achievement goal...

Addition Achievement Goal: One Plan

bob | Jason

```
1  !discount(phone,1200,10).
2
3  +!discount(Item,Value,Discount)
4          : Value > 100 <-
5              FinalValue = Value-(Value*Discount)/100;
6              .print("The final value is ", FinalValue, ".").
```

... if the context is satisfied.

Addition Achievement Goal: One Plan

bob | Jason

```
1  !discount(phone,1200,10).
2
3  +!discount(Item,Value,Discount)
4          : Value > 100 <
5          FinalValue = Value-(Value*Discount)/100;
6          .print("The final value is ", FinalValue, ").
```

Then, the actions run.

Addition Achievement Goal: One Plan

bob | Jason

```
1  !discount(phone,1200,10).
2
3  +!discount(Item,Value,Discount)
4          : Value > 100 <-
5                  FinalValue = Value-(Value*Discount)/100;
6                  .print("The final value is ", FinalValue, ").
```

Addition Achievement Goal: One Plan

bob | Jason

```
1  !discount(phone,1200,10).
2
3  +!discount(Item,Value,Discount)
4          : Value > 100 <-
5                  FinalValue = Value-(Value*Discount)/100;
6                  .print("The final value is ", FinalValue, ").
```

```
[ChonOS EmbeddedMAS] Starting the Multi-Agent System.
Jason Http Server running on http://127.0.1.1:3272
[bob] The final value is 1080.
```

Addition Achievement Goal: More Than One Plan

bob | Jason

```
1   !discount(phone,380).
2
3   +!discount(Item,Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*10)/100;
6                   .print("The final value of ", Item ," is ", FinalValue, ").
7
8   +!discount(Item,Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*10)/100;
11                  .print("The final value of ", Item ," is ", FinalValue, ").
12
13  +!discount(Item,Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*2)/100;
16                  .print("The final value of ", Item ," is ", FinalValue, ").
17
```

Addition Achievement Goal: More Than One Plan

The goal pursued.

bob | Jason

```
1   !discount(phone,380).
2
3   +!discount(Item,Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*10)/100;
6                   .print("The final value of ", Item ," is ", FinalValue, ").
7
8   +!discount(Item,Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*10)/100;
11                  .print("The final value of ", Item ," is ", FinalValue, ").
12
13  +!discount(Item,Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*2)/100;
16                  .print("The final value of ", Item ," is ", FinalValue, ").
17
```

Addition Achievement Goal: More Than One Plan

The possible plans.

bob | Jason

```
1   !discount(phone,380).
2
3   +!discount(Item,Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*10)/100;
6                   .print("The final value of ", Item ," is ", FinalValue, ").
7
8   +!discount(Item,Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*10)/100;
11                  .print("The final value of ", Item ," is ", FinalValue, ").
12
13  +!discount(Item,Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*2)/100;
16                  .print("The final value of ", Item ," is ", FinalValue, ").
17
```

Addition Achievement Goal: More Than One Plan

bob | Jason

```
1   !discount(phone,380).
2
3   +!discount(Item,Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*10)/100;
6                   .print("The final value of ", Item ," is ", FinalValue, ").
7
8   +!discount(Item,Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*10)/100;
11                  .print("The final value of ", Item ," is ", FinalValue, ").
12
13  +!discount(Item,Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*2)/100;
16                  .print("The final value of ", Item ," is ", FinalValue, ").
17
```

Addition Achievement Goal: More Than One Plan

The activated plan.

bob | Jason

```
1   !discount(phone,380).
2
3   +!discount(Item,Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*10)/100;
6                   .print("The final value of ", Item ," is ", FinalValue, ").
7
8   +!discount(Item,Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*10)/100;
11                  .print("The final value of ", Item ," is ", FinalValue, ").
12
13  +!discount(Item,Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*2)/100;
16                  .print("The final value of ", Item ," is ", FinalValue, ").
17
```

Addition Achievement Goal: More Than One Plan

bob | Jason

```
1   !discount(phone,380).
2
3   +!discount(Item,Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*10)/100;
6                   .print("The final value of ", Item ," is ", FinalValue, ".").
7
8   +!discount(Item,Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*10)/100;
11                  .print("The final value of ", Item ," is ", FinalValue, ".").
12
13  +!discount(Item,Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*2)/100;
16                  .print("The final value of ", Item ," is ", FinalValue, ".").
17
```

Addition Achievement Goal: More Than One Plan

bob | Jason

```
1   !discount(phone,380).
2
3   +!discount(Item,Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*10)/100;
6                   .print("The final value of ", Item ," is ", FinalValue, ".").
7
8   +!discount(Item,Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*10)/100;
11                  .print("The final value of ", Item ," is ", FinalValue, ".").
12
13  +!discount(Item,Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*2)/100;
16                  .print("The final value of ", Item ," is ", FinalValue, ").
17
```

```
[ChonOS EmbeddedMAS] Starting the Multi-Agent System.
Jason Http Server running on http://127.0.1.1:3272
[bob] The final value of phone is 372.4.
```

Addition Achievement Goal: More Than One Plan

When there are more plans with the **same event** name, the agent will try them **one by one**...

Addition Achievement Goal: More Than One Plan

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.
.
.

+!event[source(type)]: context ← (...).

Addition Achievement Goal: More Than One Plan

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.
.
.

+!event[source(type)]: context ← (...).

Addition Achievement Goal: More Than One Plan

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.
.
.

+!event[source(type)]: context ← (...).

Addition Achievement Goal: More Than One Plan

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.
.
.

+!event[source(type)]: context ← (...).

Addition Achievement Goal: More Than One Plan

… until it finds one that **satisfies the context**.

Addition Achievement Goal: More Than One Plan

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.
.
.

+!event[source(type)]: context ← (...).

Addition Achievement Goal: More Than One Plan

When there are two or more plans that could be **activated** at the **same time**...

Addition Achievement Goal: More Than One Plan

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.
.
.

+!event[source(type)]: context ← (...).

Addition Achievement Goal: More Than One Plan

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.
.
.

+!event[source(type)]: context ← (...).

Addition Achievement Goal: More Than One Plan

… it chooses the first one that **fits the context**.

Addition Achievement Goal: More Than One Plan

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.
.
.

+!event[source(type)]: context ← (...).

Addition Achievement Goal: More Than One Plan

However, when no one is activated, the agent finds a goal for which **no relevant plan** is available.

Plans: Deletion Achievement Goal

```
-!event[source(type)]:
        context ←
                action 1;
                action 2;
                action n.
```

Plans: Deletion Achievement Goal

```
-!event[source(type)]:
        context ←
                action 1;
                action 2;
                action n.
```

defines a deletion plan.

Plans: Deletion Achievement Goal

kate | Jason

```
1   !discount(phone, 200).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  -!discount(Item, Value) <-
19          .print("Something went wrong!").
```

Plans: Deletion Achievement Goal

By using these values...

kate | Jason

```
1   !discount(phone, 200).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  -!discount(Item, Value) <-
19          .print("Something went wrong!").
```

Plans: Deletion Achievement Goal

… none of the available plans activate.

kate | Jason

```
1   !discount(phone, 200).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  -!discount(Item, Value) <-
19          .print("Something went wrong!").
```

Plans: Deletion Achievement Goal

kate | Jason

```
1   !discount(phone, 200).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  -!discount(Item, Value) <-
19          .print("Something went wrong!").
```

Then, a contingency plan activates.

Plans: Deletion Achievement Goal

kate | Jason

```
!discount(phone, 200).

+!discount(Item, Value)
        : Value > 1000 <-
                FinalValue = Value-(Value*(10/100));
                .print("The final value of ", Item, " is ", FinalValue).

+!discount(Item, Value)
        : Value > 500 <-
                FinalValue = Value-(Value*(5/100));
                .print("The final value of ", Item, " is ", FinalValue).

+!discount(Item, Value)
        : Value > 300 <-
                FinalValue = Value-(Value*(2/100));
                .print("The final value of ", Item, " is ", FinalValue).

-!discount(Item, Value) <-
        .print("Something went wrong!").
```

Plans: Deletion Achievement Goal

kate | Jason

```
1   !discount(phone, 200).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  -!discount(Item, Value) <-
19          .print("Something went wrong!").
```

```
[ChonOS EmbeddedMAS] Starting the Multi-Agent System.
Jason Http Server running on http://127.0.1.1:3272
[kate] Something went wrong!
```

Plans: Deletion Achievement Goal

In this case, another **addition achievement** plan can cover the **missing context**.

Plans: Deletion Achievement Goal

kate | Jason

```
1   !discount(phone, 200).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  +!discount(Item, Value)
19          : Value <= 300 <-
20                  .print("There is no discount on ", Item, ").
21
22  -!discount(Item, Value) <-
23          .print("Something went wrong!").
```

Plans: Deletion Achievement Goal

kate | Jason

```
1   !discount(phone, 200).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  +!discount(Item, Value)
19          : Value <= 300 <-
20                  .print("There is no discount on ", Item, ").
21
22  -!discount(Item, Value) <-
23          .print("Something went wrong!").
```

So, this plan activates.

Plans: Deletion Achievement Goal

kate | Jason

```
1   !discount(phone, 200).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  +!discount(Item, Value)
19          : Value <= 300 <-
20                  .print("There is no discount on ", Item, ").
21
22  -!discount(Item, Value) <-
23          .print("Something went wrong!").
```

It only activates if the activated plan fails.

Plans: Deletion Achievement Goal

kate | Jason

```
!discount(phone,80).

+!discount(Item, Value)
        : Value > 1000 <-
                FinalValue = Value-(Value*(10/100));
                .print("The final value of ", Item, " is ", FinalValue).

+!discount(Item, Value)
        : Value > 500 <-
                FinalValue = Value-(Value*(5/100));
                .print("The final value of ", Item, " is ", FinalValue).

+!discount(Item, Value)
        : Value > 300 <-
                FinalValue = Value-(Value*(2/100));
                .print("The final value of ", Item, " is ", FinalValue).

+!discount(Item, Value)
        : Value <= 300 <-
                .print("There is no discount on ", Item, ".");
                !generateInvoice.

-!discount(Item, Value) <-
        .print("Something went wrong!").
```

Plans: Deletion Achievement Goal

kate | Jason

```
1   !discount(phone,80).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  +!discount(Item, Value)
19          : Value
20                  .print("There is no discount on ", Item, ".");
21                  !generateInvoice.
22
23  -!discount(Item, Value) <-
24          .print("Something went wrong!").
```

The agent tries to commit with generateInvoice, but it does not have a relevant plan.

Plans: Deletion Achievement Goal

kate | Jason

```
1   !discount(phone,80).
2
3   +!discount(Item, Value)
4           : Value > 1000 <-
5                   FinalValue = Value-(Value*(10/100));
6                   .print("The final value of ", Item, " is ", FinalValue).
7
8   +!discount(Item, Value)
9           : Value > 500 <-
10                  FinalValue = Value-(Value*(5/100));
11                  .print("The final value of ", Item, " is ", FinalValue).
12
13  +!discount(Item, Value)
14          : Value > 300 <-
15                  FinalValue = Value-(Value*(2/100));
16                  .print("The final value of ", Item, " is ", FinalValue).
17
18  +!discount(Item, Value)
19          : Value <= 300 <-
20                  .print("There is no discount on ", Item, ".");
21                  !generateInvoice.
22
23  -!discount(Item, Value) <-
24          .print("Something went wrong!").
```

As the previous plan fails, the contingency plan is activated.

Plans: Deletion Achievement Goal

Deletion plans can also have a **context**.

Plans: Deletion Achievement Goal

kate | Jason

```
1   stock(beer, 20).
2
3   !purchase(chocolate, 50).
4
5   +!purchase(Item, Amount):
6           stock(Item, Stock) &
7           Stock >= Amount  <-
8                   .print("Your product ", Item, " is available. We have ", Stock, " units.").
9
10  -!purchase(Item, Amount):
11          stock(Item, Stock) &
12          Stock < Amount <-
13                  .print("Sorry, your product ", Item, " is unavailable. We have only ", Stock, " units.").
14
15  -!purchase(Item,_):
16          .findall(stock(Item,Value), stock(Item,Value), Result) &
17          Result == [] <-
18                  .print("Sorry, we don't sell ", Item, ".").
19
20  -!purchase(_,_) <-
21                  .print("Something went wrong!").
```

Plans: Deletion Achievement Goal

Deletion plans with context...

kate | Jason

```
1   stock(beer, 20).
2
3   !purchase(chocolate, 50).
4
5   +!purchase(Item, Amount):
6           stock(Item, Stock) &
7           Stock >= Amount  <-
8                   .print("Your product ", Item, " is available. We have ", Stock, " units.").
9
10  -!purchase(Item, Amount):
11          stock(Item, Stock) &
12          Stock < Amount <-
13                  .print("Sorry, your product ", Item, " is unavailable. We have only ", Stock, " units.").
14
15  -!purchase(Item,_):
16          .findall(stock(Item,Value), stock(Item,Value), Result) &
17          Result == [] <-
18                  .print("Sorry, we don't sell ", Item, ".").
19
20  -!purchase(_,_) <-
21                  .print("Something went wrong!").
```

Plans: Deletion Achievement Goal

... and one without context.

kate | Jason

```
1   stock(beer, 20).
2
3   !purchase(chocolate, 50).
4
5   +!purchase(Item, Amount):
6           stock(Item, Stock) &
7           Stock >= Amount  <-
8                   .print("Your product ", Item, " is available. We have ", Stock, " units.").
9
10  -!purchase(Item, Amount):
11          stock(Item, Stock) &
12          Stock < Amount <-
13                  .print("Sorry, your product ", Item, " is unavailable. We have only ", Stock, " units.").
14
15  -!purchase(Item,_):
16          .findall(stock(Item,Value), stock(Item,Value), Result) &
17          Result == [] <-
18                  .print("Sorry, we don't sell ", Item, ").
19
20  -!purchase(_,_) <-
21                  .print("Something went wrong!").
```

Plans: Deletion Achievement Goal

+!event[source(type)]: context ← (...).

Plans: Deletion Achievement Goal

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

Plans: Deletion Achievement Goal

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.

.

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+!event[source(type)]: context ← (...).

Plans: Deletion Achievement Goal

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.

.

.

+!event[source(type)]: context ← (...).

-!event[source(type)]: context ← (...).

Plans: Deletion Achievement Goal

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.

.

.

+!event[source(type)]: context ← (...).

-!event[source(type)]: context ← (...).

-!event[source(type)]: context ← (...).

Plans: Deletion Achievement Goal

+!event[source(type)]: context ← (...).

+!event[source(type)]: context ← (...).

.
.
.

+!event[source(type)]: context ← (...).

-!event[source(type)]: context ← (...).

-!event[source(type)]: context ← (...).

.
.
.

-!event[source(type)]: context ← (...).

Plans: Test Goal

```
{+|-}?event[source(type)]:
context ←
        action 1;
        action 2;
        action n.
```

Plans: Test Goal

```
{+|-}?event[source(type)]:
  context ←
        action 1;
        action 2;
        action n.
```

defines if it is an addition (+) or a deletion (-) plan.

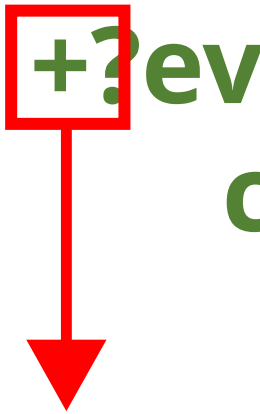
Plans: Test Goal


```
{+|-}?event[source(type)]:
context ←
        action 1;
        action 2;
        action n.
```

Plans: Addition Test Goal

```
+?event[source(type)]:
        context ←
                action 1;
                action 2;
                action n.
```

Plans: Addition Test Goal



defines an addition plan.

```
+?event[source(type)]:
    context ←
        action 1;
        action 2;
        action n.
```

Plans: Addition Test Goal

newAgent | Jason

```
1   agent(teddy).
2
3   !count.
4
5   +!count <-
6           ?agent(Name);
7           ?count(N);
8           .print(N,". My name is ", Name,".");
9           -+count(N+1);
10          .wait(500);
11          !count.
12
13  +?count(N) <-
14          .print("I need to start counting...");
15          N=1;
16          +count(N+1).
```

```
[ChonOS EmbeddedMAS] Starting the Multi-Agent S
Jason Http Server running on http://127.0.1.1:3
[newAgent] I need to start counting...
[newAgent] 1. My name is teddy.
[newAgent] 2. My name is teddy.
[newAgent] 3. My name is teddy.
[newAgent] 4. My name is teddy.
[newAgent] 5. My name is teddy.
[newAgent] 6. My name is teddy.
[newAgent] 7. My name is teddy.
[newAgent] 8. My name is teddy.
[newAgent] 9. My name is teddy.
[newAgent] 10. My name is teddy.
[newAgent] 11. My name is teddy.
[newAgent] 12. My name is teddy.
[newAgent] 13. My name is teddy.
[newAgent] 14. My name is teddy.
[newAgent] 15. My name is teddy.
[newAgent] 16. My name is teddy.
[newAgent] 17. My name is teddy.
[newAgent] 18. My name is teddy.
[newAgent] 19. My name is teddy.
```

Plans: Addition Test Goal

newAgent | Jason

```
1   agent(teddy).
2
3   !count.
4
5   +!count <-
6           ?agent(Name);
7           ?count(N);
8           .print(N,". My name is ", Name,".");
9           -+count(N+1);
10          .wait(500);
11          !count.
12
13  +?count(N) <-
14          .print("I need to start counting...");
15          N=1;
16          +count(N+1).
```

```
[ChonOS EmbeddedMAS] Starting the Multi-Agent S
Jason Http Server running on http://127.0.1.1:3
[newAgent] I need to start counting...
[newAgent] 1. My name is teddy.
[newAgent] 2. My name is teddy.
[newAgent] 3. My name is teddy.
[newAgent] 4. My name is teddy.
[newAgent] 5. My name is teddy.
[newAgent] 6. My name is teddy.
[newAgent] 7. My name is teddy.
[newAgent] 8. My name is teddy.
[newAgent] 9. My name is teddy.
[newAgent] 10. My name is teddy.
[newAgent] 11. My name is teddy.
[newAgent] 12. My name is teddy.
[newAgent] 13. My name is teddy.
[newAgent] 14. My name is teddy.
[newAgent] 15. My name is teddy.
[newAgent] 16. My name is teddy.
[newAgent] 17. My name is teddy.
[newAgent] 18. My name is teddy.
[newAgent] 19. My name is teddy.
```

Plans: Addition Test Goal

newAgent | Jason

```
1   agent(teddy).
2
3   !count.
4
5   +!count <-
6           ?agent(Name);
7           ?count(N);
8           .print(N,". My name is ", Name,".");
9           -+count(N+1);
10          .wait(500);
11          !count.
12
13  +?count(N) <-
14          .print("I need to start counting...");
15          N=1;
16          +count(N+1).
```

```
[ChonOS EmbeddedMAS] Starting the Multi-Agent S
Jason Http Server running on http://127.0.1.1:3
[newAgent] I need to start counting...
[newAgent] 1. My name is teddy.
[newAgent] 2. My name is teddy.
[newAgent] 3. My name is teddy.
[newAgent] 4. My name is teddy.
[newAgent] 5. My name is teddy.
[newAgent] 6. My name is teddy.
[newAgent] 7. My name is teddy.
[newAgent] 8. My name is teddy.
[newAgent] 9. My name is teddy.
[newAgent] 10. My name is teddy.
[newAgent] 11. My name is teddy.
[newAgent] 12. My name is teddy.
[newAgent] 13. My name is teddy.
[newAgent] 14. My name is teddy.
[newAgent] 15. My name is teddy.
[newAgent] 16. My name is teddy.
[newAgent] 17. My name is teddy.
[newAgent] 18. My name is teddy.
[newAgent] 19. My name is teddy.
```

Plans: Addition Test Goal

newAgent | Jason

```
1   agent(teddy).
2
3   !count.
4
5   +!count <-
6           ?agent(Name);
7           ?count(N);
8           .print(N,". My name is ", Name,".");
9           -+count(N+1);
10          .wait(500);
11          !count.
12
13  +?count(N) <-
14          .print("I need to start counting...");
15          N=1;
16          +count(N+1).
```

```
[ChonOS EmbeddedMAS] Starting the Multi-Agent S
Jason Http Server running on http://127.0.1.1:3
[newAgent] I need to start counting...
[newAgent] 1. My name is teddy.
[newAgent] 2. My name is teddy.
[newAgent] 3. My name is teddy.
[newAgent] 4. My name is teddy.
[newAgent] 5. My name is teddy.
[newAgent] 6. My name is teddy.
[newAgent] 7. My name is teddy.
[newAgent] 8. My name is teddy.
[newAgent] 9. My name is teddy.
[newAgent] 10. My name is teddy.
[newAgent] 11. My name is teddy.
[newAgent] 12. My name is teddy.
[newAgent] 13. My name is teddy.
[newAgent] 14. My name is teddy.
[newAgent] 15. My name is teddy.
[newAgent] 16. My name is teddy.
[newAgent] 17. My name is teddy.
[newAgent] 18. My name is teddy.
[newAgent] 19. My name is teddy.
```

Plans: Addition Test Goal

newAgent | Jason

```
1   agent(teddy).
2
3   !count.
4
5   +!count <-
6           ?agent(Name);
7           ?count(N);
8           .print(N,". My name is ", Name,".");
9           -+count(N+1);
10          .wait(500);
11          !count.
12
13  +?count(N) <-
14          .print("I need to start counting...");
15          N=1;
16          +count(N+1).
```

```
[ChonOS EmbeddedMAS] Starting the Multi-Agent S
Jason Http Server running on http://127.0.1.1:3
[newAgent] I need to start counting...
[newAgent] 1. My name is teddy.
[newAgent] 2. My name is teddy.
[newAgent] 3. My name is teddy.
[newAgent] 4. My name is teddy.
[newAgent] 5. My name is teddy.
[newAgent] 6. My name is teddy.
[newAgent] 7. My name is teddy.
[newAgent] 8. My name is teddy.
[newAgent] 9. My name is teddy.
[newAgent] 10. My name is teddy.
[newAgent] 11. My name is teddy.
[newAgent] 12. My name is teddy.
[newAgent] 13. My name is teddy.
[newAgent] 14. My name is teddy.
[newAgent] 15. My name is teddy.
[newAgent] 16. My name is teddy.
[newAgent] 17. My name is teddy.
[newAgent] 18. My name is teddy.
[newAgent] 19. My name is teddy.
```

Plans: Deletion Test Goal

```
-?event[source(type)]:
        context ←
                action 1;
                action 2;
                action n.
```

Plans: Deletion Test Goal

defines a deletion plan.

```
-?event[source(type)]:
        context ←
                action 1;
                action 2;
                action n.
```

Plans: Deletion Test Goal

teddy Jason

```
1   agent(teddy).
2
3   !count.
4
5   +!count <-
6           ?agent(Name);
7           ?count(N);
8           .print(N, ". My name is ", Name, ".");
9           -+count(N+1);
10          .wait(2000);
11          !count.
12
13  +?count(N) <-
14          N=1;
15          .fail.
16
17  -?count(N): N \== 1 <-
18          N=1;
19          +count(N).
```

Plans: Belief

```
{+|-}event[source(type)]:
context ←
        action 1;
        action 2;
        action n.
```

Plans: Belief

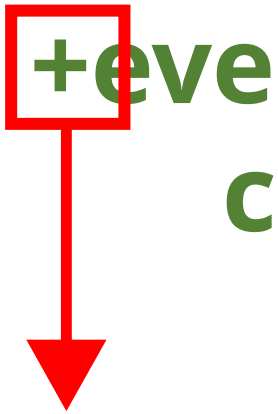
{+|-}event[source(type)]:
context ←
action 1;
action 2;
action n.

defines if it is an addition (+) or a deletion (-) plan.

Plans: Additi

```
+event[source(type)]:
    context ←
        action 1;
        action 2;
        action n.
```

Plans: Addition Belief Goal



defines an addition plan.

```
+event[source(type)]:
    context ←
        action 1;
        action 2;
        action n.
```

Plans: Addition Belief Goal

alice | Jason

```
1   stock(beer, 20).
2
3   !purchase(beer, 10).
4
5   +!purchase(Item, Amount):
6           stock(Item, Stock) &
7           Stock >= Amount  <-
8                   .print("Your product ", Item, " is available. We have ", Stock, " units.");
9                   -+stock(Item,Stock-Amount).
10
11  +stock(Item, NewStock) <-
12          .print("The stock amount for ", Item, " is now ", NewStock, ").
13
14
15  -stock(Item, NewStock) <-
16          .print("The stock amount for ", Item, " is now decreasing from ", NewStock, ").
```

Plans: Addition Belief Goal

alice | Jason

```
1   stock(beer, 20).
2
3   !purchase(beer, 10).
4
5   +!purchase(Item, Amount):
6           stock(Item, Stock) &
7           Stock >= Amount  <-
8                   .print("Your product ", Item, " is available. We have ", Stock, " units.");
9                   -+stock(Item,Stock-Amount).
10
11  +stock(Item, NewStock) <-
12          .print("The stock amount for ", Item, " is now ", NewStock, ").
13
14
15  -stock(Item, NewStock) <-
16          .print("The stock amount for ", Item, " is now decreasing from ", NewStock, ").
```

Plans: Addition Belief Goal

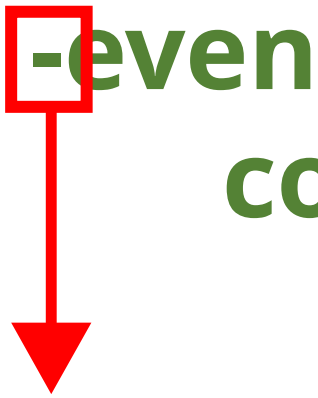
alice | Jason

```
1   stock(beer, 20).
2
3   !purchase(beer, 10).
4
5   +!purchase(Item, Amount):
6           stock(Item, Stock) &
7           Stock >= Amount  <-
8                   .print("Your product ", Item, " is available. We have ", Stock, " units.");
9                   -+stock(Item,Stock-Amount).
10
11  +stock(Item, NewStock) <-
12          .print("The stock amount for ", Item, " is now ", NewStock, ").
13
14
15  -stock(Item, NewStock) <-
16          .print("The stock amount for ", Item, " is now decreasing from ", NewStock, ").
```

Plans: Deleti

```
-event[source(type)]:
    context ←
        action 1;
        action 2;
        action n.
```

Plans: Deletion Belief Goal



defines a deletion plan.

```
-event[source(type)]:
        context ←
                action 1;
                action 2;
                action n.
```

Plans: Deletion Belief Goal

alice | Jason

```
1   stock(beer, 20).
2
3   !purchase(beer, 10).
4
5   +!purchase(Item, Amount):
6           stock(Item, Stock) &
7           Stock >= Amount  <-
8                   .print("Your product ", Item, " is available. We have ", Stock, " units.");
9                   -+stock(Item,Stock-Amount).
10
11  +stock(Item, NewStock) <-
12          .print("The stock amount for ", Item, " is now ", NewStock, ").
13
14
15  -stock(Item, NewStock) <-
16          .print("The stock amount for ", Item, " is now decreasing from ", NewStock, ").
```

Plans: Deletion Belief Goal

alice | Jason

```
1   stock(beer, 20).
2
3   !purchase(beer, 10).
4
5   +!purchase(Item, Amount):
6           stock(Item, Stock) &
7           Stock >= Amount  <-
8                   .print("Your product ", Item, " is available. We have ", Stock, " units.");
9                   -+stock(Item,Stock-Amount).
10
11  +stock(Item, NewStock) <-
12          .print("The stock amount for ", Item, " is now ", NewStock, ").
13
14
15  -stock(Item, NewStock) <-
16          .print("The stock amount for ", Item, " is now decreasing from ", NewStock, ").
```

Plans: Deletion Belief Goal

alice | Jason

```
1   stock(beer, 20).
2
3   !purchase(beer, 10).
4
5   +!purchase(Item, Amount):
6           stock(Item, Stock) &
7           Stock >= Amount  <-
8                   .print("Your product ", Item, " is available. We have ", Stock, " units.");
9                   -+stock(Item,Stock-Amount)
10
11  +stock(Item, NewStock) <-
12          .print("The stock amount for ", Item, " is now ", NewStock, ").
13
14
15  -stock(Item, NewStock) <-
16          .print("The stock amount for ", Item, " is now decreasing from ", NewStock, ").
```

Agradecimentos

OBRIGADO!

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