

# Textual Representation of Plan Explanations

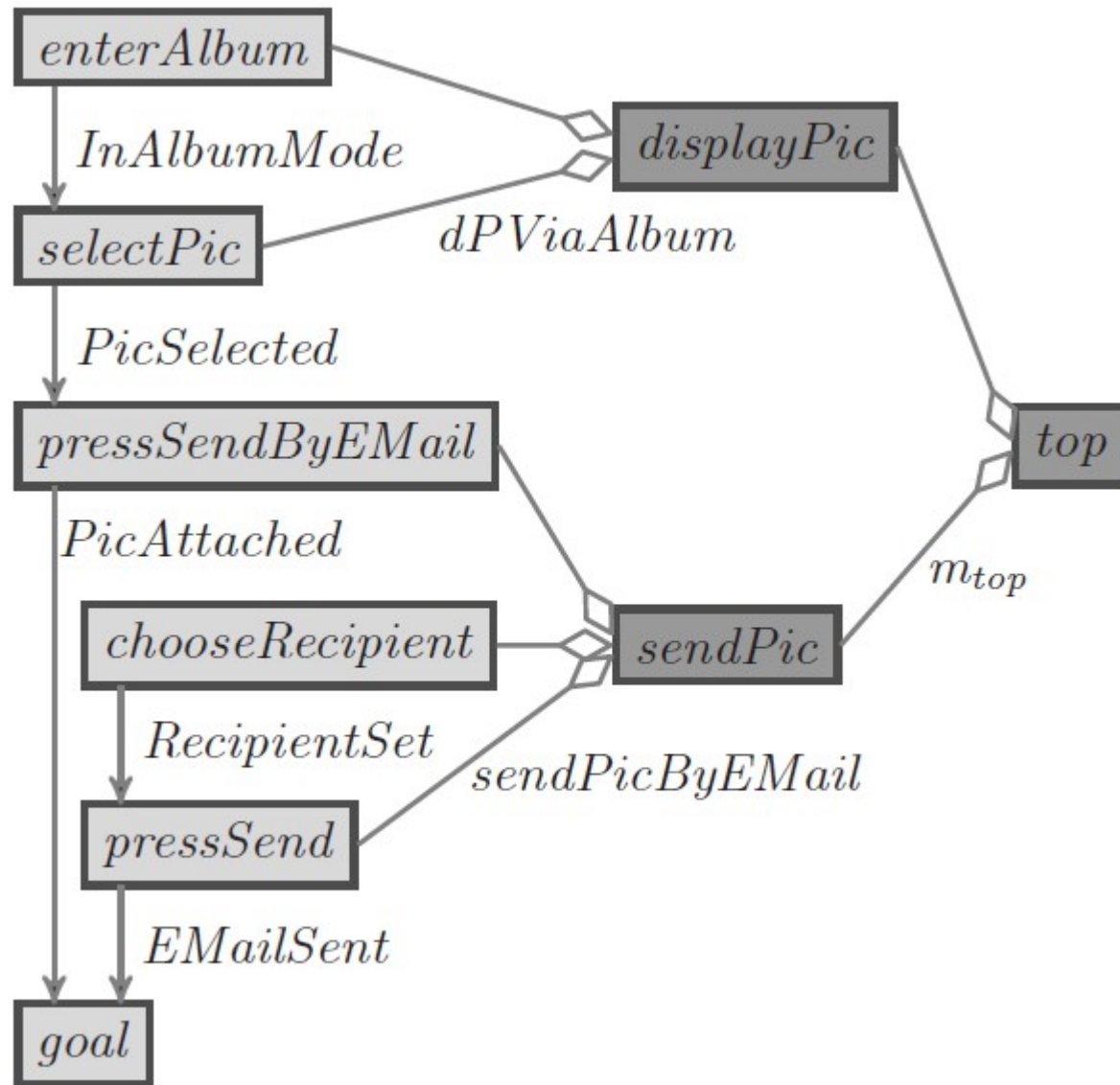
# Contents

- Fundamentals
- Generating Textual Explanations
- Demonstration

# 1. Fundamentals

- Hybrid Plans
- Formal Explanations
- Natural Language Generation

# 1.1. Hybrid Plans



# 1.2. Formal Explanations

Proving a task's necessity

=

Explaining a task's necessity

# 1.2. Formal Explanations

Three relations:

- Necessary( $t$ )
- CausalRelation( $t_1, \varphi, t_2$ )
- DecompositionRelation( $t_1, m, t_2$ )

## 1.2. Formal Explanations

C-CH:

$$\begin{aligned} \forall t:\text{Task} . [\text{Necessary}(t) \leftarrow \\ \exists t':\text{Task} ; \varphi:\text{Formula} . \\ [\text{CausalRelation}(t,\varphi,t') \wedge \text{Necessary}(t')]] \end{aligned}$$

## 1.2. Formal Explanations

D-CH:

$$\begin{aligned} \forall t:\text{Task} . [\text{Necessary}(t) \leftarrow \\ \exists t':\text{Task} ; m:\text{Method} . \\ [\text{DecompositionRelation}(t,m,t') \wedge \text{Necessary}(t')]] \end{aligned}$$

# 1.2. Formal Explanations

- |     |                                                                                                                 |            |
|-----|-----------------------------------------------------------------------------------------------------------------|------------|
| 1.  | Necessary( <i>press_newAppointment</i> )                                                                        | C-Ch 4,5   |
| 2.  | CausalRelation( <i>press_newAppointment</i> , $\phi$ , <i>set_Name</i> )                                        | Basic      |
| 3.  | DecompositionRelation( <i>set_Name</i> , <i>m</i> , <i>configure_Appointment</i> )                              | Basic      |
| 4.  | CausalRelation( <i>press_newAppointment</i> , $\phi$ , <i>configure_Appointment</i> )                           | C-Prop 2,3 |
| 5.  | Necessary( <i>configure_Appointment</i> )                                                                       | C-Ch 8,9   |
| 6.  | CausalRelation( <i>set_Time</i> , <i>isSet_Time<sub>Appointment,Date</sub></i> , <i>press_OK</i> )              | Basic      |
| 7.  | DecompositionRelation( <i>set_Time</i> , <i>m</i> , <i>configure_Appointment</i> )                              | Basic      |
| 8.  | CausalRelation( <i>configure_Appointment</i> , <i>isSet_Time<sub>Appointment,Date</sub></i> , <i>press_OK</i> ) | P-Prop 6,7 |
| 9.  | Necessary( <i>press_OK</i> )                                                                                    | C-Ch 10,11 |
| 10. | CausalRelation( <i>press_OK</i> , <i>created<sub>Appointment</sub></i> , <i>goalTask</i> )                      | Basic      |
| 11. | Necessary( <i>goalTask</i> )                                                                                    | Basic      |

# 1.3. Natural Language Generation

- Goal: natural and easy to read Text
- Six characteristic phases

# 1.3. Natural Language Generation

- Text Planning:
  - Content Determination
  - Discourse Planning
- Sentence Aggregation

# 1.3. Natural Language Generation

- Lexicalization
- Referring Expression Generation
- Linguistic Realization

## 2. Generating Textual Explanations

- Goals
- Text Planning
- Sentence Aggregation
- Lexicalization
- Referring Expression Generation
- Linguistic Realization

## 2.1. Goals

Goal:

A system that generates an easy to read, variety rich textual explanation in the english language from a formal explanation.

## 2.1. Goals

### Suggestion:

- |     |                                                                                                                 |            |
|-----|-----------------------------------------------------------------------------------------------------------------|------------|
| 1.  | Necessary( <i>press_newAppointment</i> )                                                                        | C-Ch 4,5   |
| 2.  | CausalRelation( <i>press_newAppointment</i> , $\phi$ , <i>set_Name</i> )                                        | Basic      |
| 3.  | DecompositionRelation( <i>set_Name</i> , <i>m</i> , <i>configure_Appointment</i> )                              | Basic      |
| 4.  | CausalRelation( <i>press_newAppointment</i> , $\phi$ , <i>configure_Appointment</i> )                           | C-Prop 2,3 |
| 5.  | Necessary( <i>configure_Appointment</i> )                                                                       | C-Ch 8,9   |
| 6.  | CausalRelation( <i>set_Time</i> , <i>isSet_Time<sub>Appointment,Date</sub></i> , <i>press_OK</i> )              | Basic      |
| 7.  | DecompositionRelation( <i>set_Time</i> , <i>m</i> , <i>configure_Appointment</i> )                              | Basic      |
| 8.  | CausalRelation( <i>configure_Appointment</i> , <i>isSet_Time<sub>Appointment,Date</sub></i> , <i>press_OK</i> ) | P-Prop 6,7 |
| 9.  | Necessary( <i>press_OK</i> )                                                                                    | C-Ch 10,11 |
| 10. | CausalRelation( <i>press_OK</i> , <i>created<sub>Appointment</sub></i> , <i>goalTask</i> )                      | Basic      |
| 11. | Necessary( <i>goalTask</i> )                                                                                    | Basic      |

„*press\_newAppointment* is necessary since this task is necessary for *configure\_Appointment*, that one is needed for *press\_OK* and that one is necessary for establishing the goal.“

## 2.1. Goals

- More appropriate expressions for tasks etc.
- Involving relations
- Adjustable Lexicalization
- Fast adjustability to switched domains etc.
- Preparing all necessary input files for the Smartphone-Domain

## 2.2. Text Planning

- Input: formal explanation
- Output: Text Tree

## 2.2. Text Planning

Types of inner nodes:

- Sequence (STOP)
- Sequence (COMMA)
- Elaboration
- Message

## 2.2. Text Planning

Types of messages (leaves):

- Necessary
- Decomp
- Causal
- Phi
- Goal
- Top

## 2.2. Text Planning

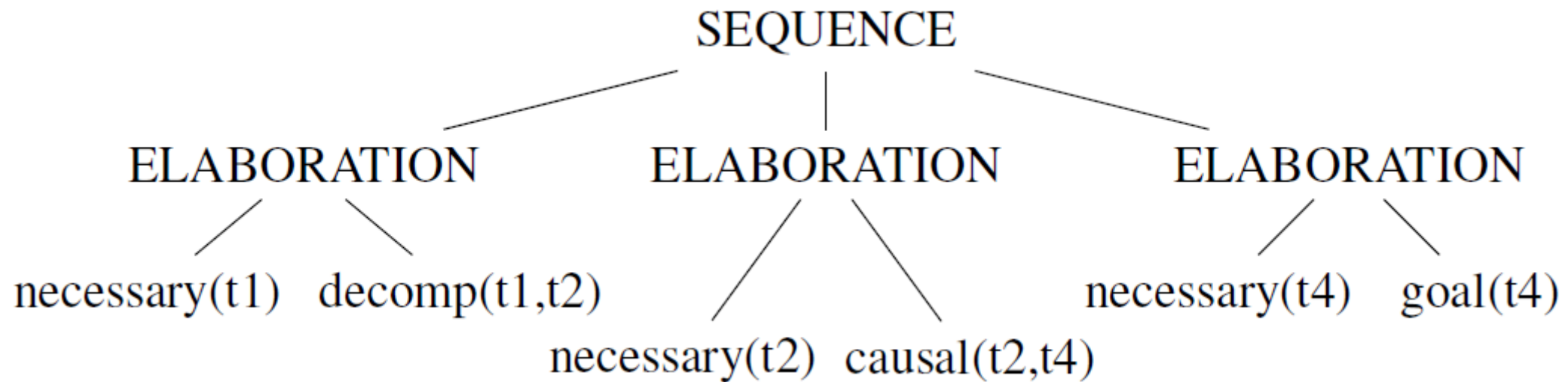
Two variations of Text Planning

- Simple: Constructs a Simple Text Tree
- Advanced: Uses Phi Nodes

## 2.2. Text Planning

- |    |                                         |            |
|----|-----------------------------------------|------------|
| 1. | Necessary(t1)                           | D-Ch 2,3   |
| 2. | DecompositionRelation(t1, $m$ , t2)     | Basic      |
| 3. | Necessary(t2)                           | C-Ch 6,7   |
| 4. | CausalRelation(t3, $\phi_3$ , t4)       | Basic      |
| 5. | DecompositionRelation(t3, $m$ , t2)     | Basic      |
| 6. | CausalRelation(t2, $\phi_4$ , t4)       | P-Prop 4,5 |
| 7. | Necessary(t4)                           | C-Ch 8,9   |
| 8. | CausalRelation(t4, $\phi_5$ , goalTask) | Basic      |
| 9. | Necessary(goalTask)                     | Basic      |

## 2.2. Text Planning



## 2.3. Sentence Aggregation

- Input: Text Tree
- Output: Sentence Tree
- delete redundant information, shorten the textual explanation and simplify the sentence structure

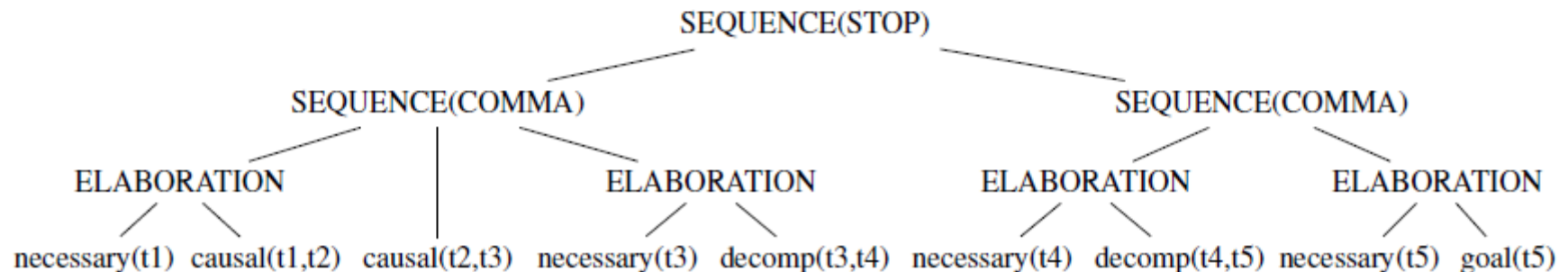
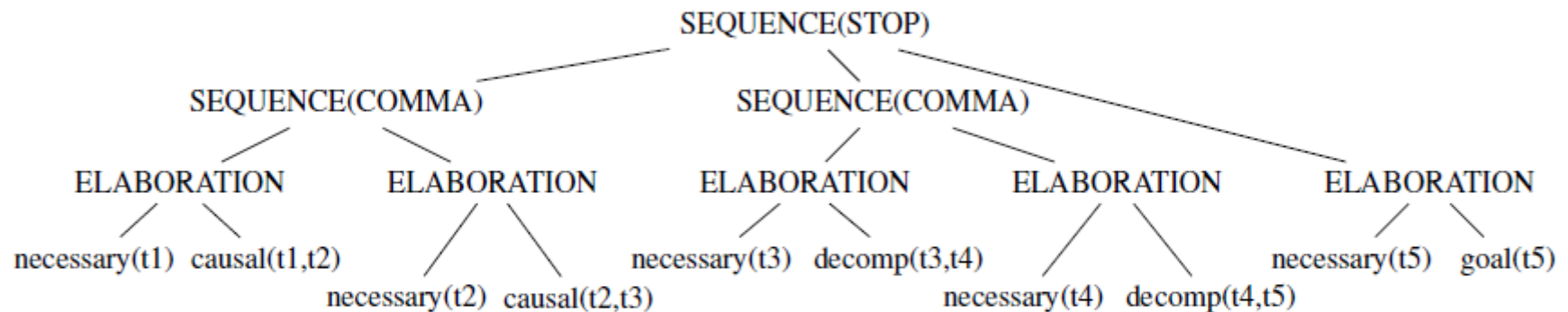
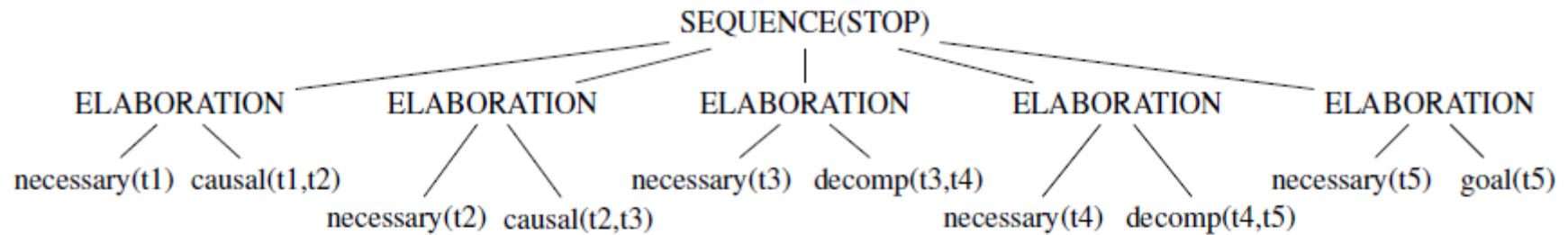
## 2.3. Sentence Aggregation

- Sentences can contain more than one elaboration node
- Sequence Nodes (COMMA) can be used to easily concatenate elaboration nodes
- Necessary Messages from inner elaboration nodes can be deleted since their information is already expressed through the context

## 2.3. Sentence Aggregation

- Three Variations:
  - Simple: Does not change the tree
  - Content-based: unites subtrees with similar messages
  - Length-based: unites subtrees to sentences with randomly chosen length

## 2.3. Sentence Aggregation



## 2.4. Lexicalization

- Input: Sentence Tree
- Output: lexicalized Sentence Tree

## 2.4. Lexicalization

- Choose for each message a predefined sentence fragment
- Inserting task names, arguments, etc.
- Three variations

## 2.4. Lexicalization

### Simple Lexicalization:

- task names remain unchanged
- arguments of tasks can not be included
- resulting text is similar to the example

## 2.4. Lexicalization

### Advanced Lexicalization:

- requires additional input
- can express tasks and their arguments in a seemingly natural way

## 2.4. Lexicalization

Input Supporting Lexicalization:

- offered sentence fragments can be modified
- other functions identical to the Advanced Lexicalization

## 2.4. Lexicalization

Example (Sentence Fragment):

;is part of;<=>0,i,to;1,c,;<=>0;0;-1;-1;1;1

means:

"to" + <task No. 0 in infinitive form> + "is part of" +  
<task No. 1 in continuous form>

## 2.4. Lexicalization

### Example (Task):

Task:

enter\_Number\_ForSMS<=>

"enter number"<=>

enter %1%'s number<=>

entering %1%'s number

## 2.5. Referring Expression Generation

### Produced text without R.E.G.:

Pressing the [eMail] button is crucial since to press the [eMail] button is part of entering the eMail menu, the task "enter the eMail menu" is needed for pressing [New eMail] and the task "press [New eMail]" is necessary as pressing [New eMail] is needed for pressing [Send].  
To press [Send] is crucial since it establishes a goal.

## 2.5. Referring Expression Generation

- 'it', 'that' and 'which' are supported
- Precursing sentence fragment offers tasks to be replaced in the following sentence
- Following sentence accepts the offered task at specified locations when they match its own task at that position

## 2.5. Referring Expression Generation

Example:

Necessary Message:

;is needed;<=>0,c,;<=>0;0;0;0;-1;-1

Causal Message:

;is needed for;<=>0,i,to;1,n,the task;<=>0;0;-1;-1;1;1

=> task 0 will be expressed through 'it'

## 2.6. Linguistic Realization

- Reducing the tree to a string
- Punctuation, whitespaces
- Expressions of inner nodes

# 3. Demonstration

|   |                                                                          |          |
|---|--------------------------------------------------------------------------|----------|
| 1 | Necessary(pressHome.Email)                                               | D-Ch 2,3 |
| 2 | DecompositionRelation(pressHome.Email, m, enterMode.Email)               | [*]      |
| 3 | Necessary(enterMode.Email)                                               | C-CH 4,5 |
| 4 | CausalRelation(enterMode.Email, inMode_Email, pressEmail.NewEmail)       | [*]      |
| 5 | Necessary(pressEmail.NewEmail)                                           | C-Ch 6,7 |
| 6 | CausalRelation(pressEmail.NewEmail, $\phi_1$ , pressEmail.NewEmail.Send) | [*]      |
| 7 | Necessary(pressEmail.NewEmail.Send)                                      | C-Ch 8,9 |
| 8 | CausalRelation(pressEmail.NewEmail.Send, $\phi_2$ , goalTask)            | [*]      |
| 9 | Necessary(goalTask)                                                      | Basic    |

# 3. Demonstration

- Simplest:

The task `press_Home.EMail` is necessary because it belongs to the task `enterMode_Email`.

That is obligatory since it is needed for the task `press_Email.NewEmail` and that is crucial as it is needed for the task `press_Email.NewEmail.Send`.

That is necessary since it establishes a goal.

# 3. Demonstration

- Most advanced:

Pressing the [eMail] button is crucial since it is part of the task “enter the eMail menu”, which is needed for pressing [New eMail] and that is necessary as it is needed for pressing [Send].

That is crucial since it establishes a goal.