A toolkit for the analysis of normative texts

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NWPT 2014, Halmstad

CHALMERS | UNIVERSITY OF GOTHENBURG

REMU

http://remu.grammaticalframework.org/

Reliable **Mu**ltilingual Digital Communication: Methods and Applications

Vetenskapsrådet

- Rule-based language technology
- Grammars, parsing, trees
- Hybrid machine translation
- **Analysis of documents**

Normative texts

What is a normative text?

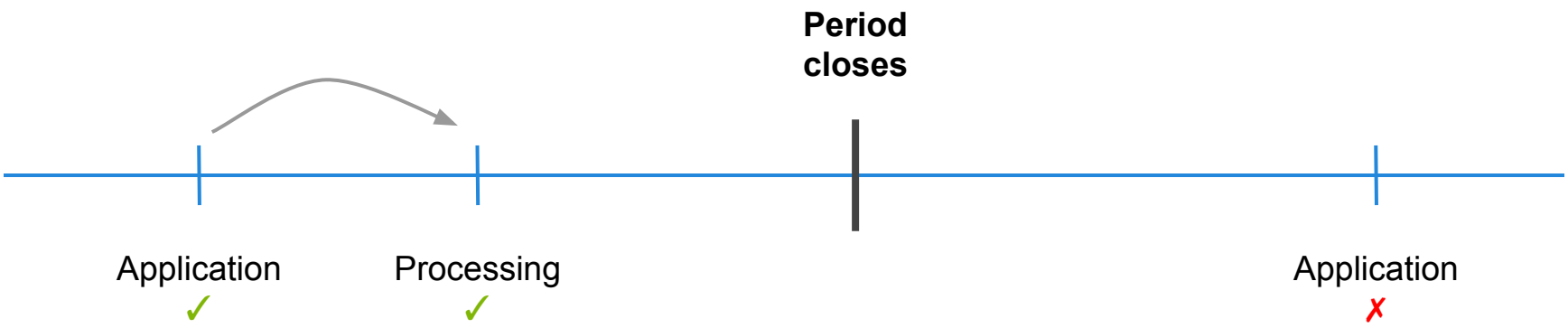
- **Document containing norms** prescribing procedures, behaviours, rights
- Examples
  - privacy policy
  - terms of service
  - service-level agreement
  - employment contract

Motivating example

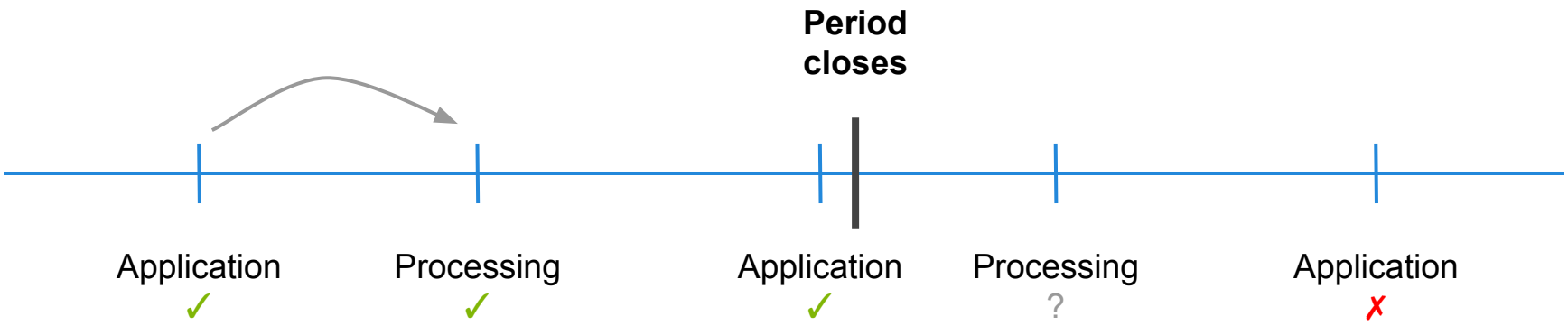
Application procedure

1. Applications may be submitted between 1st–31st May.
2. The secretary must process each application within 5 days.
3. The secretary should not process any applications after the period has closed.

Motivating example



Motivating example



Potential conflicts

- Is something wrong with this description?
- Should it be changed?

- That’s for a human to decide
- Computer can find potential conflicts

Desired tasks: static

- Detect conflicts
  - While writing (author)
  - Before accepting (party)
- Check properties
  - Safety: “*something bad won’t happen*”
  - Liveness: “*something good eventually happens*”
- Query
  - *If I do X what will the consequence be?*

Desired tasks: runtime

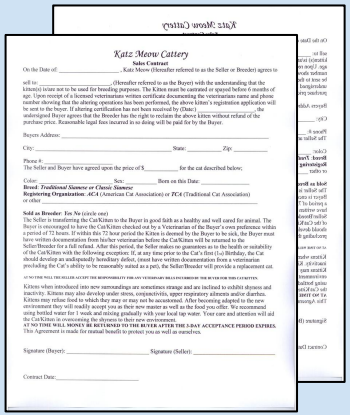
- Extract a runtime monitor
- Detect violations as they happen
- Enact reparations
- Logs, without interference

*Only **computer-mediated transactions***

Analysis requires a formalism

Natural Language

Original text



Katz Meow Cattery

Sales Contract

On the Date of: _____, Katz Meow (Hereafter referred to as the Seller or Breeder) agrees to sell to: _____, (Hereafter referred to as the Buyer) with the understanding that the kitten(s) is/are not to be used for breeding purposes. The Kitten must be castrated or spayed before 6 months of age. Upon receipt of a licensed veterinarians written certificate documenting the veterinarians name and phone number showing that the altering operations has been performed, the above kitten's registration application will be sent to the buyer. If altering certification has not been received by (Date:) _____, the undersigned Buyer agrees that the Breeder has the right to reclaim the above kitten without refund of the purchase price. Reasonable legal fees incurred in so doing will be paid for by the Buyer.

Buyers Address: _____

City: _____ State: _____ Zip: _____

Phone #: _____

The Seller and Buyer have agreed upon the price of $_____ for the cat described below;

Color: _____ Sex: _____ Born on this Date: _____

Breed: ***Traditional Siamese or Classic Siamese***

Registering Organization: ***ACA*** (American Cat Association) or ***TCA*** (Traditional Cat Association)

or other _____

Sold as Breeder Yes No (circle one)

The Seller is transferring the Cat/Kitten to the Buyer in good faith as a healthy and well cared for animal. The Buyer is encouraged to have the Cat/Kitten checked out by a Veterinarian of the Buyer's own preference within a period of 72 hours. If within this 72 hour period the Kitten is deemed by the Buyer to be sick, the Buyer must have written documentation from his/her veterinarian before the Cat/Kitten will be returned to the Seller/Breeder for a full refund. After this period, the Seller makes no guarantees as to the health or suitability of the Cat/Kitten with the following exception: If, at any time prior to the Cat's first (1st) Birthday, the Cat should develop an undiagnosis hereditary defect, (must have written documentation from a veterinarian precluding the Cat's ability to be reasonably suited as a pet), the Seller/Breeder will provide a replacement cat.

AT NO TIME WILL THE SELLER ACCEPT THE RESPONSIBILITY FOR ANY VETERINARY BILLS INCURRED BY THE BUYER FOR THIS CAT/KITTEN.

Kittens when introduced into new surroundings are sometimes strange and are inclined to exhibit shyness and inactivity. Kittens may also develop under stress, conjunctivitis, upper respiratory ailments and/or diarrhea. Kittens may refuse food to which they may or may not be accustomed. After becoming adapted to the new environment they will readily accept you as their new master as well as the food you offer. We recommend using bottled water for 1 week and mixing gradually with your local tap water. Your care and attention will aid in your Kitten in overcoming the shyness in their new environment.

AT NO TIME WILL MONEY BE RETURNED TO THE BUYER AFTER THE 3-DAY ACCEPTANCE PERIOD EXPIRES.

This Agreement is made for mutual benefit to protect you as well as ourselves.

Signature (Buyer): _____ Signature (Seller): _____

Contract Date: _____

Formalism

Model

$$P(su) \wedge [cl]F_{O(x)}(pr.co) \oplus O_{\perp}(xy \wedge (w \vee z))$$

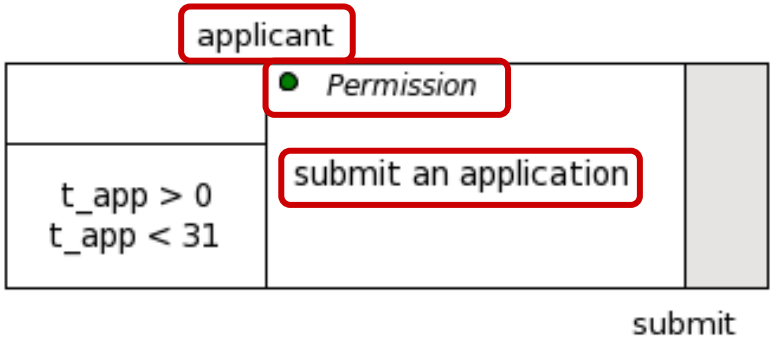
```
<contract>
 <clauses>
 <clause>[a3](P(a1))</clause>
 <clause>(P(a2.a3))</clause>
 </clauses>
 <concurrentActions>
  <action>a3#a4</action>
 </concurrentActions>
</contract>
```

Contract-Oriented Diagrams

Díaz et al. 2014

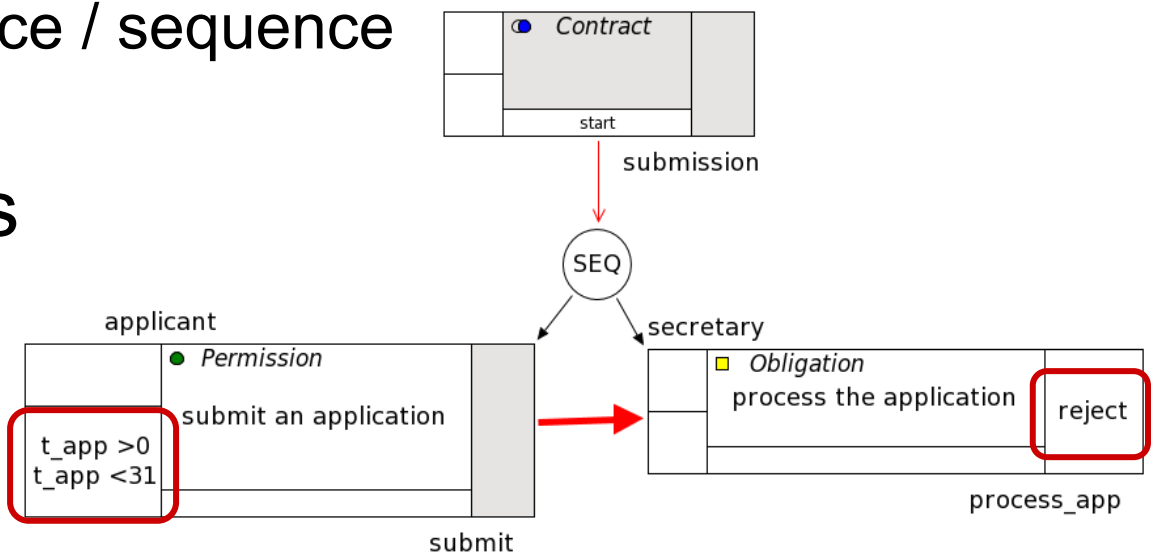
Contract-Oriented Diagrams

- A visual formalism for normative texts
- Boxes as clauses
  - agent, action, modality
- Modalities
  - Obligation O
  - Permission P
  - Prohibition F

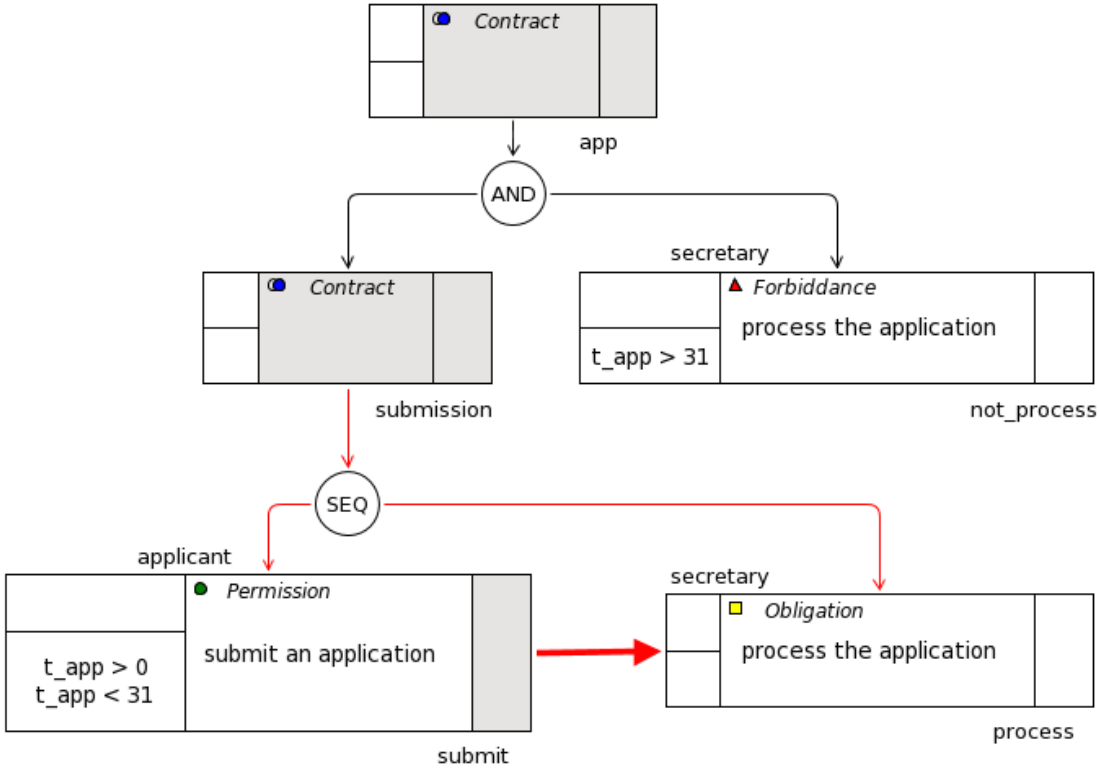


Contract-Oriented Diagrams

- Guards & timing constraints
- Complex actions, refinement
  - conjunction / choice / sequence
- Reparations
- Cross-references



Full example



Not just diagrams...

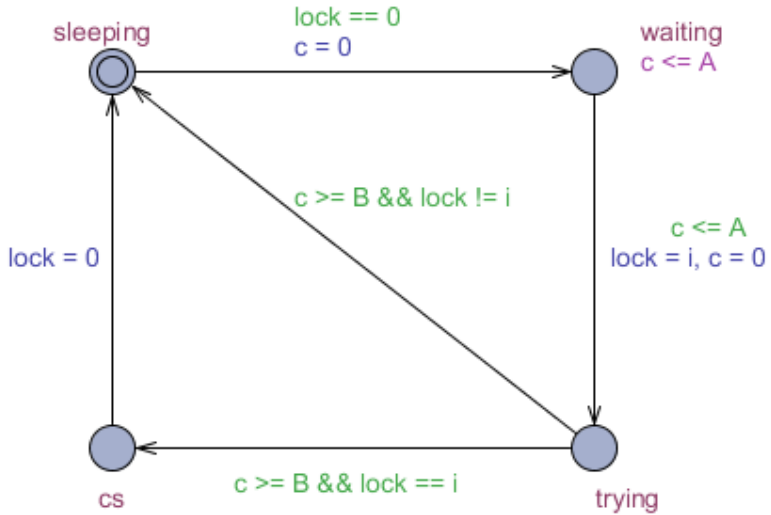
...also a formal language

- Well-defined syntax
- Trace semantics
  - Trace = sequence of actions + time stamps
  - *“A sequence of events respects a model”*
- Translation to **timed automata**

Timed Automata

Finite state automata, with:

- Real-valued clocks
  - progress together
  - can be reset
- Guards on transitions
- Node invariants



Fischer's mutual exclusion algorithm
http://crema.di.unimi.it/~carioni/pics/fischer.png

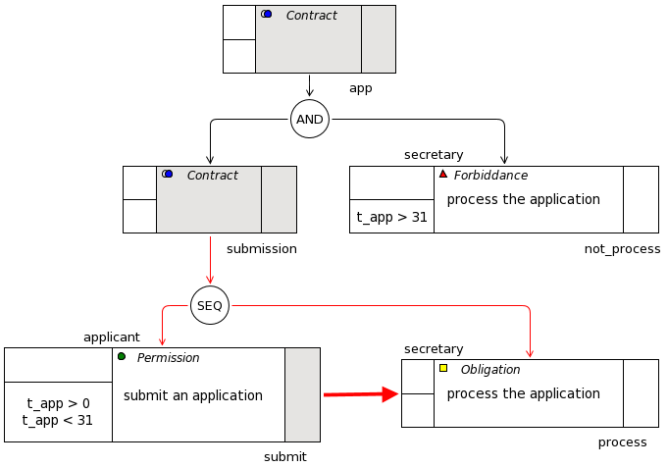
UPPAAL & NTAs

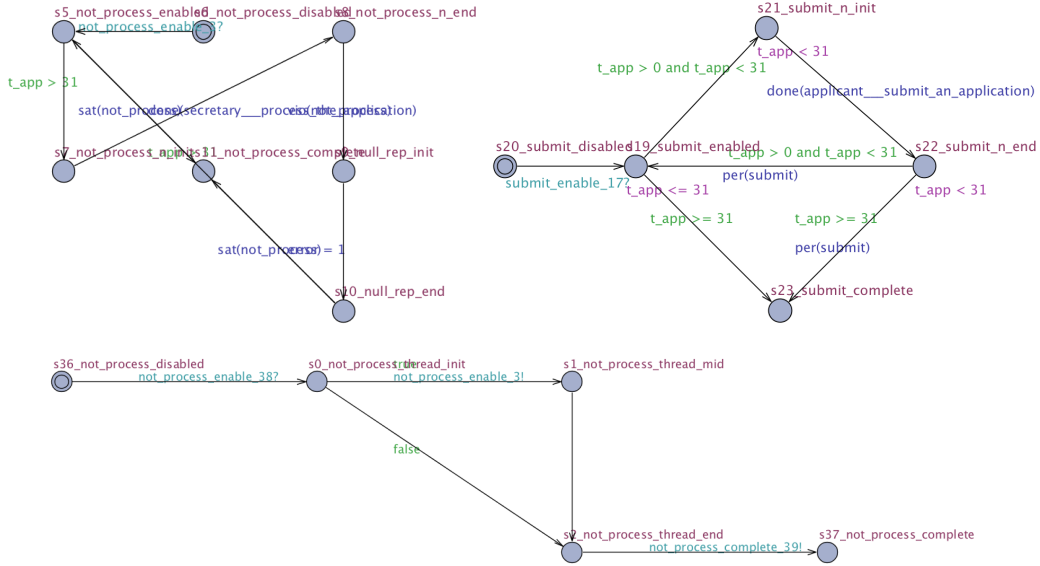
UPPAAL is a tool for working with

networks of **timed automata**

- Multiple automata running in parallel
- Synchronisation via channels
- Language & engine for model checking

Translation C-O diagram → NTA





Model checking

UPPAAL uses a subset of TCTL

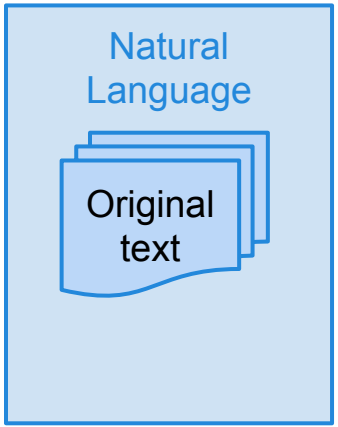
- Safety property

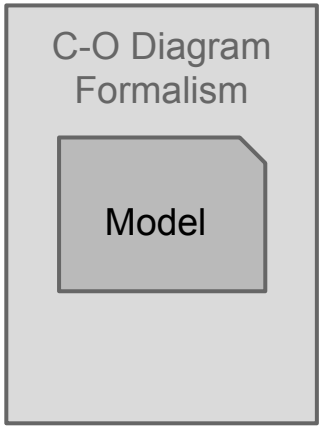
```
A[] t_app > 31 imply !process
```

- Liveness property

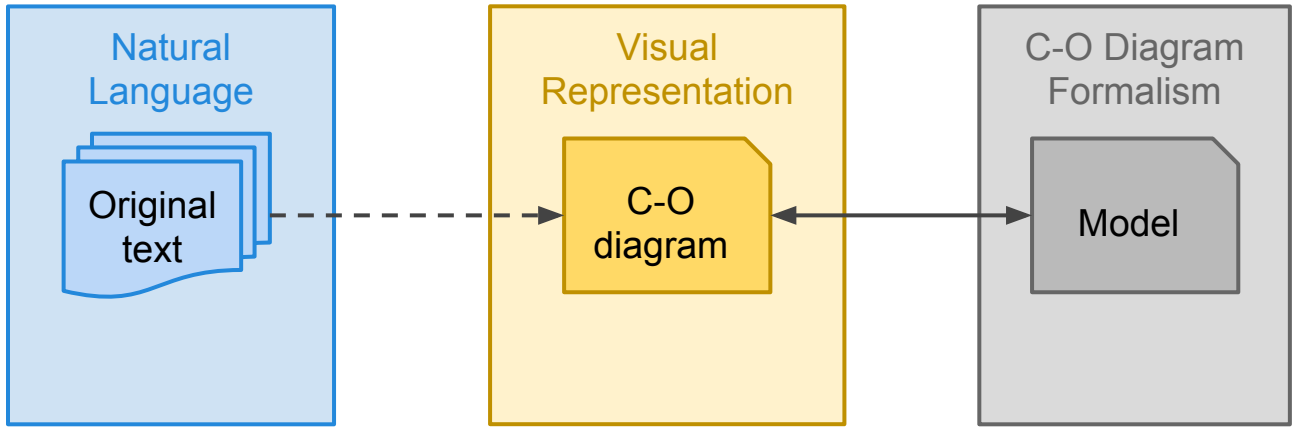
```
t_app < 31 && apply --> process
```

The picture so far

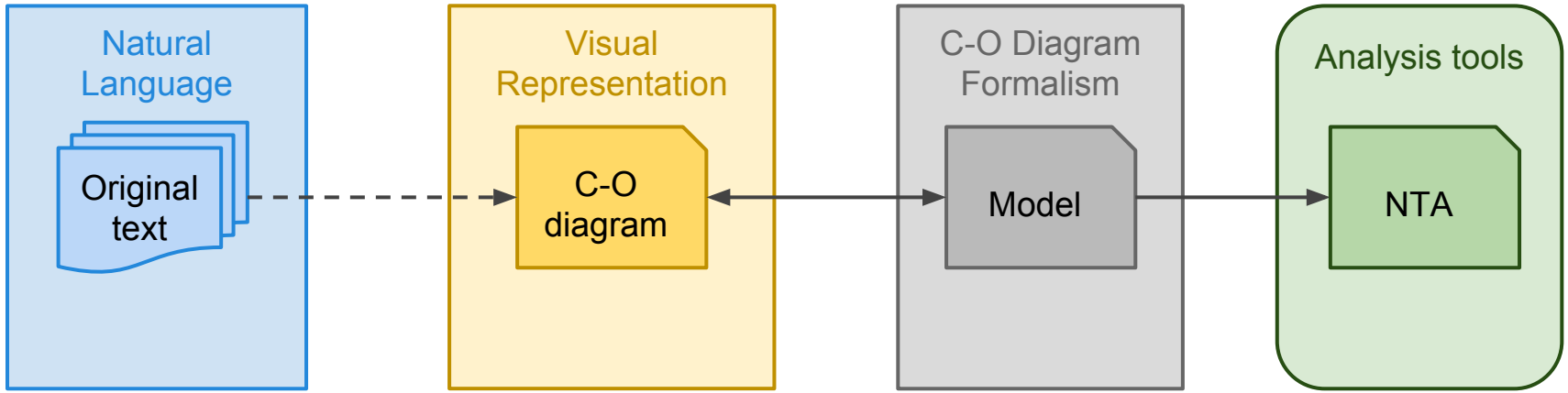




The picture so far



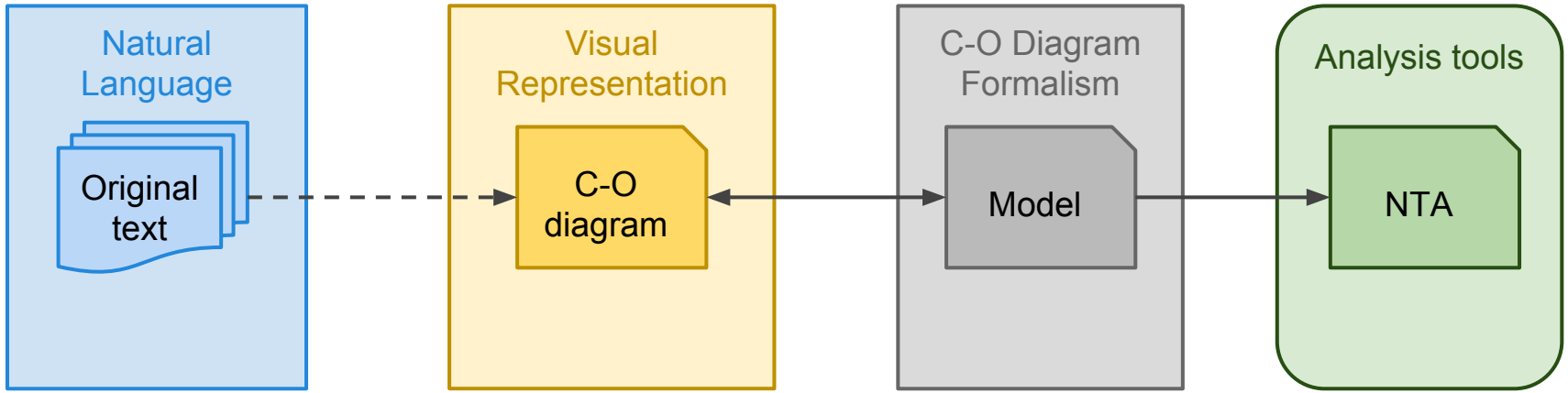
The picture so far



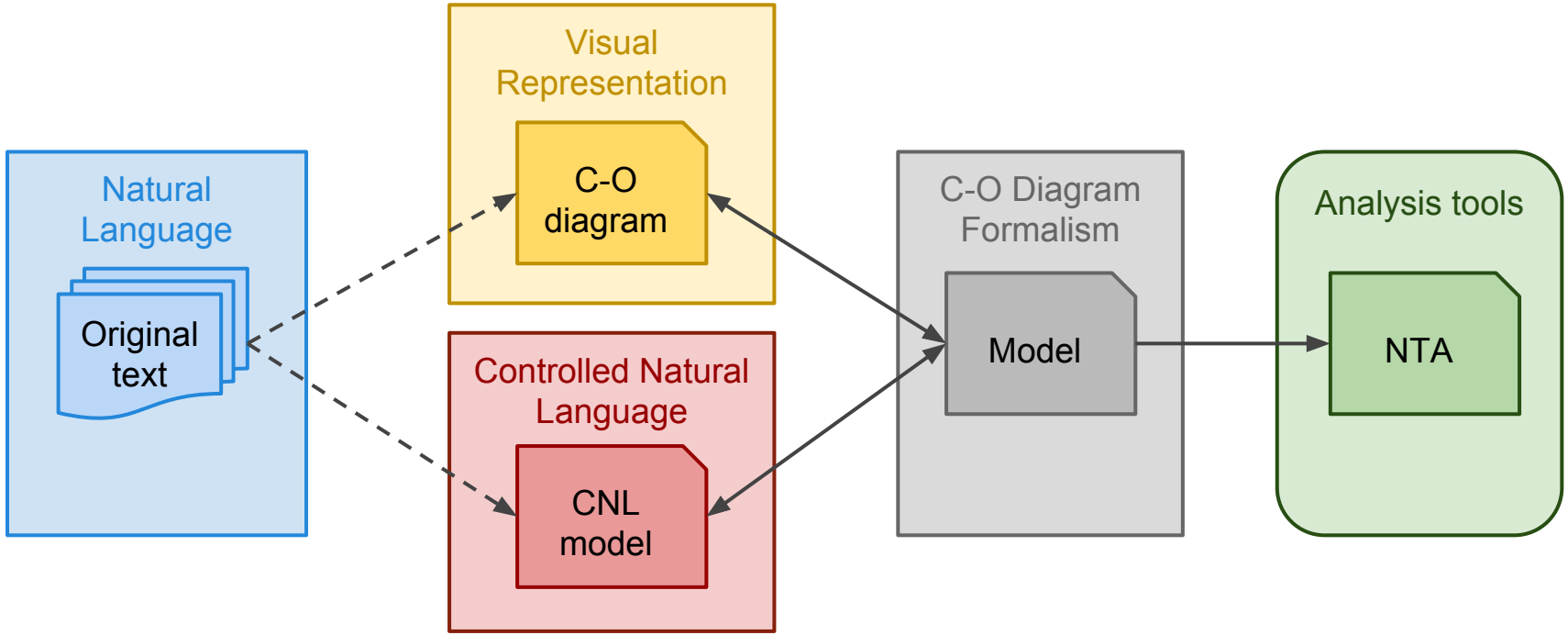
The need for CNL

- Some tasks benefit from visualisation, but
- Natural language cannot be replaced
  - Original documents are in NL
  - We want to produce NL
  - Collaboration with other stakeholders
- Two views for same model
  - Diagrams
  - CNL

The picture so far



The picture so far

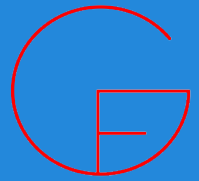


CNL

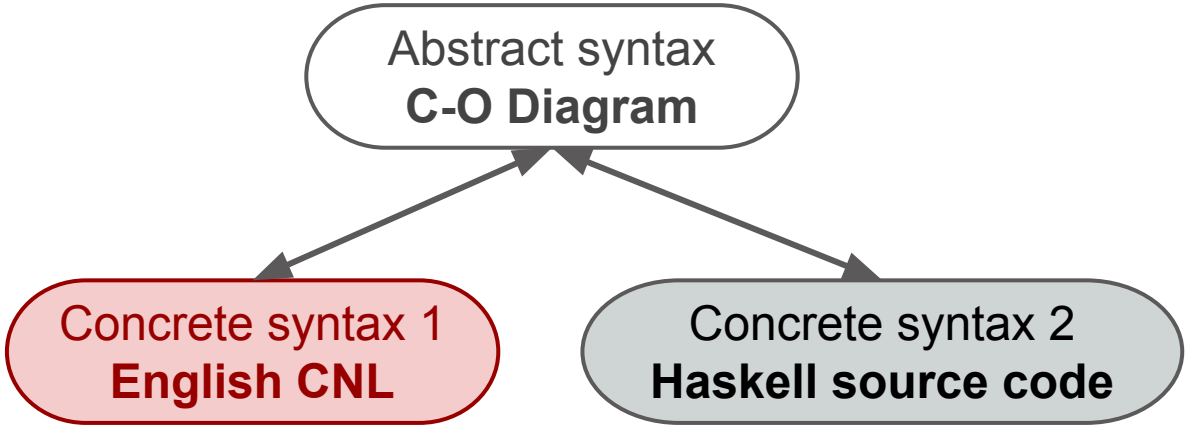
Controlled Natural Language

- Restricted subset of NL
  - Unambiguous parsing
  - Easily human-readable
  - Human-writable with little training
- English-like linearisation for C-O diagrams
- Directly parsable into formal model

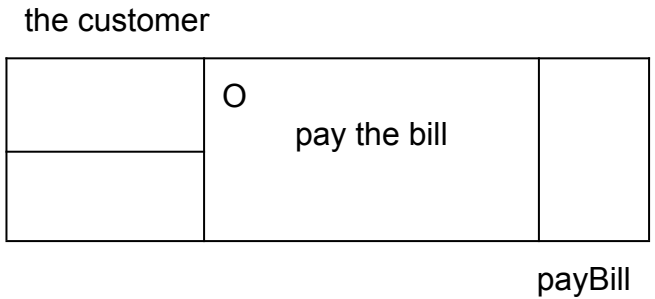
Grammatical Framework (GF)



- Framework for multilingual grammars
- Language-independent semantic interlingua
- Generation and parsing from single grammar



Example: modal variants (O)

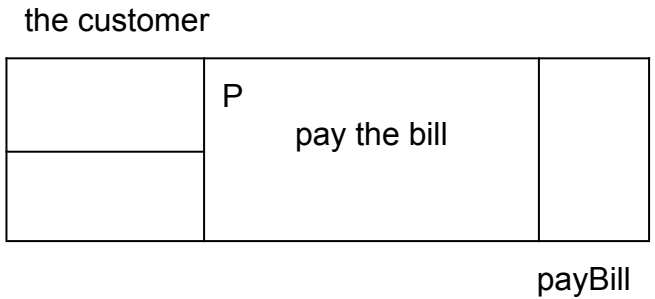


the customer **is obliged to** pay the bill

the customer **is required to** pay the bill

the customer **must** pay the bill

Example: modal variants (P)

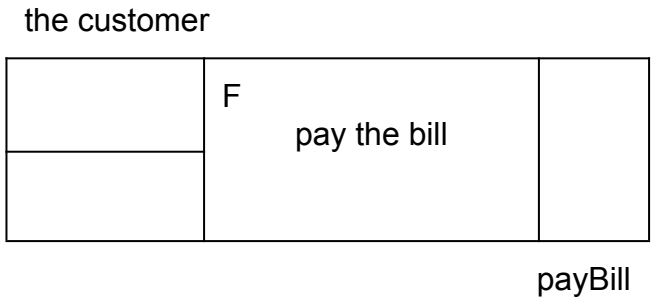


the customer **is allowed to** pay the bill

the customer **is permitted to** pay the bill

the customer **may** pay the bill

Example: modal variants (F)

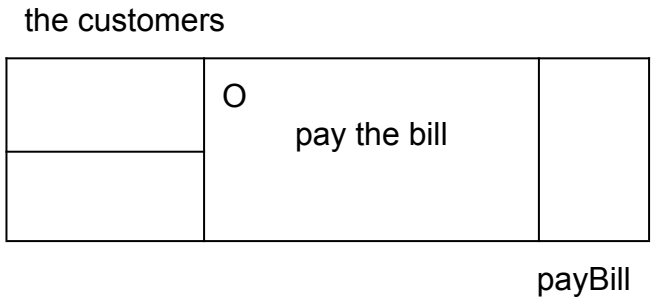


the customer **is not allowed to** pay the bill

the customer **may not** pay the bill

the customer **must not** pay the bill

Example: agreement

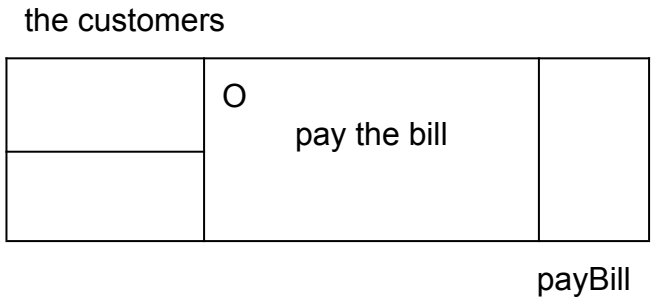


the customers **are** obliged to pay the bill

the customers **are** required to pay the bill

the customers must pay the bill

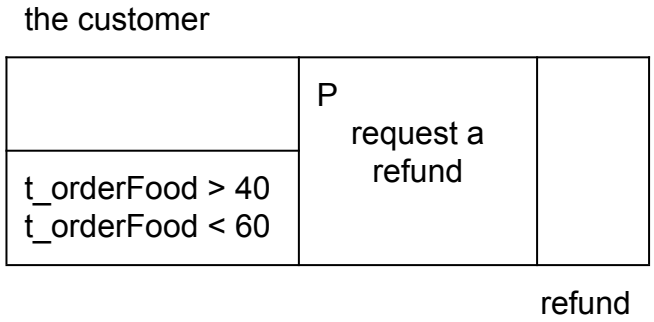
Example: resulting object




```
the customers are obliged to pay
the bill
```

```
O
  (Agent "the customers")
  (N "payBill")
  Nothing
  Nothing
  (A_Action (Action "pay the bill"))
  Just (R Nothing)
```

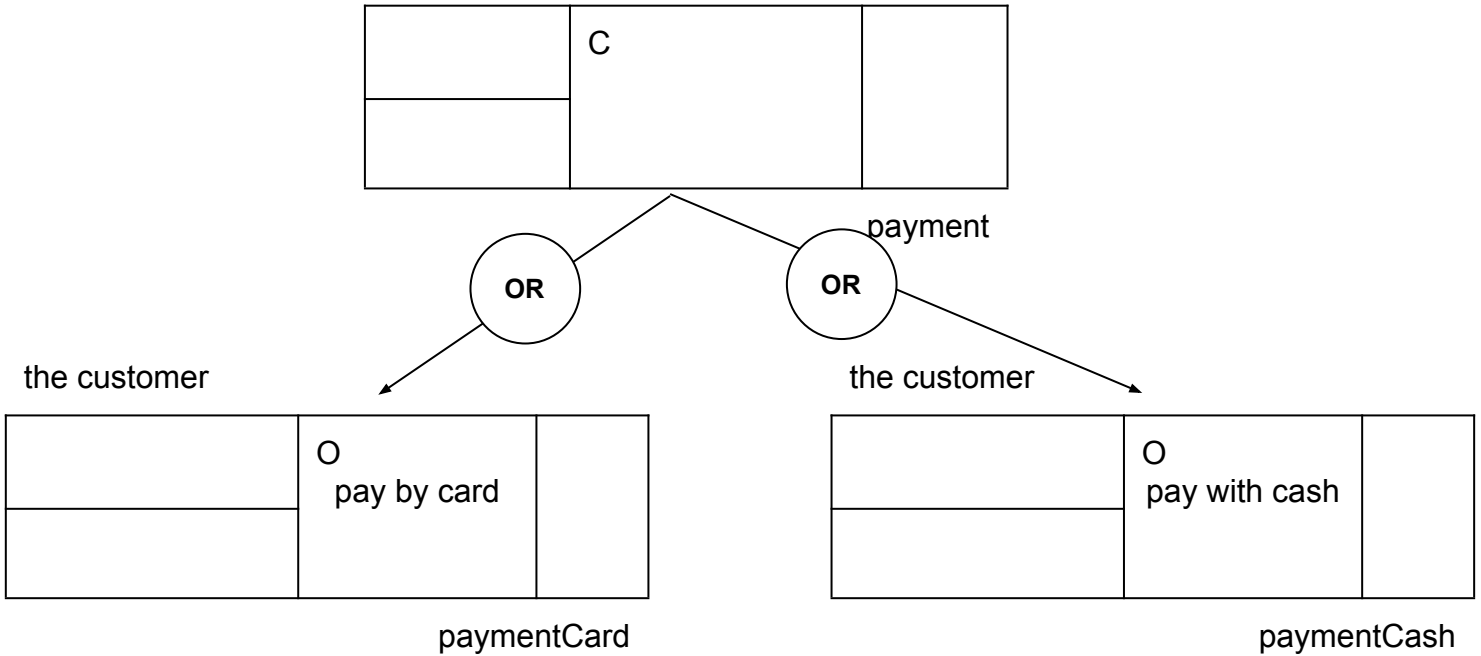
Example: two timing restrictions




```
when t_orderFood is greater than
40 and t_orderFood is less than
60 the customer may request a
refund
```

```
when
  - t_orderFood is greater than 40 , and
  - t_orderFood is less than 60
the customer may request a refund
```

Example: refinement



Example: refinement

Inline

```
the customer must pay by card or the customer is
required to pay with cash
```

Bulleted

```
any of
  - the customer must pay by card
  - the customer is required to pay with cash
```

Labels

- Something I left out
- All clauses must include a label

```
payment: any of
  - paymentCard: the customer must pay by card
  - paymentCash: the customer is required to pay with cash
```

- Needed for cross-refs, reparations
- Easily hidden with tools

Tools

Two tools

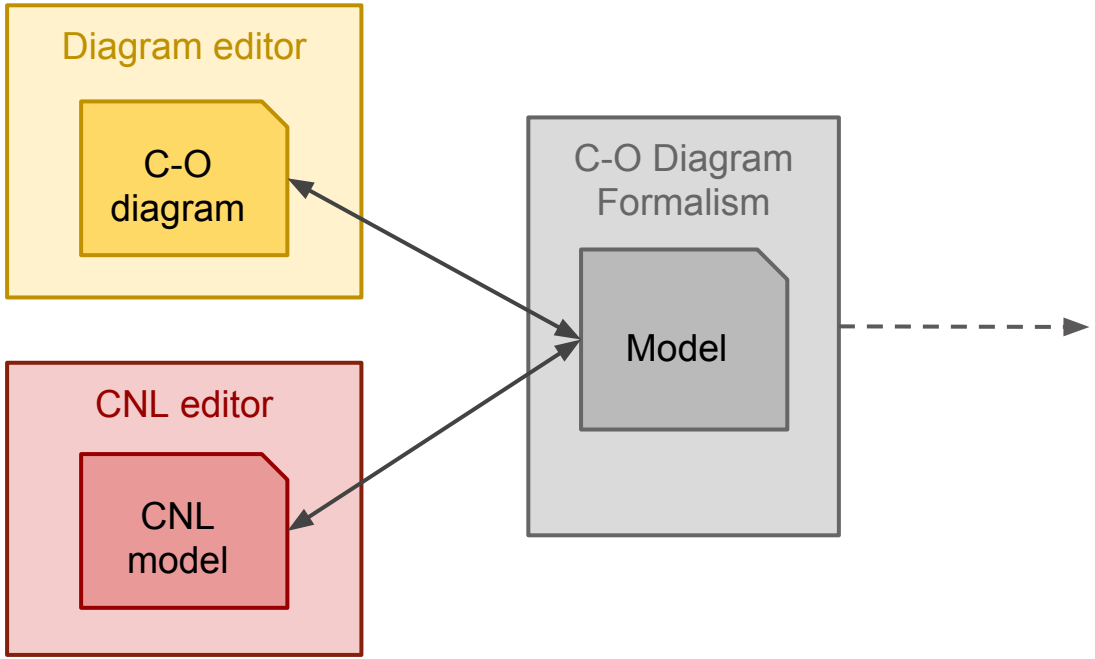
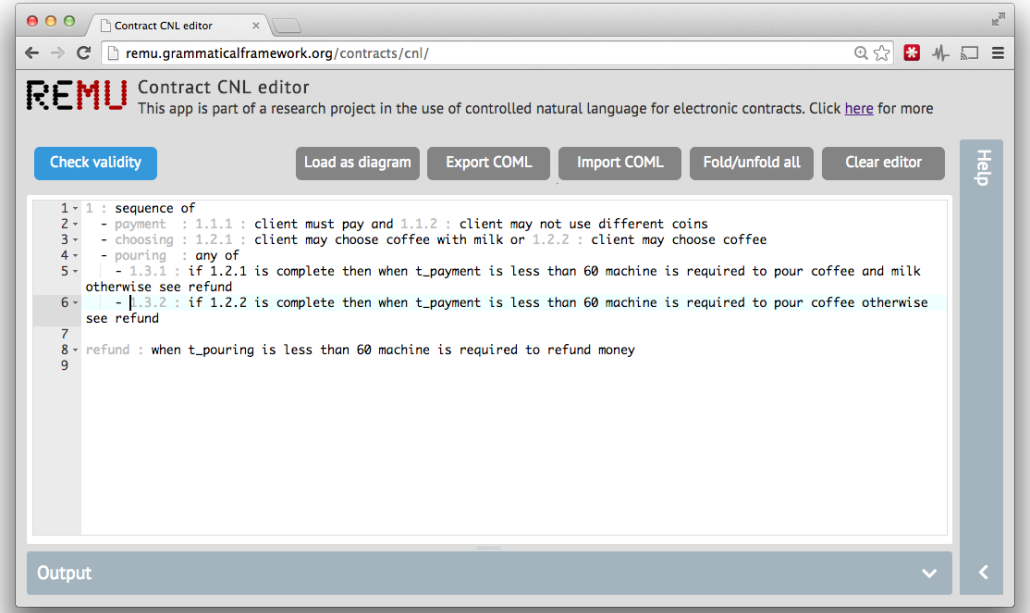


Diagram editor
C-O diagram
CNL editor
CNL model
C-O Diagram Formalism
Model

CNL editor

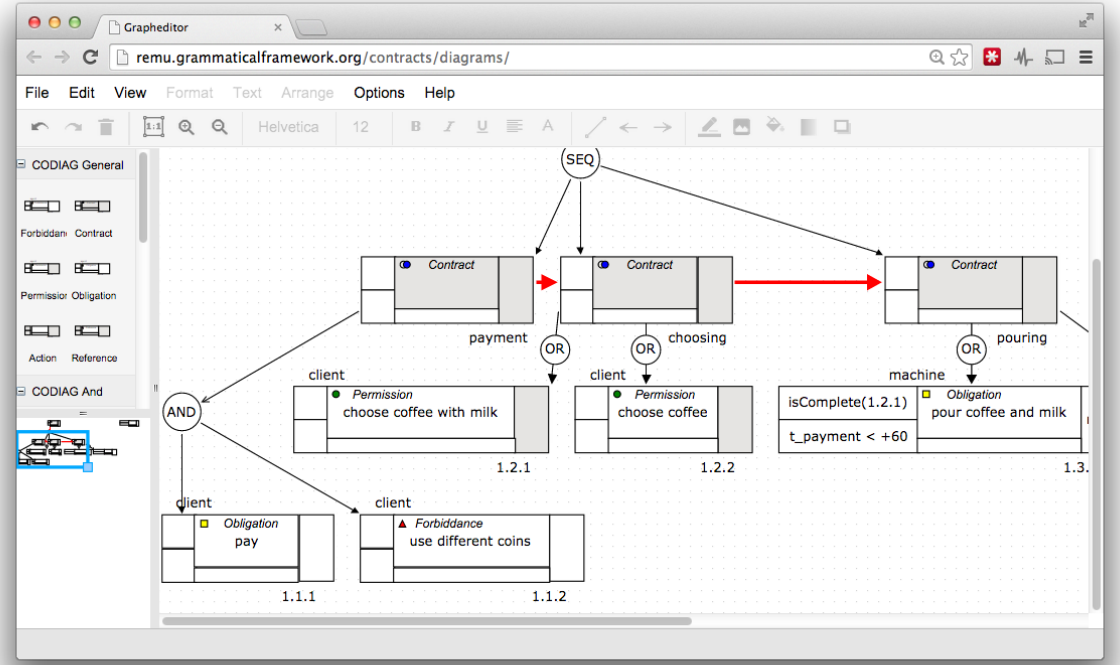
- Basic completion
- Snippets
- Highlighting/folding
- Syntax checking



http://remu.grammaticalframework.org/contracts/cnl/

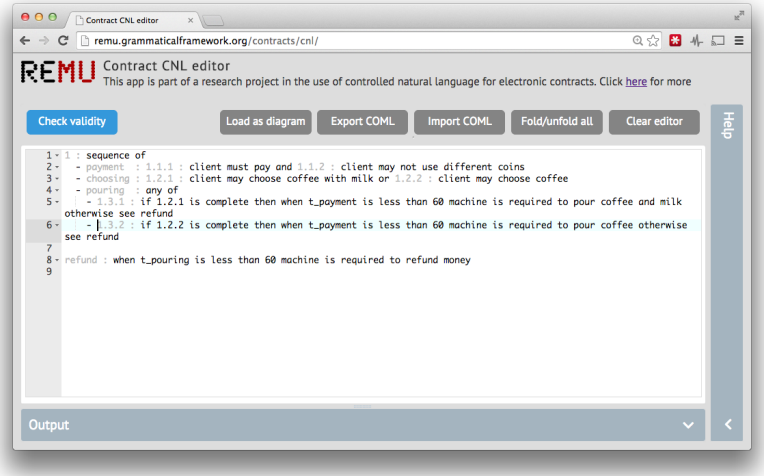
Visual diagram editor

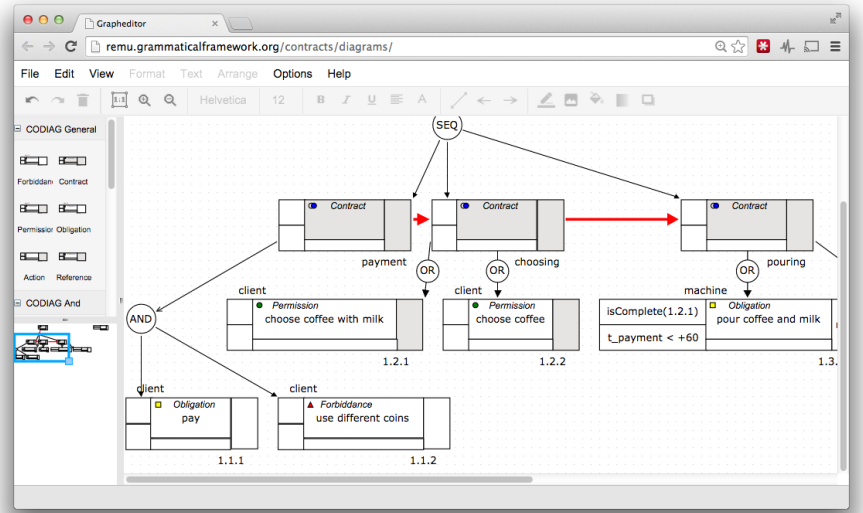
- Point and click
- Web-based
- Automatic validation



http://remu.grammaticalframework.org/contracts/diagrams/

Tool communication





- Import/export via XML

Conclusions

Summary

- C-O Diagram formalism
  - Extensions & trace semantics
- Translation to UPPAAL NTA
  - Full implementation
- CNL interface
- User modelling tools

Future work

- Correctness proof
  - Translation w.r.t. trace semantics
- Improvements to CNL
- Analysis
  - Query templates
  - Tool for generation & checking
  - Formulation of answer from counter-examples


Thanks
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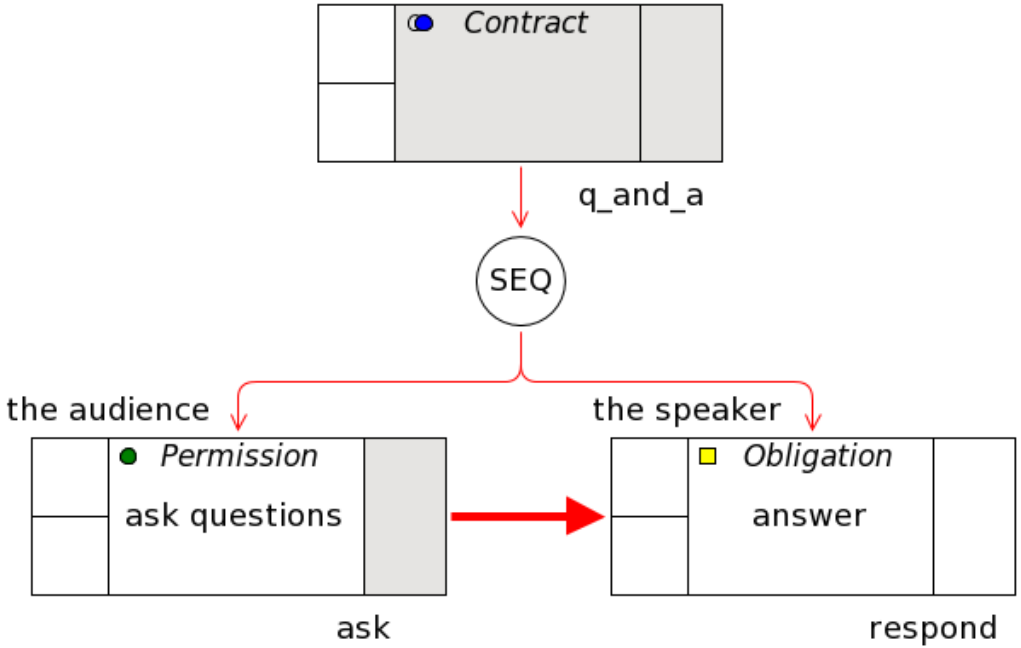
Q & A


Contract
q_and_a
SEQ
the audience
the speaker
Permission
ask questions
Obligation
answer
ask
respond