Modelling Dynamic Normative Understanding in Agent Societies

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

Christopher K. Frantz
Martin K. Purvis
Tony Bastin Roy Savarimuthu
Mariusz Nowostawski

Department of Information Science,
University of Otago
New Zealand

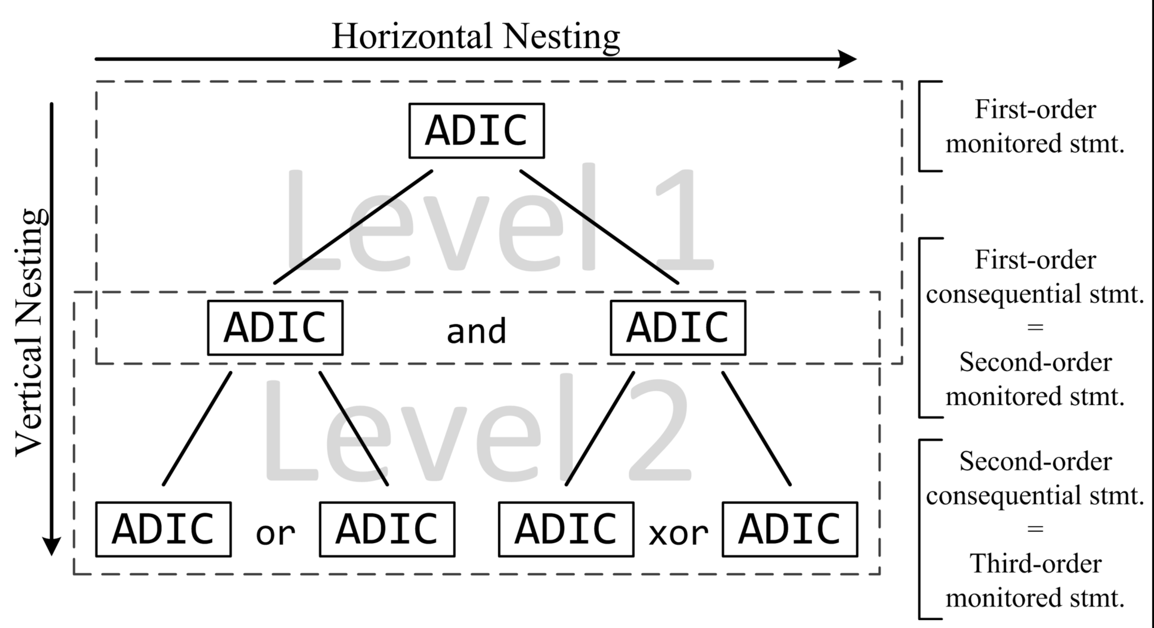
Abstract

We introduce a data-driven approach to norm generalisation using a unified structural representation based on nADICO [2], an extended variant of Crawford and Ostrom's Grammar of Institutions [1]. The transparent process manages the trade-off of providing a comprehensive representation of normative understanding in artificial societies, while offering an accessible interpretation to researchers.

Nested ADICO (nADICO)

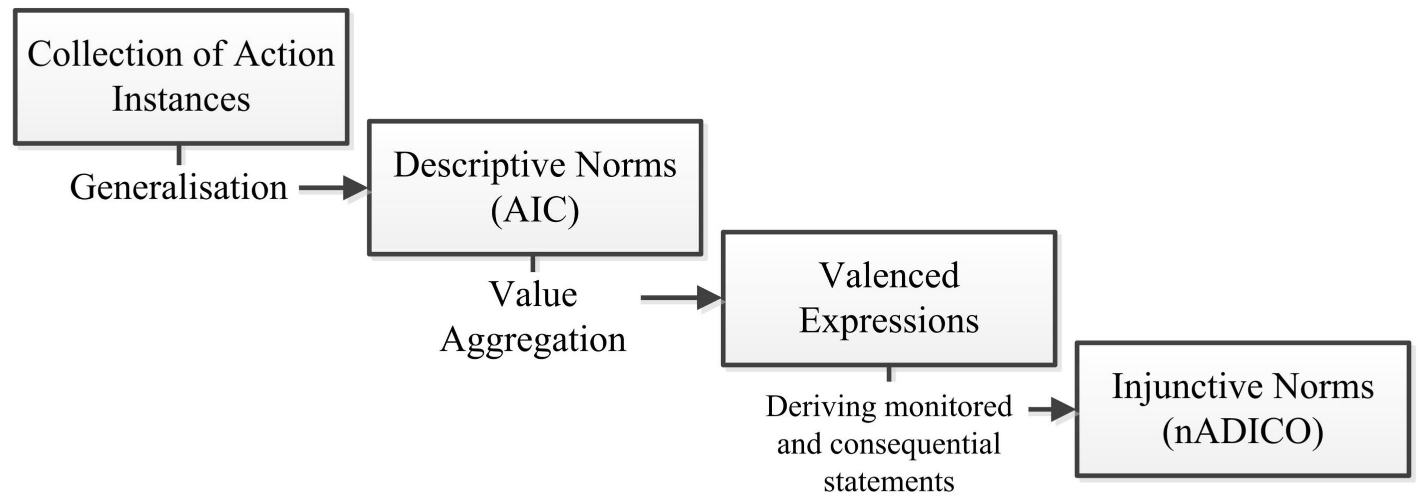
- **Grammar Components**
  - *Attributes* (*A*): Actor attributes
  - *Deontic* (*D*): Nature of Duty (Prohibition, Obligation, Permission)
  - *Aim* (*I*): Action or outcome
  - *Conditions* (*C*): Circumstances of actions (time, place, context). Defaults to 'at all times, at all places'.
  - *Or else* (*O*): Consequence for non-compliance as nADICO statement
- **Institution Types**

  Institution types can be composed based on different component combinations:
  - AIC: Convention/Descriptive Norm
  - nADICO: Injunctive Norm/Rule
- **Nesting**
  - Vertical Nesting: Substitution of 'Or else' component by nADICO statement (e.g. ADIC(ADIC))
  - Horizontal Nesting: Combination by logical operators *and*, *or*, *xor*, *not* (e.g. ADIC *and* ADIC; ADIC *or* ADIC)



Generalisation Process

The process involves the following steps:



To generalise institutional understanding from action experience/observation we use a uniform structural representation for both actions and institutions. `act` statements indicate actions, `aic` and `adic` statements represent conventions and norms respectively.

Component	Structure	Example/Instance
Attributes	attributes(i, s), with i/s being sets of individual/social attributes	attributes({id}, {role})
Action Definition	aim(a, p), with a being a natural language action descriptor, and p being a set of action properties	aim(send, {object, target})
Conditions	conditions(act, c), with act being a preceding action, and c being a set of further conditions	act(Trader2, aim(trade, {goods}), conditions(act(Trader1, aim(send, {goods, Trader2}), *)))
Action Statement	act(attributes, aim, conditions)	act(Trader1, aim(send, {goods, Trader2}), *)

Generalisation

```
act(attributes(Trader1, Seller), aim(embezzle, goods),
    c(act(attributes(Owner1, Sender), aim(send, goods), *))), -3
act(attributes(Trader2, Seller), aim(embezzle, goods),
    c(act(attributes(Owner2, Sender), aim(send, goods), *))), -5
```

Individual action instances are generalised by removing individual attributes (e.g. name, id) and grouped based on remaining properties. Doing so we arrive at descriptive norms/conventions:

```
aic(attributes(*, Seller), aim(embezzle, goods),
    c(aic(attributes(*, Sender), aim(send, goods), *)))
```

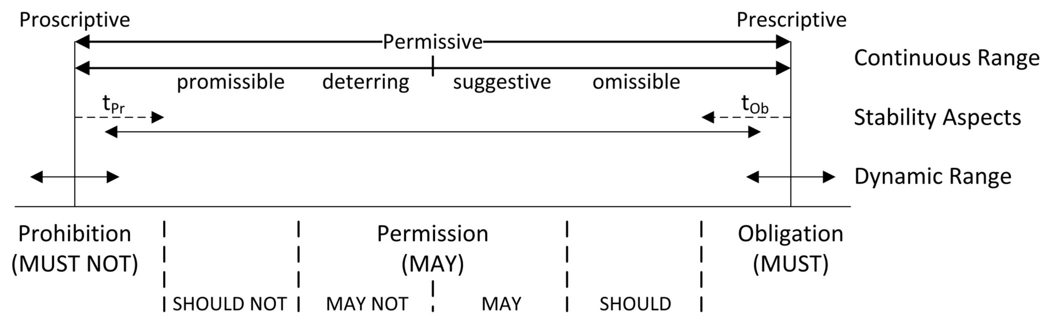
Value Aggregation

Feedback associated with individual generalised actions is aggregated based on strategies such as *rational* (mean value), *opportunistic* (extremal value), *optimistic* (most positive value), and *pessimistic* (most negative value). Applying the rational aggregation strategy, we arrive at valenced expressions.

```
aic(attributes(*, Seller), aim(embezzle, goods),
    c(aic(attributes(*, Sender), aim(send, goods), *))), -4
```

Deriving nADICO Statements

In order to derive injunctive norms, we apply the concept of Dynamic Deontics [3], which facilitates the mapping of normative understanding onto a continuous range structured by deontic compartments with attached labels (e.g. *must not*, *should not*).



The individual actions of the valenced expression are decomposed into individual actions and translated into nADICO statements (details in paper [4]).

```
adic(attributes(*, Sender), deontic(-4),
     aim(send, goods), *,
     adic(attributes(*, Seller), deontic(4),
     aim(embezzle, goods), *))
```

Assuming that -4 resolves to the deontic compartment *should not*, the derived injunctive norm is thus (literally):

'Senders should not send goods, or else Sellers should embezzle goods.'

For an example application and in-depth discussion of individual steps, refer to the paper [4].

Discussion/Outlook

In this work we provide a flexible generalisation process that allows complex norm representations based on the institutional grammar and builds on transparent procedural steps aiming at accessibility.

It has been applied to an example trader scenario in which traders act according to what they understand as the prevalent norm.

Future prospects include the extraction of ontological understanding (e.g. based on actor attributes) from derived norm understanding.

References

1. S. Crawford and E. Ostrom. *A Grammar of Institutions*, The American Political Science Review, 89 (3), pp. 582-600, 1995.
2. C. Frantz, M. K. Purvis, M. Nowostawski, and T. B. R. Savarimuthu. *nADICO: A Nested Grammar of Institutions*, PRIMA 2013, pp. 429-436, 2013.
3. C. Frantz, M. K. Purvis, M. Nowostawski, and T. B. R. Savarimuthu. *Modelling Institutions with Dynamic Deontics*, COIN IX, pp. 211-233, 2014.
4. C. K. Frantz, M. K. Purvis, T. B. R. Savarimuthu, M. Nowostawski. *Modelling Dynamic Normative Understanding in Agent Societies*, PRIMA 2014.