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Open Reading for Free Choice Permission

A Perspective from Substructural Logics

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Outlines

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- Motivations
- Open Reading
- Substructural Logics
- An Example
- Conclusions

History

- Standard Deontic Logic: Permission $=_{df}$ the dual of Obligation
  - $O(A \wedge B) \subset\supset OA \wedge OB$
  - $P(A \vee B) \subset\supset PA \vee PB$
- Many faces of permissions:
  strong/weak permission, explicit/implied/tacit permission, free choice permission (FCP), open reading, etc.
- Dynamic approach of free choice permission:

$$P(A) = [A]\neg Violation$$

- Canonical Form of FCP:

$$P(A \vee B) \supset PA \wedge PB$$

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Problems of FCP

1. $PA \supset P(A \wedge B)$
   - Monotonic case: Vegetarian free lunch

     $$P(Order) \supset P(Order \wedge not\ Pay)$$

   - Resource insensitive case:

     $$P(Eat\ a\ cookie) \supset P(Eat\ a\ cookie \wedge Eat\ a\ cookie)$$

2. $P(A \vee \sim A) \supset PB$
   - Irrelevant case:

$$P(Open\ Window \vee not\ Open\ Window) \subset\supset P(Sell\ House \vee not\ Sell\ House)$$
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Possible Solutions

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Resource Sensitivity

Chris Barker. *Free choice permission as resource-sensitive reasoning*. Semantics and Pragmatics, 2010.

Negation

Sun Xin and H. Dong. *The deontic dilemma of action negation, and its solution*. LOFT 2014.

Three Difficulties in FCP

Albert J.J. Anglberger, H. Dong, and Olivier Roy. *Open reading without free choice*. DEON 2014.

and so on...

Our Strategy

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1. Open Reading (OR):

   An action type A is permitted iff each token of A is normatively OK.

2. FCP inference

$$A \multimap B \vdash PB \supset PA$$

3. Our two-fold strategy:
   1. To avoid the problems: $(A \wedge B) \multimap A$, $(A \wedge \cdots \wedge A) \multimap A$, and $(A \vee \sim A) \multimap\!\!\circ (B \vee \sim B)$
   2. To save the plausible case:

$$(Order \wedge Pay) \multimap Order \vdash P(Order) \supset P(Order \wedge Pay)$$

4. $A \multimap B$: "If A, *normally*, then B."

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Why Substructural Logic?

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To achieve a systematic view of semantic variety in the landscape of logics for FCP.

Language

Definition (Formulas)

The set $\mathcal{L}$ of well-formed formulas of normality is defined as follows:

$$A := p \mid \bot \mid \neg A \mid (A \uplus A) \mid (A \circ A) \mid (A \multimap A) \mid P(A)$$

where $p \in Act_0$ where Act_0 is the set of all atomic propositions with regards to actions.

$A \supset B =_{def} \neg A \uplus B$.

Examples

- How to understand $A \circ B$:
  - "doing A together with doing B"
  - concurrent action:
    $Listen \circ Write\ Note$
- How to understand $A \multimap B$:
  - "doing A counting as doing B"
  - count-as relations:
    $Cycle \multimap Travel\ By\ Vehicle$,
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Definition (Structures)

The set $\mathcal{S}$ of structures of normality is defined as follows:

$$X := A \mid 1 \mid (X; X) \mid (X, X).$$

where $A \in \mathcal{L}$ is a well-formed formula.

$X[Y]$ means a structure X with a substructure Y, while $X[Z/Y]$ means a structure X with replacing the occurrences of the substructure Y by Z.

Frames

A frame for normality is a tuple $\mathcal{F} = \langle W, M, OK \rangle$ where

- W is a non-empty set of events
- $M \subseteq W \times W \times W$ is a ternary relation on W
- $OK \subseteq W \times W$ is a binary relation on W

Possible readings:

1. $Mwyz$:
   An event w combining/composing with an event y leads to an event z.
2. $OK(y, w)$:
   Seeing from event w, y is normatively OK.

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Models

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Let a tuple $\mathcal{M} = \langle \mathcal{F}, V \rangle$ be a model based on a frame $\mathcal{F}$ for normality, a function $V : Act_0 \rightarrow \wp(W)$ assigning a set of events such that $V(p) \subseteq W$ for all $p \in Act_0$, where $p \in Act_0$. A well-formed formula $A \in$ is *true* at event w in model $\mathcal{M}$, written $\mathcal{M}, w \vDash A$, and a structure X is true at w in $\mathcal{M}$, written $\mathcal{M}, w \vDash X$, are defined as follows:

$\mathcal{M}, w \vDash p$	iff	$w \in V(p)$
$\mathcal{M}, w \nvDash \bot$		for all $w \in W$
$\mathcal{M}, w \vDash \neg A$	iff	$\mathcal{M}, w \nvDash A$
$\mathcal{M}, w \vDash A \uplus B$	iff	$\mathcal{M}, w \vDash A$ or $\mathcal{M}, w \vDash B$
$\mathcal{M}, w \vDash A \multimap B$	iff	$\forall y, z \in W.(\mathcal{M}, y \vDash A \ \& \ Mwyz \Rightarrow \mathcal{M}, z \vDash B)$
$\mathcal{M}, w \vDash A \circ B$	iff	$\exists y, z \in W.\ (\mathcal{M}, y \vDash A, \mathcal{M}, z \vDash B \ \& \ Myzw)$
$\mathcal{M}, w \vDash PA$	iff	$\forall y, z \in W.\ (\mathcal{M}, y \vDash A \Rightarrow OK(y, w))$
$\mathcal{M}, w \vDash 1$		for each $w \in W$
$\mathcal{M}, w \vDash X; Y$	iff	$\exists y, z \in W.\ (\mathcal{M}, y \vDash X, \mathcal{M}, z \vDash Y \ \& \ Myzw)$
$\mathcal{M}, w \vDash X, Y$	iff	$\mathcal{M}, w \vDash X$ and $\mathcal{M}, w \vDash Y$

A Basic Logic

A basic sequent calculus N^0 of normality:

(∘R) $$\frac{X \vdash A \quad Y \vdash B}{X; Y \vdash A \circ B}$$

(∘L) $$\frac{X[A; B] \vdash C}{X[A \circ B] \vdash C}$$

(⊸ R) $$\frac{X; A \vdash B}{X \vdash A \multimap B}$$

(⊸ L) $$\frac{X \vdash A \quad Y[B] \vdash C}{Y[A \multimap B; X] \vdash C}$$

(Id) $p \vdash p$ where $p \in Act_0$

(Cut) $$\frac{X \vdash A \quad Y[A] \vdash B}{Y[X/A] \vdash B}$$

(Tra) $$\frac{X; A \vdash B \quad Y; B \vdash C}{(X, Y); A \vdash C}$$

(OR) $$\frac{X; A \vdash B}{X, P(B) \vdash P(A)}$$

One Extension N^{RaM}

$$\text{(RaM)} \quad \frac{X \vdash A \multimap C}{X \vdash \neg((A \circ B) \multimap \bot) \supset (A \circ B) \multimap C}$$

Frame Conditions

- Normality: $\forall w \forall x \forall y' [\forall y(Mwy'y \supset OK(y,x)) \supset OK(y',x)]$.

$$(\mathrm{OR})\quad \frac{X; A \vdash B}{X, P(B) \vdash P(A)}$$

- Transitivity of Normality: $\forall x \forall y \forall z \exists u [Mxyz \supset Mxyu \wedge Mxuz]$.

$$(\mathrm{Tra})\quad \frac{X; A \vdash B \quad Y; B \vdash C}{(X, Y); A \vdash C}$$

- Rational Monotonicity: $\forall x \forall y \forall z \forall s \forall u \forall y' \forall z' \forall s' \forall u' [(Mxyz \wedge Msuy) \wedge (Mxy'z' \wedge Mz's'u') \supset (Mxsz \vee Mxy'z)]$.

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An Example

An acceptable rational monotonic case:

(1)	$Order \multimap Order \vdash Order \multimap Order$	(Id)
(2)	$Order \multimap Order \vdash \neg(Order \circ Pay \multimap \bot) \supset (Order \circ Pay) \multimap Order$	(1), (RaM)
(3)	$Order \multimap Order, \neg(Order \circ Pay \multimap \bot) \vdash P(Order) \supset P(Order \circ Pay)$	(2), (OR)

where $Order, Pay \in Act_0$.

Conclusions and Future Works

1. The logics N^0 and N^{RaM} can avoid the undesired FCP results. In addition, N^{RaM} can implies the desired FCP by applying (RaM).
2. Define obligation in this substructural framework, and check the interaction of obligation and permission.
3. Compare this ternary framework with the binary framework proposed by van Benthem (1979).

Thank you!