Enacting Protocols by Commitment Concession

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Outline

- Motivation
- Commitments for negotiation
- Costs and valuations
- Concession rules
- Properties of commitment concession
- Discussion
Motivation

- A commitment creates a risk for its debtor
- Consider a purchase protocol
  - Customer will pay; merchant will deliver
  - Who should act first?
  - What should each commit to do?
- Possible strategies for commitments
  - Cautious creation: Prevent progress
  - Incautious creation: No matching payback
- Desirable to reduce risk yet enable progress
Commitment Concession

- Begin with weak commitments
- Incrementally strengthen commitments at each round
  - Calculate the consequences of a move
  - Increase the risk taken
  - Expect others to increase their risk
- Continue if others increase their risk sufficiently
Review of Commitments

- A base-level commitment
  - c(x, y, p): x commits to y to bring about p
  - c(customer, merchant, pay)

- A conditional commitment
  - cc(x, y, p, q) is a conditional commitment: x commits to y to bring about q if p is brought out first.
  - cc(customer, provider, deliver, pay)

- Commitments provide meaning to protocol messages
Example Purchasing Enactments

start ($s_0$)

create

CC(M, C, pay, goods) ($s_7$)

create

CC(C, M, goods, pay) ($s_8$)

create

C(M, C, goods) AND pay ($s_5$)

detach

C(C, M, pay) AND goods ($s_3$)

detach

send goods

pay ($s_1$)

send payment

send goods

pay AND goods ($s_2$)

discharge
## Benefits and Risks

- **Benefit of a commitment**: What the agent will gain by creating the commitment
- **Risk of a commitment**: What the agent may lose by creating the commitment

<table>
<thead>
<tr>
<th>Commitment made</th>
<th>C’s risk</th>
<th>C’s benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$cc(C, M, goods, pay)$</td>
<td>$c(C, M, pay)$</td>
<td>goods</td>
</tr>
<tr>
<td>$cc(C, M, c(M, C, goods), pay)$</td>
<td>$c(C, M, pay)$</td>
<td>$c(M, C, goods)$</td>
</tr>
<tr>
<td>$c(C, M, pay)$</td>
<td>$pay$</td>
<td>None</td>
</tr>
</tbody>
</table>

*Enacting Protocols by Commitment Concession p.7/20*
Commitment Concession Rules: 1

- Start with a weak commitment (e.g., conditional rather than base-level)

\[
\frac{G(x, p)}{CC(x, y, p, q)}
\]

(create-CC)

- Discharge a commitment after guaranteeing a benefit from other agents

\[
\frac{C(x, y, q) \quad C(y, x, p) \quad G(x, p)}{q}
\]

(discharge-C)
Commitment Concession Rules: 2

- Cooperate by increasing risk when other (trustworthy) agents make commitments

\[
\frac{\text{CC}(y, x, q, p) \cdot \text{G}(x, p)}{\text{C}(x, y, q)} \quad \text{accept}
\]

- Create a counter conditional commitment: in essence, request further commitment from other agents if they are not immediately trusted

\[
\frac{\text{CC}(y, x, q, p) \cdot \text{G}(x, p)}{\text{CC}(x, y, p, q)} \quad \text{challenge}
\]
Commitment Concession Rules: 3

- If all agents have taken some risk, take some more risk

\[
\begin{align*}
\text{cc}(x, y, p, q) & \quad \text{cc}(y, x, q, p) \\
\text{c}(x, y, q) & \quad \neg \text{cc}(x, y, p, q)
\end{align*}
\]  
(complement)

- When other agents are apparently at greater risk, commit more

\[
\begin{align*}
\text{c}(x, y, q) & \quad \text{cc}(y, x, q, p) \\
\text{c}(y, x, p) & \quad \neg \text{cc}(y, x, q, p)
\end{align*}
\]  
(ponens)
Applying the Concession Rules
Private Valuations of Propositions

Valuation is negative for the agent’s actions and positive for others’ actions.

In either case, a proposition itself can’t have a lower magnitude than a commitment for it:
\[|v_x(p)| \geq |v_x(C(\cdot, \cdot, p))|\]

- As creditor, a proposition is valued above a commitment.
- As debtor, the other way around.

A base-level commitment can’t have a lower magnitude if conditionalized:
\[|v_x(C(x, y, p))| \geq |v_x(CC(x, y, q, p))|\]
Null. Valuation of an empty set is zero:
\[ v_x(\{ \} ) = 0 \]

Separability. Valuation of a union of two sets is the sum of their valuations:
\[ v_x(S_1 \cup S_2) = v_x(S_1) + v_x(S_2) \]

As creditor. Commitment for goal is worth less than the deed: \( v_x(p) > 0 \) implies
\[ 0 \leq v_x(c(y, x, p)) \leq v_x(p) \]

As debtor. Commitment for task is worth more than the deed: \( v_x(p) < 0 \) implies
\[ 0 \geq v_x(c(x, y, p)) \geq v_x(p) \]
Coherent Valuations of States: 2

■ As creditor of conditional commitment:
\[ v_x(c(y, x, p)) \geq v_x(cc(y, x, q, p)) \geq v_x(q) + v_x(c(y, x, p)) \]

■ As debtor of conditional commitment:
\[ v_x(c(x, y, q)) \leq v_x(cc(x, y, p, q)) \leq v_x(p) + v_x(c(x, y, q)) \]
Valuations in Protocol Enactment

- Goal states: valued higher by all than nongoal states
  - $v_C(pay) + v_C(goods) > 0$
  - $v_M(pay) + v_M(goods) > 0$

- Goal states have compatible incentives

- Social welfare of a state: sum of the valuations for all agents

- Inference rules to help agents reach such states while enacting a protocol
# Example Valuations

<table>
<thead>
<tr>
<th>Condition</th>
<th>C’s valuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>goods</td>
<td>2.00</td>
</tr>
<tr>
<td>C(M, C, goods)</td>
<td>1.00</td>
</tr>
<tr>
<td>CC(M, C, pay, goods)</td>
<td>0.50</td>
</tr>
<tr>
<td>pay</td>
<td>-1.00</td>
</tr>
<tr>
<td>C, M, pay)</td>
<td>-0.50</td>
</tr>
<tr>
<td>CC(C, M, goods, pay)</td>
<td>-0.25</td>
</tr>
</tbody>
</table>

M’s valuations are the additive inverses of these
Example Enactment with Valuations

CC(C, M, goods, pay) AND C(M, C, goods)

$\nu_C:0.75$
$\nu_M:0$
$s:0.75$

CC(M, C, pay, goods) AND CC(C, M, goods, pay)

$\nu_C:0.25$
$\nu_M:0.25$
$s:0.5$

CC(M, C, pay) AND C(M, C, goods)

$\nu_C:0.5$
$\nu_M:0.5$
$s:1$

C(C, M, pay) AND goods

$\nu_C:1$
$\nu_M:1$
$s:2$
Quasidistance between States

Measure of progress based on social welfare

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Quasidistance (qd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>{}</td>
<td>{p}</td>
<td>$w(p)$</td>
</tr>
<tr>
<td>{}</td>
<td>{c}</td>
<td>$w(c)$</td>
</tr>
<tr>
<td>{}</td>
<td>{cc}</td>
<td>$w(cc)$</td>
</tr>
<tr>
<td>{q}</td>
<td>{p}</td>
<td>$w(p) - w(q)$</td>
</tr>
<tr>
<td>{c}</td>
<td>{p}</td>
<td>$w(p) - w(c)$</td>
</tr>
<tr>
<td>{cc}</td>
<td>{p}</td>
<td>$w(p) - w(cc)$</td>
</tr>
<tr>
<td>$F_1$</td>
<td>$T_1 \cup T_2$</td>
<td>$qd(F_1, T_1) + qd(F_1, T_2)$</td>
</tr>
<tr>
<td>$F_1 \cup F_2$</td>
<td>$T_1$</td>
<td>$\min(qd(F_1, T_1), qd(F_2, T_1))$</td>
</tr>
</tbody>
</table>
Commitment Concession Properties

- Each rule decreases the valuation of whoever applies it and increases the valuations of others
- Final states have positive social welfare
- Concession rules increase social welfare
- Concession rules guarantee termination in a final state
Discussion

- Application of monotonic concession to commitment protocols

- Concession moves may be
  - Independent of the domain protocol
  - Embedded into the domain protocol

- Directions
  - Study of valuation functions with different characteristics
  - Improved treatment of risk and rationality