Embedding a Card Game Language into a General Game Playing Language

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CGDL (Font, et. al. 2013)

Language domain:

- card games with optional bets,
- using one standard French deck,
- with round-robin order of moves.

Features:

- games generated by a context-free grammar,
- grammar-guided genetic programming can create and modify games,
- embedded artihmetic and boolean operations,
- embedded domain-related concepts (card, suit, number, etc.),
- concise, human readable game code.

GDL-II (Thielscher, 2010)

Language domain:

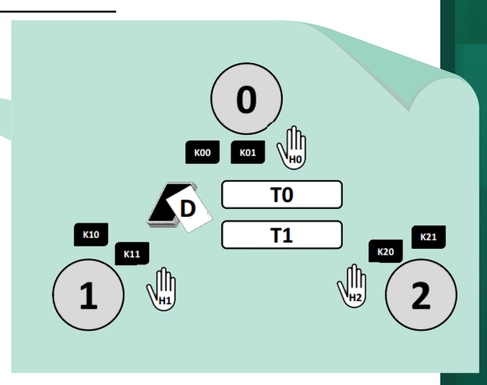
- every finite game,
- turn-based,
- with simultaneous moves.

Features:

- logic programming-like syntax,
- strictly declarative,
- no predefined concepts,
- lenghty, hardly readable game code,
- used in GGP competitions.

CGDL game example (Blackjack) ⇒ GDL-II description output

```
1  [SETTINGS] Players=3, TableLocs=2
2  [STAGES]
3    Stage 0
4  COMPUTER deal, <allplayers>, 2
5  COMPUTER give, <allplayers>, 99
6    Stage 1
7  MANDATORY if λ then bet, λ , λ
8    Stage 2
9  OPTIONAL if λ then pifr, D, 1, up
10 OPTIONAL if λ then done
11   Stage 3
12 MANDATORY if sum, HX, >, 21  then out
13 MANDATORY if sum, HX, <=, 21  then done
14   Stage 4
15 MANDATORY if sum, HX, >, HA  then gain, KA
16 [RANKING] 2:2, ..., King:10, Ace:11, Ace:1
17 [POINTS] token=1, card=0, survive=0
```




```
1 (role random) (role player1) ... (role player3)
...
26 (init (Stage ShuffleDeck COMPUTER))
27 ((init (UnShuffled ?c)) ⇐ (card ?c ?num ?suit))
28 (init (ActionAvailable 0 s0a0 random COMPUTER))...
...
161 ((next (Token ?l2 ?n3))
162   ⇐ (true (Token ?l2 ?n1))∧(movecoin ?n2 ?l1 ?l2)∧(asum ?n1 ?n2 ?n3))
163 ((next (ActionAvailable ?stage ?id1 ?p ?type))
164   ⇐ (true (ActionAvailable ?stage ?id1 ?p ?type))
165   ∧ (does ?player (action ?id2 ?vis ?cond ?act))∧(distinct ?id1 ?id2))
...
314 ((legal ?player ?act) ⇐ (tmplegal ?player ?act))
315 ((tmplegal ?player (action s4a0 visible (sum HX gt HA) (gain KA)))
316   ⇐ (true (Stage 4 MANDATORY)) ∧ (true (CurrentPlayer ?player))
317   ∧ (true (ActionAvailable 4 s4a0 ?player MANDATORY))
318   ∧ (not (true (PlayerStatus ?player aDONE)))
319   ∧ (not (true (PlayerStatus ?player aOUT)))
320   ∧ (handlocation ?player ?hand) ∧ (rsum ?hand ?n)
321   ∧ (handlocation ?p1 ?h1) ∧ (rsum ?h1 ?n1)
322   ∧ (handlocation ?p2 ?h2) ∧ (rsum ?h2 ?n2) ∧ (distinct ?p1 ?player)
323   ∧ (distinct ?p2 ?player) ∧ (distinct ?p2 ?p1)
324   ∧ (or (bgt ?n ?n1) (true (PlayerStatus ?p1 aOUT)))
325   ∧ (or (bgt ?n ?n2) (true (PlayerStatus ?p2 aOUT))))
...
432 ((movecoin ?n ?bloc1 ?hloc) ⇐ (betlocation ?player ?hloc ?bloc)
433   ∧ (does ?player (action ?id ?vi ?cond (gain KA)))
434   ∧ (betlocation ?p ?hloc1 ?bloc1) (rKA ?n))
...
471 ((sees ?player (deltacoins ?n ?loc1 ?loc2))
472   ⇐ (movecoin ?n ?loc1 ?loc2))
473   ∧ (does ?p (action ?id visible ?cond ?action))
...
487 (terminal ⇐ endstage ∧ (true (Stage ?n ?t))
488   ∧ (_stagesorder (Stage ?n ?t) ∧ (Stage EndGame none)))
489 ((goal ?player 100) ⇐ (true (Won ?player)))
490 ((goal ?player 0) ⇐ (true (Won ?p))
491   ∧ (role ?player) ∧ (not(true (Won ?player))))
...
694 (location D) ... (location H3)
695 (handlocation player1 H1) ... (handlocation player3 H3)
696 (betlocation player1 K10 K11) ... (betlocation player3 K30 K31)
...
819 (aplus1 0 1) ... (aplus1 100 101)
820 ((asum ?n 0 ?n) ⇐ (aplus1 ?n ?m))
821 ((asum ?n1 ?n3 ?n5) ⇐ (aplus1 ?n2 ?n3)
822   ∧ (aplus1 ?n4 ?n5) ∧ (asum ?n1 ?n2 ?n4))
...
```

Results

Game	CGDL code				GDL-II code			
					predicates		rules	
	Players	TableLocs	stages	rules	base	all	base	all
Uno	3	1	2	8	10	61	39	254
Blackjack	3	0	5	12	10	63	43	361
Blackjack	3	2	5	12	10	63	43	365
Poker	3	2	13	30	10	68	61	426
Poker	4	2	13	32	10	68	63	437

Theorem 1

For every CGDL game $\mathcal{G}$, presented translation provides a valid GDL-II game description with equivalent semantics.

Theorem 2

The number of created GDL-II rules is linear in terms of the original CGDL game length and the number of created predicates can be bounded by a constant.

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