General Game Player

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What is General Game Player?

- **AI Program** capable of **playing more than one game** skillfully
- **No Human Intervention** required.
- **No prior knowledge** of game.

- Requires Game Definition in specific format : **GDL**(Game Descriptive Language)

- Idea can be extended to tackle **real life** problems

Images from : google images

GDL (Game Descriptive Language)

- **Conceptualization** of games in terms of :
  - Players
  - States
  - Goals
  - Legal moves

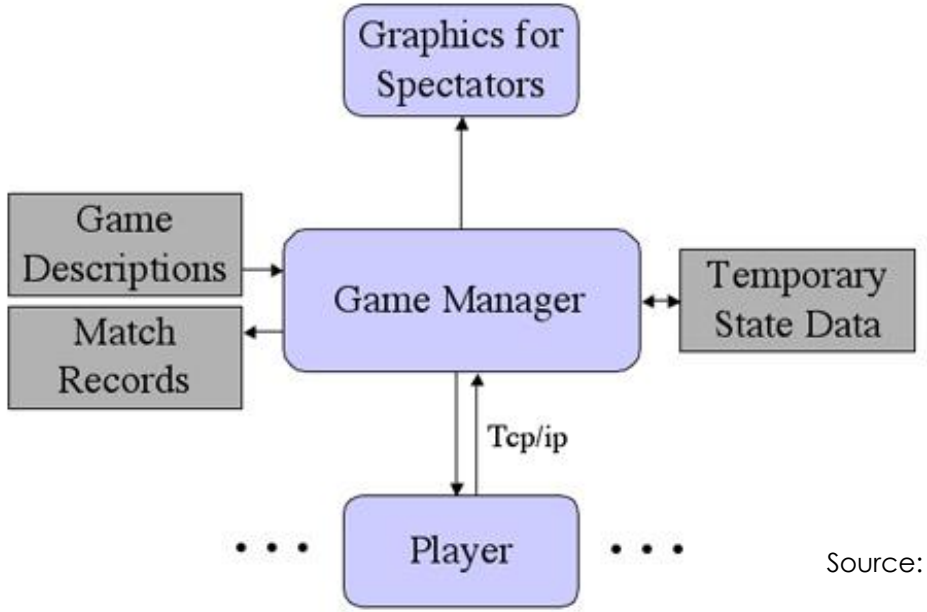
- A Part of GDL of **Tic-Tac-Toe** Game

```
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;; Tictactoe
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;; Roles
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

  (role xplayer)
  (role oplayer)

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;; Initial State
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

  (init (cell 1 1 b))
  (init (cell 1 2 b))
  (init (cell 1 3 b))
  (init (cell 2 1 b))
  (init (cell 2 2 b))
  (init (cell 2 3 b))
  (init (cell 3 1 b))
  (init (cell 3 2 b))
  (init (cell 3 3 b))
  (init (control xplayer))

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;; Dynamic Components
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

;; Cell

  (<= (next (cell ?m ?n x))
      (does xplayer (mark ?m ?n))
      (true (cell ?m ?n b)))

  (<= (next (cell ?m ?n o))
      (does oplayer (mark ?m ?n))
      (true (cell ?m ?n b)))
```

Source: http://users.dsic.upv.es/~flip/RLGGP/tictactoe.gdl

GameMaster

- **Organizes matches** between players
- Provides roles, GDL, startclock and payclock to players.



Source: logic.stanford.edu/ggp

Previous Work

- ClunePlayer (Winner of GGP competition in AAAI 2005)
  - Heuristic Evaluation Functions
- CadiaPlayer (Winner in 2007, 2008 and 2012)
  - Uses UCT and extensive Game Theory
- Ary (Winner in 2009 and 2010)
  - Basic Implementation of Monte Carlo Tree Search (MCTS)

Our Approach

- Working on **Jocular** – a basic reference GGPlayer developed by David Haley, Stanford University

- Implementation of most recent successful variation in MCTS by Cadiaplayer

"Generalized Monte-Carlo Tree Search Extensions for General Game Playing", ***2012***

MCTS

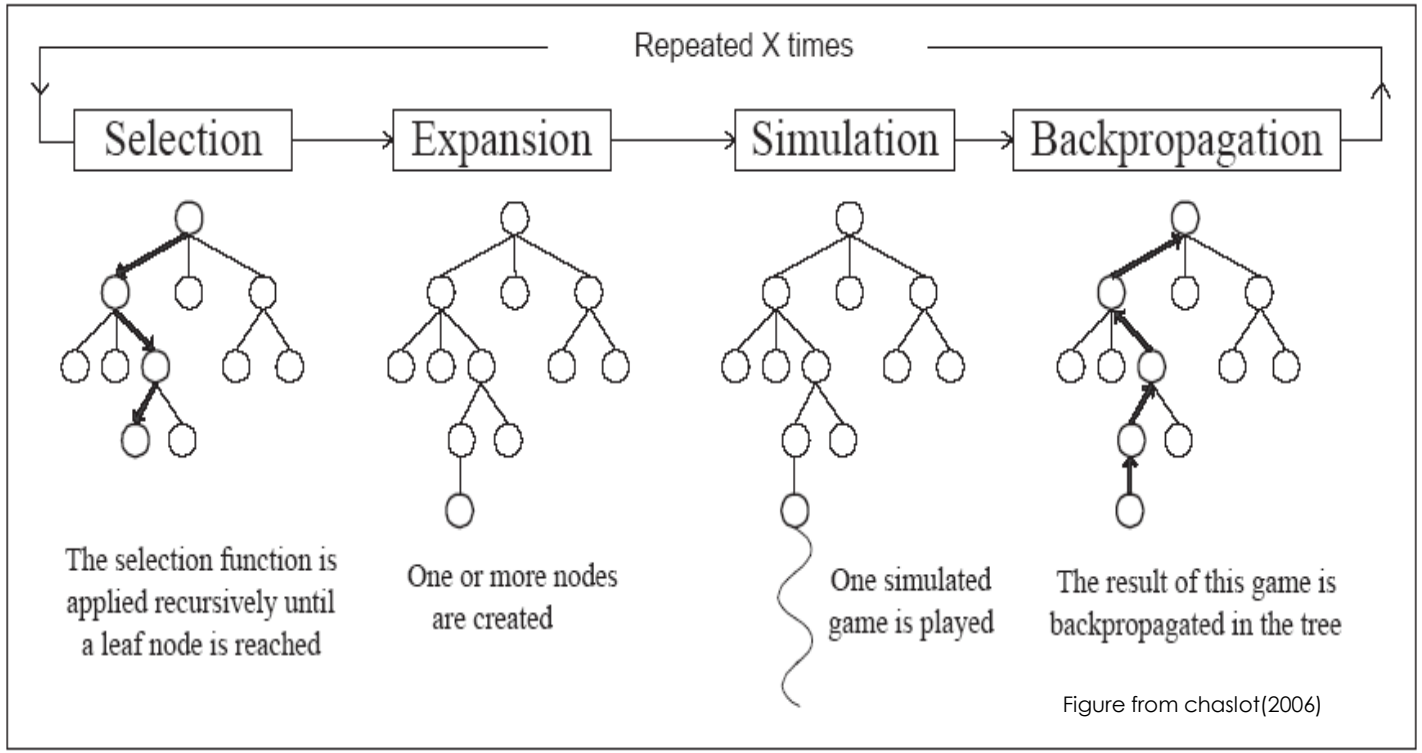


Figure from chaslot(2006)

Each node has an estimated value based on simulation results and the number of times it has been visited.

Explanation

UCT selects the most informative action which is considered to be a when selected from the set of available actions A(s) in state s using the following:

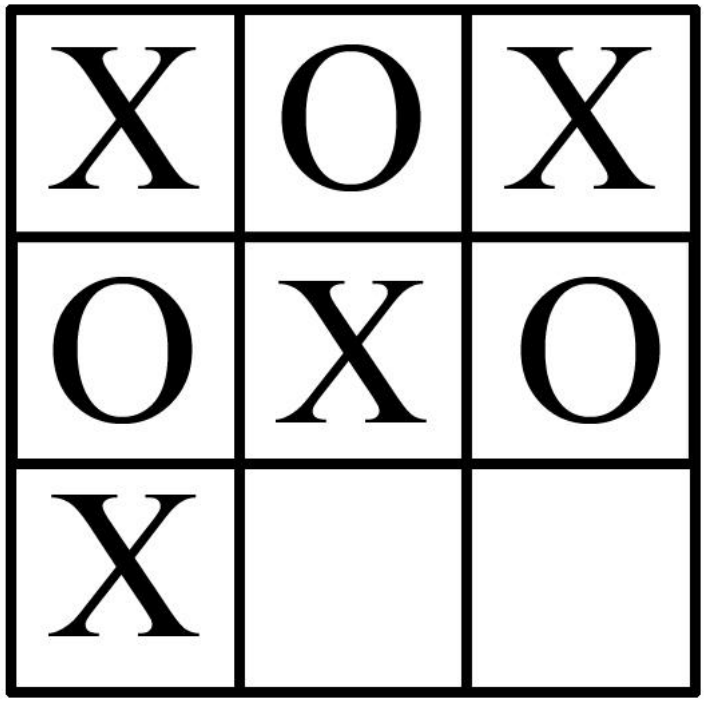
$$k = argmax_{i \in I} \left(v_i + C \times \sqrt{\frac{\ln n_p}{n_i}} \right)$$

Upper Confidence Bounds (UCB) formula

Constant parameter is to maintain balance between **exploration and exploitation** of state.

Results

- **Tic-Tac-Toe** against **Legal** Player




```
Main [Java Application] C:\Program Files\Java\jre7\bin\javaw.exe (Apr 9, 2013 5:06:15 AM)
 ########################################
 # Press Enter to shut the player down. #
 ########################################

[2013-04-09 05:06:15] INFO: Listening on port 2569.
[2013-04-09 05:06:15] INFO: Awaiting incoming connections...
[2013-04-09 05:07:05] INFO: Incoming connection from Mohit-VAIO
[2013-04-09 05:07:05] INFO:
[2013-04-09 05:07:05] INFO: ----------------------------------------------
[2013-04-09 05:07:05] INFO: NEW GAME!
[2013-04-09 05:07:05] INFO:
[2013-04-09 05:07:05] INFO:     My role : xplayer
[2013-04-09 05:07:05] INFO: Start clock : 600
[2013-04-09 05:07:05] INFO:  Play clock : 60
[2013-04-09 05:07:05] INFO:
[2013-04-09 05:07:05] INFO: match1: Game successfully created.
[2013-04-09 05:07:05] INFO: match1: Replied with: READY
[2013-04-09 05:07:05] INFO: Incoming connection from Mohit-VAIO
[2013-04-09 05:07:05] INFO: match1: Beginning move think.
[2013-04-09 05:07:18] INFO: match1: End of move think. Making move: (mark 1 1)
[2013-04-09 05:07:18] INFO: match1: Replied with: (mark 1 1) (explanation "Minimax score is 50") (taunt "Well, could be worse.")
[2013-04-09 05:07:19] INFO: Incoming connection from Mohit-VAIO
[2013-04-09 05:07:19] INFO: match1: Beginning move think. Previous moves: (mark 1 1)  noop
[2013-04-09 05:07:19] FINE: match1: Updating game state.
[2013-04-09 05:07:19] FINE: match1   - Previous: (true (cell 1 1 b))(true (cell 1 2 b))(true (cell 1 3 b))(true (cell 2 1 b))(true (cell 2 2 b
[2013-04-09 05:07:19] FINE: match1   -      New: (true (cell 1 1 x))(true (cell 1 2 b))(true (cell 1 3 b))(true (cell 2 1 b))(true (cell 2 2 b
[2013-04-09 05:07:19] INFO: match1: End of move think. Making move: noop
[2013-04-09 05:07:19] INFO: match1: Replied with: noop (explanation "Minimax score is 50") (taunt "Well, could be worse.")
[2013-04-09 05:07:20] INFO: Incoming connection from Mohit-VAIO
[2013-04-09 05:07:20] INFO: match1: Beginning move think. Previous moves: noop  (mark 2 3)
[2013-04-09 05:07:20] FINE: match1: Updating game state.
[2013-04-09 05:07:20] FINE: match1   - Previous: (true (cell 1 1 x))(true (cell 1 2 b))(true (cell 1 3 b))(true (cell 2 1 b))(true (cell 2 2 b
[2013-04-09 05:07:20] FINE: match1   -      New: (true (cell 1 1 x))(true (cell 1 2 b))(true (cell 1 3 b))(true (cell 2 1 b))(true (cell 2 2 b
[2013-04-09 05:07:20] INFO: match1: End of move think. Making move: (mark 1 3)
[2013-04-09 05:07:20] INFO: match1: Replied with: (mark 1 3) (explanation "Minimax score is 100") (taunt "HAHA! I win!")
[2013-04-09 05:07:20] INFO: Incoming connection from Mohit-VAIO
[2013-04-09 05:07:20] INFO: match1: Beginning move think. Previous moves: (mark 1 2)  noop
[2013-04-09 05:07:20] FINE: match1: Updating game state.
[2013-04-09 05:07:20] FINE: match1   - Previous: (true (cell 1 1 x))(true (cell 1 2 b))(true (cell 1 3 b))(true (cell 2 1 b))(true (cell 2 2 b
[2013-04-09 05:07:20] FINE: match1   -      New: (true (cell 1 1 x))(true (cell 1 2 x))(true (cell 1 3 b))(true (cell 2 1 b))(true (cell 2 2 b
```

References

- Jocular source code http://games.stanford.edu/resources/reference/jocular/
- Dredsen GGP server http://130.208.241.192/ggpserver/
- Ary (2009 and 2010 GGP competition winner in AAAI): http://www.ai.univ-paris8.fr/~jm/ggp/
- Cadia Player Source Code http://cadia.ru.is/wiki/public:cadiaplayer:main
- Course on GGP from Technische University, Dresden : http://www.inf.tudresden.de/content/institutes/ki/cl/study/winter09/ggp/
- Hilmar Finnsson (2012)Generalized Monte-Carlo Tree Search Extensions for General Game Playing In The Twenty-Sixth AAAI Conference on Artificial Intelligence, pp. 1550–1556.
- Hilmar Finnsson and Yngvi Björnsson (2011)Game-Tree Properties and MCTS Performance. The IJCAI-11 Workshop on General Game Playing.
- James Clune, Heuristic evaluation functions for general game playing. In AAAI, pages 1134–1139, 2007
- Stanford course on GGP : logic.stanford.edu/ggp/

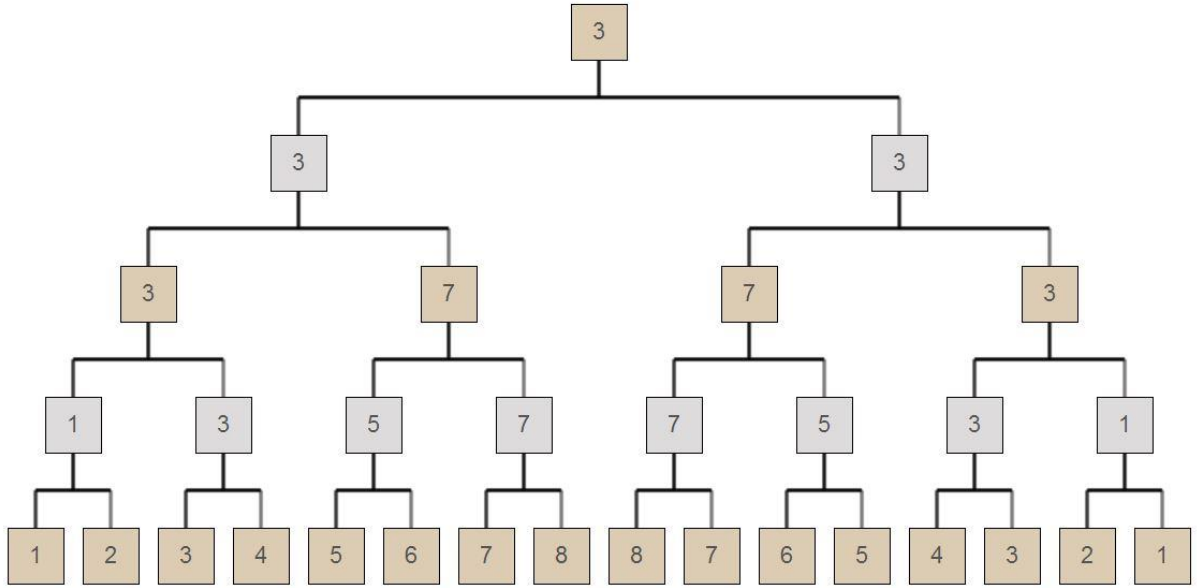
Heuristic Evaluation Functions

- Constructing evaluation functions that **represent exact values of specified games**.
- Incorporate the most essential part of original games- **payoff, control and terrmination**.
- Exact value of simplified game as an **approximation** of original game.
- Game are considered **computed lottery** to combine these evaluation functions.

MiniMax

- **Pessimistic Approach**
- Brown – Max Node – Player Move
- Blue – MinNode – Opponent Move

- Analyzes complete tree



Source : logic.stanford.edu/ggp