General Game Playing
in Common Lisp

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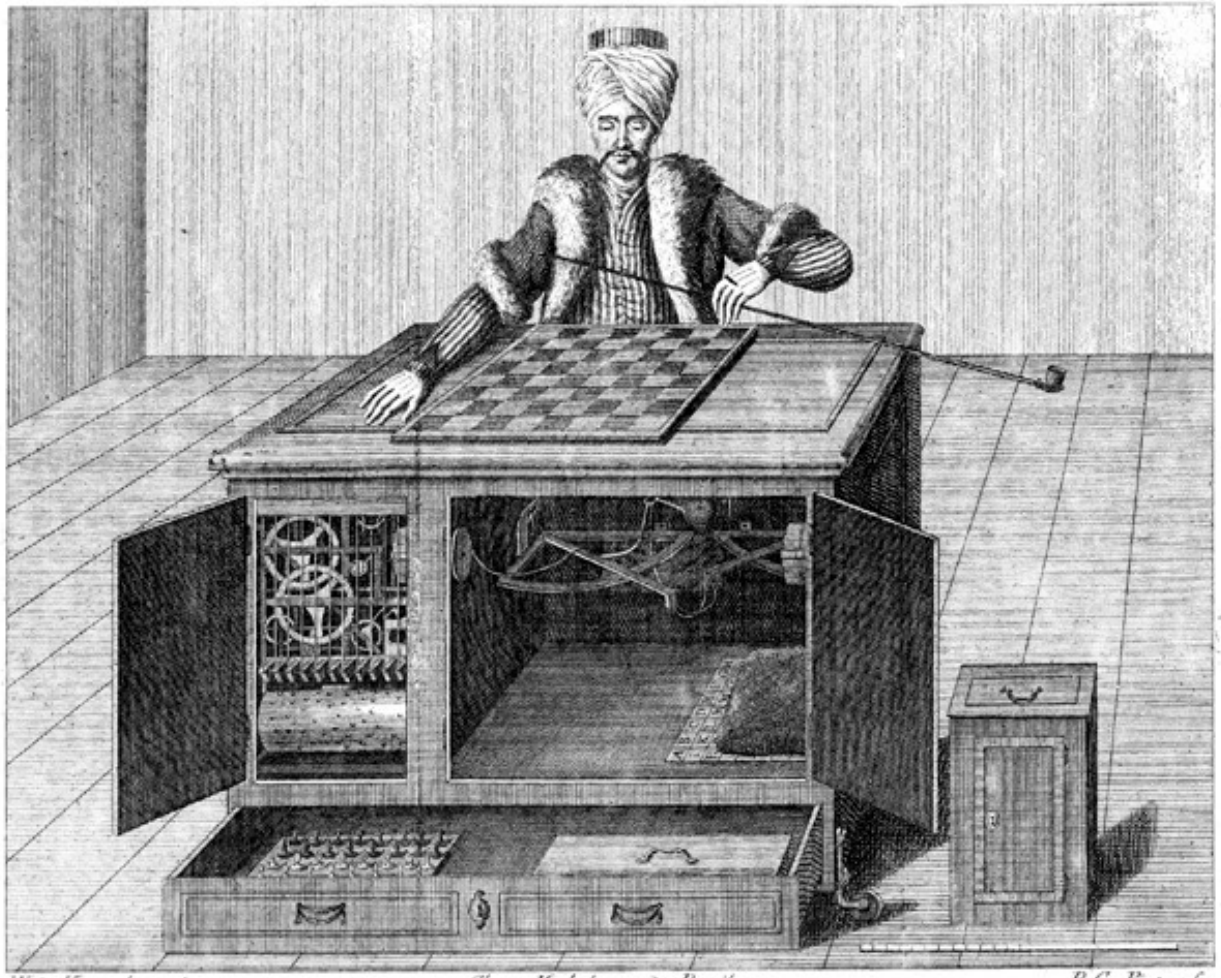
bitbucket.org
github.com
irc.freenode.net
sjl

Goal

Game AI



W. de Kempelen del. Chs. a Mechel excud. Basileæ. P.G. Platzy fc.

Der Schachspieler wie er vor dem Spiele gezeigt wird von vorne. Le Joueur d'Echecs, tel qu'on le montre avant le jeu, par devant.


VŠECHNO
VEZMI

General[1] Game Playing

[1] for some value of "General"

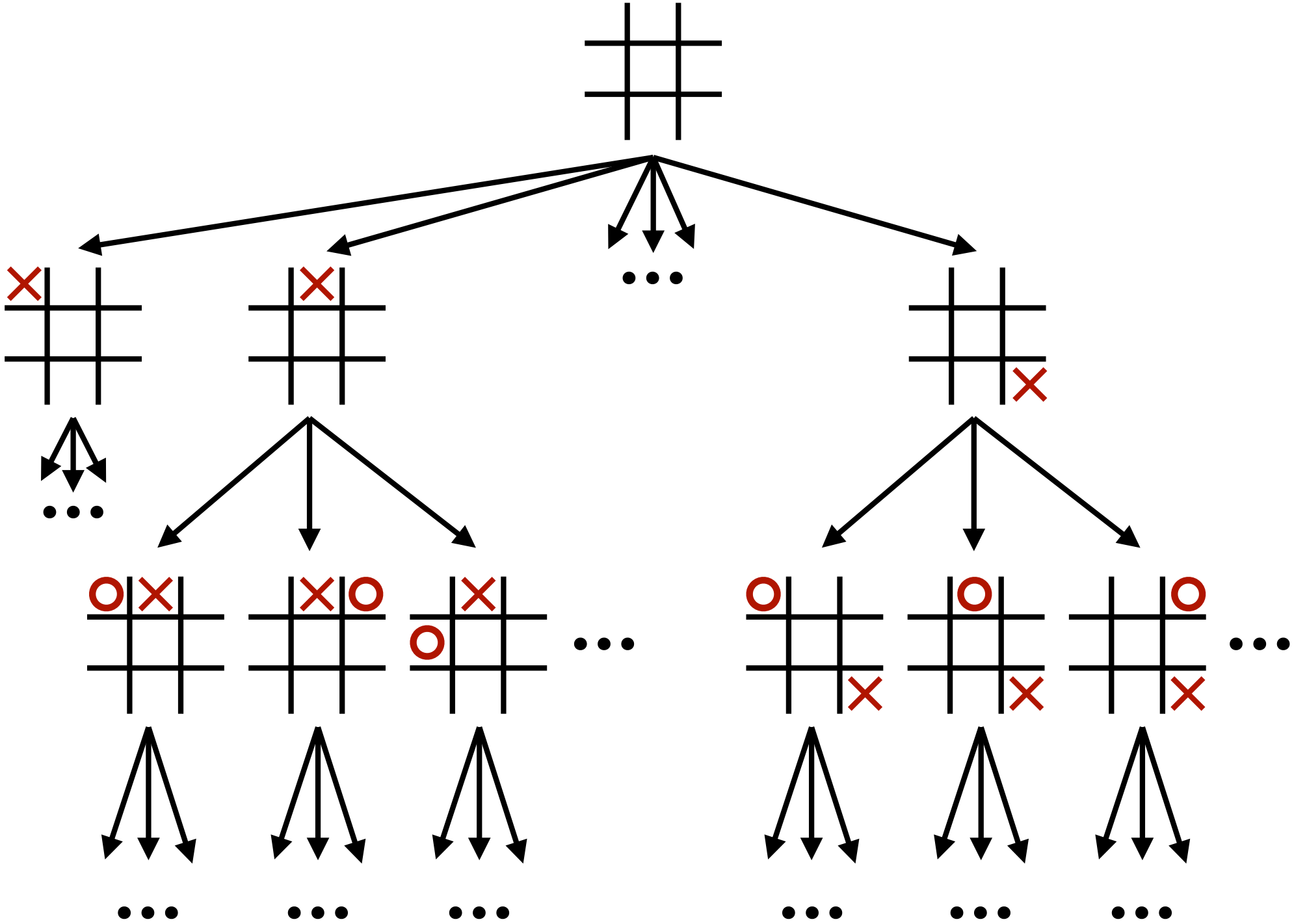
Discrete

Finite Simultaneous Moves

Playable Perfect Information

Winnable Deterministic

Reasoning
Playing
Intelligence

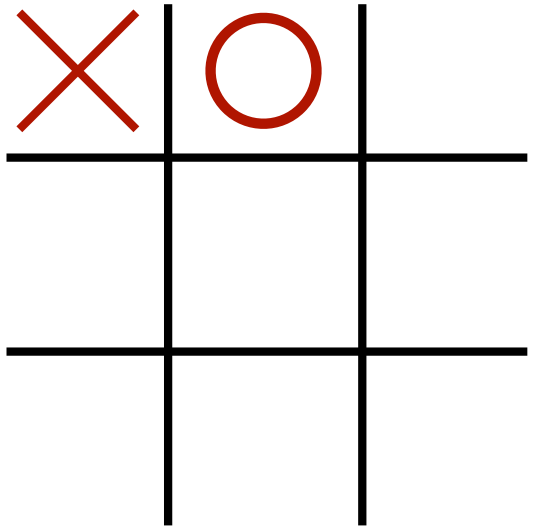


Game
Description
Language

```
;;;; Initial State & Roles

(role x)
(role o)

(init (control x))
(init (cell 1 1 blank))
(init (cell 1 2 blank))
(init (cell 1 3 blank))
(init (cell 2 1 blank))
(init (cell 2 2 blank))
(init (cell 2 3 blank))
(init (cell 3 1 blank))
(init (cell 3 2 blank))
(init (cell 3 3 blank))

;;;; Useful Rules

(<= (row ?n ?mark)
  (true (cell ?n 1 ?mark))
  (true (cell ?n 2 ?mark))
  (true (cell ?n 3 ?mark)))

(<= (column ?n ?mark)
  (true (cell 1 ?n ?mark))
  (true (cell 2 ?n ?mark))
  (true (cell 3 ?n ?mark)))

(<= (diagonal 1 ?mark)
  (true (cell 1 1 ?mark))
  (true (cell 2 2 ?mark))
  (true (cell 3 3 ?mark)))

(<= (diagonal 2 ?mark)
  (true (cell 1 3 ?mark))
  (true (cell 2 2 ?mark))
  (true (cell 3 1 ?mark)))

(<= (line ?mark) (row ?n ?mark))
(<= (line ?mark) (column ?n ?mark))
(<= (line ?mark) (diagonal ?n ?mark))

(<= open
  (true (cell ?row ?col blank)))

;;;; Terminal

(<= terminal (line x))
(<= terminal (line o))
(<= terminal (not open))

;;;; Goal Values

(<= (goal ?player 100)
  (line ?player))

(<= (goal ?player 0)
  (line ?other)
  (distinct ?player ?other))

(<= (goal ?player 50)
  (not (line x))
  (not (line o))
  (not open))

;;;; Legal Moves

(<= (legal ?player (mark ?row ?col))
  (true (cell ?row ?col blank))
  (true (control ?player)))

(<= (legal ?player noop)
  (true (control ?other))
  (distinct ?player ?other))

;;;; State Transitions

(<= (next (control x)) (true (control o)))
(<= (next (control o)) (true (control x)))

(<= (next (cell ?row ?col ?player))
  (true (cell ?row ?col ?player))
  (distinct ?player blank))

(<= (next (cell ?row ?col ?player))
  (true (cell ?row ?col blank))
  (does ?player (mark ?row ?col)))

(<= (next (cell ?row ?col blank))
  (true (cell ?row ?col blank))
  (does ?player (mark ?x ?y))
  (or (distinct ?row ?x)
      (distinct ?col ?y)))
```

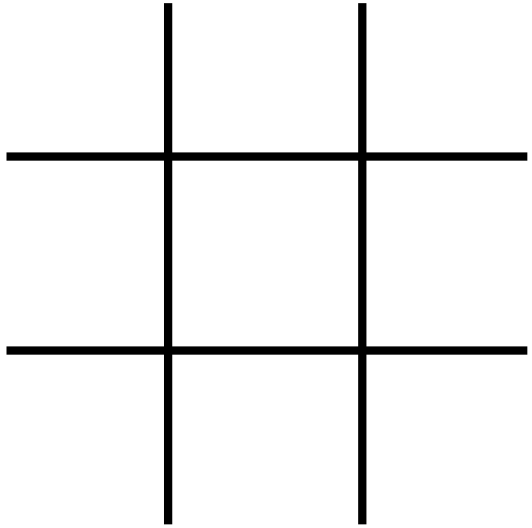
```
(true ...)
```

```
(true (control x))
(true (cell 1 1 x))
(true (cell 1 2 o))
(true (cell 1 3 blank))
(true (cell 2 1 blank))
(true (cell 2 2 blank))
(true (cell 2 3 blank))
(true (cell 3 1 blank))
(true (cell 3 2 blank))
(true (cell 3 3 blank))
```



```
(role ...)
(init ...)
```

```
(role x)
(role o)

(init (control x))
(init (cell 1 1 blank))
(init (cell 1 2 blank))
(init (cell 1 3 blank))
(init (cell 2 1 blank))
(init (cell 2 2 blank))
(init (cell 2 3 blank))
(init (cell 3 1 blank))
(init (cell 3 2 blank))
(init (cell 3 3 blank))
```



```
(<= head
    body...)
```

```
(<= (row ?n ?mark)
  (true (cell ?n 1 ?mark))
  (true (cell ?n 2 ?mark))
  (true (cell ?n 3 ?mark)))

(<= (line ?mark) (row ?n ?mark))
(<= (line ?mark) (column ?n ?mark))
(<= (line ?mark) (diagonal ?n ?mark))

(<= open
  (true (cell ?row ?col blank)))
```

```
(terminal)
(goal player value)
(legal player move)
(next ...)
```

```
(<= terminal (line x))
(<= terminal (line o))
(<= terminal (not open))
```

```
(terminal)
(goal player value)
(legal player move)
(next ...)
```

```
(<= (goal ?player 100)
  (line ?player))

(<= (goal ?player 0)
  (line ?other)
  (distinct ?player ?other))

(<= (goal ?player 50)
  (not (line x))
  (not (line o))
  (not open))
```

```
(terminal)
(goal player value)
(legal player move)
(next ...)
```

```
(<= (legal ?player (mark ?row ?col))
  (true (cell ?row ?col blank))
  (true (control ?player)))

(<= (legal ?player noop)
  (true (control ?other))
  (distinct ?player ?other))
```

```
(terminal)
(goal player value)
(legal player move)
(next ...)
```

```
;; Control flips each turn.

(<= (next (control x))
  (true (control o)))

(<= (next (control o))
  (true (control x)))
```

```
;; Any cell that's already marked
;; stays marked next turn.

(<= (next (cell ?row ?col ?mark))
  (true (cell ?row ?col ?mark))
  (distinct ?mark blank))
```

```
;; If a player chooses to mark a
;; blank cell, that cell will have
;; their mark next turn.


(<= (next (cell ?row ?col ?player))
  (true (cell ?row ?col blank))
  (does ?player (mark ?row ?col)))
```

```
;; All currently-blank cells that
;; WEREN'T marked stay blank.


(<= (next (cell ?row ?col blank))
  (true (cell ?row ?col blank))
  (does ?player (mark ?x ?y))
  (or (distinct ?row ?x)
      (distinct ?col ?y)))
```

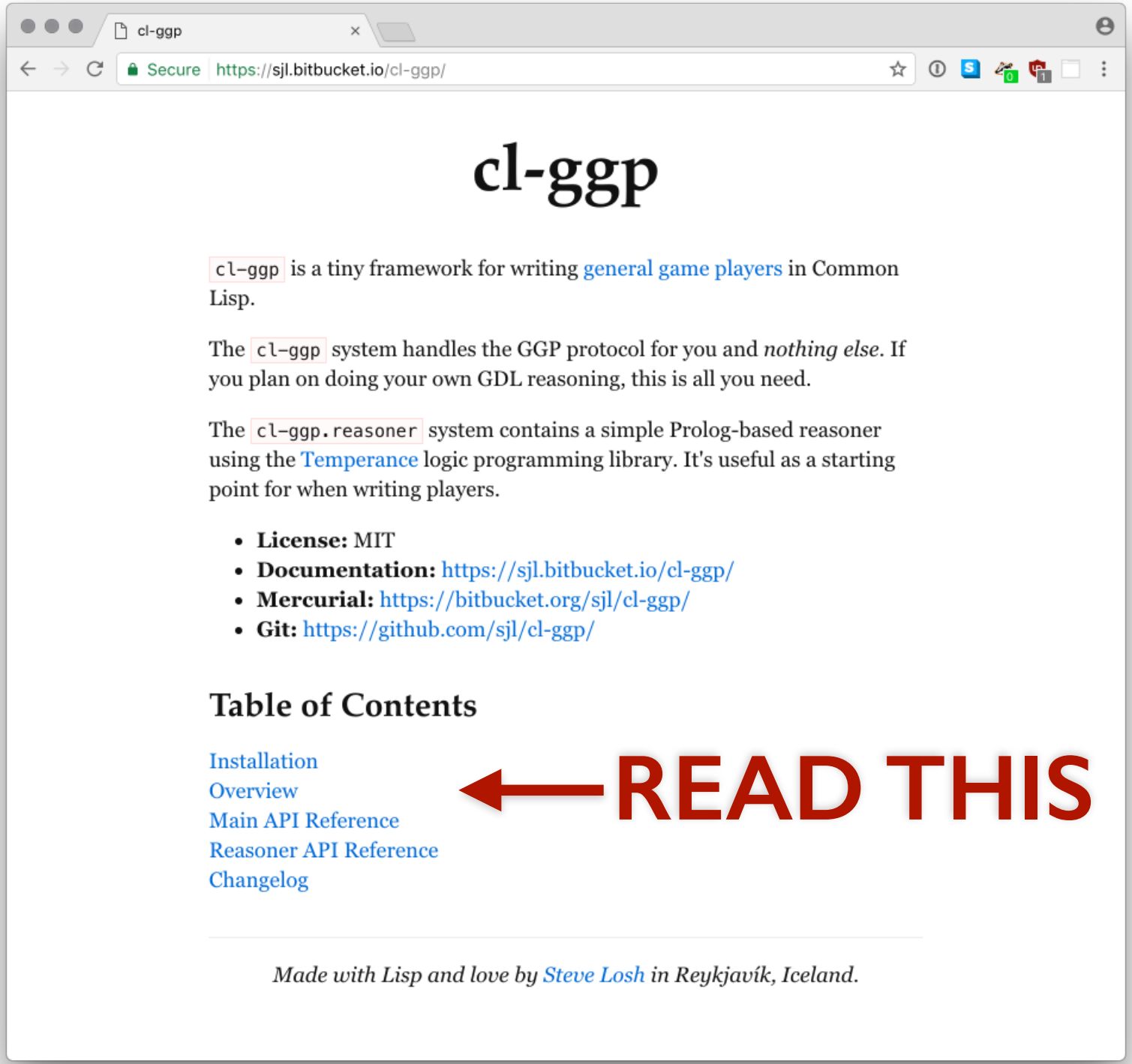
cl-ggp

https://sjl.bitbucket.io/cl-ggp/

cl-ggp

Works[1] with SBCL, CCL, ABCL, and ECL

[1] for some value of "Works"


cl-ggp
Secure https://sjl.bitbucket.io/cl-ggp/
cl-ggp
cl-ggp is a tiny framework for writing general game players in Common Lisp.
The cl-ggp system handles the GGP protocol for you and nothing else. If you plan on doing your own GDL reasoning, this is all you need.
The cl-ggp.reasoner system contains a simple Prolog-based reasoner using the Temperance logic programming library. It's useful as a starting point for when writing players.
License: MIT
Documentation: https://sjl.bitbucket.io/cl-ggp/
Mercurial: https://bitbucket.org/sjl/cl-ggp/
Git: https://github.com/sjl/cl-ggp/
Table of Contents
Installation
Overview
Main API Reference
Reasoner API Reference
Changelog
READ THIS
Made with Lisp and love by Steve Losh in Reykjavík, Iceland.

```
cd local-projects
git clone https://github.com/sjl/cl-ggp.git
git clone https://github.com/sjl/temperance.git
```

cl-ggp
cl-ggp.reasoner

```
(make-reasoner <rules>)

(initial-state   <reasoner>)
(legal-moves-for <reasoner> <state> <role>)
(terminalp       <reasoner> <state>)
(goal-value-for  <reasoner> <state> <role>)
(next-state      <reasoner> <state> <moves>)
```

```
CL-USER> (ql:quickload '(cl-ggp cl-ggp.reasoner))
; ...



CL-USER> (ggp.reasoner:make-reasoner
           (ggp:read-gdl-from-file "tictactoe.gdl"))

#<GGP.REASONER::REASONER {1015346923}>



CL-USER> (defparameter *reasoner* *)

*REASONER*
```

```
CL-USER> (ggp.reasoner:initial-state *reasoner*)

((GGP-RULES::CONTROL GGP-RULES::X)
 (GGP-RULES::CELL 1 1 GGP-RULES::BLANK)
 (GGP-RULES::CELL 1 2 GGP-RULES::BLANK)
 (GGP-RULES::CELL 1 3 GGP-RULES::BLANK)
 (GGP-RULES::CELL 2 1 GGP-RULES::BLANK)
 (GGP-RULES::CELL 2 2 GGP-RULES::BLANK)
 (GGP-RULES::CELL 2 3 GGP-RULES::BLANK)
 (GGP-RULES::CELL 3 1 GGP-RULES::BLANK)
 (GGP-RULES::CELL 3 2 GGP-RULES::BLANK)
 (GGP-RULES::CELL 3 3 GGP-RULES::BLANK))
```

```
CL-USER> (ggp.reasoner:legal-moves-for
           *reasoner*
           (ggp.reasoner:initial-state *reasoner*)
           'ggp-rules::x)

((GGP-RULES::MARK 1 1)
 (GGP-RULES::MARK 1 2)
 (GGP-RULES::MARK 1 3)
 (GGP-RULES::MARK 2 1)
 (GGP-RULES::MARK 2 2)
 (GGP-RULES::MARK 2 3)
 (GGP-RULES::MARK 3 1)
 (GGP-RULES::MARK 3 2)
 (GGP-RULES::MARK 3 3))
```

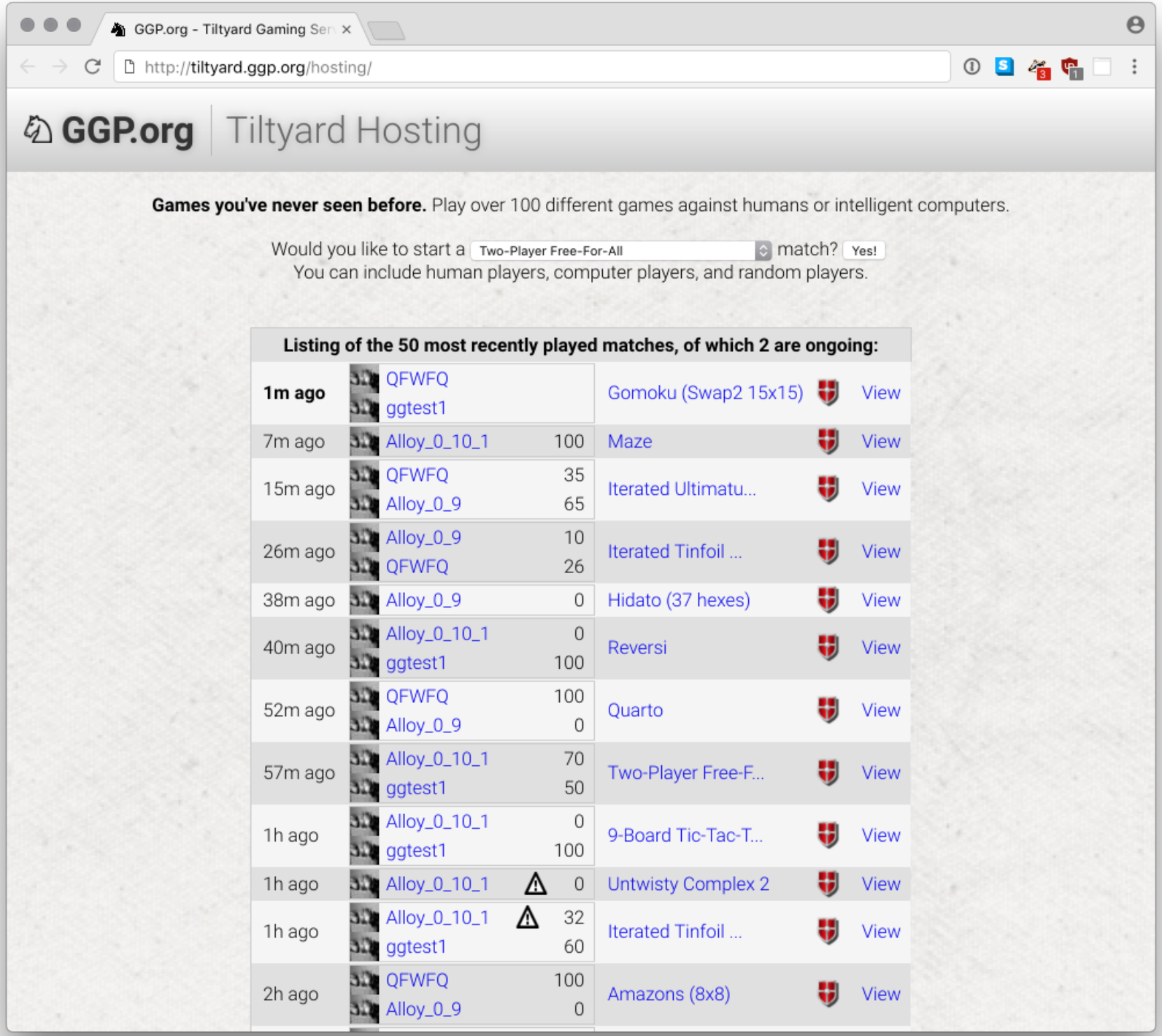
```
CL-USER> (ggp.reasoner:legal-moves-for
           *reasoner*
           (ggp.reasoner:initial-state *reasoner*)
           'ggp-rules::o)

(GGP-RULES::NOOP)
```

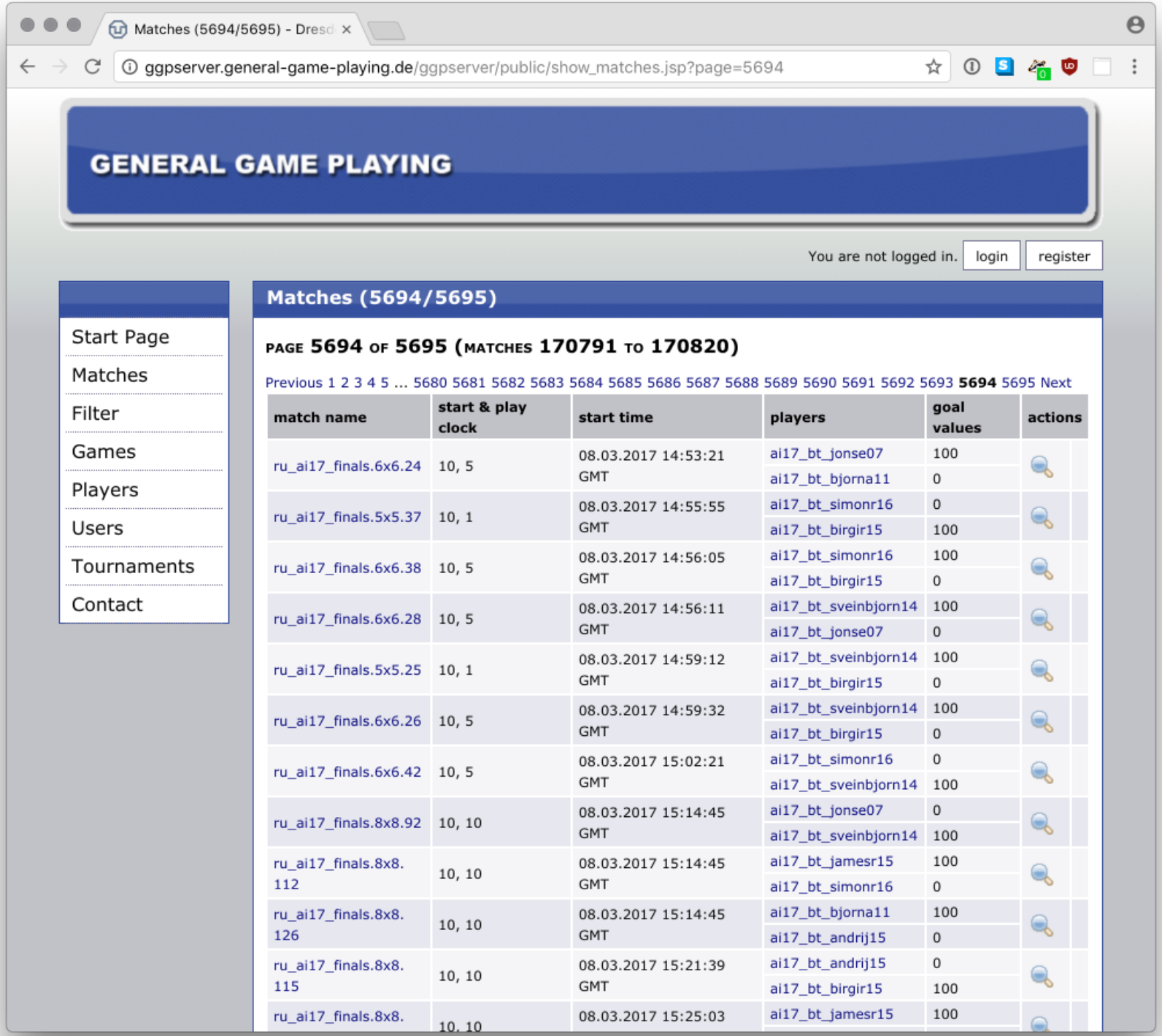
Reasoning

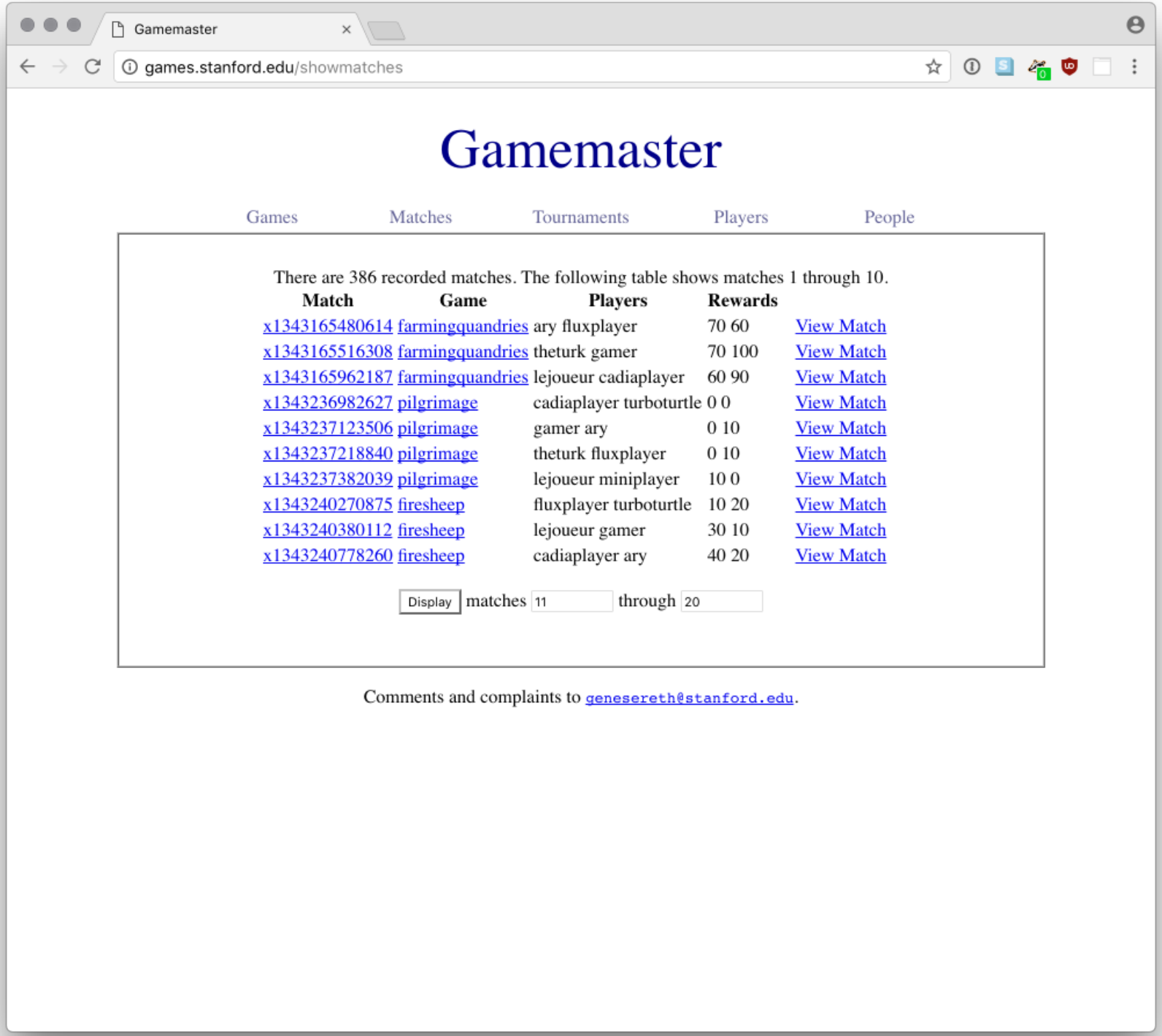
Playing

Intelligence

GGP Game/Network Protocol


GGP.org - Tiltyard Gaming Ser
http://tiltyard.ggp.org/hosting/
GGP.org
Tiltyard Hosting
Games you've never seen before. Play over 100 different games against humans or intelligent computers.
Would you like to start a Two-Player Free-For-All match? Yes!
You can include human players, computer players, and random players.
Listing of the 50 most recently played matches, of which 2 are ongoing:
1m ago QFWFQ ggtest1 Gomoku (Swap2 15x15) View
7m ago Alloy_0_10_1 100 Maze View
15m ago QFWFQ 35 Alloy_0_9 65 Iterated Ultimatu... View
26m ago Alloy_0_9 10 QFWFQ 26 Iterated Tinfoil ... View
38m ago Alloy_0_9 0 Hidato (37 hexes) View
40m ago Alloy_0_10_1 0 ggtest1 100 Reversi View
52m ago QFWFQ 100 Alloy_0_9 0 Quarto View
57m ago Alloy_0_10_1 70 ggtest1 50 Two-Player Free-F... View
1h ago Alloy_0_10_1 0 ggtest1 100 9-Board Tic-Tac-T... View
1h ago Alloy_0_10_1 0 Untwisty Complex 2 View
1h ago Alloy_0_10_1 32 ggtest1 60 Iterated Tinfoil ... View
2h ago QFWFQ 100 Alloy_0_9 0 Amazons (8x8) View


Matches (5694/5695) - Dresd
ggpserver.general-game-playing.de/ggpserver/public/show_matches.jsp?page=5694
GENERAL GAME PLAYING
You are not logged in.
login
register
Start Page
Matches
Filter
Games
Players
Users
Tournaments
Contact
Matches (5694/5695)
PAGE 5694 OF 5695 (MATCHES 170791 TO 170820)
Previous 1 2 3 4 5 ... 5680 5681 5682 5683 5684 5685 5686 5687 5688 5689 5690 5691 5692 5693 5694 5695 Next
match name
start & play clock
start time
players
goal values
actions
ru_ai17_finals.6x6.24
10, 5
08.03.2017 14:53:21 GMT
ai17_bt_jonse07
100
ai17_bt_bjorna11
0
ru_ai17_finals.5x5.37
10, 1
08.03.2017 14:55:55 GMT
ai17_bt_simonr16
0
ai17_bt_birgir15
100
ru_ai17_finals.6x6.38
10, 5
08.03.2017 14:56:05 GMT
ai17_bt_simonr16
100
ai17_bt_birgir15
0
ru_ai17_finals.6x6.28
10, 5
08.03.2017 14:56:11 GMT
ai17_bt_sveinbjorn14
100
ai17_bt_jonse07
0
ru_ai17_finals.5x5.25
10, 1
08.03.2017 14:59:12 GMT
ai17_bt_sveinbjorn14
100
ai17_bt_birgir15
0
ru_ai17_finals.6x6.26
10, 5
08.03.2017 14:59:32 GMT
ai17_bt_sveinbjorn14
100
ai17_bt_birgir15
0
ru_ai17_finals.6x6.42
10, 5
08.03.2017 15:02:21 GMT
ai17_bt_simonr16
0
ai17_bt_sveinbjorn14
100
ru_ai17_finals.8x8.92
10, 10
08.03.2017 15:14:45 GMT
ai17_bt_jonse07
0
ai17_bt_sveinbjorn14
100
ru_ai17_finals.8x8.112
10, 10
08.03.2017 15:14:45 GMT
ai17_bt_jamesr15
100
ai17_bt_simonr16
0
ru_ai17_finals.8x8.126
10, 10
08.03.2017 15:14:45 GMT
ai17_bt_bjorna11
100
ai17_bt_andrij15
0
ru_ai17_finals.8x8.115
10, 10
08.03.2017 15:21:39 GMT
ai17_bt_andrij15
0
ai17_bt_birgir15
100
ru_ai17_finals.8x8.
10, 10
08.03.2017 15:25:03
ai17_bt_jamesr15
100



Gamemaster

Games Matches Tournaments Players People

There are 386 recorded matches. The following table shows matches 1 through 10.

Match	Game	Players	Rewards	
x1343165480614	farmingquandries	ary fluxplayer	70 60	View Match
x1343165516308	farmingquandries	theturk gamer	70 100	View Match
x1343165962187	farmingquandries	lejoueur cadiaplayer	60 90	View Match
x1343236982627	pilgrimage	cadiaplayer turboturtle	0 0	View Match
x1343237123506	pilgrimage	gamer ary	0 10	View Match
x1343237218840	pilgrimage	theturk fluxplayer	0 10	View Match
x1343237382039	pilgrimage	lejoueur miniplayer	10 0	View Match
x1343240270875	firesheep	fluxplayer turboturtle	10 20	View Match
x1343240380112	firesheep	lejoueur gamer	30 10	View Match
x1343240778260	firesheep	cadiaplayer ary	40 20	View Match

Display matches 11 through 20

Comments and complaints to genesereth@stanford.edu.

ggp-base

https://github.com/ggp-org/ggp-base

cl-ggp

https://sjl.bitbucket.io/cl-ggp/

cl-ggp

cl-ggp.reasoner

```
(defclass my-player (ggp:ggp-player) ...)

(player-start-game  <player> <rules> <role> <deadline>)
(player-update-game <player> <moves>)
(player-select-move <player> <deadline>)
(player-stop-game   <player>)
```

Random Player

Reasoning

Playing

Intelligence

Google king of the united states

Web Images Shopping Videos Maps More Search tools

About 668,000,000 results (0.59 seconds)

Barack Obama

Ask Google who is the [King Of United States] and Google will inform you that it is **Barack Obama**, the current President of the United States. The Google Answer is pulled from Breitbart, a story they posted five days ago named All Hail King **Barack Obama**, Emperor Of The United States Of America!

According To Google, Barack Obama Is King Of The United ...
searchengineland.com/according-google-barack-obama-**king-united-states**-...

Feedback

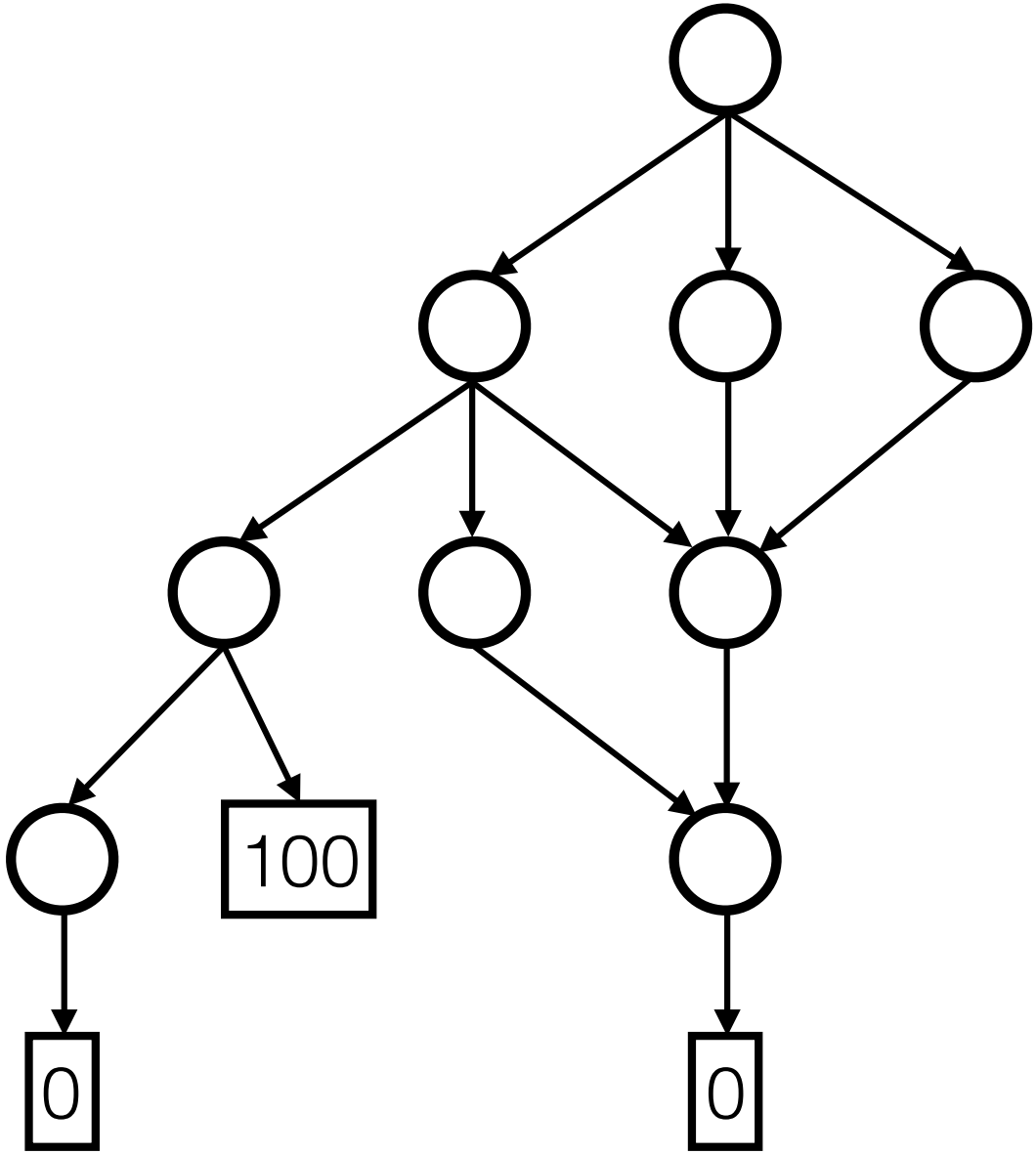
Prince Henry of Prussia (1726–1802) - Wikipedia, the free ...
en.wikipedia.org/wiki/Prince_Henry_of_Prussia_(1726–1802) ▾ Wikipedia ▾
For the brother of **King** Frederick William II of Prussia, see Prince Henry of Prussia ... 1 Biography; 2 Proposal for **King** of **United States**; 3 Ancestry; 4 References ...
Biography - Proposal for King of United States - Ancestry - References

In the news

According To Google, Barack Obama Is King Of The United States
Search Engine Land - 8 hours ago
Ask Google who is the [**King** Of **United States**] and Google will

Search the Game Tree[1]

[1] for some value of "Tree"

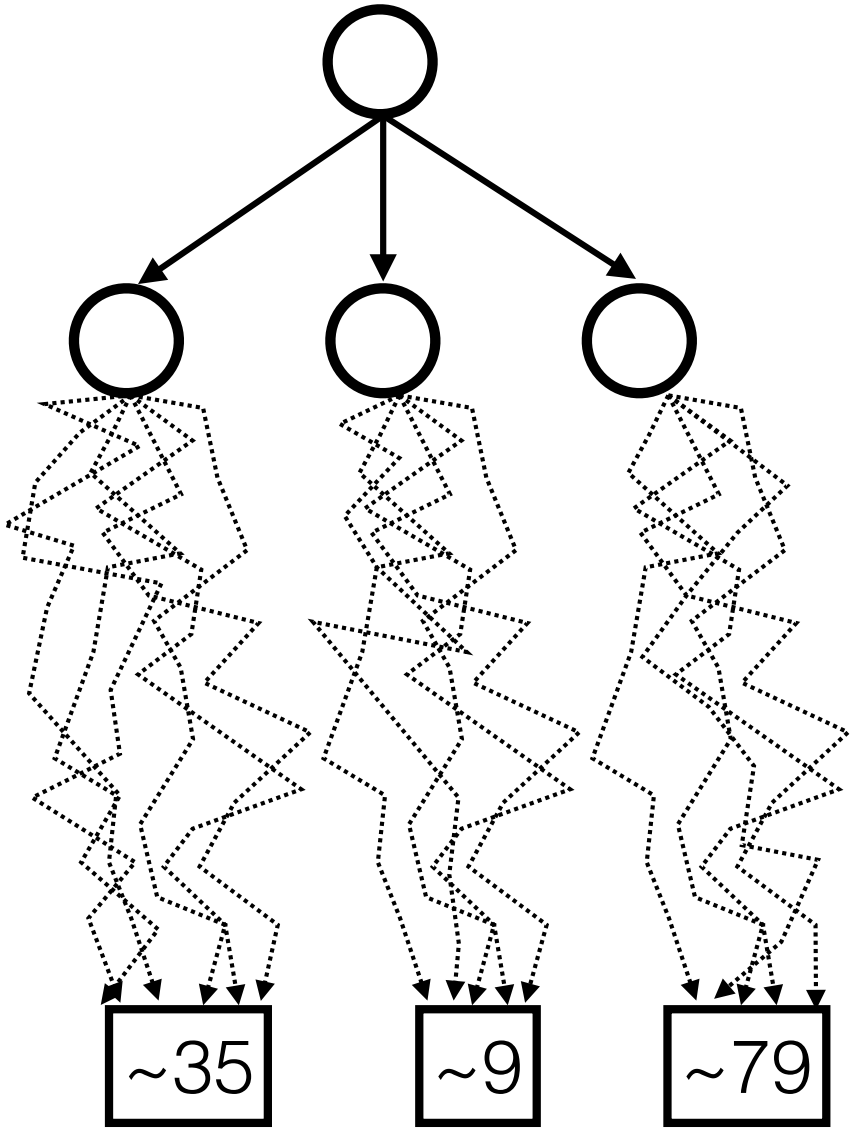

100
0
0

Depth-first search
... with minimax
... and alpha/beta pruning
... and iterative deepening
... and transposition tables

Heuristic

game state → estimated value

Monte Carlo Search


~35
~9
~79

Monte Carlo Player

More?

Improved Reasoning

Faster Prolog Implementations
Propositional Networks

Improved Search

Parallelize
Monte Carlo Tree Search
Heuristics in Playouts

Relaxing Restrictions

GDL-II
General Video Game Playing

Thanks!

The GDL & GGP Protocol Spec
http://logic.stanford.edu/classes/cs227/2013/readings/gdl_spec.pdf

cl-ggp
https://sjl.bitbucket.io/cl-ggp/

ggp-base
https://github.com/ggp-org/ggp-base

When Google's Algorithms Fail, Barack Obama Becomes King of USA
http://news.softpedia.com/news/When-Google-s-Algorithms-Fail-Barack-Obama-Becomes-King-of-US-465897.shtml

Other GGP Resources
http://www.ggp.org/
http://www.general-game-playing.de/