# Artificial Intelligence for deterministic 2 players games with UCT

Pierre Gueth

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# UCT and other AI

## Tree search algorithm

- Brute force approach
- Exhaustiv search of every game possible
- High complexity
- Works only for small game (tic-tac-toe)

## MinMax

- Standard AI for chess
- Tree search with limited depth
- Need score function
- Constant time consumption
- Doesn't work for open game like Go

## UCT

- Collaboration between INRIA and Taïwan university [LEE2009]
- Used in MOGO, first Go AI to beat professionnal player in 2008
- Monte Carlo / Tree search hybrid
- No need for score function, only game completion
- Flexible time consumption and high scalability

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- Two players alternating
- Deterministic game states
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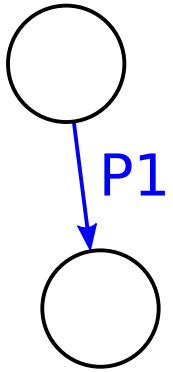


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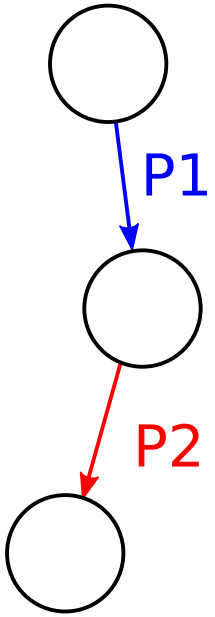

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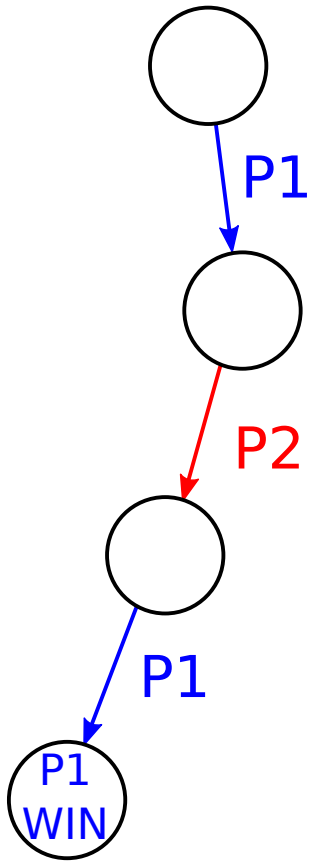

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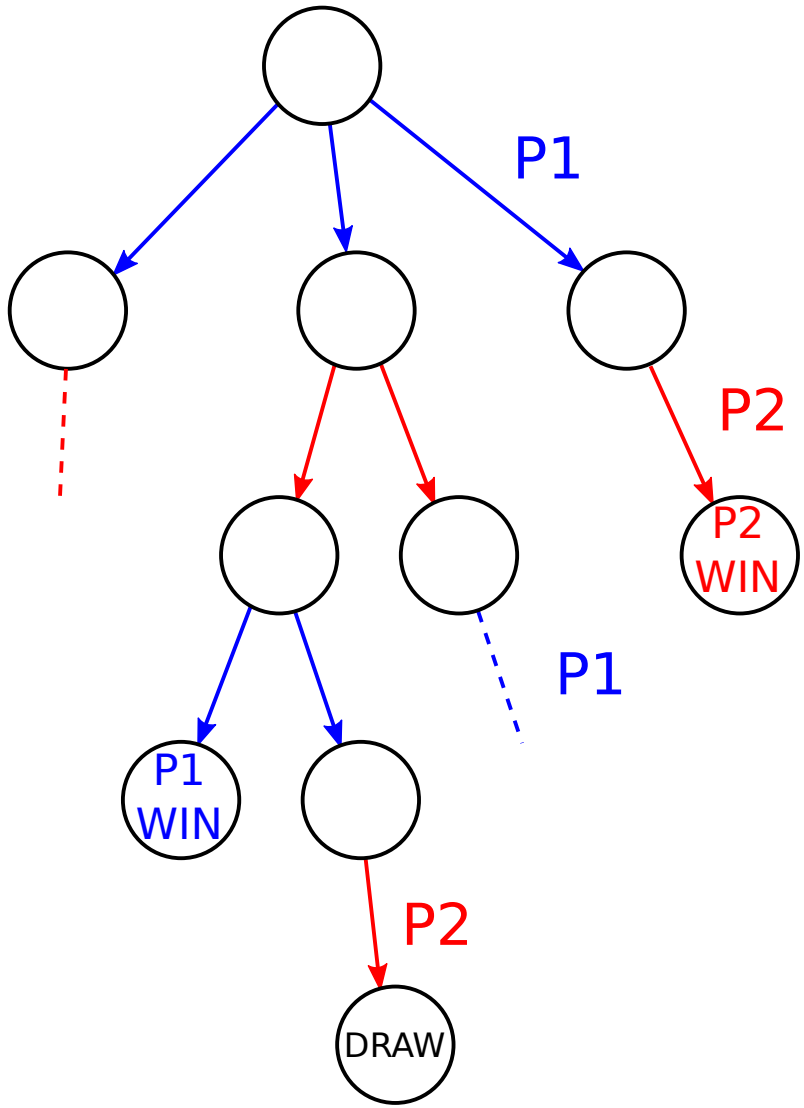


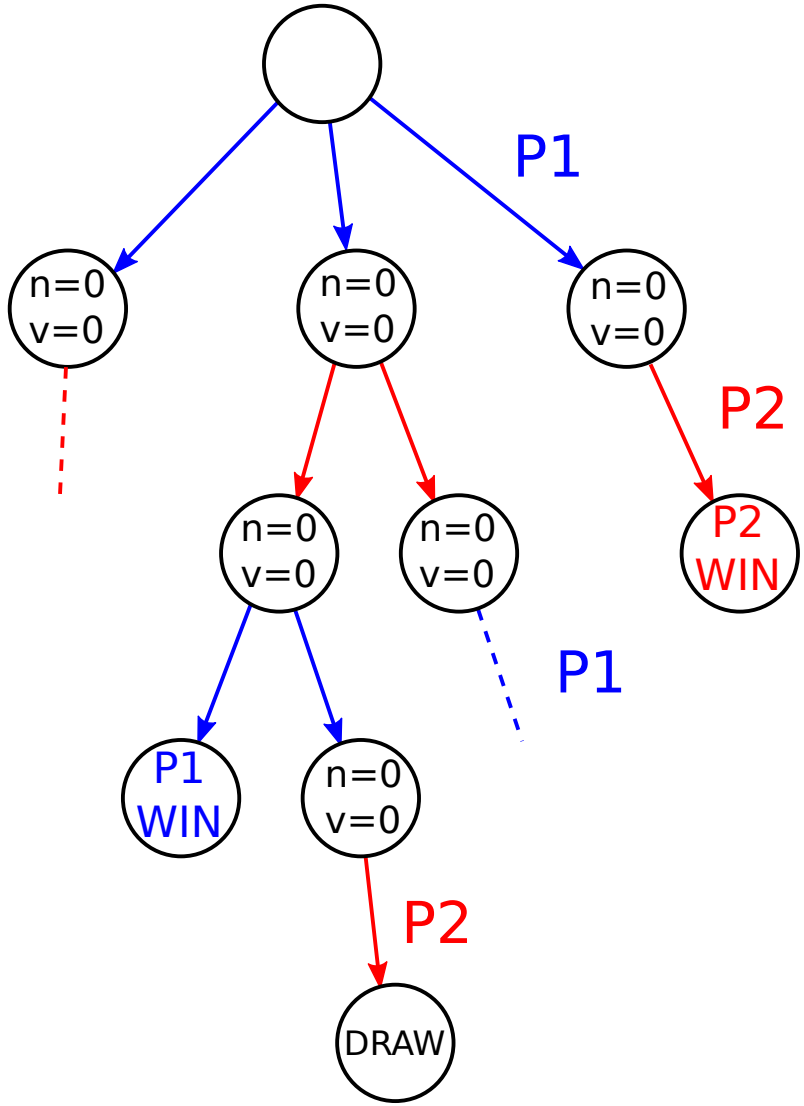
# UCT principle

1. Play random moves for both players until game reaches its end
2. Update upstream game state value
3. Select initials moves and go back to step 1

Each state has two variables :

- n = number of played games that pass by this state
- v = number of won games that pass by this state

The probability of winning by reaching each state is estimated by v/n



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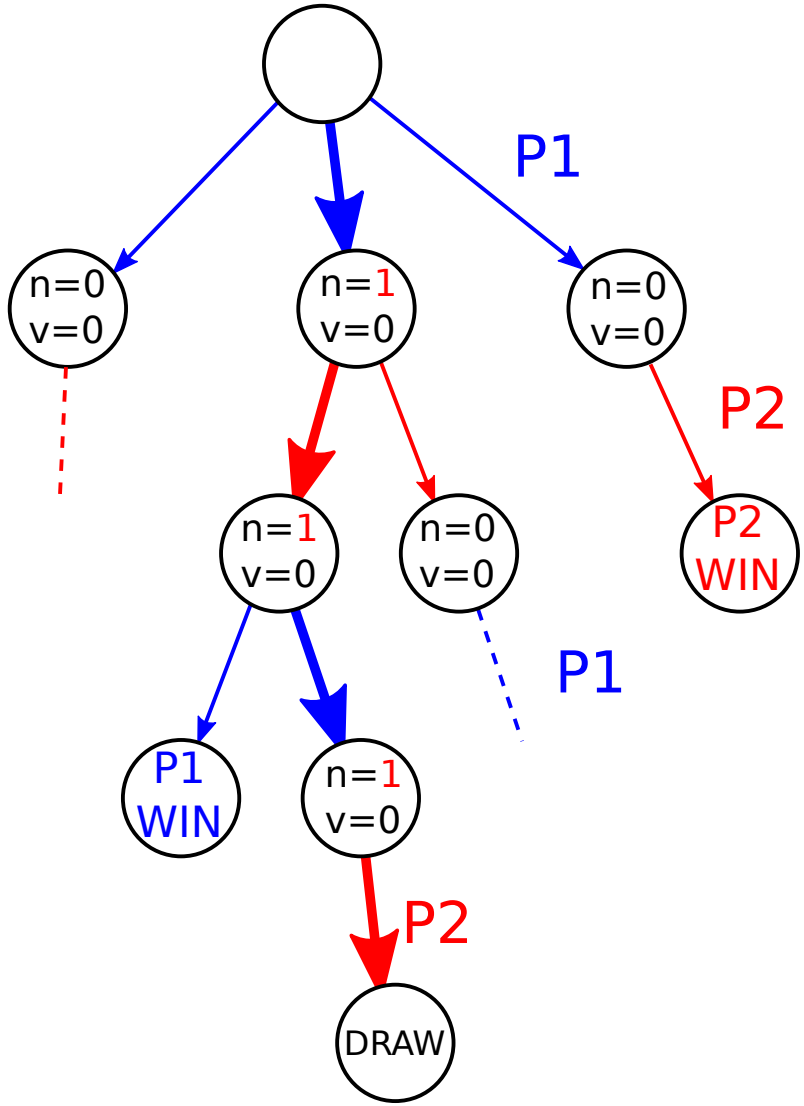

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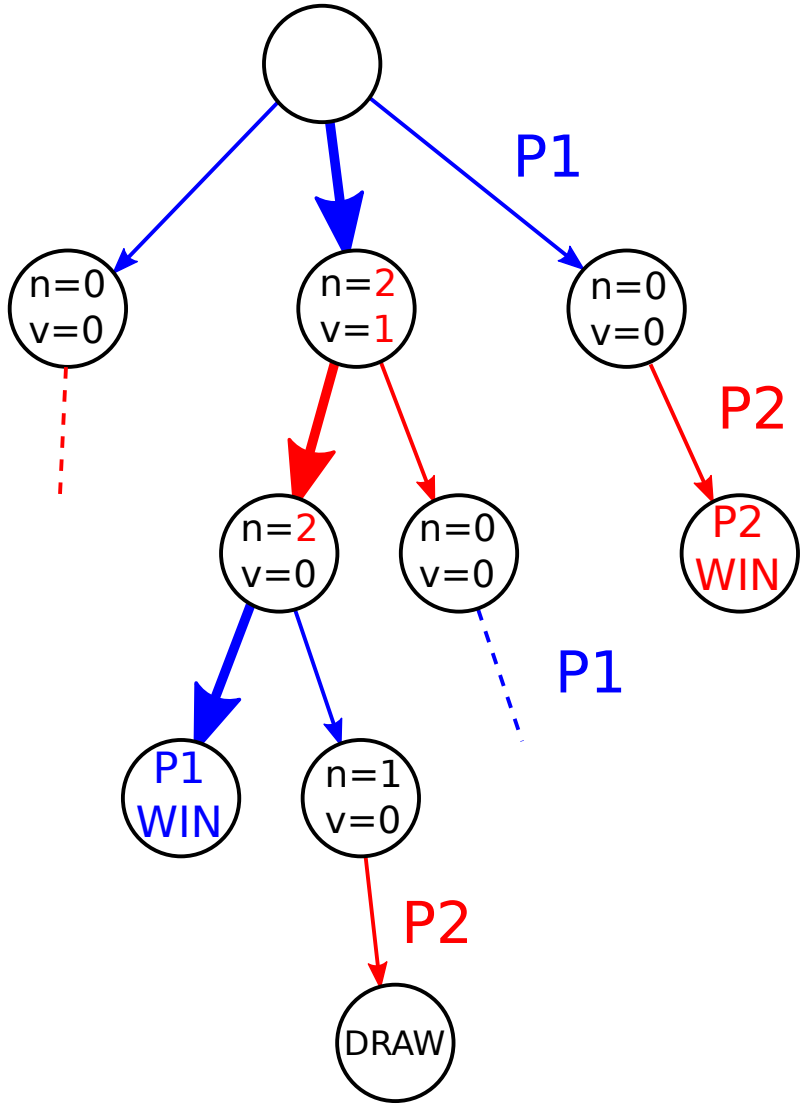

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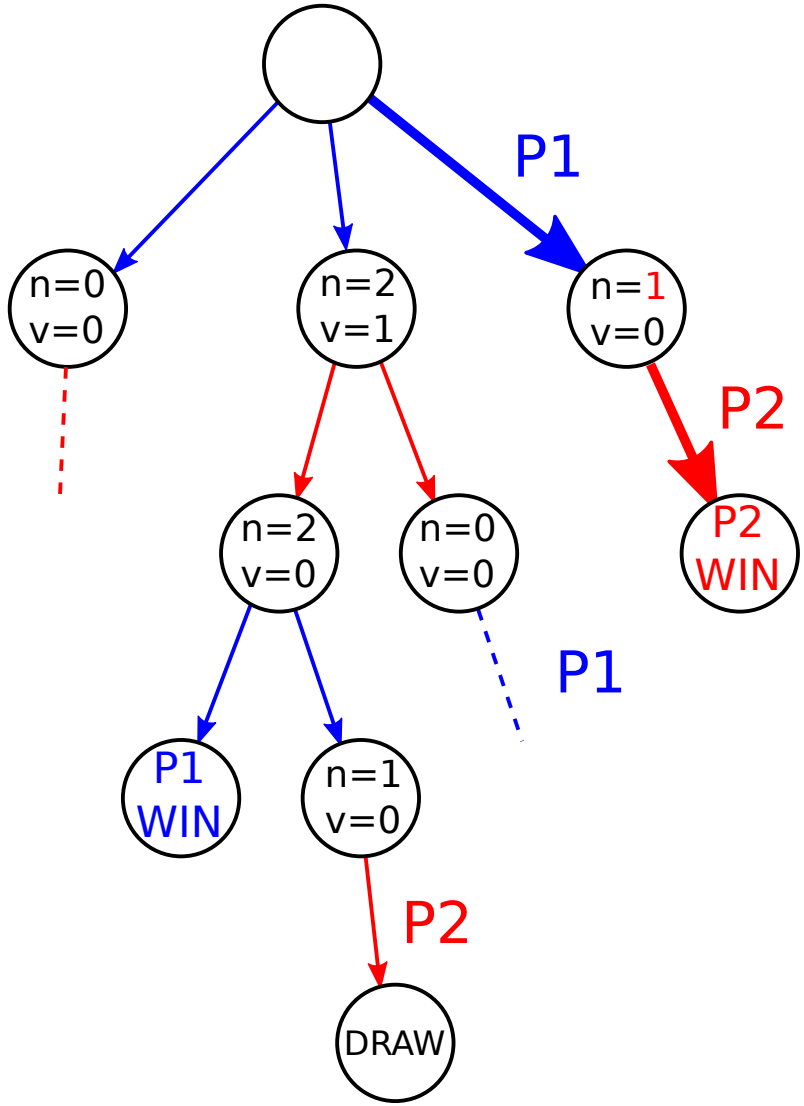

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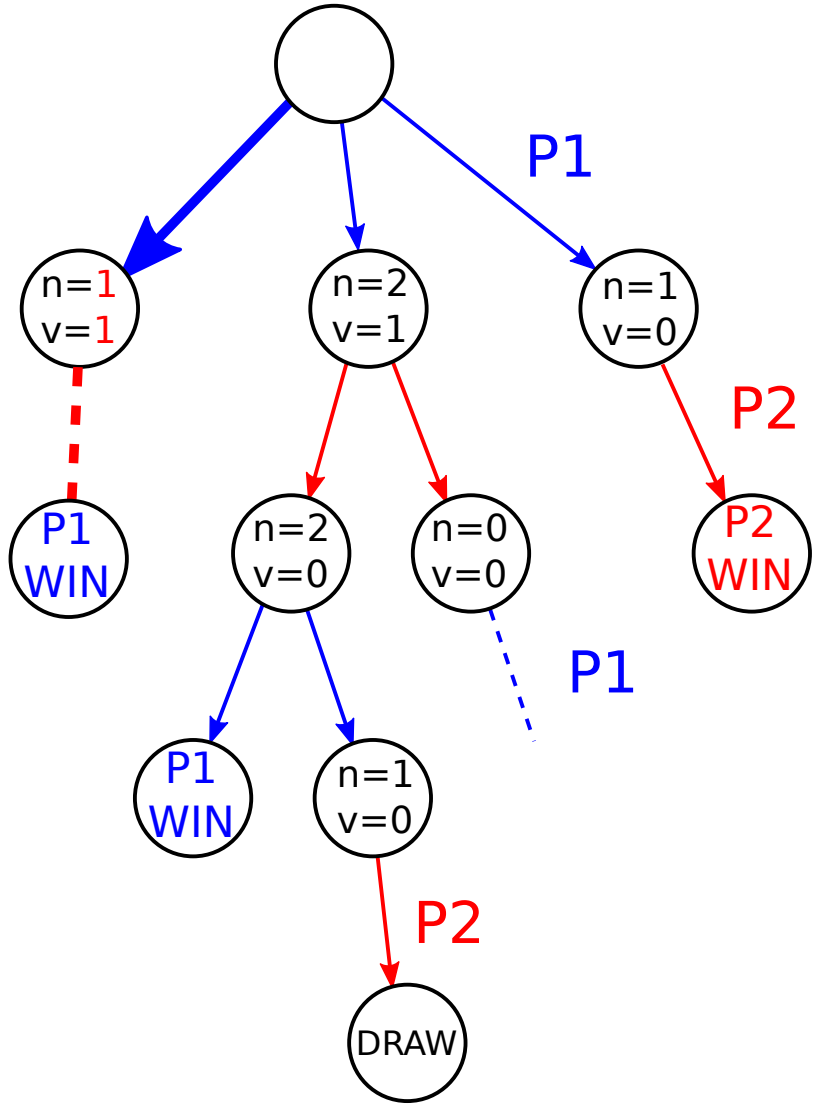

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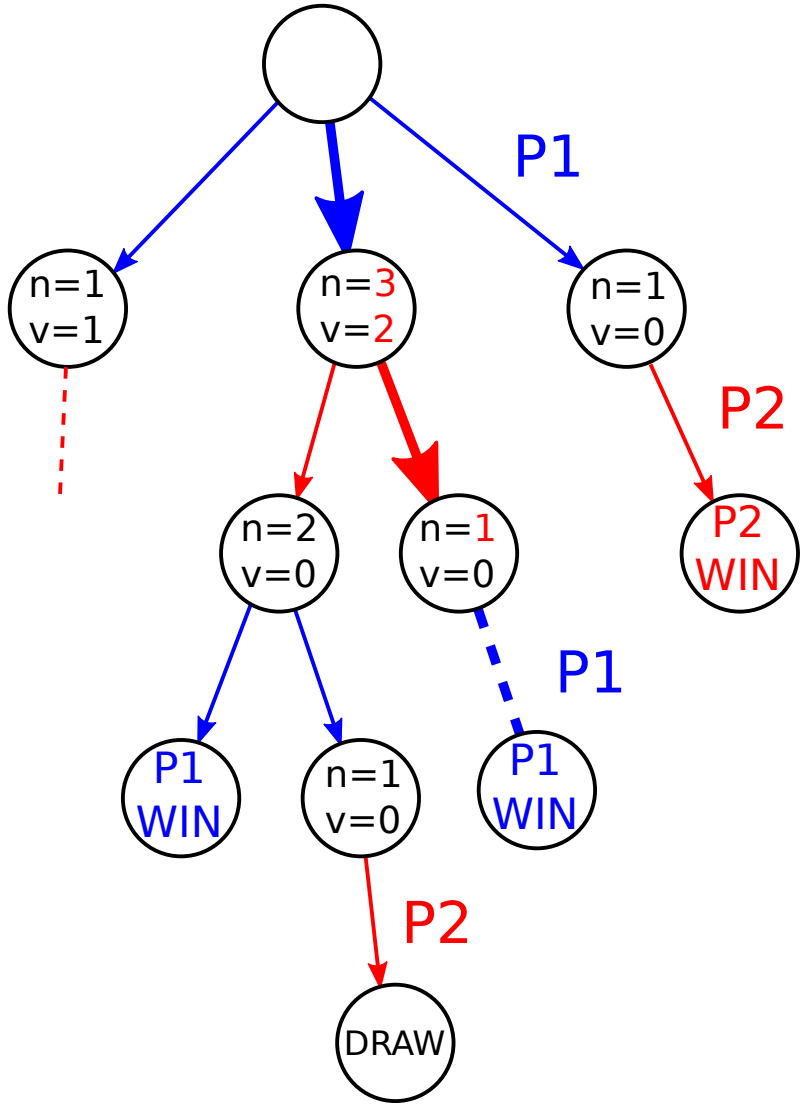

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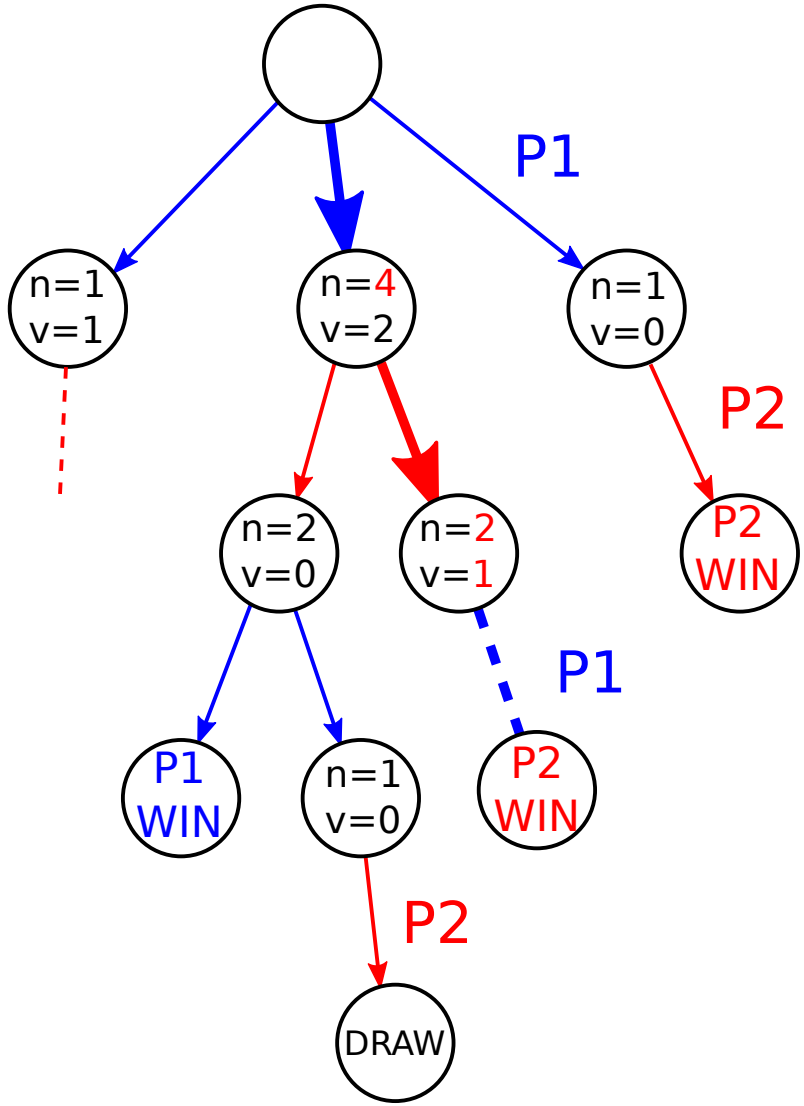

# Simulated games selection

- Exploration
  Each move has the same probability of being selected.
  This ensures that every stategies are considered.
- Exploitation
  The probability of selecting a move is proportionnal to the winning probability.
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## Tradeoff

- For small values of n, use the exploration strategy.
- For large values of n, use the exploitation strategy.

# C++ implementation

- I implemented UCT in C++
- Use Qt, CMake but mainly based on standard library
- $\sim$ 3000 C++ lines

https ://github.com/elcerdo/uct

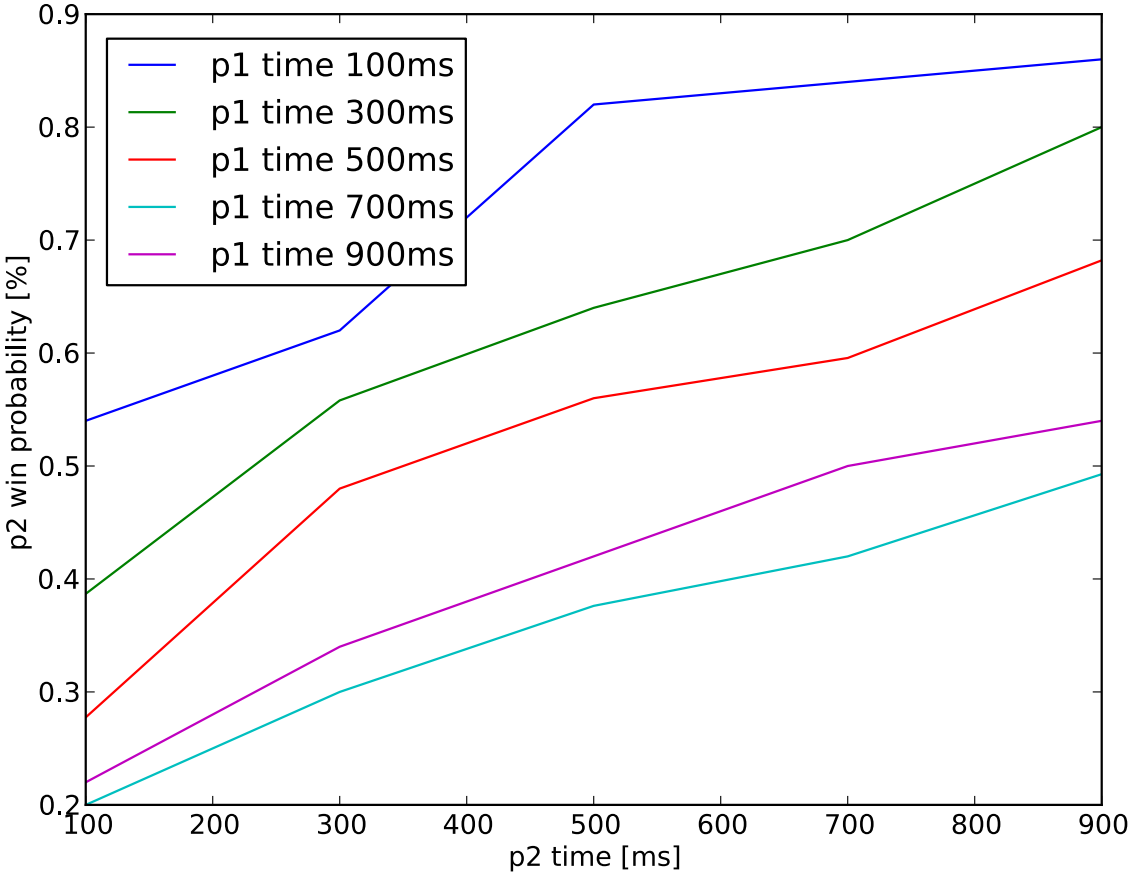
# Easy implementation of new games

```
class Board {
public:
    virtual ~Board() =0;

    virtual Board *deepcopy() const =0;
    virtual Move *parse_move_string(Token player,const char *string) const =0;
    virtual void print() const =0;
    virtual bool is_move_valid(const Move &move) const =0;
    virtual Moves get_possible_moves(Token player) const =0;
    virtual void play_move(const Move &move) =0;
    virtual bool play_random_move(Token player) =0;
    virtual Token check_for_win() const =0;
    virtual Token play_random_game(Token next_player);
};
```

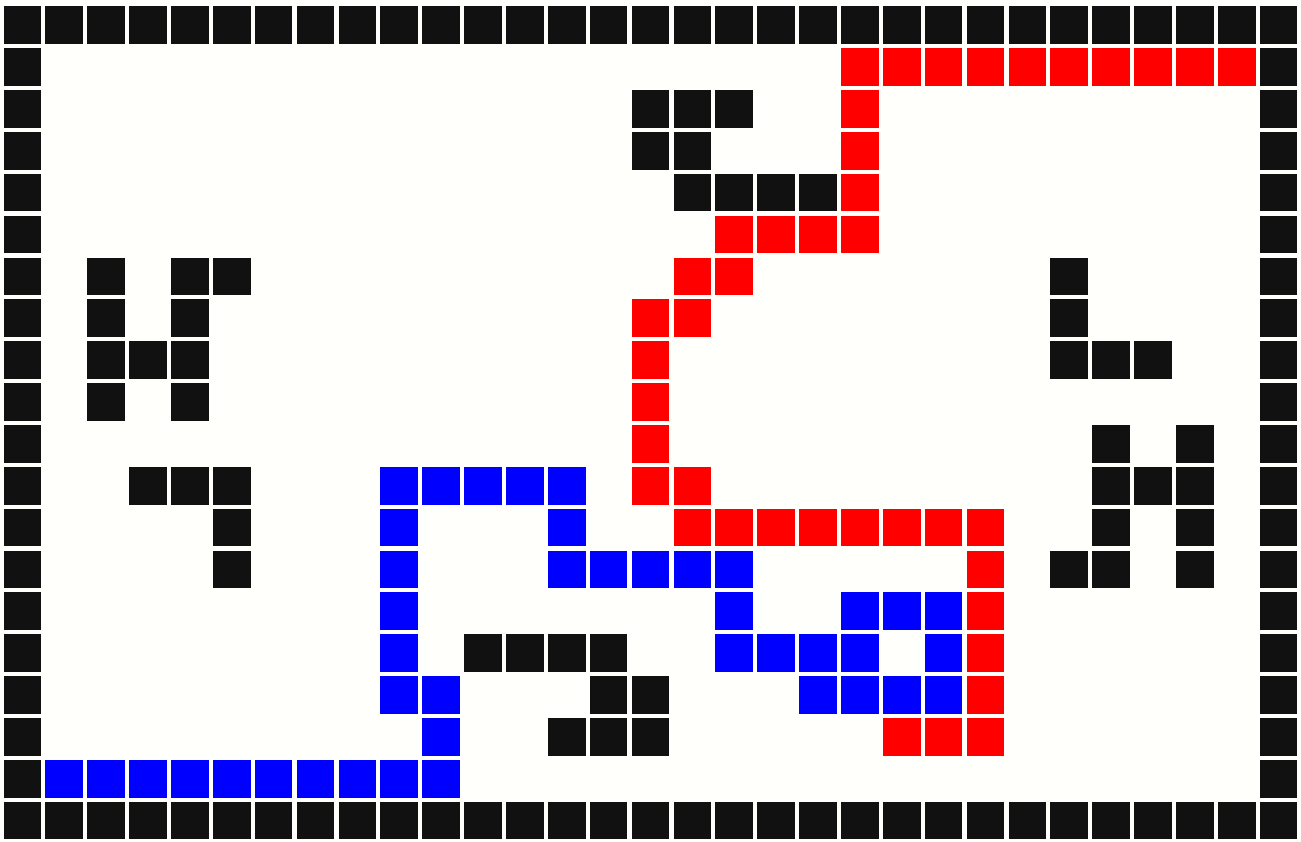
- Derivate abstract board class
- Implement a few virtual methods
- That's it !
  UCT handles the hard part of choosing the best move for you.

# AI strength vs. computation time : Othello




AI win probability increase linearly with computation time for computation time below 1s.

# Google AI Challenge 2010 : Tron



UCT finished 50th over more than 3000 contestants.

# Demonstation
# Can you beat the IA ?

# Thanks for your attention

# Pierre Gueth

## Wide technical and academical knowledge

- Classe préparatoire PT
- ENS Cachan
  aggrégation physique appliquée / EEA
- Thèse au laboratoire CREATIS (Université Lyon I)
  Imagerie médicale ultrasonore
  Estimation de mouvement
- Post doc au Centre Léon Bérard (Lyon)
  Simulation Monte-Carlo Protonthérapie (GATE)
  Imagerie $\gamma$-prompt

## Numerous computer science side project

- Freesiege, Blocks, ...
- Monte-Carlo, UCT, ...
- Autojump, cluster submission tools