Jafar — Intelligent Othello Agent

Joshua Nelson, Tim Cosgrove, Andrew Haigh

Outline

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### Jafar — Intelligent Othello Agent

Joshua Nelson, Tim Cosgrove, Andrew Haigh

COMP3130 Research Project

May 28, 2012

Jafar — Intelligent Othello Agent

Joshua Nelson, Tim Cosgrove, Andrew Haigh

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#### **Problem Overview**

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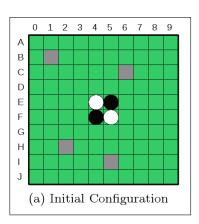
Algorithm description

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Future

Design Methodolog  The Game — 10x10 Modified Othello



#### **Problem Overview**

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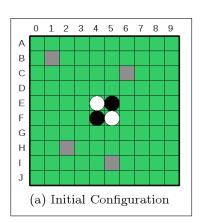
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#### **Problem Overview**

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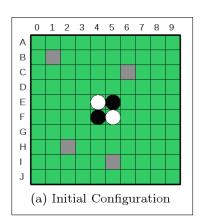
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 The Game — 10x10 Modified Othello

- The Problem Intelligent Al player
- Solution basis



#### Solution Structure

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Design Methodolog  The MetaPlayer class — Utilises knowledge of the game state and creates instances of other players accordingly

#### Solution Structure

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- The MetaPlayer class Utilises knowledge of the game state and creates instances of other players accordingly
- NegamaxPlayer (varying depth argument)
- OpeningPlayer
- GreedyPlayer

#### Static Evaluation

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Design Methodolog  The FeatureSet class — Maintains a list of features; functions which evaluate a game state based on some criteria of strength

#### Static Evaluation

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- The FeatureSet class Maintains a list of *features*; functions which evaluate a game state based on some criteria of strength
- LegalMoves
- Visibility
- StoneCount
- BlockedAdjacent, CornerPieces, SidePieces

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Improvement

Design Methodolog  Remaining challenge: decide how important each feature is (the feature 'weights')

#### Jafar — Intelligent Othello Agent

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TD-  $\lambda$ 

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- Remaining challenge: decide how important each feature is (the feature 'weights')
- ullet Solution use the TD  $\lambda$  formula to calculate the new weights

$$\bullet \ w := w + \alpha \sum_{T=1}^{N-1} \tilde{J}(x_t, w) * (\sum_{j=t}^{N-1} \lambda^{j-t} d_t)$$

#### The J Function

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Algorithm description Results

$$w := w + \alpha \sum_{T=1}^{N-1} \Delta \tilde{J}(x_t, w) * (\sum_{j=t}^{N-1} \lambda^{j-t} d_t)$$

- The J function returns a probability of winning, given a set of weights and a board.
- The perfect J function would always return 0 or 1 precisely.
- We are trying to learn a good approximation to the J function

### TD: Temporal difference

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$$w := w + \alpha \sum_{T=1}^{N-1} \Delta \tilde{J}(x_t, w) * \left( \sum_{j=t}^{N-1} \lambda^{j-t} d_t \right)$$

- $d_t$  is the *Temporal Difference* between successive game states.
- The key observation is that for an ideal J function this would always be zero.
- $\Delta J(x_t, w)$  corrects each weight according to whether it was pointing us in the right direction.

#### Initial J function

Lost game

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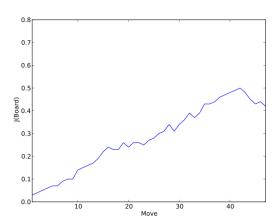
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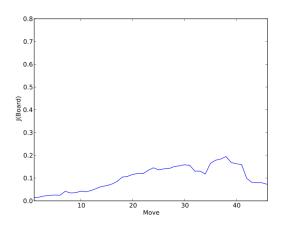
#### J function after 6000 iterations Lost game

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Algorithm description Results





# J function after 6000 iterations Won game

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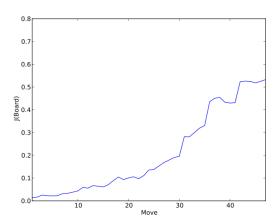
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### The first 1000 learning iterations

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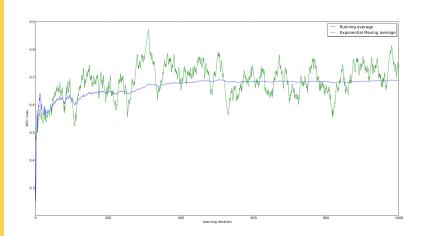
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### The first 5000 learning iterations

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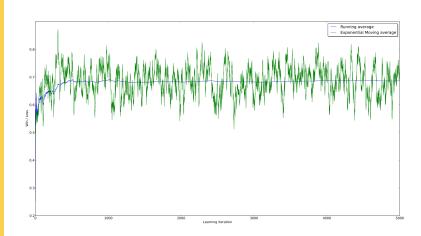
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## Self play - learnt weights

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Court Foot out

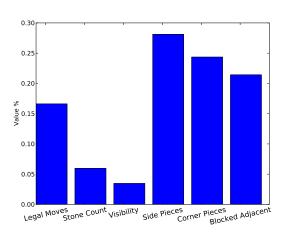
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# Self play - learnt weights White - Black

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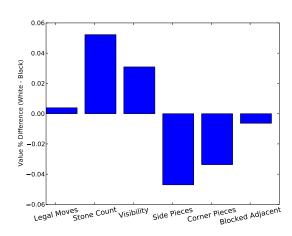
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# Feature weight space visualisation

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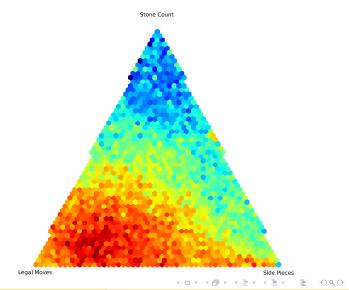
Static Evaluation

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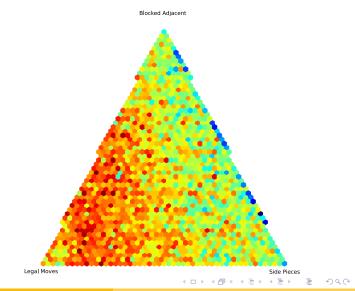
# Feature weight space visualisation

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Algorithm description

Results



### The Elo Rankings Arena

Jafar — Intelligent Othello Agent

Joshua Nelson, Tim Cosgrove, **Andrew Haigh** 

Algorithm description Results

The FloArena

- Custom made genetic algorithm
- Pits a group of randomly generated agents against each other for Elo style ranking points
- Creates new agents from those who perform best

### The Elo Rankings Arena

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The EloArena

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Custom made genetic algorithm

- Pits a group of randomly generated agents against each other for Elo style ranking points
- Creates new agents from those who perform best
- Used more as a demonstration of the learning process
- ullet Interesting to see it come to the same conclusions as TD- $\lambda$

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More attention to blocked squares

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Future Improvements

- More attention to blocked squares
- Negamax optimisations (better transposition tables, prob-cuts, etc.)

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Future Improvements

- More attention to blocked squares
- Negamax optimisations (better transposition tables, prob-cuts, etc.)
- Better use of pre-computed data

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Future Improvements

- More attention to blocked squares
- Negamax optimisations (better transposition tables, prob-cuts, etc.)
- Better use of pre-computed data
- More board features (locked squares, open squares, etc.)

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The EloArena

Future Improvements

- More attention to blocked squares
- Negamax optimisations (better transposition tables, prob-cuts, etc.)
- Better use of pre-computed data
- More board features (locked squares, open squares, etc.)
- More exploration in learning randomise the initial board and play from that to explore more options

## Design Methodology

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The FloArens

Design Methodology C with a python interface

 Used this for tic-tac-toe warm up problem, decided against due to development overhead

## Design Methodology

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Design Methodology

- C with a python interface
  - Used this for tic-tac-toe warm up problem, decided against due to development overhead

#### Java

 Sacrifice low level speed improvements for high level language features and built in data structures.

### Design Methodology

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