# Theory of Computer Games (Fall 2021) Homework 2

NTU CSIE

Due: 14:20 (UTC+8), December 9, 2021

# Outline

1 Game Description

2 Homework Requirements

3 Submission and Grading Policy

# Chinese Dark Chess (CDC)



- The game rule could be found here

  https:
  //homepage.iis.sinica.edu.tw/
  ~tshsu/tcg/2021/hwks/rules.pdf

# Chinese Dark Chess (CDC) Special Case



- All pieces have been flipped

# Chinese Dark Chess (CDC) - Score

## Score
- Win: $1.0 +$ Bonus
- Draw: $0.2 +$ Bonus
- Lose: $0$

## Bonus
- $Bonus = (Net\ Value\ /\ 1943) * 0.3$
- $Net\ Value = \max(0, Value_{my} - Value_{oppo})$
- $Value_{my} = Total\ value\ of\ my\ alive\ piece$
- $Value_{oppo} = Total\ value\ of\ opponent's\ alive\ piece$

## Value

| K/k | G/g | M/m | R/r | N/n | C/c | P/p |
| --- | --- | --- | --- | --- | --- | --- |
| 810 | 270 | 90 | 18 | 6 | 180 | 1 |

# Chinese Dark Chess (CDC) - Score



Draw

- Red Value: $90(M) + 6(N) = 96$
- Black Value: $810(k) = 810$
- Red Score:
  $= 0.2 + (\max(0, 96 - 810) \; / \; 1943) * 0.3$
  $= 0.2 + 0 = 0.2$
- Black Score:
  $= 0.2 + (\max(0, 810 - 96) \; / \; 1943) * 0.3$
  $\approx 0.2 + 0.11 = 0.31$

# Requirements

## HW Requirements

- Implement an agent of Chinese Dark Chess (CDC) using Monte-Carlo Tree Search algorithm.
- Write a report.

# Part I: CDC Agent

## CDC Agent

In your CDC agent, you need to implement following requirements:

- MCTS with UCT
- Rapid Action Value Estimate (RAVE)
- At least two of the following:
  - ▶ Progressive pruning (PP)
  - ▶ Node expansion policy
  - ▶ Temperature
  - ▶ Depth-i tree search
- Time limit: 10 seconds per ply (measured by server)
- Thread limit: 1 thread
- Memory limit: 4 GB
- Pre-processing time limit: 30 minutes (TA will trace your code)

# Part I: CDC Agent

## Baseline

Provide the baseline's source code and executable file

Baseline's specification:

- MCS pure algorithm
- 9.5 seconds per ply

# Part I: CDC Agent

## Testing

- Your CDC agent will be against the baseline on 10 specific boards.
- Take turns to move first.
- Your score is the sum of the scores of all games.

## Target

Your CDC agent needs to get scores from baseline as much as possible.

## Boards

- Sample boards: 10 boards (provided)
- Testing boards: 5 from sample boards and 5 hidden boards

(See the appendix for more detail information)

# Part I: CDC Agent

## Game Setting

- Time limit: 10 seconds per ply
- Threefold repetition rule: A game is considered draw if the same position occurs three times.
- 60-ply rule: If no capture has occured in the last 60 ply (by both players), the game is automatically a draw

# Part II: Report

## Report Structure

Your report should include but not limited to:

- Implementation
  - How to compile and run your code in linux.
  - What technique did you implement.
- Experiments
  - Compare the difference between using rand(stdlib.h) and using PCG(website) as PRNG.
  - Compare the results of using different value of exploration parameter($c$ in UCB) and parameters in other techniques.
- Discussion
  - Pros and cons of using rand(stdlib.h) and using PCG(website) as PRNG.
  - The performance of using different value of parameters.

## Submission

- Directory hierarchy:
  - ▶ student id // e.g. r09922026 (lowercase)
    - ★ Makefile // make your code
    - ★ src // a folder contains all your codes
    - ★ report.pdf // your report
- Compress your folder into a zip file and submit to
  https://www.csie.ntu.edu.tw/~tcg/2021/hw2.php
- Due to server limitation, the file size is restricted to 2 MB.

# Grading Policy

## Grading Policy

$$\text{Your Point} = P \times \left(\frac{\text{Your Score}}{\text{Boss Score}} \times W_1 + \text{Report Score} \times W_2\right)$$

- $P$ : 25
- *Your Score*: $\in [0, 26]$
- *Boss Score*: $\approx 20.6$ (Sample Boards)
- $W_1$: 0.8
- *Report Score*: $\in [0, 1]$
- $W_2$: 0.2

# Appendix

# Sample Boards

> **Information**
>
> - Average Score: Average score of testing CDC agents.
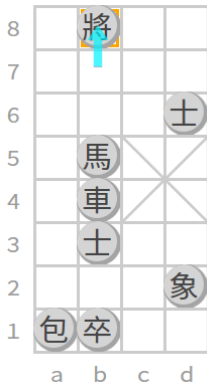> - Sample Boards Result: Boss CDC agent vs baseline.
>
> The higher the serial of the board, the more difficult.
> (round to two decimal places)

Average Score: 1.21



0

1.25 (W)

1.06 (W)

Average Score: 1.13



1

1.12 (W)

1.10 (W)

Average Score: 1.03



2

1.24 (W)

1.12 (W)

# 3

Average Score: 0.98



3



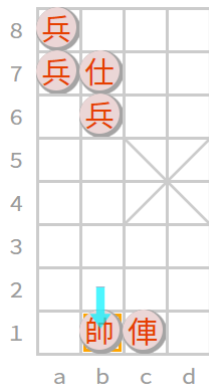1.06 (W)



1.10 (W)

4

Average Score: 0.93



4



1.10 (W)
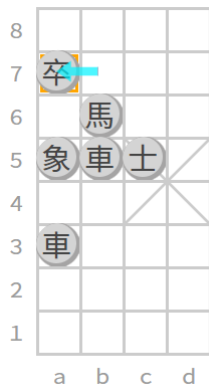


1.17 (W)

Average Score: 0.86



5

1.23 (W)

1.06 (W)

Average Score: 0.84



6

1.18 (W)

1.06 (W)

Average Score: 0.80



7

1.04 (W)

1.05 (W)

Average Score: 0.69



8



1.09 (W)



0.27 (D)

Average Score: 0.63



9

1.07 (W)

0.20 (D)