“ALEXANDRU-IOAN CUZA” UNIVERSITY OF IASI

**FACULTY OF COMPUTER SCIENCE**

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BACHELOR THESIS

**Artificial Intelligence techniques for Chess**

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Absolvent Carol Sebastian Rameder

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# Introduction

My bachelor thesis consists of an overview of Artificial Intelligence techniques used in Chess

programming and the presentation of the results of a self-developed program, capable of showing optimal and intelligent behaviour in the environment of the chess game. Moreover, comparing its performance with the theoretical analysis of the latest trends in the field and state-of-the-art chess engines led to the conclusion drawn from the study. Therefore, the approach of the given subject contains both theoretical and practical aspects.

Besides coding theoretical aspects learned from various courses during the computer science study, the general objective of this thesis is getting an in-depth view about techniques and tendencies of the Artificial Intelligence domain by facing real challenges with academic writing and selecting suitable literature for a limited subject area.

AI for Chess is one of the oldest and most studied fields in this domain and computer’s performance has grown considerably with the transition from game tree search to Deep Reinforcement Learning. Nowadays, AI algorithms have reached a superhuman level, as the world champion was firstly defeated by a computer in 1997 and are frequently used not only for training for high-level tournaments, but also for cheat detection in online games.

“*Over the years, chess has proven to be a fertile ground for ideas and techniques that have spread to other areas of AI . These include database enumeration techniques, chunking, search techniques (minimax, alpha-beta, iterative deepening), and the utility of information. Considering the lack of funding for chess, it is significant that it has produced so many results. Chess has been fertile because it provides a complex reasoning problem from a simple domain with a builtin performance criteria. The simple domain permits research to progress with little initial overhead. Having a hostile opponent adds complexity to the reasoning. In many domains (natural language understanding comes to mind), progress can be hindered by lack of performance criteria - it can be hard to tell whether the latest thesis is an improvement on the current state of the art, Chess provides precise answers to performance questions.* (...)

*Research into artificial intelligence using chess as the application domain has produced several important contributions to AI :*

* *The effectiveness of brute-force search. Chess has clearly demonstrated that simple, brute-force approaches should not be quickly discarded.*
* *Iterative search. Some of the ideas developed for alpha-beta search, iterative deepening in particular, are applicable to other search domains and games such as go, shogi and tic-tac-toe.”* (1)

## Summary

The thesis is structured in four chapters which ilustrates all needed details in cronological order:

* **Chess game elements** provides information for linking the programming part to the Chess game environment. It focuses on implementation details and prepares the data for applying further algorithms
* **The Artificial Intelligence approach** explains how the AI technique is used in oreder to make the computer simmulate smart behaviour related to the game
* **Game behaviour and stats** shows the results obtained in real game situations with conclusive examples and performance measurements
* **State of the art** brings a theoretical analysis of most the latest and most performant engines and shows a performance comparison with early used techniques that prepares the conclusion

## Motivation

I choose this specific topic for my final thesis as I saw the great potential of improving both my practical programming skills and academic research and writing by approaching a merger of two passions of mine. I have been playing chess, go to training and participate in championships for a long period of time in my childhood, as well as I recently got interested in the AI field and how computers can show intelligent human-like behaviour in different situations. Moreover, getting insights into how a computer can become smarter than people in a specific field and developing a program that can respond and adapt in a chess game is a personal fulfielment. When I first started programming, I truly considered this too hard to understand, but working on this thesis gave me the necessary steps to make it possible and bring my contribution.

## Contributions

1. Implementing the game of Chess with the user interface, playable for two players, with board representantion and move validation
2. Finding and adapting an AI algorithm for the scenerio of playing against the computer and optimize it for a greater response time and strategy
3. Analizing the results and obtained performance
4. Getting overview on current, most powerfull chess engines and in-depth knowledge in how they work and what theoretical aspects and algorithms are required for best performance
5. Making observation on the evolution in this domain drawing conclusions by comparing the researched techniques

# Chess game elements

Used technologies

why classes

numpy !!

## Game state

## The implemenation of rules and constraints

### Piece movement

### Check constraint and pins

optimized and advanved algoritm

complexity

### Game endings

## Interface

## Move making

## Diagram

# The Artificial Intelligence approach

Short intro (what can do)

why each algorithm. why ecuations ?

## Game tree search

### Mini-max

### Negamax

## Heuristic evaluation function

## Optimization

Memory time complexity

facing problems with testing time and the accuracy of moves => need of optimization speed

### Alpha – Beta pruning

### Zoobrist hashing

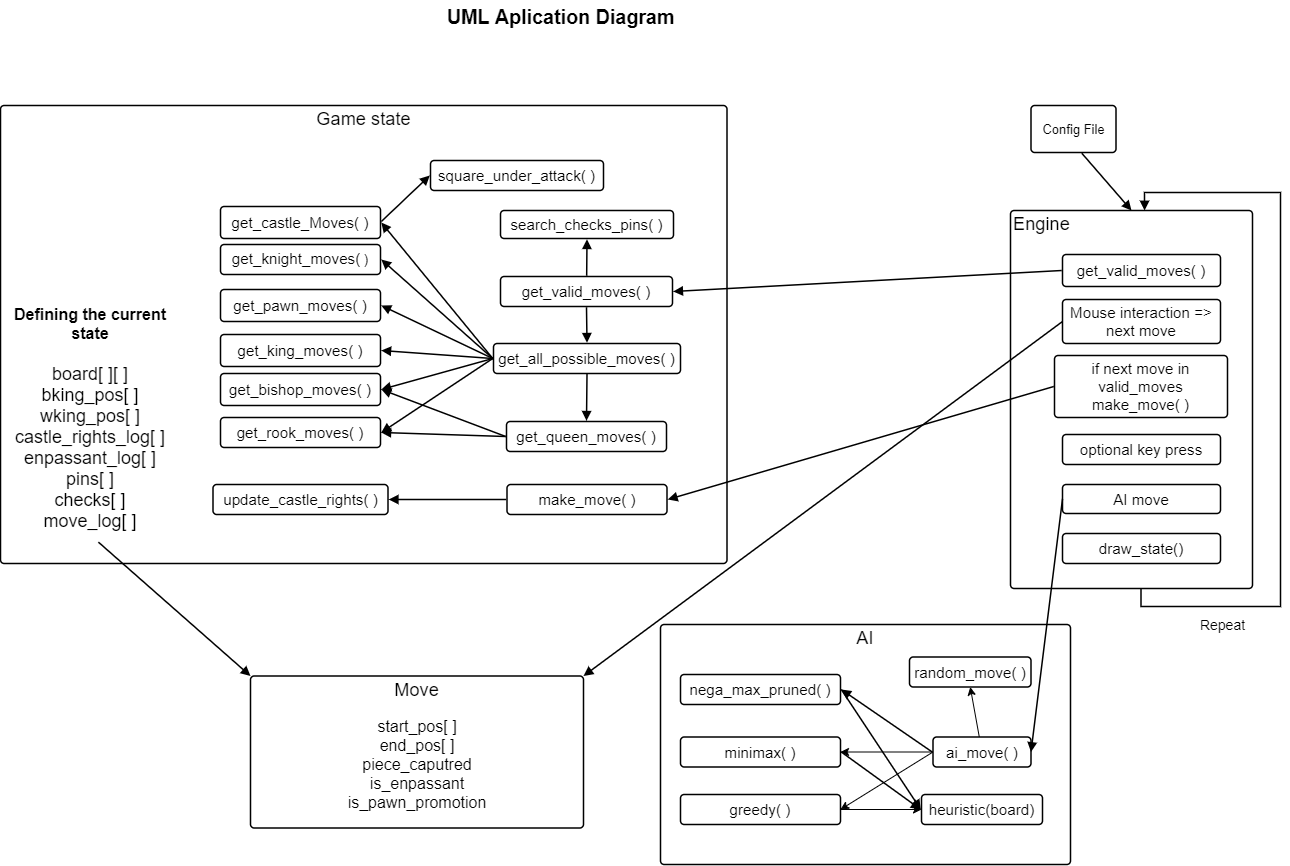
### Move ordering

### Heuristic evaluation function

### quisence search

### beam search ?!

## General structure of the program



# Game behaviour examples & stats

## Positional development

screen shots

## Force mate

## Trapping a more valuable piece

## End game situations

# State of the art

why each algorithm. why ecuations ?

## Monte Carlo Tree Search for chess

## AlphaZero

# Conclusions

Why do we achieved great results

Further possible improvements

New AI techniques DL + RL> Minmax + wtv

(bibliografie)

Mainly articles and publications

Not wiki/stack..

8)Anexe code , implementations ?!

interactiune om

# Bibliography

1. *The Role of Chess in Artificial Intelligence Research.* **Robert Levinson, David E. Wilkins, T. Anthony Marsland, Jonathan Schaeffer, Feng-hsiung Hsu.** 1991. International joint conference on Artificial intelligence.