
RESEARCH REVIEW

Deep Blue, AI nanodegree, Udacity

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Introduction

Deep Blue is a chess machine computer system that developed by IBM in mid-1990s. Garry Kasparov is the World Chess champion who is defeated by Deep Blue. This review will spot the light on two keys of Deep Blue success, which are:

- Complex evaluation function
- Search extension

Complex Evaluation Function

Deep Blue follows two strategies, fast evaluation and slow evaluation, to escape from full evaluation, when approximation evaluation will give a good result.

- Fast evaluation technique depends on simple operations which take few time to be executed. Piece placement, which is the sum of basic piece value and square-based adjustment, is one of the core functions in fast evaluation. In addition, Positional features which does not cost time like “pawn can ran” are considered to be fast evaluation function.
- Slow evaluation computes values for chess concepts by scanning one column at a time. King safety, square control, pawn structure, and pawn majority are examples of slow evaluation functions.

Search Extension

Deep Blue search uses null-window alpha-beta pruning search, in addition to some principles including:

1. Extend forcing/forced pairs
2. Forced moves are expectation depended: agent may be forced on a move which fail high at one level, and may not if it is fail low.
3. Fractional extension
4. Delay extension
5. Dual credit
6. Preserve the search envelope

Results

End game databases, the extended book, and evaluation function tuning played a role in defeating Garry Kasparov. By analyzing parallel search performance we can see that:

- Speedup averaged about 7 and observed efficiency is 30% for many deep forcing sequences positions.
- Speedup averaged about 18 and observed efficiency is 75% for quieter positions.
- A suggested overall observed efficiency of 8% in tactical positions and 12% in quiet positions.

In addition, search characteristics according to the situation helps to get good results without search explosion.

Table 2
Search characteristics, Position 1

Iteration	Minimum software depth	Maximum software depth	Estimated maximum combined depth
6	2	5	11–21
7	3	6	12–22
8	4	11	17–27
9	5	15	21–31
10	6	17	23–33
11	7	20	26–36
12	8	23	29–39

Table 3
Search characteristics, Position 2

Iteration	Minimum software depth	Maximum software depth	Estimated maximum combined depth
6	2	5	11–21
7	3	6	12–22
8	4	10	16–26
9	5	16	22–32
10	6	19	25–35
11	7	20	26–36
12	8	24	30–40

References

Campbell, M., Hoane, A., & Hsu, F. (2002). Deep Blue. *Artificial Intelligence*, 134(1-2), 57-83.
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