Programming a computer to play chess in the 1950s

Jacqueline Wagner

University of Heidelberg

jacqueline.wagner@stud.uni-heidelberg.de

April 18 2019

Overview

Theories highlighted in this presentation

- Programming a Computer for Playing Chess by Claude Shannon, 1949
- Digital Computers applied to Games by Alan Turing, 1953

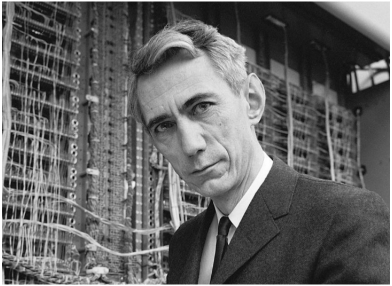
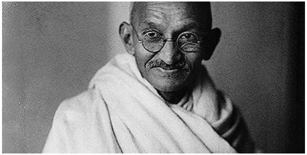


Figure: Claude E. Shannon

Image: [11]

Events that shaped the decade



Player 2

Player 1		opera	baseball
	opera	(5, 5)	(0, 0)
	baseball	(0, 0)	(10, 10)

Image 1: [8], Image 2: [14], Image 3: [19], Image 4: [6], Image 5: [10]

Advancements made in the 1940s

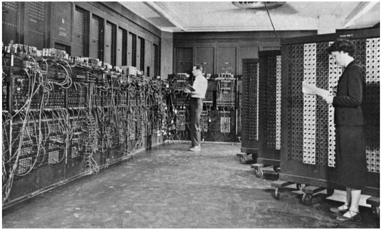


Image 1: [17], Image 2: [5], Image 3: [20], Image 4: [7]

What you might be thinking right now...

- Why are we looking at theories created in the 1940s and early 1950s?
- Is this even relevant information for me?
- Are we wasting our time?
- Why chess?

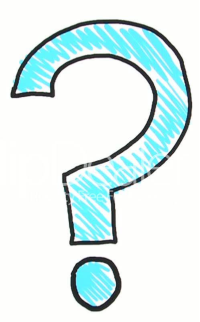


Image: [2]

Chess 101

- a game of chess can be divided into three phases
- the longest tournament lasted for 269 moves [4]
- the shortest chess tournament lasted for 4 moves [4]

Image: [16]

Playing a perfect game of chess

- consider all possible moves in a given position until an outcome has been reached
- possible since game ends after a finite number of moves
- 318,979,564,000 different ways of playing the first four moves
- 10^{120} game variations to consider

Image: [9]

Playing a skillful game of chess

- evaluate a position on the basis of
  - general layout of the position
  - number and kind of black and white pieces on the board
  - pawn formation
  - each players mobility
  - possible legal moves
- use chess principles with statistic validity

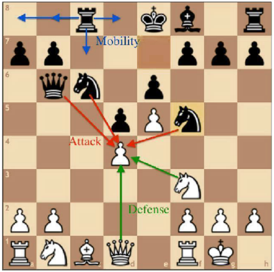


Image: [0]

Coming up with a first strategy

- calculate all possible variations out to two moves deep for each side
- apply evaluation function $f(P)$ after every move
- assume that the opponent will minimize f(P)
- choose the variation which will maximize f(P) given this constraint

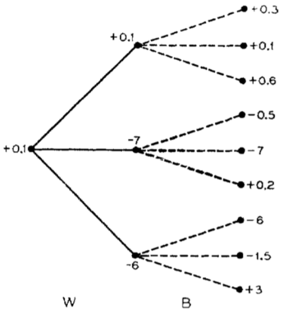


Image: [21]

Necessary Hardware

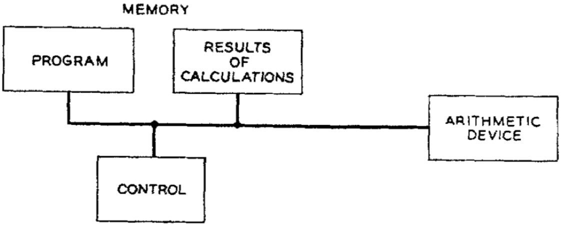


Image: [21]

Defining building blocks

- T0: Make move (a, b, c) in position P to obtain resulting position
- T1: Make list of all possible moves for pawn pieces at square (x, y) in position P
- T2-T6: Perform the above evaluation on all other types of pieces
- T7: Make list of all possible moves for all pieces in given position P
- T8: Calculate the evaluating function $f(P)$ for position P
- T9: Perform maximizing and minimizing to determine the overall best move

Some fundamental problems to consider

- $>$ 16 minutes to perform a move
- variations are only considered three moves deep
- strategy is the same in calm positions

Image: [12]

Ideas for improvement

- examine forceful variations out as far as possible
- perform evaluation once a stable position has been reached
- only evaluate worthwhile variations

Image: [3]

Shannons idea

- evaluate whether stability exists using a function $g(P)$
- explore for 2 to 10 moves until $g(P) = 0$
- evaluate whether a move M in position P is worth exploring using a function $h(P, M)$
  - forceful moves $\rightarrow$ high $h(P, M)$
  - defensive moves $\rightarrow$ medium $h(P, M)$
  - all other moves $\rightarrow$ low $h(P, M)$
- with increasing depth fewer sub-variations are examined

Turings idea

- evaluate game for at least two moves
- dead position = no captures, recaptures or checks are possible in the next move
- all other positions are considerable positions
- estimate value at the end of a sequence based on criteria, such as material, mobility, safety or threat of checkmate
- choose move which leads to the greatest value and the greatest positional value

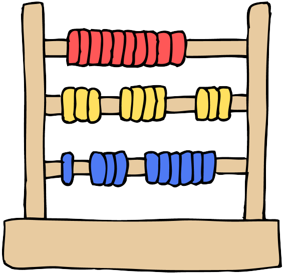


Image: [3]

More problems to consider

- machine always makes the same move in the same position $\rightarrow$ opponent can use weak decisions to win
- program is quite complicated in opening stage where masters focus on set number of variations until one player deviates

More ideas for improvement

- use statistical element to avoid repeating the same strategy over and over again
- store few hundred standard opening strategies in slow-speed memory
- change style of play by modifying selected coefficients and numerical factors
- increase strength of the player by adjusting depth of the calculation or evaluation function

Conclusion

- machine will not learn from its mistakes
- strategy relies on brute force calculation rather than logical analysis

Image: [1]

Conclusion

"It plays something like a beginner at chess who has been told some of the principles and is possessed of tremendous energy and accuracy for calculation but has no experience with the game."

Shannon, 1949
Programming a Computer for Playing Chess, page 273

Conclusion

"The computer is strong in speed and accuracy and weak in analytical ability and recognition. Hence, it should make more use of brutal calculations than humans."

Shannon, 1949
Programming a Computer for Playing Chess, page 274

Conclusion

"If I were to sum up the weakness of the above system in a few words I would describe it as a caricature of myself."

Turing, 1953
Digital Computers applied to Games, page 9

References I

Dec. 15, 2013. URL: https://www.trivalleylifechurch.org/2013/12/15/no-brain/.

Nov. 25, 2016. URL: http://hdimages.org/question-mark-image-hd/.

Aug. 7, 2017. URL: https://tmhome.com/wp-content/uploads/2014/01/meditation-higher-intelligence-research-w2.jpg.

Apr. 16, 2019. URL: https://ohfact.com/interesting-facts-about-chess/.

Apr. 17, 2019. URL: http://worldartsme.com/abacus-clipart.html#.

Evan Ackerman. Sept. 30, 2016. URL: https://spectrum.ieee.org/tech-history/space-age/a-brief-history-of-the-microwave-oven.

Jodi Beggs. Dec. 9, 2017. URL: https://www.thoughtco.com/the-meeting-game-definition-1147465.

Detlef Borchers. Feb. 16, 2016. URL: https://www.heise.de/newsticker/meldung/Vor-70-Jahren-Amerika-lernt-den-ersten-elektronischen-Universalrechner-ENIAC-kennen-3102001.html.

Gregor Delvaux de Fenffe. July 29, 2016. URL: https://www.planet-wissen.de/geschichte/diktatoren/mao_zedong_gnadenloser_machtmensch/index.html.

Stephanie Pappas. Sept. 24, 2018. URL: https://www.livescience.com/63655-why-earth-wobbles.html.

References II

- Scott Michael Rank. Apr. 16, 2019. URL: https://www.historyonthenet.com/when-did-america-enter-ww2.
- Siobhan Roberts. Apr. 30, 2015. URL: https://www.newyorker.com/tech/annals-of-technology/claude-shannon-the-father-of-the-information-age-turns-1100100.
- Ronan. July 12, 2017. URL: https://huddle.eurostarsoftwaretesting.com/when-you-have-minimum-time-for-testing-what-do-you-do/time-running-out-clock/.
- Andrew Schell. Sept. 1, 2014. URL: https://www.maximumyield.com/amino-acids-the-lego-blocks-of-plant-proteins/2/2596.
- Johnny Simon. Aug. 6, 2018. URL: https://qz.com/1349319/pictures-of-hiroshima-and-nagasakis-atomic-bomb-destruction/.
- Jimmy Soni. Aug. 16, 2017. URL: https://www.chess.com/article/view/the-man-who-built-the-chess-machine.
- Jimmy Stamp. Apr. 3, 2013. URL: https://www.smithsonianmag.com/arts-culture/how-the-chess-set-got-its-look-and-feel-14299092/.
- Steemit. Apr. 16, 2019. URL: https://steemit.com/history/@steemizen/today-in-history-the-first-frisbee.

References III

Martin Stezano. Aug. 29, 2017. URL: https://www.history.com/news/in-1950-alan-turing-created-a-chess-computer-program-that-prefigured-a-i.

Shashi Tharoor. Dec. 9, 2010. URL: https://www.welt.de/debatte/die-welt-in-worten/article11502690/Gandhis-Methoden-halfen-die-Welt-zu-veraendern.html.

Pamela Wiggins. June 9, 2018. URL: https://www.thesprucecrafts.com/guide-to-vintage-tupperware-4158189.

Claude E. Shannon. "XXII. Programming a computer for playing chess". In: *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science* 41.314 (1950), pp. 256–275. eprint: https://doi.org/10.1080/14786445008521796. URL: https://doi.org/10.1080/14786445008521796.