

# Games, Computers, and Artificial Intelligence

by J. Schaeffer and H. J. van den Herik

Tsan-sheng Hsu

徐讚昇

*tshsu@iis.sinica.edu.tw*

<http://www.iis.sinica.edu.tw/~tshsu>

# AI and game playing

## ■ Patrick Henry Winston 1984.

- *Artificial Intelligence (A.I.)* is the study of ideas that enable computers to be intelligent.
- One central goal of A.I. is to make computers more useful.
- Another central goal is to understand the principles that make intelligence possible.
  - ▷ *Making computers intelligent helps us understand intelligence.*
  - ▷ *Intelligent computers are more useful computers.*

## ■ Elaine Rich 1983.

- Intelligence requires *knowledge*.
- Games hold an inexplicable fascination for many people, and the notion that computers might play games has existed at least as long as computers.
- Reasons why games appeared to be a good domain in which to explore machine intelligence.
  - ▷ *They provide a structured task in which it is very easy to measure success or failure.*
  - ▷ *They did not obviously require large amount of knowledge.*

# Shifting goals

- **The Turing test**
  - Cannot define “intelligence”.
  - If a machine is intelligent, then it cannot be distinguished from a human.
  - Use this for filtering out computer agents.
- **From Artificial Intelligence to *Machine Intelligence*.**
  - Lots of things are better be done by machines.
  - Lots of things can be done by either human and machines.
  - Lots of things are better be done by human.
  - Try to get the best out of every possible worlds!
- **From general-purpose intelligence to domain-dependent *Expert Systems*.**
- ***From solving games, to understand intelligence, and then to having fun***
  - ▷ *Recreational*
  - ▷ *Educational*

# Early ages: The Maelzel's Chess Automaton

## ■ Late 18th century.

- The Turk
- Invented by a Hungarian named Von Kempelen.
- Chess-playing “machine.”
  - ▷ *Operated by a concealed human chess-master.*
- “Arguments” made by the famous writer Edgar Allen Poe in “*Maelzel's Chess Player*”.
  - ▷ It is as easy to design a machine which will invariably win as one which wins occasionally.
  - ▷ Since the Automaton was not invincible it was therefore operated by a human.
- Burned in a fire at an USA museum.
- “Recently” reconstructed in Californian.

# Early ages: Endgame chess-playing machine

## ■ 1914

- Made by Torres y Quevedo.
- Plays an end game of king and rook against king.
- The machine played the side with king and rook and would force checkmate in a few moves however its human opponent played.
- An explicit set of rules are known for such an endgame.
- Very advanced automata for that period of time.

# Early ages: China

- Not much materials can be found (by me)!
- Shen, Kuo, 1086
  - Analyzing the **state space** of the game Go.

# History

- **Early days: as A.I. were plagued by over-optimistic predictions.**
  - J von Neumann, 1928, “Math. Annalen”
  - C.E. Shannon, 1950, Computer Chess paper
  - Arthur Samuel began his 25-year quest to build a strong checkers-playing program at 1952
  - Alan Turing, 1953, “Faster than though”, chapter 25
- **1970s and 1980s.**
  - Concentrated on Western chess.
  - Brute-force approach
    - ▷ *The CHESS series of programs by the Northwestern University.*
    - ▷ *Analysis of Alpha-Beta pruning by Knuth and Moore at 1975.*
  - Building faster search engines.
  - Chess-playing hardware.

# Recent history

## ■ Early 1980s until today.

- Advances in theory of heuristic searches.

- ▷ *Conspiracy numbers*

- ▷ *Search enhancements such as null moves and singular extensions*

- ▷ *Learning ideas*

## ■ 1990s until now

- Witness a series of dramatic computer successes against the best of humanity.

- ▷ *CHINOOK, checkers, 1994.*

- ▷ *DEEP BLUE, chess, 1997.*

- ▷ *LOGISTELLO, Othello, 1997.*

# Taxonomy of games

- **According to number of players**
  - Single player games: puzzles
  - Two-player games
  - Multi-player games
- **According to information obtained by each player**
  - Perfect-information games: all information is available
  - Imperfect-information games: some information is not available, for example you cannot see the opponent's cards in Poker.
  - Stochastic games: there is an element of chance such as dice rolls.

# New frontiers

- **Traditional games:** using paper and pencil, board, cards, and stones.
- **Interactive computer games**
  - text only at early days
  - 2-D graphic during the 1980s with the advance of personal computers.
  - 3-D graphics with sound effects today.
- **On-line games:** players compete against other humans.
- **Challenge:**
  - better user interface: such as Wii.
  - Developing realistic characters
    - ▷ *So far very primitive: simple rule-based systems and finite-state machines*
    - ▷ *Need research in “human” intelligence”*
- **Games with Robots: RoboCup.**

# Concluding remarks

## ■ Arthur Samuel, 1960.

- Programming computers to play games is but one stage in the development of an understanding of the methods which must be employed for the machine simulation of intellectual behavior.
- As we progress in this understanding it seems reasonable to assume that these newer techniques will be applied to real-life situations with increasing frequency, and the effort devoted to games ... will decrease.
- Perhaps we have not yet reached this turning point, and we may still have much to learn from the study of games.

# References and further readings

- \* J. Schaeffer and H. J. van den Herik. Games, computers, and artificial intelligence. *Artificial Intelligence*, 134:1–7, 2002.
- Jonathan Schaeffer. The games computers (and people) play. *Advances in Computers*, 52:190–268, 2000.