# 電腦如何下象棋

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許舜欽

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# Computer Games

⌘ A Challenge of Artificial Intelligence
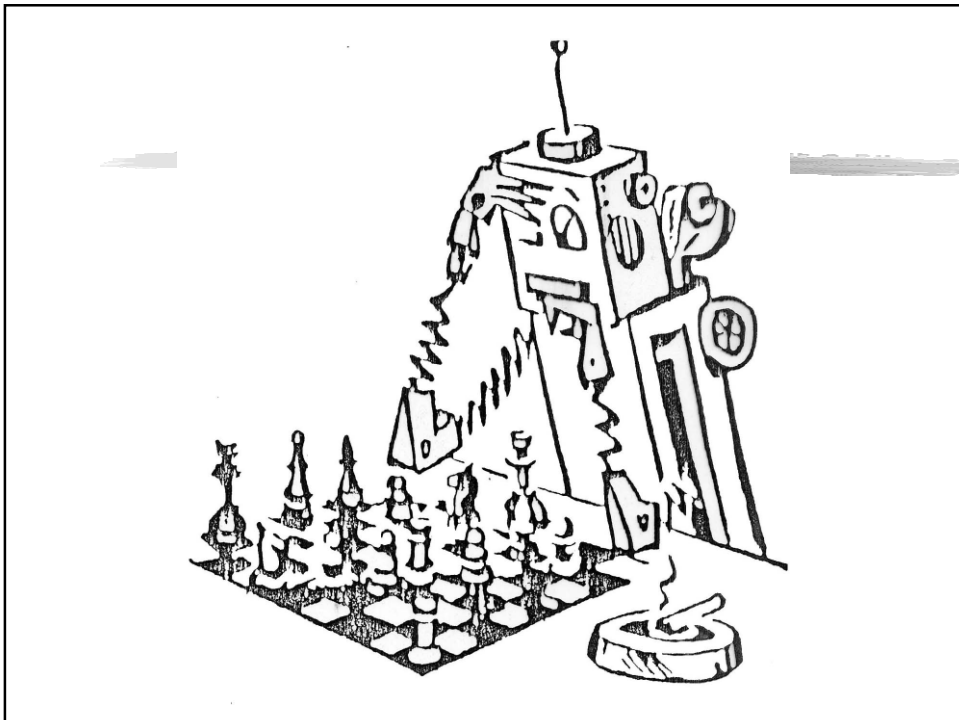
⌘ Recently solved games
- ⬜ Connect Four
- ⬜ Qubic
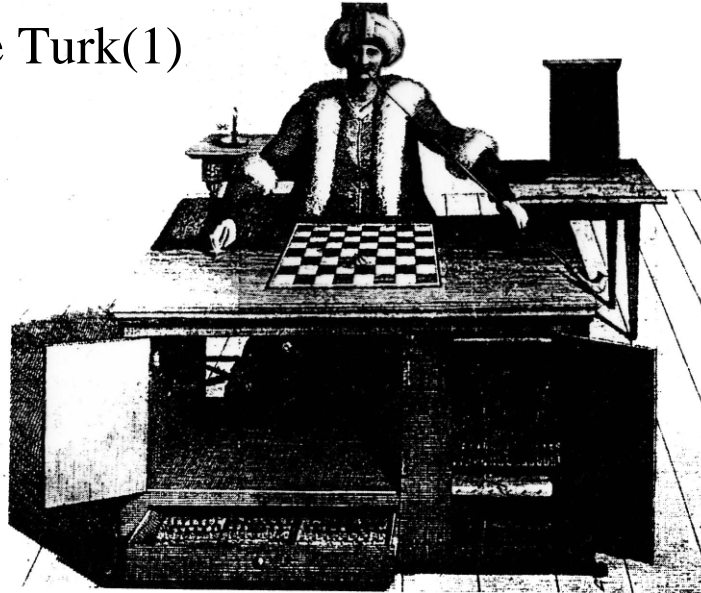- ⬜ Go-Moku
- ⬜ Nine-Men Morris
- ⬜ Awari
- ⬜ Checker

# Unsolved Board Games

- Othello
- Chess
- Chinese Chess
- Japanese Shogi
- Go

# The Turk(1)



# The Turk(2)

- By Wolfgang Kempelen in 1760
- Rebuilt in 1780
- Purchased by the impresario Maelzel in 1804
- Challenged Napoleon Bonaparte in 1809
- Came to America in 1826
- Revealed the secrets in 1834
- Destroyed by fire in Philadelphia in 1854

# The Turk(3)
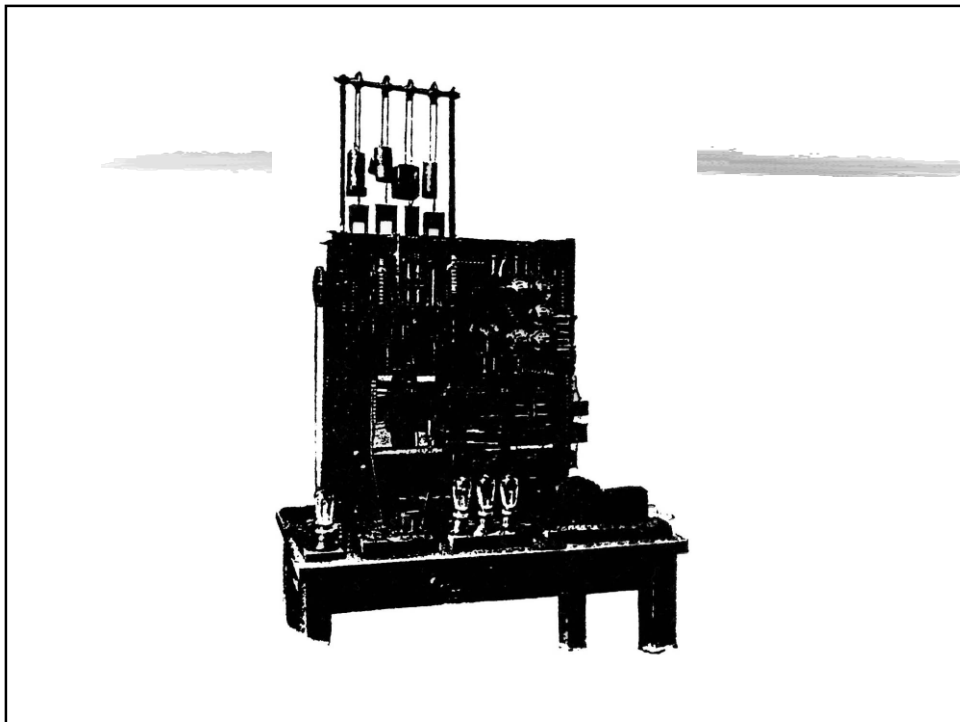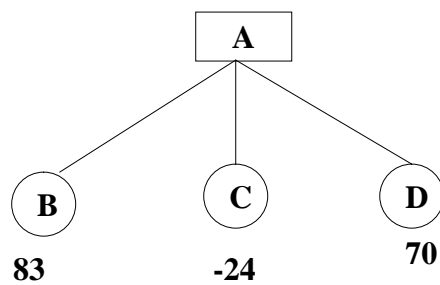
⌘Passed from hand to hand after 1837

⌘Supplied by 15 different chess players
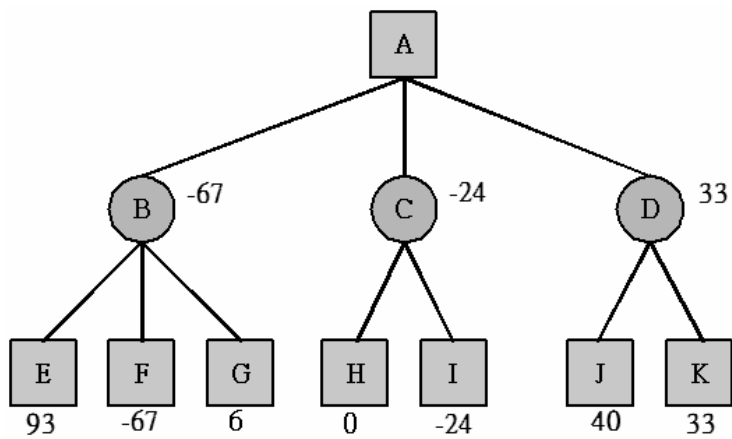
⌘Won 294 of 300 games

# The Torres Machine

最簡單的對局樹

```
        ┌───┐
        │ A │
        └───┘
        ╱  │  ╲
      ╱    │    ╲
    ╱      │      ╲
  (B)     (C)     (D)
   83     -24      70
```

# 展開兩層的對局樹



# MiniMax Procedure

⌘1950 Claude E. Shannon

⌘Type A

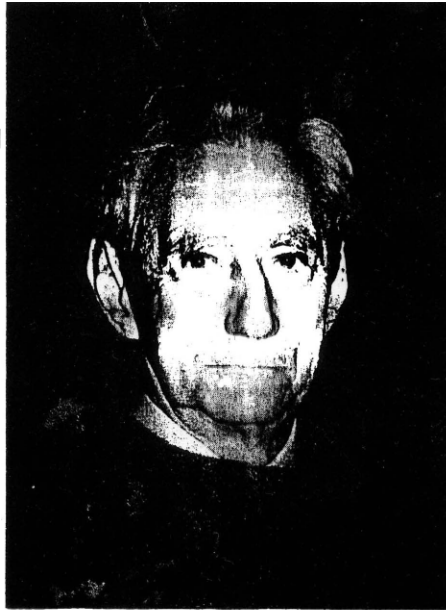⊟Exhaustive search

⌘Type B

⊟Selective search

⌘Type C

⊟Goal oriented search

Claude Shannon at Edmonton, May 1989

# The first real Chess program

⌘1958 Bernstein
  ◻6X6 Chessboard (omit Bishop)
  ◻type B search
  ◻branch factor = 7
  ◻4 plies
⌘**Simon dictum**
  ◻within 10 years ==>world champion

# USA Champion list (1)

⌘ 1970   Chess 3.0

⌘ 1971   Chess 3.5

⌘ 1972   Chess 3.6

⌘ 1973   Chess 4.0

⌘ 1974   Ribbit

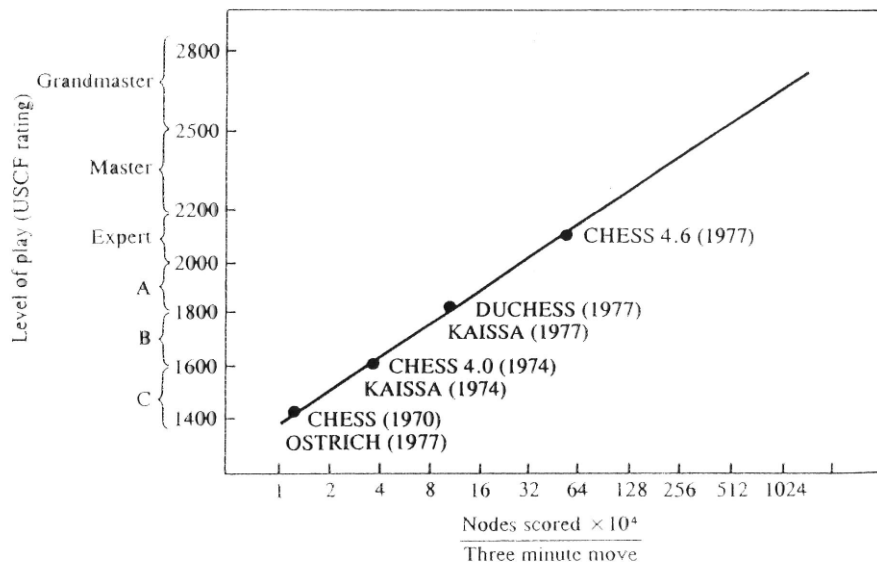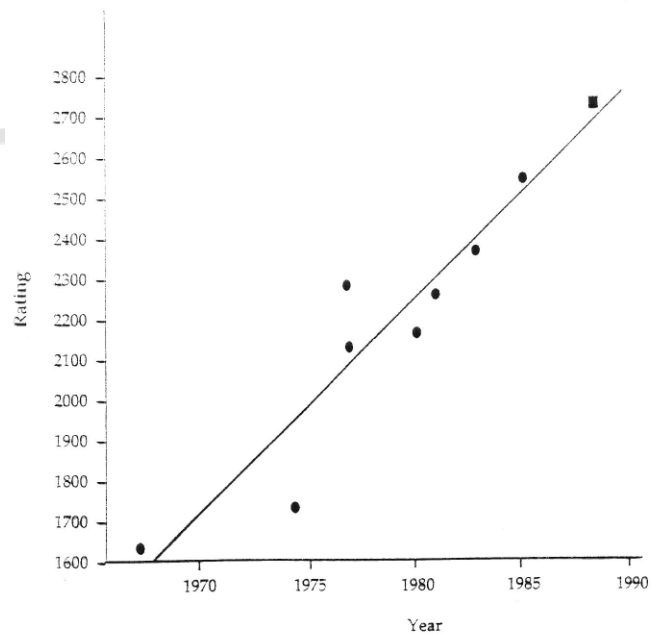⌘ 1975   Chess 4.4

⌘ 1976   Chess 4.5

⌘ 1977   Chess 4.6



**Figure 26.** Relationship between playing strength of chess programs and the number of nodes scored per move.
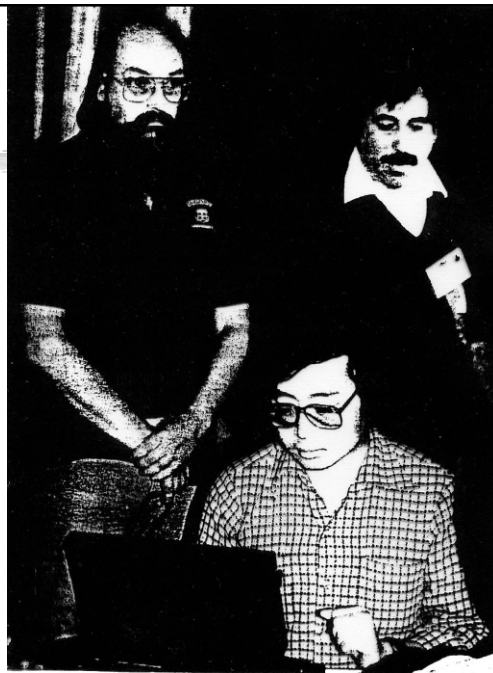
# USA Champion list (2)

- 1978  BELLE
- 1979  Chess 4.9
- 1980  BELLE
- 1981  BELLE
- 1982  BELLE
- 1984  Cray Blitz
- 1985  HITECH



Best performance ratings of chess programs

# USA Champion list (3)

- ⌘ 1986  BELLE
- ⌘ 1987  Chip test-M
- ⌘ 1988  Deep Thought
- ⌘ 1989  HITECH
- ⌘ 1990  Deep Thought
- ⌘ 1991  Deep Thought



Ken Thompson, David Slate and Feng-hsiung Hsu, 1989

電腦對人腦　棋王對棋王

"深思"每秒算出80萬步棋　還是輸人

/ 姜美珠

USA Champion list (4)

⌘1993　Socrates
⌘1994　Deep Thought

世界日報　中華民國八十五年二月十一日 星期日

# 電腦人腦棋賽・機器贏了頭盤
## 世界棋王下得辛苦・國際網路「實況轉播」



# 棋王乘勝追擊・打敗電腦挑戰
## 三勝二負一和衛冕成功、深藍計劃表現亦獲肯定

# The World Computer Chess Champions(1)

⌘1974(Stockholm)   KAISSA

⌘1977(Toronto)       Chess 4.6

⌘1980(Linz)            BELLE

⌘1983(New York)    Cray Blitz

⌘1986(Cologne)      Cray Blitz

⌘1989(Edmonton)   Deep Thought

## The World Computer Chess Champions(2)

- 1992(Madrid)  Chess Machine/Schroder
- 1995(Hong Kong)  Fritz
- 1999(Paderborn)  Shredder
- 2002(Maastricht)  Deep Junior

## The World Computer Chess Champions(3)

- 2003(Graz)  Shredder
- 2004(Ramat-Gan)  Deep Junior
- 2005(Reykjavik)  Zappa
- 2006(Torino)  Deep Junior
- 2007(Armsterdam)  Rybka
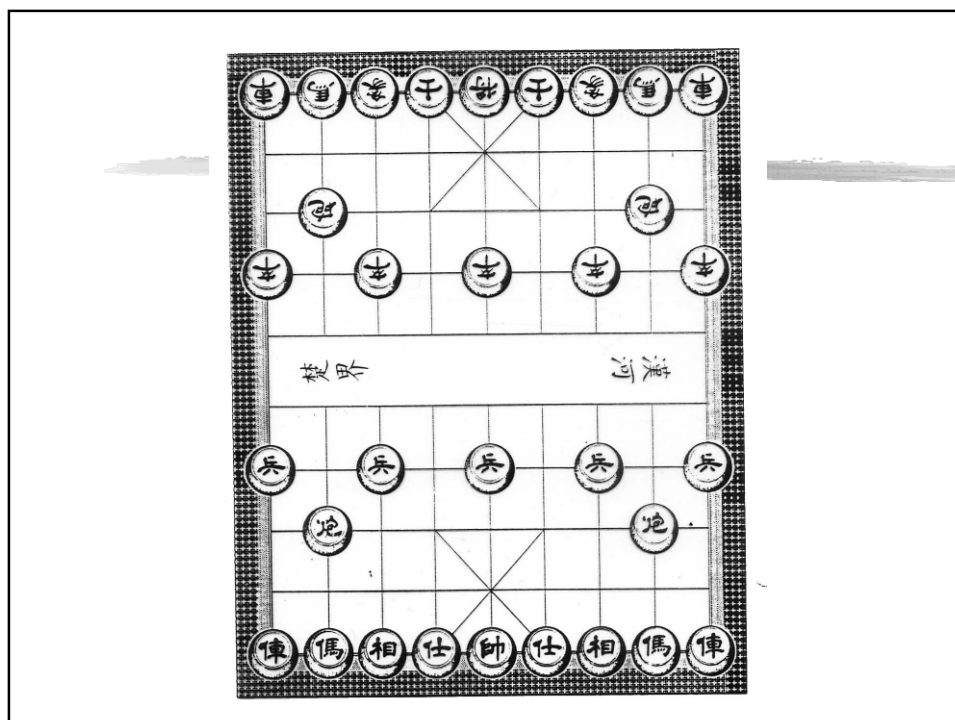
# 電腦象棋之發展

| 1981 | 張躍騰、賈玉輝 |
| --- | --- |
| 1982 | 廖嘉成、杜敏文、李家同 |
| 1985 | 黃東輝、許舜欽 |
| 1986 | 王明欽、許舜欽 |
| | 李紘、蔡明坤、林順喜 |
| | 曹國明、許舜欽 |
| | 虞希舜 |
| 1987 | 杜貴崇 |

## 1988　　3/29

- 虞希舜
- 曹國明
- 鄭武堯
- 蔡明坤
- 杜貴崇

## 1989 1st Computer Olympiad

- London
- 象棋大師--虞希舜
- 象棋專家--曹國明
- ELP--鄭武堯

# 1990 2nd Computer Olympiad

⌘London
⌘ELP--鄭武堯
⌘象棋專家--曹國明
⌘Xian---黃少龍

# 1992 4th Computer Olympiad

⌘London
⌘Surprise--吳韌
⌘ELP--鄭武堯

# 2001 6th Computer Olympiad

⌘Maastrict (Holland)

⌘ELP--鄭武堯

⌘SG--鄭明政

⌘Abyss--Tony Marsland

# 2002 7th Computer Olympiad

⌘Maastrict (Holland)

⌘ELP--鄭武堯

⌘SG--鄭明政

⌘XieXie--Pascal Tang

# 2003 8th Computer Olympiad

⌘Graz (Austria)
⌘ZMBL--涂志堅
⌘XieXie--Pascal Tang
⌘ELP--鄭武堯

# 2004 9th Computer Olympiad

⌘Ramat-Gan (Israel)
⌘Contemplation--吳光哲
⌘ELP--鄭武堯

## 2004 世界電腦象棋大賽

- 台南 成功大學
- XieXie--Pascal Tang
- ZMBL--涂志堅
- Contemplation--吳光哲

## 2005 10th Computer Olympiad

- Taipei (Taiwan)
- 象棋奇兵--趙明揚
- 象棋世家--鄭明政
- 棋天大聖—王驕

# 2006 11th Computer Olympiad

⌘Torino (Italy)

⌘棋天大聖--王驕

⌘象棋世家--鄭明政

⌘深象—黃文樟

# 2007 世界電腦象棋大賽

⌘台南 長榮大學

⌘棋天大聖--王驕

⌘象棋世家--鄭明政

⌘ELP--鄭武堯

# 2007 12th Computer Olympiad

⌘Maastrict (Holland)

⌘棋天大聖--王驕

⌘象棋世家--鄭明政

⌘XieXie--Pascal Tang

# MiniMax Procedure

## Alpha – ßeta Cutoff

Max

Min

Max          ∂ = 3

Min          ß = 2

+10  -10

3

10  3  15  9  2

---

# Heuristic

⌘ Capturing moves first
⌘ Stronger pieces first
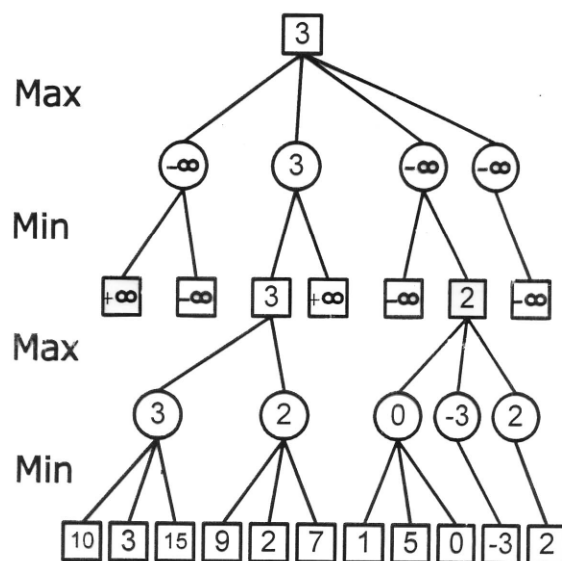
# Search techniques

⌘ Quiescent

⌘ Deep alpha-beta

⌘ Iterative deepening

⌘ Principal variation

⌘ Zero window

⌘ Tolerance

⌘ Killer heuristic

⌘ Transposition table

圖4 深層 α−β 切捨

# Static evaluation functions

1. Materia balance
2. Relative mobility
3. Pawn structure

⌘ Position weight
⌘ Guard and threat

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# 子力

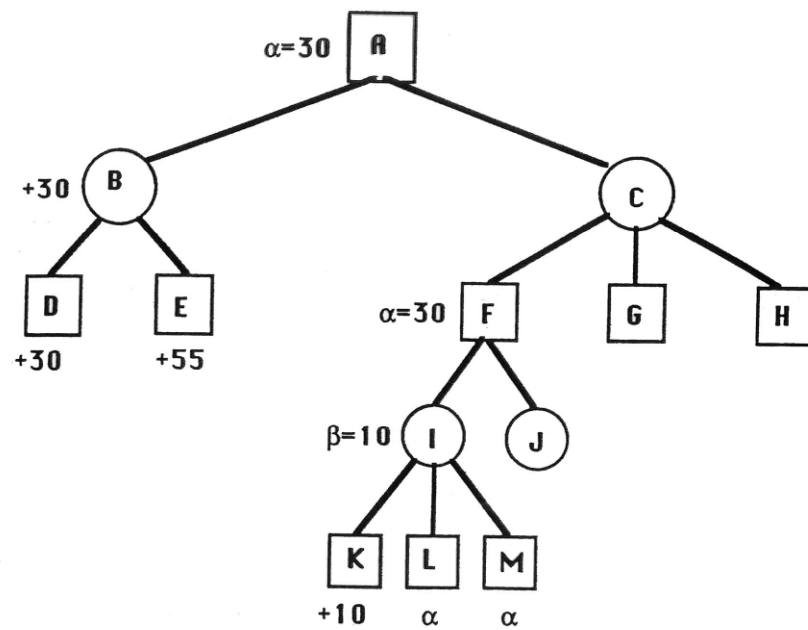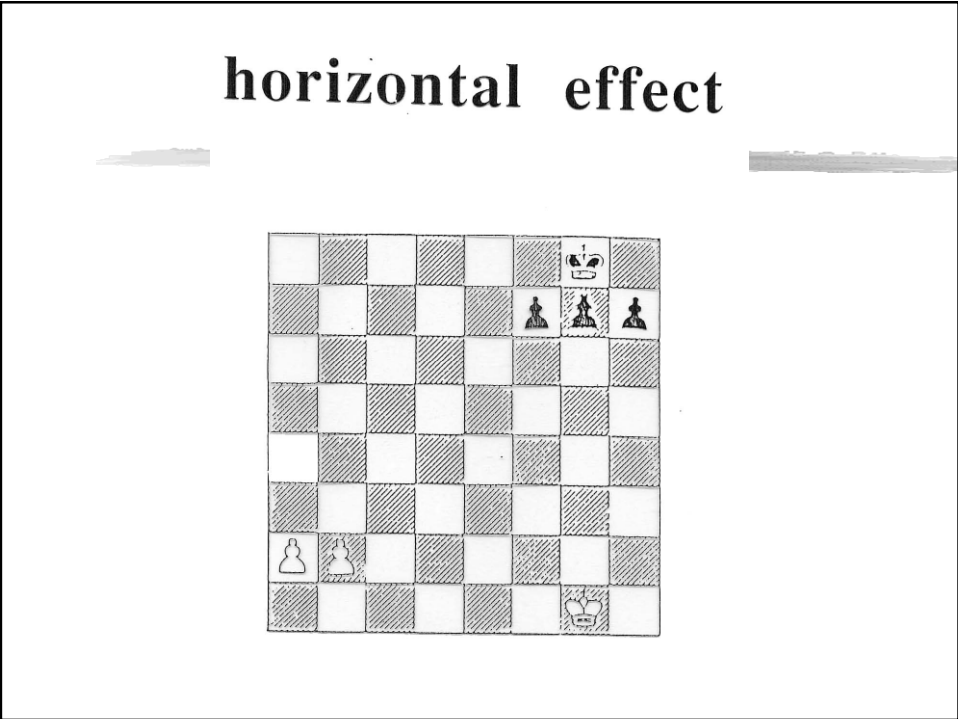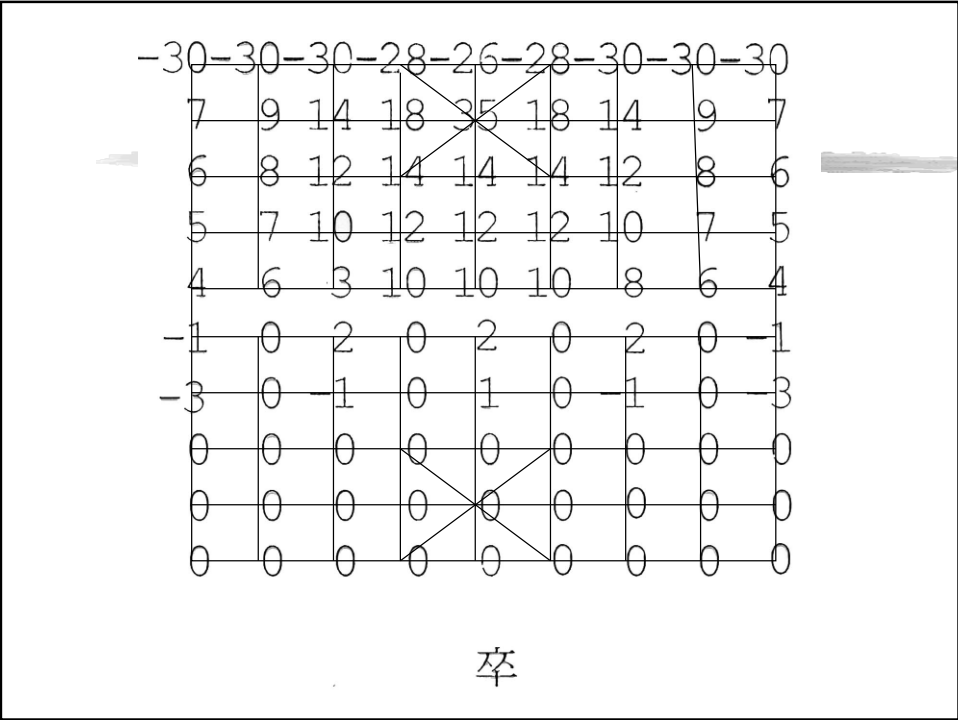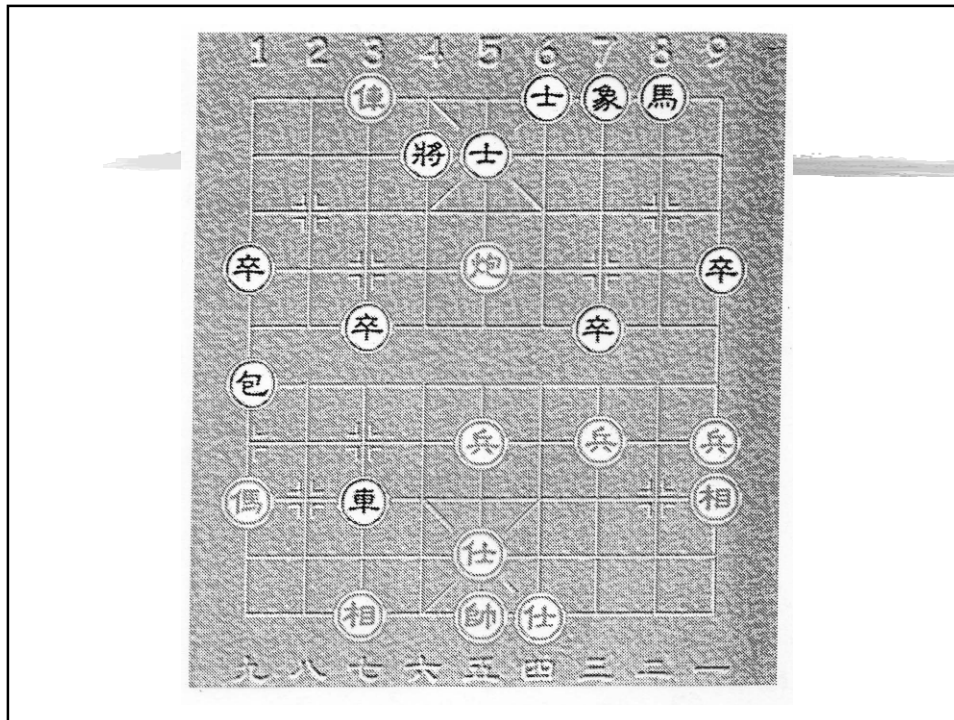| 將 | 2000 |
|---|---|
| 士 | 40 |
| 象 | 40 |
| 車 | 200 |
| 馬 | 90 |
| 包 | 90 |
| 卒 | 10 |

車

```
 8   9   8  10   9  10   8   9   8
 9   9   8  11  12  11   8   9   9
 8   8   7  11  11  11   7   8   8
 7   8  10  11  11  11  10   8   7
 6   7   6  10  10  10   6   7   6
 6   6   6   9   9   9   6   9   6
 5   6   5   8   8   8   5   6   5
 2   6   5   8   8   8   5   6   2
 4   4   3   8  -1   8   3   4   4
-1   4   2   7   7   7   2   4  -1
```

車

馬

```
 4   3   3   6   3   6   3   3   4
 3   8   8   8   8   6   8   8   3
 7   6   8   8   8   8   8   6   7
 4   9   6   9   6   9   6   9   4
 4   7   6   7   8   7   6   7   4
 0   3   6   4   4   4   6   3   0
 0   3   3   2   4   2   3   3   0
 0   2   2   2   2   2   2   2   0
 0   0   0   1  -1   1   0   0   0
 0  -2   0   0   0   0   0  -2   0
```

馬

-30 -30 -30 -28 -26 -28 -30 -30 -30
7 9 14 18 25 18 14 9 7
6 8 12 14 14 14 12 8 6
5 7 10 12 12 12 10 7 5
4 6 8 10 10 10 8 6 4
-1 0 2 0 2 0 2 0 -1
-3 0 -1 0 1 0 -1 0 -3
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

卒

# horizontal  effect

## Three Factors

⌘Programming techniques

⌘Machine speed

⌘Chinese chess expert knowledge

## 未來的展望

⌘ 開局
  ⊟ Data acquisition from internet
⌘ 中局
  ⊟ multi-processing
⌘ 殘局
  ⊟ retrograde analysis

## 未來的展望(二)

⊟ 2008　八段
⊟ 　　　台灣棋王 吳貴臨
⊟ 2011　九段
⊟ 　　　世界棋王 許銀川