# Is Chess the Drosophila of AI?

#### **Computer Games as Experimental Technologies**



Nathan Ensmenger University of Pennsylvania



#### Herbert Simon

If one could devise a successful chess machine, one would seem to have penetrated to the core of human intellectual endeavor.

#### Herbert Simon (1958)



#### CHESS METAPHORS



#### ARTIFICIAL INTELLIGENCE AND THE HUMAN MIND

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Diego Rasskin-Gutman TRANSLATED BY Deborah Klosky





#### Automaton Chess Player







#### Charles Babbage

#### 1770

82

#### **A History of Computer Chess**













#### Alan Turing





### Los Alamos "MANIAC" 1946 82 836 1890 1956 1770 **A History of Computer Chess**









# Are YOU the man

#### to command electronic giants?

From the recent advance of electronic digital computers has emerged an exciting new job—creating instructions that enable these giant computers to perform logical operations for a variety of tasks in business, science and government.

You could be eligible for a position in computer programming. Because it is a new and dynamic field, there are no rigid qualifications. Do you enjoy algebra, geometry or other logical operations? Can you do musical composition or arrangement? Do you have an orderly mind that enjoys such games as chess, bridge or anagrams . . . finally, do you have a lively imagination?

If you do, you can qualify. You will receive training (at full pay) and work at IBM's Engineering Laboratories—among the most modern in the world. For more information, write to: G. W. Woodsum, Dept. 203, International Business Machines Corp., Research Laboratory, Poughkeepsie, N. Y.

DATA PROCESSING ELECTRIC TYPEWRITERS TIME EQUIPMENT MILITARY PRODUCTS



INTERNATIONAL BUSINESS MACHINES CORPORATION

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DATA PROCESSING ELECTRIC TYPEWRITERS TIME EQUIPMENT MILITARY PRODUCTS



INTERNATIONAL BUSINESS MACHINES CORPORATION



#### Alex Bernstein, IBM Corporation (1958)



## If chess is the drosophila of AI, what is Drosophila the drosophila of?





#### Thomas Hunt Morgan

#### 74 THEORY OF EVOLUTION

2 whites, and not the usual 3:1 Mendelian ratio. Yet, as will be shown later, the result is in entire accord with Mendel's principle of segregation.









0



FIG. 64. Scheme to illustrate a method of crossing over of the chromosomes.



#### Columbia University "Fly Room"



#### MANIAC Computer, Los Alamos (1958)

### how a computer sees a chessboard



#### Claude Shannon (c. 1950)






P-K4

P-Q4



#### ply 1: white to move



#### ply 2: black to move







#### ply 4: black to move



# the limits of computation





#### average number of moves per game of chess



#### average number of plies per game of chess



### average number of plausible moves per ply



#### average number of moves to be examined per game



#### average number of moves to be examined per game



#### average number of moves to be examined per game



## total number of seconds since the origin of the universe



#### total number of atoms in the universe



#### number of moves evaluated by Deep Blue every second



### **J O still not even close**

total number of moves calculated if every atom in the universe was a chess computer as powerful as Deep Blue and had been running since the beginning of time until the end of the universe



#### construct the decision tree



#### apply the evaluation function





















#### ply 3: white to move



#### ply 3: white to maximize



#### ply 3: white to maximize



+4 +4



Thursday, October 6, 11

+1









#### ply 2: black to minimize
















#### ply 1: white to maximize



#### ply 2: black to minimize



#### ply 3: white to maximize





#### minimax optimal branch

## is the minimax algorithm the drosophila of AI?

# why chess?



### Daring ideas are like Chess men moved forward. They may be beaten, but they may start a winning game.

Johann Wolfgang von Goethe

The chess pieces are the block alphabet, which shapes thoughts; and these thoughts, although making a visual design on the chessboard, express their beauty abstractly, like a poem.

Marcel Duchamp

### Chess is like war on a board.

**Bobby Fischer** 

## Bobby Fischer (1972)



#### 1. d4 Nf6 2. c4 e6

### algebraic chess notation

1. d4 Nf6 2. c4 e6 3. Nf3 c5 4. d5 exd5 5. cxd5 d6 6. Nc3 g6 (Benoni Defense, A61) 7. Nd2 Nbd7 8. e4 Bg7 9. Be2 O-O 10. O-O Re8 11. Qc2, NH5 12. Bxh5 qxh5 13. Nc4 Ne5 14. Ne3 Qh4 15. Bd2 Ng4 16. Nxg4 hxg4 17. Bf4 Qf6 18. g3 Bd7 19. a4 b6 20. Rfe1 a6 21. Re2 b5 22. Rae1 Qq6 23. b3 Re7 24. Qd3 Rb8 25. axb5 axb5 26. b4 c4 27. Qd2 Rbe8 28. Re3 h5 29. R3e2 Kh7 30. Re3 Kq8 31. R3e2 Bxc3 32. Qxc3 Rxe4 33. Rxe4 Rxe4 34. Rxe4 Qxe4 35. Bh6 Qg6 36. Bc1 Qb1 37. Kf1 Bf5 38. Ke2 Qe4+ 39. Qe3 Qc2+ 40. Qd2 Qb3 41. Qd4 Bd3+

#### Fischer versus Spassky (0-1) Reykjavik, Iceland 1972

A       B       C       D       E       F       G       H         8       18       28       38       48       58       68       78       88       8         7       17       27       37       47       57       67       77       87       7	Partie Partie Game Partida Партия	Nr No No No	ihr Zug Votre coup Your move Su jugada Ваш ход	Nr No No No	Mein Zug Mon coup My move Mi jugada Мой ход	Turnier Nr Tournoi No Tournament No Torneo No Турнир No
6       16       26       36       46       56       66       76       86       6         5       15       25       35       45       55       65       75       85       5         4       14       24       34       44       54       64       74       84       4         3       13       23       33       43       53       63       73       83       3         2       12       22       32       42       52       62       72       82       2         1       11       21       31       41       51       61       71       81       1						Ihr Zug ist unklar Votre coup n'est pas clai Your move is not clear Jugada maldefinida Неясный ход Ihr Zug ist unmoglich Votre coup est impossible Your move is impossible Jugada imposibile
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#### preprinted correspondence chess postcard





#### IBM 360/195, Rutherford Labs (1974)

![](_page_93_Picture_0.jpeg)

#### Detroit World Computer Chess Championship (1979)

![](_page_94_Picture_0.jpeg)

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4.BS '66 '76	(11)	1
5.Chaos	(4)	5
6. Chess 1.9	(2)	1
7. Duchess	(3)	
8L'Excentriq	ue (7)	1
9.Mychess	(12)	1
10. Ostrich 80	) (1)	1
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2. Sargon 2	5 (1)	N
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*2/	0	811	1					
B12/	0	WI						
BC	0	114	1					

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W/	1
B12/	21/2
85/	1
wg/	0
W3/	2'2
W7/	3
BL	2
WID	2
B4/	2
83/	1
81/	0
W3/	1

ACM's North American Computer Chess Champions												
Round 3	Round 4	TOTAL	TIE BREANER POINTS									
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B12 2/2	N6											
85 1	112											
W9 O	BH											
W3 2'h	87											
W7 3	32											
BL 2	WE											
W10 2	89											
B4 2	WE											
81 1	WI											
81 0	24											
W2 1	83											

#### **Detroit World Computer** Chess Championship (1979)

FIRST UNITED STATES COMPUTER CHESS CHAMPIONSHIP

W

1 TONY MARSLAND 85500

2 DENNIS COOPER IBM 360-65

3 PRANTI BM

5 KETTH CDI KENNETH 6 GHAS DA WARDAR

7

BUN N

Compute Chess Tournamen

POINTS

8

![](_page_96_Picture_0.jpeg)

## Mitchell Denies Any Link to Bugging

![](_page_96_Picture_2.jpeg)

#### Stocks Jump

NEW YORK IP-The stock market sent Wall Streeters off on their Labor Day weekend in a good mood, staging a rally amid light trading. The Dow Jones industrials closed up 6.32 at 970.05.

Details in Part 3. Page 13

#### \$1 Billion U.S. Sales Accord Reached by Nixon, Tanaka

HONOLULU (2-President Nixon and Japanese Prime Minister Kakuei Tanaka today pledged joint efforts to bring trade between the two countries into better balance. In a companion announcement, the governments disclosed Japanese plans to purchase \$1 billion-plus of

![](_page_96_Picture_8.jpeg)

![](_page_96_Picture_9.jpeg)

#### Spassky Quits by Telephone in 21st Game

REYKJAVIK (UPI)-Bobby Fischer, whose bold style and capricious temperament forced the world to take a new look at the ancient game of chess, today became world chess champion in an anticlimactic telephoned resignation from Russia's Boris Spassky in the 21st game.

In typical fashion, the new champion was late for his own coronation.

Spassky called arbiter Lothar Schmid to resign less than two hours before the scheduled resumption of the 21st game which was adjourned in Fischer's favor after 40 moves Thursday.

The Russian grandmaster had spent the night analyizing the game in futile search of a way to save a draw and his title.

The title was worth \$156,250 in prize money to Fischer. Spassky's share was to be \$93,750.

![](_page_97_Picture_0.jpeg)

This is the computer that may change the course of chess playing history

Can an American chess computer beat the Soviet Chess Champion? A Confrontation between American space-age technology and a Soviet psychological weapon.

The Soviet Union regards chess as a psychological weapon, not just a game it is a symbol of communism's cultural struggle with the West.

So when Russian Anatoli Karpov competed against the Russian Defector, Victor Korchnoi, he had the entire Soviet Union's resources at his disposal, including a hypnotist and neuropsychologist look several moves ahead to determine its next move When we first designed it, it played five levels of chess Level one was for beginners and as you played against the computer, you could increase its level of difficulty until the computer became more of a challenge. Level five was quite a challenge

We thought we had the ultimate unit with five levels, until we developed our most sophistispace-age products - further assurance that your modest investment is well protected

We suggest you order a JS&A Chess Computer on our 30 day trial period Play against it Raise or lower the level as you play and watch how the computer's personality can change right in mid-game-from a tough competitor to a push over.

# why minimax?

```
int minimax(POSITION *p, int depth)
  MOVE list[MAXMOVES];
  int i,n,bestvalue,value;
  if(checkwin(p))
     if (p->color == WHITE)
        return -INFINITY;
     else
        return INFINITY;
     }
  if(depth == 0)
     return evaluation(p);
  if(p->color==WHITE)
     bestvalue = -INFINITY;
  else
     bestvalue = INFINITY;
  n = makemovelist(p,list);
  if(n == 0)
     return handlenomove(p);
  for(i=0; i<n; i++)</pre>
```

0000: D8 A2 FF 9A A2 C8 86 B2 20 1F 1F 20 6A 1F C5 F3 0010: F0 F6 85 F3 C9 0C D0 0F A2 1F B5 70 95 50 CA 10 0020: F9 86 DC A9 CC D0 12 CS 0E D0 07 20 82 02 A9 EE 0030: D0 07 C5 14 D0 0B 20 A2 03 85 F3 85 FA 85 F9 D0 00401 BF C5 0F D0 06 20 4B 03 4C 9D 01 4C 96 01 10 00 0070: 03 04 00 07 02 05 01 06 10 17 11 16 12 15 14 13 0080: 73 74 70 77 72 75 71 76 60 67 61 66 62 65 64 63 0090: FF 01 10 11 0F FF 11 DF F1 DF F1 EE F2 12 0E 1F 21 0040: B5 30 5C 45 B0 F0 08 E0 08 D0 4C 55 E6 F0 2E 0110: F6 E3 CS 01 D0 02 F6 E3 50 1E A0 0F A5 B1 D9 60 0120: 00 F0 03 88 10 F8 B9 A0 00 D5 E4 90 04 45 E4 F0 2E 0110: F6 E3 CS 01 D0 02 F6 E3 50 1E A0 0F A5 B1 D9 60 0120: 00 F0 03 88 10 F8 B9 A0 00 D5 E4 90 04 85 B1 09 60 0120: 00 F0 03 88 10 F8 B9 A0 00 D5 E4 90 04 85 B1 09 60 0120: 00 F0 03 88 10 F8 B9 A0 00 D5 E4 90 04 85 B1 09 60 0120: 00 F0 03 88 10 F8 B9 A0 00 D5 E4 90 04 82 E6 95 0140: E8 85 DD AS 00 85 B5 20 98 02 20 31 03 4C 60 10 0170: FD A0 07 A5 B1 D9 60 00 F0 05 88 F0 F1 10 F6 B9 0140: E0 F5 D0 0B A5 60 C5 B1 D0 04 A5 00 85 B4 60 50 0140: E0 C5 FA 70 03 CA 10 F7 86 F8 88 D4 C0 00 00 0210: 01 60 20 15 C2 90 02 95 E2 C6 B5 A9 F8 60 B0 10 0220: A2 10 A9 00 95 DE CA 10 F8 A8 10 85 D0 C6 B0 10 0220: A2 10 A9 00 95 DE CA 10 F8 A8 10 85 D0 C6 B0 10 0220: C6 10 22 C0 04 10 1F C0 01 F0 05 10 0E 20 8E 02 0220: D0 FB F0 D3 20 SC 02 D0 FB F0 D2 A2 04 86 B6 20 0220: C6 10 22 C0 04 10 1F C0 21 E 03 C6 B6 60 20 CA 02 70 8F 30 8D 1020: C2 30 07 88 20 8E 02 A5 B6 C5 08 D0 F7 60 A1 C0 0220: C3 10 86 B6 20 CA 02 50 05 30 33 00 07 12 01 1E 0270: C3 C6 B6 A5 B6 C9 05 F0 C2 25 05 50 C EE 20 CA 02 70 8F 30 8D 0220: C2 30 F9 50 07 88 20 00 01 28 15 90 C2 02 CA 12 F0 0250: BC A2 10 86 B6 20 CA 02 50 05 30 32 00 00 11 28 15 50 C 0220: C2 30 F9 50 95 50 CA 10 EB 60 A5 50 74 50 38 A1 30 0220: C3 50 F9 30 70 88 20 00 60 A9 57 F1 85 B1 45 B4 30 0300: F8 55 11 85 50 4C 70 03 EA 45 45 B4 50 38 0300: F8 55 11 85 50 4C 70 03 EA 45 45 B4 30 0300: F8 55 11 85 50 4C 70 03 EA 45 45 B4 50 03 0300: C1 A5 77 55 59 55 0 CA 10 EB 60 A2 04 86 59 50 CA 0300: E7 85 5		00	01	02	03	04	05	06	07	08	09	OA	OB	oc	OD	OE	0.5	
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COAD1         BF         CS         OF         DO         OS         24         DO         AC         SD         DO         DO <thd< td=""><td>0020:</td><td>DO</td><td>07</td><td>CO</td><td>A9 14</td><td>DO</td><td>DO</td><td>12</td><td>CS A2</td><td>OE</td><td>DO</td><td>07</td><td>20</td><td>B2</td><td>02</td><td>A9</td><td>EE</td><td></td></thd<>	0020:	DO	07	CO	A9 14	DO	DO	12	CS A2	OE	DO	07	20	B2	02	A9	EE	
0070: 03 04 00 07 02 05 01 06 10 17 11 16 12 15 14 13 0080: 73 74 70 77 72 75 71 76 60 67 61 66 62 65 64 63 0050: F0 FF 01 10 11 0 FF F1 DF F1 DF F21 22 F2 12 0E IF 21 00A0: 0B 0A 06 06 04 04 04 04 04 02 02 02 02 02 02 02 02 02 01001 A6 B5 30 5C A5 B0 F0 08 E0 08 D0 04 C5 E6 F0 2E 0110: F6 E3 C5 01 D0 02 F6 E3 50 1E A0 0F A5 B1 D9 60 0120: 00 F0 03 88 10 F8 B9 A0 00 D5 E4 90 04 54 E6 95 0130: E4 18 08 75 E5 95 E5 28 E0 04 F0 03 30 31 60 A5 0140: E8 85 DD AS 00 85 B5 20 4B 03 20 B2 02 00 02 0150: 20 B2 02 A9 08 85 B5 20 4B 03 20 B2 02 20 00 02 0150: 20 B2 02 A9 08 85 B5 20 4B 03 20 B2 02 20 00 02 0150: 20 B2 02 A9 08 85 B5 20 4B 03 20 B5 04 60 50 0170: FD A0 07 A5 B1 D9 60 00 F0 58 86 D7 F1 10 F6 B5 0180: A0 00 D5 E2 90 02 55 E2 C6 B5 A9 [E1 C5 B5 F0 03 0190: 20 25 03 E6 B5 60 C5 08 B0 12 20 EA 03 A2 1F B5 01A0: 50 C5 FA F0 03 CA 10 F7 86 FB 86 B0 4C 00 00 00 02200: A2 10 A9 00 55 DE CA 10 FB A9 10 85 B0 C6 B0 10 0210: 01 60 20 1E 03 A4 B0 A2 08 86 B6 C0 08 10 41 C0 02200: 02 10 FB F0 D9 20 9C 02 D0 FB F0 D2 A2 04 86 B6 20 0240: 5C 02 D0 FB F0 C7 20 9C 02 A5 B6 C9 04 D0 F7 F0 AD 02200: A2 10 A9 00 55 DE C A10 FF3 50 B2 0C A 02 70 8F 30 8D 02200: A2 00 01 A5 B1 29 F0 C7 20 9C 02 A5 B6 C9 02 00 61 20 IE 0270: 03 C6 B6 A5 B6 C9 05 F0 EB 20 CA 02 70 8F 30 8D 0220: 00 01 A5 B1 29 F0 C7 20 9C 02 A5 B6 C9 02 10 E0 3 C6 0220: 00 01 A5 B1 29 F0 C7 20 9C 02 A5 B6 C9 02 10 E0 3 C6 0220: 02 30 FB F0 D9 20 9C 02 00 F0 FE F0 D2 20 CA 20 20 CA 0220: 02 30 FB F0 D9 20 9C 02 00 F0 EF 00 22 00 CA 20 20 02 CA 0220: 02 50 F9 30 07 08 80 00 77 F5 50 95 50 CA 10 EB 60 A3 00 ED 550 0240: 5C 02 50 F9 30 07 08 80 95 F0 EB 20 CA 03 02 ED 550 0250: BC A2 0F 38 B4 60 A9 FF 65 B1 A6 B6 18 75 0250: BF A7 F5 50 95 50 CA 10 EB 60 A5 B1 A6 B6 18 75 0250: CA 57 FF 50 12 A6 88 39 FF 65 81 55 84 40 A0 00 A4 89 00 F0 03300: 20 B2 02 20 09 02 20 22 02 B2 03 22 62 00 90 02 20 E2 03300: CA A6 88 51 95 50 4C 70 03 BA 86 B3 A6 B2 55 03500: FA 50 14 A8 A8 24 FF 65 01 50 A3 FF A35 B1 85 F9 4C 03300: 55 50 85 A4 88 85 B1	0040:	BF	65	OF	DO	06	20	48	03	40	SD	01	40	PA 96	01	10	00	1.2.2.2
0080: 73 74 70 77 72 75 71 76 60 67 61 66 62 65 64 63 0090: F0 FF 01 10 11 0 FF F1 DF E1 EF 21 20 0F 1F 21 0100: A6 B5 30 5C A5 B0 F0 08 E0 08 D0 04 C5 E6 F0 2E 0110: F6 E3 C5 01 D0 02 F6 E3 50 1E A0 04 54 E6 95 0110: F6 E3 C5 01 D0 02 F6 E3 50 1E A0 04 94 E6 95 0130: E4 18 08 75 E5 95 E5 28 E0 04 B 03 20 20 20 00 02 0150: E4 85 DD AS 00 85 B5 20 4B 03 20 B2 02 20 00 02 0150: E4 85 DD AS 00 85 B5 20 4B 03 20 B2 02 20 00 02 0150: E4 85 DD AS 00 85 B5 20 4B 03 20 B2 02 20 00 02 0150: E0 FS D0 08 A5 60 55 B1 D0 04 AS 08 55 B4 60 50 0170: FD A0 07 A5 B1 D9 60 00 F0 05 88 F0 F1 10 F6 85 0180: A0 00 D5 E2 90 02 95 E2 C6 B5 A9 FE C5 B5 F0 03 0180: A0 00 D5 E2 90 02 95 E2 C6 B5 A9 FE C5 B5 F0 03 0180: A0 00 D5 F2 90 02 95 E2 C6 B5 A9 FE C5 B5 F0 03 0180: A0 00 D5 F2 90 02 95 E2 C6 B5 A9 FE C5 B5 F0 03 0180: A0 00 D5 F2 90 02 95 E2 C6 B5 A9 FE C5 B5 F0 03 0120: A1 10 A9 00 55 DE CA 10 F7 86 FB 86 B0 4C 00 90 00 02001 A2 10 A9 00 55 DE CA 10 F7 86 FB 86 B0 4C 00 90 00 02002 06 10 2E C0 04 10 1F C0 01 F0 05 10 0E 20 8E 02 0240: SC 02 D0 FB F0 C7 20 9C 02 A5 B6 C9 08 D0 F7 F0 AD 02202: 06 10 2E C0 04 10 1F C0 01 F0 05 10 0E 20 8E 02 0240: SC 02 D0 FB F0 C7 20 9C 02 D6 FB F0 D2 24 04 86 B6 20 0240: SC 02 D0 FB F0 C7 20 9C 02 A5 B6 C9 08 D0 F7 F0 AD 02202: 04 10 A9 00 01 20 1E 03 CA 02 70 8F 30 8D 02202: 05 0 F9 30 07 08 20 00 01 28 50 F0 02 1E 03 C6 02202: 04 00 01 A5 B1 29 F0 C7 20 9C 02 EA 58 65 90 20 CA 02 90 0240: 02 30 F9 30 07 08 20 00 01 28 50 F0 02 1E 03 C6 02200: A2 70 F3 50 95 50 CA 10 EB 60 A5 B1 A6 B6 18 75 02E00: A7 77 F5 50 95 50 CA 10 EB 60 A5 B1 A6 B6 18 75 02E00: A7 77 F5 50 95 50 CA 10 EB 60 A5 B1 A6 B6 18 75 02E00: A7 77 F5 50 95 50 CA 10 EB 60 A5 B1 A6 B6 18 75 02E00: A7 77 F5 50 95 50 CA 10 EB 60 A5 85 B4 450 38 0300: 20 B2 02 20 00 90 22 02 E2 03 28 68 85 B5 A5 B4 30 0 0300: 20 B2 02 20 00 90 22 02 20 22 E7 03 28 68 85 B5 A5 B4 30 0 0300: CA A5 B1 48 A8 A2 1F D5 50 C7 00 3 BA 86 B3 A6 B2 55 03300: FA 50 48 68 B3 A6 B2 56 50 55 75 A5 50 55 76 A5 50 45 50 45 70 03500: 20 A6 86 B3 A6 B2 56 50 55 50 50 50	0070:	03	04	00	07	02	05	01	06	10	17	11	16	12	15	14	13	
CODAC:       CO	0080:	73	74	70	77	72	75	71	76	60	67	61	66	62	65	64	63	1.2
0100: A6 B5 30 5C A5 B0 F0 08 E0 08 D0 44 C5 E6 F0 2E 0110: F6 E3 C5 01 D0 02 F6 E3 50 1E A0 0F A5 B1 D9 60 0120: 00 F0 03 88 10 F8 B9 A0 00 55 E4 90 04 45 66 95 0130: E4 18 08 75 E5 95 E5 28 E0 04 F0 03 30 31 60 A5 0140: E8 85 DD AS 00 85 B5 20 4B 03 20 B2 02 20 00 02 0150: 20 B2 02 A9 08 85 55 20 59 02 20 31 03 44 E6 95 0170: F0 A0 07 A5 B1 D9 60 00 F0 55 88 F0 F1 10 F6 B5 0170: F0 A0 07 A5 B1 D9 60 00 F0 55 88 F0 F1 10 F6 B5 0170: F0 03 C5 FA 03 C4 05 F7 86 F0 F1 10 F6 B5 0170: F0 A0 07 A5 B1 D9 60 00 F7 86 F0 86 D0 40 00 00 00 0220: A2 10 A9 00 95 DE CA 10 F8 A9 10 85 B0 4C 00 00 00 0220: C6 10 2E C0 04 10 1F C0 01 F0 05 86 F0 71 10 F6 B5 0170: F0 30 C7 20 9C 02 A5 B6 C5 08 01 02 E0 8E 02 0230: D0 FB F0 D9 20 9C 02 D0 F8 F0 D1 24 20 48 68 B6 20 0220: C6 10 2E C0 04 10 1F C0 01 F0 05 80 01 00 E2 8E 02 0230: D0 FB F0 D9 20 9C 02 A5 B6 C5 08 D0 17 F0 AD 02200: A2 10 A9 00 95 DE CA 10 F8 A9 10 85 B0 C6 B0 10 0210: 01 60 20 1E 03 A4 B0 A2 08 86 B6 C0 08 10 41 C0 0220: 06 10 2E C0 04 10 1F C0 01 F0 02 A2 04 86 B6 20 0220: 06 10 2E C0 41 01 FC 05 F8 20 CA 02 70 8F 30 8D 0220: 06 10 2E 00 41 01 FC 00 12 82 00 01 20 1E 0220: 06 10 2E 00 41 01 FC 03 C6 B6 60 20 CA 02 20 CA 0230: 00 F9 50 07 08 20 00 12 85 F0 20 1E 03 C6 B6 13 75 0250: BC A2 10 86 B6 20 CA 02 70 8F 55 B5 54 20 CA 30 2E D5 50 0220: 00 01 A5 B1 29 80 D0 42 A5 B1 A2 20 CA 30 0E D5 50 0220: 20 00 01 A5 B1 29 80 D0 42 A5 B1 A2 20 CA 30 0E D5 50 0220: B6 60 A2 0F 38 B4 60 A8 77 F5 50 95 50 42 A0 38 75 02201: B7 F5 0 55 50 50 CA 10 EB 60 A5 B1 A6 B6 18 75 02202: D0 F9 E0 10 30 33 A9 FF 65 D1 70 01 B8 A5 B5 30 0300: 20 B2 02 20 20 90 02 20 2E 03 28 68 85 B5 A4 50 48 03 3300: 20 A 26 E3 A6 B3 A6 B2 5A 68 55 B4 40 00 4A A9 00 F0 03300: 20 A3 85 F1 60 18 A9 00 60 A9 FF 18 B8 60 A6 85 5 03300: FA 50 14 48 A8 A2 1F D5 50 F0 03 A8 68 B3 A6 92 03300: FA 50 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03401 50 68 AA 68 85 B1 155 50 4C 70 03 BA 86 B3 A6 92 03502: FA 50 0C F0 0A 85 FF A5 B0 85 FB A5 B1 85 F9 4C 03602: B5 50 85 F1 48 A8	00A0:	OB	OA	06	06	04	01	04	F1 04	DF	E1	EE	F2	12	OE	1F	21	1.1.1.
01101: F6 E3 CS 01 D0 02 F6 E3 50 1E A0 0F A5 B1 D9 60 0120: 00 F0 03 88 10 F8 B9 A0 00 D5 E4 S0 04 54 E6 55 0130: E4 18 08 75 E5 55 E5 28 E0 04 F0 03 30 16 0 A5 01401: E8 85 DD A5 00 85 B5 20 49 00 30 02 20 31 03 4C 80 17 0160: E0 F5 D0 0B A5 60 C5 B1 D0 04 A5 00 85 B4 60 50 0170: FD A0 07 A5 B1 D5 60 00 F0 05 88 F0 F1 10 F6 B5 0180: A0 00 D5 E2 90 02 95 E2 C6 B5 A9 FEB C5 B5 F0 03 0180: A0 00 D5 E2 90 02 95 E2 C6 B5 A9 FEB C5 B5 F0 03 0190: 20 25 03 E6 B5 60 C5 08 B0 12 20 EA 03 A2 1F B5 01A01: 50 C5 FA F0 03 CA 10 F7 86 FB 86 B0 4C 00 00 00 02010: 01 60 20 1E 03 A4 B0 A2 08 86 B6 C0 08 10 41 C0 02200: 06 10 2E C0 04 10 1F C0 01 F0 05 10 0E 20 8E 02 02401: SC 02 D0 FB F0 D7 20 9C 02 D6 FB F0 D2 20 42 04 86 B6 20 02401: SC 02 D0 FB F0 C7 20 9C 02 A5 B6 C9 08 D0 F7 F0 02501: BC A2 10 A8 90 05 DE 20 SC 02 D0 FB F0 D2 20 CA 02 70 8F 30 8F 02200: A2 06 86 B6 20 CA 02 50 05 30 03 20 00 01 20 1E 02101: 01 60 20 1FB F0 D7 20 9C 02 D0 FB F0 D2 20 CA 02 70 8F 30 8F 02201: A2 06 86 B6 20 CA 02 50 05 30 03 20 00 01 20 1E 02701: 03 C6 B6 A5 B6 C9 05 F0 EB 20 CA 02 70 8F 30 8F 02201: A2 06 86 B6 20 CA 02 50 00 11 28 50 F0 20 1E 03 C6 02200: A2 00 85 B5 50 F9 S0 C7 00 11 80 A5 B5 50 02401: 02 50 F9 30 07 08 20 00 01 28 50 F0 20 1E 03 C6 02201: 8F 85 B1 29 88 D0 42 A5 B1 A2 20 CA 02 70 8F 30 88 02201: 8F 85 B1 29 88 D0 42 A5 B1 A2 20 CA 30 0E D5 50 02201: 8F 85 B1 29 88 D0 42 A5 B1 A2 20 CA 30 0E D5 50 02201: 8F 85 B1 29 88 D0 42 A5 B1 A2 20 CA 30 0E D5 50 02201: 8F 85 B1 29 88 D0 42 A5 B1 A5 B5 85 A5 B4 30 3300: 20 B2 02 200 90 22 20 22 03 28 68 85 B5 A5 B4 30 3300: 20 B2 02 20 90 02 20 22 03 28 68 85 B5 A5 B4 80 3300: 20 B3 86 B3 A6 B2 9A 68 85 B1 S5 50 48 8A 48 A5 B6 48 03300: 20 B4 86 B3 A6 B2 9A 68 85 B1 S5 50 C1 00 0F CA B5 DC 85 03300: 9A A6 83 55 B1 85 50 84 50 85 F9 A55 B1 85 F9 C 3300: 50 8A A4 88 A2 17 D5 50 F0 03 CA 10 F9 A9 0C F0 03800: FA E0 0F 00 A 85 FA A5 B0 55 FA 26 48 8A 48 A5 B6 48 03000: 55 50 8A 48 86 B0 B5 50 94 50 73 85 F1 85 50 C 20 00 22 A6 03000: 50 68 A4 68 55 B1 55 50 47 0 03 56 F3 85 50 56 FA 03	0100:	A6	B5	30	50	AS	BO	FO	08	EO	08	DO	04	C5	56	50	25	+
01201: 00 F0 03 88 10 F8 B9 A0 00 D5 E4 90 04 94 E6 95 01301: E4 18 08 75 E5 95 E5 28 E0 04 F0 03 30 31 60 A5 01401: E8 85 DD AS 00 85 B5 20 48 03 20 B2 02 20 00 02 01501: 20 B2 02 A9 08 85 B5 20 09 02 20 31 03 4C 80 17 01601: E0 F5 D0 0B A5 60 C5 B1 D0 04 A5 00 85 B4 60 50 01701: FD A0 07 A5 B1 D9 60 00 F0 05 88 F0 F1 10 F6 B3 01801: A0 00 D5 E2 90 02 95 E2 C6 B5 A9 FEB C5 B5 F0 03 01901: 20 25 03 E6 B5 60 C5 08 B0 12 20 EA 03 A2 1F B5 01A01: 50 C5 FA F0 03 CA 10 F7 86 FB 86 B0 4C 00 00 00 02001: A2 10 A9 00 95 DE CA 10 FB A9 10 85 B0 C6 B0 10 02201: 06 10 2E C0 04 10 1F C0 01 F0 05 10 0E 20 8E 02 02301: D0 FB F0 D9 20 9C 02 A5 B6 C5 04 D0 F7 F0 AD 02202: 06 10 2E C0 04 10 1F C0 91 F0 05 10 0E 20 8E 02 02301: D0 FB F0 D9 20 9C 02 A5 B6 C5 04 D0 F7 F0 AD 02202: 06 10 2E C0 04 10 1F C0 91 F0 05 10 0E 20 8E 02 02301: D0 FB F0 D9 20 9C 02 A5 B6 C9 08 D0 F7 F0 AD 02202: 06 68 B6 20 CA 02 50 05 30 03 20 00 01 20 1E 02701: 03 C6 B6 A5 B6 C9 05 F0 E2 02 CA 02 70 8F 30 8D 02801: A2 00 86 B6 20 CA 02 50 05 70 02 1E 03 C6 02801: 02 00 01 A5 B1 29 F0 CS 20 F0 EE 4C 0D 02 20 CA 02300: 02 30 03 20 00 01 20 1E 03 C6 B6 60 20 CA 02 50 55 00 2201: B5 77 F5 30 07 08 20 00 12 85 50 F0 20 1E 03 C6 02801: 02 30 03 20 00 01 28 11 A5 B1 A2 20 CA 30 0E D5 50 02201: BF 65 B1 29 88 D0 42 A5 B1 A2 20 CA 30 0E D5 50 02201: BF 65 B1 29 88 D0 42 A5 B1 A2 20 CA 30 0E D5 50 02201: BF 77 F5 50 95 50 CA 10 EB 60 A5 B1 A6 B6 18 75 03001: 20 B2 02 20 09 02 20 22 03 28 68 55 A6 A6 80 03201: BF 50 85 B1 60 20 48 03 20 B2 02 20 09 02 20 20 92 20 220 30 35 B1 60 20 48 08 A9 FF 85 B1 82 50 46 80 A6 80 03201: B5 50 85 B1 60 20 48 03 20 B2 02 20 09 02 20 20 90 22 20 E2 03300: 20 B2 02 20 09 02 20 22 02 20 23 28 68 55 A6 A6 80 03301: CA A6 E3 D0 06 A6 EF D0 02 A9 FF 18 B8 60 A6 69 55 03401: 50 68 AA 68 85 B1 95 50 4C 70 03 BA 86 B3 A6 B2 03501: FA A5 B1 48 A8 A2 1F D5 50 F0 30 CA 10 F9 A9 CC 03301: CA A6 E3 D0 06 A6 EF D0 02 A9 FF 60 32 C4 86 B5 C5 03301: FA 60 CF 00 A 85 FA A5 B0 45 F9 85 B1 65 00 00 00 00 00 00 03301: CA A6 E3 D0 06 A6 EF D0 02 A9 FF	0110:	F6	E3	CS	01	DO	02	F6	E3	50	1E	AO	OF	A5	B1	DS	60	
01401       E8       E5       D </td <td>0120:</td> <td>00</td> <td>FO</td> <td>03</td> <td>88</td> <td>10</td> <td>F8</td> <td>B9</td> <td>AO</td> <td>00</td> <td>D5</td> <td>E4</td> <td>90</td> <td>04</td> <td>94</td> <td>E6</td> <td>95</td> <td>1000</td>	0120:	00	FO	03	88	10	F8	B9	AO	00	D5	E4	90	04	94	E6	95	1000
0150: 20 B2 02 A9 08 85 B5 20 09 02 20 31 03 4C 80 17 0160: E0 F5 D0 0B A5 60 C5 B1 D0 04 A9 00 85 B4 60 50 0170: FD A0 07 A5 B1 D9 60 00 F0 05 88 F0 F1 10 F6 BS 0180: A0 00 D5 E2 90 02 95 E2 C6 B5 A9 EB C5 B5 F0 03 0190: 20 25 03 E6 B5 60 C9 08 B0 12 20 EA 03 A2 1F B5 01A0: 50 C5 FA F0 03 CA 10 F7 86 FB 86 B0 4C 00 00 00 0200: A2 10 A9 00 95 DE CA 10 FB A9 10 85 B0 C6 B0 10 0210: 01 60 20 1E 03 A4 B0 A2 08 86 B6 C0 08 10 41 C0 0220: 06 10 2E C0 04 10 1F C0 01 F0 05 10 0E 20 8E 02 0240: SC 02 D0 FB F0 D9 20 9C 02 D0 FB F0 D2 A2 04 86 B6 20 0240: SC 02 D0 FB F0 C7 20 9C 02 A5 B6 C9 08 D0 F7 F0 0250: BC A2 10 86 B6 20 CA 02 50 53 00 32 00 00 12 01 E0 0250: BC A2 10 86 B6 20 CA 02 50 05 30 03 20 00 01 20 1E 0270: 03 C6 B6 A5 B6 C9 05 F0 EB 20 CA 02 70 8F 30 8D 0280: 20 00 01 A5 B1 29 F0 C5 20 F0 EE 4C 0D 02 20 CA 0280: 20 00 01 A5 B1 29 F0 C5 20 F0 EE 4C 0D 02 20 CA 0280: 20 00 01 A5 B1 29 F0 C5 20 F0 EE 4C 0D 02 20 CA 0280: 20 00 01 A5 B1 29 F0 C5 20 F0 EF 4C 0D 02 20 CA 0280: 20 00 01 A5 B1 29 F0 C5 20 F0 EB 60 20 1E 03 C6 0280: B6 60 A2 0F 38 B4 60 A9 77 F5 50 95 60 94 50 38 0280: B6 60 A2 0F 38 B4 60 A9 F7 F5 50 95 60 94 50 38 0280: B6 60 A2 0F 38 B4 60 A9 F7 F8 85 85 B4 20 4B 03 0300: 20 B2 02 20 09 02 20 2E 03 28 68 85 B5 A5 B4 30 0310: 04 38 A9 FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B0 0310: 04 38 AS FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B0 0310: 04 38 AS FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B0 0310: 04 38 AS FF 60 18 A9 00 20 20 20 20 00 22 02 E2 03300: 20 BA 86 B3 A6 B2 9A 68 85 B1 85 50 84 84 8A 55 B6 48 0370: BA 86 B3 A6 B2 SA 60 A6 E4 E4 A0 D0 04 A9 00 F0 0360: 95 50 8A 48 A6 B0 B5 50 94 50 48 8A 48 A5 B6 48 0370: BA 86 B2 A6 B3 9A 60 A6 E4 E4 A0 D0 04 A9 00 F0 0360: 95 A6 A4 8A 65 B5 F9 CA 85 DC D0 0F CA B5 DC 85 0380: FA 90 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 15 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA B5 DC 85 0380: FA 90 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 15 0 FS 50 F9 C5 F9 CA 86 DC D0 14 85 DC 20 C8 6 0300: FA 80 0C F0 0A 85 FA A5 B0 85 FB A5 B1 8	0140:	ES	85	DD	AS	00	85	B5	20	48	04	20	03 B.2	02	20	60	A5	1.1
0160: E0 FS D0 0B A5 60 C5 B1 D0 04 AS 00 85 B4 60 50 0170: FD A0 07 A5 B1 D9 60 00 F0 05 88 F0 F1 10 F6 BS 0180: A0 00 D5 E2 90 02 95 E2 C6 B5 A9 EE C5 B5 F0 03 0190: 20 25 03 E6 B5 60 CS 08 B0 12 20 EA 03 A2 1F B5 01A0: 50 C5 FA F0 03 CA 10 F7 86 FB 86 B0 4C 00 00 00 0210: A2 10 A9 00 95 DE CA 10 F7 86 FD 86 B0 4C 00 00 00 0220: A2 10 A9 00 95 DE CA 10 FF A9 10 85 B0 C6 B0 10 0210: 01 60 20 1E 03 A4 B0 A2 08 86 B6 C0 08 10 41 C0 0220: 06 10 2E C0 04 10 1F C0 01 F0 0S 10 0E 20 8E 02 0230: D0 FB F0 DS 20 9C 02 D0 FB F0 D2 A2 04 86 B6 20 0240: SC 02 D0 FB F0 C7 20 9C 02 A5 B6 C9 08 D0 F7 F0 AD 0250: BC A2 10 86 B6 20 CA 02 50 50 03 20 00 01 20 1E 0270: 03 C6 B6 A5 B6 C9 05 F0 EB 20 CA 02 70 8F 30 8D 0280: 20 00 01 A5 B1 29 F0 CS 20 F0 EE 4C 0D 22 0C CA 0290: 02 30 03 20 00 01 20 1E 03 C6 B6 60 20 CA 02 90 77 0240: A2 06 86 B6 20 07 08 20 00 11 28 50 F0 20 1E 03 C6 0280: 20 00 01 A5 B1 29 F0 CS 20 F0 EE 4C 0D 02 20 CA 0240: A2 06 86 B1 29 85 0C A3 05 B1 A8 B6 18 75 02200: A5 77 F5 50 95 50 CA 10 EB 60 A5 B1 A6 B6 18 75 02200: B6 60 A2 0F 38 B4 60 AS 77 F5 50 95 60 94 50 38 02200: B6 60 A2 0F 38 B4 60 AS 77 F5 50 95 60 94 50 38 03000: 20 B2 02 20 09 02 20 2E 03 28 68 85 B5 A5 B4 30 0310: 04 38 AS FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B0 0310: 04 38 AS FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B0 0310: 04 38 AS FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B0 0310: 04 38 AS FF 60 18 A9 00 60 A9 FF 18 B8 60 A4 68 95 0340: 50 85 B1 60 02 48 03 20 22 02 00 02 20 02 20 22 0330: 02 BA 86 B3 A6 B2 9A 68 85 B6 68 85 B0 AA 68 95 0340: 50 A5 B1 48 A8 A2 1F D5 50 F0 03 CA 10 F9 AS CC 0360: 95 50 8A 48 A6 B0 B5 50 94 50 48 63 A6 B2 0370: BA 86 B2 A6 B3 9A 60 A6 E4 E4 A0 D0 04 A9 00 F0 0380: FA 90 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA B5 DC 85 0390: FA 90 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC 00 FC A8 55 DC 85 0390: FA 90 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC 00 07 CA 95 F9 85 0350: FA 90 0C F0 0A 85 FA A5 B0 65 FF A5	0150:	20	B2	02	A 9	08	85	B5	20	09	02	20	31	03	4C	80	17	10
0170: FD A0 07 A5 B1 D5 60 00 90 58 87 F0 F1 10 F6 B3         0180: A0 00 D5 E2 50 02 95 E2 C6 B5 A9 [EB C5 B5 F0 03         0190: 20 25 03 E6 B5 60 C9 08 B0 12 20 EA 03 A2 1F B5         01A0: 50 C5 FA F0 03 CA 10 F7 86 FB 86 B0 4C 00 00 00         0210: 01 60 20 1E 03 A4 B0 A2 08 86 B6 C0 08 10 41 C0         0220: A2 10 A9 00 95 DE CA 10 FB A9 10 85 B0 C6 B0 10         0210: 01 60 20 1E 03 A4 B0 A2 08 86 B6 C0 08 10 41 C0         0220: 06 10 2E C0 04 10 1F C0 01 F0 05 10 0E 20 8E 02         0230: D0 FB F0 D9 20 9C 02 D0 FB F0 D2 A2 04 86 B6 20         0240: SC 02 D0 FB F0 C7 20 9C 02 A5 B6 C9 08 D0 F7 F0 AD         0260: A2 06 86 B6 20 CA 02 50 05 30 03 20 00 01 20 1E         0270: 03 C6 B6 A5 B6 C9 05 F0 EB 20 CA 02 70 8F 30 8D         0280: 20 00 01 A5 B1 29 F0 CS 20 F0 EE 4C 0D 02 20 CA         0290: 02 30 03 20 00 01 20 1E 03 C6 B6 60 20 CA 02 90         0280: 20 00 01 A5 B1 29 88 D0 42 A5 B1 A2 20 CA 30 0E D5 50         0280: 86 60 A2 0F 38 B4 60 A9 77 F5 50 95 60 94 50 38         0280: 86 60 A2 0F 38 B0 42 A5 B1 A2 20 CA 30 0E D5 50         0280: 20 08 02 20 09 02 20 22 02 20 22 03 86 85 B5 A5 B4 30         0280: 20 08 B1 02 20 48 08 A9 F5 85 B5 85 B4 30 B1 85 B3 0         0280: 20 08 02 20 09 02 20 22 02 20 22 09 02 22 082         0300: 20 B2 02 20 09 02 20 22 02 20 20 03 02 20 28 20         0300: 20 B2 02 20 09 02 20 22 02 20 20 03 02 20 28 20         0300: 20 66 AA 68 85 B1 45 0 04 A8 A9 00 F0	0160:	EO	FS	DO	OB	A5	60	C5	B1	DO	04	AS	00	85	84	60	50	
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$\begin{array}{c} 0240: & \text{SC} & 02 & \text{D0} & \text{FB} & \text{F0} & C7 & 20 & 9C & 02 & \text{A5} & \text{B6} & \text{C9} & 04 & \text{D0} & \text{F7} & \text{F0} & \text{AD} \\ 0250: & \text{BC} & A2 & 10 & \text{86} & \text{B6} & 20 & \text{8E} & 02 & \text{A5} & \text{B6} & \text{C9} & 08 & \text{D0} & \text{F7} & \text{F0} & \text{AD} \\ 0260: & A2 & 06 & \text{86} & \text{B6} & 20 & \text{CA} & 02 & 50 & 05 & 30 & 03 & 20 & 00 & 01 & 20 & 1E \\ 0270: & 03 & \text{C6} & \text{B6} & \text{A5} & \text{B6} & \text{C9} & 05 & \text{F0} & \text{EB} & 20 & \text{CA} & 02 & 70 & \text{8F} & 30 & \text{8D} \\ 0280: & 20 & 00 & 01 & \text{A5} & \text{B1} & 29 & \text{F0} & \text{C9} & 20 & \text{F0} & \text{EF} & \text{4C} & 0D & 02 & 20 & \text{CA} & 02 & 90 \\ 0230: & 02 & 30 & 03 & 20 & 00 & 01 & 20 & 1E & 03 & \text{C6} & \text{B6} & 60 & 20 & \text{CA} & 02 & 90 \\ 0240: & 02 & 50 & \text{F9} & 30 & 07 & 08 & 20 & 00 & 01 & 28 & 50 & \text{F0} & 20 & 1E & 03 & \text{C6} \\ 0280: & \text{B6} & 60 & A2 & 0F & 38 & \text{B4} & 60 & A9 & 77 & \text{F5} & 50 & 95 & 60 & 94 & 50 & 38 \\ 02200: & \text{A9} & 77 & \text{F5} & 50 & 95 & 50 & \text{CA} & 10 & \text{EB} & 60 & A5 & \text{B1} & \text{A6} & \text{B6} & 18 & 75 \\ 02E0: & \text{D0} & \text{F9} & E0 & 10 & 30 & 33 & \text{A9} & \text{F7} & \text{F9} & 55 & \text{B4} & 20 & 48 & 03 \\ 0310: & 20 & 82 & 02 & 20 & 09 & 02 & 20 & 2E & 03 & 28 & 68 & 85 & \text{B6} & A6 & B0 \\ 0320: & 20 & 82 & 02 & 20 & 09 & 02 & 20 & 2E & 03 & 28 & 68 & 85 & B0 & AA & 68 & 95 \\ 0340: & 50 & 68 & AA & 68 & 55 & \text{B1} & 55 & 0 & 4C & 70 & 03 & \text{BA} & 86 & B3 & A6 & B2 \\ 03300: & 20 & B2 & 02 & 20 & 09 & 02 & 48 & 03 & 20 & B2 & 02 & 20 & 08 & 2 \\ 03300: & 50 & 68 & A4 & 8A & 6B & 0B & 55 & 05 & 45 & 50 & 48 & 8A & 48 & A5 & B6 & 48 \\ 0370: & BA & 86 & B2 & A6 & B3 & 9A & 60 & A6 & E4 & E4 & A0 & 00 & 4A & 90 & 0 & F0 \\ 0380: & FA & 90 & 0C & F0 & 0A & 85 & FA & A5 & B0 & 85 & FB & A5 & B1 & 85 & F9 & 4C \\ 03A0: & 1F & 1F & A6 & DC & 10 & 17 & A5 & F9 & D5 & DC & D0 & 0F & A86 & D48 & F9 & 85 \\ 0380: & FA & 90 & 0C & F0 & 0A & 85 & FA & A5 & B0 & 85 & FB & A5 & B1 & 85 & F9 & 85 \\ 0380: & FA & 90 & 0C & F0 & 0A & 85 & FA & A5 & B0 & 00 & 00 & 00 & 00 & 00 \\ 0380: & FA & 90 & 0C & F0 & 0A & 85 & FA & 85 & B1 & 60 & 00 & 00 & 00 & 00 \\ 0380: & FA & 90$	0230:	DO	FB	FO	DS	20	90	02	DO	FB	FO	D2	A2	04	86	BG	20	CO
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0270: 03 C6 B6 A5 B6 C9 05 F0 EB 20 CA 02 70 8F 30 8D 0280: 20 00 01 A5 B1 29 F0 C9 20 F0 EE 4C 0D 02 20 CA 0290: 02 30 03 20 00 01 20 1E 03 C6 B6 60 20 CA 02 90 02A0: 02 50 F9 30 07 08 20 00 01 28 50 F0 20 1E 03 C6 02E0: B6 60 A2 0F 38 B4 60 A9 77 F5 50 95 60 94 50 38 02C0: A9 77 F5 50 95 50 CA 10 EB 60 A5 B1 A6 B6 18 75 02D0: 8F 85 B1 29 88 D0 42 A5 B1 A2 20 CA 30 0E D5 50 02E0: D0 F9 E0 10 30 33 A9 7F 69 01 70 01 B8 A5 B5 30 02F0: 24 C9 $\overline{08}$ 10 20 48 08 A9 F9 85 B5 85 B4 20 4B 03 0310: 04 38 A9 FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B4 30 0310: 04 38 A9 FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B2 0320: B5 50 85 B1 60 20 4B 03 20 B2 02 20 09 02 20 B2 0330: 02 BA 86 B3 A6 B2 9A 68 85 B6 68 85 B0 AA 68 95 0340: 50 68 AA 68 85 B1 95 50 4C 70 03 BA 86 B3 A6 B2 0350: 9A A5 B1 48 A8 A2 1F D5 50 F0 03 CA 10 F9 A9 CC 0360: 95 50 8A 48 A6 B0 B5 50 54 50 48 8A 48 A5 B6 48 0370: BA 86 B2 A6 B3 9A 60 A6 E4 E4 A0 D0 04 A9 00 F0 0380: 0A A6 E3 D0 06 A6 EE D0 02 A9 FF A2 04 86 B5 C5 0380: FA 90 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA B5 DC 85 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA B5 DC 85 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA 55 DC 85 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA 55 DC 85 03B0: FA 80 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA 55 DC 85 03B0: FA 80 0C F0 0A 85 FA 50 85 FA 86 B0 A5 F9 85 03E0: B1 20 4B 03 4C 00 00 A9 FF 60 A2 04 66 F9 26 FA 03F0: CA D0 F9 05 F9 85 F9 85 B1 60 00 00 00 00 00 1780: 18 AS 80 65 EB 65 EC 65 ED 65 E1 65 DF 38 E5 F0 1790: E5 F1 E5 E2 E5 E0 E5 DE E5 FF E5 53 B0 02 A9 00 17A0: 4A 18 69 40 65 EC 65 ED 38 E5 F4 4A 18 69 90 65 17B0: DD 65 DD 65 DD 65 DD 65 D1 65 E1 38 E5 F4 45 E5 E5 17B0: DD 65 DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 45 E5 E5 17B0: DD 65 DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 45 E5 E5 17B0: DD 65 DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 45 E5 E5 17B0: DD 65 DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 45 E5 E5 17B0: DD 65 DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4	0260:	A2	06	86	86	20	CA	02	50	A5	30	03	20	DO	F7	FO	AD	210
$\begin{array}{c} 0280: 20 & 00 & 01 & A5 & B1 & 29 & F0 & C9 & 20 & F0 & EE & 4C & 0D & 02 & 20 & CA \\ 0290: 02 & 30 & 03 & 20 & 00 & 01 & 20 & 1E & 03 & C6 & B6 & 60 & 20 & CA & 02 & 90 \\ 02A0: 02 & 50 & F9 & 30 & 07 & 08 & 20 & 00 & 01 & 28 & 50 & F0 & 20 & 1E & 03 & C6 \\ 02E0: B6 & 60 & A2 & 0F & 38 & B4 & 60 & A9 & 77 & F5 & 50 & 95 & 60 & 94 & 50 & 38 \\ 02C0: A9 & 77 & F5 & 50 & 95 & 50 & CA & 10 & EB & 60 & A5 & B1 & A6 & B6 & 13 & 75 \\ 02D0: & 8F & 85 & B1 & 29 & 88 & D0 & 42 & A5 & B1 & A2 & 20 & CA & 30 & 0E & D5 & 50 \\ 02E0: & D0 & F9 & E0 & 10 & 30 & 33 & A9 & 7F & 69 & 01 & 70 & 01 & B8 & A5 & B5 & 30 \\ 02F0: & 24 & C9 & 08 & 10 & 20 & 48 & 08 & A9 & F9 & 85 & B5 & 85 & B4 & 20 & 4B & 03 \\ 0300: & 20 & B2 & 02 & 20 & 09 & 02 & 20 & 2E & 03 & 28 & 68 & 85 & B5 & A6 & B0 \\ 0310: & 04 & 38 & A9 & FF & 60 & 18 & A9 & 00 & 60 & A9 & FF & 18 & B8 & 60 & A6 & B0 \\ 0320: & B5 & 50 & 85 & B1 & 60 & 20 & 4B & 03 & 20 & B2 & 02 & 20 & B2 \\ 0330: & 02 & BA & 86 & B3 & A6 & B2 & 9A & 68 & 85 & B6 & 68 & 85 & D0 & AA & 68 & 95 \\ 0340: & 50 & 68 & AA & 68 & 85 & B1 & 95 & 50 & 4C & 70 & 03 & BA & 86 & B3 & A6 & B2 \\ 0350: & SA & A5 & B1 & 48 & A8 & A2 & 1F & D5 & 50 & F0 & 03 & CA & 10 & F9 & A9 & CC \\ 0360: & 95 & 50 & 8A & 48 & A6 & B0 & B5 & 50 & 54 & 50 & 48 & 8A & 48 & A5 & B6 & 48 \\ 0370: & BA & 86 & B2 & A6 & B3 & 9A & 60 & A6 & E4 & E4 & A0 & D0 & 04 & A9 & 00 & F0 \\ 0380: & FA & 90 & 0C & F0 & 0A & 85 & FA & A5 & B0 & 85 & FB & A5 & B1 & 85 & F9 & 4C \\ 03A0: & 1F & 1F & A6 & DC & 10 & 17 & A5 & F9 & D5 & DC & D0 & 0F & CA & B5 & DC & 85 \\ 03B0: & FB & CA & B5 & DC & 85 & F9 & CA & 86 & DC & D0 & 1A & 85 & DC & A2 & 0C & 86 \\ 03C0: & B5 & 86 & FA & A2 & 14 & 20 & 02 & 02 & A2 & 04 & 86 & B5 & C5 \\ 03E0: & F1 & E0 & F9 & 05 & F9 & 85 & F1 & 85 & F1 & 85 & E5 & F0 \\ 03F0: & CA & D0 & F9 & 05 & F9 & 85 & F9 & 85 & B1 & 60 & 00 & 00 & 00 & 00 \\ 1780: & 18 & A8 & 80 & 65 & EB & 65 & EC & 65 & ED & 55 & E1 & 65 & DF & 38 & E5 & F0 \\ 1790: & E5 & F1 & E5 & E2 & E5 & E0 & E5 & DE & E5 & E7 & E5 & E3 & B0 & 02 & A9 & 00 \\ 17$	0270:	03	C6	B6	A5	B6	65	05	FO	EB	20	CA	02	70	SF	30	8D	HT
02A0: 02 50 05 20 00 01 20 1E 03 C6 86 60 20 CA 02 90 02A0: 02 50 F9 30 07 08 20 00 01 28 50 F0 20 1E 03 C6 02B0: 86 60 A2 0F 38 84 60 A9 77 F5 50 95 60 94 50 38 02C0: A9 77 F5 50 95 50 CA 10 EB 60 A5 81 A6 86 18 75 02D0: 8F 85 81 29 88 D0 42 A5 81 A2 20 CA 30 0E D5 50 02E0: D0 F9 E0 10 30 33 A9 7F 69 01 70 01 88 A5 85 30 02F0: 24 C9 $\overline{08}$ 10 20 48 08 A9 F9 85 85 85 84 20 48 03 0300: 20 B2 02 20 09 02 20 2E 03 28 68 85 B5 A5 B4 30 0310: 04 38 A9 FF 60 18 A9 00 60 A9 FF 18 88 60 A6 80 0310: 04 38 A9 FF 60 18 A9 00 60 A9 FF 18 88 60 A6 80 0320: B5 50 85 B1 60 20 48 03 20 B2 02 20 09 02 20 B2 0330: 02 BA 86 B3 A6 B2 9A 68 85 B6 68 85 B0 AA 68 95 0340: 50 68 AA 68 85 B1 95 50 4C 70 03 BA 86 B3 A6 B2 0350: SA A5 B1 48 A8 A2 1F D5 50 F0 03 CA 10 F9 A9 CC 0360: 95 50 8A 48 A6 B0 B5 50 94 50 48 8A 48 A5 B6 48 0370: BA 86 B2 A6 B3 9A 60 A6 E4 E4 A0 D0 04 A9 00 F0 0380: OA A6 E3 D0 06 A6 EF D0 02 A9 FF A2 04 86 B5 C5 0390: FA 90 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA B5 DC 85 03B0: FB CA B5 DC 85 F9 CA 86 DC D0 1A 85 DC A2 0C 86 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03E0: FA 90 0C F0 0A 85 FF A5 B0 85 FB A5 B1 85 F9 4C 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA B5 DC 85 03B0: FB CA B5 DC 85 F9 CA 86 DC D0 1A 85 DC A2 0C 86 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03D0: FA E0 0F 90 12 A6 FB B5 50 85 FA 86 B0 A5 F9 85 03E0: F1 20 4B 03 4C 00 00 A9 FF 60 A2 04 06 F9 26 FA 03F0: CA D0 F9 05 F9 85 F9 85 B1 60 00 00 00 00 00 00 00 1780: 18 AS 80 65 EB 65 EC 65 ED 65 E1 65 DF 38 E5 F0 1790: E5 F1 E5 E2 E5 E0 E5 DE E5 EF E5 E3 B0 02 A9 00 17A0: 4A 18 69 40 65 EC 65 ED 38 E5 E4 4A 18 69 90 65 17B0: DD 65 DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 E5 E4 E5 E5 17E0: DD 65 DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 E5 E4 E5 E5 E5 17E0: DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 E5 E4 E5 E4 E5 E5	0280:	20	00	01	A5	B1	29	FO	65	20	FO	EE	4 C	OD	02	20	CA	-
02B0: B6 60 A2 0F 38 B4 60 A9 77 F5 50 95 60 94 50 38 02C0: AS 77 F5 50 95 50 CA 10 EB 60 A5 B1 A6 B6 13 75 02D0: 8F 85 B1 29 88 D0 42 A5 B1 A2 20 CA 30 0E D5 50 02E0: D0 F9 E0 10 30 33 A9 7F 69 01 70 01 B8 A5 B5 30 02F0: 24 C9 08 10 20 48 08 A9 F9 85 B5 85 B4 20 4B 03 0300: 20 B2 02 20 09 02 20 2E 03 28 68 85 B5 A5 B4 30 0310: 04 38 A9 FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B0 0320: B5 50 85 B1 60 20 4B 03 20 B2 02 20 09 02 20 B2 0330: 02 BA 86 B3 A6 B2 9A 68 85 B6 68 55 B0 AA 68 95 0340: 50 68 AA 68 85 B1 95 50 4C 70 03 BA 86 B3 A6 82 0340: 50 68 AA 68 85 B1 95 50 4C 70 03 BA 86 B3 A6 82 0350: 9A A5 B1 48 A8 A2 1F D5 50 F0 03 CA 10 F9 A9 CC 0360: 95 50 8A 48 A6 B0 B5 50 94 50 48 8A 48 A5 B6 48 0370: BA 86 B2 A6 B3 9A 60 A6 E4 E4 A0 D0 04 A9 00 F0 0380: 0A A6 E3 D0 06 A6 EE D0 02 A9 FF A2 04 86 B5 C5 0390: FA 90 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 0F CA B5 DC 85 03B0: FB CA B5 DC 85 F9 CA 86 DC D0 1A 85 DC A2 0C 86 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 00 A6 1780: 18 AS 80 65 EB 65 EC 65 ED 65 E1 65 E1 65 DF 38 E5 F0 1790: E5 F1 E5 E2 E5 E0 E5 DE E5 EF E5 E3 B0 02 A9 00 17A0: 4A 18 69 40 65 EC 65 ED 38 E5 E4 E5 E4 E5 E4 E5 E5 17B0: DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 E5 E4 E5 E4 E5	0290:	02	50	FO	30	00	01	20	1E	03	20	B6	60	20	CA	02	90	97
02C0: AS 77 F5 50 95 50 CA 10 EB 60 A5 B1 A6 B6 18 75 02D0: $8F 85 B1 29 88 D0 42 A5 B1 A2 20 CA 30 0E D5 50 02E0: D0 F9 E0 10 30 33 A9 7F 69 01 70 01 B8 A5 B5 30 02F0: 24 CS 08 10 20 48 08 A9 F9 85 B5 85 B4 20 4B 03 0300: 20 B2 02 20 09 02 20 2E 03 28 68 85 B5 A5 B4 30 0310: 04 38 AS FF 60 18 A9 00 60 A9 FF 18 B8 60 A6 B0 0320: B5 50 85 B1 60 20 4B 03 20 B2 02 20 09 02 20 B2 0330: 02 BA 86 B3 A6 B2 SA 68 85 B6 68 85 B0 AA 68 95 0340: 50 68 AA 68 85 B1 S5 50 4C 70 03 BA 86 B3 A6 82 0340: 50 68 AA 68 85 B1 S5 50 4C 70 03 CA 10 F9 A9 CC 0350: 9A A5 B1 48 A8 A2 1F D5 50 F0 03 CA 10 F9 A9 CC 0360: 95 50 8A 48 A6 B0 B5 50 94 50 48 8A 48 A5 B6 48 0370: BA 86 B2 A6 B3 SA 60 A6 E4 E4 A0 D0 04 A9 00 F0 0380: 0A A6 E3 D0 06 A6 EE D0 02 A9 FF A2 04 86 B5 C5 0390: FA 90 0C F0 0A 85 FA A5 B0 85 FB A5 B1 85 F9 4C 03A0: 1F 1F A6 DC 10 17 A5 F9 D5 DC D0 AF CA B5 DC 85 03B0: FB CA B5 DC 85 F9 CA 86 DC D0 1A 85 DC A2 0C 86 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 22 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 02 A6 03C0: B5 86 FA A2 14 20 02 02 A2 04 86 B5 20 00 00 A9 1780: 18 AS 80 65 EB 65 EC 65 ED 65 E1 65 E1 65 DF 38 E5 F0 1790: E5 F1 E5 E2 E5 E0 E5 DE E5 EF E5 E3 B0 02 A9 00 17A0: 4A 18 69 40 65 EC 65 ED 38 E5 E4 E5 E4 E5 E4 E5 E5 17B0: DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 E5 E4 E5 E4 E$	02B0:	B6	60	A2	OF	38	B4	60	AS	77	20 F5	50	95	60	94	50	38	- 6
0210:       87       85       B1       29       88       D0       42       A5       B1       A2       20       CA       30       0E       D5       50         02E0:       D0       F9       E0       10       30       33       A9       7F       69       01       70       01       B8       A5       B5       30       B2       02       02       03       03       A9       FF       69       01       70       01       B8       A5       B5       30       B3       02       C2       02       02       02       02       02       02       02       02       02       02       02       02       02       03       02       B2       02       03       02       03       02       02       03       02       02       03       02       02       03       02       02       03       02       03       02       03       02       03	0200:	AS	77	F5	50	95	50	CA	10	EB	60	A5	B1	AG	BG	18	75	>L
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03A0:       1F       1F       A6       DC       10       17       A5       F9       D5       DC       D0       OF       CA       B5       DC       85         03B0:       FB       CA       B5       DC       85       F9       CA       86       DC       D0       1A       85       DC       A2       0C       86         03C0:       B5       86       FA       A2       14       20       02       02       A2       04       86       B5       20       00       02       A6         03D0:       FA       E0       OF       90       12       A6       FB       B5       50       85       FA       86       B0       A5       F9       85         03E0:       B1       20       4B       03       4C       00       00       A9       FF       60       A2       04       06       F9       26       FA         03F0:       CA       D0       F9       05       F9       85       F9       85       B1       60       00       00       00       00       00       00       00       00       00       00	0390:	FA	90	OC	FO	OA	85	FA	A5	BO	85	FB	A5	B1	85	59	4 C	
03B0:       FB       CA       B5       DC       B5       F9       CA       85       DC       D0       1A       85       DC       A2       0C       86         03C0:       B5       86       FA       A2       14       20       02       02       A2       04       86       B5       20       00       02       A6         03D0:       FA       E0       0F       90       12       A6       FB       B5       50       85       FA       86       B0       A5       F9       85         03E0:       B1       20       4B       03       4C       00       00       A9       FF       60       A2       04       06       F9       26       FA         03F0:       CA       D0       F9       05       F9       85       F9       85       B1       60       00       17       18       A5 <t< td=""><td>03A0:</td><td>1F</td><td>1F</td><td>A6</td><td>DC</td><td>10</td><td>17</td><td>A5</td><td>FS</td><td>D5</td><td>DC</td><td>DO</td><td>OF</td><td>CA</td><td>B5</td><td>DC</td><td>85</td><td></td></t<>	03A0:	1F	1F	A6	DC	10	17	A5	FS	D5	DC	DO	OF	CA	B5	DC	85	
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03E0:       B1       20       4B       03       4C       00       00       A9       FF       60       A2       04       06       F9       26       FA         03F0:       CA       D0       F9       05       F9       85       F9       85       B1       60       00       10	03D0:	FA	EO	OF	90	12	AG	FB	B5	50	85	FA	86	BO	A5	F9	85	
03F0:       CA       D0       F9       05       F9       85       F9       85       B1       60       00       10       00       17       18       85       51       55       55       55       55       55       55       55       55       55       55       55       50       65       50       65       50       65       50       55       55       55       55       55       55       55       55       55       55       55       55       55       55       55       55       55       55       55	03E0:	B1	20	4B	03	4C	00	00	A9	FF	60	A2	04	06	F9	26	FA	
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17BO: DD 65 DD 65 DD 65 DD 65 E1 38 E5 E4 E5 E4 E5 E5	17A0:	4A	18	69	40	65	EC	65	ED	38	E5	E4	4A	18	69	50	65	
	1780:	DD	65	DD	65	DD	65	DD	65	E1	38	E5	E4	E5	E4	E5	Ξ5	
1700: ED ED ED ED AG B1 EO 33 FO 16 EO 34 FO 12 EO 22	1700:	25	E5	E5	EO	AG	B1	EO	33	FO	16	EO	34	FO	12	EO	22	
17E0: 18 69 02 4C 77 03	17E0:	18	69	02	4C	77	03	AO	80	10	09	84	30	00	10	10	05	

## ICROCHESS

2

- 12 -

## Peter Jennings, Microchess (1976)

![](_page_101_Figure_0.jpeg)

#### Microchess, Radio Shack TRS-80 (1979)

![](_page_102_Picture_0.jpeg)

![](_page_102_Picture_1.jpeg)

The world's strongest chess program for home computers!

### MEET BORIS THE TALKING CHESS COMPUTER

Chess has been played for centuries. Somewhere along the way, it acquired the reputation of being a game that can only be played by intellectual men. Not so! Chess is a game of strategy that can be played by anyone—men, women, and children.

This revolutionary computer, BORIS, is the perfect chess teacher, companion and opponent. He'll also take your mind off the world around you. So if you're ready for the perfect relaxer, why not make the "Great Escape" with a great new friend, BORIS.

![](_page_103_Picture_3.jpeg)

BORIS electronically displays all chess pieces on the board. (First rank displayed above.)

The Classic Game of Chess Will Never Be the Same.

0

ECTED THRT

# ab-pruning

![](_page_105_Figure_0.jpeg)

![](_page_106_Figure_0.jpeg)

![](_page_107_Figure_0.jpeg)




## game over?



### Kasparov vs. Deep Blue Game 6, May 11, 1997

If one could devise a successful chess machine, one would seem to have penetrated to the core of human intellectual endeavor.

#### Herbert Simon (1958)



### John McCarthy, Stanford University (1967)

Computer chess has developed much as genetics might have if the geneticists had concentrated their efforts starting in 1910 on breeding racing Drosophila.

We would have some science, but mainly we would have very fast fruit flies.

#### John McCarthy, AI as Sport (1997)

# If you can't beat your computer at chess, try kickboxing.

## do algorithms have politics?

The programmer, like the poet, works only slightly removed from pure thought stuff.

He builds his castles in the air, from air, creating by exertion of the imagination.

Frederick P. Brooks, The Mythical Man-Month (1975)





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	0	0	0	0	0
0	I	0	I	0	0	0	0
	0	0	0	I	0	0	0
0	0	0	0	0	0	0	0
	0	0	0	I	0	0	0

#### knight moves (black)

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	0	0	0	0	0
0	I	0		0	0	0	0
I	0	0	0		0	0	0
0	0	0	0	0	0	0	0
	0	0	0	I	0	0	0

#### knight moves (black)

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	0	0	0	0	0
0	I	0		0	0	0	0
I	0	0	0	I	0	0	0
0	0	0	0	0	0	0	0
I	0	0	0	I	0	0	0

#### 

#### knight moves (black)

#### all pieces (white)

-		-					
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	0	0	0	0	0
0	I	0	I	0	0	0	0
I	0	0	0	I	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	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	0	0	0
0	0	0	0	0	0	0	0
0	0		0			0	0
0	0	0	0	0		0	0

#### knight moves (black)

#### all pieces (white)

#### (AND, OR, NOT, XOR)