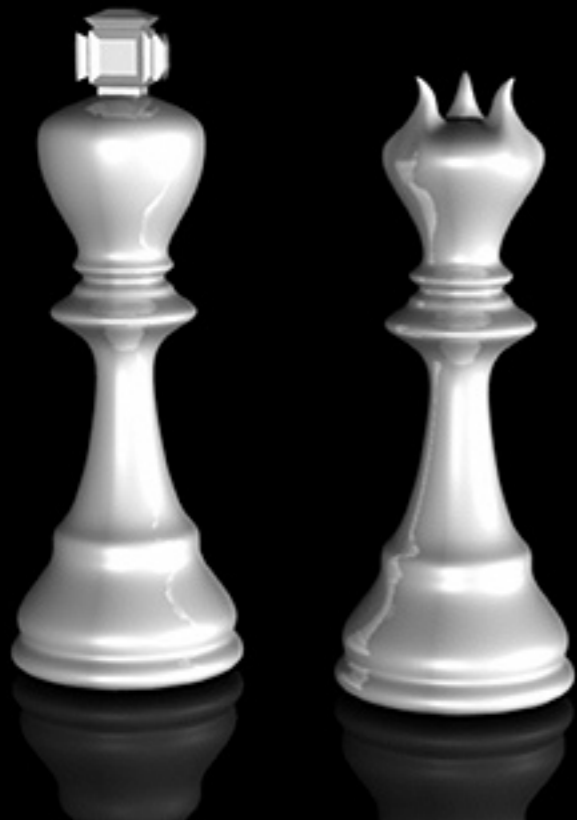
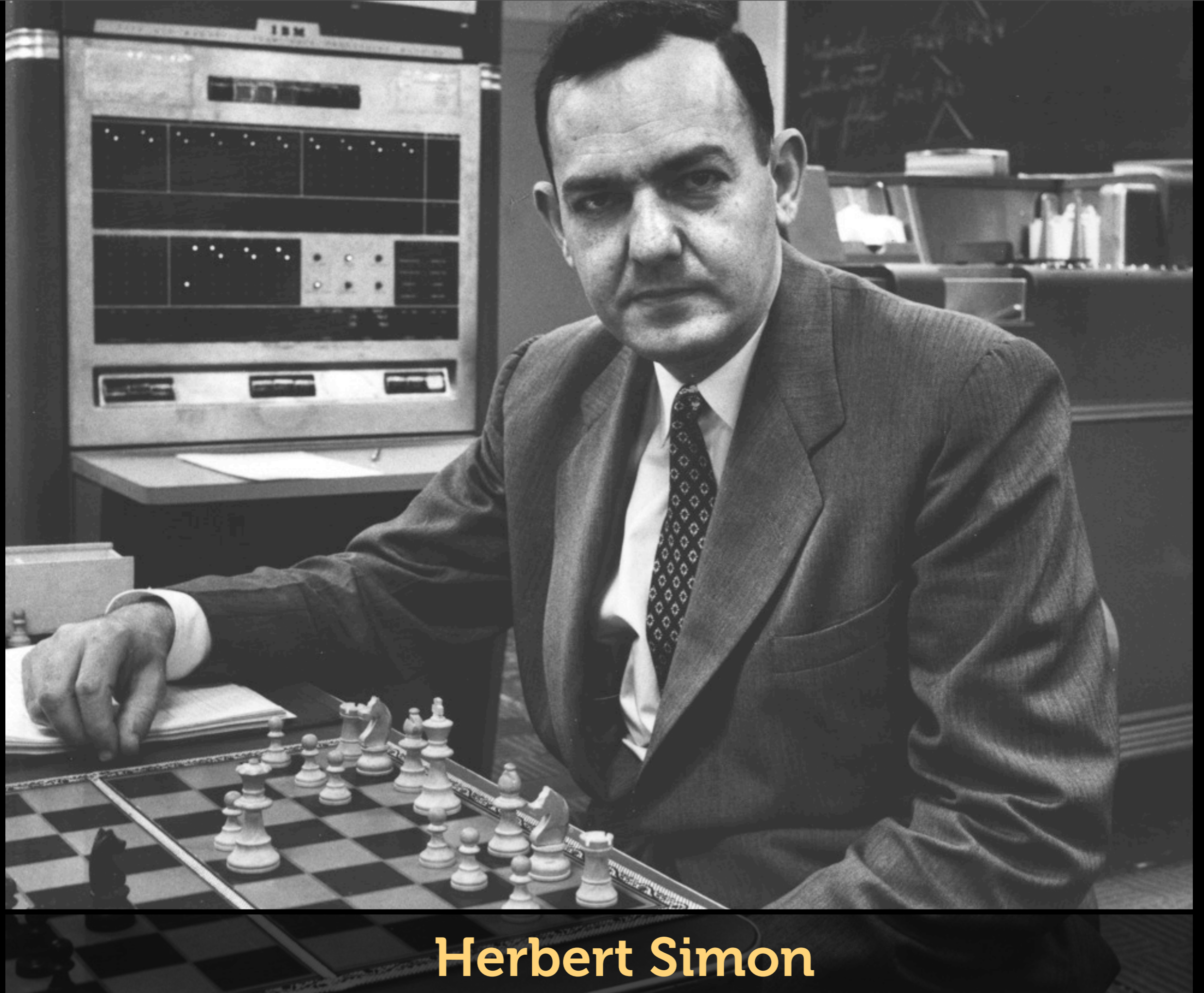


Is Chess the Drosophila of AI?

Computer Games as Experimental Technologies



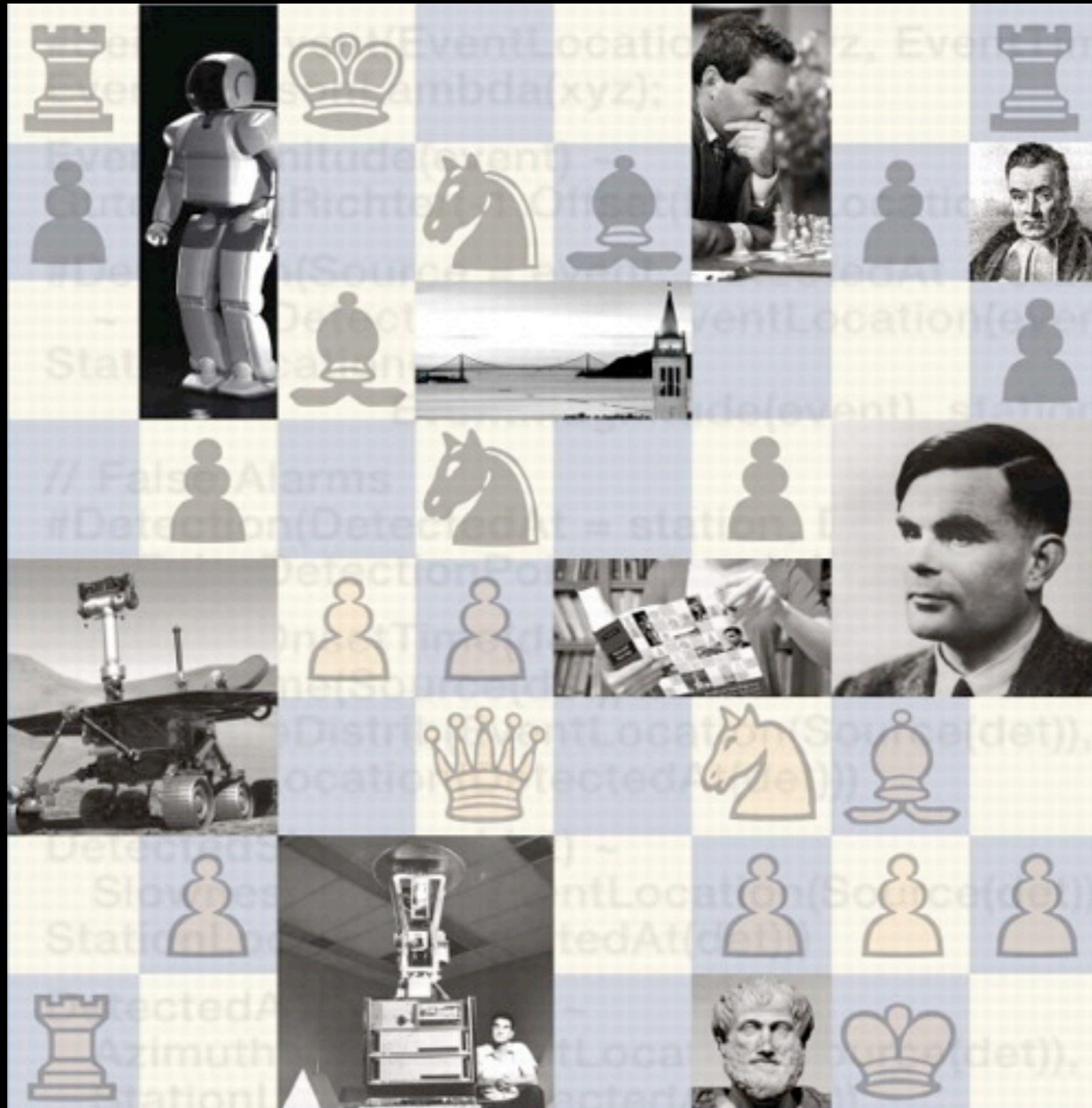
Nathan Ensmenger
University of Pennsylvania



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)



Stuart
Russell
Peter
Norvig

Artificial Intelligence

A Modern Approach

Third Edition



CHESS METAPHORS



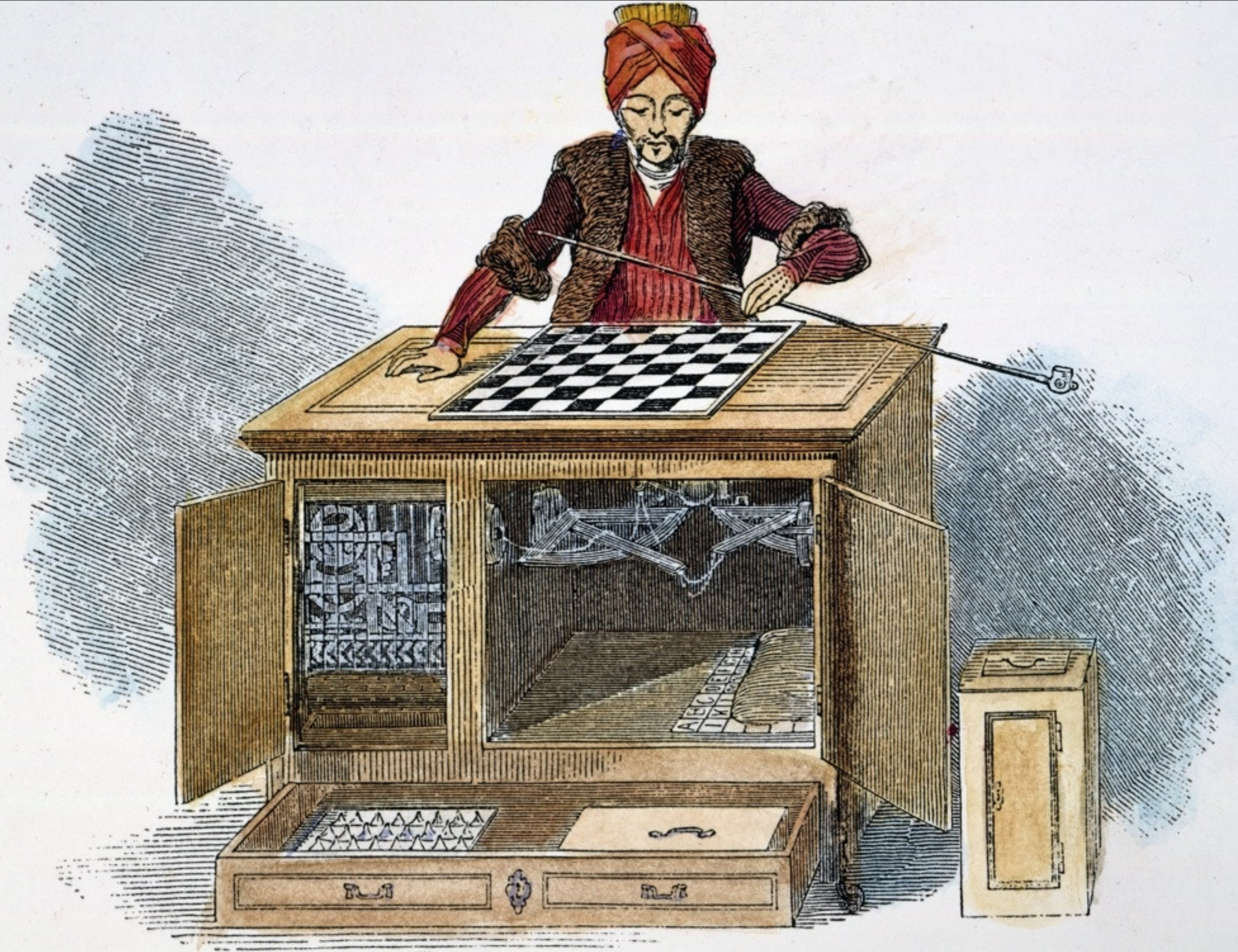
ARTIFICIAL INTELLIGENCE
AND THE HUMAN MIND



Diego Rasskin-Gutman

TRANSLATED BY Deborah Klosky

© 2009 MIT Press



THE AUTOMATON CHESS PLAYER.



THE AUTOMATON CHESS PLAYER.

Automaton Chess Player

1770

A History of Computer Chess

Maelzel's
EXHIBITION,
MASONIC HALL.

PERFORMANCE EVERY EVENING.

ON SATURDAY, MAY 17 1834

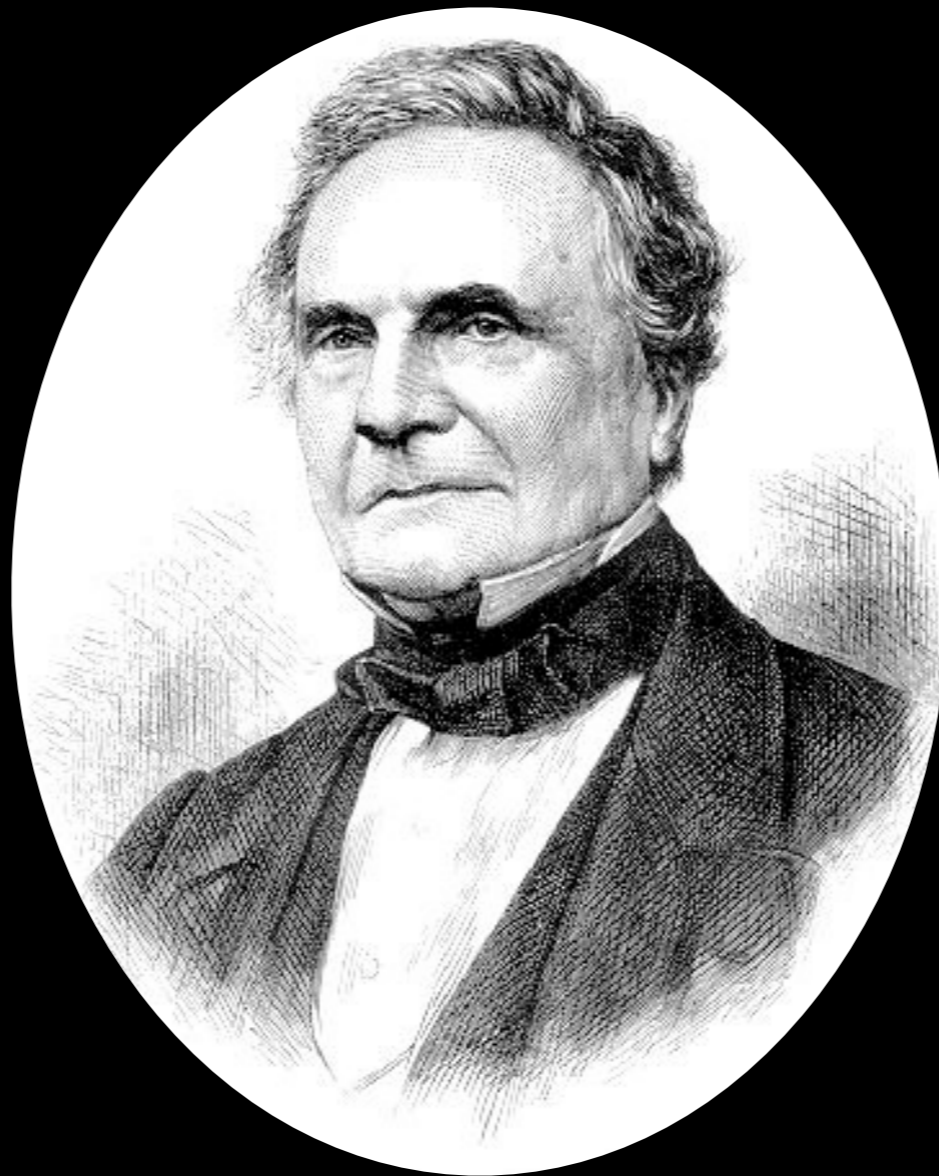
There will be two Exhibitions, one commencing at 4 o'clock P.M. the
at the usual time.—Doors open half an hour previous.

Doors open at half-past 7 o'clock. Performance to commence at 8 precise.

PART FIRST.
THE ORIGINAL AND CELEBRATED
AUTOMATON
CHESS PLAYER.

Invented by DE KEMPELIN, Improved by J. MAELZEL.

The Chess Player has withstood the first players of Europe and America, and excites universal admiration. He moves his head, eyes, lips, and hands, with the greatest facility, and distinctly pronounces the word "*Echec*," (the French word signifying "*Check*") when necessary. If a miss-move is made, he perceives and rectifies it.

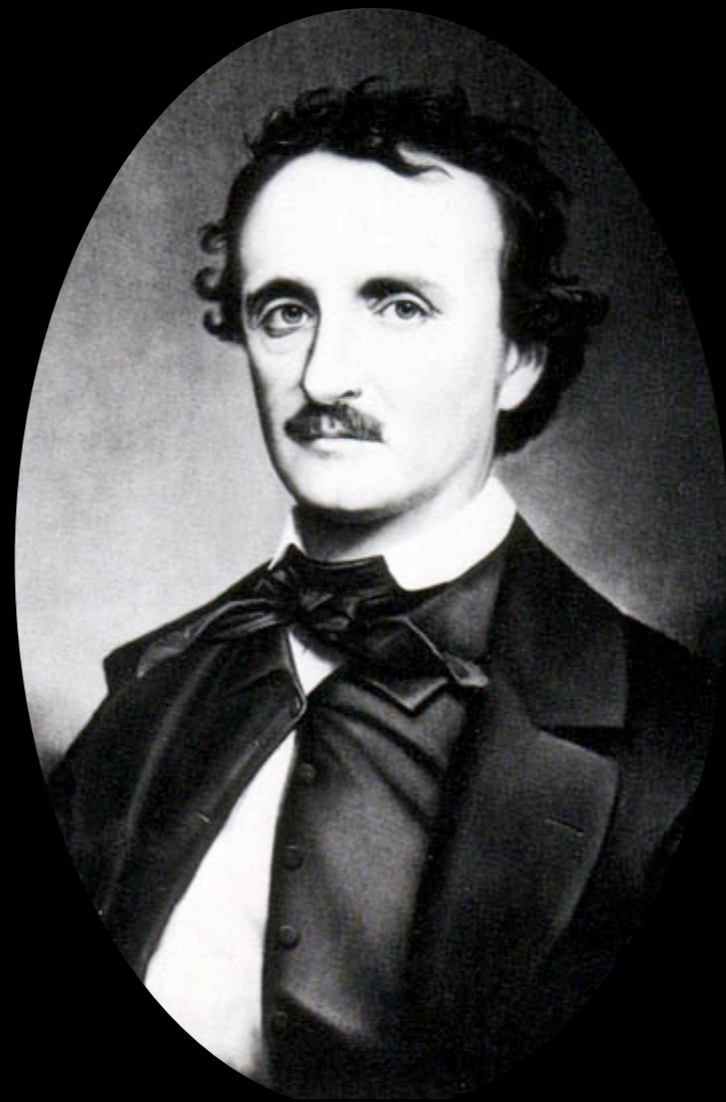


Charles Babbage

1821

1770

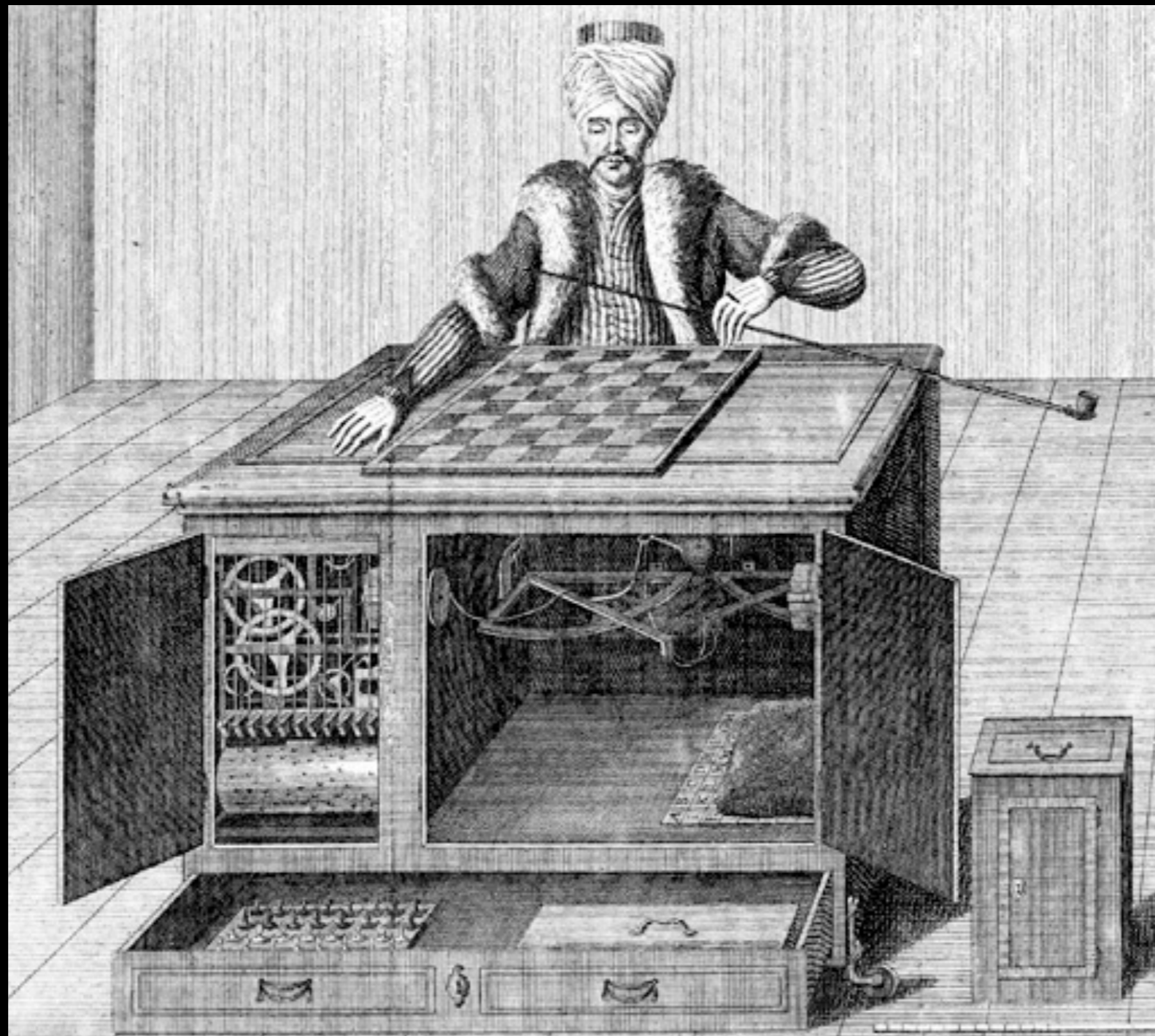
A History of Computer Chess



Edgar Allen Poe



A History of Computer Chess

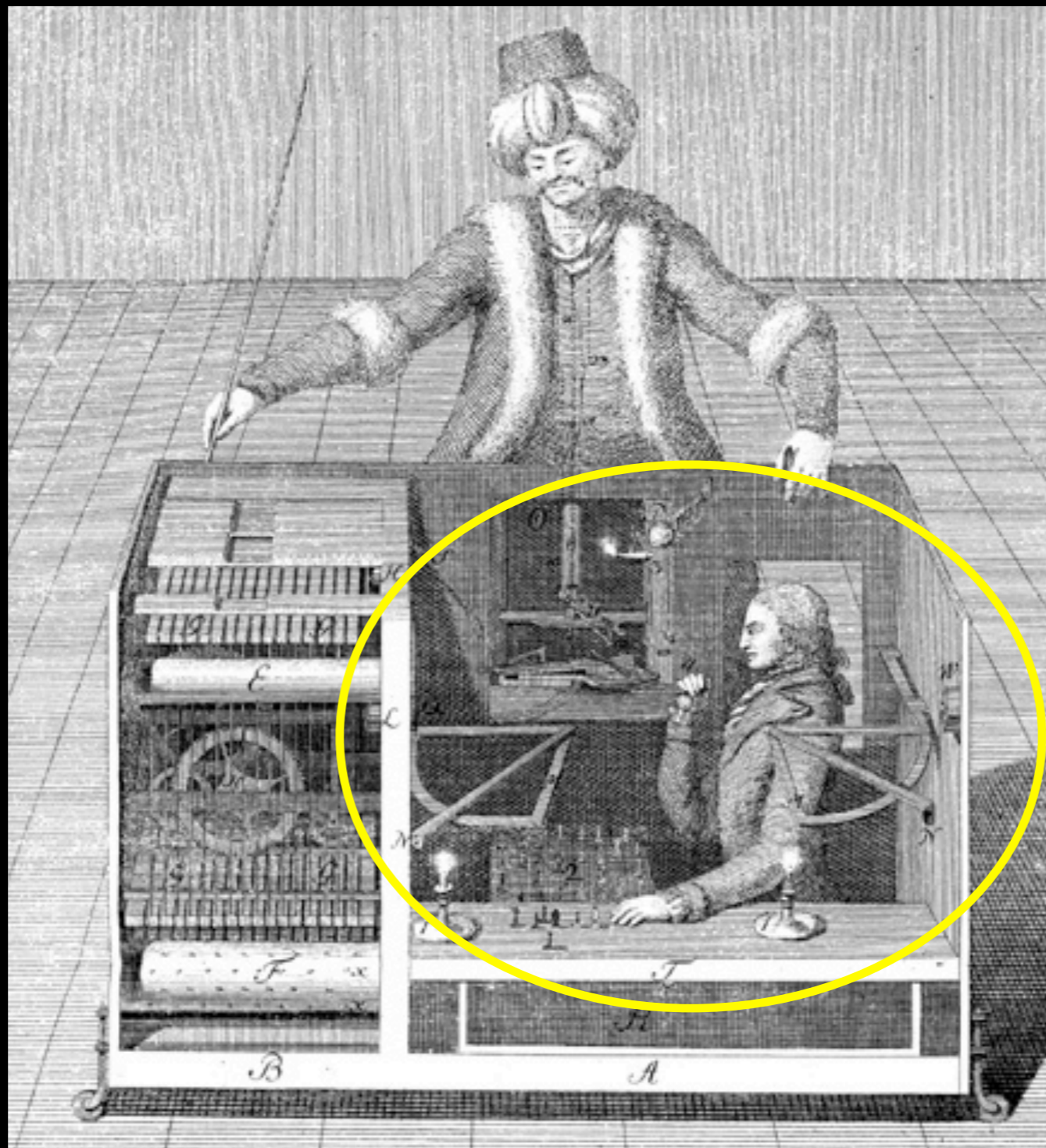


1821

1836

1770

A History of Computer Chess



1821

1836

1770

A History of Computer Chess

Plate 1.



Plate 2.



Plate 3.

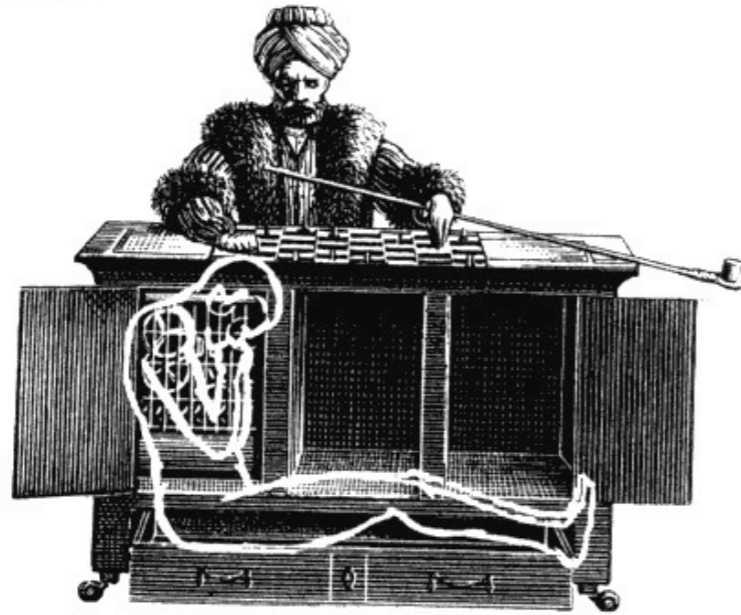
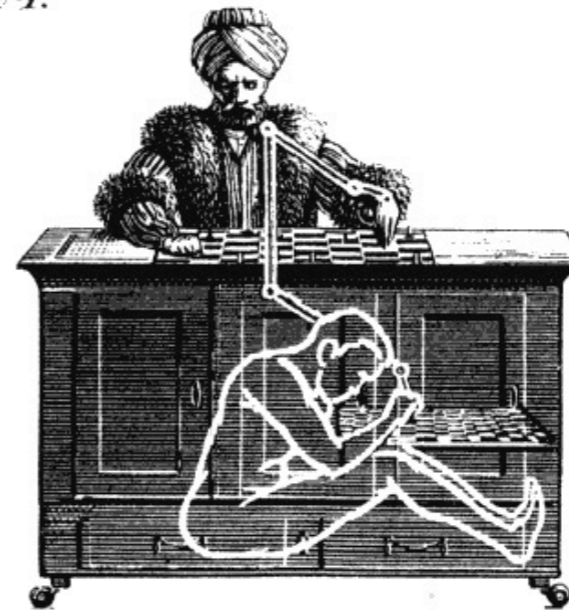


Plate 4.



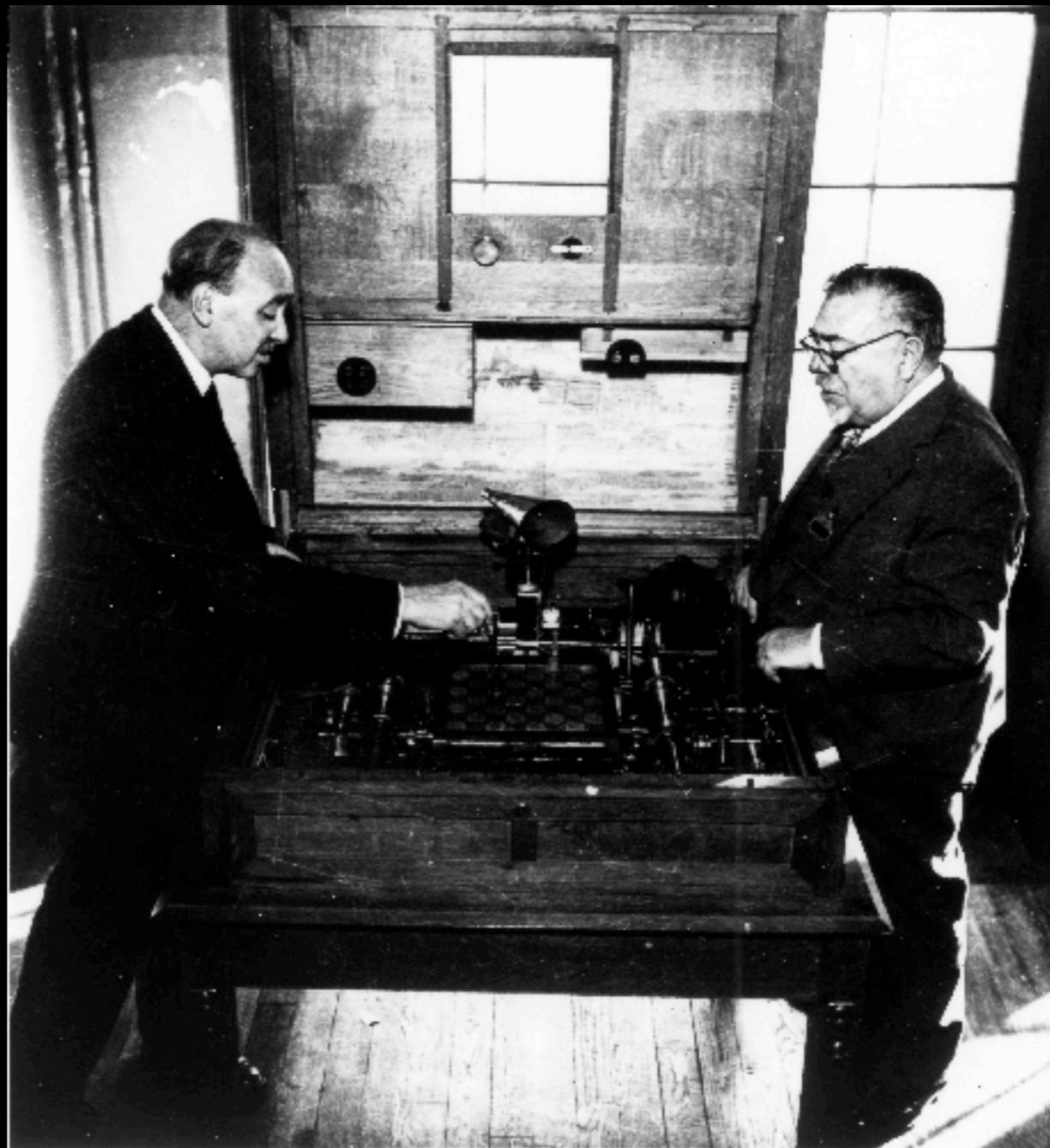
1821

1836

1770

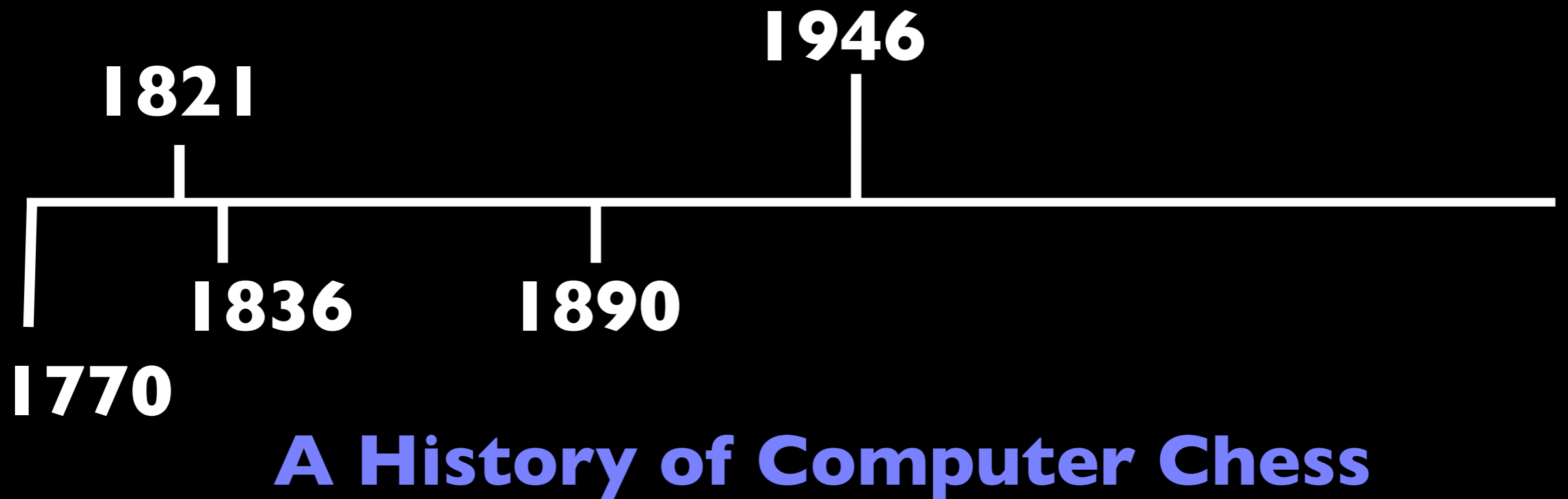
A History of Computer Chess

Leonardo Torres y Quevedo

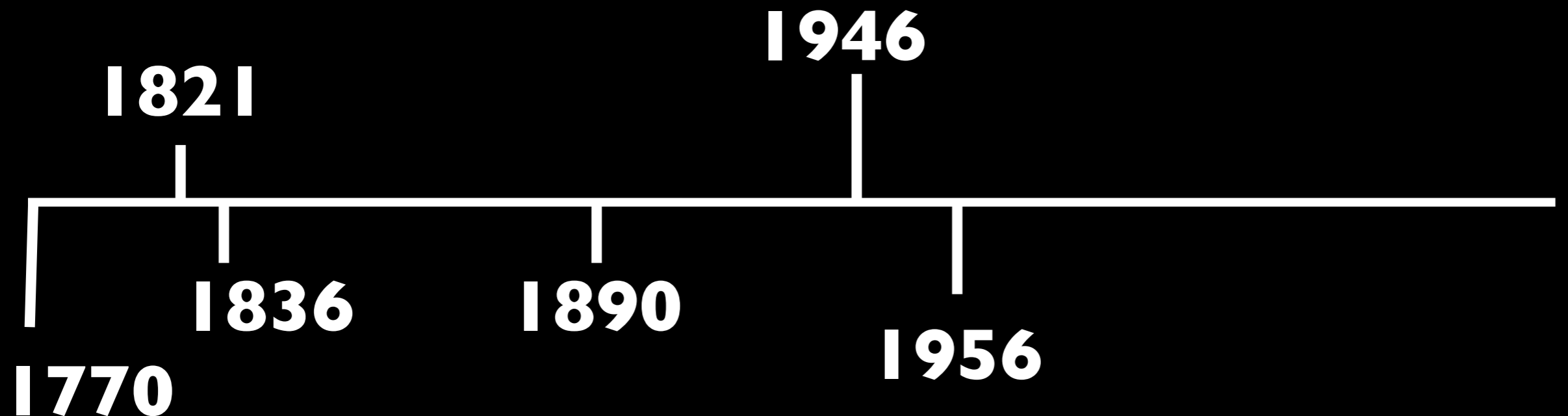


A History of Computer Chess

Alan Turing



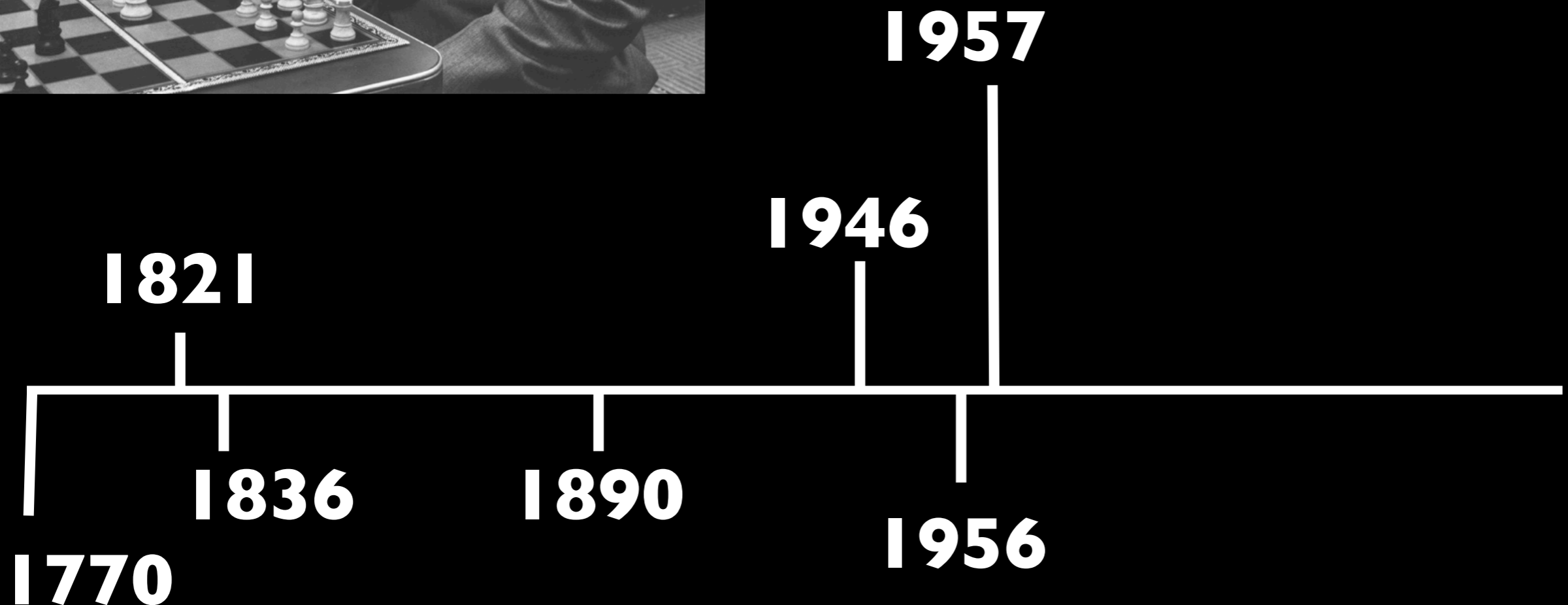
Los Alamos “MANIAC”



A History of Computer Chess



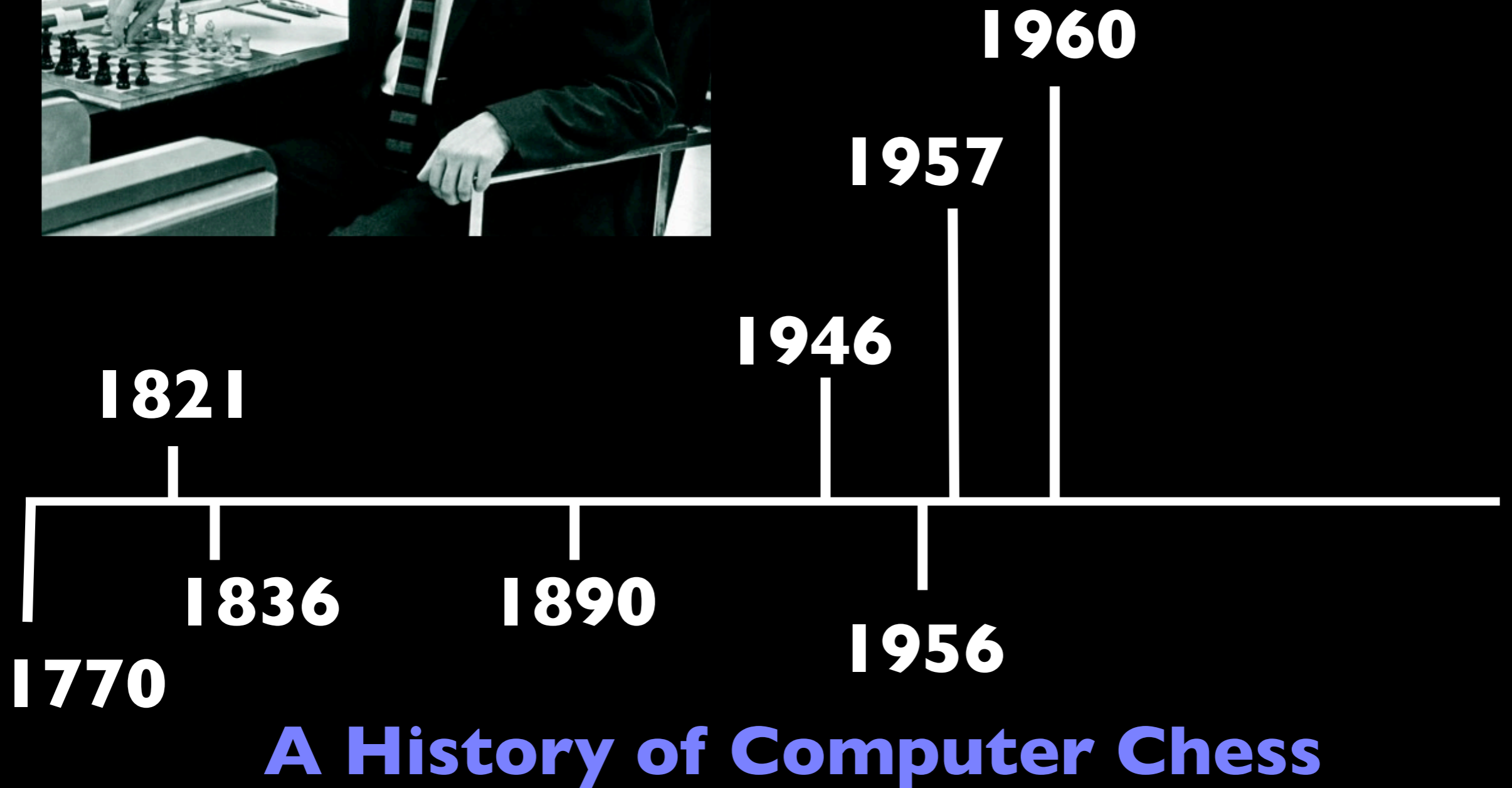
Herbert Simon



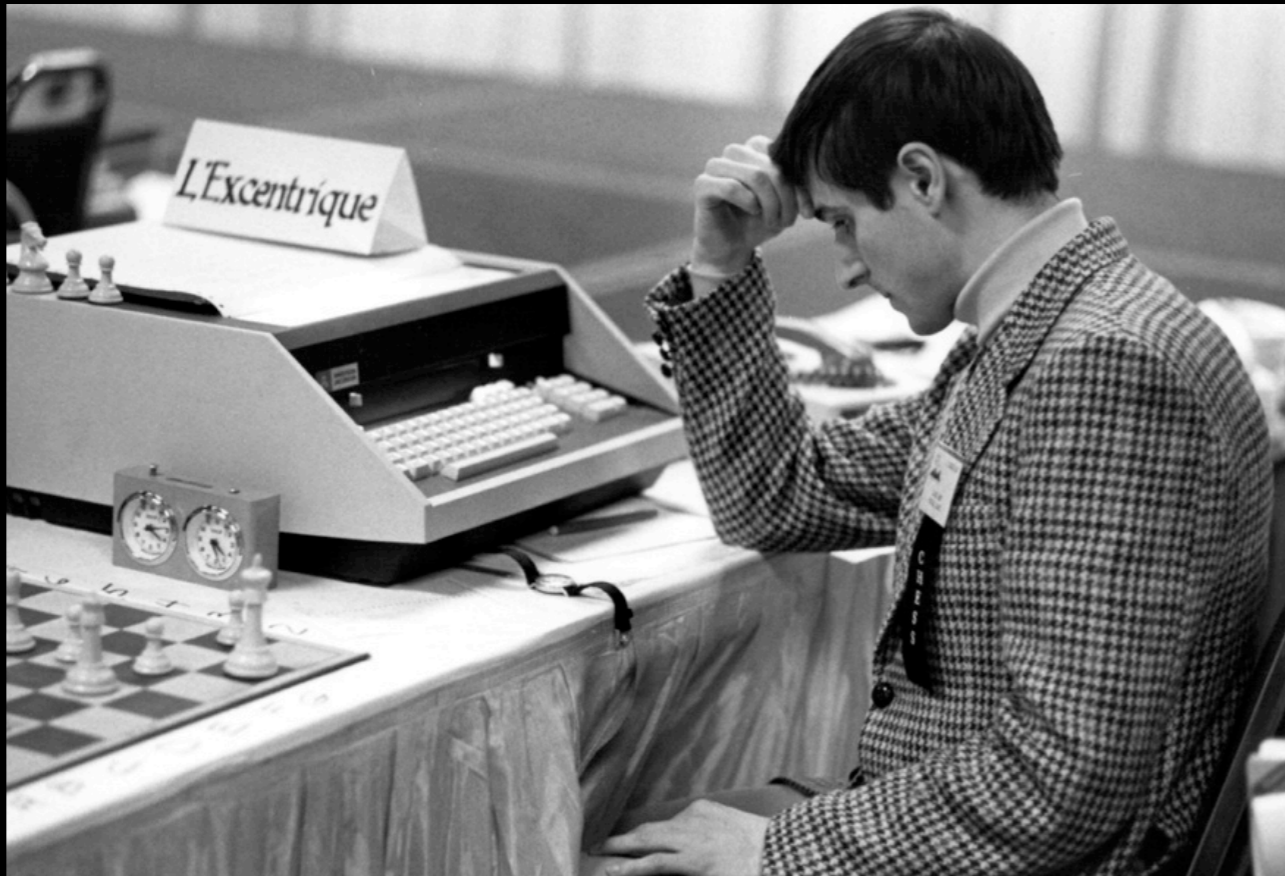
A History of Computer Chess



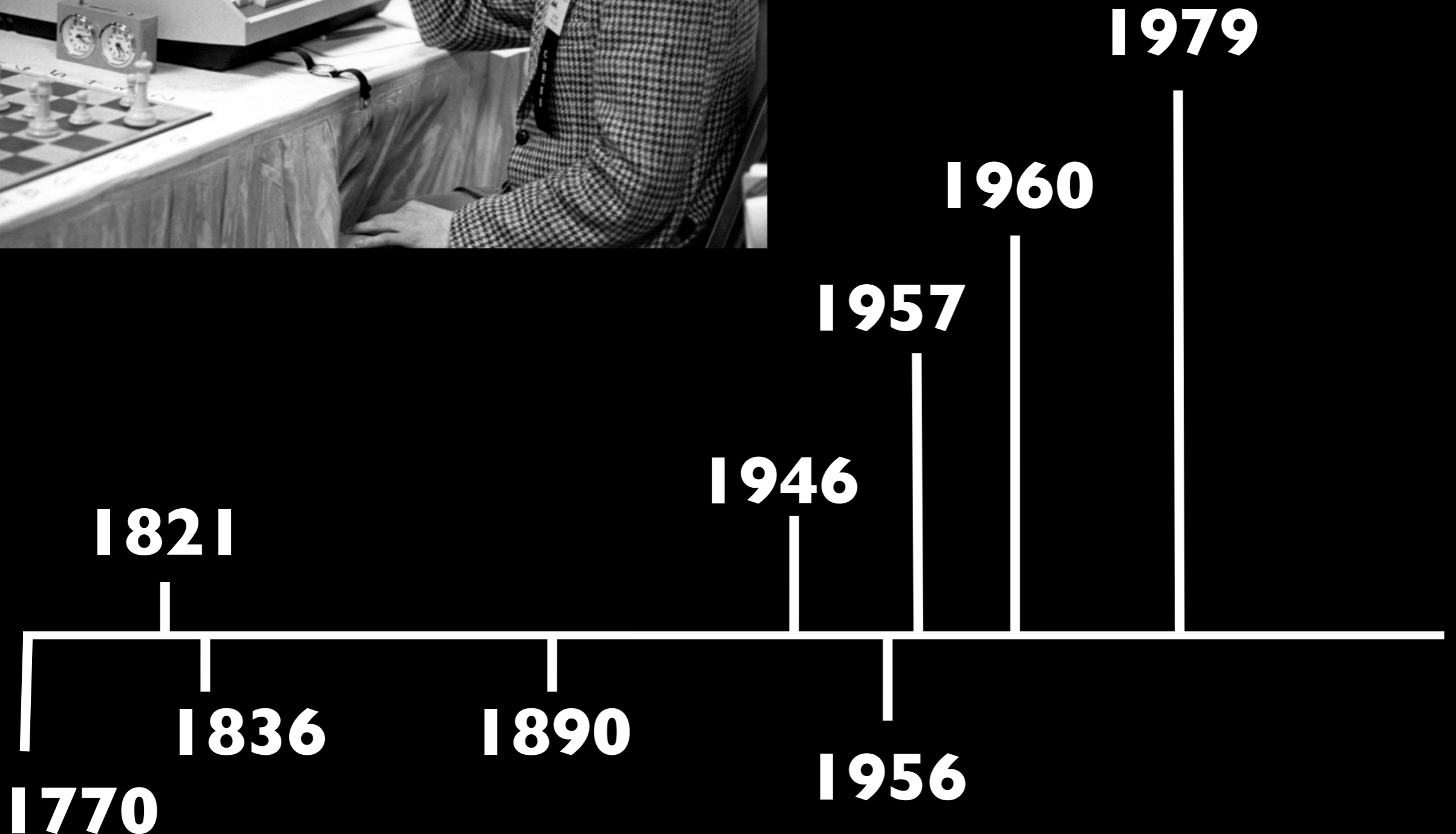
John McCarthy



A History of Computer Chess



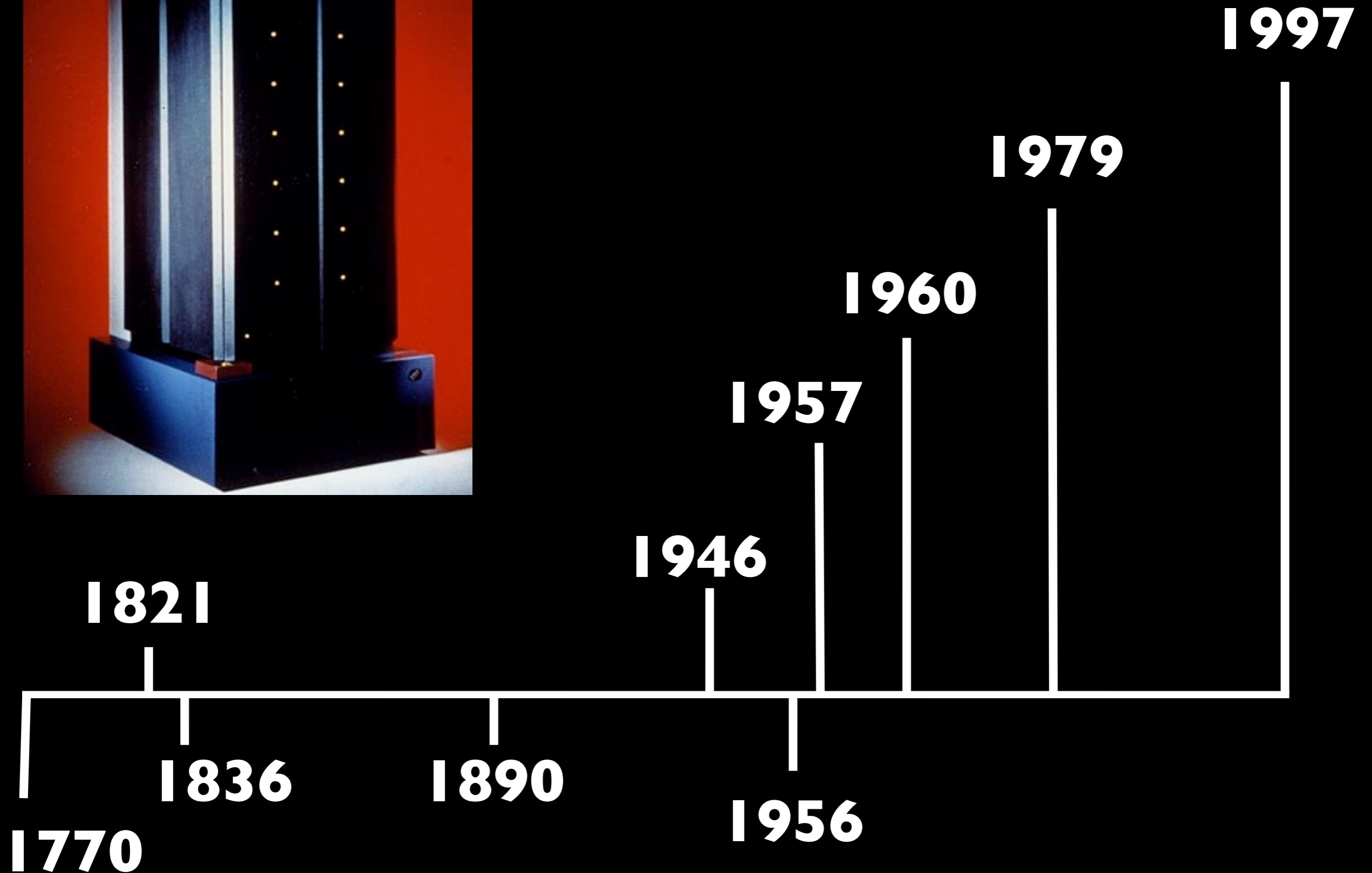
Detroit World Computer Chess Championship



A History of Computer Chess



Deep Blue



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

Are **YOU** the man

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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?**



**LORDS
OF
THE
FLY**



Drosophila Genetics and the
Experimental Life

Robert E. Kohler



Thomas Hunt Morgan

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.

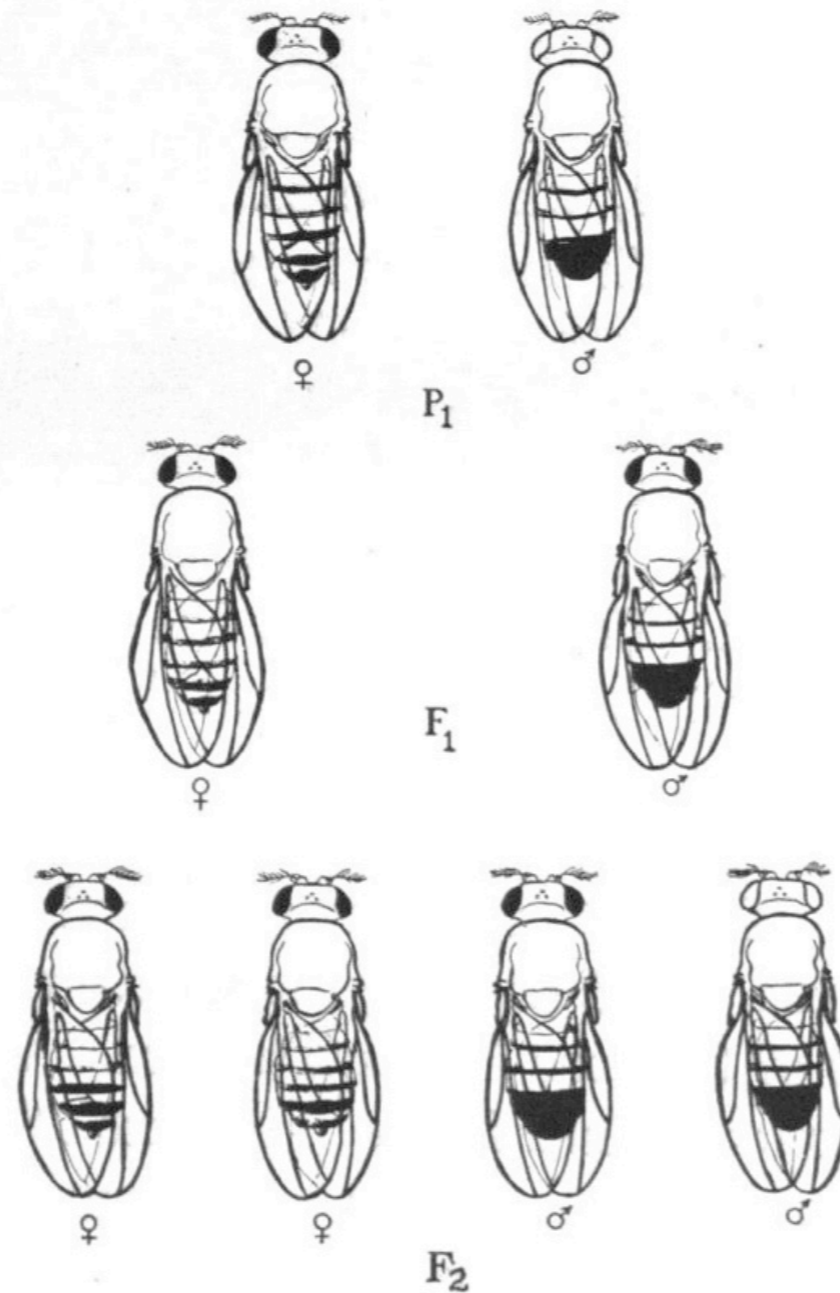


FIG. 35. Diagram showing a cross between a white eyed male and a red eyed female of the fruit fly. Sex linked inheritance.

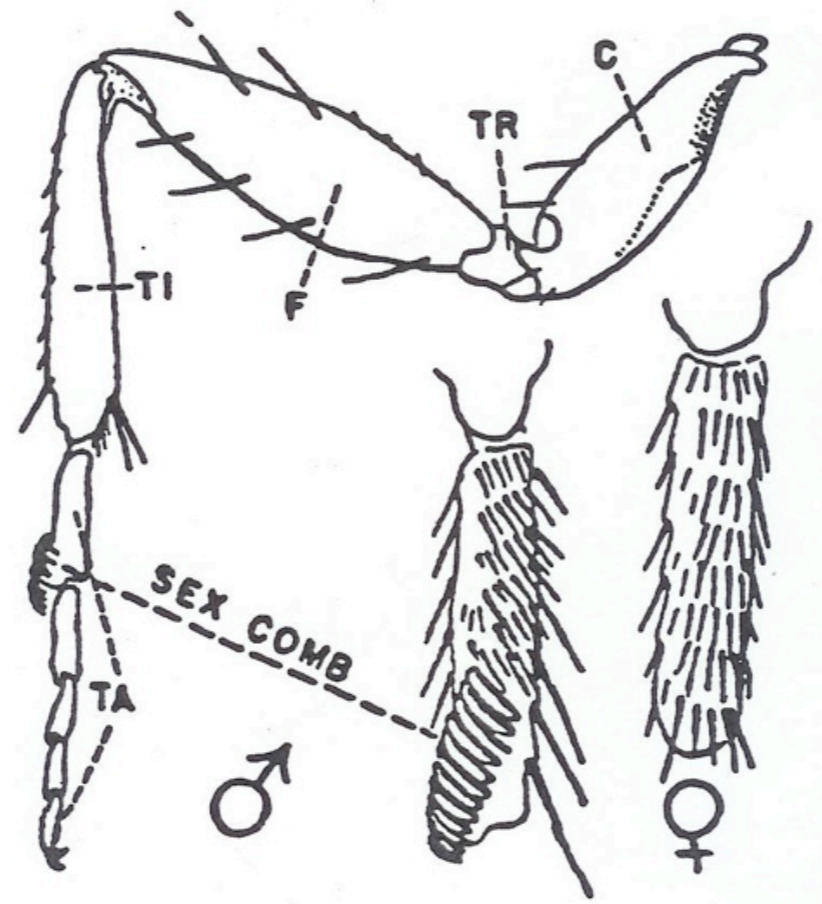
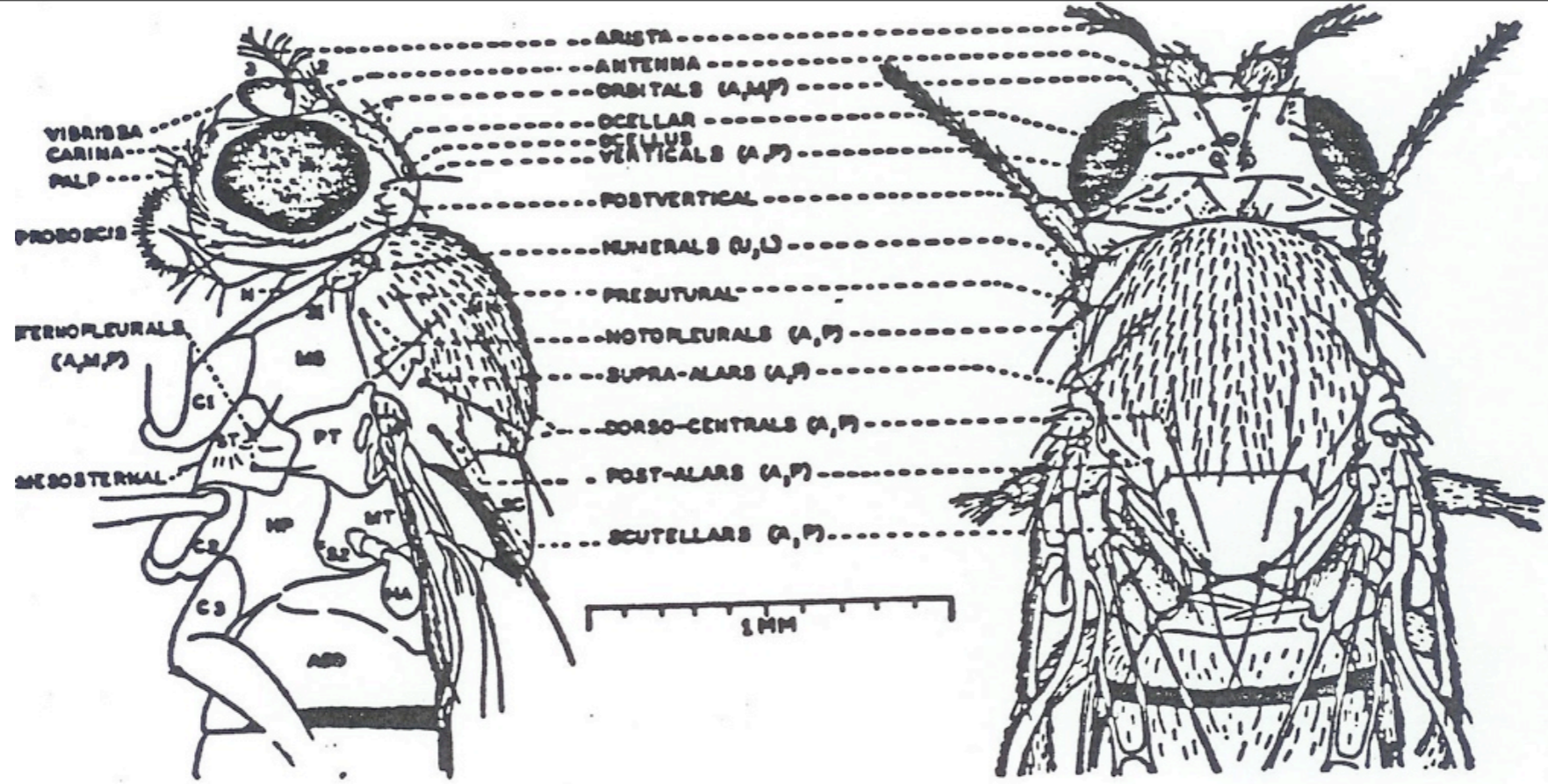
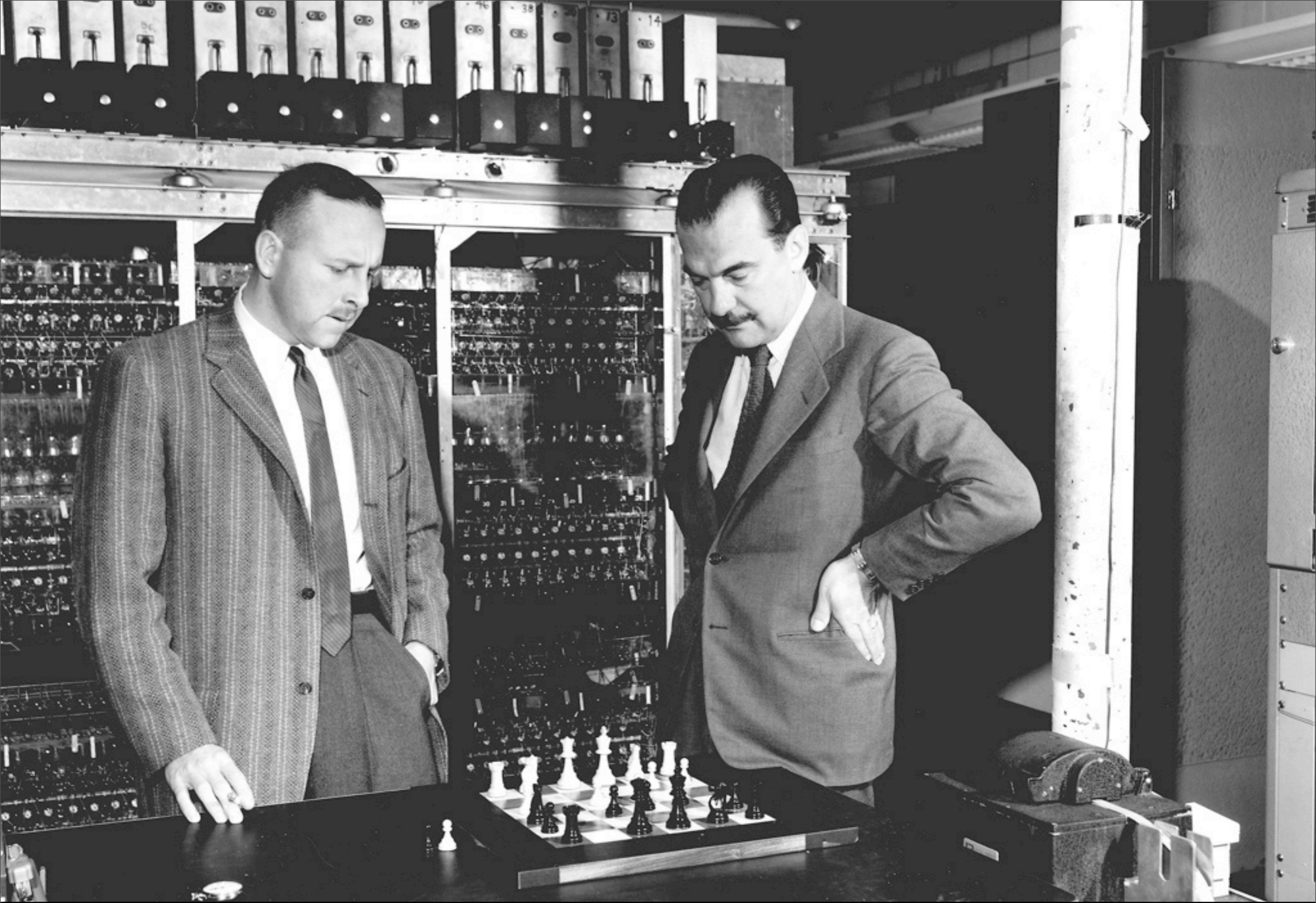




FIG. 64. Scheme to illustrate a method of crossing over of the chromosomes.



Columbia University "Fly Room"

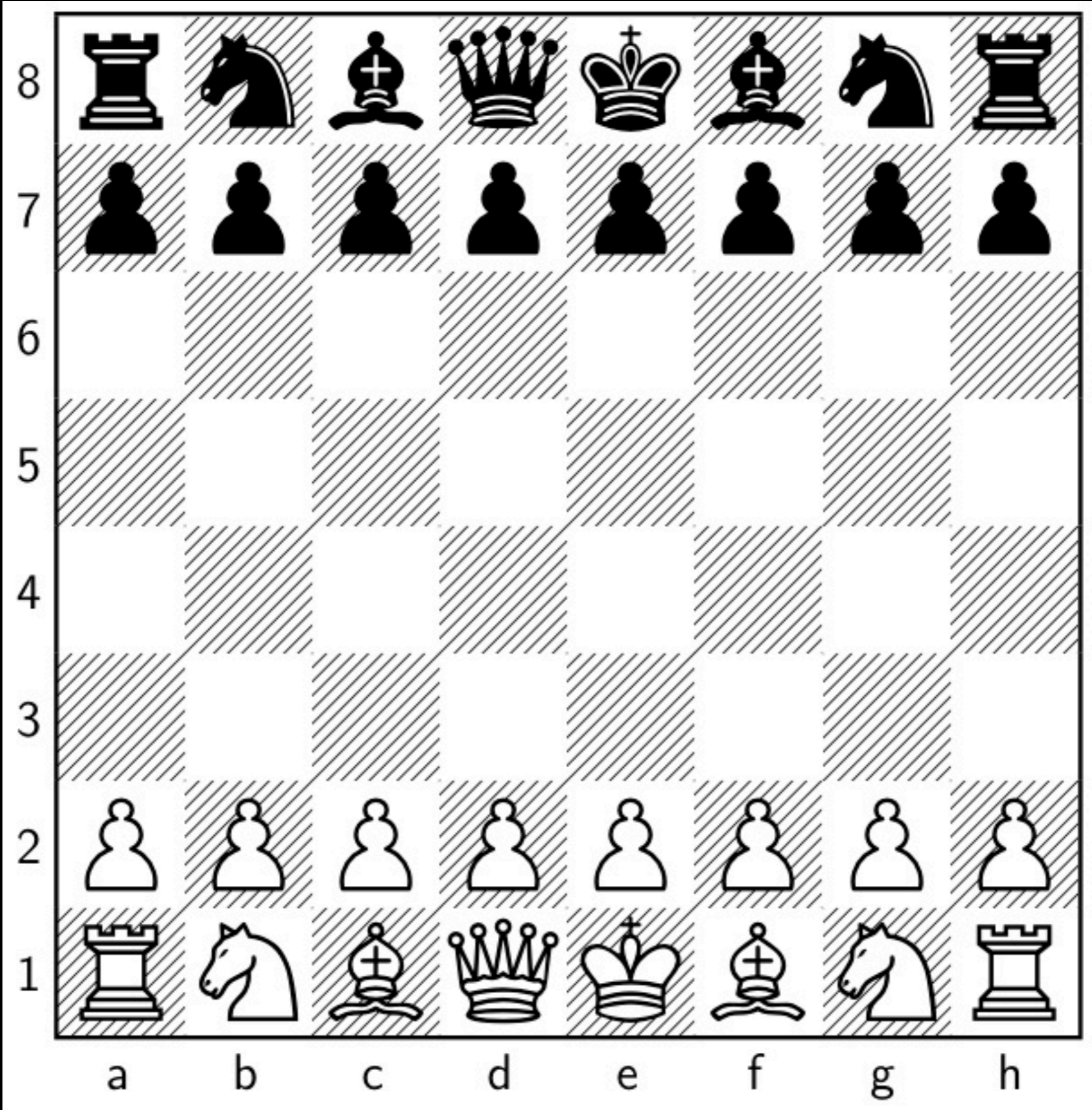


MANIAC Computer, Los Alamos (1958)

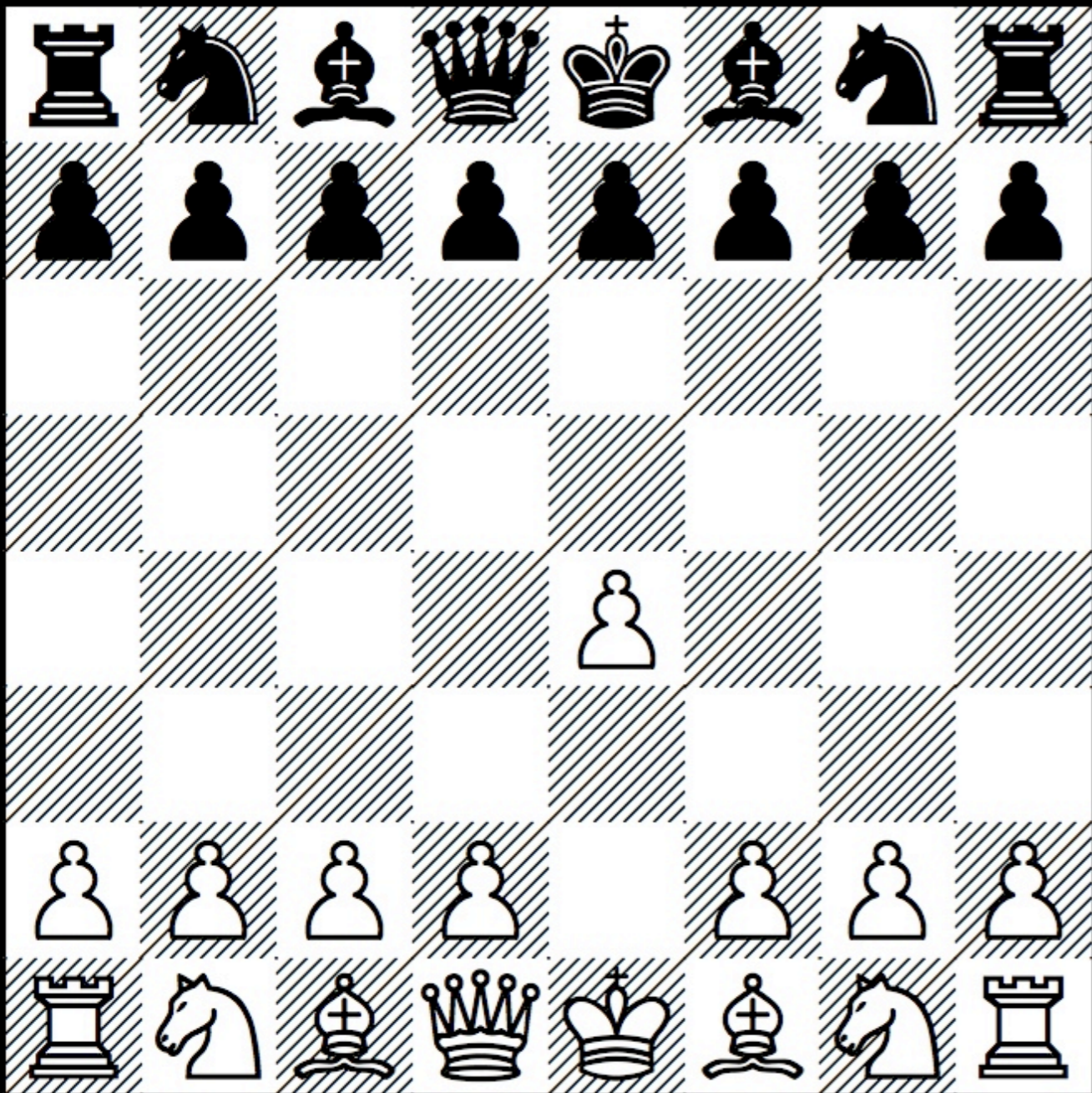
**how a computer
sees a chessboard**



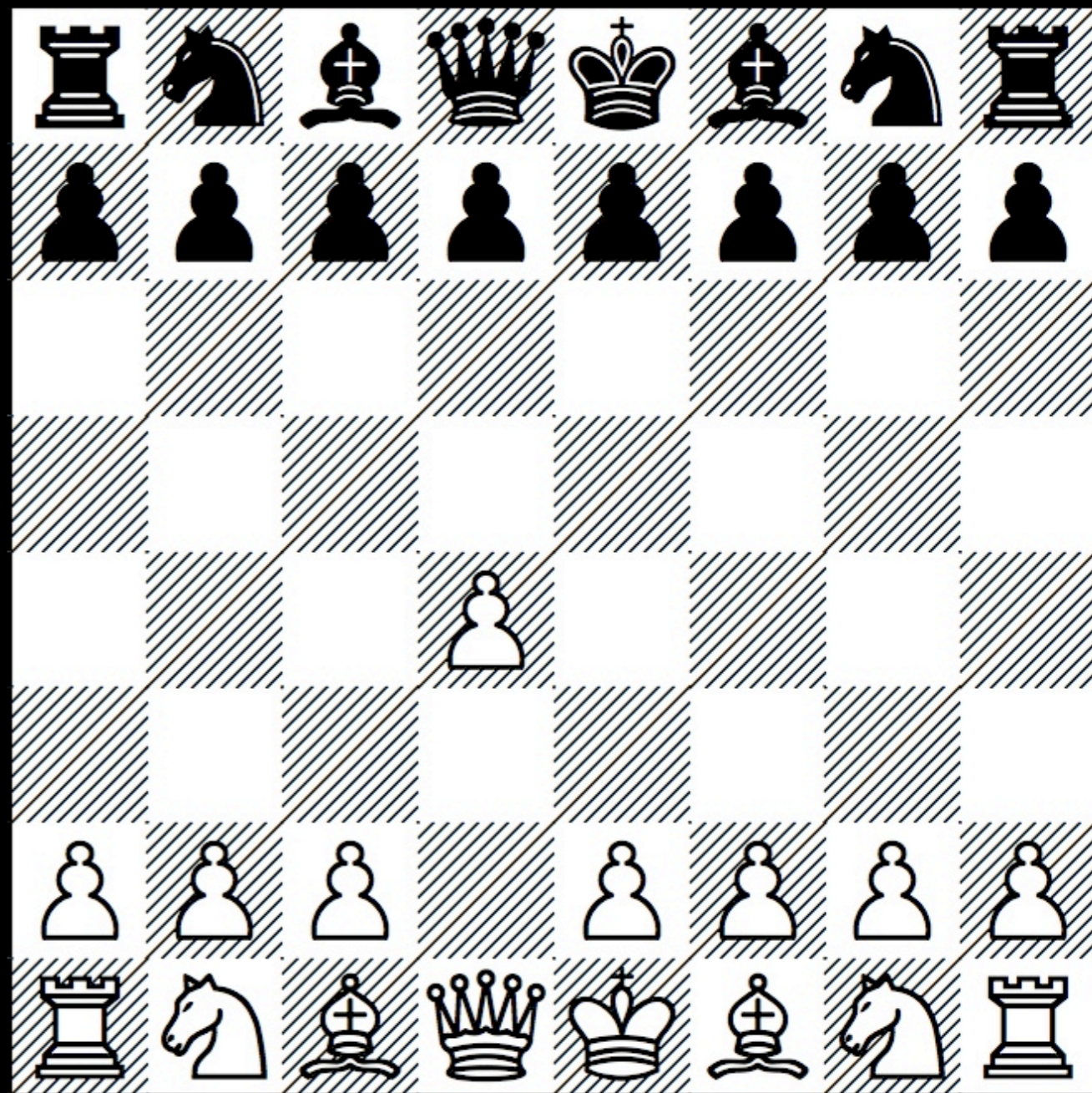
Claude Shannon (c. 1950)



8	-4	-2	-3	-5	-6	-3	-2	-4
7	-1	-1	-1	-1	-1	-1	-1	-1
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
2	1	1	1	1	1	1	1	1
1	4	2	3	5	6	3	2	4
	a	b	c	d	e	f	g	h



P-K4



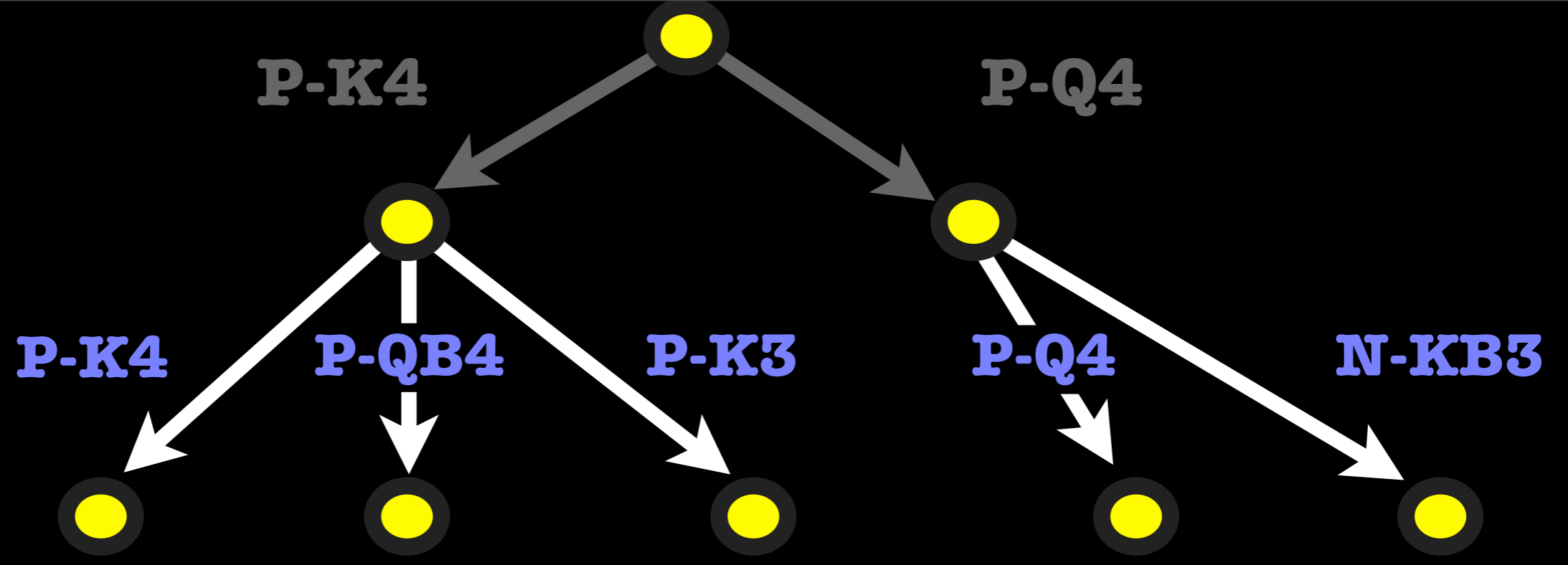
P-Q4

P-K4

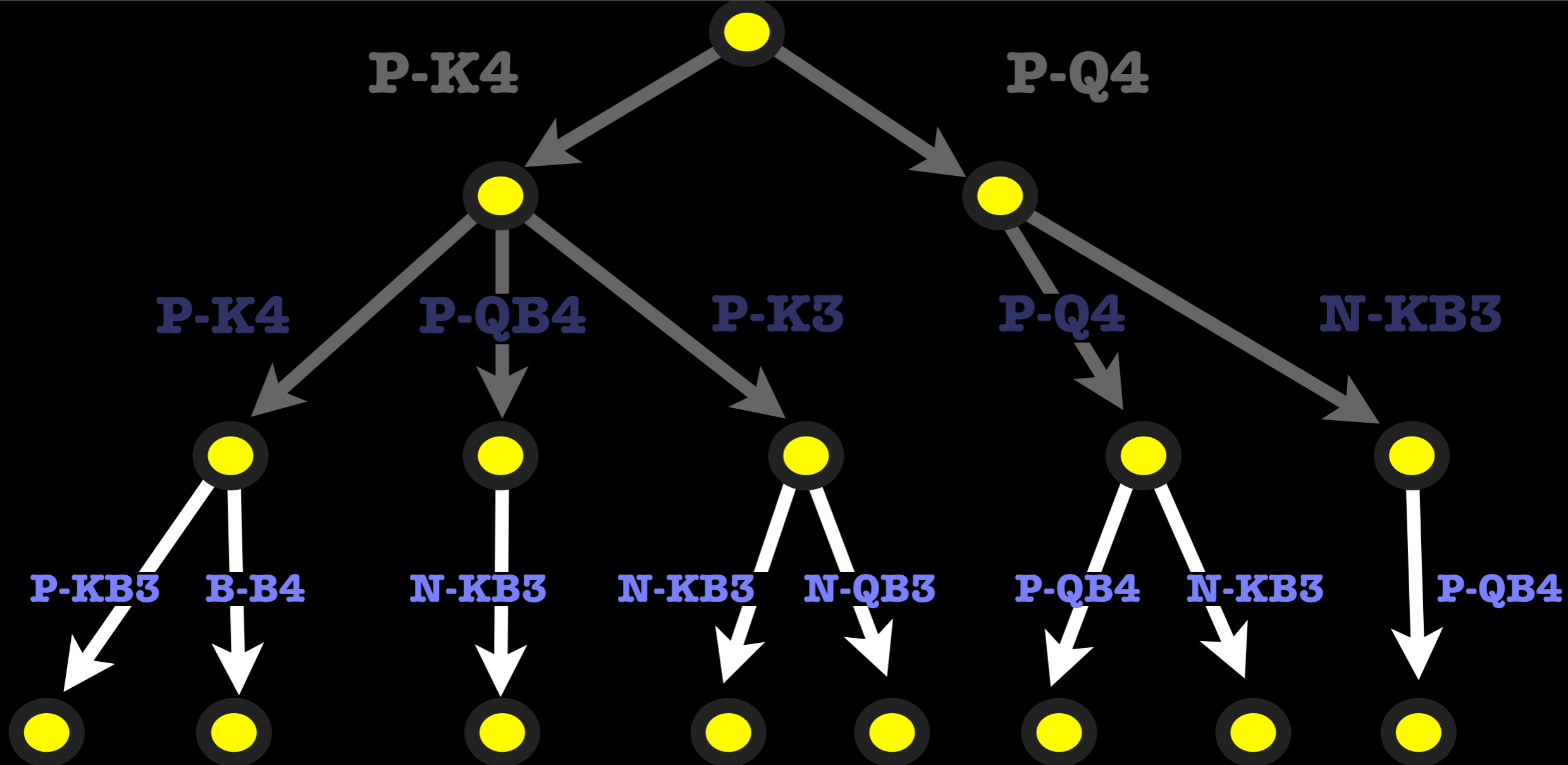
P-Q4



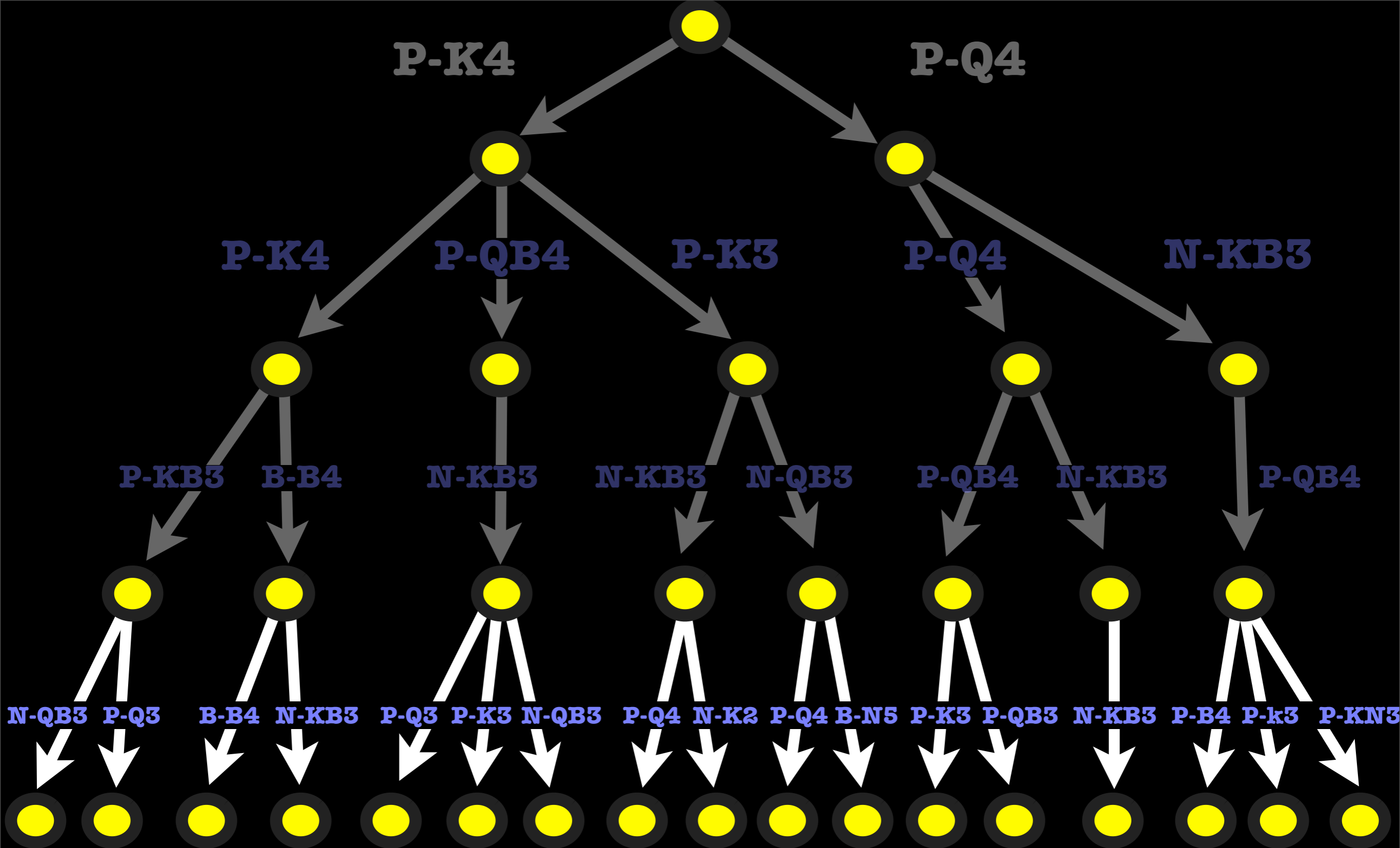
ply 1: white to move



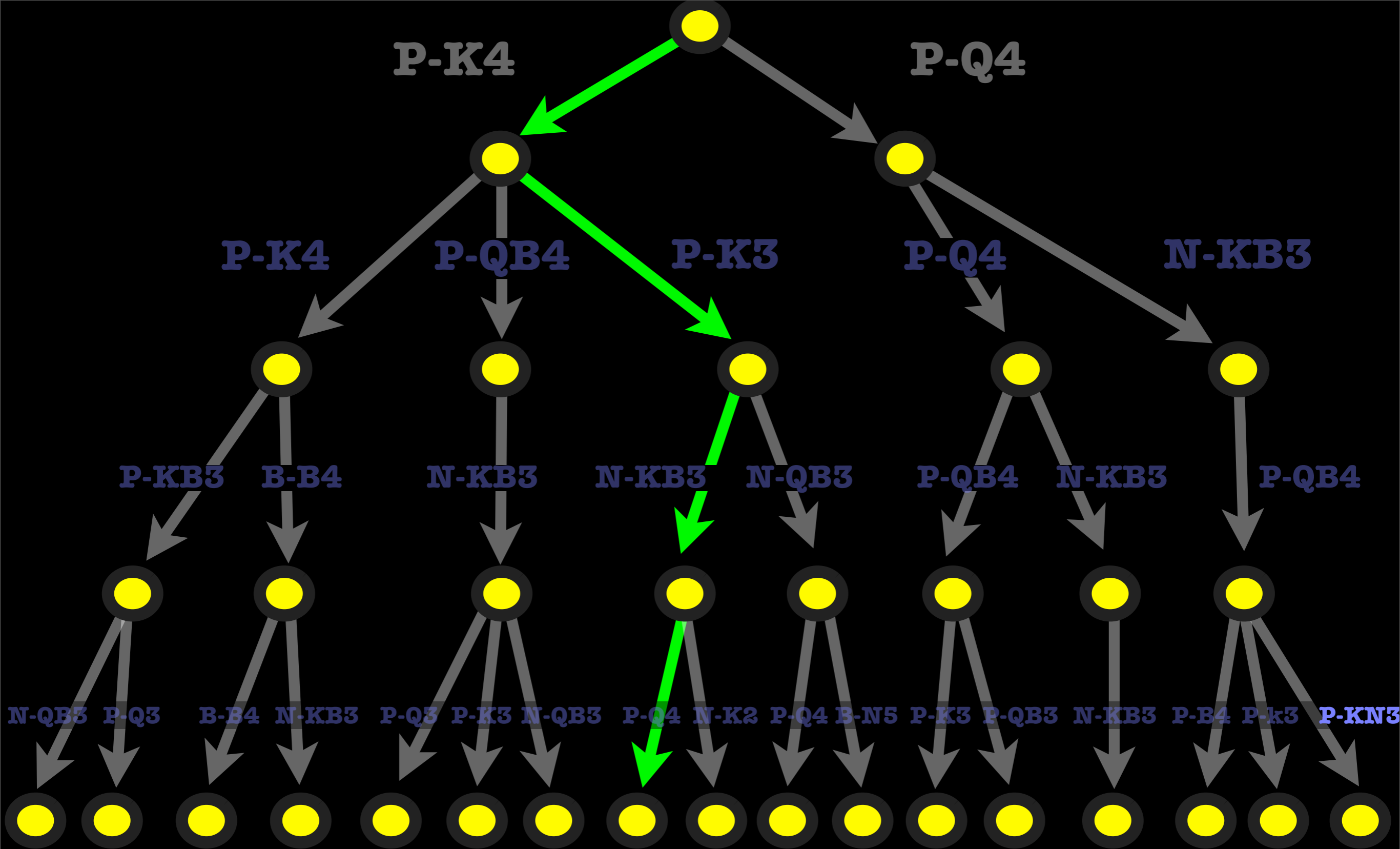
ply 2: black to move



ply 3: white to move



ply 4: black to move



the limits of computation

42

42

**average number of moves
per game of chess**

84

**average number of plies
per game of chess**

38

**average number of
plausible moves per ply**

3884

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

10 134

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

10 134

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

10 134

10^{18}

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

10 134

10^{75}

**total number of atoms in the
universe**

10134

10^6

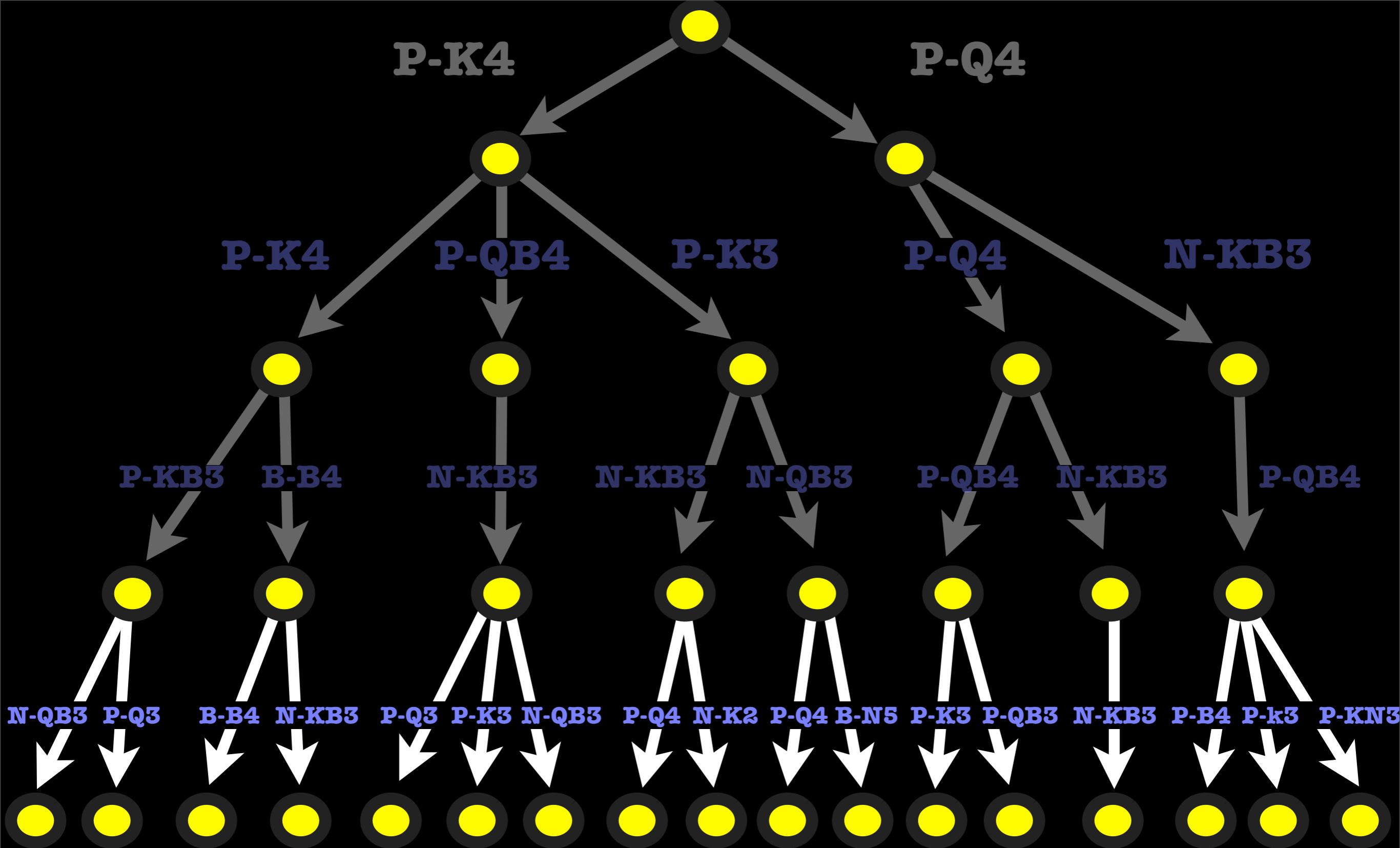
**number of moves evaluated by
Deep Blue every second**

10¹³⁴

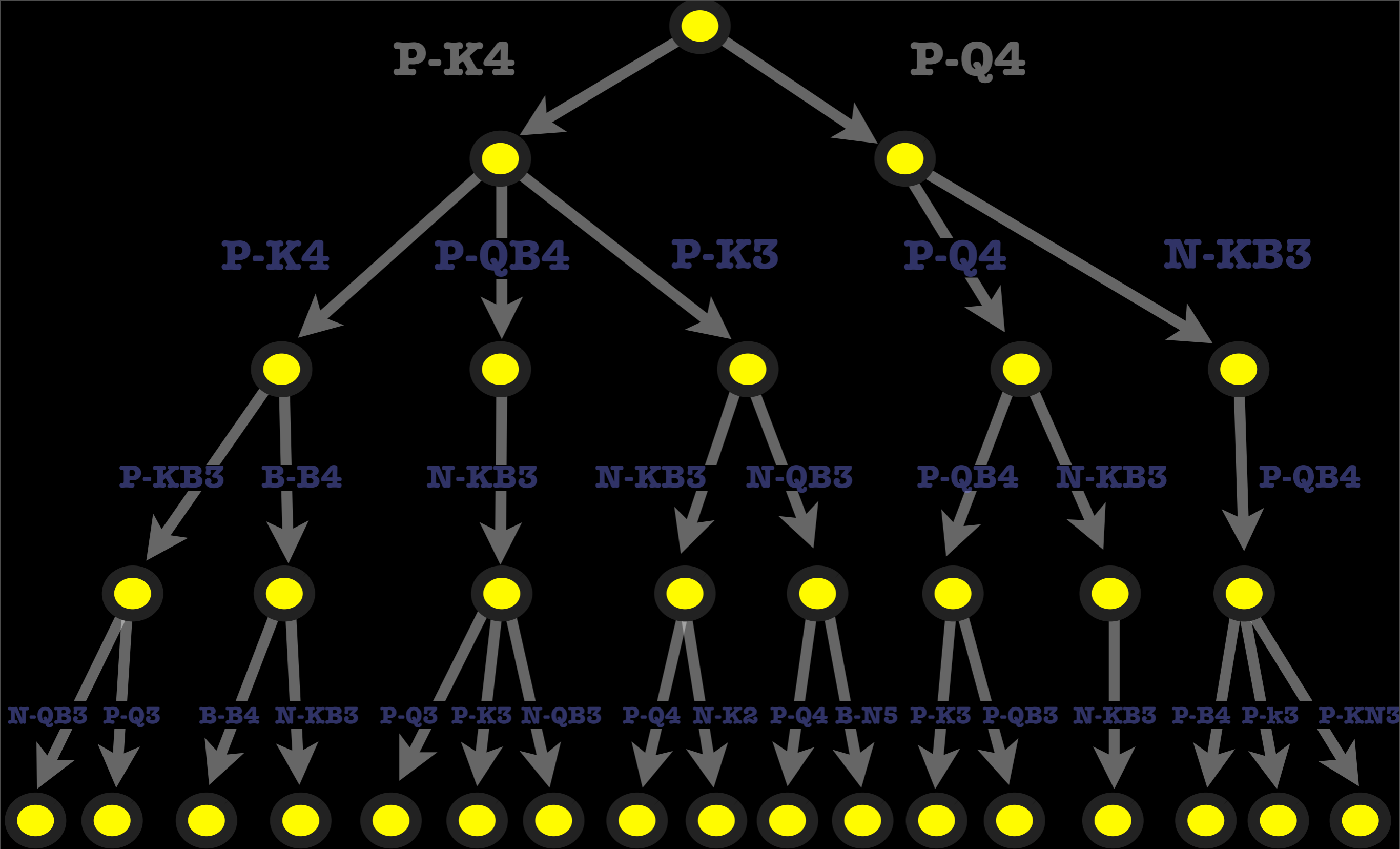
10 **still not even close**

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

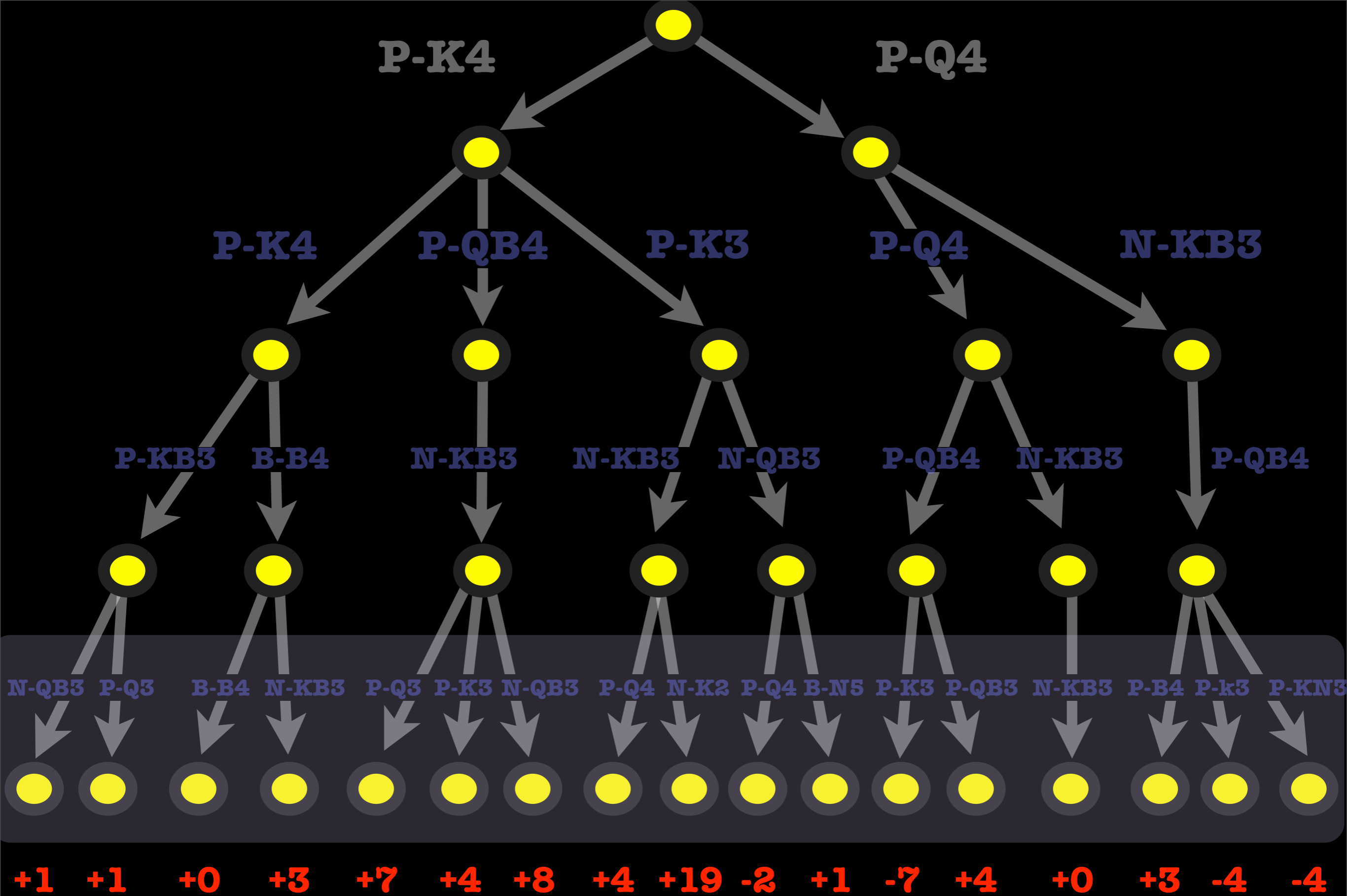
minimax



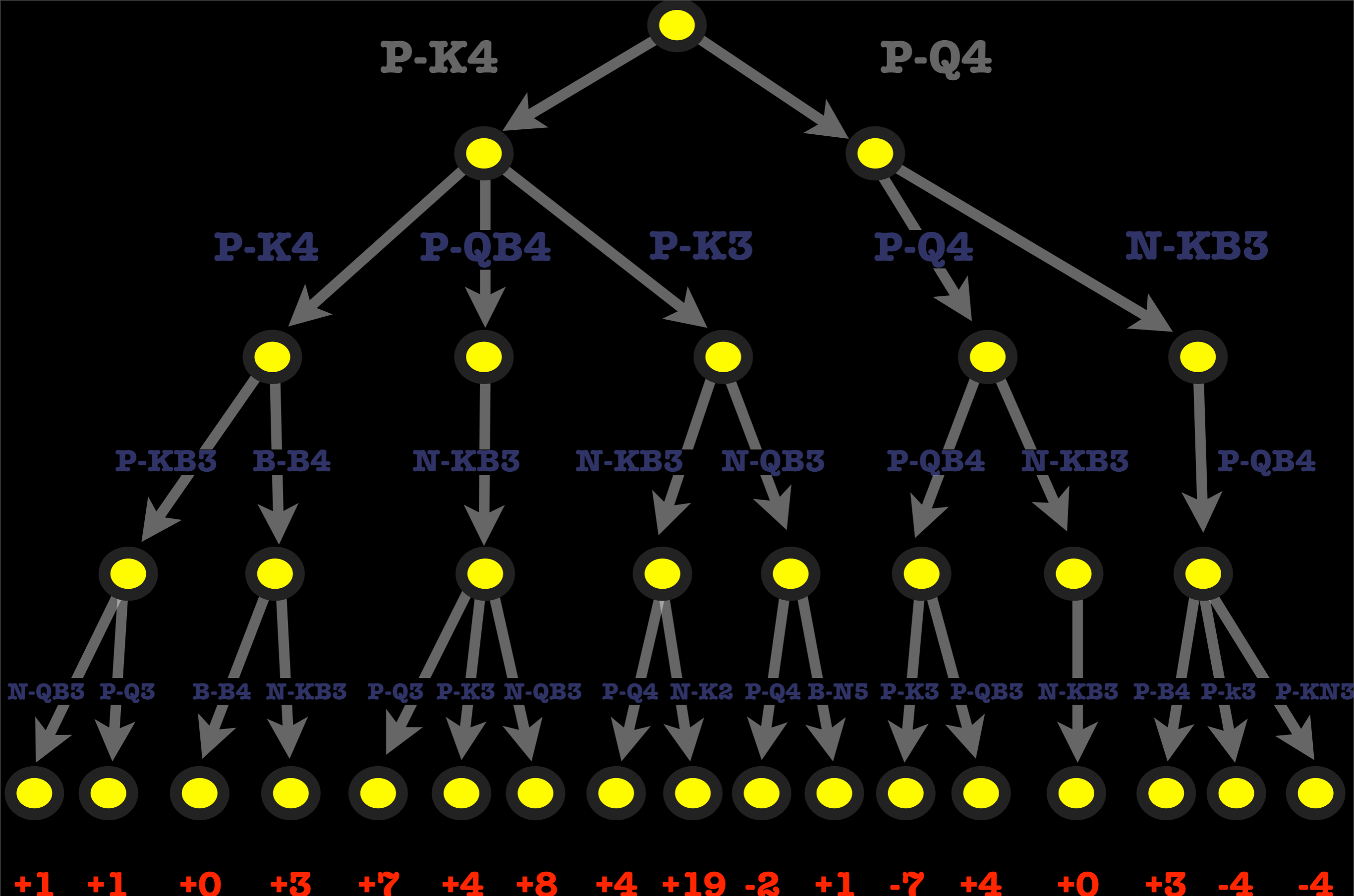
construct the decision tree



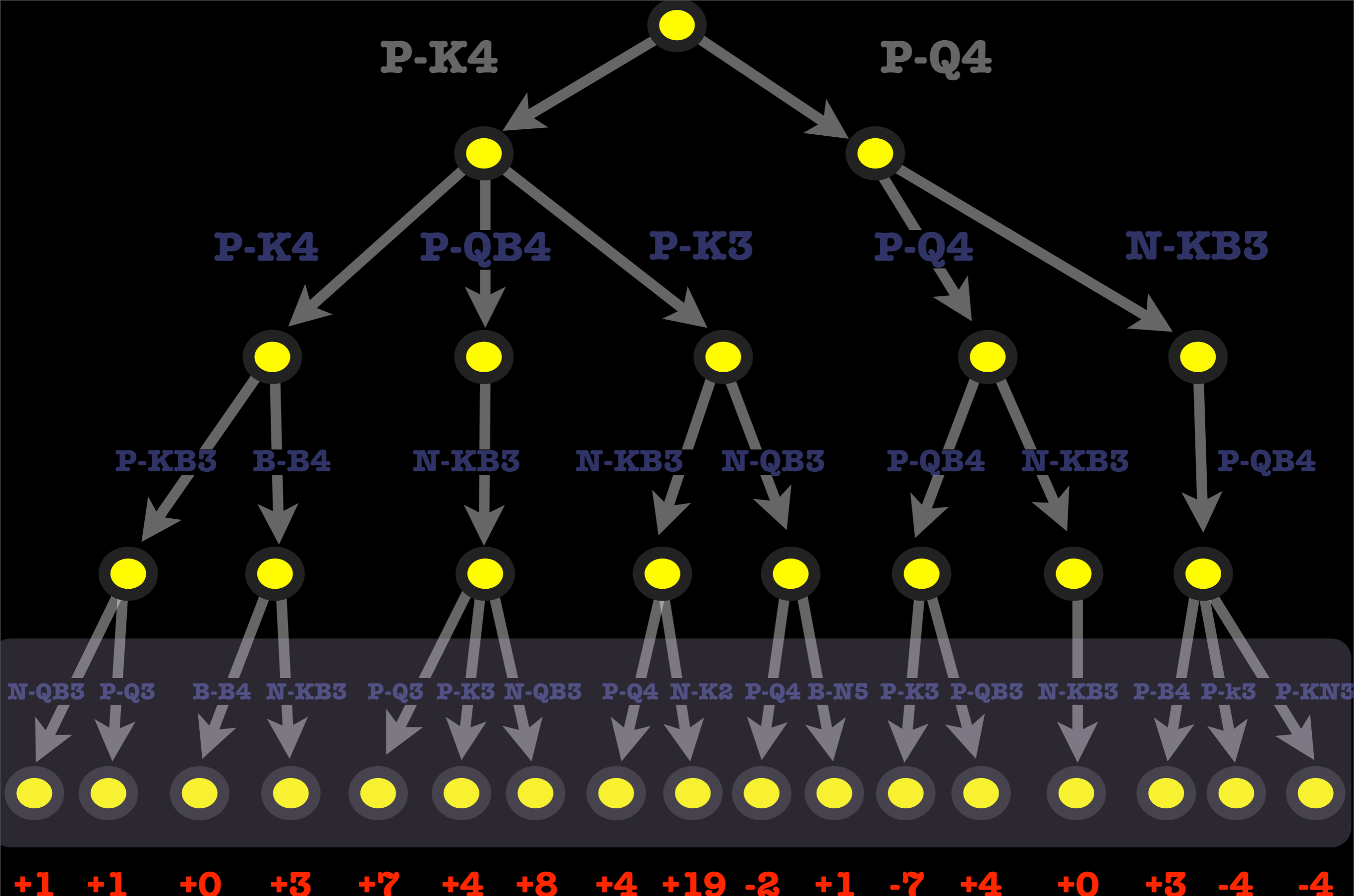
apply the evaluation function



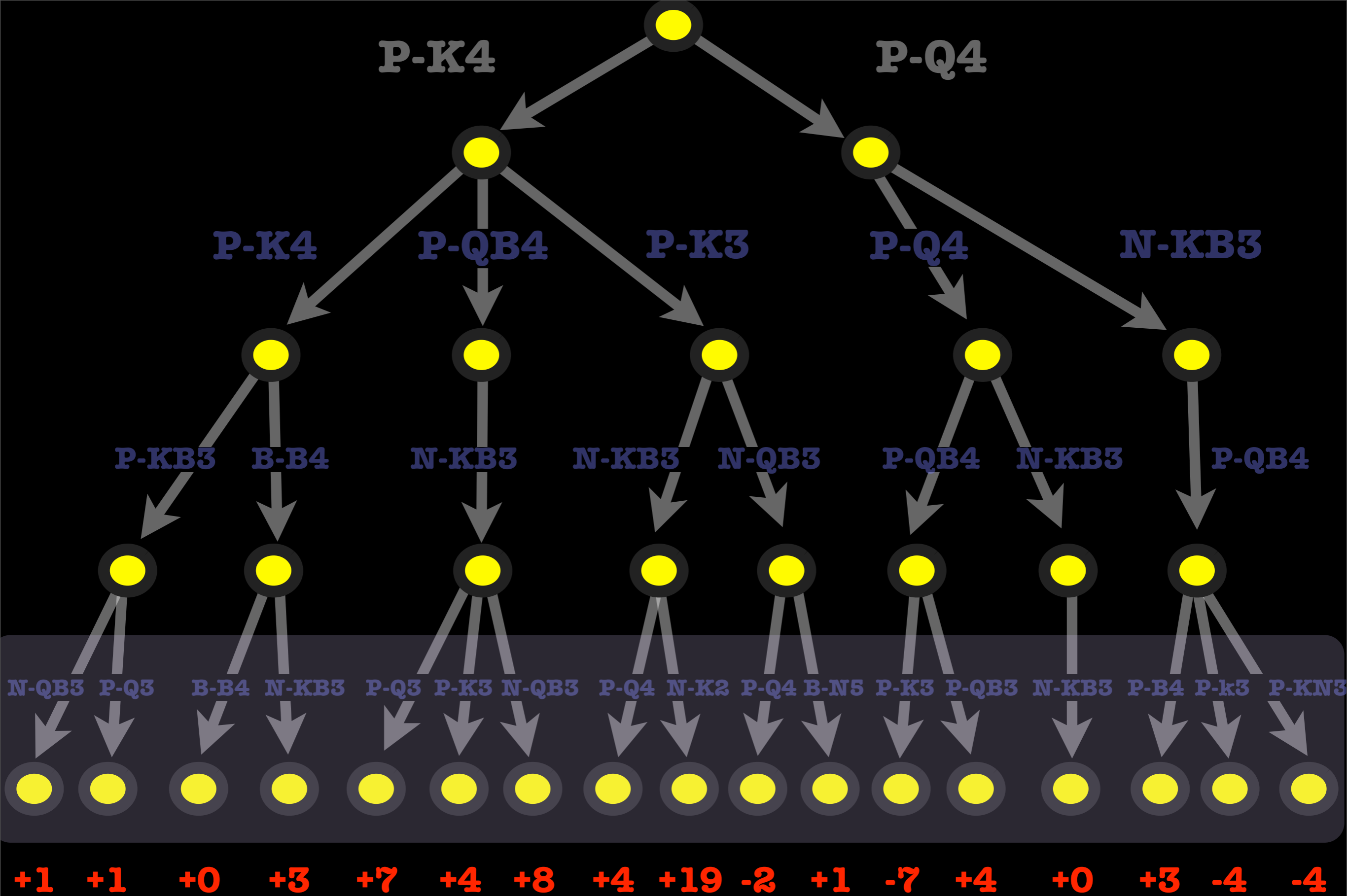
apply the evaluation function



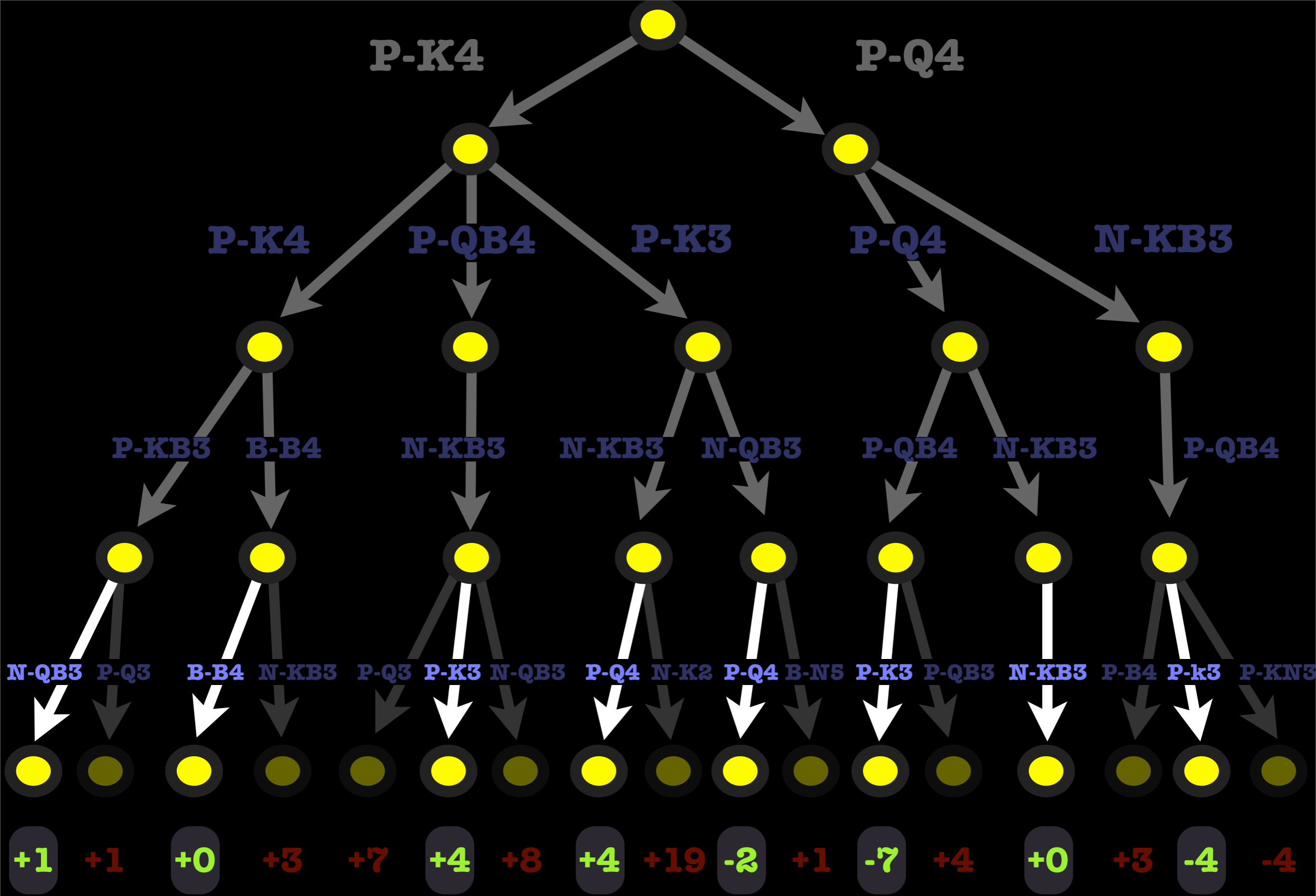
solve the minimax



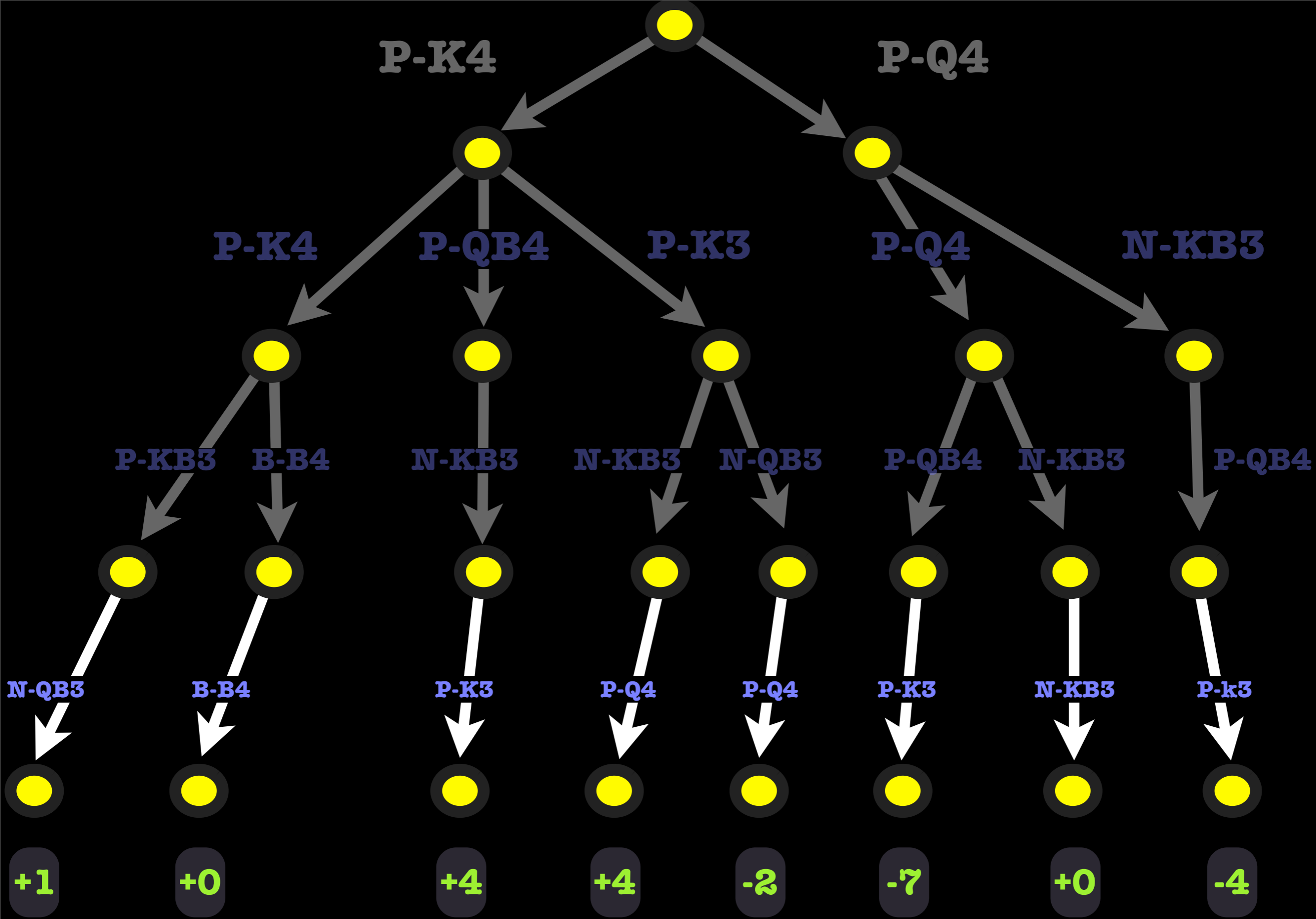
ply 4: black to move



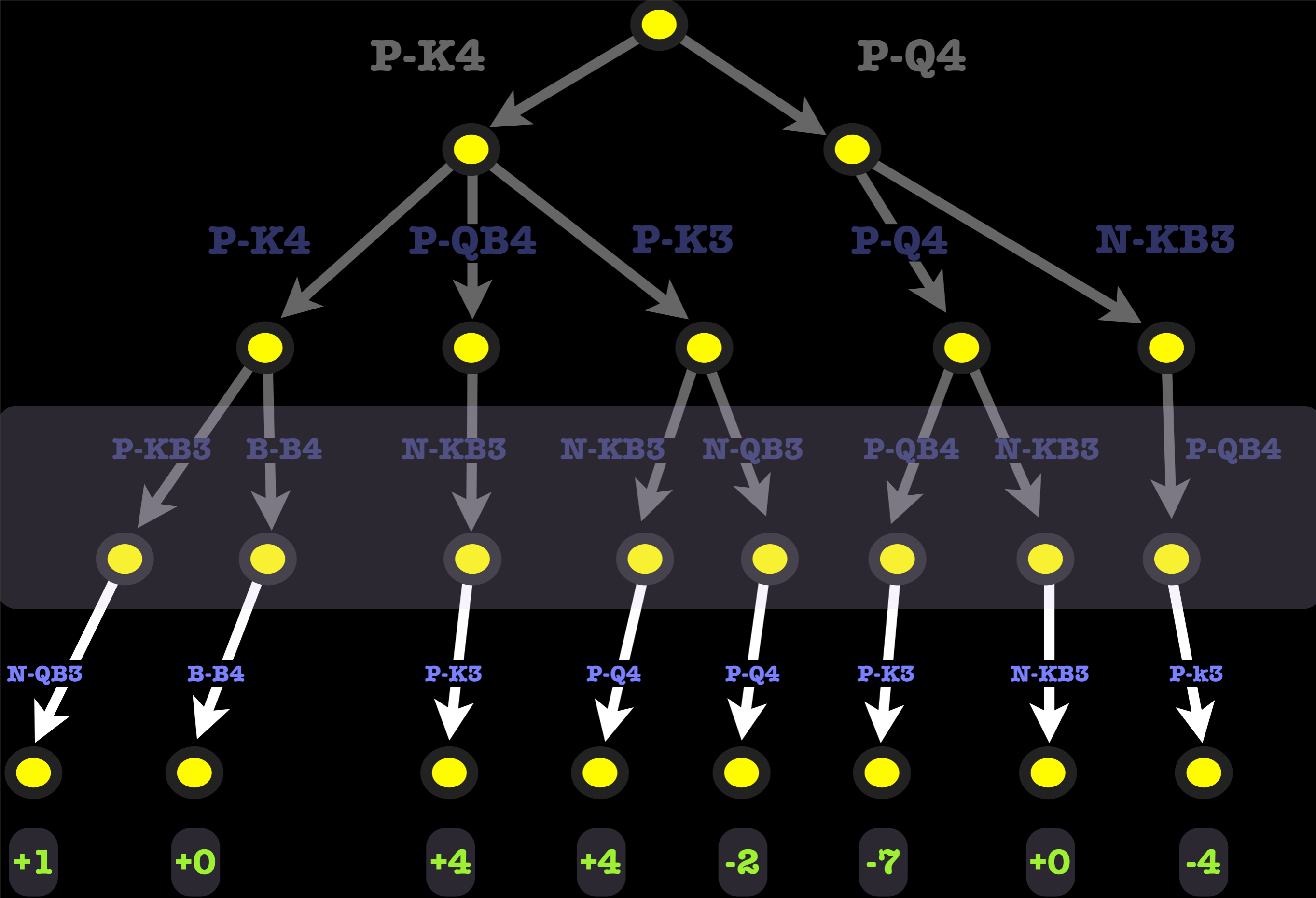
ply 4: black to minimize



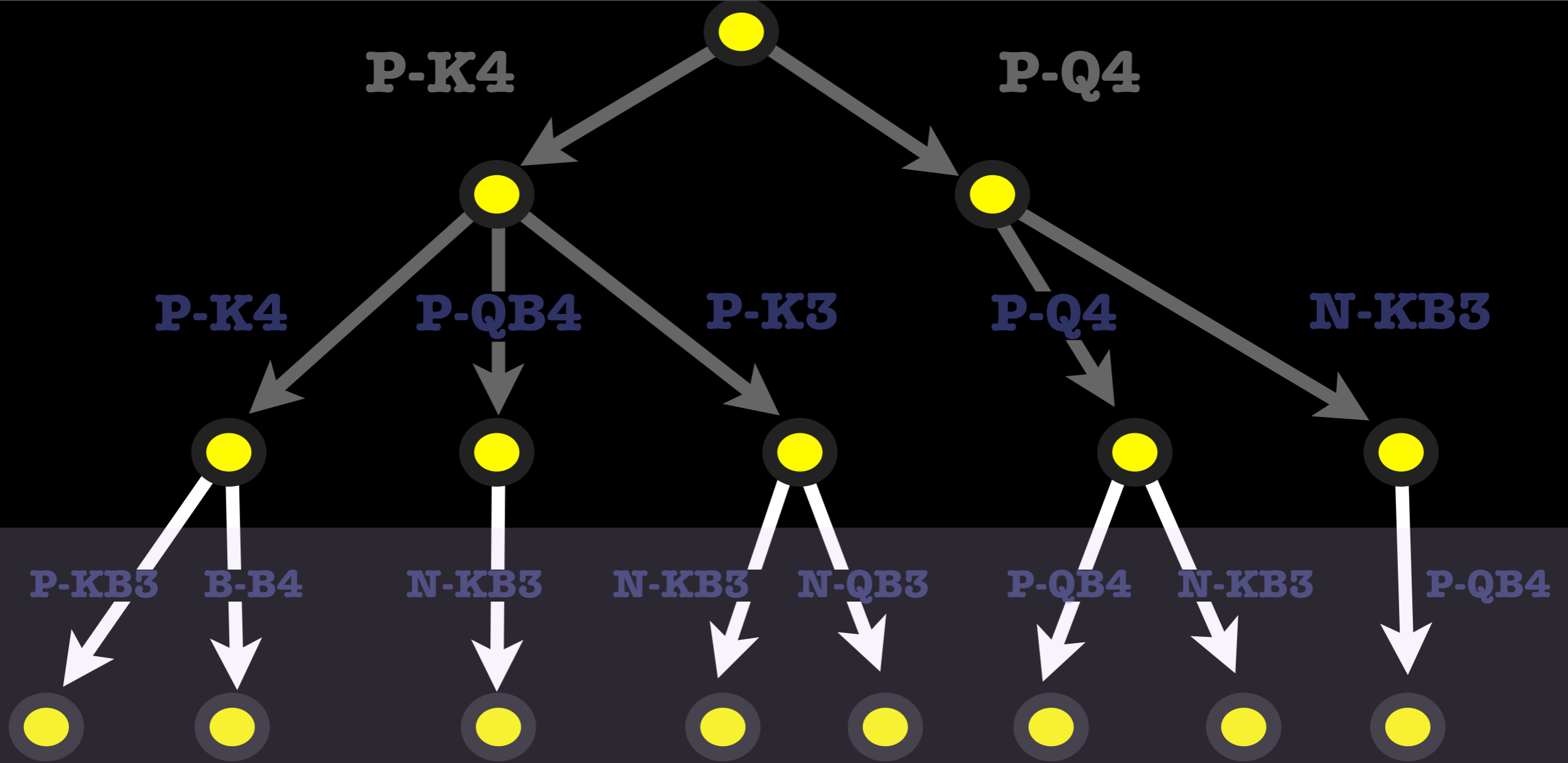
ply 4: black to minimize



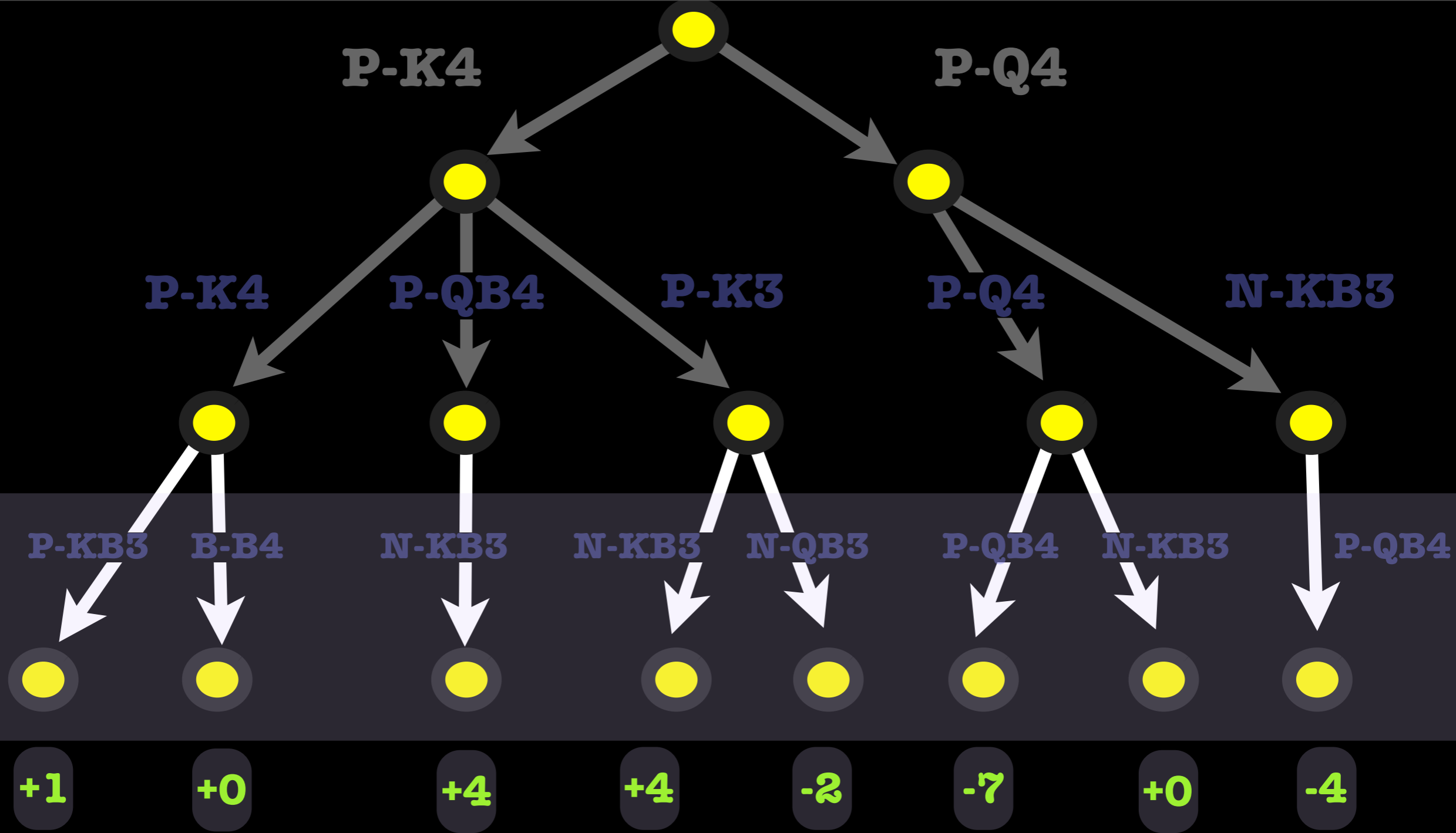
ply 4: black to minimize



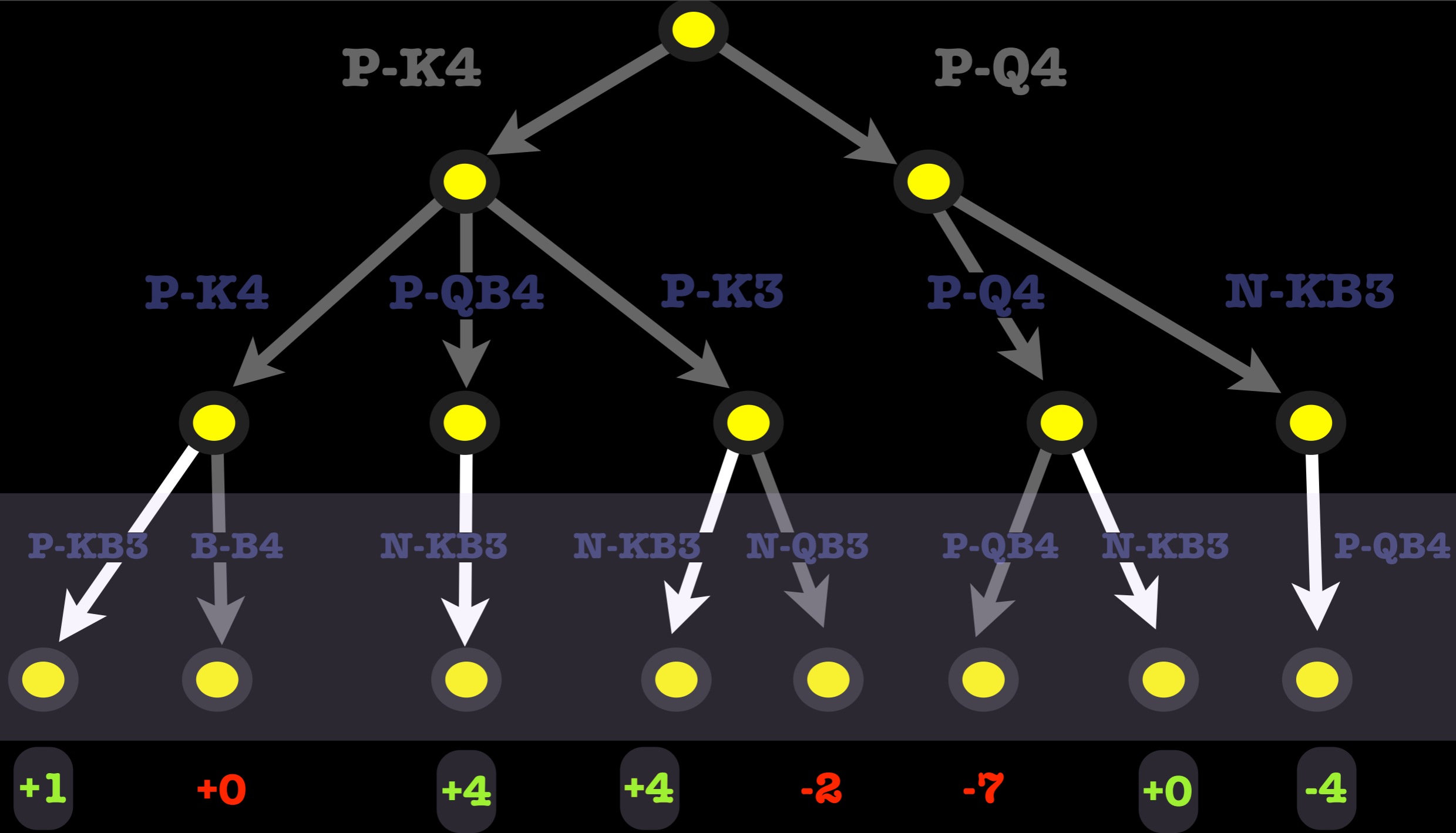
ply 4: black to minimize



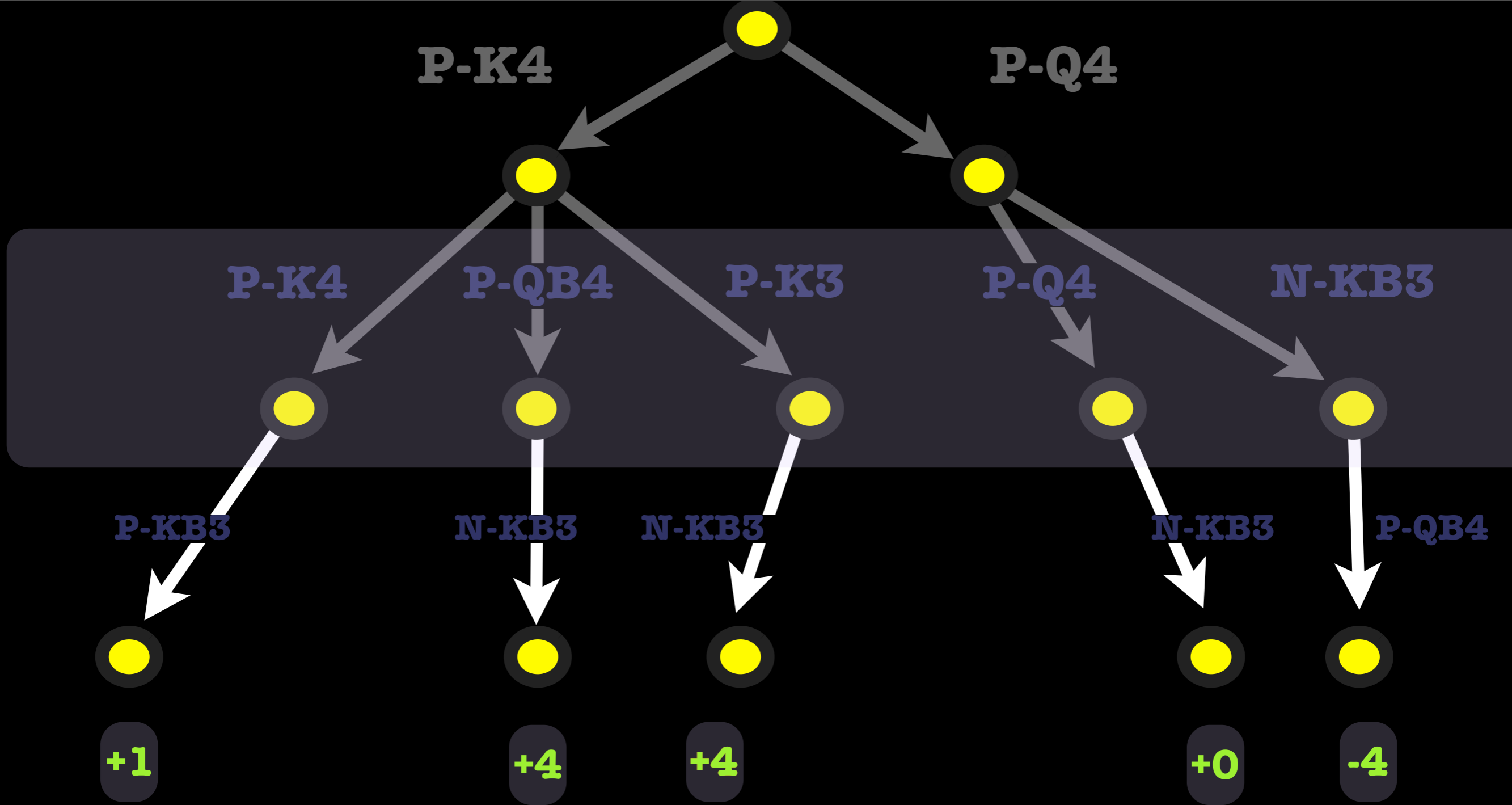
+1
+0
+4
+4
-2
-7
+0
-4



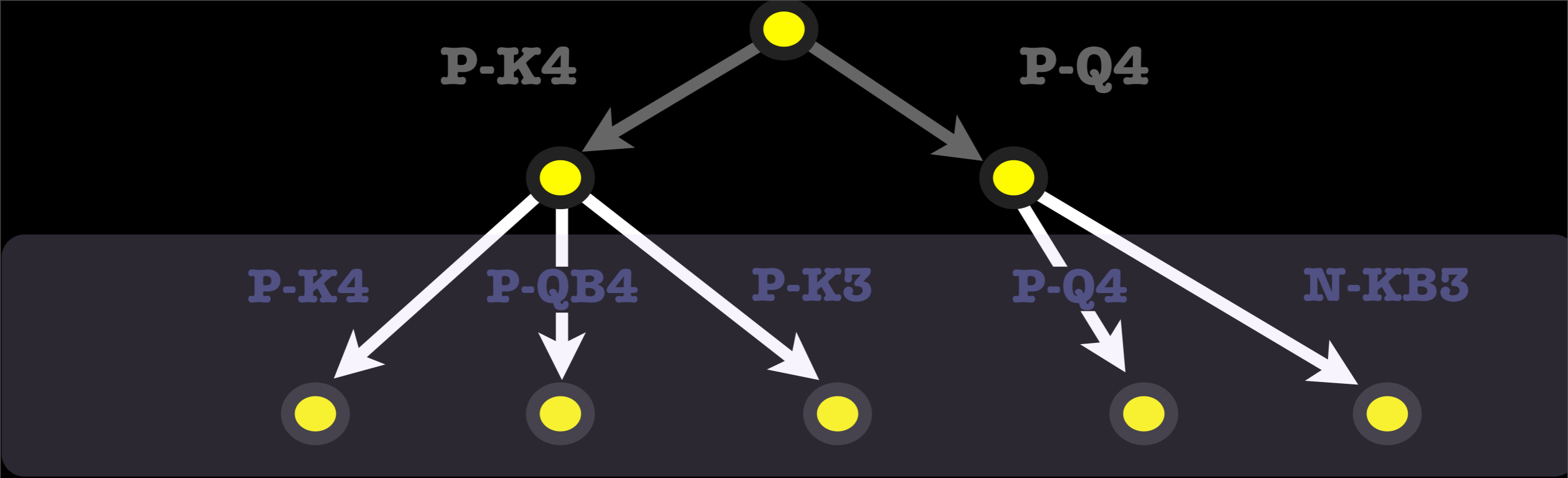
ply 3: white to move



ply 3: white to maximize



ply 3: white to maximize



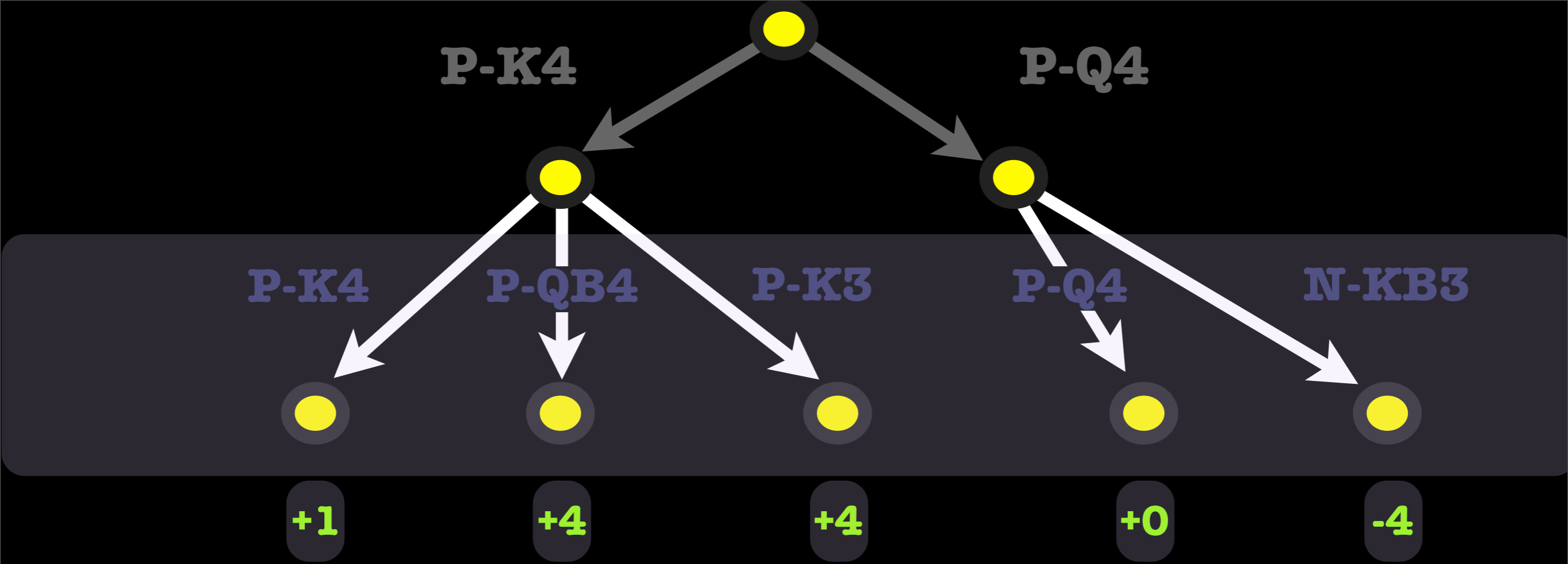
+1

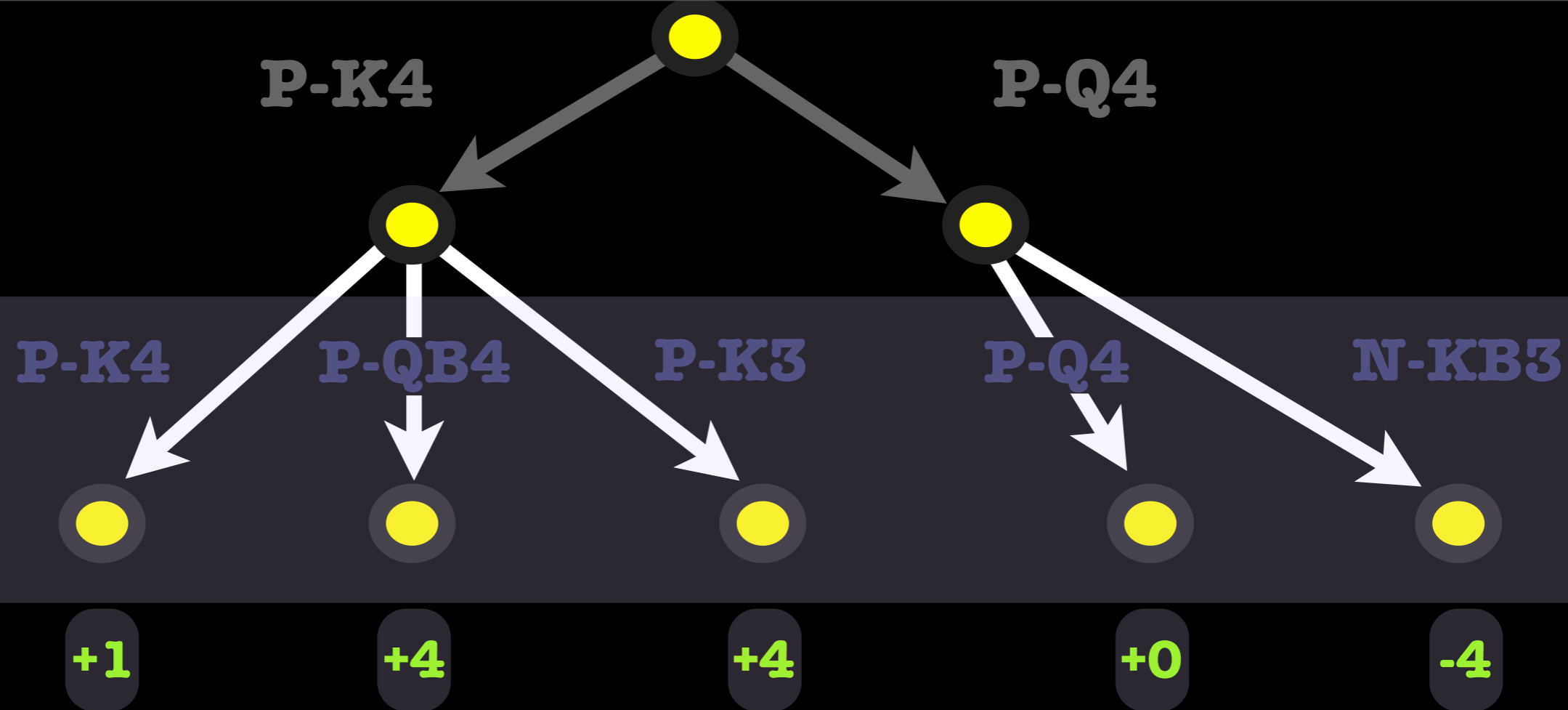
+4

+4

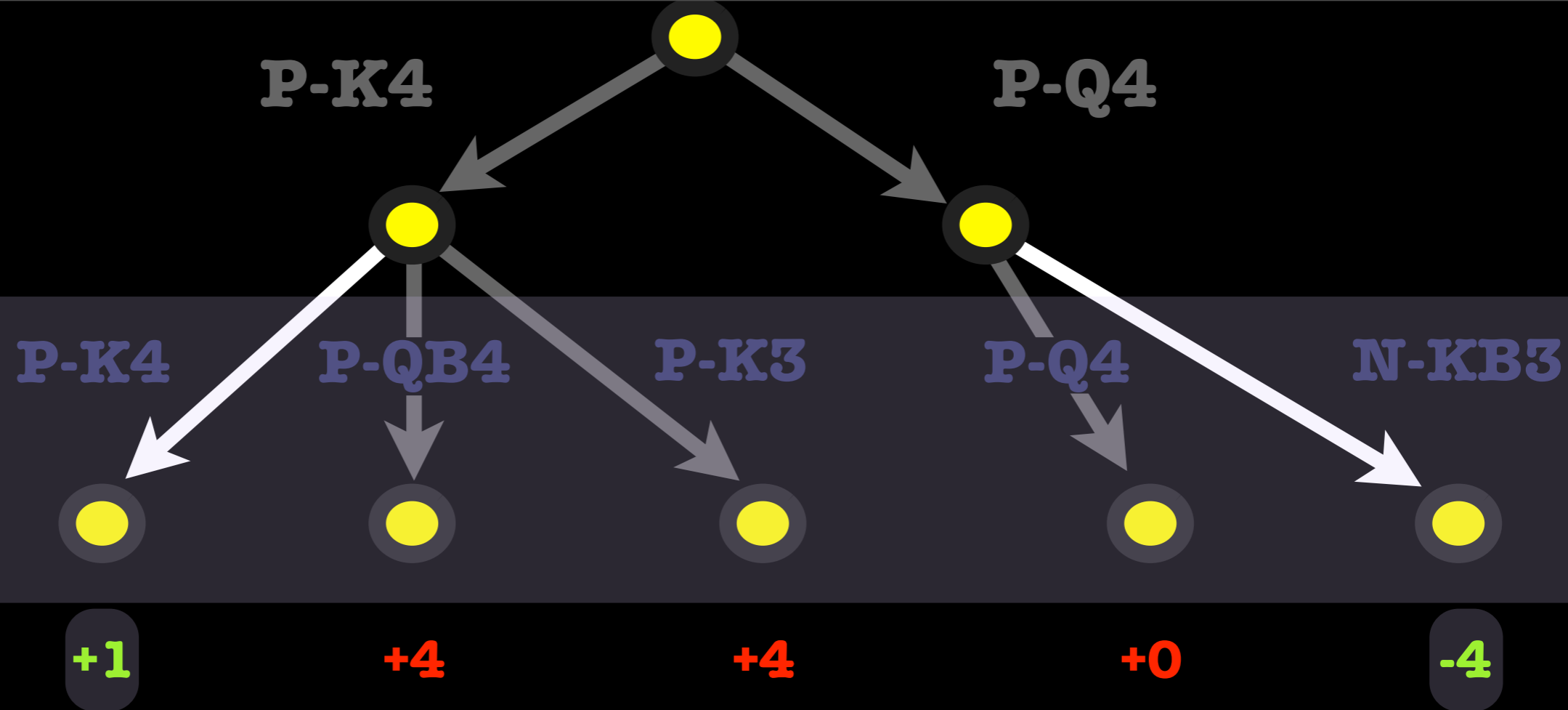
+0

-4

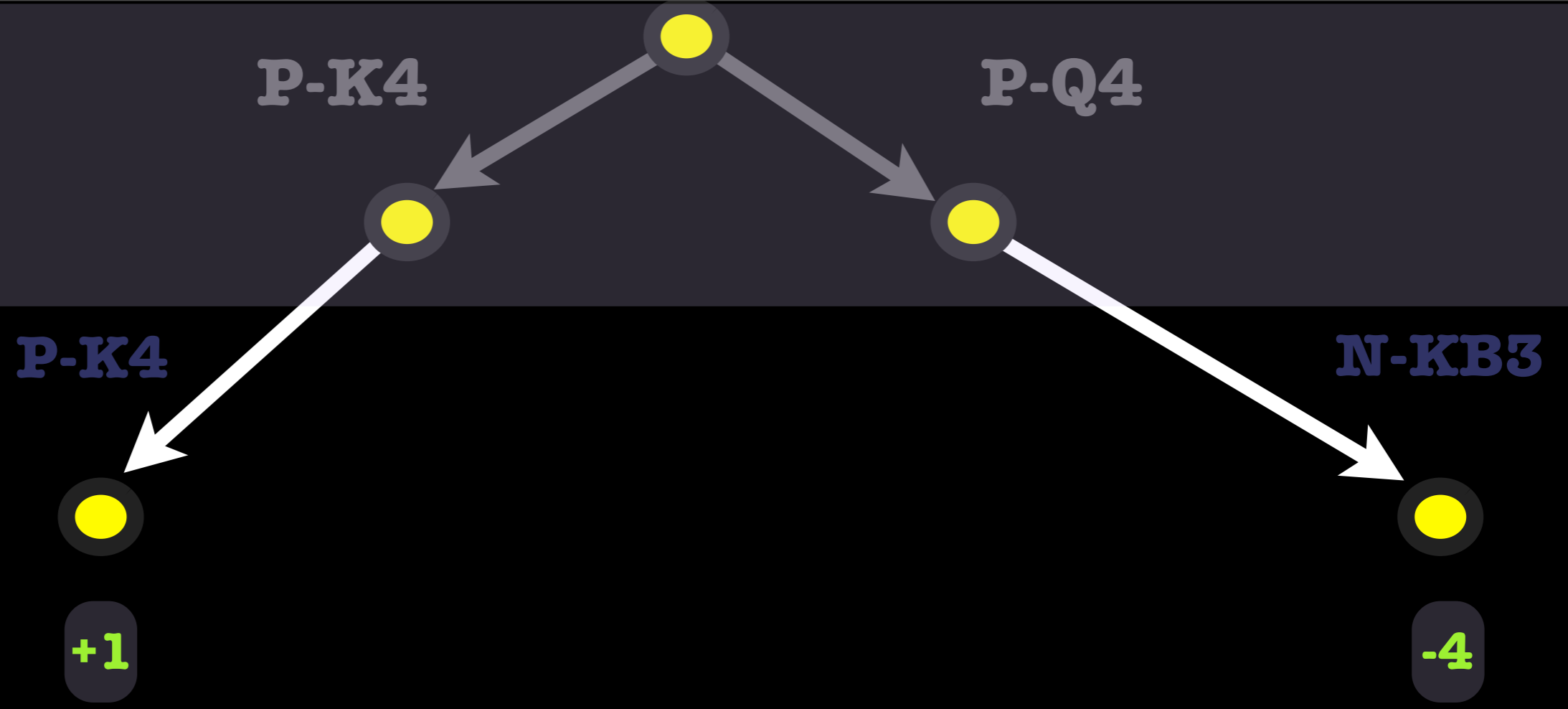




ply 2: black to move



ply 2: black to minimize



P-K4

P-Q4



+1

-4

P-K4

P-Q4



+1

-4

ply 1: white to move

P-K4

P-Q4



+1

-4

ply 1: white to maximize

P-K4

P-Q4

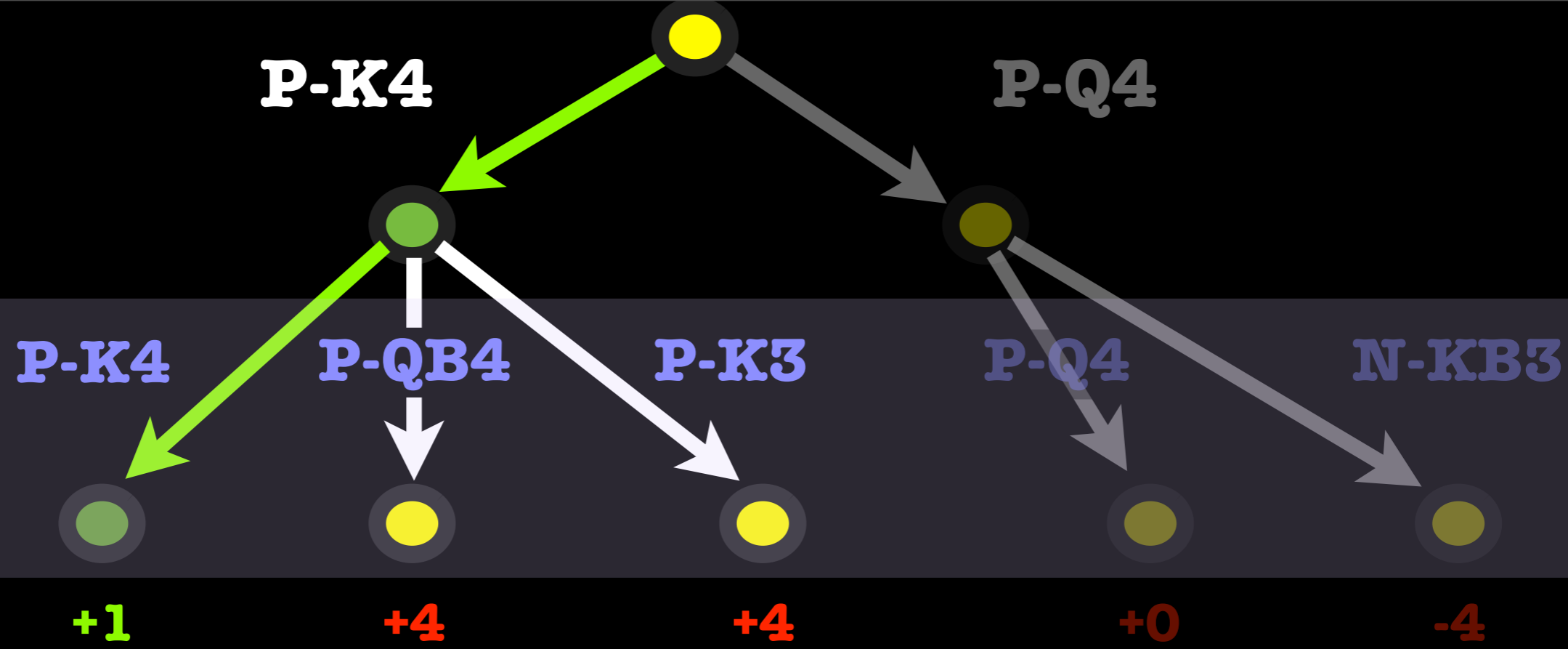


+1

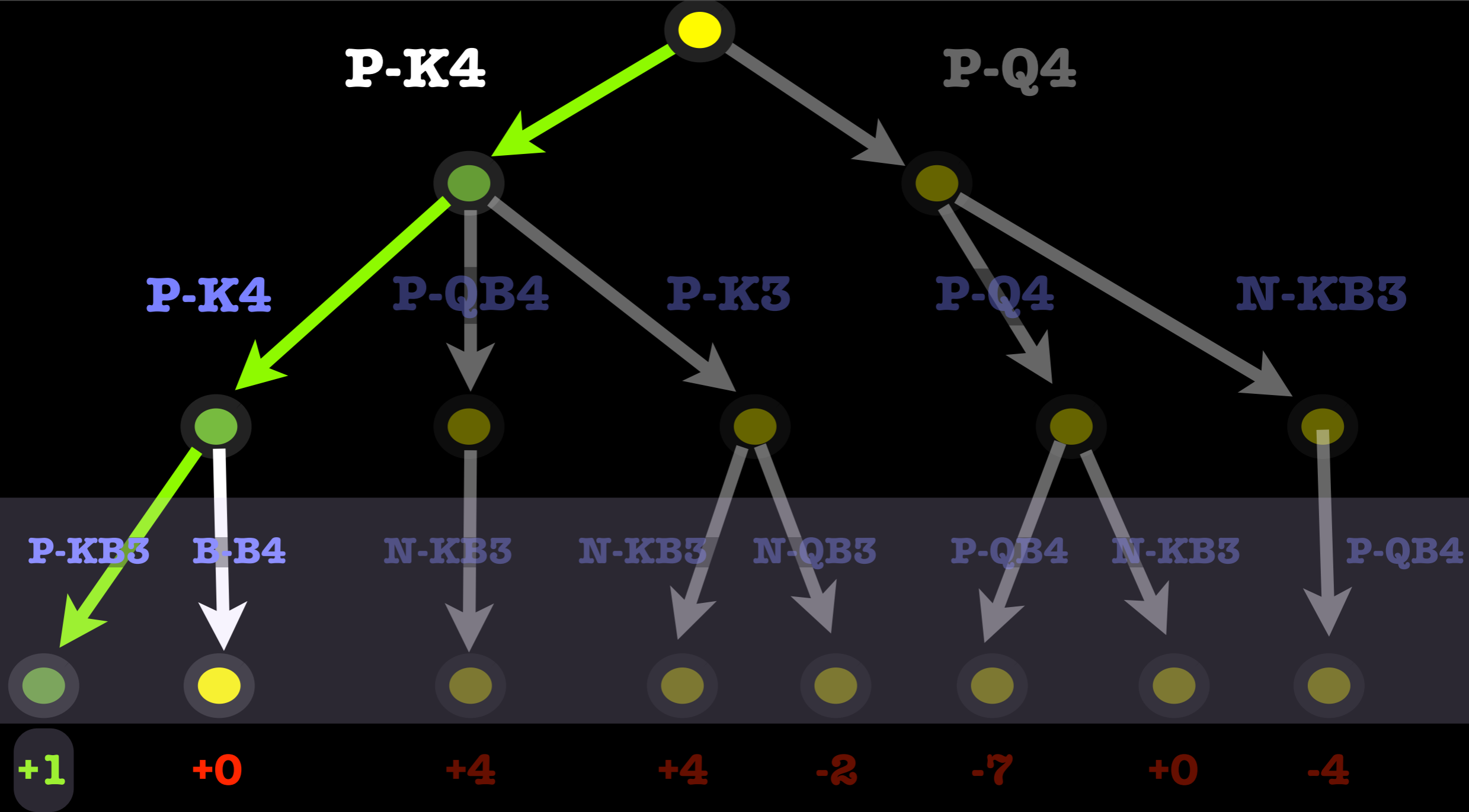


-4

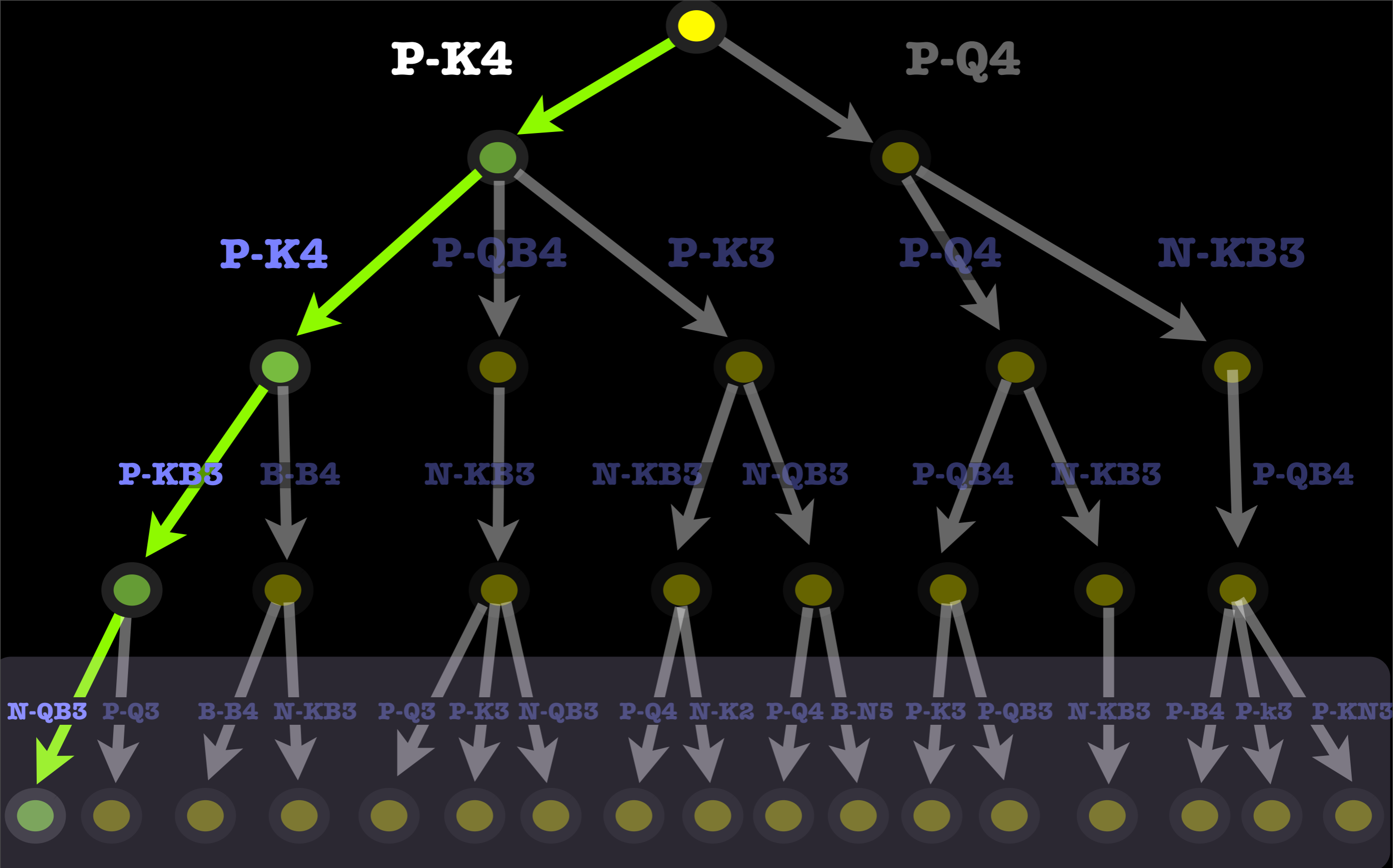
ply 1: white to maximize



ply 2: black to minimize

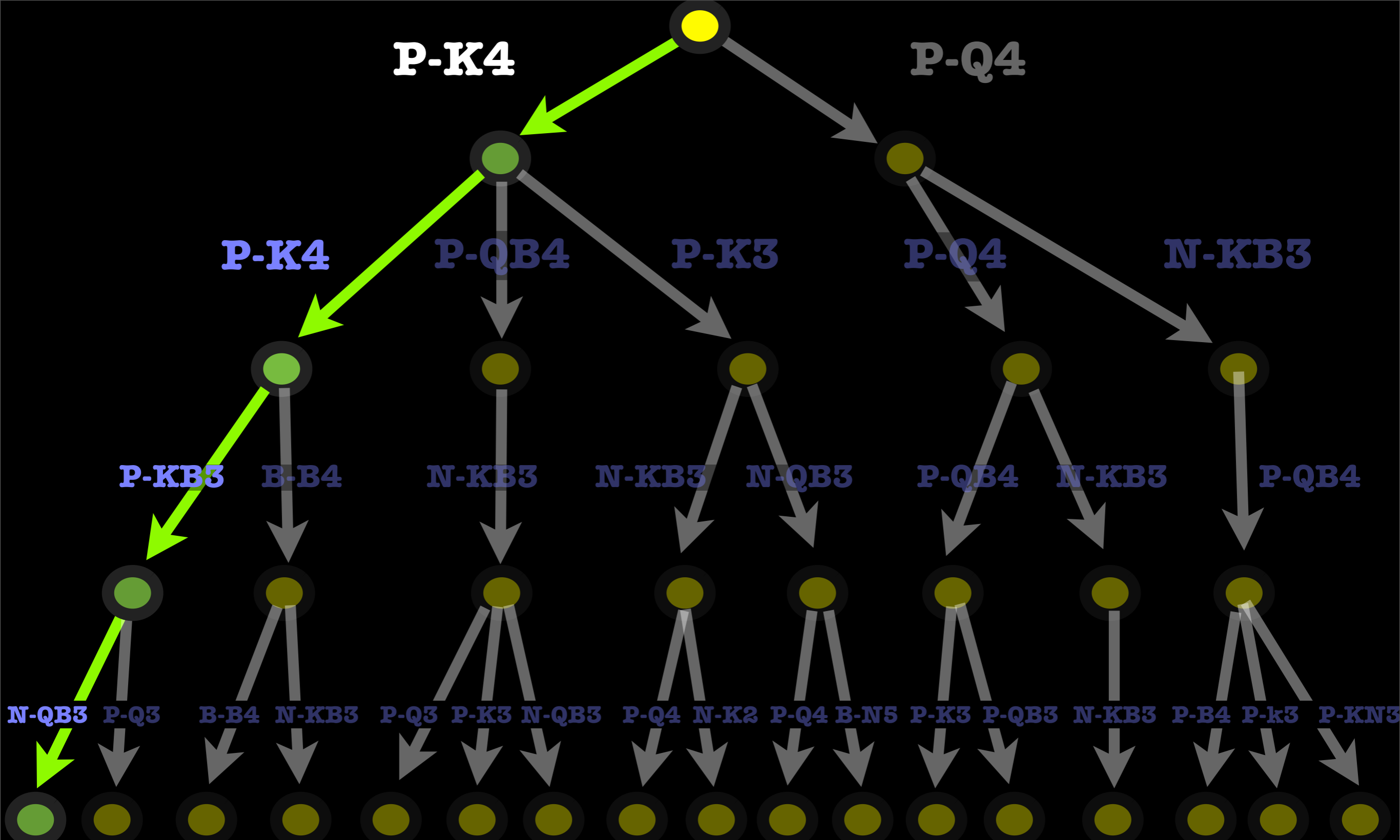


ply 3: white to maximize



+1 +1 +0 +3 +7 +4 +8 +4 +19 -2 +1 -7 +4 +0 +3 -4 -4

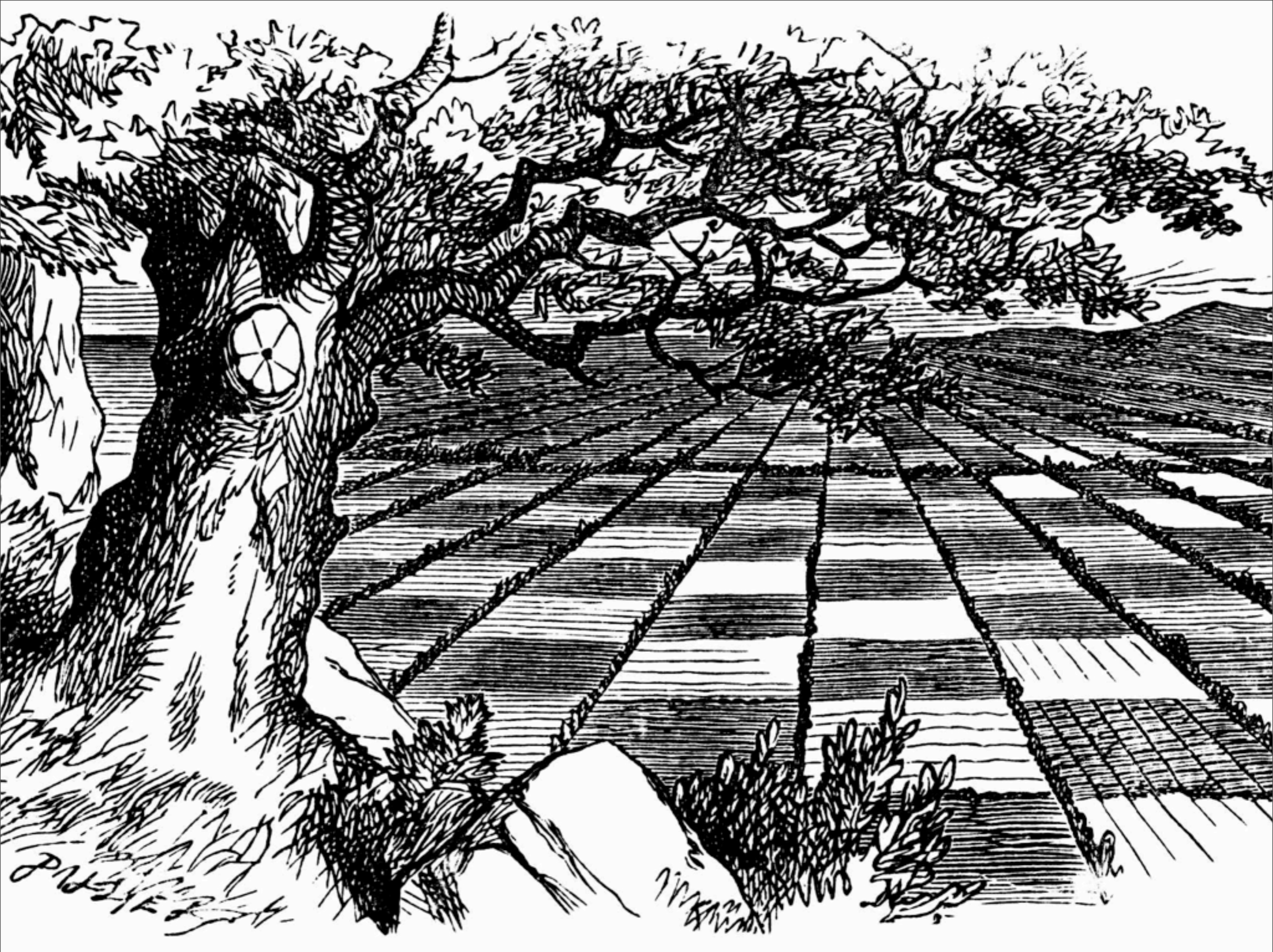
ply 4: black to minimize

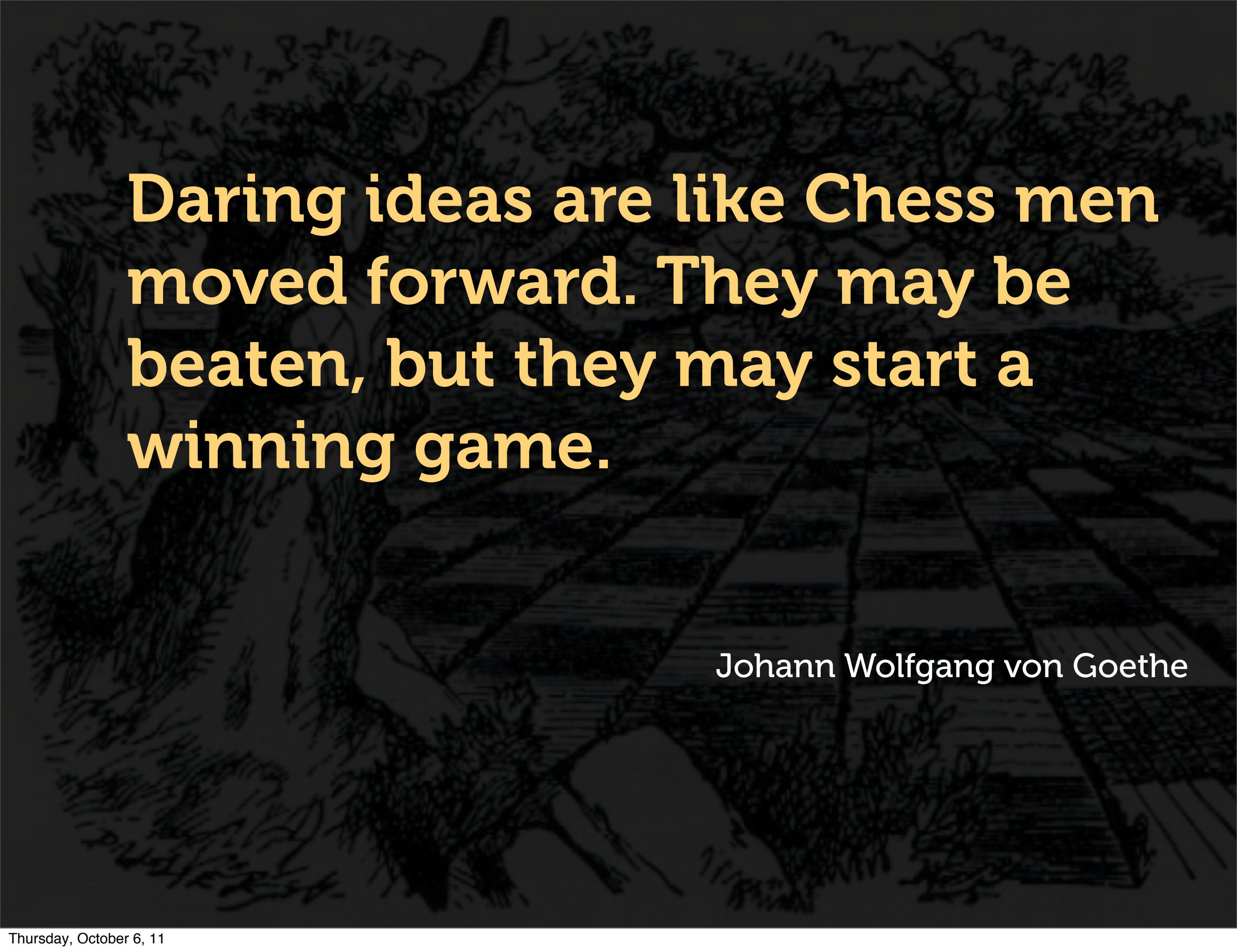


minimax optimal branch

**is the
minimax algorithm
the drosophila of AI?**

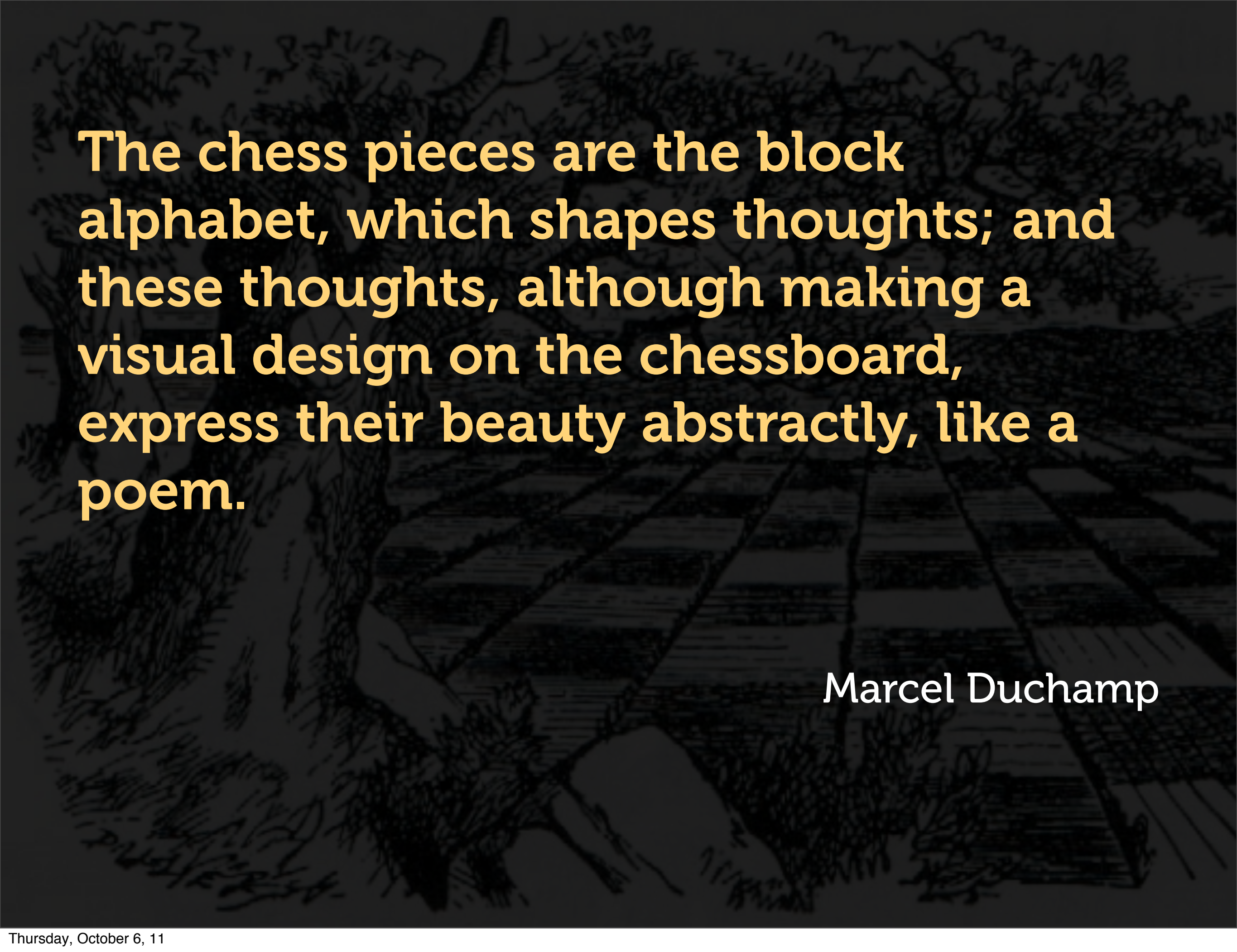
why chess?





**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

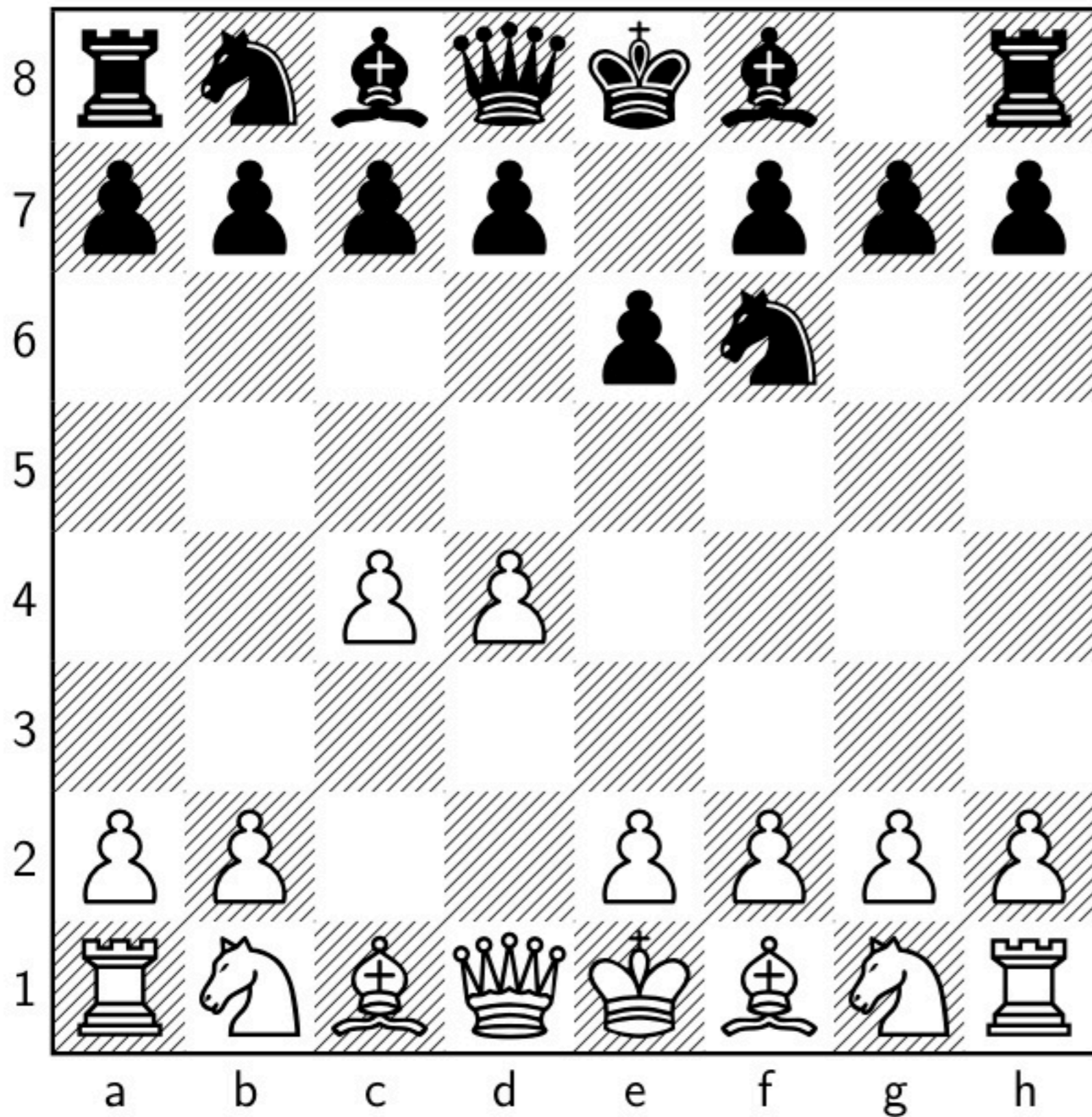


Chess is like war on a board.

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 gxh5 13. Nc4 Ne5 14. Ne3 Qh4 15.
Bd2 Ng4 16. Nxc4 hxg4 17. Bf4 Qf6 18. g3 Bd7
19. a4 b6 20. Rfe1 a6 21. Re2 b5 22. Rae1 Qg6
23. b3 Re7 24. Qd3 Rb8 25. axb5 axb5 26. b4 c4
27. Qd2 Rbe8 28. Re3 h5 29. R3e2 Kh7 30. Re3
Kg8 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
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
	A	B	C	D	E	F	G	H	

Partie	Nr.	Ihr Zug	Nr.	Mein Zug
Partie	No.	Votre coup	No.	Mon coup
Game	No.	Your move	No.	My move
Partida	No.	Su jugada	No.	Mi jugada
Партия	No.	Ваш ход	No.	Мой ход

Turnier	Nr.
Tournoi	No.
Tournament	No.
Torneo	No.
Турнир	No.
Ihr Zug ist unklar	
Votre coup n'est pas clair	
Your move is not clear	
Jugada maldefinida	
Нечеткий ход	
Ihr Zug ist unmöglich	
Votre coup est impossible	
Your move is impossible	
Jugada imposible	
Невозможный ход	

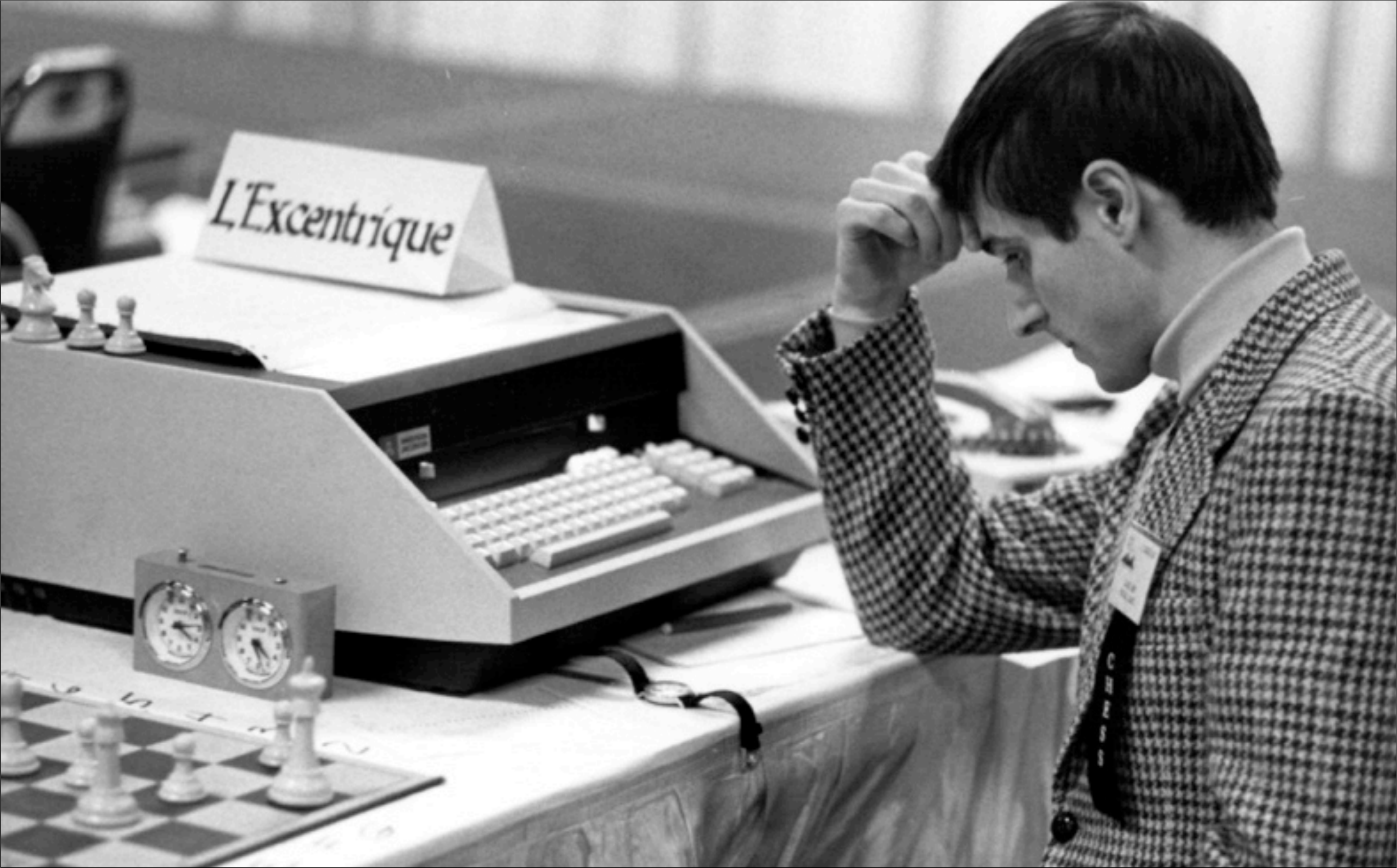
Ihr Poststempeldatum	Ihre Bedenkzeit	Tage	Ihre Zeit insgesamt	Tage
Votre date de la poste	Votre temps	Jours	Votre temps total	Jours
Your postmark date	Your time taken	Days	Your total time	Days
Su fecha postal	Tiempo consumido por Ud	Dias	Su tiempo total	Dias
Дата вашего почтового штампа	Ваше время	Дня	Ваше общее время	Дня
Empfangen am	Meine Bedenkzeit	Tage	Meine Zeit insgesamt	Tage
Reçu le	Mon temps	Jours	Mon temps total	Jours
Received on	My time taken	Days	My total time	Days
Recibido el día	Tiempo consumido por mí	Dias	Mi tiempo total	Dias
Получено	Мое время	Дня	Мое общее время	Дня
Beantwortet am	Partie	Ich biete Remis	- Ich nehme an	- Ich lehne ab
Répondu le	Partie	Je propose partie nulle	- J'accepte	- Je refuse
Replied on	Game	I offer Draw	- I accept	- I refuse
Contestado el día	Partida	Ofresco tablas	- acepto tablas	- rechazo
Отвечено	Партия	Предлагаю ничью	- соглашаюсь на ничью	- Отказываюсь от ничьей
Urlaub	Herzliche Grüße			
Vacances	Salutations			
Holidays	Yours sincerely			
Vacaciones	Saludos			
Отпуск	С приветом			
von	du			
from	del			
del	ot			
bis	au			
to	hasta			
до				

preprinted correspondence chess postcard





IBM 360/195, Rutherford Labs (1974)



Detroit World Computer Chess Championship (1979)



SCOREBOARD

ACM's North American Computer Chess Championship

Program	SEEDINGS
1. Awit	(9)
2. Belle	(1)
3. Blitz 6.9	(5)
4. BS '66 '76	(11)
5. Chaos	(4)
6. Chess 4.9	(2)
7. Duchess	(3)
8. L'Excentrique	(7)
9. Mychess	(12)
10. Ostrich 80	(8)
11. Rufus	(10)
12. Sargon 2.5	(6)

Round 1	Round 2	Round 3	Round 4
W3 0	B4 0	W11 1	B10
B8 1	W5 1/2	B12 2 1/2	W6
B4 1	W6 1	B5 1	W12
W3 0	B10 0	W9 0	B11
W11 1	B2 1 1/2	W3 2 1/2	B7
W10 1	B3 2	W7 3	B2
B2 1	W12 2	B6 2	W5
W2 0	B11 1	W10 2	B9
B12 0	W1 1	B4 2	W8
B6 0	W4 1	B3 1	W1
B5 0	W8 0	B1 0	W4
W9 1	B8 1	W2 1	B3

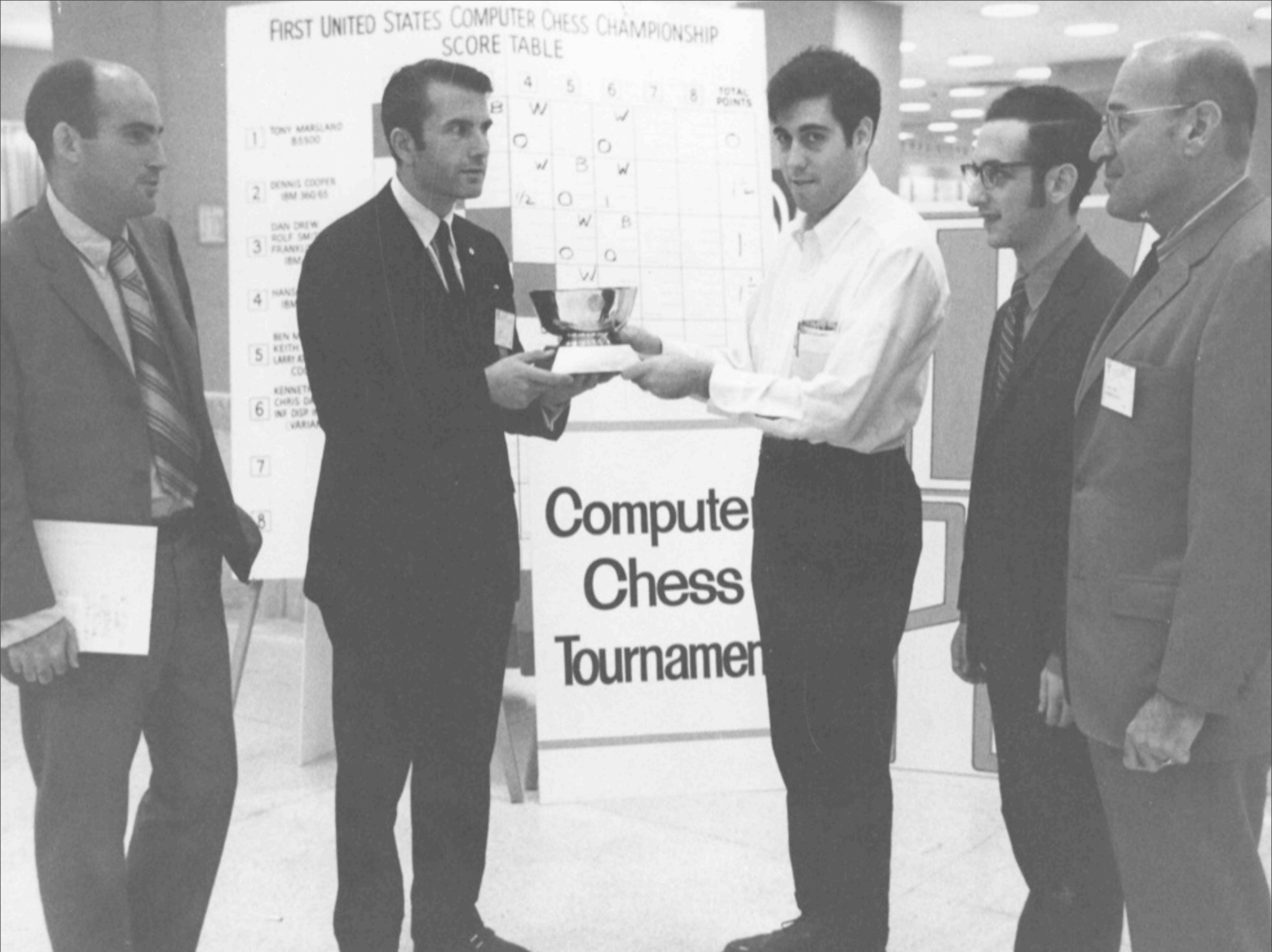
TOTAL POINTS	TIE BREAKER POINTS	FINAL RANK

Detroit World Computer Chess Championship (1979)

FIRST UNITED STATES COMPUTER CHESS CHAMPIONSHIP SCORE TABLE

	4	5	6	7	8	TOTAL POINTS
1 TONY MARLAND BSND	B	W		W		0
2 DENNIS COOPER IBM 360/65	O	W	B	W		1
3 DAN DREW BOLT SMITH FRANKLIN IBM	1/2	O	1	B		1
4 HANG IBM		W				1
5 BEN M KEITH LARRY A CD		O	O			1
6 KENNETH CHRIS D INF DSP (VARIAN)		W				1
7						
8						

Computer Chess Tournament



COMPLETE
N.Y. STOCKS

Los Angeles Times

FINAL

LARGEST CIRCULATION IN THE WEST, 1,026,499 DAILY, 1,210,556 SUNDAY.

VOL. XCI FIVE PARTS—PART ONE

★★★

FRIDAY, SEPTEMBER 1, 1972

98 PAGES

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Los Angeles Times

DAILY 10c

Mitchell Denies Any Link to Bugging

PART 1, PAGE 2

FISCHER IS KING

Stocks Jump

NEW YORK (AP)—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 (AP)—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



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.

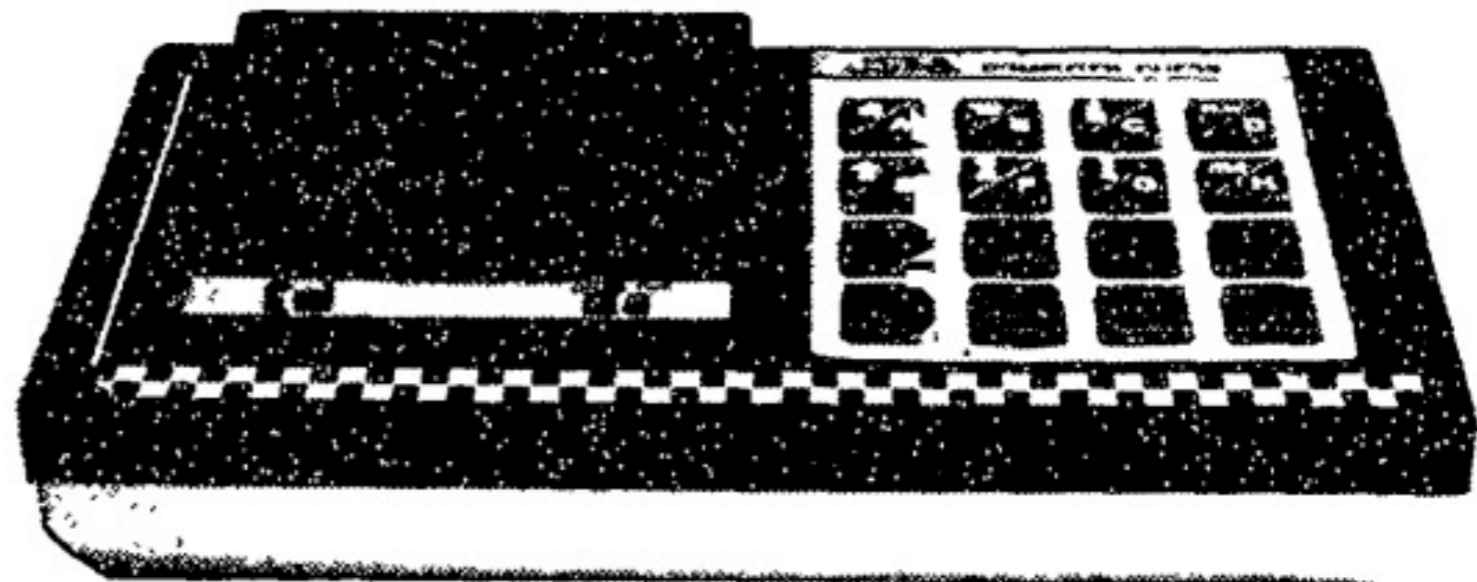
In typical fashion, the new champion was late for his own coronation.

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 analyzing 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.

Soviet Challenge



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 neuro-psychologist

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 sophisti-

space-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.

TEST LEVEL ON

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);

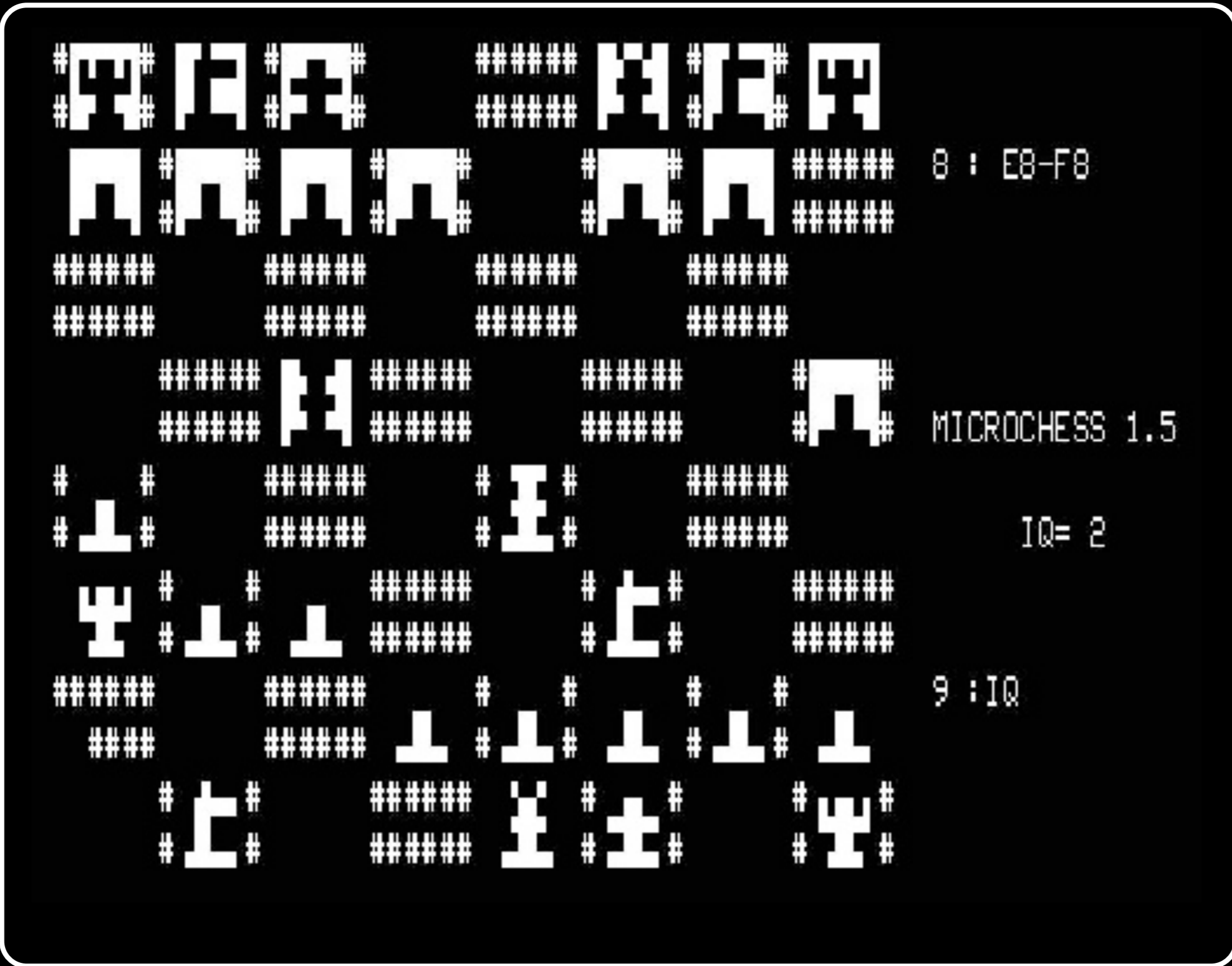
for(i=0; i<n; i++)
{
```

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	C9	0E	D0	07	20	B2	02	A9	EE
0030:	D0	07	C9	14	D0	0B	20	A2	03	85	FB	85	FA	85	F9	D0
0040:	BF	C9	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:	F0	FF	01	10	11	0F	EF	F1	DF	E1	EE	F2	12	0E	1F	21
00A0:	0B	0A	06	06	04	04	04	04	02	02	02	02	02	02	02	02
0100:	A6	B5	30	5C	A5	B0	F0	08	E0	08	D0	04	C5	E6	F0	2E
0110:	F6	E3	C9	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	94	E6	95
0130:	E4	18	08	75	E5	95	E5	28	E0	04	F0	03	30	31	60	A5
0140:	E8	85	DD	A9	00	85	B5	20	4B	03	20	B2	02	20	00	02
0150:	20	B2	02	A9	08	85	B5	20	09	02	20	31	03	4C	80	17
0160:	E0	F9	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	B9
0180:	A0	00	D5	E2	90	02	95	E2	C6	B5	A9	<u>FB</u>	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	09	10	0E	20	8E	02
0230:	D0	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	08	D0	F7	F0
0250:	BC	A2	10	86	B6	20	8E	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	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
02B0:	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	<u>E0</u>	10	30	33	A9	7F	69	01	70	01	B8	A5	B5	30
02F0:	24	C9	<u>08</u>	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	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	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
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	00	00	00	00	00
1780:	18	A9	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	E1	38	E5	E4	E5	E4	E5	E5
17C0:	E5	E5	E5	E0	A6	B1	E0	33	F0	16	E0	34	F0	12	E0	22
17D0:	F0	0E	E0	25	F0	0A	A6	B0	F0	09	B4	50	C0	10	10	03
17E0:	18	69	02	4C	77	03										

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MICROCHESS

Peter Jennings, Microchess (1976)



Microchess, Radio Shack TRS-80 (1979)

COMMODORE® 64/128™

CELEERY
SOFTWARE

GRAND MASTER

CHESS



The world's strongest chess
program for home computers!

BORIS
BORIS IS KING

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.

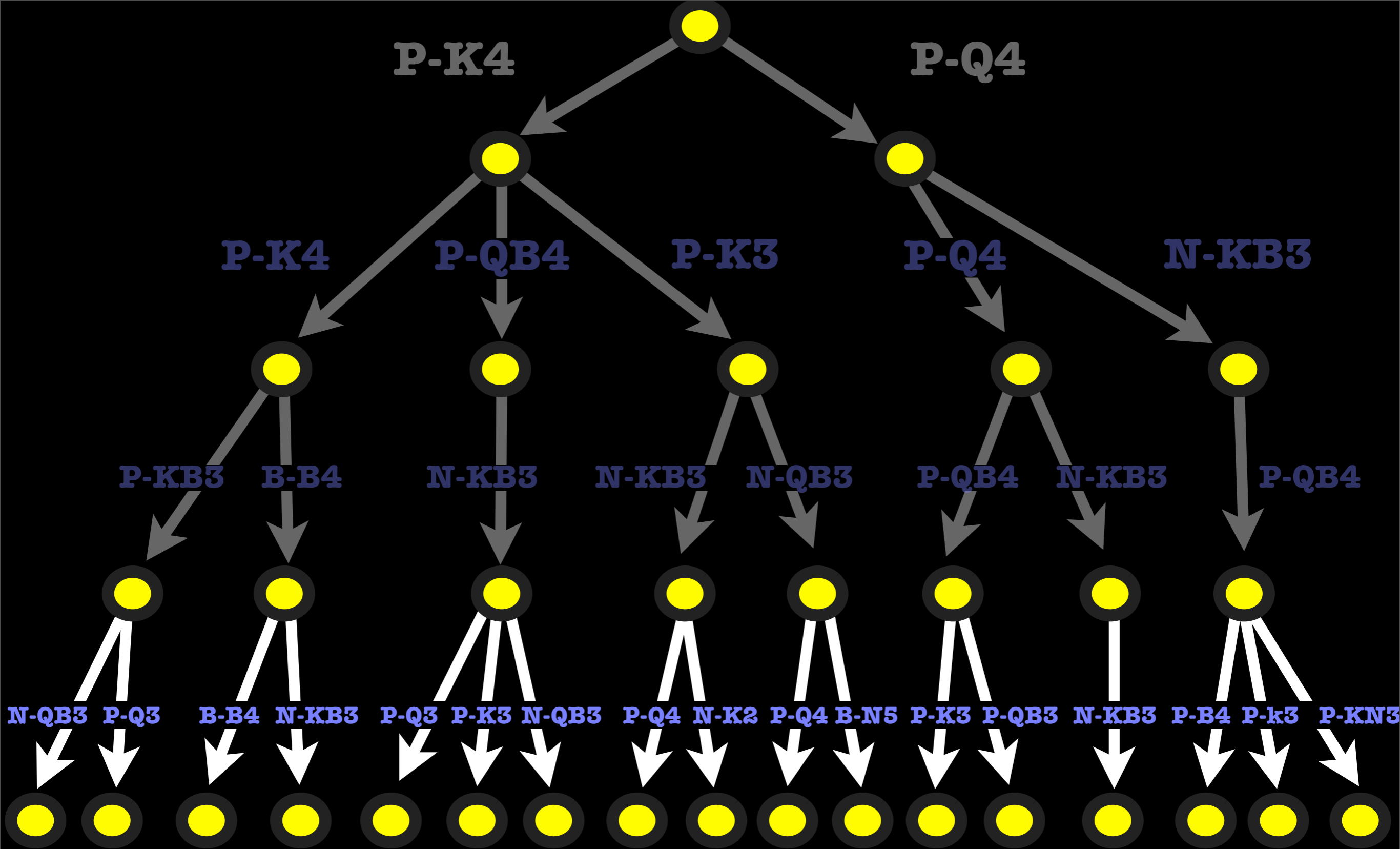
This revolutionary computer, BORIS, is the perfect chess teacher, companion and opponent. He'll also take your mind off the world around you. So if you're ready for the perfect relaxer, why not make the "Great Escape" with a great new friend, BORIS.

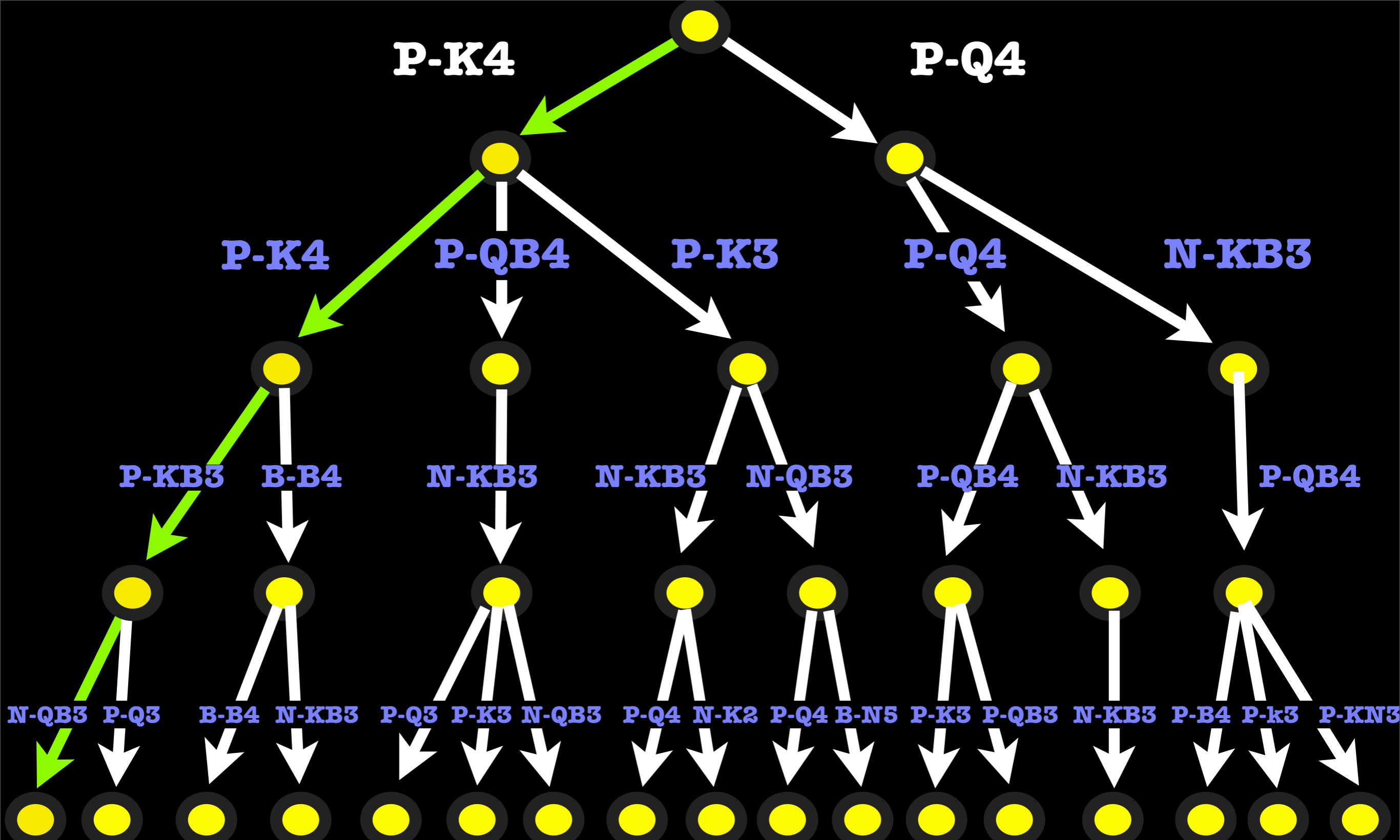


BORIS electronically displays all chess pieces on the board. (First rank displayed above.)

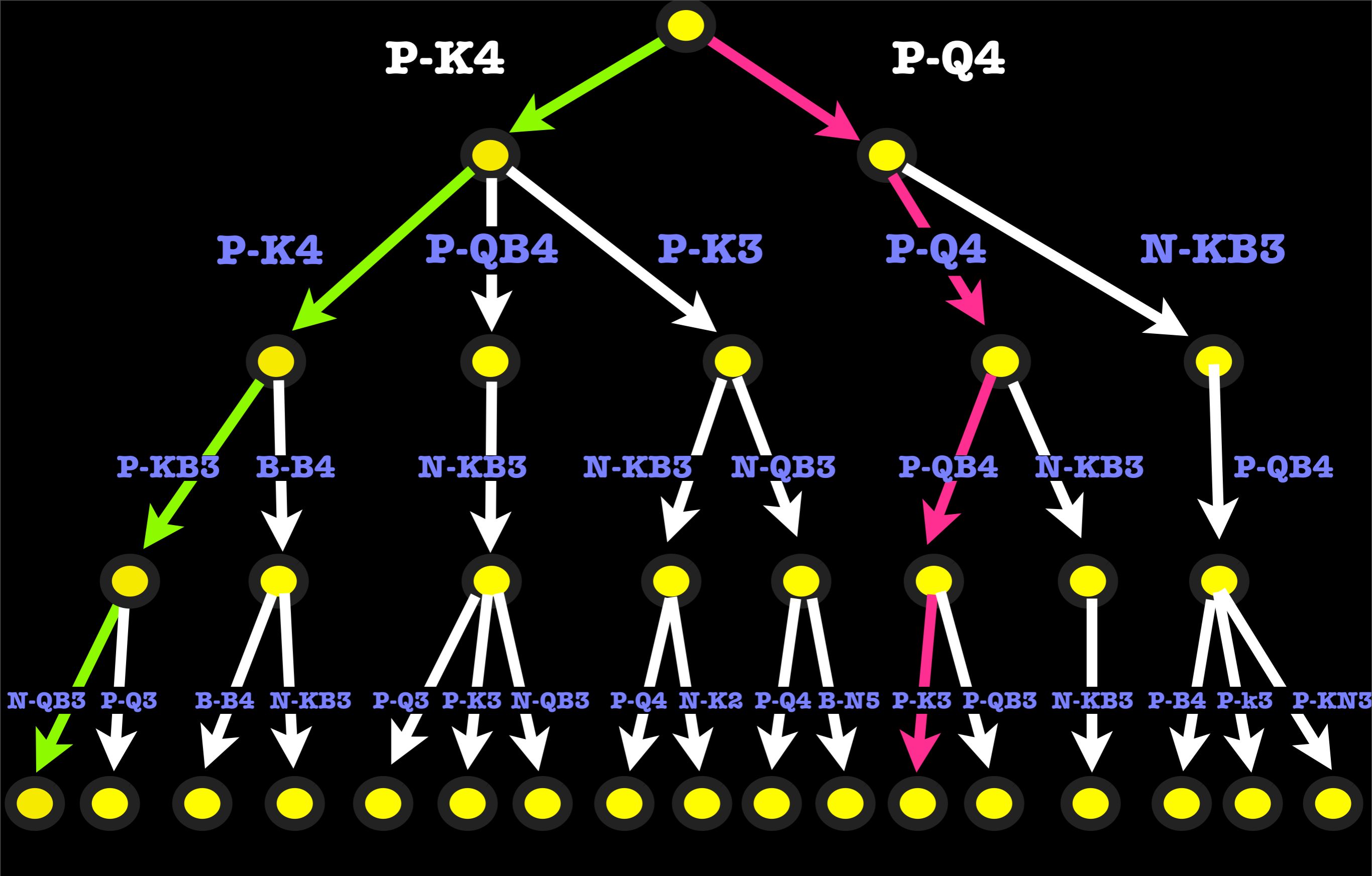
The Classic Game of Chess Will Never Be the Same.

$\alpha\beta$ -pruning





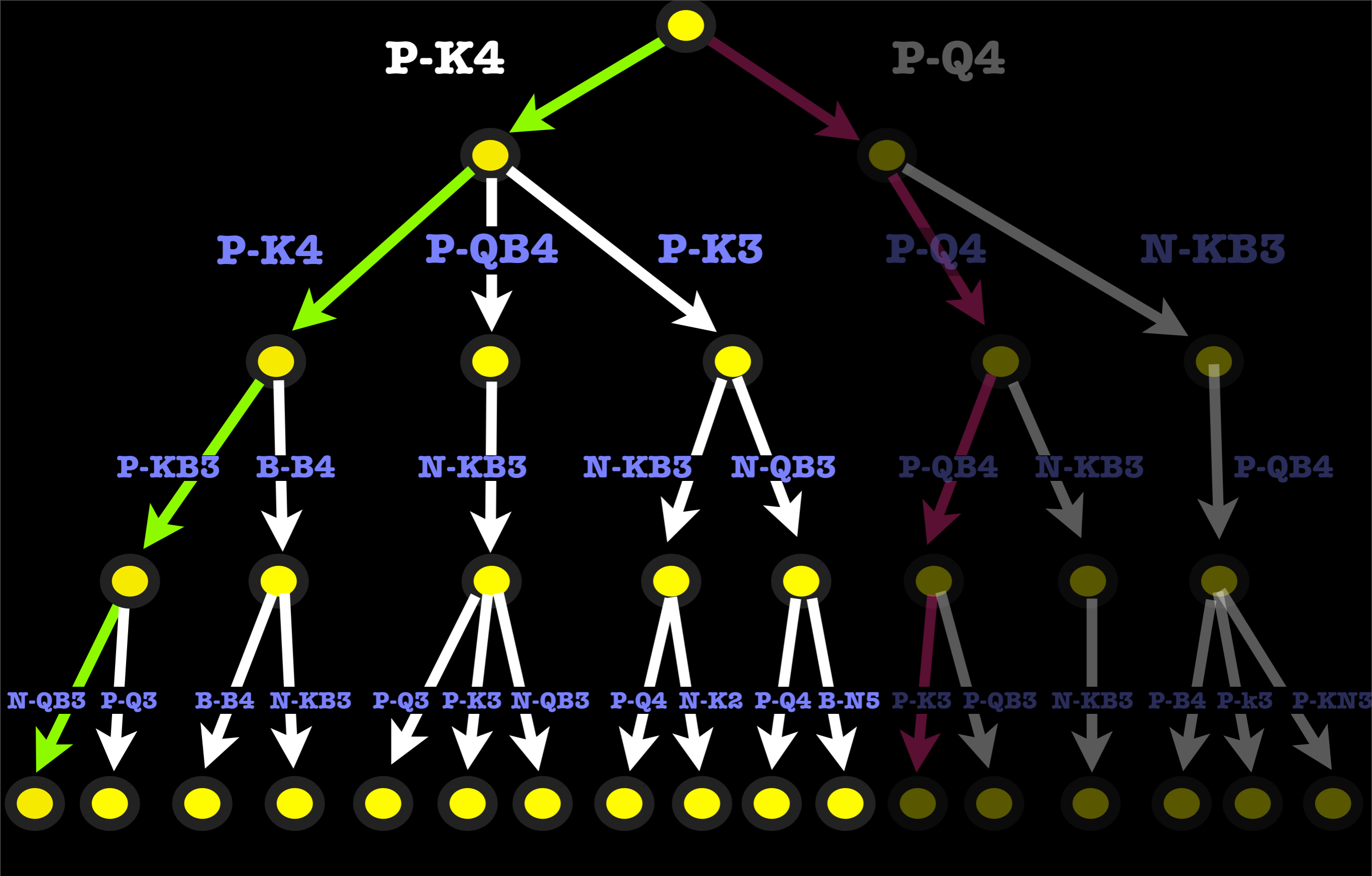
determining alpha



+1

-7

determining beta



+1

-7

alpha-beta pruning



Thursday, October 6, 11

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)

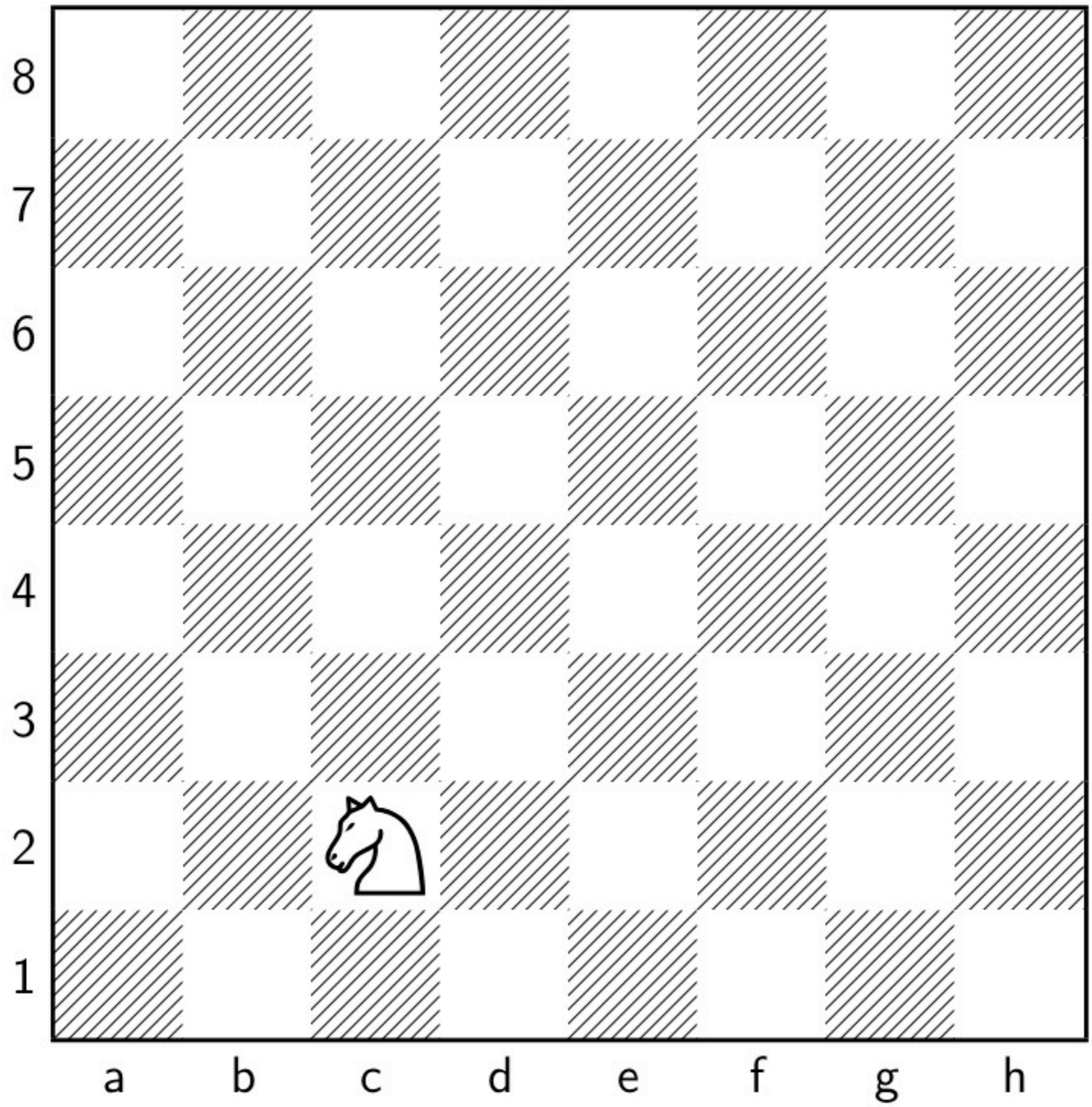
**If you can't beat your
computer at chess,
try kickboxing.**

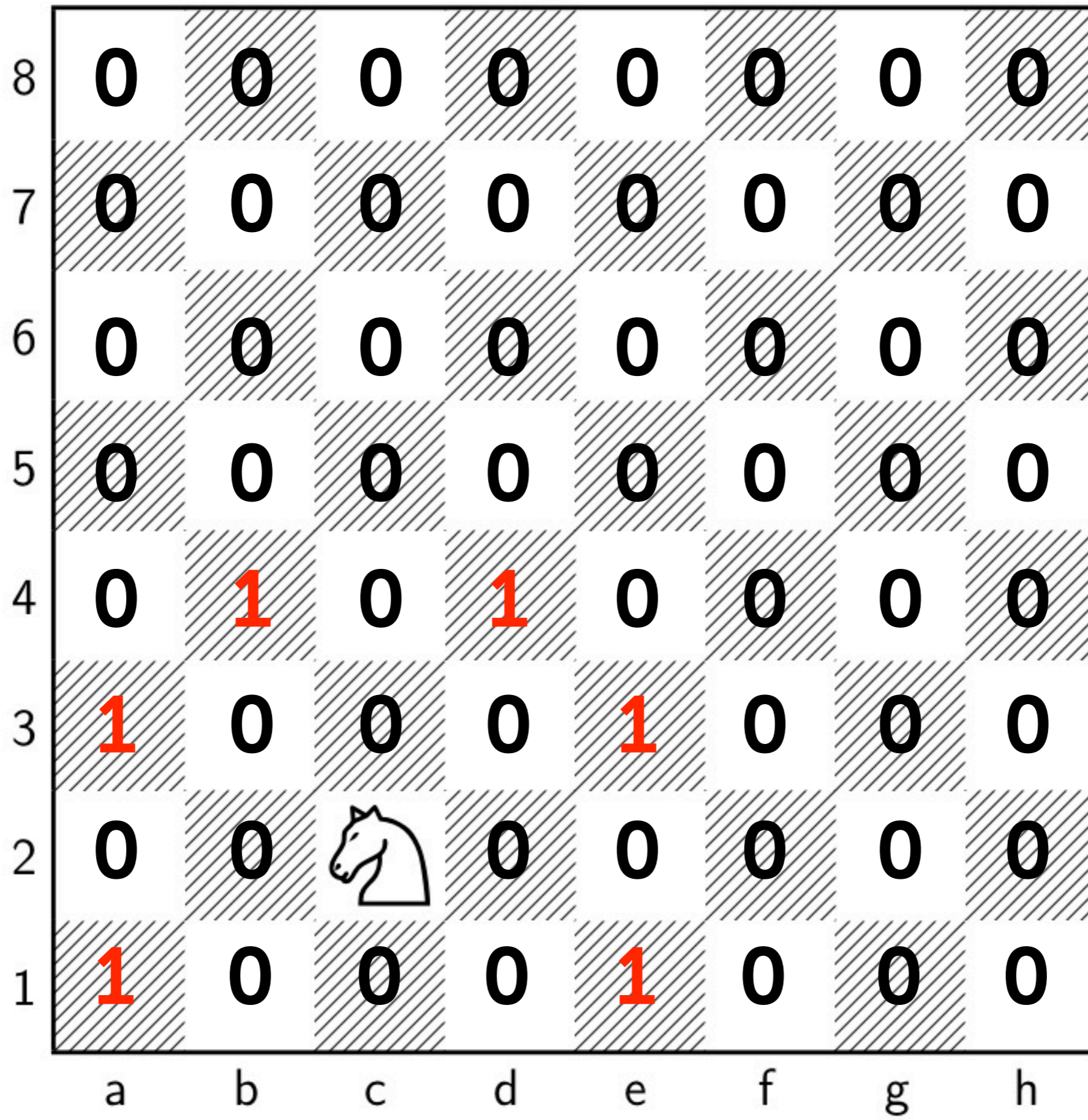
**do algorithms
have politics?**

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		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)

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)

[00000000 00000000 00000000 00000000 01010000 10001000 00000000 10001000]

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)

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

all pieces (white)

[00000000 00000000 00000000 00000000 00000000 00000000 00|0|100 00000|00]

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	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)

[00000000 00000000 00000000 00000000 01010000 10001000 00000000 10001000]

(AND, OR, NOT, XOR)

[00000000 00000000 00000000 00000000 00000000 00000000 00101100 00000100]