

# The First FIDE Man-Machine World Chess Championship

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In 1989, 1996 and 1997, world chess champion Garry Kasparov battled with the strongest computer chess program in the world – *Deep Blue* and its predecessor *Deep Thought*. In 1989, man easily defeated machine. In 1996, Kasparov also won, but this time with difficulty, including losing a game to the computer. In 1997, *Deep Blue* stunned the world by narrowly winning the match. Was *Deep Blue* the best chess player in the world? Or was the result a fluke? We had no answer, as IBM immediately retired *Deep Blue* after the match. A frustrated Kasparov wanted another chance to play the computer, but it never happened.

I am a professor in computer science, and specifically do research in the area of artificial intelligence – making computers appear to do intelligent things. Most of my research has used games to demonstrate my ideas. In the 1980's it was with my chess program *Phoenix*. In the early 1990's it was with the checkers program *Chinook*. These days it is with our poker program, *Poki*.

As a scientist, I was dissatisfied with the 1997 result. There was one short chess match which suggested that machine was better than man at chess. But science is all about producing reproducible results. More data was needed before one could objectively decide whether computer chess programs really were as good as (or better) than the best human chess player in the world. Sadly, with *Deep Blue*'s retirement, there was no opportunity to complete the scientific experiment. This is to be all the more regretted because of the historical significance of the match. One of the early grand challenge problems of artificial intelligence research was to develop a program capable of beating the best humans at chess. The *Deep Blue* match result suggested that this 50-year-old quest (dating back to Shannon's seminal paper in 1950) was over. There was no definitive scientific proof that machine was better than man, and strong chess players were united in their opinion that players like Kasparov were still much better than any computer in the world. In other words, mankind argued that the match result was a fluke.

Until last year, FIDE had steadfastly refused to have anything to do with chess programs. The Kasparov versus *Deep Blue* matches were exhibition events, meant to attract publicity, and were not sanctioned by or had any involvement with FIDE. Computers were largely pariahs in human tournaments, and FIDE still will not rate events that have computer participants. Nevertheless, in 2002 FIDE had a change of heart: they proposed to sanction and sponsor the First Man-Machine World Chess Championship. It was viewed as an opportunity to generate publicity for chess and, perhaps, a chance to

correct the impressions created by the 1997 match. It was also an attempt to compete with the so-called “Brains in Bahrain” match in October 2002, where Vladimir Kramnik, number 2 on the FIDE rating list and acknowledged as the world champion by one chess body (but not FIDE), was to play a match with the chess program *Deep Fritz*. The first FIDE championship would be held between Garry Kasparov (number 1 on the FIDE rating list) and *Deep Junior*, the current world computer chess champion. The match was scheduled to be held in early October 2002 in Jerusalem, to begin a few days before the Kramnik match (no doubt for publicity reasons).

The idea of a Man-Machine World Championship is not the first in history. In 1992, 1994 and 1995 there were a total of four sanctioned Man versus Machine Checkers World Championship matches. My program, *Chinook*, participated in all of them. There is no longer any interest in having these checkers matches, since machine has surpassed man by a large margin.

FIDE’s first step in organizing a Man versus Machine World Championship was to get a set of rules in place that was fair to both the human player and to the computer team. David Levy, an International Master with a long history of involvement in computer chess (including several famous man versus machine chess matches), was asked to organize the rules effort. David asked me to join the committee to do the work. Besides David and myself, the other members were Geurt Gijssen (FIDE arbiter), Peter Wilson (head of FIDE’s computer chess committee) and grandmaster Yasser Seirawan. Setting up the rules was quite intricate, given the sensitivities of both the human player and the computer team. This effort began in September 2002, with a first draft ready for October. However, the evolution of the rules continues to this day as we work on anticipating and preventing any problems that might arise in the course of a match.

Kramnik played *Deep Fritz* in Bahrain (an island off the coast of Saudi Arabia) in October 2002. The match was sanctioned and organized by the Einstein Group, the same organization that sponsored the 2001 match between Kasparov and Kramnik. Unfortunately, the match rules were stacked in favour of the human. Kramnik received a copy of *Deep Fritz* at least six months prior to the match start date. The programmers were not allowed to change their program in any way before or during the match. In other words, Kramnik could study his opponent well in advance of the match, and be guaranteed that that the opponent would not change. The *Deep Fritz* team did have some control over the openings played, but other than that they were essentially spectators. Their greatest fear was that there was a bug (programming error) in their program. If so, they could not fix the problem.

*Deep Fritz* is the parallel version of the well-known *Fritz* program. Franz Morsch, *Fritz*’s author, has been developing chess programs for 20 years. For the Bahrain match, *Fritz* ran on a PC containing multiple processors (8), allowing multiple lines of play to be analysed in parallel. Following the *Deep Blue* example, the parallel version of *Fritz* was christened *Deep Fritz*, in recognition of the parallel search that allowed it to analyze lines of play deeper.

Kramnik played cautiously in game 1 and drew, flattering the program by playing the solid Berlin defence of the Ruy Lopez that served him so well in his Kasparov match in 2000. However, in games 2 and 3, Kramnik played very well and scored what looked like effortless victories. In reality, looks can be deceiving. When playing a computer, you constantly have to check and double-check your analysis. You know that the computer is

searching deeply, and if you make an oversight, the computer is guaranteed to pounce. Kramnik had to exert considerable effort over the board to make sure he pressed home his advantage, without making the smallest slip.

With a draw in game 4, the match looked like it would be a rout. Kramnik had a 3-1 points lead and, given his reputation as a player who rarely loses, the match seemed to be effectively over.

[Event "Brains in Bahrain"]

[Round "1"]

[White "DEEP FRITZ"]

[Black "Kramnik,V"]

[Result "1/2-1/2"]

[ECO "C67"]

1. e4 e5 2. Nf3 Nc6 3. Bb5 Nf6 4. O-O Nxe4 5. d4 Nd6 6. Bxc6 dxc6 7. dxe Nf5 8. Qxd8+ Kxd8 9. Nc3 h6 10. b3 Ke8 11. Bb2 Be7 12. Rad1 a5 13. a4 h5 14. Ne2 Be6 15. c4 Rd8 16. h3 b6 17. Nfd4 Nxd4 18. Nxd4 c5 19. Nxe6 fxe6 20. Rxd8+ Kxd8 21. Bc1 Kc8 22. Rd1 Rd8 23. Rxd8+ Kxd8 24. g4 g6 25. h4 hxg4 26. Bg5 Bxg5 27. hxg5 Ke8 28. Kg2 1/2-1/2

[Event "Brains in Bahrain"]

[Round "2"]

[White "Kramnik,V"]

[Black "DEEP FRITZ"]

[Result "1-0"]

[ECO "D27"]

1. d4 d5 2. c4 dxc4 3. Nf3 Nf6 4. e3 e6 5. Bxc4 c5 6. O-O a6 7. dxc5 Qxd1 8. Rxd1 Bxc5 9. Kf1 b5 10. Be2 Bb7 11. Nbd2 Nbd7 12. Nb3 Bf8 13. a4 b4 14. Nfd2 Bd5 15. f3 Bd6 16. g3 e5 17. e4 Be6 18. Nc4 Bc7 19. Be3 a5 20. Nc5 Nxc5 21. Bxc5 Nd7 22. Nd6+ Kf8 23. Bf2 Bxd6 24. Rxd6 Ke7 25. Rad1 Rhc8 26. Bb5 Nc5 27. Bc6 Bc4+ 28. Ke1 Nd3+ 29. R1xd3 Bxd3 30. Bc5 Bc4 31. Rd4+ Kf6 32. Rxc4 Rxc6 33. Be7+ Kxe7 34. Rxc6 Kd7 35. Rc5 f6 36. Kd2 Kd6 37. Rd5+ Kc6 38. Kd3 g6 39. Kc4 g5 40. h3 h6 41. h4 gxh4 42. gxh4 Ra7 43. h5 Ra8 44. Rc5+ Kb6 45. Rb5+ Kc6 46. Rd5 Kc7 47. Kb5 b3 48. Rd3 Ra7 49. Rxb3 Rb7+ 50. Kc4 Ra7 51. Rb5 Ra8 52. Kd5 Ra6 53. Rc5+ Kd7 54. b3 Rd6+ 55. Kc4 Rd4+ 56. Kc3 Rd1 57. Rd5+ 1-0

[Event "Brains in Bahrain"]

[Round "3"]

[White "DEEP FRITZ"]

[Black "Kramnik,V"]

[Result "0-1"]

[ECO "C45"]

1. e4 e5 2. Nf3 Nc6 3. d4 exd4 4. Nxd4 Bc5 5. Nxc6 Qf6 6. Qd2 dxc6 7. Nc3 Ne7 8. Qf4 Be6 9. Qxf6 gxf6 10. Na4 Bb4+ 11. c3 Bd6 12. Be3 b6 13. f4 O-O-O 14. Kf2 c5 15. c4 Nc6 16. Nc3 f5 17. e5 Bf8 18. b3 Nb4 19. a3 Nc2 20. Rc1 Nxe3 21. Kxe3 Bg7 22. Nd5 c6 23. Nf6 Bxf6 24. exf6 Rhe8 25. Kf3 Rd2 26. h3 Bd7 27. g3 Re6 28. Rb1 Rxf6 29. Be2 Re6 30. Rhe1 Kc7 31. Bf1 b5 32. Rec1 Kb6 33. b4 cxb4 34. axb4 Re4 35. Rd1 Rxd1 36.

Rxd1 Be6 37. Bd3 Rd4 38. Be2 Rxd1 39. c5+ Kb7 40. Bxd1 a5 41. bxa5 Ka6 42. Ke3 Kxa5 43. Kd4 b4 44. g4 fxg4 45. hxg4 b3 46. Kc3 Ka4 47. Kb2 f6 48. Bf3 Kb5 49. g5 f5 50. Kc3 Kxc5 51. Be2 0-1

[Event "Brains in Bahrain"]

[Round "4"]

[White "Kramnik,V"]

[Black "DEEP FRITZ"]

[Result "1/2-1/2"]

[ECO "D34"]

1. d4 d5 2. c4 e6 3. Nf3 c5 4. cxd5 exd5 5. g3 Nc6 6. Bg2 Nf6 7. O-O Be7 8. Nc3 O-O 9. Bg5 cxd4 10. Nxd4 h6 11. Bf4 Bg4 12. h3 Be6 13. Rc1 Re8 14. Nxe6 fxe6 15. e4 d4 16. e5 dxc3 17. exf6 Bxf6 18. bxc3 Qxd1 19. Rfxd1 Rad8 20. Be3 Rxd1+ 21. Rxd1 Bxc3 22. Rd7 Rb8 23. Bxc6 bxc6 24. Rxa7 Rb2 25. Ra6 Bd2 26. Rxc6 Bxe3 27. fxe3 Kf7 28. a4 Ra2 29. Rc4 Kf6 30. Kf1 g5 31. h4 h5 32. hxg5+ Kxg5 33. Ke1 e5 34. Kf1 Kf5 35. Rh4 Kg6 36. Re4 Kf5 37. Rh4 Kg5 38. Kg1 Kg6 39. g4 hxg4 40. Rxg4+ Kf5 41. Rc4 1/2-1/2

I was invited to attend the Kasparov versus *Deep Junior* match as part of the officiating committee, but I had to decline because it meant leaving the university for three weeks in the middle of the fall term. Needless to say, I was very upset since the chance to be part of a FIDE world championship was very exciting to me. However, I was also invited to attend a conference that was to immediately follow the match, giving me the chance to attend games 5 and 6 (costing me only one week of classes). So, off to Jerusalem I would go – until the FIDE match was postponed! I still had my ticket to Jerusalem, so I went anyway to participate in the conference. Of course, the content of the conference had to be changed, since there was no match to post mortem.

The conference, called “Man versus Machine: The Experiment”, brought a number of experts in various disciplines together to discuss the computing, psychological, and social aspects of computers meeting and (soon) exceeding human abilities in domains requiring intelligence. A number of chess and computer chess dignitaries were in attendance, including the *Deep Junior* team.

During the conference, games 5 and 6 of the Bahrain match were played. In game 5, Kramnik had a weak position. Inexplicably, he made a one-move blunder and lost a piece. When I was shown the blunder position, it took me only a couple of seconds to spot the obvious refutation. But Kramnik missed it! Apparently, he had originally seen the refutation, went off and analyzed other moves, came back to the blunder move and played it without realizing his mistake. The result was shocking; blunders of this type are rarely seen in grandmaster play, and there is no record of Kramnik ever having committed such a trivial oversight in a tournament game.

[Event "Brains in Bahrain"]

[Round "5"]

[White "DEEP FRITZ"]

[Black "Kramnik,V"]

[Result "1-0"]

[ECO "D57"]

1. d4 Nf6 2. c4 e6 3. Nf3 d5 4. Nc3 Be7 5. Bg5 h6 6. Bh4 O-O 7. e3 Ne4 8. Bxe7 Qxe7  
 9. cxd5 Nxc3 10. bxc3 exd5 11. Qb3 Rd8 12. c4 dxc4 13. Bxc4 Nc6 14. Be2 b6 15. O-O  
 Bb7 16. Rfc1 Rac8 17. Qa4 Na5 18. Rc3 c5 19. Rac1 cxd4 20. Nxd4 Rxc3 21. Rxc3 Rc8  
 22. Rxc8+ Bxc8 23. h3 g6 24. Bf3 Bd7 25. Qc2 Qc5 26. Qe4 Qc1+ 27. Kh2 Qc7+ 28. g3  
 Nc4 29. Be2 Ne5 30. Bb5 Bxb5 31. Nxb5 Qc5 32. Nxa7 Qa5 33. Kg2 Qxa2 34. Nc8 Qc4  
**<<DIAGRAM>>**  
 35. Ne7+ 1-0

In Israel, the collection of grandmasters, masters, and computer chess experts were stunned by the game 5 result. Most of the chess players believed that the game was rigged; it was an attempt to keep the score close. After all, if Kramnik routed the computer there would be no incentive for a (lucrative) rematch. Keeping the score close was the correct thing to do. Of course, I had to ask why, if one wanted to keep the score close, would anyone do it in such an "obvious" way? The chess players were adamant that the blunder was a way of saying, "Yeah, the match was close, but I could have easily crushed the computer had I not blundered". According to them, it had to be this way. Having the computer out-play Kramnik would be unthinkable. At least, that was the conspiracy theory that most people seemed to believe.

Game 6 provided another surprise! Kramnik quickly built up a very strong position, and on move 19, he had an embarrassment of riches. He could have played 19. Bd5 with a dominating position (some say it is winning), but deep analysis convinced him that the king hunt resulting from sacrificing 19. Nxf7 was sound. Sadly, it wasn't. Deep search in such a complicated position is difficult for humans, but easy for computers. 19. Nxf7 was the wrong choice because it led into the computer's strengths, where the possibility of human error was high.

[Event "Brains in Bahrain"]  
 [Round "6"]  
 [White "Kramnik,V"]  
 [Black "DEEP FRITZ"]  
 [Result "0-1"]  
 [ECO "E15"]

1. d4 Nf6 2. c4 e6 3. Nf3 b6 4. g3 Ba6 5. b3 Bb4+ 6. Bd2 Be7 7. Bg2 c6 8. Bc3 d5 9. Ne5 Nfd7 10. Nxd7 Nxd7 11. Nd2 O-O 12. O-O Rc8 13. a4 Bf6 14. e4 c5 15. exd5 cxd4 16. Bb4 Re8 17. Ne4 exd5 18. Nd6 dxc4

**<<DIAGRAM>>**

19. Nxf7 Kxf7 20. Bd5+ Kg6 21. Qg4+ Bg5 22. Be4+ Rxe4 23. Qxe4+ Kh6 24. h4 Bf6 25. Bd2+ g5 26. hxg5+ Bxg5 27. Qh4+ Kg6 28. Qe4+ Kg7 29. Bxg5 Qxg5 30. Rfe1 cxb3 31. Qxd4+ Nf6 32. a5 Qd5 33. Qxd5 Nxd5 34. axb6 axb6

**<<DIAGRAM>>**

0-1

If the game 5 result shocked people, the game 6 result left people incredulous. The chess experts at the conference sadly shook their head in disbelief. This time there was no conspiracy theory; Kramnik might have thrown one game, but it was impossible to believe that he would throw two. More likely, game 5 was a real blunder, and the

psychological effect of this was felt in game 6. Suddenly, a match that looked to be all but over was now dead even: 3 to 3.

There is an eerie postscript to game 6. In the final position, Kramnik was down material and about to lose more. Seemed like a good time to resign. Or was it? After 34. ... axb6 35. Rxa6 b2 36. Ra7+ Kg6 37. Rd7 Rc1 38. Rd6+ Nf6 39. Rdd1 b1Q 40. Rxc1 Michael Greengard writes that "*Fritz* and Kramnik assumed Black would win easily with such a large material advantage. However, the black king can only be sheltered from the checks by the knight, and without the knight's help the b-pawn cannot be advanced. The rooks can attack the knight or the b-pawn, preventing progress by either. Various defensive postures, such as placing the rooks on b5 and b4 and just shuffling the king, prove impenetrable to *Fritz*. Also, if given the chance, White can give up a rook for the black knight and b-pawn and then the queen versus rook endgame is completely drawn." It appears that Kramnik resigned a game that was drawable!

In 1997, *Deep Blue* played wonderfully in game 2 of its match with Kasparov and, with mounting pressure and the imminent loss of a pawn, Kasparov resigned. Post-mortem analysis contained a surprise! Very deep analysis (done by a computer, of course) showed that Kasparov had an incredible resource in the position that led to a perpetual check in the main line. The world champion had resigned a drawn game. This result apparently weighted heavily on Kasparov, and may have adversely influenced his play in the rest of the 1997 match. Would there be a similar effect on Kramnik in 2002?

Games 7 and 8 of the Bahrain match proved to be anti-climactic. Kramnik took no chances and both games were short draws. Vladimir Kramnik, with a rating that hovers around 2800, had drawn an 8-game match with *Deep Fritz*. This was an impressive result for the *Fritz* team, especially considering the adverse match conditions. For Kramnik, this must have been disappointing, especially given his early success.

[Event "Brains in Bahrain"]

[Round "7"]

[White "DEEP FRITZ"]

[Black "Kramnik,V"]

[Result "1/2-1/2"]

[ECO "E19"]

1. d4 Nf6 2. c4 e6 3. Nf3 b6 4. g3 Bb7 5. Bg2 Be7 6. O-O O-O 7. Nc3 Ne4 8. Qc2 Nxc3 9. Qxc3 c5 10. Rd1 d6 11. b3 Bf6 12. Bb2 Qe7 13. Qc2 Nc6 14. e4 e5 15. d5 Nd4 16. Bxd4 cxd4 17. Bh3 g6 18. a4 a5 19. Rab1 Ba6 20. Re1 Kh8 21. Kg2 Bg7 22. Qd3 Rae8 23. Nd2 Bh6 24. f4 Qc7 25. Rf1 Kg8 26. Rbe1 Qd8 27. Kg1 Bb7 28. Re2 Ba6 1/2-1/2

[Event "Brains in Bahrain"]

[Round "8"]

[White "Kramnik,V"]

[Black "DEEP FRITZ"]

[Result "1/2-1/2"]

[ECO "D68"]

1. d4 Nf6 2. c4 e6 3. Nf3 d5 4. Nc3 c6 5. Bg5 Be7 6. e3 O-O 7. Bd3 Nbd7 8. O-O dxc4 9. Bxc4 Nd5 10. Bxe7 Qxe7 11. Rc1 Nxc3 12. Rxc3 e5 13. Bb3 exd4 14. exd4 Nf6 15. Re1 Qd6 16. h3 Bf5 17. Rce3 Rae8 18. Re5 Bg6 19. a3 Qd8 20. Rxe8 Nxe8 21. Qd2 1/2-1/2

An official involved with the match commented to me that Kramnik was mentally defeated by the end. Apparently he was visibly exhausted. The expert claimed that had the match gone on for a few more games, Kramnik would surely have lost. Clearly the mental energy required to play computers, and the psychological toll that games 5 and 6 had, were enough to make one of the strongest players in the world look merely mortal.

Meanwhile, the Kasparov versus *Deep Junior* match was postponed. The official reason was the lack of time available to make all the arrangements for the match. The organizers had a Herculean task, given that the decision to hold the match was taken in early September, and the match was to begin a scant four weeks later. This was good news for Kasparov, as he was coming off the worst tournament result in his career. In the Russia versus the World match in Moscow in September, Kasparov scored 4/10. However, the games were played using rapid time controls, not tournament time controls.

The *Deep Junior* match was rescheduled to December in Jerusalem and again I was invited to participate. Sadly, once again I was disappointed and had to decline because the event overlapped with final exams. Then it was postponed again, this time to early January, possibly in Florida. It didn't happen. Then it was announced there would be a two-game exhibition match in Jerusalem in January followed by a six-game match in New York, with the odd stipulation that the Jerusalem games did not count in determining the winner of the match. Jerusalem was cancelled because of some legal issues, but New York was still a go. Finally, match dates were fixed for January 26 to February 7. Once again I was invited. This time I would "only" need to miss two weeks of classes. It took a lot of soul searching on my part – professional responsibility versus love of chess – and in the end I decided I had to go. The university approved of my absence from class but, of course, I had to do a lot of work before, during and after the match to make up for the lost time. None of it mattered! The only thing that was important to me was that I would attend the First FIDE Man-Machine World Chess Championship in an official role. Any, maybe, get a chance to meet Garry!

The match was held at the New York Athletics Club, a beautiful building on the south edge of Central Park, a 10-minute walk to Times Square. Most of the officials and the players were housed at the NYAC. The accommodations were excellent, but had one serious drawback. The NYAC had a dress code. Men could not be in the hotel lobby, restaurants, bars, non-athletic facilities, and elevators unless they were suitably attired – jacket and tie. Yes, I brought a suit and tie with me, but they were for the times I was needed in the match. However, on my off days I planned to dress casually (blue jeans). For people like me, the hotel had a service elevator at the back that would allow me to enter and exit from the hotel in such a way that I could not be seen by the regular clientele. It was a source of constant amusement to me that I was treated as a second-class citizen because I like to dress comfortably.

The match was sponsored by X3D and Kirsan Ilyumzhinov. X3D offers a 3D visualization experience over the web. To promote their technology, X3D ([www.x3dworld.com](http://www.x3dworld.com)) has sponsored a number of diverse web events, including a Kasparov versus Karpov match in December 2002. Kirsan Ilyumzhinov is the President of the Republic of Kalmykia, formerly part of the Soviet Union. Kirsan is also the President of FIDE, and he has used his considerable wealth to sponsor numerous international chess events.

For the first FIDE Man-Machine World Championship match, Kasparov would receive a \$500,000 US appearance fee. The winner of the match would enjoy \$300,000 US, and the loser \$200,000 US.

The match promised to be exciting, pitting the best player in the world versus the best computer program in the world. Garry Kasparov's record is truly impressive. Since 1984 he has been the number 1 rated player in the world, and continues to hold that lofty position. He was world champion from 1985 to 2000, and is in a position to regain this title later this year. That kind of domination has very few precedents in competitive games and sports (Marion Tinsley in checkers and Oyama Yasuharu in shogi (Japanese chess) being notable examples). Kasparov was accompanied by GM Yuri Dokhian, IM Michael Khodarkovsky, his manager Owen Williams, his mother Klara Kasparova, and his mother's assistant.

The *Junior* chess program is the brainchild of Amir Ban and Shay Bushinsky. The Israeli program has been around for roughly 10 years, but in recent years has been one of the 3 or 4 programs that have dominated computer chess tournaments. In July 2002, *Junior* won the World Computer Chess Championship, edging out the previous champion *Shredder* in a playoff match. Against Kasparov, *Junior* would run on a machine containing four computers, hence they added the adjective "Deep" to their name. Ban and Bushinsky claim to be weak chess players. Grandmaster Boris Altermann provides the team with the expert analysis and the opening book lines that are essential to success.

The games were played in a private room on the 12<sup>th</sup> floor of the NYAC. Access was limited to a handful of VIPS and the match officials. Cameras were positioned to capture Kasparov's facial expressions and the chess board. During a game, only veteran FIDE arbiter Geurt Gijssen could interact with the players.

The public viewed the games on the 9<sup>th</sup> floor of the NYAC. There was seating for 300 people, but the room was always full and people had to be turned away. Video cameras in the playing room allowed spectators to watch Kasparov and the board. Grandmasters Maurice Ashley and Yasser Seirawan provided commentary during the games (they also did the 1996 and 1997 *Deep Blue* matches). The board was projected in 3D using X3d technology, which meant the audience had to wear special glasses to view this.

Game one started off, as usual, with both teams appearing to be a bit nervous and edgy. Kasparov had memories of the 1997 *Deep Blue* match on his mind, and was determined to erase that bitter memory. The *Deep Junior* team had nothing to lose, but wanted to achieve a credible performance. However, before the first game the programmers were a bundle of nerves, since the computer they planned to use for the match (with 8 processors at 1.6 GHz) had technical problems and they had to revert to a less powerful backup (with 4 processors at 1.9 GHz). I can attest that these problems always seem to get worked out in the last minutes before the match starts, but they consume considerable mental energy and lost sleep. And, of course, every computer programmer worries about the worst-case scenario that they overlooked something in their testing, and that the program will embarrass themselves. There is a saying in computer chess that is all too true: bugs only manifest themselves in critical games.

Game one was a brilliant exposition of the thoroughness of the Kasparov team's preparation for the match. Kasparov's early 7. g4 quickly got the program out of its opening database. Although *Deep Junior* defended as best it could by move 17 it was clear that the program was losing material, and the programmer's resigned on behalf of



the program on move 27. After the game, Kasparov revealed that he had studied the position after 13. d5 in his pre-match preparation and had concluded that it was winning. At the post-game press conference, a jovial Kasparov received a rousing round of applause from an appreciative audience.

[Event "FIDE Man-Machine WC"]

[Round "1"]

[White "Kasparov,G"]

[Black "DEEP JUNIOR"]

[Result "1-0"]

[ECO "D45"]

1. d4 d5 2. c4 c6 3. Nc3 Nf6 4. e3 e6 5. Nf3 Nbd7 6. Qc2 Bd6 7. g4

<<DIAGRAM>>

dx4 8. Bxc4 b6 9. e4 e5 10. g5 Nh5 11. Be3 O-O 12. O-O-O Qc7 13. d5 b5 14. dx4  
bxc4 15. Nb5 Qxc6 16. Nxd6 Bb7 17. Qc3 Rae8 18. Nxe8 Rxe8 19. Rhe1 Qb5 20. Nd2  
Rc8 21. Kb1 Nf8 22. Ka1 Ng6 23. Rc1 Ba6 24. b3 cxb3 25. Qxb3 Ra8 26. Qxb5 Bxb5  
27. Rc7 1-0

I was located in a room beside the playing area during the game. Here the computers used by *Deep Junior* were located, and the rest of the *Deep Junior* team (sans the operator for the game) would be located. Along with David Levy and Peter Wilson, we were the only people allowed to see the program's output. Our role was to verify that the program was playing properly, and that there was no outside interference.

During the games, I often talked with Ban, Bushinsky and Altermann to gauge their opinion of what was happening. Altermann, being a grandmaster, often had insights into the game that mere mortals like me could not discover on our own..

It was a privilege to be in the playing room at the start and end of each game, to watch the post-mortem analysis and hear the comments (sometimes in English, but often in Russian) of Kasparov and his seconds.

Game 1 had the only major technical issue in the match. On move 9, the computer output screens suddenly went blank, and Amir Ban, who was operating *Deep Junior*, rushed from the playing hall into the computer room to see if the computer had crashed. It took a few seconds (but it seemed much longer) to realize that *Deep Junior* had been thinking for over 20 minutes and that a screen saver program had automatically kicked in. Needless to say, the screen saver was disabled for subsequent games.

The above incident was my only "scary" moment in the match. As technical supervisor, I had to oversee all issues related to the computer program and computer hardware. Computer hardware reliability is always a concern in such a match. The consequences of hardware or software not working properly can be severe (including leading to the forfeit of a game), and I was hoping that such weighty decisions would not arise in this match.

Watching Kasparov play chess is actually quite entertaining. You can read from the expressions on his face and his mannerisms how well (or poorly) the game is going (Kasparov would make a lousy poker player). For example, when Kasparov is unhappy he will shake his head back and forth and restlessly move about in his chair. In contrast,

when he gets deeply immersed into the intricacies of a position, he will stare intently at the board, often not moving for many minutes on end.

There is one well-known amusing Kasparov habit that commentators like to point out. When Kasparov begins a game, he takes off his watch and carefully places it beside the board. He ignores the watch during the game, not even looking at it to see the time of day. But when he considers the game to be effectively over, he then picks up the watch and puts it back on his wrist. This is a not-so-subtle hint to the opponent that it is time to resign! Surprisingly, in game 1 even though it was quite obvious that Kasparov was going to win well before the game actually ended, Kasparov did not put his watch back on until the *Deep Junior* team resigned.

Game 2 was a rollercoaster ride for both Kasparov and *Deep Junior*. Kasparov surprised most people (including myself) by taking a passive wait-and-see approach when playing with the black pieces. He was content to keep his pieces on the back three ranks and mark time – waiting for *Deep Junior* to make a committal move that Kasparov could exploit. However, *Deep Junior* quietly built up its position and mobilized its pieces. With 21. Ra3, one of the weaknesses of chess programs was revealed. The program's deep search revealed good things for the program because of a looming b4. Kasparov ignored the threat and played Qf6. 22. b4 was played and looked strong. But Kasparov had analyzed deeper and sacrificed material with 22. ... axb3. To a human, this move is obvious. To a computer, however, the consequences of the move were likely beyond *Deep Junior*'s capacity to analyze in a few minutes. Of course, with a faster computer, *Deep Junior* might have discovered the danger of b4.

With 22 ... axb3 the game took a 180 degree turn. Kasparov's position suddenly sprung to life. However, he quickly played 25. ... Qa1+, thinking he had a win. Immediately he realized he was wrong (missing the 29. Qxf8+ resource) and a few moves later a draw was agreed. Kasparov immediately claimed that 25. ... f4 was winning. Deep computer analysis of f4 after the game could not find a win, but f4 did represent a strong way of continuing the fight. Still, with a 1.5 –0.5 lead, Kasparov had to be happy with the way things had gone thus far. The game 1 result was the product of brilliant preparation, and game 2's result showed that Kasparov's "rope-a-dope" strategy could work.

[Event "FIDE Man-Machine WC"]

[Round "2"]

[White "DEEP JUNIOR"]

[Black "Kasparov,G"]

[Result "1/2-1/2"]

[ECO "B42"]

1. e4 c5 2. Nf3 e6 3. d4 cxd4 4. Nxd4 a6 5. Bd3 Bc5 6. Nb3 Ba7 7. c4 Nc6 8. Nc3 d6 9. O-O Nge7 10. Re1 O-O 11. Be3 e5 12. Nd5 a5 13. Rc1 a4 14. Bxa7 Rxa7 15. Nd2 Nd4 16. Qh5 Ne6 17. Rc3 Nc5 18. Bc2 Nxd5 19. exd5 g6 20. Qh6 f5 21. Ra3 Qf6

<<DIAGRAM>>

22. b4 axb3 23. Rxa7 bxc2 24. Rc1 e4 25. Rxc2 Qa1+ 26. Nf1 f4 27. Ra8 e3 28. fxe3 fxe3 29. Qxf8+ Kxf8 30. Rxc8+ Kf7 1/2-1/2

During game 2, I became aware of a strong bias in my analysis. I was quick to criticize many of *Deep Junior*'s moves as being second best. However, those "second-

best” moves were good enough to get a strong position against Kasparov. In the post-game shuffling of pieces at the board, Kasparov revealed that he thought the program played very well, and that he was actually worried at one point in the game; there were attacking lines involving h4 that were cause for concern. Realizing that I was not being objective in my analysis gave me a greater appreciation for the quality of the moves played by *Deep Junior*. Just because I didn’t think they were good didn’t mean that they actually weren’t very good. But once you realize this, then you notice that almost all the chess experts – from the grandmasters that I spoke to, to the game commentators – they all had a similar bias against the computer’s moves (a very strong bias in some cases). I suspect that many chess annotators put “?” after several of *Deep Junior*’s moves in this game, and possibly gave only one (Qa1+) to Garry Kasparov. Yet the computer drew.

At the start of game 3, I could sense that the *Deep Junior* team was worried. If Kasparov won the game, the match would be effectively over. And, given that Kasparov had the white pieces, there was no doubt that he would do his utmost to win. If game 1 was any indication, there was a lot to fear about Kasparov’s opening preparation.

The *Deep Junior* team was right to be concerned, because Kasparov unleashed a surprising g4 (again!) in the opening. Whether this was part of his pre-match preparation, or a spur-of-the moment inspiration, I do not know. However, it was obvious that Kasparov would get an interesting attack.

After the game, there was criticism of how Kasparov conducted the attack. In particular, Kasparov was critical of his 14. Bxh6, since this led to a forced simplification of the position, and the attack petered out.

[Event "FIDE Man-Machine WC"]

[Round "3"]

[White "Kasparov,G"]

[Black "DEEP JUNIOR"]

[Result "0-1"]

[ECO "D45"]

1. d4 d5 2. c4 c6 3. Nc3 Nf6 4. e3 e6 5. Nf3 Nbd7 6. Qc2 b6 7. cxd5 exd5 8. Bd3 Be7 9. Bd2 O-O 10. g4

<<DIAGRAM>>

Nxg4 11. Rg1 Ndf6 12. h3 Nh6 13. e4 dxe4 14. Bxh6 exd3 15. Rxc7 Kh8 16. Qxd3 Rg8 17. Rxc8 Nxg8 18. Bf4 f6 19. O-O-O Bd6 20. Qe3 Bxf4 21. Qxf4 Bxh3 22. Rg1 Qb8 23. Qe3 Qd6 24. Nh4 Be6 25. Rh1 Rd8 26. Ng6+ Kg7 27. Nf4 Bf5 28. Nce2 Ne7 29. Ng3 Kh8 30. Nxf5 Nxf5 31. Qe4 Qd7

<<DIAGRAM>>

32. Rh5 Nxd4 33. Ng6+ Kg8 34. Ne7+ Kf8 35. Nd5 Qg7 36. Qxd4 Rxd5 0-1

*Deep Junior* played defensive moves 17.. ... Nxg8 and 18. ... f6 that were criticized by many people at the time. Again, there seemed to be a lack of objectivity by the human analysts. In hindsight, these moves were actually very good, allowing black to keep the white pieces out.

Kasparov left his h-pawn hanging and *Deep Junior* grabbed it. This had an immediate impact on Kasparov – when he saw the computer capture the pawn he immediately

became agitated, seemingly angry with himself. He sat down at the board and vigorously shook his head, visibly upset.

Black started consolidating its position, while Kasparov's attack seemed to be going nowhere. The pesky pawn on f6 kept the white knights out of key squares. Nevertheless, Kasparov mounted some counter-play, and on move 32 it looked like there would be a draw by repetition (32. Ng6 Kg7 33. Nf4 Kh8). Kasparov saw it, and knew he had a draw. But searching deeper, he found a way to play that would "also" draw: 32. Rh5 Qxd4 33. Rh7+ with a perpetual. Kasparov played the fateful 32. Rh5 and disappeared into his private area. When *Deep Junior* made its reply a few minutes later, Kasparov returned to the board and Kasparov's demeanour abruptly changed. He looked devastated, as he slumped into his seat. Kasparov had analyzed the consequences of 32. Rh5 Nxd4 Ng6+ Kg8 34. Ne7+ Kf8 35. Rxh7 which was strong, but overlooked 35. ... Nb3+ 36. Kc2 Na1+ leading to mate. Kasparov shook his head back and forth violently, staring in disbelief at what had happened. It was painful and even sad to watch. Kasparov played on for a few more moves, but then resigned rather than face a dreary endgame down two pawns.

When he resigned, a bewildered Kasparov stood up and extend his hands out to his sides as if to say "what happened". He was immediately surrounded by his second, Yuri Dokhian, and his mother, Klara Kasparova. He quickly left the playing area, but bravely attended the post-game press conference. He was very upset, claiming that the match score could be 3 to 0 now, instead of being 1.5 to 1.5. One had to feel sorry for Kasparov; he had played very well in the first three games and had no advantage to show for it.

I was more surprised by the reaction of the *Deep Junior* team. When my checkers program beat the human world champion in 1992, I was elated. To me, it was a major accomplishment, the realization of a dream, and justification for the thousands of hours of effort that led up to that momentous occasion. So how did the *Deep Junior* team react to beating the greatest chess player in history? All of the members of the team were calm and unemotional – no different in demeanour than they had been after games 1 and 2. Well, that's not quite true! Shay Bushinsky did briefly smile once.

The match was all even! *Deep Junior* had white in two of the remaining three games. Expert opinion varied wildly, alternating between Kasparov rebounding and Kasparov collapsing. While there had been good media interest for the first three games of the match, the game 3 result caused a media frenzy. The remaining three games attracted considerably more attention, but not quite that of the 1996 or 1997 *Deep Blue* matches.

Game 4 seemed to be a replay of Game 2. Kasparov kept his pieces on the back three ranks, waiting for the program to make a mistake. *Deep Junior* calmly built up a strong position – and it kept getting stronger with every move. With 24. a5 *Deep Junior* broke into Kasparov's position, and things began to look dangerous for the champion. However, Kasparov jettisoned a pawn to reach a drawn endgame.

[Event "FIDE Man-Machine WC"]  
[Round "4"]  
[White "DEEP JUNIOR"]  
[Black "Kasparov,G"]  
[Result "1/2-1/2"]  
[ECO "B44"]

1. e4 c5 2. Nf3 Nc6 3. d4 cxd4 4. Nxd4 e6 5. Nb5 d6 6. c4 Nf6 7. N1c3 a6 8. Na3 Nd7 9. Nc2 Be7 10. Be2 b6 11. O-O Bb7 12. h3 O-O 13. Be3 Rc8 14. Qd2 Nce5 15. b3 Nf6 16. f3 Qc7 17. Rac1 Rfe8 18. a3 Ned7 19. Rfd1 Qb8 20. Bf2 Rcd8 21. b4 Ba8 22. a4 Rc8 23. Rb1 Qc7 24. a5 bxa5 25. b5 Bb7 26. b6 Qb8 27. Ne3 Nc5 28. Qa2 Nfd7 29. Na4 Ne5 30. Nc2 Ncd7 31. Nd4 Red8 32. Kh1 Nc6 33. Nxc6 Rxc6 34. Kg1 h6 35. Qa3 Rdc8 36. Bg3 Bf8 37. Qc3 Ne5 38. c5 Nd7 39. Qxa5 Nxc5 40. Nxc5 Rxc5 41. Qa4 R5c6 42. Bf2 d5 43. Bxa6 Bc5 44. Bxc5 Rxc5 45. Bxb7 Qxb7 46. exd5 exd5 47. Qa7 R5c7 48. Qxb7 Rxb7 49. Rxd5 Rc6 50. Rdb5 h5 51. Kf2 Re6 52. f4 g6 53. Kg3 Kg7 54. Kh4 Kh6 55. R1b4 Rd6 56. g3 f6 57. g4 hxg4 58. hxg4 Kg7 59. Rb3 Rc6 60. g5 f5 61. Rb1 1/2-1/2

Kasparov's move 41 impressed me greatly. Time control had just passed – no more time pressure. He surveyed the position and must have been concerned. He went into deep thought for over half an hour, rarely stirring, staring at the board as if in a trance. Meanwhile, most people (including myself) thought that Kasparov was in danger of losing. Kasparov poured all his energy into the analysis and came up with 41. ... R5c6, a move that no one predicted. Further, he followed it up with the non-obvious 42. ... d5, sacrificing a pawn for a drawn endgame. Kasparov had seen all of this during his long think. It would be interesting to know whether he deliberately played for this line because he was sure that a material-hungry program would grab the pawn since it likely could not understand that the resulting ending was drawn.

As another example of human bias, during the game 24. a5 was roundly condemned. The claim was that Kasparov would be easily able to surround the b6 pawn and win it. That scenario never happened, nor was it likely to happen. Despite these claims by knowledgeable players, the b6 pawn was still standing at the end of the game.

Game 5 will go down in history for what everyone was calling "*the move*". Kasparov had his last chance with the white pieces, and everyone expected him to play for a win. After an innocuous series of opening moves, Kasparov played 10. Qc2. *Deep Junior* thought for several minutes and stunned everyone with 10. ... Bh2+. Of course this is a standard sacrifice, but it had never been played before in this position. At first, Kasparov was amused, probably convinced that it was unsound. It didn't take long before his reaction changed, and he spent considerable time at the board analyzing the consequences. The sacrifice does not lead to a forced draw. Kasparov can avoid a perpetual by playing 15. ... g3. The line leaves Kasparov up material, but subjects his king to a vicious attack. Was Bh2+ sound? The jury is still out. However, one thing was clear. *Deep Junior* made this sacrifice without the comfort of a draw to fall back on. The program must have evaluated the attack potential to be worth the material investment. This is the type of sacrifice human players understand well, but has been a weakness of computer programs. No more! Bh2+ was universally praised.

[Event "FIDE Man-Machine WC"]

[Round "5"]

[White "Kasparov,G"]

[Black "DEEP JUNIOR"]

[Result "1/2-1/2"]

[ECO "E48"]

1. d4 Nf6 2. c4 e6 3. Nc3 Bb4 4. e3 O-O 5. Bd3 d5 6. cxd5 exd5 7. Nge2 Re8 8. O-O Bd6 9. a3 c6 10. Qc2

<<DIAGRAM>>

Bxh2+ 11. Kxh2 Ng4+ 12. Kg3 Qg5 13. f4 Qh5 14. Bd2 Qh2+ 15. Kf3 Qh4 16. Bxh7+ Kh8 17. Ng3 Nh2+ 18. Kf2 Ng4+ 19. Kf3 Nh2+ 1/2-1/2

In 1997, Kasparov and *Deep Blue* were tied going into the last game of the match. Kasparov played black and quickly lost. The 2003 match looked strangely similar to 1997. How would Garry handle the pressure? Expert opinions ranged from predicting a brilliant win for Kasparov, to an embarrassing defeat for Kasparov. Which Kasparov would show up for game 6? The 1997 Kasparov that lost to *Deep Blue*, or the 1987 Kasparov who scored a pressure-packed win in the last game of his World Championship match against Anatoly Karpov?

As in games 2 and 4, Kasparov played passively, waiting for an opportunity. It quickly became clear that Deep Junior did not understand how to play the white side of the opening, and black easily equalized. Deep Junior under-estimated black counter-play on the queen side and allowed a dangerous attack sacrifice with 23. ... Rc3. The grandmasters in attendance at the game universally said that Kasparov had excellent winning chances. Surprise! The players agreed to a draw on move 28. The audience booed when this was announced. The match was over and ended in a tie.

[Event "FIDE Man-Machine WC"]

[Round "6"]

[White "DEEP JUNIOR"]

[Black "Kasparov,G"]

[Result "1/2-1/2"]

[ECO "B92"]

1. e4 c5 2. Nf3 d6 3. d4 cxd4 4. Nxd4 Nf6 5. Nc3 a6 6. Be2 e5 7. Nb3 Be7 8. O-O O-O 9. Kh1 Bd7 10. Be3 Bc6 11. Bf3 Nbd7 12. a4 b6 13. Qd3 Bb7 14. h3 Rc8 15. Rad1 h6 16. Rfe1 Qc7 17. g3 Rfd8 18. Kh2 Re8 19. Re2 Qc4 20. Qxc4 Rxc4 21. Nd2 Rc7 22. Bg2 Rec8 23. Nb3 Rxc3 24. bxc3 Bxe4 25. Bc1 Bxg2 26. Kxg2 Rxc3 27. Ba3 Ne8 28. f4

<<DIAGRAM>>

1/2-1/2

Is black winning the final position? The grandmasters said probably, but Kasparov did not rate his chances as highly. Kasparov said it was “more important not to lose than it was to win”; clearly memories of 1997 played a role in this decision. Kasparov also pointed out that the few serious mistakes that he had made in the match occurred late in the game. He was worried that in a long protracted endgame he would make a mistake and the computer would pounce. Thus, human frailties also played a role in the decision. Still, it seemed that black ran little risk in playing a few more moves.

The programmers of *Deep Junior* should be congratulated on a remarkable result. Everyone involved in the match, including Kasparov, was impressed with the quality of the program’s play. By and large, the moves were “human-like”, with very few obvious “computer moves” that distinguish many programs’ play. The astonishment and impact

of game 5's Bxh2+ will force human players to re-evaluate their opinions on the abilities of computer play.

Of course, the match result immediately posed the question: "who was the better chess player: *Deep Blue* or *Deep Junior*"? Chess program performance is largely based on two major components: search and knowledge. On paper, *Deep Blue* had a large edge in search speed. They could analyze 200 million chess positions per second. *Deep Junior* could "only" do 3 million per second (humans typically do 1-2 per second). Thus *Deep Blue* was 66X faster. Although normally this would be considered a huge advantage, the *Deep Blue* people chose not to use a nice idea called null-move searching. This would allow very deep analysis of critical lines of play, but incur some (small) risk. *Deep Junior* used this idea, enabling the program to offset much of the speed gap.

In terms of knowledge, *Deep Blue* had more chess knowledge at its disposal. Knowledge needs to be tuned, so that irrelevant pieces of knowledge do not out-weigh important pieces of knowledge. *Deep Blue*'s evaluation function may not have been tuned as well as it could have due to a lack of time. On the other hand, *Deep Junior*'s evaluation function had been continually tuned for almost a decade.

So who was better? One can't compare. Both programs played well. With *Deep Blue* now in retirement at the Smithsonian Institute in Washington, we will never get more data on just how good *Deep Blue* really was.

Garry Kasparov played very well, and except for a couple of unfortunate slips late in games 2 and 3, might have achieved a very different result. It is obvious that his understanding of chess is much superior to *Deep Junior* – or any other program for that matter. However, human weaknesses – including fatigue, pressure, and psychology – make the human vulnerable to a tireless, poker-faced, implacable computer opponent.

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In the last six months, computers have achieved remarkable success:

- Garry Kasparov (ranked #1 in the world) draws a 6-game match with *Deep Junior*.
- Vladimir Kramnik (#2 in the world) draws an 8-game match with *Deep Fritz*.
- Evgeny Bareev (#8 in the world) draws a 4-game match with *Hiarcs*.

A total of 18 games were played, with the human side winning a total of 3 games.

Although many human players still make derisive remarks about the quality of computer play, the reality is that most of this criticism is unjustified. Computers do make mistakes, but so do humans. In many cases, computer "mistakes" are not mistakes at all; they are perceived as mistakes because they do not conform to our human understanding of chess. But computers have a different understanding of the game, which involves playing moves that might be unusual or absurd – but not necessarily bad. Clearly, if these moves were as bad as many commentators have claimed, then why can't the elite players in the world crush their computer opponents?

It is time that we give (perhaps grudgingly) respect for the chess played by the top computer programs. The recent computer results are outstanding, and will only get better. The programs will continue to improve, if only because they will migrate to faster and faster hardware. Only a few years ago it was unthinkable that a top human could lose a match to a computer. The *Deep Blue* result was not a fluke. Computers are now in the same league as the top humans in the world. And, in a few years, the roles will be

reversed: it will be unthinkable that a top human could beat a computer in a match. That day is not that far off.

I want to express my admiration for and gratitude to the grandmasters who bravely put their reputations on the line against technology. Garry Kasparov sets a fine example, by being willing to part of a grand experiment that will be part of computing history. A century from now, we will look back on this period in the evolution of computer “intelligence” as being a landmark; for the first time we see computers meeting and exceeding human abilities in sophisticated domains that require “human thinking”. Without the cooperation of players like Kasparov, we would be unable to measure the progress of technology.

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Oh, yes, I did get to spend some time with Kasparov. Away from the board, free from the pressure of playing, he is very friendly and engaging. I have always regarded Kasparov as a larger-than-life, almost mythical chess player. Meeting him one on one makes you realize that he is just like you and me -- except that he has a wonderful gift for chess.

When I travel, I am not one to collect souvenirs. However, given the historical and personal importance of this match, I could not resist bringing back one memento of my New York adventure. I bought a beautiful wood chessboard, and had all the people involved in the match – players, officials, commentators, organizers – sign a square. Kasparov is on “d5”. Kirsan Ilyumzhinov is on “e4”. Ban, Bushinsky and Altermann are on “e6”, “c6”, and “g4”, respectively. I filled out the squares with autographs from other chess luminaries who attended the match. For example, former World Women’s Champion Susan Polgar’s autograph adorns “d3”. As I finish writing this article, I look up at the board, proudly hanging on the wall of my home office.