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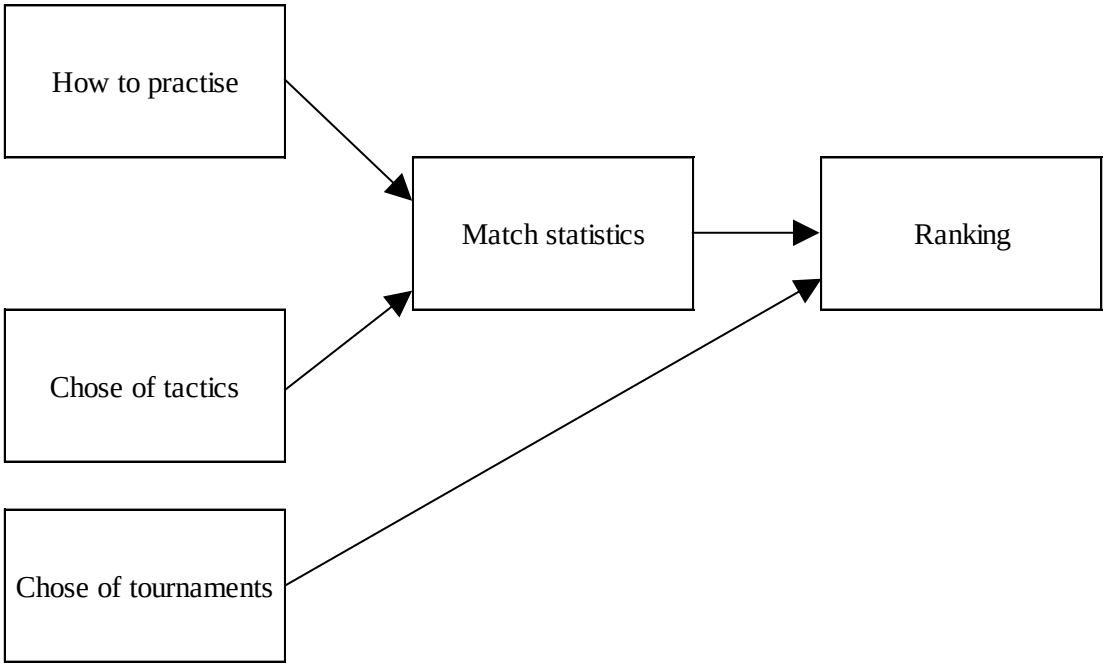
If Balls Did Not Exist I Would Invent One!

By

Pim-Pim Ace Management AB[1]



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Preface

A little over four years ago we wrote the compendium *If Balls Did Not Exist I Would Invent One!*. We were very curious of how the compendium would be accepted and we can now summarize the outcome.

To our delight essays have been written at the Institute of Gymnastics and Sports in Stockholm inspired by our compendium, see for example Hjelm and Hallgren (2009). In their essay they among other things write the following:

> *"Johansson & Johansson raise the subject of serving tactics from the perspective that every player has an optimal level as to how much they should risk on the serve, that is what first serve percentage they should have and how many double faults they should make based on their specific talents as a player. It is not automatically bad to have a lower first serve percentage or to make a few more double faults, but the choice of serve percentages should be matched with the tactics of the player. The study shows that the players serving with an optimal first serve percentage matching their playing tactics are also the players the higher ranked on the ATP-ranking.*
>
> *Furthermore Johansson & Johansson have a clear practical example of how statistical analysis can be a success factor. By studying Nadal's return statistics they found that Nadal, who normally has a better forehand, does not have the forehand as his best return shot. The statistics showed his efficiency in returning was better on the backhand side. This fact Pim-Pim used in his success comeback at the Stockholm Open where he beat Nadal. Their study also shows that players who choose the wrong tactics when they have break points in their own serve have a lower world ranking than their game deserves. An example is the Argentine Coria who not seldom chooses to play serve/volley at break points even though he normally never does this successfully.*
>
> *Their reasoning inspired undersigned to find out if you by using video based analysis can examine the efficiency of different serves, different choices of hits after serve, and where on the court the player is the most efficient."*[2]

We have also received recognition from abroad. For example from a university that researches developing coaching in tennis. One of the members in that research team wrote the following in a letter to Pim-Pim:

> *"Ever since you shot up the ranking your ability to make good tactical decision making seemed far better than most players which is why I constantly used you as an example. The players and I would constantly watch videos of you to watch your decision making so they could learn from it. I believed in your game when you were ranked around 50-60 in the world. I told many people that soon you would be in the top 5. Obviously the changes you made in your game worked very well when you got to number 9.*
>
> *You and your brother have come up with a system that has the potential, and should, revolutionize the way tennis is taught and practiced. It is a tool that would give extreme advantages to current and upcoming pros."*

[2] Hjelm and Hallgren (2009) page 6.

In the International Tennis Federation's journal ITF Coaching and Sport Science Review there is an article on match analysis written by Natasha Bykanova-Yudanov (2011). In this there is a reference to our compendium. In the article you can among other things read the following:

> *"A former top-ten Swedish player, Joachim 'Pim Pim' Johansson was often asked the same question: "Why, having one of the most effective serves in the game he wouldn't rush to the net behind it?" What puzzled the others, was a logical choice for Johansson. He knew that his forehand was much better than his net game and preferred to take the ball early and on the bounce with his strongest groundstroke. In 2004, Johansson showed the best serve results on the ATP Tour - he won more games on his serve than any other ATP Tour player. The Swede's stats were even better than Pete Sampras' - a strong argument in favour of Johansson's serve tactics. Johansson followed his powerful delivery by a big forehand from mid-court to finish the point. "All the players can play really good, it's a question of using the right tactics insists Johansson. We have to teach them in the right way from a younger age, we need to talk about tactics so they understand the logics of the game and help them develop their own individual styles".*[3]

During the four years that have passed since we first published the compendium the attitude towards co-operation between science and sports in Sweden seems to have changed, to our great delight. The rulers of sports in Sweden are now starting to realize what we have known for a long time. Namely that it would be very beneficial to base training and tactics more on science and less on general opinion. Recently the Centre of Sports Science (2012) published a report where they stated this. In the report you can read:

> *"The interviewed are unanimous in that follow up, science and analysis of the surrounding world are success factors and that more of all three is needed if done in a right manner, but in particular more science. The managers of the national team in handball Ola Lindgren and Staffan Olsson are fairly tangible as to why: "Today many, including ourselves, base things too much on rumors from someone having seen something, or trends where everyone might be making the same mistake".*[4]

This is exactly what we are trying to show in our compendium regarding tennis, that many of the choices in a player's tactics are today based on general trends which in many respects have very little, if any, relevance in improving the performance. A better approach to improving the performance is instead what we recommend in this compendium, to make use of the science. In an article in the Swedish newspaper Svenska Dagbladet the report from the Centre of Sports Science is discussed:

> *"To be able to compete successfully in the future and achieve more Swedish championship medals, the top athletes and their coaches call for less instinct and more science. […] The head coach of the national team in orienteering, Pekka Nikkulainen, says that we have been so spoilt in belonging to the top nations*

[3] Bykanova-Yudanov (2011) page 24.
[4] Centrum för idrottsforskning (2012) page 113.

in the world that we no longer strive for new knowledge to develop. […] The head of elite level sports at the National Federation of Sports, Peter Mattsson, also believes that it is "extremely important" that there is more connection to science when educating coaches. –I think that is absolutely necessary in order to achieve a better understanding for what science can contribute with. […] If you are making research on elite level sports you need to be able to reach the top athletes in their environments, Mattsson says."[5]

We are proud to have been pioneers in Sweden in this field of practicing a more science based view on tennis and its many tactical choices. The difficulty in succeeding to implement academic research in sports is exactly what Mattsson is pointing out, to meet the athletes in their own environment. We believe this is the strength of our compendium, that together we have had the competence to introduce academics into elite sports. Altogether our curiosity and our way of challenging each other has taken us to unknown territory and made us able to invent our own balls.

In the past four years we have also developed methods for analyzing golf and successfully tested these on top-ranked golfers. One who has used our analysis is Johanna Westerberg, professional golfer on the Ladies European Tour. She says the following about our golf analysis:

"The analysis concept for golf gave me totally new insights in what matters the most to practice. Earlier I had taken statistics in the classical way that you are taught in golf, but I never thought it gave me anything as I and the people around me lacked knowledge of how to analyze and interpret the statistics in a meaningful way. By using this new analysis concept I could finally make something out of the numbers and plan my practice more efficiently. In that way I could practice fewer hours and still get better results, leaving me with more energy and letting me have more time to prepare for tournaments.

I also improved my game plan through the analysis concept where we analyzed which risks are worth taking and which way would be most profitable for me to play in the long run. After the analysis my game plan became more aggressive, which suited me perfectly, and with the facts of the analysis behind me I was able to trust my decisions on the course to a larger extent than before, which is absolutely vital in golf. Thanks to the changes I made I improved my former highest ranking of 22nd to 9th in Europe, and won my first Ladies European Tour title.

I definitely believe all athletes would profit from analyzing what and how you practice and compete to be able to use the time you spend in an optimal way. Also to be able to rest more to be better prepared for tournaments and to avoid injuries that many athletes unfortunately are faced with due to too much and improper training. When it comes to tactics there is a tremendous amount to learn, both regarding which tournaments one should play and also how to play these in order to give yourself the best chances of winning as often as possible."

In this edition of the compendium we have added a chapter on analysis in golf in order to show and inspire others how the reasoning behind *If Balls Did Not Exist I Would Invent One!* easily can be applied to other sports than tennis.

[5] Svenska Dagbladet, August 2, 2012, page 31.

Our main message with the compendium has always been to show that with dedication, curiosity and an analytical and challenging way of working it is possible to improve the way things are done and this is of course not limited to tennis or other sports. Nor is it limited to only using mathematical analysis methods.

We hope that by publishing this compendium electronically we can inspire people in tennis and other sports to try apply academic research to sports. Our hope is that more people will find inspiration in our works and, like Hjelm and Hallgren (2009), be part of developing the methods presented here and thus improve tennis players' and other athletes' performances.
We finally wish all readers to enjoy and we hope that you will invent many new balls in various contexts in the future.

Pim-Pim Johansson and Niclas Johansson
Hölö, summer of 2012

Preface to the 2008 version

Almost exactly 15 years ago Pim-Pim was interviewed by Johan Esk who then worked as a reporter at the Swedish newspaper Länstidningen in Södertälje. Johan asked Pim-Pim what he would do if balls did not exist. The answer is the title of this compendium.

During these 15 years we have daily had intense discussions about tennis. We have discussed which tactics is the best, which way of training is the best, which tournaments are best to play and so on. This compendium is the result of our curiosity.

Now when Pim-Pim has finished his career as a player we have decided to publish this compendium to be able to share the knowledge we have on tennis. We are aware that the compendium can feel complicated the first time you read it. We therefore recommend the reader to read it several times to get a deeper understanding for the content.

Swedish tennis will never have the same financial conditions as the "big" tennis nations. But we have something we can compete with, and that is knowledge. In Swedish tennis we have been bad at transferring this knowledge and experience between generations of tennis players.

With this compendium we want to challenge all former players and coaches to share their experience.

We also want with this compendium to create a debate on tactics and training. In Swedish tennis we need to dare to be open to new ideas and new ways of thinking. That a player chooses to go his own way and to invent his own balls should be encouraged, not the other way around…

Pim-Pim Johansson and Niclas Johansson
Södertälje, February 10th 2008

Table of contents

1. Introduction

Before the Olympics in Amsterdam 1928 the Swedish Olympic Committee forbade their athletes to train in training camps. Since then the evolution of sports has been enormous. During the 1970's some players started hiring personal coaches and also started working with physical coaches and physiotherapists, for example stretching became a natural part of practice. The last decades the evolution has continued with athletes hiring psychologist and financial advisers. The 21st century's professional tennis players bring a large entourage to the big tournaments. In addition to one or two tennis coaches they bring a physical coach, a physiotherapist, a massage therapist, a financial adviser, a stringer and so on…

But something is actually missing. That is what this compendium is about.

In 1994 the Nobel Prize in Economic Science was awarded to John Nash who during the 1950's developed game theory. In the 1990's, inspired by the work of Nash, John Wooders and Mark Walker, professors at the University of Arizona, started to apply the game theory on tennis. The result became an article in the leading economical journal American Economic Review, where they show how game theory can be applied on tennis.

As we will later show in this compendium it is possible to actually decide whether the tactics chosen was the optimal or if there was another tactics that would have given the player a better chance of winning the match. Did the player play too much or too little serve volley? Did the player serve too much towards the T? Did he return too much towards the centre of the court? All this can be analyzed using game theory. Today's coaches do not have the knowledge to analyze this but instead they guess, which often leads to their player losing large amounts of prize money.

In a time when all professional athletes practice almost just as much the importance of practicing the right things and playing with the right tactics will increase. As we will later show the difference between being number 20 or number 80 on the world ranking is very small. It takes only small improvements (if you improve the right things) to climb the rankings. We will also show that by making small tactical adjustments (if you make the right ones) you can also improve the ranking drastically.

The compendium can also be seen as a journey towards the future of sports. The same way it in the 1920's was unthinkable to prepare for a championship in a training camp, it is now unthinkable to use mathematics to improve an athlete's performance. But in the same way training camps are now unquestionable, mathematical analysis in sports will be the just as unquestionable in the future.

Since the compendium contains many numbers and charts we cannot guarantee the absence of typographical errors.

To not discommode readers with lesser mathematical knowledge we have deliberately chosen not to be too stringent in the reasoning and to not explain the theory in detail. For the interested reader we refer to the references in chapter 11. This compendium is to be viewed as an introduction to the topic.

2. Analysis of basic match statistics

Let us begin by examining the electronically available match statistics on the internet from (almost) all matches played on the ATP Tour since the beginning of the 1990's:

x_1 = Percentage of first serves correct.

y_1 = Percentage of first serve points won (given that the first serve is correct).

x_2 = Percentage of second serves correct.

y_2 = Percentage of second serve points won (given that the second serve is correct).

r_1 = Percentage of first serve return points won (given that the opponents first serve is correct).

r_2 = Percentage of second serve return points won (given that the opponents first serve is not correct).

Diagram 1 shows Roger Federer's numbers for correct first serves x_1 for his matches on the ATP Tour up until August 2006. As can be seen this varies massively from match to match.

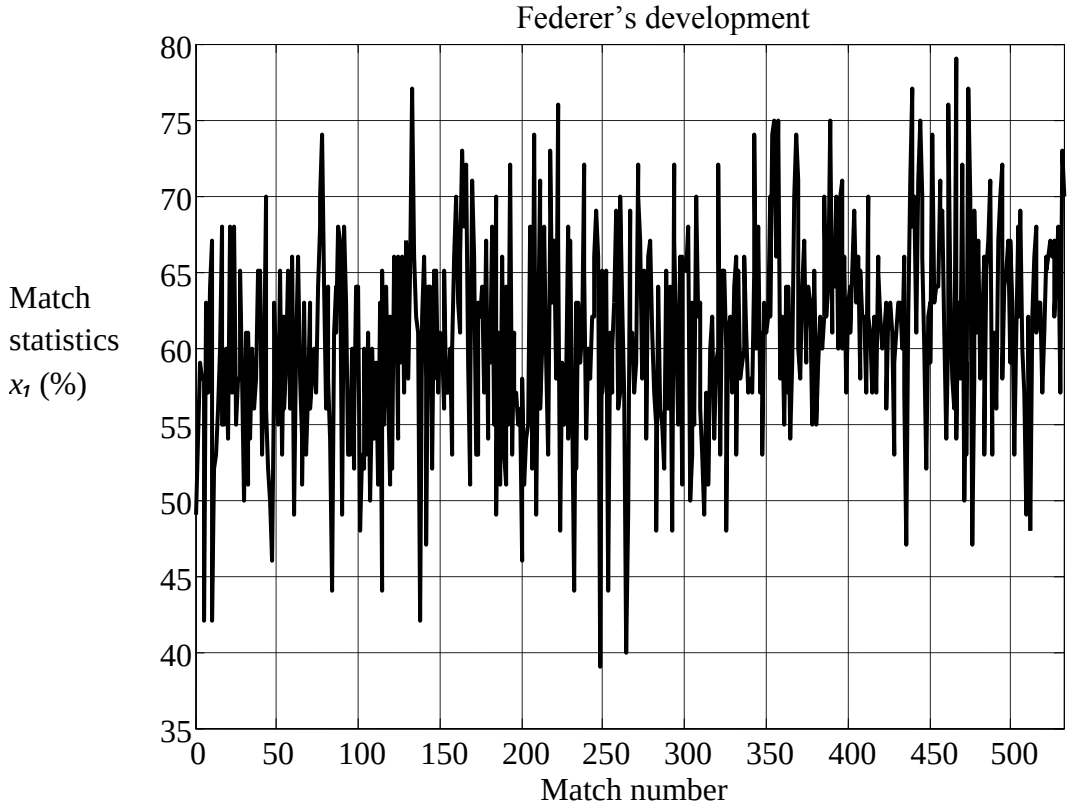

Diagram 1. Federer's match statistics, x_1 = first serve correct, percentage.

The only thing the diagram shows is that the number is normally between 50 % and 70 %. Primarily the diagram shows the difficulty in analyzing match statistics because for isolated matches the statistics are in many ways random and diagram 1 will give us almost nothing of value.

So how are you supposed to do? What is interesting is to study the long-term trend. The reason for this is that a player's world ranking is decided by how well the player performs over a longer period of time. The world ranking is based on how well the player has performed over the last 52 weeks. Let us thus make a diagram showing the long-term trend of correct first serves x_1 and first serve points won y_1 for Federer. In other words the part of the match statistics depending on random effects has been eliminated. The result is shown in diagram 2.

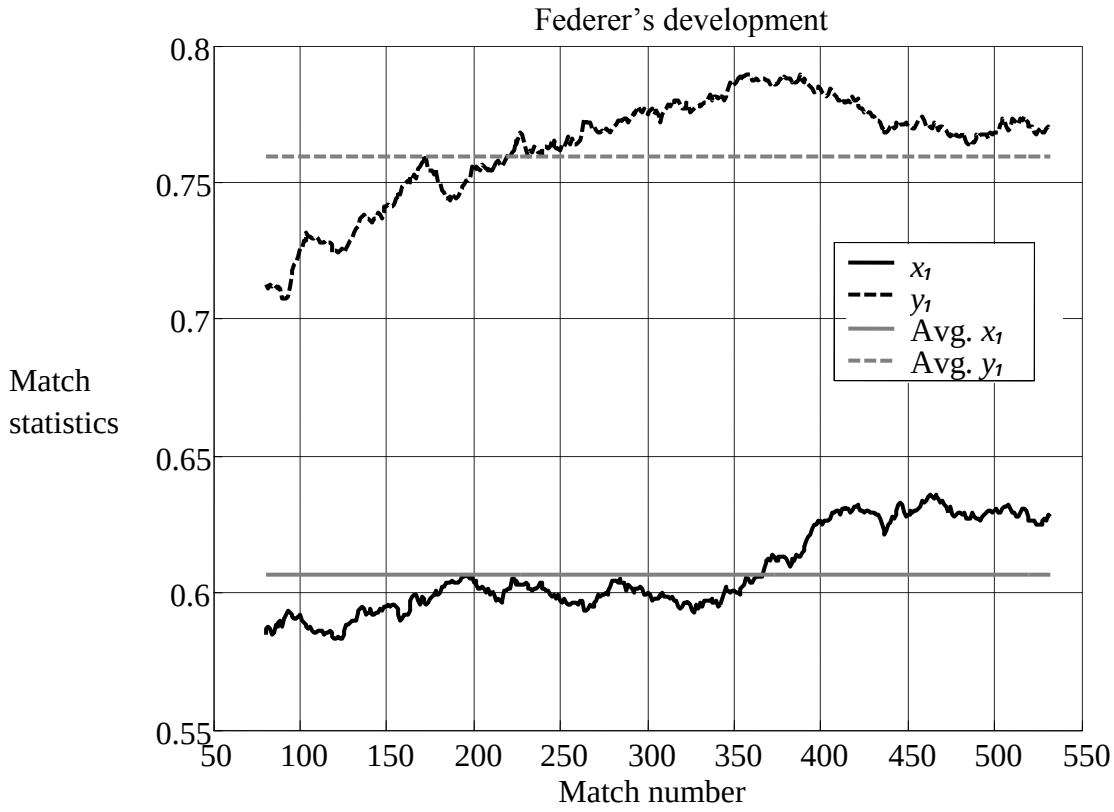

Diagram 2. Federer's match statistics, x_1 = first serve correct, percentage and y_1 = first serve points won, percentage.

Diagram 2 shows that for the first 350 matches Federer had a first serve percentage of 60 % and then improved this to 63 %. In the same way we can see that first serve points won y_1 increases a lot up until match number 350. After that first serve points won actually declines.

Even though Federer has kept the position as unthreatened world number one he has actually deteriorated in winning points when his first serve is correct.

Note that this could very well be a deliberate tactical choice. It could be that Federer has chosen to serve with less speed which has increase x_1 and decreased y_1, as we can see there is an obvious connection between the increase of x_1 and the decrease of y_1 between match number 350 and 450. In the following section we will ask the question if this tactical move by Federer was brilliant or not.

More diagrams on match statistics for Roger Federer and Ivan Ljubicic are shown in appendix 1[6]. We leave it to the reader as an exercise to analyze these diagrams.

Match statistics appears to summarize how good a tennis player is very well. The match statistics is determined by how the player practices and which tactics he uses in match play. In a recently published thesis Barnett (2006) states how match statistics show how good a player is. With Barnett's thesis you can by means of only the basic match statistics (x_1, y_1, x_2, y_2, r_1 and r_2) in a very good way actually calculate which ranking a player "should" have.

Diagram 3 shows how Federer's actual ATP ranking has developed over time. The ATP ranking is updated on a weekly basis why the curve is a little "rugged". The diagram also shows a curve of which ranking, according to analysis of match statistics, the player "should" have.

When writing "should" we hereby mean a player who meets the following criteria:

- The player is free from injury during the whole season.
- The player fights as hard in all matches, no matter if it is the final of Wimbledon or the first round in Palermo.

[6] In the diagrams the players' matches up until August 2006 are shown.

- The player is not affected by his nerves, no matter if it is match point of the final of Wimbledon or 40-0 in the first game of first round in Palermo.

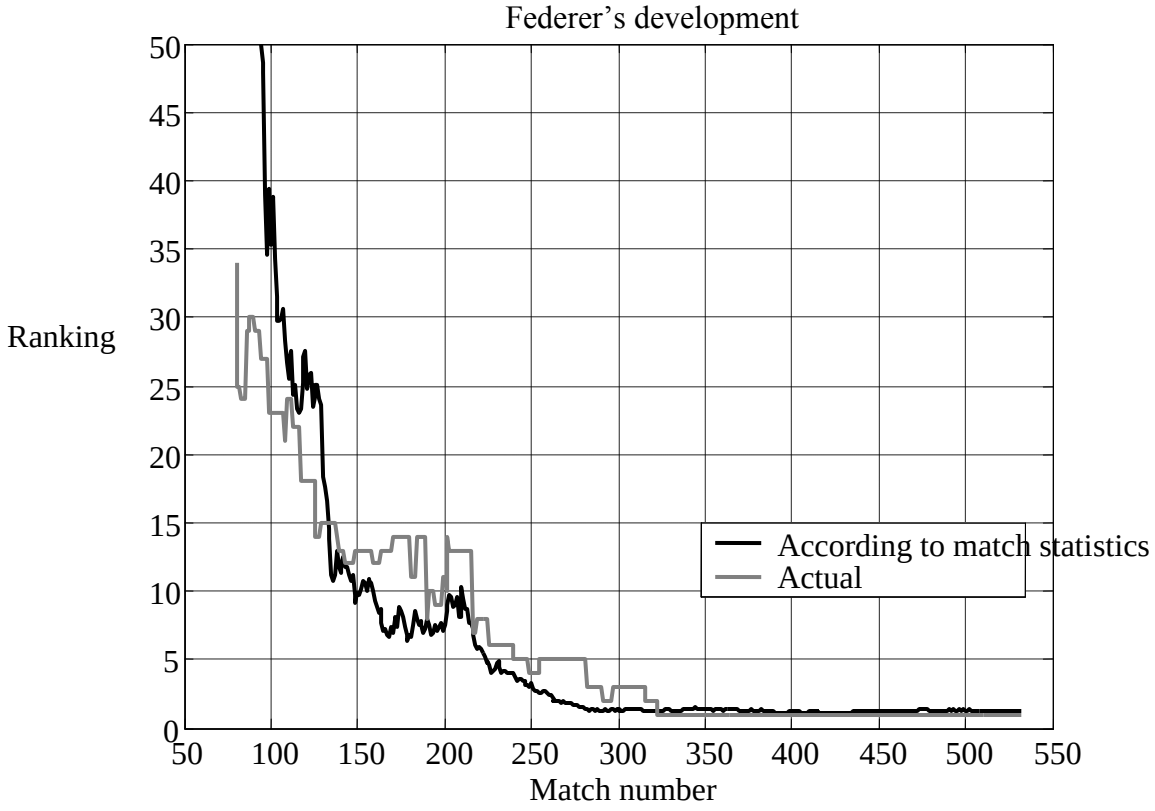

Diagram 3. Federer's ranking.

Obviously there is no player who meets all the criteria, not even Federer. However, diagram 3 does show that the actual ranking coheres very well with the ranking the player should have according to the match statistics.

Diagram 4 shows the equivalent curves for Ivan Ljubicic. Here as well the changes in the match statistics reflect the changes of the world ranking very well.

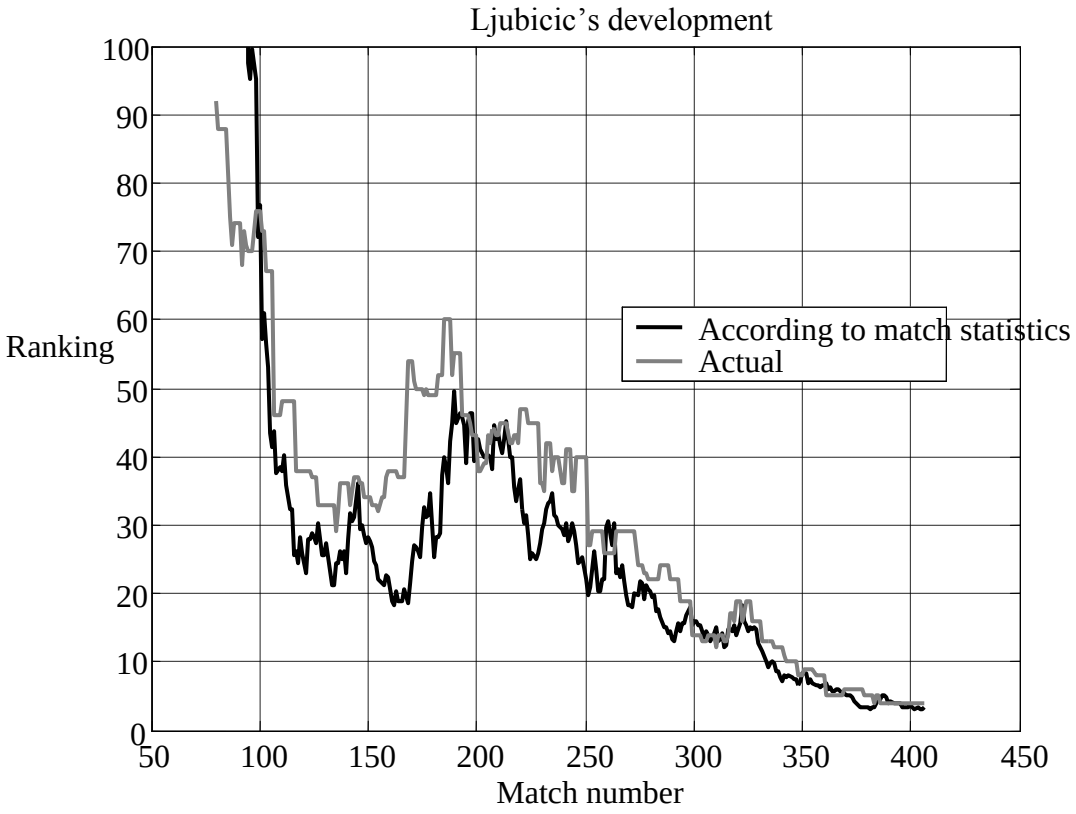

Diagram 4. Ljubicic's ranking.

The conclusion of diagram 3 and 4 is that a player's ranking is essentially decided by the match statistics the player has. This means, among other things, the following:

- A player gets the ranking he deserves. In other words, you cannot deceive mathematics in the long run. To obtain a good ranking you need to have good match statistics. And if you have good match statistics you will obtain a good ranking.
- How important a variable of the match statistics is depends on the other variables in the statistics. **This leads us to the understanding that it is vital to individually adjust a player's training according to his talents and conditions. In other words there is no standard road to success.**
- **A coach should not be influenced by opinions from journalists or other people in the tennis world on the particular parts of match statistics. For example amongst today's journalists it is regarded as worse losing an important point by making a double fault than losing the same point after a long rally from the baseline. This has actually affected players to make fewer double faults than they should. This will be analyzed in detail in following sections.**

- The most important conclusion however is that the detected connection between match statistics and ranking can be used as an instrument to decide how a player should practice. By practicing a certain way, the player's statistics are affected and thus his ranking. Therefore it is important to practice in a way that will give the player the statistics that will lead to the highest ranking possible, his talents taken into account.

By understanding how a certain change in match statistics will change the ranking you can also understand the optimum amount of time a player should focus his practice on various parts of the game.

Table 1 shows which ranking Ljubicic should have had the summer of 2006 for various values of x_1 and r_1. For example it can be made out that Ljubicic could be number 3 on the ranking either by having x_1 = 60 % and r_1 = 30 % or by having x_1 = 63 % and r_1 = 29 %.

A coach should therefore, if possible, modify the practice so that the match statistics are optimized in a way that improves the ranking.

Question[7]: Ljubicic practices 500 hours of tennis in a year. Out of these 50 hours is serve practice and 50 hours is return practice. This gives the match statistics x_1 = 55 % and r_1 = 23 %. If Ljubicic instead would practice 30 hours of serve and 70 hours of returns the match statistics would be x_1 = 50 % and r_1 = 27 %. Should Ljubicic's coach implement this change in the practice?

Answer: Yes, because according to table 1 the ranking would improve from 23 to 14!

Intuitively it is very difficult, not to say impossible, to perceive that x_1 = 50 % and r_1 = 27 gives a considerably higher ranking than x_1 = 55 % and r_1 = 23 %.

[7] The numbers in the example are fictitious; the authors have no knowledge of how Ljubicic practices.

x_1/r_1	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
50	82	64	49	38	30	23	18	14	11	9	7	6	5	4	4	3	3
51	74	57	45	35	27	21	17	13	10	8	7	6	5	4	3	3	2
52	67	52	40	31	24	19	15	12	10	8	6	5	4	4	3	3	2
53	60	47	36	28	22	17	14	11	9	7	6	5	4	3	3	3	2
54	54	42	33	25	20	16	12	10	8	7	5	4	4	3	3	2	2
55	49	38	30	23	18	14	11	9	7	6	5	4	4	3	3	2	2
56	44	34	27	21	16	13	10	8	7	6	5	4	3	3	2	2	2
57	40	31	24	19	15	12	9	8	6	5	4	4	3	3	2	2	2
58	36	28	22	17	13	11	9	7	6	5	4	3	3	3	2	2	2
59	32	25	20	15	12	10	8	6	5	4	4	3	3	2	2	2	2
60	29	23	18	14	11	9	7	6	5	4	3	3	3	2	2	2	2
61	26	21	16	13	10	8	7	5	5	4	3	3	2	2	2	2	2
62	24	19	15	12	9	8	6	5	4	4	3	3	2	2	2	2	2
63	21	17	13	11	8	7	6	5	4	3	3	3	2	2	2	2	2
64	19	15	12	10	8	6	5	4	4	3	3	2	2	2	2	2	1
65	17	14	11	9	7	6	5	4	3	3	3	2	2	2	2	2	1
66	16	12	10	8	7	5	4	4	3	3	2	2	2	2	2	1	1
67	14	11	9	7	6	5	4	4	3	3	2	2	2	2	2	1	1
68	13	10	8	7	6	5	4	3	3	3	2	2	2	2	2	1	1
69	12	9	8	6	5	4	4	3	3	2	2	2	2	2	1	1	1
70	11	9	7	6	5	4	3	3	3	2	2	2	2	2	1	1	1

Table 1. Ljubicic's ranking for the summer of 2006 as a function of x_1 and r_1, ceteris paribus[8], x_1 = first serve correct, percentage and r_1 = first serve return points won, percentage.

Before concluding this section we will make another very interesting observation, namely that the margins in professional tennis are very slim. A tiny improvement in a small part of the game will have large impact on the world ranking. If for example Ljubicic has x_1 = 50 % and r_1 = 20 % he would, according to table 1, have a world ranking of 82. If he would now improve only r_1 to 23 % his ranking would change to number 38!

By winning only 3 more points out of 100 when the opponent plays a first serve and not improving anything else the ranking in the example improves from 82 to 38!!!

Some journalists seem to think that the reason certain players can improve their results drastically in a short period of time is by using illegal substances. But here mathematics shows that a player who starts practicing smarter easily can improve his results a lot in a short period of time. In the same way players who start taking easy on their practice will soon pay the price by dropping on the rankings.

[8] Ceteris paribus is latin for "everything else equal", that is only the variables in the table change values, the other variables remain the same with the values they had in July 2006.

The primary reason to why a lot of players do not act as professionally as you would expect them to is that they are not aware of how tiny the margins are in professional tennis. But note that the ranking nonetheless is decided by chance, which we stated earlier.

In the following sections we will show how different methods of analysis can be used to determine if a player uses the optimal tactics in match situations. **With optimal tactics we mean the tactics that will give the player the best match statistics and thus the best ranking taken into consideration how the practice has been planned.**

3. Who wins a match?

Before we start analyzing optimal tactics we need some understanding for the advanced scoring system in tennis. It is advanced because as opposed to for example soccer it is not easy to answer the question above: who wins a match? In soccer the team that scores the most goals wins, but in tennis it is not always the player who wins the most points that wins the match.

To get a sense of the scoring system in tennis and to how different points have different importance for the outcome of the match we are now going to analyze one of the best matches of all time. The match is the final of Wimbledon in 1980 between Borg and McEnroe. Borg won the match 1-6, 7-5, 6-3, 6-7 (16-18), 8-6 after 3 hours and 53 minutes of play.

Let us assume that before the game started Borg's chances of winning the match were 50 %. The question now is how these chances changed during the course of the match. Is it possible, after a certain point, say 100 points, to calculate the probability of Borg winning the match by using only the current score and match statistics from the first 100 points? The answer to this question is yes, see for example Barnett (2006).

Diagram 5 shows how the probability of Borg winning the match changed during the course of the match. After point number 47 Borg had lost the first set by 1-6 and the probability of winning the match was only about 10 %. The reason it was so small is partly that Borg was down by one set to love, partly because Borg had played much worse tennis than McEnroe during the first set.

During the second set not much happened, but when Borg won this by 7-5 the probability of winning the match increased. After that Borg gradually started playing better tennis and the probability of him winning the match increased throughout the third set. When Borg won the third set after point number 194 the probability of winning the match was no higher than 50 % even though he was up by two sets to one. The reason for this is that McEnroe had won 68 % of the points when serving while Borg had only won 61 % when serving.

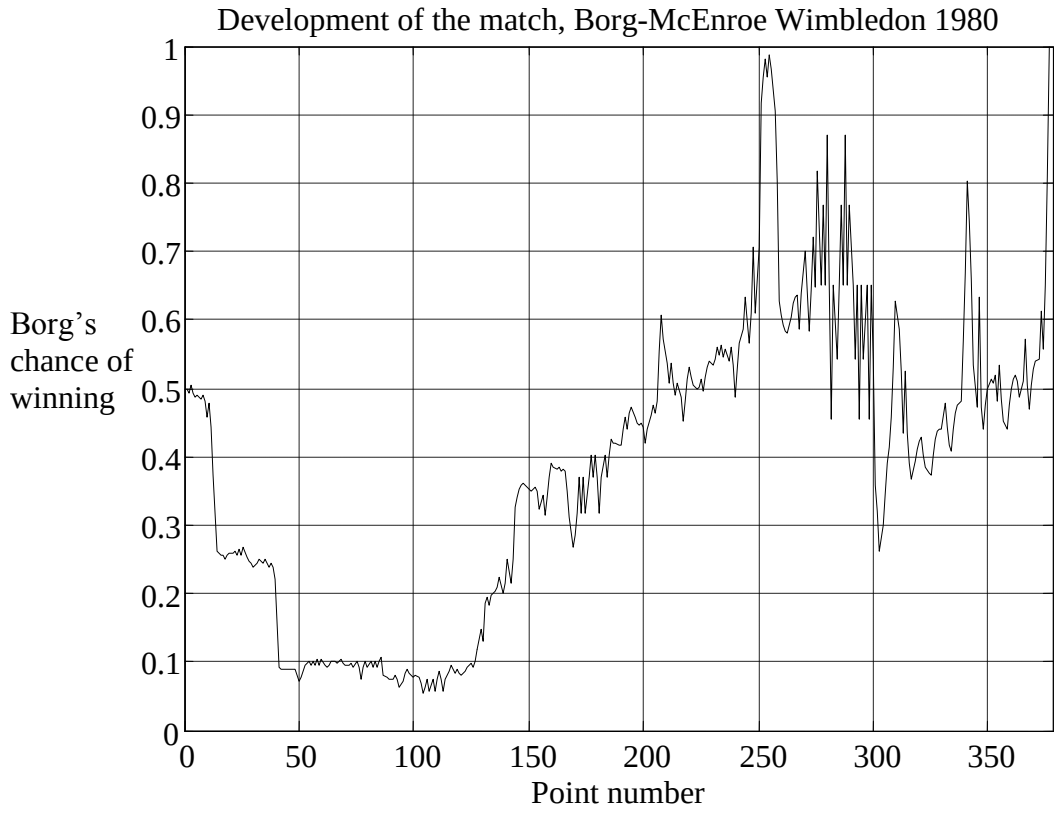

Diagram 5. Borg-McEnroe, Wimbledon 1980.

At point number 255 Borg was leading 5-4 and 40-15 and was serving for the match with two match points. This made the probability of Borg winning the match increase to almost 99 %. But as we all know Borg lost that game and subsequently the classical tie-break by 16-18. After the loss of the tie-break the chance of winning the match had dropped to under 30 %. At point number 343 Borg was up 4-3 in games and 30-40 when McEnroe was serving. The chance of winning the match then increased to 80 %. But when Borg failed to win this returning game the chance once again dropped to 50 %. The match had then gone 350 points and you could say the players were back at starting positions with both having a 50 % chance of winning the match. Finally Borg managed to win the match by 8-6 in the fifth set.

By studying a match like this in detail you realize that the margins in a single match are very small and who wins a match like this is largely decided by chance. But in spite of this fact the ranking based on matches throughout a whole season is not determined by chance. This we learned in the previous chapter.

By studying diagram 5 you also realize that certain points are “more important” than others in a match. Let us therefore introduce the following definition:

Importance of a point = the probability of winning the match given that the point is won – the probability of winning the match given that the point is lost.

The definition is best clarified in two examples: Before point number 343 the score is 2-2 in sets and 4-3 in games in favor of Borg, McEnroe is serving at 30-40. If Borg wins the point the probability of winning the match is 92 % and if Borg loses the point the probability of winning the match is 54 %. Thus the importance of the point equals 92 % - 54 % = 38 %.

Before point number 351 the score is 2-2 in sets, 4-4 in games, Borg serving at 40-0. If Borg wins the point the probability of winning the match is 52 % and if Borg loses the point the probability of winning the match is 51 %. The importance of the point is 52 % - 51 % = 1 %.

Diagram 6 shows the development of the importance of points during the match. We can clearly see that some points are more important to win than others. For example all points of the classical tie-break were important. But the most important point of the match was after all Borg’s break point at 4-3 in the fifth set.

By means of diagram 6 all points of the match can be ranked according to importance. This ranking can be viewed in appendix 2.

This analysis thus gives a numerical value to how important a point in a match is. By collecting this data for a large number of matches you can decide if your player performs better/worse than normal on important/unimportant points. With this knowledge the coach can take necessary actions to try to make the player perform equally well on all points. If for example a player underachieves on unimportant points this could mean the player lacks physical stamina and does not have the energy to fight as hard on all points. A player like that should do more fitness training.

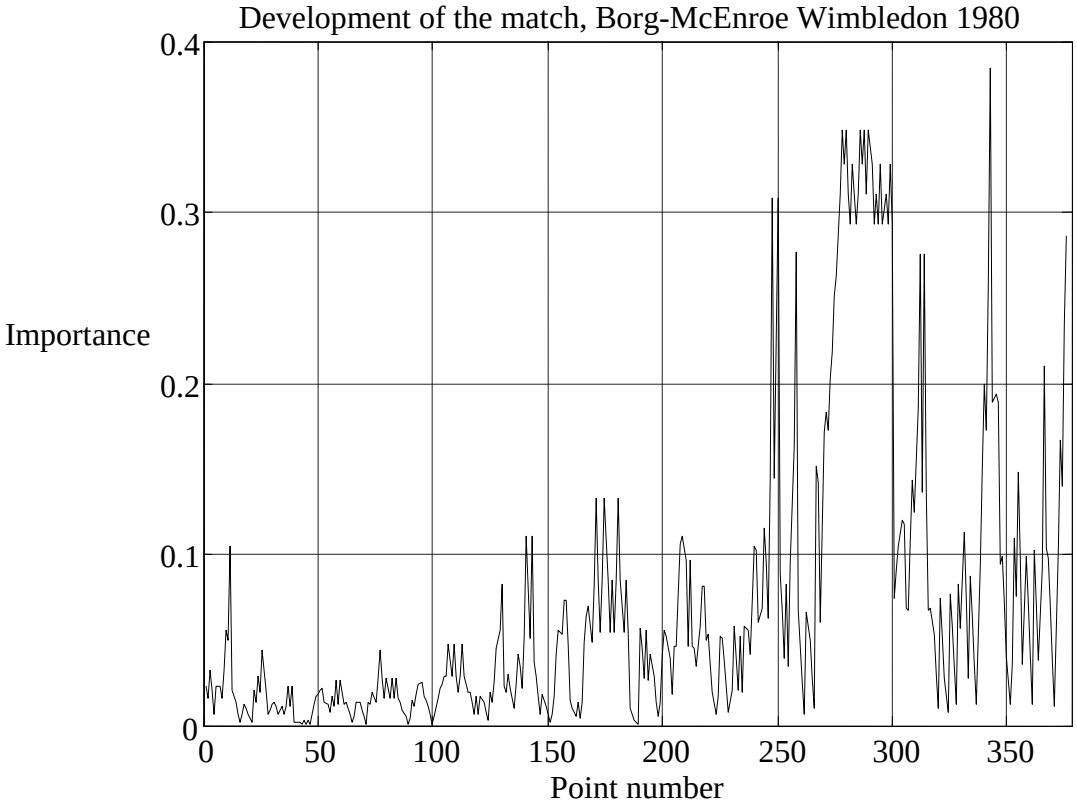

Diagram 6. Borg-McEnroe, Wimbledon 1980.

4. Optimal tactics part I: Choice of first serve percentage and second serve percentage

A professional tennis player can by varying the speed of the serve choose which serve percentage he will have[9]. The higher the serve percentage is the lower the probability of winning the point is, given that the serve is correct.

Let x be the serve percentage a player chooses and let $y(x)$ be the probability of winning the point given that the serve is correct.

Below diagram 7 shows what this curve looked like for Federer in 2001 and 2006. The curve has over the years been pushed outwards which means Federer has become better at winning points in his own serve at all choice of serve percentages. The diagram shows the choices of serve percentage Federer has made. The question is of course if these choices were optimal? In other words, was there a different choice of serve percentage that would have made Federer win a larger percentage of his service games?

[9] The serve percentage of course also depends on other factors, for example placing of the serve. To simplify we choose to disregard from this.

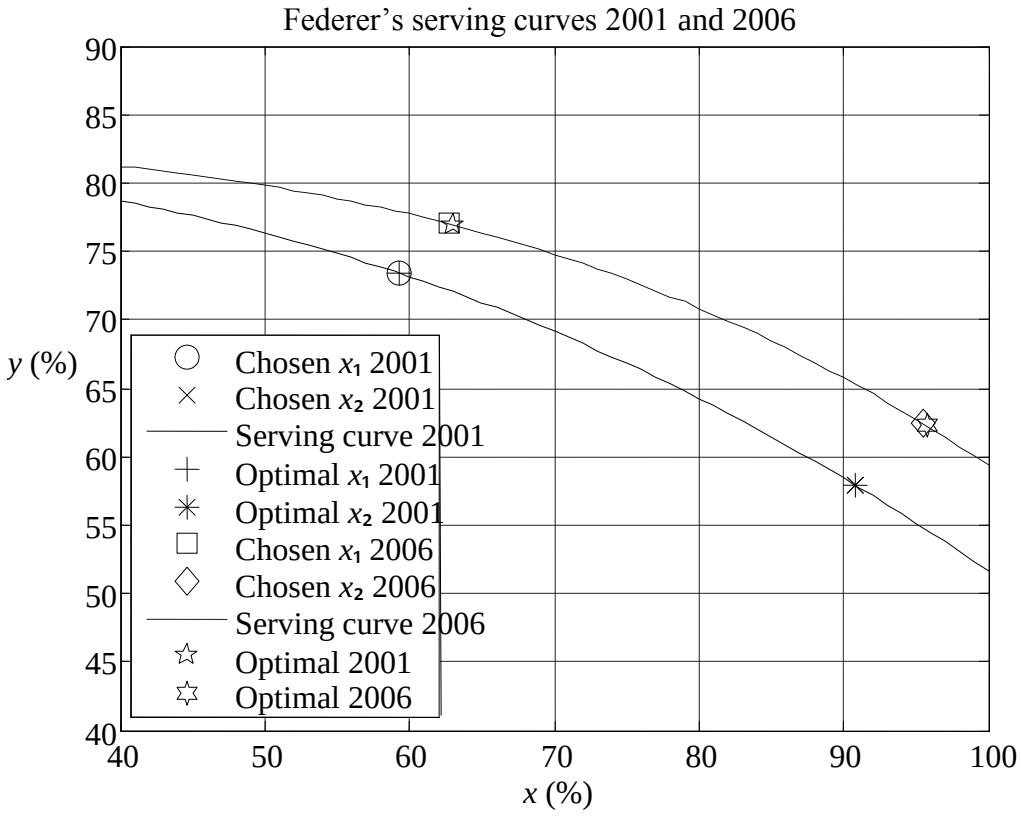

Diagram 7. Federer's serving curves for 2001 and 2006, x = serve percentage, y(x) = probability of winning the point given that the serve with serve percentage x % is correct.

By using mathematics you can actually calculate which choices of x_1 and x_2 will give the highest probability of winning a service game[10]. In diagram 7 the optimal choices are also shown[11]. **We can see that Federer has succeeded in choosing almost the exact optimal values.**

It is also very interesting to see that Federer has managed to adapt the second serve percentage gradually when he has developed as a tennis player. In an earlier section we saw that with time Federer has chosen a higher and higher percentage of both first and second serves. Diagram 7 shows this has been an optimal choice by Federer. **This conclusion also indicates one of the reasons why Federer is probably the best tennis player of the open era. He has managed to adapt his tactics to the circumstances.**

[10] For specific assumptions of the model we refer to Klaassen and Magnus (2006).
[11] For second serve percentage 2001 the optimal value equals the chosen value. That is why a symbol seems to be missing.

Diagram 8 shows what the curve *y(x)* looked like for Federer and Ljubicic in 2006. We can see that for serve percentages below 70 % Ljubicic was better than Federer at winning the points, while for serve percentages above 70 % Federer was better than Ljubicic at winning the points.

The diagram also shows the optimal values. Note that Ljubicic, as opposed to Federer, has not managed to choose the optimal values. According to the analysis Ljubicic play with too little risk in his serves for it to be optimal. In other words he makes too few double faults!!!

The diagram also shows that it is optimal for Ljubicic to choose lower serve percentages than Federer. The reason for this is that Ljubicic's serving curve is steeper than Federer's. Federer's serving curve is very flat, which means he is not as dependent on a high-speed serve to win the point when serving as other players are. The reason for this is of course that the rest of his game is superior to others.

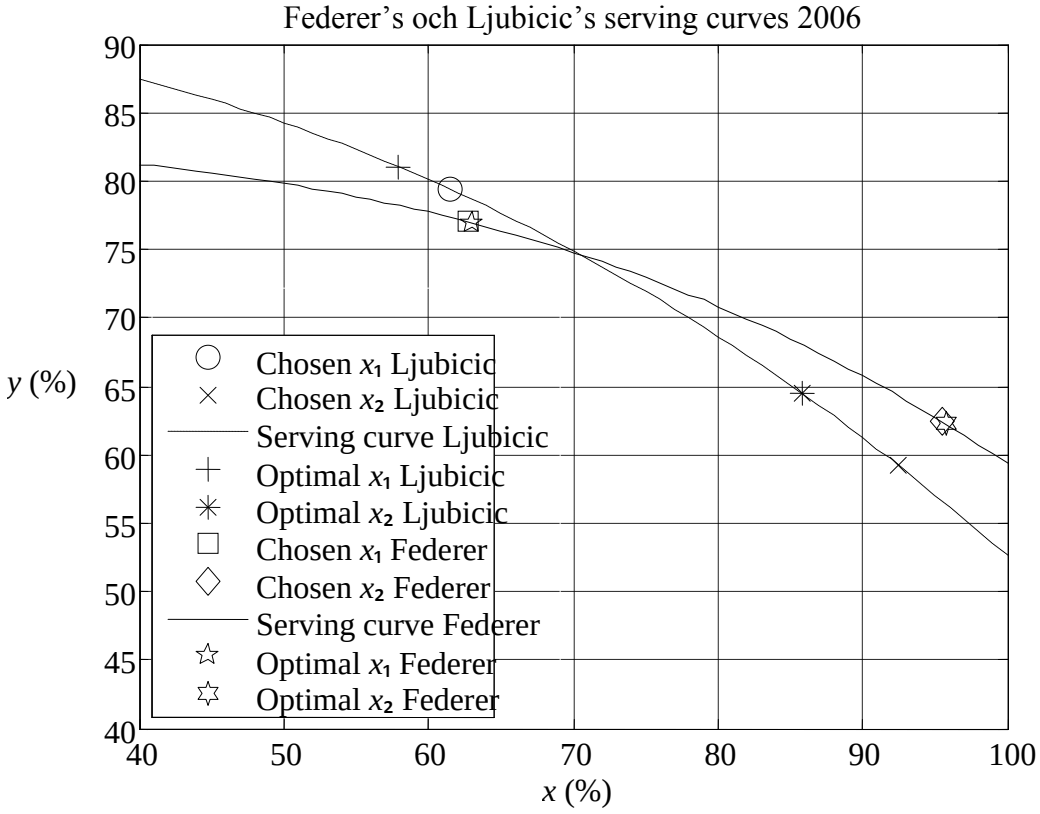

Diagram 8. Federer's and Ljubicic's serving curves, x = serving percentage, y(x) = percentage of points won given that the serve with serve percentage x % is correct.

Here we see an example of how the optimal tactics (here the choice of serving percentage) is individual. Some players should make many aces and many double faults while other players should make few aces and few double faults. What distinguishes a good coach from a bad coach is that the good coach has the knowledge and ability to adapt the tactics to the player's individual aptitude. Just because you reached success using a certain tactics with one player it does not mean another player should use the same tactics.

The question now raised is how much a player like Ljubicic actually loses by serving with serve percentages that are not optimal. Table 2 describes which ranking Ljubicic would have had in 2006 for various choices of first and second serve percentages. For example a first serve percentage of 54 % and a second serve percentage of 70 % would have given him a world ranking of 5.

x_1/x_2	**60**	**62**	**64**	**66**	**68**	**70**	**72**	**74**	**76**	**78**	**80**	**82**	**84**	**86**	**88**	**90**	**92**	**94**	**96**
50	11	9	8	7	6	5	5	4	4	4	4	4	3	3	3	4	4	4	4
52	10	8	7	6	5	5	4	4	4	4	3	3	3	3	3	3	3	4	4
54	9	7	6	6	5	5	4	4	4	3	3	3	3	3	3	3	3	3	4
56	8	7	6	5	5	4	4	4	4	3	3	3	3	3	3	3	3	3	4
58	8	7	6	5	5	4	4	4	3	3	3	3	3	3	3	3	3	3	4
60	7	6	6	5	5	4	4	4	3	3	3	3	3	3	3	3	3	3	4
62	7	6	6	5	5	4	4	4	4	3	3	3	3	3	3	3	3	3	4
64	7	6	6	5	5	4	4	4	4	4	3	3	3	3	3	3	3	4	4
66	7	7	6	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4
68	8	7	6	6	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4
70	9	8	7	6	6	5	5	5	5	4	4	4	4	4	4	4	4	5	5
72	9	9	8	7	7	6	6	6	5	5	5	5	5	5	5	5	5	5	5
74	11	10	9	8	8	7	7	7	6	6	6	6	6	6	6	6	6	6	6
76	13	12	11	10	9	9	8	8	8	7	7	7	7	7	7	7	7	7	8
78	16	15	14	13	12	11	11	10	10	9	9	9	9	9	9	9	9	9	10
80	21	19	18	16	15	15	14	13	13	12	12	12	12	12	12	12	12	13	13

Table 2. Ljubicic's ranking as a function of tactical choices of serve percentages, x_1 = first serve percentage and x_2 = second serve percentage.

The table shows a grey zone which indicates the choices of serve percentages that gives him a world ranking of number 3. During 2006 Ljubicic was in the lower right part of this zone, his "actual" world ranking fluctuated between 3 and 4 during the fall of 2006. If instead Ljubicic would have served with optimal values of x_1 and x_2, thus being in the middle of the grey zone, he would most likely have been a steady top 3 ranked player.

Klaassen and Magnus (2006) studied if the professional players use an optimal serving tactics. They have studied 508 men singles matches and 508 women singles matches from the Wimbledon Championships.

Their conclusion is that the professional players in general do not use optimal serving tactics. They also calculate a measurement of how much a professional player would improve in general if he/she would have chosen optimal values of first and second serve percentages. Their result shows that a male player who would start serving with optimal speed could increase his earnings by an average of at least 19 %. The corresponding number for a female player is 33 %.

Klaassen and Magnus (2006) also states that above all the professional players choose a too high serve percentage on the second serve. Their theory is that the players do this because they are afraid to make double faults. But it is important to remember that a lost point on a double fault is the same as a lost point after a long rally from the baseline. The opinion amongst coaches and journalists that a player should make few double faults is thus making the player lose large amounts of prize money.

A female player ranked number 10 making € 1 000 000 in a year could on average make € 330 000 more only by changing tactics to optimal serving speed!!! *According to Klaassen and Magnus (2006)*

The question now is why do players not choose the optimal tactics when it is so lucrative? The answer is that you think you are choosing the optimal tactics since you believe your coach is competent enough to decide whether a tactics is optimal or not. But it is very naïve to believe that you from the galleries without mathematical help can decide whether a player plays with optimal tactics or not.

Klaassen and Magnus (2006) also show that the better the player is (based on the ranking), the closer to optimal speed he serves with. If you think about it, it makes sense. **Since the knowledge on how to actively choose the optimal tactics not yet exists among the professional players, the player who "happen" to choose a tactics close to the optimal has a big advantage over his opponents.**

Let us now examine if the top players of 2006 served with optimal tactics. In appendix 3 all top-100 players are ranked according to how inefficient tactics they used[12]. The higher the value in column called "measurement of inefficiency[13]" the further away from optimal tactics the player is. Among "warning examples" we find a lot of offensive players like Roddick, Lopez and Mirnyi. These players choose by historical reasons almost the same second serve percentage as defensive players, even though they have a totally different style of playing and consequently should choose a totally different tactics. In 2006 Roddick had a second serve percentage of 94 %. To serve with something close to optimal tactics he should lower this by at least 10 percentage points to 84 %.

Let us also examine if the lower ranked players in the top-100 are less efficient in choice of tactics than the higher ranked players. Table 3 below shows that we came to the same conclusion as Klaassen and Magnus (2006) when examining this, namely that the lower ranked players play with a less effective tactics than the higher ranked players.

Ranking	Inefficiency
1-20	0,25%
21-40	0,21%
41-60	0,21%
61-80	0,44%
81-100	0,63%

Table 3. The inefficiency rate for top 100 players in 2006, divided into ranking groups.

We have earlier in this compendium seen how tiny the margins in the professional tennis of today are, which is why it is possible to earn a lot of money by choosing the optimal tactics.

Question: Why do you think one of the authors of this compendium risked a lot on the second serves, thus making more double faults than other top players?

Hint: In appendix 4 the top 100 players of 2004 are ranked according to service games won, with a column of how many double faults they made per match. The mean value of service

[12] For "political" reasons we have chosen not to include players with strong Nordic interests.
[13] This measurement is calculated using the theory in Klaassen and Magnus (2006).

games won for top-100 players in 2004 was 78,8 % and the mean value for the number of double faults per match was 3,2. For the ten players[14] making the most double faults in 2004 the mean value of service games won was as much as 82,4 % and the mean value for double faults per match was as much as 5,5.

[14] The players were Labadaze, Carraz, Dent, Rusedski, Arthurs, Enqvist, Karlovic, Philipoussis, Tursunov and the author.

5. Optimal tactics part II: Game theory applied to tennis

This section will first give a brief introduction to game theory. Thereafter we will apply game theory to professional tennis.

So what is game theory? In 1994 the mathematician John Nash was awarded the Nobel Prize in Economic Science for his achievements in the mathematical discipline of game theory. Also in 2005 the Nobel Prize in Economic Science was awarded to mathematicians pursuing game theory. Game theory analyzes situations where two or more parts interact. Examples of situations like these are chess, poker, tennis, balance of terror, different types of negotiations and ballots, as well as models of competition in economics.

Nash's big achievement was the formulation of the Nash equilibrium. A Nash equilibrium is the tactical situation where a player can not improve his position by changing tactics. The Nash equilibrium therefore denotes a player's optimal choice of tactics.

Nash formulated the concept already in 1950 but it took almost 50 years before he was rewarded for his geniality. When a theory is awarded a Nobel Prize a lot of scientist take interest in the subject and try to apply it in reality. Walker and Wooders at the University of Arizona came up with the idea of applying the Nash equilibrium to professional tennis and examine if the players' choice of tactics were Nash equilibriums.

They started by writing an article, Walker and Wooders (2000), where they theoretically derive a number of terms which have to be fulfilled for a player's choice of tactics to be a Nash equilibrium. **In tennis a Nash equilibrium is thus the combination of tactics where the player by changing tactics cannot improve his chances of winning the match. The Nash equilibrium therefore denotes the optimal tactics.** Their terms for optimal tactics are the following:

Term 1: "A player must play each point as if it were the only point, his play should be independent of the score."

This term states that the player should not let the score board dictate which tactics he will use. So how do you test this? By using the concept of importance presented earlier in the compendium. If a player plays with the optimal tactics the probability of winning a service point or returning point is independent of the importance of the point. For example the probability of winning a service point when the score is 40-0 should be the same as when the score is 15-30.

Klaassen and Magnus (2001) have examined if the professional players pursue this term. They have examined 90 000 points played at the Wimbledon Championships. Their conclusion can be summarized as following:

Male players won on average 65 % of all the points in their own serve. If a point had the importance of 0 % the player serving won 65,4 % of the points. If the importance of the point equals the score of 30-40 in the first game the probability of winning the point drops to 64,2 %. If the importance of the point equals the score of 2-2 in sets, 5-5 in games and 30-40 the probability of winning the point drops to 60,6 %. The corresponding numbers for female players are: 56 %, 56,6 %, 55,2 %, 53,9 % and 51,2 %.

The most interesting result is however:

"At important points it is more difficult for the server to win the point than at less important points. Furthermore, the weaker a player, the stronger are these effects."

Their conclusion is thus, the weaker a player the larger the deviation from optimal tactics is. **Thus, the weaker players are affected by nerves to a greater extent than the champions. Is this what separates the champions from the average player?**

Table 4 below describes the yearly statistics from 2004. The third column indicates the percentage of service points won during the year and the fourth column indicates the percentage of break points (in own serve) won during the year.

The results of the table totally match the study by Klaassen and Magnus. For only two of the top ranked players in 2004 were not affected by nerves at the important break points. Little to our surprise these are Federer and Agassi who both are considered to be among the best

players in the history of tennis. In the table we also find two "warning examples", that is Henman and Coria. That these players have struggled to succeed in the big championships we all know. The reason is that they (unconsciously?) choose a different tactics on important points. Coria who for example never plays serve volley not seldom chose this tactics on the break point. That a tactics like that is not very smart is stated in term 1.

Rank	Name	Won points (%) all points	Won points (%) at break point	Difference
1	Federer	70%	73%	3%
2	Roddick	72%	69%	-3%
3	Hewitt	65%	64%	-1%
4	Safin	67%	65%	-2%
5	Moya	67%	65%	-2%
6	Henman	66%	59%	-7%
7	Coria	63%	55%	-8%
8	Agassi	68%	69%	1%
9	Nalbandian	62%	58%	-4%
10	Gaudio	61%	56%	-5%

Table 4. Serving statistics from the ATP tour in 2004.

Let us now look into exactly how important it is to not underachieve on break points in your own serve. Once again we let our Croatian friend Ljubicic act as an example.

By using Dr Barnett's (2006) mathematics and some discrete-time Markov chain, you can calculate what Ljubicic's ranking in 2004 would have been according to how well he achieved on break points. Table 5 summarizes the analysis.

Ljubicic's actual values for 2004 were 68 % points won in own serve, but if it was break point only 62 % won in own serve. Ljubicic finished the year ranked 22. Our model showing he should have finished the year ranked 24 therefore conforms to reality very well. If instead Ljubicic had played with optimal tactics and not underachieved on break points, he would have ended the year ranked 15.

Players who underachieves on important points thus get a considerably lower world ranking than their game otherwise deserves. But having steady nerves however is part of the game.

Won points (%) All points	Won points (%) at break point	Difference	Ranking
68%	62%	-6%	24
68%	63%	-5%	23
68%	64%	-4%	21
68%	65%	-3%	20
68%	66%	-2%	18
68%	67%	-1%	17
68%	68%	0%	15
68%	69%	1%	14
68%	70%	2%	13
68%	71%	3%	12

Table 5. Ljubicic's possible ranking in 2004 for different values of points won at break point in own serve.

Term 2: "A player must play each point as if it were the only point, his play should be independent of the actions or outcomes of all previous points."

This term states that a player should play a point independent to what has happened earlier in the match. Especially the player should not be affected by the previous point. In the study of Wimbledon Klaassen and Magnus conclude:

Male players won on average 65 % of all the points in their own serve. If the player won the previous serving point the probability of winning the pointed raised to 65,3 % and if the player lost the previous serving point the probability of winning dropped to 64,5 %. For female players the corresponding numbers were: 56 %, 56,5 % and 55,3 %.

Once again the most interesting outcome of the article is that the worse the player, the more affected by the previous point he is. This was also the case when it came to playing regardless of the score.

In this compendium we will apply the theory on the first serve. **The theory states that the probability of hitting a correct first serve should not be affected by whether the preceding serves have been correct or not.**

How do we examine this? We will show this by using an example from the 2004 Davis Cup final between USA and Spain. Below all first serves from Roddick in the singles matches against Nadal and Moya are shown in chronological order. 1 means correct and 0 means false first serve.

01110000000011111010111000011111110001100000101011100011001001110011110001011111011110110111111110100000010010000101101100011110110011101000111110010100111011101011110101110001100011111101000111101110100000011001011111100010000000111011111000111001011001011110011100111111110.

To be able to analyze this sequence of numbers we first need a definition:

Run: A run is an uninterrupted sequence of a number. The sequence 00011000 has three runs. The sequence 00101000 has five runs.

The term that the player should not be affected by his previous serving can mathematically be formulated as the number of runs should not be too few (or too many).

Too few runs imply that if a player starts hitting a few correct first serves in a row he will get into a positive trend. In basketball this is called a "hot hand". But this also means the player will come across a "cold hand" at certain times. In tennis this is very undesirable. For with the fascinating scoring system of tennis it does not matter that at the score of 6-6 in a set you have made 24 straight aces if you then in the tie-break do not make a single correct first serve.

Too few runs thus imply the lack of stability in a player's serving. This can, among other things, be due to that the player has a poor serving technique and/or practices serving too little.

Now let us look at Roddick's serves in Davis Cup. By using mathematics you can calculate what is too few or too many runs. In this example the number of runs is too few if they fall below 122. If you count the example the number of runs is 113.

The conclusion of this example is that Roddick did not play with optimal tactics in the match against Spain as his sequence of first serves contained too few runs.

In 2004 Roddick won 91% of his service games and Federer won 92% of the service games. However table 4 shows that Roddick won 72% of the service points while Federer won 70%. How can this be explained? Well, we know that Roddick, as opposed to Federer, did not play with optimal tactics.

Professional tennis is special as it is the worst service games in a match that decides who will win the match, not the best ones. This makes stability in the serving absolutely vital. Compare to for example triple jump where the total opposite applies – the longest jump decides who wins, not the shortest.

Now to the most interesting term which below will be used to examine the placing of the first serves. But it can just as well be used to analyze other parts of the game, such as how much serve volley a player should play, where he should place the approach shots, how many drop shots he should make etc.

A player can hit a shot (for example a serve) either left or right of his opponent.

Term 3: "The expected payoff from playing left must be the same as the expected payoff from playing right, for example a player must have the same probability of winning the point, whichever direction he serves."

Figure 9 below shows a breakdown of the service box at deuce. Term 3 states that the player should vary his serving in a way that the probability of winning the point is the same no matter where the player *tries* to place his first serve.

R	C	L

Figure 9: Breakdown of the service box at deuce. R = wide in the deuce court, C = centre of the deuce court, L = towards the T of the deuce court.

The term is reasonable, as assume the opposite. That is that the probability of winning the point actually would be bigger if the player served towards L instead of R. Then the player would serve a lot more towards L since the probability of winning the point would be bigger. But eventually the returner will realize more and more serves are coming towards L which will make him prepared for that, which then will make the probability of winning the point smaller. When the probability of winning the point if the player serves towards L is exactly the same as the probability of winning the point if the player serves towards R, the player has found the optimal variation of serving.

Walker and Wooders (2001) examine if some of the greatest tennis players of the open era[15] have followed term 3. Their conclusion is that they actually serve with optimal tactics according to term 3. This is not very surprising as to win the big championships in the existing fierce competition surely optimal tactics is required. **Since players do not know what the optimal tactics is the players who "accidentally" play with optimal tactics have a huge advantage.**

Shih-Hsun Hsu, Chen-Ying Huang and Cheng-Tao Tang (2003) at the University of Taiwan were inspired by the works of Walkers and Wooders. Walker and Wooders had only studied some of the greatest players of all time. What about the less good players? Do they also use optimal tactics? The scientists from Taiwan got the idea to also study matches from the junior tournaments at the Grand Slams. In the article they introduce the concept of "simple rule" which means that the player does not serve with optimal tactics but according to some "simple rule", for example hitting every other serve L and every other serve R. Their conclusion is as follows:

"By comparing junior players with adult players, we find that the former tend to adopt simpler rules."

The quote above thus state that junior players do not use optimal tactics according to term 3 to the same extent as senior players. Of the players who reach top-10 on the junior world rankings only a little more than half manage to reach top-100 on the senior world ranking. Is the difference between who succeeds and who fails at senior level the

[15] Rosewall, Smith, Borg, McEnroe, Connors, Lendl, Edberg, Wilander, Becker, Sampras and Agassi are included in the study where 10 great finals have been studied.

tactical knowledge? If the answer is yes, why are juniors not taught how to play with optimal tactics?

Let us now examine how today's players place their first serves and if their placing fulfill the criteria for optimal tactics. In appendix 5 a table shows where the professional players of today place their correct first serves in the deuce court, and the percentage of points won in first serve depending on placing. For example we can see that in the study Kiefer has hit 664 correct first serves in the deuce court. Of these he has placed 42% towards R, 20% towards C and 39% towards L. Given he has placed a correct first serve towards R he has won 77% of the first serve points. Corresponding numbers for C and L are 66% and 82%.

The table also includes the columns *Pearson* and *p-value* which are part of a statistical test[16] to determine whether the percentage of first serve points won is the same if the serve has been placed correctly towards the R and the L. If the *p-value* is 5% or less the conclusion can be made that the percentage of first serve points won is not the same for placing towards R and L[17].

Does this mean that a player like Roddick does not serve with optimal tactics as he has a *p-value* of 0%, which is considerably lower than 5%? Not necessarily as the table only includes correct first serves, and it could be that Roddick has a different serve percentage depending on if he serves towards R or L.

Assume x_1=67%, x_2=92% and y_2=61% for all points played in the deuce court for Roddick. Then you can calculate that if the first serve percentage for Roddick is 70% when aiming towards R, 88% when aiming towards C and 52% when aiming towards L, Roddick is actually serving with optimal tactics.

In the example of Roddick he wins 88% of first serve points if he places the serve towards the T-line, which is by far best of all the players in the study, maybe even best of all players all time. Even so, he chooses to place only 34% of the correct first serves there. An explanation

[16] See Walker and Wooders (2001) for details concerning this statistical test.
[17] Note that the more points that are included in the study the lesser the difference between points won for R and L needs to be to draw the conclusion that they are not the same. For example Murray has a fairly large difference between R and L, 69% versus 80%, but the number of points played, 269 points, is too few to eliminate chance as an explanation.

to this is that the first serve percentage for Roddick when he tries to place the serve towards the T-line is so low that he is "forced" to serve most of the serves towards R or C.

Another example is Hewitt who places 51% of the serves towards R despite winning only 74% of those points as opposed to winning 81% of the points when placing the serve towards L.

The reasoning above leads us up to the following very important realization:

By improving the serve so that the first serve percentage x_1 is the same whether the player serves towards R or L, the percentage of points won for a correct first serve y_1 will also improve. For then the player can start placing more serves towards the "best" side.

The conclusion of the table in appendix 5 is thus that players with a *p-value* lower than 5% do not pursue their professional work in an optimal way. They do not serve with optimal tactics and/or do not practice serve in an optimal way.

Above we have seen an example of how game theory can be applied to create understanding for how a professional player should play tactically and how practice should be executed. We conclude this section with a quote from the Journal of Economic Surveys. The quote is from an article on how game theory can be used practically:

"An example of this might be a constant-sum game such as tennis, in which an informed coach could use insights drawn from mixed-strategy equilibrium to raise the win-rate of the player who employs him." *D J Butler (2005)*

6. Which tournaments should a professional player play?

So far in the compendium we have assumed that a player's ranking only depends on how the player practices and which tactics he uses in match play. In this section we will add another factor, namely which tournaments the player chooses to play.

What needs to be considered when choosing between playing tournaments and practicing is the following. The only way to get ranking points is to play tournaments and win matches. Hence the more tournaments the better chance to get ranking points. But on the other hand, the more tournaments the fewer weeks for practice and the higher risk of getting injured. For the coach to be able decided how many and which tournaments should be played he needs to know how important a certain tournament is for the ranking.

The tournaments throughout the year are divided into different categories. The ranking points differ between the categories as shown in table 6. The total ranking point is the sum of the points from the categories GS (=Grand Slam) and MS (=Masters Series) plus the sum of the five best tournaments from other categories.

	R128	R64	R32	R16	QF	SF	F	W
GS	5	35	75	150	250	450	700	1000
MS	-	5	35	75	125	225	350	500
Guld	-	-	5	25	60	110	175	250
800K	-	-	5	20	55	100	155	225
600K	-	-	5	15	50	90	140	200
400K	-	-	5	15	40	75	120	175

Tabel 6: Ranking points in different tournament categories.

Now assume that the goal for a player is to finish the year top-10 on the ranking. To do this it takes about 2000 points. Exactly how many points it takes of course varies from year to year. In tables 7 and 8 we will show how the probability of reaching this goal varies depending on which tournaments are played and how good the match statistics for a player is (the match statistics can be described as the probability of winning a match given the match statistics).

Table 7 shows the probability of reaching the ranking goal for three different players. One who wins 60% of all matches which "should" equal a ranking of 20, one who wins 70% of all matches which "should" equal a ranking of 9, and one who wins 80% of all matches which "should" equal a ranking of 4.

GS	P_{match}=60%	P_{match}=70%	P_{match}=80%
4	20	71	98
3	15	64	98
2	10	55	96
1	6	44	92
0	3	32	87

Table 7: The probability of finishing the year top-10 depending on how many Grand Slam tournaments are played and depending on the probability of winning a particular match. The number of other tournaments are MS=9, Gold800K=2, 800K=3, 600K=2 and 400K=4.

Table 7 shows that especially for the less great players it is very important to play the large tournaments. By playing 4 Grand Slam tournaments instead of 2 the probability of finishing the year top-10 is doubled for a player "normally" ranked 20th. A general rule is thus the worse ranked a player is the more important it is to play the large tournaments. A less great player (normally ranked 20) can by playing all the large tournaments still have a decent chance (20%) of finishing top-10. This shows the importance for the less great players to be well prepared for the large tournaments in order to have any chance of finishing the year with a high ranking.

When it comes to the small tournaments these totally lack importance for the top players, see table 8. The player normally ranked 4th does not impair his chances of finishing the year top-10 by not playing any of the 400K tournaments. There is often an opinion among players and journalists that the best players in the world have to play a lot of tournaments to obtain a certain ranking. As we can see that is not the case.

400K	P_{match}=60%	P_{match}=70%	P_{match}=80%
6	21	74	99
5	21	72	99
4	20	71	98
3	19	70	98
2	17	68	98
1	17	66	98
0	16	64	98

Table 8: The probability of finishing the year top-10 depending on how many 400K tournaments that are played and the probability of winning a particular match. The number of other tournaments are GS=4, MS=9, Gold800K=2, 800K=3, and 600K=2.

For the player normally ranked 20th the smaller tournaments have some significance. But note that the probability of reaching top-10 decreases more if the player refrains from playing 1

Grand Slam tournament than if he refrains from playing 4 400K tournaments. This once again shows the importance of being prepared for the large tournaments and above all to master all surfaces. **The example above shows it is more important to play Wimbledon than to play all of Adelaide, San José, Båstad and Metz combined! At least if the goal is to finish the year top-10.**

The conclusion is that the only reason for the best players to play small tournaments is to get match practice, which can be valuable in the preparation for the large tournaments. The points collected in these tournaments are negligible.

7. The correlation between match analysis and training

A deep understanding for how different parts of the game affect both each other and the ranking is necessary to be able to plan the training in the best possible way. So far in this compendium we have learnt for example how Ljubicic's ability to win points when the opponent hits a correct first serve affects his ranking, see table 1 for a reminder.

But to be able to plan the training in an optimal manner you obviously also need to know the correlation between the different parts of the game, not only how each separate part affects the world ranking. For example, if there is a very strong correlation between how good a player is at winning first serve points and second serve points, then it is enough for a coach to say we are going to practice winning service points and it will not matter if it is first or second serve points you practice. For if the correlation is strong the player would improve winning second serve points even if he only practices first serve points and vice versa.

Before you go on reading we want you to stop and think about if you think there is a strong correlation between how good the top-100 players in the world are at winning service points at high and low choices of serve percentages?

If there is only a very weak correlation between these parts of the game, then it would mean it is extremely important how the training is planned to get the maximum out of it. Then it will not be enough to say we are going to practice serving points, but you will need to know which type of serving point and how much to practice each type.

In this section we shall therefore analyze the correlations in winning service points at different choices of serve percentages for the top-100 ranked players in 2006. Let us start by repeating some variables:

y(50%) = Percentage of points won in own serve given the serve with serve percentage 50% is correct.

y(60%) = Percentage of points won in own serve given the serve with serve percentage 60% is correct.

y(70%) = Percentage of points won in own serve given the serve with serve percentage 70% is correct

y(80%) = Percentage of points won in own serve given the serve with serve percentage 80% is correct.
y(90%) = Percentage of points won in own serve given the serve with serve percentage 90% is correct.

In appendix 6[18] the values of these variables are shown for the top-100 ranked players in 2006[19]. Appendix 6 shows for example that Federer wins 80% of the points in own serve when the serve percentage is 50%. If Federer instead would serve with a serve percentage of 70% he only wins 74% of the points given the serve is correct. Thus, the slower the serve is the higher the serve percentage, but also the lower the chance of winning the point given the serve is correct.

Figure 10 shows the correlation between y(50%), percentage of points won at serve percentage 50%, and y(60%), percentage of points won at serve percentage 60%. Every dot in the figure represents an individual player. The horizontal axis represents the percentage of service points won if serving with a serve percentage of 50%. The vertical axis represents the percentage of service points won if serving with a serve percentage of 60%.

The dot in the top right corner of figure 10 denotes Karlovic. If Karlovic would have chosen a serve percentage of 50% he would have won 87% of the points when the serve is correct. If he instead would have served a little bit slower and chosen a serve percentage of 60% he would have won 84% of the points when the serve is correct.

By plotting out all 100 players in a diagram like this you can see if there is a correlation between y(50%) and y(60%). The figure shows there is a strong linear[20] correlation between y(50%) and y(60%). This is not very surprising as the way of playing at a serve percentage of 50% and 60% are almost the same. In both cases the serve is played at a fairly high speed and players who have a fast serve and a good first shot after the serve have a big advantage compared to the more defensive players. For example, players like Roddick and Karlovic are good at winning service points at these serve percentages, while defensive players like Nadal are not favored by short rallies.

[18] The theory from Klaassen and Magnus (2006) has been used to make these calculations.
[19] Once again we have decided to be politically correct and not included the values from the Nordic players.
[20] In the diagram a trend line has been drawn to show the linear correlation.

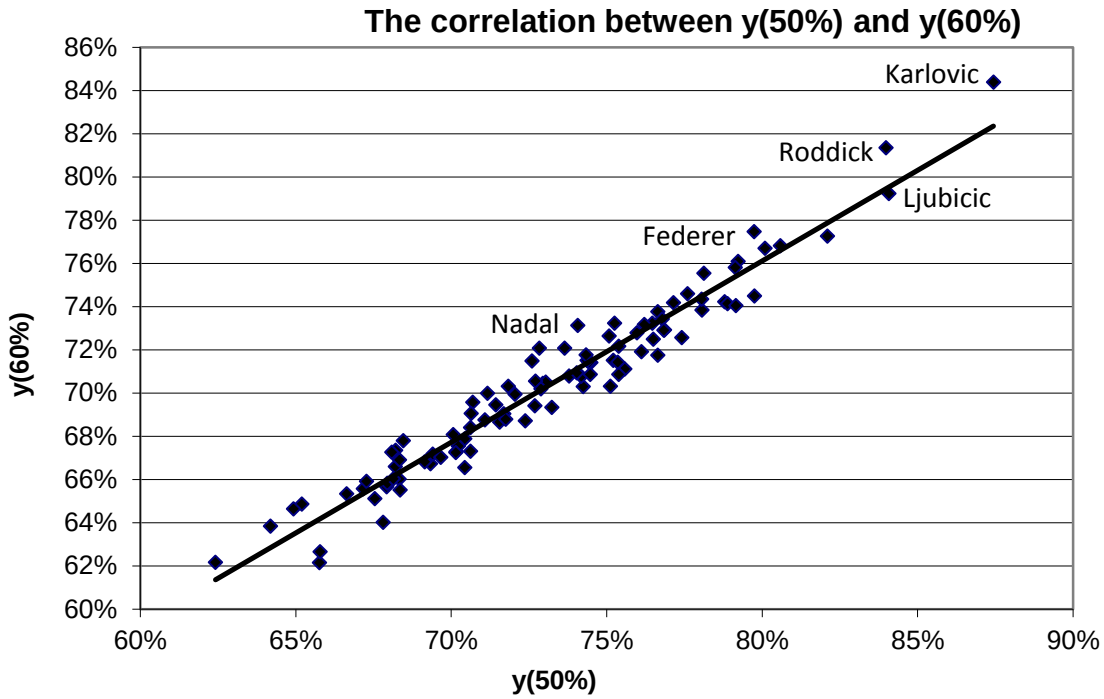

Figure 10: The correlation between y(50%) and y(60%) for top-100 in 2006, y(50%) = percentage of points won in own serve given the serve with serve percentage 50% is correct and , y(60%) = percentage of points won in own serve given the serve with serve percentage 60% is correct.

Let us now make a figure showing the correlation between y(50%) and y(70%). Figure 11 below show this.

In figure 11 we can see that there is still a strong correlation between how good a player is at winning serving points at a serve percentage of 50% compared to 70%. But the correlation is not as strong as in figure 10. Players like Roddick and Karlovic still have a big advantage in their serve at a serve percentage of 70%, but since they then serve with a lower speed than at serve percentages of 50% or 60% there will be larger amount of longer rallies where they lose some of their competitive advantage.

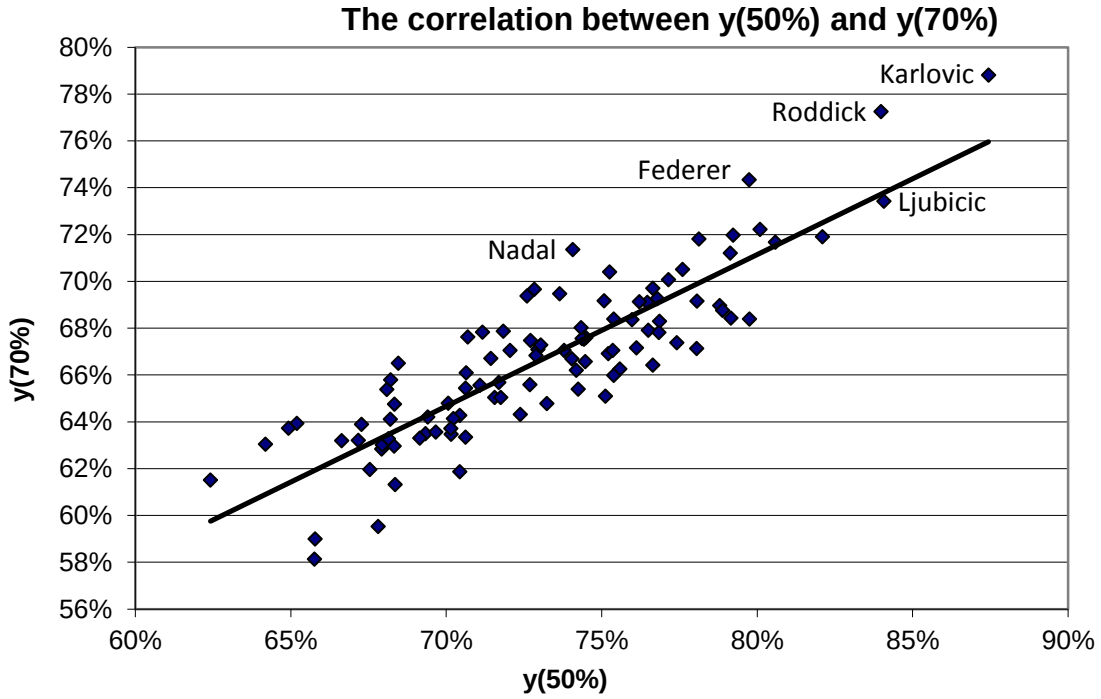

Figure 11: The correlation between y(50%) and y(70%) for top-100 in 2006, y(50%) = percentage of points won in own serve given the serve with serve percentage 50% is correct and , y(70%) = percentage of points won in own serve given the serve with serve percentage 70% is correct.

We continue with figure 12 showing the correlation between y(50%) and y(80%). Now things are happening. There is still a correlation between the different parts of the game (here the percentage of service points won at serve percentage of 50% and 80% respectively), but the correlation is fading. At a serve percentage of 80% other things than a good first serve and a good first shot after serve have importance for how good a player is. The very all round Federer can now make use of his wide range of shots and now wins the same percentage of points as Karlovic despite having a far worse serve. At serve percentages of 50%, 60% and 70% however Karlovic is far better than Federer.

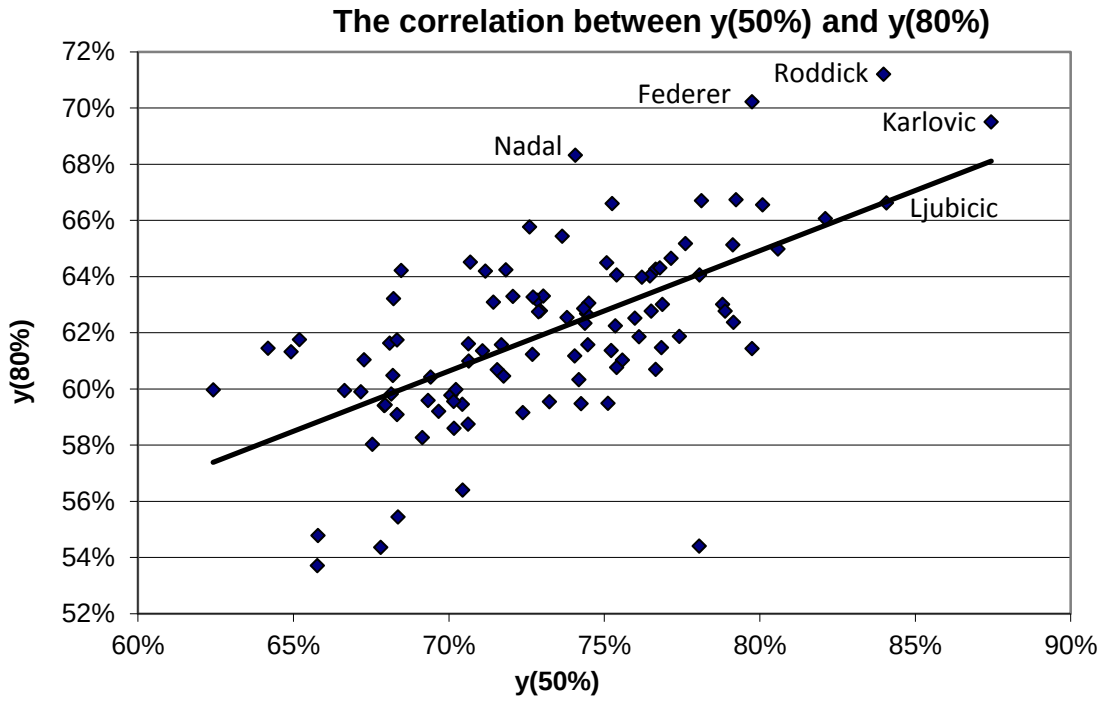

Figure 12: The correlation between y(50%) and y(80%) for top-100 in 2006, y(50%) = percentage of points won in own serve given the serve with serve percentage 50% is correct and , y(80%) = percentage of points won in own serve given the serve with serve percentage 80% is correct.

We concluded this series of figures by comparing y(50%) to y(90%). Figure 13 shows this. Now we see that the correlation is almost gone. A player like Karlovic now has almost no use of his serve and suddenly he is one of the worst players in the top-100 at winning points when serving at a serve percentage of 90%. This despite being one of the best players of the open era at winning serving points at a serve percentage of 50%. The opposite of Karlovic is a defensive player like Nadal who at a serve percentage of 90% suddenly is second best in the world at winning service points, despite being mediocre at winning service points at a lower choice of serve percentage.

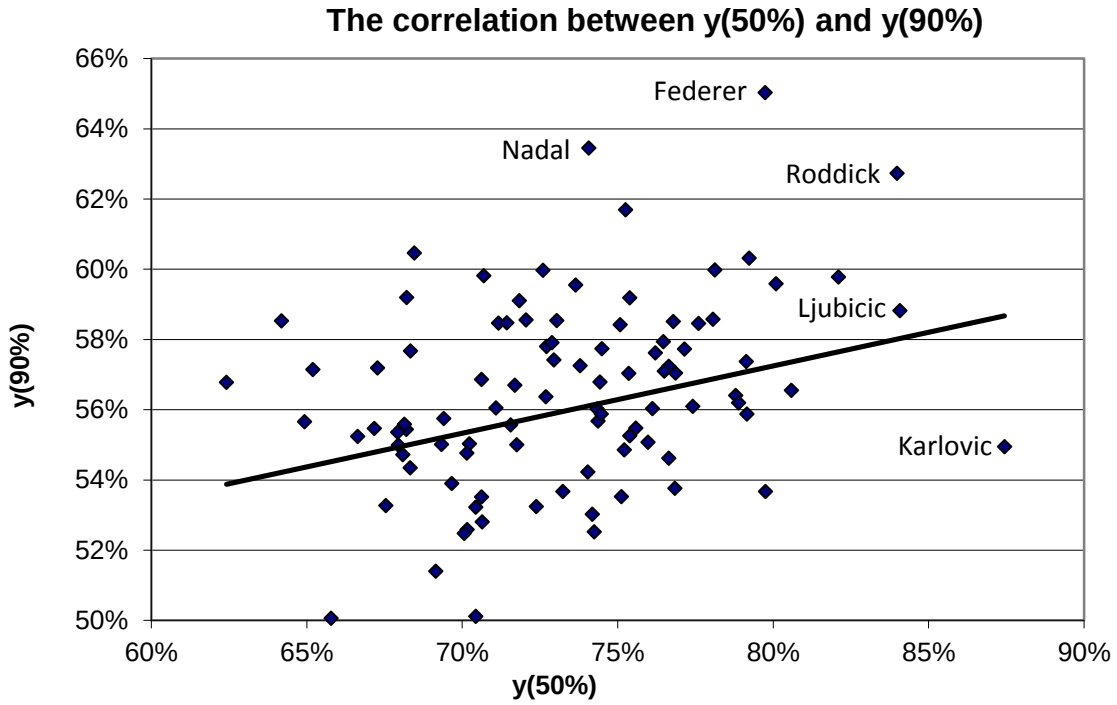

Figure 13: The correlation between y(50%) and y(90%) for top-100 in 2006, y(50%) = percentage of points won in own serve given the serve with serve percentage 50% is correct and , y(90%) = percentage of points won in own serve given the serve with serve percentage 90% is correct.

Table 9 below summarizes the results. To be able to understand the table we first need a statistical variable, namely the coefficient of determination. The coefficient of determination is a number between 0 and 100% that denotes to what extent the difference in a variable between separate individuals is explained by the difference in another variable. For example table 9 shows that 95% of the difference of how good various professional players are at winning points at a serve percentage of 60% is explained by how good these players are at winning points at a serve percentage of 50%.

	y(50%)	**y(60%)**	**y(70%)**	**y(80%)**	**y(90%)**
y(50%)	100%				
y(60%)	95%	100%			
y(70%)	76%	92%	100%		
y(80%)	40%	59%	83%	100%	
y(90%)	6%	11%	26%	64%	100%

Table 9: The coefficient of determination between the different parts of the game.

This is the same thing as saying that how good professional players are at winning service points at a serve percentage of 60%, to 95% extent depends on how good professional players are at winning service points at a serve percentage of 50%.

Most professional players have a first serve percentage of about 60% and a second serve percentage of about 90%. Let us examine what table 9 says about the correlation between these vital parts of the game.

Table 9 shows that how good professional players are at winning service points at a serve percentage of 60% is only to an 11% extent depending on how good professional players are at winning service points at a serve percentage of 90%. The remaining 89% that decides how good professional players are at winning service points at a serve percentage of 60% are things that are insignificant for winning service points at a serve percentage of 90%. The most important thing is of course the first serve.

Most professional players plan their tennis practice in a way that resembles the game of a second serve point. A common structure for a two hour practice session is as follows:

You start by a 20 min warm-up where the ball passes the net many times before someone misses. Then you proceed by practicing ground strokes, for example by playing crosscourt and down the line at high tempo for 20 min where the ball once again passes the net many times before someone misses. After that one of the players run side to side at high tempo for for example 5 times 5 min, once again passing the ball over the net many times before a miss. After that you play volley for about 15 min, again with long rallies before someone misses. Then you play points for about 20 min using the whole court where the coach starts the ball, and again the ball will pass the net several times before the point is decided. Now only 15 min remains of the two hour session and you still have not practiced anything that is specific for points with a serve percentage of 50-60%. The remaining 15 min are usually spent with 5 min of serving practice and 10 min playing points, for example playing two tiebreaks.

How large part of this practice session has been spent practicing first serve points in an efficient manner? That is how large part of the session has been spent practicing the part of the game that to 89% extent decides how good a player is at winning first serve points? (= serve percentage of 60%). We leave it to the reader to think about the answer.

Why do players then chose to almost only practice second serve points? By historical reasons. Earlier generations practiced like this so coming generations should practice like this. Have coaches even analyzed if it is wise to practice the traditional way?
As former players we recommend that you ask your coach to motivate why you practice like you do.

In 2006 the top-100 players together played about 330 000 points in own serve excluding double faults. Out of these about 207 000 were first serve points. Thus 63% of all points in own serve were first serve points (double faults excluded).

So the number of first serve points is almost twice the number of second serve points. Yet, by historical reasons, very little practice time is spent practicing this vital part of the game.

Another interesting observation is that for deciding a player's world ranking only the ability of winning points at two specific serve percentages is relevant. Namely the percentages the player chooses as his first and his second serve percentage. If for example a player has a first serve percentage of 60% and a second serve percentage of 80% it is absolutely irrelevant for his ranking how good he is at winning service points at a serve percentage of 90%.

Many players, coaches and journalists believe professional tennis is about being as complete a player as possible. By complete they mean good at all parts of the game. But it is absolutely irrelevant how bad a player is at winning service points at a serve percentage of 90% as long as he does not choose this serve percentage. Since the correlation between winning points at low and high serve percentages is not very strong you can here see a big advantage in choosing the same serve percentage on both the first and the second serve, for example hitting all the serves with a serve percentage of 70%. For then all practice time (spent practicing service games) can be spent improving this particular part of the game.

In 20-30 years time we will probably see a Wimbledon champion using this tactics. Then we are going to wonder what we were thinking back in the 20th century using different speed on the first and second serve…

Professional tennis is not about being as complete a player as possible but being excellent at a few parts of the game.

8. Joachim Pim-Pim Johansson's example of how game theory can be used

In October 2006 I was about to play world number two Rafael Nadal in the Stockholm Open. I had not played a single match against a top-100 player since I lost first round of Båstad in July 2005. How was I supposed to play to have any chance of winning this match?

In appendix 7 Nadal's statistics from the past years' Grand Slam matches are shown. The appendix shows that in total Nadal's opponents had served 516 correct first serves wide in the deuce court (= towards Nadal's backhand), winning 331 points of these, thus winning 64% of the first serve points when placing the serve wide in the deuce court. However when they placed the serve towards the T in the deuce court (= towards Nadal's forehand) they won a notable 71% of the points.

In the ad court the players won 66% of the first serve points when serving towards the T (=towards Nadal's backhand) and 75% of the points when they served wide (= towards Nadal's forehand). We can also see in the appendix that the opponents chose to hit most serves towards Nadal's backhand. Was this a good choice of tactics? Of course not, just read appendix 7.

Conclusion: Nadal's opponents place most serves towards Nadal's backhand which is a very bad choice of tactics. Instead you should serve a lot more towards Nadal's forehand.

The fact that a player has a much better forehand than backhand does not necessarily mean you should serve a lot towards the backhand, it can actually be the other way around as in the case of Nadal.

Players and coaches need to look further than one shot into the point. If you serve wide towards Nadal's forehand in the ad court it means Nadal most likely will be forced to play his next shot using his much worse backhand.

By serving the right way against Nadal you can on the shot after the serve push Nadal's weak backhand side and then on the third shot finish the point with a winner…

This is obviously something the top players are missing due to the fact that they do not analyze their opponents enough before a match.

The tactics me and my coach decided before the match was to “pin-point” Nadal’s forehand to create opportunities to hit winners towards Nadal’s backhand.

In the quarter-finals of the same tournament I faced Kristof Vliegen from Belgium. I was down 6-7, 7-6, 4-5 and 15-40 in my own serve. After missing the first serve I chose to go for an ace on the second serve as I know I then increase my chances of winning the point since I was getting tired at the end of the long match. Since I had the knowledge of the optimal tactics for me in this situation I felt very confident in hitting my second serve at 214km/h on the line…

How good would I have been if I had not invented my own balls and gone my own way? If I would have chosen to practice and play tactically like most other players I do not think I would have got to top-200. My curiosity helped me find a way of playing that made me a top-10 player.

9. Conclusion of the tennis section

In the sections above we have seen several examples of mathematical methods that can be used to make match analysis of players. To round off this compendium it is appropriate to ask *why should one make a match analysis?* For after a season or a tournament you cannot change the outcome anyway. If your player has lost the semi-finals of both Wimbledon and US Open there is no match analysis, no matter how advanced it might be, that can change this fact. This is obvious.

But if the player will go on playing tournaments the following season a correctly made match analysis can be used as a tool to determine whether the player should play with different tactics or practice in a different way in the future.

The classical (and so far only?) way to make a match analysis is to calculate for example the player's first serve percentage. Let us say this was 60% during 2006. What does this tell us? Absolutely nothing as a professional player can chose whichever first serve percentage he wants. Nothing stops him from choosing a first serve percentage of 95%, all he has to do is serve at a lower speed and aim for the center of the service box.

However, what is interesting is if it was an optimal choice to choose 60% as the first serve percentage? The answer to this question can give insight to which tactics the player should play with coming seasons.

Match analysis can also be used as a tool to answer the question if the way of practice needs to be changed. If for example a player like Roddick in the Davis Cup final of 2004 is serving with too little stability, this should be adjustable by changing something in the practice. Match analysis can thus be used as a check up to monitor that the player practices the right way.

As we have seen in this compendium it is not very difficult to interpret the results of a match analysis. For example the analysis of Ljubicic's serves tells us he should serve with a higher speed on both first and second serves, and that he should serve more and/or practice more serving towards the T-line of the deuce court. What is difficult is reaching this result. To do this it takes a person with deep mathematical knowledge. But for athletes making a lot of

money this investment would be very profitable. Remember that the female professional ranked top-10 making €1 000 000 would make another €330 000 by serving with optimal speed.

Considering the choice of speed on the serve is only one of hundreds of tactical choices a player must make during a match, it is not hard to see that all tactical choices combined affect a player's performance immensely.

But it is important to remember that even though you know what the optimal values are it might not be that easy to simply change serving tactics if you are used to serving a certain way. So, it might not be realistic to think the player will reach all the way to optimal tactics and make another € 330 000, you might only reach half-way, but € 165 000 is still a lot of money…

10. Golf

10.1 Introduction

In golf, as opposed to tennis, you have no opponent whose tactics you have to adjust to. A tennis player who for example has the best serve in the world serving wide in the deuce court cannot always hit his serve there since his opponent then would know where the serve would be placed and be ready for it. So a tennis player has to be complete enough to be able to vary and sometimes place the serve in the other direction. This does not apply in golf. The golf player can always try to hit the shots he considers his best and which will make the average score as low as possible.

How is the golfer then supposed to know what is important for his game and which shots he should concentrate mostly on and spend the most time practicing? Should the player practice like everyone else or try adjust the practice to his own strengths and weaknesses? How is the player supposed to know which shots are most important for his own game? If putting is the player's weakness, how does he know if it is the long or the short putts that are the most important to practice? Which approach shot is the most important to practice? Good or bad approach angle? Fairway or rough? How important is it to practice the right way? Can the player by improving only the putting by for example 1% drastically improve the results in tournaments? How much more prize money will you make by practicing putting 30 min more a week? As you can see the questions golf players and golf coaches are faced with are never-ending.

The traditional way of analyzing a golf player is to analyze the official statistics from the professional golf tours. An example of a statistical variable is putt per GIR, which is the number of putts per green hit in the "correct" number of shots. Other examples are sand saves which means the player has holed the ball in two shots or less from the greenside bunker, and driving accuracy which is the percentage of tee shots (no matter which club is used) that ends up on the fairway.

In the academic research in golf a few attempts have been made at from these statistics calculate what determines how good a player is. But not totally unexpected there is no clear and unequivocal correlation between these variables and a player's ranking.

This is not so strange if you think about it. Say for example that a player has improved the variable putt per GIR, does this mean the player has improved his putting? Not necessarily, it can actually be on the contrary that his putting has deteriorated but still the putt per GIR is better. How is that? Well, if the player for example has improved his driving distance and driving accuracy he will have shorter irons into the green and from better angles which will enable him to get closer to the pin, which in turn will lower the number of putts without the player improving his putting.

To be able to describe the qualities of a golf player we thus need a better model than the ordinary golf statistics.

10.2 Our golf analysis model

It turns out a golf hole is a typical example of a discrete Markov process.[21] By that we mean if a player is in a greenside bunker the only thing that determines where the ball will end up after the next shot is the player's ability to play from the greenside bunker, not how he got there. If the player ended up there after 1, 2 or 3 shots does not matter (we simplify a little by disregarding psychological aspects). How detailed you want to make the Markov model depends of course on what needs to be analyzed. The larger the model, the better it describes the player, but the more statistical data is required to estimate the probabilities of the model.
In the example we are showing we have made a model with 33 states. The model suits holes with par 3, 4 or 5 with the modification that certain states are not necessary for par 3 and par 4.

The following states are used:

- 1: The ball is on the tee box.
- 2: The ball ended out-of-bounds after the tee shot.
- 3: The ball is in the rough, the distance to the pin is 2 long irons.
- 4: The ball is in the rough, the distance to the pin is 1 long + 1 short iron.
- 5: The ball is on the fairway, the distance to the pin is 2 long irons.
- 6: The ball is on the fairway, the distance to the pin is 1 long + 1 short iron.
- 7: The ball is in the rough with a bad approach angle and 1 long iron to the pin.
- 8: The ball is in the rough with a good approach angle and 1 long iron to the pin.
- 9: The ball is in the rough with a bad approach angle and 1 short iron to the pin.
- 10: The ball is in the rough with a good approach angle and 1 short iron to the pin.
- 11: The ball is on the fairway with a bad approach angle and 1 long iron to the pin.
- 12: The ball is on the fairway with a good approach angle and 1 long iron to the pin.
- 13: The ball is on the fairway with a bad approach angle and 1 short iron to the pin.
- 14: The ball is on the fairway with a good approach angle and 1 short iron to the pin.
- 15: The ball is close to the green at pitching range.
- 16: The ball is on the edge of the green at chipping range.
- 17: The ball is in a greenside bunker.
- 18: The ball is on the green more than 5 meters from the hole.

[21] As we stated in the introduction we will not explain the mathematics in detail. For more details on discrete Markov processes we refer the reader to textbooks on probability theory.

- 19: The ball is on the green 3-5 meters from the hole.
- 20: The ball is on the green 1-3 meters from the hole.
- 21: The ball is on the green less than 1 meter from the hole.
- 22: The ball is in the hole.
- 23: Water hazard, 1 long iron to the pin.
- 24: Water hazard, 1 short iron to the pin.
- 25: Water hazard close to the green, 1 pitch/chip shot to the pin.
- 26: Out-of-bounds from state 3.
- 27: Out-of-bounds from state 4.
- 28: Out-of-bounds from state 5.
- 29: Out-of-bounds from state 6.
- 30: Out-of-bounds from state 7.
- 31: Out-of-bounds from state 8.
- 32: Out-of-bounds from state 11.
- 33: Out-of-bounds from state 12.

A hole thus starts by the ball being in state 1. After each shot the ball will change states to finally end up in state 22. The number of "moves" needed to end up in state 22 is the number of strokes on that hole.

Given you know the probabilities for the specific changes of states, that is for example the probability of ending up out-of-bounds from the tee box or the probability of ending up in a greenside bunker from the fairway, you can calculate the average score for a round of golf with 4 par 3s, 4 par 5s and 10 par 4s. Then you can analyze which strengths and weaknesses a certain player has and what affects the average score the most.

Example of questions the model can help answer:

- Our model can also calculate the traditional statistics like sand saves to compare the player to other players at specific parts of the game. But with our model you can find out exactly why a player has bad sand save statistics. It could be that from the sand the player ends up on the green 1-3 meters from the pin but is very poor at putting from this distance. The player having bad sand save statistics does not necessarily mean the player is poor at hitting bunker shots.

- The model gives a simple answer to how much a certain improvement of a certain part of the game will affect the average score and thus the prize money. The figure below shows how the average score and the prize money are affected by the probability of making a putt from the 1-3 meter range for an example player on the US PGA tour. We can see that the margins in professional golf (as in professional tennis) are very small. The example player who makes 83% of these putts would increase his yearly prize money by $ 350 000 by improving only number of putts made from 1-3 meters to 84% and not improving anything else!!!!!

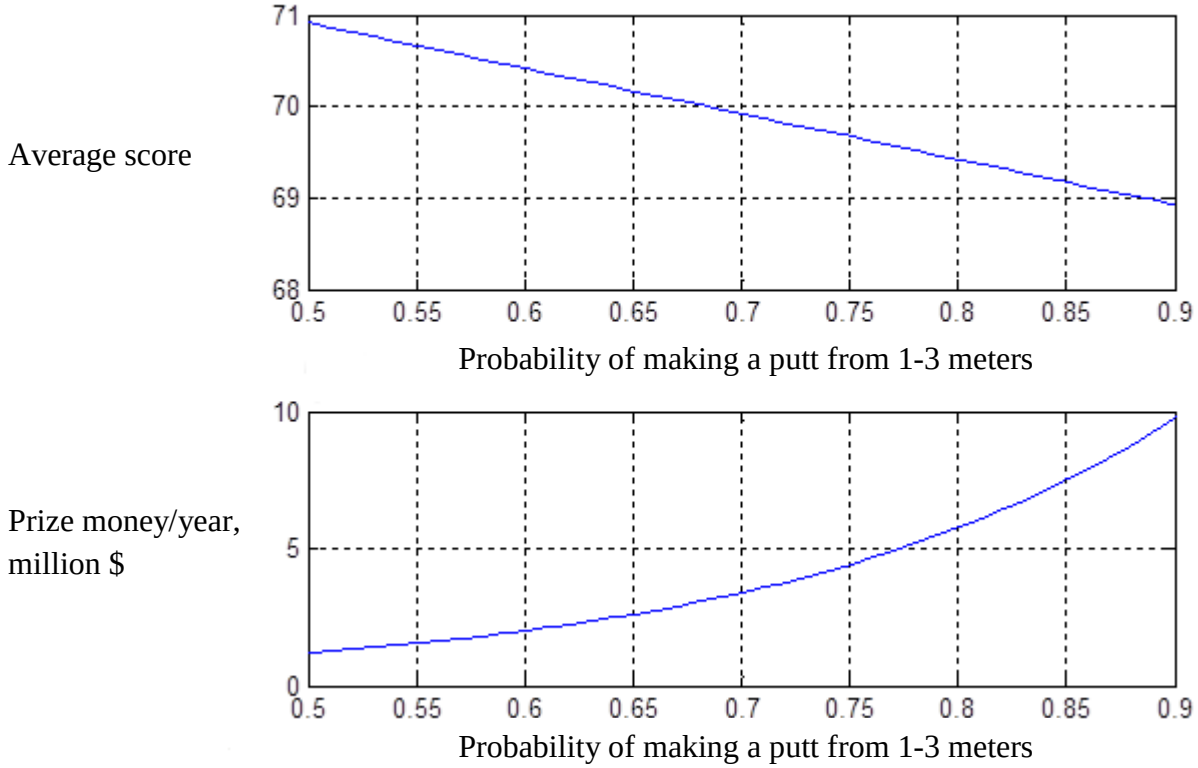

Figure 14: The correlation between putting skills and average score and prize money.

- Considering how tiny the margins are it is extremely important to practice the right parts of the game. How large part of practice should I spend putting? Which type of putts do I need to improve? What happens if I improve driving distance without losing driving accuracy? Well, that depends on how much better a player is at approach shots with short irons than with long irons. If the difference between these is big, then it can be profitable to increase driving distance. But otherwise it might not matter improving driving distance.

- Is it worth going for long tee shots on par 5s to be able to reach the green in 2? Here as well that of course depends on how good the player is at approach shots with a long iron and pitch/chip shots which the player would need to hit if he fails to reach the green with the long iron. Is it maybe better to hit a shorter and safer tee shot to lay up to a third shot into the green with a short iron and a good approach angle?

In today's professional sports no matter if it is tennis, golf or any other sport, most athletes already train the maximum amount the body can take. Furthermore most athletes in the world elite have a great talent for what they do, otherwise they would not have got as far. What decides who will be the best is how well the athlete manages his talent. That is how smart the player practices and how optimal tactics he uses in tournaments. Moreover success depends on the quality and motivation the player has when practicing and just by understanding what contributes to success the player will improve, as this understanding will affect the quality and motivation in a positive way. This as opposed to what many golfers do, practice just because they should without having any goal for the practice session.

10.3 An example of how the golf model can be used

Let us go back to the preface and what Johanna Westerberg wrote. When we started working with Westerberg before the 2009 season she had only used the traditional statistics for golf. Before the 2009 season Westerberg started taking statistics on all tournament rounds and also on some tournament like practice rounds (to be able to collect enough data to make an analysis).

The table below shows an example of a summary of the statistics collected. It shows Westerberg's play from state 16 which is chip shot from the edge of the green. The table tells us that when Westerberg plays from this state the ball will with 7% probability end up in state 18 which is on the green more than 5 meters from the hole. With the probability of 49% the ball will end up in state 20 which is on the green 1-3 meters from the hole. As we can see there is also a 4% probability that Westerberg will miss the green.

State	16	17	18	19	20	21	22
Probability	4%	0%	7%	18%	49%	21%	2%

Table 10: Statistics for Johanna Westerberg for the 2009 season.

Summaries like this were made for all the states described above. After that we ran all the statistics in a computer and let the computer make some interesting analyses.

The most interesting question we here will dwell upon is of course the following, which is the most important question for both Westerberg and all other athletes. How should an athlete change the way of practicing and/or the tactics in competitive situations to improve the performance?

For the golfer the performance is summed up in the average score. A lower average score in the long run will lead to more prize money, better ranking and higher probability of winning tournaments on the professional tour. Before the 2009 season Westerberg, age 32, had not yet managed to win on the Ladies European Tour. An obvious goal for the season was therefore to improve the game to an extent that Westerberg would have a good chance of winning a tournament on the Ladies European Tour.

By using our model we let our computer answer the following question: If Westerberg only improves 1% of a certain part of the game, how will this affect the average score? The results are shown in figure 15 below.

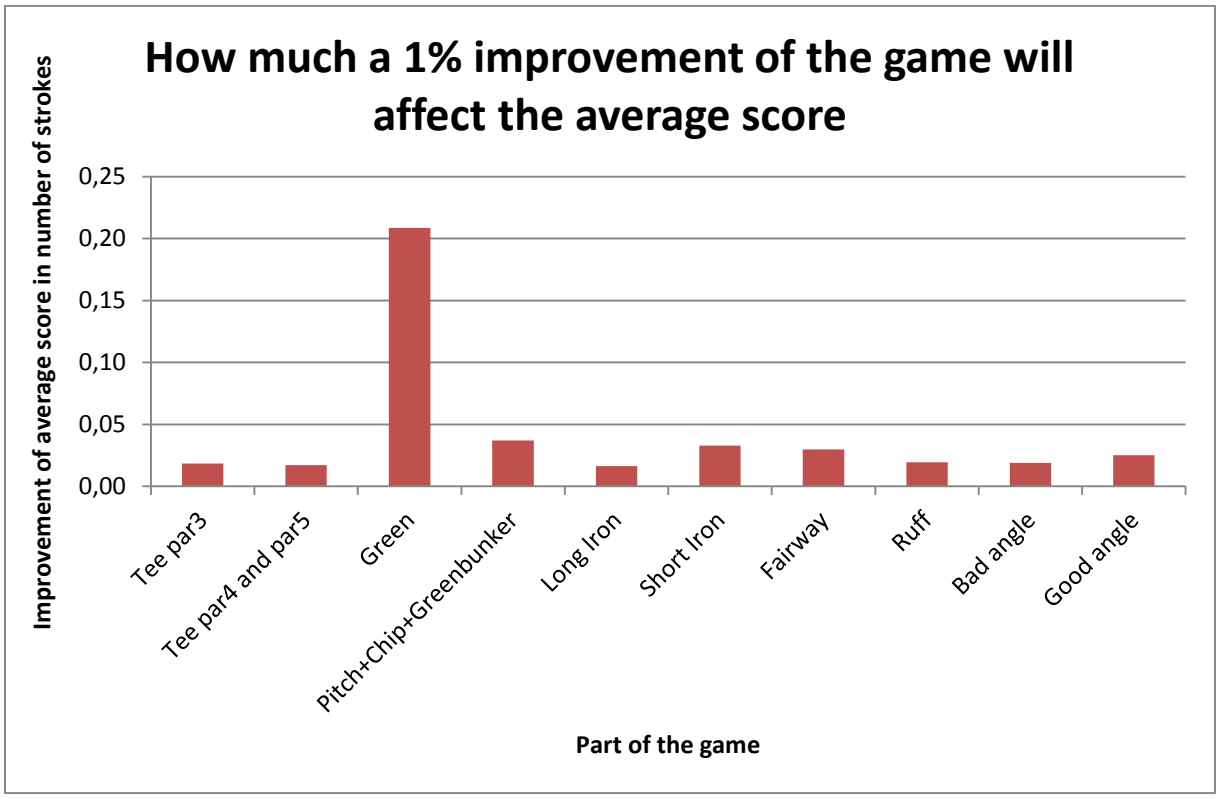

Figure 15: Summary of possibilities to improve for Johanna Westerberg.

If Westerberg improves all approach shots from a bad angle by 1% the average score improves by 0,02 strokes per round. If Westerberg instead improves all shots hit from the fairway by 1% the average score improves by 0,03 strokes and if Westerberg improves all shots on the green by 1% the average score improves by 0,21 strokes per round and so on. Remember from figure 14 how much a tiny improvement of the average score affects prize money.

For Westerberg the analysis was simple. Play on the green was what would have the absolute largest impact on performance to improve. Now a lot of you are wondering if this was not already obvious. It should be the same for all golfers that the shots played on the green are important as they make out such a large part of all strokes played? Well, the shots played on the green will probably always appear as important. But we have made this analysis on other

players, among others a player on the men's European Tour, where the results of the improvement potential in the putting were not as clear as in the case of Westerberg.

A very interesting observation is that in the rest of Westerberg's game, putting aside, there did not seem to be any particular weakness. For some players when making this analysis the potential to improve is large for for example approach shots from bad angle but not from good angle. This could then indicate the player should practice more approach shots from bad angle than from good angle to improve that part of the game, and so on. But for Westerberg the analysis was simple: Focus on improving the putting.

As we remember from the preface Westerberg wrote that she after the analysis dared to play more aggressively and considering the analysis it is not hard to understand why. As we just discussed Westerberg did not really have any weaknesses except for the putting. If for example she would have been very bad from the rough or at approach shots from a bad angle the potential to improve these parts of the game would have been larger than what we can see in the figure. But with the analysis in the back of her mind Westerberg could play more aggressively since she knew that even if she would have a bad day playing from the rough this would not affect the average score that much.

Back to the putting. When we now know the importance of the putting, let us study it more in detail. In figure 16 below we have divided the putting into different parts. In the figure we have also divided the rest of the short game into different parts to try to be pedagogical. Here we can clearly see it is the short putts Westerberg most of all should improve. It is interesting to make a comparison of how much more profitable it would be for Westerberg to improve the short putts compared to other parts of the game such as chip shots and bunker shots.

Westerberg had earlier had a weakness in the short putting. But by now making this weakness visible to her it gave her motivation to focus practice much more on this part of the game.

You can here raise the question if you by practicing more putting need to practice some other part of the game less to not increase the risk of injury, which Westerberg also mentions in the preface. We would like to claim this to be the strength of our model, that you can make the same conclusions on how much the average score would be affected by a 1% deterioration of

a certain part of the game. For deteriorations of 1% the figures will show almost the same results as for 1% improvements, except the average score deteriorates instead of improves.

Of course it is difficult to say beforehand how much 30 minutes of more putting practice will improve the play on the greens. Will it improve by 1, 2 or 3%? And how much will the bunker play deteriorate if the bunker practice is cut by 30 minutes? These questions cannot be answered beforehand. But since the difference in the figure between the short putting and the bunker play is so large it is highly likely it would be more profitable for Westerberg to revise practice time spent and practice more putting, especially the short putts, and less bunker shots.

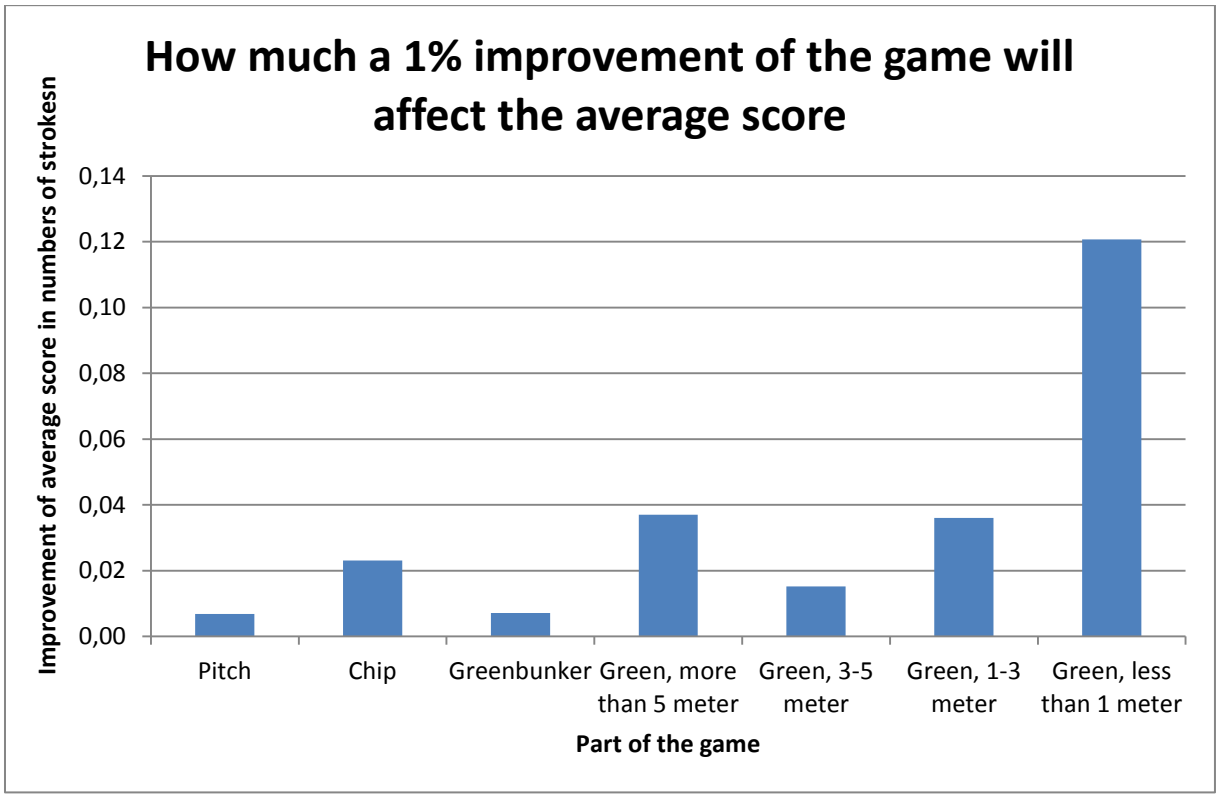

Figure 16: Summary of possibilities to improve for Johanna Westerberg.

When Westerberg has improved this part of short putting it could the following year instead be some other part of the game that will be most profitable to improve. It is thus up to players and coaches to constantly follow up and adjust practice and tactics dynamically to suit the changed conditions an updated analysis will show. This is what Roger Federer was so good at as we saw earlier in the compendium.

The largest contribution an analysis like this will make is probably the fact it gives players like Westerberg a mental security and the motivation to dare to make necessary changes in the practice. Out on the course this type of analysis also makes players like Westerberg dare to play more aggressively.

Our experience tells us no matter if it concerns tennis or golf most players in today's professional sports where the margins are tiny have some part of the game which would mean so much improving. Westerberg had the short putts, Pim-Pim had the returns and so on. The difficulty is discovering this part of the game without a good analysis, and above all daring to change the practice without this type of analysis behind.

The main purpose of an analysis like this is precisely to get input on how practice should be executed in the best way. You can either do it the traditional way and guess what is most important to improve, or do it like in this analysis and find out facts. If you believe it is easy to guess what is important you can as an exercise try to put numbers on how much it would help you or your player to improve certain parts of the game and then compare it to the numbers this analysis would give you.

A golf player who has made this analysis of his game can be more confident the practice is executed in the best way. He or she does not have to waste energy pondering if it was a correct decision to start practicing more putting and instead of practicing approach shots from bad angles focus on approach shots from good angles and so on. Instead the player can focus all energy on concentrating on the actual shots and the technique. Furthermore the knowledge of how little a player has to improve to largely improve prize money will give even more motivation to executing good practice sessions.

Worth noting is it should be up to the coach to decide how much details in the information from an analysis like this the player should take part of. Some players might be confused by too much information from an analysis like this. For players like that it might be enough that the coach has the detailed knowledge from the analysis. The coach can then by using the analysis guide the player how to practice and play tactically on the course.

In the example above we have shown a sample from a real case of how powerful this analysis can be to improve a golf player's performance. This model can easily be customized to suit

any player and the model can be analyzed from all kinds of perspectives. Only imagination limits what can be analyzed. We are convinced in the future this type of analysis will be standard for all athletes no matter what sport. Only by doing what we did with Westerberg and structured her entire game to see how the different parts influenced the whole, we could see things that would have been very difficult to see without the help of mathematics.

Pim-Pim Ace Management wants to thank you for reading and wish you the best of luck in your pursuit of success!

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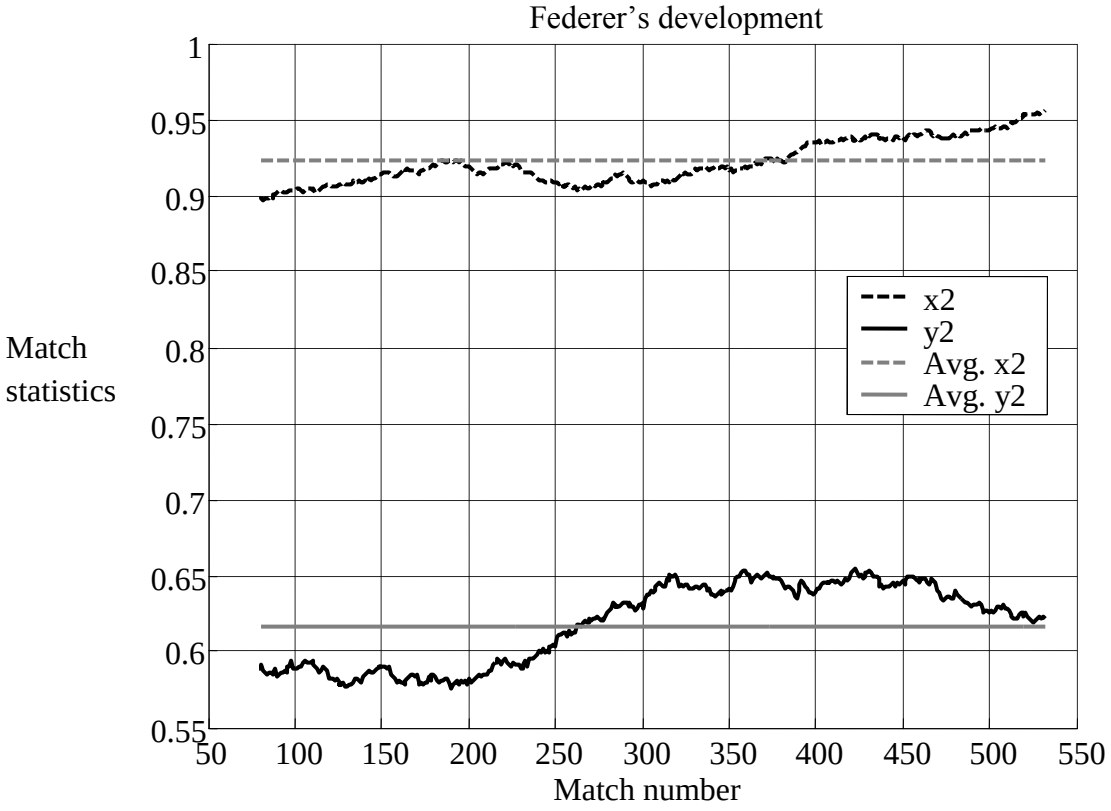
Appendix 1.


Federer's development
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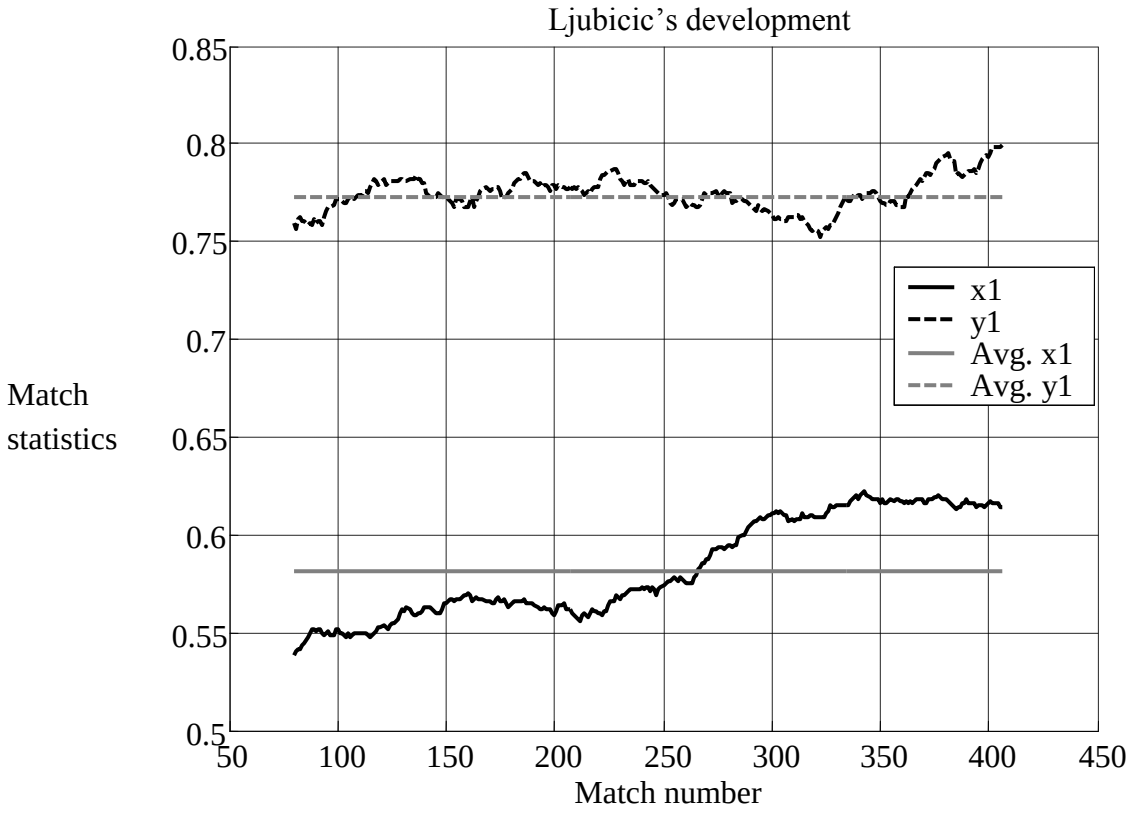
Match number
x2
y2
Avg. x2
Avg. y2
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
50
100
150
200
250
300
350
400
450
500
550


Federer's development
Match statistics
Match number
r1
r2
Avg. r1
Avg. r2
0.55
0.5
0.45
0.4
0.35
0.3
0.25
50
100
150
200
250
300
350
400
450
500
550


Ljubicic's development
Match statistics
0.85
0.8
0.75
0.7
0.65
0.6
0.55
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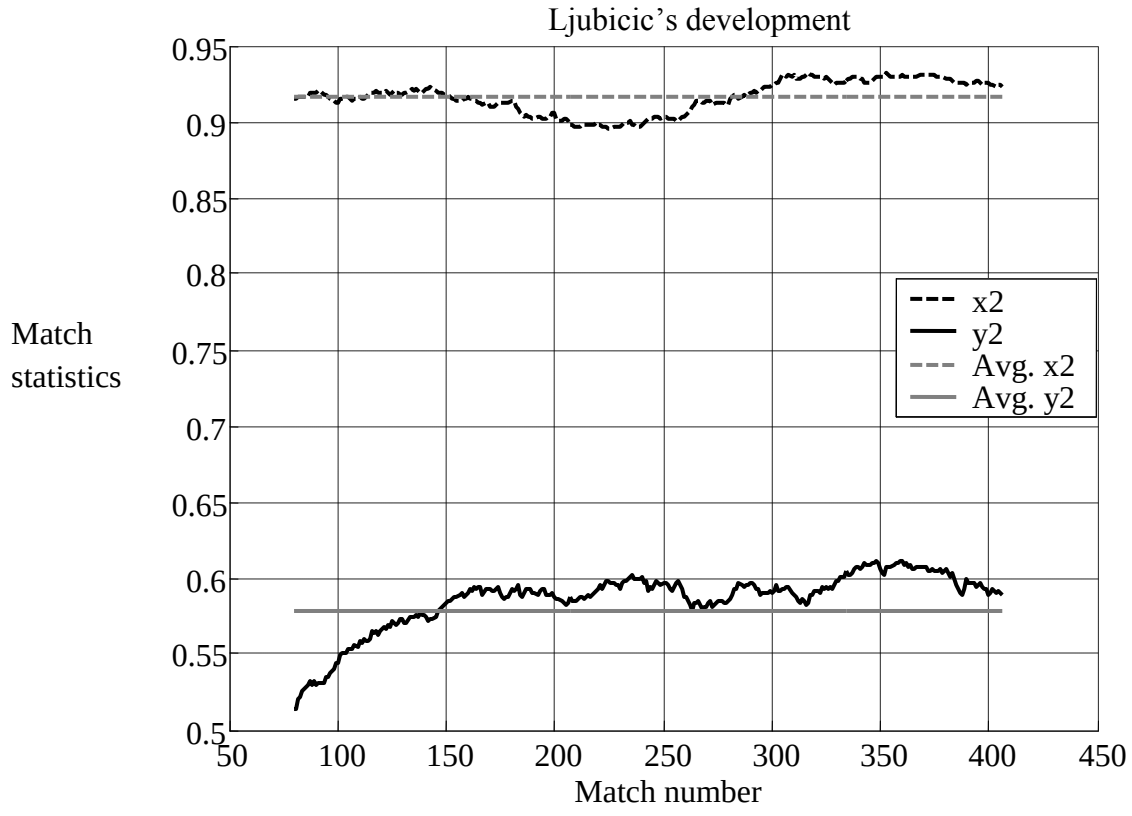
50
100
150
200
250
300
350
400
450
Match number
x1
y1
Avg. x1
Avg. y1


Ljubicic's development
Match statistics
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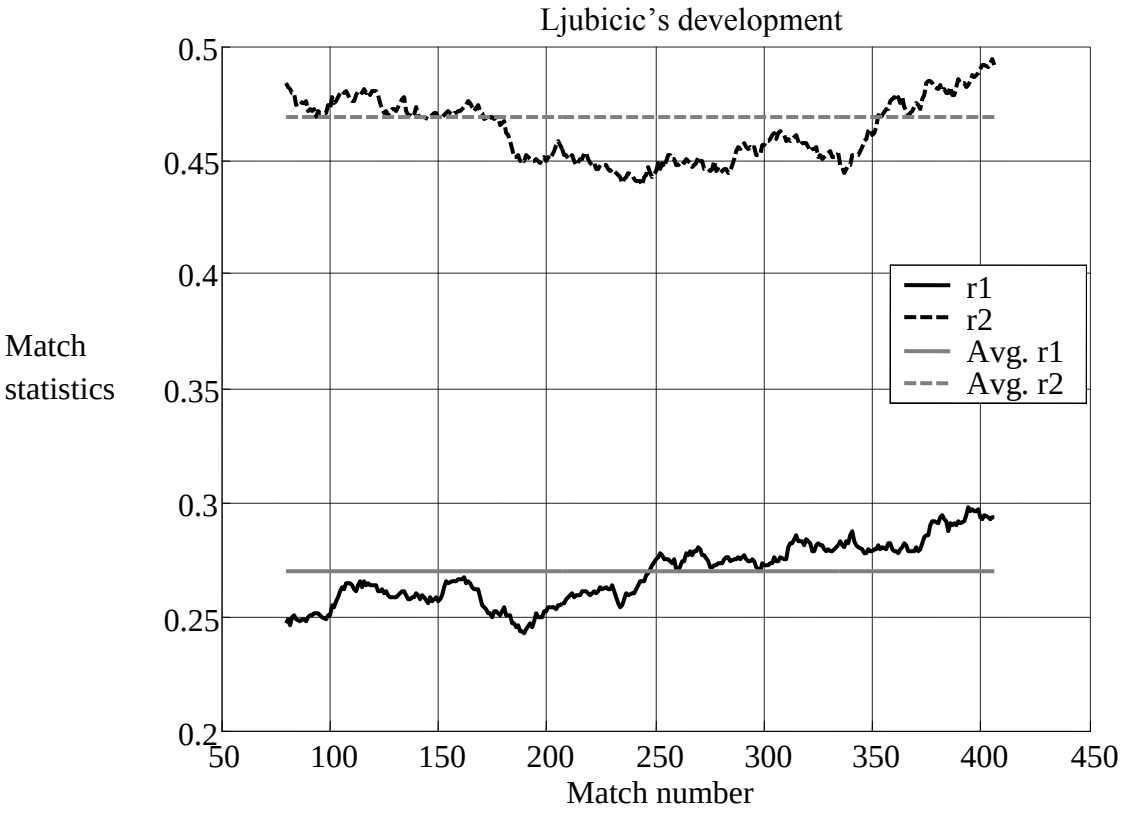
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
50
100
150
200
250
300
350
400
450
Match number
x2
y2
Avg. x2
Avg. y2


Ljubicic's development
Match statistics
0.5
0.45
0.4
0.35
0.3
0.25
0.2
50
100
150
200
250
300
350
400
450
Match number
r1
r2
Avg. r1
Avg. r2

Appendix 2

The points in the Borg-McEnroe Wimbledon 1980 match sorted by importance (1=Borg, 0=McEnroe)

No	Set	Game	Point	Serve	Won	Importance	No	Set	Game	Point	Serve	Won	Importance
343	2-2	4-3	30-40	0	0	38%	244	2-1	4-4	0-15	0	0	12%
278	2-1	6-6	6-5	0	0	35%	331	2-2	3-2	15-15	0	0	11%
280	2-1	6-6	7-6	1	0	35%	209	2-1	1-1	15-30	0	0	11%
286	2-1	6-6	10-9	0	0	35%	141	1-1	1-0	30-40	0	0	11%
288	2-1	6-6	11-10	1	0	35%	143	1-1	1-0	40-A	0	1	11%
290	2-1	6-6	12-11	0	0	35%	353	2-2	5-4	0-0	0	0	11%
279	2-1	6-6	6-6	0	1	33%	308	2-2	1-0	0-15	0	1	11%
283	2-1	6-6	8-8	0	0	33%	208	2-1	1-1	0-30	0	0	11%
287	2-1	6-6	10-10	0	1	33%	12	0-0	0-1	30-40	1	0	11%
291	2-1	6-6	12-12	0	0	33%	240	2-1	3-4	15-30	1	1	11%
295	2-1	6-6	14-14	0	0	33%	303	2-2	0-0	0-30	1	1	11%
299	2-1	6-6	16-16	0	0	33%	367	2-2	6-5	40-30	0	0	10%
277	2-1	6-6	5-5	1	1	31%	362	2-2	6-5	0-0	0	0	10%
281	2-1	6-6	7-7	1	0	31%	372	2-2	7-6	0-0	0	1	10%
285	2-1	6-6	9-9	1	1	31%	241	2-1	3-4	30-30	1	1	10%
289	2-1	6-6	11-11	1	1	31%	348	2-2	4-4	0-0	1	1	10%
293	2-1	6-6	13-13	1	0	31%	358	2-2	5-5	0-0	1	1	10%
297	2-1	6-6	15-15	1	0	31%	356	2-2	5-4	30-15	0	0	10%
248	2-1	4-4	30-40	0	0	31%	368	2-2	6-6	0-0	1	1	10%
250	2-1	4-4	40-A	0	1	31%	210	2-1	1-1	30-30	0	0	10%
282	2-1	6-6	7-8	0	1	29%	212	2-1	1-1	40-40	0	0	10%
284	2-1	6-6	8-9	1	1	29%	245	2-1	4-4	15-15	0	0	10%
292	2-1	6-6	12-13	1	1	29%	256	2-1	5-4	40-30	1	0	10%
294	2-1	6-6	13-14	0	1	29%	347	2-2	4-3	A-40	0	0	9%
296	2-1	6-6	14-15	1	1	29%	338	2-2	4-3	0-0	0	1	9%
298	2-1	6-6	15-16	0	1	29%	365	2-2	6-5	30-15	0	1	9%
300	2-1	6-6	16-17	1	0	29%	302	2-2	0-0	0-15	1	0	9%
376	2-2	7-6	15-40	0	1	29%	251	2-1	5-4	0-0	1	1	9%
258	2-1	5-4	40-A	1	0	28%	334	2-2	3-3	0-0	1	1	9%
312	2-2	1-0	30-40	0	0	28%	172	1-1	4-2	40-40	1	1	9%
314	2-2	1-0	40-A	0	0	28%	174	1-1	4-2	40-40	1	0	9%
276	2-1	6-6	5-4	1	0	26%	176	1-1	4-2	40-40	1	1	9%
342	2-2	4-3	15-40	0	0	26%	178	1-1	4-2	40-40	1	1	9%
275	2-1	6-6	4-4	0	1	25%	180	1-1	4-2	40-40	1	0	9%
375	2-2	7-6	15-30	0	1	24%	182	1-1	4-2	40-40	1	1	9%
274	2-1	6-6	4-3	0	0	22%	184	1-1	4-2	40-40	1	1	9%
366	2-2	6-5	30-30	0	0	21%	329	2-2	3-2	0-0	0	0	8%
273	2-1	6-6	3-3	1	1	20%	130	0-1	6-5	30-40	0	1	8%
340	2-2	4-3	0-30	0	1	20%	254	2-1	5-4	30-15	1	1	8%
345	2-2	4-3	A-40	0	1	19%	170	1-1	4-2	15-40	1	1	8%
344	2-2	4-3	40-40	0	0	19%	218	2-1	1-2	30-30	1	1	8%
346	2-2	4-3	40-40	0	0	19%	217	2-1	1-2	15-30	1	1	8%
311	2-2	1-0	15-40	0	0	19%	325	2-2	2-2	0-0	1	1	8%
271	2-1	6-6	2-2	0	0	18%	207	2-1	1-1	0-15	0	1	8%
341	2-2	4-3	0-40	0	0	17%	354	2-2	5-4	15-0	0	1	8%
272	2-1	6-6	2-3	1	1	17%	301	2-2	0-0	0-0	1	0	7%
270	2-1	6-6	2-1	0	0	17%	332	2-2	3-2	30-15	0	0	7%
373	2-2	7-6	0-15	0	0	17%	321	2-2	2-1	0-0	0	0	7%
257	2-1	5-4	40-40	1	0	16%	157	1-1	3-1	15-30	1	1	7%
267	2-1	6-6	0-0	0	0	15%	158	1-1	3-1	30-30	1	1	7%
339	2-2	4-3	0-15	0	1	15%	239	2-1	3-4	15-15	1	0	7%
355	2-2	5-4	15-15	0	0	15%	349	2-2	4-4	15-0	1	1	7%
247	2-1	4-4	30-30	0	1	15%	359	2-2	5-5	15-0	1	1	7%
249	2-1	4-4	40-40	0	1	15%	363	2-2	6-5	15-0	0	0	7%
309	2-2	1-0	0-30	0	1	14%	168	1-1	4-2	0-30	1	0	7%
268	2-1	6-6	0-1	1	1	14%	369	2-2	6-6	15-0	1	1	7%
374	2-2	7-6	15-15	0	1	14%	243	2-1	4-4	0-0	0	1	7%
313	2-2	1-0	40-40	0	1	14%	317	2-2	1-1	0-0	1	1	7%
315	2-2	1-0	40-40	0	0	14%	306	2-2	0-0	40-30	1	1	7%
171	1-1	4-2	30-40	1	1	13%	259	2-1	5-5	0-0	0	0	7%
175	1-1	4-2	40-A	1	1	13%	307	2-2	1-0	0-0	0	1	7%
181	1-1	4-2	40-A	1	1	13%	316	2-2	1-0	A-40	0	0	7%
310	2-2	1-0	0-40	0	0	12%	252	2-1	5-4	15-0	1	1	7%
304	2-2	0-0	15-30	1	1	12%	263	2-1	5-6	0-0	1	1	7%
305	2-2	0-0	30-30	1	1	12%	167	1-1	4-2	0-15	1	0	6%

No	Set	Game	Point	Serve	Won	Importance
335	2-2	3-3	15-0	1	1	6%
246	2-1	4-4	30-15	0	1	6%
242	2-1	3-4	40-30	1	1	6%
269	2-1	6-6	1-1	1	1	6%
216	2-1	1-2	15-15	1	0	6%
326	2-2	2-2	15-0	1	1	6%
231	2-1	3-3	0-0	0	0	6%
236	2-1	3-3	40-30	0	0	6%
190	1-1	5-3	0-0	1	1	6%
330	2-2	3-2	15-0	0	1	6%
237	2-1	3-4	0-0	1	1	6%
10	0-0	0-1	15-30	1	1	6%
129	0-1	6-5	15-40	0	0	6%
155	1-1	3-1	0-15	1	1	6%
193	1-1	5-3	30-15	1	1	6%
201	2-1	0-1	0-15	1	1	6%
173	1-1	4-2	A-40	1	0	5%
177	1-1	4-2	A-40	1	0	5%
179	1-1	4-2	A-40	1	0	5%
183	1-1	4-2	A-40	1	0	5%
185	1-1	4-2	A-40	1	1	5%
156	1-1	3-1	15-15	1	0	5%
318	2-2	1-1	15-0	1	1	5%
220	2-1	2-2	0-0	0	0	5%
202	2-1	0-1	15-15	1	1	5%
225	2-1	2-2	40-30	0	0	5%
322	2-2	2-1	15-0	0	0	5%
234	2-1	3-3	30-15	0	0	5%
140	1-1	1-0	30-30	0	1	5%
142	1-1	1-0	40-40	0	1	5%
226	2-1	2-3	0-0	1	1	5%
11	0-0	0-1	30-30	1	0	5%
219	2-1	1-2	40-30	1	1	5%
264	2-1	5-6	15-0	1	1	5%
169	1-1	4-2	0-40	1	1	5%
166	1-1	4-2	0-0	1	0	5%
107	0-1	4-4	30-40	1	1	5%
109	0-1	4-4	40-A	1	1	5%
113	0-1	4-4	40-A	1	1	5%
159	1-1	3-1	40-30	1	1	5%
206	2-1	1-1	0-0	0	1	5%
211	2-1	1-1	40-30	0	1	5%
213	2-1	1-1	A-40	0	0	5%
260	2-1	5-5	15-0	0	0	5%
205	2-1	0-1	40-30	1	1	5%
128	0-1	6-5	15-30	0	1	5%
191	1-1	5-3	15-0	1	1	5%
214	2-1	1-2	0-0	1	1	5%
77	0-1	2-2	30-40	1	1	4%
26	0-0	1-3	30-30	0	0	4%
195	2-1	0-0	0-0	0	0	4%
238	2-1	3-4	15-0	1	0	4%
137	1-1	1-0	0-15	0	0	4%
154	1-1	3-1	0-0	1	0	4%
200	2-1	0-1	0-0	1	0	4%
350	2-2	4-4	30-0	1	1	4%
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227	2-1	2-3	15-0	1	1	4%
364	2-2	6-5	30-0	0	1	4%
370	2-2	6-6	30-0	1	1	4%
144	1-1	2-0	0-0	1	1	4%
221	2-1	2-2	15-0	0	0	4%

No	Set	Game	Point	Serve	Won	Importance
352	2-2	4-4	40-15	1	1	4%
336	2-2	3-3	30-0	1	1	4%
357	2-2	5-4	40-15	0	0	4%
215	2-1	1-2	15-0	1	0	4%
255	2-1	5-4	40-15	1	0	4%
138	1-1	1-0	15-15	0	0	3%
327	2-2	2-2	30-0	1	1	3%
3	0-0	0-0	15-15	0	0	3%
9	0-0	0-1	15-15	1	0	3%
133	1-1	0-0	15-15	1	1	3%
319	2-2	1-1	30-0	1	1	3%
105	0-1	4-4	15-30	1	1	3%
106	0-1	4-4	30-30	1	0	3%
108	0-1	4-4	40-40	1	0	3%
110	0-1	4-4	40-40	1	1	3%
112	0-1	4-4	40-40	1	0	3%
114	0-1	4-4	40-40	1	1	3%
24	0-0	1-3	15-15	0	0	3%
145	1-1	2-0	15-0	1	1	3%
196	2-1	0-0	15-0	0	0	3%
192	1-1	5-3	30-0	1	0	3%
265	2-1	5-6	30-0	1	1	3%
323	2-2	2-1	30-0	0	0	3%
333	2-2	3-2	40-15	0	0	3%
76	0-1	2-2	30-30	1	0	3%
78	0-1	2-2	40-40	1	1	3%
80	0-1	2-2	40-40	1	1	3%
82	0-1	2-2	40-40	1	1	3%
84	0-1	2-2	40-40	1	1	3%
58	0-1	1-0	30-30	0	0	3%
60	0-1	1-0	40-40	0	0	3%
194	1-1	5-3	40-15	1	1	3%
95	0-1	3-3	30-30	1	1	3%
127	0-1	6-5	15-15	0	1	3%
261	2-1	5-5	30-0	0	0	3%
104	0-1	4-4	0-30	1	1	2%
94	0-1	3-3	15-30	1	1	2%
136	1-1	1-0	0-0	0	1	2%
1	0-0	0-0	0-0	0	0	2%
6	0-0	0-0	40-30	0	0	2%
131	1-1	0-0	0-0	1	1	2%
228	2-1	2-3	30-0	1	1	2%
37	0-0	1-4	40-A	1	1	2%
39	0-0	1-4	40-A	1	0	2%
7	0-0	0-1	0-0	1	1	2%
52	0-1	0-0	30-30	1	1	2%
103	0-1	4-4	0-15	1	0	2%
134	1-1	0-0	30-15	1	1	2%
139	1-1	1-0	30-15	0	1	2%
4	0-0	0-0	30-15	0	0	2%
22	0-0	1-3	0-0	0	0	2%
27	0-0	1-3	40-30	0	0	2%
230	2-1	2-3	40-15	1	1	2%
233	2-1	3-3	30-0	0	1	2%
51	0-1	0-0	15-30	1	1	2%
13	0-0	0-2	0-0	0	0	2%
25	0-0	1-3	30-15	0	1	2%
132	1-1	0-0	15-0	1	0	2%
222	2-1	2-2	30-0	0	0	2%
235	2-1	3-3	40-15	0	1	2%
74	0-1	2-2	15-15	1	1	2%
111	0-1	4-4	A-40	1	0	2%
115	0-1	4-4	A-40	1	1	2%
116	0-1	5-4	0-0	0	0	2%
125	0-1	6-5	0-0	0	0	2%

No	Set	Game	Point	Serve	Won	Importance
148	1-1	3-0	0-0	0	0	2%
50	0-1	0-0	0-30	1	1	2%
93	0-1	3-3	15-15	1	0	2%
204	2-1	0-1	40-15	1	0	2%
153	1-1	3-0	40-30	0	0	2%
224	2-1	2-2	40-15	0	1	2%
49	0-1	0-0	0-15	1	0	2%
56	0-1	1-0	15-15	0	0	2%
96	0-1	3-3	40-30	1	1	2%
119	0-1	5-4	30-15	0	0	2%
121	0-1	5-5	0-0	1	1	2%
146	1-1	2-0	30-0	1	1	2%
2	0-0	0-0	15-0	0	1	2%
8	0-0	0-1	15-0	1	0	2%
79	0-1	2-2	A-40	1	0	2%
81	0-1	2-2	A-40	1	0	2%
83	0-1	2-2	A-40	1	0	2%
85	0-1	2-2	A-40	1	1	2%
102	0-1	4-4	0-0	1	0	2%
91	0-1	3-3	0-0	1	1	2%
97	0-1	4-3	0-0	0	0	2%
160	1-1	4-1	0-0	0	0	2%
23	0-0	1-3	15-0	0	1	1%
53	0-1	0-0	40-30	1	1	1%
165	1-1	4-1	40-30	0	0	1%
197	2-1	0-0	30-0	0	0	1%
67	0-1	1-1	40-30	1	1	1%
72	0-1	2-2	0-0	1	1	1%
75	0-1	2-2	30-15	1	0	1%
117	0-1	5-4	15-0	0	0	1%
122	0-1	5-5	15-0	1	1	1%
14	0-0	0-2	15-0	0	0	1%
126	0-1	6-5	15-0	0	1	1%
163	1-1	4-1	30-15	0	0	1%
199	2-1	0-0	40-15	0	0	1%
62	0-1	1-1	0-0	1	1	1%
68	0-1	2-1	0-0	0	0	1%
86	0-1	3-2	0-0	0	0	1%
31	0-0	1-4	15-30	1	1	1%
18	0-0	0-3	0-15	1	1	1%
328	2-2	2-2	40-0	1	1	1%
337	2-2	3-3	40-0	1	1	1%
351	2-2	4-4	40-0	1	0	1%
361	2-2	5-5	40-0	1	1	1%
48	0-1	0-0	0-0	1	0	1%
54	0-1	1-0	0-0	0	0	1%
59	0-1	1-0	40-30	0	1	1%
61	0-1	1-0	A-40	0	0	1%
73	0-1	2-2	15-0	1	0	1%
30	0-0	1-4	0-30	1	1	1%
32	0-0	1-4	30-30	1	1	1%
34	0-0	1-4	40-40	1	1	1%
36	0-0	1-4	40-40	1	0	1%
38	0-0	1-4	40-40	1	0	1%
92	0-1	3-3	15-0	1	0	1%
149	1-1	3-0	15-0	0	0	1%
371	2-2	6-6	40-0	1	1	1%
57	0-1	1-0	30-15	0	1	1%
98	0-1	4-3	15-0	0	0	1%
19	0-0	0-3	15-15	1	1	1%
63	0-1	1-1	15-0	1	1	1%
161	1-1	4-1	15-0	0	0	1%
186	1-1	5-2	0-0	0	0	1%
266	2-1	5-6	40-0	1	1	1%

No	Set	Game	Point	Serve	Won	Importance
320	2-2	1-1	40-0	1	1	1%
135	1-1	0-0	40-15	1	1	1%
29	0-0	1-4	0-15	1	0	1%
69	0-1	2-1	15-0	0	0	1%
87	0-1	3-2	15-0	0	0	1%
55	0-1	1-0	15-0	0	1	1%
123	0-1	5-5	30-0	1	1	1%
229	2-1	2-3	40-0	1	0	1%
324	2-2	2-1	40-0	0	0	1%
5	0-0	0-0	40-15	0	1	1%
15	0-0	0-2	30-0	0	0	1%
17	0-0	0-3	0-0	1	0	1%
187	1-1	5-2	15-0	0	0	1%
262	2-1	5-5	40-0	0	0	1%
118	0-1	5-4	30-15	0	1	1%
20	0-0	0-3	30-15	1	1	1%
28	0-0	1-4	0-0	1	0	1%
33	0-0	1-4	40-30	1	0	1%
35	0-0	1-4	A-40	1	0	1%
99	0-1	4-3	30-0	0	0	1%
147	1-1	2-0	40-0	1	1	1%
150	1-1	3-0	30-0	0	0	1%
152	1-1	3-0	40-15	0	1	1%
223	2-1	2-2	40-0	0	1	1%
64	0-1	1-1	30-0	1	1	1%
120	0-1	5-4	40-15	0	0	1%
70	0-1	2-1	30-0	0	0	1%
88	0-1	3-2	30-0	0	0	1%
101	0-1	4-3	40-15	0	0	1%
162	1-1	4-1	30-0	0	1	1%
198	2-1	0-0	40-0	0	1	1%
66	0-1	1-1	40-15	1	0	0%
90	0-1	3-2	40-15	0	0	0%
164	1-1	4-1	40-15	0	1	0%
44	0-0	1-5	30-30	0	0	0%
46	0-0	1-5	40-40	0	0	0%
124	0-1	5-5	40-0	1	1	0%
188	1-1	5-2	30-0	0	0	0%
16	0-0	0-2	40-0	0	0	0%
21	0-0	0-3	40-15	1	1	0%
40	0-0	1-5	0-0	0	1	0%
41	0-0	1-5	0-15	0	0	0%
42	0-0	1-5	15-15	0	0	0%
151	1-1	3-0	40-0	0	1	0%
65	0-1	1-1	40-0	1	0	0%
43	0-0	1-5	30-15	0	1	0%
45	0-0	1-5	40-30	0	1	0%
47	0-0	1-5	A-40	0	0	0%
71	0-1	2-1	40-0	0	0	0%
89	0-1	3-2	40-0	0	1	0%
100	0-1	4-3	40-0	0	1	0%
189	1-1	5-2	40-0	0	0	0%

Appendix 3: Match analysis for the top-100 players in 2006

Rank	Name	Measure of inefficiency	Rank	Name	Measure of inefficiency
92	Del Potro	0,00%	10	Gonzalez	0,16%
1	Federer	0,00%	62	Kohlschreiber	0,16%
52	Santoro	0,01%	30	Wawrinka	0,17%
58	Becker	0,01%	47	Fish	0,17%
11	Haas	0,01%	13	Berdych	0,18%
90	Di Mauro	0,01%	82	Greul	0,19%
22	Tursunov	0,01%	7	Robredo	0,20%
63	Horna	0,01%	38	Volandri	0,21%
24	Youzhny	0,01%	66	Mahut	0,21%
12	Baghdatis	0,01%	97	Devilder	0,21%
14	Ferrer	0,01%	64	Tipsarevic	0,23%
16	Djokovic	0,02%	27	Acasuso	0,23%
33	Chela	0,02%	18	Gasquet	0,24%
2	Nadal	0,02%	**	********	**%
4	Blake	0,02%	**	********	**%
41	Melzer	0,02%	91	Andreev	0,28%
21	Hrbaty	0,02%	**	********	**%
75	Hernych	0,03%	20	Hewitt	0,31%
28	Grosjean	0,03%	45	Simon	0,31%
68	Garcia-Lopez	0,04%	36	O. Rochus	0,32%
70	Goldstein	0,04%	48	Kiefer	0,33%
23	Ferrero	0,04%	94	Kunitsyn	0,34%
3	Davydenko	0,05%	**	********	**%
99	Dlouhy	0,05%	74	Seppi	0,36%
**	********	**%	80	Koubek	0,38%
34	Gaudio	0,05%	61	Martin	0,38%
93	Delic	0,06%	**	********	**%
19	Stepanek	0,06%	31	Vliegen	0,42%
42	Clement	0,07%	17	Murray	0,46%
37	Malisse	0,07%	**	********	**%
39	Henman	0,07%	69	Monaco	0,51%
89	Lu	0,08%	88	Dancevic	0,53%
73	Spadea	0,08%	56	Mayer	0,54%
76	Hajek	0,08%	40	Benneteau	0,56%
43	Moya	0,08%	59	Mirnyi	0,56%
49	Lee	0,08%	79	Lopez	0,66%
100	Kim	0,08%	53	Srichaphan	0,67%
60	Serra	0,08%	96	Schüttler	0,69%
85	Montanes	0,09%	5	Ljubicic	0,70%
32	Almagro	0,09%	77	Phau	0,76%
86	Gimelstob	0,09%	8	Nalbandian	0,76%
46	Monfils	0,09%	78	C. Rochus	0,89%
50	Gicquel	0,11%	35	Verdasco	1,20%
29	Calleri	0,12%	83	Starace	1,23%
26	Safin	0,12%	6	Roddick	1,28%
57	Ramirez-Hidalgo	0,14%	95	Llodra	1,30%
44	Massu	0,15%	67	Lapentti	1,52%
51	Ginepri	0,15%	72	Roitman	2,08%
81	Vassallo-Arguello	0,15%	87	Kendrick	3,35%
65	Bracciali	0,16%	98	Karlovic	3,52%

Appendix 4: Service games won for the top-100 players in 2004

Rank	Name	Service games won (%)	Number of double faults per match
12	J.Johansson	91,9	4,7
1	Federer	91,7	2,1
2	Roddick	91	2,3
63	Karlovic	90	5,4
8	Agassi	88	2,3
42	Mirnyi	87	3,8
48	Rusedski	87	5,6
80	Arthurs	87	5,5
4	Safin	86	2,1
22	Ljubicic	86	2,3
45	Llodra	86	2,3
5	Moya	85	2,7
25	Lopez	85	3,6
54	Verkerk	85	4,4
95	Morrison	85	3,9
34	Fish	84	4,1
50	Saulnier	84	3,1
6	Henman	83	4,1
15	Grosjean	83	2,0
29	Ancic	83	3,2
59	Escude	83	2,4
3	Hewitt	82	3,6
17	Haas	82	3,4
24	Pavel	82	1,8
30	T.Johansson	82	2,1
32	Ferrero	82	2,6
35	Verdasco	82	3,2
92	Carraz	82	6,1
14	Hrbaty	81	2,9
27	Srichaphan	81	3,0
33	Söderling	81	2,7
71	Dupuis	81	2,4
78	Sluiter	81	2,8
11	Canas	80	3,4
21	Gonzalez	80	3,8
38	Stephanek	80	3,6
55	Calleri	80	3,3
81	Carlsen	80	3,1
83	Philipoussis	80	5,4
84	Hanescu	80	2,3
96	Ferreira	80	2,7
13	Robredo	79	3,1
16	Youzhny	79	2,9
19	Spadea	79	2,6
20	Kiefer	79	3,8
36	Kuerten	79	2,8
39	Horna	79	2,5
40	Melzer	79	3,3
51	Zabaleta	79	2,9
75	Gambill	79	3,1
85	Popp	79	4,1
7	Coria	78	2,7
23	Novak	78	1,8
31	Dent	78	5,7
56	Beck	78	4,3
62	Arazi	78	1,9
72	H-T.Lee	78	2,3
73	Enqvist	78	5,5
76	Blake	78	2,4
86	Tursunov	78	5,0
91	Clement	78	2,9
94	Gasquet	78	3,7
99	Muller	78	3,0
9	Nalbandian	77	2,9
28	Davydenko	77	2,7
37	Schuettler	77	2,9
46	Nadal	77	2,0
47	Mayer	77	2,6
49	Andreev	77	3,2
53	Schalken	77	1,8
58	Ginepri	77	2,5
44	Malisse	76	1,8
57	Santoro	76	1,8
65	Bjorkman	76	3,3
66	Acasuso	76	2,7
69	Nieminen	76	2,8
82	Mello	76	2,9
18	Massu	75	2,4
60	Berdych	75	3,8
68	O.Rochus	75	3,1
77	Benneteau	75	3,3
10	Gaudio	74	3,0
52	Costa	74	2,1
87	Corretja	74	3,5
93	Ulihrach	74	4,0
100	Reid	74	1,8
26	Chela	73	2,4
61	Koubek	73	3,0
64	A.Martin	73	4,0
67	Sargsian	73	3,0
70	Labadze	72	6,4
74	Sanchez	72	1,7
97	Patience	72	3,5
79	Mantilla	71	3,8
41	Volandri	70	2,7
43	Ferrero	69	2,7
88	Monaco	68	2,5
98	C.Rochus	66	2,1
89	Montanes	65	2,5
90	Saretta	64	3,8

Appendix 5: A Gametheoretical service analysis

Testing for equality of winning probabilities in the decue court for the directions R and L.

Player	Number of points	Serve direction (%) R	C	L	Win Rate (%) R	C	L	Pearson	p-value	
O.Rochus	555	45%	31%	25%	65%	60%	79%	8,9	0%	*
Roddick	845	49%	17%	34%	80%	75%	88%	8,2	0%	*
Ljubicic	475	44%	16%	39%	71%	73%	83%	8,1	0%	*
Baghdatis	497	37%	21%	42%	68%	71%	80%	7,3	1%	*
Davydenko	1043	27%	34%	39%	73%	65%	64%	6,6	1%	*
Robredo	869	39%	37%	24%	77%	65%	68%	5,4	2%	*
Hewitt	988	51%	13%	36%	74%	72%	81%	4,9	3%	*
Grosjean	527	44%	20%	36%	72%	76%	80%	4,3	4%	*
Monfils	316	33%	27%	41%	67%	67%	79%	4,2	4%	*
Gaudio	611	26%	33%	41%	61%	63%	70%	3,9	5%	*
Murray	269	33%	35%	32%	69%	61%	80%	2,8	9%	
Coria	581	40%	31%	29%	72%	62%	79%	2,7	10%	
Kiefer	664	42%	20%	39%	77%	66%	82%	2,6	10%	
Ancic	370	40%	22%	38%	71%	65%	80%	2,6	11%	
Youzhny	353	32%	20%	48%	68%	62%	76%	2,3	13%	
Gonzalez	578	40%	28%	33%	77%	69%	72%	1,7	19%	
Berdych	385	45%	22%	33%	73%	62%	67%	1,4	24%	
Federer	1468	40%	22%	39%	78%	74%	80%	0,8	37%	
Ferrero	475	31%	28%	41%	69%	63%	73%	0,7	41%	
T.Johansson	474	51%	20%	30%	78%	71%	81%	0,6	44%	
Djokovic	449	28%	35%	37%	67%	62%	71%	0,6	46%	
Ginepri	476	46%	17%	37%	71%	61%	74%	0,4	52%	
Ferrer	519	30%	37%	33%	64%	56%	67%	0,4	55%	
Srichaphan	427	33%	27%	40%	73%	66%	70%	0,2	68%	
Safin	608	30%	22%	48%	80%	61%	81%	0,1	70%	
Nalbandian	1101	33%	27%	41%	71%	66%	70%	0,1	75%	
Blake	604	37%	25%	38%	76%	66%	77%	0,1	80%	
Haas	754	34%	19%	46%	79%	69%	78%	0,1	81%	
Gasquet	479	33%	21%	46%	72%	61%	73%	0,1	82%	
Agassi	792	46%	17%	37%	72%	66%	72%	0,0	94%	
Nadal	955	26%	28%	46%	71%	65%	71%	0,0	95%	
Hrbaty	362	48%	25%	27%	73%	57%	73%	0,0	99%	
All players	19869	38%	25%	37%	73,2%	65,7%	75,5%	10,1	0%	*

* = Indicates rejection at the 5-percent level of significance.

Data is collected from the US Open 2004, 2005 and 2006, Australian Open 2005 and 2006 and French Open 2005 and 2006.

Appendix 6: Match analysis for the top-100 players in 2006

Rank	Name	y(50%)	y(60%)	y(70%)	y(80%)	y(90%)	Rank	Name	y(50%)	y(60%)	y(70%)	y(80%)	y(90%)
1	Federer	80%	77%	74%	70%	65%	51	Ginepri	73%	71%	67%	63%	58%
2	Nadal	74%	73%	71%	68%	63%	52	Santoro	71%	67%	63%	59%	54%
3	Davydenko	73%	71%	69%	66%	60%	53	Srichaphan	75%	73%	70%	67%	62%
4	Blake	74%	71%	68%	63%	58%	54	Bjorkman	**%	**%	**%	**%	**%
5	Ljubicic	84%	79%	73%	67%	59%	55	Mathieu	**%	**%	**%	**%	**%
6	Roddick	84%	81%	77%	71%	63%	56	Mayer	75%	72%	67%	61%	55%
7	Robredo	71%	70%	68%	64%	58%	57	Ramirez-Hidalgo	73%	69%	65%	60%	54%
8	Nalbandian	68%	68%	67%	64%	60%	58	Becker	82%	77%	72%	66%	60%
9	Ancic	**%	**%	**%	**%	**%	59	Mirnyi	81%	77%	72%	65%	57%
10	Gonzalez	77%	74%	70%	64%	57%	60	Serra	68%	66%	63%	59%	55%
11	Haas	79%	76%	72%	67%	60%	61	Martin	67%	66%	63%	60%	55%
12	Baghdatis	76%	71%	66%	61%	55%	62	Kohlschreiber	73%	70%	67%	63%	58%
13	Berdych	79%	74%	69%	63%	56%	63	Horna	74%	72%	69%	65%	60%
14	Ferrer	68%	67%	64%	60%	55%	64	Tipsarevic	77%	72%	66%	61%	55%
15	Nieminen	**%	**%	**%	**%	**%	65	Bracciali	75%	71%	67%	62%	57%
16	Djokovic	75%	73%	69%	64%	58%	66	Mahut	76%	73%	68%	63%	55%
17	Murray	69%	67%	63%	60%	55%	67	Lapentti	74%	71%	66%	60%	53%
18	Gasquet	78%	75%	71%	65%	58%	68	Garcia-Lopez	70%	67%	63%	59%	53%
19	Stepanek	78%	76%	72%	67%	60%	69	Monaco	64%	64%	63%	61%	59%
20	Hewitt	72%	69%	66%	62%	57%	70	Goldstein	68%	65%	62%	58%	53%
21	Hrbaty	72%	69%	64%	59%	53%	71	Johansson, T	**%	**%	**%	**%	**%
22	Tursunov	76%	72%	67%	62%	56%	72	Roitman	70%	68%	65%	60%	52%
23	Ferrero	71%	70%	68%	65%	60%	73	Spadea	70%	68%	64%	60%	55%
24	Youzhny	72%	69%	65%	61%	56%	74	Seppi	68%	66%	63%	59%	54%
25	Söderling	**%	**%	**%	**%	**%	75	Hernych	67%	65%	63%	60%	55%
26	Safin	77%	73%	69%	64%	59%	76	Hajek	66%	62%	58%	54%	49%
27	Acasuso	75%	72%	68%	64%	59%	77	Phau	68%	66%	63%	60%	56%
28	Grosjean	75%	71%	66%	61%	55%	78	Rochus, C	68%	66%	61%	55%	48%
29	Calleri	79%	74%	69%	63%	56%	79	Lopez	80%	74%	68%	61%	54%
30	Wawrinka	74%	71%	67%	63%	57%	80	Koubek	69%	67%	64%	60%	56%
31	Vliegen	77%	74%	70%	65%	58%	81	Vassallo-Arguello	65%	65%	64%	62%	57%
32	Almagro	76%	73%	69%	64%	58%	82	Greul	70%	67%	64%	60%	55%
33	Chela	71%	68%	65%	62%	57%	83	Starace	68%	67%	65%	62%	55%
34	Gaudio	70%	68%	64%	59%	53%	84	Pless	**%	**%	**%	**%	**%
35	Verdasco	73%	72%	70%	63%	48%	85	Montanes	70%	67%	62%	56%	50%
36	Rochus, O	68%	67%	66%	63%	59%	86	Gimelstob	75%	70%	65%	59%	54%
37	Malisse	77%	72%	68%	63%	57%	87	Kendrick	78%	74%	67%	54%	33%
38	Volandri	62%	62%	62%	60%	57%	88	Dancevic	76%	73%	69%	64%	58%
39	Henman	74%	71%	68%	63%	57%	89	Lu	74%	72%	68%	62%	56%
40	Benneteau	71%	69%	66%	61%	53%	90	Di Mauro	66%	63%	59%	55%	50%
41	Melzer	71%	69%	66%	61%	56%	91	Andreev	74%	72%	68%	63%	56%
42	Clement	73%	71%	67%	63%	59%	92	Del Potro	65%	65%	64%	61%	56%
43	Moya	77%	73%	68%	63%	57%	93	Delic	74%	71%	67%	62%	56%
44	Massu	72%	70%	67%	63%	59%	94	Kunitsyn	67%	66%	64%	61%	57%
45	Simon	68%	66%	63%	59%	55%	95	Llodra	77%	73%	68%	61%	54%
46	Monfils	72%	69%	65%	60%	55%	96	Schüttler	68%	67%	65%	62%	58%
47	Fish	78%	74%	69%	64%	59%	97	Devilder	68%	64%	60%	54%	48%
48	Kiefer	73%	69%	66%	61%	56%	98	Karlovic	87%	84%	79%	70%	55%
49	Lee	72%	70%	68%	64%	59%	99	Dlouhy	69%	67%	63%	58%	51%
50	Gicquel	77%	73%	67%	62%	56%	100	Kim	70%	67%	64%	59%	54%

Appendix 7: A Gametheoretical analysis of Nadal's first serve return points

			Serve Direction			Points Won			Win Rate				
Match	Server	Court	R	C	L	R	C	L	R	C	L	Pear.	p-val.
All matches	Opponent	Deuce	516	240	324	331	141	231	0,64	0,59	0,71	4,59	0,03
All matches	Opponent	Ad	458	219	288	304	121	215	0,66	0,55	0,75	5,72	0,02
04 U.S. OPEN	Roddick	Deuce	10	1	14	5	1	11	0,50	1,00	0,79	2,14	0,14
04 U.S. OPEN	Roddick	Ad	14	4	3	8	4	2	0,57	1,00	0,67	0,09	0,76
05 AUSTRALIAN OPEN	Hewitt	Deuce	24	3	21	17	2	17	0,71	0,67	0,81	0,62	0,43
05 AUSTRALIAN OPEN	Hewitt	Ad	18	4	5	14	3	4	0,78	0,75	0,80	0,01	0,92
05 AUSTRALIAN OPEN	Reynolds	Deuce	4	3	12	2	1	8	0,50	0,33	0,67	0,36	0,55
05 AUSTRALIAN OPEN	Reynolds	Ad	9	3	5	4	2	2	0,44	0,67	0,40	0,03	0,87
05 AUSTRALIAN OPEN	Youzhny	Deuce	12	6	17	8	3	12	0,67	0,50	0,71	0,05	0,82
05 AUSTRALIAN OPEN	Youzhny	Ad	16	8	14	11	4	10	0,69	0,50	0,71	0,03	0,87
05 AUSTRALIAN OPEN	Benneteau	Deuce	4	6	8	1	4	4	0,25	0,67	0,50	0,69	0,41
05 AUSTRALIAN OPEN	Benneteau	Ad	3	9	5	3	3	3	1,00	0,33	0,60	1,60	0,21
05 FRENCH OPEN	Puerta	Deuce	28	6	13	18	3	8	0,64	0,50	0,62	0,03	0,87
05 FRENCH OPEN	Puerta	Ad	13	2	21	7	1	16	0,54	0,50	0,76	1,83	0,18
05 FRENCH OPEN	Burgsmüller	Deuce	8	21	5	5	13	4	0,63	0,62	0,80	0,44	0,51
05 FRENCH OPEN	Burgsmüller	Ad	5	19	4	1	11	2	0,20	0,58	0,50	0,90	0,34
05 FRENCH OPEN	Malisse	Deuce	15	6	2	9	5	1	0,60	0,83	0,50	0,07	0,79
05 FRENCH OPEN	Malisse	Ad	15	6	4	8	3	3	0,53	0,50	0,75	0,61	0,44
05 FRENCH OPEN	Gasquet	Deuce	8	16	2	6	6	2	0,75	0,38	1,00	0,63	0,43
05 FRENCH OPEN	Gasquet	Ad	7	8	5	5	2	3	0,71	0,25	0,60	0,17	0,68
05 FRENCH OPEN	Ferrer	Deuce	15	7	4	12	3	2	0,80	0,43	0,50	1,47	0,23
05 FRENCH OPEN	Ferrer	Ad	11	10	5	6	1	4	0,55	0,10	0,80	0,95	0,33
05 FRENCH OPEN	Grosjean	Deuce	23	7	4	13	5	4	0,57	0,71	1,00	2,76	0,10
05 FRENCH OPEN	Grosjean	Ad	16	8	12	11	3	6	0,69	0,38	0,50	1,01	0,31
05 FRENCH OPEN	Federer	Deuce	20	8	12	12	6	8	0,60	0,75	0,67	0,14	0,71
05 FRENCH OPEN	Federer	Ad	9	7	17	5	4	11	0,56	0,57	0,65	0,21	0,65
05 U.S. OPEN	Blake	Deuce	19	10	12	16	4	10	0,84	0,40	0,83	0,00	0,95
05 U.S. OPEN	Blake	Ad	13	6	14	10	4	11	0,77	0,67	0,79	0,01	0,92
05 U.S. OPEN	Jenkins	Deuce	25	5	8	17	3	6	0,68	0,60	0,75	0,14	0,71
05 U.S. OPEN	Jenkins	Ad	9	10	11	6	6	7	0,67	0,60	0,64	0,02	0,89
05 U.S. OPEN	Reynolds	Deuce	9	13	7	7	12	5	0,78	0,92	0,71	0,08	0,77
05 U.S. OPEN	Reynolds	Ad	11	8	5	8	5	4	0,73	0,63	0,80	0,10	0,76
06 FRENCH OPEN	Federer	Deuce	27	7	4	19	3	2	0,70	0,43	0,50	0,66	0,42
06 FRENCH OPEN	Federer	Ad	18	7	8	15	3	6	0,83	0,43	0,75	0,25	0,62
06 FRENCH OPEN	Ljubicic	Deuce	14	7	9	10	3	7	0,71	0,43	0,78	0,11	0,74
06 FRENCH OPEN	Ljubicic	Ad	18	2	11	11	2	9	0,61	1,00	0,82	1,37	0,24
06 FRENCH OPEN	Djokovic	Deuce	12	4	9	7	2	4	0,58	0,50	0,44	0,40	0,53
06 FRENCH OPEN	Djokovic	Ad	10	8	6	6	6	2	0,60	0,75	0,33	1,07	0,30
06 FRENCH OPEN	Hewitt	Deuce	17	7	7	11	4	5	0,65	0,57	0,71	0,10	0,75
06 FRENCH OPEN	Hewitt	Ad	14	12	4	10	10	2	0,71	0,83	0,50	0,64	0,42
06 FRENCH OPEN	Mathieu	Deuce	39	7	9	18	2	4	0,46	0,29	0,44	0,01	0,93
06 FRENCH OPEN	Mathieu	Ad	37	5	11	27	2	9	0,73	0,40	0,82	0,35	0,55
06 FRENCH OPEN	Kim	Deuce	15	3	10	8	2	6	0,53	0,67	0,60	0,11	0,74
06 FRENCH OPEN	Kim	Ad	14	6	5	8	3	4	0,57	0,50	0,80	0,83	0,36
06 FRENCH OPEN	Söderling	Deuce	15	13	11	10	3	8	0,67	0,23	0,73	0,11	0,74
06 FRENCH OPEN	Söderling	Ad	19	11	2	8	5	2	0,42	0,45	1,00	2,43	0,12
06 U.S. OPEN	Youzhny	Deuce	14	11	21	12	8	16	0,86	0,73	0,76	0,48	0,49
06 U.S. OPEN	Youzhny	Ad	12	9	16	7	4	13	0,58	0,44	0,81	1,76	0,18
06 U.S. OPEN	Novak	Deuce	14	9	7	12	5	6	0,86	0,56	0,86	0,00	1,00
06 U.S. OPEN	Novak	Ad	14	6	11	7	2	10	0,50	0,33	0,91	4,74	0,03
06 U.S. OPEN	Moodie	Deuce	17	12	17	9	9	13	0,53	0,75	0,76	2,06	0,15
06 U.S. OPEN	Moodie	Ad	27	9	12	20	5	10	0,74	0,56	0,83	0,40	0,53
06 U.S. OPEN	Horna	Deuce	19	9	11	15	7	10	0,79	0,78	0,91	0,72	0,40
06 U.S. OPEN	Horna	Ad	25	4	12	14	3	9	0,56	0,75	0,75	1,24	0,26
06 U.S. OPEN	Philippoussis	Deuce	9	3	12	8	3	12	0,89	1,00	1,00	1,40	0,24
06 U.S. OPEN	Philippoussis	Ad	13	4	7	12	4	6	0,92	1,00	0,86	0,22	0,64
07 AUSTRALIAN OPEN	Gonzalez	Deuce	15	12	5	8	9	3	0,53	0,75	0,60	0,07	0,80
07 AUSTRALIAN OPEN	Gonzalez	Ad	10	4	8	8	4	7	0,80	1,00	0,88	0,18	0,67
07 AUSTRALIAN OPEN	Murray	Deuce	15	8	16	9	4	10	0,60	0,50	0,63	0,02	0,89
07 AUSTRALIAN OPEN	Murray	Ad	20	9	14	17	8	13	0,85	0,89	0,93	0,49	0,48
07 AUSTRALIAN OPEN	Wawrinka	Deuce	15	4	11	5	2	7	0,33	0,50	0,64	2,34	0,13
07 AUSTRALIAN OPEN	Wawrinka	Ad	9	1	12	6	0	10	0,67	0,00	0,83	0,79	0,37
07 AUSTRALIAN OPEN	Kohlschreiber	Deuce	19	4	14	12	2	7	0,63	0,50	0,50	0,57	0,45
07 AUSTRALIAN OPEN	Kohlschreiber	Ad	16	6	8	11	3	5	0,69	0,50	0,63	0,09	0,76
07 AUSTRALIAN OPEN	Kendrick	Deuce	16	2	10	10	2	9	0,63	1,00	0,90	2,37	0,12
07 AUSTRALIAN OPEN	Kendrick	Ad	13	4	11	10	1	10	0,77	0,25	0,91	0,84	0,36