

1 UNITED STATES PATENT AND TRADEMARK OFFICE  
2 BEFORE THE PATENT TRIAL AND APPEAL BOARD

3  
4 GOOGLE, INC., and YOUTUBE, LLC, )  
5 )  
6 Petitioner, )  
7 vs. )  
8 NETWORK-1 TECHNOLOGIES, INC., )  
9 Patent Owner. )  
\_\_\_\_\_ )

Case No. IPR2015-00347

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16 VIDEOTAPED DEPOSITION OF PIERRE MOULIN, PhD

17 VOLUME I

18 Santa Monica, California

19 Wednesday, August 19, 2015

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22 NETWORK-1 EXHIBIT 2006  
23 Google Inc. v. Network-1 Technologies, Inc.  
IPR2015-00345

24 REPORTED BY: RICH ALOSSI, RPR, CCRR, CSR NO. 13497

25 Job No: 96808

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16 VIDEOTAPED DEPOSITION OF PIERRE MOULIN, PhD,  
17 VOLUME I, taken on behalf of the Patent Owner, at 201  
18 Santa Monica Boulevard, Sixth Floor, Santa Monica,  
19 California, on Wednesday, August 19, 2015, from 9:02 AM to  
20 5:39 PM, before RICH ALOSSI, RPR, CCRR, CSR NO. 13497.

21 \* \* \*

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1 SANTA MONICA, CALIFORNIA; WEDNESDAY, AUGUST 19, 2015

2 9:02 AM - 5:39 PM

3 - - -

4 THE VIDEOGRAPHER: Good morning. This is the  
5 start of Tape Number 1 of the videotaped deposition  
6 of Pierre Moulin in the matter of Google,  
7 Incorporated, and YouTube, LLC, versus Network-1  
8 Technologies, Incorporated. This case is before the  
9 US Patent and Trademark Office, Patent Trial and  
10 Appeal Board. Case number is IPR2015-00347.

11 This deposition is being held at 201 Santa  
12 Monica Boulevard, on the sixth floor, in  
13 Santa Monica, California. Today's date is  
14 August 19th, 2015. The time is 9:03 AM.

15 My name is Scott McNair from TSG  
16 Reporting, Incorporated. I'm the legal video  
17 specialist. The court reporter today is  
18 Rich Alossi, also in association with TSG Reporting.

19 Will counsel please identify yourselves  
20 for the record.

21 MR. DOVEL: My name is Greg Dovel. I  
22 represent the patent owner, Network-1.

23 MR. ELACQUA: My name is Jim Elacqua with  
24 Skadden Arps, here to represent Google and YouTube.

25 MR. CHEN: Ian Chen with Skadden, also on

1 behalf of Google and YouTube.

2 MR. SONNENTAG: Rich Sonnentag, in-house  
3 counsel at Google.

4 MR. FENSTER: Marc Fenster with Russ, August &  
5 Kabat, representing the patent holder in the  
6 litigation.

7 THE VIDEOGRAPHER: Thank you. Will the court  
8 reporter please swear in the witness.

9 THE REPORTER: Please raise your right hand.

10 Do you solemnly state that the testimony  
11 you are about to give in the matter now pending  
12 shall be the truth, the whole truth and nothing but  
13 the truth?

14 THE WITNESS: I do.

15 THE REPORTER: Thank you.

16 We're on the record.

17 - - -

18 PIERRE MOULIN, PhD,  
19 having been first duly sworn by  
20 the court reporter, was examined  
21 and testified as follows:

22 - - -

23 EXAMINATION

24 BY MR. DOVEL:

25 Q Your name is pronounced -- is it Moulin?

1 A Yes. Almost.

2 Q Dr. Moulin?

3 A Yes.

4 Q Now, Dr. Moulin, you're familiar with the  
5 concept of whether or not an algorithm is sublinear?

6 A Yes.

7 Q Were you familiar with that before you  
8 started work on this case?

9 A Yes.

10 Q Is the concept of whether an algorithm is  
11 sublinear with respect to the database size that  
12 it's used over, is that a concept that's common in  
13 your field?

14 A Yes.

15 Q When is it during the course of one's  
16 education that one would learn about the concept of  
17 sublinear?

18 A The concept of sublinear arises in many  
19 contexts, not just databases. The first time  
20 someone would be exposed to that would be typically  
21 in a university course, depending on their field.

22 Q When you say "university course," what  
23 course would that be?

24 MR. ELACQUA: It depends on the field. So it  
25 could be in computer science. Often that might be



1 introduced at the senior level, or if it's  
2 electrical engineering, that might also be  
3 introduced around the same time. Each program is a  
4 different curriculum.

5 MR. DOVEL: I'm going to mark as Exhibit  
6 Number 1004-237 the Declaration of Dr. Moulin from  
7 the case related to the '237 patent.

8 (Exhibit 1004-237 was marked for  
9 identification by the court reporter and is  
10 attached hereto.)

11 MR. DOVEL: I've placed that in front of the  
12 witness.

13 BY MR. DOVEL:

14 Q In your Declaration that I've placed in  
15 front of you, you provide a definition of the  
16 concept of sublinear execution time; is that  
17 correct?

18 A Where?

19 Q Pages 19 to 20 of your Declaration.

20 A That is correct, yes.

21 Q Now, on page 20 you've got a diagram that  
22 illustrates the concept of what is a sublinear  
23 search and what is a linear search; correct?

24 A It illustrates it, yes.

25 Q Is it the case that if we have a linear

1 search, that it will have a constant slope as you've  
2 depicted in your diagram there?

3 A "Constant slope" in terms of -- in terms  
4 of the number of entries in the search database, you  
5 mean? Is that what you mean?

6 Q Yes. Yes.

7 A In this example, yes.

8 Q Is it the case that as sublinear is used  
9 in the patent, it's going to result in a scaling of  
10 the search time compared to the size of the database  
11 such that it will have a constant slope?

12 A You say if it is a linear search?

13 Q If it's a linear search. Right.

14 So let me give you a different question.

15 A Only in this example, yes.

16 Q Let me give you a different question so we  
17 have a clean record.

18 If we have an algorithm that is a linear  
19 search, is it the case that it will have a constant  
20 slope if we plot the search time compared to the  
21 size of the database?

22 A Yes.

23 Q Is it the case that if we have a sublinear  
24 search, then the slope will curve down and approach  
25 zero if we plot search time compared to the size of

1 the database?

2 A Not necessarily.

3 Q When wouldn't it do that?

4 A Because this is an example that shows only  
5 how search time is as a function of number of  
6 entries in the search database. But that's not the  
7 only criterion.

8 Q What's the other criteria?

9 A Well, it's the size of the database that  
10 matters. So number of entries is only one factor  
11 that affects the size of the database.

12 Q Let's -- let's talk about the size of the  
13 database, then.

14 Is it the case that if we have a sublinear  
15 search as it's used in the Cox -- withdrawn.

16 When we're talking about the Cox patents,  
17 do you understand we're talking about the four  
18 patents that you filed declarations for in  
19 connection with these proceedings before the PTAB?

20 A Yes.

21 Q If we have a sublinear search as it's used  
22 in the Cox patents, is it the case that if we plot  
23 search time compared to the size of the database  
24 over which we are searching, then the -- it will  
25 produce a curve such that it curves downward and

1 approaches zero?

2 A You need to be more specific. Sublinear  
3 is mentioned in many places in all four patents in  
4 slightly different contexts. So I would like you to  
5 be more specific.

6 Q Are you -- is it your testimony --  
7 withdrawn.

8 We're talking about sublinear as it's used  
9 in the claims of the patents.

10 A Right.

11 Q You understand that some of the claims  
12 have the phrase "sublinear search," some of them  
13 have the phrase "sublinear time search"?

14 A That's my recollection.

15 Q Is it the case that sublinear search and  
16 sublinear time search mean the same thing in the  
17 patents?

18 A I would have to check every instance of  
19 sublinear data. Used in different contexts,  
20 sometimes not defined precisely, you would have to  
21 refer me to a specific instance.

22 Q As the phrase "sublinear search" is used  
23 in the claims of the patents, is it used  
24 consistently, or does it mean different things in  
25 the claims?

1 A It's used somewhat vaguely.

2 Q I didn't ask whether it was vague. I want  
3 to know does it mean the same thing or does it mean  
4 different things?

5 A I don't know. Because it's done vaguely,  
6 I cannot know for sure.

7 Q You don't know one way or the other --  
8 withdrawn.

9 When you did your analysis and decided  
10 that the prior art anticipates --

11 A Right.

12 Q -- and you decided that it disclosed a  
13 sublinear time search, what definition did you use?

14 A It's in relation to the size of the  
15 database, which itself depends both on the number of  
16 entries in the database and on the size of each  
17 entry, each record. That's the standard definition.

18 Q That's the standard definition; right?

19 A Yes.

20 Q When you say "standard," you're talking  
21 about the standard, well-known definition in the  
22 art?

23 A Yes.

24 Q And what it refers to, to be more precise,  
25 is that if we have a sublinear search, that means

1 that the search time is going to grow at less than a  
2 linear relationship compared to the size of the  
3 database as we increase the size of the database?

4 A That is correct.

5 Q And we can increase the size of the  
6 database either by increasing the number of entries  
7 or by increasing the size of each entry in the  
8 database?

9 A That is correct.

10 Q Is it the case that if we have a sublinear  
11 search -- withdrawn.

12 Is it your understanding that the term  
13 "sublinear search" and "sublinear time search" is  
14 used in the patent claims to have that definition  
15 that you just gave, the standard definition?

16 A Again, it has often not been defined  
17 precisely. The word "sublinear" is used in a  
18 slightly different context in the different patents.

19 When they say "sublinear," my  
20 understanding is, again, consistent with the art. I  
21 understand that to mean what we just discussed. So  
22 it would mean what you just discussed.

23 So every time I read "sublinear" in the  
24 patents, that's my understanding of it. Even though  
25 it was not clearly defined.

1 MR. DOVEL: I'm going to place in front of the  
2 witness another exhibit which I'm going to mark as  
3 Exhibit 1001-237. This is the '237 patent.

4 (Exhibit 1001-237 was marked for  
5 identification by the court reporter and is  
6 attached hereto.)

7 BY MR. DOVEL:

8 Q I'd like you to turn to the claims of the  
9 '237 patent.

10 Do you see Claim 1 uses the phrase  
11 "sublinear time search"?

12 A Yes.

13 Q Do you see Claim 5 uses the term  
14 "sublinear time search"?

15 A Yes.

16 Q Does the phrase "sublinear time search,"  
17 as it's used in the '237 patent claims, refer to a  
18 search where the search time decreases at less than  
19 a linear -- or increases at less than a linear rate  
20 as we increase the size of the dataset over which  
21 we're searching?

22 A The claims do not say "as you increase the  
23 size of the database."

24 If I read Claim 5, it reads, "A sublinear  
25 time search of extracted features of identified

1 media works," by which one could understand that it  
2 means in terms of the database size. But it's  
3 not -- it does not read that explicitly.

4 Q If you read this claim in connection with  
5 the patent as a whole, as one of ordinary skill in  
6 the art, would you understand that when it uses the  
7 phrase "sublinear time search," it's talking about a  
8 search whereby the search time grows at less than a  
9 linear rate as we increase the size of the dataset  
10 over which we're searching?

11 A The size of the database, yes, that would  
12 be my understanding.

13 Q Now, in your field, is there a common  
14 system of notation that's used when we're talking  
15 about the -- when we're talking about how the search  
16 time or execution time scales with respect to the  
17 size of the database?

18 A Yes.

19 Q What is that notation?

20 A Well, it's the so-called order of  
21 notation.

22 Q Is it sometimes referred to as the "big O  
23 notation"?

24 A Yes.

25 MR. DOVEL: I'm going to mark as Exhibit 2005



1 a blank piece of notebook paper. And we're going to  
2 make some notations on it.

3 (Exhibit 2005 was marked for identification  
4 by the court reporter and is attached  
5 hereto.)

6 MR. DOVEL: And the first thing I'm going to  
7 write is "O(n)." I'm going to stick that in front of  
8 the witness.

9 THE WITNESS: Okay.

10 BY MR. DOVEL:

11 Q Are you familiar with that notation?

12 A Yes.

13 Q What does that indicate to you, as one of  
14 ordinary skill in the art?

15 A So there's a parameter, N, which is a  
16 number. And one, let's say, looks at computational  
17 time as a function of N. So if N grows, order N  
18 means that the search time will not increase faster  
19 than linearly. So it could increase linearly, or it  
20 could increase sublinearly.

21 Q What that tells us is that the upper bound  
22 for the increase in the execution time is going to  
23 be linear; right?

24 A At most linear.

25 Q Is it the case that -- withdrawn.

1           And there, when we see that -- withdrawn.

2           In your field, when somebody writes that  
3 notation,  $O(n)$ , they're using  $N$  to refer to the size  
4 of the dataset over which is being searched; is that  
5 right?

6           A    This is a very general notation in  
7 mathematics and computer science. So you can apply  
8 it to a database, for instance, where  $N$  could be the  
9 size of the database. That would be one  
10 application, yes.

11          Q    If  $N$  refers to the size of the dataset  
12 over which we're searching, then if we've got a  
13 database and what we know about it -- withdrawn.

14                If  $N$  refers to the size of the database  
15 over which we're searching, and if we have an  
16 algorithm or search that performs at --  $O(n)$ , as  
17 we've written there in Exhibit 2005, does -- what  
18 does that tell us about whether it's linear or  
19 sublinear?

20          A    It says -- it is at most linear. That's  
21 often a source of confusion, by the way. It means  
22 at most linear. It does not mean necessarily  
23 linear.

24          Q    That would indicate -- withdrawn.

25                Is it the case that when scientists in

1 your field are assessing the complexity of an  
2 algorithm and how its execution time scales, that  
3 it's based upon using a hypothetical dataset?

4 A If you apply that notation to -- to a  
5 dataset and you say  $N$  is the size of the dataset,  
6 that would mean that the function on the left side,  
7 which is a search time in your example, grows at  
8 most linearly with  $N$ .

9 Q If we have a -- let's assume we've got  
10 a -- another algorithm and what we know about it is  
11 that its search time, compared to the size of the  
12 database,  $N$ , is that it's  $O(kn)$ , where  $K$  is a  
13 constant.

14 What does that indicate to you?

15 A The constant -- if  $K$  is a constant, the  
16 two equations you've written are equivalent, because  
17  $O(n)$  or order of, say,  $2N$  is the same thing  
18 mathematically.

19 Q Does it, in both instances, indicate that  
20 the search time is on the order of linear?

21 A At most linear.

22 Q If all we know about a search is that its  
23 search time compared to the size of the database  
24 over which we're searching grows  $O(n)$  or  $(kn)$ , do we  
25 know that it's sublinear?

1           A    We don't know because the notation is not  
2 refined enough to indicate that. You would have to  
3 use another notation.

4           Q    What other notation?

5           A    The theta of N notation.

6           Q    What's the "theta alpha notation"?

7           A    "Theta of N" notation.

8           Q    Theta of N notation.

9           A    So if instead of big O you had written  
10 theta, that would mean linear N.

11          Q    Why don't you go ahead and write that down  
12 for me on Exhibit 2005.

13                   And what you've written there is, just for  
14 the record, something that looks like an H with a  
15 circle around it, (n). And that's pronounced theta  
16 of N?

17          A    It's capital letter theta. Greek letter.

18          Q    And it's pronounced "theta N"?

19          A    Theta of N.

20          Q    Theta of N.

21                   Now, if we have something that's theta of  
22 KN, what does that indicate?

23          A    Again, if K is a constant, like 2, there  
24 is no difference between theta of N and theta of KN.  
25 They mean the same thing mathematically.

1 Q When we're assessing whether or not a  
2 given search is a sublinear search or sublinear time  
3 search, do we determine it based upon whether or not  
4 the search time grows compared to the size of the  
5 query?

6 A You have said -- okay. We need to be  
7 specific here.

8 You say the search time. Okay. You're  
9 looking at the search time as a function of -- now  
10 this has to do with query; before you talked about  
11 the size of the database. Which one is it?

12 Q Let me back up and ask you another couple  
13 of questions.

14 When we're -- in this field when we're  
15 talking about a -- using a search, what we're doing  
16 is we're comparing a query or a pattern against a  
17 database of data; is that right?

18 A Yes.

19 Q And if we talk -- is it -- are there other  
20 words for "query" or "pattern"?

21 What's the -- what's the best one to use?

22 A "Query" is fine. One could -- could say  
23 "probe" as well.

24 Q "Probe" or "query" or "pattern," they're  
25 all synonymous in this context?

1           A    Yes.

2           Q    In -- in looking at some of the prior art,  
3 they refer to a -- trying -- having a song or a  
4 melody that is unknown and then trying to determine  
5 what that melody actually is.

6                    You're familiar with that sort of prior  
7 art?

8           A    Yes.

9           Q    Is the unknown melody the equivalent of  
10 the query or the pattern that we're searching for?

11           A    So the -- the -- what's submitted by the  
12 user is the query; what you are comparing it against  
13 is -- is the database. So it --

14           Q    When you say "database," is that the same  
15 thing as "dataset" in this context?

16           A    Yes.

17           Q    Now, if we're trying to determine whether  
18 a given algorithm is sublinear or linear, do we  
19 assume that the query size is fixed or does the  
20 query size vary when we're trying to assess whether  
21 it's sublinear?

22           A    It depends on the problem considered, the  
23 different flavors of these problems.

24           Q    If we're trying to determine whether  
25 something is sublinear as it's used in the claims of

1 the -- claims of the patents -- withdrawn.

2           If we're talking about the concept of  
3 sublinear search or sublinear time search as it's  
4 used in the '237 patent, does that refer to a search  
5 time that grows at a sublinear rate as we increase  
6 the size of the pattern, or -- or does it refer to a  
7 search that increases at a sublinear rate as we  
8 increase the size of the database?

9           A   Usually, the one that matters is the size  
10 of the database, because that's a big one.

11          Q   When the -- in your definition that you  
12 set forth on page 19, where you said, "A sublinear  
13 search means a search whose execution time has a  
14 sublinear relationship to database size," you're  
15 referring to "sublinear" as it's used in the '237  
16 patent; is that right?

17          A   Let me check the '237 patent.

18                What I gave in my Declaration is a general  
19 definition of sublinear search. In the patent  
20 here -- for instance, if you look at Claim 5 that  
21 you -- we just discussed, sublinear time is used.  
22 It does not say what the reference is.

23                Again, in those problems, the parameter  
24 that's very big that's of concern is the size of the  
25 database.

1 Q Is it the case that in doing your analysis  
2 to determine whether or not prior art anticipated,  
3 you applied the definition that a sublinear search  
4 or a sublinear time search was one whose execution  
5 time has a sublinear relationship to the database  
6 size?

7 A That is correct, yes.

8 Q Is that the correct definition that should  
9 be applied, or are you applying the wrong  
10 definition?

11 A In my opinion, this is the correct  
12 definition to be used.

13 Q Would it be wrong to apply a definition  
14 that said, "I'm going to determine if it's sublinear  
15 based upon whether or not the search time grows  
16 compared to the size of the query or the pattern?

17 A Mathematically, this could be done.  
18 Whether it's relevant from an engineering point of  
19 view is a different matter.

20 My opinion here is as an engineer. Okay?  
21 The parameter that's big that's of concern is the  
22 database size.

23 Q In trying to determine whether or not the  
24 '237 patent is anticipated, is it your opinion that  
25 the definition you've set forth in paragraph 53 is



1 the correct one?

2 A That's the definition I have applied. And  
3 I, yes, believe it's correct. That's my opinion.

4 Q Would it be wrong, then, to assess whether  
5 a search is sublinear by applying a definition that  
6 said, "It's sublinear if this execution time has a  
7 sublinear relationship to the size of the query or  
8 the pattern"?

9 A It would not be very relevant. Again,  
10 mathematically, it can be done. Everything can be  
11 done. But it would not be relevant, from an  
12 engineering viewpoint, for an application like this.

13 Q It wouldn't be relevant to the --  
14 assessing the '237 claims; is that right?

15 A In the field of database search in  
16 general -- and this includes the -- the patents  
17 we're discussing -- it's the database size that is  
18 the large number. And when you say "order of,"  
19 typically you refer to that.

20 Q If we're trying to determine whether the  
21 '237 -- withdrawn.

22 Let's assume somebody came along and said,  
23 "Listen, I'm going to assess the '237 patent, but  
24 I'm not going to look at whether or not this prior  
25 art scales based upon the size of the database; I'm

1 going to look at whether it scales based upon the  
2 size of the query or the pattern."

3 Would they then be accurately assessing  
4 the '237 patent claims?

5 A No. They would be looking at only one  
6 small view of the problem. They -- they could not  
7 look only at that. It's only a very partial view of  
8 the problem.

9 Q Is it the case that for something to be --  
10 withdrawn.

11 Is it the case that for a search to be  
12 sublinear as it's used in the '237 patent, it's not  
13 enough for it to have execution time that is  
14 sublinear in relationship to the size of the  
15 pattern; it must also be sublinear in relationship  
16 to the size of the database?

17 A When I read "sublinear" in, say, Claim 5  
18 of the patent, as we just did, I understand  
19 sublinear to mean in relation with the size of the  
20 database. It does not say anything about in  
21 relation with the size of the query.

22 Q If we were doing -- withdrawn.

23 If someone was doing an assessment --  
24 withdrawn.

25 Let's assume that the Patent Trial and

1 Appeal Board was presented with prior art that  
2 presented a search that was linear with respect to  
3 the size of the database, but it was sublinear with  
4 respect to the size of the pattern.

5 Would that prior art demonstrate a  
6 sublinear search as it's used in Claim 25?

7 A People say it's a linear search, again,  
8 because it's in relation with the size of the  
9 database. And as you just said, that complexity is  
10 still linear; so people would say it is a linear  
11 search.

12 Q It is not a sublinear search?

13 A It's only sublinear in terms of the size  
14 of the query, which is generally not the  
15 parameter of -- the relevant parameter.

16 Q Is it the case that if we had a piece of  
17 prior art that was linear with respect to the size  
18 of the database but sublinear with respect to the  
19 size of the query or the pattern, that that prior  
20 art would not teach a sublinear search as it's used  
21 in Claim 25?

22 A Again, if one understands sublinear to be  
23 in terms in relation to the size of the database,  
24 that would be a -- a linear search.

25 Q My question wasn't "if one understands"; I

1 want to get your understanding of Claim 25. So you  
2 still haven't answered my question. I'll ask you  
3 again.

4 Let's assume we've got a piece of prior  
5 art that scales at a sublinear relationship with the  
6 size of the pattern or query but it scales at a  
7 linear relationship with the size of the database  
8 that's being searched.

9 Would that prior art demonstrate or  
10 disclose a sublinear search as it's used in the  
11 claims of the '237 patent?

12 A No. Again, because my understanding is  
13 the claims of the '237 patent, whenever there's  
14 mention of "sublinear," it means in terms of the  
15 database size. It does not say it explicitly; it's  
16 my inference based on my knowledge and my expertise.

17 Q Let's assume we have a search that's  
18 execution time is  $O(mn)$ , where  $M$  means the size of  
19 the query,  $N$  means the size of the database or  
20 dataset that we're searching over.

21 What does that tell us?

22 A Well, it means that the search time,  
23  $f(m)n$ , grows at most linearly.

24 Q Is it the case that this would be a  
25 sublinear search as it's used in the '237 patent?

1           A   No.  It says, again, it's at most linear  
2   in terms of M times N.

3           Q   Let's assume we have a -- withdrawn.

4                    What I've tried to write there -- and see  
5   if I wrote it correctly -- is we've got a search,  
6   and the search time is  $O(f(m)n)$ .

7                    Does that -- do you understand what that  
8   refers to?

9           A   Yes.

10          Q   What would that indicate?

11          A   Well, that the search time, as a function  
12   of that quantity in parentheses, grows at most  
13   linearly.

14          Q   Is it the case that if N, in that example,  
15   refers to the size of the database, do we have,  
16   then, a sublinear search?

17          A   Well, you have to tell me if M grows too,  
18   or if it's a constant like in your -- in your  
19   previous example?

20          Q   Let's assume that M is the size of the  
21   query.

22          A   Uh-huh.

23          Q   M, as in Mary.  And that N, as in Nancy,  
24   is the size of the database.

25          A   Okay.

1           Q    In that instance, does this describe a  
2 search that has -- that is -- has sublinear  
3 execution time when compared to the size of the  
4 database?

5           A    Your question is incomplete. There's an  
6 assumption you need to specify. Does M grow, or  
7 does N grow, or is it both?

8           Q    Well, my question is if we're presented  
9 with this information, and we want to know is this  
10 search sublinear or linear with respect to the size  
11 of the database, where N is the size of the  
12 database, does that tell us?

13          A    No. Because you have not told me how  
14 either M or N grows. The product of  $f(m)n$  has to  
15 grow. For that to grow, either M or N has to grow,  
16 or both. But you need to tell me which one.

17          Q    If N refers to the size of the database,  
18 and we're trying to assess whether that describes a  
19 search that is sublinear with respect to the size of  
20 the database, can we -- what does that tell us?

21          A    This tells us that the search time grows  
22 at most linearly in terms of the product  $f(m)n$ . You  
23 have not told me whether it is M that grows or N  
24 that grows. The product has to grow, but there are  
25 different ways in which it can grow. N alone can

1 grow and M is fixed, or M can grow and N grows.

2 So the answer depends on your assumption.

3 You need to specify your assumptions.

4 Q If we're trying to determine or assess  
5 whether or not this search is sublinear with respect  
6 to database size, and if N, as in Nancy, refers to  
7 database size, then would that indicate that we're  
8 going to be assessing this assuming that N grows and  
9 that M is fixed?

10 A It depends on the problem. In some  
11 problems, indeed, M could be fixed and N grows.  
12 That's a -- a possibility.

13 Q Well, my question is if we're trying to  
14 determine whether or not a given search is sublinear  
15 with respect to the size of the database, that means  
16 that we're going to determine execution time  
17 compared to the growth of the database, N; right?

18 A Yes.

19 Q If that's the case when we're presented  
20 with this information, then is the assumption that M  
21 is fixed if we're trying to determine whether it's  
22 sublinear with respect to the growth of N?

23 A Different applications could have  
24 different M. Some applications could have fixed M;  
25 other applications could have M grow like N. It

1 depends on the application.

2 Q If we're trying to -- suppose I present  
3 you with an algorithm, and I say to you, "I want to  
4 know, in your opinion, does this describe a linear  
5 or a sublinear algorithm with respect to the  
6 database time?"

7 And I --

8 A "Size," you mean.

9 Q Right. With respect to the database size.

10 And I present -- let's take Algorithm 1,  
11 2, 3, 4, the one that says " $O(mn)$ ." I present that  
12 to you.

13 A Yes.

14 Q Do you have an opinion?

15 A Can you repeat your question.

16 Q Yeah. If -- so just to be clear, in fact,  
17 I'm going to take Exhibit 2005, and just for  
18 clarity, I'm going to put a number next to each of  
19 these formulas we've written down. Starting at the  
20 top, it will be 1, 2, 3, 4, 5.

21 Let's take a look at Formula Number 4.  
22 Assume you're presented that information about a  
23 given search. And the question is -- withdrawn.

24 Assume you're given number -- Formula  
25 Number 4 and told that M, as in mother, refers to



1 the size of the query;  $N$ , as in Nancy, refers to the  
2 size of the dataset that we're searching over.

3 And you're asked the question, "Does that  
4 tell us anything about whether or not the search is  
5 sublinear with respect to the size of the database?"

6 A I don't have enough information to answer  
7 this. It's really exactly like if you told me, "Ten  
8 is the sum of two numbers; tell me which ones."

9 Q If we know that  $M$  refers to the size of  
10 the query and  $N$  refers to the size of the database,  
11 and we're interested in whether or not the -- a  
12 search is sublinear with respect to the size of the  
13 database, does that tell us that it -- with respect  
14 to the size of the database -- that it grows on the  
15 order of  $N$ , as in Nancy?

16 A  $M$  and  $N$  could be related. You have not  
17 defined the relationship between them. If  $M$  is  
18 fixed, there's one answer, and -- which I've given  
19 earlier -- it is: The growth is at most linear.

20 But if  $M$  grows with  $N$  as well, then the  
21 answer is different.

22 Q Let's -- I want you to assume that  $M$   
23 refers to the size of the query,  $N$  refers to the  
24 size of the database, and that there is no  
25 relationship between them except that  $N$  is greater

1 than M. The size of the database is greater than M.

2 A Okay. So when you say there's no  
3 relationship, do you assume that M is fixed?

4 Q Well, if we're trying to answer this  
5 question, is that the assumption that should be  
6 made?

7 A The way you have said it, mathematically,  
8 to suggest M is fixed. So I want to make sure we're  
9 on the same page.

10 Q Okay. What about the way I've said it  
11 suggests that M is fixed?

12 A Because you said there's no relation  
13 between them. So that suggests to me that if one --  
14 say N increases, M does not because it's not  
15 related. That's my assumption from what you said.

16 Q Okay. Let's assume they're not related.

17 In other words, were -- is that the  
18 typical problem we're facing, is that we've got a  
19 database of a certain size that may change, and  
20 we've got different queries of different lengths,  
21 whether the -- the query length is not going to  
22 affect the database size in a typical problem --

23 A There may be a relationship.

24 Q It's possible?

25 A Depends on the problem.

1 Q In the typical cases, is it that they do  
2 not have a relationship?

3 A I've encountered both types of problems.

4 Q Well, the question isn't whether you've  
5 encountered them.

6 What's typical?

7 A Well, both are typical, I would say. It  
8 depends on the problem.

9 Q Okay. Now, let's assume that we have a --  
10 a problem we're dealing with where the size of the  
11 query and the size of the dataset are unrelated.

12 And you're presented with the information  
13 that's in Formula 4, that the search time is on the  
14 order of M, as in mother, times N, as in Nancy,  
15 where M refers to the size of the query, N refers to  
16 the size of the data set?

17 What information does that tell you about  
18 whether it's linear or sublinear?

19 A So based on your assumptions that you laid  
20 out, I treat M as a fixed number. Then the answer  
21 is the same I gave earlier: It would tell me that  
22 the search time is at most linear in N, as Nancy.

23 Q Let's assume we've got a search that's  
24  $O(f(m)n)$ , where M and N are unrelated. What does  
25 that -- where N refers to the size of the database.

1           What information does that tell us about  
2 whether it's linear or sublinear?

3           A    Same answer.

4           Q    Which is what?

5           A    That, again, it would be -- the search  
6 time would be at most linear in  $N$ .

7           Q    Linear as to the size of the dataset that  
8 we're searching over?

9           A    Exactly. Yes. And that's because you  
10 have treated  $M$  as fixed. So whether it's  $(m)$  or  
11  $f(m)$  that appears in the equation is irrelevant.

12          Q    I've written down Equation or Formula  
13 Number 6, which I'm going to read it as on the order  
14 of  $N$ , as in Nancy, times log of  $M$ ; is that right?

15          A    Yes.

16          Q    Let's again assume that  $N$  refers to the  
17 size of the database,  $M$  refers to the size of the  
18 query.

19               Does that -- if we have a -- withdrawn.

20               If we have a search that is described as  
21 set forth in Formula 6, where  $N$  refers to the size  
22 of the database, what does that tell us about  
23 whether it's linear or sublinear?

24           A    Same answer as previously. You have  
25 replaced  $f(m)$  with  $\log(m)$ . It's just a particular

1 function,  $f(m)$ . So that would tell me that search  
2 time is at most linear in terms of  $N$ .

3 Q If you're presented with that, does that  
4 tell you that we have a sublinear search?

5 A In terms of  $N$ , yes.

6 Q In terms of --

7 A Sorry. Let me rephrase this.

8 It's at most linear.

9 Q Does that tell us that we have a sublinear  
10 search?

11 A It does not tell me that, because of the  
12 meaning of the order of notation. It says, at most,  
13 linearly.

14 Q Let me ask you a different problem.

15 Let's assume we have a search algorithm,  
16 and what it does, it is able to perform its  
17 search -- withdrawn.

18 Let's assume we've got a search algorithm,  
19 and we're trying to take a pattern or query and see  
20 if it matches any portion of a dataset. And in that  
21 process, our particular algorithm operates such that  
22 it doesn't need to look at every single character in  
23 the dataset.

24 Are you familiar with algorithms of that  
25 sort?

1           A    Yes.

2           Q    Knowing just that information and no more,  
3 does that tell you one way or the other whether it's  
4 linear or sublinear?

5           A    No, it does not.

6           Q    Why not?

7           A    Because you have -- when you tell me it  
8 does not look at every character, you don't tell  
9 me -- you know, does it look at only half the  
10 characters? Does it look at the square root of  
11 number of characters?

12                    So many possibilities. You need to  
13 specify that.

14           Q    If it's the case that it looks at a  
15 fraction of the characters, one -- one out of eight,  
16 one half, something like that -- does that tell you  
17 whether or not the algorithm is sublinear?

18           A    If it's a fixed fraction -- for instance,  
19 you tell me one eighth -- so if the algorithm looks  
20 at one eighth of the number, if it looks at one  
21 eighth of the size of the dataset, that would be  
22 linear. Again, as the dataset -- as the data size  
23 goes to infinity, if you keep looking at one eighth,  
24 it would be a linear relationship. It's one eighth  
25 of M.

1 Q It would be something like Formula  
2 Number 2,  $O(kn)$ ?

3 A No. Because Formula Number 2 uses the  
4 order of notation; I would need to use the theta of  
5  $N$  notation.

6 Q So you would say that this one is not just  
7  $O(n)$ , it would actually be --

8 A It behaves as a constant times  $N$ .

9 Q And that would be a linear relationship;  
10 right?

11 A Because you assume -- you look at, say,  
12 one eighth, you -- your calculation involves one  
13 eighth of the database.

14 Q Why don't you turn to page 20 of your  
15 Declaration.

16 A Yes. Yes.

17 Q On page 20, this is where you've got the  
18 chart that explains linear search versus sublinear  
19 search; right?

20 A Right.

21 Q If we've got a search and what we know  
22 about it is that it looks at a constant fraction of  
23 the characters in the dataset, is that going to  
24 be -- if we were to plot it -- one that gives us a  
25 straight line like you plotted there?

1           A    Well, my charts, my plots, only the  
2 horizontal axis is the number of entries in the  
3 database. So it says nothing about how many samples  
4 I'm evaluating for each entry.

5           Q    All right. Let's assume we've -- we've  
6 got a chart -- let's broaden your -- your definition  
7 here.

8                    Let's assume you're plotting search time  
9 versus size of a dataset. Okay?

10          A    Okay.

11          Q    If it's linear versus sublinear, we're  
12 still going to plot the same thing you've plotted  
13 there; is that right?

14          A    Yes.

15          Q    Now, let's assume we also know that our  
16 particular search algorithm examines a fraction of  
17 the characters in the dataset. Is that -- and that  
18 that fraction is constant over time as the size of  
19 the dataset increases.

20                    Is it the case, then, that that is going  
21 to be a linear or sublinear search?

22          A    It would be at least linear because,  
23 again, your assumptions are not completely  
24 specified. The fact that it evaluates a constant  
25 fraction means the complexity is at least linear.



1 Q And it could be worse?

2 A Yes. Because it depends on the work you  
3 do with those samples. It might be that the  
4 algorithm is very complex. And as complexity, N  
5 square.

6 Q Would that tell us that it's definitely  
7 not sublinear?

8 A Yeah, N square is definitely not  
9 sublinear.

10 Q But if we knew that the algorithm  
11 evaluates a constant fraction of the characters,  
12 does that tell us that it's not sublinear?

13 A Yes.

14 Q Why is that?

15 A Well, because the work involved includes  
16 evaluating a fixed fraction of N. So then, by  
17 definition, this cannot be sublinear.

18 Q Why is that?

19 A Because you work, let's say, at least  $n/8$ ,  
20 to take your example from earlier. To have a  
21 sublinear relationship, it would need some function  
22 that grows less than linearly. So  $n/8$  grows  
23 linearly.

24 Q Are you familiar with a search algorithm  
25 known as the Boyer-Moore algorithm?

1 A Yes.

2 Q When did you first encounter that?

3 A Hard to say. I -- I don't remember.

4 Q Many years ago?

5 A Probably, yes.

6 Q Is the Boyer-Moore algorithm one that's  
7 been well studied, or is it something that people  
8 know very little about?

9 A It's a pretty well-known algorithm.

10 Q Is it one that numerous peer-reviewed  
11 papers have been written describing the performance  
12 of the Boyer-Moore algorithm?

13 A Many papers have been written, as far as I  
14 know, discussing the paper and improving it, yes.

15 Q If we take the basic Boyer-Moore --  
16 withdrawn.

17 When you say "improving it," there are  
18 variations of the Boyer-Moore algorithm; is that  
19 right?

20 A Yes. Many.

21 Q Where people have taken it and modified it  
22 in various ways?

23 A Or modified the assumptions.

24 Q Let's take the basic Boyer-Moore  
25 algorithm.

1           Are -- have you done any analysis  
2 yourself, independently, to determine whether or not  
3 the Boyer-Moore algorithm is an algorithm that is  
4 sublinear with respect to the size of the database  
5 being searched?

6           A    The Boyer-Moore algorithm says nothing  
7 about a database.  It's a very basic problem that  
8 involves finding a pattern in a string.  You know,  
9 that algorithm could be used in a variety of  
10 contexts, including database searching.

11          Q    Is the -- is the Boyer-Moore algorithm one  
12 that is sublinear with respect to the size of the  
13 dataset being searched?

14          A    The Boyer-Moore -- let me just review  
15 this.  Can you point me in my Declaration where this  
16 was discussed.

17          Q    Well, I'll get to that in a second --

18          A    Fine.

19          Q    -- let's start -- let's start with your --  
20 what you recall.

21          A    I don't recall the constants in  
22 Boyer-Moore.  I would have to check them in my  
23 Declaration.

24          Q    When you say "the constants," what do you  
25 mean by "the constants"?

1           A    Well, the Boyer-Moore algorithm presents  
2   an efficient search algorithm, and you have a  
3   average-case performance; there's also worst-case  
4   performance.  And it tries to precisely determine  
5   what that performance is.

6           The "order of" is viewed as somewhat  
7   imprecise.  It does not tell me what the constants  
8   could be.  So  $1/8n$  or  $10n$  are both  $O(n)$ .  But the  
9   constants are the same:  $1/8$  or  $10$ .

10          Q    In preparing your Declaration, you -- you  
11   made some comments about the Boyer-Moore algorithm,  
12   is that right, in your Declaration?

13          A    Yes.

14          Q    All right.  When you made those comments,  
15   did you do that from your memory, or did you do some  
16   research to determine the performance of the  
17   Boyer-Moore algorithm?

18          A    I don't recall.  I probably did it from  
19   memory, yeah.

20          Q    Can you describe generally how the  
21   Boyer-Moore algorithm functions, what it does.

22          A    Yeah.  So if you have too much string --  
23   let's say the word "second."  If you want to find  
24   that string in, say, a page of text or in a book,  
25   there's a straightforward way to do it, which most

1 people might do. They would use a sliding window  
2 and repeat, "Do I see the word 'second'?" But it's  
3 not the most efficient way.

4 So Boyer-Moore does it much more  
5 efficiently by keeping a table and cuts down on the  
6 search time.

7 Q Now, based on what you know about the  
8 algorithm and how it works, if we increased the size  
9 of the string or dataset that we're searching over,  
10 is the search time going to go down on a sublinear  
11 way, or is it going to be linear?

12 A I would have to double-check this. I  
13 don't remember.

14 Q Well, I'm going to point to your  
15 Declaration --

16 A Right. Right.

17 Q -- just based on what you understand about  
18 the algorithm.

19 A I would have to double-check. I don't  
20 want to -- to make a mistake in the complexity.

21 Q What do you think it is, based on the way  
22 you've just described it?

23 Does that sound like something where the  
24 search time would go down as you increase the size  
25 of the database?

1           A    No.  That could not be.

2           Q    Why not?

3           A    Well, the larger your database, or in this  
4 case, the page of text in the example I gave, the  
5 more work you have to do.  So it could not possibly  
6 go down.

7           Q    Could it be the case that based on the way  
8 Boyer-Moore operates, that the search time would be  
9 sublinear such that as we continue to increase the  
10 size of the database, the proportion of time that we  
11 needed would go down?

12          A    Again, sublinear in what -- I need to  
13 review -- there are different ways to state the  
14 complexity.  I need to review the way it was done in  
15 my Declaration.

16          Q    When you say the way it was done in your  
17 Declaration, what are you referring to?

18          A    Well, Boyer-Moore was discussed in my  
19 Declaration.  Again, there are two quantities of  
20 interest.  One is the size of the pattern you are  
21 trying to match, and the other one is the length of  
22 the string, okay, of the text in the example.

23          Q    All right.  Well, I'm going to get you  
24 your Declaration.  In fact, why don't you just close  
25 it.  I don't want you to get confused here.

1 A Pardon?

2 Q I'm going to have you look at it in a  
3 minute. I need to -- you have to focus on my  
4 questions first.

5 When you did your analysis that you put in  
6 your Declaration, did you go to some basic sources  
7 to see what it -- what the published results were  
8 for the performance of the Boyer-Moore algorithm?

9 A I verified them. I have, again, some  
10 recollection of what the complexity -- both the  
11 worst-case and the average-case complexity of  
12 Boyer-Moore are, and I verified them, yes.

13 Q Now, when you -- did you look at  
14 Boyer-Moore's original paper describing the  
15 algorithm?

16 A Yes. That's my recollection, at least.

17 Q Did you look at some of the other  
18 well-known papers that assess the performance of the  
19 Boyer-Moore algorithm or just -- just the original  
20 Boyer-Moore paper?

21 A Well, the performance was already assessed  
22 in the paper itself. So follow-up papers looked at  
23 the variations of the problem. They referred to  
24 Boyer-Moore because it's a golden standard.

25 Q Did you -- do you recall seeing any paper

1 that said that -- withdrawn.

2 Do you recall seeing any paper that  
3 presented an analysis, either theoretical or  
4 experimental, that showed that the Boyer-Moore  
5 algorithm was sublinear with respect to the size of  
6 the dataset being searched?

7 A Again, performance of this algorithm is  
8 given in terms of two quantities. I would have to  
9 review -- I don't remember the -- the exact formula.  
10 I would have to review it. I don't know it offhand.

11 Q When you did your analysis --

12 A Right.

13 Q -- in preparing your Declaration, did you  
14 see any source, any published source that presented  
15 either theoretical results -- that is a mathematical  
16 calculation -- or actual experimental results that  
17 showed that the Boyer-Moore algorithm was sublinear  
18 with respect to the size of the dataset being  
19 searched?

20 MR. ELACQUA: Asked and answered.

21 THE WITNESS: Yeah. Boyer-Moore gives those  
22 results. As I've just said, there's a formula which  
23 apparently you don't want me to check. I don't  
24 remember the formula by heart, okay. They give a  
25 formula. The time complexity in terms of these two



1 parameters.

2 BY MR. DOVEL:

3 Q When you say "these two parameters,"  
4 you're talking about the query and the database  
5 size; is that right?

6 A The string -- the long string in which we  
7 try to find the pattern.

8 Q Okay. But my question is when you did  
9 your work, did you see an actual paper that  
10 presented either experimental results or a  
11 theoretical calculation?

12 A The theoretical calculation was done by  
13 Boyer-Moore. Other works have used it, for  
14 instance, Iwamura, Ghias. This algorithm has been  
15 used by -- by many people.

16 Q Are you telling me that when you prepared  
17 your Declaration, you looked at the original  
18 Boyer-Moore paper?

19 A I don't recall. I think I did. I don't  
20 recall if I looked at original paper or a reference  
21 that gave Boyer-Moore. There are different ways to  
22 obtain the formula. You can, of course, look at the  
23 original paper or you can look at a reference that  
24 gives that formula.

25 Q Okay.

1           A    I don't remember which one I did.

2           MR. DOVEL:   Okay.  Let's go ahead and take a  
3 break, and we will return in about five minutes.

4           THE VIDEOGRAPHER:  We're off the record at  
5 9:58 AM.

6                   (Off the record.)

7           THE VIDEOGRAPHER:  We are back on the record  
8 at 10:11 AM.

9           MR. DOVEL:  I'm holding a document entitled "A  
10 Fast String Searching Algorithm."  It's by Boyer and  
11 Moore.  This will be Exhibit Number 2006.

12                   (Exhibit 2006 was marked for identification  
13 by the court reporter and is attached  
14 hereto.)

15 BY MR. DOVEL:

16           Q    I've placed Exhibit 2006 in front of the  
17 witness.

18                   Dr. Moulin, do you recognize this paper  
19 generally as the paper by Boyer and Moore that  
20 published the Boyer-Moore algorithm?

21           A    Yes.

22           Q    I'm going to look at several parts of this  
23 with you, but I just want to look at the abstract.

24                   One of the things it says in the abstract  
25 is, "The worst-case behavior of the algorithm is

1 linear in  $i$  plus  $patlen$ ."

2 Do you see that?

3 A Yes.

4 Q "Patlen," that refers to the length of the  
5 pattern or length of the query; is that right?

6 A I assume so. Seeing this, I'm -- I have  
7 not read the paper itself. I'm, again, familiar  
8 with the result; I have seen the result quoted in  
9 other papers. So I would have to read the notation.  
10 But it seems straightforward.

11 Q Well, if we look at the introduction on  
12 page 1, the first sentence says, "Suppose that  $pat$   
13 is a string of length  $patlen$ ."

14 Do you see that?

15 A Yes.

16 Q Is it your understanding, then, that  
17  $patlen$  is going to correspond to the length of the  
18 query?

19 A Yes.

20 Q Now, if we look in the introduction, down  
21 about paragraph 1, 2, 3, you see a sentence that  
22 says, "We now present a search algorithm which is  
23 usually 'sublinear.'"

24 Do you see that?

25 A Yes.

1 Q And then he goes on to describe what he  
2 means by "sublinear."

3 Do you see that?

4 A Yes. Again, I would have to read it  
5 carefully.

6 Q Is what Boyer and Moore are describing  
7 here when they used the term "sublinear" is an  
8 algorithm that is sublinear with respect to the  
9 length of the pattern or query?

10 A I would have to read this. Again, this is  
11 not a paper I have read before. I'm familiar with  
12 the results, but I have to read the whole paragraph.

13 Q You have not read this paper before?

14 A I am familiar with the results, but I have  
15 not read the entire paper before.

16 Q Have you read any portion of the paper  
17 before?

18 A I'm -- the results, yes.

19 Q Have you read any portion of the paper  
20 before?

21 A I -- I might have seen -- again, I've seen  
22 before -- I'm sure I did not read it completely.

23 Q In preparing your Declaration, did you  
24 pull up a copy of the Boyer-Moore article to see  
25 what it said about the performance of the

1 Boyer-Moore algorithm?

2 A I looked at the results. That does not  
3 mean that I read the paper completely.

4 Q So I want to get an answer to my question.

5 Did you -- when you say you looked at the  
6 results, did you look at portions of this paper in  
7 preparing your Declaration?

8 A I looked at the main results. So if  
9 that's what you call a portion, yes. I did not read  
10 the complete paper.

11 Q When you said you looked at the main  
12 result, what page was that on?

13 A The main results, I don't remember which  
14 page it's on. The main results is given already in  
15 the -- in the abstract, and it's stated more  
16 precisely further down in the paper.

17 Q Okay. Let's take a look at what it says  
18 in the abstract.

19 Does the abstract state that the  
20 Boyer-Moore algorithm is sublinear with respect to  
21 the size of a database?

22 A There's no database in Boyer-Moore.

23 Q Does Boyer-Moore -- does the abstract  
24 state that the Boyer-Moore algorithm is sublinear  
25 with respect to the size of the dataset being

1 searched?

2           A    There's two notions of complexity. One,  
3 as I said before, is worst case, and the other one  
4 is average case.

5                    So if you look at worst-case behavior of  
6 the algorithm, which is at the end of the abstract,  
7 "The worst-case behavior of the algorithm is linear  
8 in  $i$  plus  $patlen$ ."

9                    Then earlier, there is somewhere a  
10 discussion about the average performance. Okay.  
11 Here. So it's a few sentences above. On average,  
12 the algorithm executes fewer than  $i$  plus  $patlen$   
13 machine instructions. So you need to separate the  
14 two.

15           Q    Well, let's take both.

16                    Did either one of those address --  
17 withdrawn.

18                    The abstract, what it talks about is the  
19 behavior of the algorithm with respect to the length  
20 of the pattern; right?

21           A    The sum. There's  $i$ , and there's  $patlen$ .

22           Q    And what does  $i$  represent?

23           A    So  $i$  represents, in their notation, the  
24 location of the first occurrence of the pattern in  
25 the string.

1 Q What does the -- when we -- if we know  
2 that an algorithm -- withdrawn.

3 What does the abstract indicate with --  
4 withdrawn.

5 Does the abstract indicate that -- or have  
6 comments about the behavior or performance of the  
7 algorithm with respect to the pattern length?

8 A Yes. Because both -- whether you look at  
9 average or worst-case performance, it's  
10 characterized in terms of  $i$  and  $patlen$ .

11 Q Does the abstract have any comments about  
12 the performance of the Boyer-Moore algorithm with  
13 respect to the size of the dataset being searched?

14 A Implicitly, yes.

15 Q What's the implicit?

16 A Well, because this location prior to  $i$  can  
17 vary, it could be 1, okay, this  $i$  could be the very  
18 first character in the string, or it could be the  
19 last possible location.

20 Q And what does that tell us about whether  
21 it's sublinear with respect to the size of the  
22 dataset?

23 A Well, so if you view  $patlen$  as being a  
24 fixed number, say 10 -- you're trying to match a  
25 word -- and you have a string of length, say  $N$ , then

1 the largest possible value of  $i$  is  $n-10$ . Okay? So  
2 it is a function of  $N$ .

3 Q Is it the case that the average value of  $i$   
4 is going to be  $n/2$ ?

5 A Yes.

6 Q Approximately?

7 A Yes.

8 Q Is it the case that if we have -- let's  
9 take the worst-case behavior.

10 When it says, "The worst-case behavior of  
11 the algorithm is linear in  $i$  plus  $\text{patlen}$ ," that's a  
12 statement that if we put it in big  $O$  notation, that  
13 it would be  $O(n+m)$ ; is that right?

14 A Yes.

15 Q I'm going to write that down. Number 7.

16 And in Number 7,  $N$  would correspond to the  
17 size of the dataset,  $M$  to the length of the pattern;  
18 is that right?

19 A Yes.

20 Q Is it the case that what Boyer-Moore tells  
21 us in the abstract, if we look at the upper bound  
22 for the behavior, it's  $O(n+m)$ ; is that right?

23 A What do you call "the upper bound"? The  
24 worst-case behavior?

25 Q Yes.



1 A Yes.

2 Q Is another way for that -- when we're  
3 talking about worst-case behavior, is that also  
4 referred to as "the upper bound"?

5 A Well, an upper bound is not unique. It's  
6 "an upper bound."

7 Q Is it the case that -- withdrawn.

8 Now, so if we look at the -- look at that  
9 statement, does that suggest that the Boyer-Moore  
10 algorithm is sublinear with respect to the size of  
11 the dataset?

12 A This is -- you're looking at the  
13 worst-case behavior.

14 Q Yes.

15 A So the worst-case behavior is linear.

16 Q Would that be sublinear?

17 A No. The worst-case behavior is linear in  
18  $i$  plus  $patlen$ . Now, the worst case, again, is when  
19  $i$  is  $N$  minus  $patlen$ , that would be linear  $N$ , the  
20 worst case.

21 Q Is there anything in the -- in the  
22 abstract that tells you that the Boyer-Moore  
23 algorithm is sublinear with respect to the size of  
24 the dataset being searched?

25 A Let me read the abstract again.

1           So the way, in that paper, they have  
2 characterized performance is in terms of  $i$  and  
3  $\text{patlen}$ .  $i$  is a number that ranges from 1 to a value  
4 close to  $N$ . Okay. So it does not give the  
5 performance directly in terms of  $N$ ; it's in terms of  
6  $i$  and  $\text{patlen}$ .

7           Q    When you read the abstract to the  
8 Boyer-Moore algorithm paper, does it suggest that  
9 the Boyer-Moore algorithm is sublinear with respect  
10 to the size of the dataset?

11          A    With respect to the size of the string,  
12 the dataset?

13          Q    Yes.

14          A    So in the worst case, no. It's linear in  
15 the worst case.

16          Q    Does it have any suggestion that it's  
17 sublinear with respect to the size of the dataset?

18          A    Well, for instance, if  $i$  was the square  
19 root of  $N$ , then it would be sublinear.

20          Q    Well, that's not my -- question is "if."

21                My question is this: Is it the case that  
22 if you look at the abstract here, does the abstract  
23 provide any indication that the Boyer-Moore  
24 algorithm is sublinear with respect to the size of  
25 the dataset?

1           A    The abstract does not give performance --  
2    it gives performance in terms of  $i$  plus  $patlen$ , not  
3    directly in terms of  $N$ .  So this  $i$  could be as small  
4    as 1 or as big as  $N$  minus  $patlen$ .

5           Q    You haven't answered my question.

6                    Does the abstract provide any indication  
7    that the Boyer-Moore algorithm is sublinear with  
8    respect to the size of the dataset being searched?

9           A    No.

10          MR. ELACQUA:  Object.  Asked and answered.

11         BY MR. DOVEL:

12          Q    What was your answer?

13          A    No.

14          Q    Why not?

15          A    Because the abstract talks about something  
16    else.  It talks about  $i$  and  $patlen$ .

17          Q    And because it talks about  $i$  and  $patlen$ ,  
18    what it tells you is that the expected -- withdrawn.

19                 As you understand  $i$ ,  $i$  is a function of  $N$ ;  
20    right?

21          A    No.   $i$  is a number anywhere between 1 and  
22     $N$  minus  $patlen$ .

23          Q    As  $N$  grows, does -- withdrawn.

24                 Now, if we look at -- you've said that you  
25    looked at the main results of Boyer-Moore to

1 determine -- withdrawn.

2           You said earlier that you looked at the  
3 main results in this paper, which is Exhibit 2006,  
4 to determine the -- what it had to say about the  
5 performance of the Boyer-Moore algorithm.

6           Did you look someplace other than the  
7 abstract or just the abstract?

8           A    I don't recall where I looked exactly. I  
9 know I looked at other references as well.

10          Q    Other references.

11                Other than this paper?

12          A    Yes.

13          Q    Okay. I'm talking about this paper.

14          A    I don't recall where exactly I -- I read  
15 the results we're discussing. These are very  
16 well-known results. Again, I've seen -- I've seen  
17 those results before.

18          Q    When you say the "results," the  
19 performance of the Boyer-Moore algorithm is well  
20 known?

21          A    Yes. It's a well-established paper in  
22 1977.

23          Q    Well-known to people in your field; right?

24          A    Well-known to many people.

25          Q    How about to you? Was the performance of

1 the Boyer-Moore algorithm well known to you?

2 A I knew it was much faster than brute  
3 force. Again, the exact order of and constants, I  
4 have read them a while ago. I refreshed my memory  
5 for this case. But it's a well-known way to improve  
6 over brute-force algorithms.

7 Q Having refreshed your memory, what is your  
8 memory of what the performance of the Boyer-Moore  
9 algorithm is?

10 A Well, we've just discussed it.

11 So you look at worst-case complexity; you  
12 look at average performance, average complexity.  
13 There are two quantities of interest. One is the  
14 length of the pattern, called patlen here in this  
15 paper, and there is the location, the location of  
16 the pattern in the string, which ranges from 1 to N  
17 minus patlen.

18 Q Are you familiar with any analysis of the  
19 Boyer-Moore algorithm with respect to the size of  
20 the dataset being searched?

21 A It's described here. So, again, this  $i$ ,  
22 if you look at the worst case,  $i$  is  $N$  minus patlen,  
23 then you obtain it. As I said, it will be a linear  
24 relationship.

25 Q As one of ordinary skill in the art, if

1 you read the Boyer-Moore article, would you come to  
2 the conclusion that what it says about the time  
3 complexity of the Boyer-Moore algorithm is that it  
4 would scale execution time in a linear relationship  
5 worst case, compared to the size of the dataset  
6 being searched?

7 A Yes. And also, it is known to be much  
8 faster than brute force. A person of ordinary skill  
9 in the art would know that.

10 Q The fact that it's faster than brute force  
11 does not tell you that it's sublinear; right?

12 A No.

13 Q In fact, what this paper tells you based  
14 on the analysis that's here is that it's on the  
15 order of linear; right?

16 A In the worst case, yes.

17 Q Now, did you -- in your Declaration, you  
18 didn't mention the Boyer-Moore paper, which says  
19 that the Boyer-Moore algorithm has a performance  
20 compared to the size of the database that's on the  
21 order of linear; is that right?

22 A I need to check where this is discussed in  
23 my Declaration. Can you point me to the right page.

24 Q I think I can. Give me a minute.

25 A Sure.

1 Q Take a look at page 27 in your  
2 Declaration. Stick with the right page here.

3 In paragraph 72, you mention the  
4 Boyer-Moore algorithm.

5 Do you see that?

6 A Yes.

7 Q In your Declaration, you didn't mention  
8 that in the Boyer-Moore paper, that Boyer-Moore  
9 described the algorithm as having a linear  
10 relationship with respect to the size of the  
11 database rather than sublinear; is that true?

12 A Can you repeat your question. Sorry.

13 Q Yeah. In your Declaration --

14 A Yes.

15 Q -- when you discussed the Boyer-Moore  
16 algorithm at paragraph 72, do you mention the  
17 Boyer-Moore paper, which states that the Boyer-Moore  
18 algorithm has a linear relationship rather than a  
19 sublinear relationship with respect to the size of  
20 the database?

21 A Well, I quoted Exhibit 1017, which reads,  
22 "On the average, the Boyer" -- "the algorithm has a  
23 sublinear behavior." So reference Exhibit 1017  
24 was -- I have to remember what it was.

25 Q That's a reference by Raita.

1 A By --

2 Q Raita, R-a-i-t-a.

3 A Okay.

4 Q I need an answer to my question.

5 A So as I just read -- so -- I quoted a  
6 passage from that exhibit that reads, "On the  
7 average, the Boyer-Moore algorithm has a sublinear  
8 behavior." That's all I did.

9 Q I need an answer to my question.

10 A Sorry. Can you say it again.

11 Q Sure. In paragraph 72, when you discussed  
12 the Boyer-Moore algorithm and its performance, did  
13 you mention the Boyer-Moore paper that you had  
14 reviewed which described the performance as linear  
15 rather than sublinear?

16 A I quoted another paper. That's all I did.

17 Q Did you mention the Boyer-Moore paper?

18 A I mentioned Exhibit 1017 as the reference.  
19 I mentioned -- and that sentence discusses the  
20 Boyer-Moore algorithm, yes.

21 Q Not the algorithm.

22 Did you mention the Boyer-Moore paper?

23 A Not in this paragraph 72. As you told me,  
24 Exhibit 1017 is another paper. This paragraph does  
25 not quote the Boyer-Moore paper.



1 Q In paragraph 72, did you mention the  
2 results that are found in the Boyer-Moore paper that  
3 describe the algorithm as linear rather than  
4 sublinear?

5 A In that paragraph, the only discussion of  
6 sublinearity is a quote from another paper, which is  
7 Exhibit 1017.

8 Q From that, I can infer the answer to my  
9 question. I need you to answer it.

10 A I'm sorry. Can you repeat the precise  
11 question.

12 Q In paragraph 72 in your Declaration --

13 A Yes.

14 Q -- when you discuss the Boyer-Moore  
15 algorithm and its performance, did you also mention  
16 that the Boyer-Moore paper described the performance  
17 as linear?

18 A Not in that paragraph, no.

19 Q Why not?

20 A I'm just reading the five lines here, and  
21 it does not say that.

22 Q Why didn't you put it in here?

23 A I don't remember why I didn't mention it.

24 Q Did you want to conceal it from the Patent  
25 Trial and Appeal Board?

1 A Of course not.

2 Q Then why not put it in here?

3 A Because it may not have been truly  
4 relevant. The whole relevance of Boyer-Moore is to  
5 indicate one way in which sublinearity can be  
6 obtained. There are many ways. So this is just one  
7 way in which it can be obtained.

8 Q You are -- is it -- withdrawn.

9 In paragraph 72, are you representing to  
10 the Board that it's your understanding that the  
11 Boyer-Moore algorithm has a sublinear behavior with  
12 respect to the size of the dataset?

13 A No. This is just a quote of another paper  
14 discussing Boyer-Moore. This Boyer-Moore algorithm  
15 has been used in a variety of contexts, including,  
16 of course, content recognition. I'm simply quoting  
17 from another paper here. I'm not presenting  
18 anything about what you asked.

19 Q Well, you say, "It is my opinion that  
20 Iwamura further teaches how the search can be  
21 sublinear"; right?

22 A Let me just read again.

23 That's right. So --

24 Q When you used the word "sublinear" there,  
25 are you using it to mean sublinear with respect to

1 the size of the dataset?

2 A It is -- okay. The search can be  
3 sublinear in the size of the database. There are  
4 many ways for which it is sublinear in the size of  
5 the database. I actually want to supplement this  
6 opinion. I said, "For example, this is just one  
7 way." I want to supplement my opinion, if you wish.

8 Q Well, I want to an understanding of what  
9 you wrote here --

10 A Right.

11 Q -- and what you were trying to tell the  
12 Board.

13 A Right.

14 Q You understood the Board was going to read  
15 this as actual sworn testimony by you; right?

16 A Yes.

17 Q And when you wrote this, were you trying  
18 to convey to the Board that the Boyer-Moore  
19 algorithm is one that, if you use it, it's sublinear  
20 with respect to the size of the database?

21 A No. No.

22 Q If one were to read this -- withdrawn.

23 Is it your opinion that the Boyer-Moore  
24 algorithm is sublinear with respect to the size of  
25 the database?

1           A    It does not say anything, because  
2 Boyer-Moore is kind of a piece in a puzzle; right?

3                    It's used to find a pattern in a string.  
4 If you want to apply it to a larger problem like  
5 database searching, as Iwamura has done, there's a  
6 variety of ways to use that. I did not even do the  
7 analysis that Iwamura may have done. Because  
8 there's a variety of ways to obtain sublinearity.

9           Q    Is it your opinion that, using the  
10 Boyer-Moore algorithm, that it is a search technique  
11 that is sublinear with respect to size of the  
12 dataset being searched?

13           A    If you look at the basic Boyer-Moore  
14 problem, which is finding a pattern in the string,  
15 the worst-case behavior is linear in the size of  
16 the -- of the string.

17           Q    Is it your opinion that the Boyer-Moore  
18 algorithm is sublinear with respect to the size of  
19 the dataset being searched?

20           MR. ELACQUA: Asked and answered.

21           THE WITNESS: I cannot answer the question.  
22 If you read the Boyer-Moore paper, as we have  
23 discussed, the parameters are  $i$  and  $patlen$ .  
24 BY MR. DOVEL:

25           Q    Is it your opinion, sir, that the

1 Boyer-Moore algorithm is a search whose execution  
2 time scales with a less-than-linear relationship to  
3 the size of the dataset to be searched?

4 A In the worst case, no.

5 Q Why not?

6 A As we discussed, in the worst case, this  
7 number,  $i$ , can be as large as  $N$  minus  $\text{patlen}$ . And  
8 then the complexity is linear in  $N$ .

9 Q When we read paragraph 72, are you  
10 conveying to the reader that the Boyer-Moore  
11 algorithm is sublinear with respect to the size of  
12 the dataset being searched?

13 A No. All I do is quote a part of a paper  
14 that shows why that algorithm is much faster than  
15 brute force. That's all I'm doing. You're  
16 inferring things I'm not saying or writing.

17 Q Well, when it says, "On the average, the  
18 Boyer-Moore algorithm has a sublinear behavior," are  
19 you trying to convey that that means sublinear with  
20 respect to the size of the dataset being searched?

21 A I quoted their paper, which is this  
22 Exhibit 1017. The usual comparison is with  
23 brute-force algorithms. Okay? So if I -- my  
24 recollection is that this notion of sublinearity  
25 there was in comparison with a brute-force search

1 algorithm. That's my recollection.

2 Q When you quoted this language --  
3 withdrawn.

4 You could have quoted language from dozens  
5 of different papers; right?

6 It's all possible; right?

7 A It's possible.

8 Q You had to select which paper to quote  
9 from; right?

10 A Yes.

11 Q And you had to select which sentence to  
12 quote; right?

13 A Yes. This is simply to illustrate the  
14 point that there are much faster ways which are  
15 sublinear relative to brute-force search to do a  
16 search. This is only meant to be an example.

17 As I said, there are many ways why Iwamura  
18 teaches that the search is sublinear. We don't even  
19 have to go into Boyer-Moore. There are many other  
20 ways in that pattern that show sublinearity.

21 Q Well, I need to talk about the ways that  
22 you put in your Declaration.

23 A Right.

24 Q Now, when you were writing your  
25 Declaration, did you try to identify the clearest

1 example of sublinearity in Iwamura?

2 A At the time I wrote my Declaration, the  
3 Board had not come up with its claim construction.

4 After I read the claim construction by the  
5 Board, I rethought all my assumptions, including, of  
6 course, about sublinear. And I have found many  
7 other reasons why Iwamura teaches a sublinear  
8 method.

9 Q I didn't ask you about "after."

10 Why aren't you answering my question?

11 A That's the way it happened. After -- you  
12 asked me why did I think a certain way back then and  
13 why have I supplemented my views now.

14 Q No, I didn't ask you about supplementing  
15 your views.

16 A Okay. Can you repeat the question.

17 Q Sure. I'm asking you about when you wrote  
18 this.

19 A Yes.

20 Q This is the paragraph in your report where  
21 you discuss whether or not Iwamura teaches  
22 sublinearity; right?

23 A Yes.

24 Q You don't have any other paragraph in your  
25 report where you say, "Here's where Iwamura

1 discloses a sublinear time search"; right?

2 A I would have to double-check that.

3 Q Well, you've got a claim chart in addition  
4 to this text; right?

5 A Okay. Yes.

6 Q So let's go look at the claim chart.

7 And if we look at --

8 A It's page 29; right?

9 Q If you look at the top of page 29, there's  
10 Element (b) from Claim 1.

11 Do you see that?

12 A Right. Yes.

13 Q That's the claim that has the sublinear  
14 portion; right?

15 A Yes. Yes.

16 So if you're asking me why, well, I gave  
17 one element. You know, this chart is big enough as  
18 it is. There are many claims. Again, there are  
19 many other elements. And the element that was given  
20 there is that Iwamura discloses searching using an  
21 algorithm that's faster than -- much faster than  
22 brute force.

23 Q Now, what you wrote here -- you're talking  
24 about your claim chart on page 29; is that right?

25 A Yes.



1 Q And you're talking about the top box?

2 A Yes.

3 Q You wrote, "Iwamura discloses searching  
4 using the Boyer-Moore algorithm," and then you've  
5 got a cite to Iwamura; right?

6 A Yes.

7 Q And then you say "which is sublinear";  
8 right?

9 A Yes.

10 Q And what you meant by that was that  
11 Boyer-Moore is faster than brute force; is that  
12 right?

13 A Yes. Because I quoted from this  
14 Exhibit 1017, yes.

15 Q What you were trying to convey when you  
16 wrote that is that Boyer-Moore is faster than brute  
17 force?

18 A Yes.

19 Q Would you agree that if you were to write  
20 this more clearly so that it accurately conveyed  
21 what you meant, it would read, "Iwamura discloses  
22 searching using the Boyer-Moore algorithm, which is  
23 faster than brute force"?

24 A I don't know if I would say it that way,  
25 no. You are putting words in my mouth.

1 Q What's the clearest way to say what you  
2 wanted to say when you wrote that sentence?

3 A This is a factual statement. So  
4 Boyer-Moore is much faster than brute force. If you  
5 look at the asymptotics, the complexity of  
6 Boyer-Moore relative to brute-force search can go to  
7 zero, which indicates sublinearity.

8 Q Well, are you saying that the Boyer-Moore  
9 algorithm is one where, as the size of the database  
10 increases, the -- the execution time will be  
11 increased at a less-than-linear relationship?

12 A I did not say that, no.

13 Q Okay. When you wrote this, were you  
14 trying to convey that Iwamura discloses searching  
15 using the Boyer-Moore algorithm, which is much  
16 faster than brute force?

17 A Yes. This is the primary motivation of  
18 why Iwamura would use that algorithm. It's much  
19 faster than brute force.

20 Q When you wrote this, were you trying to  
21 convey that searching using the Boyer-Moore  
22 algorithm would be sublinear with respect to the  
23 size of the dataset being searched?

24 A No. I did not -- no.

25 Q Why did you use the word "sublinear"?

1 A Because I quoted from this Exhibit 1017.

2 Q My question, sir, is did you quote it  
3 because you wanted to indicate that Boyer-Moore --  
4 the Boyer-Moore algorithm was sublinear?

5 A Okay. This reference, like many other  
6 references, compares fast algorithms, such as  
7 Boyer-Moore, with brute-force search. This  
8 algorithm has a complexity that is much lower than  
9 brute force. So I'm simply quoting a well-known  
10 fact about Boyer-Moore.

11 If you read most papers on search, when  
12 they compare it with the brute force, they say  
13 Boyer-Moore and their variants are sublinear  
14 relative to brute-force search. That's all I'm  
15 doing. I'm quoting a reference that says that.

16 Q So you were using this to refer to -- that  
17 Boyer-Moore was sublinear as compared to brute  
18 force; is that right?

19 A Under the proper assumptions, yes.

20 Q Did -- when you wrote this, do you think  
21 that it would be possible -- did you consider that  
22 some -- withdrawn.

23 When you wrote this sentence here on  
24 page 29, did you think that someone at the Board  
25 looking at this might think that you meant that a --

1 the Boyer-Moore algorithm was sublinear as used in  
2 the patent claim?

3 A I didn't think of it that way, no.

4 Q Well, you could have chosen a lot of  
5 different words there. Instead of saying it's  
6 sublinear, you could have said that it's faster than  
7 brute force.

8 You could have written that instead;  
9 right?

10 A I guess I could have. This is a document  
11 I wrote, you know, many months ago. It's one of  
12 four documents. It has 90 pages. If you ask me why  
13 did I write these words or why did I quote that  
14 paper and why not another one, it's hard to say.

15 Q Well, take a look at claim language on the  
16 left side.

17 A Yes.

18 Q You wrote that sentence right next to the  
19 claim language that says, "Perform a sublinear time  
20 search of extracted features" --

21 A Right.

22 Q -- do you see that?

23 A Yes.

24 Q Did you write the sentence, "Iwamura  
25 discloses searching using the Boyer-Moore algorithm,

1 which is sublinear," to indicate that the  
2 Boyer-Moore algorithm would be a sublinear time  
3 search?

4 A I wrote that -- again, I'm trying to  
5 remember how I thought several months ago, when I  
6 wrote that paragraph.

7 I wrote -- again, in view -- there was no  
8 claim construction at the time; so I was reading  
9 about the ways in which the search can be improved  
10 over brute-force search. And I just referred to an  
11 element that's disclosed in Iwamura. As I said,  
12 there are many other reasons about why Iwamura  
13 discloses his linear search technique.

14 Q When you wrote your Declaration, you had  
15 in mind that sublinear meant having execution time  
16 that increased at a less-than-linear relationship  
17 compared to the size of the dataset being searched;  
18 right?

19 A That's in the context of database search,  
20 yes.

21 Q And then you wrote this claim chart in  
22 order to indicate where in Iwamura it disclosed each  
23 part of the claim; right?

24 A That's correct, yes.

25 Q And next to the phrase "a sublinear time

1 search" in the claim, you wrote, "The Boyer-Moore  
2 algorithm, which is sublinear"; right?

3 A It's not me who wrote it. I'm quoting  
4 from a reference.

5 Q Well, you wrote the words "which is  
6 sublinear"; right?

7 A I quoted from a reference, again, showing  
8 why there are much faster alternatives to brute  
9 force.

10 Q Let me rephrase it --

11 A I'm not -- again, to make it very clear,  
12 I'm not claiming that using Boyer-Moore simply alone  
13 is going to yield a sublinear search for that  
14 database problem. I'm not claiming that. Just to  
15 be -- to make it clear.

16 Q Okay. Would you agree, sir, that if --  
17 that one way to read this would be that you were  
18 claiming that the claim language, "perform a  
19 sublinear time search," was satisfied by searching  
20 using the Boyer-Moore algorithm?

21 A That might be one way of reading it. It's  
22 not the way I'm reading this now.

23 As I said, the way I'm reading this is I'm  
24 quoting language from a reference. And, again, to  
25 make the record clear, I'm not claiming that

1 Boyer-Moore, as this alone, is going to give us a  
2 sublinear time search in a database search problem.  
3 I'm not claiming that. And I did not claim it in  
4 this document.

5 Q Well, do you see how someone might read it  
6 as that claim?

7 A I -- different people can read things  
8 differently. All I know is what I just told you.

9 Q Would it be reasonable for the Board to  
10 have read this as you opining, you asserting, that  
11 Iwamura discloses a sublinear time search because it  
12 discloses searching using the Boyer-Moore algorithm,  
13 which is sublinear?

14 A Again, I don't know how different people  
15 can read it. If there's any ambiguity, I hope I  
16 just cleared it up. I'm not claiming that  
17 Boyer-Moore alone is going to give us a sublinear  
18 time search for the database search problem.

19 Q To be candid with the Board, wouldn't it  
20 have been better to say, "Board, the Boyer-Moore  
21 algorithm is linear, not sublinear"?

22 A Listen, there are many words that I -- I'm  
23 sure I could have chosen better words. So I agree  
24 with you, there is probably better ways to write  
25 this. I don't dispute that.

1 Q Do you agree that it would have been  
2 better to tell the Board, "The Boyer-Moore algorithm  
3 is linear, not sublinear"?

4 A I don't -- I'm not saying it's linear  
5 either. I -- I don't know. All I'm saying is I'm  
6 not representing that the Boyer-Moore algorithm  
7 alone is going to give us a sublinear time search  
8 for database searching. That's all I'm saying.

9 Q Would the Boyer-Moore algorithm alone give  
10 you a sublinear time search for searching a string?

11 A Again, are you looking at worst case? The  
12 answer is no.

13 Q All right. I'm going to give you a pen.

14 A Okay.

15 Q I'm going to give you a chance to be  
16 candid with the Board. I'd like you to modify that  
17 sentence so that it clearly states what you really  
18 meant to say.

19 MR. ELACQUA: Objection. Asked and answered.

20 And he's not writing anything out.

21 MR. DOVEL: You've got -- you've really got to  
22 just keep your objections --

23 THE WITNESS: I just said -- I just said it.  
24 I don't feel comfortable writing this. I need to  
25 think about what I write. I just told you what my



1 view is. I make it very clear in that box I'm not  
2 representing that -- I just don't know.

3 I'm not representing that Boyer-Moore  
4 alone is going to give us a sublinear time  
5 complexity for database search. I'm not  
6 representing that.

7 BY MR. DOVEL:

8 Q Why don't you write that, then. Right  
9 now, write it.

10 A Well, it's on the record.

11 Q We've got a written document with your  
12 name on it that you signed under oath.

13 A Yes.

14 Q I'm giving you a chance to correct your  
15 testimony under oath.

16 MR. ELACQUA: Objection. He's just stated the  
17 answer on the record.

18 MR. DOVEL: Sir, you've got to keep your --  
19 your objections to one word.

20 MR. ELACQUA: No, I don't. That's not the  
21 rule.

22 MR. DOVEL: That is the rule.

23 MR. ELACQUA: No, it isn't the rule.

24 It's asked and answered. Objection.

25 THE WITNESS: Everything that's written

1 here -- you say I'm not candid. I'm -- I'm candid.  
2 If there's a way to clarify my reply, I just did. I  
3 can only repeat it.

4 BY MR. DOVEL:

5 Q Now, sir, did you look at other --  
6 withdrawn.

7 When you had to try to find something to  
8 quote for the Board, why did you go to the Raita  
9 article rather than one of the many well-known  
10 articles that discuss the Boyer-Moore algorithm and  
11 its performance?

12 A This paper, Boyer-Moore, has been widely  
13 cited. So I just picked a reference. Frankly, it's  
14 a minor point. If you asked me why I picked this  
15 reference rather than others, often it simply does  
16 not matter.

17 This is one case where, you know, I could  
18 have picked any reference, and it does not matter.  
19 It's a minor point. Again, there are many ways why  
20 Iwamura discusses a sublinear search.

21 Q Now, sir, you say "it's a minor point."

22 A Right.

23 Q The only thing you identify in your  
24 Declaration about Iwamura that could disclose a  
25 sublinear time search is the Boyer-Moore algorithm;

1 correct?

2 A As far as I remember, yes. In that

3 Declaration at that time, yes.

4 Q The only testimony you presented to the  
5 Board to -- to establish that Iwamura discloses  
6 searching using a sublinear time search is that  
7 Iwamura discloses searching using the Boyer-Moore  
8 algorithm; correct?

9 A That's before they made the claim  
10 construction about sublinear. Once they made the  
11 claim construction, I found additional reasons why  
12 Iwamura clearly discloses his sublinear search.

13 Q Again --

14 A So at that time, this is the reason that I  
15 incorporated it, and there are additional reasons.

16 Q How does the Board's construction differ  
17 from the construction that you used when you  
18 prepared your report?

19 A Well, I need to look at the precise  
20 language they used for claim construction.

21 Can -- can I see this?

22 Q That they used or you used?

23 A That they used.

24 MR. DOVEL: I've marked as Exhibit 6-237 the  
25 Board's decision with respect to the '237 patent.

1           (Exhibit 6-237 was marked for  
2           identification by the court reporter and is  
3           attached hereto.)

4           MR. DOVEL: I'm going to place a copy of that  
5           in front of the witness.

6           THE WITNESS: Yes. I want to compare that  
7           with my own claim --

8           BY MR. DOVEL:

9           Q    I'd like you to look at page 7, the  
10           Board's decision. And you will see that the Board  
11           quotes both your definition and the patent owner's  
12           on that page, and then offers its own.

13                    Do you see that?

14           A    Yeah. Let me just read the -- the  
15           construction.

16                    Okay. So their construction is, "A  
17           sublinear search is a search whose execution time  
18           scales with a less-than-linear relationship to the  
19           size of the dataset to be searched," which is not  
20           identical to what I had. Let me try to find my own  
21           construction at the time.

22           Q    When you say it's "not identical," it's  
23           not identical word-for-word, but it means the exact  
24           same thing; right?

25           A    Well, let me just review the way I wrote

1 it. Okay? Because if you are asking me about  
2 precise words, I want to make sure I'm using the  
3 right words.

4 Okay. So it was 53 and 54 in my  
5 Declaration.

6 Okay. So I wrote, "A sublinear search" --  
7 in paragraph 53 -- "means a search whose execution  
8 time has a sublinear relationship to database size."  
9 So the two definitions are consistent, but they are  
10 not identical.

11 So once I read the constructions of the  
12 Board -- not just on sublinearity, but on  
13 everything -- I reevaluated all my -- my opinions.  
14 My opinions have not changed. I -- I supplement --  
15 I can supplement them, but my opinions about the  
16 anticipation and so on has not changed the least  
17 bit.

18 Q Now, would you agree, sir, that the  
19 construction that the Board applied is consistent  
20 with the construction that you applied with respect  
21 to sublinear?

22 A Yes.

23 Q Was there anything that's in the Board's  
24 construction that's materially different than the  
25 construction that you applied?

1           A    It is not the same language.  It is  
2 slightly different, but it is consistent.

3           Q    Is there anything about the different  
4 language that results in a different meaning for the  
5 Board's construction than yours?

6           A    It's the same -- you could say it's the  
7 same meaning.  They are essentially equivalent.

8           Q    Would you agree, sir, that the Board's  
9 construction of sublinear didn't do anything to  
10 change your opinions?

11          A    It made me reevaluate my assumptions.

12                There's a way I think as a researcher.  
13 When I read a paper or resource, it usually makes me  
14 rethink all my assumptions.  And it could be I have  
15 read something that even decodes what I thought  
16 about before.

17                When I read the Board's decision, it made  
18 me think, you know, in -- in, sometimes, ways that  
19 can supplement what I wrote.  And, again, I found  
20 other reasons why Iwamura discloses a sublinear  
21 search.

22          MR. DOVEL:  I'm going to place in front of the  
23 witness Exhibit 1010, which is the Ghias patent.

24    //

25    //

1           (Exhibit 1010 was marked for identification  
2           by the court reporter and is attached  
3           hereto.)

4 BY MR. DOVEL:

5           Q    I'd like you to turn to Column 6.

6           A    Yes.

7           Q    Now, on Column 6, starting at line 23,  
8    Ghias has a discussion of several algorithms that  
9    are developed to address the problem of approximate  
10   string matching.

11           Do you see that?

12          A    Yes.

13          Q    And then Ghias discusses the running times  
14   for those algorithms.

15           Do you see that?

16          A    Yes.

17          Q    "Running times" here was the same as  
18   execution time?

19          A    If you have a single processor, yes.

20          Q    What Ghias discloses here are algorithms  
21   whose performance is linear with respect to the size  
22   of the dataset that's being searched; is that  
23   correct?

24          A    Well, let me review what the symbols are.

25   N and M.   So M here is number of pitch differences

1 in the query, and N is the size of the string, which  
2 is a song here.

3 Q I need an answer to my question.

4 A I'm sorry. What was your question?

5 Q Yeah. Sir, is it the case that Ghias, in  
6 Column 6, lines 23 to 35, identifies algorithms  
7 whose search time scales at a linear relationship to  
8 the size of the dataset being searched?

9 A It's the string. Okay? That's why I  
10 clarified. Okay? The -- what you call the "dataset  
11 being searched" here is the string. So N is the  
12 size of the string.

13 Q Okay. You've told me that N is the size  
14 of the string; right?

15 A Yes. Yes.

16 Q Does this indicate to you, if you read  
17 this, that these algorithms are linear with respect  
18 to the size of the dataset being searched?

19 A They're at most linear. It says or the --  
20 of -- "On the order of." It means -- this notation,  
21 again, means at most linear.

22 Q Does the information that's presented here  
23 suggest to you that these -- that these algorithms  
24 are sublinear with respect to the size of the  
25 dataset being searched?



1           A    It does not say that.  First, there's no  
2 database.  Okay?  Again, this refers to a single  
3 song.

4           Q    Well, when it says "string," string would  
5 be a dataset; right?

6           A    If you view a song as a dataset, fine.

7           Q    Do you view it that way?

8           A    Well, I'm just reading from what Ghias  
9 wrote.  And because they're, of course, in that  
10 problem, there's a database that has many songs.

11                    So just to make it clear, N is not the  
12 size of the database; N is the size of a single  
13 song.

14           Q    Reading this, do you interpret this to  
15 suggest that these algorithms are sublinear with  
16 respect to the size of the dataset being searched?

17           A    No.  This, again, reads "of the order of."  
18 So it means at most linear.

19           Q    And what does it tell us about the  
20 performance of these algorithms -- withdrawn.

21                    What does this paragraph tell you about  
22 the execution time of these searches with respect to  
23 the size of the dataset being searched?

24           A    It only speaks about the size of the -- of  
25 the song.  And what is written there is a comparison

1 between these fast-matching algorithm and -- and  
2 brute force, which is exactly like in Boyer-Moore  
3 that we just discussed. It's the exact same  
4 concept.

5 Q Does this tell us -- withdrawn.

6 When you read this, did this indicate to  
7 you that these algorithms were ones that would be  
8 used to perform a sublinear search with respect to  
9 the size of the dataset being searched?

10 A It's the same issue as with Boyer-Moore  
11 that we just discussed. So relative to brute force,  
12 which is complexity order MN, these fast algorithms,  
13 okay, such as Baeza-Yates and Gonnet, have a search  
14 complexity that vanishes as M times N goes to  
15 infinity.

16 Q My question, sir, is did you read this to  
17 indicate or suggest that these algorithms would --  
18 could be used to perform a sublinear time search  
19 with respect to the size of the dataset being  
20 searched?

21 A No.

22 Q At any point, did you ever read this and  
23 say, "Aha, these algorithms here teach a sublinear  
24 time search as it's used in the '237 patent"?

25 A "These algorithms" -- I'm just reading

1 here -- "teach that they are fast search  
2 algorithms," okay, "for this problem of matching a  
3 pattern into a song that are much faster than brute  
4 force." Okay?

5 Q Did you, at any point, ever read this  
6 portion of Ghias and say to yourself, "This teaches  
7 a sublinear time search as it's used in the '237  
8 patent"?

9 A It teaches to -- of a search that is much  
10 faster than brute force. Again, Ghias, just like  
11 Iwamura, disclose sublinear search in many ways.

12 So this paragraph we're discussing alone  
13 does not discuss -- does not disclose sublinear  
14 search, possibly. Sublinear search is disclosed  
15 many other ways through -- through that patent.

16 Q Well, I'm talking about this passage here.

17 A Right.

18 Q Did you ever read this and say to  
19 yourself, "What it says here about these algorithms,  
20 in this description of these algorithms, tells me  
21 that we have a sublinear time search"?

22 A No. I don't represent that, no.

23 Q Did you look up these papers here to see  
24 what these algorithms were?

25 A Yes, I looked them up.

1           Q    Did the Ricardo Baeza-Yates paper, the  
2 first one or the second one, did they disclose a  
3 sublinear time search with respect to the size of  
4 the dataset being searched?

5           A    Again, what you call "the dataset" is a  
6 string. Okay? And so these algorithms, if I  
7 remember well, disclose a sublinear complexity  
8 relative to brute force.

9           Q    That wasn't my question.

10          A    Okay. Can you rephrase it --

11          Q    Sure.

12          A    Can you restate your question.

13          Q    Did you look up these algorithms that are  
14 described here in Columns 6, lines 23 to 35, to  
15 determine whether they disclosed algorithms that  
16 would do a search that was sublinear with respect to  
17 the size of the dataset being searched?

18          A    Again, the dataset, in this context of  
19 those papers, is a single string. It's not a  
20 database, okay, it's a single string. These papers  
21 quote formulas that indicate sublinearity relative  
22 to brute-force search. That's all they do.

23                I'm not, again, representing that using  
24 those algorithms alone are going to give us a  
25 sublinear complexity for searching the data -- the

1 entire database of songs. I don't represent that,  
2 to make it clear.

3 MR. DOVEL: Yeah. Let's take a break, and  
4 we'll change our tape.

5 MR. ELACQUA: Sure.

6 THE VIDEOGRAPHER: This marks the end of  
7 Videotape Number 1 in the deposition of Pierre  
8 Moulin. We're off the record at 11:06 AM.

9 (Off the record.)

10 THE VIDEOGRAPHER: We are back on the record  
11 at 11:15 AM. This marks the beginning of Videotape  
12 Number 2 in the deposition of Pierre Moulin.

13 BY MR. DOVEL:

14 Q I want you to look at the Ghias reference  
15 again. That's Exhibit 1010.

16 In Column 6, starting at lines -- line 36  
17 through 59, Ghias describes using an algorithm and  
18 what the performance of the algorithm would be.

19 Do you see that?

20 A Let me read the whole section. So you say  
21 36 to 59?

22 Q Yes.

23 A Okay.

24 Q Does this portion of Ghias, Column 6,  
25 lines 36 through 59, does that describe a search

1 algorithm whose execution time is sublinear with  
2 respect to the size of the dataset being searched?

3 A No, it does not, again, because we see  
4 it's with respect to the size of the dataset being  
5 searched, which is a song, a single song here.

6 Q And why doesn't that disclose a sublinear  
7 time search?

8 A Well, for many reasons. So first, it's  
9 the order of notation, which always means at most,  
10 something.

11 Second, you know, there's always the issue  
12 of worst-case scenario and average performance; so  
13 these are quite different. So it simply does not  
14 disclose that. And also, the reference, again, is  
15 brute force. Okay? So it compares with this  $O(mn)$   
16 for brute-force search.

17 Q Is it the case that what is disclosed here  
18 is a search whose execution time would scale at less  
19 than a linear relationship to the size of the  
20 dataset being searched?

21 A Possibly. It depends on parameters, such  
22 as  $K$ . They even give you an example there.

23 "When  $K$  is equal to  $M$ " -- this is line 43  
24 through 46 or 45 -- "then the search is immediate."  
25 Okay. So -- so it's obviously sublinear in that

1 case.

2 Q When you say, "When K equals M," what do  
3 you mean by, "When K equals M"?

4 A So this is line 43, starting with "K  
5 equals M."

6 Q And what does "K equals M" indicate? What  
7 does that mean?

8 A Well, K is number of mismatches, and M is  
9 the length of the query.

10 Q So that's when you've got a particular  
11 problem where the number of mismatches is the same  
12 as the number of the query?

13 A That's right. And then the search stops  
14 after only one step.

15 Q If we have a search where we don't have a  
16 known or fixed number of mismatches that -- set to  
17 the length of the query, does this tell us anything  
18 about whether we've got a sublinear search?

19 A No. The algorithm must tell you -- you  
20 must input K into the algorithm. So if you say, "I  
21 don't know K," you cannot run the algorithm.

22 Q Is K the number of allowed mismatches?

23 A K -- let's see the way they define it.  
24 So this is on line 37. "The algorithm  
25 addresses the problem of string matching with K

1 mismatches." So it's exactly K.

2 Q All right. Is -- are you saying that if  
3 somebody knew how many mismatches you had, then you  
4 could input a specific K?

5 A That's what K is. So if you know there  
6 are three mismatches, then K is equal to three.

7 Q What's a mismatch?

8 A Mismatch. So if I have a single string of  
9 English text, okay, so if the two letters I'm  
10 comparing are the same, there's no mismatch, and in  
11 any other case, there is a mismatch.

12 Q Are you saying that -- that you're going  
13 to be allowing for up to three mismatches?

14 A For exactly three mismatches. That's what  
15 this says.

16 Q Okay.

17 A Lines 36, 37.

18 Q It says, "If there are no mismatches, we  
19 have a simple string matching problem." And by  
20 that, you mean if there's no mismatches, that would  
21 mean that we are going to find our string exactly  
22 matched -- or our query exactly matched someplace in  
23 the string; is that right?

24 A We'll try to find it. It may not be  
25 there.